
# The economic impact of climate change and adaptation in the Outermost Regions

## *Final report*

June 2014

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European Commission, Directorate-General for Regional and Urban policy
REGIO DG 02 - Communication
Mrs Ana-Paula Laissy
Avenue de Beaulieu 1
1160 Brussels
BELGIUM

E-mail: regio-publication@ec.europa.eu
Internet: http://ec.europa.eu/regional_policy/index_en.cfm

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Table of Contents

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## Purpose of this Report

This report has been produced for the purpose of reporting the findings of the Study on the Impact of Climate Change and Adaptation Measures in the Outermost Regions (under framework CLIMA.A.4/FRA/2011/0027). The findings are based upon resources available in the public domain supplemented by consultation with representatives of the OR (although no field trips have been undertaken for this study). The findings presented are the considered views of the project team based upon the information available and used to inform the study.

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| 1 | Draft final report | 22 April 2013 |
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# Structure of this report

This report presents the findings of a study on the economic impacts of climate change and adaptation measures in the Outermost Regions[1] (OR) of the European Union (EU). The overall approach is to firstly understand the information which can be used to develop and understanding of climate risk and adaptation across the OR including information relating to climate impacts and economic data. Next, the EU funds which have (or could be) used on adaptation relevant resilience projects in the OR are examined. This information in combination allows a climate change risk assessment to be completed and policy recommendations to be made, building upon lessons learnt and targeting areas of key vulnerability.

The report is structured as follows:

- Section 1 presents an introduction to the project and its scope, setting the overall context for the study and its objectives;
- Sections 2 and 3 focus upon the information available to inform this study. Section 2 summarises the outcomes of a literature review and consultation with representatives of the OR. It presents an overview of the climate impacts considered likely for each OR based on projections of climate change and places this within the context of regional and national climate strategies. The approach to taking this information on climate impacts into a climate risk assessment is presented, based on a climate change risk assessment framework developed specifically for this study. Section 3 focuses upon the availability of data suitable for assessing the economic impact climate change may have on the OR;
- Section 4 provides an overview of some of the key EU funds which could be applied to finance adaptation initiatives in the OR and how those funds have been used in the OR to date;
- Section 5 combines the assessment of climate impacts, risk and challenges with the economic features of each OR to identify some of the potential socio-economic impacts of climate change in each OR;
- Section 6 presents a summary of each of the OR setting out the main points identified through the assessment of climate change risks, socio-economic implications and the application of EU funds; and
- Section 7 presents recommendations for each OR on potential interventions in the main risk areas identified in the study.

The document is accompanied by technical appendices, which present the data supporting the analysis including the main elements of the climate risk assessment framework. As the full framework is spreadsheet based it is not replicated here although the methods used and the key outcomes are presented in this report.

[1] The Outermost Regions of the EU are: Guadeloupe (France), Martinique (France), St Martin (France), French Guiana (France), La Réunion (France), Canary Islands (Spain), Azores (Portugal), Madeira (Portugal) and (from early 2014) Mayotte (France).

# 1 Introduction

As the climate of the globe changes, the resilience of regions to the impacts of climate change will not be uniform. Some regions will experience more severe changes than others, changes which threaten areas of high biodiversity importance ('biodiversity hotspots') or locally important economic activities and livelihoods. Others, while not being exposed to such severe impacts may have limited adaptive capacity and so be vulnerable to climate impacts. The European Union (EU) Adaptation Strategy[2], adopted in spring 2013, recognises that the Outermost Regions[1] (OR) of the EU are particularly vulnerable to the impacts of climate change. They are regions characterised by their remoteness, insularity, climate, terrain and richness of biodiversity as well as an economic dependence on a small number of products. They are important to the EU for the development of trade with third countries.

The OR are an integral part of the EU and are subject to the same regulations, policies and directives as the rest of the EU however, in a changing climate, the OR are also amongst the parts of EU facing some of the most significant challenges. Major impacts to their ecosystems have been identified including extinction of endemic species, coral bleaching and shoreline erosion. Observations have already shown changes to water and air temperature, cyclone activity, ocean acidification and sea level rise have occurred. Such observed changes are consistent with projections of future climate change.

Climate risks (or opportunities) are a consequence of climate change. For example, increasing ocean temperatures can result in coral bleaching. The consequence of this is that coral reefs die and their protective, supportive and provisionary functions are lost. The resulting risk is that vulnerable coastlines could lose the protection offered by shallow coral reefs, thereby increasing risk of erosion and flooding, and that ecosystems supported by the coral collapse.

Adaptation is the action of climate risk management. Well informed adaptation is based on assessment of risk, understanding of good practice and the application of sustainable interventions which increase resilience and reduce vulnerability. This could be a physical measure such as coastal erosion management schemes or 'softer' interventions such as ecosystem-based adaptation through maintaining and restoring coastal ecosystems, coastal flood warning schemes or support in diversifying the local economy.

Adaptive capacity is based on understanding climate risk, awareness of adaptation needs and the availability of resources to increase levels of resilience and preparedness to climate impacts. Adaptive capacity can be increased through measures as simple as knowledge sharing, for example using facilities such as the EU's European Climate Adaptation Platform (Climate-ADAPT[3]), but also through the application of appropriate strategies, policy and legislation or via investment, such as can be financed through the European Regional Development Fund (ERDF) or Cohesion Policy Funds which could, for example, be used for the development of blue or green infrastructure. EU regional policy is an investment policy, supporting job creation, competitiveness, economic growth, improved quality of life and sustainable development. These investments support delivery of the Europe 2020 Strategy[4] and, in line with the objectives and actions set out in the EU Adaptation Strategy have a role in increasing the level of adaptation across the EU, including the OR.

Understanding the current state of knowledge, knowledge gaps and the effectiveness of current activities informs effective adaptation planning. Further, good adaptation is based on understanding the economic costs and benefits of action versus no action. In spite of knowledge gaps and uncertainty, there are no-regret[5] and synergy measures such as ecosystem-based adaptation and green infrastructure that can be implemented now. One of the objectives of this study is to examine the current state of knowledge, seeking examples of action within the OR to address climate risk.

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[2] http://ec.europa.eu/clima/policies/adaptation/what/documentation_en.htm
[3] http://climate-adapt.eea.europa.eu/
[4] http://ec.europa.eu/europe2020/index_en.htm
5 The Climate-ADAPT platform states that "No-regret measures are activities that yield benefits even in the absence of climate change" (Source: http://climate-adapt.eea.europa.eu/uncertainty-guidance/topic2)

Although each of the OR has a unique character and face separate climate challenges, combining the state of knowledge for each may result in knowledge exchange that could increase levels of resilience across the regions. Understanding the EU funds that may apply, and how they have been used to date, may also suggest a range of options to support the OR in furthering understanding of climate risks and implementing good adaptation actions. The overall objective of this study is therefore to make policy recommendations such that available EU funds can be employed most effectively.

In order to compare each of the OR, an assessment framework has been developed, based upon available datasets which consider each of the OR consistently. This is important because different models and approaches are used to compile datasets of climate projections and economic data and hence, when comparing data from two sources, it is not clear how much of any differences results from the data methods used. This sets some constraints in that it limits the data available to inform the study (discussed in section 2 and 3 of this report) but it offers the advantage of allowing each of the OR to be compared using the same sources of data, eliminating one are of significant uncertainty.

The study is focused upon identification of climate impacts and priorities for adaptation activities to manage risks and opportunities for the OR associated with future climate change. Mitigation, i.e. the reduction of emissions of greenhouse gases, is not considered directly within the scope of this study although it is recognised that energy infrastructure is diversifying to include more low carbon energy sources and that this can have adaptation benefits through increasing energy security but also be vulnerable to climate impacts at the same time. This is a perspective considered in this study, rather than the mitigation benefits per se.

The overall objectives of this study are to examine the available information which can underpin an assessment of climate impacts for the OR and their economic consequences, examining existing actions (including through the use of EU funds) and the develop recommendations for further action which will develop the resilience of the OR to the challenges (and opportunities) they face as climate continues to change.

# 2 Climate change and the Outermost Regions

From the perspective of the OR, there are significant challenges in understanding how climate may change over coming decades. Climate models, the main tool for creating projections of future climate change, are typically at a resolution which is not refined enough to allow small islands to be resolved. This means that within a climate model, the 'grid box' or 'cell' where a small island should be located will typically appear as ocean rather than land. Given their size, all of the OR (with the exception of French Guiana) are therefore unresolved by current global climate models. Further, the OR are diverse in their geography, with significant topographic features a climate model cannot resolve. One example of this is the mountains of La Réunion which would be unlikely to be well represented even if a model were at a resolution high enough to include the island itself as land. In addition to this, some key processes are not well understood, such as mechanisms for the mid-summer drought in the Caribbean or how the Indian Ocean monsoon may be impacted by climate change. This also means that the identification of tipping points is limited, especially where there are non-linear behaviours such as in ecosystem dynamics. One of the exceptions to this is work done which suggests a change in rainfall which will result in a decline of the Amazon rainforest.

The Intergovernmental Panel on Climate Change (IPCC AR4) fourth climate change assessment reports (IPCC, 2007a and 2007b), although published a number of years ago, remains valid and, for this study, provides a single source of consistent information for all of the OR. More recently, the fifth assessment report has been published (Summary for policy makers (IPCC, 2013) published 11th November 2013 although the Working Group II (WGII) contribution on impacts, adaptation and vulnerability will not be published until 2014[6]). This builds upon the AR4 and incorporates subsequent new findings of research[7].

Although there are some climate modelling data for specific OR, such as those developed within the SIAM II project (Santos, Forbes and Moita, 2002) for Madeira and Azores, using the IPCC AR4 for this study has the advantage that it allows each of the OR to be considered against the same set of projections (thereby eliminating some uncertainty in likely future change due to differences between the models being used). Another advantage is that the challenge of understanding the impact of climate change on small islands is addressed within the IPCC AR4 (Chapter 11 of the Working Group I report (IPCC 2007a) and Chapter 16 of the Working Group II report (IPCC 2007b)). The small islands assessment in the IPCC AR4 only considered the Caribbean, Pacific and Indian Ocean islands although data (if not interpretation) is provided for the Atlantic region as well.

The assessment presented for small islands within the IPCC AR4 is based upon the Multi-Model Dataset (MMD) hosted at the Program for Climate Model Diagnosis and Intercomparison (PCMDI). This is a dataset formed from a series of standardised experiments run using a wide range of climate models, meaning that the results are not biased by any one model and that indications of levels of uncertainty can be gained from the spread of the model projections. Using the MMD data for this study gives a better indication of uncertainty and eliminates the potential bias inherent in individual climate models.

The MMD data presented in the IPCC AR4 gives projected changes under one emissions scenario (A1B from the Special Report on Emissions Scenarios (SRES), IPCC, 2000), averaged over the period 2080 to 2099. These projections are used in this study to give an indication of possible changes in climatic factors (such as changes to ambient and water temperatures and precipitation) over the rest of this century. The identification of changes over specific time horizons (or of potential tipping points being reached) has not been undertaken. The range of uncertainties in projections of climate change for the OR are sufficient that further, and more in depth, study of climate change and the OR would be required to do this but this is beyond the scope of this study. The IPCC AR4 climate projections do however give a clear indication of the nature of future changes and are sufficient to identify likely impacts upon the OR. Within the climate risk assessment undertaken for

[6] IPCC Fifth Assessment Report, http://www.ipcc.ch/

[7] For the timescales of this study it has not been possible to draw upon the AR5 however the key areas of uncertainty in the climate projections for this study such as frequency and intensity of tropical cyclones or regional patterns of rainfall change remain uncertain in AR5 even with the improvements in climate modelling. It should be noted that, although the AR5 allows some refinement in the projections used in this study, it does not fundamentally alter any of the findings of this study.

this study, local trends and knowledge (including local modelling studies) have however been taken into account where available to supplement the information taken from the IPCC AR4. It has to be noted that this information varies in volume and quality across the OR (as seen in the presentation of climate impacts for each of the OR in the sections below).

A summary of the IPCC AR4 projections used to inform the assessment are given in Appendix C. The data focuses upon temperature and precipitation change as this is the data most commonly provided by models. These are not the only relevant parameters in this study however. Although not quantified via the MMD data, the IPCC AR4 also states that there is "unanimous agreement among the coupled climate-carbon cycle models driven by emission scenarios run so far that future climate change would reduce the efficiency of the Earth system (land and ocean) to absorb anthropogenic $CO_2$". Increasing atmospheric $CO_2$ leads directly to increasing acidification in the upper parts of the ocean and it is estimated that reductions of pH between 0.14 and 0.35 units could occur by the end of the century, a change harmful to coral reef and impacting many marine ecosystems.

There are other parameters which are relevant to this study which cannot however be quantified in this way. For example, few climate models are able to simulate tropical cyclones (because of the high resolution required) and hence there is less certainty in projected changes in the frequency and severity of tropical cyclones than in changes in temperature or rainfall. Studies have shown however, that future tropical cyclones would likely become more severe with greater wind speeds and more intense precipitation (IPCC, 2007a). Studies such as this are used to supplement the climate change data projections in this assessment.

## 2.1 Climate change plans and strategies

This chapter considers the anticipated impacts of climate change across the OR. Information is drawn from available literature and from consultation with representatives from the OR. Although the focus of this section is climate impacts rather than climate risk or adaptation (discussed in later sections of this report), it is important to acknowledge the adaptation or climate strategies and plans in place which have contributed to the understanding of climate impacts for the OR. This is true for strategies and plans at a national, regional or local (OR) level as it provides a contextual framework for the assessment undertaken in this study. This includes for example the Europe 2020 strategy and the Horizon 2020 programme (see section 7 for further details of Horizon 2020 and the OR).

Information on national climate strategies can be found on the EU's Climate-ADAPT platform but some of the key points in relevant national strategies are summarised below. Table 2.1 provides an overview summary of climate strategies, at local (i.e. OR) and national levels, with further detail on OR plans being presented in the OR specific sections which follow (see for example Section 2.2.1 for Guadeloupe).

**Table 2.1 Climate Change Strategies relevant to the OR**

| **French Outermost Regions** | |
|---|---|
| Responsibility for climate change adaptation is split between national, regional and local levels.<br>The creation of a French National Observatory for the Effects of Global Warming (ONERC) in 2001, tasked specifically with adaptation to climate change was followed by the adoption of the National Adaptation Strategy in 2006;<br>The first National Adaptation Plan (for the period 2011 to 2015) was published on 20 July 2011 and aims to present concrete measures designed to prepare for and exploit new climatic conditions in France. In the National Plan for adaptation, specific measures for the OR were proposed. Furthermore, in the case of other fields of action (e.g. biodiversity), some measures were completed but with additional recommendations in line with the specific context and challenges of the French OR (see Section 2.2.1 below).<br>Regional adaptation guidelines are defined in Regional Climate, Air and Energy Schemes (SRCAE) and local adaptation actions are designed within Territorial Climate-Energy Plans (PCET). | |
| Guadeloupe | The Regional Plan for Climate, Air and Energy of Guadeloupe (SRCAE Guadeloupe), released in December 2012, analysed the vulnerability of the island to climate change and identified priority actions for adaptation to be implemented by 2020-2050 (see Section 2.2.1). |

| | |
|---|---|
| Martinique | The draft Regional Plan for Climate, Air and Energy of Martinique was submitted to a stakeholder validation process. It gives an overview of the contribution of Martinique to climate change and on the impacts of climate change. The cost of inaction is assessed to be around 250 million Euros by 2025 and 510 million Euros by 2050, i.e. in the case that no action is taken to reduce contributions to climate change. Adaptation actions that are proposed in the Plan aim at integrating better climate change challenges in planning and development policies (see Section 2.2.2) |
| St Martin | Although St Martin has no climate change strategy is place, there are relevant plans and actions underway. For example, the Conservatoire du Littoral and the Reserve Naturelle St Martin are implementing actions to better integrate climate challenges into conservation and restoration projects. This is described further in Section 2.2.3 |
| French Guiana | A study "About the impact of climate change in French Guiana" was published in 2011 by the French geological survey (Bureau de Recherches Géologiques et Minières, BRGM). It provided a first overview of the impacts, vulnerabilities and potential adaptation actions for the territory. Another study carried out by BRGM has since further analysed the cost of the impacts of climate change and to begin to define potential options to adapt (this work is still in progress).<br>The Regional Plan for Climate, Air and Energy of French Guiana was released in December 2012. It highlights the importance of adaptation but is focused mainly on mitigation issues and does not define adaptation actions. |
| La Réunion | The final version of the Regional Plan for Climate, Air and Energy of La Réunion was submitted to public consultation at the end of 2012. |
| Mayotte | No strategy for adaptation has yet been defined although it is known that changes in Mayotte's climate have already led to consequences across human and natural environments. |
| **Portuguese Outermost Regions** | |
| Portugal adopted its first National Strategy for Adaptation to Climate Change (ENAAC) in 2010. The ENAAC set out the need for adaptation action by summarising the main observed changes in the climate in Portugal during the 20th century; and summarising available climate scenarios and projections data for Portugal.<br>The strategy identified nine priority sectors for action, as follows: The nine sectors considered are: territory and urban development; water resources; safety of people and goods; human health; energy and industry; tourism; agriculture, forests and fisheries; coastal areas; and biodiversity.<br>The ENAAC also created an inter-ministerial coordination group aimed to address all cross-cutting issues and provided a forum for discussing issues that are, by nature, cross-sectoral. The coordination group also includes representatives of the Ministry of Foreign Affairs, the Autonomous Regions of Azores and Madeira and of the National Association of Portuguese Municipalities. | |
| Madeira | Madeira does not at present have a regional climate change strategy, however it intends to develop one in the next few years. The development of the strategy will be lead by the Regional Government of Madeira and the Department for Spatial Planning and Environment. It is likely the strategy would focus on potential impacts of climate change to the islands, assess the vulnerability of different sectors and include some adaptation measures.<br>Current efforts are focussed on research activities aimed at developing a solid knowledge base. A number of research programme are being supported by the European "Transnational Cooperation Programme Madeira-Açores-Canarias (MAC) 2007-2013". |
| Azores | The Azores adopted its Regional Strategy on Climate Change (ERAC) 2011. This will be implemented through the Regional Plan for Climate Change (PRAC), which is expected in 2014. The PRAC will focus on the following sectors: coast zone management, water management, energy, biodiversity, fisheries, agriculture and forestry, tourism, transport, health, industry and communication infrastructure. |
| **Spanish Outermost Regions** | |
| Spain adopted its first national adaptation strategy, the National Climate Change Adaptation Plan8 (PNACC in Spanish) in 2006. A second version of the PNACC was adopted in 2011. | |

[8] http://www.magrama.gob.es/es/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/default.aspx

| | |
|---|---|
| The PNACC provides a reference framework for the coordination of the Public Administrations' efforts in dealing with the assessment of impacts, vulnerability, and adaptation options to address the impacts of climate change in a series of sectors and natural resources acknowledged as potentially affected. Work is carried out through a series of specific Work Programmes<br>To date, two PNACC Work Programmes (for PNACC 2006) have been adopted:<br>First Work Programme (WP1, 2006). Focused on developing a national programme on regionalised climate change scenarios, and on the assessment of climate change impacts and vulnerability in sectors considered key and horizontal to others: water resources, biodiversity and coastal areas.<br>Second Work Programme (WP2, 2009). Continued WPI activities and set additional and ambitious goals to address climate change adaptation in Spain. It is structured in four axes for action: (i) sectoral impacts and vulnerability assessments, (ii) mainstreaming climate change adaptation into sectoral regulations and planning tools, (iii) mobilising sectoral stakeholders, and (iv) setting up of an indicator system on climate change impacts and adaptation. Additionally, the WP2 builds on two basic pillars: (1) promoting R&D+i activities, and (2) reinforcing the coordination between all the administrative levels with responsibility for adaptation to climate change. | |
| Canary Islands | The Canary Islands adopted their Climate Change Strategy for the Canary Islands in 2009. The strategy focussed on climate change mitigation and education measures, but it included a mandate to develop an adaptation plan. An Adaptation Plan for the Canary Islands is expected in 2014. Some preliminary studies on adaptation in particular sectors have been published to date, including Climate Adaptation Plan for the Canary Islands: Impacts on coastal and shoreline infrastructure (2009) and Climate Adaptation Plan for the Canary Islands: Construction, territorial planning and urbanism (2009). |

### 2.1.1 French National Adaptation Plan

The French National Plan for adaptation to climate change (2011-2015) responds to the challenges and needs of the French Outermost regions, although it does not specifically consider them. During the elaboration of the Plan, the French Outermost regions (Guadeloupe, Martinique, French Guiana and La Réunion[9]) were consulted in order to ensure that the recommendations made by national working groups were correctly addressing the challenges Outermost Regions face. Most of the national recommendations did although some would require modification to the local context when implementing them. In addition, nine complementary recommendations were set out to consider the specific needs of the French OR.

Adaptation actions set out specifically for the French OR, or adaptation actions specifically mentioning the French OR, include:

In the field of human health:

- communication on protection from the sun and harmful UV rays;
- monitoring the development of micro-organisms that produce toxins; and
- mapping surface waters that are exposed to the risk of a degradation of their quality in the case of extreme temperatures.

In the field of biodiversity:

- strengthening existing monitoring tools to take into account climate change impacts on biodiversity;
- Implementing and preserving Green and Blue corridors (*Trame Verte et Bleue)* and identifying / preserving an ecological network in the OR (REDOM - BEST); and
- mapping habitats with regular updating, in order to follow-up changes in the distribution and areas of habitats.

In the field of natural risks:

- developing knowledge on changes in tropical cyclone activity in the OR;
- assessing the impacts of climate change on coastal natural hazards; and
- following-up the evolution of the meteorological forest index;

In the field of infrastructure and transport:

- adapting the technical standards for building, maintenance and management of the transport networks (infrastructure and materials);

[9] Mayotte and St Martin did not have Outermost Region Status at the time the French National Adaptation Plan was drafted.

- defining a methodology to assess the vulnerability of maritime, terrestrial and air transport networks and make it accessible for local governments, operators and managers; and
- establishing the state of vulnerability of maritime, terrestrial and air transport networks and preparing responses adapted to the climate change challenges at local and global levels.

In the field of energy and industries:

- making available hydrological and climate-related data.

In the field of finance and insurance,

- increasing the insurance coverage for individuals;
- developing measures promoting adaptation for individuals; and
- increasing the uptake of home protection insurance by households.

In the field of coastal management:

- developing knowledge on swells and impacts on coastal erosion;
- studying the role of coral reefs and mangroves as natural defences against coastal erosion; and
- adapting regulations and governance to improve an integrated management of coastal areas.

## 2.2 Climate change and the Caribbean OR – Guadeloupe, Martinique, St Martin and French Guiana

The climate of the Caribbean is, on average, dry in winter and wet in summer although the geographic features of each island in the Caribbean also have a significant influence. The storm and hurricane season (June to November) is the region's primary source of rainfall and generally coincides with the rainy season. Year to year, variation in rainfall is highly influenced by both the El Niño Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO).

The MMD used in the IPCC AR4 shows that models typically have a good level of skill in simulating annual temperatures in the Caribbean, i.e. there is not a significant degree of variation between them and they are able to replicate the region's climatology relatively well. However, in case of precipitation there is a systematic underestimation of rainfall and a wide range of variation amongst the models used indicating a high degree of uncertainty in future projections of rainfall (see below).

All Caribbean islands are very likely to warm during this century, although the warming is likely to be smaller than the global annual mean warming in all seasons, as the ocean will moderate the warming over land. The projections show that temperatures in the Caribbean are likely to increase and that days which are currently considered to be 'warm' will become a 'typical' day by the end of the century. Temperature increases will be greater for French Guiana where MMD data suggests temperature increases may be 0.5°C to 1.5°C higher than for the Caribbean island OR. Summer rainfall in the Caribbean is likely to decrease in the vicinity of the Greater Antilles but changes elsewhere, and in winter, are uncertain. Overall, rainfall is likely to decrease, with the largest decreases likely in the northern hemisphere (NH) during spring and summer (the projections suggest a 20% decrease in NH summer rainfall could be seen although the MMD data does suggest that the reduction could be as large as 35%).

The estimated change in frequency of extremely dry days suggests an increase in future frequency and severity of drought conditions, with an average of approximately a third of days by the end of the century being equivalent to an extremely dry day in the current climate. Uncertainty over the future evolution of the El Niño Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO) (processes which both influence rainfall in the Caribbean but which are not necessarily well represented within climate models) increase the level of uncertainty in interannual variability of seasonal rainfall and the frequency of cyclones, suggesting that in any one year, average rainfall could be significantly more, or less, than the average projected change in rainfall.

Sea levels are likely to continue to rise (on average) during the century around the small islands of the Caribbean Sea and the coast of French Guiana however the rise is unlikely to be geographically uniform and there are large deviations among models on regional estimates of sea level rise so the degree of change for each island in the Caribbean and for French Guiana is uncertain.

In general, there is a lack of data sets which are sufficiently long term and homogenised to be suitable inputs to regional climate models of the French OR in the Caribbean and so there are currently no detailed simulations of future climate change for the French OR, including Guadeloupe, Martinique, Saint Martin and French Guiana. Nonetheless, there are some recent initiatives intended to develop knowledge on climate change impacts in French OR in the Caribbean. The research program EXPLORE 2070 (2010-2012) supported by the French Ministry of Environment intends to build simulations of climate change in France and in all of French OR.

Each of the Caribbean OR is considered below in sections 2.2.1 to 2.2.4.

### 2.2.1 Climate impacts on Guadeloupe

Guadeloupe is a diverse territory consisting of two islands separated by a very narrow strip of water. One part of the territory is characterised by a mountainous landscape and tropical forests, the other a flatter landscape with mangrove swamp to the southwest. Much of the coastline of Guadeloupe has benefited from the protection of coral reef. Guadeloupe is a territory suffering from overcrowding and settlements in sensitive ecosystems resulting in deforestation, pressure on natural resources and pollution.

Some changes in climatic factors have already been observed in Guadeloupe, most commonly: an increase of sea water temperature, increase of the frequency of extreme weather events such as drought and heavy rainfall and the intensity of tropical cyclones, and change in duration and characteristics of the rainy and dry seasons. Although there is no evidence to link such events directly to a long term change in climate at this time, many of the changes observed are consistent with projections of future climate for Guadeloupe (based on IPCC AR4).

In December 2012, Guadeloupe adopted a Regional Plan for Climate, Air and Energy ("Schéma Régional Climat Air Energie" (SRCAE Guadeloupe, 2012b). The document aims to provide a reference framework to ensure consistency in the policies implemented in the field of sustainable development, energy and adaptation to climate change.

The document presents a state of knowledge on climate change in Guadeloupe, including an overview of both the contribution of Guadeloupe to global climate change and the impacts of climate change relevant to the island. . Within the plan, the most vulnerable sectors to climate change (determined through stakeholder consultation) are: Public health, Water resources, Building and transport, and Agriculture and Fisheries. Recommendations are set out for implementing actions to reduce the contribution of Guadeloupe to climate change and adaptation to climate change is presented in the Regional Plan as a key concern to be integrated in economic development and planning policies of the island. See Box 1 for a summary of the recommended actions.

There have been studies which use statistical techniques and global climate models to estimate projected changes in climate for Guadeloupe. One study estimate average temperature is likely to increase by 1°C by the middle of this century and by approximately 2°C by the end of the century, during both summer and winter seasons (Climator project by INRA, 2010). The sensitivity of ecosystems and the character of island habitats suggest that species may migrate toward the highlands as a result of increasing temperatures, disrupting existing ecosystems and impacting their long term sustainability. Projected increases in temperatures also suggest a probable rise in demand for cooling and air conditioning, resulting in greater demand for energy in the future.

The difference between the dry and the wet seasons may not be as noticeable in the future as in the current climate as precipitation is expected to increase during the dry season - a change already observed in Guadeloupe (source: Interview with Conseil Régional of Guadeloupe). Water shortages in lakes and rivers have been observed during the dry season (SRCAE Guadeloupe, 2012b) and more droughts are expected in the future. Although an increase in rainfall during the dry season may ease pressure on the water storage required to meet overall water resource needs, it is not clear what the consequences of changes in rainfall will be as an increase in disease related to water quality is also thought likely (SRCAE Guadeloupe, 2012b). Other health related consequences of climate change could be associated with occurrence of new tropical diseases, which are considered more severe, more frequent and atypical for the islands (SCRAE Guadeloupe, 2012b).

This impact has already been observed in the island, for example with incidence of dengue fever in 2007 and 2009 which affected thousands of people are resulted in a number of fatalities.

Increasing sea temperature and ocean acidification lead to coral bleaching. Human activity is also responsible for the increase in sediment from erosion, which in turn are thought to be 'suffocating' coral. Loss of the health and integrity of coral reef could lead to a reduction of coastal fish populations reliant on the health of coastal reefs (French Ministry of Environment, 2010). It is currently estimated that around 80% of coral reefs of Guadeloupe are already dead as a result of changing sea water temperatures (source: interview with Conseil Régional Guadeloupe and IFRECOR, the French Initiative on Coral Reefs).

Consequences of sea level rise in Guadeloupe are expected to be significant as most urban development and infrastructure is located along the coast. Further, a rise in sea levels will result in degradation of mangrove and a possible reduction of fish stocks, due to the role of mangroves as fish nurseries (French Ministry of Environment, 2010).An increase in the intensity and frequency of tropical storms would also mean that mangroves will potentially no longer have the time they need to regenerate between two weather events (IUCN, 2010). In addition, hurricanes can lead to intensified erosion of beaches, which has already been observed in Guadeloupe. Given the importance of coastal areas to the economy of Guadeloupe and the islands biodiversity, any increase in the intensity of storms, especially when combined with increased vulnerability due to loss of protection by coral reef is a significant concern.

More detailed information on the anticipated impacts of climate change in Guadeloupe and their potential implications is presented in the climate risk assessment set out in Appendix D.

| **Box 1: Recommended actions set out in the Regional Plan for Climate, Air and Energy of Guadeloupe** | |
|---|---|
| Public health | • Developing knowledge on the links between health and climate change<br>• Support the implementation of a network of national experts and researchers on climate change and its impacts on human health<br>• Strengthening monitoring and early-warning of the quality of the environment (e.g. air, water, and food) and vector-borne diseases, by strengthening the resources involved in the existing regional system. This latter works in elaborating suggestions to improve the process of health-related risk management and climate crisis |
| Territorial development and planning | • Increasing the integration of the energy and climate concerns in planning documents (to be implemented by 2020-2030)<br>Adapting the standards of building, construction and maintenance of the built environment to climate change challenges (to be implemented by 2020-2050) |
| Adapt and protect resources | • Integrating the constraints of climate change in the Blueprint for water resources planning and management (to be implemented by 2020-2050)<br>• Reinforcing the protection and safeguard of ecosystems and natural environment (to be implemented by 2020-2050)<br>• Adapting, supporting and promoting the production of local agricultural production (to be implemented by 2018-2020)<br>• Supporting and adapting the fishery production (to be implemented by 2020-2050) |
| Governance | • The priority action is integrating consistency in the regional policies and adapting national policies (to be implemented by 2020-2030) |
| Knowledge development and accessibility | • Supporting innovation (to be implemented by 2020-2030)<br>• Improving the knowledge of Greenhouse gas emissions and pollutants emissions and in Guadeloupe (to be implemented by 2015-2020)<br>• Supporting research on pollution linked to sandy gods (to be implemented by 2015-2020)<br>• Improving knowledge by observing the effects of climate change on the territory (to be implemented by 2020-2050). |
| External cooperation | • Strengthen the exchange of information, knowledge, experiences and best practices with external partners (to be implemented by 2020-2030) |
| Jobs and training | • Structure sectors and increase the expertise in energy efficiency-related jobs (to be |

| | |
|---|---|
| | implemented by 2020-2050) |
| Financial sector | • Developing a specific financial engineering focused on energy efficiency (to be implemented by 2020-2030)<br>• Integrating criteria related to energy and carbon to assess the compliance of funding (to be implemented by 2017) |
| Communication | • Increasing the awareness of stakeholders (to be implemented by 2020-2030)<br>• Creating a process of informing and alerting citizens in the case of a pollution peak (implemented in 2012)<br>• Strengthening information, awareness and training dealing with climate change (to be implemented by 2017) |

### 2.2.2 Climate Impacts on Martinique

In terms of future developments, Martinique has an ambition to achieve energy independence by 2030, to be achieved through an increased use of renewable energies. Supporting its ambition, Martinique is in the process of finalising its Regional Plan for Climate, Air and Energy ("*Schéma Régional Climat Air Energie*" (SRCAE)[10]) and this is believed to be the first initiative of this kind in Martinique which addresses challenges associated with climate change. Developing the Plan has provided the opportunity to develop an overview of the contribution of Martinique to climate change and the impacts of climate change in the territory. Stakeholder consultation on the Plan was completed at the end of 2013 with an expectation that the Plan will be finalised once the consultation responses have been examined.

As is the case for Guadeloupe, there is a lack of climate model projections developed specifically for Martinique. However, some research has been conducted (SRCAE Martinique 2012) which estimated that between 1960 and 2000:

- Temperature has increased by approximately 1.5°C;
- The sea level has risen by approximately 3.5 mm per year; and
- Both hurricane and thunderstorm seasons have become more variable in their timing.

With limited resources, Martinique does not have the capacity to attribute any alteration or trend in weather conditions to climate change, although as for Guadeloupe, many of the changes observed are consistent with climate projections. A very small number of studies on the impacts of climate change in Martinique have been carried out to date. Among them, the "LarGE" research laboratory of the University of Les Antilles and French Guiana is carrying out research on extreme events, natural risks and disasters.

Although there is relatively little research into the future impacts of climate change on Martinique, some assumptions can be made. For example, given proximity and common characteristics of Martinique and Guadeloupe, it is reasonable to assume that the likelihood and magnitude of climate change impacts will be similar in these two territories. There have also been events which allow assumptions about potential future impacts to be made. For example, after hurricane DEAN in 2007, the Regional Health Agency of Martinique observed an increase in cases of leptospirosis (in particular in rural areas). It is reasonable to assume that the expected increase of extreme weather events could contribute to future increase in the frequency of outbreaks of this and similar diseases. Further, although no clear trend in rainfall has been observed to date, flooding is an existing risk in Martinique which causes damage to infrastructure. This suggests a vulnerability to flood risk which may increase if annual precipitation, or frequency of extreme rainfall events, increase as a result of climate change.

More detailed information on the anticipated impacts of climate change in Martinique is presented in the climate risk assessment set out in Appendix D.

The Regional Plan for Climate, Air and Energy defined the Strategy to tackle the challenges of climate change and considers three pillars:

[10] http://www.srcae-martinique.fr/public/

- Energy savings;
- Energy efficiency; and
- Diversification of energy sources in a sustainable way.

Models were developed to assess the contribution of Martinique to climate change and how demand for energy may evolve in the future, depending on the implemented actions by 2020.

Preparation of the Plan allowed an estimate to be made of the cost of inaction for Martinique. This was estimated to be around 250 million Euros by 2025 and 510 million Euros by 2050 if no action is taken to tackle the causes of climate change (globally). This estimate took into account expected damages due to storms and their impact on tourism, coastal infrastructures, marine coastal ecosystems and agricultural production.

As a result of the assessment made, specific actions to address adaptation challenges are set out in the Plan, with the objective of a better integration of these challenges in planning and development policies. The actions are:

- Structuring existing knowledge in order to identify the gaps and the needs of research;
- Improving knowledge of the main areas of vulnerability
- Integrating climate change challenges in planning policies and documents in a structured way; and
- Strengthening the consideration of climate change related risks in planning policies and development.

### 2.2.3 Climate Impacts on St Martin

St Martin, located at the North of the Lesser Antilles, is a volcanic and mountainous island. The literature review has identified very little information of direct relevance to this study for St Martin. Except for temperature increases, information on other climate indicators for the Lesser Antilles (including St Martin) derives from global or regional models. Some information can be inferred from climate impacts in the region and hence the assessment of climate impacts for Guadeloupe and Martinique is taken as indicative of the likely climate change impacts in St Martin.

The exposure to hurricane risk and the vulnerability of the coastline to sea level rise appear to be the most researched impacts of climate change, even though still poorly documented. Due to its geographical situation and its natural features, the island is highly exposed to extreme weather events such as hurricanes. The latest hurricanes occurred in 1995 (Luis) and 1999 (Jose and Lenny). They had a strong impact on tourism and since then St Martin has faced difficulties in boosting this activity. As for the other Caribbean French OR, the intensity and frequency of hurricanes is expected to increase due to climate change.

One of the key features of the island is the existence of barrier beaches or sandbars which are low and narrow. Most communities have settled on these sandbars, resulting in a highly urbanised coastline. In this context, the sea level rise concerns about 6% of the land area of St Martin. These areas are considered to be vulnerable to temporary flooding (or permanent inundation for the lowest lands) (ONERC, 2012). Furthermore, St Martin has the highest ratio of buildings exposed to flooding as a result of sea level rise (expressed as built area exposed to flooding over total built area) out of all French OR (ONERC, 2012).

Furthermore, St Martin presents the characteristics of a dry island with scattered hills and some areas with abundant vegetation. St Martin faces a chronic deficit in water resources due to low rainfall and scarcity of groundwater resources (ONERC, 2012). Temperature increases could worsen the water deficit.

In the field of biodiversity, no studies have dealt with the current and future consequences of climate change on biodiversity in St Martin. One study covers the Lesser Antilles (Joseph, 2011). The National Nature Reserve of Saint Martin is a marine protection area which includes coral reefs and mangrove areas. It aims to assist in the conservation of key habitats. It is estimated that the main consequences of climate change will be an increase of erosion. The impacts of climate change will tend to accelerate the disappearance of habitats (Joseph, 2011).

The Conservatoire du Littoral, a French public organisation whose role is to protect natural sites and coastlines in France, , has responsibility for 355 hectares of the island. Sites include 84 hectares of coastline, 14 salt ponds and 7 outlying islands (Pinel, Tintamarre, Petite Clé, Caye Verte, Rocher Créole, Rocher de l'Anse Marcel and Grand Ilet in the Simpson Bay lagoon). The Conservatoire believes that climate change will increase the vulnerability of coastlines to erosion and that the land they protect will be impacted. For this reason, the Conservatoire is working to assess the vulnerability of protected land areas to erosion and to integrate consideration of climate change into projects. For instance, in St Martin, the Conservatoire is working towards better protection of the mangrove and dry coastal forest (as they provide a carbon sink) as well as working on erosion control and shoreline restoration.

In addition, the protected "Réserve Naturelle St Martin" acts as a 'climate change sentinel' and can be used to understand the vulnerability of the island's biodiversity. Adaptation actions that are being implemented include:

Improving scientific knowledge by:
- Monitoring impacts on coral reefs; and
- Monitoring impacts on bird's migratory routes.

An adaptation strategy to:
- Control anthropogenic pressure on protected areas;
- Restore damaged populations and habitats; and
- Develop adaptation tools to climate change (e.g. modelling artificial reefs and coral reefs restoration).

Finally, St Martin benefits from work done across the Caribbean. For example, in November 2013, a workshop on the resilience of marine protected areas to climate change took place in St Martin. The objective of the workshop was to share knowledge and best practices across the Caribbean, contributing to local and regional capacity building and analysing adaptation options to reduce risk and build resilience.

### 2.2.4 Climate Impacts on French Guiana

A study "About the impact of climate change in French Guiana" was carried out in 2011 by the French geological survey, (Bureau de Recherches Géologiques et Minières, BRGM). It provided a first overview of the impacts, vulnerabilities and potential adaptation actions for the territory. Another study carried out by BRGM has since begun to further analyse the economic impacts of climate change and to assess adaptation options (the study is still underway). Furthermore the environmental association, WWF, is undertaking a study on the climate change impacts on biodiversity and ecosystems located in the plateau of French Guiana.

As concerns the impacts of climate change in French Guiana, as with the other Caribbean OR, there is no regional climate model for the Antilles-Guiana region that could help refine the information given by global climate projections. Similarly, there are no regional projections of sea level rise that have been made to date for French Guiana. However, some trends have already been observed. For example, temperatures have risen by +0.28°C per decade over the period 1965-2009 (ONERC, 2010b).

Although records show no clear trend in rainfall patterns over a similar time period (1955-2004) (French Ministry of Environment, 2010), climate projections suggest an increase in rainfall during rainy season and decreased rainfall during the dry season across the Eastern Amazonia (SRCAE Guyane, 2012). According to the IPCC AR4, Eastern Amazonia could experience an increase in temperatures and change to the water balance (especially to evapotranspiration) by 2050, that could lead to increased soil aridity and, potentially, to the transformation of tropical forest to savannahs, a tipping point that would see the loss of significant ecosystems (IUCN, 2010). Risk of extinction of tropical forest species if the climate becomes too warm or too dry is considered one of the most significant issues for French Guiana (SRCAE Guyane, 2012).

An amplification of rainfall intensity during the rainy season could increase risks of landslides (BRGM, 2011), while longer dry seasons could lead to an increase in the occurrence of wildfires such as those which have occurred in recent years in Brazil and French Guiana (SRCAE Guyane, 2012). Since 1970, there has been an

increase in the periods of low-flow on the Comté River during dry season (DIREN Guyane, 2010). This impacts biodiversity and the quality of ecosystems.

The French Guiana coast could be particularly exposed to marine-related hazards and disasters such as erosion and storms resulting in coastal flooding and inundation (SRCAE Guyane, 2012). Projections of storm frequency and severity, and regional patterns of sea level rise, are uncertain but current estimates do suggest an increasing risk of coastal flooding. The coastline of French Guiana is already fairly unstable because currents and sedimentation processes in this region are under the influence of the Amazon estuary dynamics (BRGM, 2011). The impact of climate change on these processes is not clear, but increases in salinity have been recorded in some rivers near the coast (BRGM, 2007).

Regarding health issues in French Guiana, the region is already exposed to several vector-borne diseases, such as yellow fever, dengue fever and malaria. The equatorial, humid climate of French Guiana is favourable to several insect species known to be agents of pathogens. An increase in temperature, in particular during the rainy season, could further contribute to the persistence and spread of such agents i.e. extension of agents to new areas, emergence of the disease all year round instead of periodic outbreaks, more intense epidemics, etc (BRGM, 2011).

More detailed information on the anticipated impacts of climate change in the French Guiana is presented in the climate risk assessment set out in Appendix D.

In the broader context of climate change, French Guiana has the ambition to meet 50% of energy demand from renewable energy sources by 2030, moving towards greater energy security. Supporting this objective, the Regional Plan for Climate, Air and Energy (Schéma Régional Climat Air Energie (SRCAE)[11]) of French Guiana was released in June 2012.

The document provides an overview of the contribution made by French Guiana to climate change and an assessment of vulnerability to climate change. It highlights the need for developing monitoring and the evaluation of the climate dynamics in the territory. Furthermore, it emphasises the need to define adaptation actions and to integrate adaptation challenges in planning and development documents and policies. It does not however define any specific adaptation actions although the current BRGM study aims to identify the main adaptation actions to be implemented at a local level.

Increasing awareness and sharing knowledge are also priority actions to tackle climate change challenges and to this end, in April 2013, a workshop was organised in French Guiana to discuss climate change issues, share knowledge and develop capacity building.

## 2.3 Climate change and the Indian Ocean OR – La Réunion and Mayotte

The climate of this region is dominated by the Asian monsoons. The wet season for Mayotte and La Réunion is from December to March when winds are predominantly from the west to northwest. The dry (and cool) season is from May to October when the southeast trade winds dominate. Although monsoons occur every year, and their patterns have been studied for many years, there remains significant uncertainty regarding their duration. The greatest challenge in this region is simulating the year on year variation associated with monsoon and the Madden Julian Oscillation (MJO), processes not well understood or well represented in climate models (IPCC, AR4).

The MMD used in the IPCC AR4 shows that models typically overestimate temperatures for the region (by an average of 0.6°C compared to climatology) but that simulations of rainfall are only slightly below the observed annual mean. The models do not however represent interannual variability well. All Indian Ocean islands are very likely to warm during this century, although the warming is likely to be smaller than the global annual mean across all seasons as the ocean will moderate the warming over land. Rainfall is likely to decrease in the southern hemisphere (SH) winter for both Mayotte and La Réunion. There is confidence in this

[11] http://www.guyane.developpement-durable.gouv.fr/IMG/pdf/SRCAE_Guyane-VF_26062012.pdf

projection as there is a high degree of correlation between climate models that this will be the case (see Box 11.1, IPCC 2007a).

Sea levels are likely to continue to rise globally on average during this century however this is unlikely to be geographically uniform. There are large deviations among models on regional estimates of sea level rise so the degree of change for each island in the Indian Ocean is considered uncertain. Recorded data on sea levels between 1993 and 2001 indicates that sea level has been falling in the western Indian Ocean (IPCC, AR4).

### 2.3.1 Climate change impacts on La Réunion

In 2008, Météo France released the findings of a study on expected climate change impacts in La Réunion. The main findings were that:

- The future change in annual mean precipitation is estimated to be between -2 and +20% in the Indian Ocean compared to long term averages. In La Réunion, winters are likely to become drier and extreme weather events more severe;
- Sea level is expected to rise between 0.2 and 0.6m by 2100;
- Trade winds are expected to increase in strength; and
- A decrease in the frequency of cyclones, but an increase in their magnitude, is expected over the longer term.

The final version of the Regional Plan for Climate, Air and Energy of La Réunion was submitted to public consultation at the end of 2012(SRCAE La Réunion, 2011). It provides state of the art knowledge on climate change impacts and presents the main vulnerabilities of the territory. The plan highlights the lack of specific data and climate models for this area of the Indian Ocean, as highlighted by the Conseil Régional of La Réunion (source: interview with Conseil Régional of La Réunion). Nonetheless, some changes that may be related to climate change have already been observed:

- Winters are becoming drier and there is an increase in the number of extreme weather events in La Réunion (IOC, 2011);
- There is a trend of increasing rainfall in the eastern part of the island and decreasing rainfall in the west. Western parts of the island are already the driest and so this is expected to further decrease water availability, especially for irrigation;
- There are, on average, around 20 fire outbreaks a year in La Réunion. The most exposed areas are forests in the highlands (western part of the island). Further reduction in rainfall could exacerbate this risk;
- Coastal flooding is one of the main risks faced by La Réunion (French Ministry of Environment, 2011a) although changes in future frequency of coastal flooding and in sea level rise are not clear; and
- Several incidents of coral bleaching have been recorded in the past decade: 2001, 2003, 2004 and 2005 (IUCN, 2010).

In addition, invasive species are considered to be the primary cause of biodiversity loss in La Réunion, although this is not currently linked to changing climate (UICN, 2010).

According to the Regional Plan for Climate, Air and Energy of La Réunion (SRCAE La Réunion, 2011), the climate change impacts most likely to affect natural and human systems in La Réunion are:

- Disturbances to existing ecosystems, an increase in the prevalence of invasive species and potential loss of biodiversity;
- Changes in agricultural yields (although this could be positive or negative depending upon the crop) and in land use;
- Negative impacts on human health as a consequence of heat waves and an increase in vector-borne diseases;
- Change in geographical distribution of water resources; and
- Economic and social impacts related to the redistribution of the tourist flows and the impacts of extreme weather events on transport infrastructures.

More detailed information on the anticipated impacts of climate change in La Réunion is presented in the climate risk assessment set out in Appendix D.

As concerns adaptation to climate change, the Plan put emphasis on the need to develop an adaptation strategy at a local level. Furthermore, it defines future potential adaptation measures for the region. The priority actions are:

- Anticipating the effects of climate change by developing knowledge on climate change impacts on the territory, in particular in relation to natural risks; and
- Managing urban planning in order to sustainably grow to meet the needs of an increasing population, savings in energy consumption, and preservation of natural and agricultural ecosystems, all within the context of climate change.

La Réunion was also involved in the Acclimate project carried out by the Indian Ocean Commission (IOC), a four-year project focused on adaptation to climate change[12]. The project, concluded at the end of 2012, culminated in the adoption of a regional strategy for adaptation (January 2013). The IOC highlight a range of achievements for this project including: improved knowledge of the region's climate and its impacts; strengthening of the capacity of the meteorological services of the IOC's member States (Comoros, Madagascar, Reunion (France), Mauritius and Seychelles); and the launch of various awareness raising and training initiatives. The regional adaptation strategy is designed to guide the actions of IOC cooperation until 2020 and focuses on four sectors: food security, water, health and the environment (although there will be a second phase which focuses upon natural disasters, infrastructure, transport, energy, and tourism.)

### 2.3.2 Climate change impacts on Mayotte

A full assessment has not been undertaken for Mayotte as it is to become an Outermost Region in 2014. A literature review of climate impacts has however been undertaken and is summarised here. As noted in Table 2.1, no adaptation strategy for Mayotte has been developed as yet.

Mayotte has a strong seasonal irregularity of rains with 75% precipitation occurring in the summer (Chevet et al. 2012). In addition to varying seasonal precipitation and resulting water resources, Mayotte also suffers from disproportionate geographical distribution of rainfall. The northeastern and southern areas of the island are richer in water whereas most of the population is concentrated in other regions (Chevet et al. 2012).

Another climate change impact of concern is sea level rise. Between 1993 and 2011, a 3 to 5 mm per year increase in sea level has been observed (Chevet et al. 2012). Flooding due to sea level rise has already occurred and will continue to damage Mayotte's ecosystems and infrastructure. Rising sea levels also will damage beaches and threaten Mayotte's flora and fauna (Chevet et al. 2012).

Mayotte's steep slopes and heavy precipitation patterns result in high levels of soil erosion (Chevet et al. 2012). Human activities, especially extensive coastal deforestation, expedite the soil erosion process. Additionally, the periods of drought that alternate with aggressive rains results in low quality soil further damaging Mayotte's agricultural prospects (Chevet et al. 2012). Low quality soil could be further damaged by the expansion of market gardening, which would further deplete organic resources and encourage further erosion (Chevet et al. 2012).

Similar to La Réunion, the one of the biggest climate change challenges facing Mayotte is the destruction of natural habitats, which needs to be avoided. The western islands of the Indian Ocean and Madagascar consist of one of the 24 globally recognised Conservation International biodiversity hotspots (Petit and Prudent 2008). With approximately 1,000 species of vascular plants observed in an area of 354 km$^2$ in 2005, Mayotte has one of the richest collections of tropical insular fauna as well as incredibly high species density (Petit and Prudent 2008). However, water and inland ecosystems are already being degraded, and changes in climate will only exacerbate this process.

[12] http://www.acclimate-oi.net/

Mayotte's biodiversity is concentrated on its lagoon. At 1,100 km2, it is one of the largest lagoons in the world (Petit and Prudent, 2008). It is enclosed by a 196 km coral reef with an additional 18 km reef border to the south (Petit and Prudent 2008). The double barrier reef is quite rare and yields a rich diversity of coral. Unfortunately, half of Mayotte's coral reefs have already been degraded due to over-fishing, domestic and agricultural pollution, and sedimentation (Petit and Prudent, 2008). Mayotte's lagoon is home to more than 530 species of molluscs, approximately 700 species of fish, 22 marine mammals (including 12 species of dolphins and the dugong), 2 species of turtles which breed in Mayotte, 735 hectares of mangroves, 760 hectares of sea grass beds, and 11 species of sea grass (Petit and Prudent, 2008). Sedimentation into the lagoon caused by widespread soil erosion poses a serious risk to the lagoon's ecosystems and biodiversity (Petit and Prudent 2008), such as extensive damage to sea grass beds and coral reefs.

Of particular concern are also Mayotte's wetlands since their water ecosystems play an important role in the island's drinking water supply. The wetlands also mitigate the risk of flooding; therefore any damage will likely increase the possibility and, thus, occurrence of floods in the island (Chevet et al. 2012). In addition, sea level rise will be detrimental to Mayotte's mangroves. The increase in sea level is already at a higher rate than the rate of mangrove surface sediments, which endangers these fragile ecosystems (Chevet et al. 2012). Moreover, increased water temperatures will be particularly damaging to local turtle populations (hawksbill and green turtles use Mayotte as their nesting sites). Incubation temperature of turtle eggs determines the sex of the turtles, e.g. above the key incubation temperature, females are born; below – males (Petit and Prudent 2008). As a result, these turtles can act as indicators of climate change. With an increase in water temperatures, a balance between male and female turtles can no longer be maintained (Petit and Prudent 2008). Increased ocean temperatures also could influence the movements of migratory marine mammals who frequent the Southern Ocean for the feeding season (Petit and Prudent 2008).

Primary forests on the island have been in decline. This has been aggravated by old-fashioned agricultural practices and population growth (Chevet et al., 2012; Petit and Prudent, 2008). In addition, Mayotte's natural forests face many legacy issues whose repercussions exacerbate current ecological issues. For instance, almost all of Mayotte's natural forests were converted into sugar plantations in the 19th century (Petit and Prudent, 2008). According to Chevet et al. (2012), loss of native forests has already reached a point where reforestation cannot mitigate the damage.

As Mayotte's climate changes, species may migrate to higher ground, which could destabilize the natural equilibrium and facilitate the spread of invasive species. Migration of species upwards will be of particular importance to Mayotte's tropical rainforests because they are already at the upper limits of their bio-climatic zones (Chevet et al. 2012).

Mayotte suffers from both the introduction of exotic invasive species and damage from native species which have taken on invasive qualities. Altogether more than 80 invasive species (of which 30 are widespread; Soubeyran 2008) are observed in the island. For example:

- a number of exotic species, mainly fruits and spices, were introduced to Mayotte in the 19th century (Soubeyran 2008); and
- native vines, that have begun to choke the canopy, represent an example of a natural species taking on invasive characteristics (Soubeyran 2008).

The case of the floating fern Salvinia Molesta is indicative of the danger of invasive species in Mayotte. In 2007, the ferns completely covered the surface of the municipal water supply. It took fifteen people six months to remove the fern from the Combani water reserve (Soubeyran 2008).

Changes in Mayotte's climate have already led to consequences across human and natural environments. For example, one impact of increased water temperature has been coral bleaching, from which Mayotte has suffered on multiple occasions (for example, 36% of the coral reef was lost between 1982 and 1983; Petit and Prudent 2008). In 1998 nearly 90% of corals were lost on the outer margins (Petit and Prudent 2008). This resulted in an explosion toxic micro-algae (Gambierdiscus toxicos), which proliferated on degraded coral reefs and can cause ciguatera in humans through consumption of infected fish (Petit and Prudent 2008). While there was no significant increase in food poisoning observed as a result of the 1998 events (Petit and

Prudent 2008), it does not preclude the possibility that coral bleaching may result in future outbreaks of food poisoning in Mayotte.

## 2.4 Climate change and the Atlantic Ocean OR – Canary Islands, the Azores and Madeira

As noted, the IPCC AR4 chapters on small islands did not consider the OR in the Atlantic Ocean (Madeira, Azores and the Canary Islands), however regional projections are given for the region based on the MMD. These projections are for the 'Tropical North Atlantic' and can be taken as indicative of the changes projected for the islands.

Following global warming trends, temperature increases are likely although they will be lower than the global average due to the moderating effect of the ocean. Estimated changes to the number of extremely warm days in a season suggest that, by the end of the century, a typical day will be the equivalent of an extremely warm day in today's climate. Changes in rainfall are expected to be small (as an average) and there is no significant change in extreme rainfall (wet or dry periods) suggested by the MMD data. As with the other regions, sea levels are expected to rise (on average) but regional variation in the pattern of change make projections uncertain. Changes to the frequency and intensity of storms are also uncertain.

For the Canary Islands region, the Project ClimaImpacto[13] is currently generating climate scenarios and quantifying the impacts of climate change on the archipelago. Initial measurements taken at a regional level have confirmed an increase in temperatures since 1940 (almost one tenth per decade) and suggested a slight decrease in average rainfall (Martin et al., 2012).

For the Portuguese OR, the SIAM II project (Santos, Forbes and Moita 2002) estimated the temperature increase between 1ºC to 2ºC in the Azores, and 2ºC to 3ºC in Madeira, broadly consistent with the IPCC regional assessment. The same project gave projections of a significant reduction (about 30%) in annual precipitation for Madeira, with little change in annual rainfall suggested for the Azores.

### 2.4.1 Climate impacts on the Canary Islands

The Canaries archipelago is situated 100 km off the coast of Africa and comprises seven islands of volcanic origin: the Eastern group (Gran Canaria, Fuerteventura and Lanzarote) and the Western group (Tenerife, La Gomera, El Hierro and La Palma).

Climate in the region is generally mild (Canary Islands Government, 2010) although with a very uneven geographic distribution. The warmest temperatures are recorded in coastal areas, where the annual average is about 20 ºC. As altitude increases in the most mountainous islands, the average temperature decreases by up to 12 ºC in Gran Canaria, El Hierro and La Gomera, to 10 ºC in the highlands of La Palma, or to 5°C on Mount Teide (3,718 metres altitude) in Tenerife (State Meteorological Agency of Spain, 2012). Precipitation is characterized by low levels of rainfall, especially in the lowlands (less than 300 mm a year), due to the predominance of the Azores Anticyclone. In higher altitudes, rainfall can reach 800-1000 mm per annum in areas of windward slopes exposed to wet and constant trade winds (Canary Islands Government, 2010). Summer is the driest season of the year, there is high interannual variability (i.e. a succession of wet years and dry years) and intense precipitation events (torrential rainfall) are a natural phenomenon in the region (Canary Islands Government, 2010).

The archipelago is mountainous and has a complex topography, very compartmentalised, with steep slopes and small watersheds and ravines. The coastline is rugged and rocky, with cliffs being the predominant formation (78% of the total) although there are also various significant stretches of beaches.

Potential effects of climate change are already being observed in the Canary Islands. Available data from ClimaImpacto (ClimaImpacto, 2012) indicate that:

[13] European initiative supported by the "Transnational Cooperation Programme Madeira-Açores-Canarias (MAC) 2007-2013". http://climaimpacto.eu/en/

- there is a high level of confidence that temperatures have increased (almost 0.1°C per decade, from 1944 to the present);
- average precipitation levels show a decreasing trend, with a significant decline in autumn rainfall; and
- extreme heat and rainfall events have become more frequent and intense (Martín Esquivel, 2012).

Potential indirect consequences of these variations are identified as being:

- increased risk of fire;
- increased frequency and severity of heat waves;
- more persistent periods of drought; and
- more frequent events of Saharan dust invasion (ClimaImpacto, 2012; consultation with representative of the OR).

The emergence of diseases of tropical origin (ClimaImpacto, 2012) and the presence of species adapted to warmer conditions (e.g. African birds) has also been observed in the region (IUCN, 2008). The combination of steep mountainous landscapes with more extreme precipitation events increases the risk of flooding and landslide events (ClimaImpacto, 2012).

Of particular relevance for the Canaries is that climate change could potentially cause changes in the intensity and the altitude at which cloud banks caused by the action of trade winds develop. Some authors (Sperling et al., 2004) suggest that this would imply local changes in the weather and, especially, in the distribution of the laurel rainforest. This forest has an important role in the hydrological recharge of the aquifer, is of great importance in terms of biodiversity for the archipelago and is part of the Natura 2000 network of EU protected sites.

The effects of climate change are also evident on marine-coastal areas, although consultation with a representative of the region has indicated that more research is required in this area. Martin et al., (2012),, reports that sea temperature in the centre and western part of the Canaries has increased almost 0.1°C per decade between 1948 and 2010, whereas measurements during the period 1949-2001 suggest that there is a positive trend of sea level rise of around +0.39mm/year (Tel & Garcia, 2012). Available data also suggest a long term trend towards the acidification of the ocean, increased storm activity and changes in the intensity and direction of waves and winds (Martín Esquivel, 2012). Higher waves, sea-level rise and bigger storm surges are expected to increase coastal erosion and to cause damage to seafront property and shoreline ecosystems (Canary Islands Government, 2010). Warmer waters will potentially affect the migratory routes of marine species and threaten the survival of deep cold-water corals and other native species (Canary Islands Government, 2010).

More detailed information on the anticipated impacts of climate change in the Canary Islands is presented in the climate risk assessment set out in Appendix D.

### 2.4.2 Climate Impacts on the Azores

The Azores comprises nine islands: the Eastern group (Sao Miguel and Santa Maria islands), Central group (Terceira, Graciosa, Sao Jorge, Pico and Faial islands) and Eastern group (Flores and Corvo islands) (Portuguese Environment Agency, 2010). Current climate in the Azores is generally moist with oceanic features (European Commission, 2012), average maximum temperatures in the summer between 18 to 24°C and average annual minimum temperatures between 4 to 8°C (Instituto de Meteorologia de Portugal, 2012). The archipelago is characterised by a very rich natural landscape and biodiversity, and challenging topography (there are high altitude regions inland).

Climate scenarios (IPCC, 2007b) for the region of the Azores predict a 1.9-2.4°C increase in annual temperatures by the end of the century. According to studies, there is a trend towards an increasing number of "summer days" (when temperatures exceed 25°C) and "tropical nights" (when temperatures exceed 20°C) (Autonomous Region of the Azores, 2011). Despite the likely increase in summer days and tropical nights, it is expected that due to oceanic thermoregulatory effect, the Azores are unlikely to suffer from increased frequency of excessively hot and/or excessive cold days.

While the annual level of precipitation is not expected to rise, the Azores will see changes in the annual pattern of rainfall, with expected wetter summers and drier remaining seasons (see IPCC 2007 climate change scenarios). Changes in seasonal precipitation are expected to have a major impact on water management in the island, mainly on availability of freshwater resources. Saltwater intrusion in the groundwater of the Azores is a concern as observed in many of the wells that have been drilled to the basal aquifer (Jones & Phillips, 2011). Changes in the annual patterns of precipitation may require intensified exploitation of groundwater aquifers during the "drier" seasons, further augmenting the problem of saltwater intrusion.

Given that the majority of infrastructure is located on the coast; coastal hazards associated with changing climate are of key concern in the Azores. While the Regional Climate Change Strategy (Autonomous Region of Azores, 2011) states that there are insufficient sea-level measurements over significant timeframes to conclude whether local sea level rise is a long-term trend or just a seasonal variation; consultation with a representative of the OR confirmed that sea level rise is felt to be a serious threat to resources, infrastructure, coastal ecosystems and the population of the islands. In addition, with expected increase in ocean temperature, it is believed that tropical storms will reach the Azores more frequently and with greater strength (Autonomous Region of the Azores, 2011), increasing the risk of floods and coastal flooding.

With more frequent severe rainfall events, it is expected that the Azores may experience an increase in landslides, which are already the most common natural hazard in the archipelago, especially on the coast. The coastal areas of the Azores are more vulnerable to landslides due to the greater exposure to intense erosion processes and the presence of urban development (Quaternaire Portugal, 2011). Consultation with a representative of the OR confirmed that anticipating and managing weather extremes are considered key priorities for the Azores.

Deep, cold-water corals – unique habitats of the region of Macaronesia - are particularly sensitive to climate change (IUCN, 2008). Damage to the corals caused by increasing water temperatures and ocean acidification may lead to biodiversity loss and reduction in commercial fish stocks. Pests and diseases are likely to be of particular concern with regards to the biodiversity, fisheries and agriculture of the Azores. Another major concern for the Azores and other regions within Macaronesia is the impact invasive exotic species invasions may have on the unique habitats of laurel forests and coastal vegetation (Quaternaire Portugal, 2011).

More detailed information on the anticipated impacts of climate change in the Azores is presented in the climate risk assessment set out in Appendix D.

### 2.4.3 Climate Impacts on Madeira

The archipelago of Madeira consists of two inhabited islands (Madeira Island and Porto Santo Island) and two groups of uninhabited islands (Desertas and Selvagens). The island of Madeira is characterised by challenging topography with high altitudes; while the island of Porto Santo has a gentler terrain. The Madeira archipelago is situated in the subtropical region, with a mild climate throughout the year (European Commission, DG Regional Policy, 2012a), with average annual temperatures between 14 ºC and 18 ºC in coastal areas and between 6 °C and 12 °C in higher altitude areas (State Meteorological Agency of Spain and Institute of Meteorology of Portugal, 2012). Precipitation is more abundant in the Island of Madeira than in Porto Santo and it is characterised by seasonal and topographic variability (concentrated in the winter months and in high altitude areas) (Santos & Aguiar, 2006).

Climate scenarios (IPCC, 2007b) for the region of Madeira predict a 1.9 to 2.4°C increase in annual temperatures by the end of the century. Similarly, Santos & Aguiar (2006) report an expected increase of 2ºC to 3ºC in this century and point out a potential increase in the occurrence of extreme heat episodes and heat waves, although such episodes are not expected to be of long duration.

One of the key impacts of climate change in Madeira is linked to the projected decrease in annual precipitation in the region, characterised by a lower level of rainfall throughout autumn, winter and spring months, and a small increase in precipitation in the summer (Santos & Aguiar, 2006). It is estimated that the volume of water available annually for recharge of water resources will halve by the end of the century (Cruz et al.). This is likely to have severe implications across the majority of economic sectors as well as human and

environmental systems. In particular, it is likely to aggravate the problem of salt water intrusion already observed in wells located along the coast.

Furthermore, the tropical climate of the region is characterised by the occurrence of very intense rainfall over short periods of time (sometimes no more than 2-3 hours) which can result in floods and/or landslides (Baioni, 2011). These natural disasters have already been recorded with frequency in the past and recent data suggest a progressive increase in their occurrence over the last century (Baioni, 2011). The damaging events of 2010 are noteworthy: new records of accumulated precipitation caused by intense rainfall triggered intense flooding and numerous shallow rapid landslides (Fragoso et al., 2012). However, there is no evidence to suggest that this is related to climate change or that such events may occur more frequently in the future. While one study pointed out that it was not possible to conclude on the trend of flood risk because climate models underestimate high values of precipitation over short periods of time (hourly) (Santos & Aguiar, 2006), a different study stated that an increase in floods and landslides in Madeira is linked to human activity and economic development, rather than to natural factors (Baioni, 2011).

Similarly, projections relating to the frequency of wildfires in Madeira are not straightforward. Literature reviewed (Santos & Aguiar, 2006) indicates that climate change will have little impact on the likelihood of wildfires outbreaks, however, the consequences of wildfires are likely to include severe socio-economic and environmental losses.

An increase in pests and diseases is one impact of climate change which is a key concern for the Autonomous Region of Madeira. Some studies have indicated a rise in the incidence of a number of vector-borne diseases as a result of climate change is likely. For example, an outbreak of dengue fever in 2012, brought to Madeira from Egypt, has been emphasized by a representative of the OR during consultation. This event represents the first epidemic of dengue fever in Europe since 1928 (Eurosurveillance, 2012). It is suggested that with increased ambient temperatures, an associated risk of greater occurrence of pests and diseases will have a negative impact on the region's economy, particularly on agriculture and tourism.

The rich biodiversity of the archipelago, already threatened by human activities, is highly sensitive to climatic changes. Species that currently find their optimum range at high altitudes, including rare and endemic species, may disappear as a result of increased temperatures, since they will not be able to move to higher altitudes. Others may benefit from warmer conditions, and may expand their territories (Santos & Aguiar, 2006).

Coastal climate-related hazards have been highlighted by a representative of the OR as one of the key concerns for Madeira, given the location of the majority of infrastructure by the coast. Climate scenarios (IPCC, 2007b) for the region of Madeira predict a mean sea level rise of 0.35mm by the end of the century. At a regional level, the impacts of rising sea levels and coastal flooding are still being investigated.

More detailed information on the anticipated impacts of climate change in the Madeira is presented in the climate risk assessment set out in Appendix D.

## 2.5 Climate risk and identifying knowledge

The information presented so far has focused upon the ways that climate is changing across the OR and some of the impacts of this as well as considering, to an extent, the broader context of the current response in terms of adaptation strategies (whether at Member State, regional or local levels). To build upon this, an assessment framework has been developed for this study which provides a structure for a systematic review of information on the current knowledge of climate impacts in the OR (see Appendix C). This takes the main climate impacts identified for the OR and other key impacts likely (associated with increasing temperatures, changes in patterns of rainfall, etc) and identifies the sectors where the impact is of relevance (See Table C.2 in Appendix C).

Within this framework, the impacts of climate change considered in this study can then be assessed for each OR across 13 sectors based on the available evidence (whether from literature review or consultation with representatives of the OR). The sectors assessed are:

- 7 economic sectors: agriculture and forestry, fisheries & aquaculture, energy, tourism, construction & buildings, transport and waste; and
- 6 human and environmental systems: health, biodiversity, coastal zone management, soil, water and disaster & risk.

Taking this climate impact assessment as the basic framework, a climate risk assessment has been developed for the OR. Information relating to each impact, where identified as relevant to a sector (as set out in Table C.2 in Appendix C), is reviewed and an 'impact' score assigned. An Impact score of High, Medium or Low has been assigned based on three factors:

- Whether the impact is negative or positive, i.e. a potential risk (or threat) or an or opportunity;
- The likelihood of the impact occurring based on the IPCC AR4 data (set out in Appendix C), including whether there is evidence that the impact may already be occurring (such as is the case with coral bleaching for example); and
- The scale of the impact on the sector.

To give an example, coastal flooding may be very likely as a result of sea level rise and increased coastal storm intensity but if there is limited energy or transport infrastructure on the coast then the overall impact is scored as 'low' for the energy and transport sectors.

The impact score is combined with a vulnerability score, again assessed as being High, Medium, Low. This score reflects the vulnerability of the sector to the impacts of climate change and is assessed based on:

- The socio-economic importance of the sector, for example the contribution made by the sector to the economy of the OR the number of people employed in the sector;
- Particular vulnerability of a demographic group, such as the elderly or those on low incomes;
- Awareness and understanding (at OR level) of climate impacts on that sector, typically as a result of research programmes; and
- Evidence and level of sector's adaptive capacity such as actions within a local adaptation strategy or actions already taken to increase resilience of the sector to the impacts of climate change..

Finally, by combining the impact and vulnerability scores an indication of the level of risk (or opportunity) is determined. Risks are thus based not only one a combination of physical impact and vulnerability to it but also the environmental, social and economic consequences of the impact. Those areas where the highest overall climate risks are identified are then most likely to be those which should be considered a priority for adaptation action.
The allocated scores for both impact and vulnerability are based upon both available literature and consultation with representatives of the OR. The approach is subjective in that risks which cannot be quantified are assessed but the approach and this results in some uncertainty however, the overall risk mapping for each OR has been reviewed by representatives of the OR and is felt to accurately capture the main issues being faced by these territories.

The method can only be applied where there is information to allow a score to be assigned. This means that the assessment framework also highlights those areas where there are significant gaps in current knowledge. Where little or no information on an impact in a particular sector is found it may be because the risk is not considered to be a significant one but it could also be due to a lack of awareness. The most significant gaps in knowledge identified by the literature review relate to soil and to waste management. The impact of climate change on soil is highly complex and uncertain, so it is perhaps unsurprising that there appears to be a low level of knowledge on climate change and soils across the OR. It can be speculated that the impacts of climate change on waste management are considered less of a priority for adaptation action than water or infrastructure and hence there is, as yet, limited work done on climate change in this sector (as applies in the OR). This is an area of active research amongst the climate research community. In addition, the relationship between the occurrence of natural catastrophe (e.g. hurricanes and cyclone) and climate change has been identified as an area requiring additional investigation on the local level.

The lack of detailed climate change information specific to Mayotte and St Martin is also clear, with much of the information summarised in this study being either very specific for a given sector (for example majority of

information on climate change impacts in Mayotte refer to biodiversity), relevant to the region more broadly or drawn from more generic sources.

Further details of the methodology applied and the resulting risk assessment matrices for each OR are presented in Appendix D. These matrices clearly highlight the sectors (and therefore the population they employ) which are most vulnerable as well as showing where knowledge gaps exist.

# 3 Economic impacts of climate change on the OR

## 3.1 Economic framework to complement the climate risk assessment

The purpose of the economic part of the study is to gain some insight into the economic impacts of the climate risks identified in the climate risk assessment (see Appendix D). Owing to the relatively low availability of economic information for each OR, this section provides an economic context to the climatic impacts with (where possible) some qualitative assessment of the impacts' implications and importance for each OR.

The limited data available for the study means that the analysis cannot apply an explicitly-defined and parameterised economic model. Such a model would better capture, in a formal manner, the linkages between different elements of the economy (their interdependencies) and allow identification of the indirect ('knock-on') effects arising from losses in economic activity in a sector. Effects could include the initial (direct) reductions in employment and income in a sector, as well as further rounds of indirect effects that may either increase or decrease the initial direct effect (resulting for example from a lower spending in the economy).

In the absence of sufficient economic (and related) data, it is difficult to justify the construction and application of a complete economic model as many of the relationships would be heavily reliant on assumptions. The outcomes from such an analysis would tend to reflect the assumptions more than they would the underlying data.

Instead, the approach acknowledges the data limitations and seeks to provide some indication of the scale or importance of climate impacts and adaptation by relating the findings from the assessment of the climate impacts to the available data. The approach is intended to gauge the extent to which climate-sensitive parts of the OR might have a bearing on overall economic performance.

The core economic data for the assessment come from official sources, specifically, Eurostat[14]. The decision to restrict the data used to official EU sources partly reflects the nature of the task, which did not allow for a detailed data collection and verification exercise. However, the approach also allows us to draw comparisons between the ORs that would not have been possible if a range of different sources had been used (i.e. at MS level). It is noted however that where an in-depth assessment of the vulnerabilities of a single OR (or even those of a single MS), there is likely to be benefit in considering other data, such as local tourism statistics of national economic datasets. Where it is available and does add value to this assessment, other economic data is considered as a supplement to the analysis of each OR (see Section 6).

The key regional statistics with which to build up a depiction of each OR are:

- Gross Value Added (GVA) [15], distinguished by economic sector; and
- Employment, also by sector.

The initial part of the assessment (the climate risk assessment for each OR described in Section 2.5) made use of the above data to:

- Establish a sense of the relative economic importance of each aspect of the OR economies;
- Feed into vulnerability scoring in the climate risk assessment; and
- Provide initial economic context to the analysis.

[14] http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

[15] The sum of GVA across the economy, plus taxes and subsidies, gives GDP. Thus, in order to derive regional GDP, it is necessary to be able to identify the distribution of these taxes and subsidies. In general, these data are not available and the calculation of reported regional GDP is usually based on a simple assumption that taxes and subsidies are proportional to GVA. As such, the analysis focuses on GVA because it is the statistic reported by individual regions, and because GDP would not reveal much more (owing to the sharing assumption).

This included, for example, analysis of the contribution of a sector (e.g. agriculture) to economic growth. An overview of this information for each OR is provided in Appendix F.

The ideal scenario for developing the assessment in this study would be to understand the likely economic impact of climate impacts upon each OR and then to explore the cost of adaptation action versus no action being taken. The information available to complete the climate risk assessment made it clear however that there is generally insufficient information currently available across the OR for this to be possible. As an alternative, based on the data which is available, the economic analysis took two forms:

- Sector-level analysis which allows the reliance of each OR on agricultural land and tourists to be understood (as these are the sectors where there is good, directly comparable economic data available across the OR); and
- A higher-level assessment of the impact of climatic events on the macroeconomic trajectory of each OR.

Each of the above are explained in more detail in the next two sections (Section 3.1.1 and 3.1.2).

### 3.1.1 Sector-level economic analysis

The sector-level analysis involves the development of a series of metrics to gain insight into the economic vulnerability of each OR to climate-change impacts.

The sector-level economic analysis augments the main GVA and employment data with other supporting data from Eurostat to calculate, for example, indicators of the productive value of land on each OR (GVA divided by agriculture land area). Thus, for a climate impact that affects a given area of agricultural land, an OR with a higher yield per hectare would tend to be affected more in economic terms than one with a lower yield.

Similarly, an OR characterised by greater output per unit would tend to be more vulnerable to negative impacts of climate change (because loss of one unit – e.g. hectare or tourist, represents greater loss in output). Combined with an assessment of the land at risk in an OR, one might then comment on the potential economic damage from climate change.

At the sector level, the economic data from Eurostat conform to the European Nomenclature statistique des activités économiques dans la Communauté européenne (NACE) classification[16], a standardised system for categorising economic activities. The most up-to-date classification, NACE Revision 2, is as follows:

- Agriculture, forestry and fishing;
- Industry (except construction);
- Construction;
- Wholesale and retail trade, transport, accommodation and food service activities;
- Information and communication;
- Financial and insurance activities;
- Real estate activities;
- Professional, scientific and technical activities; administrative and support service activities;
- Public administration, defence, education, human health and social work activities; and
- Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies.

Of the above, the limited nature of the supporting data from Eurostat and the requirement to link to the physical indicators means that the sector-level analysis is only feasible for agriculture, forestry and fishing, although in economic terms, this sector is still more aggregate than the sectors assessed for climate risk. In some ORs it is noted that there are specific data available that could be used to extend the analysis but it

[16] Statistical classification of economic activities in the European Community: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-07-015/EN/KS-RA-07-015-EN.PDF

would be important to verify the accuracy of these figures and ensure consistency so as to avoid issues such as double counting[17].

The other sectors identified in the NACE classification do not map so well to the social or environmental dimensions of the climate impact assessment framework and, as such, the economic analysis is not able to shed as much light on these aspects of the assessment. Tourism is not defined as a sector in the economic statistics; most tourism activities would be classified either as part of wholesale and retail or part of arts and entertainment (see below).

The somewhat limited scope of the economic assessment (owing to a lack of suitable data) is summarised in Table 3.1 below. The table also notes the main secondary data source for the assessment: tourism data from the World Travel & Tourism Council (WTTC[18]).

[17] In addition, it should be noted that Eurostat receive many of these figures anyway.
[18] http://www.wttc.org/research/economic-impact-research/

**Table 3.1 Availability and Comparability of OR Data for Economic Assessment**

| Assessment Sector | Data |
|---|---|
| Agriculture | Agriculture GVA and employment aggregated in the Eurostat data into: Agriculture, Forestry and Fisheries. |
| Forestry | Forestry GVA and employment aggregated in the Eurostat data into: Agriculture, Forestry and Fisheries. |
| Fisheries & Aquaculture | Fisheries & Aquaculture GVA and employment aggregated in the Eurostat data into: Agriculture, Forestry and Fisheries.<br>Eurostat database includes 'Catches by fishing area' (database code fish_ca) but no data available for the OR. |
| Energy | Eurostat database includes 'Primary production and final consumption by NUTS 2 regions' (database code env_rpep) but no data available for the OR. |
| Tourism | World Travel & Tourism Council analysis on the value of tourism in the OR combined with economic and tourist data from Eurostat. |
| Construction & Buildings | Eurostat database provides figures for Construction GVA, but other data on the built environment are more limited. |
| Transport | Some Eurostat data on passenger flows but economic data are too aggregate to link satisfactorily. |
| Waste | Eurostat has various waste and waste water databases but few contain sufficient data on the OR. Moreover, the economic data are too limited to be linked properly to the waste data. |
| Health | No suitable indicator could be identified with a suitable counterpart in the available economic data. Time lags would make this difficult to assess. |
| Biodiversity | No suitable indicator could be identified with a suitable counterpart in the available economic data (noting that valuation of ecosystem services is a developing area which could be used to complement this assessment in the future, see http://ec.europa.eu/environment/nature/biodiversity/economics). |
| Coastal Zone Management | No suitable indicator could be identified with a suitable counterpart in the available economic data. |
| Soil | No suitable indicator could be identified with a suitable counterpart in the available economic data. |
| Water | Eurostat database includes, among others, 'Regional water statistics' (database code reg_env_wat) but no data are available for the OR. |
| Disaster & Risk | No suitable indicator could be identified with a suitable counterpart in the available economic data. |

**Agriculture**

The two key agriculture indicators in the assessment are:

- **The value (GVA) each hectare (ha) of OR's land represents.** This indicator can be roughly described as 'productivity' of the agricultural land, and/or 'agricultural intensity' of each OR. This is calculated as the (average) of agricultural GVA over 2000-2006, divided by the amount of agricultural land on each; OR

- **The dependence of the OR economies on agriculture for economic growth.** This indicator assesses the relative importance of agriculture to the OR in economic terms by calculating the share of GVA accounted for by that sector.

**Tourism**

Tourism is not defined as a separate sector in the core economic statistics, because it spans a number of different economic activities. However analysis by the WTTC of the contribution of tourism in the OR to GDP, combined with data from Eurostat on indicators such as non-resident hotel stays gives some indication of the amount of economic activity associated with tourism. The three indicators considered in the analysis are:

- The (average) amount of tourism GVA associated with one night spent in a hotel by a non-resident;
- Tourism as a proportion of total (economy-wide) GVA; and
- Tourism employment.

It is important to note that the analysis that follows considers the OR economic vulnerability to reductions in tourism, but it does not quantify any likely reduction in the number of tourists. That is, given a reduction in tourism, the metrics aim to provide some indication as to how much economic output might be affected. No attempt is made to gauge the impact of climate change on tourist numbers owing to the wide range of potential driving factors (such as for example consumer tastes and fashion, impacts upon biodiversity, importance of natural assets and man-made infrastructure, etc). It is believed that officials in the individual OR would be better placed to make such an estimate but even for them this would be extremely difficult to quantify with any degree of accuracy.

The nature of the conventional economic accounting system is such that it does not explicitly identify a tourism sector in its own right. Instead, the main economic data identify sectors such as retail, accommodation and transport, of which some of the goods and services meet demand from tourists. The purpose of Tourism Satellite Accounts is to provide a depiction of the tourism sector that can be reconciled with the main economic data. These statistics remain relatively underdeveloped, focusing more on physical indicators such as non-resident hotel stays. Moreover, the data are quite sparse for the OR and the analysis in this study has been augmented with expenditure data from the WTTC. Data from the WTTC are only available for three of the four French ORs (Guadeloupe, Martinique and La Réunion). There are no reports for French Guiana, the Azores, Madeira or the Canary Islands.

The first statistic is the amount of tourism GVA associated with each night spent by a non-resident in a hotel in an OR. This is calculated as the mean value over the period from 2006-09, to give an indication of the amount of GVA generated in the tourism sectors from tourist expenditure.

The next metric is the share of each OR's economy accounted for by tourism-related activities. If the tourism industry makes up a small proportion of the economy as a whole, then the OR is relatively less dependent on this sector and thus more resilient to a downturn arising from a climate event: a negative impact on the tourism industry brought about by climate change will not have a large negative impact on the economy as whole, other things being equal. The final metric focuses on employment: the number of jobs supported by tourism in the OR.

The second and third metrics are derived from a combination of Eurostat and WTTC data. The WTTC analysis reports both:

- The direct contribution to economic activity; and
- The total contribution to economic activity.

The former is a measure of the value of trade that takes place directly with tourists while the latter takes into account wider effects from capital investment and government spending to support tourism, as well as supply-chain effects and the impact of wages from employment being spent in the OR. In general, it is the wider economic impact of the latter that matters in this assessment and it is usually this kind of figure that is reported in official publications. It is these wider effects that an explicit model-based treatment, for example, would seek to identify for other sectors, too.

### 3.1.2 Economy-wide analysis

The second part of the analysis takes a somewhat higher-level view of the structure of the OR economies, by considering the extent to which the data already show an economic impact from climatic events or events which are likely to be experienced more frequently as climate changes.

The analysis gives some indication as to how climate impacts (or relevant events) have affected the OR economies in the past and, therefore, some indication as to how future climate impacts might affect the OR (especially if the climate impacts include higher frequency/larger events). This approach is adopted as an alternative to looking at the cost and benefits of adaptation as the analysis of impacts and the supporting literature review (and consultation) highlighted that data is not currently available to enable a focus on adaptation. Instead, the analysis considers what the costs of climate impacts could be in the future and hence the value to timely adaptation in order to avert such financial impacts.

An example of this is the way in which construction activity varies through time. If increases in activity follow a known climate event, like a hurricane, then the increase in activity may yield some indication as to the economic cost of the event. This is a subtle difference from the conventional interpretation of economic activity in economic statistics.

Indicators such as GVA (and, in turn, GDP) measure the quantity of production (i.e. the circulation of goods and services) in an economy. The conventional view would be that higher economic activity from a particular sector, such as construction, contributes to economic performance.

However, if it is known that the additional construction activity does not in fact expand an economy's built environment, but is merely replacing lost buildings and repairing damage from a climatic event, then there is some cost associated with the climate event and the economic activity. In this case, the argument is that, were the economy at or near full capacity, the financial resources allocated to construction have been *diverted* from elsewhere in the economy. Had there been no climate event, those resources would have been spent on more economically-beneficial activities i.e. resources diverted at the expense of other sectors of the economy. This diversion is not readily identifiable in the data and the analysis pursued in this study simply seeks to identify whether climatic events may have temporarily (or, possibly, permanently) altered the trajectory of an OR's economy. This is a slightly weaker form of the original resource-diversion argument.

In principle, a more complete assessment would explicitly examine the capital stock (an indicator of the value of productive assets in an economy) in each OR, rather than simply the expenditure flows each year. Such analysis would show the damage to infrastructure from the climate impacts, through a reduction in this capital stock (reflecting lost assets). Ideally this could be extended to include natural capital although this would require an estimate of the value of natural capital, an exercise which can be controversial and still includes many uncertainties or differences in approach.

There has, in the past, been work to estimate such capital stocks, at the level of NUTS 2 regions in the EU-27. However, the data for the OR are currently too limited to shed much additional light on this aspect of the analysis and standard methods for constructing such capital-stock estimates would not typically account for climate damage in a manner that would be satisfactory for this study.

Another sector will might arguably exhibit economic effects of a climatic event is agriculture. In this case, damage to the natural environment will affect the productive capacity of the agriculture sector, leading to lower output.

The above argument suggests some way of gauging the economic impacts of climate impacts by locating (temporary) departures from past economic trends, although establishing clear metrics that can be extrapolated or applied elsewhere is difficult.

One reason for this is the likely non-linearity of the effects: a single large impact would very likely have larger effects than the sum of ten impacts with magnitude one-tenth of the single one. Also, in some cases, such as agriculture, the timing of the event may matter with respect to the crop cycle.

In general, only large events could reasonably be cited as the cause of large changes in economic activity. Smaller and more isolated events are for the most part more difficult to separate in the data from planned investment programmes or more modest weather effects as they will not necessarily generate simultaneous impacts in multiple sectors the way a larger event might. This potentially introduces some bias into the nature of the effects (as well as limiting the extent to which this kind of analysis of economic trajectories is

possible). Other confounding effects include measures implemented to improve resilience to climate events as well as the possibility that not all large events may have hit OR in areas with economic value. The short timespan of the available data also limits the analysis to 'recent' history (1995 onwards).

The nature of the data are such that establishing causality in such a context is difficult and, as such, the analysis in this part of the assessment can only be regarded as putative in nature. While the focus is on two sectors where the impacts are likely to be most visible, some degree of caution is advised when interpreting such results as the assessment identifies correlations only.

For some OR, there is also some analysis on the possible impacts of past events. Again, given the lack of data, it is difficult to draw strong conclusions, but such analysis does help to give some sense of scale to past climate impacts, relative to the wider economy of each OR.

The analysis also considers the size of EU subsidies (ERDF, ESF and EAFRD) compared to the size of each OR's economy (as measured by total GVA). This gives some indication as to the contribution of EU support to each OR. The main indicator involves a comparison of the annual average support[19] to GVA in 2007 (the first year of the subsidy period) and 2010 (the most recent year of available GVA data).

### 3.1.3 Data assessment, data gaps, and the scope of the assessment

The principal data source for the analysis is Eurostat, which provides official regional data at the NUTS 2[20] level for a variety of economic and related indicators.

Regional data remain quite sparse compared to their national (Member State-level) counterparts and the data for the OR are even more limited. While there are a number of Eurostat databases for regional statistics, relatively few contain any figures for the OR.

In addition to lower availability/coverage, the quality of data at the regional level also tends to be poorer. Examples of this include implausibly large one-off increases in some indicators before a return to a value more in line with past trends. The approach has been to use whatever data are available but to avoid, for example, calculating summary and descriptive statistics that include such clear outliers from the underlying trend.

Given these limitations on the data and its availability, the analysis presented in the sections that follow should be interpreted with care and taken as indicative of the scale of economic vulnerability of the OR to climate events.

There were insufficient data on Saint Martin to conduct an economic analysis while Mayotte is not yet recognised as a region in the Eurostat data (according to the NUTS classification) so there are no suitable data for this region, either.

The Eurostat data were supported by WTTC analysis of the contribution of tourism to the ORs' GVA. These data were only available for three ORs:

- Guadeloupe;
- Martinique; and
- Réunion.

As described previously in this section, this data source is preferred because it confers the advantage of comparability across ORs (the data and analysis follows a common method) but also because the analysis identifies both the direct effect (value of trade with tourists) but also wider economic effects (transmitted through supply chains and through workers in the tourism industry spending their wage income).

[19] The subsidy allocation divided by seven; one for each year in the period 2007-13.

[20] The Nomenclature of Territorial Units for Statistics (NUTS) is a European system for dividing up the geography of the EU. There are three levels of detail and NUTS 2 refers to 'basic regions for the application of regional policies': http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/introduction

It should be noted that there are in some cases local data sources available for the other ORs but it would be a quite substantial exercise to gather and interpret the data so that conclusions could be drawn on a consistent basis. Due to issues of quality and consistency it is not always clear that this would add much value to the overall analysis.

## 3.2 Identification of knowledge gaps – economic

In order to relate the information gathered in the risk assessment above to economic trends and developments, there is a requirement for both:

- The economic data themselves, in order to pick out key features and trends at an economic level; and
- Supporting data with which to link climate impacts to the economic data.

There are some economic data with which to construct a picture of the structure of each OR's economy (in terms of economic output and employment) but the level of disaggregation by sector remains fairly limited, distinguishing industry from construction but not different types of industry. Moreover, the timespan of the data is also quite limited with 1995 being the earliest year available in the Eurostat data.

Overall, the coverage of the data by region is poor relative to the Member State-level data and the quality is also somewhat worse, with missing values in some series and clear outliers in others (indicating implausible outcomes).

In the case of the supporting data, there are figures available but the data, again, tend to be sparser at the regional level, particularly for the OR. This limits the extent to which climate impacts can be linked to economic data (where it is available).

The limited availability of both is an important constraint on the analysis that is discussed further in the Section. The data limitations also constrains the assessment to a traditional approach which ignores the externalities, particularly environmental impacts and their consequences as well as opportunities which arise from the maintenance and restoration of healthy ecosystems. One example would be the development of green infrastructure and the use of ecosystem-based adaptation. Given the importance of natural assets to the economy of the OR, such an approach would be advantageous. Given the scope of this study and the aim of maintaining a consistency in assessment across the OR, this is not however feasible within this study.

Results from the analysis are presented in Chapter 5 which presents a more pragmatic approach to the analysis that seeks to make best use (for the purposes of this study) of the available data. Before this analysis is presented it is important to complete the presentation of available information for this study and hence Section 4 sets out the context of EU funds relevant to adaptation to climate change in the OR.

# 4 Assessment of EU funds for the 2007-2013 programming period

This section analyses the adaptation and mainstreaming measures implemented in the Outermost Regions under the EU funds for the current programming period (2007-2013), with particular focus on the Cohesion Policy funds, the Common Agricultural Policy (CAP) Pillar 2/rural development funds and the Common Fisheries Policy.

In almost all of the OR, measures funded by Cohesion Policy and the CAP rural development funds are not specifically targeted to climate change adaptation, but rather focused on water management (water treatment and provision of drinking water); the adoption of extreme weather resilient infrastructure (especially with respect to port infrastructure); and the preservation and protection of natural heritage, although of course these can each have adaptation benefits.

Overall, EU funding plays a critical role in the development of the OR, particularly with regard to the planning and financing of infrastructure. The extent to which climate change impacts and adaptation needs are taken into account in the planning, programming and spending of these funds therefore represents an important opportunity to build overall climate resilience in the OR.

An overview of each fund and overall findings is presented below. A more detailed assessment of funds for adaptation in each OR is in Chapter 6 and Appendix E together with an overview of the methodology for the assessment of funds..

The EU has recognized the geographical and economic differences of the OR from those of the other regions of Europe (i.e. in their remoteness, insularity, small size, difficult topography and climate, and economic dependence on a small number of products). Despite these specific characteristics, these regions also have major assets and the potential to contribute to their own development and to that of Europe as a whole. They can act as excellent laboratories for studying and combating the effects of climate change, they have exceptional biodiversity and marine ecosystems, great potential for the development of renewable energies and leading-edge agri-environmental research, and so on[21].

Although the OR are geographically distant from EU Member States, they are covered by EU Law and represent an economically and biologically important component of the EU. The Council can adopt specific measures and common policies for the OR, under the Lisbon Treaty (Article 349 of the Treaty on the Functioning of the European Union), taking into account their particular conditions.

***Legislative framework***

The Commission paper "The Outermost Regions – an Asset for Europe", issued in October 2008 frames the EU's policy. It has two objectives. First, to address the new difficulties facing the OR: globalization, climate change, demographic trends, migratory flows and the sustainable management of natural resources, including marine resources and agricultural products. Secondly, to boost the regions' economic development, with particular focus on high-value-added assets, e.g. the agri-food industry, biodiversity, renewable energy, astrophysics, aerospace, oceanography, volcanology, seismology and the regions' role as outposts of the EU.[22]

In particular, the OR are designated as ideal locations for experimentation to combat climate change due to their remarkable biodiversity and marine ecosystems; scientific hotspots for their geographical areas; and their high-quality agricultural produce[23].

The agriculture, fisheries and tourism sectors are the main sources of employment for the four million or so inhabitants of these regions. They are also the sectors which host many cutting-edge projects that are supported by the EU and are of value to the EU as a whole.

[21] EC, Research EU Focus, (2010), European Research Area, Boosting the potential of the Outermost Regions

[22] COM [2008] 642, The Outermost Regions – an Asset for Europe, and COM(2012)287, The outermost regions of the European Union: towards a partnership for smart sustainable and inclusive growth.

[23] Regional Challenges in the Perspective of 2020 – Phase 2: Deepening and Broadening the Analysis Austrian Institute for spatial planning (ÖIR), August 2011.

These sectors are also those most affected by climate change. The adoption of measures to counteract these effects is therefore necessary. EU funds play a crucial role here. EU spending programmes on regional and rural development, research and other areas must have a climate change dimension and must help coordinate action - at local, regional and national level – to adapt to climate change.

The first Forum for the Outermost Regions[24] took place in 2010 and the second in 2012. The Forum provides an opportunity to strengthen dialogue with these regions and to exchange experience. EU policy takes account of the specific characteristics of these regions and aims to transform their potential into real growth and opportunities. This means, for example, strengthening their research and renewable energy capabilities and using their unique position to measure the effects of climate change.

A recent study, "Regional Challenges in the Perspective of 2020 – Phase 2: Deepening and Broadening the Analysis"[25], highlights three priority areas facing the OR: socio-demographic and economic issues; climate change; and energy.

In this context, this section presents an overview of how the EU funds have been utilized in the 2007-2013 and how they have contributed to mainstream and implement adaptation in the OR.

### *EU funding opportunities/instruments*

EU funds support adaptation in two ways, by:

- Promoting climate change policies and initiatives; and
- Making investments "climate resilient" by ensuring that all projects take climate change into consideration.

Many existing EU funding mechanisms – which aim to increase competitiveness, regional integration and accessibility - are used to address the specific needs of the OR. The OR benefit from specific public aid schemes and are granted special tax regimes due to their situation.

An overview of the main EU funding opportunities for the OR is in the table below. The most important instruments (i.e. that allocate the largest share of funds) for the OR are those under shared management between the European Commission and the Member States, namely the Cohesion Policy funds (ERDF, ESF, CF) and the Rural Development Fund (EAFRD) under the CAP and in some cases the European Fisheries Fund (EFF).

**Table 4.1 Overview of the main EU Funds for the OR in the period 2007-2013**

| Funding Instrument | | Beneficiary OR | EU allocation |
|---|---|---|---|
| **EU Cohesion Policy** | | | |
| **ERDF** | **European Regional Development Fund** | All | EUR 4,500 million |
| | INTERREG IVB MAC programme | Madeira, Azores, Canary Islands + neighbouring | EUR 55.3 million |
| | INTERREG IVB Caribbean programme | Martinique, Guadeloupe, French Guiana, St Martin + neighbouring | EUR 64 million |
| | INTERREG IVB Indian Ocean programme | Réunion, Mayotte + neighbouring | EUR 47 million |

[24] Forum for Outermost Europe website: http://ec.europa.eu/regional_policy/conferences/rup2010/index_en.htm

[25] OiR (2011), Regional Challenges in the Perspective of 2020 – Phase 2: Deepening and Broadening the Analysis, Vienna/Heisdorf/Bonn

| | | | |
|---|---|---|---|
| | INTERREG IVB Amazonia programme | French Guiana | EUR 12.8 million |
| **CF** | **Cohesion Fund** | Azores<br>Madeira<br>Canaries* | EUR 70 million<br>EUR 100 million<br>n\a |
| **ESF** | **European Social Fund** | All | EUR 1,300 million |
| **Common Agricultural Policy** | | | |
| **EAFRD** | **European Agricultural Fund for Rural Development** | All | EUR 1,200 million |
| **POSEI**** | **Programme of Options Specifically Relating to Remoteness and Insularity** | All | EUR 4,160 million |
| **Common Fisheries Policy** | | | |
| **EFF** | **European Fisheries Fund** | All | EUR 101.4 million |

*Source: Complied from DG REGIO website*

** The Cohesion Fund in Spain is implemented through a National level Operational Programme called Operational Programme Cohesion Fund – ERDF. The amount of Cohesion Fund specifically dedicated to the Canary Islands is not available. See examples of projects in section 4.1.1.*

*** POSEI programmes are financed under the European Agricultural Guidance and Guarantee Fund (EAGGF). The POSEI system was set up in 2001. It provides grants for production, processing and marketing of agricultural products in the OR and is the equivalent to the first pillar of the CAP (see section 4.1.2).*

The objectives of these funds are broad and mainly target economic and social development and convergence with the EU mainland. Within these objectives, however, are a range of priorities and measures relevant for targeting climate change adaptation. For example, ERDF funding is used in the OR for the preservation of natural assets, water distribution and treatment, disaster management and health infrastructure. Similarly, the rural development funds under the CAP can address erosion and promote water-saving practices, including through the use of green infrastructure.

Other instruments such as the voluntary scheme BEST Preparatory Action, the LIFE Programme and the Framework Programme for Research and Innovation (FP7) are managed at the national government level. They can also play an important role for tackling climate change adaptation and are therefore described in the analysis.

**Table 4.2 EU Funds for Research, Environment and Biodiversity for the OR in the period 2007-2013**

| Funding Instrument | | Beneficiary OR | Amount for the OR |
|---|---|---|---|
| **FP7** | **Seventh Framework Programme** | All | n/a* |
| **LIFE** | **Financial Instrument for the Environment** | All | n/a* |
| **BEST** | **Voluntary scheme for Biodiversity and Ecosystem Services in Territories of the EU Outermost Regions and Overseas Countries and Territories** | All + OCT | EUR 2 million (including OCT) |

**Projects funded under the FP7 and LIFE are dispersed across many implementing partners across the EU and beyond. While it is not possible to calculate the exact amount of funding dedicated to the OR in the field of climate change research, examples of projects where OR have played an important role are presented in section 4.1.4 and in Appendix E.*

The aim of the analysis is to identify the main measures of EU funding programmes for OR that are dedicated to climate change adaptation objectives. An activity is defined as adaptation related if it is intended to reduce the vulnerability of human or natural systems to the impacts of climate change and climate-related risks, by maintaining or increasing adaptive capacity and resilience[26]. A detailed methodology for the assessment is contained in Appendix E. According to the methodology, measures financed under the Structural Funds and Rural Development Funds are categorised as fully or partially contributing to climate change adaptation objectives ('climate adaptation related only' or 'significantly climate adaptation related'). Specific attention is given to measures implemented in the context of:

- **Cohesion Policy Funds:** The **European Regional Development Fund (ERDF)** and the **Cohesion Fund (CF)** promote the achievement of climate change adaptation objectives, for example through funding investments for risk prevention measures and environmental protection or environmental infrastructure measures (biodiversity conservation, water supply and wastewater treatment). The assessment covers the extent to which the funding helps create resilience to future climate changes and risks. The **European Social Fund (ESF)** can also contribute for climate change adaptation purposes through support to projects promoting the reform of education and training systems, adaptation of skills and qualifications, up-skilling of the labour force, and the creation of new jobs in sectors related to the environment and energy;

- **The Common Agricultural Policy (CAP):** The **European Agricultural Fund for Rural Development (EAFRD)** funds rural development programmes in the EU Member States and regions. Such programmes contain a package of measures grouped around 4 axes, two of which are significantly climate adaptation related: axis 1 - improving the competitiveness of the agricultural and forestry sector; and axis 2 - improving the environment and the countryside; and

- **Common Fisheries Policy**: The **European Fisheries Fund (EFF)** provides funding to help the fishing industry and coastal communities adjust to changing conditions, which could include climate change adaptation.

For each OR, expenditures for the ERDF and the EAFRD have been analysed using a specific categorization of adaptation-significance developed for this study. For each OR the measures that seem to have higher climate adaptation significance have been then clustered by sectors in an overview table[27]. Other instruments that have a minor impact on climate adaptation (e.g. BEST for biodiversity, LIFE for the environment and the FP7 for research and innovation) are also presented. For these types of tools, examples of projects relevant to climate change adaptation will be presented rather than an in-depth analysis of the policies themselves.

### 4.1.1 Cohesion Policy

EU Cohesion Policy promotes the economic development and convergence of the OR with the EU mainland through specified financial instruments, in line with wider EU development objectives. For the 2014-2020 budget period, Cohesion Policy legislative package have been adopted in November 2013[28]. In line with the Europe 2020[29] strategy and other EU policies and legislation on climate change, the Cohesion Policy for 2014-2020 more directly targets climate change; this is a significant opportunity for the OR that is discussed further in the recommendations in Section 7 of this report.

***ERDF Regional programmes***

[26] OECD (2011), Handbook on the OECD-DAC Climate Markers
[27] See each region's summary in Section 6
[28] Inforegio-Newsroom: http://ec.europa.eu/regional_policy/newsroom/detail.cfm?LAN=en&id=1145&lang=en
[29] COM(2010) 2020: EUROPE 2020 A strategy for smart, sustainable and inclusive growth

Operational Programmes are the key planning tool for Cohesion Policy expenditure. These set the funding priorities, identify objectives and parameters for spending – e.g. the future development of projects. Each of the OR has prepared an Operational Programme for ERDF spending for the 2007-2013 period; analysis of these documents shows that they have dedicated some investments to climate change adaptation interventions, and that this is done to a greater extent than in the previous programming period (2000 – 2006)[30]. Such investments, however, do not directly address climate adaptation objectives as they have broader impacts. According to the methodology used (see Appendix E), significantly adaptation related measures include risk prevention investments; measures that have a lower significance to climate change adaptation objectives include environmental protection and environmental infrastructure measures.

In the table below the overall allocations of the ERDF for each Regional Operational Programme[31] is presented in comparison to the allocations devoted to measures that are considered to be significantly adaptation related.

Two different scaling factors are applied to these measures to show that only a certain share of the total allocation for a measure could be counted as 'significantly climate related' expenditure. Finally, a rough estimation of the percentage share of the total ERDF dedicated to climate adaptation is given.

**Table 4.3 Breakdown of ERDF allocations relevant for climate change adaptation in the OR for the period 2007-2013, million EUR**

| | ERDF allocations | Allocations to measures with higher adaptation significance[32] | 50% | Allocation to measures with lower adaptation significance[33] | 30% | Total allocation for climate adaptation relevant measures | % of the total ERDF expenditures adaptation related |
|---|---|---|---|---|---|---|---|

[30] European Parliament, 2011, The role of regional policy in addressing the effects of climate change in Outermost Regions

[31] These include only Regional Operational Programmes; Interregional Operational Programmes and relevant allocations are presented in each Outermost Region's factsheet. The methodology for carrying out the analysis and a comprehensive assessment of EU funds are presented in Appendix E.

[32] Code 53 – Risk prevention (including the drafting and implementation of plans and measures to prevent and manage natural and technological risks), code 54 – other measures to preserve the environment and prevent risks

[33] Code 45 - Management and distribution of water (drinking water), code 46 - Water treatment (waste water), code 51 – Promotion of biodiversity and nature protection (including NATURA 2000), code 55 – Promotion of natural assets, code 56 – Protection and development of natural heritage

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Canary Islands** | 1000 | / | 0 | 66 | 19.8 | 19.8 | 2.0 |
| **Azores** | 966 | 38.2 | 19.1 | 149.6 | 44.88 | 63.98 | 6.6 |
| **Madeira** | 321 | 14.5 | 7.25 | 37.7 | 11.31 | 18.56 | 5.8 |
| **French Guiana** | 305 | 1 | 0.5 | 23 | 6.9 | 7.4 | 2.4 |
| **Martinique** | 417 | 27.8 | 13.9 | 38.7 | 11.61 | 25.51 | 6.1 |
| **Guadeloupe** | 542 | / | 0 | 82.4 | 24.72 | 24.72 | 4.6 |
| **Réunion** | 1000 | 16.5 | 8.25 | 179 | 53.7 | 61.95 | 6.2 |

*Source: Financial tables in each Operational Programme*

The shares of the ERDF[34] allocated to significantly climate adaptation related measures account for less than 10 per cent of the total ERDF allocation in the OR, ranging from around six per cent in the Azores, Madeira, Martinique, and La Réunion, to four per cent in Guadeloupe and only two per cent in the Canary Islands and French Guyana As shown in the table, the bulk of these funds went to measures that only accounts for 30 per cent of the expenditure as being climate adaptation related, such as distribution and protection of scarce water resources, protection and valorisation of biodiversity, the treatment of waste and the promotion of sustainable tourism and use of agricultural land.

Cohesion Policy funds important measures for preventing natural disasters and building capacity that are considered directly relevant to climate change adaptation. In the period 2007-2013, management and risk prevention, natural disaster prevention against floods, forest fires, droughts and coastal erosion have been given the priority in most Operational Programmes in the OR. Allocations also support building capacity on risk prevention and building institutional capacity with the exchange of good practice/know-how at transitional, cross-border and interregional level.

### *ERDF territorial cooperation*

Climate change adaptation can play an important role also in the context of the European Territorial Cooperation objective of the Cohesion Policy. Climate change adaptation can in fact feature in the programmes for cooperation between regions funded by the ERDF under this objective. For the OR it rests principally on the INTERREG IVB Programmes of transnational cooperation. Interreg promotes development in four areas of the OR and the neighbouring countries:

- The Caribbean: INTERREG IVB, Caribbean Programme, for the French OR;
- Macaronesia: INTERREG IVB, MAC for Madeira, the Azores and the Canary Islands;
- Indian Ocean: INTERREG IVB Indian Ocean Programme, for La Réunion; and
- Amazonia: INTERREG IVB, French Guyana countries.

One of the main programme priorities of the Caribbean INTERREG IVB, is to strengthen environmental management and risk prevention in French Guiana, Guadeloupe and Martinique. Operations relevant to climate change adaptation under this priority include the promotion of the implementation of prevention plans and warning systems, surveillance and monitoring of natural hazards, the support of comprehensive security

[34] The analysis has considered funds programmed for the 2007-2013; data on actual expenditure are not yet available. See methodology section for more details.

plans and coastal sea ports for the region. The promotion of natural assets and the protection and development of natural heritage are also among the priorities.

One of the main programme priorities of the Operational Programme 'Madeira-Azores-Canaries', MAC INTERREG IVB is to strengthen environmental management and risk prevention in the three OR. Relevant operations under this priority include the promotion of the implementation of prevention plans and warning systems, surveillance and monitoring of natural hazards, the support of comprehensive security plans and coastal sea ports for the region. The promotion of natural assets is also among the priorities. It ensures the sustainable management of plants and marine protected areas, the development of strategies for recovery and protection of biodiversity and natural resources and the improvement of coastal environmental quality.

The Commission intended to improve transnational and cross-border cooperation policies implemented under Cohesion Policy in order to better benefit the OR and better ensure the inclusion of these regions in their regional context. With the 2004 Communication[35], the Commission envisaged launching a 'wider neighbourhood action plan'[36] to facilitate cooperation between the OR and neighbouring countries. The Communication recognised that some of the funding allocated to cross-border cooperation in the OR could be allocated to projects implemented with neighbouring non-member countries (particularly the ACP countries and those around the Mediterranean). According to the Communication, those cooperation programmes could be coordinated at the level of programming and implementation with the Regional Indicative Programmes (RIP) financed by the European Development Fund (EDF) in the ACP countries.

The OR can act as privileged partners with their neighbouring third countries, specifically in projects to enhance administrative capacities, training, education and health, creation of SMEs, agriculture, fisheries and prevention of natural hazards[37].

To encourage joint cooperation projects between the OR on the one hand, the overseas countries and territories and third countries of the Union which are their neighbours who are beneficiaries of the European Development Fund (EDF) on the other hand, the cooperation programs under the Structural Funds could be coordinated at the level of programming and execution with the EDF. To this end, the Commission is continuing its work to strengthen the coordination strategy of Community financial instruments.

For example, the Operational Programme 'Madeira - Açores - Canary Islands'[38] envisaged that the objectives of different priority axes could be pursued in a coordinated manner with other Community external cooperation instruments, namely the EDF. These objectives have resulted in joint projects with third countries, some of them financed exclusively through ERDF, and others with partners of ACP countries. The Operational Programme 'Amazonia' lists the non-member countries and regions involved in this cooperation programme, namely Suriname and the Amazon states of Amapa, Para and Amazonas in Brazil. The involvement of the EDF and the Development Cooperation and Economic Cooperation financing instrument (DCECI) was sought.

In conclusion, investments for adaptation under both the Regional Operational Programmes and the Territorial Cooperation Programmes include:

- Water management – water treatment and provision of drinking water, distribution and protection of scarce water;
- Adoption of extreme weather resistant infrastructure – especially with respect to port infrastructure;
- Preservation and protection of natural heritage – allocating nature reserves and developing regulation for natural resource use, protection and valorisation of biodiversity;
- Promotion of sustainable tourism; and
- Use of agricultural land.

***Cohesion Fund***

[35] COM (2004) 343, A stronger partnership for the outermost regions, Brussels, 26.5.2004
[36] ibid
[37] COM (2008) 642, The outermost regions: an asset for Europe, Brussels, 17.10.2008
[38] See Operational Programme 'Madeira - Açores - Canarias' fiche on DG REGIO website

The Canary Islands and the Portuguese OR are eligible to received funding from the Cohesion Fund; allocations are derived from Operational Programmes developed at the Member State level. The Portuguese OP 'Territorial Enhancement' contains dedicated priority axes for the Azores (approximately 1.5% of total funding) and Madeira (approximately 2.1% of total funding). The Cohesion Fund has been used by Madeira for improving port infrastructure, introducing co-generation for electricity production and by supporting better waste management, water supply and water management systems. The Cohesion Fund was also part of the reprogramming of the national budget for Portugal[39]. An additional amount of EUR 265 million was allocated to the region of Madeira with the aim of covering the costs of reconstruction occurred due to the storm of February 2010[40]. The Azores used the Cohesion Fund to strengthen the archipelago's maritime transport efficiency and safety levels and for environmental protection (water resources and water management) and to promote renewable energy production. The Cohesion Fund is implemented in Spain through an Operational Programme called Operational Programme Cohesion Fund – ERDF. The Canary Islands have used the Cohesion Fund to develop port infrastructure: protection works of Port of Granadilla (67 million Cohesion Fund of 114 million[41]) and the new seawall and dock in the port of Las Palmas[42].

***European Social Fund (ESF)***

The ESF can support a climate-resilient economy by funding actions dedicated to the reform of education and training systems, adaptation of skills and qualifications, up-skilling of the labour force, and the creation of new jobs. This instrument is implemented through a national Operational Programme, it is therefore difficult to assess whether it has been used for funding specific measures in the OR and even more difficult to understand whether these measures contributed to achieving climate change adaptation objectives in the OR.

### 4.1.2 Common Agricultural Policy

Climate change presents both threats and opportunities for the agricultural, forestry and rural sectors in the OR. Agriculture and rural development need to adapt to the expected climatic adversities which will impact production processes. At the same time, adaptation represents opportunities for improving farming practices and upgrading infrastructure.

The Common Agricultural Policy (CAP) aims to ensure a fair standard of living for farmers and to provide a stable and safe food supply at affordable prices for consumers. The CAP's budget is spent in 3 different ways: (1) income support for farmers (direct payments), (2) rural development and (3) market support. The first and third (Pillar I) are managed by the EU through the European Agricultural Guidance and Guarantee Fund (EAGGF), whereas the second (Pillar II) is financed under shared management with the European Agricultural Fund for Rural Development (EAFRD).

*Pillar I – European Agricultural Guarantee Fund (EAGF) and Programme of Options Specifically Relating to Remoteness and Insularity (POSEI)*

The EU aid for agriculture in the OR is delivered under the Programme of Options Specifically Relating to Remoteness and Insularity (POSEI), financed under the European Agricultural Guarantee Fund (EAGF)[43]. The aims of the POSEI programmes are to help the OR cope with the permanent handicaps (climate, remoteness, small size of holdings) and the specific constraints experienced (lack of economies of scale, economic dependence, very high production costs).

[39] Parliamentary questions, 24 May 2012: Reallocating Cohesion Fund monies to Madeira
[40] Article 5 of Organic Law No 2/2010 of 16 June 2010, establishing the resources that ensure funding for initiatives supporting the reconstruction of Madeira following the February 2010 storms
[41] ElDia.es (6 June 2013), La UE confirma que financiará el puerto de Granadilla con 67 millones
[42] Court of Auditors (2012), Special Report No 4 / 2012 – Using Structural and Cohesion Funds to co-finance transport infrastructures in seaports: an effective investment?, p.30
[43] Council Regulation (EC) No 247/2006 of 30 January 2006 laying down specific measures for agriculture in the outermost regions of the Union

In 2006, the POSEI arrangements were reformed[44] to enable better flexibility and capacity for timely response to the specific needs of the OR. The reform involved a shift from management of the measures by the Commission towards greater regional participation, and to decentralization and flexibility in decision-making, on the basis of programmes presented by Member States for approval by the Commission[45].

The programmes use two different instruments to meet the regions' specific needs. Specific supply arrangements (SSAs) are a system of compensation for the higher costs caused by the insularity and remoteness of the regions concerned. Measures to assist local agricultural products (MLAPs) are aimed at developing local agricultural production and the supply of agricultural products.

**Table 3.4 POSEI financial allocation, 2007-2011**

| **POSEI financial envelopes in millions € -** | | | | | |
|---|---|---|---|---|---|
| **Programme** | **FY* 2007** | **FY 2008** | **FY 2009** | **FY 2010** | **FY 2011 & ff.**** |
| **French overseas departments** | 126.6 | 262.6 | 269.4 | 273.0 | 278.41 |
| **Azores and Madeira** | 77.9 | 86.98 | 87.08 | 87.18 | 106.21 |
| **Canary islands** | 127.3 | 268.4 | 268.4 | 268.4 | 268.42 |
| **TOTAL** | **331.8** | **617.98** | **624.88** | **628.58** | **653.04** |

**=financial year **= future financial years*
*Source: DG REGIO website*

*Pillar II – European Agriculture Fund for Rural Development (EAFRD)*

The European Agriculture Fund for Rural Development (EAFRD) is the funding instrument that aims at strengthening the EU's rural development policy and simplifying its implementation. Rural Development Programmes (RDPs) co-financed by the EAFRD contain a package of measures grouped around 4 axes, two of which are relevant for climate change adaptation: axis 1: Improving the competitiveness of the agricultural and forestry sector and axis 2: improving the environment and the countryside.

Climate change challenges have been well recognized in the baseline analysis for all the 2007-2013 EU Rural Development Programmes and addressed in their strategies[46]. Prior to the CAP Health Check[47] and the European Economic Recovery Plan (EERP) in 2008, the original RDPs for the 2007-13 programme period included a wide range of measures which directly and indirectly benefited the three main dimensions of climate action – mitigation, adaptation and renewable energy. The allocation of additional resources for climate actions from the CAP Health Check, the EERP and the subsequent amendment of RDPs increased the capacity of the OR to cope with the impacts of climate change through these funding measures.

[44] Council Regulation (EC) No 247/2006 of 30 January 2006 laying down specific measures for agriculture in the outermost regions of the Union
[45] Court of Auditors (2010), Specific measures for agriculture in favour of the outermost regions of the union and the smaller Aegean Islands, Special report no 10, 2010
[46] ENRD, (2010), Climate Change and Renewable energy measures in EU RDPs 2007-2013, Member States profiles.
[47] RAPID press release : IP/09/1568 from 22/10/2009

RDPs focus on two key sets of actions that can be considered relevant for climate change adaptation: one preserving genetic resources within the overarching aim to protect biodiversity; and the other managing water efficiently through improved irrigation and enhanced water storage.

Most of the OR struggle with climatic conditions that range from very dry to excessively wet. The challenge therefore is to introduce water saving techniques during dry periods and efficient drainage equipment during wet periods, taking into account the unequal geographic distribution of demand for water. Efforts to address water management issues are taken made under both axes 1 and 2 of the EAFRD.

A screening exercise of the RDPs for each OR has been undertaken to identify how the issue of climate change adaptation has being tackled in the OR. This analysis is presented in each region's summary in section 6.

### 4.1.3 Common Fisheries Policy – EFF

Climate change adaptation in coastal and marine areas is covered in the European Union (EU) Adaptation Strategy[48], adopted in spring 2013 and the accompanying working document on, coastal and marine issues. The inclusion of adaptation measures in the framework of the integrated Maritime Policy, in the implementation of the Marine Strategy Framework Directive and in the reform of the Common Fisheries Policy is part of the Commission's strategy of ensuring climate change considerations are integrated in all relevant policies.

There are several fisheries issues linked to climate change with positive and negative impacts. Climate change is an added stress on marine ecosystems and fish stocks. Changes in productivity and seasonality affect the exploitation of living marine resources. These need to be tackled by adequate climate change adaptation policies. For example, there is a need to maintain (or restore) the productivity of the marine ecosystem for fisheries. As a result, fisheries policy must ensure that adequate measures will be taken as changes appear in the OR.

The European Fisheries Fund (EFF) is the current financial tool for creating a viable fisheries and aquaculture sector that both respects nature and meets the demands of consumers and the food industry. EU structural aid under the EFF is more climate-friendly now than it was under previous programmes, but fundamental problems, contradictions and inefficiencies persist: the balance between resources and fishing pressure remains only an aspiration.

This financing tool does not allocate specific funding for adaptation to climate change. Nevertheless, in priority axis 3 there is an important provision for the protection and development of aquatic fauna and flora, fishing ports, fostering the protection of the environment and natural resources that might be affected by climate change.

Moreover, the EFF introduces a territorial dimension that seeks to promote 'sustainable development and improvement of the quality of life of coastal fishing areas'. In other words, some assistance is targeted at communities around the fisheries sector, and not just fishermen, fish farmers and secondary industry. There are a number of measures targeted at the sustainable development of coastal communities, e.g. a requirement to protect the environment in fisheries areas and to protect natural capital to ensure long term benefits. Funding is also targeted towards infrastructure and facilities, including ports.

### 4.1.4 Other EU Funding Programmes

***Research Policy - FP7***

The potential of the OR in the areas of research and innovation remains insufficiently developed, despite the EU having a strategy towards the OR since 2004[49]. Their characteristics make it difficult to develop a critical mass of activities that can tap into the European Research Area (ERA), in spite of an increasing effort to harmonize priorities.

[48] http://ec.europa.eu/clima/policies/adaptation/what/docs/swd_2013_133_en.pdf

[49] EC, Research EU Focus, (2010), European Research Area, Boosting the potential of the Outermost Regions

However, excellent work is being carried out in the OR, particularly in the areas of renewable energy, marine research, health and biodiversity which are indirectly linked to climate change research. The European Commission Communication "The Outermost Regions: an asset for Europe"[50] underlines the extent to which these regions possess exceptional potential and assets within the EU, and proposes a change in approach for the research area.

Similarly, the staff working document of the Commission entitled "Regions 2020"[51] studies the possible impact of the main challenges confronting Europe in the next 20 years. The analysis emphasizes the opportunities offered by the OR, which will then be 'in the front line and whose experience will be important for their geographical surroundings and for the rest of the territory of the Union'.

OR receive funding from the Capacities programme of the Seventh Framework Programme, namely under the theme called Research potential of Convergence Regions. The aim of the theme is to stimulate the realization of the full research potential of the enlarged European Union by unlocking and developing the research potential in the EU´s 'convergence regions' and OR, and helping to strengthen the capacities of their researchers to successfully participate in research activities at EU level. The EU Member States have earmarked a total of € 340 million for funding these activities over the duration of FP7.

In addition, through their participation in the Cooperation programme in FP7, the OR have already contributed to the European Research Area by focusing on their assets - above all, in environmental research focusing on climate change and renewable energies.

While it is not possible to assess whether the RTDI activities financed by the FP7 have been allocated to projects related to research in the field of climate change, it is possible to identify research activity and relevant projects developed in the OR under the Seventh Framework Programme (FP7).

The OR have clear strengths and potential for research and innovation, particularly in areas such as:

- agricultural research;
- biodiversity;
- climate change;
- tropical health;
- marine resources;
- renewable energy;
- astrophysics;
- aerospace; and
- volcanology and seismology.

Science can provide some of the tools to better manage, protect and also improve decisions on the sustainable 'use' of oceans. In the "Blue Book" - Communication on an Integrated Maritime Policy for the European Union[52], it is clearly stated that the EU Maritime Policy 'must be based on excellence in marine research, technology and innovation'. The European Commission is strongly committed to supporting marine and maritime research. Over the last 30 years, the EU Framework Programmes have funded a vast number of projects on marine research and the OR were at the forefront of this. The Environment Theme funded research on a number of topics on key marine issues such as: climate-related ocean processes; coastal threats (for example tsunamis); managing Europe's deep sea resources including the seafloor; and topics targeting the development of innovative marine monitoring sensors. In addition one topic is specifically dedicated to the OR – building research partnerships to sustainably manage biodiversity.

[50] EC, COM (2008) 642 final, The outermost regions: an asset for Europe

[51] Staff Working Document SEC(2008)2868 Final Regions 2020, an assessment of future challenges for EU regions

[52] European Commission (2007), "Blue Book" - Communication on an Integrated Maritime Policy for the European Union, COM(2007) 575 final

All these projects bring together the resources and the expertise needed to reinforce the leadership of the European scientific community in areas such as climate change research, ocean acidification, deep sea, earth observation and so forth.

The following table presents some example of FP7 projects in different research areas where OR have been involved. Information on research activity and further relevant projects in each Outermost Region is also presented in Appendix E. According to the methodology developed in Appendix E, the majority of these projects classify under the category 'significantly climate adaptation relevant' expenditures, as they refer to adaptation-related climate research including meteorological and hydrological observation and forecasting, impact and vulnerability assessments etc. However, it is not possible to quantify the exact amount of allocation dedicated to the OR, as by nature, FP7 funding are divided between several partners all over Europe and outside Europe within a consortium for each project.

**Table 4.5 Examples of FP7 projects where the OR have partnered**

| Name | Research Area | OR involved | Objectives | EU contribution (EUR) |
|---|---|---|---|---|
| EUCarinet | ICT | Guadeloupe, French Guiana | To strengthen sustainable policy dialogue on S&T between EU Member States and associated states on the one hand, and countries from the Caribbean region on the other — namely members of the African, Caribbean and Pacific Group of States (ACP), overseas departments and collectivities as well as overseas countries and territories (OCTs). http://www.eucarinet.eu/ | 1,532,485 |
| GROOM | Marine resources | Canaries | The main objective of this Action is the coordination of ongoing research using gliders, and the conception of future research, to operate fleets of autonomous underwater gliders in order to provide cost-effective methods for the discovery and monitoring of the ocean at global, regional and coastal scales with benefit to both basic oceanographic research and operational applications for marine activities. http://www.groom-fp7.eu/ | 3,500,000 |
| MEDIRAS | Renewable Energy | Canaries | To develop and demonstrate cost-effective and reliable solar-driven desalination systems for regions affected by water scarcity and high insolation. http://www.mediras.eu | 2,118,196 |
| ReDEco (MarinERA) | Marine resources | Azores | ReDEco - Regional Drivers of Ecosystem Change and its Influence on Deep-Sea populations in the Mediterranean. To study the effects of regionally driven ecosystem changes in selected deep-sea habitats of the Mediterranean Sea and will focus on key drivers of climate change such as temperature changes, shifts in surface productivity and cold water cascading, and will examine their impacts on deep-sea populations. http://marinera.seas-era.eu/ | 924,753 |
| TROPOS | Marine resources | Canaries | Developing a floating modular multi-use platform system for use in deep waters, with an initial geographic focus on the Mediterranean, Tropical and Sub-Tropical regions, but designed to be flexible enough so as to not be limited in geographic scope. The system will to allow better monitoring of impacts of climate change on deep-water habitats. http://www.troposplatform.eu/ | 4,877,911 |
| NET-BIOME (ERA-NET) | Biodiversity | All | To network the Regional Research Policies on sustainable management of biodiversity in the European tropical and subtropical OR and Territories http://www.netbiome.org/ | 2,518,311 |

| Name | Research Area | OR involved | Objectives | EU contribution (EUR) |
|---|---|---|---|---|
| ESONET- FP6 | Marine resources | Azores | European Seas Observatory NETwork. MoMAR-Monitoring the Mid-Atlantic Ridge: Studying the temporal variability in active processes such as hydrothermalism, ecosystem dynamics, volcanism, seismicity and ground deformation, in order to constrain the dynamics of mid-ocean ridge hydrothermal ecosystems. Ocean observations build the knowledge base and help the exchange of information for planning action for climate change adaptation. http://www.esonet-noe.org/ | 7,000,000 |
| RUN sea science | Biodiversity | Réunion | Improvement of the Tropical Sea sciences research potential in Western Indian Ocean, and of the technology capacities in La Réunion Island: To defend these vast marine territories, world heritages of biodiversity, in the face of international pressure to overexploit them. http://run-sea-science.fr/?rubrique26 | 922,953 |
| STORMI-TURTLE | Biodiversity | French Guiana | Focus on the adaptive strategies of critically-endangered species facing environmental constraints and will tackle one of the most important questions relating to the global change impacts on marine biodiversity. http://www.nioz.nl/ | 160,748 |
| STRONGER | Tropical Health | French Guiana | Strengthening transdisciplinary research on infectious and emerging diseases in French Guiana: linking fieldwork, benchside and bedside. To set-up a taskforce that is more capable of managing infectious and emerging diseases in French Guiana. http://www.pasteur-cayenne.fr/stronger/ | 3,726,156 |

***LIFE + Programme***

The Life + programme is the European Union's financial instrument for the environment. Its main aim is to enable the translation of European environmental commitments and policies into concrete actions by co-funding pilot and demonstration projects of European interest.

Life+ is made up of three components: Nature and Biodiversity, Environment Policy & Governance, including climate change and energy, and Information & Communication.

Projects funded under the Nature and Biodiversity theme aim to improve the conservation status of species and natural habitats, in connection with the Birds or Habitats Directives or the Natura 2000 network. Climate Change and Energy sub-theme funded projects aim at exploring innovative ways of implementing mitigation or adaptation measures to reduce GHG and targeting energy production and distribution, renewable energy technologies and energy-efficiencies.

The LIFE + projects database[53] indicates that several projects have been financed under the 'climate change and energy' them in the OR, but only one specifically addresses climate change adaptation objectives. The project 'life-QUF - Quick urban forestation'[54] is being implemented in the Spanish territory, including the Canary Islands. The project aims to face the challenges posed by the dry climate of Southern Europe by promoting the reforestation of southern European cities. The project is ongoing and results are not available yet.

[53] http://ec.europa.eu/environment/life/project/Projects/

[54] Available at the LIFE + project database: http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=4671

Moreover, Life + Cap DOM is the first Life+ project involving the creation of a network of local non-profit organizations and the protection of fauna in the French overseas entities. Life+ Cap DOM[55] aims to provide the human, technical and financial means to take rapid, concrete action in favour of threatened birds and habitats in the French Overseas Departments. Between 2010 and 2015, pilot actions and appropriate management tools will be developed and put in place in French Guiana, Martinique and Réunion. The results will be translated, shared and disseminated in the other European overseas entities and neighbouring eco-regions.

***BEST Preparatory Action - Voluntary scheme for Biodiversity and Ecosystem Services in Territories of the EU Outermost Regions and Overseas Countries and Territories***

The OR are home to exceptional biodiversity. Situated in the three large oceans and at a range of latitudes, these entities are biodiversity rich and play host to more endemic species (species that are exclusive to a restricted geographical area) than are found on the whole of continental Europe.

In July 2008 a conference on "The European Union and its Overseas Entities: Strategies to counter Climate Change and Biodiversity Loss[56]" was held in La Réunion under the French Presidency of the European Union resulting in the "Message from Réunion Island", which was repeated – inter alia - in the Environment Council Conclusions adopted on 25 June 2009. BEST is a follow-up to the "Message from Réunion Island". BEST, the "Voluntary scheme for Biodiversity and Ecosystem Services in Territories of European Overseas", aims to promote conservation and sustainable use of biodiversity and ecosystem services, including ecosystem-based approaches to climate adaptation and mitigation.

The actions contribute to the protection of natural and semi-natural habitats characteristic of the EU OR and promote the sustainable use of biodiversity and ecosystem services through practical examples including examples for ecosystem-based approaches to climate change adaptation and mitigation and green infrastructure providing multiple benefits. In addition the actions shall reinforce existing and encourage new partnerships with a view to establishing a governance structure for a durable implementation of BEST beyond the lifetime of the preparatory action.

The two open calls for proposals BEST 2011 and BEST 2012 to implement a preparatory action initiated by the European Parliament with a budget of EUR 2 million each attracted 41 eligible proposals (BEST 2011) and 42 proposals (BEST 2012). Nine projects have been chosen in the frame of BEST 2011 and 7 projects in the frame of BEST 2012. Examples of such projects are presented in Table 4.6.

A number of measures have been implemented as part of efforts to adapt to climate change in the OR. Some examples are presented in Section 6. Well-managed marine protected areas can improve the state of reefs and increase their resilience to assaults by the elements. Monitoring reefs through the voluntary participation of civil society allows changes to be observed, even on those islands where research capacity is limited. Conservation of some species of coral can be achieved using artificial reefs; this also helps to limit the impact of hurricanes on coastal areas. The plantation and restoration of mangroves in targeted zones enables the conservation of these habitats which are vital to the overall equilibrium of marine ecosystems.

**Table 4.6 Examples of pilot projects financed by BEST preparatory action in OR**

| Name | Beneficiary |
|---|---|
| **2012** | |
| Quantification des services écosystémiques associées aux agroécosystems - Cas des systèmes à base de bananes plantains en Martinique | Conseil Régional de Martinique |

[55] Project website: http://www.lifecapdom.org/the-project/article/summary

[56] Joint nature conservation committee information paper (2008), The European Union and its Overseas Entities: Strategies to counter Climate Change and Biodiversity Loss, DEFRA

| Name | Beneficiary |
|---|---|
| Piloting the Development and Implementation of National-level joint activities between the Rio Conventions in support of Ecosystem-based approaches to climate change mitigation and adaptation | CBD Secretariat |
| Building partnerships and awareness of biodiversity and climate change in Europe overseas for the future of BEST | IUCN Brussels Regional Office |
| Création de nouvelles aires protégées dans les forêts publiques à la Réunion et à Mayotte | Office National des Forêts |
| **2011** | |
| Changes in submerged vegetation: assessing loss in ecosystems services from fondose to depauperate systems dominated by opportunistic vegetation | Universidad de Las Palmas de Gran Canaria |
| Migration Routes of Megaptera Novaeangliae | Association Globice Réunion |

***European Union Solidarity Fund***

The European Union Solidarity Fund (EUSF) offers financial support following a major natural disaster[57]. The Fund complements the public efforts of the beneficiary State. Intended to finance measures alleviating non-insurable damage in principle, the urgent actions eligible for the Fund are the following:

- Immediate restoration to working order of infrastructure and plant in the fields of energy, drinking water, waste water, telecommunications, transport, health and education;
- Providing temporary accommodation and funding rescue services to meet the immediate needs of the population concerned;
- Immediate securing of preventive infrastructures and measures of immediate protection of the cultural heritage; and
- Immediate cleaning up of disaster-stricken areas, including natural zones.

The Fund was created as a reaction to the severe floods in Central Europe in the summer of 2002. Since then, it has been used for 49 disasters covering a range of different catastrophic events including floods, forest fires, earthquakes, storms and drought. 23 different European countries have been supported so far for an amount of more than € 3.2 billion. As shown in the table 3.7 below, of these € 3.2 billion, almost 50 million have been directed to support the costs of three natural disasters occurred in the OR.

[57] Mathieu Fichter, European Commission – DG REGIO, Thematic Coordination: The Maritime Dimension of Climate Change: Role & actions of Cohesion Policy

**Table 4.7 Use of EUSF in the OR**

| Occurrence | Nature of disaster | Damage Amount (€,millions) | EUSF Amount (€, millions) |
|---|---|---|---|
| **February 2007** | Cyclone Gamède (la Réunion) | 211 | 5.3 |
| **August 2007** | Hurricane Dean (Martinique) | 509 | 12.8 |
| **February 2010** | Madeira floods and landslides | 1 | 31.3 |

*Source: DG Regio website*

Application from Spain relating to wildfires occurred in 2012 on the Canary Islands has been rejected on 30 April 2013 because it did not meet the so called criterion of 'exceptional regional disaster' for mobilising the fund[58]. The estimated total damage was much lower than the threshold applicable for Spain[59].

### 4.1.5 European Investment Bank loans and intervention in the Outermost Regions in favour of adaptation to climate change

OR benefit from combined regional and social cohesion funds from the European Union. In addition to these grants, the European Investment Bank (EIB) provides long support to projects that contribute to improving the quality of life of residents (hospitals, educational institutions, etc.) and investments in infrastructure transport and telecommunications. In addition to this, innovative financing methods of Cohesion Policy are being considered to partially resolve the lack of investment in the OR. The European Parliament supports the creation of local investment funds in each OR as well as the development of regional capital investment[60].

Climate change considerations are mainstreamed in all EIB sectoral policies and integrated into all operational activities. The OR received some funding from EIB loans mainly for the modernization and expansion of electricity production plant and for construction and modernization of a road network. These are not properly adaptation initiatives, but could be considered as an example of climate-resilient projects that improve adaptation to climate change impacts.

[58] This criterion implies that the major part of the population of the affected area needs to be affected, with serious and long lasting (i.e. longer than a year) repercussions on living conditions and the economic stability of the region affected. The three components need to be met cumulatively.

[59] Email correspondence with Andrea Lamprecht, Competence Centre Administrative Capacity Building; Solidarity Fund, Directorate-General Regional and Urban Policy

[60] European Parliament (2014), Report on optimising the potential of outermost regions by creating synergies between the Structural Funds and other European Union programmes (2013/2178(INI)), Committee on Regional Development, Rapporteur: Younous Omarjee

**Table 4.8 EIB Loans for climate-resilient projects in the OR**

| Year of signature | Name of contract | Sector | Region | Project description | Amount of loan in millions € |
|---|---|---|---|---|---|
| 2009 | PUERTO DE LAS PALMAS EXTENSION | AIR TRANSPORT | CANARY ISLANDS | Enlargement, in width, of the port of Las Palmas, in the Canary Islands, through the construction, in particular, of a new breakwater and additional terminals | 50 |
| 2009 | CANARY AIRPORTS INFRASTRUCTURE | AIR TRANSPORT | CANARY ISLANDS | Enlargement of the airports of Tenerife and Fuerteventura, in the Canary Islands | 80 |
| 2007 | PORTOS DA MADEIRA B | Sea transport | MADEIRA | Modernisation of port infrastructure in Funchal, Caniçal and Porto Novo on the island of Madeira | 10 |
| 2010 | RECONSTRUCAO MADEIRA FRAMEWORK LOAN A | Electricity production, transmission and distribution | MADEIRA | Rebuilding of essential infrastructure on the island of Madeira. | 2.5 |
| 2010 | RECONSTRUCAO MADEIRA FRAMEWORK LOAN A | Water and waste treatment, management and sanitation activities | MADEIRA | Rebuilding of essential infrastructure on the island of Madeira. | 27.5 |

*Source: EIB website, own compilation*

The EIB has also a strong experience of financing afforestation and reforestation schemes within the European Union and around the world[61]. Such type of projects would facilitate adaptation to some of the effects of climate change such as soil erosion and increased flood risk, to which the OR are particularly vulnerable. In 2012, the EIB approved € 570 million in loans for forestry projects. The EIB project database[62], however, does not record any project that has been financed in the OR for reforestation purposes in the period 2007-2013.

### 4.1.6 Non-EU initiatives

Outside the EU, other donors and funding institutions have also supported adaptation initiatives, actions and measures in OR. These include bi-lateral donors, the World Bank (GEF), and UNEP.

This section presents some examples of non-EU funded projects. They are good practice examples and provide an overview of how adaptation objectives could advance in the agendas of the OR. They also offer useful knowledge sharing lessons.

Unlike the activities financed by the EU (namely under Cohesion Policy), the initiatives financed by International Financial Institutions in the Caribbean regions are specifically dedicated to climate change adaptation. They start with building the scientific knowledge base and raising the awareness and continue with training the management capacity of the relevant institutions so that on a later stage adaptation strategies could be concretized into concrete interventions in the sector most at risk of climate change. Although not directly involved, the OR located in the Caribbean region could definitely benefit from the

[61] EIB (2012), Growing a greener economy: the EIB and forestry, brochure, October 2013, available at: http://www.eib.org/attachments/thematic/forestry_and_climate_change_en.pdf

[62] EIB project database available at: http://www.eib.org/projects/loans/sectors/index.htm

partnership approach promoted by CARICOM and its international donors. Such approach is in fact specifically aimed at creating a permanent capacity to address climate change in the Caribbean.

### *Adapting to climate change in the Caribbean (ACCC)[63]*

The Adaptation to Climate Change in the Caribbean (ACCC) is a project funded by the Canadian International Development Agency (CIDA) which ran from October 2001 to March 2004. The project built on the initial experience gained through the Caribbean Planning for Adaptation to Climate Change (CPACC[64]) project, which concluded in December 2001. The project was overseen by the World Bank, with support provided by CARICOM (CARIbbean COMmon market[65]). This EUR 1.4 million project involved nine individual components that continued from CPACC in order to consolidate, extend and make sustainable climate change responses. They are also designed to lead into and complement the Global Environmental Facility (GEF) program – MACC (Mainstreaming Adaptation to Climate Change[66]) presented in the following paragraph.

A special attention besides planning adaptation strategy in different sector (water, human health and agriculture), was given to awareness raising and capacity building activities. The added value of such project is the built partnership between regions.

As a result of the project, the Caribbean Community Climate Change Centre (CCCCC)[67] was established as a sustainable and self-financing institution for coordinating all climate change related activities in the region. The Centre is the key node for information on climate change issues and on the region's response to managing and adapting to climate change in the Caribbean. It provides climate change-related policy advice and guidelines to the Caribbean Community (CARICOM) Member States through the CARICOM Secretariat and to the UK Caribbean Overseas Territories and is archive and clearing house for regional climate change data and documentation.

The ACCC project also contributed to build the scientific and technical competence to address climate change issues in the region was strengthened; and citizens, the private sector and governments of the region have the knowledge to support and conduct appropriate climate change responses.

The project also ensured a greater consideration of climate in CIDA's other projects in the region (e.g. ENCAPD[68], ENACT[69]), bringing the issue of climate change adaptation high on the political agenda as well as stimulating and assisting the completion of regional adaptation strategies adopted by 11 Caribbean countries[70].

| | |
|---|---|
| **Project title** | Adapting to climate change in the Caribbean (ACCC) |
| **Funding origin** | Canadian International Development Agency (CIDA) |
| **Funding allocation** | EUR 1.4 million |
| **OR interested** | Guadeloupe, Martinique |

*Source: ACCC website*

### *The Mainstreaming Adaptation to Climate Change (MACC) project[71]*

63 http://www.caricom.org/jsp/projects/macc%20project/accc.jsp
64 http://www.ima-cpacc.gov.tt/
65 http://www.caricom.org/
66 See next paragraph
67 http://caribbeanclimate.bz/
68 Environmental Capacity Development Project
69 Environmental Action Programme extension
70 Canadian International Development Agency (CIDA), (2005), Adapting to climate change in the Caribbean (ACCC), Final Report, p. 9. The 11 countries are not specified.
71 http://www.caricom.org/jsp/projects/macc%20project/macc.jsp

The Mainstreaming Adaptation to Climate Change (MACC) project ran from 2004 to 2007. MACC is implemented by the World Bank, with funding of USD 5 million from the GEF. The executing agency is the CARICOM Secretariat located in Georgetown, Guyana. In-kind participants include the Government of Canada and the Government of the United States of America through the National Oceanic and Atmospheric Administration (NOAA).

The project's main objective is to mainstream climate change adaptation strategies into the sustainable development agendas of the Small Island and low-lying states of CARICOM. MACC adopted a learning-by-doing approach to capacity building, consolidating the achievements of CPACC and ACCC. It built on the progress achieved in past projects by furthering institutional capacity, strengthening the knowledge base, and deepening awareness and participation.

As MACC tried to build capacity in a cost-effective way, the expected outcomes of this project included a full set of deliverables that was monitored and evaluated. This contributed to the long-term sustainability of project activities and objectives, since participant countries will be able to benefit from the project even when it is completed.

Additionally, a regional level capacity is to be built. Outcomes fall under three general themes, including:

- The mainstreaming of adaptation to climate change into national and sectoral planning and policies through the use of climate models developed and customized through the project;
- A strong public education and outreach (PEO) program and a comprehensive communications strategy including all stakeholders in the Caribbean mass media; and
- The creation of an environment conducive to the implementation of measures for adaptation to climate change.

| | |
|---|---|
| **Project title** | Mainstreaming Adaptation to Climate Change (MACC) |
| **Funding origin** | World Bank |
| **Funding allocation** | USD $5 million |
| **OR interested** | Guadeloupe, Martinique and French Guiana |

*Source: MACC website*

# 5 Assessing Economic Impacts of Climate Change in the OR

This section presents outcomes of the sectoral and macroeconomic analysis for each of the OR (where there was data available from official sources to support the analysis; the limitations are discussed in section 3 of this report). The economic impact of recent extreme events is considered as this provides an indication of what the potential overall cost of climate impacts could be in the future where no adaptation measures are put in place. Some of the social implications of the consequences of this assessment are also discussed.

## 5.1 Guadeloupe

As an average over 2000-06, agriculture accounts for around 3.5% of Guadeloupe's GVA. Primary productions are sugarcane and banana, which account for about 30% and 5% of the agricultural surface respectively (ONERC, 2012). Of the OR, Guadeloupe is somewhat more agriculture-intensive than most, although not substantially so: agriculture accounts for 2-4% of GVA in most regions. Only in The Azores is it much higher, at 11-12%.

Overall, by the agriculture metrics employed here, Guadeloupe is not noticeably more vulnerable to impacts upon this sector than the other French OR, although these OR do show relatively more vulnerability, in terms of the share of agriculture in total GVA than Madeira (2.2%) or The Canary Islands (1.7%).

There were only data on tourism from WTTC for three of the OR (Guadeloupe, Martinique and Réunion, all French OR). On a volume basis, the data show Guadeloupe to be relatively more popular as a tourist destination, with an average of 388,000 overnight stays each year, compared to 150,000 stays or less in Martinique and Réunion, averaged over 2006-2011. The ratio of tourist stays to population in Guadeloupe is also higher than for Martinique or Réunion[72].

However, the total direct value of that tourism is similar to Martinique (both are around €150m each year) and around half that of Réunion (just over €300m). Guadeloupe has relatively more tourists staying overnight than the other two OR but the value per tourist of that industry is lower: one overnight tourist stay generates less than €370 of direct trade and the potential loss associated with that one stay is smaller than it would be in the other OR for which there are data.

In terms of direct trade, the contribution of tourism to GVA in Guadeloupe is similar to that in Martinique and Réunion, at 2.6%. However, accounting for wider impacts (spending to support tourism activities, as well as the wages generated by tourism and spent in the economy), that share rises to some 18% for Guadeloupe. On that basis, Guadeloupe's economy shows relatively greater dependence on tourism than Martinique (12%) or La Réunion (8%). This suggests that any impact upon the tourism industry in Guadeloupe could have a more significant social impact that on either Martinique or La Réunion.

In terms of the higher-level macroeconomic impacts of climate events, Guadeloupe is perhaps the best example among the OR:

- Hurricanes Iris, Luis and Marilyn all hit Guadeloupe in 1995, with a large increase in construction activity in 1996 (the following year, by over 30%), which might reasonably be attributed to recovery and rebuilding from the storm damage[73]. The value of the damage (some €457m[74]) is difficult to reconcile with GVA but the overall scale compared to construction output (of €124m) seems

[72] 388,000 stays in Guadeloupe compared to a population of almost 450,000 gives a ratio of 0.9. This compares to much lower ratios of 0.4 and 0.1 for Martinique and Réunion.
[73] An additional piece of evidence that might support that assertion would be if there were data from the years before 1995 (prior to the hurricanes and storm). There would be a stronger case for attributing the change in economic activity to these events had economic activity clearly fallen when comparing 1995 to 1994.
[74] ONERC (2012), 'Les outre-mer face au défi du changement climatique, décembre 2012':
http://www.developpement-durable.gouv.fr/Les-outre-mer-face-au-defi-du.html

comparable and does appear the recovery following the event may have driven much of the growth in the economy in that year[75] (although this is a temporary effect); and

- Hurricane George struck Guadeloupe in 1998, destroying 90% of the banana crop. This is coincident with a near-10% in agricultural GVA.

The above suggest that Guadeloupe already has a recent history of climatic events affecting its economy at the macro level and are also indicative of some degree of macroeconomic vulnerability. The impact of Hurricane Dean in 2007 is more difficult to identify in the data.

Guadeloupe has been allocated almost €870m of European subsidies over 2007-13. On an annual basis, this is equivalent to 1.6% of its GVA and similar to the ratio for most other OR. Only The Azores receives a substantially larger amount of funds relative to total GVA each year, of more than 4%.

**Table 5.1 Sector Metrics for Guadeloupe**

| **Agriculture** | Average agriculture GVA (€ millions; 2000 prices) | Average share of agriculture in total GVA (%) | Average utilised agricultural area ('000s ha) | GVA per ha of utilised agricultural land (€/ha; 2000 prices) | Average crop yields (100 kg/ha) | Average crop value (€/kg) |
|---|---|---|---|---|---|---|
| | 199.7 | 3.5% | 46.2 | 4,331.8 | 567.9 | 0.08 |
| **Tourism: Direct** | Average direct contribution to GVA (€ millions; 2000 prices) | Average direct contribution to GVA (%) | Average direct contribution to employment ('000s) | Average direct contribution to employment (%) | Average nights spent by non-residents in hotels ('000s) | Tourism GVA per night spent in hotel (€; 2000 prices) |
| | 156.0 | 2.6% | 3.5 | 2.7% | 388.0 | 371.4 |
| **Tourism: Total** | Average total contribution to GVA (€ millions; 2000 prices) | Average total contribution to GVA (%) | Average total contribution to employment ('000s) | Average total contribution to employment (%) | Average nights spent by non-residents in hotels ('000s) | Tourism GVA per night spent in hotel (€; 2000 prices) |
| | 1,072.1 | 17.9% | 19.7 | 15.5% | 388.0 | 2,567.8 |

Notes: Agriculture averages calculated over 2000-2006; Tourism GVA averages calculated over 2006-2009; and other tourism averages calculated over 2006-2011.

Sources: Calculations from Eurostat and WTTC.

[75] Noting the difficulties in comparing GVA and damage (which corresponds better to requirements for gross output).

**Table 5.2 Macroeconomic Trends in Guadeloupe**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Agriculture GVA growth (% pa)** | : | -5.7 | 17.8 | -9.9 | 38.4 | 5.3 | -10.2 | -1.8 | -7.4 | 16.6 | 2.2 | -2.6 | -6.6 | -0.8 | 21.9 | -19.3 |
| **Construction GVA growth (% pa)** | : | 32.4 | -1.9 | 1.4 | -9.1 | -1.8 | 7.1 | -16.8 | -2.0 | 11.4 | 4.6 | 10.9 | -24.5 | -7.1 | -4.4 | 1.4 |
| **Agriculture share of GVA (%)** | 3.4 | 3.1 | 3.5 | 3.1 | 4.0 | 4.1 | 3.6 | 3.4 | 3.2 | 3.5 | 3.5 | 3.3 | 3.2 | 3.1 | 3.9 | 3.1 |
| **Construction share of GVA (%)** | 9.1 | 11.6 | 10.9 | 10.6 | 9.1 | 8.7 | 9.0 | 7.4 | 7.2 | 7.7 | 7.7 | 8.3 | 6.5 | 5.9 | 5.8 | 5.8 |

Sources: Calculations from Eurostat.

**Table 5.3 EU Support to Guadeloupe**

| | 2007-13 (€m) | Annual average (€m) | Share of 2007 GVA (%) | Share of 2010 GVA (%) |
|---|---|---|---|---|
| **ERDF (European Regional Development Fund)** | 543 | 78 | 1.1% | 1.0% |
| **ESF (European Social Fund)** | 185 | 26 | 0.4% | 0.3% |
| **EAFRD (European Agricultural Fund for Rural Development)** | 142 | 20 | 0.3% | 0.3% |
| | | | | |
| **Total GVA in 2007 (€m)** | 7,318 | | | |
| **Total GVA in 2010 (€m)** | 7,572 | | | |

Source: Eurostat.

The socio-economic context for Guadeloupe is set out in Box 2 below. This shows that although the contribution of the agricultural and construction sectors is relatively modest (combined with the large public sector work force), that it is also an important source of income for many people in Guadeloupe, people likely to be amongst the most vulnerably economically and with the lowest levels of resilience to climate change (including in relation to housing and health). The information presented in Box 2 also underlines that there are issues with the remoteness and lack of infrastructure or amenities for sections of the population. These are issues which are taken into account when assessing climate risks (see Appendix D and Section 6).

**Box 2 – Socio-economic context – Guadeloupe**

Together with Martinique (and Corsica), Guadeloupe will be the most rapidly ageing French region over the next two

decades, in contrast to previous decades when the population was generally younger than on the French mainland. As the aged population increases in number (and as a proportion of the total population), the population at school and working age will decrease. Immigration to Guadeloupe, although greater that Martinique for example, will not be at a level sufficient to compensate for the number of people leaving Guadeloupe. Many of those leaving are young men (under the age of 35) seeking work or to study, although longer term many do return.

The employment rate of 20-64 year olds (55% in 2010) was well below the French national and EU averages (69%). Although the number of jobs in some sectors has increased, especially in construction and private services, this has been able to balance the number of people seeking work. Although more women than men are unemployed, the most significantly impacted demographic group is young men where more than one in every two individuals is without employment. Of those in employment, a large proportion have been on short-term contracts and so vulnerable to any shocks to the labour market.

The labour market is service sector led (public sector and private services), accounting for over 80% of salaried workers. Numbers in the construction industry rose considerably between 2005 and 2007 (+20%) so that the sector accounts for 7.2% of salaried workers in the island. Other industrial activities employed 6.9%. Agriculture only employs 2% of salaried workers following a sharp fall in numbers between 2005 and 2007 (-9%).

With a significant proportion of the population living off social benefits, many live off a minimum income. In 2006, the poverty threshold was fixed at 6,806 Euros (compared with 10,560 in mainland France) and the income of 17.8% of Guadeloupe's population fell under this figure, a rise from 13.5% in 2001.

As a result of recent construction work not meeting the needs of the general population, 15% of dwellings in Guadeloupe are overpopulated. Furthermore, 15% of households do not have basic amenities (electricity, indoor water supply, sewage disposal).

Although life expectancy in Guadeloupe had reached the national level by the beginning of the 21st century, the gap has widened again since 2005. At the same time, infant mortality and maternal mortality remain high, respectively twice and five times higher than the national level. Mortality due to infectious diseases and external causes, notably accidents, are more frequent than on the French mainland.

Low education levels, exclusion from the work force and social vulnerability contribute strongly as social causes of mortality in Guadeloupe. Through lack of sufficient information or financial means, patients consult the doctor when the disease is already at an advanced stage. The number of general practitioners, and particularly specialists, per inhabitant are below the national average (10% and 33% respectively) and access to hospitals and other health centres remains difficult for isolated parts of the island.

There are problems related to water distribution and quality. Waste collection and sewage disposal still present a challenge to the environment, as 20% of households neither benefit from mains sewage disposal nor have a septic tank, and very little household waste is recycled (3% in 2005). The use of the dangerous pesticide chlordecone during the 1970s and up until 1993 contaminated soil and water sources, including the coastal regions.

In Guadeloupe, 14.7% of energy production is from renewable sources (geothermal, solar or hydraulic energy or wind power) however, this remains insufficient and below the EU target. The region imports all its fuel.

Source - Demographic and migration trends in the outermost regions: impacts on territorial, social and territorial cohesion? Executive Summary – Guadeloupe, European Commission[76]

## 5.2 Martinique

The agriculture assessment yields similar metrics as for the other French OR and suggests that Martinique is somewhat more dependent on agriculture than Madeira or the Canary Islands, but somewhat less dependent than Guadeloupe or French Guiana. On average in the period 2000-2006, agriculture represented some 3.3% of total GVA in Martinique compared to 2.2% in Madeira, 1.7% in The Canary Islands, 3.5% in Guadeloupe and 4.7% in French Guiana (all calculated on the same basis). Approximately 28% of the land in Martinique is used by the agriculture sector (around 31,000ha). Primary productions are bananas and sugarcane, which occupy 27% and 10% of the agricultural surface respectively. Among the other OR, only Madeira (6,100 ha) and French Guiana (23,800 ha) have less agricultural land in total.

In Martinique, there are relatively few overnight hotel stays by non-residents each year: 152,000 on average for the period 2006-2011 compared to 388,000 in Guadeloupe and substantially more in The Canary Islands (almost 40m), Madeira (almost 5m) or even the Azores (nearly 600,000). However, the value per stay is around three times higher than it is for Guadeloupe: €1,134 per stay compared to €367 per stay in Guadeloupe (also calculated as annual averages). Overall, the contribution of direct transactions with tourists

[76] http://ec.europa.eu/regional_policy/activity/outermost/publications_en.cfm

in Martinique is similar to Guadeloupe, at €154m each year (in 2000 prices). This equates to around 2.6% of annual GVA.

Accounting for wider economic impacts, the contribution of tourism to GVA increases from 2.7% in the direct case to almost 12%, averaged over 2006-2009. While the value of the direct transactions is fairly small (actually lower than the contribution of agriculture), the wider value of tourism is much higher, supporting the view that tourism is a critical sector of the Martinique economy, though perhaps not so important as it is to Guadeloupe (where the contribution is closer to 18%).

Martinique was hit by hurricanes in 1995 (Marilyn), 2001 (Iris) and 2007 (Dean)[77]. Of those, there is little evidence to suggest that Hurricane Marilyn had much of an impact at the macroeconomic level, based on its timing (September 1995) and the trends in agriculture and construction GVA. The former sees growth in 1996 and, in any case, the main growing season had largely passed; while the latter sector saw a decline in GVA growth and it seems unlikely that all the rebuilding would have been completed by the end of 1995, had the damage been substantial.

The evolution of the Martinique economy in 2001 fits the hypothesised post-hurricane pattern better with agriculture GVA falling sharply by almost 11% and construction GVA rising by almost 18% in the year that Hurricane Iris hit. The pattern is reversed the following year, lending support to the idea of a temporary shift in GVA.

However, the economic data do not suggest that Hurricane Dean had much of an effect at the macroeconomic level: the data on the two key sectors do not move in the way one would expect under these circumstances.

As with Guadeloupe (which is in the vicinity of Martinique), there is therefore some evidence to suggest that some climatic events are already having some bearing on the macroeconomic trajectory of Martinique (some evidence of macroeconomic vulnerability).

Between 2007-13, Martinique has been allocated around €417m of ERDF funds; almost €100m of ESF funds and around €100m of EAFRD funds. On an annual basis, this is equivalent to around 1.2% of the OR's GVA, a similar share to most of the other OR, all of which receive, on an annual basis, funds equivalent to around 2% of total GVA, with the exception of the Azores (more than 4%).

[77] United States National Oceanic and Atmospheric Administration National Hurricane Center: http://www.nhc.noaa.gov/pastall.shtml

**Table 5.4 Sector Metrics for Martinique**

| | Average agriculture GVA (€ millions; 2000 prices) | Average share of agriculture in total GVA (%) | Average utilised agricultural area ('000s ha) | GVA per ha of utilised agricultural land (€/ha; 2000 prices) | Average crop yields (100 kg/ha) | Average crop value (€/kg) |
|---|---|---|---|---|---|---|
| **Agriculture** | 187.7 | 3.3% | 31.2 | 6,003.1 | 596.3 | 0.10 |
| | Average direct contribution to GVA (€ millions; 2000 prices) | Average direct contribution to GVA (%) | Average direct contribution to employment ('000s) | Average direct contribution to employment (%) | Average nights spent by non-residents in hotels ('000s) | Tourism GVA per night spent in hotel (€; 2000 prices) |
| **Tourism: Direct** | 156.3 | 2.7% | 3.6 | 2.8% | 152.2 | 1,148.4 |
| | Average total contribution to GVA (€ millions; 2000 prices) | Average total contribution to GVA (%) | Average total contribution to employment ('000s) | Average total contribution to employment (%) | Average nights spent by non-residents in hotels ('000s) | Tourism GVA per night spent in hotel (€; 2000 prices) |
| **Tourism: Total** | 677.8 | 11.5% | 13.9 | 10.8% | 152.2 | 4,963.1 |

Notes: Agriculture averages calculated over 2000-2006; Tourism GVA averages calculated over 2006-2009; and other tourism averages calculated over 2006-2011.

Sources: Calculations from Eurostat and WTTC.

**Table 5.5 Macroeconomic Trends in Martinique**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Agriculture GVA growth (% pa)** | : | 10.3 | 6.8 | 1.7 | 3.0 | 5.0 | -10.8 | 17.7 | -7.3 | -11.0 | -5.7 | -1.1 | 11.3 | -2.1 | 22.2 | -19.3 |
| **Construction GVA growth (% pa)** | : | -2.9 | -4.9 | 0.9 | 0.3 | -2.7 | 17.8 | -11.6 | -1.8 | 1.7 | 7.2 | -6.5 | -4.8 | -8.4 | -4.1 | 1.4 |
| **Agriculture share of GVA (%)** | 3.5 | 3.7 | 3.8 | 3.8 | 3.8 | 3.9 | 3.4 | 3.9 | 3.6 | 3.1 | 2.8 | 2.7 | 3.1 | 3.0 | 3.8 | 3.0 |
| **Construction share of GVA (%)** | 7.7 | 7.2 | 6.6 | 6.5 | 6.3 | 6.0 | 6.8 | 6.0 | 5.9 | 5.7 | 5.9 | 5.3 | 5.3 | 4.8 | 4.8 | 4.7 |

Sources: Calculations from Eurostat.

**Table 5.6 EU Support to Martinique**

| | 2007-13 (€m) | Annual average (€m) | Share of 2007 GVA (%) | Share of 2010 GVA (%) |
|---|---|---|---|---|
| **ERDF (European Regional Development Fund)** | 417 | 60 | 0.8% | 0.8% |
| **ESF (European Social Fund)** | 98 | 14 | 0.2% | 0.2% |
| **EAFRD (European Agricultural Fund for Rural Development)** | 103 | 15 | 0.2% | 0.2% |
| | | | | |
| **Total GVA in 2007 (€m)** | 7,179 | | | |
| **Total GVA in 2010 (€m)** | 7,330 | | | |
| Source: Eurostat. | | | | |

The socio-economic context for Martinique is set out in Box 3 below. This shows that, in addition to the public sector, the agricultural sectors is an important source of income for many people in Martinique, people likely to be amongst the most vulnerably economically and with the lowest levels of resilience to climate change (including in relation to housing and health). The information presented in Box 3 also underlines that as with much of the OR, there are issues with the remoteness and lack of infrastructure or amenities for sections of the population. These are issues which are taken into account when assessing climate risks (see Appendix D and Section 6).

**Box 3 – Socio-economic context – Martinique**

According to the national statistics office (INSEE) projections, the population of Martinique will stagnate over the next 20-30 years and, as noted previously, the population is rapidly aging, with the proportion of people over the age of 65 increasing. As with Guadeloupe, immigration will not be at a level sufficient to compensate for the number of people leaving the island. Many of those leaving are young men (under the age of 35) seeking work or to study, although longer term many do return.

Illiteracy is high in Martinique although progress has been made in recent years and there is a high proportion of tertiary educated people aged 30-34.

The employment rate of the 20-64 year olds was the highest of all French Overseas Departments (56% in 2010 although still well below national and EU averages. In contrast to women in Guadeloupe, Martinicain women have similar unemployment rates to men (22.7% and 20.6% respectively in 2009)9. However there are distinct differences according to age. Young people have the highest unemployment rates (61%), the rate being far higher than in Guadeloupe or mainland France. Among young adults, 38% of 20-24 year olds were neither students nor employed. Although this rate is the lowest of all ORs, this is twice as high as national average (20%). Furthermore, one third of the under 30s in work were on short-term contracts in 2009.

The labour market is service sector led (public sector and private services), accounting for over 80% of salaried workers. Numbers in the construction industry rose considerably between 2005 and 2007 (+20%) so that the sector accounts for 6.5% of salaried workers in the island. Other industrial activities employed 6.9%. Agriculture employs 4.2% of salaried workers.

With 22% of the population over 15 living off social benefits, many live off a minimum income (16%). In 2006, the poverty threshold was fixed at 7394 Euros (compared with 10,560 in mainland France), higher than other French Overseas Departments, with 19% of the population being in poverty in 2006.

As a result of recent construction work not meeting the needs of the general population, 15% of dwellings in Martinique are overpopulated. Furthermore, 12% of households do not have basic amenities (electricity, indoor water supply, sewage disposal).

Although life expectancy in Martinique had reached the national level by the turn of the 1990s, infant mortality and maternal mortality remain high, respectively twice and three times higher than the national level. The population of

**Box 3 – Socio-economic context – Martinique continued ..**

Martinique is particularly affected by chronic diseases linked to problems of nutrition, such as diabetes, obesity, cardiovascular diseases (the primary cause of mortality). Access to hospitals and other health centres remains difficult for isolated parts of the island.

There are problems related to water distribution and quality. The use of the dangerous pesticide chlordecone during the 1970s and up until 1993 contaminated soil and water sources, including the coastal regions. On the other hand, the production of waste has decreased by 4.2% between 2006 and 2007, despite a 0.6% increase in the population. Over 42% of waste products are used in energy production, but selective collection for recycling remains at a low level.

In Martinique, electricity production from renewable sources only covers 2% of the island's needs. It is produced by the waste incineration factory (4 MW), wind turbines in Vauclin (1 MW) and from 42 solar panel installations connected to the EDF network. This clearly insufficient and the region continues to import the entirety of its petrol.

Source - Demographic and migration trends in the outermost regions: impacts on territorial, social and territorial cohesion? Executive Summary – Martinique, European Commission[78]

### 5.3 French Guiana

As for other OR, the economy of French Guiana is dominated by the services sector. Agriculture accounts for around 5% of total GVA in French Guiana each year, based on an average during the period 2000-2006. Key crops include cereal and sugarcane. This share is relatively high both among the French OR. Only the Azores have a higher dependence on agriculture (11-12% on average, again between 2000-2006). The amount of GVA associated with 1 ha of agricultural land is similar to most of the other OR. To that extent, French Guiana is somewhat more vulnerable to climate impacts that affect agriculture.

There were no data available from WTTC on tourism by value in French Guiana, only a Eurostat figure for the total number of nights spent in hotels by all non-residents each year: 55,000 stays per year, calculated as an average between 2006-2011. This figure is the lowest of any of the OR[79] and, moreover, the ratio of tourist stays to population is also among the lowest when comparing French Guiana to the other OR (0.2 per capita compared to 0.4 in Martinique and nearly 20 for Madeira and The Canary Islands). Unless the value of those stays was very high, the implication is that tourism is less important to French Guiana than perhaps it is for the other OR.

In absolute terms, French Guiana receives a relatively small amount of EU subsidy, totalling less than €500m over the 2007-13 period. However, relative to its economic size, this represents around 2% of GVA each year (when the subsidies are averaged out over the seven-year period). This ratio is similar to most of the other OR (for The Azores, the ratio is higher, at around 4%).

[78] http://ec.europa.eu/regional_policy/activity/outermost/publications_en.cfm
[79] The OR with the next-lowest number of stays is Réunion, with 76,000 each year.

**Table 5.7 Sector Metrics for French Guiana**

| | Average agriculture GVA (€ millions; 2000 prices) | Average share of agriculture in total GVA (%) | Average utilised agricultural area ('000s ha) | GVA per ha of utilised agricultural land (€/ha; 2000 prices) | Average crop yields (100 kg/ha) | Average crop value (€/kg) |
|---|---|---|---|---|---|---|
| **Agriculture** | 78.3 | 4.7% | 23.8 | 4,071.8 | 589.1 | 0.07 |
| | Average direct contribution to GVA (€ millions; 2000 prices) | Average direct contribution to GVA (%) | Average direct contribution to employment ('000s) | Average direct contribution to employment (%) | Average nights spent by non-residents in hotels ('000s) | Tourism GVA per night spent in hotel (€; 2000 prices) |
| **Tourism: Direct** | : | : | : | : | 54.5 | : |
| | Average total contribution to GVA (€ millions; 2000 prices) | Average total contribution to GVA (%) | Average total contribution to employment ('000s) | Average total contribution to employment (%) | Average nights spent by non-residents in hotels ('000s) | Tourism GVA per night spent in hotel (€; 2000 prices) |
| **Tourism: Total** | : | : | : | : | 54.5 | : |

Notes: Agriculture averages calculated over 2000-2006; Tourism GVA averages calculated over 2006-2009; and other tourism averages calculated over 2006-2011.

Sources: Calculations from Eurostat and WTTC.

**Table 5.8 Macroeconomic Trends in French Guiana**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Agriculture GVA growth (% pa)** | : | 15.4 | -6.6 | 10.9 | 0.6 | -11.8 | 0.7 | 6.8 | -7.2 | 16.0 | 8.4 | 17.2 | -1.0 | 1.2 | 29.4 | -19.3 |
| **Construction GVA growth (% pa)** | : | 17.3 | 10.8 | -5.7 | -1.1 | -6.2 | 24.1 | -21.6 | -1.7 | 17.8 | -6.9 | 7.1 | -10.4 | -5.2 | 1.5 | 1.4 |
| **Agriculture share of GVA (%)** | 4.8 | 5.6 | 5.2 | 5.3 | 5.1 | 5.1 | 4.4 | 4.5 | 4.1 | 4.8 | 4.9 | 5.4 | 5.3 | 5.2 | 6.5 | 5.1 |
| **Construction share of GVA (%)** | 7.9 | 9.6 | 10.4 | 9.1 | 8.6 | 9.2 | 9.6 | 7.2 | 7.0 | 8.3 | 7.4 | 7.3 | 6.6 | 6.0 | 5.9 | 5.8 |

Sources: Calculations from Eurostat.

**Table 5.9 EU Support to French Guiana**

| | 2007-13 (€m) | Annual average (€m) | Share of 2007 GVA (%) | Share of 2010 GVA (%) |
|---|---|---|---|---|
| **ERDF (European Regional Development Fund)** | 305 | 44 | 1.6% | 1.4% |
| **ESF (European Social Fund)** | 100 | 14 | 0.5% | 0.5% |
| **EAFRD (European Agricultural Fund for Rural Development)** | 77 | 11 | 0.4% | 0.4% |
| | | | | |
| **Total GVA in 2007 (€m)** | 2,769 | | | |
| **Total GVA in 2010 (€m)** | 3,093 | | | |
| Source: Eurostat. | | | | |

Box 4 sets out the socio-economic context for French Guiana. The geography for the territory and the significant natural assets of French Guiana shape much of the socio-economic situation. The majority of the population are situated along the cost, as is most of the significant infrastructure, but there is a population inland who have very special needs and historical and cultural differences to the majority of the population. Connecting these populations to services is a significant challenge. The information presented in Box 3 also underlines that, although not an island, French Guiana has much in common with the rest of the OR with issues relating to remoteness and lack of infrastructure or amenities for large sections of the population. These are issues which are taken into account when assessing climate risks (see Appendix D and Section 6).

**Box 4 – Socio-economic context – French Guiana**

With 86,504 km2, French Guyana is the largest of all French regions; however, 96% of the territory is covered by equatorial forest and most of the population resides along the 300 km long coastal area. But, the various populations living inland have too often been forgotten in the past, despite French Guyana's population is experiencing the fastest growth of all French regions, from 2000 to 2008, growing annually by 4% (close to 5% for some years).

In 2007, foreign-born immigrants made up 30% of the population, most originating from Haiti and bordering countries (Surinam and Brazil). Migrants are particularly young - almost three out of four are 18 to 35 years old when they enter the region and 61% are women This high figure is related to family reunification that was the reason for admission for more than half of arrivals in 2006.

French Guyana is by far the youngest region in the EU, with only 4% of the population aged 65 years and over and 35% of children under age 15 (twice as much as in mainland France). As a result, the dependency ratio is the highest of all of the OR.

Only 19% of 30-34 years olds hold tertiary diplomas compared with 42% in France. Furthermore, there is a large gap between the French Guyana-born (17%) and migrants born in mainland France (62%). Foreign migrants have very low qualification levels, with only 4% holding tertiary diplomas. Migration from mainland France increases the skill levels of the labour force, but the high number of low skilled foreign migrants has a strong counter effect. Despite highly-skilled migration from Europe (French and other EU nationals), the region is the third lowest OR in terms of skill levels after the Azores and Madeira.

Given the speed of population growth it is perhaps unsurprising that the employment market has been unable to keep pace with demand for jobs. In 2010, the employment rate of the 20-64 years olds (53%) was below the average of Caribbean French Overseas Departments and well below national and EU (69%) averages (although male employment rates are typically higher that other French Overseas Departments). Guyanese people who have jobs are often on fixed-term contracts or working part-time. Part-time work is more frequent among young workers below age 30 (19%) and among women (18%).

**Box 4 – Socio-economic context – French Guiana Continued ..**

In 2005-2007, construction was the main component of employment growth, with a 30% increase, followed by industry (+10%), and these sectors account for respectively 7% and 9% of all jobs. However, as in other Departments, the number of jobs in agriculture has been declining (-12.2%).

Almost fifteen percent (14.8%) of the population over the age of 15 live on social benefits. In 2006, the poverty threshold was fixed at 5952 Euros (compared with 10,560 in mainland France), with 27% of the population being in poverty in 2006. higher than all of the other French Overseas Departments,

French Guyana is the French Overseas Departments with the highest proportion of 'poor' housing (32%) (shanty, traditional or wooden houses lacking electricity, running water or sewage disposal). Due to high fertility and large families, the average number of persons per room is higher than in other Overseas Departments and the proportion of households in social housing (16%) is well below the number of households that should be entitled to such housing.

Life expectancy in French Guiana is 2.5 years below the national average and both infant mortality and maternal mortality are much higher than the national level. Infectious diseases are more frequent in French Guyana than on the continent, partly owing to the climate. The highly dispersed nature of the resident population, low educational levels, unemployment, inactivity, social vulnerability and cultural factors are the main social causes of high mortality in French Guyana. Availability of health services in French Guyana is the lowest of all French Overseas Departments, mainly due to rapid population growth. The numbers of doctors and specialists per inhabitant are respectively 40% and 60% below national average. For people residing in the interior of the territory, far from the coastal area, considerable expense and time are necessary to travel to hospitals and health centres.

Access to health services for all is difficult, because most of the facilities are in the coastal areas and many medical specialties are lacking. For instance, there are only 3 cardiologists and no intensive care unit. Many cases are referred to mainland France hospitals, because of what amounts to a two-tiered health care system: one tier for the well-off and another for the poorer population. Among health priorities are malaria and dengue fever that result in high losses of work days, other infectious diseases (yellow fever) and new diseases (chicoungunya, ebola).

Thanks to the size of the territory and large rivers, dams produce 70% of French Guyana's electricity, far above the EU2020 goal (20%). At the same time, all fossil fuels are imported. French Guyana has sufficient space to produce bio-fuels, but the environmental impact has to be evaluated first. It also appears that the dams release more greenhouse gases in tropical climate. French Guyana also witnesses significant difficulties in providing safe drinking water (due to mercury contamination in some areas). Extending waste water collection and treatment to informal urban areas is also a challenge.

Source - Demographic and migration trends in the outermost regions: impacts on territorial, social and territorial cohesion? Executive Summary – French Guyana, European Commission[80]

## 5.4 La Réunion

Averaged over 2000-2006, Réunion has the lowest dependence on agriculture among the French OR (2.1%; the other three have agriculture sectors that account for 3% or more of GVA; in French Guiana, the share is 4.7%). La Réunion also has a relatively low dependence when compared to the other, Portuguese and Spanish, OR (similar to Madeira at 2.2% but substantially lower than The Azores at 11-12%). To that extent there is little about this sector that suggests much vulnerability to climate risk, and this supports the risk analysis elsewhere in this study. Agriculture occupies 18% of the land in La Réunion. Sugarcane is the primary production and occupies more than half of all agricultural land (ONERC, 2012).

Réunion is one of just three OR for which the WTTC publishes analysis of the contribution of tourism to the economy. As an average share over 2006-2009, the direct value of tourism is similar to that of Guadeloupe and Martinique (a little under 3%), although it should be borne in mind that the Réunion economy is substantially larger than either of those two; approximately €10bn each year compared to €6bn in the other two. The total value of tourism is higher, even though the share is similar.

Once the wider economic effects have been included the value of tourism to Réunion amounts to some 8% of annual GVA when taken as an average over 2006-09. This is lower than Guadeloupe (18%) or Martinique (12%), possibly indicating a slightly higher dependence on imports to support tourism in Réunion; relatively less of the value added is retained in local business, actually making Réunion somewhat more resilient in economic terms to reductions in tourism.

In terms of broader macroeconomic impacts of climate change, Tropical Cyclone Dina caused flooding in Réunion at the beginning of 2002 but it is difficult to discern any macroeconomic effect from Table 0.2 in

[80] http://ec.europa.eu/regional_policy/activity/outermost/publications_en.cfm

terms of a departure from trend: agriculture GVA declines by 2.7%, but this is in keeping with the declines in the previous two years while construction GVA grows by 1.3%, but by less than the 4.7% seen in 2001. This may be because the impacts were small relative to the economy of Réunion (€95m of damage compared to total GVA of €9.2bn in 2002, at current prices).

There are other instances of agriculture output falling and construction activity rising, but from the available information, it is difficult to attribute these to the impact of climate change-related events. The fire in November 2011 is currently too recent to assess properly from a macroeconomic point of view.

Compared to its annual GVA, Réunion receives EU subsidies of a similar size to most other OR[81]: 1.8% of total GVA on an annualised basis. The majority (just over €1bn) comes from the ERDF with a further €517m from the ESF and the remaining €329m from the EAFRD.

**Table 5.10 Sector Metrics for Réunion**

| **Agriculture** | **Average agriculture GVA (€ millions; 2000 prices)** | **Average share of agriculture in total GVA (%)** | **Average utilised agricultural area ('000s ha)** | **GVA per ha of utilised agricultural land (€/ha; 2000 prices)** | **Average crop yields (100 kg/ha)** | **Average crop value (€/kg)** |
|---|---|---|---|---|---|---|
| | 191.7 | 2.1% | 48.6 | 3,949.2 | 952.0 | 0.04 |
| **Tourism: Direct** | Average direct contribution to GVA (€ millions; 2000 prices) | Average direct contribution to GVA (%) | Average direct contribution to employment ('000s) | Average direct contribution to employment (%) | Average nights spent by non-residents in hotels ('000s) | Tourism GVA per night spent in hotel (€; 2000 prices) |
| | 307.5 | 2.9% | 7.0 | 3.0% | 75.6 | 4,823.2 |
| **Tourism: Total** | Average total contribution to GVA (€ millions; 2000 prices) | Average total contribution to GVA (%) | Average total contribution to employment ('000s) | Average total contribution to employment (%) | Average nights spent by non-residents in hotels ('000s) | Tourism GVA per night spent in hotel (€; 2000 prices) |
| | 825.6 | 7.8% | 17.5 | 7.4% | 75.6 | 12,936.5 |

Notes: Agriculture averages calculated over 2000-2006; Tourism GVA averages calculated over 2006-2009; and other tourism averages calculated over 2006-2011.

Sources: Calculations from Eurostat and WTTC.

[81] This amounts to 2% or less of GVA each year with the exception of The Azores, where the annual share is more than 4%.

**Table 6.11 Macroeconomic Trends in Réunion**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Agriculture GVA growth (% pa)** | : | 7.7 | -2.9 | -12.2 | 23.8 | -3.8 | -11.1 | -2.7 | -7.2 | 5.5 | 14.4 | 5.5 | -26.3 | 3.8 | 23.2 | -19.3 |
| **Construction GVA growth (% pa)** | : | -1.1 | 2.1 | 6.6 | 11.4 | 0.9 | 4.7 | 1.3 | -1.9 | 11.6 | 12.8 | 19.9 | -16.6 | -2.8 | -3.4 | 1.4 |
| **Agriculture share of GVA (%)** | 2.9 | 3.1 | 2.8 | 2.4 | 2.8 | 2.6 | 2.2 | 2.1 | 1.9 | 1.9 | 2.1 | 2.1 | 1.5 | 1.5 | 1.9 | 1.5 |
| **Construction share of GVA (%)** | 6.6 | 6.4 | 6.2 | 6.3 | 6.6 | 6.5 | 6.5 | 6.3 | 6.2 | 6.4 | 6.9 | 7.9 | 6.6 | 5.9 | 5.9 | 5.8 |

Sources: Calculations from Eurostat.

**Table 6.12 EU Support to Réunion**

| | 2007-13 (€m) | Annual average (€m) | Share of 2007 GVA (%) | Share of 2010 GVA (%) |
|---|---|---|---|---|
| **ERDF (European Regional Development Fund)** | 1,014 | 145 | 1.1% | 1.0% |
| **ESF (European Social Fund)** | 517 | 74 | 0.6% | 0.5% |
| **EAFRD (European Agricultural Fund for Rural Development)** | 329 | 47 | 0.4% | 0.3% |
| | | | | |
| **Total GVA in 2007 (€m)** | 12,761 | | | |
| **Total GVA in 2010 (€m)** | 13,951 | | | |

Source: Eurostat.

The socio-economic context for La Réunion is set out in Box 5 below. This shows that one of the most significant socio-economic challenges is the low level of education amongst many of the young people who remain in the island (with many with higher educational attainment taking the opportunity to leave the island to further their education). The pressures of an increasing population exacerbate competition for land, squeezing land available for agriculture which could provide job opportunities. With many people living in poor accommodation and a lack of infrastructure in the islands interior, many people are socially vulnerable and likely to be amongst the most vulnerably economically and with the lowest levels of resilience to climate change (including in relation to housing and health). These are issues which are taken into account when assessing climate risks (see Appendix D and Section 6).

**Box 5 – Socio-economic context – Reunion Island**

Reunion Island's population has increased by 15% in a decade (2000 to 2010), a concern as the population is likely to reach over one million by 2020, threatening the availability of land for uses other than housing and supporting infrastructure. Migration flows are significant but net migration is near zero due to similar numbers of in and out migrants. As with other OR, the leaving are mainly young adults (ages 15 to 34). Nevertheless, the population is relatively young, with 26% of people being under the age of 15. A similar brain drain is observed to that in the French Caribbean islands, but it is even more severe for Reunion Island since 60% of the island-born with tertiary education live in mainland France.

In 2010, the employment rate of the 20-64 years old population (50%) was the lowest of all French Overseas Departments and far below the national and EU averages (69%). Women are more frequently unemployed than men while young adults are the most likely to be unemployed, with unemployment strongly associated with low educational level. Half of the people in long-term unemployment have been unemployed for 3 years or more, meaning that they are virtually 'excluded' from the labour market. Over one-third (39%) of families with children have no adult in paid work.

Reunion Island shows the highest proportion of workers holding fixed-term contracts of all French Overseas Departments ( 16% in 2009), compared to 14% in French Guyana and 10% in Caribbean Departments. This situation is most frequent for young people, with almost one out of three workers below the age of 30 holding such contracts. Reunion Island's economy is mostly based on services and secondarily on construction (9%), industry (5%) and agriculture (4%).

With 23% of the population over 15 living off social benefits, many live off a minimum income (17%). In 2006, the poverty threshold was fixed at 5676 Euros (compared with 10,560 in mainland France), higher that other French Overseas Departments, with 17% of the population being in poverty in 2006.

As a result of recent construction work not meeting the needs of the general population, 17% of all households live in crowded apartments while 15% of housing could be considered as 'poor' (shanty, traditional or wooden houses lacking electricity, inside water or sewage disposal.). Water supply and waste water collection is difficult due to urban sprawl.

Although life expectancy in Reunion Island is 2.5 years less than the national level and both infant and maternal mortality remain high. Infectious diseases are more frequent on the island than on the continent. Low educational level, unemployment, inactivity and social vulnerability are the main social causes of high mortality in Reunion Island. People delay visits to health services until their condition becomes severe, due to lack of knowledge or low resources. The relatively low availability of health services (particularly in the island's interior) is also a cause of high mortality.

In 2009, 32.5% of Reunion Island's electricity production was from renewable sources, down from 40% in 2004. The reason for this decline is a more rapid increase in consumption than the corresponding increase in renewable energy production. All fuels used in Reunion Island are imported.

Source - Demographic and migration trends in the outermost regions: impacts on territorial, social and territorial cohesion? Executive Summary – Reunion Island, European Commission[82]

## 5.5 Canary Islands

The economy of the Canary Islands is far larger than any of the other regions that make up the OR: between €20-30bn over the period for which there are data compared to €10bn for Réunion and €6bn or less for the others[83]. Most of that economic activity (70-80%) is concentrated in services, with, on average over 2000-2006, only 1.7% accounted for by agriculture, with an emphasis on tree fruits (bananas and tomatoes, in particular).

While it has the largest agricultural sector of the OR in absolute terms (€430m compared to €200m or less for all but the Azores, where the sector is somewhat larger in value, representing around €300m), the Canary Islands show a limited dependency on agriculture in percentage terms. The amount of GVA associated with a single hectare is similar to most of the other regions; €5,470 per ha, within the range of €4,000-6,000 of most of the others[84].

Of the OR, The Canary Islands are by far the most popular tourist destination, with, on average, around 40m stays per year over 2006-2011. In contrast, Madeira has on average less than 5m stays per year and for the other OR the annual total is less than 0.5m. Even in the absence of comparable economic data across OR,

[82] http://ec.europa.eu/regional_policy/activity/outermost/publications_en.cfm

[83] In real terms, though not at Purchasing Power Standards, making cross-country comparisons somewhat problematic.

[84] The exception is Madeira, which has a far-higher implied GVA per ha of €11,500.

there is other evidence to suggest that the Canary Islands are highly dependent on tourism, including a DG Regional Policy report[85] that states that the number of overnight stays per capita over 1996-2008 was 74.7, substantially larger than the average for Spain as a whole.

While there are instances of climatic events that one might think would indicate that the Canary Islands are already being affected in macroeconomic terms by climate change, such events are more difficult to discern in the available economic data:

- While it is true that agriculture activity fell (by 3.7%) and construction activity rose (by 8.9%) in 2002 (when heavy flooding in Santa Cruz de Tenerife led to more than €120m of damages (Dorta, 2007), there appears to be some continuation of the trends in previous years: it is not immediately obvious that there had been a significant climate impact in that sense;
- The impact of Tropical Storm Delta in 2005[86], leading to power outages, is not particularly clear in Table 0.2; nor is it evident in the data in Appendix F that it had much of a macroeconomic effect: the estimate of €6.9m of damage to agricultural infrastructure, for example, is too small to identify in the aggregate data available from Eurostat; and
- The (macroeconomic) impact of the fires in August 2012 (which are too recent to compare to any economic data) remains to be seen although, at an estimated €3m[87] of damage in the agriculture sector, it may be difficult to see this in the forthcoming economic data.

Events in 2007 may arguably show up at the macroeconomic level although these two sets of events alone fail to explain the increase in construction GVA of almost €300m in current prices[88]:

- Storm damage of almost €18m to El Hierro[89], the smallest of the Canary Islands, coincided with a strong increase in construction GVA (although it would account for a small portion of the overall increase); combined with; and
- The forest fires on Gran Canaria, Tenerife and La Gomera, which lead to direct damages of some €144m[90].

Overall, evidence for existing substantial impacts to the economic performance of The Canary Islands at the macroeconomic level is fairly weak. This is of course not to say that the impacts are not significant at a sector/local level, only that their impacts are not straightforward to identify in the available *macroeconomic* data.

The Canary Islands have been allocated around €1bn of ERDF subsidies over 2007-13, with a further €271m from the ESF and EAFRD. While a relatively large amount in absolute terms compared to the other OR, the size of The Canary Islands economy is such that, on an annualised basis, these funds represent around 0.5% of GVA. This is the lowest amount of funds relative to GVA of any of the OR.

[85] DG Regional Policy (2011), 'Growth Factors in the Outermost Regions'

[86] http://www.wwf.or.jp/activities/lib/pdf_climate/environment/stormy_europe_report_final_010306.pdf http://www.climateadaptation.eu/spain/en#storms

[87] http://www.gobiernodecanarias.org/noticias/?module=1&page=nota.htm&id=150727

[88] Because the figure is GVA, the value of the damage should exceed the change in GVA.

[89] http://www.montesquieu-institute.eu/9353000/1/j4nvgs5kjg27kof_j9vvhfxcd6p0lcl/vj6iphzu2gxo/f=/15767_08.pdf

[90] http://www.montesquieu-institute.eu/9353000/1/j4nvgs5kjg27kof_j9vvhfxcd6p0lcl/vj6iphzu2gxo/f=/15767_08.pdf http://edz.bib.uni-mannheim.de/daten/edz-ma/ep/08/EST19989.pdf

**Table 5.13 Sector Metrics for the Canary Islands**

| | Average agriculture GVA (€ millions; 2000 prices) | Average share of agriculture in total GVA (%) | Average utilised agricultural area ('000s ha) | GVA per ha of utilised agricultural land (€/ha; 2000 prices) | Average crop yields (100 kg/ha) | Average crop value (€/kg) |
|---|---|---|---|---|---|---|
| **Agriculture** | 431.8 | 1.7% | 80.4 | 5,470.1 | 922.7 | 0.06 |
| | Average direct contribution to GVA (€ millions; 2000 prices) | Average direct contribution to GVA (%) | Average direct contribution to employment ('000s) | Average direct contribution to employment (%) | Average nights spent by non-residents in hotels ('000s) | Tourism GVA per night spent in hotel (€; 2000 prices) |
| **Tourism: Direct** | : | : | : | : | 39,555.0 | : |
| | Average total contribution to GVA (€ millions; 2000 prices) | Average total contribution to GVA (%) | Average total contribution to employment ('000s) | Average total contribution to employment (%) | Average nights spent by non-residents in hotels ('000s) | Tourism GVA per night spent in hotel (€; 2000 prices) |
| **Tourism: Total** | : | : | : | : | 39,555.0 | : |

Notes: Agriculture averages calculated over 2000-2006; Tourism GVA averages calculated over 2006-2009; and other tourism averages calculated over 2006-2011.

Sources: Calculations from Eurostat and WTTC.

**Table 5.14 Macroeconomic Trends in the Canary Islands**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Agriculture GVA growth (% pa)** | : | 18.1 | 8.7 | 1.7 | -5.3 | -17.1 | -3.4 | -3.7 | -3.3 | -1.4 | -0.5 | -0.1 | 8.2 | -4.0 | -0.4 | -5.7 |
| **Construction GVA growth (% pa)** | : | -0.7 | 4.4 | 12.7 | 15.1 | 7.6 | 10.8 | 8.9 | -1.3 | 4.3 | 0.6 | -0.4 | 3.7 | 7.7 | -14.7 | -7.5 |
| **Agriculture share of GVA (%)** | 2.5 | 2.9 | 3.0 | 2.9 | 2.6 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.6 | 1.5 | 1.6 | 1.6 | 1.7 | 1.5 |
| **Construction share of GVA (%)** | 7.9 | 7.6 | 7.7 | 8.2 | 8.7 | 9.1 | 9.6 | 10.2 | 9.8 | 10.0 | 9.8 | 9.5 | 9.5 | 10.9 | 9.6 | 8.7 |

Sources: Calculations from Eurostat.

**Table 5.15 EU Support to the Canary Islands**

| | 2007-13 (€m) | Annual average (€m) | Share of 2007 GVA (%) | Share of 2010 GVA (%) |
|---|---|---|---|---|
| **ERDF (European Regional Development Fund)** | 1,019 | 146 | 0.4% | 0.4% |
| **ESF (European Social Fund)** | 117 | 17 | 0.0% | 0.0% |
| **EAFRD (European Agricultural Fund for Rural Development)** | 154 | 22 | 0.1% | 0.1% |
| | | | | |
| **Total GVA in 2007 (€m)** | 37,428 | | | |
| **Total GVA in 2010 (€m)** | 37,247 | | | |
| Source: Eurostat. | | | | |

The socio-economic context for the Canary Islands is set out in Box 6 below. This shows that one of the most significant socio-economic challenges is the pressure that population (and more specifically, high population density) puts on finite water resources and the consequences of this upon households (and biodiversity and economic sectors reliant upon water). The likelihood that immigrant population will live in rented accommodation may impact their adaptive capacity and minimise any driver for adaptations to the home. These issues presented in Box 6 are taken into account when assessing climate risks (see Appendix D and Section 6).

**Box 6 – Socio-economic context – Canary Islands**

The Canary Islands region is the most populated of the OR. Migration trends have transformed over recent decades, meaning that the Canary Islands have ceased to be a land of emigration and have become an important immigration destination at the southern limit of the EU. Recently, there has been high population mobility at all scales: external and internal, permanent, temporary or circular. This mobility has impacted Canary Islands society in various ways while, at the same time, the population has continued to age. Population issues have become central in public debate in the region.

Considering occupations by sector, the tertiary sector has increased its share in the economy. Meanwhile, the farming sector has lost jobs and the industrial sector holds less importance than on the national level. During the period of economic growth, from 1994 to 2007, the construction sector accounted for most jobs. However, the current crisis has drastically reduced its position. It is in this sector, in addition to some parts of the service sector, that the proportion of low-skilled jobs is the greatest. Immigration contributes highly to this labour force. The Canary Islands labour market is characterised by temporary contracts, particularly amongst the young, women, immigrants and low skilled workers.

The housing market in the Canary Islands is characterised by a low proportion of rented property and, as elsewhere in Spain, by a sharp rise in housing prices during the last phase of economic growth. The second home market has expanded rapidly over recent years owing to both internal and external demand. Apart from EU nationals, the immigrant population lives more often than Spanish households in rented dwellings. Home ownership is particularly infrequent amongst immigrants originating from Africa.

Life expectancy in the Canary Islands is below the Spanish average but above that for the whole of the EU. In terms of numbers of medical staff, the Canary Islands are less well provided for than Spain although the region does have a higher number of hospital beds per 1000 inhabitants.

Poverty and income inequalities are high in the region with the economic crisis is further exacerbating them. The proportion of households and of individuals living in relative poverty is higher than the national average, the Canary Islands ranking fifth out of 17 regions. The situation has worsened recently.

The volume of drinking water provided and of water consumed has been increasing over the last decade. Annual consumption by households is at the national level, but the unitary value of water is higher in the Canary Islands.

**Box 6 – Socio-economic context – Canary Islands Continued ..**

Desalinisation plays a key role in water provision, ahead of surface or underground water sources. Particularly notable is that 85% of water resources are privately managed. Crude electricity production increased until 2008. Energy consumption rose over the same period (until 2007). Each island within the region, apart from Fuerteventura, manages its electricity production independently.

Source - Demographic and migration trends in the outermost regions: impacts on territorial, social and territorial cohesion? Executive Summary – Canary Islands, European Commission[91]

## 5.6 The Azores

The analysis suggests that, of the OR, The Azores shows the greatest economic dependence on agriculture. This sector contributes some €273m (2000 prices) to the island's GVA, based on an average over 2000-2006. This is typically equivalent to 11-12% of total GVA each year.

For the purposes of comparison, the OR with the next-largest agriculture share in total GVA (calculated as an average over a similar period) is French Guiana, at less than 5%. This greater reliance on agriculture in The Azores, combined with agriculture's relatively higher vulnerability to climate change, supports the risk-assessment finding that the economy of the Azores is likely to be at relatively greater risk from climate change compared to the other OR.

While the economy of The Azores shows relatively higher dependence on agriculture, the data also show that greater vulnerability of the sector to climate change is because a much larger area of the island is devoted to agriculture: 131,000 ha compared to 80,000 ha in The Canary Islands and even less in the other OR. The Azores are relatively land-intensive in terms of crop weight per hectare, with the Eurostat data indicating that potatoes and sugar cane are the most prevalent crops on the island.

Overall, The Azores show somewhat lower agricultural land intensity by value than the other OR, with 1 ha of agricultural land representing just over €2,000 of value added (in 2000 real terms, averaged over 2000-2006) compared to €4,000-6,000 in the other OR[92]. A 1 ha reduction in agricultural land represents a smaller amount of GVA in euro terms, although, by virtue of the importance of the sector to The Azores, the proportion of GVA potentially 'lost' is greater.

There were no data available from WTTC on tourism by value in Azores, only a Eurostat figure for the total number of nights spent in hotels by all non-residents each year: 584,000 stays per year, an average over 2006-2011. This is substantially lower than for Madeira or The Canary Islands (almost 5m and 40m, respectively) but not much different to the other OR in absolute terms. As a ratio to the total population, The Azores see around 2.5 tourist overnight stays per capita, which exceeds the same ratio for any of the French OR (all less than 1.0) but is far behind Madeira or the Canary Islands (where the ratios approach 20).

In both absolute terms and relative to its economic size, The Azores receives relatively large amounts of EU support. In euro terms, the OR has been allocated ERDF funds of similar size (almost €1bn) to The Canary Islands and Réunion, which have substantially larger economies. The Azores is also the recipient of some of the largest quantities of ESF and EAFRD funds compared to the other OR. On an annualised basis, The Azores receives ERDF funds equivalent to around 4% of its GVA; ESF funds equivalent to 1% and EAFRD funds equivalent to around 1.3% (based on figures for 2010, the most recent year for which there are GVA data). The shares are similar for 2007, the first year of the European subsidies.

[91] http://ec.europa.eu/regional_policy/activity/outermost/publications_en.cfm

[92] With the exception of Madeira, which has a far higher GVA per hectare value of almost €11,500 per ha.

**Table 5.16 Sector Metrics for the Azores**

| | **Average agriculture GVA (€ millions; 2000 prices)** | **Average share of agriculture in total GVA (%)** | **Average utilised agricultural area ('000s ha)** | **GVA per ha of utilised agricultural land (€/ha; 2000 prices)** | **Average crop yields (100 kg/ha)** | **Average crop value (€/kg)** |
|---|---|---|---|---|---|---|
| **Agriculture** | 273.0 | 11.6% | 130.9 | 2,091.9 | 767.3 | 0.03 |
| | Average direct contribution to GVA (€ millions; 2000 prices) | Average direct contribution to GVA (%) | Average direct contribution to employment ('000s) | Average direct contribution to employment (%) | Average nights spent by non-residents in hotels ('000s) | Tourism GVA per night spent in hotel (€; 2000 prices) |
| **Tourism: Direct** | : | : | : | : | 584.3 | : |
| | Average total contribution to GVA (€ millions; 2000 prices) | Average total contribution to GVA (%) | Average total contribution to employment ('000s) | Average total contribution to employment (%) | Average nights spent by non-residents in hotels ('000s) | Tourism GVA per night spent in hotel (€; 2000 prices) |
| **Tourism: Total** | : | : | : | : | 584.3 | : |

Notes: Agriculture averages calculated over 2000-2006; Tourism GVA averages calculated over 2006-2009; and other tourism averages calculated over 2006-2011.

Sources: Calculations from Eurostat and WTTC.

**Table 5.17 Macroeconomic Trends in the Azores**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Agriculture GVA growth (% pa)** | : | 7.4 | -0.7 | 2.2 | 21.6 | -5.9 | -3.7 | 12.2 | -1.3 | 6.8 | 3.2 | -2.1 | -6.6 | 13.6 | -1.8 | 4.2 |
| **Construction GVA growth (% pa)** | : | -4.9 | 4.8 | 5.9 | -3.4 | -3.0 | 17.9 | -2.3 | -10.0 | 2.4 | -6.2 | -1.8 | 6.6 | -2.0 | -14.3 | -9.1 |
| **Agriculture share of GVA (%)** | 11.2 | 11.7 | 11.3 | 11.0 | 12.6 | 11.7 | 10.7 | 11.6 | 11.4 | 11.9 | 12.1 | 11.0 | 10.6 | 11.6 | 11.6 | 11.9 |
| **Construction share of GVA (%)** | 9.8 | 9.1 | 9.2 | 9.3 | 8.5 | 8.1 | 9.0 | 8.5 | 7.6 | 7.7 | 7.1 | 6.8 | 7.1 | 6.7 | 5.9 | 5.2 |
| Sources: Calculations from Eurostat. | | | | | | | | | | | | | | | | |

**Table 5.18 EU Support to the Azores**

| | 2007-13 (€m) | Annual average (€m) | Share of 2007 GVA (%) | Share of 2010 GVA (%) |
|---|---|---|---|---|
| **ERDF (European Regional Development Fund)** | 966 | 138 | 4.5% | 4.2% |
| **ESF (European Social Fund)** | 190 | 27 | 0.9% | 0.8% |
| **EAFRD (European Agricultural Fund for Rural Development)** | 294 | 42 | 1.4% | 1.3% |
| | | | | |
| **Total GVA in 2007 (€m)** | 3,064 | | | |
| **Total GVA in 2010 (€m)** | 3,279 | | | |
| Source: Eurostat. | | | | |

Box 7 summarises a report from the European Commission which sets out the socio-economic context for the Azores. Perhaps the biggest socio-economic challenge facing the Azores is stagnation in terms of the population, with relatively little flow of people into or out of the region. This combined with limited resources (including water), poorly coordinated infrastructure and current economic opportunities are likely to be some of the major factor in social vulnerability to the impacts of climate change. These issues presented in Box 7 are taken into account when assessing climate risks (see Appendix D and Section 6).

**Box 7 — Socio-economic context – Azores**

According to projections, the population of the Azores will grow very little up to 2020, stagnating and then starting to decrease, mainly due to families being smaller rather than emigration. Contrary to other regions, the Azores do not receive a large number of immigrants, however, the Azores has shifted from being a "pull" region with a population which severely suffered the impact of emigration, mostly towards North America, to a "push" region, which receives immigrants, mostly coming from Portuguese speaking African countries and from Brazil.

It is difficult to generalise about the Azores as the islands are diverse. The largest islands (São Miguel and Terceira) are more densely populated and attract the most population from the other islands (and most likely immigrants). The islands still show different levels of demographic aging, including islands with a high percentage of aged population, with a negative natural movement and which are not attracting a foreign population.

The Azores are included in the group of regions where the level of education of the working population is the lowest in Portugal. On average, young people do not undertake long course studies, entering the work force as school leavers without going on to further study although there is a tendency for the older generation of young people to return to high school, professional courses or university studies.

The region's economy shows very specialised sub-sectors, such as the dairy sector. Enterprises are mostly constituted by small or micro unities of production meaning that the region has a weak capacity to create or increase the employment structure or attract salaried workers from the existing labour market. Tourism has been progressively gaining weight in the Azores although a lack of integrated and effective transport infrastructure is a potential barrier to growth of this sector.

Most water is taken from underground sources with consumption expected to increase in the future. Energy production has a considerable geothermic contribution to it, particularly in São Miguel, the main island. However fossil fuels are still used for the great volume of distributed electricity. However, at the beginning of the millennium, the Azores showed an increase in the production of electricity from renewable sources, having reached in 2001 a quarter of all the energy consumed in the region, meeting its 2020 objectives.

Source - Demographic and migration trends in the outermost regions: impacts on territorial, social and territorial cohesion? Executive Summary – Azores, European Commission[93]

## 5.7 Madeira

Madeira has the smallest amount of land devoted to agriculture among the OR (around 6,000 ha compared to 23,800 in French Guiana and much more in other regions[94]). Moreover, as a share of total land area, less of the land on Madeira is devoted to agriculture (around 6.5% compared to 20% in Réunion and as much as 56% in The Azores). Only French Guiana has a lower share of land devoted to agriculture, but only by virtue of its large land area; French Guiana still has almost four times as much agricultural land as Madeira.

Overall, Madeira lies somewhere in the middle of the regions in terms of economic dependence on agriculture (2.2% of GVA, on average), although the amount of GVA associated with 1 ha of agricultural land is by far the highest for any of the OR: €11,500 per ha compared to around €2,000 per ha for The Azores and €4,000-6,000 for the other regions. The implication is that a 1 ha reduction in agricultural land in Madeira would lead to a €11,500 fall in agricultural GVA (in real terms). Madeira also has the highest implied crop value by weight, with Eurostat data suggesting that the main crop on the island is potatoes.

However, at the economy-wide level, such an impact is of relatively low overall significance to Madeira: both in absolute terms and as a share, agriculture represents a small part of the economy: typically 2.5% or less each year.

There were no data available from WTTC on tourism by value in Madeira, only a Eurostat figure for the total number of nights spent in hotels by all non-residents each year: 4.85m stays per year (averaged over 2006-2011), making Madeira the second-most popular tourist destination among the OR (second to The Canary Islands). While there are no WTTC data to calculate tourism as a share of the economy of Madeira on a comparable basis to the other OR, it seems reasonable to assume that the island has moderate to high dependence on tourism.

[93] http://ec.europa.eu/regional_policy/activity/outermost/publications_en.cfm
[94] Over 80,000 in The Canary Islands and almost 131,000 in The Azores.

Madeira suffered from flooding in February 2010, with estimated damage (in current prices) of[95]:

- €1.08bn to infrastructure (capital stock); and
- €122m of direct losses to businesses and agriculture.

The first of these, damage to infrastructure, is not straightforward to identify in the Eurostat GVA data because its impacts can only be observed indirectly (as a result of no macroeconomic data on capital stocks). Lost infrastructure may inhibit economic activity, suppressing growth, as well as necessitating construction work (but not necessarily immediately; the expenditure may be spread over a longer period).

The GVA data for 2010 do not show an increase in construction activity in that year. In fact, they show a decrease by 4.8% although it is possible that a general economic decline (with falls in industry and business output, but not agriculture) meant that any rebuilding work was offset. Overall, construction employment fell in 2010 from 12,200 to 10,300.

The scale of the business and agriculture GVA losses are perhaps similar to the €122m losses quoted above, although the two are not immediately comparable[96].

On an annualised basis, Madeira receives European support equivalent to around 2% of its annual GVA, and half of that comes from ERDF funds. This ratio is similar to most other OR (The Azores being the main exception, which has been allocated somewhat more funds over 2007-13, over 4%, compared to 2% or less for the other OR).

**Table 5.19 Sector Metrics for Madeira**

| **Agriculture** | **Average agriculture GVA (€ millions; 2000 prices)** | **Average share of agriculture in total GVA (%)** | **Average utilised agricultural area ('000s ha)** | **GVA per ha of utilised agricultural land (€/ha; 2000 prices)** | **Average crop yields (100 kg/ha)** | **Average crop value (€/kg)** |
|---|---|---|---|---|---|---|
| | 72.0 | 2.2% | 6.1* | 11,448.5* | 429.2 | 0.26 |
| **Tourism: Direct** | Average direct contribution to GVA (€ millions; 2000 prices) | Average direct contribution to GVA (%) | Average direct contribution to employment ('000s) | Average direct contribution to employment (%) | Average nights spent by non-residents in hotels ('000s) | Tourism GVA per night spent in hotel (€; 2000 prices) |

[95] European Commission: http://europa.eu/rapid/press-release_IP-10-1205_en.htm?locale=EN
European Investment Bank: http://www.eib.org/projects/press/2010/2010-203-portugal-eib-loan-for-madeira-flood-damage-reconstruction.htm

[96] The current-price loss to GVA is almost €34m, but the value of the output loss in this instance is better compared to gross output rather than GVA (net output). Gross output measures the total value of the activity, while GVA nets out the value of the inputs to production (e.g. construction materials etc) and will be smaller as a result.

| | | | | | | |
|---|---|---|---|---|---|---|
| | : | : | : | : | 4,851.3 | : |
| **Tourism: Total** | Average total contribution to GVA (€ millions; 2000 prices) | Average total contribution to GVA (%) | Average total contribution to employment ('000s) | Average total contribution to employment (%) | Average nights spent by non-residents in hotels ('000s) | Tourism GVA per night spent in hotel (€; 2000 prices) |
| | : | : | : | : | 4,851.3 | : |

Notes: Agriculture averages calculated over 2000-2006 with the exception of agricultural land (marked with an asterisk), where there is a clear outlier in 2006 (an implausibly large value) which has been excluded; Tourism GVA averages calculated over 2006-2009; and other tourism averages calculated over 2006-2011.

Sources: Calculations from Eurostat and WTTC.

**Table 5.20 Macroeconomic Trends in Madeira**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Agriculture GVA growth (% pa)** | : | 1.8 | 6.3 | -2.3 | 3.8 | -4.4 | -1.1 | 18.2 | 1.8 | 14.8 | -0.3 | 10.8 | 1.7 | -0.4 | -5.1 | 2.1 |
| **Construction GVA growth (% pa)** | : | -4.9 | -0.1 | 22.8 | 2.6 | -2.6 | -4.3 | -4.5 | 4.4 | 9.4 | -5.4 | -2.2 | 3.8 | -16.2 | -9.3 | -4.8 |
| **Agriculture share of GVA (%)** | 2.8 | 2.8 | 2.8 | 2.5 | 2.4 | 2.0 | 2.1 | 2.1 | 2.2 | 2.4 | 2.4 | 2.4 | 2.5 | 2.4 | 2.4 | 2.4 |
| **Construction share of GVA (%)** | 13.4 | 12.4 | 11.6 | 13.1 | 12.7 | 10.7 | 10.7 | 8.7 | 9.5 | 9.9 | 9.3 | 8.3 | 8.7 | 7.1 | 6.6 | 6.3 |

Sources: Calculations from Eurostat.

**Table 5.21 EU Support to Madeira**

| | 2007-13 (€m) | Annual average (€m) | Share of 2007 GVA (%) | Share of 2010 GVA (%) |
|---|---|---|---|---|
| **ERDF (European Regional Development Fund)** | 321 | 46 | 1.1% | 1.0% |
| **ESF (European Social Fund)** | 125 | 18 | 0.4% | 0.4% |
| **EAFRD (European Agricultural Fund for Rural Development)** | 179 | 26 | 0.6% | 0.6% |
| | | | | |
| **Total GVA in 2007 (€m)** | 4,358 | | | |
| **Total GVA in 2010 (€m)** | 4,562 | | | |

Source: Eurostat.

Box 8 summarises a report from the European Commission which sets out the socio-economic context for the Madeira. Population density and the challenges presented by the archipelagos landscape set the wider context for Madeira, limiting opportunity in some ways (i.e. for growth in the agricultural sector). A dependence upon tourism makes the archipelago vulnerable to any impact which makes Madeira seem a less desirable destination than alternatives such as the Canary Islands. As with much of the rest of the OR, the quality of biodiversity is a significant asset but the limitations on water availability are likely to increase pressure on natural resources, particularly as population grows.

**Box 8 – Socio-economic context – Madeira**

Although two islands are inhabited, Porto Santo and the island of Madeira itself, the region's population is concentrated on the island of Madeira ( 98,2%), and mainly in Funchal, the main residential centre of the archipelago. The population of the archipelago as a whole increased 9.4% during the first decade of the new millennium due to the return of emigrants to the region as well as the incoming immigrants. Projections suggest that the population of Madeira should grow for some time, then stagnate and decrease in a very significant way. In terms of internal migrations there is a displacement of people from the northern coast towards the municipal centre of the main island. The population is also aging.

Madeira is the second region of Portugal in terms of the lowest number of graduates, with a high proportion of young people choosing not to enter further education (or to complete high school). This results in a young population lacking in qualifications, particularly in relation to the demands of the challenges of economic modernisation.

Most of the working population of Madeira (70%) is employed in the service sector (many linked to tourism) with agriculture, forestry and fishing corresponding to 10% and the remainder working in small scale industrial transformation (SME's), the energy sector or (mostly) public construction.

Water availability is already a problem on the island of Porto Santo but it is expected to become an increasing challenge in Madeira (given seasonal changes and climate impacts), With abrupt and steep hillsides, the island of Madeira has a particular biodiversity of which the Laurisilva forest in an example acknowledged worldwide as having a particular scientific, tourist and patrimonial interest (classified by UNESCO). The natural environment is an important resource of this island and an essential support of numerous activities, particularly tourism.

Source - Demographic and migration trends in the outermost regions: impacts on territorial, social and territorial cohesion? Executive Summary – Madeira, European Commission[97]

### 5.7 St Martin and Mayotte

St Martin and Mayotte are the most recent OR. St Martin was separated administratively from Guadeloupe in July 2008 and consists of two parts: a Dutch associated state: Sint Maarten, and a French COM (Collectivité d'Outre-Mer): Only the latter, St Martin, is an OR. Given their more recent status as OR, there is limited socio-economic information available for either St Martin or Mayotte. Box 9 below summaries a report on demographic and migration trends for St Martin, the findings of which echo the lack of data also highlighted within this report. Based on available data it would appear that one of the main challenges for St Martin is the diversity of its population (in terms of languages and cultures of the immigrant population) and maintaining access to services for all as a result. This combined with economic dependency on tourism, itself reliant to an extent upon the islands natural assets as an attraction for tourists, make St Martin vulnerable to any impacts of climate change which could deter tourists or reduce their numbers.

**Box 9 – Socio-economic context – St Martin**

In the 1980s, St Martin experienced a construction boom related to the development of tourism. This resulted in extremely high immigration that caused a very rapid population growth, given the small size of the total population. The population increased from 8,000 inhabitants in 1982 to nearly 29,000 in 1990. It stabilized in the 1990s since a fair proportion of migrants left after the end of the construction boom. Population growth resumed in the 21st century, with the arrival of a

[97] http://ec.europa.eu/regional_policy/activity/outermost/publications_en.cfm

new but more moderate-level migration wave (0.7% net migration p.a.) than the previous one. Should the growth rate remain constant, the population will double in 25 years.

The age structure of St Martin's population is young, with almost 30% being aged less than 15 years old and only 4% being aged 65 years or more. St Martin has a large share of foreign immigrants (36% of the population in 19992; higher than in French Guyana - 32%), the St Martin-born population comprising only 44% of the population and French mainlanders (métropolitains) 19%. In 2007, 38% of the population held foreign nationality. The rapid growth in population outstretched the capacity of infrastructure. This combined with a large foreign-born population presenting a variety of linguistic and cultural backgrounds has resulted in significant proportions of the compulsory school age children not attending school.

The employment situation is better than for education. In 2007, the employment rate of the 20-64 year olds in St Martin (59.6%) was higher than in the French Overseas Departments, but still considerably below national and EU averages (69%). The employment rate was much higher in 1990 (63%), at the time of the construction boom, and a rate particularly high for men (74%). One out of five employed people are self-employed workers or employers and 24% of salaried workers are on fixed term contracts. Services jobs (linked to tourism) form the largest share of employment (84%), followed by construction (10%), industry (5%) and agriculture (1%). Hotels and restaurants provide 17% of all jobs, which is much more than in other Overseas Departments (below 4%), a consequence of the island's large tourism industry. Unemployment has however been increasing due to the impact of the global economic 2008 crisis on tourism.

In 2007, only 25% of household heads were home-owners. Such a low figure is due to the large foreign-born and mainland French populations who live (mostly) in rented property. In 1999, 14% of housing was categorised as 'poor' (shanty and traditional houses lacking one of the basic facilities: electricity, water source inside housing or connection to main drains), close to the average for Guadeloupe and Martinique.

Source - Demographic and migration trends in the outermost regions: impacts on territorial, social and territorial cohesion? Executive Summary – St Martin, European Commission[98]

As Mayotte became an Outermost Region on January 1st 2014, it was not included in the same European Commission study used here as the primary source to provide the socio-economic context for the OR and hence information is very limited. According to the 2007 census[99], 63.5% of the people living in Mayotte were born in Mayotte, 4.8% were born in the rest of the French Republic (either metropolitan France or overseas France except Mayotte), 28.3% were immigrants from the Comoros, 2.6% were immigrants from Madagascar and the remaining 0.8% came from other countries.

A 2008 study on climate change and biodiversity (Petit and Prudent, 2008) highlighted the pressures of demand for land in Mayotte, particularly in low lying coastal areas which tend to be densely populated. At the same time however, it is likely that coastal erosion and rising sea levels will encourage people to migrate towards the interior increasing pressure on the islands natural ecosystems. The same study notes the dependency of the economy on fishing and the impact that coral bleaching could have upon this. The island is not self, sufficient and imports much of its food stuffs from France. Given the remoteness of the territory, tourism opportunities are seen as being limited.

[98] http://ec.europa.eu/regional_policy/activity/outermost/publications_en.cfm
[99] http://www.insee.fr/fr/themes/tableau.asp?reg_id=27&ref_id=popop008

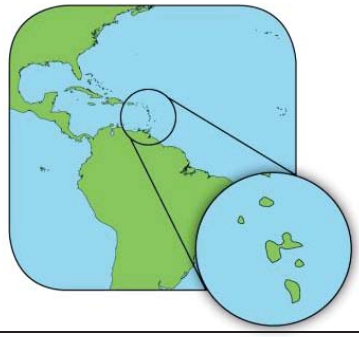
# 6 Summary assessment for each of the Outermost Regions

In this section, the main findings of the assessment are presented in summary format, allowing all of the information for each OR to be viewed together in a consistent format. This is a synthesis of the assessment of climate risk across the sectors considered, economic impacts associated with sectors vulnerable to climate change and a summary of EU funds that have been used for adaptation relevant work, including example projects. Further details on the assessment are presented in Appendices D, E and F. The purpose of this section of the report is to condense a lot of information into summary form[100]. Recommendations on areas for action are made in the following section, Section 7.

Given the limited information for Mayotte and for St Martin which is available to inform this study, no detailed summary assessments are presented. Instead, shortened versions are presented which give an overview of the assessment which has been possible given information constraints. Further, as a guide, indications are the there is significant similarity between the challenges (and opportunities) for Mayotte and la Reunion, and for St Martin and Martinique respectively.

[100] A supplementary report has also been produced which draws information from across the study to provide material on the OR suitable for publication on Climate-ADAPT.

# Guadeloupe



Adaptation Strategy: Yes
Location | Caribbean Sea
Surface area | 1,705 km$^2$
Topography | 5 islands, mountainous (north), significant number of bays and inlets
Population | 403,000 inhabitants
GDP per capita (2010) (EU average=100)| 65.9

## Climate

| | Characteristic features | Climate change - key issues |
|---|---|---|
| Temperature | • Average annual temperatures: 26°C | • Annual temperature: 1.8-2.4ºC increase is predicted in the IPCC report (2007).<br>• SRCAE Guadeloupe (2012b) estimate +1.5ºC rise between 1960 and 2000. |
| Precipitation | • Rainy season from June to November<br>• Year to year, variation in rainfall is highly influenced by both the El Niño Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO). | • The difference between the wet and the dry season may not be as great in future.<br>• Annual patterns: a wetter dry season has been observed. |
| Sea level rise | | • Mean sea level rise: 0.35mm (IPCC 2007). |
| Extreme weather events | • Due to its location, Guadeloupe is at risk of hurricanes and tropical storms<br>• Heat waves are expected though none are recorded to date.<br>• More droughts are expected. | • SRCAE Guadeloupe (2012) observed increased variation in the occurrence of both the hurricane and thunderstorm season. |
| Natural disasters | • Due to the presence of the Lesser Antilles Subduction Zone there is a risk of seismic activity and Soufriere is an active volcano. There is also a risk of tsunami, flooding and landslides. | • Floods/landslides are expected to occur more frequently as a result of more extreme rainfall or storms and an increase in their frequency.<br>• Increased prevalence of coastal flooding/inundation, which is likely to be magnified by the sea-level rise and increased sea storms. |

## Economic activities

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Agriculture | • Agriculture is declining but remains an important sector for the territory<br>• Most of the agricultural production (sugar cane and bananas) is for export.<br>• The sector is diversifying to meet local needs (SRCAE Guadeloupe 2012b)<br>• Occupies 25% of the land area, of which 30% dedicated to sugar cane and 5% to bananas.<br>• Contributes to 3.4% of GVA | • Crops are vulnerable to climate fluctuations.<br>• Risk of competition for water between agricultural and domestic sector during droughts.<br>• Parasite problem in banana plantations could be aggravated by climate change. |
| Forestry | • Forest covers 40% of island territory (69 000 ha).<br>As regards forestry sector, local production seems to be very limited as well as not really structured and with low profitability | • Whilst there has never been a wildfire observed in Guadeloupe, there is potential for an increase in the frequency of wildfires. |
| Fisheries | • Fisheries and aquaculture represent 32% of the | • Loss of mangrove swamps could lead to a reduction in |

| | Features and key figures | Climate change - key issues |
|---|---|---|
| | value of the primary sector.<br>• Employs 1600 people<br>• Still traditional, though there has been some modernisation. | fish stocks.<br>• Possible increase of diseases and appearance of new species.<br>• Coastal fishery depends on the health of the coral reef. |
| Construction | • Buildings are highly concentrated and most of the infrastructure exists along the coast.<br>• Most of the infrastructure and buildings were built in at risk areas.<br>• 90% of the houses are not resilient to climatic impacts.<br>• The use of air conditioning systems is spreading.<br>• An earthquake plan has been implemented.<br>• Efforts are being taken to improve slope stability.<br>• Contributes 6.2% to GVA, but has a periodic output that is heavily influenced by hurricanes. | • Constructions are in risk-areas of rising sea levels, floods or landslides, which could be more frequent or intense due to climate change.<br>• Buildings are highly vulnerable to climate impacts. |
| Tourism | • Mass tourism is experiencing a decline.<br>• Rural/natural tourism is growing.<br>• One of the island's key industries, accounting for around 25% of GVA. | • Coastal flooding and erosion.<br>• More frequent and severe extreme weather events (i.e. floods, heat waves) |

## Social services and infrastructure

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Energy | • Decentralised generation system<br>• Increasing use of renewable. | • Infrastructure damage due to climate change related events (i.e. floods, landslides, SLR).<br>• Cost and uncertainty of electricity generation |
| Transport | • All major infrastructure is located along the coast<br>• Already suffering from coastal inundation and flooding | • Infrastructure damage due to climate change related events.<br>• Disturbance to transport routes<br>• Very vulnerable |
| Waste | • •Development of water sewerage infrastructure has been delayed and is currently thought inadequate.<br>• A proportion of homes still have no mains water | • Infrastructure damage due to climate change related events |
| Water | • Water is relatively abundant in Guadeloupe but the resources are very unevenly distributed because of temporal and spatial variability<br>• Water shortages have been observed during dry season.<br>• A proportion of homes still have no mains water | • Water shortages in lakes and rivers have been observed in the dry season, though a wetter dry season may offset this. |
| Coastal zone management | • Infrastructure, buildings and people are located close to the coast.<br>• No integrated coastal zone management plan exists | • Coastal flooding and erosion.<br>• Destruction of mangroves swamps and salt water intrusion of low lying areas |
| Health | • Air conditioning systems are available.<br>• There are parts of Guadeloupe with limited | • More frequent and severe extreme weather events (i.e. floods, heat waves) |

| | Features and key figures | Climate change - key issues |
|---|---|---|
| | access to health care services (most infrastructure being coastal) | • Spread of vector-borne diseases e.g. dengue fever.<br>• An increase in diseases associated with poor water quality is also expected. |
| Disaster management | | • More frequent and severe climate-related hazards |

## Natural environment

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Biodiversity | • Significant number of native species.<br>• Wide range of habitats | • Low resilience to climate change impacts due to the small size of the ecosystems and human-pressure (limits migration)<br>• Higher temperatures are causing species to migrate into the highlands, threatening some species (highland rainforest) and opening the door for invasive alien species. Coral bleaching and loss of coral reefs. |
| Soil | • High diversity of soils resulting from interactions between volcanic activity, climate and topography.<br>• Soil is a limited resource because of the geographical features (insularity, terrain, land shortage).<br>• "Urban sprawl" phenomenon is observed | • Possible increase in erosion or hyper sedimentation phenomena due to longer cyclone season (more cyclones, intense precipitations) |

## Areas for adaptation intervention

### Key messages

- The most vulnerable sectors to climate change that were determined through a stakeholder consultation are: Public health, Water resources, Building and transport, and Agriculture and fishery.
- Human Health is a key social area to consider for adaptation action as the island is at risk of both increases in vector-borne diseases, and deaths arising from the increased risk of flooding. There are issues with communicating risks to parts of the population and in making sure all of those at risk have adequate access to health care provision;
- Water is one sector where the implementation of adaptation measures, in particular measures to mitigate the impact of water shortages, appears to be more urgent. Not all homes have mains water and water resources will come under increasing pressure if there is growth in the population;
- Construction, Transport and Tourism are economic sectors that should be considered as a priority for adaptation, especially regarding the vulnerability of roads. The ability of the population to access services depends upon good infrastructure;
- Coastal zone management is an important area where actions should be undertaken by regional authorities to reduce anthropogenic pressure and increase the resilience to coastal flooding;
- Adaptations to prevent a loss of biodiversity should also be considered, particularly given the growth in 'nature tourism'. Biodiversity is a significant natural asset in Guadeloupe and thought needs to be given to how it can be made sustainable as climate changes; and
- Disaster prevention is a key social area to consider for adaptation, particularly given the challenges of any communication or awareness raising campaign and the ability of portions of the population to readily access services. Disaster could deter tourist and impact the economy.

### Socioeconomic implications

- GDP per capita is roughly two thirds of the EU average. This is likely to be linked to the aging population, high level of unemployment, the relatively low level of exports (mainly agricultural) and a high level of employment in the service sector. A higher percentage of people in Guadeloupe live in

poverty than is typical in the EU. This suggests a social vulnerability linked to the impacts of climate change.

- Guadeloupe's economy shows a slightly higher reliance on agriculture to the other French OR: the sector accounts for around 3.5% of total GVA, calculated as an average over 2000-2006;
- Eurostat data show that, of the French OR, Guadeloupe has the most overnight stays by tourists each year: 388,000 stays (averaged over 2006-2011) - more than twice that of the other French OR but substantially less than The Azores (580,000 per year), Madeira (almost 5m) or The Canary Islands (almost 40m). The direct value of that tourism is not correspondingly larger than the other French OR, though: each stay represent around €367 compared to more than €1,100 per stay in Martinique;
- Guadeloupe does however have a higher *overall* dependence on tourism, with tourism accounting for an estimated 18% of economy-wide GVA; higher than Martinique (12%) or Réunion (8%), as an average over 2006-09;
- The economic data suggest that Guadeloupe's economy has been noticeably affected by climate events, particularly the three hurricanes in 1995 (associated with a more-than-30% increase in construction activity the following year) and Hurricane George in 1998, which destroyed 90% of the banana crop; this coincides with a 10% fall in agriculture GVA; and
- On an annualised basis, Guadeloupe receives European subsidies equivalent to around 1.6% of its GVA each year; similar to the other OR with the exception of The Azores (where the share is more than 4%).

## Climate change adaptation activities

### Overview

- In December 2012, Guadeloupe adopted a Regional Plan for Climate, Air and Energy ("Schéma Régional Climat Air Energie" (SRCAE Guadeloupe, 2012b)), previously having been published in draft for consultation (SRCAE Guadeloupe, 2012a). The document covered Guadeloupe's contribution to climate changes and the expected impacts of climate change on the island;
- Adaptation to climate change is presented in the Regional Plan as a key concern to be integrated in economic development and planning policies of the island. The Regional Plan for Climate, Air and Energy of Guadeloupe (SRCAE Guadeloupe) identified priority actions for adaptation to be implemented by 2020-2050. Adaptation actions are recommended in the fields of: public health; territorial development and planning; governance; knowledge development and accessibility; external cooperation; and communication. Further actions are identified to adapt and protect resources.

### Contribution of EU funds to climate change adaptation

#### *Cohesion Policy – ERDF*

- Guadeloupe received a total of about EUR 542 million EU contributions in the programming period 2007-2013. Only a minor share of the ERDF budget allocation is dedicated to funding activities that could be considered as significantly adaptation related.
- The largest share, EUR 75 million (around 13.8% of the total ERDF allocations for Guadeloupe) is being spent in management and distribution of water.
- The Operational Programme Interreg Caraibes IV, aimed to strengthen environmental management and risk prevention in French Guiana, Guadeloupe and Martinique: almost 9% of the total ERDF allocation for the programme (about EUR 47 million).
- The promotion of natural assets and the protection and development of natural heritage are also among the priorities and accounts for 3.8 million (8% of total ERDF budget of the programme).

#### *Common Agricultural Policy (CAP) – EAFRD*

- Total EU contribution for rural development from the CAP is estimated at EUR 141 million for 2007-2013;
- Measure 214[101] accounts 15 million (8.2% of the total EAFRD allocations for Guadeloupe). It demonstrates synergies between climate change mitigation and adaptation includes sub-measures that deal with both aspects; and

[101] Agri-environment payments

- Measure 125[102] accounts for 33 million (around 18% of the total EAFRD allocations for Guadeloupe). It covers operations related to water supply and efficiency of irrigation. Water efficiency is promoted through investments in individual or collective dams and water storage facilities for water storage during rainfall periods as well as drainage equipment.
- Measure 121[103] allocates 21 million (around 12% of the total EAFRD allocations for Guadeloupe) to measures including investments for the modernization of irrigation systems, deposits and drainage and waste water management.

| Overview of the climate change adaptation relevant measures by sector of Guadeloupe in the programming period 2007-2013 | | |
|---|---|---|
| | **ERDF** | **EAFRD** |
| Biodiversity | Actions under the heading "promotion of biodiversity and nature protection" and development of natural heritage | EARDF offers some measures, which may be safeguarding biodiversity |
| Risk Prevention | From the INTERREG programme, drafting and implementation of plans and measures to prevent and manage natural and technological risks | Water storage facilities for water storage during rainfall periods as well as drainage equipment |
| Tourism/ health | Tourism facilities as the national park, national forest office and the preservation of the literal zone, ecotourism | Offers one measure for the promotion of tourism activities in natural environment |
| Water | Management and distribution of drinking water. Management and distribution of water and water treatment comprise roughly 14 % of the total ERDF budget Guadeloupe | Modernization of irrigation systems, deposits and drainage and waste water management. Activities funded comprise interventions in the preservation of the water cycle as well as purification of water through phytosanitary practices and forestry |

*Source: European Parliament (2011) + own compilation*

### *Common Fisheries Policy – EFF*

- The European Commission approved the Operational Programme for the French fishing industry for the period 2007-2013 (EUR 14.7 million);
- The total eligible public expenditure under this programme is EUR 436.2 million, with EU assistance through the European Fisheries Fund (EFF) amounting to € 216.0 million;
- EUR 34.3 million of EFF aid were allocated to the convergence regions (Overseas Departments)[104]; and
- As there is only one national Operation Programme, it is not possible to know the exact allocations dedicated to Guadeloupe for climate change adaptation objectives.

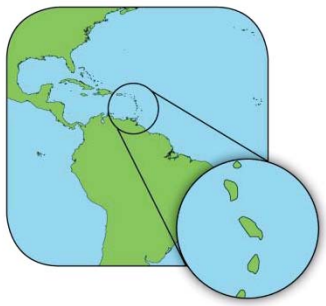
### Examples of significantly adaptation related projects

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| Geothermal project | Energy | ERDF | Geothermal energy has numerous benefits for the island, especially a degree of energy independence. It is also a low carbon energy source with little associated pollution, produces cheaper electricity than diesel-powered plants, and creates local jobs in construction and maintenance. | |

[102] Infrastructure related to the agricultural sector
[103] modernization of agricultural holdings
[104] EAS (2010), The European Fisheries Fund Compilation of Member State Operating Programmes for Fisheries 2007-2013

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| Island port facilities | Infrastructure | ERDF | To complete rebuilding of Gustavia's boardwalk, using reinforced concrete on top of thick piles driven into the seabed. A wave-attenuating device made of blocks of rock was installed to help protect the boardwalk against future storms. | |
| EUCarinet | Research | FP7 | To strengthen sustainable policy dialogue on Science and Technology between EU Member States and associated states on the one hand, and countries from the Caribbean region on the other — namely members of the African, Caribbean and Pacific Group of States (ACP), overseas departments and collectivities as well as overseas countries and territories (OCTs). | |

# Martinique



Adaptation Strategy: Yes
Location | Caribbean Sea
Surface area | 1,128 km$^2$
Topography | 1 island, mountainous (north), significant number of bays and inlets
Population | 395,953 inhabitants
GDP (2009) (EU=100)| 71.8

## Climate

| | Characteristic features | Climate change - key issues |
|---|---|---|
| Temperature | • Average annual temperatures: 26 °C | • Annual temperature: 1.8-2.4ºC increase is predicted in the IPCC report (2007).<br>• SRCAE Martinique (2012) estimate +1.5ºC rise between 1960 and 2000. |
| Precipitation | • Rainy season from June to November<br>• Year to year, variation in rainfall is highly influenced by both the El Niño Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO). | • Annual patterns: no change has been documented. |
| Sea level rise | | • Mean sea level rise: 0.35mm (IPCC 2007). Regional measurements by SRCAE Martinique (2012) however show a rise of 3.5mm per year. |
| Extreme weather events | • Due to its location, Martinique is at risk of Hurricanes and tropical storms<br>• Several heat waves have been recorded throughout history. | • SRCAE Martinique (2012) observed increased variation in the occurrence of both the hurricane and thunderstorm season.<br>• The development of periods of very hot weather is expected.<br>• Droughts in July are increasing in frequency. |
| Natural disasters | • Due to the presence of the Lesser Antilles Subduction Zone there is a risk of seismic activity and Mt Pelee is an active volcano. | • Floods/landslides are expected to occur more frequently as a result of extreme rainfall or storms. Likelihood of coastal flooding is likely to be magnified by the sea-level rise and increased sea storms. |

## Economic activities

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Agriculture | • Represents 28% of the land surface.<br>• Main products are bananas (27% of agricultural land) and sugar cane (10%).<br>• Employs 6% of the salaried workforce (IEDOM 2012c)<br>• Contributes 3.3% of GVA | • Crops are vulnerable to climate fluctuations.<br>• Risk of competition for water between agricultural and domestic sector during droughts.<br>• Market-gardening productions are very sensitive to diseases and parasites and are thus threatened in a climate-change context. |
| Forestry | • Forest covers 43% of island territory (47 000 ha).<br>• Marginal role<br>• 1,200ha of artificial mahogany plantation | • No specific information on the impact of climate change on this particular sector |
| Fisheries | • Less significant than agriculture.<br>• Martinique has a high demand for fish products and is not self sufficient | • Mangrove swamps (fish nurseries) are at risk, potentially resulting in reduced fish stocks.<br>• Possible increase of diseases and appearance of new |

| | Features and key figures | Climate change - key issues |
|---|---|---|
| | • 1300 persons work in this sector<br>• Artisanal and relatively unstructured sector | species.<br>• Coastal fishery depends on the health of the coral reef. |
| Construction | • High urbanisation and construction along the coast.<br>• A lot of the infrastructure is known to be at risk.<br>• Growth rate implies a fairly variable industry; typically it represents 5% of GVA.<br>• The island has an earthquake plan. | • Construction has taken place in areas at risk of rising sea levels, floods or landslides, which could be more frequent or intense due to climate change. |
| Tourism | • Key economic sector<br>• Growing across a range of tourist options including cultural, cruising and natural tourism. | • Coastal flooding and erosion.<br>• More frequent and more severe extreme weather events (i.e. floods, heat waves)<br>• Heavily dependent on the islands natural resources. |

## Social services and infrastructure

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Energy | • Re-orientating towards renewable energy production | • Infrastructure damage due to climate change related events (i.e. floods, landslides, SLR).<br>• Cost and uncertainty of electricity generation |
| Transport | • Most of the infrastructure is located along the coast.<br>• Adaptation measures are already being implemented | • Infrastructure damage due to climate change related events.<br>• Disturbance to transport routes<br>• Damage due to coastal inundation. |
| Waste | • No information identified<br>• There is a proportion of homes that have no waste water collection. | • Infrastructure damage due to climate change related events |
| Water | • Water is relatively abundant in Martinique but the resources are very unevenly distributed because of temporal and spatial variability.<br>• There are a proportion of homes that have no connection to mains water. | • Infrastructure damage due to climate change related events.<br>• Water quality could degrade because of climate change. Higher water temperatures<br>• Competition between agricultural and domestic sector during droughts |
| Coastal zone management | • Earthquake Plan Antilles focuses in particular on coastal risks. | • Coastal flooding and erosion.<br>• More frequent and severe extreme weather events (i.e. floods, heat waves)<br>• Coastal zone is particularly vulnerable to climate change |
| Health | • There are parts of Martinique with limited access to health care services (most infrastructure being coastal) | • More frequent and more severe extreme weather events (i.e. floods, heat waves)<br>• Spread of vector-borne diseases |
| Disaster management | • Experience in disaster management.<br>• The Conseil Régional Martinique is developing a strategic plan to manage natural risk.<br>• Implementing an earthquake plan. | • More frequent and severe climate-related hazards<br>• Increase in magnitude and frequency of natural risks |

## Natural environment

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Biodiversity | • Very varied wealth of fauna and flora<br>• Original forest ecosystem and remarkable sub-marine landscape.<br>• Natural forest covers 26% of the area. | • Low resilience to climate change impacts due to the small size of the ecosystems and human-pressure (limits migration).<br>• Species are migrating into the highlands.<br>• Biodiversity is threatened and conditions could become favourable for an invasive alien species.<br>• Coral bleaching has been observed |
| Soil | • High diversity of soils resulting from interactions between volcanic activity, climate and topography.<br>• Soil is a limited resource because of the geographical features (insularity, terrain, land shortage).<br>• "Urban sprawl" phenomenon is observed | • Possible increase in erosion or hyper sedimentation phenomena due to longer cyclone season (more cyclones, intense precipitations) |

## Areas for adaptation intervention

### Key messages

- Transport, Tourism and Construction are economic sectors that should be considered as a priority for adaptation, especially regarding infrastructure damage and water shortages. Given limitations on water resources, any growth in demand will put pressure on water supplies making them more vulnerable during periods of drought;
- Human health and disaster prevention are key social areas that should be considered for adaptation action. Human diseases (e.g. vector-borne diseases) and deaths could increase due to warmer climate conditions and the increase of extreme weather events, mainly flooding. The challenge of ensuring access to health care services and communication/raising awareness of risks is already recognised as a problem in Martinique;
- Agriculture is the environmental system where the implementation of adaptation measures appears to be more urgent, especially regarding water (both flood and drought) issues. Extreme events have already demonstrated the vulnerability of this sector;
- Given biodiversity's importance to tourism and its high level of vulnerability, adaptations that target biodiversity should be considered in order to increase 'nature tourism';
- Although information on adaptation actions may be limited, note should be made of the impacts of coral bleaching and saltwater intrusion on fish stocks, tourism and the increased risk of coastal flooding;
- Coastal zone management is an important area where actions should be undertaken by the authorities to reduce anthropogenic pressure and increase the resilience of the coast given vulnerability to natural hazards; and
- The development and use of ecosystem-based adaptation/Green Infrastructure brings multiple benefits at comparatively low cost.

## Socioeconomic implications

- GDP per capita is approximately seventy percent of the EU average, a similar level to that of Guadeloupe. This is likely to be linked to the aging population, high level of unemployment, the relatively low level of exports (mainly agricultural) and a high level of employment in the service sector. A higher percentage of people in Martinique live in poverty than is typical in the EU. This suggests a social vulnerability linked to the impacts of climate change.
- Martinique's economy shows a similar reliance on agriculture to Guadeloupe's: over 2000-2006, agriculture accounted for some 3.3% of total GVA. Of the OR, Martinique has the third-lowest land area devoted to agriculture: 31,200 ha;

- While Martinique has, on average, fewer overnight tourist stays each year compared to Guadeloupe (150,000 compared to 388,000, based on an average over 2006-2009), the amount of GVA associated with each stay is higher: €1,100 compared to €367. Martinique is more vulnerable to a reduction in (absolute) tourist numbers;
- There is some evidence to support the idea that Martinique's economy has been affected by climate events in the past, with Hurricane Iris in 2001, coinciding with an 11% fall in agriculture GVA (possibly related to crop damage) and an almost 18% increase in construction activity (a marked departure from trend, possibly representing rebuilding efforts); and
- On an annualised basis, Martinique receives European subsidies equivalent to around 1.2% of its GVA each year; similar to the other OR with the exception of The Azores (where the share is more than 4%).

## Activities relevant to climate change adaptation

### Overview

- Martinique is currently finalising its Regional Plan for Climate, Air and Energy ("Schéma Régional Climat Air Energie" (SRCAE)). This work is the first initiative by Martinique, that deals with climate change. The Plan determined specific actions to address adaptation challenges, with the objective of a better integration of these challenges in planning and development policies; ;
- Martinique has not had the capacity to observe climate change impacts, however a small range of studies looking at the impacts of climate change on Martinique have been carried out. For example, those by the "LarGE" research laboratory of the University of Les Antilles and French Guiana;
- The local government of Martinique has the ambition to become a key observer of climate change impacts for the Caribbean region, metropolitan France and the European Union. Potential actions include cooperation and knowledge exchange on climate change best practices with neighbouring territories or the implementation of an observatory of the climate change impacts and actions to support the operational management of these impacts. For example, Martinique has recently answered a call for a preparatory action, namely BEST - Biodiversity Program in Outermost Regions. The submitted proposal deals with the implementation of an observatory on biodiversity which may be detrimentally impacted by climate change and natural risks. This action is in line with the targeted measures of the French National Plan for adaptation;
- There are some examples of adaptation measures already undertaken in practice in the field of energy (burying cables underground to minimise future impact of cyclones on the electricity system), improvements to transport (roads and tramway lines near the airport), coastal zone management (implementation of plans to prevent coastal risks in territories located near the shore) and disaster risk management (ongoing effort to prepare and implement a strategy for disaster management). Information on costs were not however available; and
- In addition, Martinique cooperates with Guadeloupe, Martinique and La Réunion as part of the IFRECOR project related to the coral reefs (http://www.ifrecor.org/) which addresses climate change adaptation in its strategic action plan.

### Contribution of EU funds

#### *Cohesion Policy – ERDF*

- Of the EUR 420 million granted to Martinique, only a minor share is dedicated to funding activities significantly adaptation related;
- Measures on water management received 20 million (around 5% of the total ERDF allocations for Martinique);
- Risk prevention measures received almost EUR 27 million (7% of the ERDF funding), while nature conservation, the promotion of natural assets, the promotion and development of environmental heritage received EUR 18 million (about 5% of the total share);
- The Operational Programme Interreg Caraibes IV, aims to strengthen environmental management and risk prevention in French Guiana, Guadeloupe and Martinique: accounts for almost 9% of the total ERDF allocation for the programme (about EUR 47 million); and

- The promotion of natural assets and the protection and development of natural heritage are also among the priorities and accounts for EUR 3.8 million (8% of total ERDF budget of the programme).

### *Common Agricultural Policy (CAP) – EAFRD*

- Total EU contribution for rural development from the CAP is estimated at EUR 100.6 million for 2007-2013;
- Measure 214[105] allocates EUR 7 million (almost 8% of the total EAFRD allocations to Martinique). It demonstrates synergies between climate change mitigation and adaptation since it includes sub-measures that deal with both aspects;
- Measure 125[106] allocates EUR 21 million (around 21%). It covers operations related to water supply and efficiency. Water efficiency is promoted through investments in individual or collective dams and water storage facilities for water storage during rainfall periods as well as drainage equipment; and
- Measure 121[107] allocates EUR 21 million (around 21% of the total EAFRD allocations for Martinique) to measures including investments for the modernization of irrigation systems, deposits and drainage and waste water management.

**Overview of the climate change adaptation relevant measures by sector of the Martinique in the programming period 2007- 2013**

| | ERDF | EAFRD |
|---|---|---|
| Biodiversity | Limited support, actions "promotion of biodiversity and nature protection", "protection and development of natural heritage" as well as "promotion of natural assets" support with a limited budget share | Support for restoring agricultural production potential damage by natural disasters. Compensatory allowances for natural handicaps, agri-environmental payments, drainage, clearing and fight against erosion as well as promotion of access to irrigation, water-saving practices |
| Disaster Risk | Drafting and implementation of plans and measures to prevent and manage natural and technological risks | |
| Tourism/ health | Funding in this field is provided in action such as e-health as well as health infrastructure, water treatment waste management and nature preservation. | Promotion of tourism activities |
| Energy/ transport | Activities in investments in co-generation and energy management, renewable energy initiatives such as wind, solar, biomass and hydroelectric energy technology support. Prominent support of multimodal transport | |
| Water | Management and distribution of drinking water and water treatment | Modernization of irrigation systems, deposits and drainage and waste water management |

*Source: European Parliament (2011) + own compilation*

### *Common Fisheries Policy – EFF*

- The European Commission approved the Operational Programme for the French fishing industry for the period 2007-2013 (EUR 14.7 million);
- The total eligible public expenditure under this programme is EUR 436.2 million, with EU assistance through the European Fisheries Fund (EFF) amounting to € 216.0 million;
- EUR 34.3 million of EFF aid will be allocated to the convergence regions (Overseas Departments)[108]; and

[105] Agri-environment payments
[106] Infrastructure related to the agricultural sector
[107] modernization of agricultural holdings

- As a programme implemented at national level, it is not possible to know the exact allocations dedicated to Martinique for climate change adaptation objectives.

### Examples of significantly adaptation related projects

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| Maison de la Nature | Biodiversity | ERDF | To highlight the region's specific ecosystems and the relations between man and the natural world | |
| APRM | Infrastructure | ERDF | To establish common rules for the construction. The project aims to establish a common basis for the definition of technical standards for construction in the countries of the Caribbean and the means to implement to distribute, to adopt and respect. | www.interreg-caraibes.org/spip.php?rubrique31 |
| CARIWATNET | | EDF | Increasing scientific excellence of Caribbean partners and to jointly develop integrated managements plans for selected watersheds on the Islands of the islands that respects and enhances indigenous knowledge, protect environmental resources, increases livelihood security, restores biodiversity and reduces the communities' vulnerability to the effects of climate change. | |

[108] EAS (2010), The European Fisheries Fund Compilation of Member State Operating Programmes for Fisheries 2007-2013

# St Martin

Adaptation Strategy: No
Location | Caribbean Sea
Surface area | 56 km$^2$
Topography | part of 1 island, mountainous.
Population | 36,969 inhabitants
GDP per capita (2008) | $15,400

## Climate

| | Characteristic features | Climate change – key issues |
|---|---|---|
| Temperature | • Average annual temperatures: 26°C<br>• | • Annual temperature: 1.8-2.4ºC increase is predicted in the IPCC report (2007). |
| Precipitation | • Rainy season from June to November<br>• Year to year, variation in rainfall is highly influenced by both the El Niño Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO).<br>• Low rainfall and scarcity of groundwater resources. | • Temperature increases could worsen the water deficit.<br>• The difference between the wet and the dry season may not be as great in future.<br>• Annual patterns: a wetter dry season has been observed. |
| Sea level rise | • Most communities have settled on barrier beaches or sandbars which are low and narrow. | • Mean sea level rise: 0.35mm (IPCC 2007).<br>• Increase of erosion.<br>• Temporary flooding in areas especially in coastal areas |
| Extreme weather events | • Hurricanes and tropical storms<br>• More droughts are expected. | • The intensity and frequency of hurricanes is expected to increase due to climate change. |
| Natural disasters | • | • Floods/landslides are expected to occur more frequently as a result of more extreme rainfall or storms and an increase in their frequency.<br>• Increased prevalence of coastal flooding/inundation, which is likely to be magnified by the sea-level rise and increased sea storms. |

## Economic activities

| | Features and key figures | Climate change – key issues |
|---|---|---|
| Agriculture | • The island faces a chronic deficit in water resources due to low rainfall and scarcity of groundwater resources. | • Temperature increases could worsen the water deficit and impact agricultural yields. |
| Forestry | • St Martin presents the characteristics of a dry island with scattered hills and some areas with abundant vegetation.<br>• There is no established forestry sector | |
| Construction | • Most communities have settled on barrier beaches or sandbars which are low and narrow.<br>• The number of building permits issued between 2009 and 2012 decreased by 44.3% | • Out of all French OR, St Martin has the highest ratio of buildings exposed to flooding this risk is likely to increase as climate changes. |

| | Features and key figures | Climate change - key issues |
|---|---|---|
| | | |
| Tourism | • Tourism corresponds to approximately 80% of GDP (including the impact on domestic demand and construction).<br>• The island's tourism development is driven mainly by the cruise industry. | • Coastal flooding and erosion will impact tourism infrastructure, including the one airport<br>• Any impacts on biodiversity may negatively impact 'nature tourism'. |

## Social services and infrastructure

| | Features and key figures | Climate change – key issues |
|---|---|---|
| Energy | • St Martin imports fuels and 'connects' with the Dutch part of the island to balance supply and demand. | • Fuel supplies could be disrupted (as transported by sea) impacting energy security |
| Transport | • The islands airport is famously situated adjacent to a beach.<br>• Much of the islands infrastructure is location at the coast. | • Sea level rise and coastal flooding will impact transport infrastructure, a key vulnerability for the island. |
| Waste | • No information available | |
| Water | • The island faces a chronic deficit in water resources due to low rainfall and scarcity of groundwater resources. | • Temperature increases could worsen the water deficit. |
| Coastal zone management | • Most communities have settled on sandbars and barrier beaches. | • Coastal flooding and erosion is one of the main risks.<br>• Permanent inundation for the lowest lands. |
| Health | • No information available | |
| Disaster management | • No information available | |

## Natural environment

| | Features and key figures | Climate change- key concerns |
|---|---|---|
| Biodiversity | • The National Nature Reserve of Saint Martin is a marine protection area which includes coral reefs and mangrove areas. | • Increase of erosion.<br>• The impacts of climate change will tend to accelerate the disappearance of habitats. |
| Soil | • No information available | |

## Areas for adaptation intervention

### Key messages

- There is no climate change strategy in place for St Martin and limited resources to understand how climate is changing or what its impacts may be; and
- Coastal zone management is an important area where actions should be undertaken to increase the resilience of the coast to flooding, given the vulnerability of infrastructure and tourism amenities to coastal flooding.

### Socioeconomic implications

- Tourism corresponds to approximately 80% of GDP (including the impact on domestic demand and construction). Due to the small size of the economy, the development of a single project can have a significant impact on GDP.

### Climate change adaptation activities

An adaptation strategy has been implemented in the natural protected area "Réserve Naturelle St Martin". Specific actions of the strategy include the following:

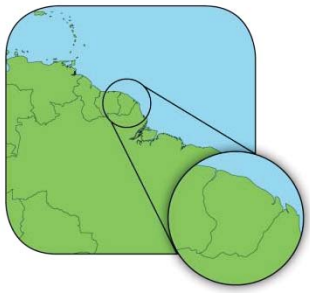
- Controlling anthropogenic pressure on protected areas;
- Restoring damaged populations and habitats; and
- Developing adaptation tools to climate change (e.g. modelling artificial reefs and coral reefs restoration).

### Contribution of EU funds to climate change adaptation

No allocation of funds have been identified which are specifically to St Martin for projects with a significant adaptation component.

# French Guiana

Adaptation Strategy: Yes
Location | South America
Surface area | 83,846 km$^2$
Topography | Continental plateau, 94% jungle, low altitude coastal band.
Population | 236,250 inhabitants
GDP (2009) (EU=100)| 52.8



## Climate

| | Characteristic features | Climate change - key issues |
|---|---|---|
| Temperature | • Average annual temperatures: 26 °C | • Annual temperature: 2.6-3.6ºC increase is predicted in the IPCC report (2007).<br>• +0.28ºC/decade rise was observed from 1965-2009 (ONERC, 2010a)<br>• A warmer dry season is expected (SRCAE Guyane 2012) |
| Precipitation | • Rainy season from June to November.<br>• Year to year variation is highly influenced by the El Niño Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO). | • Annual patterns: the rainy season is becoming wetter and the precipitation deficit in the dry season is becoming greater. |
| Sea level rise | | • Mean sea level rise: 0.35mm (IPCC 2007).<br>• Sea levels could rise by 0.23m to 0.47m by 2100 (SRCAE Guyane 2012) |
| Extreme weather events | | • The development of periods of very hot weather is expected.<br>• Droughts in July are increasing in frequency. |
| Natural disasters | • Flooding and landslides<br>• 70% of the population could be a risk of being affected by at least 1 natural hazard. | • Floods/landslides are expected to occur more frequently as a result of extreme rainfall or storms. Likelihood of coastal flooding is likely to be magnified by the sea-level rise and increased sea storms. |

## Economic activities

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Agriculture | • Least developed of all France's OR (French Ministry of Interior, 2011)<br>• Represents 0.3% of the territory and 2.9% of the active workforce.<br>• Very poor soils<br>• Local production meets 15% of demand (Prefecture de la région Guyane, 2007 cited in BRGM, 2011)<br>• Contributes towards 5.7% of GVA.<br>• Farmers in French Guiana already have to deal with many pests and diseases because of equatorial conditions | • Very little information to assess the impact of climate change upon agriculture.<br>• A decrease in rainfall during critical periods could favour the development of pests. |
| Forestry | • 826, 000 hectares are exploited.<br>• Employs 700 people (website of the Préfecture de la region Guyane)<br>• Third most productive sector after space and | • Increased frequency of wildfires.<br>• Changes in rainfall could change the balance of ecosystems in rainforest and result in loss of biodiversity and loss of forestry opportunity. |

| | Features and key figures | Climate change - key issues |
|---|---|---|
| | fisheries | |
| Fisheries | • Second most productive industry. | • Mangrove swamps (fish nurseries) are at risk, potentially resulting in reduced fish stocks.<br>• Increasing water temperatures leading to loss of local species (IFREMER, 2007). |
| Construction | • Represented 9% of the value added to the economy in 2007 (IEDOM, 2012b).<br>• This sector is declining; it lost 6% of its employees between 2009 and 2010. | • Constructions are in areas that are at risk of rising sea levels, floods or landslides, which could be more frequent or intense due to climate change. |
| Tourism | • Heavily dependent on the space sector.<br>• Employs 5% of the workforce<br>• Represented only 2% of the value added to the economy in 2007 (IEDOM, 2012b)<br>• Cruise tourism is increasing (IEDOM, 2012b) | • Coastal flooding and erosion.<br>• More frequent and severe extreme weather events (i.e. floods, heat waves) |

## Social services and infrastructure

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Energy | • In 2007 represented only 2% of the value added to the economy (IEDOM, 2012b)<br>• Renewable energy meets 60% of consumption in 2011 | • Infrastructure damage due to climate change related events (i.e. floods, landslides, SLR).<br>• Cost and uncertainty of electricity generation |
| Transport | • No information available | • Infrastructure damage due to climate change related events.<br>• Disturbance to transport routes |
| Waste | • • No information available | • Infrastructure damage due to climate change related events |
| Water | • Second highest in the world in terms of available freshwater per inhabitant.<br>• 95% of the drinking water is taken from coastal rivers. | • Water storage and supply issues.<br>• Comté river (DIREN Guyane, 2010) has seen an increase in periods of low flow since 1970.<br>• Damage due to climate change related events.<br>• Salt water intrusion is occurring in coastal rivers.<br>• Water temperatures are rising. |
| Coastal zone management | • No information available | • Coastal flooding and erosion (French Guiana already has an unstable coastline).<br>• More frequent and severe extreme weather events (i.e. floods, heat waves) |
| Health | • Limited information available | • More frequent and severe extreme weather events (i.e. floods, heat waves)<br>• Spread of vector-borne diseases |
| Disaster management | • Certain geographic/social features (e.g. steep landscapes) contribute to increase natural hazards' effects | • More frequent and severe climate-related hazards |

## Natural environment

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Biodiversity | • Possesses a very rich biodiversity.<br>• Designated as a biodiversity hot-spot<br>• High marine biodiversity<br>• 7000 plant species and 100 animal species are on the IUCN's red list. | • Extinction of tropical forest species (SRCAE Guyane 2012).<br>• Biodiversity is threatened and conditions could become favourable for invasive alien species. |
| Soil | • Poor soil quality. | • Poor soil quality makes it vulnerable |

## Areas for adaptation intervention

### Key messages

There is very little data available which is specifically focused upon adaptation however several comments can be made based on the assessment of likely climate risks:

- Fisheries and Aquaculture and the Buildings and Construction sector are the economic sectors that should be considered as a priority due to their vulnerability to climate impacts;
- Biodiversity is the environmental system where the implementation of adaptation measures is most urgent. The importance of the ecosystems in French Guiana and their fragility means that they are particularly vulnerable;
- Disaster and risk management should be considered a priority area for action given the vulnerability to impacts such as flooding and inundation; and
- The threat of wildfires should be addressed.

## Socioeconomic implications

- French Guiana shows a relatively high dependence on agriculture. The sector accounts for almost 5% of total GVA each year (averaged over 2000-2006), which, of the OR, is second only to The Azores (11-12% each year). This suggests a higher reliance on this climate-sensitive sector compared to most other ORs;
- There are no WTTC data with which to assess the value of tourism in French Guiana on a comparable basis to other OR in this study. French Guiana has the lowest average number of overnight tourist stays each year (averaged over 2006-2009) and this is also low as a ratio to the population of the OR (0.2 per capita compared to almost 20 in Madeira or the Canary Islands). It seems likely that French Guiana has a lower dependence on tourism compared to the other ORs; and
- On an annualised basis, European subsidies represent around 2% of French Guiana's annual GVA. This is similar to the other OR with the exception of The Azores (where the share is more than 4%).

## Activities relevant to climate change adaptation

### Overview

French Guiana has not yet implemented specific actions for adaptation. The Regional Plan for Climate, Air and Energy ("*Schéma Régional Climat Air Energie*" (SRCAE)[109] of French Guiana was released in June 2012. The document emphasizes the priority to define adaptation actions and to integrate adaptation challenges in the planning and development documents and policies. Nonetheless, it does not define adaptation actions. The study BRGM is currently carrying out aims at identifying the main actions to be implemented at local level to adapt to climate change.

### Contribution of EU funds to climate change adaptation

***Cohesion Policy – ERDF***

109 http://www.guyane.developpement-durable.gouv.fr/IMG/pdf/SRCAE_Guyane-VF_26062012.pdf

- Within the ongoing period (2007-2013), the ERDF contributes roughly EUR305 million. Only a minor share of the ERDF budget was used for measures significantly adaptation relevant;
- The largest share (EUR 23 million – around 7.5% of the total ERDF allocations) was allocated for water management, which can be considered significant for climate change adaptation;
- Less than 1% of total ERDF funding was dedicated to risk prevention and environmental protection measures;
- The Operational Programme Interreg Caraibes IV, aimed at strengthening environmental management and risk prevention in French Guiana, Guadeloupe and Martinique: almost 9% of the total ERDF allocation for the programme (about EUR 47 million);
- The promotion of natural assets and the protection and development of natural heritage are also among the priorities and account for 3.8 million (8% of total ERDF budget of the programme); and
- The territorial cooperation programme Amazonia is also of relevance for French Guiana with EUR 12 million allocated. The programme dedicates some funding to risk prevention and the promotion of natural assets and the protection and development of natural heritage objectives, which also involve neighbouring countries.

### *Common Agricultural Policy (CAP) – EAFRD*

- Total EU contribution for rural development from the CAP is estimated at EUR 77 million for 2007-2013. The main emphases of the programme include: improving and developing infrastructure for the adaptation of agriculture and forestry, offering basic services for the economy and rural population, vocational training and information actions, including diffusion of scientific knowledge and innovative practices for people working in the agricultural, food and forestry sectors;
- Measure 214[110] allocates 2 million (only 1% of the total EAFRD budget for French Guiana). It demonstrates synergies between climate change mitigation and adaptation since it includes sub-measures that deal with both aspects;
- Measure 227[111] accounts for EUR 3.6 million (1% of the total EAFRD budget for French Guiana). It aims to encourage the establishment of preventive measures for natural risks;
- Measure 125[112] allocates 15 million (5.1% of total EAFRD allocation for French Guiana) It covers operations related to water supply and efficiency; and
- Measure 121[113] allocates 7 million (2% of total EAFRD allocation for French Guiana) for investments in the modernization of irrigation systems, deposits and drainage and waste treatment.

**Overview of the climate change adaptation relevant measures by sector of the French Guiana in the programming period 2007- 2013**

| | ERDF | EAFRD |
|---|---|---|
| Biodiversity | The Regional park of Guiana (PNRG) and the Amazons Park of Guiana (PAG) have been created in order to protect the environment and to encourage the development of local economic activities as well | Payments to farmers in mountain areas that are intended to compensate for natural handicaps support for infrastructure improvements and eco-system restoration and preservation |
| Disaster Risk | Risk prevention measures come from both the Interreg programmes | Preventive measures for natural risks. |
| Tourism/ health | Initiatives in developing potentials of high added value and innovation (enhance a knowledge based economy | |

[110] Agri-environment payments
[111] Non-productive investments
[112] Infrastructure related to the agricultural sector
[113] Modernization of agricultural holdings

| Overview of the climate change adaptation relevant measures by sector of the French Guiana in the programming period 2007- 2013 | | |
|---|---|---|
| | **ERDF** | **EAFRD** |
| | and foster research in fields of biotechnology) | |
| Energy/transport | Technologies aimed at reducing the impact of corrosion and degradation of materials caused by humidity, heat, sun and sea air support in the field of knowledge building and innovation for the improvement of energy infrastructure (renewable energy), port infrastructure | Capacity building and sustainable practices in agriculture and forestry as well as support for renewable energy production |
| Water | Provision of potable water | Water supply and efficiency; modernization of irrigation systems, deposits and drainage and waste treatment. |
| Other | | Vocational training and information actions, including diffusion of scientific knowledge and innovative practices for people working in the agricultural, food and forestry sectors. |

*Source: European Parliament (2011) + own compilation*

### *Common Fisheries Policy – EFF*

- The European Commission approved the Operational Programme for the French fishing industry for the period 2007-2013 (EUR 14.7 million);
- The total eligible public expenditure under this programme is EUR 436.2 million, with EU assistance through the European Fisheries Fund (EFF) amounting to € 216.0 million;
- EUR 34.3 million of EFF aid will be allocated to the convergence regions (Overseas Departments)[114]; and
- As the programme is implemented at a national level, it is not possible to know the exact funds allocated to French Guiana for climate change adaptation objectives.

**Examples of significantly adaptation related projects**

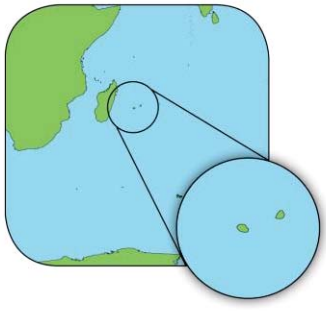
| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| GUYASIM | Environmental monitoring | ERDF | Provide a means of quantifying changes in the environmental services provided by the forest ecosystem, such as: carbon storage, the erosion or preservation of biodiversity and soil functioning Research findings and knowledge in the areas of spatial plotting of Guianese forest ecosystem services, socioeconomic development options and the impact of climate change on the Guianese forest ecosystem will all be built into the programme | http://www.ecofog.gf/spip.php?article429 |
| CARTAM-SAT | Environmental mapping system | ERDF | The purpose of CARTAM-SAT is to develop automated methods for storing, cataloguing, processing and interpreting satellite images, with a view to creating a dynamic mapping system for Guianese territory that will be automated and intelligent. | http://www.seas-guyane.org |
| VIRUSES | Health | ERDF | Research program on the involvement of wildlife in the phenomena of emergence or re-emergence of viruses from four viral families, all of importance in public health. | |

[114] EAS (2010), The European Fisheries Fund Compilation of Member State Operating Programmes for Fisheries 2007-2013

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| HABITATS | Biodiversity | ERDF | To develop and validate tools to assess forest biodiversity: it is to draw a map of forest habitat throughout Guyana and implement standardized protocols for counting wildlife | |
| Securing river Ouanary | Infrastructure | ERDF | Within the context of securing river works, the work involves the demolition of existing structures and construction collapsed later a wharf and pier and a bridge with floating pontoon. | |
| AQUAA | Infrastructure | ERDF | To promote the idea of sustainable development in the construction, inform the public objectively and develop operational and taking into account the notions of environmental quality in operations buildings and urban planning. | |
| SIG MANA | Energy | ERDF | Development of a hydroelectric water over the river Mana north west of French Guiana, 50 km from Saint Laurent du Maroni and Mana 8 km. This plant will be installed on Valentine Mom jump upstream of the bridge and jump Sabbath happen in real time according to the flow of the river without water storage. | |
| Drinking water from the river Matiti Kourou | Water | ERDF | To secure the existing system, to mobilize at short notice a new resource of drinking water on the island of Cayenne. | |
| STRONGER | Health | FP7 | To set-up a taskforce that is more capable of managing infectious and emerging diseases in French Guiana. | http://www.pasteur-cayenne.fr/stronger/ |
| STORMI-TURTLE | Biodiversity | FP7 | Focus on the adaptive strategies of critically-endangered species facing environmental constraints and will tackle one of the most important questions relating to the global change impacts on marine biodiversity | http://www.nioz.nl/ |
| Kaw-Roura Nature Reserve | Tourism/Biodiversity | ERDF | The Kaw-Roura Nature reserve is an example of a successful combination of both climate change adaptation and mitigation strategies. By preserving natural habitats some of the damaging effects of climate change can be minimised, while education programmes encourage the sustained uptake of more ecologically sustainable practices. | |
| Life+ Cap DOM | Biodiversity | LIFE + | To provide the human, technical and financial means to take rapid, concrete action in favour of threatened birds and habitats in the French Overseas Departments | http://www.lifecapdom.org |

## La Réunion

Adaptation Strategy: Yes
Location | Indian Ocean
Surface area | 2503.7 km$^2$
Topography | 1 island, volcanic island.
Population | 839, 480 inhabitants
GDP (2009) (EU=100)| 52.8



## Climate

| | Characteristic features | Climate change – key issues |
|---|---|---|
| Temperature | • Average annual temperatures: 21-32 °C at the coast, 12-22 °C in the mountains. | • Annual temperature: 1.9-2.4ºC increase is predicted in the IPCC report (2007).<br>• Sea temperatures are rising. |
| Precipitation | | • Average precipitation: estimated to between -2 and +20% in the Indian Ocean compared to long term averages.<br>• Annual patterns: drier winters.<br>• Rainfall is increasing on the eastern part of the island and decreasing on the western. |
| Sea level rise | | • Mean sea level rise: 0.35mm (IPCC 2007).<br>• Sea level rise is predicted to be between 20 and 60 cm by 2100 |
| Extreme weather events | • Tropical cyclones | • There is evidence of more extreme weather events (IOC, 2011). |
| Natural disasters | • Wildfires<br>• Volcanic and seismic activity<br>• Tsunami risk<br>• Flood and landslides | • Floods/landslides are expected to occur more frequently as a result of extreme rainfall or storms. Likelihood of coastal flooding is likely to be magnified by the sea-level rise and increased sea storms.<br>• Risk of landslides is high in areas with volcanic activity.<br>• Increase in wildfires |

## Economic activities

| | Features and key figures | Climate change – key issues |
|---|---|---|
| Agriculture | • Occupies 20% of the land and employs 10% of the population.<br>• Vulnerability limited as local production could be replaced by imports.<br>• Main activity within the primary sector which represents 1% of GVA.<br>• Declining importance but still contributes to exports and supports other sectors (agro-food industry).<br>• Key social and ecological role in rural areas (67% of territory).<br>• Contributed 1.6% towards GVA in 2009. | • Sugar cane occupies more than 50% of the agricultural surface. This production is considered to be sensitive to temperature increase and rainfalls decrease. Decrease in yields are foreseeable.<br>• Changes in land use<br>• Impacts on water availability for irrigation are expected (IOC, 2011)<br>• Salinisation of aquifers is observed in the west of the island. This has the potential to impact water availability for agriculture. |
| Forestry | • Forests cover over 50% of the island, but less than 3% is exploited and the economic potential is small. | • Increased frequency of wildfires. |
| Fisheries | • Some traditional fishing takes place but the island is also used as a base for industrial fishing.<br>• Around 900 people are employed in the industry.<br>• Recent growth is now slowing. | • Potential changes in migration routes of some species such as tuna |
| Construction | • Contributed 6.2% to GVA in 2009 | • Constructions are in risk-areas of rising sea levels, floods or landslides, which could be more frequent or intense due to climate change. |

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Tourism | | • Coastal flooding and erosion.<br>• More frequent and severe extreme weather events (i.e. floods, heat waves)<br>• Low capacity to adapt |

## Social services and infrastructure

| | Features and key figures | Climate change – key issues |
|---|---|---|
| Energy | • Electricity production is based on a variety of sources.<br>• Good capacity | • A heatwave could lead to an increase in demand due to the use of cooling systems.<br>• Infrastructure damage (in particular hydroelectricity and the distribution grid) due to climate change related events (i.e. cyclones).<br>• Great uncertainty in the cost of future electricity generation |
| Transport | • Roads lie at the heart of economic activity on the island<br>• Low capacity to adapt | • Infrastructure damage (in particular roads) due to climate change related events (i.e. heavy rain triggering a landslide).<br>• Disturbance to transport routes |
| Waste | • No information available | • Infrastructure damage due to climate change related events |
| Water | • Water resources are abundant but unevenly distributed across the island (SRCAE La Réunion 2011). | • The west of the island will be driers.<br>• The water sewerage network is highly vulnerable to extreme weather events. |
| Coastal zone management | • Most of the coastline is either rocky or alluvial with only short stretches of sandy beach.<br>• La Réunion has experience of managing their coastal zone. | • Coastal flooding and erosion is one of the main risks that La Réunion tackles (French Ministry of Environment, 2011a)<br>• Coastal inundation may become an issue in future |
| Health | • Vector-borne diseases are the primary threat. | • More frequent and severe extreme weather events (i.e. floods, heat waves)<br>• Spread of vector-borne diseases |
| Disaster management | • Certain geographic/social features (e.g. steep landscapes) contribute to increase natural hazards' effects<br>• Already experienced in cyclone management. | • More frequent and severe climate-related hazards<br>• Not experienced in dealing with non cyclone events. |

## Natural environment

| | Features and key figures | Climate change- key concerns |
|---|---|---|
| Biodiversity | • Possesses a great diversity in habitats.<br>• Climate change is not the main threat to the islands biodiversity (IUCN, 2010) | • Loss of biodiversity.<br>• An increase in invasive species.<br>• Invasive species are the first cause of biodiversity loss.<br>• Coral bleaching has been observed in the past decade. |

| | Features and key figures | Climate change- key concerns |
|---|---|---|
| Soil | • No information available | |

## Areas for adaptation intervention

### Key messages

- Construction, Transport and Tourism are the economic sectors that should be considered as a priority for adaptation, especially regarding infrastructure damage and, in the case of tourism, the spread of disease;
- Biodiversity is the environmental system where the implementation of adaptation measures appears to be more urgent;
- The energy sector should consider adaptive actions (heatwaves could lead to increased demand due to demand for cooling);
- Coastal zone management is an important area where actions should be undertaken by regional authorities to reduce anthropogenic pressure and increase the resilience of the coast to flooding; and
- Human health and disaster prevention are key social areas to consider for adaptation action. Human diseases (e.g. vector-borne diseases) and deaths could increase due to warmer climate conditions and the increase of extreme weather events, mainly flooding and wildfires.

### Socioeconomic implications

- La Réunion shows a relatively low dependence on agriculture, which accounts for just over 2% of total GVA each year (the average over 2000-2006). Only The Canary Islands has a lower share, at 1.7%;
- The economy of La Réunion is larger than those of the other three French OR: €10bn compared to less than €6bn each year in the others. As such, while the direct value of tourism (direct transactions with tourists) in the economy is higher, as a share of total GVA the sector is similar in size to Guadeloupe and Martinique: between 2.6% and 2.9%;
- However, while the direct contribution of tourism to La Réunion's economy is comparable to Guadeloupe and Martinique, the total contribution, accounting for supply-chain and other indirect effects, is somewhat lower: 8% compared to 18% in Guadeloupe and 12% in Martinique. This may indicate a lower dependence on local business, suggesting that the economy of La Réunion as a whole may be somewhat more resilient to downturns in tourism;
- While there are instances of climate events hitting La Réunion, there are no obvious periods in which this is associated with marked deviations from trend growth in agriculture or construction. It is not immediately obvious whether La Réunion has been substantially affected by climate change at macroeconomic level in the recent past; and
- On an annualised basis, European subsidies represent around 1.8% of La Réunion's annual GVA. This is similar to the other OR with the exception of The Azores (where the share is more than 4%).

## Climate change adaptation activities

### Overview

- The final version of the Regional Plan for Climate, Air and Energy of La Réunion was released in March 2011. It focuses on climate change impacts and future potential adaptation strategies for the region;
- As concerns adaptation to climate change, the Regional Plan put emphasis on the need to develop an adaptation strategy at a local level. Furthermore, it defines future potential adaptation measures for the region. The priority actions are:
    - Anticipating the effects of climate change by developing knowledge on climate change impacts on the territory, in particular in relation to natural risks;
    - Managing urban planning in order to integrate population increase by 2030, savings in energy consumption, and preservation of natural and agricultural ecosystems in a context of climate change.

In practice, current projects in developing new transport infrastructure (e.g. the new coastline road) are taking into account the climate change impacts.

### Contribution of EU funds to climate change adaptation

#### *Cohesion Policy – ERDF*

- For the 2007-2013 period Réunion received EUR 1 billion from the ERDF budget, of which only a minor share is attributed to activities significantly adaptation related;
- The largest shares were invested in adaptation measures, more precisely in "water management" and "water treatment" (EUR 132 million – around 13 % of the total ERDF budget for Réunion);
- Promotion of natural assets and development of environmental heritage took around EUR 42 million – accounting for 4% of the total ERDF spending; and
- Risk prevention was allocated only EUR 15 million (almost 2% of the total ERDF spending).

#### *Common Agricultural Policy (CAP) – EAFRD*

- Total EU contribution for rural development from the CAP is estimated at EUR 321 million for 2007-2013;
- Measure 226[115] and measure 227[116] aim to encourage the establishment of preventive measures for natural risks;
- Measure 226 accounted for EUR 12 million[117] (only 0.3% of the total EAFRD allocations for Réunion). It includes action for fighting erosion and desertification from natural catastrophes such as floods;
- Measure 227 accounted for EUR 10 million[118] (3.3% of the total EAFRD allocations for Réunion) includes actions such as the creation and recovery of open spaces in forests (clearings), elimination of undesirable or invasive plants species, investments for providing information on the use of forests and other non-productive investments with a view to restore and conserve habitats and species, especially high natural value areas such as Natura 2000 sites; and
- Measure 125[119] allocated EUR 988,200 (only 0.31% of the total EAFRD spending). It covered operations related to water supply and efficiency. Water efficiency in Réunion is promoted through investments in individual or collective dams and water storage facilities for water storage during rainfall periods as well as drainage equipment.

**Overview of the climate change adaptation relevant measures by sector of Réunion in the programming period 2007-2013**

| | ERDF | EAFRD |
|---|---|---|
| Biodiversity | Only a moderate 4.5% of the total budget is dedicated to the promotion of biodiversity and nature protection, promotion of natural assets and protection and promotion of natural heritage | Payments to farmers in areas that are intended to compensate for natural handicaps; Conservation and enhancement of forest ecosystem Improving and developing infrastructure related to the evolution and adaptation of agriculture and forestry: maintenance of cane production (introduction of varieties in sugarcane production adapted to the agro-ecological zones of the island), agri-environmental payments: fight against erosion, conservation of biodiversity |
| Disaster Risk | Drafting and implementation of plans and measures to prevent and manage natural and technological risks | Action for fighting erosion and desertification from natural catastrophes such as floods |
| Tourism/ health | Water treatment, drinking water provision, waste management support of renewable energies | Promotion of tourism activities (facilities dedicated to the reception of tourists within the perimeter of Parc de la Réunion (Nature Reserve) |

[115] Restoring forestry and introducing prevention actions
[116] Non-productive investments
[117] The amount includes national funding
[118] The amount includes national funding
[119] Infrastructure related to the agricultural sector

| Overview of the climate change adaptation relevant measures by sector of Réunion in the programming period 2007-2013 | | |
|---|---|---|
| | **ERDF** | **EAFRD** |
| Energy/ transport | Not necessarily all directed towards climate change adaptation, port adaptation investments, health infrastructure and initiatives such as e-health measures, development of a knowledge based economy: construction of schools following the standards of High Quality Environment (HQE), university research | Recovering energy from biomass |
| Water | Management and distribution of drinking water and water treatment | Individual or collective dams and water storage facilities for water storage during rainfall periods as well as drainage equipment |

*Source: European Parliament (2011) + own compilation*

### *Common Fisheries Policy – EFF*

- The European Commission approved the Operational Programme for the French fishing industry for the period 2007-2013 (EUR 14.7 million);
- The total eligible public expenditure under this programme is EUR 436.2 million, with EU assistance through the European Fisheries Fund (EFF) amounting to € 216.0 million;
- EUR 34.3 million of EFF aid will be allocated to the convergence regions (Overseas Departments)[120]; and
- As a programme implemented at national level, it is not possible to know the exact allocations dedicated to Réunion for climate change adaptation objectives.

### Examples of significantly adaptation related projects

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| SEAS-OI | Environmental monitoring | ERDF | To put in place a centre of excellence in remote sensing using a station to receive and process high-resolution satellite images covering the entire south-west area of the Indian Ocean. These are useful in relation to regional problems concerning land planning, the management of natural land environments, maritime monitoring, epidemiological monitoring, the preservation of biodiversity, monitoring of climate indicators and the management of natural hazards. | http://www.espace.ird.fr/ |
| Water sharing | Water | ERDF | To tap into the abundant supplies of water found on the eastern seaboard of Réunion in an attempt to meet the growing requirements of domestic and other users in the western part of the island. Redistributing water from one side of the island to the other clearly is a way of adapting to the effects of climate change. | |

[120] EAS (2010), The European Fisheries Fund Compilation of Member State Operating Programmes for Fisheries 2007-2013

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| New road | Infrastructure | ERDF | The new route is expected to accommodate upwards of 40 000 vehicles per day by 2015, the structures have been designed in such a way as to protect the fragile ecosystem at the bottom of the various ravines and to safeguard the natural characteristics of the landscape by using a limited number of piers. Rainwater processing systems have also been installed, together with anti-noise panels, to reduce pollution. Renewable energy is also being given a boost with the installation of solar panels. | Conseil régional de la Réunion |
| RUN sea science | Biodiversity | FP7 | To defend these vast marine territories, world heritages of biodiversity, in the face of international pressure to overexploit them. | http://run-sea-science.fr/?rubrique26 |

# Mayotte

Adaptation Strategy: No
Location | Indian Ocean
Surface area | 374 km$^2$
Topography | 1 main and 1 small island in a lagoon, mountainous (inland), numerous bays and small islands
Population (2012) | 212,645 inhabitants
GDP per capita (2009) (EU average=100)| 27.96

## Climate

| | Characteristic features | Climate change - key issues |
|---|---|---|
| Temperature | • Average annual temperatures: 25°C. | • Annual temperature: 1.9-2.4ºC increase is predicted in the IPCC report (2007).<br>• Sea temperatures are rising. |
| Precipitation | • Strong seasonality with 75% of rains in the summer, but with irregular duration differing year to year.<br>• Geographically concentrated in northeastern and southeastern areas. | • Average precipitation: estimated to between -2 and +20% in the Indian Ocean compared to long term averages.<br>• Rainfall is likely to decrease in winter (IPCC 2007a), compounding the effects of alternating drought-flood periods. |
| Sea level rise | • Despite recorded falling sea levels in western Indian Ocean (IPCC, AR4), Mayotte has seen a steady increase of 3 to 5 mm per year between 1993 and 2011 (Chevet et al. 2012). | • Mean sea level rise: 0.35mm (IPCC 2007).<br>• Sea level rise is predicted to be between 20 and 60 cm by 2100<br>• Further flooding expected to damage beaches and threaten flora and fauna (especially the mangroves). |
| Extreme weather events | • Cushioned between Madagascar and the African continent, Mayotte experiences relatively less damage from hurricanes and tropical storms than its larger neighbour. | • There is evidence of more extreme weather events in the region (IOC, 2011). |
| Natural disasters | • Landslides, flooding, mudslides.<br>• Tsunami risk | • Floods/landslides are expected to occur more frequently as a result of extreme rainfall or storms. Likelihood of coastal flooding is likely to be magnified by the sea-level rise and increased sea storms. |

## Economic activities

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Agriculture | • Involves approximately one-third of the population (15,700 households from agricultural census of 2010)<br>• Mostly small scale, non-professional, polyculture farming is practiced to achieve autonomy for basic staples (bananas, cassava, fruits, vegetables, livestock) or as a complementary income source.<br>• Local production accounts for 40% of produce consumed. | • With limited land available for cultivation and limited water resources, projected changes in temperature may impact current agricultural land and crops. |
| Forestry | • No information available | |
| Fisheries | • Coexistence of a wide range of practices: modern industrial tuna fishing, long line fishing, small scale artisanal/coastal fishing either as a vocation or for subsistence.<br>• Fish farming is the major source for foreign | • Changing sea temperatures and impacts on coral reef will change the composition of fish stock and have the potential to limit catch size. |

| | Features and key figures | Climate change - key issues |
|---|---|---|
| | trade, less than 100 tonnes of fish | |
| Construction | • No information available | • With most people living at or near the coast, construction may be required further inland, requiring measures to protect against new challenges (such as landslide) |
| Tourism | • Tourist sector rapidly developing (52,800 visitors in 2010. cf. 200,000 to La Réunion).<br>• Accounts for 7% of registered businesses and 2% of workforce. | • Tourism Is not as economically important at much of the rest of the OR and it is not clear what the impact of climate would be given current modest demand. |

## Social services and infrastructure

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Energy | • Heavy dependence on fossil fuels (91.7% in 2009) | • Much infrastructure sis located at the coast and therefore may be vulnerable to coastal flooding and/or inundation |
| Transport | • Roads saturated around capital Mamoudzou (19,000 vehicles/day on northern and southern axes).<br>• Airport facilities limited (sole commercial airport is single strip) with a new runway to be completed by 2015.<br>• Saturated ferry traffic between Grande-Terre and Petite-Terre islands, | • Much infrastructure sis located at the coast and therefore may be vulnerable to coastal flooding and/or inundation |
| Waste | • Numerous challenges in regards to waste management and treatment. | |
| Water | • Water treatment practices and facilities not keeping up with increasing water use.<br>• Public sanitation issues, degradation of water quality in waterways and lagoon witnessed. | • Climate change is likely to exacerbate existing water problems. |
| Coastal zone management | • No information available | • Much infrastructure sis located at the coast and therefore may be vulnerable to coastal flooding and/or inundation |
| Health | • Prevalence of hygiene and environmental risks, infectious tropical diseases. | • Climate change may result in the range of infectious disease increasing. |
| Disaster management | • Cushioned between Madagascar and the African continent, Mayotte experiences relatively less damage from hurricanes and tropical storms than its larger neighbour. | |

## Natural environment

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Biodiversity | • Highest concentration found in lagoon covering 1,100 $km^2$, one of the largest in the world.<br>• Rare double barrier reef of 196km with additional 18km border to the south, with rich diversity of coral<br>• Currently half of the reefs have been degraded due to over-fishing, pollution, and sedimentation. | • Sedimentation due to soil erosion poses a serious risk to the lagoon's ecosystem.<br>• Higher temperatures may cause species to migrate to highlands, threatening highland rainforests species that have nowhere else to go. 80 invasive species (30 widespread), of both exotic and native origin have already been identified. |

| | Features and key figures | Climate change - key issues |
|---|---|---|
| | • Together with other western Indian Ocean islands, comprises one of 24 globally recognised Conservation International biodiversity hotspots.<br>• Rich collection of tropical insular fauna (1,000 different species of vascular plants in 354 $km^2$ area, 2005) and high species density.<br>• Wetland ecosystems play important role in the island's drinking water supply.<br>• Mitigate flood risks. | • Coral bleaching and loss of coral reefs to increase, leading to possible outbreaks of food poisoning.<br>• Increased water temperatures threat to local turtle populations (hawksbill and green turtles).<br>• Rising temperatures may disrupt migratory patterns of marine mammals.<br>• Loss of wetlands will likely increase the occurrence of flood damage to the island. |
| Soil | • High level of soil erosion due to steep slopes and heavy precipitation, which is further exacerbated by human activity.<br>• Soil quality is low due to alternating drought and aggressive rains. | • Climate change is likely to exacerbate existing challenges |

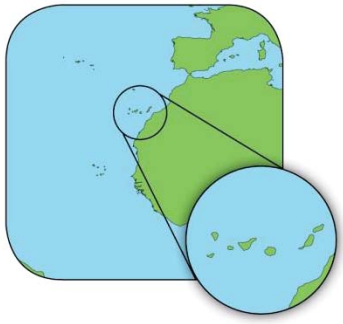
## Areas for adaptation intervention

### Key messages

- One of the biggest climate change challenges is how to avoid the destruction of natural habitats, a significant asset in Mayotte.
  Another is how to protect the mainly coastal infrastructure and manage relocation of the population to inland areas without significant loss of habitats and negative impacts on sensitive ecosystems.

As a new Outermost Region, limited information has been identified within this study which is specific to Mayotte. For example, no allocation of funds have been identified which are specifically to Mayotte for projects with a significant adaptation component. The prefecture of Mayotte recently conducted studies as part of the Strategic Action Project on the State of Mayotte (P.A.S.E.M. 2011-2013). These include formulation of plans to integrate EU funding 2014-2020 (FEADER, FEAMP, FEDER, FEDER-Interreg, & FSE).

# Canary Islands



Adaptation Strategy: Yes
Location | Atlantic Ocean (Macaronesia)
Surface area | 7,447 km$^2$
Topography | 7 islands, mountainous (inland)
Population | 2,100,229 inhabitants
GDP per capita (2010) (EU average=100)| 85

## Climate

| | Characteristic features | Climate change - key issues |
|---|---|---|
| Temperature | • Average annual temperatures: 20 °C (decreases at altitude)<br>• Average sea temperatures: extreme values range typically between 17.5-25 ºC | • Annual temperature: 1.9-2.4ºC increase is predicted in the IPCC report (2007). Martin et al., (2012) reports +0.09ºC per decade since 40's (+0.17ºC since 70's)<br>• Sea temperature: reported +0.1ºC per decade since 40's (+0.28ºC since 70's). |
| Precipitation | • Overall low rainfall values with seasonal variability.<br>• Conditioned by trade winds and the Azores Anticyclone.<br>• Rainfall levels increase in altitude and from east to west (i.e. east islands are dryer) | • Average precipitation: an overall decline trend has been observed, especially in the windward slopes (-25 to -39 mm/ decade since 40's) of Gran Canaria and Tenerife.<br>• Annual patterns: drier autumn season and likely dryer winters has been documented. |
| Sea level rise | | • Mean sea level rise: 0.35m (IPCC 2007) by end of the century. Measurements during 1949-2001 suggest that there is a positive trend in the Canaries of around +0.39mm/year (Tel & Garcia, 2012). |
| Extreme weather events | • Short and intense episodes of rainfall are frequent in the region. Rainfall of >200mm/24h has been recorded in the islands.<br>• Heat waves and droughts have been recorded throughout history. | • Regional data suggest that precipitation tends to concentrate in shorter and more intense episodes. The effects of nearby tropical storms (e.g. Delta storm in 2005) could reach the Canaries more frequently.<br>• An increase in the number and intensity of heat waves during 1944-2007 has been documented. |
| Natural disasters | • Steep mountainous slopes combined with intense rainfall events create appropriate conditions for landslides and flooding.<br>• Wildfires are of particular concern during summer. | • Floods/landslides are expected to occur more frequently as a result of extreme rainfall or storms. Coastal flooding is likely to be magnified by sea-level rise and a projected increase of sea storms.<br>• Wildfires are likely to be more frequent with increased dryer conditions. |

## Economic activities

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Agriculture | • Main activity within the primary sector but only represents about 1% of regional GVA. Its importance is declining but still contributes to exports and other sectors (agro-food industry).<br>• Key social and ecological role in rural areas (67% of territory). | • Vulnerability of rural agriculture due to the way production is set up, e.g. small arable plots.<br>• Accentuation of salinity problems and greater irrigation needs.<br>• Increase in pests and diseases |
| Forestry | • Marginal role compared to agriculture or fisheries. | • Increased frequency of wildfires. |
| Fisheries | • Lower weight than agriculture.<br>• Traditional fishing in Canaries' waters coexists with industrial fishing in nearby African waters. | • Changes in the distribution of migratory species (i.e. tuna).<br>• Impact on the upwelling of cold waters near the African coast |

| | Features and key figures | Climate change - key issues |
|---|---|---|
| | • Aquaculture is gaining relevance. | • Increase of diseases and appearance of new species. |
| Construction | • Significant role in the economy in terms of employment and GVA.<br>• High urbanisation of the coast. Urban settlements are also located in areas of steep slopes or near ravines. | • Constructions are in risk-areas of rising sea levels, floods or landslides, which could be more frequent or intense due to climate change. |
| Tourism | • Key economic sector (>30% of the region's GDP and employment).<br>• More than 10 million tourists/year<br>• 75% of touristic activity is coastal | • Coastal flooding and erosion.<br>• More frequent and severe extreme weather events (i.e. floods, heat waves) |

## Social services and infrastructure

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Energy | • High energy dependency on imports<br>• Isolated grid systems<br>• Infrastructure is mainly coastal<br>• Strong relationship with the water industry (energy intense). | • Infrastructure damage due to climate change related events (i.e. floods, landslides, SLR).<br>• Cost and uncertainty of electricity generation |
| Transport | • Crucial role as it supports tourism and trade. There is a high demand for mobility between and within islands. | • Infrastructure damage due to climate change related events.<br>• Disturbance to transport routes |
| Waste | • Small and remote character of terminal waste areas. | • Infrastructure damage due to climate change related events |
| Water | • Limited freshwater resources with groundwater being the main source.<br>• About 30% of water resources come from non-conventional sources. | • Infrastructure damage due to climate change related events.<br>• Accentuation of salinity problems<br>• Water shortage scenarios |
| Coastal zone management | • Coast/marine ecosystems are under high tourist and urban pressure<br>• The coastline has about 6% of artificial coast and 16% of beaches. | • Coastal flooding and erosion.<br>• More frequent and severe extreme weather events (i.e. floods, heat waves) |
| Health | • Similar health resources as in mainland Europe (i.e. hospital beds)<br>• Exposed to uncontrolled immigration from Africa | • More frequent and severe extreme weather events (i.e. floods, heat waves) and more episodes of Saharan air intrusion<br>• Spread of vector-borne diseases |
| Disaster management | • Certain geographic/social features (e.g. steep landscapes) contribute to increase natural hazards' effects | • More frequent and severe climate-related hazards |

## Natural environment

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Biodiversity | • Designated as a biodiversity hot-spot<br>• High level of endemism<br>• High levels of marine biodiversity (e.g. meadows of seagrass, corals) | • Low resilience to climate change impacts due to the small size of the ecosystems and human-pressure (limits migration) |
| Soil | • High levels of soil diversity<br>• Currently affected by severe erosion | • Soil erosion and desertification linked to more frequent and severe extreme climatic events |

| Features and key figures | Climate change - key issues |
|---|---|
| processes | |

## Socioeconomic implications

- The economy of the Canary Islands is substantially larger than any of the other OR, at €20-30bn each year, compared to €10bn in La Réunion and €6bn or less in the others. The majority of that activity is concentrated in services and the OR has the lowest dependence on agriculture, accounting for 1.7% of total GVA (average over 2000-2006);
- Tourism is a vital contributor to the economy of The Canary Islands. Of the OR, the Canary Islands are by far the most popular tourist destination, with 40m overnight stays each year (average over 2006-2011), substantially more than Madeira (5m) or any of the other OR (600,000 or less); and
- There have been a number of climate events that have affected the Canary Islands over the last years (e.g. tropical storm Delta in 2005, severe wildfires in 2007 or flooding events in 2002 in Tenerife), but is not straightforward to associate them with developments in the economic data, at least not at a macroeconomic level.

## Areas for adaptation intervention

### Key messages

- Energy, Construction, Transport and Tourism are economic sectors that should be considered as a priority for adaptation, especially regarding infrastructure damage that may occur as a result of more frequent and intense climatic events (e.g. heavier rainfall causing floods);
- The fisheries sector should consider adaptation measures to counteract risk from changes in the distribution of migratory species and an increase in diseases;
- The implementation of adaptation measures appears to be especially urgent to protect the rich biodiversity of the archipelago, characterised by high levels of endemic species. Numerous climatic risks such as the potential increase in invasive species adapted to warmer conditions are likely to have a severe impact on the fragile biodiversity of the archipelago, already under high anthropogenic pressure;
- Coastal zone management is an important area where actions should be undertaken by regional authorities to reduce anthropogenic pressure and increase the resilience to predicted changes in marine dynamics (e.g. sea level rise). In particular the city of Las Palmas de Gran Canaria has been highlighted as a particularly vulnerable to sea level rise (source: consultation with OR representative);
- Human health and disaster prevention are key social areas to consider for adaptation action. Human diseases (e.g. vector-borne diseases) and deaths could increase due to warmer climate conditions and the increased frequency of extreme weather events, mainly heat waves; and
- Several opportunities have been identified. Tourism may benefit from a longer summer tourist season and the increased possibility of observing new species of tropical origin in the Canaries (e.g. whale watching). On the island of el Hierro new fisheries have developed related to tropical fish (e.g. “gallo aplomado”). In addition there are opportunities linked with the development of renewable energies and the need to adapt buildings to a change in the climate conditions.

## Activities relevant to climate change adaptation

### Overview

- The Climate Change Strategy for the Canary Islands was approved in 2009. It focused on mitigation and education measures, although it included a mandate to develop an adaptation plan. A preliminary assessment of the potential impacts of climate change was developed in 2010;
- The Department of the Environment is now assessing the vulnerability of the Canaries to climate change as a step towards developing the Adaptation Plan, expected in 2013/2014, which will include short, medium and long term measures. In the short term, the most relevant measures (still under evaluation) will possibly be in the fields of water resources (groundwater recharge), biodiversity

(exotic/ native species extinctions, changes in forest), agriculture (crops, pests, and irrigation) and health (heat waves, new diseases);

- At present, there are relevant adaptation measures underway in the areas of energy (i.e. development of renewable energies to enhance energy security in the context of the Energy Plan for the Canary Islands (Canary Islands Government 2006)) and of natural risks management through monitoring and prevention measures such as the Plan against extreme adverse weather events (PEFMA); and
- Important efforts are being focused on research activities aimed at the development of a solid knowledge base. A number of research programmes are being supported by the European "Transnational Cooperation Programme Madeira-Açores-Canarias (MAC) 2007-2013".

**Use of EU funds**

The Canary Islands has been allocated around €1.3bn of European subsidies over 2007-2013. While large for an OR, the large size of the economy of the Canary Islands means that this actually accounts for a very low share of total GVA: 0.5% on an annualised basis.

### *Cohesion Policy – ERDF*

Within the ongoing period (2007-2013) the ERDF totals roughly EUR 1 billion. Within this budget, the bulk of expenditures allocated to activities that could be considered as significantly adaptation related was directed to management and distribution of water ( EUR 54 million – around 5.3% of total ERDF allocation).

- Only 1.1 % of the ERDF budget was dedicated to promotion of biodiversity and nature protection.

### *Common Agricultural Policy (CAP) – EAFRD*

- Total EU contribution for rural development from the CAP is estimated at EUR 153 million for 2007-2013;
- The revised RDP did not specifically recognize the need to deal with climate change, but rather increased the amount of funding for water management (45%) and biodiversity (36%);
- Measure 125[121] absorbs EUR 11 million (8% of the total EAFRD allocation). Under this measure explicit reference is made to supporting investments in irrigation infrastructures for better management and sustainable use of water resources ion agriculture;
- Measure 121[122] accounts for EUR 37 million (of 25 % of the total EAFRD allocation) It includes investments for the modernisation of irrigation systems, deposits, pumping, drainage, establishment of new structures and improvement of existing ones and systems to improve water quality, with the objective to save water; and
- Measure 226[123] and measure 227[124] support the establishment of preventive measures in order to prevent natural risks, such as forest fires. They account for, EUR 9.7 million and 14.3 million respectively (6.5% and 9.5% of the total EAFRD allocation for the Canary Islands).

**Overview of the climate change adaptation relevant measures by sector of the Canaries in the programming period 2007-2013**

| | ERDF | EAFRD |
|---|---|---|
| Biodiversity | Very limited answers to these challenges | Measures for biodiversity preservation and protection of natural resources; agri-environment payment (combat erosion, prevent natural disasters, protect biodiversity)<br><br>Capacity building in agriculture (increase knowledge and awareness in relation to sustainable agriculture and forestry |

[121] Infrastructure related to the development and adaptation of agriculture and forestry
[122] Modernization of agricultural holdings
[123] Restoring forestry potential and introducing prevention actions
[124] Non-productive investments

| | | |
|---|---|---|
| | | issues, access counselling services to improve the overall and environmental performance of their exploitation) |
| Disaster Risk | Only through the INTERREG programme, drafting and implementation of plans and measures to prevent and manage natural and technological risks | |
| Tourism/ health | Water management and risk prevention comparably high share of support for health – either through health infrastructure support or through services and applications for citizens (such as e-health) network of surveillance (environmental information)<br><br>Grants for research in innovative and advanced research and development projects among others in the fields of biomedicine and health, sustainable development and management of natural resources, biodiversity, renewable energy, climate change and desertification | Promotion of tourism activities, restoring the traditional landscape of rural areas |
| Energy/Transport | ERDF supports solar energy and photovoltaic, wind energy and biomasses, hydropower and geothermic energy, port infrastructure | |
| Water | Water management and risk prevention, provision of drinking water, guaranteeing an adequate water quality, the efficient distribution of potable water to the most remote areas, protection of public water and sustainable water use encouraged through more restrictive pricing policies<br><br>waste management systems, reuse, recycling and reducing waste generation | Improving and developing infrastructure related to the evolution and adaptation of agriculture and forestry<br><br>improvement of water management, efficiency of irrigation systems and quality of irrigation water |

*Source: European Parliament (2011) + own compilation*

### *Common Fisheries Policy – EFF*

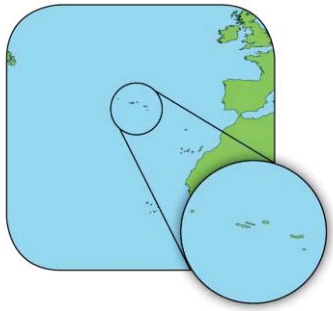
- Circa EUR 2 million has been approved for the Operational Programme for the Spanish Fisheries Industry, for the period 2007-2013, with EU assistance through the EFF amounting to € 1,131.9 million;
- EUR 945.7 million will be granted to convergence regions and EUR 186.2 millions to non-convergence regions. Being a programme implemented at national level; and
- It is not possible to provide the exact allocations dedicated to the Canary Islands for climate change adaptation objectives because the Programme has been implemented at the national level.

### Examples of significantly adaptation related projects

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| RESCAN | Disaster risk | ERDF | To boost the coordination of security and emergency services across the region by introducing a digital mobile radio network in order to address any emergency or natural disaster. | http://www.gobcan.es/dgse/temas/rescan.html |
| EXMAR | Biodiversity | ERDF | To create a comprehensive space for research excellence in marine science – particularly for research, technological development, and innovation among research groups. | http://agencia.itccanarias.org/es/actuaciones/2010/actuacion_proyectos_estructurantes/sub_pe_exmar.jsp |
| COST Action ES0904 & GROOM | Marine research | FP7 | The main objective of this Action is the coordination of ongoing research using gliders, and the conception of future research, to operate fleets of autonomous underwater gliders in order to provide cost-effective methods for the discovery and monitoring of the ocean at global, | http://www.ego-cost.eu<br>http://www.groom-fp7.eu/ |

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| | | | regional and coastal scales with benefit to both basic oceanographic research and operational applications for marine activities. | |
| ISLE-PACT | Energy | Yes | To increase the share of renewable energy generation in order to increase energy security and self-sufficiency | http://www.islepact.eu/ |
| MEDIRAS | Energy | FP7 | To develop and demonstrate cost-effective and reliable solar-driven desalination systems for regions affected by water scarcity and high insolation | http://www.mediras.eu |
| "El-Hierro project" | Energy | PPP | Aims to achieve energy independence for the island of el Hierro. Improvements to energy infrastructure should increase resilience of the energy sector to the potential impacts of climate change | http://www.unescocan.org/pdf/HierroProject.pdf |
| HERITPROT | Risk Prevention | Interreg IVC | Fire Risk Prevention and Improvement of the Fire Extinction Systems of the Historic Town Centres of Cities named Word Heritage | http://www.heritprot.com/ |
| ClimaImpacto MAC (2007-2013) | Several areas | Yes | Generate climate scenarios and quantifying the impacts of climate change in the Canary Islands and the Macaronesian region. The project has recently published a draft report on the preliminary evaluation of the archipelago's vulnerability to climate change. | http://climaimpacto.eu/ |
| LITOMAC MAC (2007-2013) | Coast | Yes | Aims to develop an Integrated Strategy for the coastal fringe of the Canary Islands, Azores and Madeira. | http://www.litomac.com |
| FORESTMAC MAC (2007-2013) | Forestry | Yes | Aimed at the development of an insular strategy to ensure the sustainability of forest resources in the Macaronesian region. | http://www.foresmac.com |
| BIOCLIMAC MAC (2007-2013) | Biodiversity | Yes | Aimed at ensuring genetic variability of selected plant species | http://www.bioclimac.com |
| PREMUMAC MAC (2007-2013) | Risk | Yes | Aimed at enhancing natural risks' prevention and management in the municipalities of the Macaronesia. | http://www.premumac.com |
| MOSQIMAC MAC (2007-2013) | Health | Yes | Integrated management of vector Aedes aegypti. Generate risk maps of diseases transmitted by mosquito in cooperation with Madeira. | http://www.ull.es/view/institutos/tropicales/Inicio/es |
| Climatique (POCTEFEX 2008-2013) | Several areas | Yes | Exchange of institutional and professional experiences with regards to climate change between the region of Souss Massa Draa (Morocco) and the Canaries. | http://climatique.itccanarias.org/es/ |
| BIONATURA (Interreg IIIB) | Biodiversity | Yes | Rounds up some events that develop tools for the cooperative management of endangered species, exotic species and natural areas in Azores, Madeira and the Canaries. | http://www.interreg-bionatura.com/ |

# Azores



Adaptation Strategy: Yes
Location | Atlantic Ocean (Macaronesia)
Surface area | 2,322 km$^2$
Topography | 9 islands, mountainous (inland)
Population | 245,811 inhabitants
GDP per capita (2010) (EU average =100)| 75

## Climate

| | Characteristic features | Climate change - key issues |
|---|---|---|
| Temperature | • Average temperatures: summer – 18-24 °C; winter – 16 °C<br>• Sea water temperatures: 14-22 °C | • Annual temperature: 1.9-2.4ºC increase (IPCC, 2007b)<br>• Annual patterns: greater frequency of summer days (T>25ºC) and tropical nights (T>20ºC). |
| Precipitation | • High seasonal variation | • Annual patterns: greater inter-annual variability and seasonality |
| Sea level rise | | • Mean sea level rise: 0.35mm (IPCC 2007).<br>• Regional Climate Change Strategy (ERAC 2011) states that there are insufficient sea-level measurements over insufficient time to conclude if sea-level rise is a long term trend or a seasonal variation, but that there may be an increase in sea level by 1 m by the end of the century. |
| Extreme weather events | • Average storm in the Azores – duration: 2.3 days; frequency: 3 storms per year.<br>• Extreme weather events frequency: 1 every 7 years<br>• Rise in extreme temperature events has not been observed | • Tropical storms are expected to occur more frequently and with greater strength<br>• Anticipating and managing weather extremes is a priority<br>• Due to oceanic thermoregulatory effect frequency of excessively hot or cold days is unlikely to change |
| Natural disasters | • Coastal flooding occurs as a result of extreme weather events with high waves<br>• A landslide is one of the most common natural hazards<br>• Wildfires are not of particular concern due to humid climate | • Likelihood of coastal flooding is further magnified by the sea-level rise<br>• Floods are expected to occur more frequently as a result of extreme rainfall and storms<br>• Occurrence of prolonged periods of drought is expected<br>• Higher possibility of landslides as a result of changes to precipitation patterns and increased frequency of extreme weather events |

## Economic activities

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Agriculture | • 65% of total land used is utilised as agricultural area<br>• Majority of agricultural areas located along the coast and at lower altitudes | • Temperature rise<br>• Increase in pests and diseases<br>• Floods and coastal flooding<br>• Availability of water (droughts, change in rainfall patterns, saltwater intrusion)<br>• Limited possibility to move production inland due to difficult topography |
| Forestry | • 9.2% of the land in the Azores is utilised for forestry | • Lower availability of water (change in the annual patterns of rainfall, saltwater intrusion) |

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Fisheries | • Contributing around a quarter of total production from this sector in Portugal<br>• Important role in the Azores' economy (consultation with a representative) | • Changes in the distribution of migratory species (i.e. tuna).<br>• Increase of diseases and invasive species. |
| Construction | • GVA in 2010 of around 7%<br>• Role in the local economy increased in recent years due to increase in demand from the public sector | • Greater likelihood of landslides<br>• Greater occurrence of coastal flooding (based on the assumption that majority of buildings is located along the coasts) |
| Tourism | • Greater likelihood of landslides<br>• Greater occurrence of coastal flooding (based on the assumption that majority of buildings is located along the coasts) | • Greater frequency of extreme weather events, sea level rise and coastal flooding<br>• Damage to tourist infrastructure Decrease in attractiveness of Azores as a tourist destination |

## Social services and infrastructure

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Energy | • No interconnection with either European or African continent<br>• Nine isolated energy systems<br>• The majority of the primary energy in the Azores comes from oil.<br>• In 2010, 30-37% of electricity in the island was generated from renewable sources | • Damage to the energy infrastructure and electricity grids as a result of extreme weather events and natural disasters (floods and coastal flooding) and loss of land (coastal inundation) |
| Transport | • Both regional and international, and related infrastructure is crucial for the economy of the Azores.<br>• There is no alternative to air transportation.<br>• Maritime transport of goods is of high relevance to the economy of the Azores. | • Damage to the transport infrastructure as a result of extreme weather events, natural disasters (coastal flooding, landslides) and sea level rise (coastal inundation). |
| Waste | • Limited land availability<br>• High reliance on transport between islands and with the mainland | • Damage to waste infrastructure (extreme weather events, flooding, sea level rise). |
| Water | • Availability of freshwater is highly dependent on weather conditions | • Water scarcity (due to changes in the annual patterns of rainfall and salinisation of freshwater resources) |
| Coastal zone management | • Coastal zone area represents approximately 40% of the territory of the archipelago<br>• High rate of urban development<br>• Coastal Zone Management Plans (Planos de ordenamento da orla costeira - POOC's) have been developed and approved for all islands. . | • Intensified coastal erosion<br>• Coastal flooding<br>• Coastal inundation<br>• Opportunities for moving coastal infrastructure inland will be limited due to the steep geography, high altitudes and unfavourable weather |
| Health | • Health services of comparable standard to mainland Europe (based on a number of hospital beds and number of nurses per inhabitant)<br>• Significant investment in health services in recent years | • Extra pressure on the health sector resulting from greater occurrence of natural disasters |
| Disaster & risk management | • Anticipating and managing weather extremes are key priorities for the Azores (consultation with a representative of the region). | • Increased occurrence of natural disasters (particularly landslides, floods and coastal flooding) |

## Natural environment

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Biodiversity | • Very rich biodiversity and endemism<br>• One of the most unique features of the archipelago is laurel forest | • Very rich biodiversity and endemism<br>• One of the most unique features of the archipelago is laurel forest (IUCN, Petit & Prudent, 2008). |
| Soil | • No information | • Lower availability of water (change in the annual patterns of rainfall, saltwater intrusion) |

## Socioeconomic implications

- Of the OR, the Azores shows the greatest dependence on agriculture, which accounts for more than 11% of total GVA each year (average over 2000-2006). This compares to 5% in French Guiana and less than 4% for the other OR. Agricultural land accounts for more than half the land area on the Azores, substantially more than any other OR. This supports the risk-assessment finding that agriculture in The Azores (and, by extension, its economy) is vulnerable to climate change; and
- As an average between 2006-2011, the Azores saw some 580,000 overnight tourist stays each year. This is lower than in Madeira or the Canary Islands (5m and 40m, respectively) but higher than any of the other OR. There are no WTTC data on the economic value of tourism and it is difficult to gauge how dependent this OR is on tourists.

## Areas for adaptation intervention

### Key messages

- Agriculture and tourism (economic sectors), transport, coastal zone management and water (social services and infrastructure) and biodiversity (natural environment), should be considered as priority areas for adaptation;
- Climate change impacts associated with the highest economic and environmental risk to the Azores are: increase in floods, increase in coastal flooding, coastal inundation, saltwater intrusion and change to annual pattern of rainfall. Coral bleaching, increase in water temperatures, increase in invasive species, pests and diseases present high potential risks to biodiversity of the archipelago. Greater likelihood of landslides carries specific risks for buildings and transport;
- Anticipation of natural disasters, mitigation of their impacts across all sectors and resilience building should be considered a priority. Key impacts on disaster and risk management are associated with extreme weather events (storms and severe rainfall), flooding (both inland and in coastal areas) as well as an increase in landslides; and
- A few opportunities may emerge for the Azores as a result of climate change. The rise in annual temperature and change in annual patterns of precipitation may create more favourable conditions for tourism in the islands (specifically in the winter months when currently little tourists visit the archipelago). Possible greater likelihood of intense precipitation episodes may lead to a small increase in outputs from hydropower plants. A positive impact may also be observed within the fisheries due to potential for new commercial fishing species migrating to Azorean waters.

## Activities relevant to climate change adaptation

### Overview

- The Regional Strategy on Climate Change (ERAC) was approved in October 2011;
- The ERAC will be put into action through the Regional Plan for Climate Change (PRAC) which will cover the following sectors: coastal zone management, water management, energy, biodiversity, fisheries, agriculture and forestry, tourism, transport, health, industry and communication infrastructure;
- The PRAC is due to be completed in 2014, followed by the implementation of the plan (consultation with a representative of the OR);

- Adaptation to climate change in the Azores is expected to bring new opportunities for the region, mainly through development of new infrastructure and technological innovation;
- While climate change is considered an important issue, the majority of current investments in the Azores concentrate on growing local economy and creating new employment opportunities (consultation with a representative of the OR); and
- The Government of the Azores has already developed some plans with relation to existing problems which may be augmented by climate change. These may have an added adaptation benefit. Example includes the Regional Plan for the Eradication and Control of Invasive Plant Species in Sensitive Areas (PREFICIAS), defining methodologies and strategies for the eradication and control of invasive species.

### Use of EU funds

The Azores has been allocated a similar amount of European Funds as the Canary Islands (over €1bn over 2007-2013). Because the economy of the Azores is much smaller (around €2.5bn in GVA compared to more than EUR 20bn for the Canary Islands), this represents a much larger share of GVA to the other OR on an annualised basis: more than 4% compared to 2% or less in the other OR (0.5% in the Canary Islands).

#### *Cohesion Policy - ERDF*

- Within the ongoing period (2007-2013), the ERDF contributes roughly EUR 966 million;
- About EUR 38,4 million (4 % of the total ERDF Fund for the Azores) have been allocated specifically to improving prevention systems and risk management:
  - developing studies and plans;
  - raising awareness and informing the general public about civil protection issues;
  - undertaking technical and scientific work with the University of the Azores, the public and private entities on monitoring and evaluating risks and disasters; and
  - constructing and revamping fires stations and acquiring equipment for civil protection.
- 10.3% of the total ERDF budget for the Azores has been dedicated to other measures that could be significant to climate change adaptation: tackle water management; and
- Around EUR 5 million (only about 4.6% of the total ERDF budget) goes for nature protection and the promotion of natural assets.

### Common Agricultural Policy (CAP) – EAFRD

- The Azores RDP (PRORURAL[125)] does not specifically focus on climate change adaptation;
- Compared to ERDF funding, the support by the second pillar of the CAP (e.g. rural development funds) addressing climate change has been moderate (improve soil quality and decrease erosion), the majority being dedicated to climate change mitigation objectives;
- Total EU contribution for rural development from the CAP is estimated at EUR 275 million for 2007-2013;
- Measure 222[126], with EUR 136,000 (only 0.05 % of the total EAFRD funding) encouraged agro-forestry systems on agricultural land and corresponding infrastructures; and
- Measure 126[127], with EUR 500,000 (only 0.2 % of the total EAFRD funding) encouraged investment in restoring fixed assets, including on-farm plantations, greenhouses and infrastructures – which may be affected by severe natural disasters.

| **Overview of the climate change adaptation relevant measures by sector of the Azores in the programming period 2007-2013** | | |
|---|---|---|
| | **ERDF** | **EAFRD** |
| Biodiversity | Nature protection | Very limited support addressing climate change: |

[125] Programa de Desenvolvimento Rural da Região Autónoma dos Açores (PRORURAL)
[126] Measure 222: First establishment of agroforestry systems on agricultural land
[127] Measure 126: Restoring agricultural production potential

| | | |
|---|---|---|
| | Promotion of natural assets<br>Protection and management of natural heritage | Compensatory allowances for areas with natural handicaps (other than mountainous regions)<br>Conservation and enhancement of rural heritage<br>Maintenance of production conditions that may be affected by severe natural disasters. |
| Disaster Risk | Developing studies and plans.<br>Raising awareness and informing the general public about civil protection issues.<br>Undertaking technical and scientific work with the University of the Azores, the public and private entities on monitoring and evaluating risks and disasters.<br>Constructing and revamping fires stations and acquiring equipment for civil protection. | Improve soil quality and decrease erosion; restoring fixed assets, including on-farm plantations, greenhouses and infrastructures – which may be affected by severe natural disasters. |
| Tourism/ health | | Promotion of tourism activities – i.e. the development of tourism initiatives and other recreational and leisure activities<br>Enhancement of environmental components and increase in sustainability |
| Energy/ transport | Infrastructure investments in the fields of ports<br>Production of renewable energy and the use of geothermal energy | |
| Water | Water treatment and water management (drinking water)<br>Waste treatment<br>Improving and developing infrastructure (adequate management of water resources, irrigation) | |
| Other | | Capacity building and sustainable farming practices |

*Source: European Parliament (2011) + own compilation*

### Common Fisheries Policy – EFF

- Circa EUR 10 million Operational Programme for the Portuguese Fisheries Industry were approved for the period 2007-2013, where total eligible public expenditure of the programme is € 324.9 million, with EU assistance through the EFF amounting to € 246.5 million;
- EUR 223.9 million of the EFF assistance is allocated to the convergence regions of Portugal (Norte, Centro, Alentejo, Algarve and the Azores) and € 22.5 millions to the non-convergence regions (Lisbon & Madeira)[128]; and
- It is not possible to provide the exact allocations dedicated to the Azores for climate change adaptation objectives because the Programme has been implemented on the national level.

### Examples of significantly adaptation related projects

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| ISLE-PACT | Energy | Yes | Increasing energy security and resilience of energy infrastructure to the impacts of climate change by increasing the share of renewable energy generation. | http://www.islepact.eu/ |
| ClimarCost & Climaat I and II | Climate Monitoring | ERDF<br>MAC | The geostrategic position of the Azores makes these islands an ideal place for climatological and meteorological investigations. The Climaat I, Climaat II and ClimarCost projects developed, by means of a scientific cooperation, the | http://www.climaat.angra.uac.pt |

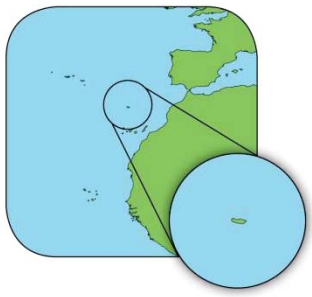
[128] EAS (2010), The European Fisheries Fund Compilation of Member State Operating Programmes for Fisheries 2007-2013

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| | | | methodologies needed for studying meteorology and climate of the Atlantic island regions, including the surrounding ocean. | |
| MarinERA | Marine research | FP6 | Marine phylogeographic structuring during climate change<br>ReDEco - Regional Drivers of Ecosystem Change and its Influence on Deep-Sea populations in the Mediterranean<br>To study the effects of regionally driven ecosystem changes in selected deep-sea habitats of the Mediterranean Sea and will focus on key drivers of climate change such as temperature changes, shifts in surface productivity and cold water cascading, and will examine their impacts on deep-sea populations. | http://marinera.seas-era.eu/dissemination/documents/MarinERA_LEGACY_bd.pdf |
| The Green Islands Project | Energy | Yes | Designing tools to develop the strategy to meet energy demand in the islands with renewable energy. Adaptation benefit comes from increase in energy security and increased resilience of the infrastructure to the impacts of climate change. | http://www.green-islands-azores.uac.pt |
| ClimaImpacto<br>MAC (2007-2013) | Several areas | Yes | Generate climate scenarios and quantifying the impacts of climate change in the Canary Islands and the Macaronesian region. | http://climaimpacto.eu/ |
| LITOMAC<br>MAC (2007-2013) | Coast | Yes | Aims to develop an Integrated Strategy for the coastal fringe of the Canary Islands, Azores and Madeira. | http://www.litomac.com |
| FORESTMAC<br>MAC (2007-2013) | Forestry | Yes | Aimed at the development of an insular strategy to ensure the sustainability of forest resources in the Macaronesian region. | http://www.foresmac.com |
| BIOCLIMAC<br>MAC (2007-2013) | Biodiversity | Yes | Aimed at ensuring genetic variability of selected plant species | http://www.bioclimac.com |
| PREMUMAC<br>MAC (2007-2013) | Risk | Yes | Aimed at enhancing natural risks' prevention and management in the municipalities of the Macaronesia. | http://www.premumac.com |
| CoralLab | Biodiversity | N/A | New laboratory set up to investigate impacts of climate change (increasing water temperatures and ocean acidification) on deep-sea cold-water corals. | http://www.eu-hermione.net/news/science/38-corallab-set-up-in-the-azores |
| BIONATURA<br>(Interreg IIIB) | Biodiversity | Yes | Cooperative management of endangered and exotic species, as well as natural areas in Azores, Madeira and the Canaries. | http://www.interreg-bionatura.com/ |
| MoMAR | Ocean observation | FP6 | Studying the temporal variability in active processes such as hydrothermalism, ecosystem dynamics, volcanism, seismicity and ground deformation, in order to constrain the dynamics of mid-ocean ridge hydrothermal ecosystems. Ocean observations build the knowledge base and help the exchange of information for planning action for climate change adaptation. | http://www.esonet-noe.org/ |

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| NET-BIOME | Biodiversity | FP7 | To network the Regional Research Policies on sustainable management of biodiversity in the European tropical and subtropical Outermost Regions and Territories | http://www.netbiome.org/ |
| TROPOS | Marine research | FP7 | Developing a floating modular multi-use platform system for use in deep waters, with an initial geographic focus on the Mediterranean, Tropical and Sub-Tropical regions, but designed to be flexible enough so as to not be limited in geographic scope. The system will to allow better monitoring of impacts of climate change on deep-water habitats. | http://www.troposplatform.eu/ |

# Madeira

Adaptation Strategy: No
Location | Atlantic Ocean (Macaronesia)
Surface area | 801 km$^2$
Topography | 2 main islands (Porto Santo and Madeira) with diverse inland terrain, and 2 groups of uninhabited islands (Selvagens and Desertas islands)
Population | 247,568 inhabitants
GDP per capita (2010) (EU average =100)| 104



## Climate

| | Characteristic features | Climate change - key issues |
|---|---|---|
| Temperature | • Mild climate during the year<br>• Average annual temperature: 14-18°C in coastal areas and 6-12°C in high altitudes | • Annual temperature: 1.9-2.4ºC increase is predicted in the IPCC report (2007).<br>• Santos & Miranda (2006) reports an expected increase of 2ºC to 3ºC by the end of the century. |
| Precipitation | • Significant on Madeira island. Lower levels in Porto Santo.<br>• High seasonal variability (about 80% of rainfall occurs between October and March)<br>• Topographic variability (400 mm in coast compared to 3000mm in highlands). | • Average precipitation: projected to decrease by a third. Estimates suggest that annual volume of water available for recharge of water resources will halve by the end of the century.<br>• Annual patterns: projected drier autumn, spring and winter seasons. Possible small increase in precipitation in the summer. |
| Sea level rise | | • Mean sea level rise: predicted at 0.35m by the end of the century (IPCC 2007). |
| Extreme weather events | • Extreme precipitation events over short periods of time (approx. 2-3 hours) are a natural phenomenon, mainly during autumn and spring.<br>• The number of days with T>25°C, is in the order of 40 days/year in areas south and west of the Island of Madeira. | • New records of accumulated precipitation caused by intense rainfall episodes have been recently recorded (2010). However, it is not possible to identify a clear trend in the evolution of heavy rainfall events and its relation to climate change.<br>• Future climate scenarios suggest more frequent heat waves although these are not expected to be of long duration. |
| Natural disasters | • Landslides/flooding are common natural hazards, due to steep topography (mainly in Madeira's island) combined with intense rainfall events.<br>• Important wildfires have been recently recorded (2012). | • Observed increase in the occurrence of floods and landslides over the last century. Severe damaging flood episodes and storms have been recently recorded. However, it is not possible to identify a clear trend linking the risk of flooding and landslides with impacts of climate change.<br>• At higher altitudes, a small increase in the risk of fire is expected due to increased temperatures and drier conditions. |

## Economic activities

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Agriculture | • Main activity within the primary sector but only represents 2% of GVA<br>• Contributes to employment (10% in 2008) and to self-sufficiency (local markets).<br>• Key social and ecological role. Part of the cultural and touristic identity. | • Vulnerability of rural agriculture due to the way production is set up, e.g. small arable plots.<br>• Greater irrigation needs and salinity intrusion problems<br>• Increase in pests and diseases affecting crops. |

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Forestry | • Less important than agriculture or fisheries.<br>• Relevant in rural areas and environmentally (i.e. soil protection) | • Reduced water availability<br>• Potential increase in flooding/landslide events<br>• Increased wildfires frequency. |
| Fisheries | • Lower weight than agriculture<br>• Crucial for some fishing communities<br>• Important in the regional market | • Increase of diseases and invasive species.<br>• Loss of deep water corals |
| Construction | • Used to be the second largest sector in economic and employment terms.<br>• Urbanisation is concentrated along the coast and in flood prone locations near the mouth of large rivers. | • Constructions are in risk-areas of rising sea levels or flash floods, which could be more frequent or intense due to climate change. |
| Tourism | • Dominant economic sector<br>• Main contributor to the services sector (84% of GVA and 71% of employment in 2010)<br>• 70% relies on international tourists | • Increased risk of transmitting infectious tropical diseases.<br>• Impact on thermal comfort<br>• More frequent and severe natural disasters (i.e. floods) |

## Social services and infrastructure

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Energy | • High energy dependency on imports<br>• Isolated and small grid system<br>• Infrastructure is mainly coastal<br>• Hydropower generation (15% of electricity production) | • Cost and uncertainty of electricity generation<br>• Competition for water for cooling of power stations and hydropower generation |
| Transport | • Crucial role as it supports tourism and trade. Increased demand for mobility between islands. | • Infrastructure damage due to climate-related hazards.<br>• Disturbance to transport routes. |
| Waste | • Recent investments in modern waste management facilities. | • Infrastructure damage and extra pressure on waste services due to climate change related events |
| Water | • Groundwater resources are the main source of water supply<br>• Water desalination technologies have been reported (i.e. Porto Santo). | • Reduced availability of water for recharge and runoff<br>• Accentuation of salinity problems |
| Coastal zone management | • High anthropogenic pressure on the coastal areas<br>• No specific regional coastal management plans identified | • Potential increased intensity and frequency of extreme weather events (e.g. cyclones, floods).<br>• Coastal erosion |
| Health | • Similar health resources as in mainland Europe (i.e. hospital beds)<br>• Population at risk of vector-borne diseases and flash floods | • Spread of tropical diseases (in 2012 epidemic of dengue fever).<br>• More frequent and severe natural disasters (i.e. floods) |
| Disaster management | • Highly exposed to natural hazards (i.e. due to steep landscapes)<br>• Existence of prevention and response programmes to emergencies | • More frequent and severe climate-related hazards |

## Natural environment

| | Features and key figures | Climate change - key issues |
|---|---|---|
| Biodiversity | • Designated as a biodiversity hot-spot<br>• High level of endemism (the relict Laurel Forest has been declared UNESCO World Heritage Site in 1999)<br>• Rich marine biodiversity (i.e. corals) | • Low resilience to climate change impacts due to human-pressure and small size of the ecosystems<br>• High altitude's species at risk due to warmer conditions<br>• Spread of tropical diseases and invasive species |
| Soil | Insufficient information was available to assess the vulnerability of soils to climate change in Madeira | |

## Socioeconomic implications

- Of the OR, Madeira has the smallest amount of land devoted to agriculture (6,100 ha) and the second-smallest in percentage terms (7.5% compared to 0.3% in French Guiana, although this OR's territory is substantially larger overall). As a share of total GVA, agriculture is of relatively low importance to Madeira (2.2%, averaged over 2000-2006) although it does have the highest amount of GVA associated with a single hectare of land (€11,500 per ha compared to less than €6,000 per ha for all the other OR);
- According to a DG Regional Policy report from 2011, as the second most popular OR for tourism (5m overnight stays each year, averaged over 2006-2009) Madeira has a moderate-to-high dependence on tourism (there are no WTTC data to compare across OR in this particular study); and
- It is not immediately obvious from the economic data whether Madeira has been affected by climate events at a macroeconomic level, although the estimated damage of recent events, such as the flooding in February 2010 was quite substantial.

## Areas for adaptation intervention

## Key messages

- The increase in disease and pests due to warmer and dryer conditions has been identified as a major risk for the archipelago. In particular, action is likely to be required against the transmission of vector-borne diseases, which have already been recorded in Madeira;
- Tourism is crucial in the economy of Madeira and its resilience against the impacts of climate change could be improved. Key climate change impacts identified as of the greatest risk to tourism in Madeira are: increase in diseases, floods including coastal flooding and coastal inundation;
- The energy, construction and transport sectors should be also considered for potential adaptation interventions, specifically with relation to increasing the resilience of their infrastructures against events such as flooding (including in coastal areas) and landslides;
- Madeira is home to a rich biodiversity, which needs to be protected against the impacts of climate change, specifically preserving archipelago's unique Laurel Forests and endemic species from impacts such as invasive species, pests and diseases but also water related impacts such as drought, floods, change to the annual patterns of rainfall and saltwater intrusion. Wildfires have also been identified as of high risk to biodiversity;
- The adaptive capacity of water systems is likely to benefit from being enhanced by regional authorities to reduce the risk of water shortage scenarios resulting from decreased precipitation. Water shortages were identified as likely to affect agriculture, forestry and tourism;
- Coastal hazards such as sea level rise and coastal flooding are likely to adversely affect majority of the economic sectors as well as public services; and
- A few opportunities may emerge for Madeira as a result of climate change. The rise in annual temperature may create more favourable conditions for the expansion of agriculture and forestry into higher altitude areas. The appearance of new species of whales in the waters of the archipelago may increase its attractiveness to tourists as a whale-watching destiny.

## Activities relevant to climate change adaptation

### Overview

- Madeira is intending to prepare a regional strategy on climate change although the document in unlikely to be published in the next couple of years. The preparation of the strategy will be led by the Regional Government of Madeira and the Department for Spatial Planning and the Environment;
- The strategy is likely to cover potential impacts of climate change on the islands, assess vulnerability of different sectors to these impacts and include some adaptation measures noting that more studies will need to be conducted to better understand potential impacts and map vulnerability of the Autonomous Region of Madeira to climate change. The strategy will also include climate change mitigation actions; and
- Current efforts are being focused on research activities aimed at the development of a knowledge base. A number of research programmes are being supported by the European "Transnational Cooperation Programme Madeira-Açores-Canarias (MAC) 2007-2013".

### Contribution of EU funds to climate change adaptation

On an annualised basis, European Funds represent around 2% of Madeira's annual GVA. This is similar to the other OR with the exception of The Azores (where the share is more than 4%).

#### *Cohesion Policy - ERDF*

- Within the ongoing period (2007-2013), the ERDF contributes roughly EUR 321 million. A minor share of the total is dedicated to funding activities that could be considered as significantly addressing climate adaptation objectives;
- About EUR 14.5 million (4.5 % of the total ERDF Fund for Madeira) have been allocated specifically to improving prevention systems and risk management and other measures to preserve environment;
- Around EUR 28.2 million (8.8 % of the total ERDF budget for the Madeira) tackled water management; and
- Around EUR € 9.4 million (about 3 % of the total ERDF budget) goes for nature protection and the promotion of natural assets.

#### *Common Agricultural Policy (CAP) – EAFRD*

- The Madeira RDP (PRODERAM[129]) programme allocates the total additional budget to the priority "Climate change". The programme focused on adaptation mainly through water supply management and efficiency issues, especially in terms of co-financing irrigation projects;
- Total EU contribution for rural development from the CAP is estimated at EUR 175 million for 2007-2013;
- Measure 125[130] accounts for EUR 41 million (around 24% of the total EARDF allocation in the PRODERAM). It integrates projects and actions related to irrigation and water management. The measure aims to develop collective irrigated plots systems;
- The development and management of such systems was reinforced with a EUR 4 million (EARDF contribution), to improve sustainable utilization of regional water resources and to adapt to climate change; and
- Measure 126[131] accounts for EUR 42 million (around 25% of the total EARDF allocation). It tackles the conditions that may be affected by severe natural disasters through investment in the reestablishment/restoration of fixed assets, including on-farm plantations, greenhouses and infrastructure. Disaster situations are covered, namely those caused by climate changes or fire.

[129] Programa de Desenvolvimento Rural da Região Autónoma da Madeira 2007-2013

[130] Improving and developing infrastructure related to the development and adaptation of agriculture and Forestry

[131] Restoring agricultural production potential damaged by natural disasters and introducing appropriate prevention actions

| Overview of the climate change adaptation relevant measures of Madeira by sector in the programming period 2007-2013 | | |
|---|---|---|
| | **ERDF** | **EAFRD** |
| Biodiversity | Nature protection measures and promotion of natural assets. | Provides mainly support for compensation of farming in less favoured areas and only to a small extent for the conservation of the rural heritage<br><br>Maintenance of the production conditions that may be affected by severe natural disasters through the investment regarding the re-establishment/restoration of fixed capital, including on-farm plantation |
| Disaster Risk | Improving prevention systems and risk management and other measures to preserve environment. | Fire prevention |
| Tourism/ health | The main measures addressing climate change and contributing to climate change adaptation in relation with tourism are improvements of water and waste treatment. | |
| Energy/ transport | Supporting renewable energy as well as sustainable transport systems the support is low in volume and spreads across the fields of capacity building (training and advisory services), | Agri-environmental measures, afforestation and diversification of agricultural activities (renewable energy) |
| Water | Water procurement as well as water treatment, waste management, but also the improvement of port infrastructure offers also some minor measures in order to improve infrastructure and/or improve the adaptive capacity of agricultural production against climate change | Development and improvement of collective irrigated plots systems |

*Source: European Parliament (2011) + own compilation*

### *Common Fisheries Policy – EFF*

- Circa EUR 10 million Operational Programme for the Portuguese Fisheries Industry were approved for the period 2007-2013, when total eligible public expenditure of the programme is € 324.9 million, with EU assistance through the EFF amounting to € 246.5 million;
- EUR 223.9 million of the EFF assistance is allocated to the convergence regions of Portugal (Norte, Centro, Alentejo, Algarve and the Azores) and € 22.5 million to the non-convergence regions (Lisbon & Madeira)132;
- It is not possible to provide the exact allocations dedicated to the Azores for climate change adaptation objectives because the Programme has been implemented on the national level.

### Examples of relevant projects

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| Socorridos hydroelectric plant | Energy | ERDF | To harness renewable energy sources, optimise water production for inhabitants and improve irrigation while protecting the island's natural resources. | http://www.eem.pt/ |

[132] EAS (2010), The European Fisheries Fund Compilation of Member State Operating Programmes for Fisheries 2007-2013

| | | | |
|---|---|---|---|
| Floods aid | Disaster risk | EUSF | To help Portugal meet emergency costs following the flooding and landslides on Madeira island in February 2010. This support mainly helped reimburse costs of emergency measures such as relief operations, cleaning up the affected areas and repair of basic infrastructures. It helped the people of Madeira affected by the floods as well as the local economy and ensured the restoration of the natural landscape. |

*Source: European Parliament (2011) + own compilation*

### *MAC programme*

- One of the main priorities of the Operational Programme 'Madeira-Azores-Canaries' is to strengthen environmental management and risk prevention in the three outermost regions;
- The protection and management of coastal zones and marine resources as well as maritime and coastal safety account for EUR 2.5 million (5% of the total ERDF allocation for the programme - about EUR 5.6 million). Operations under this priority include the:
- promotion of the implementation of prevention plans and warning systems;
- surveillance and monitoring of natural hazards; and
- support of comprehensive security plans and coastal sea ports.
- The promotion of natural assets is also among the priorities and accounts for 5% of total ERDF budget. It ensures:
- sustainable management of plants and marine protected areas;
- development of strategies for recovery; and
- protection of biodiversity and natural resources and the improvement of coastal environmental quality.

### Examples of significantly adaptation related projects

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| Germobanco | Biodiversity | ERDF MAC | To protect and preserve the huge agricultural biodiversity in Macaronesia and value the potential of local crop varieties. Several new seed management systems were implemented. | http://www.germobanco.eu |
| MaReS | Research | ERDF MAC | To organize a common tool for Macaronesian archipelagos, analysis, coordination, identifying opportunities to enable them to meet the challenges of sustainability through a research and development strategy in the Atlantic regions competitive European island.<br>Terrestrial Applications of Remote Sensing of Environment in the Azores<br>Very High Resolution satellite images for land management in the Macaronesia<br>Satellite Oceanography in the Azores<br>Geological hazards and monitoring activities at the Azores archipelago<br>Making use of space technologies – governing risks to foster new opportunities for Azores | http://maresmacaronesia.eu/ |
| ISLE-PACT | Energy | Yes | To increase the share of renewable energy generation in order to enhance energy security. | http://www.islepact.eu/ |
| ClimaImpacto MAC (2007-2013) | Several areas | ERDF MAC | Generate climate scenarios and quantifying the impacts of climate change in the Canary Islands and the Macaronesian region. | http://climaimpacto.eu/ |
| LITOMAC<br>MAC (2007-2013) | Coast | ERDF MAC | The objectives are:<br>Definition of the coastal fringes of the Macaronesian region. | http://www.litomac.com |

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| | | | Create a Regional Information System Coastal Territorial Macaronesian.<br>Develop a Strategy for Integrated Coastal Macaronesian Region. | |
| FORESTMAC<br>MAC (2007-2013) | Forestry | ERDF MAC | The insular defence strategy common to the national authorities and the EU aimed at the sustainability of forest resources and to economic, environmental and social Macaronesia. | http://www.foresmac.com |
| BIOCLIMAC<br>MAC (2007-2013) | Biodiversity | ERDF MAC | To carry out effective measures to conserve native plant species in the Azores, Madeira and the Canary Islands off the potential threats of climate change, contributing the development of the Global Strategy for Plant Conservation. | http://www.bioclimac.com |
| PREMUMAC<br>MAC (2007-2013) | Risk | ERDF MAC | Planning activities for the risk situation of the participating municipalities. Creating a municipal culture for the prevention of risk situations using different tools to be put in place. Preparation of municipal corporations to implement a plan of action in case of catastrophe in the municipality. | http://www.premumac.com |
| MOSQIMAC<br>MAC (2007-2013) | Health | ERDF MAC | Integrated management of vector Aedes aegypti. Generate risk maps of diseases transmitted by mosquito in cooperation with Madeira. | http://www.ull.es/view/institutos/tropicales/Inicio/es |
| BIONATURA<br>(Interreg IIIB) | Biodiversity | Yes | Grounds up some events that develop tools for the cooperative management of endangered species, exotic species and natural areas in Azores, Madeira and the Canaries. | http://www.interreg-bionatura.com/ |
| MacSimar | Marine research | ERDF<br>MAC | To leverage the capabilities R & D in the fields of climatology, meteorology and oceanography operating through the components of modelling, monitoring and disseminating information in a timely manner and at a scale appropriate to the sectors that depend on it. | http://macsimar.eu/ |
| ESTRAMAR | Marine research | ERDF<br>MAC | To promote R + D Maritime Marine Macaronesian regions of Europe and Africa for its approach and results are directed to contribute to better coordination of the scientific-technical-business, in areas such as security and sustainable transport, tourism, shipping and ports, increased coastal protection, resources and marine biodiversity and the provision and management of natural hazards and thus help boost economic development of these regions, following international targets. | http://estramar.eu/ |
| MaReS | Research | ERDF MAC | To organize a common tool Macaronesian archipelagos, analysis, coordination, identifying opportunities to enable them to meet the challenges of sustainability through a research and development strategy in the Atlantic regions competitive European island.<br>Canaries Space Centre: Taking care of Earth from | http://maresmacaronesia.eu/ |

# 7. Policy recommendations

This report argues that the OR must be reinforced against the risk of climate change and their capacity to adapt and to reduce the effects of catastrophe must be improved. Most of OR are eligible to receive considerable amounts of external funding, mainly from the EU, aimed at improving their development in line with the EU 2020 goals of smart, sustainable and inclusive growth. The OR have an important opportunity to ensure that spending programmes carefully consider the projected impacts of climate change and take concrete actions to improve climate change resilience, as well as ensure that spending does not negatively impact vulnerability.

The recommendations primarily target the authorities within the OR responsible for managing the spending programmes – with particular emphasis on larger programmes within the ESIF such as Structural Funds and the Rural Development Fund. At the same time, they can also guide officials within the Commission and others responsible for programming and supervision of funding to support the OR in ensuring that spending effective considers climate change impacts and targets resilience. Finally, the recommendations can also benefit the wide range of stakeholders involved in preparing spending programmes and developing projects – sectoral and local authorities, utilities, academic and research organisations, NGOs and others. The recommendations both raise awareness of the need to consider climate change impacts in all spending categories and provide concrete ways in which this can be done.

The recommendations are set in the context of the EC communication on "The outermost regions of the European Union: towards a partnership *for smart, sustainable and inclusive growth"*[133] as well as the recently adopted EU Adaptation Strategy[134]. Both of these documents focus on long-term, sustainable development that works within the boundaries of changing climate to both develop safeguards and take advantage of opportunities.

The EC communication focuses on diversification and modernization of economies in the OR. It encourages the OR to develop new practices in traditional sectors like agriculture or fisheries and to exploit the potential for new products arising from their biodiversity and marine ecosystems.

The EU Adaptation Strategy, adopted in April 2013, recognises that the OR are particularly vulnerable to the impacts of climate change. The accompanying documents[135,136] dedicate a special focus to the OR, stressing that they are particularly vulnerable to sea-level rise and extreme weather events and that adaptation measures to increase the resilience of infrastructure have become vital for these regions.

The 2014-2020 EU Multi-Annual Financial Framework (MFF)[137] sets out strategic orientations to govern the development and implementation future EU funding instruments. It is envisioned that at least 20 per cent of the MMF should be spent on climate change related activities. Such increase should primarily be achieved through the mainstreaming of climate-related objectives and obligations across the MMF. EU Funds for cohesion, agriculture, infrastructure, research and innovation can all contribute to finance actions to combat and adapt to climate change and the effort should be strongly promoted also in the OR.

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[133] COM(2012) 287 final, The outermost regions of the European Union: towards a partnership for smart, sustainable and inclusive growth

[134] http://ec.europa.eu/clima/policies/adaptation/what/documentation_en.htm

[135] SWD(2013) 133 final, Commission Staff Working Document: Climate change adaptation, coastal and marine issues http://ec.europa.eu/clima/policies/adaptation/what/docs/swd_2013_133_en.pdf

[136] SWD(2013) 137 final, Commission Staff Working Document: Adapting infrastructure to climate change http://ec.europa.eu/clima/policies/adaptation/what/docs/swd_2013_137_en.pdf

[137] Information on the MFF available at: http://ec.europa.eu/budget/mff/index_en.cfm

Recommendations on opportunities for integrating climate change impacts and adaptation measures into funding opportunities are provided below, for each of the main EU funds, covering the main policy sectors as shown in the table below:

| Chapter section | Sector | Fund |
|---|---|---|
| Section 7.2 | Cohesion, regional development and social sectors | CF, ERDF and ESF |
| Section 7.3 | Rural development and agriculture | CAP – Pillar 1 and 2 (EAFRD) |
| Section 7.4 | Maritime and fisheries | EMFF |
| Section 7.5 | Research and innovation | Horizon 2020 |
| Section 7.6 | Environment | LIFE and BEST |
| Section 7.7 | Infrastructure – energy, transport, communications | CEF |

## Cohesion Policy

**Summary: key recommendations for considering climate change adaptation when preparing Cohesion Policy Operational Programmes in the OR**

- Ideally, spending programmes should be driven by development and sectoral strategies already in place, including **adaptation plans or strategies and research and innovation strategies for smart specialization,** and follow the same set of selected priorities
- Consider carefully how climate change adaptation will fit in with the **thematic objectives** selected for prioritization in the OPs. If limitations exist for selecting the objective on adaptation, remember that climate change adaptation can be addressed also through other funding objectives, including environmental protection, low carbon economy etc.
- Consider using Cohesion Policy funds directly to fund more **research** and strategic planning for climate change adaptation where information is lacking
- Efforts should be made to ensure that all future infrastructure (energy, transport, buildings etc.) are **climate proofed**
- **Horizontal principles** (Article 8 of the Common Provision Regulation ) include climate change adaptation – use this to ensure the programmes cover climate change impacts
- Climate change adaptation should be integrated into **assessment procedures**, ex-ante evaluation, SEA and EIA
- Develop **regional risk assessments for disaster management** and a **research and innovation strategy for smart specialization** in order to select thematic objectives for climate adaptation and research and innovation respectively (**ex-ante conditionality**)
- A new focus on **result indicators** and required **common indicators** provides an opportunity to include adaptation into indicators for all programmes
- ERDF can be used to promote **technical assistance and institutional capacity building** activities and ESF for **training and awareness raising**
- Response to climate change needs to **involve all actors**
- Exploit opportunities under the new initiative for **community-led development**
- Enhance the use of **regional cooperation instruments** (INTERREG) especially for building capacities and exchanging best practices with other Member States and regions.

**Further resources**

- Technical Guidance on integrating climate change adaptation in programmes and investments of Cohesion Policy (DG Climate Action) http://ec.europa.eu/clima/policies/adaptation/what/docs/swd_2013_135_en.pdf
- Practical guidance for integrating climate change and biodiversity into SEA procedures (DG Environment) http://ec.europa.eu/environment/eia/pdf/SEA%20Guidance.pdf
- Adaptation Strategies page of the CLIMATE-ADAPT platform, which shows which countries have adopted strategies and

**Summary: key recommendations for considering climate change adaptation when preparing Cohesion Policy Operational Programmes in the OR**

provided links to them http://climate-adapt.eea.europa.eu/web/guest/countries

The EU's Cohesion Policy can promote a more proactive and positive approach to climate change by raising awareness, implementing innovative approaches and encouraging initiatives to limit risks and impacts. For the 2014-2020 funding period, Cohesion Policy will have an increased focus on climate change, both mitigation and adaptation. For the first time in the history of the policy, a **dedicated funding objective for climate change adaptation** has been agreed (Thematic objective 5: Promoting climate change adaptation, risk prevention and management). Furthermore, there is a 20% target across the entire EU budget for funding that targets climate change.

The **ERDF** and **Cohesion Fund** Regulations present a list of possible **priority actions** which will be eligible for financing under Thematic objective 5 and that the OR should prioritise in the when preparing the Operational Programmes (OPs) that will govern all Cohesion Policy spending from 2014-2020. These include:

- Supporting dedicated investment for adaptation to climate change; and
- Promoting investment to address specific risks, ensuring disaster resilience and developing disaster management systems.

More concretely, the OR have the opportunity to dedicate Cohesion Policy funds towards many actions that directly support adaptation to climate change. These include:

- Development of strategies and action plans for adaptation to climate change and risk prevention and management plans at national, regional and local level and building up a knowledge base and data observation capacities and mechanisms for the exchange of information;
- Increased investment in adaptation to climate change and risk prevention and management, including:
  - avoiding damage and increasing resilience to the built environment and other infrastructure;
  - protecting human health;
  - decreasing future pressure on water resources;
  - investing in flood and coastal defences; and
  - decreasing the vulnerability of ecosystems in order to increase ecosystem resilience and enable ecosystem-based adaptation;
- Development of tools (detection, early warning and alert systems, risk mapping and assessment);
- Increased investment in disaster management systems, to facilitate disaster resilience and risk prevention and management of natural risks, including weather-related risks (such as storms, extreme temperature events, forest fires, droughts, floods) and geophysical risks (such as avalanches, landslides, earthquakes, volcanoes), and to support societal responses to industrial risks (early warning systems, risk mapping).

### Recommendations for funding climate change adaptation through Cohesion Policy 2014-2020 in the OR

In order to **take advantage of the thematic objective dedicated to climate change adaptation**, Member States must select it as one of their priorities. As climate change adaptation is critical for the OR, they will need to work closely with national-level authorities to ensure that the climate change adaptation thematic objective is adopted as one of the priority areas for funding. This will in turn enable the OR to dedicate more funding that directly addresses climate change adaptation.

It may be the case, due to the thematic concentration requirements[138] established in the Cohesion Policy 2014-2020 Regulations, that Thematic objective 5, addressing climate change adaptation, is not selected by the respective Member States authorities. This does not mean, however, that climate change adaptation cannot be targeted by the funds, nor that climate change impacts should not be taken into account in all spending.

As seen in the analysis of 2007-2013 OPs and funding allocations carried out in this report, where climate change adaptation was not a direct priority, there are many important ways in which the OR can indirectly fund **climate change adaptation through other thematic objectives**, such as those concerning environmental protection, research and technological development, and the integration of climate change adaptation and mitigation through support for low carbon economy. More cost-effective options could also be encouraged through private means (financial instruments such as JESSICA for the energy sector) while public funds could support less-cost effective but promising preventive and adaptation measures.

In all cases, the OR should consider the Commission's working paper **"Technical Guidance on integrating climate change adaptation in programmes and investments of Cohesion Policy"**[139]. This paper accompanies the EU Strategy on adaptation to climate change and suggests how Member States and regions can better consider adaptation in all funding areas of Cohesion Policy. It considers both direct funding for climate change adaptation measures and also integrating adaptation concerns into all areas of spending, particularly vulnerable sectors such as transport, energy, health and housing infrastructure.

There are also opportunities for the OR to fund adaptation-related initiatives through the **European Social Fund (ESF)**. The ESF is in fact now envisioned to support projects promoting the reform of education and training systems, adaptation of skills and qualifications, up-skilling of the labour force, and the creation of new jobs in sectors related to the environment and energy[140].

The following table presents a list of non-exhaustive options for financing specific adaptation measures under different thematic objectives as laid down in the ERDF, ESF and Cohesion Fund Regulations. The table is a guiding tool for OR authorities to develop adaptation options based on regional circumstances, needs and priorities. The funding opportunities are linked to the sectors in each OR that resulted most at risk from the vulnerability assessment developed in the framework of this project. It is recommended that each OR prioritizes climate adaptation funding in some specific sectors as shown in the table. All funding must, also be aligned with other sources (e.g. national/regional funding programmes, private sector initiatives and investors, etc.) according to the EU additionality principle.

[138] Article 4(c) of Regulation (EU) No 1301/2013 on the European Regional Development Fund and on specific provisions concerning the Investment for growth and jobs goal and repealing Regulation (EC) No 1080/2006 lays down rules for thematic concentration for the ERDF: for less developed regions, at least 50% of the total ERDF resources at national level is to be allocated to the thematic objectives 'Strengthening research, technological development and innovation', 'Enhancing SMEs competitiveness' and 'Supporting shift towards low-carbon economy' of which 12 % is to be dedicated to the latter.

[139] Commission Staff Working Document SWD(2013) 135 final, 16.4.2013

[140] Regulation (EU) No 1304/2013 on the European Social Fund and repealing Regulation (EC) No 1081/2006, 20.12.2013, Brussels

**Table 7.1 Opportunities for funding climate adaptation measures in Cohesion Policy**

| **Indirect opportunities for climate action** | | | |
|---|---|---|---|
| **Thematic Objectives** | **Selected Opportunities** | **Sector to prioritise** | **OR** |
| TO 1 Strengthening research, technological development and innovation. | **Selected relevant activities proposed in the Regulations**<br>• Enhancing research and innovation infrastructure (R&I) and capacities to develop R&I excellence and promoting centres of competence, in particular those of European interest. (ERDF)<br>• Promoting business R&I investment, product and service development, technology transfer, social innovation and public service application, demand simulation, networking, clusters and open innovation through smart specialisation (ERDF)<br>• supporting technological and applied research, pilot lines, early product validation actions, advanced manufacturing capabilities and first production in Key Enabling Technologies and diffusion of general purpose technologies (ERDF) | **Research** | **All** |
| TO 2 Enhancing access to and use and quality of ICT | **Selected relevant activities proposed in the Regulations**<br>• Strengthening ICT application for e-government, e-learning, e-inclusion and e-health. (ERDF) | **Research** | **All** |
| TO 4 Shift towards a low-carbon economy in all sectors | **Selected relevant activities proposed in the Regulations**<br>• Promoting low-carbon strategies for all types of territories, in particular for urban areas, including the promotion of sustainable multimodal urban mobility and mitigation-relevant adaptation measures;; (ERDF & Cohesion Fund)<br>• Promoting the production and distribution of renewable energy sources; (ERDF)<br>• Promoting energy efficiency and renewable energy use in enterprises; (ERDF)<br>• Supporting energy efficiency smart energy management and renewable energy use in public infrastructure, including in public buildings, and in the housing sector; (ERDF)<br>• Promoting promoting research and innovation in, and adoption of, low-carbon technologies;(ERDF)<br>• Promoting the use of high-efficiency co-generation of heat and power based on useful heat demand. (ERDF) | **Energy** | **Canary Islands**<br>**Azores**<br>**Madeira**<br>**Réunion** |
| TO 5 Promoting climate change adaptation, risk prevention and management" | **Selected relevant activities proposed in the Regulations**<br>• Supporting investment for adaptation to climate change, including ecosystem-based approaches; (ERDF)<br>• Promoting investment to address specific risks, ensuring disaster resilience and developing disaster management systems. (ERDF) | **Disaster risk** | **Canary Islands**<br>**Azores**<br>**Guadeloupe**<br>**Martinique**<br>**Réunion** |

| **Indirect opportunities for climate action** | | | |
|---|---|---|---|
| **Thematic Objectives** | **Selected Opportunities** | **Sector to prioritise** | **OR** |
| TO 6 Protecting the environment and promoting resources efficiency | **Selected relevant activities proposed in the Regulations**<br>• Addressing the significant needs for investment in the waste and water sector to meet the requirements of the environmental acquis; (ERDF and Cohesion Fund)<br>• Promoting innovative technologies to improve environmental protection and resource efficiency in the waste sector, water sector and with regard to soil, or to reduce air pollution. (ERDF) | **Water/coastal zone management** | **Canary Islands**<br>**Azores**<br>**Madeira**<br>**Guadeloupe**<br>**Martinique** |
| | • Conserving, protecting, promoting and developing natural and cultural heritage; (ERDF and Cohesion Fund) | **Tourism** | **Canary Islands**<br>**Azores**<br>**Madeira**<br>**Guadeloupe**<br>**Martinique**<br>**Réunion** |
| | • Taking action to improve the urban environment, to revitalise cities, regenerate and decontaminate brownfield sites (including conversion areas), reduce air pollution and promote noise-reduction measures; (ERDF and Cohesion Fund)<br>• Supporting industrial transition towards a resource- efficient economy, promoting green growth, eco-innovation and environmental performance management in the public and private sectors. (ERDF) | **Construction and Buildings** | **Canary Islands**<br>**Madeira**<br>**Guadeloupe**<br>**Martinique**<br>**Réunion** |
| | • Protecting and restoring biodiversity, soil protection and promoting ecosystem services including through NATURA 2000 and green infrastructures. (ERDF) | **Biodiversity** | **All** |

| **Indirect opportunities for climate action** | | | |
|---|---|---|---|
| **Thematic Objectives** | **Selected Opportunities** | **Sector to prioritise** | **OR** |
| TO 7 Promoting sustainable transport and removing bottlenecks in key network infrastructures | **Selected relevant activities proposed in the Regulations**<br>• Developing and improving environmentally-friendly (including low-noise) and low-carbon transport systems, including inland waterways and maritime transport, ports, multimodal links and airport infrastructure, in order to promote sustainable regional and local mobility; (ERDF)<br>• Enhancing regional mobility by connecting secondary and tertiary nodes to TEN-T infrastructure, including multimodal nodes; (ERDF)<br>• Developing and rehabilitating comprehensive, high quality and interoperable railway systems, and promoting noise-reduction measures. (ERDF) | **Transport** | **Canary Islands**<br>**Azores**<br>**Madeira**<br>**Guadeloupe**<br>**Martinique**<br>**Réunion** |
| | • Improving energy efficiency and security of supply through the development of smart energy distribution, storage and transmission systems and through the integration of distributed generation from renewable sources. (ERDF) | **Energy** | **Canary Islands**<br>**Azores**<br>**Madeira**<br>**Réunion** |
| Cross-cutting for all 11 TO Sustainable urban development | **Selected relevant activities proposed in the Regulations**<br>The ERDF Regulation envisages ring-fencing 5 % of funding for integrated sustainable urban development measures and for the setting up of an urban development platform to promote exchanges between cities. (ERDF) | **Construction and Buildings** | **Canary Islands**<br>**Madeira**<br>**Guadeloupe**<br>**Martinique**<br>**Réunion** |
| TO 9 Promoting social inclusion and combating poverty | **Selected relevant activities proposed in the Regulations**<br>• Investing in health and social infrastructure which contribute to national, regional and local development, reducing inequalities in terms of health status, promoting social inclusion through improved access to social, cultural and recreational services and transition from institutional to community-based services; (ERDF)<br>• Enhancing access to affordable, sustainable and high-quality services, including health care and social services of general interest; (ESF)<br>• Undertaking investment in the context of community-led local development strategies; (ESF and ERDF) | **Health** | **Canary Islands**<br>**Madeira**<br>**Guadeloupe**<br>**Martinique**<br>**French Guiana**<br>**Réunion** |
| TO 10 Investing in education, skills and | **Selected relevant activities proposed in the Regulations** | **Awareness** | **All** |

| **Indirect opportunities for climate action** | | | |
|---|---|---|---|
| **Thematic Objectives** | **Selected Opportunities** | **Sector to prioritise** | **OR** |
| lifelong learning | • Enhancing access to lifelong learning, upgrading the skills and competences of the workforce and increasing the labour market relevance of education and training systems. (ESF) | **raising** | |
| TO 11 Enhancing institutional capacity and an efficient public administration | **Selected relevant activities proposed in the Regulations**<br>• Investment in institutional capacity and in the efficiency of public administrations and public services with a view to reforms, better regulation and good governance; (ESF)<br>• Capacity building for all stakeholders education, lifelong learning, training and employment and social policies, including through sectoral and territorial pacts to mobilise for reform at the national, regional and local levels. (ESF)l. | **Technical assistance** | **All** |

*Source: a compilation on the basis of the Cohesion Policy Regulations*

Given that the development of basic infrastructure remains a priority, especially for the less developed OR[141], regional authorities should ensure that all future infrastructures (energy, transport, environment, buildings) are **climate proofed**. Economic valuation is one important tool for influencing development strategies and decision-making. All projects at the identification and evaluation stages should be assessed with regard to their social and environmental impacts ('climate proofed'). OR managing authorities should ensure that some share of their budget is allocated to designing solutions for reducing risks and improving their resilience to climate change impacts for example by making funding conditional on compliance with this rule or by including positive contributions to tackling climate change as award criteria in the project selection process.

At the same time, operational guidelines should also introduce **sustainability criteria** for investments which would ensure that certain types of adaptation measures (e.g. infrastructure like dams and dykes) do not impose unintended negative impacts on the natural environment (maladaptation). In this respect, the criteria should also indicate possible 'green' adaptation options which include eco-system-based approaches and soft measures in terms of administrative capacity which are often more cost-efficient and advantage the creation of new jobs and business opportunities.

The table below presents some examples of prevention and adaptation measures that the OR can finance through Cohesion Policy Funds with the aim of mainstreaming climate change and climate proofing investments under different sectors. A long list of adaptation options is provided by the report "Climate proofing CAP and Cohesion Policy" which will be soon published on the Climate-Adapt portal[142].

**Table 7.2 Examples of adaptation measures financed under Cohesion Policy**

| Sector | Prevention and adaptation measures |
|---|---|
| **Disaster & Risk** | • Information and Monitoring system on spread and relevance of vector-borne, food-borne diseases<br>• Protection from forest fires<br>• Soft coastal defences<br>• Flood gates (with impacts for several policy fields)<br>• Dike reinforcement and heightening<br>• Heat Warning System<br>• Remote sensing and satellite imagery for early warning systems: for extreme weather events |
| **Energy** | • Energy efficient adaptation of offices, industrial plants to heat (e.g. passive cooling systems)<br>• Increase robustness of transmission grids to storm damages<br>• Installation of additional network capacities (smart grids)<br>• Hydropower reservoir power stations: Increase dam height to allow for higher variability in water availability<br>• Adjustments in design standards for wind turbine generators (consideration of extreme storm)<br>• Installation of additional storage facilities to adapt to higher volatility in base load<br>• Higher energy efficiency of ventilation systems<br>• Energy efficient adaptation of homes against heat (e.g. passive cooling systems)<br>• Cooling of thermal power plants<br>• Targeted retrofitting to increase robustness of thermal power plants in coastal areas |
| **Construction & Buildings** | • Protection of buildings to storms, extreme precipitation<br>• Strategic urban and regional planning to prevent further accumulation of assets in vulnerable areas<br>• Green and blue Spaces, incl. green roofs |

[141] European Commission: (2012) Second Forum of Outermost Regions: working together towards Europe 2020, Summary
[142] http://climate-adapt.eea.europa.eu/

| Sector | Prevention and adaptation measures |
|---|---|
| | • More water-efficient building constructions |
| **Water** | • Installation and retrofitting of environmental infrastructures to prevent natural disasters (e.g. protection against avalanche)<br>• Additional rain overflow basins to adapt sewage system against flooding, enhancing water storage capacity of reservoirs<br>• Adaptation to sewage systems against droughts and low-water level<br>• River restoration (buffer zone), restoration of wetlands<br>• Leakage control in water distribution system<br>• Demand management (rationale water use, restriction of groundwater consumption, etc.)<br>• Desalination of water<br>• Sustainable urban drainage systems |
| **Biodiversity** | • Further conservation areas and habitat recreation<br>• Maintaining and improving habitat management (conservation management, green corridors, etc.) |
| **Health** | • Energy efficient cooling of hospitals<br>• Additional care and support of vulnerable citizens through health infrastructure (workers, buildings) |
| **Transport** | • Heat-resistant asphalt and adjustment of maintenance<br>• Shifting of road alignments beyond areas at risk<br>• Retrofitting existing road infrastructure concerning increased precipitation<br>• Adjustments of maintenance of rail infrastructures<br>• Adaptation of rail infrastructure to heat and temperature change<br>• Retrofitting trains concerning increased temperatures on Air Conditioning<br>• Retrofitting airports against heat<br>• Retrofitting airports against higher precipitation<br>• Retrofitting existing infrastructure of shipping concerning extreme events<br>• Improvement of waterflow management, including creation of water storage facilities<br>• Adequate design and maintenance of bridges and tunnels<br>• Vegetation management along roads and rails |
| **Tourism** | • Diversification of tourist offers in different regions (winter + summer tourism) |
| **Other** | • Awareness raising and information sources, especially for small-scale project developers<br>• Awareness raising to companies regarding adaptation to climate change |

## 7.1 Recommendations for integrating climate change adaptation into Cohesion Policy overall in the OR

In the Regulations governing the 2014-2020 EU Cohesion Policy, there are a number of legal provisions which explicitly address climate change adaptation or indirectly imply that climate change adaptation needs to be taken into account into different assessment and performance checks. By following these procedures and overarching principles the OR can ensure that funding programmes integrate climate change adaptation overall.

The Regulations include provisions which require taking climate change into account in **assessment procedures, such as ex-ante evaluation, SEA and EIA**. A specific article in the Common Provisions

Regulations[143] prescribes that ex-ante evaluations of each programme shall assess the adequacy of planned measures to promote sustainable development, which could also entail the potential to adapt to climate change impacts. For major projects, where the EIA is a compulsory instrument, the Regulation further specifies that the environmental analysis of projects should consider also climate mitigation and adaptation needs. The Commission's guidance documents for integrating climate change and biodiversity into EIA and SEA can be very useful for the OR authorities to make sure that climate change is taken into account in the environmental analysis of regional programmes and projects[144].

The Regulation also established a new system **of ex-ante conditionalities** (Article 19), which contains conditions that Member States and regions must meet in order to receive funding.

For the climate change adaptation objective, the ex-ante conditionality requires that Member States have **national/regional risk assessments for disaster management** in place[145]. The experience the OR have in implementing disaster risk reduction can contribute greatly to address the climate adaptation challenges, in terms of policy and institutional approaches as well as technical methods and tools (e.g. hazard and vulnerability assessment, land use planning, construction of dams, dykes and seawalls, early warning systems). The OR authorities should explore specific synergies between disaster risk reduction and climate change adaptation in order to maximise the results (e.g. by financing activities which enhance disaster prevention and preparedness in such a way that it contributes to climate change adaptation[146]). Examples of such activities include:

- Developing emergency preparedness plans and disaster risk reduction strategies in order to protect key infrastructure assets from the impacts of climate change (this includes setting up early warning systems, addressing governance issues and promoting awareness);
- developing, testing and building capacity for emergency preparedness plans at various levels, in collaboration with other relevant authorities, to improve the handling of extreme events; and
- restoring the function of wetlands in combination with sound land-use planning thereby reducing the exposure to floods and improving water availability in areas affected by water scarcity and or variable rainfall patterns.

For the thematic objectives on research and innovation and access and use of quality ICT, the ex-ante conditionality requires the existence of a **national or a regional research and innovation strategy for smart specialisation (RIS3)** in line with the National Reform Programme. The RIS3 ex-ante conditionality requires regions to identify the knowledge specialisations that best fit their innovative potential, based on their assets and capabilities. It is suggested that the RIS3 of the OR **focus investments on a limited number of priorities** on the basis of their own strengths and international specialisation. Within this 'Smart specialisation' approach[147] the OR should take into account the

[143] Regulation EU) No 1303/2013 laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006

[144] Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment and Strategic Environmental Assessment, issued 04.04.2013 available at http://ec.europa.eu/environment/eia/

[145] See Annex IV of the Common Provisions Regulation

[146] Medarova-Bergstrom, K. and Volkery, A. (2012) Walking the talk - practical options for making the 2014-2020 EU MFF deliver on climate change. Final report for the Dutch Ministry of Infrastructure and the Environment. IEEP, Brussels. http://www.ieep.eu/assets/919/Walking_the_talk__options_for_EU_MFF_to_deliver_on_climate_change.pdf

[147] Inforegio (2012), Panorama: Smart Specialisation, the driver of future economic growth in Europe's regions, no. 44

challenges that they face in terms of adaptation to climate change and the preservation and management of their natural assets. For example, the OR could act against the impact of climate change (e.g. extreme weather phenomena) and mitigate flooding, droughts and wild fires by prioritising and financing specific activities aimed at the restoration of ecosystems' natural capacity. Also, protected areas and other biodiversity hot-spots represent the potential for creating centres of excellence for research in biodiversity, terrestrial and marine ecosystems. In this context, the OR' natural assets can be the very start of innovation activities and the development of new technologies or solutions. Such potential should be exploited under the framework of EU Structural Funds as well as by Research Programmes[148] (Horizon 2020 - see section 0). The Commission has created tools to help the Member States and the Regions develop their individual smart specialisation strategies. The Smart Specialisation Platform[149] (S3 Platform) provides advice, access to data material, guidance and methodological support, example of good practice and mutual learning tools to peers and experts[150].

In this regard, it is suggested that investments in the OR also focus on options that are of a **cross-cutting nature and concern soft measures.** OR authorities should carry out activities for developing the knowledge base and tools for risk assessment and risk reduction as well as awareness-raising of public administrations under the 2014-2020 EU Cohesion Policy for three reasons. First, they could improve the overall planning processes at regional levels linking forecasts on climate change impacts/costs to investment planning. Secondly, they could lead to more autonomous adaptation in the long-term and reduce the need for EU intervention. Thirdly, they could enhance the ability and skills of regional authorities to develop bottom-up options that are better suited to their local circumstances (Hjerp et al, 2012).

Over-arching ex-ante conditionalities also relate to the capacity to carry out **environmental assessments**. Member States and regions, including the OR, will have to ensure that these are in place when preparing programmes and the assessments should consider climate change impacts and adaptation requirements[151].

Specific **evaluation and monitoring methods** can contribute to more effective interventions. A set of 'common indicators', established in the Annexes of the fund-specific Regulations, should be accompanied by programme-specific indicators and used in the context of the performance framework. All managing authorities should identify ad-hoc indicators and data collection activities to better monitor the progress of programmes towards the achievement of climate change targets (e.g. indicators for greenhouse gas emissions, energy, environmental infrastructure, risk prevention, biodiversity and soil[152]). In order to

[148] (Horizon 2020 - see section 0).
[149] http://s3platform.jrc.ec.europa.eu/
[150] Further references: Smart specialisation factsheet: http://ec.europa.eu/regional_policy/sources/docgener/informat/2014/smart_specialisation_en.pdf; The 'Guide to research and Innovation Strategies for Smart Specialisations (RIS3)' gives methodological guidance for policy-makers and implementing bodies on how to design, draft and implement a national/regional RIS3 http://s3platform.jrc.ec.europa.eu/en/c/document_library/get_file?uuid=e50397e3-f2b1-4086-8608-7b86e69e8553; 'Connecting Smart and Sustainable Growth through Smart Specialisation' is a practical guide to integrating sustainable growth, eco-innovation, and ecosystems objectives into a RIS3. http://ec.europa.eu/regional_policy/sources/docgener/presenta/green_growth/greengrowth.pdf
[151] For reference on how to integrate climate concerns into environmental assessment, consult: Practical guidance for integrating climate change and biodiversity into SEA procedures (DG Environment) http://ec.europa.eu/environment/eia/pdf/SEA%20Guidance.pdf; and Practical guidance on integrating climate change and biodiversity into EIA (DG Environment) http://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf
[152] See Annexes to the ERDF and Cohesion Fund Regulations

specifically measure results of a climate change activity, it is suggested that OR authorities include a list of indicators into the SEAs, some of which should be linked to adaptation efforts and incorporated in the OPs' performance frameworks.

The ERDF can also be used for institutional capacity building. The OR can undertake **technical assistance** and institutional capacity building activities to help authorities in charge of Cohesion Policy measures to implement more innovative strategies and climate adaptation measures. Some of the recommendations in this regard include:

- strengthening scientific know-how capacity;
- fostering training;
- creating network; and
- establishing private-public partnerships.

Any response to climate change needs to **involve all actors**: the European Union, the concerned member states, the territories, but also associations, businesses, research community, the media and civil society. The new initiative for **community-led development** is an important opportunity for promoting bottom-up climate change adaptation actions. Regional and local communities in the OR are best placed for pooling and dissemination of data, information and good practice and should have a major role in the dialogue between the EU and the member States and the scientific professional at the local level. The challenge in this is that, as has been mentioned, there are still large parts of the population of the OR that struggle to access services, live in poverty and are hard to engage. Developing community-led development for such groups, often those most vulnerable to climate impact, would be challenging be likely to be more successful than many alternative approaches. These initiatives would promote integrated and multi-sectoral area-based developments and actions. Being a bottom-up initiative, the scope and type of activities that will be financed under the community-led development initiative will depend on the priorities of regions. However, there is certainly scope for incorporating climate change related activities/options especially in a horizontal manner both in terms of mitigation and adaptation. The initiative is in fact very suitable to enhance the integration of adaptation considerations and ensure that local developments are made resilient to potential climate change impacts.

**Cooperation between regions** is essential in order to harmonize monitoring, build capacity, exchange best practices and share data. Many of the issues related to climate change are more effectively treated at a regional level; regional cooperation can create many opportunities (co-development, exchange of best practices, economies of scale, synergies, etc.) while also increasing the voice of OR at national and European level. Cooperation instruments, particularly the transnational (INTERREG B) and interregional (INTERREG C) Programmes, play a major role as they can create economies of scales and synergies thanks to the skills and resource sharing approach. Types of activities supported by such programmes and that could be carried out by the OR to strengthen regional adaptation action are:

- raising the region's awareness about adaptation issues;
- promoting exchange of experience and good practice;
- developing working methods;
- ensuring the dissemination of data; and
- coordinating strategies and taking into account the sea basin dimension.

Lessons could be learnt from the current programming period, where the majority of projects that tried to address adaptation objectives in the OR were financed under the Operational Programme 'Madeira-Azores-Canaries' (see Appendix E for reference on examples of projects). Example could also be drawn from several regions in Europe that used INTERREG funds to pool resources and carry out climate impacts and vulnerabilities assessments as well as to assess and test specific selected adaptation measures[153].

[153] A study on 'Study of Adaptation Activities at Regional Level in the EU' and a publication on 'Climate change adaptation practice across the EU' will be soon

As OCTs and all Caribbean countries, in particular, share similar characteristics with the OR, strengthening the resilience to address the economic, environment and natural disasters related vulnerabilities is essential. As presented in section 4.1.6, many Caribbean countries already started acting to adapt to climate change (e.g. ACCC and MACC projects organised in collaboration with CARICOM). Closer collaboration between Guadeloupe, Martinique and French Guiana OR and CARICOM, the association of Caribbean communities and the OCTA, the association of OCTs, will enable valuable exchange of experience in this and other areas of mutual interest for Caribbean islands.

Several provisions in the new programming period allow for stronger socio-economic cooperation between the EU, the OR and ACP Countries, as well as Overseas Countries and Territories (OCTs), in the Caribbean, Western Africa and Indian Ocean. The new Overseas Association Decision (OAD)[154], entered into force in 2014, states that appropriate measures will allow for matching of funding of credits from the EDF and the Union budget to finance cooperation projects between the OCTs, the ACP Countries, the OR as well as other countries, in particular simplified mechanisms for joint management of such projects. The Decision reflects the evolution of the relations from development assistance to mutually-beneficial partnership and support to sustainable development. It takes into account global changes since 2001 and environment and climate change rank higher on the regional and global agendas.

To make this partnership principle more practicable, the new European Territorial Cooperation Regulation[155] includes specific provisions that increase 2014-2020 allocations for cooperation between these regions and partners outside the Union. In its Article 4 the Regulation explicitly states that 'Cooperation programmes involving the outermost regions shall receive not less than 150% of the ERDF support they received in the 2007-2013 period. In addition, EUR 50 million from the allocation for interregional cooperation shall be set aside for outermost regions' cooperation'. To foster regional integration, it is also suggested that a consultation of OCTs/ACP on the draft ERDF Programmes should take place prior to submission to European Commission as well as a better definition of the role of OCTs/ACP in the context of the ERDF Programmes in terms of financial management, programming, monitoring, evaluation and control and participation in ERDF monitoring committees.

Combining EDF funds with programmes and instruments under the EU budget would make it possible to leverage and rationalise proposed investments in the OR. They have the opportunity to focus cooperation efforts on actions that help the OR and the OCTs to adapt to and mitigate the impact of climate change. These include activities in the fields of conservation of biodiversity and ecosystem services, disaster risk reduction, sustainable management of natural resources and promotion of sustainable energy.

## 7.2 Common Agricultural Policy

| **Summary: key recommendations for considering climate change adaptation when preparing Rural Development Programmes in the OR** |
|---|
| Given the high importance that climate change impacts have on many of the developmental goals of the OR, they should consider the following when developing and implementing their RDPs for 2014 – 2020:<br>• Spending programmes should be driven by rural and sectoral strategies already in place, including **adaptation plans or strategies** |

available on the Commission's website at: http://ec.europa.eu/clima/publications/index_en.htm#Adapt

[154] Marc Debois (DEVCO - Planning ACP) & Theo Saramandis (DEVCO - Taskforce OCT), EuropeAid, ppt: European Development Fund (EDF): Cooperation between African, Caribbean, Pacific (ACP) countries; Overseas Countries & Territories (OCTs) and Overseas Regions (OR)

[155] Regulation (EU) No 1299/2013 on specific provisions for the support from the European Regional Development Fund to the European territorial cooperation goal

**Summary: key recommendations for considering climate change adaptation when preparing Rural Development Programmes in the OR**

- Select the **priorities** dedicated to **climate change adaptation:**
- Fostering knowledge transfer and innovation (priority 1);
- Enhancing the competitiveness of agriculture and farm viability (Priority 2);
- Restoring, preserving and enhancing ecosystems (Priority 4); and
- Promoting resource efficiency and transition to a low carbon economy (priority 5).

- **Identify dedicated adaptation measures** that can be used to deliver the selected priorities

- Identify the **multiple benefits** that can be achieved through the use of the measures identified to respond to climate adaptation needs, for example, economic, social and environmental benefits

- Ensure **coherence** with other elements of the CAP, particularly **cross compliance**

- Identify any **safeguards** that need to be put in place to ensure **expenditure is resilient to climate change** and that approaches are sufficiently flexible to allow adjustments to be made as predictions about climatic changes evolve over time

- Climate adaptation features as a **horizontal issue** that must be taken into account in the development of programmes and RDPs must demonstrate that activities under all Union priorities contribute to climate change adaptation (Article 5 of EAFRD Regulation)

- The requirement for a set of **common indicators** within the Common Monitoring and Evaluation Framework provides an opportunity to include adaptation into results and impact indicators for a range of measures

- Climate change adaptation should be integrated into **assessment procedures**, ex-ante evaluation, SEA and EIA

- Response to climate change needs to **involve all actors**; exploit opportunities under the initiative for **community-led development**

- The requirement for the **Farm Advisory System** to include advice on climate adaptation and broaden its scope beyond cross-compliance to rural development measures

- Pillar 1: the allocation 30 % of green direct payments to **crop diversification, permanent grassland and ecological focus areas** (e.g. landscape features, fallow land, buffer strips, Etc.) could contribute to increasing the resilience of agricultural land to climate impacts

Addressing the challenges presented by climate change is signalled as an important priority for the CAP in the legislative package for the 2014-2020 programming period. A political agreement was reached in June 2013 and the formal adoption of the reform came at the end of 2013[156].

The climate focus is particularly highlighted in relation to rural development policy[157], where climate adaptation features much more strongly as an objective within the Regulations for 2014-2020 that has been the case in the past.

Of the priorities for rural development that are of most relevance to climate adaptation and that the OR should therefore highlight in their planning documents, are the following:

- Fostering knowledge transfer and innovation (priority 1);
- Enhancing the competitiveness of agriculture and farm viability (Priority 2);
- Restoring, preserving and enhancing ecosystems (Priority 4); and
- Promoting resource efficiency and transition to a low carbon economy (priority 5).

[156] http://europa.eu/rapid/press-release_MEMO-13-1157_en.htm

[157] Regulation (EU) No 1305/2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005

Building on the analysis in the preceding sections, this section sets out recommendations on how to improve the integration of climate adaptation needs within the CAP to ensure that all CAP expenditure in the OR is effectively climate proofed and so that it delivers improved outcomes for climate change resilience.

### 7.2.1 Recommendations for funding climate change adaptation through CAP 2014-2020 in the OR

The **six priorities** that replace the current axis structure of the EAFRD introduce more flexibility as there are no longer any constraints on which measures can be used to deliver which priority. This will help to increase the scope and incentive for the OR to address these priorities in a flexible manner so that to use packages of measures to deliver the needs identified within their programmes.

The six Union priorities for rural development all contribute to the **cross-cutting objective of innovation, environment and climate change mitigation and adaptation**. This new requirement will help OR to ensure that climate proofing takes place during the preparation of Rural Development Programmes (RDP) and should aid in building synergies between different priorities, objectives and measures to deliver multiple objectives.

More concretely, OR can carry out a number of **rural development measures** that are relevant for addressing adaptation:

- The **agri-environmental-climate measure** (Article 28), which provides support to farmers for adopting environmental or climate related management on their land;
- **Investments in physical assets** (Article 17), providing support for investments in 'tangible and/or intangible investments which can improve the competitiveness of the business or be non-productive in nature, linked to achieving requirements under the agri-environment-climate or forest-environment measures;
- **Natura 2000 and Water Framework Directive payments** (Article 30), compensating beneficiaries for the restrictions placed on them in these areas which are not experienced by those farmers/foresters outside these areas;
- Various **forestry measures**, in particular Article 22 for the afforestation and creation of woodland, Article 23 for the establishment of agri-forestry systems and Article 34 for forest-environmental and climate services and forest conservation; and
- **Knowledge transfer and information actions** (Article 14) and providing support for advisory services, farm management and farm relief services (Article 15).

Table 6.3 illustrates how the OR could benefit from the CAP Regulation to fund adaptation options. It explains what type of adaptation options the OR can implement to cope with climate change impacts under different rural development measures as listed in the Regulations.

**Table 7.3 Adaptation measures in the CAP Regulations**

| Adaptation option | Thematic focus | Rural Development Measures |
|---|---|---|
| **Farm infrastructure options** | | |
| Adaptation of agricultural infrastructure (e.g. Buildings) | Avoidance of damage from extreme events | Article 17 – Investments in physical assets |
| Improvement of animal rearing conditions (shading and sprinklers) | Avoidance of heat stress | Article 17 – Investments in physical assets<br>Article 33 – Animal welfare<br>Article 22 – Afforestation and creation of woodland<br>Article 28 – Agri-environment-climate |
| Irrigation efficiency | Improved water management | Article 17 – Investments in physical assets |
| **Land management options** | | |
| Buffer strips (permanent vegetation) | Improving water management, Biodiversity resilience | Article 28 – Agri-environment-climate<br>Article 17 – Investments in physical assets<br>(Pillar 1 – ecological Focus Areas) |
| Conservation areas and habitat restoration | Improving habitat / biodiversity resilience | Article 28 – Agri-environment climate<br>Article 17 – Investments in physical assets<br>Article 30 – Natura 2000 and Water framework directive payments |
| Afforestation | Soil and forest management | Article 24 – Afforestation and creation of woodland<br>Article 23 – Investments in forest area development and improvement of the viability of forests |
| Diversified crop rotation | Soil and water management | Article 28 – Agri-environment-climate<br>(Pillar 1 – crop diversification) |
| Maintenance of permanent grassland | Improving habitat / biodiversity resilience<br>Soil Management | Article 28 – Agri-environment-climate<br>Article 17 – Investments in physical assets<br>Article 30 – Natura 2000 and Water framework directive payments<br>(Pillar 1 – Maintenance of permanent grassland) |
| **Farm management** | | |
| Insurance schemes | Risk management | Article 36 – Risk management<br>Article 37 – Crop, animal and plant insurance<br>Article 38 – Mutual funds for animal and plant diseases and environmental incidents |
| **Farm Advice** | | |
| Farm Advice | Advice / Capacity Building for land managers | Article 14 – Knowledge transfer and information actions<br>Article 15 – Advisory services, farm management and farm relief services<br>(Pillar 1 – Farm Advisory Service) |

*Source: Methodologies for Climate Proofing Investments and Measures under Cohesion and Regional Policy and the Common Agricultural Policy, A report for DG Climate, August 2012.*

A number of other rural development measures are also relevant for the OR to address climate change impacts, for example those measures that help to prevent and restore damage to agricultural production and forests as a result of forest fires, natural disasters and other catastrophic events (Article 18, agriculture and 24, forests). Although this is an important opportunity to deal with emergencies related to extreme weather events, land managers should be encouraged to avoid reliance upon these funds as an

alternative to effective long-term adaptation and securing proper insurance coverage against climate risks.

For the new programming period, there is greater emphasis on the importance of advice, collaborative action and innovation from which the OR authorities could benefit. For example, the minimum scope of the **Farm Advisory Service**, which all Member States must operate, has been extended to include both cross compliance as well as the implementation of Pillar 2 measures, and which must now cover advice on actions relating to climate change adaptation[158].

Although not legally binding, the EAFRD Regulation includes a provision for **earmarking of funding for climate action** which the OR could apply to strengthen their efforts toward climate change adaptation. Specifically, it is established that 30% of total EAFRD contribution should be included in each programme for action on climate change mitigation and adaptation as well as environmental issues by supporting agri-environment-climate, organic farming payments, and payments to areas facing natural or other specific constraints measures[159].

The **LEADER approach** continues to play an important role within the EAFRD. The OR should place greater emphasis on using bottom-up approaches for innovation, rural development and potentially also climate change adaptation. A minimum spending requirement on LEADER is stipulated (at least 5 % of total EAFRD contribution to each regional rural development programme, Article 59(5)). The LEADER approach has proven to be effective for stimulating bottom-up and innovative activities, and there is potential that it could contribute also to climate adaptation provided that adaptation is highlighted sufficiently in the preparatory support (Article 42) for LEADER action groups and that other capacity building and planning infrastructure also provides some impetus for action.

There are opportunities within Pillar 1 for Member States to shift funds to measures potentially relevant for adaptation. The introduction of a new **'greening'** component to **direct payments** is aimed at ensuring that 'all EU farmers in receipt of support go beyond the requirements of cross compliance and deliver environmental and climate benefits as part of their everyday activities'[160]. It is established that Member States should use part of their national ceilings for direct payments in order to support e this group of three measures: crop diversification, permanent grassland and ecological focus areas (e.g. landscape features, fallow land, buffer strips, etc.). It is possible in this way to concentrate a greater share of allocations to measures relevant for climate change adaptation. Although such arrangements are made by the national level authorities, they could indirectly also benefit the OR.

### 7.2.2 Recommendations for integrating climate change adaptation into CAP overall for the OR

In the Regulations governing the 2014-2020 CAP, there are a number of legal provisions and innovative tools which explicitly address climate change adaptation and facilitate the process of taking into account climate change adaptation needs during the preparation and implementation of RDPs. These procedures and overarching principles provide a good opportunity for the OR to ensure that funding programmes integrate climate change adaptation overall.

The importance of **partnerships and networks** as a means of improving the delivery of RDP outcomes, facilitating the emergence of creative solutions to issues faced and capacity building is a core element of the EAFRD. There is a need in the OR to **share experience** and **best practice** on adaptation in the period leading up to and during programme development and implementation.

[158] Article 12 of Regulation (EU) No 1306/2013 on the financing, management and monitoring of the common agricultural policy
[159] recital 22 of Regulation (EU) No 1305/2013
[160] Regulation (EU) No 1307/2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy

- The **European Network for Rural Development (ENRD)**[161] is currently providing support to a Focus Group looking at how to improve the delivery of environmental services through rural development, to inform the drafting of the EAFRD implementation regulations and the development of RDPs. A similar process could be facilitated in relation to climate adaptation, for example through the **New Focus Group on Knowledge Transfer and Innovation**, through the organisation of workshops and seminar, or production of suitable materials to which the OR authorities could participate;
- New partnerships are envisaged under the auspices of the **European Innovation Partnership (EIP) on Agricultural Productivity and Sustainability** through the development of an EIP network and operational group. Also relevant for climate adaptation is the **EIP on water**, which is supposed to interact with the agricultural EIP, with the latter focusing on farm level actions and the water EIP dealing with infrastructure and allocation issues beyond farm level. The OR authorities, in coordination with the national level authorities could exploit the opportunities, provided under these initiatives, to integrate adaptation concerns into both the development of new technologies as well as encourage a wider understanding of adaptation vulnerabilities and priorities ; and
- The use of **European Climate-ADAPT**[162] platform should be explored in this context as a portal for information on adaptation and learning from other Member States and regions.

A number of **ex-ante conditionalities** have been introduced that Rural Development Programmes need to comply with before they can be approved. Those conditions relevant for climate adaptation are set out below and should help ensure climate adaptation issues are more fully considered in Member States and regions, providing an improved foundation on which RDPs can build.

- Condition 4.4 requires the existence of **national risk assessment for disaster management**, that take into account climate adaptation and considering, where appropriate, national or regional climate adaptation strategies. Since some OR have not yet established integrated climate adaptation strategies (see Table 2.1), they should consider individual sectoral strategies that take into account adaptation needs, as well as more general risk assessments relating to climate change impacts on the environment;
- Condition 5.3 relating to the priority 5 on promoting **resource efficiency** and supporting low carbon and climate resilient economy, requires the presence of a **water pricing policy** – this should lead to a more efficient use of water; and
- Condition 1.2 requires sufficient capacity to provide advice in relation to climate action in agriculture and forestry, and a description of the structure of extension of the **advisory system** is required. The design of the system and the way adaptation is incorporated will influence the effectiveness of this provision.

Ensuring that any future investments in infrastructure are climate proofed will depend upon the establishment of suitable **project selection criteria** and safeguards. Article 45 sets out the eligibility criteria for investments and includes the provision that environmental impacts of investment operations need to be assessed. Similar provisions for climate adaptation should be added to require that all investments are assessed to ensure that they are resilient to future climate change and do not lead to maladaptation. To make this easier, adaptation and climate-proofing safeguards should be included in the **criteria for the selection of projects** (Article 49).

The **Common Monitoring and Evaluation Framework** are applicable to all CAP instruments. The evaluation requirements for the 2014-2020 programming period consist of the need for all regions to carry out an ex ante and an ex post evaluation of their RDPs. It is essential that OR authorities develop suitable **indicators and qualitative methods** to assess this so that evaluations will provide robust information also on climate adaptation actions. Such evaluation should assess the degree to which RDPs

[161] http://enrd.ec.europa.eu/
[162] http://climate-adapt.eea.europa.eu/web/guest/agriculture-and-forestry

are climate-proofed and the extent to which climate adaptation needs have been addressed in the implementation of RDPs.

## 7.3 Maritime Affairs and Fisheries

The Integrated Maritime Policy (IMP) and the Blue Growth initiative are of major importance for the OR. They offer a new approach to maritime governance, accompanied by a joint European maritime agenda and horizontal instruments for an all-encompassing, efficient approach for the various sub-sectors of this new marine cluster. Climate change has been identified as one of the main challenges for the IMP. It aims to strengthen the coherence of EU policies related to the sea and provide ways to address the vulnerability of the coastal and marine areas that the ORs should take into account.

The implementation of the IMP and the growth, jobs and sustainability objectives of the reformed Common Fisheries Policy (CFP) will be supported by the new instrument European Maritime and Fisheries Fund (EMFF). The EMFF sustains 'Smart, Green Fisheries' to foster the transition to sustainable fishing, which is more selective, produces no discards, and does less damage to marine ecosystems. The support will focus on innovation and added value that can make the fisheries sector economically viable and resilient to external shocks and to competition from third countries. Having in mind the specificities of the OR, the remoteness, the isolation and the climate, important increases that benefit them have been proposes: 50% more for the budget dedicated to the compensation regime for outermost region fish and fisheries products as well as up to 35 % higher aid intensity in all payments.

The Operational Programmes (OPs) for the EMFF are implemented at national level. The OR should however participate to the consultation process for the preparation of the National Operational Programme. The Commission has prepared a guidance document[163] that aims to ensure that climate change adaptation objectives are embedded in the design of the 2014-2020 EMFF Operational Programmes. The document brings to the attention of the Member States and all stakeholders, including the OR authorities, those issues identified by the EU Adaptation Strategy and its accompanying documents relevant to the fisheries and marine sectors. The OR have an important role to play in this process, as they can ensure that their climate change adaptation needs are understood and fully integrated into the EMFF OPs. The document also proposes examples of EMFF measures and their potential for adaptation. The EMFF established measures that are considered to be adaptation significant and that should be prioritized in the OR. A non-exhaustive list of options is presented in the table below:

**Table 7.4 Examples of EMFF measures and their potential for adaptation**

| **EMFF measure** | **Types of adaptation** |
|---|---|
| Sustainable development in fisheries | |
| Art 35 Support conservation measures | Improving status of marine ecosystems and in particular their resilience to climate change |
| Art 36 Investment in equipment limiting the impact of fishing | |
| Art 38 (1)(b-f) Protection biodiversity | |
| Art 41 (1) Fishing ports, landing sites | Construction or modernisation of shelters better managing the risk of extreme weather events |
| Art 42 (1)(b) Equipment limiting the impact of inland fishing | |
| Art 42 (1)(c) Inland fishing | |

[163] SWD(2013) 299 final, Principles and recommendations for integrating climate change adaptation considerations under the 2014-2020 European Maritime and Fisheries Fund operational programmes, http://ec.europa.eu/clima/policies/adaptation/what/docs/swd_2013_299_en.pdf

| | |
|---|---|
| Art 42 (5) Participation of inland fishermen in managing N2000 | |
| Sustainable development in aquaculture | |
| Art 45 Innovation | Switch to fish species or fish production processing and distribution techniques better adapted to changing climate conditions |
| Art 46 Investments in off-shore and non-food aquaculture | |
| Art 52 Promotion of aquaculture with high level of environmental protection | Reducing water consumption in aquaculture or ensuring release of clean water downstream<br><br>Promoting forms of aquaculture better suited to current and projected changes in climatic conditions |
| Art 54 Aquaculture providing environmental services | Developing aquaculture that provides environmental services, very often considered as part of a cost-effective package of adaptation measures to a changing climate. |

*Source: SWD(2013) 299 final, Principles and recommendations for integrating climate change adaptation considerations under the 2014-2020 European Maritime and Fisheries Fund operational programmes*

In addition, the 'Integrated Maritime Policy' supports priorities which generate savings and growth and cut across sectors, such as marine knowledge, maritime spatial planning, integrated coastal zone management, integrated maritime surveillance, the protection of the marine environment and of biodiversity, and the adaptation to the adverse effects of climate change on coastal areas. The OR should strengthen and perpetuate the participation in initiatives organised by different directorates of the European Commission (e.g. OURCOAST[164] - DG ENV, EMODnet[165] – DG MARE).

All OR with the exception of Réunion can also benefit from the 'Atlantic Strategy' which brings together all the stakeholders and Member States on the edge of the Atlantic. The OR participated in the development of the annual Action Plan for a Maritime Strategy in the Atlantic area by identifying and agreeing on priority investments and research needs to be supported by the 2014-2020 EU financial framework. The Action Plan[166] sets some priorities which are relevant to climate adaptation. Specific objectives of the Action Plan include contributing to the development of tools and strategies to address global climate change issues, including mitigation and adaptation strategies. This can be achieved by developing co-operative partnerships to identify and monitor the impacts of global climate change on marine activities, ecosystems and coastal communities in the Atlantic area, including developing better predictive and risk assessment capabilities. Another priority in which the OR can assume a leading role refers to developing ocean observing and predictive capability to reduce uncertainty in the behaviour of the Atlantic Ocean and the impact of climate change. Several research projects have been carried out in the OR in the past programming period to achieve this objective. The OR can definitely strengthen their knowledge in the field and act as pioneers in developing new instruments and platforms for ocean observation and ecosystem monitoring. Such activities could be financed under the Horizon 2020 Framework Programme for Research and Innovation which is presented in the following paragraph.

## 7.5 Research and innovation – Horizon 2020

The OR can be pioneers for ecosystem management in the face of new threats, acting as testing grounds to define and experiment with new strategies. They deserve special consideration and adequate financial

[164] DG ENV website: http://ec.europa.eu/ourcoast/index.cfm?menuID=3

[165] The European Marine Observation and Data Network, DG MARE website: https://webgate.ec.europa.eu/maritimeforum/category/162?tid_1=506

[166] COM(2013) 279 final, Action Plan for a Maritime Strategy in the Atlantic area. Delivering smart, sustainable and inclusive growth http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0279:FIN:EN:PDF

means. They have interesting, strong aspects –unique in the EU– that present these regions as privileged laboratories for research and experimentation: the development of renewable energies or the monitoring of phenomena related to the effects of climate change could guarantee the OR play a real role as platforms for regional, technological and scientific cooperation. Measures for adaptation implemented by the OR could serve as a model for the rest of Europe and the world; this would ensure that the specific vulnerability of the regions in the face of climate change could become strength and a driver of innovation.

With the Regulation establishing **Horizon 2020 -The Framework Programme for Research and Innovation**, the Commission wanted to increase and better streamline funding for research and innovation over the seven-year period from 2014 to 2020. Key priorities include support for excellence in science, industrial innovation and addressing societal grand challenges including the achievement of a bio-based economy, clean energy, sustainable transport systems, climate change and resource efficiency. Horizon 2020 will provide a number of opportunities for OR to participate in the programme and contribute to Europe's Blue Growth initiative. The Regulation for Horizon 2020 includes a number of marine related research themes such as:

- the supply of marine renewable energy, including remote offshore wind;
- maritime transport and logistics research and technology needs;
- fisheries, aquaculture and marine biotechnology; and
- climate-ocean interactions, adaptation to climate change, the sustainable management of marine ecosystems (from coastal to the deep sea), as well as the exploitation of deep-sea raw materials.

Furthermore, under the theme 'Inclusive, innovative and secure societies'[167] specific measures will be taken to unlock excellence in less developed regions, thereby widening participation in Horizon 2020. More specifically, under this theme university and research institutes in the OR could apply for funding for research activities dealing with the topics such as 'Science and innovation for adaptation to climate change: from assessing costs, risks and opportunities to demonstration of options and practices' and 'Potential of current and new measures and technologies to respond to extreme weather and climate events'. OR are also located in geographic strategic areas which provide favourable conditions for global earth observations. Horizon 2020 can support the study and understanding of global phenomena like climate change or of large ecosystems like the deep sea floor. In the context of this report, a long list of projects to which the OR have contributed was presented. Such involvement in research activity should continue in the future as it is essential to develop the knowledge base for legitimizing the prioritization of action toward a better climate change action. Stronger science-policy interaction mechanisms should also be developed so that the results of the scientific research and enhanced knowledge form the basis for more evidenced-based decision making and are integrated into regional planning documents.

## 7.6 Environment – LIFE and BEST

The new **'Climate Action' component of the 2014-2020 LIFE programme** will promote activities previously covered under the thematic component 'Environment Policy and Governance'[168] and will be distributed to three specific priority areas: 'Climate Change Mitigation', 'Climate Change Adaptation' and 'Climate Governance and Information'. Specific objectives have been outlined for each of the three areas, which with regard to mitigation should contribute to greenhouse gas monitoring and reporting, policies relating to land use, land use change and forestry (LULUCF), emissions trading systems, renewable energy, energy efficiency, transport and fuels amongst others. Despite being a rather small stream of funding for climate change action, this component of the future LIFE programme remains very important. Priority Action 2 of the EU Adaptation Strategy encourages using LIFE funding to support capacity building and step up adaptation action. The OR authorities could carry out several concrete activities such as, in the following vulnerable areas: mountain and island areas, with emphasis on sustainable and resilient agricultural, forestry and tourism sectors and sustainable management of water; or combating

[167] http://ec.europa.eu/programmes/horizon2020/en/h2020-section/secure-societies-%E2%80%93-protecting-freedom-and-security-europe-and-its-citizens

[168] Regulation (EU) No 1293/2013 on the establishment of a Programme for the Environment and Climate Action (LIFE).

desertification and forest fires in drought-prone areas. The Strategy also promotes mainstreaming adaptation into urban land use planning, building layouts and natural resources management.

2013 is the third and last year of the **BEST Preparatory Action** after which the initiatives will have to be supported from other sources. With the view of exploring opportunities for future funding, the IUCN Brussels Regional Office is carrying out a project financed by the BEST Preparatory Action 'Building Partnership and Awareness of Biodiversity and Climate Change in Europe overseas for the Future of BEST'[169] to which all OR representative should take part. The project is organised along three interconnected activities and result areas, namely, the organisation of a 'Europe Overseas Roundtable on Biodiversity and Climate Change' for partnership and consensus building; the formulation of proposals for the future of BEST which identify options for governance and financial mechanisms; and the development for a Communication Strategy for Europe Overseas and BEST. The overarching aim of the project is to strengthen biodiversity conservation and climate change adaptation in Europe overseas by raising their profile and generating support for action, and proposing mechanisms to enhance biodiversity and climate change policies and programmes targeted at Europe overseas.

## 7.7 Infrastructure and Connecting Europe Facility

The Commission working document on 'Adapting infrastructure to climate change'[170] which accompanies the EU Adaptation Strategy highlights that the OR are particularly affected by the impacts of climate change that 'put additional pressure on infrastructure and urban settlements'. Adaptation measures to increase the resilience of infrastructure are therefore essential for the OR.

Policy responses for improved climate resilience focus on the enhancement of technical and scientific knowledge, on the review of building and construction standards, on sustainable urban planning solutions. The OR should benefit from Cohesion Policy for financing the adaptation of existing and the climate-resilient and climate-proofed construction of new infrastructure. The opportunities offered by this instrument have been presented in section 7.1.1.

In addition to the Cohesion Policy, the Connecting Europe Facility (CEF) Regulation incorporates a number of provisions which take climate change considerations into account[171]. As a new, centralised EU funding instrument, it brings together plans for financing large-scale priority projects of European significance in the fields of transport, energy and communications. In the preamble the Regulation stipulates that infrastructure investments under the CEF should contribute to promoting the transition to a low-carbon and climate-resilient economy by incorporating both mitigation and adaptation measures in the preparation, design and implementation of projects of common interest. One of the general objectives of the CEF is to enable the EU to reach the 20-20-20 climate and energy targets while ensuring greater solidarity among Member States. Specific objectives for transport include the promotion of sustainable and efficient transport (by focusing primarily on rail); a specific objective for energy concerns the integration of energy from renewable sources into the transmission network and the development of carbon dioxide networks (carbon capture and storage). Clearly the OR authorities should make sure that the benefits of targeted climate change financing are not offset by carbon intensive projects. In this regard, an innovative provision (art.10.5) states that co-financing rates for projects may be increased by up to 10 percentage points for actions having cross-sector synergies (e.g. reaching climate mitigation objectives, enhancing climate resilience or reducing the greenhouse gas emissions).

169 http://iucn.org/about/union/secretariat/offices/europe/activities/overseas/overseas_about/best_euoverseas/

170 SWD(2013) 137 final, Commission Staff Working Document: Adapting infrastructure to climate change http://ec.europa.eu/clima/policies/adaptation/what/docs/swd_2013_137_en.pdf

171 Regulation (EU) No 1316/2013 establishing the Connecting Europe FacilityCOM(2011)665/3,

## 7.8 Recommendations based upon the climate risk assessment

The overarching approach to this study has been to assess available data (including literature) and to use this to assess likely levels of climate risk to each of the OR, based on exposure to a specific climate impact upon a sector and the relevance of that sector to the economy and the people of the OR. Where adaptation actions are already implemented, or planned, vulnerability to the risk is reduced. The outcome of the assessment is a high level mapping of those sectors which are most vulnerable to climate change. Logically then, these are the sectors which are likely to be those where adaptation actions should be considered a priority. By linking the potential adaptation measures identified in this section, i.e. based on relevant EU funding mechanisms, to the mapping of vulnerability to climate impacts, a sectoral level set of actions for each OR can be derived. This is a high level, overarching set of possible but specific adaptation measures which might be considered by each of the OR (see Appendix G).

It has to be recognised however that this study is also characterised by a lack of data and a lack of specific examples which can be clearly identified as an adaptation action. Flood defences can be considered an adaptation but without further investigation of each new scheme proposed, it is not clear whether allowance for changing rainfall (as a result of climate change) is taken into account. If it is not, then the scheme is not a good example of adaptation but is instead addressing a current challenge. Where such as scheme is designed with defence limits that cannot be extended in the future, e.g. flood barriers increased in height, then this may actually be a maladaptation as it is investing in a solution which may be of a very limited lifetime.

A lack of awareness of climate risks, particularly for some sectors such as waste, is also clear in the assessment, as is a lack of action (in these areas). Although the majority of the OR have a climate change strategy in place (whether adopted or in development), many of the actions are dominated by a need for energy security and meeting 2020 targets for renewable energy. Adaptation can appear secondary in these strategies, although it is likely that this is because adaptation is more difficult to understand, to quantify or to monetise (i.e. what are the likely costs avoided due to a new flood defence scheme when the frequency of flood and its severity is uncertain). It is certainly true that no examples of adaptation which have been supported by an appropriate cost benefit analysis which takes climate change into account have been identified during this study (although it is not clear whether they exist and are not made public or if the representatives consulted were not aware of the supporting financial assessment).

As a result of this assessment it is therefore possible to make some specific recommendations which relate to information. These actions address the need to gather and exchange information between the OR in order to develop a better understanding of climate risk and effective adaptation, including the cost effectiveness of specific measures. The recommendations also address the need to monitor progress across the OR of Community policies in order to evaluation their effectiveness and correct implementation.

It is recommended that:

- Structures are put in place to improve cooperation across the OR. There is a level of cooperation in the Caribbean, the Indian Ocean and the MAC region however it is possible that these structures do not fully address the specific needs of the OR. Consideration should be given to the scope of existing collaborations and the establishment of a OR adaptation partnership. This will build upon existing experience and ensure that all OR are well connected to research programmes (no matter which region they are taking place) but, more importantly, it will facilitate the exchange of knowledge and best practice across the OR. The partnership could work within existing structures but it is likely to be most effective if it is a standalone initiative funded by the EU and relevant Member States. EU funds described previously in this section could be applicable;
- Data should be collected and an evidence base developed. This should include information on extreme events, local climatology and long term trends (for identification of changes likely to be due to climate change) but also on adaptation projects. All of the projects listed in the OR summaries presented in Section 6 have been identified because they are relevant and so information related to the outcomes of these projects should be accessible through a database for the OR. The importance of one database for all of the OR is that this allows knowledge to be

shared, although it has to be recognised that there is likely to be limited value in making sure all outputs are available in French, Spanish and Portuguese;

- To collect data, a monitoring network is recommended, particularly focused upon biodiversity loss, sea level rise and extreme events. This should be linked into plans relating to safety, disaster and emergency services, especially disaster resilience and recovery planning. This includes collecting data on the cost of events when they occur, the number of people impacted and any impacts upon the economy;
- The success of EU funded projects, or adaptation policy options, needs to be understood and metrics defined to allow their effectiveness and correct implementation to be judged, with a particular focus upon climate risk and adaptation. Metrics should be developed for all projects but it would be beneficial to also consider metrics which are specific to the challenges of the OR, given that these are often not typical for many EU Member States and citizens. Metrics should include success of engaging communities (where relevant), the degree to which knowledge has been shared successfully across the OR (where relevant) and the impact on levels of adaptive capacity; and
- A database of case studies should be developed, demonstrating the application of a cost benefit analysis to an adaptation measure. This is an area where no data has been found and yet it would be a simple mechanism by which to demonstrate the cost effectiveness of adaptation measures and the appropriate use of methods to measure both costs and benefits.

# 8 Conclusions

The Outermost Regions, being geographically distant from the rest of Europe, will face very different challenges (and opportunities) from climate change impacts when compared too much of the EU. The OR are varied in topography and characteristics among themselves, being located variously in the Caribbean, Atlantic and Indian oceans, and consisting of islands with the exception of French Guyana. Importantly for this study, they are also amongst the regions of the EU which are most exposed, and most vulnerable, to the impacts of climate change and hence actions taken to increase resilience are required as a matter to urgency.

However there are some commonalities among the OR and this offers opportunity for knowledge to be exchanged, with lessons learnt from challenges addressed in one region likely to be of relevance across much of the OR.

All of the OR are characterised by high levels of **biodiversity** and are host to a number of endemic species. With some habitats already under pressure from urban creep and development or existing risks such as wild fire and drought, further pressures are likely as warmer temperatures may also lead to upward migration of habitats – in mountainous OR this may threaten species currently established on mountain tops, as they are not able to migrate further upland. This includes the characteristic laurel forests of the Macaronesian OR (Madeira, Azores, Canary Islands) and the highland tropical rainforest in Martinique.

Changing rainfall patterns may endanger some species and habitats, with 'tipping points' likely such that Amazonian rainforest in French Guiana for example may decline and be lost. For much of the OR, as islands, they are vulnerable to the impacts of invasive species, which may increase due to climate change impacts such as warmer temperatures. There will also likely be an increase in the number of pests occurring, which would threaten both biodiversity and **agriculture**. Although French Guiana is considered to be less vulnerable to invasive species, since it is not an island, agricultural crops are still considered to be at risk from an increase in pests due to warming temperatures. Agriculture is also threatened by an increase in extreme weather events (e.g. hurricanes), which can devastate crops.

**Human health** will also be impacted, with the occurrence of vector-borne diseases (such as malaria, dengue) expected to increase, as changing climate conditions favour insect vectors such as mosquitoes (some increases in vector-borne diseases have already been observed).

Due to high level of concentration of population and infrastructures along the coast of all of the OR, the projected **increase in coastal flooding** as a result of increased storm frequency and sea level rise, and the resulting increase in coastal inundation, will have significant impacts on all coastal infrastructure. This will include transport, energy and health infrastructures, in addition to domestic and commercial properties such as hotels. Some OR currently benefit from coastal protection provided by shallow-water coral reefs. If water temperatures increase as projected, leading to coral bleaching and a loss of corals, these OR will be at increased risk of coastal flooding. **Loss of coral reefs** due to coral bleaching (linked to warmer water temperatures) would also result in a loss of biodiversity, and in some cases affect the fisheries industry, as corals act as fish nurseries. Depending on the level of dependence between the existence of coral reefs and the tourism attraction of an OR, the loss of corals may also negatively affect tourism.

For many of the OR, **tourism** is a significant contributor to the overall economy. Several of the predicted physical climate impacts may make the OR less attractive to tourists. These include an increase in vector-borne diseases, an increase in water-borne diseases (linked to an increase in flooding, loss of biodiversity, a potential increase in extreme weather events (some occurrences of extreme events have already been observed in recent years, e.g. flooding, mudslides), and average temperatures rising to the point they become sufficiently hot to deter visitors.

**Warmer temperatures** may also present some potential opportunities for the OR in that they may help extend the length of the tourist season in some OR (though others may become too hot), and they may

lead to new species being available for the fisheries sector in some OR (although in other OR the opposite may be true).

An increase in the occurrence of **drought** will impact both human and natural systems. It may impact negatively on agriculture (leading to reduced crop output) and threaten biodiversity (in particular drought-sensitive species.). It could also lead to competition for water between domestic and agricultural sector; and for OR with limited freshwater reserves already suffering from **saltwater intrusion** it may exacerbate theses problems (saltwater intrusion will also be exacerbated by rising sea levels).

It is clear that the OR need to take action to strengthen their ability to cope with climate change and predicted impacts. In this context, the EC communication on "The outermost regions of the European Union: towards a partnership *for smart, sustainable and inclusive growth*" encourages OR to develop new practices in traditional sectors such as fisheries and agriculture, to exploit the potential for new products arising from their biodiversity and marine ecosystems, as well as developing their potential for climate research and renewable energy among other areas.

Building upon this, when developing adaptation actions, OR can draw from a number of EU funding streams. Key funding opportunities arise from:

- **Cohesion Policy Funds**: the **European Rural Development Fund** (**ERDF**) and the **Cohesion Fund** (**CF**) can promote a more proactive and positive approach to climate change by raising awareness, implementing innovative approaches and encouraging initiatives to limit risks and impacts. Priority actions include:
  - Supporting dedicated investment for adaptation to climate change; and
  - Promoting investment to address specific risks, ensuring disaster resilience and development disaster management systems.
- The **European Social Fund (ESF)**, which is currently envisioned to support projects promoting the reform of education and training systems, adaptation of skills and qualifications, up-skilling of the labour force, and the creation of new jobs in sectors related to the environment and energy;
- The **Common Agriculture Policy** (**CAP**): **the European Agricultural Fund for Rural Development** (**EAFRD**) funds rural development programmes in EU states and regions, including those which aim to 'improve the competitiveness of agricultural and forestry sector' and 'improving the environment and the countryside'; and
- **Common Fisheries Policy:** the **European Fisheries Fund (EFF)** provides funding to help the fishing industry and coastal communities adjust to changing conditions, which can include climate change adaptation.

Since the development of basic infrastructure remains a priority, especially for less developed OR, efforts should be made to ensure all future infrastructures (energy, transport, environment, buildings) are climate proofed. At the same time, operational guidelines should introduce sustainability criteria for investments to ensure that adaptation measures do not impose unintended negative impacts on the natural environment (maladaptation).

It is recommended that better monitoring and data collation would be of value across the OR. This study has found that lack of data is the greatest barrier to developing a robust assessment of risks. Observatories at regional level would be of significant value, similar to the French Observatory but with a focus specifically upon climate risk to the OR. There is sufficient information on future climate risks, for example in the IPCC AR4 and AR5, that projections of some aspects of climate change can be made with confidence whilst there are approaches to uncertainty that could be applied for others. Lack of climate projections or evidence and attribution of change in climate for any part of the OR should not be taken as a reason for inaction.

There are many knowledge gaps must be addressed. In some cases there are active programmes of research, many funded by the EU, but the assessment identified very few risks relating to health, waste or

soil were identified, for example, even though these are sectors which will be impacted by climate change. It is assumed that this is an indication of a perceived low level of risk but given some of the factors already known in terms of climate change and risks to health, particularly where parts of the OR have significant communities for whom access to health care is challenging, this is more likely to be due to a lack of evidence than low levels of risk. Clarity is needed in whether a lack of information relates to low levels of risk or an absence of data. Without this clarity, some significant risks could be overlooked.

As noted, natural assets (both marine and terrestrial) are at significant risk across the OR as a result of climate change. For much of the OR, sea level rise, coastal inundation and salt water intrusion are likely to make existing populations migrate further inland where it is possible to do so, putting pressure on existing habitats. Climate change will put pressure on many ecosystems but these are often the asset which is attracting tourist to the OR, providing significant employment and contribution to the economy. Although challenging, this assessment suggests that focus should be placed on risk to natural systems and developing appropriate adaptation strategies.

Given their unique characteristics, OR can be pioneers for ecosystems management in the face of new threats, acting as testing ground to experiment with new strategies.
Overall, OR face some significant threats from climate change impact, however, if early and co-ordinated adaptation actions are taken, the impacts from these threats can be minimised, and opportunities from climate change capitalised upon.

# Appendix A: Glossary of terms and acronyms

| **Terms** | |
|---|---|
| Adaptation | In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate. |
| Adaptation measures | This refers to actual adjustments, or changes in decision environments, which might enhance resilience or reduce vulnerability to observed or expected changes in climate. |
| Adaptive capacity | The combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities. |
| Climate change impact | A specific change in a system caused by its exposure to climate change. Impacts may be harmful (threat) or beneficial (opportunity). |
| Climate variability | Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability). |
| Deforestation | Those practices or processes that result in the conversion of forested lands for non-forest uses. |
| Disaster risk management | Processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response, and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, resilience, and sustainable Development (IPCC FAR, SREX Glossary) |
| Disaster risk reduction | The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events. |
| ENSO | El Niño, in its original sense, is a warm water current that periodically flows along the coast of Ecuador and Peru, disrupting the local fishery. This oceanic event is associated with a fluctuation of the intertropical surface pressure pattern and circulation in the Indian and Pacific Oceans, called the Southern Oscillation. This coupled atmosphere-ocean phenomenon is collectively known as El Niño-Southern Oscillation. During an El Niño event, the prevailing trade winds weaken and the equatorial counter current strengthens, causing warm surface waters in the Indonesian area to flow eastward to overlie the cold waters of the Peru current. This event has great impact on the wind, sea surface temperature, and precipitation patterns in the tropical Pacific. It has climatic effects throughout the Pacific region and in many other parts of the world. The opposite of an El Niño event is called La Niña. |
| Emission scenario | A plausible representation of the future development of emissions of substances that are potentially radiatively active (e.g. greenhouse gases, aerosols), based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socioeconomic development, technological change) and their key relationships. Concentration scenarios, derived from emission scenarios, are used as input to a climate model to compute climate projections. |
| Erosion | The process of removal and transport of soil and rock by weathering, mass wasting, and the action of streams, glaciers, waves, winds and underground water. |
| Evaporation | The process by which water changes from a liquid to a gas or vapour. |
| Evapotranspiration | The combined process of evaporation from the Earth's surface and transpiration from vegetation. |
| Extreme weather event | An extreme weather event is an event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of the observed probability density function. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. Single extreme events cannot be simply and directly attributed to anthropogenic climate change, as there is always a finite chance the event in question might have occurred naturally. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that |

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| | is itself extreme (e.g. drought or heavy rainfall over a season). |
| Inundation | The rising of a body of water and its overflowing onto normally dry land. Inundation in this report used to indicate areas which are experiencing increasing periods of being covered by water (to clarify from floods, which are defined less frequent events). |
| Extremely warm summer | Examining all of the summers simulated in a particular realisation of a model in the 1980 to 1999 control period, the warmest of these 20 summers can be computed as an estimate of the temperature of the warmest 5% of all summers in the control climate. The period 2080 to 2099 is then examined, and the fraction of the summers exceeding this warmth determined. This is referred to as the probability of extremely warm summers. |
| Extremely wet/dry | As above but for the highest/lowest precipitation |
| North Atlantic Oscillation (NAO): | The North Atlantic Oscillation (NAO) consists of opposing variations of barometric pressure near Iceland and near the Azores. It is the dominant mode of winter climate variability in the North Atlantic region. |
| Ocean Acidification | Increased concentrations of carbon dioxide in sea water causing a measurable increase in acidity (i.e., a reduction in ocean pH). This may lead to reduced calcification rates of calcifying organisms such as corals, molluscs, algae and crustaceans. |
| Resilience | The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change. |
| Risk | The combination of the probability of an event and its negative consequences. |
| Saltwater intrusion | Displacement of fresh or ground water by the advance of salt water due to its greater density, usually in coastal and estuarine areas. |
| Scenario | A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived from projections, but are often based on additional information from other sources, sometimes combined with a narrative storyline. |
| Sensitivity | The degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise). |
| Vulnerability assessment | A vulnerability assessment is the process of identifying, quantifying, and prioritising (or ranking) the vulnerabilities in a system. |
| Vulnerability | Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. |
| **Acronyms** | |
| ACP | African, Caribbean and Pacific States |
| AR4 | 4th Assessment report of the IPCC |
| BEST | Voluntary scheme for Biodiversity and Ecosystem Services in Territories of the EU Outermost Regions and Overseas Countries and Territories |
| BRGM | The French Geological Society |
| CAP | Common Agricultural Policy |
| CEP | Connecting Europe Facility |
| CF | Cohesion Fund |
| CZM | Coastal Zone Management |
| DCECI | Development Cooperation and Economic Cooperation financing instrument |
| DIREN | Direction Régional the l'Environnement Guyane |
| EAFRD | European Agricultural Fund for Rural Development |

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|---|---|
| EAGGF | European Agricultural Guidance and Guarantee Fund |
| EFF | European Fisheries Fund |
| EIP | European Innovation Partnership |
| ENRD | European Network for Rural Development |
| ENSO | El Niño Southern Oscillation |
| ERA | European Research Area |
| ERDF | European Regional Development Fund |
| ESF | European Social Fund |
| FP7 | Seventh Framework Programme |
| GDP | Gross Domestic Product |
| GVA | Gross Value Added |
| ICA | Integrated Coastal Management |
| ICZM | Integrated Coastal Zone Management |
| IFRECOR | French Initiative on Coral Reefs (from the French 'Initiative Française pour les Récifs Coralliens') |
| INRA | French National Institute for Agricultural Research |
| INTERREG | European Territorial Co-operation Programme |
| IPCC | Intergovernmental Panel on Climate Change |
| LEADER | Links between the rural economy and development actions (from the French "Liaison Entre Actions de Développement de l'Économie Rurale") |
| MAC | Madeira-Azores-Canaries |
| MLPAS | Measures to assist local agricultural products |
| MMD | Multi-Model Dataset |
| NACE | Statistical classification of economic activities in the European Community (from the French "Nomenclature statistique des activités économiques dans la Communauté européenne"). |
| NAO | North Atlantic Oscillation |
| NUTS | Nomenclature of Territorial Units for Statistics |
| ONERC | National Observatory for the Impacts of Global Warming (from the French: "Observatoire National sur les Effets du Réchauffement Climatique"). |
| OR | Outermost Regions |
| PCMDI | Program for Climate Model Diagnosis and Intercomparison |
| POSEI | Programme of Options Specifically Relating to Remoteness and Insularity |
| RDP | Rural Development Programme |
| RIP | Regional Indicative Programmes |
| RIS3 | Regional Innovation Strategies for Smart Specialisation |
| SME | Small and Medium Enterprises |
| SRCAE | Schéma Régional Climat Air Energie |
| SRES | Special Report on Emissions Scenarios |
| WTTC | World Travel & Tourism Council |

# Appendix B: Sources and references

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# Appendix C: Climate change and the OR

The climate change scenarios used are taken from the IPCC AR4(2007) and are based on the Multi-Model Dataset (MMD) regional climate projections (IPCC AR4, Working Group I, Table 11.1). The figures shown in the table below (Table C.1) give the 25%, 50% (median) and 75% quartiles of the projected change (relative to 1980 to 1999 averages) by 2080-2099 under the A1B emissions scenario. Estimated changes to the frequency of a range of extreme events and sea level rise are also shown for the same period and emissions scenario. The IPCC AR4 presents projections for this emissions scenario only but notes that the global mean near-surface temperature and precipitation responses (between the period 1980 to 1999 of the 20th-century integrations and the period 2080 to 2099) in the ensemble mean of the MMD models can be estimated, taking the ratio 0.69:1:1.17 for the B1:A1B:A2 scenarios.

The data presented on extremes, i.e. extremely warm or extremely dry days shows where 14 of the 21 models in the MMD agree on an increase (bold) or decrease in the extremes. These are based on changes over sea and so can be taken as indicative only. To determine an 'extremely warm' summer, all summers simulated by a model in the 1980 to 1999 control period are examined and the warmest of these 20 summers is taken to be an estimate of the warmest 5% of all summers in the control climate simulation. The period 2080 to 2099 is then examined, and the fraction of the summers exceeding this level are identified. This is then referred to as the probability of extremely warm summers. The results are tabulated after averaging over each of the MMD models. Similar calculations are used to determine extremely wet days, etc.

The sea level rise projections given indicate the global mean estimate of change although it has to be noted that regional variations are highly uncertain and could be significantly more or less than the global average.

**Table C.1 Climate change projections for the OR by region**

| | Season | Atlantic | | | Indian Ocean | | | Caribbean | | | French Guiana | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 25% | 50% | 75% | 25% | 50% | 75% | 25% | 50% | 75% | 25% | 50% | 75% |
| Average temperature change (°C) | DJF | 1.9 | 2.1 | 2.3 | 2.0 | 2.1 | 2.4 | 1.8 | 2.2 | 2.4 | 2.2 | 2.6 | 3.5 |
| | MAM | 1.9 | 2.0 | 2.2 | 2.0 | 2.2 | 2.5 | 1.8 | 2.0 | 2.4 | 2.7 | 3.6 | 3.8 |
| | JJA | 1.9 | 2.1 | 2.4 | 1.9 | 2.1 | 2.4 | 1.8 | 2.0 | 2.4 | 2.7 | 3.4 | 3.6 |
| | SON | 2.0 | 2.2 | 2.6 | 1.9 | 2.0 | 2.3 | 1.9 | 2.0 | 2.5 | 2.7 | 3.2 | 3.7 |
| | Annual | 1.9 | 2.1 | 2.4 | 1.9 | 2.1 | 2.4 | 1.8 | 2.0 | 2.4 | 2.6 | 3.2 | 3.6 |
| Average precipitation change (%) | DJF | -8 | -6 | 3 | 2 | 4 | 9 | -11 | -6 | 0 | -18 | -14 | -9 |
| | MAM | -7 | -2 | 6 | 3 | 5 | 6 | -20 | -13 | -6 | -25 | -16 | -10 |
| | JJA | -2 | 2 | 7 | -1 | 3 | 5 | -35 | -20 | -6 | -25 | -9 | -4 |
| | SON | -5 | -1 | 3 | 2 | 4 | 7 | -18 | -6 | 1 | -10 | -4 | 7 |
| | Annual | -3 | 1 | 3 | 3 | 4 | 5 | -19 | -12 | -3 | -16 | -9 | -5 |
| "Extremely Warm"(%) | DJF | - | **100** | - | - | **100** | - | - | **100** | - | - | **96** | - |
| | MAM | - | **100** | - | - | **100** | - | - | **100** | - | - | **100** | - |
| | JJA | - | **100** | - | - | **100** | - | - | **100** | - | - | **100** | - |
| | SON | - | **100** | - | - | **100** | - | - | **100** | - | - | **100** | - |
| | Annual | - | **100** | - | - | **100** | - | - | **100** | - | - | **100** | - |
| "Extremely Wet" (%) | DJF | - | - | - | - | **19** | - | - | 2 | - | - | 2 | - |
| | MAM | - | - | - | - | **22** | - | - | 3 | - | - | 2 | - |
| | JJA | - | - | - | - | **17** | - | - | 2 | - | - | - | - |
| | SON | - | - | - | - | **17** | - | - | - | - | - | - | - |
| | Annual | - | - | - | - | **30** | - | - | 3 | - | - | 2 | - |
| "Extremely Dry" (%) | DJF | - | - | - | - | 1 | - | - | - | - | - | **25** | - |
| | MAM | - | - | - | - | 1 | - | - | **18** | - | - | **18** | - |
| | JJA | - | - | - | - | - | - | - | **40** | - | - | **24** | - |
| | SON | - | - | - | - | 2 | - | - | **22** | - | - | **15** | - |
| | Annual | - | - | - | - | 2 | - | - | **39** | - | - | **33** | - |
| Mean Sea Level rise | | 0.35 | | | 0.35 | | | 0.35 | | | 0.35 | | |

**Table C.2 Climate Impact Assessment**

| Climatic factor | | | | | | Biophysical impact | Example social, environmental or economic consequence | Agriculture and Forestry | Fisheries & Aquaculture | Energy | Tourism | Construction & Buildings | Transport | Waste | Health | Biodiversity | Coastal Zone Management | Soil | Water | Disaster & risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | Precipitation | Wind (storm, hurricane, etc) | Sea level rise | Ocean acidification | Evapotranspiration | | | | | | | | | | | | | | | |
| ■ | ■ | | | | ■ | Increases in pests (i.e. insects, vermin, etc) and disease | Pressure on native species and habitats including marine ecosystems. Potential negative impact on health with risk of new vector-borne disease or epidemi. Reduction in agricultural and forestry yields. Possible loss of tourism revenue | ■ | ■ | | ■ | ■ | | ■ | ■ | ■ | | ■ | ■ | ■ |
| ■ | ■ | ■ | | ■ | | Increase in invasive species | Pressure on native species and habitats including marine ecosystems. Opportunity for fishery based on new species. Requirement for increased management of agricultural and forestry lands. Possible loss of tourism revenue. | ■ | ■ | | ■ | | | | | ■ | | ■ | | |
| ■ | | | | | | Change in demand for cooling / heating, including impacts of overheating in buildings as temperatures increase | Loss of productivity and requirement for extra investment in cooling / heating for existing buildings, particularly tourism locations and health, education facilities, etc. Heat stress to livestock and to crops grown under cover. Opportunities for new crops to be grown. Additional cost in providing tourism amenity (hotels, restaurants, attractions, etc). Increased energy and water demand and likely additional cost for consumers. Challenges in (hygienic) food storage and transportation. | ■ | | ■ | ■ | ■ | ■ | | | | | ■ | |
| ■ | | | | | ■ | Increased risk of heat related mortality as temperatures increase (particularly associated with heat wave) | Increased number of deaths among vulnerable members of population, putting strain on health services. Additional risks in tourism sector which could impact revenues and reputation as a destination | | | | ■ | | | | ■ | | | | | ■ |

| Climatic factor | | | | | | Biophysical impact | Example social, environmental or economic consequence | Agriculture and Forestry | Fisheries & Aquaculture | Energy | Tourism | Construction & Buildings | Transport | Waste | Health | Biodiversity | Coastal Zone Management | Soil | Water | Disaster & risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | Precipitation | Wind (storm, hurricane, etc) | Sea level rise | Ocean acidification | Evapotranspiration | | | | | | | | | | | | | | | |
| | ■ | | | | | Increased risk of flood due to increasing frequency of storms and extreme rainfall events | Risks to infrastructure, transport, buildings, ports, agricultural land from flooding, scour, erosion, water ingress, etc as a result of flood. Contamination of water resources. Debris. Erosion. Contamination of homes and tourist amenities. Risk to life. Pressure on waste sector during the clean up and recovery. | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | ■ | | | | | Change to annual patterns of rainfall (for example wetter winters but drier summers) | Requirement for water storage and distribution with possible capacity issues. Stress to ecosystems. Risk to agriculture/forestry if rainfall decreases during key times in the growing seasons. Shift in the tourist season if 'rainy season' shifts. Competition for resources where water is required for energy generation. | ■ | | ■ | ■ | | | | | ■ | | | ■ | |
| | ■ | | | | ■ | Low water levels in lakes and rivers (likely to be seasonal) | Habitats and ecosystems may become stressed and water quality degrade. Tourism may be restricted or negatively impacted. Energy generation may be compromised impacting energy security where hydro provides a component of the energy mix. | | ■ | ■ | ■ | | | | | ■ | | | ■ | |
| | ■ | | | | ■ | Drought | Risk to crops and forestry particularly to rainforest where the evapotranspiration balance is key. Competition for water resources, including from the energy sector, tourism, domestic, etc. Deterioration in water quality. Degradation of soil. Risk of wildfire and stress to biodiversity. | ■ | | ■ | ■ | | | | | ■ | | ■ | ■ | ■ |
| | ■ | | ■ | | | Increase in coastal flooding as a result of increased storm frequency and sea level rise | Increased infrastructure damage affecting all forms of transport, including ports, and any coastal infrastructure for energy, water or waste treatment (including desalination). More frequent closure of coastal routes, beaches, promenades, etc. Risk of flooding to tourist property with loss of reputation as a desirable destination. Contamination of coastal waters (washing off land). Increased risk of | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

| Climatic factor | | | | | | Biophysical impact | Example social, environmental or economic consequence | Agriculture and Forestry | Fisheries & Aquaculture | Energy | Tourism | Construction & Buildings | Transport | Waste | Health | Biodiversity | Coastal Zone Management | Soil | Water | Disaster & risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | Precipitation | Wind (storm, hurricane, etc) | Sea level rise | Ocean acidification | Evapotranspiration | | | | | | | | | | | | | | | |
| | ■ | | ■ | | | | erosion. Potential for salt water to reach crops and cause damage. Greater need for flood resilient buildings. Pressure on waste sector during clean up. Contamination of freshwater habitats. | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | | | ■ | | | Coastal inundation (causing loss of habitable land and coastal squeeze) as a result of sea level rise | Loss of habitats, agricultural land, developed land, property, etc. Loss of functional infrastructure such as roads and risk to pipe and cables associated with energy and water infrastructure. Possible risk of contamination due to inundation of waste facilities. Increased pressure on available land. | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | | | ■ | | | Saltwater intrusion | Degradation of soils and change in the PH of soils, impacting ecosystems, habitats, crops, livestock, etc. A potential reduction in available fresh water resources. | ■ | | | | | | | | ■ | | ■ | ■ | |
| ■ | | | | ■ | | Coral bleaching | Impact on all marine ecosystems, many being catastrophically damaged and/or lost. Likelihood of reduced fish stocks and impact of fisheries and aquaculture. Reduced coastal resilience to erosion. Increased wave heights which may exceed the design of existing coastal defences. Loss of tourism revenue (diving, fishing etc). Increased risk of coastal flooding. | | ■ | | ■ | ■ | ■ | | | ■ | ■ | | | ■ |
| | ■ | | | | | Increased risk of landslide/mudslide | As a consequence of heavy rainfall and habitat changes, risks of mudslide/landslide could increase putting infrastructure at risk | | | | | ■ | ■ | | | | | | | ■ |

| Climatic factor | | | | | | Biophysical impact | Example social, environmental or economic consequence | Agriculture and Forestry | Fisheries & Aquaculture | Energy | Tourism | Construction & Buildings | Transport | Waste | Health | Biodiversity | Coastal Zone Management | Soil | Water | Disaster & risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | Precipitation | Wind (storm, hurricane, etc) | Sea level rise | Ocean acidification | Evapotranspiration | | | | | | | | | | | | | | | |
| | ■ | | | | | Subsidence | On susceptible soils, cycles of wetting and drying could increase risk of subsidence and ground movement, putting building integrity at risk. | | | | | ■ | ■ | | | | | | | |
| ■ | ■ | ■ | | | ■ | Wildfire | Disrupt to the equilibrium of the ecosystems and soils. Impacts on biodiversity. Contamination of water resources. Risk to infrastructure and disruption to travel. Risk to human health. Damage to the built environment (economic losses) and threat to the tourism activity. Increase fresh water demand for extinction activities (which may limit success in containing the fire). Pressure on waste sector during clean up. | ■ | | | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ |
| ■ | ■ | | | | ■ | Soil degradation influencing carbon storage capacity of soils | Degraded soils may not be effective stores of carbon; as a result soils role may change from carbon sinks to carbon source (related to degradation of soils rich in organic matter). | | | | | | | | | | | ■ | | |
| ■ | | | | | | Increased water temperatures | Stress to ecosystems and to biodiversity. Deterioration in water quality. | | ■ | | | | | | | ■ | | | ■ | |

# Appendix D: Climate risk assessment for the OR

**Methodology**

An assessment framework providing information on the current knowledge of climate impacts in the OR has been developed. The impacts discussed in Section 2 have been assessed for each OR across 13 sectors in total. These covered:

- 7 economic sectors: agriculture and forestry, fisheries & aquaculture, energy, tourism, construction & buildings, transport and waste; and
- 6 human and environmental systems: health, biodiversity, coastal zone management, soil, water and disaster & risk.

The climate change impacts have been evaluated and scored based on the following criteria:

- Whether the impact is positive or negative (while the majority of climate change impacts will bring negative consequences, some impacts may result in an improvement of the social, environmental or economic situation in OR);
- The likelihood of the impact occurring; and
- The magnitude of the impact in the OR on the sector assessed.

Table D.1 shows further details of the approach. The impacts which may bring negative consequences to the OR were assigned a negative "-"score while opportunities are scored positively. Not all climate change impacts were identified as relevant to all sectors. Appendix B presents the list of all of the impacts assessed and their relevance to each of the sectors considered in the study.

**Table D.1 Criteria used to assess climate change impacts in the OR.**

| Impact | Criteria | Score |
|---|---|---|
| Low | Impact is not currently observed or occurs rarely, likelihood of the impact occurring more frequently as result of climate change is low, consequences of the impact occurring are small | 1 / -1 |
| Medium | Impact is not currently observed or occurs rarely but when it happens, there are large social, environmental and economic consequences, or vice versa; the score was also applied for impacts of moderate likelihood and magnitude | 2 / -2 |
| High | Impact is already observed and it is likely to occur more frequently as result of climate change, resulting in large social, environmental and economic consequences) | 3 / -3 |

Within the assessment, where no supporting information on an impact in the OR has been identified, the respective cell has been left blank. This allowed identification of potential knowledge gaps. The outcome of this scoring process is not included within this report as the tables are very large. They will be provided with the final report as a separate document. For this report, the impact scores are part of the overall risk score and so can be inferred (see below).

The next step is to establish the vulnerability of each sector to each impact. This vulnerability has been evaluated and scored based on the following criteria:

- Importance of the sector to the economy of the OR – this has been a primary criteria against which a range of indicators have been considered, including contribution of the sector to GDP (or GVA) and employment, whether the sector has been historically important and / or if it is an area OR would like to grow moving forward;
- Awareness of potential impacts within the OR and evidence of preparedness to face them; and
- Level of adaptive capacity.

It should be noted that data is extremely limited to assess the vulnerability of a sector within the OR and so these scores are estimates based on the information available.

**Table D.2 Criteria used to assess vulnerability of the economic sectors and human and environmental systems to impacts of climate change**

| Vulnerability | Criteria | Score |
|---|---|---|
| Low | Sector has little economic, social and/or environmental importance and/or it has high adaptive capacity and good awareness of possible risks. | 1 |
| Medium | Sector is moderately important from an economic, social and/or environmental point of view, relative to other sectors. There may be some awareness of the possible risks and/or preparedness to face the consequences. | 2 |
| High | Sector is important from the economic, social and/or environmental point of view. It is characterised by low adaptive capacity and little awareness of possible risks. | 3 |

Impact and vulnerability scores were then combined in the common framework using the formula:

(IMPACT) x (VULNERABILITY) = RISK/OPPORTUNITY.

This allowed assessment of the level of risk and/or opportunity in each sector for each of the OR. As explained in Table D.3 below, risk/opportunity scores have been identified as low (score 1 to 3), medium (score 4/-4 or 6/-6) or high (score 9/-9). For the purposes of this study, impacts with high risks scores, i.e. where an overall score of -9 is recorded, are those identified as being potential areas for adaptation interventions. Where an opportunity has been identified as a result of climate change, the cells have been highlighted in green. Some impacts may result in both positive and negative consequences; in this case the cells have been split.

**Table D.3 Risk and opportunity score matrix**

| | | Vulnerability | | |
|---|---|---|---|---|
| | **Risk / Opportunity** | **Low (1)** | **Medium (2)** | **High (3)** |

| Impact | | | | |
|---|---|---|---|---|
| | **Low (1/-1)** | Low (1/-1) | Low (2/-2) | Low (3/-3) |
| | **Medium (2/-2)** | Low (2/-2) | Medium (4/-4) | Medium (6/-6) |
| | **High (3/-3)** | Low (3/-3) | Medium (6/-6) | High (9/-9) |

For the purpose of this report, adaptation measures have been assessed qualitatively, according to their relevance to the areas for adaptive interventions. These will be evaluated more systematically through synthesis of all available data (including economic and use of funds), according to the set of criteria outlined in the project proposal. At this stage further consistency checks will also be completed to make sure that all information available, whether via literature or from stakeholder consultation, has been taken into account. The outcome will be presented in the final report.

## Guadeloupe

### Climate Impacts

**Table D.4 Climate impacts - Guadeloupe**

| Biophysical impacts | Comments |
|---|---|
| Increases in pests and disease | Increases in pests and diseases are relevant to the Health, Agriculture and Biodiversity sectors.<br>There is already an emergence and resurgence of new epidemics of dengue which are more severe, more frequent and atypical (SRCAE Guadeloupe, 2012b). An increase of diseases related to water quality due to temperature increases is expected (SRCAE Guadeloupe, 2012b).<br>Within agriculture, intensive banana monoculture plantations are at particular risk from an increase in parasites. |
| Increase in invasive species | The migration of species towards the highlands as a result of increasing temperatures and disruption of existing ecosystems may create conditions which favour invasive alien species. It has been observed that after the destruction of habitats by cyclones, invasive species are the first to re-establish a presence. |
| Increase in temperatures | Temperature is projected to increase of 1°C by the middle of this century and by approximately 2°C by the end of the century, during both summer and winter seasons (Climator project by INRA, 2010).<br>Increase in temperatures will particularly affect the Energy and Construction sectors.<br>Energy consumption has increased by 45% between 2000 and 2011, principally due to increased domestic consumption. This is in part due to an increase in demand for cooling (in addition to general increase in demand). Electricity production increased between 2000 and 2012, with the exception of 2011, when it decreased, due to a lower demand for cooling, highlighting a link between electricity production and temperature (SRCAE Guadeloupe, 2012b). This suggests that as temperatures increase, so will demand for energy. |
| Increase in extreme temperature events | Heat waves are expected but there is no evidence of heat wave having occurred to date. During heat wave, stresses on people, agriculture, infrastructure and biodiversity are likely, as are peaks in energy demand. Health may be at risk, particularly amongst the more vulnerable members of the population, including some tourists, |
| Increased risk of flood due to increasing frequency of storms and extreme rainfall events | An increase in the intensity and frequency of tropical storms as a result of climate change means that mangroves will potentially no longer have the time they need to regenerate between two weather events (IUCN, 2010). Extreme rainfall can cause erosion and loss of soils. Flooding may lead to displacement of population and cause damage to infrastructure, including |

| Biophysical impacts | Comments |
|---|---|
| | health and transport infrastructure. The Energy, Tourism, Construction and Transport sectors are particularly likely to be affected by this risk. |
| Change to annual patterns of rainfall (for example wetter winters but drier summers) | The difference between the dry and the wintering seasons may not be as marked in the future as in the current climate as precipitation is expected to increase during the dry season. This change has already been observed in Guadeloupe (Source: Interview with Conseil Régional of Guadeloupe). This may ease the pressure on water storage in meeting water resource needs.<br>On the other hand, the agricultural sector is adapted to the current seasonal patterns. For example; the sugar cane is traditionally cut during the dry season. The most recent dry season was uncharacteristically wet, which caused the loss of thousands of tonnes of sugar cane as the machinery could not be used in the flooded fields. |
| Low water levels in lakes and rivers (likely to be seasonal) | Water shortages in lakes and rivers have been observed during dry season. (SRCAE Guadeloupe 2012b). |
| Drought | More droughts are expected.(SRCAE Guadeloupe, 2012b). Droughts may affect the availability of water for agricultural and human use. They will also affect the hydropower generation capacity of the island. |
| Increase in coastal flooding as a result of increased storm frequency and sea level rise | It is anticipated that increased storm frequency and sea level rise will lead to coastal flooding. This will lead to flooding of coastal areas, which are highly populated and where the majority of island infrastructure is located, therefore this impacts is very relevant across several sectors (construction, health, transport). Additionally, erosion of beaches may increase as a result of increased storms and hurricanes. |
| Coastal inundation (causing loss of habitable land and coastal squeeze) as a result of sea level rise | In the context of the drafting of the "Schéma Régional Climat Air Energie" (SRCAE Guadeloupe 2012a), a simulation of an increase of the sea water level was carried out by the BRGM. The consequences are estimated to be high since the development of Guadeloupe is mainly organised along the coasts.<br>Coastal inundation would have a number of impacts across sectors including biodiversity, construction, health and transport. For biodiversity, water rising would result in mangrove destruction. Since mangroves are fish nurseries, this will result in a possible reduction of fish stocks. (French Ministry of Environment, 2010). For threatened infrastructure located on the coast, the risk from coastal inundation is lower than from coastal flooding, as the slower pace of coastal inundation will allow for some relocation of infrastructures to avoid damage. |
| Saltwater intrusion | With sea levels rise there is a risk of saltwater intrusion of low land areas. No information could be found on the impact of this on the water sector in Guadeloupe, however potentially it could affect the water resource available for human and agricultural use. |
| Coral bleaching | Increasing sea temperature and ocean acidification lead to coral bleaching. Loss of the health and integrity of coral reef could lead to a reduction of coastal fish populations depending on health of coastal reefs (French Ministry of Environment, 2010). Loss of coral reef also suggests loss of protection they offer to the coastline and risk of great damage during storm events. In Guadeloupe, water temperature is now above 29°C during longer periods. About 80% of coral reefs are now thought to be dead due to the increase of sea water temperature. (source: interview with Conseil Régional Guadeloupe) |
| Increased risk of landslide/mudslide | No evidence of studies into landslide and risk has been identified but it is reasonable to assume that slope stability could be negatively impacted as climate changes, increasing risks of landslide. |
| Subsidence | No information has been identified with regard to subsidence and Guadeloupe. |
| Wildfire | No information has been identified with regard to risk of wildfire and Guadeloupe. |
| Soil degradation influencing carbon storage capacity of soils | No information has been identified with regard to soil degradation or carbon sequestration by soil and Guadeloupe. |
| Increased water temperatures | No information has been identified with regard to water temperature in rivers and lakes in Guadeloupe and the impact this may have on ecosystems. |

**Table D.5 Sectoral vulnerability to climate change – Guadeloupe**

| Sectors | Vulnerability | Rationale |
|---|---|---|
| Agriculture | MODERATE | Agriculture represents about 25% of the surface of Guadeloupe. Primary productions are sugar cane and banana which occupy about 30% and 5% of the agricultural surface, respectively (ONERC, 2012).<br>Secondary productions are fruits, vegetables and livestock. 13 000 persons work in the agricultural sector. This represents 7% of the active population. Most of the agricultural production (sugar cane and bananas) is for export. Agriculture does not cover local needs. (SRCAE and IEDOM, 2012a).<br>Overall, agriculture is declining but still remains a fundamental sector for Guadeloupe. |
| Forestry | LOW | Forest covers 40% of island territory (69 000 ha).<br>As regards forestry sector, local production seems to be very limited (ONF Guadeloupe172) as well as not really structured and with low profitability (ONERC, 2012). |
| Fisheries & Aquaculture | MODERATE | Fisheries and aquaculture represent 32% of the value of the primary sector. About 1600 persons work in this sector.<br>It remains an artisanal and relatively unstructured sector of secondary economic importance (ONERC, 2012). Modernisation is occurring since a few years. The sector is growing. In terms of number of fishermen, Guadeloupe is (in 2008) the 7th French department (French Senate173). It is considered that the sector offers interesting development possibilities (ONERC, 2012).<br>Annual production is about 10 000 tonnes in Guadeloupe and covers 60% of local needs (ONERC, 2012). |
| Energy | MODERATE | The energy sector represents only 0,5% of the value added of the economy (in 2010). Hydropower production represents 0,8 % of the total of the electricity production in 2011. Renewable energy represents 8% of the total production of electricity in 2011 (IEDOM, 2012a).<br>There is still a high dependency to fossil energy, but there are several power stations. The use of renewable energy encourages the decentralisation of energy production infrastructures. This decreases the level of vulnerability of the sector to climate change impacts.<br>Regarding impacts on the Energy sector and the adaptation actions, there is no specific information available in the literature. There is objective to develop the use of renewable energy, with the ambition to reduce the energy dependency and to value the natural resources available on the territory. This will also help to reduce carbon emissions. |
| Tourism | HIGH | Tourism is one of the main economic sectors of Guadeloupe. Today the sector faces difficulties. Between 2000 and 2009, the number of tourists in Guadeloupe decreased from 623,000 to 364,000 tourists. (ONERC, 2012) Tourism activities depend directly on the quality of environmental resources and accessibility (e.g. beaches, forests, natural parks). Accommodations are located close to the sea. The quality of beaches is a key criterion to attract tourists. |
| Construction & Buildings | MODERATE | As concerns demand of cooling/heating: the level of household equipment has increased at 3.5% per year between 2001 and 2011 (IEDOM, 2012a): Household equipment for cooling and heating decreases the level of vulnerability.<br>The majority of infrastructures (ports, airports and aerodromes, roads), hotel or socioeconomic facilities and other buildings are located close to the coasts (i.e. high vulnerability). Many infrastructures and buildings are built in risk areas. There is a "Plan Seisme Antilles" developed in Guadeloupe. The first phase (2007-2013) has involved strengthening the housing, through consolidation or reconstruction of school buildings, multi-family housing and infrastructure crisis management. |

[172] http://www.onf.fr/guadeloupe/onf_guadeloupe/onf/connaitre/economie/20080306-064005-758987/@@index.html

[173] http://www.senat.fr/rap/r08-519-1/r08-519-157.html

| Sectors | Vulnerability | Rationale |
|---|---|---|
| Transport | HIGH | High vulnerability estimated because all major transport infrastructures, airport, and other economic infrastructures (residential and business areas) are located along the coasts. They are already impacted by coastal inundation and floods resulting from extreme weather events. The Transport sector represents 3.7% of the value added of the economy (in 2010) (IEDOM, 2012a). |
| Waste | | No information could be found for this sector for Guadeloupe, therefore the vulnerability could not be assessed. |
| Health | MODERATE | Regarding heat waves, the use of air conditioning systems is spreading (decreasing the vulnerability). Vulnerability regarding the potential contamination of water systems due to heat waves remains high.<br>When the impacts are located on the coasts, vulnerability can be higher (potential deaths and accidents resulting from extreme weather events) because population and infrastructures are highly concentrated along the coasts.<br>The health system is considered to be good, with a high number of beds available. |
| Biodiversity | HIGH | Guadeloupe's natural heritage is rich in natural habitats; includes a significant number of native species. There is a wide range of ecosystems distributed according to the exposure of the hillsides, such as high altitude savannahs, tropical rain forests, or dry forests, all of which are home to a tremendous variety of remarkable species. |
| Coastal Zone Management | HIGH | Highly exposed to coastal risks. Infrastructures, buildings, population are mainly located close to the coasts. |
| Soil | MODERATE | In Guadeloupe soil is a limited resource because of specific geographical features (insularity, terrain, land shortage). In addition, "urban sprawl" phenomenon is observed. (French Ministry of Environment, 2011b). Artificial land covers 10% of the territory in Guadeloupe (French Ministry of Agriculture, 2012) whereas in Metropolitan France it is 5% (INSEE174).<br><br>Some sectors of the island have a hilly relief (volcanoes) with steep inclines this combined with the alternation of rainy and dry seasons is favourable to erosion and landslides. (ONERC, 2012). This can be further increased by agricultural practices. Indeed, intensive crop systems (banana, pineapple, sugarcane) in steep lands could seriously damage the soil by water erosion because of the aggressiveness of tropical rainfalls (Khamsouk & Roose, 2003). Moreover, the development of market gardening crops that contribute to the reduction of soil fertility (decrease in organic matter content, erosion) may further accentuate this soil degradation trend (ONERC, 2012).<br><br>There is a high diversity of soils in Guadeloupe resulting from interactions between volcanic activity, climate and topography. In particular, water retention capacity is very variable depending on soil composition and structural characteristics. (Bussière et al, 2011)<br><br>A particularity of Guadeloupe and Martinique that may increase their vulnerability to Climate change is the issue of chlordecone. Chlordecone is a pesticide that was formerly used in bananas plantations. This lead to a large-scale soil pollution with respectively 1/5 and 2/5 of agricultural soils polluted with this compound in Guadeloupe and Martinique. |
| Water | MODERATE | Water is relatively abundant in Guadeloupe (French Ministry of Environment, 2010) but the resources are vey unevenly distributed (ONERC, 2012) because of temporal and spatial variability. The Guadeloupian climate has two seasons: "Carême" is a 6 month-long dry season and "Hivernage" is a 4 month-long hurricane and rainy season. In addition, rainfalls are more abundant in Basse-Terre because of its rough volcanic relief than Grande-Terre which features lower terrain. (SDAGE Guadeloupe).<br><br>Water needs (both for drinking and irrigation) have been increasing steadily in the past years. This trend should continue in the years to come supported by the socioeconomic development of the island (SRCAE). |

[174] http://www.insee.fr/fr/themes/document.asp?reg_id=24&ref_id=18689

| Sectors | Vulnerability | Rationale |
|---|---|---|
| | | Guadeloupe already experiences water shortage during Carême (dry) season. There are at this period important discrepancies between water needs and available water volumes. This is because the majority of the water is withdrawn from rivers whose level is very dependent on rainfalls. In parallel, Carême is the time of year where water needs are the most important, in particular for irrigation. (SRCAE Guadeloupe)<br><br>Another issue is the ageing drinking water supply system. It is estimated that about 50% of the water is lost because of leakage before reaching consumers' tap. (SRCAE Guadeloupe). |
| Disaster & risk | MODERATE | Climate change impacts potentially increase the magnitude and the occurrence of natural risks. However, the vulnerability is moderate and not high, because the territory already has experience in disaster management. Also, there is already a "Plan Seisme Antilles" (Earthquake action plan). The first phase (2007-2013) has involved strengthening the housing, through consolidation or reconstruction of school buildings, multi-family housing and infrastructure crisis management. |

**Table D.6 Risks and opportunities resulting from climate change – Guadeloupe**

| Sectors | Agriculture | Forestry | Fisheries & Aquaculture | Energy | Tourism | Construction & Buildings | Transport | Waste | Health | Biodiversity | Coastal Zone Management | Soil | Water | Disaster & risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Increase in pests and diseases | | | | | | | | | | | | | | |
| Increase in invasive species | | | | | | | | | | | | | | |
| Increase in temperature | | | | | | | | | | | | | | |
| Increased in extreme temperature events | | | | | | | | | | | | | | |
| Increase in floods | | | | | | | | | | | | | | |
| Change to annual patterns of rainfall | | | | | | | | | | | | | | |

| Sectors | Agriculture | Forestry | Fisheries & Aquaculture | Energy | Tourism | Construction & Buildings | Transport | Waste | Health | Biodiversity | Coastal Zone Management | Soil | Water | Disaster & risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Low water levels in lakes and rivers | | | | | | | | | | | | | | |
| Drought | | | | | | | | | | | | | | |
| Increase in coastal flooding | | | | | | | | | | | | | | |
| Coastal inundation as a result of sea level rise | | | | | | | | | | | | | | |
| Saltwater intrusion | | | | | | | | | | | | | | |
| Coral bleaching | | | | | | | | | | | | | | |
| Increased risk of landslide/mudslide | | | | | | | | | | | | | | |
| Subsidence | | | | | | | | | | | | | | |
| Wildfire | | | | | | | | | | | | | | |
| Soil degradation influencing carbon storage capacity of soils | | | | | | | | | | | | | | |
| Increased water temperatures | | | | | | | | | | | | | | |

Notes: Colour coding of the cells in the risk matrix: Red – high risk, Orange – moderate risk, Olive – low risk, Green – opportunity, Grey – the risk is relevant to the sector however could not be assessed. Blank – impacts not relevant to the sector.

## Martinique

**Table D.7 Climate impacts – Martinique**

| Biophysical impacts | Comments |
|---|---|
| Increases in pests and disease | In the aftermath of hurricane DEAN (in 2007), the Regional Health Agency of Martinique observed an increase in the number of leptospirosis cases, in particular in rural areas. It is expected that the increase of extreme weather events will contribute to increasing human diseases. Banana plantations are at risk from new pests and diseases, particularly because they are grown as intensive monoculture plantations. Also within agriculture, market gardening operations are very sensitive to pests and diseases. |
| Increase in invasive species | The migration of species towards the highlands and the disruption of existing equilibriums run the risk of creating conditions favourable for invasive alien species. (SRCAE Martinique 2012) |
| Increase in temperatures | Temperature has increased by 1.47°C between 1960 and 2000. (SRCAE Martinique 2012). It is very likely that temperatures will continue to increase. Higher temperatures could negatively affect agriculture (by reducing the growing period for fruit and vegetable crops). They could also negatively impact the Tourism sector (as tourists choose to go elsewhere |

| Biophysical impacts | Comments |
|---|---|
| | if temperatures become too hot for comfort). The Energy and Construction sectors may be affected by an increase in demand for cooling due to higher temperatures. |
| Increase in extreme temperature events | There is no evidence that such events have been observed but given climate projections, It is likely that there will be an increase in the frequency of periods of very hot weather. |
| Increased risk of flood due to increasing frequency of storms and extreme rainfall events | Changes to the interannual variability of hurricane activity and thunderstorm activity have been observed (SRCAE Martinique 2012). An increase in flooding would impact the health sector e.g. through increased occurrence of water-borne diseases and diseases related to quality of water. In the aftermath of flooding, there might be an increase in insect vector-borne diseases, as standing water provides an ideal habitat for these insects. Health infrastructres may also be affected by floods. Increased flooding may also deter tourists from visiting the island. |
| Change to annual patterns of rainfall (for example wetter winters but drier summers) | Longer dry seasons and progressive reduction of precipitation nin mountain areas could lead to the migration of dry bio-climate toward higher altitude, and the progressive disappearance of humid mountain bioclimate and ultimately the disappearance of highland tropical forest. Changes to annual patterns of precipitation may also affect the availability of water for human and agricultural consumption. |
| Low water levels in lakes and rivers (likely to be seasonal) | Low levels of water would lead to increasing competition for water between human and agricultural use (such competition has already been observed during a drought in 2010). |
| Drought | There is a trend towards an increase of droughts in the month of July in past years. (SRCAE Martinique 2012). Drought would lead to competition for available water resources between domestic and agricultural use (as already experienced during the 2010 drought). |
| Increase in coastal flooding as a result of increased storm frequency and sea level rise | The sea level rising is about 3.5 mm per year. The season for hurricanes and thunderstorms, which was relatively fixed, appears to have become more variable. (SRCAE Martinique 2012). Increased coastal flooding and seal-level rise could lead to the destruction of mangroves, and therefore reduction in available fish stocks (mangroves act as fish nurseries).. (French Ministry of Environment, 2010) Martinique also faces damage to coastal infrastructure (including transport and health infrastructure), which is predominantly distributed along the coastline. |
| Coastal inundation (causing loss of habitable land and coastal squeeze) as a result of sea level rise | Sea level rise has been observed at a rate of about 3.5 mm per year between 1960 and 2000. (SRCAE Martinique 2012). Coastal inundation will threaten coastal infrastrucute (housing, health and transport infrastructure) in the same way coastal flooding will. However, given the longer timescales for coastal inundation, it may be possible to relocate some of the affected infrastructures inland, in time. |
| Saltwater intrusion | With sea levels rising there is an increasing risk of saltwater intrusion in low land areas. This affects the availability of water for domestic and agricultural consumption. It also threatens biodiversity and encourages the development of saltwater-tolerant species. |
| Coral bleaching | Coral beaching is already observed in the region. This threatens the health and ultimate survival of coral reefs, and the functions they provide: as fish nurseries and in offering coastal protection. Therefore biodiversity, fisheries, and coastal infrastructure are all at risk. |
| Increased risk of landslide/mudslide | It is thought that there will be an increased risk of landslides, indeed a significant landslide was already observed in 2011. This presents threats to infrastructure (construction and transport), health (human health at risk), and disaster management sectors. |
| Subsidence | No information relating to subsidence has been identified for Martinique |
| Wildfire | No information relating to wildfire has been identified for Martinique |
| Soil degradation influencing carbon storage capacity of soils | No information relating to soil quality or degradation has been identified for Martinique |
| Increased water temperatures | An increase of water temperatures is already observed (French Ministry of Environment, 2010). Any increases in water temperature stress native biodiversity although no information was identified during the literature review of this being the case, with the exception of coral bleaching which has been observed (higher water temperatures lead to coral bleaching which reduces fish populations using the reef as nurseries) . Higher temperatures could have negative impacts on Health as they will favour the reproduction |

| Biophysical impacts | Comments |
|---|---|
| | of bacteria responsible for intoxication risks. |

**Table D.8 Sectoral vulnerability to climate change – Martinique**

| Sectors | Vulnerability | Rationale |
|---|---|---|
| Agriculture | MODERATE | Agriculture represents about 28% of the surface of Martinique. Banana plantations occupy 27% of the agricultural surface and sugar cane 10%. Secondary productions are cattle, pigs, fruits and vegetables.<br>Agriculture supports about 6% of salaried workers in Martinique (IEDOM, 2012c). It is a fragile sector but is still considered as having an important role in the economy (Conseil GénéralMartinique175). |
| Forestry | LOW | Forest covers 43% of island's territory (47,000 ha). There are about 1200 ha of artificial broadleaf mahogany plantation that are being economically exploited (1.5% of island territory) (source: National Forestry Office website for Martinique )– this is the main species for timber production in the island. However production has a low profitability and low yields (15 $m^3$/ha/year) because of natural constraints (terrain, diseases, poor soils) and poor operating equipment. No specific adaptation actions in the forestry sector have been identified in the literature.<br>Overall, the vulnerability of the forestry sector is considered low. |
| Fisheries & Aquaculture | MODERATE | Fishery is one of the traditional economic sectors in Martinique. Coastal fishery is undertaken using small boats with around 60% of fishermen operating at less than 12NM from the coast (ONERC, 2012). About 1,300 people are employed in the sector (in 2008, in terms of number of fishermen, Martinique was ranked 8$^{th}$ across French territories).<br>Despite Martinique has a high demand for fish products, it is not self sufficient. Annual production fluctuates between 4-6,000 tonnes (ONERC, 2012). Over exploitation of resources in the past led to the creation in 1999 of areas were fishing is prohibited (ONERC, 2012; Conseil Général Martinique[176]).<br>As fisheries remains an artisanal and relatively unstructured sector of secondary economic importance (ONERC, 2012), it's vulnerability is assessed as moderate. |
| Energy | MODERATE | Martinique targets the development of the renewable energy production in order to decrease its dependency on fossil energy and harness the natural resources available on the island. This will lead to reduction in carbon emissions and increased resilience of the electricity system. While<br>there is no extensive information available in the literature on the impacts of climate change on the energy sector, or existing adaptation actions, from 2009 following damages caused by cyclone Dean, the local electricity supplier had been undertaking works to secure the electricity networks by burying the power lines. Approximately 20 million Euros of private investment was planned to make the electricity networks more resilient to future cyclones. Overall, given some actions are already undertaken to increase resilience of the energy system; vulnerability of the energy sector is assessed as moderate. |

[175] http://www.cg972.fr/site/telechargement/pdf/agenda21_agriculture.pdf
[176] http://www.cg972.fr/site/telechargement/pdf/agenda21_peche_aquaculture.pdf

| Sectors | Vulnerability | Rationale |
|---|---|---|
| Tourism | HIGH | Tourism is highly integrated in the economy of Martinique, contributing 9% of the Net Gross Domestic Product and 10% of employment in 2011). However the sector is not as strong as it used to be. Between 2006 and 2010, the number of tourists has been increasing but at a lower intensity than before: from 535,000 in 2006 to 620,780 tourists in 2010 (ONERC, 2012). In addition, tourism in Martinique depends highly on natural resources and will therefore be affected by potential impacts of climate change. While actions are developed by public institutions to increase the attractiveness of Martinique as a tourist destination, overall vulnerability of the sector is assessed as high. |
| Construction & Buildings | MODERATE | There is an overall lack of research and projects related to climate change adaptation in Martinique in the built environment. The majority of infrastructure (ports, airports and aerodromes, roads), hotels or socioeconomic facilities and other buildings are located close to the coast, in high-risk areas. However, through the first phase of "Plan Seisme Antilles" (2007-2013) (Earthquake action plan), Martinique strengthened the resilience buildings, through consolidation or reconstruction of schools, multi-family housing and implementation of infrastructure crisis management. With regards to demand for cooling and heating in Martinique, the utilisation of household equipment increased at 3.5% per year between 2001 and 2011 (IEDOM, 2012c). |
| Transport | HIGH | All major transport infrastructures, including the airport, are located along the coast. There is evidence that these are already negatively impacted by coastal inundation and floods as a result of extreme weather events. While some adaptation measures have already been implemented on roads and tramway lines (for example in the airport area), the sector is considered highly vulnerable. |
| Waste | | There was insufficient information available on the waste sector in Martinque to allow assessment of its vulnerability.<br>According to the United Nations Statistics Division177, 100% of the population of Martinique is served by municipial waste collection, with 211,000 tonnes collected in 2007. According to Barriga & Themelis (2011), there are three regulated and three un-regulated landfills, one anaerobic digestion plants and one waste-to-energy facility operating in Martinique. The waste to energy plant was built in 2002 to address problems associated with lack of landfills space and to advance waste management practices in the island. It treats approximately 30% of total waste arising and covers 4% of islands total electricity demand. |
| Health | MODERATE | The health system is considered to be good. While no information has been available on the quality of public health services in Martinique specifically, the health sector is considered less developed in the French OR's compared to the continental France (based on the number of doctors, particularly specialists; and hospital beds) (European Commission, 2012c). Moreover, lack of resources to accommodate medium to long-term hospital stays requires frequent transfer of patients to the mainland; and therefore makes the sector highly reliant on transport infrastructure. |
| Biodiversity | HIGH | Martinique is home to a large number of flora and fauna species, and is characterised by complex forest and marine ecosystems (IUCN, 2008).<br>The IUCN (2008) report, judged that the terrestrial ecosystems in the island are "relatively degraded". This is primarily caused by human activities and returning natural disasters (IUCN, 2008). However, natural forests with around 396 species of indigenous trees, still cover circa 26% of the total land area, . The biodiversity of the island can generally be characterised by high endemism.<br>In terms of marine ecosystems, Martinique has three types of coral reef: barrier, fringe and shallow, in addition to underwater prairies and mangroves. This supports rich biodiversity, being home to "182 species of fish, 48 species of corals, 70 sponges and 331 molluscs" (IUCN,2008). Overall, given the current state of, and high endemisms and uniqueness of the ecosystems in Martinique, the biodiversity in the island is assessed as highly vulnerable. |

[177] http://unstats.un.org/unsd/environment/municipalwaste.htm

| Sectors | Vulnerability | Rationale |
|---|---|---|
| Coastal Zone Management | HIGH | While vulnerability of Martinique to coastal hazards is not directly assessed in the literature (CETMEF 2012), the island is highly exposed to coastal risks. Majority of infrastructure (including roads and buildings) and population are located near the shores, in particular on the West coast which is considered more vulnerable to impacts of climate changes compared to other parts of the island. Extreme weather events recurring in Martinique provide further evidence on the coastal risks, such as increased erosion. For instance, after the Dean Hurricane in 2007, the retreat of the coast line was estimated at up to 20m (CETMEF 2012).<br>Plans for preventing coastal risks have been prepared for all coastline territories. However coastal zone management measures are not well described in these plans. Overall the vulnerability of coastal zone management is considered high. |
| Soil | MODERATE | In Guadeloupe and Martinique soil is a limited resource because of their specific geographical features (insularity, terrain, land shortage) and "urban sprawl" (French Ministry of Environment, 2011b). Artificial land covers 10% of the territory in Guadeloupe and 15% in Martinique (French Ministry of Agriculture, 2012), compared to Metropolitan France where it is only 5% (INSEE178). At the same time, there is a high diversity of soils in Martinique and Guadeloupe resulting from interactions between volcanic activity, climate and topography. In particular, water retention capacity is very variable depending on soil composition and structural characteristics (Bussière et al, 2011).<br>Some sectors of the island have a hilly relief (volcanoes) with steep inclines. This combined with the alternation of rainy and dry seasons is favourable to erosion and landslides (ONERC, 2012). These phenomena are further increased by agricultural practices. For example, intensive crop systems (banana, pineapple, sugarcane) in steep lands could seriously damage the soil through water erosion (due to aggressiveness of tropical rainfalls) (Khamsouk & Roose, 2003). Soil degradation may be further accentuated by development of market for gardening crops that contribute to the reduction of soil fertility by decreasing organic matter content in soil and erosion)(ONERC, 2012). A specific characteristic of soils in Guadeloupe and Martinique that may increase their vulnerability to climate change is the issue of chlordecone. Chlordecone is a pesticide that was formerly used in bananas plantations. This lead to a large-scale soil pollution with respectively 1/5 and 2/5 of agricultural soils polluted with this compound in Guadeloupe and Martinique. |
| Water | MODERATE | Regarding the issue of water, the situation in Martinique is similar to Guadeloupe. Water is relatively abundant in Martinique but the resources are very unevenly distributed (both temporal and spatial variability). Martinique has two seasons: “Carême” (dry) (critical for water resources in the island) and “Hivernage” (rainy). In addition, rainfalls are much more abundant in the northern, mountainous part of the island (Observatoire de l’Eau Martinique179).<br>Water management in Martinique requires modernisation. More than 90% of the drinking water is taken from rivers, which makes the water supply very sensitive to freshwater shortages (droughts, landslides destroying catchment points, etc.). The supply system is ageing and a large share of water is lost because of leakage (Conseil Général Martinique180). Such factors increase the vulnerability of the territory. Concurrence between domestic and agricultural uses of water has been previously observed during the 2010 drought and could increase in the future (ONERC, 2012). |
| Disaster & risk | MODERATE | Climate change impacts potentially increase the magnitude and the likelihood of occurrence of natural risks. Martinique is highly exposed to coastal hazards, in particular during extreme weather events such as hurricanes. Authorities are aware that the operational management of natural risks needs to be improved; however there is already a significant local experience in disaster management. Some actions have also already been undertaken to increase island’s resilience (as mentioned in the description of the |

[178] http://www.insee.fr/fr/themes/document.asp?reg_id=24&ref_id=18689

[179] http://www.observatoire-eau-martinique.fr/leau-en-martinique/le-climat-1/le-climat

[180] Agenda 21 Martinique - Fiche 12 Ressources en eau et assainissement.

| Sectors | Vulnerability | Rationale |
|---|---|---|
| | | construction and building sector, the first phase of "Plan Seisme Martinique" (2007-2013)(Earthquake action plan) involved strengthening of the housing infrastructure).<br>The Conseil Régional Martinique has one employee working specifically on the definition and implementation of a strategic plan to better manage risks of natural disasters. The plan, which is currently being developed, will aim to integrate natural risks into the economic development strategies for Martinique. |

**Table D.9 Risks and opportunities resulting from climate change – Martinique**

| Sectors | Agriculture | Forestry | Fisheries & Aquaculture | Energy | Tourism | Construction & Buildings | Transport | Waste | Health | Biodiversity | Coastal Zone Management | Soil | Water | Disaster & risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Increase in pests and diseases | | | | | | | | | | | | | | |
| Increase in invasive species | | | | | | | | | | | | | | |
| Increase in temperature | | | | | | | | | | | | | | |
| Increased in extreme temperature events | | | | | | | | | | | | | | |

| Sectors | Agriculture | Forestry | Fisheries & Aquaculture | Energy | Tourism | Construction & Buildings | Transport | Waste | Health | Biodiversity | Coastal Zone Management | Soil | Water | Disaster & risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Increase in floods | | | | | | | | | | | | | | |
| Change to annual patterns of rainfall | | | | | | | | | | | | | | |
| Low water levels in lakes and rivers | | | | | | | | | | | | | | |
| Drought | | | | | | | | | | | | | | |
| Increase in coastal flooding | | | | | | | | | | | | | | |
| Coastal inundation | | | | | | | | | | | | | | |
| Saltwater intrusion | | | | | | | | | | | | | | |
| Coral bleaching | | | | | | | | | | | | | | |
| Increase in landslide/mudslide | | | | | | | | | | | | | | |
| Subsidence | | | | | | | | | | | | | | |
| Wildfire | | | | | | | | | | | | | | |
| Soil degradation influencing carbon storage capacity of soils | | | | | | | | | | | | | | |
| Increased water temperatures | | | | | | | | | | | | | | |

Notes: Colour coding of the cells in the risk matrix: Red – high risk, Orange – moderate risk, Olive – low risk, Green – opportunity, Grey – the risk is relevant to the sector however could not be assessed. Blank – impacts not relevant to the sector.

## French Guiana

**Table D.10 Climate impacts – French Guiana**

| Biophysical impacts | Comments |
|---|---|
| Increases in pests and disease | As regards human health, French Guiana is already exposed to several vector-borne diseases (yellow fever, dengue fever, malaria). Indeed, the local equatorial humid climate is favourable to several insect species known to be vectors for pathogens. An increase of temperature, in particular during the rainy season, could further contribute to the persistence and implantation to such vectors i.e. extension of vectors to new areas, circulation of disease all year round instead of periodic outbreaks, more intense epidemics (BRGM, 2011). For agriculture, a decrease in rainfall in certain periods could favour the |

| Biophysical impacts | Comments |
|---|---|
| | spread of pests. |
| Increase in invasive species | Continental tropical ecosystems are generally viewed as less vulnerable to biological invasions than island ones. In French Guiana, the number and abundance of naturalized alien plants in the relatively undisturbed tropical lowland rainforests and savannas remains very low.<br>There is potential for the increase in the area covered by drier vegetation types such as dry forests or savannas. This change could favour the spread of some invasive plant species, including the two fire-tolerant and fire promoting invasive species (Acacia mangium and Melaleuca quinquenervia) found in French Guiana. Such change would lead to a considerable decrease in biodiversity (IUCN, 2010) and increase the risk of invasive species (i.e. those better able to cope with the changed climate conditions). |
| Increase in temperatures | A rise in temperatures has already been measured at the scale of French Guiana by Meteo France: +0.28°C by decade over the period 1965-2009 (ONERC, 2010b). Higher temperatures would lead to higher demand for space cooling, and therefore higher energy demand. Higher temperatures may also lead to a decrease in tourism as tourists may choose other destinations if it becomes too hot (although the majority of tourism to French Guiana is related to the space industry or family tourism, therefore more resistant than purely recreational tourism). |
| Increase in extreme temperature events | A warmer dry season is expected in years to come in Eastern Amazonia (SRCAE Guyane, 2012). |
| Increased risk of flood due to increasing frequency of storms and extreme rainfall events | No information has been found on the frequency or severity of storms impacting French Guiana. Increased rainfall during the rainy seas could however increase risk of flooding. This could affect domestic and commercial buildings, as well as transport and health infrastructures. Flooding may also lead to human displacement and have negative health impacts due to contamination of water sources. There is an additional risk due to the significant amount of unplanned (illegal) building developments in French Guiana, which makes flood risk estimation and prevention much harder. |
| Change to annual patterns of rainfall (for example wetter winters but drier summers) | An increase in rainfall during rainy season as well as precipitation deficit during dry season is expected in years to come in Eastern Amazonia (SRCAE Guyane, 2012). This change in pattern could have implications for water supply and storage. In agriculture, some crops are sensitive to changes in rainfall (bananas, rice, vegetables) and may be at risk of reduced yields. Hydropower generation would also be affected (hydropower generation is a significant contributor to total power demand within French Guiana). |
| Low water levels in lakes and rivers (likely to be seasonal) | Since 1970, an increase of low-flow periods during dry season is observed on the Comté river (DIREN Guyane, 2010). This is likely to impact biodiversity and the quality of ecosystems, as well as the availability of water. This would also have impacts on transport for those villages/areas which rely on river transport (impacts were already observed in late 2012 and early 2013). |
| Drought | Water stress during drier period/longer dry seasons may lead to a change from forest ecosystems to savannah (BRGM, 2011). Drought will also affect the availability of water sources. Within agriculture, some crops are sensitive to changes in rainfall (bananas, rice, vegetables) and may be at risk. Droughts leading to decreased yields could result in increased need for agricultural land (to counterbalance declining productivity) which could lead to deforestation. Hydropower generation output would also be reduced (hydropower is a significant contributor to total generation within French Guiana). In transport, drought will decrease river levels and reduce the availability of river transport (this has already been observed in late 2012 and early 2013). |
| Increase in coastal flooding as a result of increased storm frequency and sea level rise | Because of its natural configuration, French Guiana coast could be particularly exposed to typical marine-related hazards and disasters such as erosion and storms provoking submersions (SRCAE Guyane, 2012). Projections on storm frequency and severity, and on regional patterns of sea level rise are however uncertain. Current estimates do however suggest an increasing risk of coastal flooding. Coastal flooding would negatively impact on all the population and buildings located on the coast, as well as any transport or health infrastructure located on the coast. The high level of illegal building developments in French Guiana make it harder to develop flood risk prevention planning, which increases the threat from this risk. |
| Coastal inundation (causing loss of | In French Guiana, sea level rise could be of 0.23m to 0.47 m by 2100 (SRCAE Guyane, |

| Biophysical impacts | Comments |
|---|---|
| habitable land and coastal squeeze) as a result of sea level rise | 2012). Note that the coastline in French Guiana has already a natural instability because currents and sedimentation processes in this region are under the influence of the Amazon estuary dynamics (BRGM, 2011). In addition, coastal erosion is observed. The coast line in French Guiana is unstable but the link with climate change (through currents, sedimentation processes, swells, etc.) is unclear. |
| Saltwater intrusion | Coastal rivers are facing saltwater intrusion issues (BRGM, 2007). These affect the availability of water resources (for domestic and agriculture needs). |
| Coral bleaching | There are no significant coral reefs in French Guiana. |
| Increased risk of landslide/mudslide | An increase in rainfalls during rainy season could increase the risks of landslides (BRGM, 2011). Landslide risk is a threat to all infrastructure (health, transport, buildings etc.) |
| Subsidence | Information has not been found relating to subsidence in French Guiana. |
| Wildfire | Longer dry seasons could lead to an increase in the occurrence of wildfires. Wildfires have been observed in recent year in Brazil but not yet in French Guiana (French Ministry of Environment, 2010) |
| Soil degradation influencing carbon storage capacity of soils | There is an identified possibility of more pronounced dry and wet season thus increasing soil erosion dynamics. |
| Increased water temperatures | Modifications in fish populations have been observed. Most of local fish species are already in the upper bound of their range of temperature tolerance. If water temperature increase continues, local species may move elsewhere (IFREMER, 2007). Similarly, in freshwater bodies, species will become stressed and ecosystems may degrade. |

**Table D.11 Sectoral vulnerability to climate change – French Guiana**

| Sectors | Vulnerability | Rationale |
|---|---|---|
| Agriculture | LOW | Agricultural sector in French Guiana can be seen as the least developed agricultural sector of all French ORs (French Ministry of the Interior181). It represents 0.3% of the territory (declared surfaces, ONERC, 2012).<br>Permanent grasslands represent 40% of arable land (ONERC, 2012).<br>In 2006, about 2.9% of active population work in this sector (French Senate182) a level below metropolitan France (3.4%). Natural conditions are not favourable to agriculture because of climate and very poor soils183.<br>It is considered that local production covers 15% of the population needs. |
| Forestry | MODERATE | French Guiana is equivalent in size to Portugal with 95% of the territory covered by forest (8 Mha, ONERC, 2012).<br>826 000 hectares are currently being exploited and produce about 70 000 m3 of logs a year. |

[181] http://www.outre-mer.gouv.fr/IMG/pdf/Etude_dvpt_agricole_-_CCTP.pdf
[182] http://www.senat.fr/rap/r08-519-1/r08-519-157.html
[183] http://www.sololiya.fr/nou_ka_ale/je_comprends/l_agriculture/1_la_situation_de_l_agriculture_en_guyane

| Sectors | Vulnerability | Rationale |
|---|---|---|
| | | Forestry is the 3rd productive sector after space sector and fisheries. It represents about 700 direct jobs. (Préfecture de Guyane184) Therefore the vulnerability is judged to be moderate for forestry. |
| Fisheries & Aquaculture | HIGH | Second productive sector after space sector. The port of Larivot is the third French fishing port (in value) (Prefecture de Guyane185) |
| Energy | MODERATE | The Energy sector represents only 2% of the value added of the economy (in 2007).<br>Share of renewable energy in the electricity consumption: 60% in 2011 (majority of biomass and hydroelectricity). Hydroelectricy represents 56% of the domestic production in 2010.<br>The distribution network is only developed along the coastline (from Saint-Laurent-du-Maroni to Cacao). Other areas far away from the coast are being powered by thermal power plant. Because of the increase of the population and of the equipment rate of households, the demand for power has been increasing and is expected to continue increasing. (IEDOM, 2012b)<br>The small size of the network makes it particularly vulnerable to the introduction of intermittent energy. The regional insularity contributes to the fragility of the network. French Guiana imports 75% of the energy it consumes: its dependency is high. The electric network is not stable. (SRCAE French Guiana 2012)<br>Investments have been undertaken by EDF to increase the capacity of power production (construction of new thermal power plants, dams etc.) |
| Tourism | LOW | The Tourism sector (accommodation and catering) represents only 2% of the value added of the economy (in 2007) and 5% of employees in 2010. It is mainly business sector, related to the spatial sector (and does not depend much on natural resources) and family tourism. Increase of cruise tourism. In 2009, French Guiana received 83,000 tourists (113,400 in 2007) (IEDOM, 2012b). |
| Construction & Buildings | HIGH | The Construction sector represents 9% of the value added of the economy (in 2007) (IEDOM, 2012b).<br>The sector is declining. It lost 6% of employees in 2010 compared to 2009. Buildings are located on the coastline and in the river borders.<br>Buildings located in lowland areas are vulnerable to sea level rise.<br>There is a high pressure on land due to illegal and spontaneous construction (in Cayenne for instance). In Matoury, the number of illegal constructions increased of 40 % between 1999 and 2003. It is estimated that 8,500 existing housing located along the coast (around 30,000 inhabitants) were illegal in 2003 (Sonia Fayman, 2006). The phenomenon of illegal construction makes the management and prevention of natural risks more difficult.<br>There is a deficit of buildings and the demand for housing is not satisfied. The number of insalubrious housing is high (around 10,000) and is still increasing (+ 10% per year). Around 15% of the population of French Guiana is considered to live in substandard housing (IEDOM, 2012b).<br>The high density of housing along the coast will have an impact on the availability of drinking water, on a context of sea level rise.<br>The risk of landslide and subsidence is mostly present in urban areas (coastline and Island of Cayenne) (BRGM, 2011). |
| Transport | MODERATE | The Transport sector represents only 4% of the value added of the economy (in 2007) (IEDOM, 2012b).<br>Transport by road: the main roads (450 km) are located along the coast (N1 and N2). The road network is interconnected. In Mana, two main roads are located in an area exposed to the risk of flooding.<br>Ports: there are 4 ports: Dégrad-des-Cannes, Vieux port de Cayenne, Kourou-Pariacabo and Saint-Laurent-du-Maroni.<br>Water transport: it is used to access to the inhabitants who live inland. The rivers should be accessible all year. |

184 http://www.guyane.pref.gouv.fr/la-filiere-foret-bois-de-guyane-contexte

185 http://www.guyane.pref.gouv.fr/rubrique/developpementcooperation/developpement-economique/filiere-peche

| Sectors | Vulnerability | Rationale |
|---|---|---|
| Waste | MODERATE | The annual average production of waste is 395 kg per inhabitant (the French average is 425 kg per inhab.). In French Guiana, 91% of the household waste is collected; but this rate decreases to 20% in some areas inside the territory.<br>Waste management is an issue in French Guiana. There are several non-compliant waste landfills. France was sentenced by the European Commission in 2007 because of these non-compliant landfills. At the beginning of 2011, six non-compliant landfills were still censed. The challenge for French Guiana is to improve its waste management to reduce the risks of contamination of soils and ground and surface water.<br>In terms of disposal and treatment, there are nine landfills operated "officially" by the local competent authorities and 3 which are authorised (Camopi, Cayenne and Saint-Laurent-du-Maroni). None of these sites does meet the current regulatory requirements. In total, around 110,000 tonnes of municipal waste and 25,000 tonnes of industrial waste raw are stored in a non-compliant form (Préfecture de Guyane186). |
| Health | HIGH | There is a lack of financial and human resources and health infrastructures. Infrastructures are located close to the coasts and in a few specific places. The equipment rate has decreased, exacerbated by an increase of the population. There are still malaria epidemics (with 1,600 cases in 2010). In 2004, 16% of the households had no access to drinking water (ONERC, 2012). |
| Biodiversity | HIGH | 96% of the territory is covered by forest. Very rich biodiversity. Biodiversity hotspot. For instance about 7000 plant species and 100 animal species found in French Guiana on IUCN red list.<br>High marine biodiversity (sea turtles, etc.) |
| Coastal Zone Management | MODERATE | The coastline is 350 km. French Guiana is not so vulnerable to coastal risks (related to storms and hurricanes), but vulnerable to sea level rise and more vulnerable given the degree of development along the coast. Mangroves (70,000 ha) ensure a role of protection against the coastal erosion (ONERC,2012).<br>Lowlands are areas located between 5 and 40 km along the coast. They could get flooded. More than 85% of the population lives on lowlands (between the regions of Cayenne and Saint-Laurent-du-Maroni) (BRGM, 2011). French Guiana faces coastal erosion due to the nearby Amazonia. The coasts are considered to be one of the most unstable coasts of the world. Nonetheless the vulnerability of the coastline to erosion is not well assessed except for Cayenne, Rémire-Montjoly and Awala Yalimapo (CETMEF 2012).<br>There is still a lack of knowledge and understanding of the coastal dynamic. This is certainly a barrier for the definition and implementation of coastal zone management strategy and plans (BRGM, 2011) |
| Soil | MODERATE | 96% of the territory is covered by forest. French Guianese rain forest has developed on some of the poorest soils in the world. Fertility of forest soils is low (Freycon et al, 2003). Coastal erosion is observed. The coast line in French Guiana is unstable but the link with climate change (through currents, sedimentation processes, swells, etc.) is unclear. It is expected that climate change will affect coastal dynamics. Regarding soil erosion, French Guiana is not on the path of cyclones and has landscapes with moderate relief. For these reasons, French Guiana is less prone to soil erosion risk than Réunion or Guadeloupe/Martinique for example. |
| Water | HIGH | French Guiana has very abundant water resources. With about 800,000 m3/cap/year of available freshwater, French Guiana is only surpassed by Alaska and Greenland whereas the value for metropolitan France is 4,000 m3/cap/year (SDAGE Guyane 2010-2015). However, the management of drinking water is a major issue in this region. Demographic growth is high (population is expected to double by 2030) and water consumption increase faster than population with the improvement of living standards (SDAGE Guyane 2010-2015). Some water infrastructures are reaching their capacity limit187. Water needs are unevenly |

[186] http://www.guyane.pref.gouv.fr/gestion-des-dechets-le-contexte-guyanais/
[187] http://www.eauguyane.fr/redevances/role-redevance-1.htm

| Sectors | Vulnerability | Rationale |
|---|---|---|
| | | distributed over the territory, most of the population being concentrated on the littoral area (Comité de Bassin de Guyane188). In addition, about 15% of the population lives in isolated areas and remains not connected to the drinking water supply system (BRGM, 2011). These populations are already confronted to waterborne diseases (Mansotte et al, 2010).<br><br>The fact that 95% of the water for human consumption is withdrawn from rivers makes this resource vulnerable to seasonal variability. During low-water season, salt from seawater can progress upstream up to water intake point thus making water unfit for human consumption (BRGM, 2011) |
| Disaster & risk | HIGH | Not so exposed to risks of hurricanes or wildfires, but exposed to risk of landslide/mudslide, flood, epidemics so some experience of managing risk/disaster.<br>70 % of the population is estimated to be exposed to risk of flood, landslide or coastal risks (e.g. coastal flooding). All local territories are exposed to the risk of flood (only rare exceptions). (BRGM, 2011).<br>At the end of 2012, beginning of 2013, French Guiana experiences a drought event, but this is not a frequent phenomenon. |

**Table D.12 Risks and opportunities resulting from climate change – French Guiana**

| Sectors | Agriculture | Forestry | Fisheries & Aquaculture | Energy | Tourism | Construction & Buildings | Transport | Waste | Health | Biodiversity | Coastal Zone Management | Soil | Water | Disaster & risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Increase in pests and diseases | | | | | | | | | | | | | | |
| Increase in invasive species | | | | | | | | | | | | | | |

188 http://www.bassin-guyane.fr/index.php?option=com_content&view=article&id=8&Itemid=14

| Sectors | Agriculture | Forestry | Fisheries & Aquaculture | Energy | Tourism | Construction & Buildings | Transport | Waste | Health | Biodiversity | Coastal Zone Management | Soil | Water | Disaster & risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |
| Increase in temperature | | | | | | | | | | | | | | |
| Increased in extreme temperature events | | | | | | | | | | | | | | |
| Increase in floods | | | | | | | | | | | | | | |
| Change to annual patterns of rainfall | | | | | | | | | | | | | | |
| Low water levels in lakes and rivers | | | | | | | | | | | | | | |
| Drought | | | | | | | | | | | | | | |
| Increase in coastal flooding as a result of increased storm frequency and sea level rise | | | | | | | | | | | | | | |
| Coastal inundation as a result of sea level rise | | | | | | | | | | | | | | |
| Saltwater intrusion | | | | | | | | | | | | | | |
| Coral bleaching | | | | | | | | | | | | | | |
| Increased risk of landslide/mudslide | | | | | | | | | | | | | | |
| Subsidence | | | | | | | | | | | | | | |
| Wildfire | | | | | | | | | | | | | | |
| Soil degradation influencing carbon storage capacity of soils | | | | | | | | | | | | | | |
| Increased water temperatures | | | | | | | | | | | | | | |

Notes: Colour coding of the cells in the risk matrix: Red – high risk, Orange – moderate risk, Olive – low risk, Green – opportunity, Grey – the risk is relevant to the sector however could not be assessed. Blank – impacts not relevant to the sector.

## La Réunion

**Table D.13 Climate impacts - La Réunion**

| Biophysical impact | Comments |
|---|---|
| Increases in pests and disease | Any change in temperature or rainfalls can contribute to the appearance of new pests or diseases although there is no evidence identified in the literature review that this is currently the case in la Réunion.<br>In the past years, efforts were made to diversify the agricultural productions. Fruits and vegetables production for local consumption has increased. Such crops are typically very sensitive to diseases and parasites, and thus more vulnerable to possible new climate change-related pests and diseases.<br>La Réunion is highly vulnerable to vector-borne diseases (in particular Chickungunya and dengue). Climate change will have an impact, but it remains difficult to specify its scale. |
| Increase in invasive species | No details have been identified for an increase of invasive species directly due to climate change but there is the potential for changes in migration routes of some species such as tuna (already observed in Pacific). Invasive species are considered to be the first cause of biodiversity loss in Réunion (although not currently linked to changes in climate) (IUCN, 2010).<br>An effect of climate change could be an increase of wildfires, which are favourable to the spread of invasive species. After forest fires, invasive species tend to recolonise instead of native species. Authorities have been obliged to set up specific plans to fight against invasive species growing on burnt areas. |
| Increase in temperatures | In la Réunion the temperature has increased by 0.62°C between 1969 and 2008 (Météo-France, 2009). Recent analyses taking into account data from years 2009 to 2011 showed a more pronounced trend with increases above 1° in some areas, over 40 years (ONERC, 2012). Higher temperatures may lead to increased demand for space cooling and therefore increased energy demand. If temperatures increase beyond the optimal comfort range, tourism may suffer as people choose to go elsewhere. |
| Increase in extreme temperature events | The share of "hot" days or nights has increased markedly (ONERC, 2012). Although there is currently no data on this, there is the potential for an increase in human deaths associated with extreme temperature events. |
| Increase in floods due to increasing frequency of storms and extreme rainfall events | The expected increase of extreme rainfall events will increase the risk of flood. The most exposed areas are ravines and areas on the coastline. It is estimated that 16% of the inhabitants are exposed to flooding (INSEE, 2009). Flooding leads to damage on buildings and construction, as well as on transport and health infrastructure In addition, increasing frequency of storms will have another impact on the energy sector, requirement wind farms to be built to withstand high winds. This is an additional significant cost and will impact negatively on the investment into new wind farm developments. |
| Change to annual patterns of rainfall (for example wetter winters but drier summers) | At the level of the Indian Ocean, changes between -2 and +20% of annual precipitation have been estimated, with a most important increase in the Northern part of the Indian Ocean. At the level of La Réunion: winters are becoming drier and there is an increase of the number of extreme weather events (IOC, 2011). For some decades, rainfalls have been increasing in the Eastern part of the Island and decreasing in the Western part. Changes in rainfall patterns will affect hydropower generation (several power stations had to close during the 2011 drought). |
| Low water levels in lakes and rivers (likely to be seasonal) | Droughts have an impact on the production of hydroelectricity. Several hydraulic power stations had to stop in 2011 because of the drought. This led to an overall decrease of the share of renewable energy in the island's electricity mix between 2010 and 2011. |
| Drought | Models predict that the west of the island will be drier. This is already the part of the island with the least rainfalls. Impacts on water availability for irrigation are expected (IOC, 2011). Drought will affect the availability of water resources and may lead to competition between domestic, tourism and agriculture sectors for water. In addition drought will impact the energy sector as it will affect hydropower generation (this has already been observed: during a drought event in 2011 several power stations had to close). |
| Increase in coastal flooding as a result of increased storm frequency and sea | Coastal flooding is one of the main existing risks La Réunion tackles (French Ministry of Environment, 2011a). Around 80% of the population lives on the coastline. Most of the main cities and economic centres are located on the coastline. Models estimate an |

| Biophysical impact | Comments |
|---|---|
| level rise | increase in coastal flooding in the future. Construction and buildings have already been damaged by extreme weather events and the consequent coastal flooding (e.g. Hurricane GAMEDE in 2007). The coastal hazard was introduced for the first time in the Plan for natural risk prevention in 2011. |
| Coastal inundation (causing loss of habitable land and coastal squeeze) as a result of sea level rise | Most of the roads are located on the coastline, as are the majority of cities and other infrastructure (e.g. health infrastructure). These will all be affected by the expected increase in coastal inundation (IRD La Réunion). However, given the slower timescales of inundation (compared to coastal flooding), it may be possible to take adaptive action and relocated some of the infrastructures away from risk areas. |
| Saltwater intrusion | Salinisation of aquifers is observed in the west of the island. About 25% of the water withdrawn is taken from coastal aquifers. This has the potential to impact water availability for agriculture and human use (domestic, tourism) (BRGM, 2011b). |
| Coral bleaching | Coral bleaching has been observed in the past decade. (in 2001, 2003, 2004 and 2005) (IUCN, 2010). Loss of coral reefs would lead to a significant loss of biodiversity. In addition, the natural coastal defence function of reefs would be lost, which would render coastlines (population and infrastructure) at greater risk of flooding. |
| Increase of landslides/mudslides | Cirque (features associated with volcanic activity) are areas where the risk of landslide is high (BRGM, 2006). |
| Subsidence | No information has been identified in the literature relating to subsidence on La Réunion. |
| Wildfires | There are, on average, around 20 fire outbreaks a year in La Réunion. It is expected that an indirect effect of climate change could be an increase of wildfires. The most exposed areas are forest in the highlands in the western part of the island. An increase in the occurrence of wildfires would threaten biodiversity. Human health and infrastructure (roads, buildings) are considered to be at low risk from wildfires since they are located away from natural areas most likely to suffer from wildfires. |
| Soil degradation influencing carbon storage capacity of soils | Erosion is a very intense process in la Réunion. This is due the combination of various factors: humid tropical climate, the mountainous relief with steep inclines and active volcanism. The context of demographic growth and insularity further accentuates the pressure on soil resources.<br>An increase of the number of extreme weather events could further accentuate the erosion process. |
| Increased water temperatures | There is an observed trend toward increasing temperatures of surface water. Warmer water temperatures lead to coral bleaching. Major coral bleaching events were recorded in 1998, 2001, 2003 and 2004 coincided with periods of high water temperatures (Réserve Naturelle Marine de la Réunion, 2012). Loss of coral reefs due to bleaching will lead to loss of biodiversity and loss of coral reefs natural coastal protection function. Warmer water temperatures may also lead to the loss of some fish species. |

**Table D.14 Sectoral vulnerability to climate change – La Réunion**

| Sectors | Vulnerability | Rationale |
|---|---|---|
| Agriculture | MODERATE | Agriculture occupies about 18% of the surface of La Réunion (ONERC, 2012). Sugar cane occupies more than 50% of the agricultural surface and is the major production. Secondary productions are fruits, vegetables and livestock (chickens, pigs) (ONERC, 2012) Agriculture remains an important sector with about 10 % of active population involved in the sector (French Ministry of Environment, 2010). Number of jobs linked to agriculture is estimated to be 15,000 (Chambre d'Agriculture de la Réunion189). There is a strategic plan to diversity agricultural production and to increase the share of local production in the food consumption of the island. To date, the self-sufficiency rate for fruits and vegetables |

[189] http://www.Réunion.chambagri.fr/spip.php?rubrique55

| Sectors | Vulnerability | Rationale |
|---|---|---|
| | | is 80% (ONERC, 2012). Vulnerability is limited by the fact that a majority of production for local consumption could be replaced with imported goods (IOC, 2011) but the current strategy is focussed towards diversification of production and increasing of self-sufficiency (SRCAE La Réunion) |
| Forestry | LOW | Forest covers more than 50% of the island territory (137 000 ha). About 3,500 ha are exploited. 4.900 $m^3$ of logs were produced in 2008 (Direction de l'Alimentation, de l'Agriculture et de la Forêt de La Réunion[190]). |
| Fisheries & Aquaculture | LOW | There are several types of fisheries in Réunion. With on one side traditional fishing along the coast and large-scale industrial fishing operating in the Kerguelen area and using Réunion as a support base. In total there are about 900 fishermen in la Réunion. This sector has experienced growth in past few years and is now slowing down. |
| Energy | HIGH | Electricity production is based on a mixed infrastructure combining thermal, hydro and renewable energy resource. The resource being most exposed to the impacts of climate change is hydraulics. It is already vulnerable to drought. In 2011, the production of electricity from hydraulics decreased by around -26% compared to 2010 (IDEOM La Réunion 2011). The demand for energy is highly increasing. The electricity network is improperly sized.<br>The key issues are the ability of the island to control the increasing demand for energy and the vulnerability of the distribution network to hurricanes. The energy sector is acknowledged to be less sensitive to impacts of climate change and with a good capacity to adapt compared to the other sectors. The infrastructure network for energy distribution is composed by air network (58.8%) and underground/ submarine network (41.2%). This represents about 1 500km of high voltage lines that are vulnerable to cyclones.<br>It is vulnerable to climate change and extreme weather events (SRCAE La Réunion). The particular cyclonic context leads to the need to install large power turbines that can support strong winds. The additional costs of investment and operation limit investment in wind energy on the island despite significant potential on the coast.<br>Uncertainties on the impact of climate change on energy resources are still too important to make predictions (SRCAE La Réunion). |
| Tourism | MODERATE | The main type of tourism is family tourism (around 45% of arrivals in 2011) (IDEOM La Réunion 2011). This allows the tourism sector to resist to crisis (e.g. Chikungunya crisis). La Réunion is diversifying its offers by valuing its natural resources (volcanoes and forests) (ONERC, 2012). The tourism sector is acknowledged to be a sensitive sector to impacts of climate change and with a low capacity to adapt (SRCAE La Réunion). The risk of an increase of epidemics related to vector-borne diseases (Chikungunya) is the main concern. |
| Construction & Buildings | MODERATE | In the case of some specific areas (e.g. from Sainte-Suzanne to Saint-Benoit, South-West), there are urban areas located close to the coast. Coastal erosion threatens construction and buildings in these areas. |
| Transport | HIGH | The transport sector is acknowledged to be a sensitive sector to impacts of climate change and with a low capacity to adapt. Transport by roads is at the heart of economic activity on the island. The network consists in several main roads that are located on the coastline. It is exposed to cyclones and heavy rainfall events, blocking rafts and triggering landslides. Although new infrastructures are being developed, areas around cirque (remains of volcanic crater) remain particularly vulnerable (SRCAE La Réunion). |

[190] http://daaf974.agriculture.gouv.fr/La-filiere-foret-bois

| Sectors | Vulnerability | Rationale |
|---|---|---|
| Waste | LOW | Around 85% of household and similar waste is buried (in 2006). Waste storage centres are saturated. Part of the waste is exported for its recycling and reuse due to the insularity of the territory. There is a lack of infrastructures to store, recycle and reuse waste. An increase of waste is expected due to the increase of the number of inhabitants and the increase of consumption (DIREN Réunion, 2006). The sector is facing difficulties and limitations, but it is not particularly vulnerable to climate change. |
| Health | MODERATE | La Réunion benefits from a good health system (the best of the French OR). The island had 11 public and 17 private health facilities in 2010. In 2011, the coverage by health professionals was around 1 in 75 people which increased at a rate higher than the population growth. Indicators of the health system are close to the European indicators (ONERC, 2012). La Réunion is highly vulnerable to vector-borne diseases (in particular Chickungunya and dengue). About heat waves, the use of air conditioning systems is spreading (decreasing the vulnerability). The vulnerability remains high as concerns the potential contamination of water systems due to heat waves. The creation of the Research and observation Centre on emerging diseases for the Indian ocean (CRVOI) increases the capacity of adaptation (and decreases the vulnerability). |
| Biodiversity | HIGH | The Réunion has rugged landscape and extreme climatic variations which have resulted in a great diversity of habitats. Depending on the altitude and orientation of the hillsides, there are savannahs, semi-arid forests, swampy thickets, high altitude rainforests and mountain forests in Tamarin. Close to 200 natural environments have been documented. |
| Coastal Zone Management | MODERATE | Exposed to coastal risks. 15% of habitat buildings are vulnerable. Several studies were undertaken by BRGM between 2004 and 2009 to identify the areas of coastal erosion and assess the changes. The study of the coastal erosion risk was made for the whole territory. Several studies were undertaken to assess the risk of coastal inundation, but not for the whole island. (CETMEF 2012).<br>In the case of some specific areas (e.g. from Sainte Suzanne to Saint Benoit, South-West), there are urban areas located close to the coast. Coastal erosion threatens construction and buildings. In some areas, coastal erosion has already led to damage on houses or the disappearance of beaches. Some other areas are exposed to the risk of coastal erosion but are less vulnerable because they are not urban areas (e.g. La Fournaise). |
| Soil | HIGH | There is a number of distinct types of soils in la Réunion resulting from interactions between past and recent volcanic activity, climate and topography. Precipitations and the presence of a basaltic bed-rock is favourable to the formation of "andosols". Andosols have a relatively low fertility (DIREN Réunion, 2006). Most of the fruits, vegetables and sugar cane are cultivated on this type of soil (MVAD191).<br>Erosion is a very intense process in la Réunion. This is due the combination of various factors: humid tropical climate, the mountainous relief with steep inclines and active volcanism. It is estimated that the average erosion at island's level is 3 cm per century, which means that erosion can be much more important than this in some specific areas. (BRGM, 2002).<br>The context of demographic growth and insularity further accentuates the pressure on soil resources. Artificial land covers 10% of the territory (French Ministry of Agriculture, 2012). |
| Water | MODERATE | Water resources are abundant in la Réunion but unevenly distributed between the south and west coasts that are dry and the windward east coast (and to a lesser extent North coast) that experiences high rainfalls (world records in this area) (IOC, 2011; SDAGE Réunion). On the highly populated west coast, water consumption is higher than what local resources can provide (ONERC, 2012).<br>Demographic growth is high in la Réunion and demand for water is increasing. It must be underlined that la Réunion already has water consumption per capita that is a lot higher than France's average (IOC, 2011; SDAGE Réunion).<br>La Réunion relies too much on the catchment of superficial waters (rather than ground waters) whose availability can be variable. 62% of the drinking water is withdrawn from superficial waters (ACCLIMATE). Water storage infrastructures do not have enough capacity to prevent water in the event of resource unavailability. (SDAGE Réunion). The supply system is ageing with an estimated 44% of leakage. (IOC, 2011; SDAGE Réunion) |

[191] http://www.mvad-Réunion.org/-Guide-de-la-Fertilisation-

| Sectors | Vulnerability | Rationale |
|---|---|---|
| Disaster & risk | MODERATE | La Réunion is highly exposed to natural risks. Climate change impacts potentially increase the magnitude and the occurrence of natural risks. Around 16% of the inhabitants are exposed to the risk of flooding for instance (INSEE, 2009) The culture of risks is well developed within the population in particular for risks of hurricanes. This increases the vulnerability of the territory. However, the vulnerability is modest rather than high, because the territory has already experience in disaster management. Flooding and landslide risks are already monitored and covered by plans to prevent from risks (SRCAE La Réunion 2012) |

**Table D.15 Risks and opportunities resulting from climate change – La Réunion**

| Sectors | Agriculture | Forestry | Fisheries & Aquaculture | Energy | Tourism | Construction & Buildings | Transport | Waste | Health | Biodiversity | Coastal Zone Management | Soil | Water | Disaster & risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Increase in pests and diseases | | | | | | | | | | | | | | |
| Increase in invasive species | | | | | | | | | | | | | | |
| Increase in temperature | | | | | | | | | | | | | | |
| Increased in extreme temperature events | | | | | | | | | | | | | | |
| Increase in floods | | | | | | | | | | | | | | |
| Change to annual patterns of rainfall | | | | | | | | | | | | | | |
| Low water levels in lakes and rivers | | | | | | | | | | | | | | |
| Drought | | | | | | | | | | | | | | |
| Increase in coastal flooding | | | | | | | | | | | | | | |
| Coastal inundation as a result of sea level rise | | | | | | | | | | | | | | |
| Saltwater intrusion | | | | | | | | | | | | | | |
| Coral bleaching | | | | | | | | | | | | | | |
| Increased risk of landslide/mudslide | | | | | | | | | | | | | | |
| Subsidence | | | | | | | | | | | | | | |
| Wildfire | | | | | | | | | | | | | | |
| Soil degradation influencing carbon storage capacity of soils | | | | | | | | | | | | | | |
| Increased water temperatures | | | | | | | | | | | | | | |

Notes: Colour coding of the cells in the risk matrix: Red – high risk, Orange – moderate risk, Olive – low risk, Green – opportunity, Grey – the risk is relevant to the sector however could not be assessed. Blank – impacts not relevant to the sector.

## Canary Islands

**Table D.16 Climate impacts – Canary Islands**

| Biophysical impacts | Comments |
|---|---|
| Increases in pests and disease | In recent years, there have been several cases of new human diseases not previously recorded in the Canary Islands (e.g. "rickettsiosis" or "ciguatera" cases), although more research needs to be done on the likelihood of them becoming endemic in the Islands (ClimaImpacto, 2012). It has also been documented that climate change could facilitate the spread of tropical diseases in the Canary Islands, especially insect-vector borne diseases (e.g. Dengue, West Nile, Malaria etc.) (ClimaImpacto, 2012). In addition, events of algae blooms which can be toxic to marine species (Ramos et al., 2005) and pests affecting crops (e.g. African locust crickets in 2004) have been recently documented (Canary islands Government, 2010) as a potential result of increased sea and air temperatures. |
| Increase in invasive species | Invasive alien species are particularly problematic in insular ecosystems and climate change could facilitate their introduction, naturalization and/ or expansion. These species can be introduced either through international trade or by natural processes (e.g. marine migration) (Canary Islands Government, 2010). In particular, the presence of many species of African and tropical origin adapted to warmer conditions (e.g. Saharan birds, tropical fish), to the detriment of indigenous species, has been documented in the region (IUCN, 2008). Climate change has also been identified as one of the causes that has facilitated the naturalization and subsequent invasion of the natural ecosystems of plant exotic species, which had been, until now, restricted to gardens and greenhouses (Martín Esquivel, 2010).<br>The impacts of invasive alien species on the rich biodiversity of the region are assessed as high. In particular, it has been reported that invasive species negatively affect 73% of the top 100 endangered and priority species for conservation in the archipelago (Silva, L et al. 2008). |
| Increase in temperatures | Climate scenarios (IPCC, 2007) predict a 1.9 -2.4°C increase in annual temperatures by the end of the century.<br>There is a high level of confidence that temperatures have increased in the Canary Islands in recent decades. Martin et al., (2012) reports that measurements in Tenerife and Gran Canaria show that average temperature has increased almost one tenth (+0.09°C) per decade since the mid 1940's. This trend has been more significant since the 1970's, with an increase of almost +0.17°C per decade in both islands. In the island of La Palma temperatures have increased on average +0.3°C per decade between 1970 and 2000 (Martín Esquivel, 2012). Warmer temperatures may have some positive impacts, such as increasing the length of the tourist season (around summer), and in the energy sector the potential for solar PV. |
| Increase in extreme temperature events (particularly associated with heat wave) | There is evidence that that the number of heat waves occurred in the Canary Islands between 1916 and 2006 increased significantly after 1994 (Martín Esquivel, 2012).<br>Measurements in the period 1947 - 2007 in the Canary Islands reveal that of a total of 41 heat waves recorded, 12 have taken place in the last five years of the period, and 4 of them in 2007 (ClimaImpacto, 2012).<br>In addition, it has been recorded that these heat waves last longer and have become more persistent, increasing the risk of affecting human health. In this sense, in the 21st century, heat waves have already accounted for more deaths than any other meteorological phenomenon in the Canary Islands (specifically, 16 victims in 2004 and 2006 episodes) (ClimaImpacto). However, it is important to note that the use of air conditioning systems is high (decreasing the intensity of the impact).<br>In connection with heat waves, it is important to mention that an increase in the intensity and frequency of episodes of Saharan air intrusion during the period 1958-2006 has been documented (Martín Esquivel, 2012). Warm bodies of air carrying dust particles from Africa are favoured by increased temperatures and a drop in the strength of the north-easterly trade winds. The presence of Saharan dust in suspension has important health implications for the population (i.e. allergies, respiratory illnesses) and can also cause disruptions to air transport. |

| Biophysical impacts | Comments |
|---|---|
| Increased risk of flood due to increasing frequency of storms and extreme rainfall events | There is a high level of confidence that rainfall in the Canaries has been occurring in shorter, more intense episodes in fewer days, during the period 1970-2010, (Tarife et al., 2012).<br>In addition, studies and predictions regarding the path of tropical storms in the North Atlantic show a shift towards the centre of the North Atlantic (Zhao et al., 2009), suggesting that these storms more frequently reach the Macaronesia region. While the Canaries are not located in the potential path of these Atlantic tropical and sub tropical storms, the collateral effects of nearby storms can cause significant damage (e.g. Delta storm in 2005) (Martín Esquivel, 2010; Consultation with representative of the OR).<br>Heavier rainfall events in combination with the mountainous landscape and complex topography of the archipelago have the potential to cause significant damage to urban settlements and infrastructure, which are frequently located in areas at risk of flood (Canary Islands Government, 2010). Events such as the one in March 2002 in Santa Cruz de Tenerife destroyed infrastructure and caused serious damage to various properties (ClimaImpacto, 2012). During the period 1995-2005 flooding events caused 13 deaths in the Canary Islands (Arranz Lozano, 2006). |
| Change to annual patterns of rainfall (for example wetter winters but drier summers) | Available data (Martín Esquivel, 2012) suggest that autumn precipitation has decreased in the Canary Islands. In this sense, November precipitations in Tenerife and Gran Canaria experienced a significant decrease of -5.5mm per decade since the mid 40's. Regarding winter, while there is evidence that precipitation in January tends to decrease, it is not so clear regarding the months of February and March (Martín Esquivel, 2012). A decrease in rainfall amounts during the autumn and winter seasons has the potential to impact the availability of water resources and the water reserve of forest soils, making it difficult to overcome summer drought episodes (Canary Islands Government, 2009a). |
| Low water levels in lakes and rivers (likely to be seasonal) | A decreasing trend in average precipitation has been documented for the Canary Islands, especially on the windward side of the islands of Tenerife and Gran Canaria (Martín Esquivel, 2012).<br>It has been documented that decreased rainfall levels together with increased temperatures result in a reduction in the natural recharge of groundwater systems of the archipelago (Braojos Ruíz et al, 2006). However, freshwater surface resources are not of relevance in the water system of the archipelago mainly due to the high permeability of soils (Canary Islands Government, 2010). Therefore the impacts of climate change on surface runoff and inland water bodies have not been considered to be of significance (Braojos Ruíz et al, 2006). |
| Drought | The climate of the Canary Islands is characterised by high annual variability in precipitation levels (i.e. succession of wet (or very wet) years and dry (or very dry) years) influenced by the Azores Anticyclone (Canary Islands Government, 2010). Periods of drought are frequent in the region and have been documented in all the islands (Olcina J., 2001). However, more persistent periods of drought are to be expected as a result of warmer and dryer conditions in the archipelago (Canary Islands Government, 2010; consultation with a representative of the OR). |
| Increase in coastal flooding as a result of increased storm frequency and sea level rise | Measurements during the period 1949-2001 in Santa Cruz de la Palma, Gran Canaria and Arrecife suggest that there is a positive trend of sea level rise of around +0.39mm/year (Tel & Garcia, 2012). It has also been observed that the frequency of sea storms in the Northern part of the islands is increasing and, as a consequence, the intensity of waves (GIOC (TRAMA SL), 2005).<br>Other changes in marine dynamics, such as a change in the direction of waves, have also been documented for the Canary Islands in a study carried out by the University of Cantabria on the impacts of climate change in the coast of Spain (Losada I., 2008). This study highlights that the archipelago is likely to be exposed to increased coastal erosion and flooding episodes, as well as to major changes in the rebase and stability of defensive marine works (e.g. dykes) and other seafront property and infrastructure.<br>Additionally, in coastal areas, which are densely populated, there is evidence of serious flood and infrastructure damage, due to deficiencies in drainage systems and lack of suitable drainage networks (ClimaImpacto, 2012).<br>Nonetheless, it should be noted that the coastline is rugged and rocky, with cliff formations making up 78% of the coastline. However, Las Palmas de Gran Canaria, the largest city in the Canary Islands, is on the coast and has been highlighted as being at particular risk (source: consultation with OR representative). |

| Biophysical impacts | Comments |
|---|---|
| Coastal inundation (causing loss of habitable land and coastal squeeze) as a result of sea level rise | Available projections suggest that wave heights (with a 50 years return period) are likely to increase in the archipelago's coast. It is expected that this increase will result, in low coastal areas (small slopes) adjacent to the beaches, in tens of metres of coastal inundation ( Losada I., 2008).<br>Beaches are also at risk of shoreline erosion and retreat as a result of sea level rise. The projected retreat in the archipelago could reach up to 15 meters in the northern coast (Canary Islands Government, 2010). Southern beaches in the Canary Islands would also be additionally affected by a variation in the direction of the incidence of waves. In these areas, the retreat could reach a maximum of up to 50 m in some beaches by the middle of the century (Canary Islands Government, 2010; Losada I., 2008).<br>The largest city in the archipelago, Las Palmas de Gran Canaria, is on the coast and has been highlighted as being at particular risk of coastal inundation (source: consultation with OR representative). |
| Saltwater intrusion | All of the islands of the archipelago, to varying degrees, have salinity problems in some of their groundwater bodies (ClimaImpacto, 2012) due to overexploitation of the aquifers. This is likely to be accentuated by climate change. A lower volume of water would affect overall water quality and decrease groundwater levels in aquifers, which in coastal areas would facilitate seawater intrusion. This phenomenon is likely to be enhanced by sea level-rise (ClimaImpacto, 2012). Saltwater intrusion into aquifers would affect the availability of water resources for domestic and tourist consumption. |
| Coral bleaching | Deep water corals (e.g. *Lophelia pertusa*) are unique habitats present in the Macaronesia region, very sensitive to ocean acidification and increased temperatures (IUCN, 2008). Deep-water corals have particular value in terms of biodiversity, providing habitats and feeding grounds for a range of species, including commercial fish species (UNEP, 2004). However, according to the literature (UNEP, 2004), the cold- water corals do not have coastal protection role as is the case with the warm-water corals. While the impacts of climate change on deep water corals are still being investigated, it is believed that "climate change could cause changes in the current systems and affect food supply in deeper waters" (UNEP, 2004).<br>Damage to coral reefs may have negative effects on the fishing sector in addition to the loss of marine biodiversity of the archipelago. Damage or loss of corals may also affect the tourism sector, making the Canary Islands a less attractive tourist destination. However, there is limited evidence for this at present. |
| Increased risk of landslide/mudslide | Landslide episodes in the region mainly originate from precipitation events (either from heavy rainfall over short periods of time or from rainfall less intense but of longer duration), are generally associated with flooding events and may cause significant damage to infrastructure and urban settlements (Canary Islands Government, 2010). During the period 1995-2005 landslide events caused 6 deaths in the Canary Islands (Arranz Lozano, 2006).<br>More extreme precipitation events (Martín Esquivel, 2012) may increase the risk of landslides events in the region. |
| Subsidence | As concerns this impact, no information has been identified in the literature. |
| Wildfire | Available data show that the number of fires has increased between 1970 and 2007 at a rate of 20 outbreaks per decade in the archipelago (Martín Esquivel, 2012). In this sense, wildfires are likely to be more frequent with increased temperatures, prolonged periods of drought and greater water stress. In particular, it has been documented that the probability of fire is four times higher under heat wave conditions than under normal north-trade wind conditions (Dorta et al., 1991). An increase in the occurrence of wildfires would have a negative impact on human health, as well as threatening buildings and infrastructure and potentially impacting negatively on the tourism sector. |
| Soil degradation influencing carbon storage capacity of soils | The soils of the archipelago are already significantly affected by desertification and erosion processes. It has been documented that an increase in extreme climatic events or natural disasters (e.g. floods or wildfires) as a result of climate change would potentially increase the risk of soil erosion and desertification (Canary Islands Government, 2010). |

| Biophysical impacts | Comments |
|---|---|
| Increased water temperatures | Martín et al. (2012), reports that sea temperature in the centre and western part of the Canaries has increased almost one tenth per decade between 1948 and 2010. This trend has been more significant since the 70's, with an increase of almost +0.28°C per decade. Available data also suggest a long term trend towards the acidification of the ocean (Santana-Casiano et al. 2007). Warmer water temperatures are a threat to coral reefs (as warmer water temperatures cause coral bleaching) and so may lead to a loss of biodiversity. In the fisheries sector however, water waters may present new opportunities, as new species suitable for fishing may occur. |

**Table D.17 Sectoral vulnerability to climate change - Canary Islands**

| Sectors | Vulnerability | Rationale |
|---|---|---|
| Agriculture | MODERATE | The primary sector, of which agriculture is the main activity, only represented about 1% in terms of GVA and 3% in terms of employment in 2011 (Confederación Canaria de Empresarios, 2012)). While not a major producer and contributor to regional economy, agriculture is important in terms of local identity and exports (banana and tomatoes mainly). It also supports a range of other sectors (agro-food industry) and plays a major environmental and social role in rural areas (Canary Islands Government, 2010). These represent approximately 67.07% of the region's territory and account for 16.44% of its population (Canary Islands Government, 2012b). Due to the way agricultural production is set up in these areas e.g. small plots of arable land and high dependence on irrigation, the sector will be particularly vulnerable to the impacts of climate change (e.g. pests, hydrological stress, etc.). |
| Forestry | LOW | Although 75%% of the territory is classified as forest area (Canary Islands Government, 2010), the forestry sector plays a marginal role in the economy of the Canary Islands. The main timber resource is the Canary Pine (Pinus Canariensis) but only in the island of Tenerife there is a market of a certain dimension (Foresmac, 2011). Despite its insignificant weight in economic terms, forests have a major ecological importance (e.g. water collection properties, carbon sink,). In addition, the Laurel forest is an ancient forest unique to the Macaronesian region. Overall, forestry in Canary Islands seems highly vulnerable from an ecological point of view; rather than as an economic sector (that is forestry products). |
| Fisheries & Aquaculture | MODERATE | The contribution of the fishing sector in the archipelago's economy is relatively small as it only represents about 0.7% of regional GVA (Canary Islands Government, 2010). However it has been historically relevant in coastal areas, as cultural identity and as tourist activity (recreational). The fishing activity can be classified into two major groups: a) developed in the archipelago's waters with a traditional character and b) developed in African waters with an industrial character (Litomac, 2011). Currently, the fishery production is being progressively substituted by aquaculture (Canary Islands Government, 2009). Aquaculture is a rising economic activity and might become a sector of importance moving forward, but it is vulnerable to climate change impacts such as rising water temperatures and the appearance of invasive species from tropical regions (IUCN, 2008). Additionally, climate change may affect the distribution of migratory species such as tuna or sardines currently of great importance to the island's fisheries economy (Canary Islands Government, 2010). |
| Energy | HIGH | The energy sector is characterised by the isolated and small size of the energy systems, dependence on external sources of energy: oil and its derivatives provided 99.13% of the primary energy while renewable energy only provided 0.87% of this energy in 2007 (European Commission, DG Regional Policy, 2011). Other characteristics are the strong relationship with the water industry (desalination is energy intense) and the existence of favourable conditions for the exploitation of renewable energy sources (Canary Islands Government, 2009).<br>The electricity network is disconnected from the European grid and each island has an independent electrical grid (with the exception of the interconnection between Fuerteventura and Lanzarote). These factors increase the cost and the uncertainty of electricity generation. High energy dependency on imports, isolated grid systems and concentration of energy infrastructure along the coast (92% of the total (Litomac, 2011)) |

| Sectors | Vulnerability | Rationale |
|---|---|---|
| | | make the energy sector highly vulnerable to the impacts of climate change. |
| Tourism | HIGH | The tertiary sector, of which tourism is the main sector, represented about 80% of region's GVA in 2011 (Confederación Canaria de Empresarios, 2012). Tourism has become the key sector of the regional economy, and with more than 10 million tourists, the archipelago has become the fourth destination of international tourism in Spain (ClimaImpacto, 2012). Due to its direct connection to the environment and climate, tourism is considered a sensitive sector to changes in climate. Tourism is also vulnerable to climate impacts related to the availability of water and energy resources. Also the fact that most of the tourism infrastructure is located along the coastline (75% of economic touristic activity (Litomac, 2011)) increases the vulnerability to climate change impacts such as coastal flooding. Beach erosion could be of special concern in the Eastern islands of Lanzarote and Fuerteventura.<br>Consultation with a representative of the OR has highlighted that an important risk indirectly affecting the touristic activity in the archipelago is the geographic redistribution of tourism in favour of destinations in northern latitudes and mountain areas, which would diminish the current tourist attraction of the Canary Islands. Conversely, a possible benefit would be the expansion of the spring and autumn seasons (opportunity). |
| Construction & Buildings | HIGH | With about 2 million inhabitants, the Canary Islands are the most populated OR (IUCN, 2008). Due to steep mountainous landscapes, urban areas with high population densities are predominantly coastal, especially in the two main islands, where the degree of urbanisation of the coast is 29% for Gran Canaria and 33% for Tenerife (Canary Islands Government, 2010). While it should be noted that in the Canaries this generally refers to a range between 0 and 700 m altitude from sea level, there are specific areas in Las Palmas de Gran Canaria, Lanzarote and Fuerteventura that could be directly affected by sea-level elevation. The specific case of the city of Las Palmas de Gran Canaria is important because it is the largest urban agglomeration in the Canary Islands and part of it is built on a sandy isthmus, almost at sea level. Urban settlements are also located in areas of steep slopes or near ravines at risk of flood or landslides in heavy rain situations (Canary Islands Government, 2010).<br>In addition, it is important to note that until the recent economic crisis, the construction sector played a significant role in the growth of the economy of the Islands, developing fast in the last decade (data from 2008 indicate that 21% of total residential buildings (housing) were approved in the period 2002-2008, (Canary Islands Government, 2009c). While this sector has been significantly affected by the recent economic crisis the need to adapt buildings to warmer conditions may boost the economic construction activity. |
| Transport | HIGH | Transport is a crucial sector in the Canary Islands, due to its dual insularity (archipelago) and its remoteness from the European mainland. While the aviation sector, with 6 international airports, plays a major role in the tourist activity, the maritime sector is crucial for the exportation of agricultural products and the importation of food and other goods. With about 40 seaports in the islands, artificial coast represents 6% of the total archipelago's coastline (Canary Islands Government, 2010). In addition, due to high population and urban dispersion in each of the islands, there is a huge demand for mobility between and within the islands, which results in an intensive use of private vehicles with an estimated 1.12 million vehicles and 3.5 million daily trips (Canary Islands Government, 2010). Transport infrastructures especially near the coast, are likely to be affected by climate change impacts such as increased frequency of extreme rainfall and significant wind events. |
| Waste | MODERATE | The small and remote character of terminal waste areas within the production chain of waste, coupled with the high cost of energy and transport may increase the difficulties for the disposal and treatment of certain waste. Climate change may put additional pressure on the waste sector during clean-up and recovery of waste resulting from increased frequency of events such as floods, landslides, inundations, wildfires etc. Additionally waste infrastructure may be damaged by these impacts. However it should be noted that this is speculation as there is not sufficient information in the literature to evaluate the impacts of climate change in the waste sector. |

| Sectors | Vulnerability | Rationale |
|---|---|---|
| Health | MODERATE | Increased temperatures and dryer conditions in the archipelago could accentuate the severity and frequency of extreme events affecting human health (heat waves, episodes of Saharan air intrusion wildfires, storms etc.). Warming could also favour the spread of tropical vector borne diseases, especially if there is an increase of uncontrolled immigration from Africa due to adverse climate conditions. Additionally, urban areas are concentrated along the coastal line and close to ravines which increases their vulnerability to certain extreme weather events (Canary Islands Government, 2010).<br>However, it is important to note that the public health service is equivalent to the mainland Europe, with the facilities of equivalent standard to the EU (I.e. number of hospital beds) (European Commission, DG Regional Policy, 2012b). There is at least one hospital in each of the islands. In recent years there has have significant investment in the health services and infrastructure in the Canaries under the Regional Plan of Health Service Infrastructure 2005-2010. |
| Biodiversity | HIGH | The Canary Islands have been designated as a biodiversity hot-spot; a region where a large number of endemic species are subject to anthropogenic threats, mainly the destruction of habitats and the introduction of exotic species. In the archipelago, 21% of plants, 100% of reptiles and 39% of invertebrates are endemic species (IUCN, 2008), which are very sensitive to climate changes. In addition, the Canary Islands are home to the Laurel forest, a forest unique to the Macaronesian region which has been identified as a conservation priority (IUCN, 2008). Marine ecosystems such as the Meadows of the seagrass *Cymodocea nodosa* also hold high levels of biodiversity (Canary Islands Government, 2010).<br>Overall, biodiversity in the Canaries is especially vulnerable to climate change due to the small size of the ecosystems (insularity limits migration), its high level of endemism and the pressure of human induced-activities (high population density, fragmentation of land, fishing activities) which reduces significantly its resilience to a change in climate conditions. |
| Coastal Zone Management | HIGH | It has been documented that climate change will potentially affect the coast and marine ecosystems of the Canaries, which are already under high tourist and urban pressure (Canary Islands Government, 2010). The artificial coast and beaches, which represent 6% and 16% of the coastline respectively (Canary Islands Government, 2010) will be potentially vulnerable to events such as coastal erosion/sedimentation, coastal storms and sea level rise. These effects require authorities to address beach erosion and coastal flooding/inundation, but at present instruments are in the process of being developed. In 2004, the regional government initiated a process to develop Shoreline Management Guidelines (Directrices de Ordenacion Litoral) which aim to implement the principles of integrated coastal zone management in the archipelago, although its adoption is currently being delayed (OSE, 2010). In addition, the Canary Islands is part of the LITOMAC project (a European initiative) towards the development of an Integrated Strategy for the coastal fringe of the Canary Islands, Azores and Madeira. |
| Soil | HIGH | The Canary Islands are characterized by the presence of fragile and unique ecosystems and agro systems, where soil constitutes a strategic resource in environmental, social and economic terms. The region displays high levels of soil diversity, with representation of nine of the twelve soil orders defined by the Soil Taxonomy (Canary Islands Government, 2010). However, the archipelago has been identified as one of the regions of the European Union with greater risk of desertification (United Nations Convention to Combat Desertification, Annex IV). Initial estimates presented by the regional government on the impact of water erosion indicated that approximately 43.4% of the archipelago's territory (329,000 hectares) was affected by severe erosion processes, with losses exceeding 12 tonnes per hectare per year (1.2 mm of topsoil) (Canary Islands Government, 2010). Extreme climatic events (e.g. flooding, wildfires) which could become more frequent as a result of climate change would potentially increase the risk of erosion and desertification. |
| Water | MODERATE | The availability of freshwater resources in the Canary Islands is limited by the characteristics of the archipelago (insularity, a dry and warm climate). Groundwater is the traditional freshwater resource (providing 90% of water for consumption), although there |

| Sectors | Vulnerability | Rationale |
|---|---|---|
| | | has been an over-exploitation of aquifers due to the intensification of agriculture, population growth and tourism development. As a result, all the islands, to varying degrees, have salinity problems in some of its groundwater bodies, which could be accentuated by climate change (ClimaImpacto, 2012). As a response to the lack of water resources, the region is rather advanced in the field of water technologies, mainly desalination and reutilisation. Currently, about 30% of water resources come from non-conventional sources (ClimaImpacto, 2012), which increases the resilience of the archipelago to water shortage scenarios resulting from climate change. |
| Disaster & risk | MODERATE | The Canary Islands present certain geographic features (e.g. mountainous landscapes, periodic heavy rainfall events, high population densities in steep areas) that contribute to increase the effects of climate-related hazards (floods, landslides, storms, etc.). In addition its dual insularity (archipelago) and remoteness can complicate the delivery of assistance (state, regional or island) operating by air or sea (European Commission, 2012). The Canaries operates "the Canaries Emergency and Security Network (RESCAN)" and has in place a Spatial Data Infrastructure (IDECanarias) as tool for natural disaster prevention and analysis. While the infrastructure of the Canaries is vulnerable to natural disasters, the existence of monitoring and prevention programmes like the Plan against extreme adverse weather events (PEFMA) reduces vulnerability of the archipelago to potential increased frequency of natural disasters. |

**Table D.18 Risks and opportunities resulting from climate change - Canary Islands.**

| Sectors | Agriculture | Forestry | Fisheries & Aquaculture | Energy | Tourism | Construction & Buildings | Transport | Waste | Health | Biodiversity | Coastal Zone Management | Soil | Water | Disaster & risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Increase in pests and diseases | | | | | | | | | | | | | | |
| Increase in invasive species | | | | | | | | | | | | | | |
| Increase in temperature | | | | | | | | | | | | | | |
| Increased in extreme temperature events | | | | | | | | | | | | | | |
| Increase in floods | | | | | | | | | | | | | | |
| Change to annual patterns of rainfall | | | | | | | | | | | | | | |
| Low water levels in lakes and rivers | | | | | | | | | | | | | | |
| Drought | | | | | | | | | | | | | | |
| Increase in coastal flooding | | | | | | | | | | | | | | |
| Coastal inundation as a result of sea level rise | | | | | | | | | | | | | | |
| Saltwater intrusion | | | | | | | | | | | | | | |
| Coral bleaching | | | | | | | | | | | | | | |
| Increased risk of landslide/mudslide | | | | | | | | | | | | | | |
| Subsidence | | | | | | | | | | | | | | |
| Wildfire | | | | | | | | | | | | | | |
| Soil degradation influencing carbon storage capacity of soils | | | | | | | | | | | | | | |
| Increased water temperatures | | | | | | | | | | | | | | |

Notes: Colour coding of the cells in the risk matrix: Red – high risk, Orange – moderate risk, Olive – low risk, Green – opportunity, Grey – the risk is relevant to the sector however could not be assessed. Blank – impacts not relevant to the sector.

## Azores

**Table D.19 Climate impacts – Azores**

| Biophysical impact | Comments |
|---|---|
| Increases in pests and disease | Pests and diseases are likely to be of particular concern with regards to the biodiversity, fisheries and agriculture of the Azores. Thus far, examples include plagues of rat (Rattus rattus), which are considered a particular threat to laurel forest, because they can alter forest dynamics and regeneration capabilities (European Commission, 2008). Laurel forests are endemic to Macaronesia, therefore the impact of pests and disease on the biodiversity in the Azores is assessed as high.<br>However, evidence of greater frequency and/or greater magnitude of diseases in the Azores has not been found in the literature to date. |
| Increase in invasive species | Increase in invasive species is expected as temperatures in the region increase. Existing evidence include more frequent occurrence of new tropical fish in the Azorean waters. An invasive species – Green algae (*Caulerpa webbiana)*, has also been observed. This impact is likely to be facilitated further by climate change (IUCN Petit J. & Prudent G., 2008). A major concern for the Azores and other regions of the Macaronesia is the impact exotic species invasions may have on the unique habitats of laurel forests. Increase in invasive species is also identified as one of the key risks to coastal vegetation (Quaternaire Portugal, 2011). |
| Increase in temperatures | Climate scenarios (IPCC, 2007b) for the region of the Azores predict 1.9 -2.4°C increase in annual temperatures by the end of the century. According to studies, there is a trend towards an increasing number of "summer days" (when temperatures exceed 25°C) and "tropical nights" (with temperatures exceeding 20°C) (Autonomous Region of the Azores, 2011).<br>Increase in temperatures will have a number of implications across sectors. For example in biodiversity, it is expected that species with current habitats located at the higher altitudes of the Azores will be particularly susceptible to higher temperature. This is because they will not be able to move to higher altitudes to find the optimum weather conditions. In agriculture, rising temperatures are expected to decrease the productivity of the land due to drier soils (Consultation with a representative of the OR). On the other hand, greater occurrence of summer days and tropical nights can bring positive impacts on the coastal tourism in the region by creating more favourable weather conditions. |
| Increase in extreme temperature events | While an increase in summer days and tropical nights is expected in the Azores as a result of climate change, due to oceanic thermoregulatory effect the Azores are unlikely to suffer from increased frequency of excessive heat and/or excessive cold days (Autonomous Region of the Azores, 2011). Therefore overall this impact on the health sector has been assessed as low. Consultation with a representative of the OR confirmed that rise in extreme temperatures events have not yet been observed and that this represents low risk to agriculture, forest and water (though risks associated with increase in extreme temperature events have not been assessed for these sectors)(source: consultation with OR representative). |
| Increase in floods | Given the trend of increasing surface temperature of the ocean, conditions are created for tropical storms to reach the Azores more frequently and with greater strength (Autonomous Region of the Azores, 2011).<br>Consultation with a representative of the OR highlighted that particular attention should be given to the possibility of tropical storms at the end of their cycles, which have in the past, dissipated at Azorean latitudes. With climate change, these storms can have a prolonged cycle and extended routes due to the increase in the sea surface temperature. During the interview it was observed that increase in extreme weather episodes, including the occurrence of prolonged periods of drought or precipitation, will have serious implications on water resources, water flow processes and the risks associated with the occurrence of floods and landslides (source: consultation with OR representative).<br>It is therefore expected that floods may occur more frequently in the Azores as a consequence of extreme rainfall and storms. This is predicted to cause economic losses across all sectors, due to damages to the integrity of local infrastructure, buildings and other equipment (Urban, F., and Mitchell, T. , 2011) and as a result of decreased economic productivity. Environmental damage may also occur as a result of pollution, for example from flooded landfills (which remain the main waste disposal route in the island).<br>A positive impact resulting from flooding and / or intense rainfall may be observed in the hydropower sector, where increased generation due to increased river run-off and higher water levels could occur (Urban, F., and Mitchell, T., 2011). However, this impact is expected to be small as hydropower currently accounts for only 4% of the total electricity generation in the archipelago. |

| Biophysical impact | Comments |
|---|---|
| | |
| Change to annual patterns of rainfall | Change in the annual pattern of rainfall is considered one of the major global warming impacts in the Azores with expected greater inter-annual variability and seasonality (Autonomous Region of Azores, 2011). Consultation with a representative of the OR has confirmed that changes to the annual patterns of precipitation have been observed in the island particularly between September and February. This is expected to have implications on the water availability in the archipelago and may have implications for water storage infrastructure. In addition, the decreased precipitation during some seasons implies an increase in groundwater pumping during that time, which may lead to overexploitation of the aquifers and increase in freshwater salinisation problems (Jones A. & Phillips, M., 2011).<br>Changes in annual pattern of rainfall will impact productive capacity of agricultural systems with smaller quantities of water available for irrigation. With regards to biodiversity, it is also expected to change phenological cycle of plants (Autonomous Region of the Azores, 2011). |
| Low water levels in lakes and rivers | As a result of changes in the annual pattern of precipitation, the natural water cycle in the archipelago will be disrupted. Water levels in lakes and rivers are likely to be lower at the periods of lower precipitation; overall it is expected that islands' freshwater reserves will be depleted as a result of climate change. This could impact freshwater ecosystems and biodiversity. |
| Drought | Occurrence of prolonged periods of drought is expected in the Azores as a result of climate change (Autonomous Region of the Azores, 2011). This will have implications on water flow processes and freshwater resources with potential consequences for the health of ecosystems. Consultation with a representative of the OR also indicated that droughts will facilitate the spread of diseases in the islands (source: consultation with OR representative). |
| Increase in coastal flooding as a result of increased storm frequency and sea level rise | One of the key impacts of climate change in the Azores is the greater frequency of storms of tropical origin (Autonomous Region of the Azores, 2011). Consultation with a representative of the OR confirmed that anticipating and managing weather extremes are considered key priorities.<br>Coastal hazards, such as coastal flooding, are particularly important in the Azores because of the archipelago's limited land availability for economic activity. Most of the population and economic activity is located along the coast which can make impacts of coastal flooding more severe. Increased frequency and strength of coastal storms in the archipelago is a major concern. Studies have concluded that the average storm in the Azores lasts for 2.3 days and on average the archipelago experiences 3.1 storms per year. Extreme weather events occur in the Azores on average once every seven years, during which waves can reach "maximum significant wave height of 11.7 m and highest wave height of 22.2 m, which usually result in coastal flooding". Likelihood of coastal flooding in the Azores is further amplified by the impact of increased mean sea-level on potential storm surges (Borges, P. et al, 2011.).<br>Given the majority of urban settlements and infrastructures are located on the coast, coastal flooding is expected to affect energy, waste and water infrastructure, buildings, agriculture and other sectors. |
| Coastal inundation as a result of sea level rise | While the literature review did not provide conclusive evidence on the potential impact of sea level rise in the Azores (Azores climate change strategy states that there are insufficient sea-level measurements over significant timeframes to conclude whether sea level rise is a long-term trend or just seasonal variation), consultation with a representative of the OR confirmed that this is a serious threat to resources, infrastructure, coastal ecosystems and the population. |
| Saltwater intrusion | Saltwater intrusion in the groundwater of the Azores is a concern as observed in many of the wells that have been drilled to the basal aquifer. As a result some of the wells have already been abandoned causing economic losses (Jones A. & Phillips, M., 2011). Fresh water resources are extremely scarce in the Azores, therefore impacts of greater saltwater intrusion is predicted to be high, particularly given evidence of the impacts already being observed. |
| Coral bleaching | Deep water corals are unique habitats present in the Macaronesia region, very sensitive to ocean acidification (IUCN, 2008). Deep-water corals have particular value in terms of biodiversity, providing habitats and feeding grounds for a range of species, including commercial fish species (UNEP, 2004). Around 60% of fishing activity in the Azores is undertaken on the seamounts with deep-water corals having an important role in maintaining fishing stocks (WWF, no date). According to the literature (UNEP, 2004), the cold- water corals do not have coastal protection role as is the case with the warm-water corals.<br>While the impacts of climate change on deep water corals are still being investigated, it is believed that "climate change could cause changes in the current systems and affect food supply in deeper waters" (UNEP, 2004). Damage to coral reefs may decrease attractiveness of Azores as a tourist destination and have negative effects on |

| Biophysical impact | Comments |
|---|---|
| | the fishing sector in addition to the loss of biodiversity. |
| Increase of landslides/ mudslides | Landslide is one of the most common natural hazards in the Azores, especially in coastal areas with loose rocks and soils and high cliffs (like in the islands of S. Jorge, Faial and Flores) (Quaternaire Portugal, 2011). The coastal areas of the Azores are also more vulnerable to landslides due to the greater exposure to intense erosion processes and presence of urban development along the coasts, including bottom of the cliffs (both settlements and roads irrespectively of the level of cliff stability) (Quaternaire Portugal, 2011). To date, landslides were triggered by earthquakes, volcanic eruptions and extreme weather events. Given changes in the annual precipitation pattern and possible increase in the frequencies of extreme weather events as a result of climate change, there is a higher probability of landslides in the archipelago (Jones & Phillips, 2011). Consultation with a representative of the OR confirmed hazards associated with more frequent mass movement of soil. |
| Subsidence | Specific information on the impacts of climate change on subsidence in the Azores has not been identified in the literature. However it is anticipated that changes in the sea level can be augmented by local land subsidence (European Parliament, 2011). |
| Wildfires | Evidence of more frequent occurrence and greater magnitude of wildfires in the Azores has not been found in the literature examined. It is believed that due to mostly humid climate in the Azores, wildfires are not an impact of major concern in the archipelago, compared to drier regions of the Macaronesia like Canary Islands or Madeira. However, given projected changes in annual precipitation and rise in temperatures, risk of this impact could potentially increase. |
| Soil degradation influencing carbon storage capacity of soils | Specific information on the impacts of climate change on the quality of soil in the Azores has not been identified in the literature examined. However, it is speculated that, due to changes in hydraulic cycle (particularly droughts), increased soil erosion and salt water intrusion, the quality of soils in the Azores will degrade as a consequence of changes in climatic conditions. |
| Increased water temperatures | A representative of the OR consulted in this study highlighted that there is a possibility of tropical storms having prolonged cycles and extended routes (therefore reaching the Azores more frequently), as a result of increase in the surface temperature of the sea water.<br>In addition, the consequences of increased water temperatures (such as invasive tropical species) have already been documented; these are likely to become more severe moving forward. Several species of tropical fish have already been observed in the Azorean water as a consequence of increased water temperatures (IUCN Petit & Prudent, 2008). Consultation with a representative of the OR suggested that attractiveness of the Azores as a tourist destination may increase as a result of increasing water temperatures.<br>Overall, the impact of water temperature increase in the Azores is expected to be high as it will have a number of consequences, such as increase in alien species discussed above. |

**Table D.20 Sectoral vulnerability to climate change - Azores**

| Sector | Vulnerability | Rationale |
|---|---|---|
| Agriculture | HIGH | A large part of the territory of the Azores (131,000 ha - approx. 65% of total land used) is used for agriculture (MEMO/07/485, 2007). While the role of agriculture has diminished compared to 1970's, when it supported approximately 40% of the population (European Commission, DG Regional Policy, 2011), this sector contributes around €273m (2000 prices) to the island's GVA, which translated to approximately 11-12% of the total GVA each year (Eurostat, averages calculated over 2000-2006). In addition, agriculture is important in the Azores due to the value it adds in terms of environment and landscape, which in turn has an impact on the attractiveness of Azores as a tourist destination (European Commission, ESPON, 2012). According to data from Eurostat, potatoes and sugar cane are the most prevalent crops on the islands. Given high altitudes inland of the Azores islands characterised by rainy and foggy weather, agricultural production is limited to the lowlands, and therefore mainly located along the coast, near urban settlements. Adaptive capacity of the sector is therefore relatively low given production will not be able to move to higher altitudes due to unfavourable weather conditions. |

| Sector | Vulnerability | Rationale |
|---|---|---|
| Forestry | MODERATE | While forestry remains one of the economic sectors of the Azores, it is of lower importance than agriculture or fisheries. According to data from 2007, 9.2% of the land in the Azores is utilised for forestry (MEMO/07/485, 2007), compared to 65% for agriculture and 20.5% occupied by natural areas. Majority of land covered by forests and nature are areas protected under the Regional Network of Protected Areas or the Natura 2000 programme (Isle-Pact, 2012).<br>While no information has been found on the specific contribution of forestry to the Azorean economy, it appears that the sector is of lower economic importance compared to agriculture. It must be noted that this assessment does not consider vulnerability of Azorean forests in terms of its contribution to natural heritage and biodiversity but in terms of the economic forestry sector. |
| Fisheries and Aquaculture | MODERATE | In 2008, the Azores fisheries sector contributed to 26.8% of the total production from this sector in Portugal (European Commission, DG Regional Policy, 2011). Consultation with a representative of the OR confirmed crucial role of fisheries in the archipelago's economy, however this is considered lower compared to agriculture. |
| Energy | HIGH | Azorean energy infrastructure consists of nine isolated energy systems that are not interconnected. Similarly there is no grid connection with either African or European continent. This increases vulnerability of the island's energy sector to impacts of climate change, specifically those associated with greater risks of natural disaster. The energy and construction industries contributed 16.3% in terms of GVA and 23.8% in terms of employment in 2010 (AICEP Portugal Global).<br>The majority of the primary energy in the Azores comes from oil, with the largest share used for road transport and electricity generation. In 2010, between 30 and 37% of electricity in the island was generated from renewable sources; the renewable portfolio in the Azores comprises of geothermal, marine, wind and hydro energy (Azores Regional Government, 2008). According to the Strategic Plan for Waste Management in the Azores (PEGRA) two energy from waste plants were installed in the islands of Terceira and São Miguel - the final destination of the waste produced across all islands.<br>To make their electricity system more resilient and better utilise renewable energy sources, Azores are also researching energy storage systems such as flywheels and batteries. Towards 2018, the Azores plan to increase the share of renewables in total electricity production to 75%, and in total primary energy consumption to 40% (Antonio & Vieira, 2010).<br>Overall, a high vulnerability score has been assigned to this sector to emphasise the susceptibility of the system to impacts of climate change due to fragmentation, reliance on oil and energy equipment imports (which is often a challenge in small islands because of the bad weather conditions and small harbours) (Isle-Pact, 2012) and the crucial role of energy for all economic activities in the island. |
| Tourism | HIGH | Coastal tourism in the Azores emerged as a new sector in the mid 1990s (Jones & Phillips, 2011) therefore is still considered fragile. Based on the averages calculated over 2006 and 2011, the total number of nights spent in hotels by all non-residents each year was 584,000 stays per year. This is substantially lower than for Madeira or The Canary Islands but not much different to the other OR in absolute terms. This equates to approximately 2.5 tourist overnight stay per capita, which is well behind other Macaronesian OR for which this ratio is around 20. Despite the tourism is not as developed as in the Madeira or in the Canary Islands, tourism in the Azores continues to grow in importance. It is responsible for approximately "6.4% – 6.8% of regional GDP, 4,700 jobs in the hospitality sector i.e. 4% of total employment and 7% of the service sector" (INTA,2011). According to the "Tourism and hospitality strategy in the Azores" further development of tourism is crucial to reduce unemployment and grow the local economy (INTA, 2011). Consultation with a representative of the OR confirmed crucial role of tourism in the archipelago's economy. |
| Construction & Buildings | MODERATE | Contribution of the construction and public works sector to the Azorean economy has increased in recent years. This was driven by increased demand from the public sector for roads, public buildings and social housing (Azores Regional Government, 2008). In 2010, construction contributed to approximately 7% of total GVA across sectors (Isle-Pact, 2012). Given the geographical characteristics of the Azores, the urban areas are located mainly on the sea coast (at altitude lower than 350m), with the inland territory (higher altitudes) mostly deserted (European Commission. ESPON, 2012). High altitudes in the inland areas of the Azores islands limit the adaptive capacity of the construction and building sector in some ways, as moving urban settlements and infrastructure inland would be challenging. |

| Sector | Vulnerability | Rationale |
|---|---|---|
| Transport | HIGH | Transport, both regional and international, and related infrastructure is crucial for the economy of the Azores. There is no alternative to air transportation and maritime transport of goods is also of great relevance. Any damage to related infrastructure or greater frequency of severe weather events will have implications for all economic sectors of the Azores. This has been confirmed through the consultation with a representative of the OR. |
| Waste | MODERATE | Waste management in the Azorean islands is challenging due to the very high costs of transportation between the islands and with the mainland, and lack of available land for waste management activities, particularly for landfills.<br>To address some of these challenges, and align waste management practices with European legislation, the Azores adopted the Strategic Plan for Waste Management – PEGRA, incorporating principles of sustainable development, for each island as well as for the whole region (Brito, A.G et al. 2007), as well as the Strategic Plan for Industrial and Special Waste (PERIEA) (Quaternaire Portugal, 2011). Following the strategy set in PEGRA, waste processing centres have been installed in less populated islands, with centres in islands of Graciosa, Flores and Corvo already in operation, in Pico and Sao Jorge recently completed, and in Faial and Santa Maria under construction at the time of writing this report. Climate change may put additional pressure on the waste sector because of the damage to the infrastructure, including transport and clean-up and recovery of waste following natural disasters such as floods and landslides. |
| Health | MODERATE | The quality of public health service in the Azores is comparable to the mainland Europe, based on the number of hospital beds and number of nurses available per patient (European Commission, DG Regional Policy, 2012b). There are 3 hospitals to cover 9 islands (patients are transported by air). Recent years have seen significant investment in the health services and infrastructure in the Azores. Reliance on air transportation between the islands of the archipelago does however make the sector more vulnerable to severe weather conditions. Based on the evidence collected for this study, it was not possible to assess how well the Azorean public health system is prepared to deal with the potential impacts of climate change, such as more frequent outbreaks of diseases or emergencies caused by more frequent natural disasters. |
| Biodiversity | HIGH | The Azores are home to important endemic species (including preglacial European species) (ETC/ACC, 2010) and are characterised by very rich biodiversity (though the number of endemic species is lower compared to Madeira and the Canary Islands due to the distance between the Azores and the mainland, and intensive land use) (European Commission, 2009). One of the most unique features of the archipelago is the laurel forest, which appears only in the Macaronesia region, and is particularly susceptible to the impacts of climate change (IUCN, 2008). As mentioned under the forestry sector, majority of land covered by forests and nature are areas protected under the Regional Network of Protected Areas or the Natura 2000 programme, but "with a lack of conservative management plans or effective implementation" (European Commission, 2008). The Azores is also characterised by rich marine biodiversity in the sea mounts surrounding the archipelago and supported by deep, cold-water corals. |
| Coastal Zone Management | HIGH | The Azorean coastal zone area represents a significant proportion of the territory of the archipelago (943 km coastal length for a total area of 2322 km2). The most recent Coastal Zone Management Plans (CZMP) were approved for four islands: Santa Maria, Graciosa, Flores and Corvo, which are characterised by highest ecological values even though they are the smallest of the archipelago (European Commission). Overall, CZMPs have been approved for all islands (Consultation with a representative of the OR). The vulnerability of the Azorean coast is already high due to anthropogenic pressures and high rate of urban development (Lameiras et al., 2007). As part of the Litomac project, the "Technical Guidance for coastal management in the Autonomous Region of Azores" (Quaternaire Portugal, 2011) has been published. The adaptive capacity of the coastal infrastructure to climate change is thought to be low, given that opportunity of moving it further inland will be limited due to the steep geography, high altitudes and unfavourable weather. |
| Soil | NOT ASSESSED | Insufficient information has been identified to assess the vulnerability of soil to impacts of climate change in the Azores. |
| Water | HIGH | Azores are particularly sensitive to climatic mechanisms that determine the hydrology of the islands. Availability of freshwater is highly dependent on weather conditions. Water scarcity has been identified as the key concern for the Azores with regards to climate impacts (Autonomous Region of the Azores, 2011). Integrated Management Plan for Water Resources |

| Sector | Vulnerability | Rationale |
|---|---|---|
| | | has been developed on both an island and regional level (Governo da Região Autónoma dos Açores, 2012).<br>No information on measures which would increase adaptive capacity of the water sector in the Azores, such as for example desalination plants have been identified suggesting a high degree of vulnerability to the climatic changes. |
| Disaster & risk | MODERATE | The Azores archipelago is exposed to different natural hazards already responsible for severe social, environmental and economic losses. Azores are located in the area of high seismic activity which has been responsible for approximately 57% of all natural disasters occurring in the archipelago in the last century (Quaternaire Portugal, 2011). Azores operate a multi-parametric monitoring network to detect early signals of natural disasters. "Geophysical, geodetic, geochemical and meteorological independent techniques provide data that are integrated in the scope of a continuous hazard and risk assessment programme to support civil protection of regional and local authorities" (Gaspar et al., 2011).<br>While the infrastructure of the Azores is vulnerable to natural disasters, the existence of monitoring and prevention programmes reduces vulnerability of the archipelago to potential increase in the frequency of natural disasters. Consultation with a representative of the region confirmed that anticipating and managing weather extremes are key priorities for the Azores. |

**Table D.21 Risks and opportunities resulting from climate change - Azores.**

| Sectors | Agriculture | Forestry | Fisheries and aquaculture | Energy | Tourism | Construction & buildings | Transport | Waste | Health | Biodiversity | Coastal Zone Management | Soil | Water | Disaster & risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Increase in pests and diseases | | | | | | | | | | | | | | |
| Increase in invasive species | | | | | | | | | | | | | | |
| Increase in temperature | | | | | | | | | | | | | | |
| Increased in extreme temperature events | | | | | | | | | | | | | | |
| Increase in floods | | | | | | | | | | | | | | |
| Change to annual patterns of rainfall | | | | | | | | | | | | | | |
| Low water levels in lakes and rivers | | | | | | | | | | | | | | |
| Drought | | | | | | | | | | | | | | |
| Increase in coastal flooding | | | | | | | | | | | | | | |
| Coastal inundation as a result of sea level rise | | | | | | | | | | | | | | |
| Saltwater intrusion | | | | | | | | | | | | | | |
| Coral bleaching | | | | | | | | | | | | | | |
| Increased risk of landslide/mudslide | | | | | | | | | | | | | | |
| Subsidence | | | | | | | | | | | | | | |
| Wildfire | | | | | | | | | | | | | | |
| Soil degradation influencing carbon storage capacity of soils | | | | | | | | | | | | | | |
| Increased water temperatures | | | | | | | | | | | | | | |

Notes: Colour coding of the cells in the risk matrix: Red – high risk, Orange – moderate risk, Olive – low risk, Green – opportunity, Grey – the risk is relevant to the sector however could not be assessed. Blank – impacts not relevant to the sector.

## Madeira

**Table D.22 Climate impacts – Madeira**

| Biophysical impact | Comments |
|---|---|
| Increases in pests and disease | New pests and diseases may be introduced in Madeira due to changed climatic conditions. Similarly, tolerance of existing pests and disease may be altered due to climate change (Santos & Aguiar, 2006).<br>Climate change may lead to creation of more favourable conditions in Madeira for vector survival and parasite development which in turn may lead to greater rate of transmission of vector-borne diseases, particularly in spring and autumn (Casimiro & Santos, 2002).<br>Santos & Aguiar (2006) predicted an increased risk of spread of dengue and yellow fewer as a result of climate change (assuming the infected vector is introduced in the island). Other diseases likely to increase in the islands were: Escaro-nodular fever and Lyme disease, anaplasmosis and murine typhus (Santos & Aguiar, 2006). In the case of leptospirosis, which was widespread in both islands of the Autonomous Region of Madeira, Santos and Aguiar (2006) expected that risk of transmission would decline due to decrease in precipitation, although there was significant uncertainty associated with this conclusion.<br>In December 2012, Madeira experienced an outbreak of dengue fever which was reported as "Europe's first sustained transmission since the 1920's" (Reuters, 2012a). Over 2,000 people became infected. It was predicted that eradication of the mosquito transmitting the disease would be challenging as it had found a suitable habitat in Madeira.<br>Increase in the spread of vector-borne diseases is likely to have negative consequences for tourism and health. Introduction of new pests may result in negative impacts on agriculture, forestry and biodiversity of the Autonomous Region of Madeira (Eurosurveillance, 2012) |
| Increase in invasive species | Consultation with a representative of the OR confirmed greater occurrence of infestation with foreign plants and animals in the islands, which may be linked to increased temperatures. Santos and Aguiar (2006) reported that introduction of invasive species could lead to extermination of some native species. This can occur due to changes invasive species could introduce to the ecosystem (for example the nutrient cycles), as well as competition between new and existing species.<br>There has been some evidence of the invasive species occuring in the Madeira's laurel forests (Guimarães A. & Olmeda C. 2008.). Examples include invasion with Hedychium gardnerianum, introduced as an ornamental plant in Madeira, but which spread across large parts of laurel forest inside Madeira Natural Park. There is also evidence of problems with species native to Madeira (such as *Clethra arborea* - an ornamental plant*)* which started spreading across the laurel forests.<br>Some evidence of new species appearing in the waters of Madeira has also been found. This includes two new species of crab and shrimp (defining a new boundary for their occurrence in the North Eastern Atlantic). An increased presence of whales, which start using Madeira waters as migratory route and play area, has also been observed (Santos & Aguiar, 2006). |
| Increase in temperatures | Temperatures in Madeira are expected to increase by 2ºC to 3ºC by the end of the century (Santos & Aguiar, 2006)<br>While the impact of increased temperatures on buildings and their energy demand varies depending on the building type, fittings (e.g. lighting) and climate, it is expected that in Madeira an increased need for cooling and air conditioning will be observed as a result of climate change. The key change will be observed across tourist facilities, with estimated increase in demand for cooling in hotels of 15 - 30% compared to current levels (Santos & Aguiar, 2006), leading to greater demand for energy.<br>Increased temperatures will also have an impact on the fuel efficiency in road transport. A study (Aguair & Casimiro, 2007) has shown that while frequency of air conditioning use will increase only slightly with climate change, this will be reflected in the increase in overall energy demand in the island, since road transport is the main use of primary energy in the region of Madeira.<br>With regards to agriculture, Santos & Aguiar (2006) reported that production of some crops, for example banana and potato, could be benefited by increase in temperatures. It is expected that increase in temperatures will extend cultivation season as well as allow cultivation of certain crops at higher altitudes. There is also an opportunity to diversify the range of crops cultivated in Madeira. Similarly positive impacts of increased temperatures have been |

| Biophysical impact | Comments |
|---|---|
| | suggested for natural forests where productivity can increase (Santos & Aguiar, 2006). |
| Increase in extreme temperature events | Future climate scenarios indicate that Madeira may experience increased frequency of heat waves as well as episode of extreme heat although such episodes are not expected to be of long duration (Santos & Aguiar, 2006).<br>Although some studies have suggested that mortality in Madeira can increase as a result of increased frequency of heat waves, observations as part of CLIMAAT II project have not confirmed this to be the case (Santos & Aguiar, 2006). The observed trend of increasing number of average daily deaths in the region is thought to be linked to demographics (an aging population) rather than environmental factors.<br>Based on information available, it is not possible to conclude that in the future the high heat conditions will result in greater mortality in the region of Madeira although it is known that during heat waves vulnerable members of society are at greater risk of ill health or death (evaluation of excessive mortality in Portugal as a result of 2003 heat waves by Trigo et al. 2009, demonstrated that significant increments in mortality appeared among people older than 45). |
| Increase in floods due to increasing frequency of storms and extreme rainfall events | Madeira's tropical climate is characterised by the occurrence of very intense rainfall over short periods of time (approx. 2-3 hours) (Santos & Aguiar, 2006). Combined with high altitudes and steep terrain, this provides conditions for the occurrence of flash floods and landslides.<br>The impacts of floods in Madeira are likely to be high as the most flood prone areas are near the mouth of large rivers which offered the most favourable conditions for locating cities and majority of the infrastructure. As a result, larger cities of the region (Funchal, Ribeira Brava, Ponta do Sol, San Vicente, Santa Cruz and Machico) are exposed to potential risk of floods (Santos & Aguiar, 2006). Flash floods in Madeira in February 2010 were caused by a record high precipitation over a short period of time (Fragoso et al., 2012), and resulted in 42 deaths and estimated damage to infrastructure of €1.08 billion (European Commission, 2010).<br>Following floods in Madeira in 2010, the Portuguese government published a decree on flood management (Decreto-Lei N 115/2010. Diário da República, 1.ª série — N.º 206 — 22 de Outubro de 2010), which among others, required authorities in Madeira to evaluate future risks of floods in the context of climate change.<br>An increase in the average number of days with heavy rainfall could indicate an increased risk of flooding however, current data does not suggest an increased risk of this type of natural disasters due to climate change (Santos & Aguiar, 2006). A small reduction in extreme precipitation events is expected, however, this decrease is not evident in the observed annual maximum daily rainfall, so it is not possible to identify a clear trend linking the risk of flooding with impacts of climate change (Cruz et al.). The lack of a direct link between the greater occurrence of floods and climate change was also pointed out by a representative of the OR during consultation. It should be noted that while current climate models can predict future daily precipitation, hourly precipitation figures cannot be represented. Given the flash floods in Madeira to date have been caused by very intensive precipitation over a short period of time, such phenomena cannot be modelled with relation to climate change by current climate models.<br>One study concluded that while the main factor prompting landslides and floods is rainfall, an increase in the number of damaging events recorded on Madeira Island in recent times is related mostly to human activity (economic development and population growth), rather than to natural factors (Baioni, 2011).<br>Despite a clear link between greater likelihood of floods and climate change cannot be drawn for Madeira at this stage, potential impact of floods, as demonstrated by incident of 2010, would result in significant damage to the infrastructure and risk to human life. |
| Change to annual patterns of rainfall (for example wetter winters but drier summers) | In Madeira, the patterns of rainfall are already very diverse, showing both seasonal and topographic variability. The Regional Water Plan for Madeira indicated that about 80% of all rainfall occurs in the wet season (between October and March), with maximum precipitation values in November and minimum in July (Autonomous Region of Madeira, 2008). The level of precipitation also varies between lower (coastal areas) and higher altitudes (inland), for example for the Island of Madeira the average annual precipitation varies between 600mm on the south coast, 1000mm in the north coast and 3000mm inland (Autonomous Region of Madeira, 2008). The average annual rainfall in Madeira is expected to decrease by between 20 and 40% (Santos & Aguiar, 2006). This will be driven mainly by the significant reductions in |

| Biophysical impact | Comments |
|---|---|
| | precipitation in the autumn, winter and spring months (from 40% in winter and spring to 60% in autumn). Greatest reduction in rainfall, up to 700mm in absolute terms will be observed in the highlands (Santos & Aguiar, 2006). Increase in precipitation of 60 to 80% (depending on the emission scenario) could be observed in the summer months (Santos & Aguiar, 2006).<br>Some projections show a reduction of 40 to 50% of the volume of water available annually for water systems recharge by the end of the century (Santos & Aguiar, 2006).. The reduction in recharge would lead to decreased groundwater levels in the volcanic-based aquifers (Cruz et al.). Reduced availability of water resources has been highlighted in the consultation with a representative of the OR as one of the key concerns. |
| Low water levels in lakes and rivers (likely to be seasonal) | As discussed with regards to changes in the annual patterns of rainfall, water available for recharge and runoff is expected to be reduced by 30% by 2050 and further by 40% - 50% by the end of the century (Santos & Aguiar, 2006). Lower groundwater levels in volcanic aquifers will reduce groundwater discharge to streams (Cruz et al), resulting in lower water levels in lakes and rivers. Such reductions are likely to stress freshwater ecosystems. |
| Drought | To date, droughts in Madeira occurred with some frequency and affected mainly the south-east of the island (Universidade Tecnica de Lisboa, 2011). More persistent and perhaps frequent periods of drought are thought to be likely to occur as a result of the projected decreased precipitation and increase in temperatures although this remains a speculation. Drought will negatively impact hydropower generation output, and hydropower contributes a significant amount to total power generation in Madeira (15% of total). Drought would impact biodiversity negatively, as it will place plants and animals under high water stress. |
| Increase in coastal flooding as a result of increased storm frequency and sea level rise | The existing data on the potential increase in risk of storms and coastal flooding as a result of climate change do not allow yet drawing definite conclusions (Santos & Aguiar, 2006). Hurricane Vince developed in the eastern North Atlantic and it passed Madeira in 2005 (Höppe and Pielke,2005). This has been seen as an unusual event, as hurricanes usually did not affect the region and therefore was seen as a confirmation of development of new pattern of hurricane activity (Höppe and Pielke, 2005). Given greater likelihood of extreme weather events as a result of climate change has been reported for Canary Islands and Azores (see respective assessments), it is assumed that the same will also apply for Madeira.<br>Coastal flooding has been highlighted by a representative of the OR as one of the key concerns in Madeira, given the insularity of the region and location of majority of infrastructure on the coasts. |
| Coastal inundation (causing loss of habitable land and coastal squeeze) as a result of sea level rise | According to ETC/ACC (2010) the sea-level in the region of Macaronesia rose by 1.7mm/yr through the 20th Century, in line with the global average. Projections indicate further increase in sea level in the region, estimated at between 0.18 to 0.59m by 2100 (ETC/ACC (2010)). Impact of sea-level rise on coastal ecosystems will be high, with particular threats to the biodiversity of marshes, dunes and beaches (ETC/ACC, 2010). Coastal inundation will also impact on the population and all infrastructures located on the coast, as for coastal flooding above. However, given the slower timelines for coastal inundation compared to coastal flooding, it may be possible to relocated some key infrastructure away from the coast in time. |
| Saltwater intrusion | It is expected that the current trend of increasing salt concentration in groundwater, already observed in some basins, will continue, especially in wells located near the sea and which are overexploited (Santos & Aguiar, 2006). This will be caused by: decreased precipitation, decreased groundwater levels, increased water extraction during summer months and sea level rise. The ability of existing infrastructure to meet demand for water in Madeira will be substantially decreased; this will worsen if it coincides with an increase in water requirements for example for irrigation (Santos & Aguiar, 2006). |
| Coral bleaching | As in case of other regions of Macaronesia, Madeira is home to a large number of deep water coral reefs, stretching from Norway to West Africa. Deep water corals are sensitive to the acidification of the oceans which inhibits their growth and regeneration (IUCN, 2008). Loss of corals is likely to have a negative impact on the fish populations and biodiversity in the waters of Madeira. |
| Increased risk of landslide/mudslide | As discussed with reference to potential increase in floods, landslides in Madeira already occur and are linked to the events of very heavy rainfall over a short period of time, or less intense precipitation over a longer period (Santos & Aguiar, 2006). As determined for floods, despite a clear link between greater likelihood of floods and climate change cannot be drawn for Madeira at this stage (Santos & Aguiar, 2006), potential impact of landslides, as demonstrated by incident of 2010, would result in significant damage to the infrastructure and risk to human life. |

| Biophysical impact | Comments |
|---|---|
| Subsidence | No specific evidence on the likelihood or magnitude of subsidence has been identified in the literature to date. |
| Wildfire | The impact of climate change on the likelihood or magnitude of fire is believed to be low overall (Cruz et al.). Estimates for urbanised and agricultural areas (lower altitudes, mainly southern coastal areas) show no significant change in the risk of fire as a result of climate change and overall determine the risk of fire as low. At higher altitudes, mainly occupied by forests, a small increase in the risk of fire is expected due to increased temperatures and drier conditions (Cruz et al.). Wildfires in Madeira in 2012 started after a period of severe drought and high temperatures (Reuters, 2012b). |
| Soil degradation influencing carbon storage capacity of soils | No specific evidence on the likelihood or magnitude of soil degradation in the Madeira has been identified in the literature reviewed. It is however expected that a scenario of decreased precipitation or increase frequency of floods will increase the vulnerability of soil to erosion and potential desertification. In this sense, the project CLIMAAT (2006) indicated that projections for the archipelago suggest a reduction of the humidity of soils in line with forecasted decreased precipitations and increased evapotranspiration. Additionally, it is important to note that Portugal has been declared as affected by desertification under the United Nations Convention to Combat Desertification (Annex IV). |
| Increased water temperatures | Projections for the north-east Atlantic indicate that sea surface temperature and ocean heat content are increasing in all regions, although at different rates and this trend is expected to continue throughout the 21st century (EEA, 2012).<br>Changes in water temperatures have already extended the marine growing season and changed movement patterns of marine zooplankton and fish (EEA, 2012). In Madeira new marine species have already been observed (see information on invasive species above) which demonstrates further the impact of rising water temperatures. Despite potential negative effects of rising water temperatures, new tropical species appearing in the waters of Madeira may provide an opportunity for the tourism and fisheries sectors. For example "whale watching" businesses could be developed given greater occurrence of whales in the area, which could in turn attract more tourists to the islands. Fisheries could also benefit from changes in species distribution and presence of non-indigenous species (ETC/ACC, 2010). |

**Table D.23 Sectoral vulnerability to climate change – Madeira**

| Sector | Vulnerability | Rationale |
|---|---|---|
| Agriculture | MODERATE | Out of all Outermost Regions, Madeira has the smallest amount of land devoted to agriculture - around 6,000 ha, corresponding to 6.5% of total area. However, this activity still provided around 10% of the employment in 2008 (European Commission, DG Regional Policy, 2011) and showed high levels of 'productivity' of the agricultural land, with the average value of €11,500 per ha (Eurostat). In addition, the sector´s importance is high from an environmental and social perspective. Agricultural landscapes are part of the cultural and tourist identity of the region and also play a protective role over the environment (European Commission, DG Regional Policy, 2011). The agriculture sector contributes to a high degree of self-sufficiency in local food consumption, thus guaranteeing greater economic independence (European Commission, DG Regional Policy, 2011). This sector, characterised by small plots of arable land, is highly sensitive to climatic variations. While decreased precipitation levels forecasted for the region will potentially increase the need for irrigation, increased temperatures may favour the expansion of the agricultural area in altitude and can also lead to increased productivity (Cruz et al). |

| Sector | Vulnerability | Rationale |
|---|---|---|
| Forestry | LOW | About 66% of the region's territory is covered by forests, which are grouped in two main categories: native forests with high ecological value (Laurel forest) coexist with exotic forests (covering about 18% of the territory) introduced either for economic purposes (wood exploitation) or for the protection of soils against erosion (Regional Government of Madeira, 2007). While the forestry sector has a low weight in the regional economy, it is of relevance in rural areas and from an environmental perspective. The Rural Development Program (Autonomous Region of Madeira, 2011) indicates that beyond its economic value, the forestry sector plays an important protective role in Madeira, particularly in terms of defence of soil erosion and protection of the hydrological cycle. Overall, forestry in Madeira seems highly vulnerable from an ecological point of view (see impacts on biodiversity below); rather than as an economic sector (that is forestry products). |
| Fisheries and Aquaculture | MODERATE | The contribution of the fisheries sector to the overall economy of the archipelago in terms of GDP is small (approximately stands at 0.5%, although it could be up to 1%, if associated activities are considered). Direct and indirect fishing activities provide employment to almost 1.5% of the population (Regional department of fisheries of Madeira, 2013). In spite of the apparent low weight in the region's economy, the sector is crucial for at least two fishing communities (Câmara de Lobos and Caniçal) which rely on this activity. In addition, the strategic importance of fish in the regional market should be noted as should be increasing volume of fish in the diet of the population (Regional department of fisheries of Madeira, 2013). |
| Energy | HIGH | The energy sector in Madeira highly relies on imports (approximately 92% in 2009), generating only 8% of its primary energy from local sources (Regions 2020). As of 2009, Madeira had three thermal power plants (combustion of fuel oil, 228.42MW) responsible for approximately 77.9% of total electricity production, one municipal solid waste plant (8 MW, 3.72% of total electricity), 10 hydroelectric plants (51.10 MW, ca. 14.4% of total electricity) and 10 wind parks (39.02 MW, 3.95% of total electricity). Solar energy contributed only 0.3% of total electricity produced in Madeira. The largest demand for electricity comes from domestic (30%), trade and services (23%) and hotels (18%). Another challenge faced by electricity system in Madeira is a fluctuating population (due to tourism), which puts a high strain on the island energy supply, particularly in terms of meeting summer peaks. The Sustainable Energy Action Plan for Madeira was approved in March 2012 (Isle-pact, 2012b). The Autonomous Region of Madeira does not have access to European electricity grid, therefore whole energy demand needs to be met by the energy produced on the island. The electricity system is small, dispersed and facing increasing cost of imports. This makes the islands' energy sector highly vulnerable to potential impacts of climate change. |
| Tourism | HIGH | Tourism is the dominant economic sector in Madeira, with the island being one of the oldest tourist destinations in the world. 70% of tourism in Madeira depends on international tourists (Turismo de Portugal, 2007), it is therefore dependant on good transport links with the mainland Europe. According to European Commission, DG Regional Policy (2011) "taking into account all direct and indirect effects of tourism, the empirical evidence would quantify the importance of tourism in Madeira with a high number (even if official statistics consider lower figures: 21% for GDP and 14% for employment)". The total number of nights spent in hotels by all non-residents each year: 4.85m stays per year, making Madeira the second-most popular tourist destination among the OR (second to The Canary Islands) (Eurostat). Moreover tourism is a high contributor to the services sector, which in 2010 was responsible for 84% of GVA and 71% of employment (AICEP Portugal Global). |

| Sector | Vulnerability | Rationale |
|---|---|---|
| Construction & Buildings | HIGH | The construction sector in Madeira used to be the second largest sector in quantitative and qualitative terms (GDP, employment and impact) (European Commission, DG Regional Policy, 2011). In recent years a decline was observed, with increasing unemployment in the sector. In 2010, industry (energy and construction) jointly provided 14.1% GVA and 16.9% of employment breakdown (AICEP Portugal Global).<br>Population, socio-economic activities and infrastructure in Madeira is concentrated along the coast (European Commission. DG for Maritime Affairs and Fisheries, 2009), therefore making construction and buildings potentially more vulnerable to the impacts of climate change, specifically coastal hazards. |
| Transport | HIGH | Transport and related infrastructure is crucial for all aspects of Madeira's economy. As in case of the Azores, there is no alternative to air transportation, which plays a major role in international tourism. The Autonomous Region of Madeira has two airports: in Santa Cruz in the island of Madeira and in the island of Porto Santo (both located in coastal areas) (AICEP Portugal Global). Recent years have seen a significant investment in inland infrastructure, particularly road network, Madeira airport and maritime ports (AICEP Portugal Global). Transport between the islands relies on either aviation or ferries; extreme weather events and increased frequency of storms is therefore likely to have a major impact on the transport infrastructure in the Madeira, potentially causing severe economic losses. |
| Waste | MODERATE | Disposing of waste in islands characterised by a limited landfill capacity can be challenging (European Commission, DG Regional Policy, 2012a?). The Residual Solid Waste Management Plan (PERRAM) was published in 1999 (Governo regional da Madeira, 1999). Over the last 10 years, Madeira invested in three new waste management facilities, to sort, recycle and treat municipal solid waste (European Commission, DG Regional Policy, 2012a?). The vulnerability of these facilities and waste infrastructure generally to the impacts of climate change is not however clear from the literature reviewed. |
| Health | HIGH | Climate change has already been identified as an element affecting the incidence of vector organisms capable of transmitting vector-borne diseases in the archipelago of Madeira. A mosquito vector (Aedes aegypti) of yellow fever and dengue was first recorded in the island of Madeira in 2004 (European parliament, 2011). Despite all the vector control management initiatives, the mosquito population has found favourable climatic conditions to proliferate, causing significant public health consequences (European Parliament, 2011). As a result, the region is at high risk of vector-borne diseases due to increased temperatures and already in November 2012 it was recorded an outbreak of dengue fever after 1,891 probable cases have been reported, of which 966 were laboratory confirmed. This event represents the first epidemic of dengue fever in Europe since 1928 (Eurosurveillance, 2012). Vector control strategies are putting the health services of the archipelago under high pressure. Overall, health resources in the Autonomous Region of Madeira are considered of similar standard to the mainland Europe, based on the number of hospital beds and nurses per inhabitant (European Commission. DG Regional Policy, 2012b). |

| Sector | Vulnerability | Rationale |
|---|---|---|
| Biodiversity | HIGH | Considered as a biodiversity 'hot-spot', the archipelago of Madeira holds unique natural ecosystems and a high diversity of endemic and rare species (almost 500 species of vascular plants and close to a thousand insects (IUCN, 2008). In particular, the island of Madeira is home to the world´s largest and best-preserved Laurel Forest, declared in 1999 a UNESCO World Heritage Site (Regional department of fisheries of Madeira). Covering over 22% of the territory of the island, the forest is home to a rich biodiversity, including the most threatened bird of Europe, the Madeiran Petrel (Pterodroma Madeira) (IUCN, 2008). These unique ecosystems and species, already threatened by human related activities, are very sensitive to a change in the climatic conditions. Species that currently find their optimum at high altitudes, including endemic and rare ones, may disappear as a result of increased temperatures. Others may be benefited from warmer conditions, and may expand their territories (e.g. Laurel forest) (CLIMAAT II, 2006). Madeira's waters are characterised by a number of marine mammals, including whales, dolphins, and porpoises (28 species) and monk seals. Marine turtles (at least two species) are also known to use the area during their life cycle (Netbiome). |
| Coastal Zone Management | HIGH | No specific Coastal Management Plans were identified for Madeira (European Commission. DG for Maritime Affairs and Fisheries, 2009). While in Portugal, responsibility for coastal protection lies at the national level; the regional governments should develop plans for their coastal zones independently (European Commission. DG for Maritime Affairs and Fisheries, 2009). Over the period 1998-2008, €135 million has been invested in coastal protection activities in the port areas in Madeira (European Commission. DG for Maritime Affairs and Fisheries, 2009).<br>Based on the evidence identified by the literature review, it is believed that with a lack of integrated coastal management plans and existing high anthropogenic pressure on the coastal areas of the archipelago, the vulnerability of the coastal zone to impacts of climate change is high. |
| Soil | NOT ASSESSED | Insufficient information was available to assess the vulnerability of soils to climate change in Madeira. |
| Water | MODERATE | The water sector is crucial for support of economic activities in Madeira. Lack of freshwater resources may have both direct and indirect impacts on the quality of life and socioeconomic activities in the islands. Freshwater in Madeira can't be imported from the mainland or other regions. To reduce its vulnerability to water resources depletion, Madeira utilises water desalination in the island of Porto Santo. Presence of an infrastructure for reclaimed water reuse in Porto Santo has also been documented (Delgado et al.).<br>Project CLIMAAT (2006) concluded that with an expected overall decrease in precipitation in the region, the water supply to the population and tourist sector does not seem to be compromised, although the impact would more significant for the agriculture. In addition, it is believed that due to utilisation of desalination plants and water re-use infrastructure, the vulnerability of the sector to climate change impacts is moderated. |
| Disaster & risk | MODERATE | Madeira remains highly exposed to natural hazards, which may become more frequent due to climate change. As an example, Madeira suffered from flooding in February 2010, with estimated damage (in current prices) of : €1.08bn to infrastructure (capital stock); and €122m of direct losses to businesses and agriculture. Developing instruments for disaster & risk prevention is therefore a crucial for the region. At a national level, the Portuguese National Platform for Disaster Risk Reduction (including the regions of Madeira and Azores) was established in 2010 towards better coordination of preparedness, prevention and response activities (Global Platform for Disaster Risk Reduction, 2011). Since 2006, the regional government operates an integrated communication service (Sistema Integrado de Comunicações de Segurança, Emergência e Defesa da Madeira) and is part to the European project PREMUMAC. The existence of prevention and response programmes reduces vulnerability of the archipelago to potential increased frequency of natural disasters. |

**D.24 Risks and opportunities resulting from climate change - Madeira.**

| Sectors | Agriculture | Forestry | Fisheries & Aquaculture | Energy | Tourism | Construction & Buildings | Transport | Waste | Health | Biodiversity | Coastal Zone Management | Soil | Water | Disaster & risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Increase in pests and diseases | | | | | | | | | | | | | | |
| Increase in invasive species | | | | | | | | | | | | | | |
| Increase in temperature | | | | | | | | | | | | | | |
| Increased in extreme temperature events | | | | | | | | | | | | | | |
| Increase in floods | | | | | | | | | | | | | | |
| Change to annual patterns of rainfall | | | | | | | | | | | | | | |
| Low water levels in lakes and rivers | | | | | | | | | | | | | | |
| Drought | | | | | | | | | | | | | | |
| Increase in coastal flooding | | | | | | | | | | | | | | |
| Coastal inundation as a result of sea level rise | | | | | | | | | | | | | | |
| Saltwater intrusion | | | | | | | | | | | | | | |
| Coral bleaching | | | | | | | | | | | | | | |
| Increased risk of landslide/mudslide | | | | | | | | | | | | | | |
| Subsidence | | | | | | | | | | | | | | |
| Wildfire | | | | | | | | | | | | | | |
| Soil degradation influencing carbon storage capacity of soils | | | | | | | | | | | | | | |
| Increased water temperatures | | | | | | | | | | | | | | |

Notes: Colour coding of the cells in the risk matrix: Red – high risk, Orange – moderate risk, Olive – low risk, Green – opportunity, Grey – the risk is relevant to the sector however could not be assessed. Blank – impacts not relevant to the sector.

# Appendix E: Assessment of EU Funds (2007 to 2012)

## Methodology

The purpose of this task/section is to provide a clear analysis of the potential of EU Funds, namely the European Regional Development Fund (ERDF), the European Agricultural Fund for Rural Development (EAFRD) and the European Fisheries Fund (EFF), to address climate change adaptation objectives in Outermost Regions. The main objective is to give a general picture of the main approaches to using EU funds for addressing climate change adaptation in the 2007-2013 programming period.

The categorization of spending and data available differ considerable across the EU funds; therefore a separate methodological approach has been applied to each type of fund. The methodology mobilized to carry out the assessment makes use of statistical data on Structural Funds and Rural Development Funds budgets of the Outermost Regions in the 2007-2013 period; the EFF is instead subject to a general analysis since the operational programmes for the fisheries fund are at national level. This means that precise allocations in the field of fisheries are not specifically available for each Outermost Region.

The aim of the exercise is to identify the main features of the measures of such funding programmes for Outermost Regions that are dedicated to climate change adaptation objectives. An activity is defined as adaptation related if it intends to reduce the vulnerability of human or natural systems to the impacts of climate change and climate-related risks, by maintaining or increasing adaptive capacity and resilience[192].

**Cohesion Policy – ERDF**

Section 4 analyses the ORs use of Structural Funds for climate adaptation related measures in the programming period 2007-2013.

The methodology used relies on DG REGIO[193] data available on the programmed expenditure for 2007-2013 period. The dataset contains data on planned expenditure from the financial tables of approved Regional Operation Programmes. However, it is important to note that the specification of measures in these various programmes is generally not detailed enough to enable exact determination of the amount of funds allocated for measures addressing climate change adaptation. On the one hand, Cohesion Policy funding categories for 2007-2013do not explicitly address climate change adaptation, but rather focus on other objectives (e.g. nature protection, territorial cohesion, economic growth), which are related to climate change adaptation. On the other hand, actual expenditure is not available yet for the 2007-2013 programming period, so the data used are funding allocations.

To better understand how the OR are using 2007-2013 Structural Funds for adaptation related measures, we have first identified those funding categories[194] with adaptation potential. As none of the measures is completely dedicated to adaptation, we have then assigned the potentially relevant measures into two categories and classified them into two groups ('higher significance' and 'lower significance') based on the content of the measures.

A scaling factor of either 50% (higher climate adaptation significance) or 30% (lower climate adaptation significance) has then been applied to each category to show that only a certain share of the total allocation for a measure should be considered adaptation significant.. This categorization of measures is shown in the table below.

[192] OECD (2011), Handbook on the OECD-DAC Climate Markers
[193] http://ec.europa.eu/regional_policy/country/prordn/index_en.cfm

**Table E.1 ERDF Climate adaptation potentially relevant measures and classification**

| Relevance to adaptation | Codes [195] ERDF | % of the activity's expenditure that is climate adaptation related |
|---|---|---|
| higher climate adaptation significance | **49** 'Mitigation and adaptation to climate change' | **50 %** |
| | **53** 'Risk prevention (including the drafting and implementation of plans and measures to prevent and manage natural and technological risks)' | |
| | **54** 'Other measures to preserve the environment and prevent risks' | |
| lower climate adaptation significance | **45** Management and distribution of water (drinking water) | **30 %** |
| | **46** Water treatment (waste water) | |
| | **51** Promotion of biodiversity and nature protection (including NATURA 2000) | |
| | **55** Promotion of natural assets | |
| | **56** Protection and development of natural heritage | |

There are some categories of expenditure that are quite straightforward to classify (e.g. code 49 'Mitigation and adaptation to climate change'). However, there are other categories that are trickier and need more attention. They could potentially address climate adaptation, but are not described in the Operational Programmes in enough detail to understand whether they could be beneficial to climate change adaptation or not. A certain caution is necessary with investments addressing 'risk prevention'. Here the scope is wide and could include activities related to man induced disaster. At the same time, disaster resilience can include early warning systems and developing adaptive capacities which would be a straightforward adaptation activity.

Climate resilience may also be incorporated into a variety of funding measures throughout the regional Operational Programmes, especially those regarding infrastructures, making the adaptation elements integrated difficult to track. One example is the policy measure under the ERDF programme "multimodal transport", which could either contain resilience measures (e.g. the restoration of old infrastructure to be more climate resilient) or on the contrary could also mean the co-funding of additional highway infrastructure. Other examples are climate mitigation measures that could create synergies with the adaptation measures (e.g. codes 39 – 42 Renewable energy: wind, solar, biomass, hydroelectric, geothermal and other; code 43: Energy efficiency, co-generation, energy management); and other infrastructure measures (e.g. building of dams, enforcing of harbor infrastructure etc.). Given the methodological limitation, these types of measures have not been considered. Moreover, the impacts of Cohesion Policy programmes in addressing climate change may have both positive and negative implications on regional climate change adaptation. The true impact on climate change is usually difficult to identify in the short term, and becomes clear from a long term assessment. For example, sustainable tourism in Outermost Regions can have both positive and negative effects. By supporting the preservation of natural heritage and channeling the access of these resources to tourists, local biodiversity is preserved. However, the additional attractiveness of the tourist destination may produce negative effects on climate change in the long run through the increase of waste in the region.

[195] Categorization of funds assistance for 2007-2013, codes for the priority theme dimension, Annex II, Commission Regulation (EC) No. 1828/2006.

To get an indication of the extent to which each OR is using 2007-2013 Structural Funds for climate adaptation related measures, we have calculated the total amount of funds allocated in each regional OP for each potentially relevant measure and then applied the scaling factor of 50 or 30 percent to the total amount. These calculations are shown in Chapter 4 of this report and are also given in the sections of this appendix for each OR below. In addition the percentage share of each relevant category against total ERDF spending is shown in a pie chart for each OR, to demonstrate the relative weight of the spending category for the region overall.

**Common Agricultural Policy - EAFRD**

The methodology used for analysis of the allocation of EAFRD dedicated to adaptation to climate change is based on the categorization adopted by the EAFRD Regulation[196] as amended after the CAP Health Check and European Economic Recovery Plan[197]. As adopted in Article 16a and Annex II, from 1 January 2010, the Member States had to provide in their rural development programmes, in accordance with their specific needs, for types of operations having climate change priorities. Moreover, according to the same article, Member States had to raise the aid intensity to such priorities by 10 percentage points.

The methodology used relies on ENRD[198] data available on the programmed expenditure for 2007-2013 period. The dataset contains data on planned expenditure from the financial tables of approved Rural Development Programmes. It is important to note that the available specification of measures in these various programmes are more detailed compared to those of the Regional Operation Programmes. This allows a more precise differentiation of the funds used to address climate change.

The selected measures are listed in the table below.

**Table E.2 EAFRD climate adaptation relevant measures**

| Groups of measures | Measures |
|---|---|
| **Axis II - improving the environment and countryside** | |
| Encourage the introduction or maintenance of production methods compatible with the protection of environmental values and water and soil resources within the agriculture and forestry activity | **214** agri-environmental payment |
| Improving the sustainability of forest stands | **221** first afforestation of agricultural land<br>**222** first establishment of agroforestry systems on agricultural land<br>**225** forest-environment payments<br>**226** restoring forestry potential and introducing prevention actions<br>**227** support for non-productive investments -afforestation protection |
| **Axis I - improving the competitiveness of the agricultural and forestry sector** | |

[196] COUNCIL REGULATION (EC) No 1698/2005 of 20 September 2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD)

[197] The Member States/regions in question have proposed amendments to their Rural Development Programmes (RDPs) to make use of extra funding provided by the Health Check of the Common Agricultural Policy and the European Economic Recovery Plan (EERP), agreed in November 2008. The extra funding in question totals € 4.4 billion for the EU as a whole and must be spent through RDPs in the period 2009 to 2013. Member States/regions choose the priorities on which to spend their funding from a list which includes climate change, restructuring of the dairy sector and broadband for rural areas.

[198] http://enrd.ec.europa.eu/

| Groups of measures | Measures |
|---|---|
| New financial instruments and management of risks and crisis | **121** modernization of agricultural holdings<br>**125** improving and developing infrastructure related to the development and adaptation of agriculture and forestry<br>**126** restoring agricultural production potential damaged by natural disasters and introducing appropriate prevention action |

Modernization of agricultural holdings (measure 121) considers adaptation to climate change as it aims at improving water consumption and water quality. Example of operations under this measure include preventive mechanisms against adverse effects of climate-related extremes events (e.g. setting up for hail nets), water saving technologies (e.g. efficient irrigation systems), water storage (including water overflow areas), water saving production techniques (e.g. adapted cropping patterns), and installation of waste water treatment on farms and in processing and marketing.

Under measure 125, explicit reference is made to supporting investments for the improvement and development of irrigation infrastructure. These refer to operations such as water storage systems, investments in individual or collective dams and water storage facilities for water storage during heavy rainfall periods as well as drainage equipment, improvement of electric installations for irrigation, installation of water consumption meters, modification of pumping etc.

Measure 126 is highly relevant as it refers to maintenance of the production conditions that may be affected by severe natural disasters through the investment regarding the reestablishment/restoration of fixed capital, including on-farm plantation and infrastructures.

Under axis II, despite measure 214 is mainly relevant for climate mitigation, it demonstrates synergies that could exist between the two aspects of climate change. In particular, it encourages farmers to continue their livestock activities in areas sensitive to environmental risks by adopting environmental friendly activities, supports the conservation of plant species under risk of genetic erosion and conservation in-situ and ex-situ, as well as investments for extensive agricultural systems of dry land or the management of wetlands, building synergies with biodiversity objectives.

Measure 221 and 222 also ensure synergies with mitigation. They support afforestation with natural productive species to fight serious problems of soil erosion and desertification, spatial planning of pastures and conservation, conservation and improvement of forest lanes etc.

Measure 224 strengthens the protection of biodiversity, the conservation of forest species of high value, the promotion of diversity of forest species in the stands and the reduction of risk associated with invasive plants.

Measure 225 encourages the holders of forest areas to undertake voluntary and mandatory standards strengthening the protective role of forests against spoil erosion, while measures 226 and 227 are of high importance as they promote the establishment of preventive measures in order to prevent natural risks, such as forest fires and the prevention of natural hazards, action for fighting erosion and desertification from natural catastrophes, creation and recovery of open spaces in forest, elimination of un desirable or intrusive plant species, hydro-forest restoration to address adverse effects of heavy rainfall in some areas, restoration of green cover and activities of reforestation, construction of structures like ditches fences and bays.

**Common Fisheries Policy – EFF**

While the methodology mobilized so far makes use of statistical data on Structural Funds and Rural Development Funds budgets of the Outermost Regions in the 2007-2013 period, the European Fisheries Fund is instead subject to a general analysis since the operational programmes for the fisheries fund are at national level. This means that precise allocations dedicated to climate change adaptation measures in the field of fisheries are not specifically available for each Outermost Region.

**Non EU adaptation funded initiatives**

Outside the EU, other donors and funding institutions have also supported adaptation initiatives, actions and measures in Outermost Regions. These primarily include the World Bank (GEF), The European Investment Bank and UNEP.

For the analysis of these funding no special methodology has been developed. Instead, a general research on the main IFIs website portals has been conducted. The examples of projects non EU funded mentioned in section 4are useful to be taken into account as good practices. They give a good overview on how adaptation objectives are brought forward in the outermost regional programming agendas. Opportunities to transfer knowledge gained from non EU funded initiative should be considered.

## EU Funds assessment

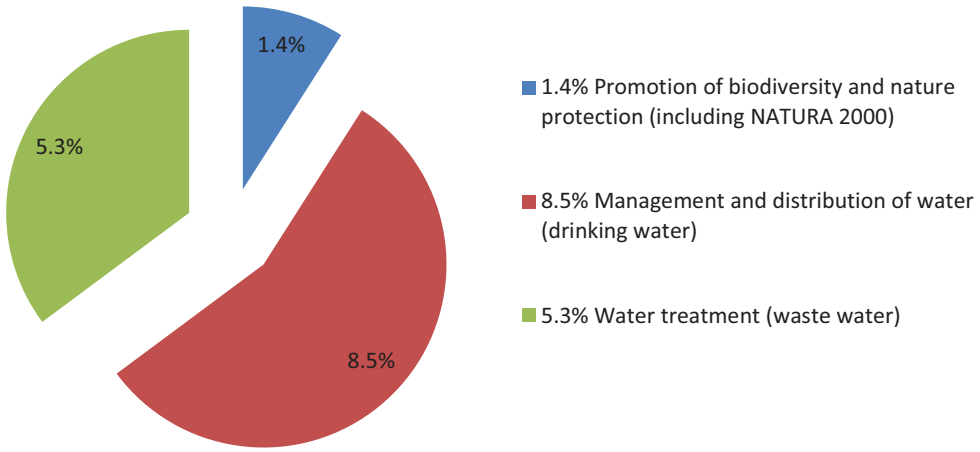
### Guadeloupe

#### Use of EU funds

**Cohesion Policy – ERDF**

Guadeloupe received a total of about EUR 542 million EU contributions in the programming period 2007-2013. Based on the methodology described above, approximately 15% of the budget was allocated to activities that could be considered as significantly adaptation related, with the largest share being spent in management and distribution of water. Generally, Guadeloupe is probably the Outermost Region with the least support for climate change adaptation from the Cohesion Policy. Figure E.1 shows the share of total funds allocated to each of the adaptation related measures.

**Figure E.1 2007-2013 ERDF Budget for selected adaptation related measures on Guadeloupe**




*Source: OP of ERDF for Guadeloupe*

**Common Agricultural Policy (CAP) – EAFRD**

Total EU contribution for rural development from the CAP is estimated at EUR 141 million for 2007-2013. The individual measures relevant for addressing climate change within its RDP are mainly within Axes 1 and 2: support of less favoured areas (mountain) as well as agri-environmental payments. The overall contribution from CAP addressing climate change issues is to be considered as very moderate.

In terms of adapting to cope with the potential impacts of climate change Guadeloupe RDP focuses on two key sets of actions: one relating to the preservation of genetic resources with the overarching objective to protect biodiversity; and one relating to water management through efficiency improvements in irrigation infrastructures and enhancement in the capacity to store water.

Access to water resources is a very specific problem in Guadeloupe, as in all Outermost Regions, where climatic conditions are responsible for the alternation between very dry and excessively wet periods. The challenge therefore is to introduce water-saving techniques during dry periods and efficient drainage equipment during wet periods, taking into account the unequal geographic distribution of demand for water.

The RDP revised after the Heath Check for Guadeloupe gives more importance to biodiversity, especially conservation of genetic resources, and water management (48%), enhancing the climate change focus[199].

The main measure through which the RDP seeks to support efforts to adapt to climate change is measure 214 – agri-environment payments - which demonstrates synergies between climate change mitigation and adaptation since it includes sub-measures that deal with both aspects. Conservation of genetic resources involves protection of threatened species in order to preserve diversity of animal farms species as well as preserve plant resources threatened by extinction. For the latter the objective is not only to protect but also to re-integrate in the soil traditional plant varieties threatened by genetic erosion. For the conservation of genetic resources of animal breed, Guadeloupe focuses on the "Creole" bovine breed. The conservation of threatened species is also accompanied by the use of apiculture as a means to protect and preserve biodiversity. Integrated farming is also applied for different purposes adapting to regional specificities and problems: integrated banana production in Guadeloupe aims to maintain the banana crop which suffers from a specific pest.

Under axis 1, the main measure through which RDP seeks to support efforts to adapt to climate change is measure 125 – infrastructure related to the agricultural sector – which covers operations related to water supply and efficiency. This measure is almost 18% of the total EAFRD allocation for Guadeloupe. Water efficiency is promoted through investments in individual or collective dams and water storage facilities for water storage during rainfall periods as well as drainage equipment.

Water management is also addressed by measure 121 – modernization of agricultural holdings – including investments for the modernization of irrigation systems, deposits and drainage and waste water management.

Other measures implemented within the RDP under Axis 1 are likely to create synergies in order to improve the management conditions of farmlands and cope with adaptation to climate change particularly against natural catastrophes (hurricanes, earthquakes, volcanic eruptions). These include measure 126 – restoring agricultural production potential – which finances material and immaterial incensement for the restoration of agricultural production potential (replanting of orchards, reconstruction of buildings) especially in territories affected by natural disasters like Guadeloupe is. However, their official financial weight in axis 2 and in the programmes in general is rather small so as to imply significant impact.

**Common Fisheries Policy – EFF**

During 2000-2006 France received over € 278 million from the EU under the Financial Instrument for Fisheries Guidance (FIFG). As a result, more than 9,500 projects received support. The new EU programme for 2007-2013 aims to build on the success of the previous programme. It seeks to consolidate a viable fisheries and aquaculture sector that respects resources and the marine environment, while meeting the demands of consumers and the food industry; and safeguarding, as far as possible, the income of fishermen.

[199] The proportion of additional funding from the CAP Health Check is given in brackets.

The European Commission recently approved the Operational Programme for the French fishing industry for the period 2007-2013 (EUR ~14.7 million). The total eligible public expenditure under this programme is €436.2 million, with EU assistance through the European Fisheries Fund (EFF) amounting to € 216.0 million. € 34.3 million of EFF aid will be allocated to the to the convergence regions (Overseas Departments)[200]. As the programme implemented at national level, it is not possible to know the exact allocations dedicated to French Guiana for climate change adaptation objectives.

**Research and Innovation**

Guadeloupe's background has paved the way for the emergence of innovation in some sectors. The island has thus been able to position itself resolutely as a testing ground for:

- experimenting with renewable energy forms: solar, photovoltaic, thermal, biomass, high-pressure geothermal, small hydro and ocean energy (the share of renewable energy in primary energy consumption is 13.7 %);
- developing and adapting equipment and surface materials to fit the climate and seismic conditions; and
- developing knowledge and a database on volcanic/tectonic activity.

With regard to tropical agronomy, the varied nature of the constraints has enabled the development of expertise recognized at international level. One example of this are studies on species adaptation and resistance to climate, parasites and stress. In light of the emerging issue of sustainable agriculture, food and health, there is a significant body of research examining the impact of pesticides on health and the environment, the reduction of their use or even of any inputs in agriculture

Promoting an open approach, the Guadeloupe research is planned to focus on several, previously identified domains:

- renewable energies;
- risks and equipment;
- promoting biodiversity; and
- ICT.

**Examples of relevant research projects**

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| EUCarinet | Research | FP7 | To strengthen sustainable policy dialogue on S & T between EU Member States and associated states on the one hand, and countries from the Caribbean region on the other — namely members of the African, Caribbean and Pacific Group of States (ACP), overseas departments and collectivities as well as overseas countries and territories (OCTs). | |

[200] EAS (2010), The European Fisheries Fund Compilation of Member State Operating Programmes for Fisheries 2007-2013

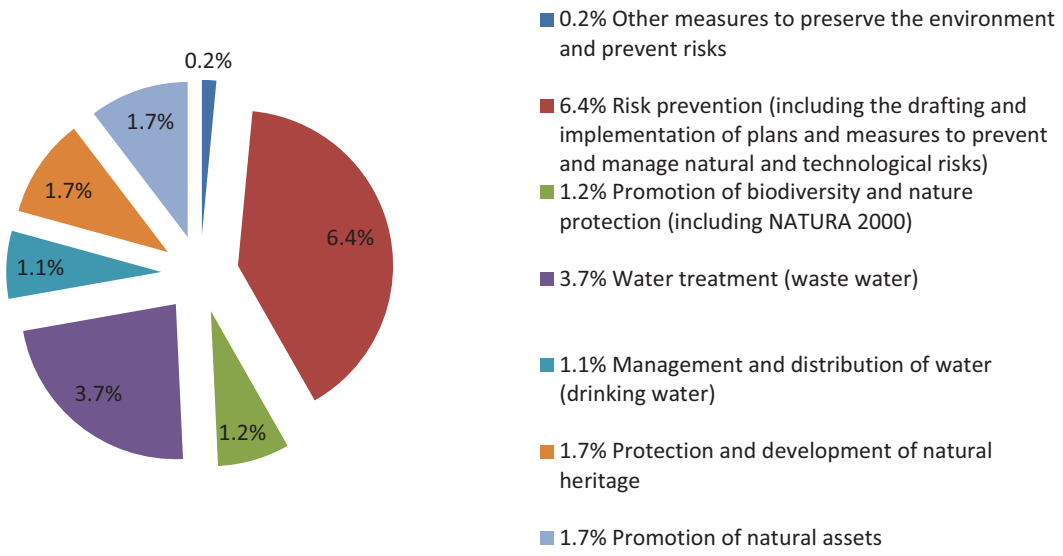
## Martinique

### Use of EU funds

#### Cohesion Policy - ERDF

Approximately 15% of the EUR 420 million granted to Martinique is dedicated to funding activities addressing climate change adaptation. The highest share was directed to "risk prevention" measures that received almost 7% of the ERDF funding, while the "promotion of natural assets" and the "promotion and development of environmental heritage" about 3.5% of the share. Figure E.2 shows the share of total funds allocated to each of the adaptation related measures.

**Figure E.2 2007-2013 ERDF Budget for selected adaptation related measures on Martinique**




*Source: OP of ERDF for the Martinique*

#### Common Agricultural Policy (CAP) – EAFRD

Total EU contribution for rural development from the CAP is estimated at EUR 100.575.000 for 2007-2013. In terms of actions supported through EAFRD showing potential relevance for addressing climate change, the payments under the heading of supporting farming in less favoured areas (mountains) as well as agri-environmental payments seem to be the most important.

In terms of adapting to cope with the potential impacts of climate change Guadeloupe RDP focuses on two key sets of actions: one relating to the preservation of genetic resources with the overarching objective to protect biodiversity; and one relating to water management through efficiency improvements in irrigation infrastructures and enhancement in the capacity to store water.

Access to water resources is a very specific problem in Martinique, as in all Outermost Regions, whose climatic conditions are responsible for the alternation between very dry and excessively wet periods. The double challenges there therefore is to introduce water saving techniques during dry periods and efficient drainage equipment during wet periods, taking into account the unequal geographic distribution of demand for water. Efforts to address water management issues are taken made under both axes 1 and 2.

The revised RDP for Martinique recognized more importance to biodiversity, especially conservation of genetic resources, and water management (81%) enhancing the climate change focus[201].

The main measure through which the RDP seek to support efforts to adapt to climate change is measure 214 – *agri-environment payments* - which demonstrates synergies between climate change mitigation and adaptation since it includes sub-measures that deal with both aspects. Conservation of genetic resources involves protection of threatened species in order to preserve diversity of animal farms species as well as preserve plant resources threatened by extinction. For the latter the objective is not only to protect but also to re-integrate in the soil traditional plant varieties threatened by genetic erosion. The conservation of threatened species is also accompanied by the use of apiculture as a means to protect and preserve biodiversity. Integrated farming is also applied for different purposes adapting to regional specificities and problems: integrated banana production in Martinique aims to maintain the banana crop which suffers from a specific pest.

Under axis 1, the main measure through which RDP seeks to support efforts to adapt to climate change is measure 125 – infrastructure related to the agricultural sector – which covers operations related to water supply and efficiency. This measure is almost 21% of the total EAFRD allocation for Martinique. Water efficiency is promoted through investments in individual or collective dams and water storage facilities for water storage during rainfall periods as well as drainage equipment.

Water management is also addressed by measure 121 – *modernization of agricultural holdings* – including investments for the modernization of irrigation systems, deposits and drainage and waste water management. This measure accounts for almost 20% of the total EAFRD allocation for Martinique.

Other measures implemented within the RDP under Axis 1 are likely to create synergies in order to improve the management conditions of farmlands and cope with adaptation to climate change particularly against natural catastrophes (hurricanes, earthquakes, volcanic eruptions). These include measure 126 – restoring agricultural production potential – which finances material and immaterial incensement for the restoration of agricultural production potential (replanting of orchards, reconstruction of buildings) especially in territories affected by natural disasters like Martinique is. However, their official financial weight in axis 2 and in the programmes in general is rather small so as to imply significant impact.

**Common Fisheries Policy – EFF**

During 2000-2006 France received over € 278 million from the EU under the Financial Instrument for Fisheries Guidance (FIFG). As a result, more than 9,500 projects received support. The new EU programme for 2007-2013 aims to build on the success of the previous programme. It seeks to consolidate a viable fisheries and aquaculture sector that respects resources and the marine environment, while meeting the demands of consumers and the food industry; and safeguarding, as far as possible, the income of fishermen.

The European Commission recently approved the Operational Programme for the French fishing industry for the period 2007-2013 (EUR ~14.7 million). The total eligible public expenditure under this programme is € 436.2 million, with EU assistance through the European Fisheries Fund (EFF) amounting to € 216.0 million. € 34.3 million of EFF aid will be allocated to the to the convergence regions (Overseas Departments)[202]. Being the programme implemented at national level, it is not possible to know the exact allocations dedicated to French Guiana for climate change adaptation objectives.

**Research and innovation**

On the basis of these territorial characteristics, research and innovation have developed and grown around the starting point: adding value to Martinique outputs. A skills assessment highlighted important themes, organised around common clusters:

- biodiversity, agronomy, agro-transformation and agro-environment cluster;

[201] The proportion of the additional funding from the CAP HC is given in brackets

[202] EAS (2010), The European Fisheries Fund Compilation of Member State Operating Programmes for Fisheries 2007-2013

- human and social sciences cluster;
- natural hazards, soil, water and geothermal studies cluster;
- health cluster; and
- aquaculture and fishing resources cluster.

New clusters have sprouted from these sectors in line with current concerns: waste management; refrigeration; maintenance in tropical areas; renewable wind and marine energy; earthquake and cyclone resistant construction; and ICT.

Interregional cooperation follows the same lines — the projects envisaged to develop digital connections, a tourism observatory, a Caribbean-wide research centre and a platform for civil protection.

### Examples of relevant research projects

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| CARIWATNET | | EDF | Increasing scientific excellence of Caribbean partners and to jointly develop integrated managements plans for selected watersheds on the Islands of the islands that respects and enhances indigenous knowledge, protect environmental resources, increases livelihood security, restores biodiversity and reduces the communities' vulnerability to the effects of climate change. | |

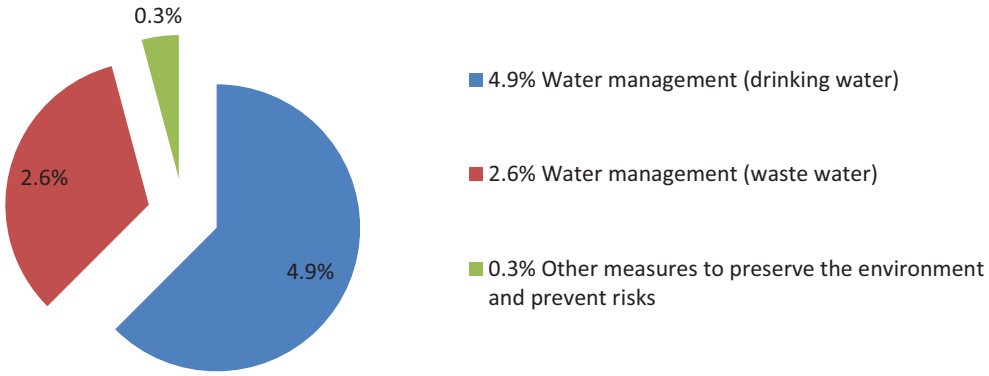
## French Guiana

### Use of EU funds

#### Cohesion Policy – ERDF

Within the ongoing period (2007-2013), the EU contributed roughly EUR 305 million for the ERDF in French Guiana. As can be seen in the figure below, only a minor share of the budget was used for measures addressing climate change adaptation. With regard to activities that could be considered as significantly adaptation related, the largest share was allocated for "water management", while only less than 1 % was dedicated to risk prevention measures. Figure E.3 shows the share of total funds allocated to each of the adaptation related measures.

**Figure E.3 2007-2013 ERDF Budget for selected adaptation related measures on the French Guiana**




*Source: OP of ERDF for the French Guiana*

Furthermore, one of the main programme priorities of the Operational Programme Interreg Caraibes IV, is to strengthen environmental management and risk prevention in French Guiana, Guadeloupe and Martinique. This accounts for almost 9% of the total ERDF allocation for the programme (about EUR 47 million). Operations under this priority includes the promotion of the implementation of prevention plans and warning systems, surveillance and monitoring of natural hazards, the support of comprehensive security plans and coastal sea ports for the region. The promotion of natural assets and the protection and development of natural heritage are also among the priorities and accounts for 8% of total ERDF budget of the programme.

The territorial cooperation programme Amazonia is also of relevance for French Guiana. Despite involving also other neighbouring countries that are not subject of the analysis, the programme dedicates some funding to risk prevention and the promotion of natural assets and the protection and development of natural heritage objectives.

**Common Agricultural Policy (CAP) – EAFRD**

Compared to ERDF funding, the support for climate change by the second pillar of the CAP (e.g. rural development funds) has been moderate. Total EU contribution for rural development from the CAP is estimated at EUR 77 million for 2007-2013. As French Guiana is not really a region with intensive agricultural production, the support from the CAP is much lower than in the other Outermost Regions. The main emphases of the programme include: improving and developing infrastructure for the adaptation of agriculture and forestry, offering basic services for the economy and rural population, vocational training and information actions, including diffusion of scientific knowledge and innovative practices for people working in the agricultural, food and forestry sectors.

In terms of adapting to cope with the potential impacts of climate change, the French Guiana RDP focuses on three key sets of actions: one relating to the preservation of genetic resources with the overarching objective to protect biodiversity; another relating to efficient water management, irrigation and enhanced water storage; and the third relating to the risk management of natural disasters.

The revised RDP for French Guiana put more emphasis on biodiversity, especially the conservation of genetic resources, and water management (21%) enhancing the climate change focus despite the fact that the climate-relevant percentage of funding remains lower than that of other French OR[203].

[203] The proportion of the additional funding from the CAP HC is given in brackets

Under axis 2, measure 214 – *agri-environment payments* - demonstrates synergies between climate change mitigation and adaptation since it includes sub-measures that deal with both aspects. Conservation of genetic resources involves protection of threatened species to preserve diversity of animal farms species as well as to preserve plant resources threatened by extinction. For the latter, the objective is not only to protect but also to re-integrate in the soil traditional plant varieties threatened by genetic erosion. Measure 214 is further supported with additional funding for the conservation of genetic diversity from the CAP HC.

Measure 227 – *non-productive investments* – aims to encourage the establishment of preventive measures for natural risks. Measure 227 includes actions such as creation and recovery of open spaces in forests (clearings), elimination of undesirable or intrusive plants species, investments for providing information on the use of forests and other non-productive investments with a view to restore and conserve habitats and species, especially high natural value areas such as Natura 2000 sites. Measure 227 accounts 1% of the total EAFRD budget for French Guiana. It might seem a rather low share, but it is much more compared to the other French Outermost Regions, where, apart from Réunion, 227 is not financed at all.

Under axis 1, the main measure through which RDP of Réunion seeks to support efforts to adapt to climate change is measure 125 – infrastructure related to the agricultural sector – which covers operations related to water supply and efficiency. Water efficiency in Réunion is promoted through investments in individual or collective dams and water storage facilities for water storage during rainfall periods as well as drainage equipment. This measure accounts for more than 5% of the total EAFRD allocation.

Water management is also addressed by measure 121 – modernization of agricultural holdings – including investments for the modernization of irrigation systems, deposits and drainage and waste treatment. Measure 121 has been supported with additional funding for water management following the CAP HC. The revised RDP targets additional funding to production techniques which allows a more rational use of water and to investments in waste water treatment facilities on farms.

**Common Fisheries Policy – EFF**

During 2000-2006 France received over € 278 million from EU support under the Financial Instrument for Fisheries Guidance (FIFG). As a result, more than 9,500 projects received support. The new EU programme for 2007-2013 aims to build on the success of the previous programme. It seeks to consolidate a viable fisheries and aquaculture sector that respects resources and the marine environment, while meeting the demands of consumers and the food industry; and safeguarding, as far as possible, the income of fishermen.

The European Commission recently approved the Operational Programme for the French fishing industry for the period 2007-2013 (EUR ~14.7 million). The total eligible public expenditure under this programme is € 436.2 million, with EU assistance through the European Fisheries Fund (EFF) amounting to € 216.0 million. € 34.3 million of EFF aid will be allocated to the convergence regions (Overseas Departments)[204]. As a programme implemented at national level, it is not possible to know the exact allocations dedicated to French Guiana for climate change adaptation objectives.

**Research and Innovation**

French Guiana has assets: a geostrategic entry point for the EU in South America and the crossing point between the Mercosur regional trade agreement (1) and the Caribbean Community, Caricom (2). Due to its desirable location, research activities have been developed and the research and technological development (RTD) mechanism was set up. This enabled the development of several promising sectors organised around different clusters, including:

204 EAS (2010), The European Fisheries Fund Compilation of Member State Operating Programmes for Fisheries 2007-2013

- tropical rain forest: research on the tropical rain forest ecosystem;
- agronomy and agro-transformation: valorization of natural substances for pharmaceutical or cosmetic purposes; promoting plant or animal species;
- water: research on tropical aquatic environments; ocean dynamics and hydrology;
- health: health monitoring; research for emerging or re-emerging illnesses(malaria); virology or retro virology; telemedicine and remote sensing to monitor infectious illnesses;
- human sciences: ethnology; ethno-sciences; archaeology;
- engineering sciences: ICT; alternative sources of energy; material corrosion.

### Examples of relevant research projects

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| STRONGER | Health | FP7 | To set-up a taskforce that is more capable of managing infectious and emerging diseases in French Guiana. | http://www.pasteur-cayenne.fr/stronger/ |
| STORMITURTLE | Biodiversity | FP7 | Focus on the adaptive strategies of critically-endangered species facing environmental constraints and will tackle one of the most important questions relating to the global change impacts on marine biodiversity | http://www.nioz.nl/ |

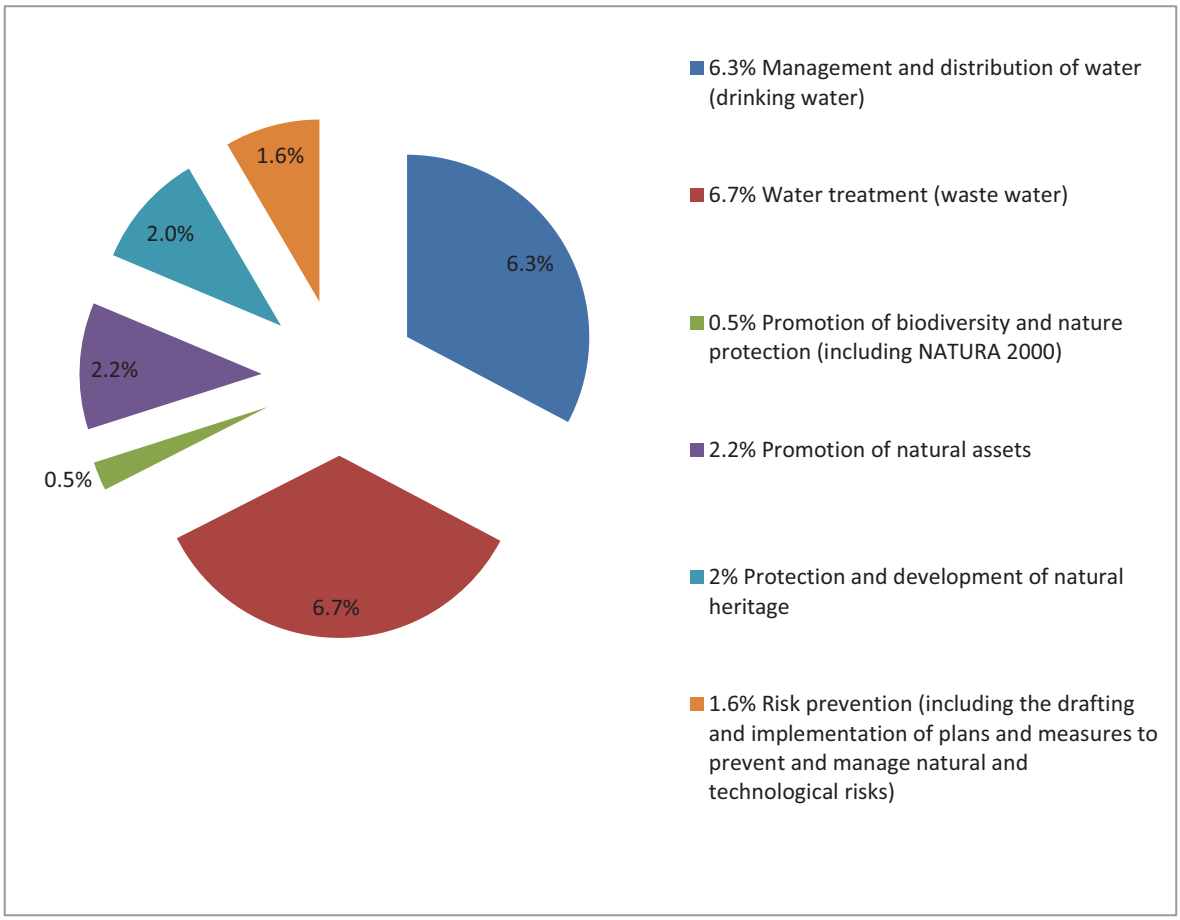
## La Réunion

### Use of EU funds

#### Cohesion Policy – ERDF

For the 2007-2013 period Réunion received EUR 1 billion from the ERDF budget. The largest share of funding attributed to activities significantly adaptation related were invested in “water management” and “water treatment”, with a share of 13%. “Promotion of natural assets” and “development of environmental heritage” took around 4% of the total ERDF spending, while “risk prevention” only 1.6%. Figure E.4 shows the share of total funds allocated to each of the adaptation related measures.

**Figure E.4 2007-2013 ERDF Budget for selected adaptation related measures on Réunion**




*Source: OP of ERDF for the Réunion*

One of the main programme priorities of the Operational Programme Interreg Caraibes IV is to strengthen environmental management and risk prevention in Guadeloupe, French Guiana, and Martinique. This accounts for almost 9% of the total ERDF allocation for the programme (about EUR 47 million). Operations under this priority include the promotion of the implementation of prevention plans and warning systems, surveillance and monitoring of natural hazards, the support of comprehensive security plans and coastal sea ports for the region. The promotion of natural assets and the protection and development of natural heritage are also among the priorities and accounts for 8% of the total ERDF programme budget.

**Common Agricultural Policy (CAP) – EAFRD**

Compared to ERDF funding, support from CAP rural development funds relevant for climate change adaptation has been moderate. Total EU contribution for rural development from the CAP is estimated at EUR 321 million for 2007-2013. In terms of actions supported through EAFRD showing potential relevance for addressing climate, the payments under the heading of supporting farming in less-favoured areas (mountains) as well as vocational training and information actions and agri-environmental payments seem to be the most important.

In adapting to climate change, the Guadeloupe RDP focuses on three key sets of actions: one relating to the preservation of genetic resources with the overarching objective to protect biodiversity; one relating to water management through efficiency improvements in irrigation infrastructures and enhancement water storage; and one relating to risk management of natural disasters.

Access to water resources is a very specific problem in Réunion, as in all Outermost Regions, whose climatic conditions alternate between very dry and excessively wet periods. The twin challenges are

therefore to introduce water saving techniques during dry periods and efficient drainage equipment during wet periods, taking into account the unequal geographic distribution of demand for water. Efforts to address water management issues are taken under both axes 1 and 2.

The revised RDP for Réunion put more importance on biodiversity, especially conservation of genetic resources, and water management (75%) enhancing the climate change focus[205].

Under axis 2, measure 226 – restoring forestry and introducing prevention actions – and measure 227 – non-productive investments – aim to encourage the establishment of preventive measures for natural risks. Measure 226 includes action for fighting erosion and desertification from natural catastrophes such as floods. Measure 227 includes actions such as the creation and recovery of open spaces in forests (clearings), elimination of undesirable or intrusive plants species, investments for providing information on the use of forests and other non-productive investments with a view to restore and conserve habitats and species, especially high natural value areas such as Natura 2000 sites. Measure 227 accounts of 3.5% of the total EAFRD budget for Réunion. It might seem a rather low share, but it is much more compared to the other French Outermost Regions, where, apart from Guyana, measures 226 and 227 are not financed at all.

Under axis 1, the main measure through which RDP of Réunion seeks to support efforts to adapt to climate change is measure 125 – infrastructure related to the agricultural sector – which covers operations related to water supply and efficiency. Water efficiency in Réunion is promoted through investments in individual or collective dams and water storage facilities for water storage during rainfall periods as well as drainage equipment. Water management under measure 125 is reinforced with additional funding stemming from the CAP HC in Réunion (the additional funding for this measure representing almost 10% of total additional funding for the Réunion RDP).

Measure 214 – *agri-environment payments* - demonstrates synergies between climate change mitigation and adaptation since it includes sub-measures that deal with both aspects. Conservation of genetic resources involves protection of threatened species in order to preserve diversity of animal farms species as well as to preserve plant resources threatened by extinction. For the latter the objective is not only to protect but also to re-integrate in the soil, traditional plant varieties threatened by genetic erosion. Integrated farming is also used for specific regional problems: to support the fight against intrusive exotic species. Measure 214 is further supported with additional funding from the CAP HC with a new sub-measure for the conservation of genetic diversity.

**Common Fisheries Policy – EFF**

During 2000-2006 France received over € 278 million from the EU under the Financial Instrument for Fisheries Guidance (FIFG). As a result, more than 9,500 projects received support. The new EU programme for 2007-2013 aims to build on the success of the previous programme. It seeks to consolidate a viable fisheries and aquaculture sector that respects resources and the marine environment, while meeting the demands of consumers and the food industry; and safeguarding, as far as possible, the income of fishermen.

The European Commission recently approved the Operational Programme for the French fishing industry for the period 2007-2013 (EUR ~14.7 million). The total eligible public expenditure under this programme is € 436.2 million, with EU assistance through the European Fisheries Fund (EFF) amounting to € 216.0 million. € 34.3 million of EFF aid will be allocated to the to the convergence regions (Overseas Departments)[206]. As the programme is implemented at national level, it is not possible to know the exact allocations dedicated to French Guiana for adaptation objectives.

**Biodiversity**

205 The proportion of the additional funding from the CAP HC is given in brackets

206 EAS (2010), The European Fisheries Fund Compilation of Member State Operating Programmes for Fisheries 2007-2013

The Net-Biome initiative, an inter-regional research programme funded by the European Commission and coordinated by the Regional Council of the Réunion Island, provides a model for European overseas wide cooperation, which aims to coordinate research efforts for the protection of ecosystems in the face of global change.

**Research and Innovation**

In Réunion, special attention has been devoted to supporting the entire research sector — be it by developing traditional industries, the natural starting point for developing experimentation and research centers, or by emerging sectors. Tied to the geographical characteristics of the territory and its tropical nature, research activities have been developed with a strong emphasis on the following key themes:

- water, maritime and aquaculture resources;
- natural hazards;
- agro-transformation and plant resources;
- human and social sciences;
- health; and
- engineering sciences (ICT energies).

### Examples of relevant research projects

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| RUN sea science | Biodiversity | FP7 | To defend these vast marine territories, world heritages of biodiversity, in the face of international pressure to overexploit them. | http://run-sea-science.fr/?rubrique26 |

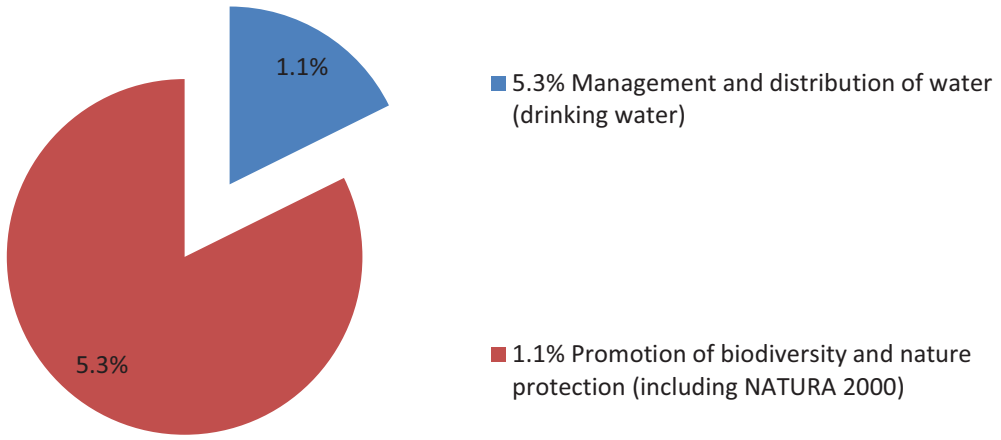
## Canary Islands

### Use of EU funds

**Cohesion Policy - ERDF**

Within the ongoing period (2007-2013) the ERDF totals roughly EUR 1 billion. The bulk of the expenditures that could be considered as significantly adaptation related is allocated for the management and distribution of water (5.3%). No allocation has been prioritized for risk prevention activities and only a minor share (1.1%) for the "promotion of biodiversity and nature protection". Figure E.5 shows the share of total funds allocated to each of the adaptation related measures.

**Figure E.5 2007-2013 ERDF Budget for selected adaptation related measures on the Canaries**




*Source: OP of ERDF for the Canaries*

**Common Agricultural Policy (CAP) – EAFRD**

Compared to ERDF funding, the support for climate change in the second pillar of the CAP (e.g. rural development funds) has been moderate. Total EU contribution for rural development from the CAP is estimated at EUR 153 million for 2007-2013. The main emphasis of the programme is on the modernisation of agricultural holdings as well as adding value to agricultural and forestry products. Unlike other Outermost Regions the agri-environmental measures seem here to be of low importance.

Climate change adaptation has been tackled in the Rural Development Plan of the Canary Islands. Following the CAP Health Check, the plan was revisited to give further emphasis on the new challenges stressed by the HC in relation to climate change, biodiversity and water management. These priorities were already addressed by the original RDP, more specifically, water management was mainly addressed under axis 1, biodiversity and climate change were addressed under axis 2. However, the revised RDP placed additional emphasis in particular to adaptation to climate change.

The original RDP already provided for funding to increase organic farming and integrated farming, sustainable use of water resources and the soil, maintain autochthonous livestock species, improve management capacity and defence of the forest sector, restoration of water and forestry systems to fight problems of erosion and desertification. The revised RDP did not specifically recognize the need to deal with climate change, but rather increased the amount of funding for water management (45%) and biodiversity (36%)[207]. Climate change adaptation is in fact primarily supported by the RDP through water management measures that aim to achieve water savings and improve the efficiency of irrigation systems.

Further efforts to address adaptation to climate change are undertaken by forestry measures of axis 2, in order to reduce the effects of forest fires and prevent the deterioration of soils from adverse climate conditions and risks (irregular rainfalls, combined with period of droughts). Landscape management actions, mainly for restoring potential and in traducing preventive action (%) address adaptation to climate change.

207 The proportion of the additional funding from the CAP HC is given in brackets

The main measure through which RDP seeks to support efforts to adapt to climate change is measure 125 – *infrastructure related to the development and adaptation of agriculture and* forestry – which covers operation related to water supply and efficiency. This is an important measure that absorbs 8% of the total EAFRD allocation. Under this measure explicit reference is made to supporting investments in irrigation infrastructures for better management and sustainable use of water resources ion agriculture. Example of supported actions include improvement of hydraulic structures to reduce water losses, modification of pumping, transport and distribution systems, installation of water consumption meters, communication technology to improve information on irrigation and energy networks, investments in waste water treatment systems, improvement of electric installations for irrigation.

Water management is also addressed by measure 121 – modernization of agricultural holdings – including investments for the modernisation of irrigation systems, deposits, pumping, drainage, establishment of new structures and improvement of existing ones and systems to improve water quality, with the objective to save water. A share of 25 % of the total EAFRD allocation is dedicated to this measure in the RDP of Canary Islands.

Under axis 2, measure 226 – restoring forestry potential and introducing prevention actions – and measure 227 – non-productive investments – have has objectives to use the establishment of preventive measures in order to prevent natural risks, such as forest fires. They accounts for, respectively, 6.5% and 9.5% of the total EAFRD allocation for the Canary Islands. Measure 226 includes actions for fighting erosion and desertification from natural catastrophes such as forest fires and floods. Measures 227 includes actions such as hydro-forest restoration to address adverse effects of heavy rainfall in some areas, restoration of green cover and activities of re-plantation, constructions of structures like ditches, fences, bays etc and restoration of forest lanes when there is a need to deter erosive processes.

**Common Fisheries Policy – EFF**

The European Commission approved the Operational Programme for the Spanish Fisheries Industry for the period 2007-2013. The total eligible public expenditure of the programme is € 2,088.3 million, with EU assistance through the EFF amounting to € 1,131.9 million, of which € 945.7 million will be granted to convergence regions and € 186.2 million to non-convergence regions. Being a programme implemented at national level, it is not possible to know the exact allocations dedicated to the Canary Islands for climate change adaptation objectives.

**Research & innovation**

Research in the Canary Islands brings together a large community of people and enjoys significant resources in the current economic conditions. This territory is driven, in particular, by the agricultural, fishing and tourism sectors. Shared for the most part with public institutions, research has clustered around activities that both address local needs and also benefit regionally through sharing knowledge, expertise and building centres of excellence.

In the Canary Islands the research funding strategy is general for all subjects and regulated by a plan produced by the Government of the Canary Islands, which has 2 transversal- instrumental areas (Technology of the Information and Communications, and Biotechnologies) and 9 scientific-technological priorities sectors; among these sectors one is Natural Resources and within this is Energy, Water, Climate Change and Biodiversity.

**Examples of relevant research projects**

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| COST Action ES0904 & | Marine research | FP7 | The main objective of this Action is the coordination of ongoing research using gliders, and the conception of future research, to operate fleets of autonomous | http://www.ego-cost.eu<br>http://www.groom-fp7.eu/ |

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| GROOM | | | underwater gliders in order to provide cost-effective methods for the discovery and monitoring of the ocean at global, regional and coastal scales with benefit to both basic oceanographic research and operational applications for marine activities. | |
| MEDIRAS | Energy | FP7 | To develop and demonstrate cost-effective and reliable solar-driven desalination systems for regions affected by water scarcity and high insolation. | http://www.mediras.eu |

## Azores

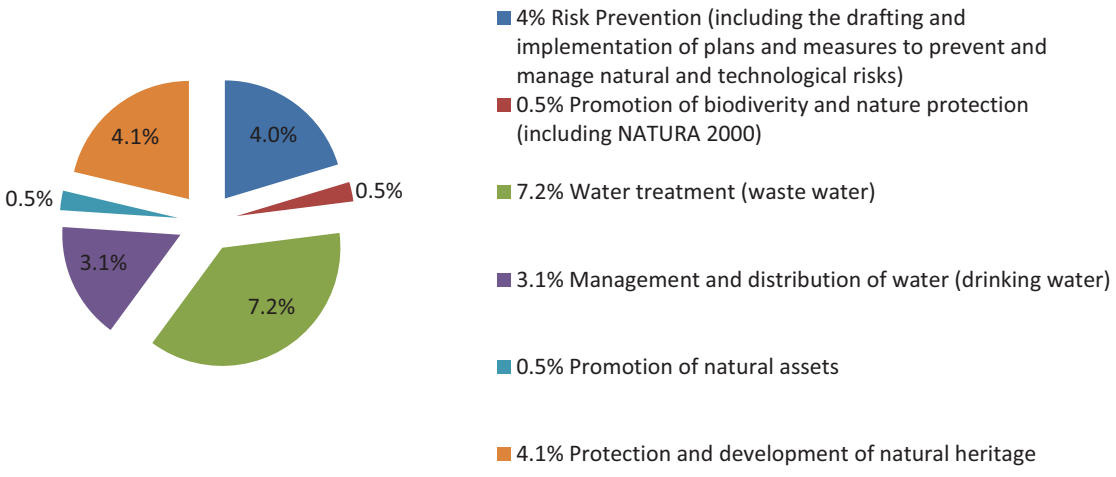
### Use of EU funds

#### Cohesion Policy – ERDF

Within the ongoing period (2007-2013), the ERDF contributes roughly EUR 966 million. Funds have been allocated specifically to "improving prevention systems and risk management". About 4% of the total Azores ERDF budget has financed the following interventions: developing studies and plans, raising awareness and informing the general public about civil protection issues, undertaking technical and scientific work with the University of the Azores, the public and private entities on monitoring and evaluating risks and disasters, constructing and revamping fires stations and acquiring equipment for civil protection. Regarding other measures that could be considered as significantly adaptation related, the ERDF has mainly been used to tackle water management. More than 10% of the budget went to water management measures.

Within the ongoing programming period, only about 1.4% of the total ERDF budget goes for nature protection and the promotion of natural assets. This lack of support has the potential to decrease the adaptive capacity of the ecosystem in the medium term. Figure E.6 shows the share of total funds allocated to each of the adaptation related measures.

**Figure E.6 2007-2013 ERDF Budget for selected adaptation related measures on the Azores**




*Source: OP of ERDF for the Azores*

**Common Agricultural Policy (CAP) – EAFRD**

According to the Portuguese Strategic Plan, forest replanting and sustainable management are the key tools to protect the environment. Axis II integrates the actions under the objective of "Contributing to adaptation to climate change and its mitigation." Measures and actions under Axis II of the NSP contribute to the environmental valorization of forests and the countryside in various ways. For example, through the conservation of water resources and soil, the contribution to preserving and improving biodiversity and landscape values and in terms of climate change and desertification.

Compared to ERDF funding, the support by the second pillar of the CAP (e.g. rural development funds) addressing climate change has been moderate. Total EU contribution for rural development from the CAP is estimated at EUR 275 million for 2007-2013.

The Azores RDP (PRORURAL[208]) does not specifically focus on climate change adaptation. This is probably due to the fact that after the CAP Health Check, additional resources have been channelled to the priority "Diary restructuring" rather than to "Climate Change".

The EAFRD supports mainly less-favoured areas without influencing climate change adaptation and agri-environmental activities (measure 214[209]). Only a very small part of the share finances intervention to improve soil quality and decrease erosion, the majority being dedicated to climate change mitigation objectives.

There are two other measures that are relevant to adaptation. Measure 222[210] encouraged agro-forestry systems on agricultural land and corresponding infrastructures; and measure 126[211] encouraged investment in restoring fixed assets, including on-farm plantations, greenhouses and infrastructures – which may be affected by severe natural disasters. These measures account for respectively only 2% and 0.05 % of the total EAFRD allocation.

**Common Fisheries Policy – EFF**

The European Commission approved the Operational Programme for the Portuguese Fisheries Industry for the period 2007-2013 (EUR ~10 million). The total eligible public expenditure of the programme is € 324.9 million, with EU assistance through the EFF amounting to € 246.5 million. € 223.9 million of the EFF assistance is allocated to the convergence regions of Portugal (Norte, Centro, Alentejo, Algarve and the Azores) and € 22.5 millions to the non-convergence regions (Lisbon & Madeira)[212]. Being a programme implemented at national level, it is not possible to know the exact allocations dedicated to the Azores for climate change adaptation objectives.

**Research and innovation**

The research themes in the Azores are organized around the following clusters:

- knowledge of marine resources and the economic potential of the sea;
- biodiversity conservation;
- preventing natural hazards linked to volcanoes and earthquakes;
- study of the effects of climate change, atmospheric science;
- agronomy and veterinary sciences, biotechnology; and
- renewable energy (marine).

[208] O Programa de Desenvolvimento Rural da Região Autónoma dos Açores (PRORURAL)

[209] Measure 214: Agri-environment payments accounts for 16 % of the total EAFRD allocation

[210] Measure 222: First establishment of agroforestry systems on agricultural land

[211] Measure 126: Restoring agricultural production potential

[212] EAS (2010), The European Fisheries Fund Compilation of Member State Operating Programmes for Fisheries 2007-2013

### Examples of relevant research projects

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| MarinERA | Marine research | FP6 | Marine phylogeographic structuring during climate change<br>ReDEco - Regional Drivers of Ecosystem Change and its Influence on Deep-Sea populations in the Mediterranean<br>To study the effects of regionally driven ecosystem changes in selected deep-sea habitats of the Mediterranean Sea and will focus on key drivers of climate change such as temperature changes, shifts in surface productivity and cold water cascading, and will examine their impacts on deep-sea populations. | http://marinera.seas-era.eu/dissemination/documents/MarinERA_LEGACY_bd.pdf |
| MoMAR | Ocean observations | FP6 | Studying of the temporal variability in active processes such as hydrothermalism, ecosystem dynamics, volcanism, seismicity and ground deformation, in order to constrain the dynamics of mid-ocean ridge hydrothermal ecosystems | http://www.esonet-noe.org/ |
| NET-BIOME | Biodiversity | FP7 | To network the Regional Research Policies on sustainable management of biodiversity in the European tropical and subtropical Outermost Regions and Territories | http://www.netbiome.org/ |
| TROPOS | Marine research | FP7 | Developing a floating modular multi-use platform system for use in deep waters, with an initial geographic focus on the Mediterranean, Tropical and Sub-Tropical regions, but designed to be flexible enough so as to not be limited in geographic scope | http://www.troposplatform.eu/ |

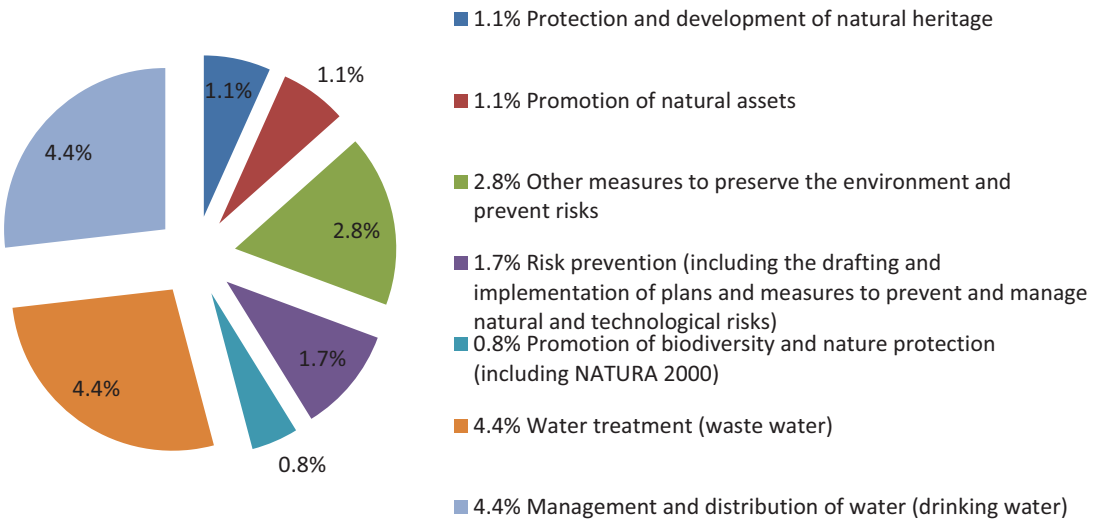
## Madeira

### Use of EU funds

#### Cohesion Policy – ERDF

For the ongoing period (2007-2013) just a minor share of the ERDF budget (EUR 321 million) was dedicated to funding activities significantly climate adaptation related. Measures like “water and waste water management” consumed the better part of the ERDF expenditures (almost 10%), while “risk prevention and other measures to preserve environment” only a small part (almost 5%), together with the “promotion and development of natural assets” and the “protection and development of natural heritage”, which also accounted for less than 3%. Figure E.7 shows the share of total funds allocated to each of the adaptation related measures.

**Figure E.7 2007-2013 ERDF Budget for selected adaptation related measures on Madeira**




*Source: OP of ERDF for Madeira*

**Common Agricultural Policy (CAP) – EAFRD**

According to the Portuguese Strategic Plan, forest replanting and sustainable management are the key tools to protect the environment. Axis II integrates the actions under the objective of "Contributing to adaptation to climate change and its mitigation." Measures and actions under Axis II of the NSP contribute to the environmental valorization of forests and the countryside in various ways. For example, through the conservation of water resources and soil, the contribution to preserving and improving biodiversity and landscape values and in terms of climate change and desertification

Compared to ERDF funding, the support by the second pillar of the CAP addressing climate change is even smaller. Total EU contribution for rural development from the CAP is estimated at EUR 175 million for 2007-2013.

The Madeira RDP (PRODERAM) programme allocates the total additional budget to the priority "Climate change". The programme focused on adaptation mainly through water supply management and efficiency issues, especially in terms of co-financing irrigation projects.

Measure 125 - *Improving and developing infrastructure related to the development and adaptation of agriculture and Forestry* - accounts for 24% of the total EAFRD allocation in the PRODERAM[213]. It integrates projects and actions related to irrigation and water management. The measure aims to develop collective irrigated plots systems. The development and management of such systems was reinforced with a EUR 4 million (EAFRD contribution), to improve sustainable utilization of regional water resources and to adapt to climate change. Measure 125's objectives are:

- to promote water availability. To be able to face irregular rainfall distribution during and between years, thus valorizing and rationalizing water use, reducing pressure on its exploitation, ensuring a more efficient use and safeguarding of natural values and landscape, conserving or recovering streams, in a global and integrated way;

[213] Programa de Desenvolvimento Rural da Região Autónoma da Madeira 2007-2013

- to support the development of irrigation, as a key instrument for the development and competitiveness of agriculture, taking into account environmental aspects and the need to ensure an adequate and sustainable use of water, infrastructure and soil, and strictly enforcing the Water Framework Directive;
- to improve the efficiency and management of the existing irrigation infrastructures, primarily aiming to modernize them;
- to intervene is some irrigation dams in order to enforce the new safety standards;
- to contribute to eco-efficiency and pollution reduction by supporting environmental requalification; and
- to contribute to improving the competitiveness of farm holdings and top develop strategic chains.

Measure 126 - *restoring agricultural production potential damaged by natural disasters and introducing appropriate prevention actions* - accounts for 25% of the total EAFRD allocation. It tackles the conditions that may be affected by severe natural disasters through investment in the reestablishment/restoration of fixed assets, including on-farm plantations, greenhouses and infrastructure. Disaster situations are covered, namely those caused by climate changes or fire.

Measure 222 contributes to reducing the effects of climate change through the establishment of agro-forestry systems in agricultural land and corresponding infrastructure. Its objectives are:

- to restore forest production potential in areas affected by fires and harmful biotic agents, including restoring and rehabilitating forest stands, ecosystems and communities/habitats, and also conserving soil and water (immediate post-fire rehabilitation);
- to contribute to reduce the effects of climate change, to improve biodiversity, to minimize the effects of soil erosion and to protect water resources; and
- to introduce appropriate preventive measures associated with forest stands, at the level of the infrastructure network to be restored or established.

**Common Fisheries Policy – EFF**

The European Commission approved about EUR 10 million the Operational Programme for the Portuguese Fisheries Industry for the period 2007-2013 (). The total eligible public expenditure of the programme is € 324.9 million, with EU assistance through the EFF amounting to € 246.5 million. € 223.9 million of the EFF assistance is allocated to the convergence regions of Portugal (Norte, Centro, Alentejo, Algarve and the Azores) and € 22.5 million to the non-convergence regions (Lisbon & Madeira)[214]. As a programme implemented at national level, it is not possible to know the exact allocations dedicated to Madeira for climate change adaptation objectives.

**MAC programme**

One of the main priorities of the Operational Programme 'Madeira-Azores-Canaries' is to strengthen environmental management and risk prevention in the three outermost regions. It involves the protection and management of coastal zones and marine resources as well as maritime and coastal safety. This accounts for 5% of the total ERDF allocation for the programme (about EUR 5.6 million). Operations under this priority include the promotion of the implementation of prevention plans and warning systems, surveillance and monitoring of natural hazards and the support of comprehensive security plans and coastal sea ports. The promotion of natural assets is also among the priorities and accounts for 5% of total ERDF budget. It ensures the sustainable management of plants and marine protected areas, the development of strategies for recovery and protection of biodiversity and natural resources and the improvement of coastal environmental quality. Risk prevention allocations are considered in the MAC Programme.[215] Funding is not substantial though. Only EUR 2.5 million went to risk prevention

214 EAS (2010), The European Fisheries Fund Compilation of Member State Operating Programmes for Fisheries 2007-2013

215 Transitional cooperation Madeira, Azores, Canaries.

interventions, namely the promotion of the implementation of prevention plans and warning systems, surveillance and monitoring of natural hazards, and the support of comprehensive security plans and coastal sea ports of the region; and even less, only EUR 1 million, to other measures to preserve the environment and prevent risk.

### Research and innovation

Research in Madeira has a regional dimension, with an emphasis on regional development, and a global dimension focused on the creation of research centres capable of attracting and retaining researchers and students from international markets. At the regional level, research focuses on the conservation and valorisation of agricultural and marine resources and overcoming the disadvantages linked to Madeira's extreme remoteness, particularly with the aid of the development of ICT and renewable energy.

Research activities are organized around different clusters which reflect the territory's key assets:

- marine sciences and oceanography;
- animal and marine biology;
- plant biology;
- agriculture and agribusiness;
- water and the environment;
- IT and ICT;
- renewable energy and energy conservation; and
- interactive technologies and service design.

Most of the research projects in Madeira have been financed under the 'Madeira- Açores-Canarias' (MAC) transnational cooperation programme for the period 2007–13.

### Examples of relevant research projects

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| MaReS | Research | ERDF<br>MAC | To organize a common tool Macaronesian archipelagos, analysis, coordination, identifying opportunities to enable them to meet the challenges of sustainability through a research and development strategy in the Atlantic regions competitive European island.<br>Terrestrial Applications of Remote Sensing of Environment in the Azores<br>Very High Resolution satellite images for land management in the Macaronesia<br>Satellite Oceanography in the Azores<br>Geological hazards and monitoring activities at the Azores archipelago<br>Making use of space technologies – governing risks to foster new opportunities for Azores | http://maresmacaronesia.eu/ |
| MacSimar | Marine research | ERDF<br>MAC | To leverage the capabilities R & D in the fields of climatology, meteorology and oceanography operating through the components of modelling, monitoring and disseminating information in a timely manner and at a scale appropriate to the | http://macsimar.eu/ |

| Name | Focus | EU-funds | Objectives | Link to further information |
|---|---|---|---|---|
| | | | sectors that depend on it. | |
| ESTRAMAR | Marine research | ERDF<br>MAC | To promote R + D Maritime Marine Macaronesia regions of Europe and Africa for its approach and results are directed to contribute to better coordination of the scientific-technical-business, in areas such as security and sustainable transport, tourism, shipping and ports, increased coastal protection, resources and marine biodiversity and the provision and management of natural hazards and thus help boost economic development of these regions, following international targets. | http://estramar.eu/ |

# Appendix F: Economic Structure of the OR

This appendix provides a brief overview of the economic structure of each OR. The focus is on output (GVA) and employment in each region, along with their breakdowns by broad sector. This allows for the identification, for example, of the relative contributions of agriculture and construction to economic performance.

The data are sourced from official regional statistics from Eurostat[216]. The original Eurostat GVA data are expressed in current prices, and thus do not distinguish movements in the volume of output from the price of that output. Constant-price ('real terms') output figures have been constructed by deflating the GVA data by a set of sectoral price deflators from the DG ECFIN annual macroeconomic (AMECO[217]) database. These deflators are for the parent country of each OR, rather than being OR-specific[218].

While some data on GDP by European region are available, these series are not considered in the analysis in this appendix. The transition from GVA to GDP involves the addition of taxes and subsidies on products and region-level estimates of GDP typically share out these taxes and subsidies according to the share of GVA in each sector. As a consequence, movements in reported regional GDP do not differ much from movements in reported regional GVA and there is little value in considering both in the context of this study. The preference is for GVA over GDP, as it bears a closer resemblance to the data actually collected in the EU.

Eurostat operates a common statistical classification of economic activities, in order to ensure comparability across Member States and constituent regions: the *Nomenclature générale des Activités économiques dans les Communautés Européennes* (NACE)[219]. At the level of spatial detail that separately identifies each OR, the current NACE classification (Revision 2) distinguishes ten broad types of economic activity:

- Agriculture, forestry and fishing;
- Industry (except construction);
- Construction;
- Wholesale and retail trade, transport, accommodation and food service activities;
- Information and communication;
- Financial and insurance activities;
- Real estate activities;
- Professional, scientific and technical activities; administrative and support service activities;
- Public administration, defence, education, human health and social work activities; and
- Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies

The most up-to-date information (where data are available) follows the above breakdown. However, this most recent version of the NACE system has only been implemented relatively recently and not all Member States or EU regions have revised past data to conform to the latest classification. As such, for some of the OR, less recent figures are reported at a lower level of detail, conforming to the previous NACE Revision 1.1 classification of activities:

[216] http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database
[217] http://ec.europa.eu/economy_finance/db_indicators/ameco/
[218] This is a relatively crude approach that assumes similar cost and price structures in each OR as for the parent country. However, in the absence of suitable OR-specific data, there is no obvious alternative.
[219] The Statistical classification of economic activities in the European Communities: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-07-015/EN/KS-RA-07-015-EN.PDF

- Agriculture; fishing;
- Industry (except construction);
- Construction;
- Wholesale and retail trade; hotels and restaurants; transport;
- Financial intermediation; real estate; and
- Public administration and community services; activities of households.

The point of transition is not consistent across the OR and, for example, the French OR GVA data are based on the NACE Revision 1.1 classification up to and including 2006 whereas for The Canary Islands, the last year of NACE Revision 1.1 data is 2007.

The correspondence between the two classifications is not straightforward as some NACE Revision 1.1 activities are now spread over multiple NACE Revision 2 activities and, as such, no attempt has been made to reconcile the two datasets into a single format. Broadly, NACE Revision 2 seeks to identify more detail in services, to reflect the increasingly services-oriented structure of European economies.

The completeness of the OR data, both across sectors and through time, differs markedly and no attempt has been made to fill in any missing data.

Other than the conversion from current to constant prices in the GVA figures, the data match those from Eurostat and we report figures in all years for which there are data available.

Supplementary data from the Eurostat Regio database are also included to give a set of basic population, social and educational indicators.

**Guadeloupe**

In the period 1996-2006, the Guadeloupe economy experienced steady growth, reaching a peak rate of 6.2% in 1999 (see Tables F.1 and FE.2). Employment on the island has been more volatile, with instances of strong growth (e.g. 8.9% in 2007) and sharp decline (10.8% in 2003). Although unemployment also fell in 2007, it is still above 20%. The employment data for Guadeloupe are limited in their sectoral breakdown and, as such, we do not discuss it here. We report the available data, mostly as aggregates, in Table F.3.

Tourism is one of the island's key industries, with Wholesale and Retail Trade; Hotels and Restaurants; Transport (the sector most closely linked with tourism), accounting for around 25% of total GVA. In the period 1997-2002, the sector experienced steady growth, reaching a peak of 5.3% in 1999. Over 2003-05, the sector declined, returning to growth in 2006.

The construction sector has seen quite rapid changes in GVA, ranging from 32.4% growth in 1996 to a 16.8% fall in 2002. This can be linked to the periodic tropical storms and hurricanes that hit the island, resulting in storm damage and leading to highly-varied construction requirements over time. This is particularly evident in 1996, when construction output increased by 32.4% after the island was hit by three consecutive cyclones in 1995. It is likely that such fluctuations would become more severe if climate change leads to higher frequency and more extreme events of this type.

The Financial intermediation; Real Estate sector, which accounts for around 23% of the economy, is the only sector that experienced continuous growth in the period 1996-2005, growing by as much as 12.1% in 2005. It contracted slightly by 1.3% in 2006, before growing again, mainly driven by growth in financial and insurance activities.

**Table F.1 GVA in Guadeloupe 1995-2006**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing | 148 | 140 | 165 | 148 | 205 | 216 | 194 | 190 | 176 | 206 | 210 | 205 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Industry (except construction) | 255 | 255 | 297 | 343 | 343 | 343 | 327 | 332 | 350 | 377 | 378 | 400 |
| Construction | 390 | 516 | 507 | 514 | 467 | 459 | 492 | 409 | 401 | 447 | 467 | 518 |
| Wholesale/retail trade, transport, accommodation and catering | 1,174 | 1,173 | 1,210 | 1,257 | 1,323 | 1,345 | 1,389 | 1,431 | 1,429 | 1,435 | 1,390 | 1,442 |
| Financial intermediation and real estate | 921 | 928 | 992 | 1,049 | 1,145 | 1,163 | 1,264 | 1,331 | 1,349 | 1,443 | 1,617 | 1,596 |
| Public administration and other service activities | 1,411 | 1,453 | 1,485 | 1,515 | 1,643 | 1,754 | 1,796 | 1,833 | 1,832 | 1,931 | 1,983 | 2,076 |
| Total | 4,299 | 4,466 | 4,655 | 4,826 | 5,126 | 5,280 | 5,462 | 5,527 | 5,538 | 5,838 | 6,045 | 6,238 |

Notes: Figures are in € millions and in 2000 prices. Data conform to NACE Revision 1.1 sector classification.

Sources: Calculated from Eurostat and DG ECFIN AMECO data.

**Table F.2 GVA in Guadeloupe 2007-10**

| | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|
| Agriculture, forestry and fishing | 191 | 203 | 197 | 187 |
| Industry (except construction) | 411 | 428 | 401 | 464 |
| Construction | 391 | 376 | 360 | 352 |
| Wholesale/retail trade, transport, accommodation and catering | 1,125 | 1,139 | 1,077 | 1,121 |
| Information and communication | 304 | 315 | 310 | 314 |
| Financial and insurance activities | 280 | 289 | 319 | 302 |
| Real estate activities | 701 | 698 | 702 | 713 |
| Professional, scientific, technical, administrative and support activities | 498 | 495 | 479 | 449 |
| Public administration, defence, education, human health and social work | 1,888 | 1,892 | 1,777 | 1,944 |
| Arts, entertainment and recreation and other service activities | 182 | 182 | 171 | 219 |
| Total | 5,972 | 6,016 | 5,794 | 6,065 |

Notes: Figures are in € millions and in 2000 prices. Data conform to NACE Revision 2 sector classification.

Sources: Calculated from Eurostat and DG ECFIN AMECO data.

**Table F.3 Employment in Guadeloupe 2001-11**

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing | : | : | : | : | : | : | : | : | : | : | 3.1 |
| Industry (except construction) | : | : | : | : | : | : | : | : | : | 8.5 | 8.7 |
| Construction | : | : | : | : | : | : | : | : | 3.6 | 8.9 | 8.9 |
| Wholesale/retail trade, transport, accommodation and catering | : | : | : | : | : | : | : | : | 9.7 | 23.6 | 27.1 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Information and communication | : | : | : | : | : | : | : | : | : | : | 2.1 |
| Financial and insurance activities | : | : | : | : | : | : | : | : | : | : | 2 |
| Real estate activities | : | : | : | : | : | : | : | : | : | : | 1.4 |
| Professional, scientific, technical, administrative and support activities | : | : | : | : | : | : | : | : | : | 7.1 | 7.6 |
| Public administration, defence, education, human health and social work | : | : | : | : | : | : | : | : | 11.9 | 44.8 | 44.9 |
| Arts, entertainment and recreation and other service activities | : | : | : | : | : | : | : | : | : | 5.8 | 5.8 |
| Total | 123.8 | 129.2 | 115.2 | 117.7 | 116.7 | 119.4 | 130 | 131.5 | 124.8 | 126.3 | 128.6 |
| Note: Figures are in '000s. Where the breakdown is available, data conform to the NACE Revision 2 classification.<br>Source: Eurostat. | | | | | | | | | | | |

**Table F.4 Socioeconomic Indicators in Guadeloupe 2006-11**

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| Population (persons) | 444254 | 444959 | 447118 | 447280 | 449272 | 449965 |
| Unemployment rate (% 15 years and over) | 26.9 | 22.6 | 21.9 | 23.4 | 23.8 | 22.6 |
| People at risk of poverty or social exclusion (% of total population) | n/a | n/a | n/a | n/a | n/a | n/a |
| Number of students in Upper secondary education (level 3) | 24163 | 24304 | 24598 | 23972 | 23583 | 23525 |
| Number of students in Upper secondary education (level 3) (% of population) | 5.4 | 5.5 | 5.5 | 5.4 | 5.2 | 5.2 |
| Persons aged 25-64 with upper secondary education attainment (%) | n/a | n/a | n/a | n/a | n/a | n/a |
| Source: Eurostat Regio database. | | | | | | |

**Martinique**

Other than a period of relatively flat growth in 2002-03, GVA in Martinique has grown steadily, at 3-4% pa (see Table F.5). The data suggest that Martinique entered recession in 2007, with sharp falls in output in 2007 and 2009 in particular (see Table E.15). Owing to a change in sector classification (from NACE Rev 1.1 to NACE Rev 2), it is difficult to compare the data directly between 2006 and 2007, but the key sectors affected in this period included industry and retail/transport/hospitality. Visitor exports typically account for around 3% of total GVA.

Employment in Martinique has remained relatively stable since 2001, at 120,000-130,000 (see Table F.7). In contrast to the declines in GVA seen in the recession, employment grew modestly during that period, although unemployment has remained roughly constant at 21-22% since 2007.

When looking at the sectoral breakdowns of GVA growth, we get a picture of what industries have been driving overall economic growth. The largest sectors in the Martinique economy are services (retail/transport/hospitality, financial and public services). Financial and public services account for some 60% of GVA in Martinique. These two sectors are somewhat larger than retail/transport/hospitality but, combined, services in Martinique account for around 80% of the OR's GVA. The agriculture and fishing sector grew strongly to 2000, but there has been a sustained decline since 2003. While growth in the agriculture and fishing sector was relatively strong during a period when growth in the other non-service sectors was either flat or volatile, the contribution to overall growth was small, owing to this sector's low importance in aggregate (agriculture accounts for less than 4% of GVA in Martinique).

Because services are so important to the Martinique economy, overall economic performance is closely tied to that of services.

**Table F.5 GVA in Martinique 1995-2006**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing | 158 | 174 | 186 | 189 | 195 | 205 | 183 | 215 | 200 | 178 | 168 | 166 |
| Industry (except construction) | 357 | 335 | 392 | 414 | 445 | 397 | 421 | 444 | 466 | 536 | 569 | 587 |
| Construction | 347 | 337 | 321 | 324 | 325 | 316 | 372 | 329 | 323 | 329 | 352 | 330 |
| Wholesale/retail trade, transport, accommodation and catering | 1,036 | 1,154 | 1,143 | 1,175 | 1,176 | 1,210 | 1,210 | 1,243 | 1,242 | 1,284 | 1,254 | 1,302 |
| Financial intermediation and real estate | 1,072 | 1,115 | 1,176 | 1,201 | 1,229 | 1,252 | 1,378 | 1,338 | 1,359 | 1,476 | 1,602 | 1,713 |
| Public administration and other service activities | 1,533 | 1,571 | 1,644 | 1,691 | 1,816 | 1,851 | 1,888 | 1,922 | 1,918 | 1,952 | 1,990 | 2,094 |
| Total | 4,504 | 4,687 | 4,862 | 4,994 | 5,186 | 5,231 | 5,453 | 5,491 | 5,508 | 5,754 | 5,935 | 6,191 |

Notes: Figures are in € millions and in 2000 prices. Data conform to NACE Revision 1.1 sector classification.

Sources: Calculated from Eurostat and DG ECFIN AMECO data.

**Table F.6 GVA in Martinique 2007-10**

| | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|
| Agriculture, forestry and fishing | 184 | 193 | 188 | 178 |
| Industry (except construction) | 544 | 559 | 525 | 607 |
| Construction | 314 | 298 | 286 | 280 |
| Wholesale/retail trade, transport, accommodation and catering | 928 | 926 | 878 | 914 |
| Information and communication | 284 | 289 | 286 | 290 |
| Financial and insurance activities | 262 | 267 | 295 | 279 |
| Real estate activities | 699 | 687 | 693 | 704 |
| Professional, scientific, technical, administrative and support activities | 573 | 562 | 545 | 511 |
| Public administration, defence, education, human health and social work | 1,927 | 1,905 | 1,795 | 1,963 |
| Arts, entertainment and recreation and other service activities | 156 | 154 | 145 | 186 |
| Total | 5,870 | 5,838 | 5,635 | 5,911 |

Notes: Figures are in € millions and in 2000 prices. Data conform to NACE Revision 2 sector classification.

Sources: Calculated from Eurostat and DG ECFIN AMECO data.

**Table F.7 Employment in Martinique 2001-11**

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing | : | : | : | : | : | : | : | : | : | 5.4 | 5.3 |
| Industry (except construction) | : | : | : | : | : | : | : | : | 3.6 | 6.9 | 7.4 |
| Construction | : | : | : | : | : | : | : | : | 4.1 | 8.7 | 8.3 |
| Wholesale/retail trade, transport, accommodation and catering | : | : | : | : | : | : | : | : | 10.8 | 27.6 | 27.5 |
| Information and communication | : | : | : | : | : | : | : | : | : | : | 2.9 |
| Financial and insurance activities | : | : | : | : | : | : | : | : | : | : | 2.3 |
| Real estate activities | : | : | : | : | : | : | : | : | : | : | 2.4 |
| Professional, scientific, technical, administrative and support activities | : | : | : | : | : | : | : | : | : | 8.8 | 9.2 |
| Public administration, defence, education, human health and social work | : | : | : | : | : | : | : | : | 13.1 | 43.8 | 46.8 |
| Arts, entertainment and recreation and other service activities | : | : | : | : | : | : | : | : | : | 5.1 | 5.7 |
| Total | 119.6 | 120.5 | 122.8 | 122.7 | 123.4 | 121.6 | 128.7 | 127.0 | 129.2 | 130.7 | 133.8 |

Note: Figures are in '000s. Where the breakdown is available, data conform to the NACE Revision 2 classification.

Source: Eurostat.

**Table F.8 Socioeconomic indicators in Martinique 2006-11**

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| Population (persons) | 397732 | 397730 | 397693 | 396404 | 394173 | 392423 |
| Unemployment rate (% 15 years and over) | 24.1 | 21.1 | 22.3 | 21.8 | 21 | 20.8 |
| People at risk of poverty or social exclusion (% of total population) | n/a | n/a | n/a | n/a | n/a | n/a |
| Number of students in Upper secondary education (level 3) | 23870 | 23173 | 22969 | 22172 | 21218 | 20554 |
| Number of students in Upper secondary education (level 3) (% of population) | 6.0 | 5.8 | 5.8 | 5.6 | 5.4 | 5.2 |
| Persons aged 25-64 with upper secondary education attainment (%) | n/a | n/a | n/a | n/a | n/a | n/a |
| Source: Eurostat Regio database. | | | | | | |

**French Guiana**

Economic growth in French Guiana has fluctuated greatly, with years of double-digit decline followed by double-digit growth (see Tables F.9 and F.10). In the later part of the period for which we have data, the economy of the OR has tended to grow, with periods of strong growth (more than 5% pa) as well as periods of little-to-no growth (0.5% or less in some years). Employment in the OR has been similarly volatile, with generally positive growth over 2005-10 (see Table F.11). There was a sharp fall in unemployment in 2007 but it remains at around 20%.

The sectoral breakdown of GVA in French Guiana shows the key sectors of the economy to be public and business services, followed by retail/hospitality i.e. services. All these sectors account for at least 15% of output in the economy and, together, account for around three-quarters of economy-wide GVA.

Industry is of modest importance to the economy of French Guiana, accounting for 12-13% of the GVA from 2000 onwards. Agriculture and construction account for the remaining 12% of GVA in French Guiana and thus contribute little to the OR's economic performance compared to the others noted above. French Guiana has proven relatively resilient to the global recession, seeing a slight fall in GVA in 2007 (by around 0.5%) followed by two years of steady growth.

The Eurostat data on employment in French Guiana by sector are quite limited, with a complete breakdown available for 2011 only. In this year, the data show the public sector to be by far the largest employer in the OR, accounting for almost 40% of employment. Retail and hospitality is the second-largest but the gap is wide, with this sector accounting for barely more than 15% of employment in 2011.

**Table F.9 GVA in French Guiana 1995-2006**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing | 78 | 90 | 84 | 94 | 94 | 83 | 84 | 89 | 83 | 96 | 104 | 122 |
| Industry (except construction) | 162 | 134 | 159 | 172 | 179 | 213 | 251 | 260 | 275 | 238 | 264 | 288 |
| Construction | 130 | 153 | 169 | 160 | 158 | 148 | 184 | 144 | 142 | 167 | 155 | 166 |
| Wholesale/retail trade, transport, accommodation and catering | 446 | 332 | 241 | 288 | 325 | 81 | 230 | 299 | 298 | 372 | 370 | 396 |
| Financial intermediation and real estate | 257 | 327 | 363 | 389 | 376 | 383 | 437 | 432 | 436 | 407 | 457 | 517 |
| Public administration and other service activities | 573 | 562 | 605 | 650 | 700 | 707 | 722 | 780 | 781 | 739 | 760 | 787 |
| Total | 1,646 | 1,598 | 1,620 | 1,752 | 1,832 | 1,615 | 1,908 | 2,005 | 2,014 | 2,018 | 2,111 | 2,275 |

Notes: Figures are in € millions and in 2000 prices. Data conform to NACE Revision 1.1 sector classification.

Sources: Calculated from Eurostat and DG ECFIN AMECO data.

**Table F.10 GVA in French Guiana 2007-10**

| | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|
| Agriculture, forestry and fishing | 121 | 131 | 135 | 128 |
| Industry (except construction) | 211 | 225 | 223 | 258 |
| Construction | 149 | 146 | 149 | 145 |
| Wholesale/retail trade, transport, accommodation and catering | 345 | 356 | 358 | 372 |
| Information and communication | 106 | 112 | 117 | 119 |
| Financial and insurance activities | 52 | 55 | 65 | 61 |
| Real estate activities | 232 | 236 | 252 | 256 |
| Professional, scientific, technical, administrative and support activities | 174 | 176 | 181 | 169 |
| Public administration, defence, education, human health and social work | 818 | 837 | 834 | 912 |
| Arts, entertainment and recreation and other service activities | 54 | 55 | 55 | 71 |
| Total | 2,264 | 2,329 | 2,368 | 2,492 |

Notes: Figures are in € millions and in 2000 prices. Data conform to NACE Revision 2 sector classification.

Sources: Calculated from Eurostat and DG ECFIN AMECO data.

**Table F.11 Employment in French Guiana 2001-11**

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing | : | : | : | : | : | : | : | : | : | : | 0.8 |
| Industry (except construction) | : | : | : | : | : | : | : | : | : | 3.7 | 3.7 |
| Construction | : | : | : | : | : | : | : | : | : | 4.7 | 5.0 |
| Wholesale/retail trade, transport, accommodation and catering | : | : | : | : | : | : | : | : | : | 8.9 | 8.8 |
| Information and communication | : | : | : | : | : | : | : | : | : | : | 0.6 |
| Financial and insurance activities | : | : | : | : | : | : | : | : | : | : | 0.6 |
| Real estate activities | : | : | : | : | : | : | : | : | : | : | 0.4 |
| Professional, scientific, technical, administrative and support activities | : | : | : | : | : | : | : | : | : | : | 4.1 |
| Public administration, defence, education, human health and social work | : | : | : | : | : | : | : | : | 7.1 | 21.8 | 22.4 |
| Arts, entertainment and recreation and other service activities | : | : | : | : | : | : | : | : | : | : | 2.7 |
| Total | 42.8 | 45.8 | 41.2 | 41.0 | 42.4 | 43.4 | 50.3 | 51.1 | 57.0 | 59.6 | 57.5 |

Note: Figures are in '000s. Where the breakdown is available, data conform to the NACE Revision 2 classification.

Source: Eurostat.

**Table F.12 Socioeconomic Indicators in French Guiana 2006-11**

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| Population (persons) | 205954 | 213031 | 219266 | 224469 | 229040 | 234127 |
| Unemployment rate (% 15 years and over) | 28.5 | 20.1 | 21.4 | 20.2 | 21 | 21 |
| People at risk of poverty or social exclusion (% of total population) | n/a | n/a | n/a | n/a | n/a | n/a |
| Number of students in Upper secondary education (level 3) | 8476 | 9060 | 9600 | 10188 | 10708 | 11389 |
| Number of students in Upper secondary education (level 3) (% of population) | 4.1 | 4.3 | 4.4 | 4.5 | 4.7 | 4.9 |
| Persons aged 25-64 with upper secondary education attainment (%) | n/a | n/a | n/a | n/a | n/a | n/a |

Source: Eurostat Regio database.

**La Réunion**

La Réunion has enjoyed a period of sustained economic growth over 1995-2008 (see Tables F.13 and F.14), generally exceeding 3% pa. With the exception of 2003, when employment fell modestly, employment has also increased strongly over that period, although there was a decline of 2% in 2009 (which was followed by two years of growth once more). Unemployment remains at close to 30%.

At the sectoral level, La Réunion's economy is dominated by services, particularly the public sector, which has historically accounted for around 40% of GVA (although this share has been falling somewhat in recent times). In all, services account for around 80% of the island's GVA. Growth in these sectors thus drives growth in the economy as a whole. The Eurostat data show agriculture to be the smallest sector in the economy in GVA terms, accounting for around 2% of economic activity from 2000 onwards. This compares to a share of around 3% in the mid-to-late 1990s: the sector's importance has gradually waned over time.

As mentioned previously, employment growth has been strong in La Réunion with particularly strong growth (in excess of 5% pa) seen over 2005-07 (see Table F.12). The availability of sectorally-disaggregated data for this OR is limited but, in 2011 (the only year for which the breakdown is complete), the largest employers in La Réunion were the public sector and the retail/hospitality sector. This broadly mirrors the pattern of GVA across sectors.

**Table F.13 GVA in La Réunion 1995-2006**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing | 192 | 207 | 201 | 176 | 218 | 210 | 187 | 182 | 168 | 178 | 203 | 214 |
| Industry (except construction) | 379 | 429 | 500 | 519 | 585 | 606 | 637 | 654 | 693 | 764 | 820 | 877 |
| Construction | 430 | 425 | 434 | 463 | 515 | 520 | 544 | 551 | 541 | 604 | 681 | 816 |
| Wholesale/retail trade, transport, accommodation and catering | 1,005 | 1,107 | 1,228 | 1,303 | 1,401 | 1,468 | 1,462 | 1,497 | 1,497 | 1,666 | 1,759 | 1,844 |
| Financial intermediation and real estate | 1,539 | 1,617 | 1,726 | 1,843 | 1,905 | 1,961 | 2,234 | 2,328 | 2,352 | 2,520 | 2,582 | 2,715 |
| Public administration and other service activities | 2,991 | 2,865 | 2,959 | 3,035 | 3,164 | 3,282 | 3,369 | 3,491 | 3,490 | 3,712 | 3,807 | 3,891 |
| Total | 6,535 | 6,650 | 7,047 | 7,339 | 7,788 | 8,047 | 8,433 | 8,702 | 8,741 | 9,443 | 9,853 | 10,358 |

Notes: Figures are in € millions and in 2000 prices. Data conform to NACE Revision 1.1 sector classification.

Sources: Calculated from Eurostat and DG ECFIN AMECO data.

**Table F. 14 GVA in La Réunion 2007-10**

| | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|
| Agriculture, forestry and fishing | 158 | 175 | 172 | 163 |
| Industry (except construction) | 906 | 987 | 934 | 1,081 |
| Construction | 681 | 685 | 663 | 649 |
| Wholesale/retail trade, transport, accommodation and catering | 1,760 | 1,863 | 1,782 | 1,853 |
| Information and communication | 580 | 628 | 626 | 634 |
| Financial and insurance activities | 475 | 514 | 572 | 542 |
| Real estate activities | 1,298 | 1,352 | 1,375 | 1,396 |
| Professional, scientific, technical, administrative and support activities | 824 | 857 | 838 | 785 |
| Public administration, defence, education, human health and social work | 3,360 | 3,523 | 3,345 | 3,659 |
| Arts, entertainment and recreation and other service activities | 337 | 352 | 335 | 431 |
| Total | 10,379 | 10,937 | 10,643 | 11,193 |

Notes: Figures are in € millions and in 2000 prices. Data conform to NACE Revision 2 sector classification.

Sources: Calculated from Eurostat and DG ECFIN AMECO data.

**Table F.15 Employment in La Réunion 2001-11**

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing | : | : | : | : | : | : | : | : | 3.7 | 10.1 | 9.4 |
| Industry (except construction) | : | : | : | : | : | : | : | : | 9.8 | 16.6 | 15.6 |
| Construction | : | : | : | : | : | : | : | : | 12.2 | 17.5 | 17.1 |
| Wholesale/retail trade, transport, accommodation and catering | : | : | : | : | : | : | : | : | 25.3 | 43.6 | 46.1 |
| Information and communication | : | : | : | : | : | : | : | : | : | : | 3.2 |
| Financial and insurance activities | : | : | : | : | : | : | : | : | : | 5.3 | 4.8 |
| Real estate activities | : | : | : | : | : | : | : | : | : | : | 3.4 |
| Professional, scientific, technical, administrative and support activities | : | : | : | : | : | : | : | : | 5.6 | 12.2 | 16.3 |
| Public administration, defence, education, human health and social work | : | : | : | : | : | : | : | : | 34.5 | 89.0 | 89.7 |
| Arts, entertainment and recreation and other service activities | : | : | : | : | : | : | : | : | 8.2 | 12.4 | 14.7 |
| Total | 187.2 | 201.4 | 198.7 | 199.8 | 211.1 | 223.6 | 238.4 | 241.5 | 236.8 | 242.2 | 243.8 |

Note: Figures are in '000s. Where the breakdown is available, data conform to the NACE Revision 2 classification.

Source: Eurostat.

**Table F16. Socioeconomic Indicators in La Réunion 2006-11**

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| Population (persons) | 781962 | 794107 | 808250 | 816364 | 821136 | 829402 |
| Unemployment rate (% 15 years and over) | 28.3 | 24.1 | 24.4 | 27.1 | 28.9 | 29.6 |
| People at risk of poverty or social exclusion (% of total population) | n/a | n/a | n/a | n/a | n/a | n/a |
| Number of students in Upper secondary education (level 3) | 44494 | 44840 | 45364 | 45485 | 44932 | 45184 |
| Number of students in Upper secondary education (level 3) (% of population) | 5.7 | 5.6 | 5.6 | 5.6 | 5.5 | 5.4 |
| Persons aged 25-64 with upper secondary education attainment (%) | n/a | n/a | n/a | n/a | n/a | n/a |
| Source: Eurostat Regio database. | | | | | | |

### The Canary Islands

Throughout the period 1996-2008, the Canary Islands saw steady growth in GVA, ranging from 2.2% in 1996 to a peak of 7.6% in 1999. Growth since 2000 has generally been around 3% pa (see Tables F.17 and F.18). Employment also experienced strong growth over 2000-07, ranging from 2.3% to 7.1% (see Tables F.19and F.20). However, the global economic crisis affected the Canary Islands severely, with large falls in output and employment (despite an increasing population) and unemployment increasing from 10% to almost 30%. According to the Eurostat database, almost 40% of the population is described as at risk of poverty.

The Canary Islands' economy is based primarily on tourism, resulting in the Wholesale and Retail Trade; Hotels and Restaurants; Transport sector being the largest sector in the economy, accounting for around 40% of the region's total GVA. In the period 1997-2007, GVA generally grew steadily, with some years of high growth (e.g. 7.3% in 1999) and near-zero growth in others (2000 and 2005). Over 2000-07, employment, somewhat unusually, grew at a faster rate than output, with a growth high of 8% in 2003.

The Financial intermediation; Real estate sector accounts for 20% of total GVA and is largely fuelled by Foreign Direct Investment for the development of tourism real estate, due to the tax breaks offered by the government. The sector has experienced strong growth between 1996-2007, particularly between 1997-2000, when there were instances of double-digit GVA growth. Growth in employment was also generally strong in this period, pre-recession.

**Table F.17 GVA in the Canary Islands 1995-2007**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing | 457 | 540 | 587 | 597 | 566 | 469 | 453 | 436 | 422 | 416 | 414 | 413 | 447 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Industry (except construction) | 1,597 | 1,613 | 1,688 | 1,722 | 1,724 | 1,703 | 1,784 | 1,830 | 1,944 | 1,896 | 1,991 | 1,961 | 1,964 |
| Construction | 1,435 | 1,425 | 1,487 | 1,676 | 1,930 | 2,076 | 2,300 | 2,505 | 2,472 | 2,580 | 2,595 | 2,583 | 2,679 |
| Wholesale/retail trade, transport, accommodation and catering | 7,898 | 7,884 | 8,005 | 8,301 | 8,903 | 8,927 | 9,375 | 9,547 | 9,755 | 9,870 | 9,881 | 10,188 | 10,536 |
| Financial intermediation and real estate | 2,491 | 2,666 | 2,939 | 3,301 | 3,811 | 4,404 | 4,579 | 4,642 | 4,902 | 5,064 | 5,498 | 5,758 | 5,973 |
| Public administration and other service activities | 4,388 | 4,536 | 4,721 | 4,905 | 5,130 | 5,336 | 5,469 | 5,646 | 5,857 | 6,044 | 6,207 | 6,423 | 6,664 |
| Total | 18,267 | 18,663 | 19,429 | 20,503 | 22,063 | 22,915 | 23,960 | 24,606 | 25,351 | 25,869 | 26,585 | 27,326 | 28,264 |

Notes: Figures are in € millions and in 2000 prices. Data conform to NACE Revision 1.1 sector classification.

Sources: Calculated from Eurostat and DG ECFIN AMECO data.

**Table F.18 GVA in the Canary Islands 2008-10**

| | 2008 | 2009 | 2010 |
|---|---|---|---|
| Agriculture, forestry and fishing | 429 | 453 | 404 |
| Industry (except construction) | 2,373 | 2,231 | 2,288 |
| Construction | 2,885 | 2,449 | 2,276 |
| Wholesale/retail trade, transport, accommodation and catering | 9,855 | 9,362 | : |
| Information and communication | : | : | : |
| Financial and insurance activities | 7,280 | 6,407 | : |
| Real estate activities | : | : | : |
| Professional, scientific, technical, administrative and support activities | : | : | : |
| Public administration, defence, education, human health and social work | 6,435 | 6,487 | : |
| Arts, entertainment and recreation and other service activities | : | : | : |
| Total | 29,257 | 27,389 | 26,086 |

Notes: Figures are in € millions and in 2000 prices. Data conform to NACE Revision 2 sector classification.

Sources: Calculated from Eurostat and DG ECFIN AMECO data.

**TableF.19 Employment in the Canary Islands 1999-2009**

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and | 41.8 | 37.3 | 34.0 | 36.4 | 37.6 | 29.1 | 29.6 | 33.2 | 27.4 | : | 0.0 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| fishing | | | | | | | | | | | |
| Industry (except construction) | 127.8 | 141.0 | 155.6 | 162.5 | 164.4 | 172.1 | 167.0 | 185.7 | 194.4 | 168.8 | : |
| Construction | 82.4 | 90.7 | 107.2 | 113.6 | 120.4 | 126.5 | 115.5 | 124.1 | 140.1 | 107.6 | : |
| Wholesale/retail trade, transport, accommodation and catering | 254.6 | 270.8 | 287.7 | 293.5 | 317.0 | 313.0 | 329.2 | 347.8 | 364.4 | 347.5 | : |
| Financial intermediation and real estate | 46.2 | 51.8 | 59.9 | 69.6 | 67.2 | 69.3 | 80.7 | 82.0 | 86.0 | 80.6 | : |
| Public administration and other service activities | 158.4 | 168.4 | 172.0 | 190.9 | 202.9 | 214.3 | 230.1 | 235.4 | 237.3 | 237.4 | : |
| Total | 629.3 | 673.8 | 712.6 | 750.5 | 787.9 | 806.3 | 836.1 | 880.4 | 915.4 | 861.7 | 795.3 |

Note: Figures are in '000s. Data conform to the NACE Revision 1.1 classification.

Source: Eurostat.

**Table F.20 Employment in the Canary Islands 2008-11**

| | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|
| Agriculture, forestry and fishing | 24.7 | 22.1 | 27.6 | 21.7 |
| Industry (except construction) | 60.1 | 50.0 | 44.2 | 39.2 |
| Construction | 108.4 | 75.2 | 70.6 | 53.4 |
| Wholesale/retail trade, transport, accommodation and catering | 335.6 | 320.2 | 310.5 | 344.9 |
| Information and communication | 13.3 | 11.3 | 8.3 | 8.0 |
| Financial and insurance activities | 17.0 | 13.3 | 9.6 | 11.7 |
| Real estate activities | 3.6 | 4.6 | 5.9 | 5.5 |
| Professional, scientific, technical, administrative and support activities | 63.8 | 67.8 | 66.7 | 63.6 |
| Public administration, defence, education, human health and social work | 175.1 | 178.2 | 171.0 | 174.1 |
| Arts, entertainment and recreation and other service activities | 60.2 | 52.6 | 57.9 | 56.2 |
| Total | 861.7 | 795.3 | 772.2 | 778.2 |

Note: Figures are in '000s. Data conform to the NACE Revision 2 classification.

Source: Eurostat.

**Table F.21 Socioeconomic Indicators in the Canary Islands 2006-11**

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| Population (persons) | 1953361 | 1997010 | 2041468 | 2076585 | 2088225 | 2100229 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Unemployment rate (% 15 years and over) | 11.7 | 10.4 | 17.4 | 26.2 | 28.7 | 29.7 |
| People at risk of poverty or social exclusion (% of total population) | 34.6 | 29.3 | 31.5 | 37.2 | 37.6 | 39.9 |
| Number of students in Upper secondary education (level 3) | 63034 | 59970 | 61267 | 59986 | 66144 | 68622 |
| Number of students in Upper secondary education (level 3) (% of population) | 3.2 | 3.0 | 3.0 | 2.9 | 3.2 | 3.3 |
| Persons aged 25-64 with upper secondary education attainment (%) | 21.3 | 21.7 | 22.5 | 23.6 | 24 | 23.9 |
| Source: Eurostat Regio database. | | | | | | |

**The Azores**

Before the recession in 2008, the Azores saw steady economic growth. This growth in GVA was particularly strong between 1998 and 2001, reaching a peak of 6.4% in 1999, before slowing to a steadier 2-3% pa in the period 2005-08 (see Tables F.22 ).

Agriculture, forestry and fishing are key sectors in the Azores economy, accounting for 11-12% of GVA over 1995-2009. The sector has seen some large fluctuations in annual growth, both positive and negative, ranging from a peak of 21.6% in 1999 to a low of -6.6% in 2007. Employment in this sector has also fluctuated somewhat, although has generally remained in the range 12,000-14,000 in recent years (see Table F.23 and 24).

On the other hand, the Industry, and Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities (effectively, retail, transport and hospitality) sectors have seen strong and steady GVA growth over 1996-2008. Industry reached a peak growth rate of 18.9% in 1998, while growth in the Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities sector peaked at 10.2% in 1999. However, employment growth in Industry was more modest pre-recession. Growth in employment was stronger in the Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities sector.

The Public administration, defence, education, human health and social work activities sector is the largest sector of the Azores economy, accounting for around 30% of GVA in the economy. The sector saw GVA growth between 1996 and 2002 ranging from 1.5% in 1997 to 5.4% in 2001. Apart from 4.9% growth in 2007, the sector proceeded to see negative or low rates of growth in the period 2003-09. During this period employment was fairly stable, albeit with sharp growth of 10.8% in 2010.

Overall, The Azores has a relatively low unemployment rate, although it did increase to 10% in 2011 (the most recent year of data). Prior to that, unemployment was around 6%.

**Table F.22 GVA in the Azores 1995-2010**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing | 202 | 217 | 216 | 220 | 268 | 252 | 243 | 273 | 269 | 287 | 296 | 290 | 271 | 308 | 303 | 315 |
| Industry (except construction) | 112 | 121 | 131 | 156 | 160 | 178 | 183 | 199 | 213 | 222 | 233 | 246 | 265 | 277 | 266 | 288 |
| Construction | 177 | 168 | 176 | 186 | 180 | 175 | 206 | 201 | 181 | 185 | 174 | 171 | 182 | 178 | 153 | 139 |
| Wholesale/retail trade, transport, accommodation and catering | 403 | 411 | 420 | 444 | 489 | 508 | 541 | 560 | 577 | 598 | 617 | 640 | 640 | 650 | 641 | 667 |
| Information and communication | 45 | 47 | 45 | 47 | 53 | 51 | 58 | 58 | 60 | 59 | 63 | 68 | 71 | 75 | 67 | 63 |
| Financial and insurance activities | 51 | 50 | 53 | 54 | 71 | 73 | 86 | 87 | 101 | 95 | 100 | 116 | 121 | 134 | 136 | 131 |
| Real estate activities | 158 | 161 | 168 | 171 | 171 | 169 | 175 | 175 | 175 | 173 | 176 | 175 | 170 | 181 | 185 | 184 |
| Professional, scientific, technical, administrative and support activities | 63 | 65 | 67 | 65 | 64 | 64 | 70 | 70 | 75 | 77 | 83 | 81 | 83 | 84 | 80 | 85 |
| Public administration, defence, education, human health and social work | 553 | 572 | 580 | 606 | 622 | 636 | 670 | 684 | 669 | 664 | 665 | 672 | 705 | 694 | 704 | 713 |
| Arts, entertainment and recreation and other service activities | 43 | 45 | 48 | 51 | 50 | 46 | 45 | 49 | 47 | 44 | 47 | 51 | 58 | 65 | 65 | 65 |
| Total | 1,807 | 1,856 | 1,904 | 2,001 | 2,128 | 2,152 | 2,276 | 2,356 | 2,368 | 2,404 | 2,454 | 2,508 | 2,566 | 2,645 | 2,599 | 2,650 |

Notes: Figures are in € millions and in 2000 prices. Data conform to NACE Revision 2 sector classification and extend back to 1995 – no NACE Revision 1.1 data are reported.

Sources: Calculated from Eurostat and DG ECFIN AMECO data.

**TableF.23 Employment in the Azores 1999-2009**

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing | 17.5 | 15.7 | 13.5 | 13.5 | 13.1 | 13.2 | 13.1 | 13.4 | 12.8 | 14.6 | : |
| Industry (except construction) | 10.6 | 11.0 | 11.0 | 11.4 | 11.1 | 11.0 | 10.7 | 12.4 | 11.8 | 11.1 | : |
| Construction | 13.4 | 14.0 | 16.7 | 18.1 | 17.7 | 16.7 | 16.1 | 15.4 | 17.0 | 18.7 | : |
| Wholesale/retail trade, transport, accommodation and catering | 19.0 | 19.7 | 21.2 | 21.1 | 22.1 | 25.3 | 26.7 | 25.2 | 26.2 | 25.7 | : |
| Financial intermediation and real estate | : | : | : | : | : | : | 4.8 | 5.2 | : | 4.9 | : |
| Public administration and other service activities | 32.3 | 32.2 | 32.4 | 33.5 | 33.8 | 34.4 | 33.9 | 35.9 | 35.1 | 36.2 | : |
| Total | 95.5 | 96.2 | 98.4 | 101.0 | 102.1 | 104.9 | 105.3 | 107.5 | 107.3 | 111.2 | 112.2 |

Note: Figures are in '000s. Data conform to the NACE Revision 1.1 classification.

Source: Eurostat.

**Table F.24 Employment in the Azores 2008-11**

| | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|
| Agriculture, forestry and fishing | 14.2 | 14.2 | 12.4 | 13.6 |
| Industry (except construction) | 11.1 | 10.7 | 10.4 | 9.1 |
| Construction | 18.8 | 16.7 | 15.9 | 12.1 |
| Wholesale/retail trade, transport, accommodation and catering | 24.5 | 26.7 | 25.4 | 23.5 |
| Information and communication | : | : | : | 1.3 |
| Financial and insurance activities | : | : | : | 1.3 |
| Real estate activities | : | : | : | 0.3 |
| Professional, scientific, technical, administrative and support activities | : | : | : | 4.5 |
| Public administration, defence, education, human health and social work | 26.8 | 29.7 | 30.9 | 31.6 |
| Arts, entertainment and recreation and other service activities | 9.2 | 7.6 | 8.5 | 9.4 |
| Total | 111.2 | 112.2 | 110.3 | 106.7 |

Note: Figures are in '000s. Data conform to the NACE Revision 2 classification.

Source: Eurostat.

**Table F.25 Socioeconomic Indicators in the Azores 2006-11**

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| Population (persons) | 242241 | 243018 | 244006 | 244780 | 245374 | 246732 |
| Unemployment rate (% 15 years and over) | n/a | 4.3 | 5.5 | 6.7 | 6.9 | 11.5 |
| People at risk of poverty or social exclusion (% of total population) | n/a | n/a | n/a | n/a | n/a | n/a |
| Number of students in Upper secondary education (level 3) | 9286 | 8618 | 9439 | 9758 | 10064 | 9949 |
| Number of students in Upper secondary education (level 3) (% of population) | 3.8 | 3.5 | 3.9 | 4.0 | 4.1 | 4.0 |
| Persons aged 25-64 with upper secondary education attainment (%) | 11.1 | 11.2 | 10.8 | 12.2 | 11.8 | 10.5 |
| Source: Eurostat Regio database. | | | | | | |

**Madeira**

Madeira has generally experienced strong GVA growth in the period 1996-2006, growing by as much as 17.1% in 2002. However, since then, there have been some fluctuations in economic performance: in 2001 and 2003, GVA fell by 4.3% and 4% respectively, before recovering to 9.3% growth in 2006 (see Table F.26).

The Wholesale and Retail Trade, Transport, Accommodation and Food Service Activities sector is the largest sector of the economy by GVA, accounting for around 30% of GVA. The sector has generally experienced strong growth, reaching a peak rate of 21.7% in 2000. In line with the economy as a whole, the sector's growth since then has been somewhat volatile: GVA fell by 9.8% in 2003, followed by slow growth over 2006-08 and a decline of 1.1% in 2009. Employment growth in the sector has similarly fluctuated, from 12.2% growth in 2001, to a fall of 7.2% in 2006, with further ups and downs to 2011 (see Tables F.27 and F.28).

Construction, another of the main sectors in the economy, has experienced much slower and negative growth in GVA. Apart from 1998 and 2004, when the sector grew by 22.8% and 9.4% respectively, GVA has generally fallen or grown by much slower rates. In the period 2000-11, employment has also generally been falling, by -12.6% in 2007 and a further 20% in 2009 during the global recession.

The Professional, Scientific and Technical Activities; Administrative and Support Service Activities sector has seen erratic GVA growth over the period for which data are available. This sector has historically accounted for 10-15% of Madeira's GVA.

**Table F.26 GVA in Madeira 1995-2010**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing | 56 | 57 | 61 | 59 | 61 | 59 | 58 | 69 | 70 | 80 | 80 | 89 | 90 | 90 | 85 | 87 |
| Industry (except construction) | 143 | 158 | 162 | 182 | 184 | 207 | 224 | 231 | 242 | 252 | 259 | 278 | 273 | 277 | 266 | 259 |
| Construction | 269 | 256 | 256 | 314 | 322 | 314 | 300 | 286 | 299 | 327 | 310 | 303 | 314 | 264 | 239 | 227 |
| Wholesale/retail trade, transport, accommodation and catering | 593 | 604 | 696 | 743 | 771 | 939 | 931 | 1,046 | 943 | 996 | 1,067 | 1,072 | 1,079 | 1,122 | 1,110 | 1,133 |
| Information and communication | 49 | 48 | 49 | 52 | 53 | 55 | 59 | 76 | 78 | 82 | 83 | 90 | 89 | 94 | 94 | 90 |
| Financial and insurance activities | 63 | 64 | 87 | 117 | 129 | 202 | 156 | 173 | 158 | 170 | 168 | 236 | 211 | 267 | 257 | 269 |
| Real estate activities | 152 | 156 | 164 | 168 | 177 | 186 | 189 | 209 | 206 | 208 | 206 | 211 | 222 | 234 | 226 | 232 |
| Professional, scientific, technical, administrative and support activities | 147 | 150 | 145 | 148 | 212 | 361 | 260 | 534 | 451 | 481 | 374 | 588 | 522 | 576 | 522 | 495 |
| Public administration, defence, education, human health and social work | 488 | 512 | 515 | 546 | 556 | 541 | 562 | 592 | 658 | 663 | 714 | 703 | 728 | 715 | 725 | 766 |
| Arts, entertainment and recreation and other service activities | 52 | 54 | 63 | 62 | 65 | 67 | 65 | 65 | 59 | 59 | 62 | 63 | 67 | 74 | 74 | 74 |
| Total | 2,012 | 2,059 | 2,197 | 2,392 | 2,531 | 2,929 | 2,803 | 3,281 | 3,163 | 3,319 | 3,323 | 3,633 | 3,596 | 3,712 | 3,598 | 3,632 |

Notes: Figures are in € millions and in 2000 prices. Data conform to NACE Revision 2 sector classification and extend back to 1995 – no NACE Revision 1.1 data are reported.

Sources: Calculated from Eurostat and DG ECFIN AMECO data.

**Table F.27 Employment in Madeira 1999-2009**

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, forestry and fishing | 16.6 | 15.9 | 13.4 | 13.6 | 10.7 | 10.4 | 10.6 | 11.7 | 13.2 | 12.3 | : |
| Industry (except construction) | 14.8 | 14.3 | 12.5 | 11.1 | 10.9 | 9.2 | 9.6 | 10.7 | 9.8 | 8.9 | : |
| Construction | 18.3 | 20.3 | 20.1 | 19.3 | 19.0 | 19.9 | 21.1 | 21.4 | 18.7 | 18.5 | : |
| Wholesale/retail trade, transport, accommodation and catering | 28.1 | 27.0 | 30.3 | 31.8 | 32.1 | 34.7 | 33.4 | 31.0 | 31.9 | 35.9 | : |
| Financial intermediation and real estate | : | : | : | : | 4.7 | : | : | 4.4 | 5.1 | 5.9 | : |
| Public administration and other service activities | 28.6 | 27.2 | 27.7 | 32.2 | 34.9 | 35.1 | 38.7 | 37.9 | 37.7 | 37.0 | : |
| Total | 109.4 | 107.8 | 107.6 | 111.9 | 112.3 | 113.5 | 117.1 | 117.3 | 116.5 | 118.5 | 118.7 |

Note: Figures are in '000s. Data conform to the NACE Revision 1.1 classification.

Source: Eurostat.

**Table F.28 Employment in Madeira 2008-11**

| | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|
| Agriculture, forestry and fishing | 11.7 | 12.6 | 14.2 | 11.8 |
| Industry (except construction) | 9.0 | 8.3 | 8.1 | 7.6 |
| Construction | 18.5 | 14.8 | 12.2 | 10.3 |
| Wholesale/retail trade, transport, accommodation and catering | 34.5 | 33.7 | 34.7 | 33.1 |
| Information and communication | : | : | : | 1.5 |
| Financial and insurance activities | : | : | : | 1.0 |
| Real estate activities | : | : | : | 0.4 |
| Professional, scientific, technical, administrative and support activities | 5.9 | 5.7 | 6.6 | 7.4 |
| Public administration, defence, education, human health and social work | 28.8 | 32.9 | 32.8 | 31.5 |
| Arts, entertainment and recreation and other service activities | 7.1 | 7.0 | 7.3 | 7.7 |
| Total | 118.5 | 118.7 | 119.8 | 112.3 |

Note: Figures are in '000s. Data conform to the NACE Revision 2 classification.

Source: Eurostat.

**Table F.29 Socioeconomic Indicators in Madeira 2006-11**

| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| Population (persons) | 245197 | 245806 | 246689 | 247161 | 247399 | 268045 |
| Unemployment rate (% 15 years and over) | 5.4 | 6.8 | 6 | 7.6 | 7.4 | 13.8 |
| People at risk of poverty or social exclusion (% of total population) | n/a | n/a | n/a | n/a | n/a | n/a |
| Number of students in Upper secondary education (level 3) | 11932 | 11164 | 10147 | 10767 | 11134 | 11200 |
| Number of students in Upper secondary education (level 3) (% of population) | 4.9 | 4.5 | 4.1 | 4.4 | 4.5 | 4.2 |
| Persons aged 25-64 with upper secondary education attainment (%) | 12.4 | 13.1 | 14.5 | 14.4 | 14.2 | 16.1 |
| Source: Eurostat Regio database. | | | | | | |

# Appendix G

# Recommendations

The table below highlights those recommendations identified within Section 7, based on use of the three main EU Funds applicable. These are the actions which, on the basis of the climate risk assessment, which should be considered as potential priority areas for consideration for actions within each of the OR. This is based upon the outcome of the climate risk assessment, selecting those sectors thought to be most vulnerable to climate change for each OR (where vulnerability is based upon impacts on the environment, economy and society but where adaptive capacity is low). Mayotte and St Martin have not been included in this table as there was limited information to inform the climte risk assessment. Recommendations for each are however discussed in Section 7.

It is not suggested that the sectors and OR not highlighted for potential action are not also important. This table indicates only those sectors and OR where the assessment has identified a particularly high risk to the sector in a particular OR (See Appendix D). For this reason, the recommendations here are limited by the data available to inform the assessment and so should not be considered comprehensive.

**Table G.1 Mapping of vulnerable sectors to recommendations identified in Section 7**

| Potential adaptation measures | Cohesion Funding | CAP * | EMFF** | Guadeloupe | Martinique | French Guiana | Reunion | Canary Islands | Azores | Madeira |
|---|---|---|---|---|---|---|---|---|---|---|
| **Agriculture** | | | | | | | | | | |
| Consider using Cohesion Policy funds directly to fund more research and strategic planning for climate change adaptation where information is lacking | ✓ | | | | | | | | ✓ | |
| Enhance the use of regional cooperation instruments (INTERREG), especially for building capacity and exchanging best practice with other Member States and regions. | ✓ | | | | | | | | ✓ | |
| Climate change adaptation should be integrated into assessment procedures, ex-ante evaluation, SEA and EIA | | ✓ | | | | | | | ✓ | |
| Farm infrastructure options: adaptation of agricultural infrastructure through avoidance of damage from extreme events; improvement of animal rearing conditions - use of shading and sprinklers to avoid heat stress; irrigation efficiency for improved water management. | | ✓ | | | | | | | ✓ | |
| Land management options: use of buffer strips to improve water management and biodiversity resilience; conservation areas and habitat restoration to improve habitat/biodiversity resilience; afforestation for soil and forest management diversified crop rotation for soil and water management,; maintenance of permanent grassland to improve habitat/biodiversity resilience. | | ✓ | | | | | | | ✓ | |
| Farm management - insurance schemes to improve risk management | | ✓ | | | | | | | ✓ | |
| Farm advice - capacity building for land managers. | | ✓ | | | | | | | ✓ | |

| Potential adaptation measures | Cohesion Funding | CAP * | EMFF** | Guadeloupe | Martinique | French Guiana | Reunion | Canary Islands | Azores | Madeira |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| **Forestry** | | | | | | | | | | |
| Consider using Cohesion Policy funds directly to fund more research and strategic planning for climate change adaptation where information is lacking | ✓ | | | | | | | | | |
| Enhance the use of regional cooperation instruments (INTERREG), especially for building capacity and exchanging best practice with other Member States and regions. | | | | | | | | | | |
| Improving status of marine ecosystems and in particular their resilience to climate change | | | | | | | | | | |
| **Fisheries & Aquaculture** | | | | | | | | | | |
| Consider using Cohesion Policy funds directly to fund more research and strategic planning for climate change adaptation where information is lacking | ✓ | | | | | ✓ | | | | |
| Enhance the use of regional cooperation instruments (INTERREG), especially for building capacity and exchanging best practice with other Member States and regions. | | | | | | ✓ | | | | |
| Improving status of marine ecosystems and in particular their resilience to climate change (for example investing in conservation, protecting biodiversity, investing in equipment limiting the impact of fishing) | | | ✓ | | | ✓ | | | | |
| Construction or modernisation of fishing infrastructure to increase resilience to extreme weather events (e.g. Fishing ports, landing sites) | | | ✓ | | | ✓ | | | | |
| Switch to fish species or fish production processing and distribution techniques better adapted to changing climate conditions (e.g. Investing in offshore and non-food aquaculture). | | | ✓ | | | ✓ | | | | |
| Promoting forms of aquaculture better suited to current and projected changes in climatic | | | ✓ | | | ✓ | | | | |

| Potential adaptation measures | Cohesion Funding | CAP * | EMFF** | Guadeloupe | Martinique | French Guiana | Reunion | Canary Islands | Azores | Madeira |
|---|---|---|---|---|---|---|---|---|---|---|
| conditions | | | | | | | | | | |
| Developing aquaculture that provides environmental services, very often considered as part of a cost-effective package of adaptation measures to a changing climate. | | | ✓ | | | ✓ | | | | |
| **Energy** | | | | | | | | | | |
| Consider using Cohesion Policy funds directly to fund more research and strategic planning for climate change adaptation where information is lacking | ✓ | | | | | | ✓ | | ✓ | ✓ |
| Enhance the use of regional cooperation instruments (INTERREG), especially for building capacity and exchanging best practice with other Member States and regions. | | | | | | | ✓ | | ✓ | ✓ |
| Efforts should be made to ensure future infrastructure is climate proofed | ✓ | | | | | | ✓ | | ✓ | ✓ |
| Energy efficient adaptation of homes, offices and industrial buildings to cope with increased temperatures (e.g. use of passive coooling systems). | ✓ | | | | | | ✓ | | ✓ | ✓ |
| Increase the robustness of transmission grids to storm damage | ✓ | | | | | | ✓ | | ✓ | ✓ |
| Installation of additional network capacities (smart grids). | ✓ | | | | | | ✓ | | ✓ | ✓ |
| Hydropower reservoir power stations: increase dam height to allow for higher variability in water availability | ✓ | | | | | | ✓ | | ✓ | ✓ |
| Ensure that design standards for wind turbines take into consideration potential for extreme storms | ✓ | | | | | | ✓ | | ✓ | ✓ |
| Installation of additional storage facilities to adapt to higher volatility in base load | ✓ | | | | | | ✓ | | ✓ | ✓ |
| Ensure higher energy efficiency of ventilation systems | ✓ | | | | | | ✓ | | ✓ | ✓ |
| Plan to ensure the cooling demand of thermal power plants can be met under future | ✓ | | | | | | ✓ | | ✓ | ✓ |

| Potential adaptation measures | Cohesion Funding | CAP * | EMFF** | Guadeloupe | Martinique | French Guiana | Reunion | Canary Islands | Azores | Madeira |
|---|---|---|---|---|---|---|---|---|---|---|
| drought/heat conditions - make contingency plans | | | | | | | | | | |
| Targeted retrofitting to increase robustness of thermal power plants in coastal areas | ✓ | | | | | | ✓ | | ✓ | ✓ |
| **Tourism** | | | | | | | | | | |
| Consider using Cohesion Policy funds directly to fund more research and strategic planning for climate change adaptation where information is lacking | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| Enhance the use of regional cooperation instruments (INTERREG), especially for building capacity and exchanging best practice with other Member States and regions. | | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| Diversification of tourist offers in different regions (development of winter and summer tourism). | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| **Construction & Buildings** | | | | | | | | | | |
| Consider using Cohesion Policy funds directly to fund more research and strategic planning for climate change adaptation where information is lacking | ✓ | | | ✓ | | ✓ | | ✓ | | ✓ |
| Enhance the use of regional cooperation instruments (INTERREG), especially for building capacity and exchanging best practice with other Member States and regions. | | | | ✓ | | ✓ | | ✓ | | ✓ |
| Efforts should be made to ensure future infrastructure is climate proofed (general) | ✓ | | | ✓ | | ✓ | | ✓ | | ✓ |
| Improve protection of buildings to storms, extreme precipitation | ✓ | | | ✓ | | ✓ | | ✓ | | ✓ |
| Strategic urban and regional planning to prevent further development of assets in vulnerable areas (e.g. Building in flood plains) | ✓ | | | ✓ | | ✓ | | ✓ | | ✓ |
| Increase use of Green and Blue spaces, including green roofs | ✓ | | | ✓ | | ✓ | | ✓ | | ✓ |

| Potential adaptation measures | Cohesion Funding | CAP * | EMFF** | Guadeloupe | Martinique | French Guiana | Reunion | Canary Islands | Azores | Madeira |
|---|---|---|---|---|---|---|---|---|---|---|
| Increase the uptake of more water-efficient buildings | ✓ | | | ✓ | | ✓ | | ✓ | | ✓ |
| **Transport** | | | | | | | | | | |
| Consider using Cohesion Policy funds directly to fund more research and strategic planning for climate change adaptation where information is lacking | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| Enhance the use of regional cooperation instruments (INTERREG), especially for building capacity and exchanging best practice with other Member States and regions. | | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| Use of heat-resistant asphalt and adjustment of maintenance regimes | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| Moving road alignments beyond areas at risk (of e.g. Flooding). | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| Retrofitting existing road infrastructure concerning increased precipitation | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| Adjust maintenance regime for rail infrastructures | ✓ | | | | | | | ✓ | | |
| Adaptation of rail infrastructure to heat and temperature change | ✓ | | | | | | | ✓ | | |
| Retrofitting trains for increased air-conditioning demand due to increased temperatures | ✓ | | | | | | | ✓ | | |
| Retrofitting airports against heat and against higher precipitation | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| Retrofitting existing shipping infrastructure against extreme events | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| Future-proofing: adequately design and maintain bridges and tunnels | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| Vegetation management along roads (and railway). | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |

| Potential adaptation measures | Cohesion Funding | CAP * | EMFF** | Guadeloupe | Martinique | French Guiana | Reunion | Canary Islands | Azores | Madeira |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| **Waste** | | | | | | | | | | |
| Consider using Cohesion Policy funds directly to fund more research and strategic planning for climate change adaptation where information is lacking | ✓ | | | | | | | | | |
| Enhance the use of regional cooperation instruments (INTERREG), especially for building capacity and exchanging best practice with other Member States and regions. | | | | | | | | | | |
| **Health** | | | | | | | | | | |
| Consider using Cohesion Policy funds directly to fund more research and strategic planning for climate change adaptation where information is lacking | ✓ | | | | | ✓ | | | | ✓ |
| Enhance the use of regional cooperation instruments (INTERREG), especially for building capacity and exchanging best practice with other Member States and regions. | | | | | | ✓ | | | | ✓ |
| Energy efficient cooling of hospitals | ✓ | | | | | ✓ | | | | ✓ |
| Additional care and support of vulnerable citizens through health infrastructure (workers, buildings). | ✓ | | | | | ✓ | | | | ✓ |
| **Biodiversity** | | | | | | | | | | |
| Consider using Cohesion Policy funds directly to fund more research and strategic planning for climate change adaptation where information is lacking | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Enhance the use of regional cooperation instruments (INTERREG), especially for building capacity and exchanging best practice with other Member States and regions. | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

| Potential adaptation measures | Cohesion Funding | CAP * | EMFF** | Guadeloupe | Martinique | French Guiana | Reunion | Canary Islands | Azores | Madeira |
|---|---|---|---|---|---|---|---|---|---|---|
| Develop further conservation areas and recreate habitats. | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Maintain and improve support habitat management (conservation management, green corridors). | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Coastal Zone Management** | | | | | | | | | | |
| Consider using Cohesion Policy funds directly to fund more research and strategic planning for climate change adaptation where information is lacking | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| Enhance the use of regional cooperation instruments (INTERREG), especially for building capacity and exchanging best practice with other Member States and regions. | | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| Promote technical and institutional capacity building activities (ERDF can be used). | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| Training and awareness raising (ESF funds can be used) | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | ✓ |
| **Soil** | | | | | | | | | | |
| Consider using Cohesion Policy funds directly to fund more research and strategic planning for climate change adaptation where information is lacking | ✓ | | | | | | | ✓ | | |
| **Water** | | | | | | | | | | |
| Consider using Cohesion Policy funds directly to fund more research and strategic planning for climate change adaptation where information is lacking | ✓ | | | | | | | | ✓ | |
| Enhance the use of regional cooperation instruments (INTERREG), especially for building capacity and exchanging best practice with other Member States and regions. | | | | | | | | | ✓ | |
| Installation and retrofitting of environmental infrastructures to prevent natural disasaters (e.g. Protection against avalanche). | ✓ | | | | | | | | ✓ | |

| Potential adaptation measures | Cohesion Funding | CAP * | EMFF** | Guadeloupe | Martinique | French Guiana | Reunion | Canary Islands | Azores | Madeira |
|---|---|---|---|---|---|---|---|---|---|---|
| Additional rain overflow basins to adapt sewage system against flooding, enhancing water storage capacity or reservoirs | ✓ | | | | | | | | ✓ | |
| Adaptation of sewage systems against droughts and low-water levels | ✓ | | | | | | | | ✓ | |
| River restoration (buffer zones), restoration of wetlands | ✓ | | | | | | | | ✓ | |
| Leakage control in water distribution system | ✓ | | | | | | | | ✓ | |
| Water demand management (e.g. Restricting groundwater consumption) | ✓ | | | | | | | | ✓ | |
| Desalination of water | ✓ | | | | | | | | ✓ | |
| Increase use of Sustainable Urban Drainage Systems | ✓ | | | | | | | | ✓ | |
| **Disaster & risk** | | | | | | | | | | |
| Consider using Cohesion Policy funds directly to fund more research and strategic planning for climate change adaptation where information is lacking | ✓ | | | | | ✓ | | | | |
| Develop regional risk assessments for disaster management. | ✓ | | | | | ✓ | | | | |
| ERDF can be used to promote technical assistance and institutional capacity building activities and ESF for training and awareness raising | ✓ | | | | | ✓ | | | | |
| Enhance the use of regional cooperation instruments (INTERREG), especially for building capacity and exchanging best practice with other Member States and regions | | | | | | ✓ | | | | |
| Increased investment in disaster management systems, to facilitate disaster resilience and risk prevention and management of natural risks | ✓ | | | | | ✓ | | | | |
| Information and Monitoring systems on spread and relevance of vector-borne, food-borne diseases | ✓ | | | | | ✓ | | | | |
| Protection from forest fires | ✓ | | | | | ✓ | | | | |

| Potential adaptation measures | Cohesion Funding | CAP * | EMFF** | Guadeloupe | Martinique | French Guiana | Reunion | Canary Islands | Azores | Madeira |
|---|---|---|---|---|---|---|---|---|---|---|
| Soft coastal defences | ✓ | | | | | ✓ | | | | |
| Flood gates | ✓ | | | | | ✓ | | | | |
| Dyke reinforcement and heightening | ✓ | | | | | ✓ | | | | |
| Heat Warning Systems | ✓ | | | | | ✓ | | | | |
| Remote sensing and satellite imagery for early warning systems: for extreme weather events | ✓ | | | | | ✓ | | | | |

*Note these measures were proposed by 'Methodologies for Climate Proofing Investments and Measures under Cohesion and Regional Policy and the Common Agricultural Policy' (report for DG Climate, August 2012) but have not necessarily been approved / been legislated for at present.

** Source of EMFF recommendations: SWD(2013) 299 final, Principles and recommendations for integrating climate change adaptation considerations under the 2014-2020 European Maritime and Fisheries Fund operational programmes

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