European Commission

Climate change adaptation practice across the EU

Understanding the challenges and ways forward in the context of multi-level governance

Climate Action

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Introduction

The climate is changing and it is already affecting the way we live. Policymakers at national, regional and local levels need a strategic approach to understand and respond to climate change. How does climate change affect key policy sectors across Europe and what is already being done about it, particularly at the local and regional levels? And how, specifically, have some authorities achieved good results in adaptation planning and action?

Climate change impacts are becoming more visible across the EU and pose serious risks to our way of life. Some climate change impacts are very visible – such as heat waves, storms, floods, droughts and sea level rise. Others are not so easy to see or understand because they will occur 20, 50 or 80 years from now and predictions about what will happen are not very certain. For example, wine growers in the Rhône-Alpes region of France are now starting to harvest grapes about one month earlier than they did 60 years ago, mainly due to temperature increases. Because of its unique geographic position and climatic conditions, Malta is simultaneously more exposed to both flooding and water scarcity. In Romania, however, projected effects are more long term: farmers there can expect a decline in maize yield of 14 per cent by 2050, as precipitation levels decrease.

Climate change impacts are occurring and will continue to occur, and our future well-being depends on our ability to 'adapt' our physical infrastructure, our systems, our planning and our behaviour to a new and uncertain reality. The UN's body for assessing climate change, the IPPC[1], defines adaptation as 'adjustments in natural or human systems in response to actual or expected stimuli or their effects, which moderates harm or exploits beneficial opportunities'[2]. From a policy perspective, adaptation means taking climate scenarios and their possible socio-economic impacts into account into all types of policy-making and planning. To do so will require more flexible, forward thinking and more collaboration across political, social and economic actors.

Climate change impacts do not respect administrative borders. Impacts will vary across the EU, and within each Member State. To be effective, climate change adaptation requires responses at all levels of governance – the national, regional, local and collectively at the EU level. Recognising this, the European Commission adopted an EU Strategy on adaptation to climate change in April 2013[3]. Its three priorities are: 1) Promoting action by Member States; 2) Better informed decision-making and 3) Increasing resilience in key vulnerable sectors.

To a great extent, planning on climate change adaptation is already happening across Europe. Over half of the EU Member States have a national-level adaptation strategy in place that can guide regions, cities, municipalities, sectoral authorities such as those responsible for water or health as well as business and individuals to determine their own way forward[4]. To be successful, this strategic planning has to be based on a clear understanding of what may happen in the future and how that can impact our livelihood. And it has to consider impacts and responses across a wide range of policy sectors, such as agriculture, forestry, health, water and infrastructure, to name a few. There is less experience with the actual implementation of adaptation strategies, particularly the consideration of longer-term climate change impacts into investments. Full engagement of the private sector and private finance is also a significant task for the future.

Purpose and content of the publication

Adaptation is a challenging undertaking that is only just beginning across the EU. This publication aims to provide policy makers, project developers and other actors with illustrative examples of adaptation activities at national, regional and local levels.

The examples and case studies presented here stem from research on climate change adaptation at the regional level in all the EU Member States. The research results are contained in the *Study of Adaptation Activities at Regional Level in the EU,* prepared for the European Commission DG Climate Action in 2013[5]. As part of this research, a long list of practice examples was identified, from across the

EU. These examples cover a range of adaptation practices: efforts to better understand climate change impacts; planning for adaptation at all levels; and the implementation of concrete adaptation solutions. These and other examples drawn from literature and the growing database of cases on the European Climate Adaptation Platform (Climate-ADAPT) have been used to demonstrate what is being done about climate change in key policy sectors; ten examples have been selected as the subject of the longer case studies.

This publication is presented in two parts. The first part contains a short overview of climate change impacts on key policy sectors: Agriculture and forestry; Biodiversity; Coastal areas; Disaster risk reduction; Health; Infrastructure and Water management. Impacts are shown by sector to provide a better understanding of what climate change means for our livelihood, and also for policy-making. Possible adaptation responses for the main impacts are presented by exemplifying existing good practice.

The second part contains ten case studies which demonstrate how adaptation to climate change is researched, planned and delivered across the EU. The ten case studies are quite diverse in content. They address different levels of governance – from the national to the local as well as trans-boundary issues both within and across Member States. They cover a range of geographic and climatic areas in the EU. They address different vulnerable sectors, such as agriculture, water management, tourism, and coastal areas.

The ten case studies have been selected based on a number of factors. A starting point was whether the case addressed a priority need or challenge that authorities face in dealing with climate change – such as the need to communicate across stakeholder groups, raise awareness about climate change, or look for greener solutions. Next, cases were evaluated to determine whether the example was interesting (did it tell a story?) and useful (did it provide concrete, productive results?) and replicable (could it be done elsewhere in a similar way?). Finally, cases were chosen in order to provide a diverse set of examples in terms of challenges addressed, climate change impacts and sectors, types of measures, and geographical location.

Ten examples of adaptation in practice

For each case, emphasis is placed on how the results have been achieved. The case studies describe the motivation for action, the specific steps taken and factors responsible for the success of the measure. The case studies address many of the common challenges posed by climate change adaptation: lack of awareness and information; dealing with uncertainty; tackling multiple objectives simultaneously; and reaching out to a wide range of often unfamiliar partners. Above all, these cases are meant to demonstrate that solutions to these seemingly insurmountable challenges do exist and that the lessons learned are widely applicable.

For adaptation processes to begin, societies need to be aware of the potential risks, vulnerabilities and opportunities they can expect. The first case study tackles the challenge of lack of awareness on climate change. It presents an awareness raising project initiated by civil society organisations and targets the county level in Poland. In Poland, counties oversee emergency response to many climate driven events such as floods, fires and storms. Through this project, they are working together to strengthen their capacities to understand how and build resilience to climate change in their territories.

Adaptation responses and actions need to be based on reliable, understandable knowledge about climate projections and the potential impacts on key economic sectors. When little is known or understood, it is nearly impossible for authorities to plan and act. In Romania, the scientific community and practitioners are working together to study location-specific climate change impacts and identify solutions in the agriculture sector with a longer-term perspective.

Climate impacts are broad and complex. Most will affect multiple sectors, different levels of governance and stakeholder groups simultaneously. Addressing these types of impacts will require different stakeholders to work together. Three case studies explain how this is done in the context of preparing regional adaptation strategies. In the Lombardy region of Italy, one institution worked across all relevant sectors to prepare detailed guidelines for developing the region's adaptation strategy. The case study on the Highland region in Scotland shows how a commitment to transparency and openness combined with a dedicated method for stakeholder involvement resulted in a robust and workable adaptation strategy. In France, the national energy and environment agency directly supports regional authorities to secure the input of sectoral authorities, also through a dedicated procedure.

Climate change is a trans-boundary issue. To tackle it effectively, Member States and regions must work together with colleagues across administrative borders to understand and address common climate challenges. In Sweden, the neighbouring counties of Västra Götaland and Värmland work together to manage an area highly prone to flooding. In the Pyrenees mountain region, authorities from France, Spain and Andorra have developed a common approach to collect and analyse climate data and develop coordinated adaptation responses.

In Greece the island region of Crete has begun to address its lack of expertise and financing for adaptation. Through involvement in a project financed by the EU, Crete was able to harness knowledge from other EU regions on concrete adaptation options and to advance the formulation of adaptation policy in the region.

The final two case studies provide insights on how climate change adaptation is implemented in practice, showcasing two successful technical approaches. In the Netherlands a long experience of working with traditional flood infrastructure – dams and storm surge barriers – is complemented with more natural solutions that will restore habitats and lengthen the lifetime of existing infrastructure. In Malta, an intelligent technical solution simultaneously addresses two key climate vulnerabilities – floods and drought.

Useful, practical ways forward

Rather than provide new answers, this publication is meant to demonstrate how others have tackled common challenges and to motivate readers to consider similar approaches in their own communities. While these case studies are diverse, together they illustrate some useful, practical ways forward for policy makers and other actors working on climate change.

For adaptation, participatory policy-making is a particular challenge due to the large number of different interests that need to be involved. Climate change cuts across traditional policy sectors, and also impacts a wide range of community interests, including those of businesses and individuals. Good practice has shown that what often works is a structured process to addressing this challenge in policy-making and planning. This can be done in different ways. In Lombardy, Italy, this process is coordinated by an inter-institutional environmental body, which integrates the input of various sectoral authorities and other interests into a detailed guideline that serves as a roadmap for the preparation of the adaptation strategy. In France, the national agency supports regions directly by coordinating sectoral input on climate change strategies. In the Highland region of Scotland, a series of 25 workshops structured across relevant groups was designed by the regional authority. In Sweden a handbook guides municipalities to work together to manage flood risks. In the Pyrenees, scientists and policy-makers from three different countries adapted their processes for collecting and understanding climate data into a compatible system to ensure future actions are complementary, given the common climate change challenges they face.

Many adaptation solutions offer multiple benefits; looking for these in planning adaptation actions not only reduces risk, but can also incentivise different groups to support the process. Most measures aimed at adapting to climate change have additional benefits, such as the economic opportunities created by the development of Oyster beds in the Oosterschelde estuary.

Adaptation requires new thinking. As climate change scenarios are inherently complex and uncertain, solutions need to be flexible and cost-effective. New concepts such as the role of natural processes and biodiversity that were previously not well understood are emerging as key parts of the solution, as seen in the Oosterschelde case. Infrastructure that is expected to last for many decades is particularly vulnerable and long-term thinking must be integrated into planning and investment now, as seen in Malta.

Adaptation planning is only as good as the science it is based upon; if climate change impacts are poorly understood or lack detail, it is difficult to develop credible response options. In many of the case studies, dedicated effort is made to translate climate science into terms that policy makers and other stakeholders can understand, both to raise awareness and enable their concrete inputs. In Romania, where agriculture that is vital to many communities is under threat, a series of vulnerability studies and pilot actions was developed jointly between scientists, practitioners and authorities.

Finally, the importance of learning from others should not be underestimated. While good practice publications and other case study collections such as those found on Climate-ADAPT are a start, active collaboration with partners from around the EU can ignite the new and advanced thinking that climate change adaptation requires. Many of the practices shown in this publication were in one way or another inspired by other examples – many of them brought together through EU-funded programmes such as the research framework programme (FP7, now Horizon 2020), Interreg for European territorial cooperation or the LIFE instrument for environment. These initiatives have proven to be indispensable not only for bringing forth new ideas from new places, but also as a source of funding to jump start action.

Useful resources:

- **Adaptation Inspiration Book 22 implemented cases of local climate change adaptation to inspire European citizens**
- **Climate-ADAPT European Climate Adaptation Platform**
- **European Commission, Agriculture and Rural Development**
- **European Commission, DG Climate Action**
- **European Commission, DG Environment**
- **European Commission, Regional Policy**
- **European Commission, Research and Innovation**
- **European Environment Agency Adaptation in Europe Addressing risks and opportunities from climate change in the context of socio-economic developments**
- **Horizon 2020 EU Framework Programme for Research and Innovation**
- **LIFE Programme EU financial instruments supporting environmental and nature conservation**

1. The Intergovernmental Panel on Climate Change
2. IPCC (2007)
3. EC (2013) An EU Strategy on adaptation to climate change, COM(2013) 216 final
4. Climate-ADAPT
5. DG Climate Action

CLIMATE CHANGE ADAPTATION PRACTICE ACROSS THE EU

HOW WILL KEY POLICY SECTORS BE AFFECTED BY CLIMATE CHANGE AND WHAT IS BEING DONE?

Agriculture and forestry

Agriculture and forestry are strategically important economic sectors in the EU, with a direct relationship to climate systems. They are therefore likely to be affected significantly by many predicted climatic changes.

Increases in the concentration of atmospheric CO_2; higher average temperatures; changes in precipitation patterns; and changes in the frequency of extreme weather events will affect agriculture. These and other likely climate impacts will have consequences for the availability of water, the composition and stability of soils and the types of pests and diseases that will need to be managed by the agriculture and forestry sectors in the future. These factors will lead to significant changes in the conditions for cropping and livestock production across the EU. In turn this will affect the pattern and viability of certain types of crop or livestock species, with potentially profound impacts on the extent and type of agriculture across Europe. Many new risks are likely, as well as some opportunities – although overall the result of these changes is predicted to be more negative than positive for agriculture in Europe.

Climate change will also have consequences for forestry. In the past, relatively slow natural shifts in the climate have enabled forest species and communities to adapt and evolve. However, on-going and predicted changes in the climate are likely to occur over shorter time-frames such that natural forest systems will be less able to adapt. These changes are also predicted to lead to increased risk of outbreaks of pests and diseases, as well as disruption from more frequent storms and fires. There are some potential opportunities, for example commercial forests in Northern Europe are expected to benefit from increased yields. But overall the economic viability, productivity and resilience of forestry is predicted to be negatively affected across Europe, especially in parts of Southern Europe. As a result, the capacity of forests to provide ecosystem services, including their vital role in providing a carbon sink, could be severely compromised.

Examples of adaptation in agriculture forestry sectors

Planning for climate change

Preparing for climate change and developing appropriate adaptation responses in the agriculture and forestry sectors requires careful planning due to the economic and social importance of these sectors and the relatively long time horizons required to bring about change in agricultural practices and forest management. A key initial step is therefore to develop a better understanding of the predicted climate change impacts in order to support effective long-term decision making.

An example of such planning is the *Calchas* project in Greece which developed an integrated forest fire analysis system (the project was co-financed by the EU Programme LIFE+). This project modelled likely changes in the frequency and scale of forest fires to enable system users to consider management options for reducing the risk of forest fires. The project also promoted the integration of likely climate change impacts and adaptive responses into future forest management and development plans.

The *Caravan* tool developed by the Finnish Environmental Institute is an example of an on-line resource aimed at assessing climate change vulnerability and adaptive capacity in the Nordic countries. The tool could be used to facilitate adaptation planning at regional and local levels.

One example of an adaptation plan for the agriculture and forestry sectors is Finland's *Action Plan for the Adaptation to Climate Change of the Ministry of Agriculture and Forestry 2011–2015.* The plan identifies a range of measures that will be implemented to reduce these risks, whilst maximising any benefits, including:

- Monitoring and responding to changes in plant and animal diseases.
- Climate-proofing existing processes by explicitly requiring the consideration of climate change, in particular in activities related to the Common Agricultural Policy (CAP).
- Seeking and monitoring new varieties of seed and livestock that are more resilient to climatic changes.
- Promoting diversification in agriculture and forestry.
- Increased communication on the importance of climate change adaptation.

These measures are being implemented by the Ministry, and the action plan will be revised on a regular basis as necessary.

Delivering adaptation actions

Climate change impacts are already occurring in agriculture and forestry, and some dedicated adaptation measures are also underway. These include measures to secure water availability, or manage new diseases or pests, or to introduce new crops or practices that can minimise vulnerability to known climate risks. A concrete example of this type of action in the agriculture sector is the construction of new reservoirs to provide storage for summer irrigation or water for livestock in regions where drought or water availability is already an issue, and is predicted to worsen under climate change. This is something that can be managed through improvements to in-farm irrigation systems.

A successful example in designing and delivering adaptation options for the agricultural sector is Extremadura, Spain. Four main factors contribute to the success of adaptation policies in Extremadura. Firstly, the strategic document developed for adaptation in the agriculture sector *Plan for Climate Change Adaptation in the Agricultural Sector* supports these initiatives by seeking modernisation of in-farm irrigation systems in response to expected decrease in water availability in the future. Second, funding is planned and dedicated for adaptation options in agriculture. The 2007-2013 EU-funded *Rural Development Programme* in the Extremadura region provides funding for farmers to develop farming practices. Third, the funding mechanism encourages measures that are adapted to local conditions and crop requirements and which minimise erosion or soil degradation. Finally, this funding also supports farmers in selecting options that have considerable side benefits for adaptation. For instance, farmers are encouraged to select crop varieties that have greater resistance to drought and high temperatures.

The adaptation actions carried out in the Czech Republic's Šumava and Krkonoše National Parks form another example**.** The parks have suffered severe deterioration of their forest canopies due to acid rain and poor management over the past century. The forests are also considered vulnerable to climate change impacts, which are expected to bring increases in pests and diseases. United Nations organisations and local partners, including the Czech Ministry of Environment, the two National Park Administrations and local municipalities, developed and funded a project to find a balance between the preservation of these forests and their biodiversity with the promotion of economic prosperity in these remote areas. Reforestation and rehabilitation activities were undertaken in areas affected by climate change, for example by wind storms and bark beetle population booms. Specific actions included replanting regimes to diversify tree species and to stabilise degraded ecosystems whilst storing carbon – providing both mitigation and adaptation functions. These actions – specifically, replanting trees and closing gaps in the forest canopy – will also provide more habitats, increasing the resilience of the

forests. It will also improve the health of individual trees so that they are more resistant to pests and disease and other likely climate change impacts.

Additional examples of adaptation actions in agriculture and forestry include Slovenia's *Action Plan for Forestry and Agriculture*. The plan includes piloting barn breeding of livestock to reduce the impact of hotter summers (risks of heat stroke and sun-burn) on sows and piglets. Further, the EU-funded *Rural Development Programme* (2007 – 2013) for Slovenia supports the purchase of hail nets (since extreme weather events are anticipated to increase, including hail storms) and investment in water infrastructure in response to predicted climate change impacts.

The actions highlighted above attempt to decrease the significance of any climate impacts. An alternative response is to seek to avoid these impacts. Within the agriculture sector this can be done, for example, by changing existing cropping areas in response to changing conditions – an action which is being promoted in Bulgaria through their *Third National Action Plan on Climate Change 2013-2020*. This is facilitated by changes to zoning patterns which indicate what crops are more or less suitable in different areas.

Increased structural and genetic diversity within forests can further deliver multiple benefits by increasing biodiversity, landscape amenity value and other ecosystem services such as flood risk and soil regulation. In Wales, UK, the Welsh Government is seeking to improve the resilience of forests to climatic changes by increasing diversity of tree species to reduce the likely impacts of pests and climate change on Wales' forests and forestry sector. This is being done through the programme: *Making Woodlands More Diverse*. This programme is based on a review of projected climate impacts which identified changes to pest, disease and weather patterns as significant and as increasing threats to Wales' forestry sector. Diversification of planting and management was seen as the most effective response. This has now been implemented in several ways, including changes to their *Glastir* funding scheme (an agri-environment scheme funded by the Rural Development Plan for Wales 2007-2013), the *Woodland Strategy for Wales* and in the production of guidance documents for forest managers.

In some instances it might be necessary to find ways of spreading the costs of a specific climate change impact. This can be achieved by putting in place insurance or creating cooperative structures where risks and losses are shared amongst a group, such as among the agricultural cooperatives that are common in many parts of Europe. National plans in both Spain and Slovenia have adapted EU-funded Rural Development Programmes to provide resources for insurance schemes in the event of crops being destroyed or damaged, a risk that is expected to increase with climate change.

Looking for opportunities from climate change

Adaptation actions can also be used to maximise the potential benefits of climate change. For example, changing or diversifying crops may bring other benefits, such as improved crop productivity (leading to higher yields, turnover and employment potential), reduced need for and use of agri-chemicals and fertilisers, and wider environmental benefits (e.g. improved water quality, conditions for pollinators). As shown in the Caravan tool – *A Regional Assessment of Vulnerability and Adaptive Capacity for the Nordic Countries* – and in Finland's adaptation plan for agriculture and forestry, commercial forestry in parts of Northern Europe is expected to benefit as the climate changes and atmospheric carbon remains high. Recognising where there are opportunities and putting in place measures that can make the most of these is something that all adaptation measures should seek to achieve.

Useful resources:

- AEA Energy & Environment Adaptation to Climate Change in the Agriculture Sector
- Board of Extremadura Plan for Climate Change Adaptation in the Agricultural Sector for Extremadura
- Ministry of Environment and Water of Bulgaria Third National Action Plan on Climate Change 2013-2020
- Calchas project Development of an integrated analysis system for the effective fire conservancy of forests
- Climate-ADAPT Website Agriculture and forestry sector information
- Finland, Ministry of Agriculture and Forestry Action Plan for the Adaptation to Climate Change of the Ministry of Agriculture and Forestry 2011–2015
- Finnish Environment Institute CARAVAN tool
- Welsh Government Making Woodlands More Diverse

Biodiversity

The Convention on Biological Diversity defines biodiversity as the 'variability among living organisms...'. *This includes diversity of genetic resources, species and ecosystems. Plants and animals interact and react with each other and with the physical environment in ways that are essential for human life. These natural systems – called ecosystems – provide humans with essential goods and services such as food, natural resources, and fresh water.*

Climate change impacts, such as increasing temperatures, changing precipitation patterns, and sea level rise will affect Europe's biodiversity. Temperature increases can cause a shift in timing of specific plant and animal life-cycles, meaning that food sources for some species will no longer be plentiful when needed. Such changes are likely to lead to increased population fluctuations and local extinctions of certain plant and animals. Habitats on which plant and animal species depend are expected to be subject to increased erosion, drought, flooding, changes in nutrient balances and increased frequency and severity of fires and storms.

Biodiversity is able to respond to climatic changes, for example plants or animals that thrive in colder conditions can gradually migrate to locations further north as temperatures increase. However, the speed of changes associated with climate change will often exceed the ability of biodiversity to respond naturally, especially within a densely populated and developed area such as Europe.

When placed within the context of other pressures, such as habitat fragmentation, degradation and loss, changes in land-use and pollutant levels, overexploitation and invasive alien species, the additional stress of climate change can be very significant, as it interacts with and often exacerbates these other pressures. The natural environment also plays an important role in reducing the negative impacts of climate change. Terrestrial and marine ecosystems currently absorb roughly half of the anthropogenic CO_2 emissions. Future climate change may negatively impact this, resulting in increases in emissions to the atmosphere.

Examples of adaptation in biodiversity

Understanding the impacts of climate change on biodiversity and ecosystems

Interactions between biodiversity, climate change and other pressures such as land use change and invasive species are complex and often not well understood. There is a need for robust evidence and careful planning to ensure that actions taken to adapt to climate change are effective, efficient and do not result in increased vulnerability in the long run or lead to other unintended negative outcomes.

In the UK, environmental authorities and agencies have developed a 'state of the art' library on biodiversity-related climate change impacts, through the research programme *Biodiversity and climate change: a summary of impacts in the UK*. The results of this work form the basis for the country's response to climate change in the biodiversity sector and have provided a valuable input to various policy mechanisms including the national level climate change adaptation programme.

The Netherlands Environmental Assessment Agency has developed an *Adaptation strategy for climate-proofing biodiversity.* The strategy includes an assessment of the current state of biodiversity, likely climate change impacts as well as possible adaptation responses. The assessment found that existing nature protection policy did not adequately address climate change adaptation in the biodiversity sector. The strategy proposes priority actions including connecting habitats; removing features that inhibit natural movement (such as man-made barriers designed to control coastal sediment movement and sea walls) and using targeted agri-environment funding to support mobility of species across specific parts of the landscape. A particular feature of this strategy is that it identifies wider benefits that the proposed adaptation actions can deliver, such as reduced flooding risk, improved recreational areas and water quality and addressing high temperatures through green infrastructure in urban areas.

Delivering adaptation actions

Poland's Biebrza National Park is unique in Europe for its combination of peat and wetland habitats. These habitats provide homes for a variety of species, particularly birds. Climate change impacts – particularly drier conditions due to less rainfall and reduced runoff from mountain snowfall – threaten the park's wetland habitats. Illegal drainage from local farming also contributes to the damage and is expected to increase as climate change-related drier conditions worsen.

In response to these challenges, a *Climate-Adapted Management Plan (CAMP)* was developed for the park, as part of the EU-funded transnational project *HABIT-CHANGE*. Preparation of the *CAMP* involved talking to local farmers and other stakeholders to find sustainable responses to the drier conditions. The *CAMP* developed management actions designed to reduce the predicted impacts of climate change on different habitat types. Examples of management actions include: switching from mechanical mowing to grazing (to reduce soil compaction); using measures to prevent water run-off in winter; and stopping activities at certain times of the year to avoid disturbance to birds.

Integrated adaptation planning and delivery is also carried out in the German Bundesland (region) of Brandenburg. The region is relatively dry and characterised mainly by sandy, free-draining soils. Climate change is expected to result in reduced levels of ground water in the area, which can dry out habitats and increase the risk of uncontrolled fires.

Recognising these risks for biodiversity, the Innovation Network for Climate Change Adaptation Brandenburg Berlin has been investigating appropriate adaptation actions, as part of a larger research project on adaptation in the Brandenburg region, funded by the German federal government. The project recognised that current conservation approaches applied static goals and targets and were not responsive to the expected changes in climate and other factors requiring flexible planning. To improve flexibility in existing conservation strategies and plans, the following actions were proposed:

- Targeting and selection of conservation sites based on their vulnerability to predicted changes in the climate;
- Integrating climate change considerations into protected area management plans;
- Providing advice to policy makers (in particular in urban development) on how to increase habitat connectivity for all species to enable migration as the climate changes.

A specific measure within this project is creation of a 'landscape framework' that helps to integrate climate change considerations into biodiversity management planning in the region. Another is the reintroduction of the capercaillie (a large type of fowl) to improve and strengthen the natural cycles and functions of the pine-oak forests and heath landscapes in which these birds once lived.

The *Bavarian Climate Protection Programme* addresses forestry and land-use, and integrates biodiversity protection with climate change adaptation. Under this programme, nearly half the acutely endangered spruce in the region's private and communal forests will be converted into climate-tolerate mixed forest by 2020. Other planned measures include:

- Preservation and restoration of floodplains and marshlands;
- Promotion of climate-friendly agricultural use of moorlands, for instance through re-conversion of arable land into waterlogged grasslands;
- Improvement to the microclimate in large built-up areas including maintenance and improvement of green spaces and fresh-air corridors.

Ecosystem-based approaches to adaptation

Biodiversity and ecosystem services can play an important role in climate change adaptation, as natural solutions are often cost-effective and provide a wide range of benefits. Climate change is expected to cause sea level rise, placing increased pressure on coastal habitats as they are squeezed by rising water levels. Sea level rise and other changes also bring increased risks of flooding. Removing existing man-made sea defences and allowing the controlled re-establishment of natural systems is an approach that can improve flood protection whilst also creating new habitats. This is seen in the case study *Natural processes complement flood infrastructure in the Netherlands* in this publication.

Another examples comes from the river Scheldt in Belgium, where a new system of flood protection dykes has been built inland of existing dykes. In the process, the existing dykes were deliberately breached to allow the sea water and sediment to run in and inundate the area. This created 170 Ha of new habitat for coastal plants, birds and invertebrates, effectively expanding and improving the adjacent large nature reserve *Verdronken Land van Saeftinghe*. In addition to reducing flood risk, the new habitat presents opportunities for recreation and other uses that are expected to boost the local economy.

Useful resources:

> Altera and Eurosite Guidelines on Climate Change and Natura 2000
> Bavarian State Ministry of the Environment and Public Health Bavarian Climate Programme 2020
> Centre for Econics and Ecosystem Management Adaptation of governmental nature conservation management to climate change in Brandenburg (northeastern Germany)
> Climate-ADAPT Website Biodiversity sector information
> CLIMSAVE Project Climate Change Integrated Assessment Methodology for Cross-Sectoral Adaptation and Vulnerability in Europe
> Ecologic Institute and ECI Assessment of the potential of ecosystem-based approaches to climate change adaptation and mitigation
> European Commission DG Environment Green Infrastructure
> European Commission DG Environment Nature & Biodiversity
> European Environment Agency (EEA) Climate Change Impacts and Vulnerability in Europe 2012
> European Environment Agency (EEA) SOER 2010 Biodiversity
> GRaBS Project Adaptation to climate change using green and blue infrastructure
> Habit-Change Project Adaptive management for protected areas
> HEDWIGE – PROSPER Project Creation of new wetlands along the river Scheldt
> Joint Nature Conservation Committee Biodiversity and Climate Change – a summary of impacts in the UK
> Netherlands Environmental Assessment Agency Adaptation strategy for climate-proofing biodiversity
> Ourcoast Project

Coastal Areas

Coastal areas are the interfaces between land and the sea. These areas are diverse in geographic size and form and provide a wide range of social and economic benefits and opportunities, including fishing, tourism and recreation. Coastal areas also contain specialist habitats that support a variety of marine species and ecosystems.

Climate change affects coastal areas in four main ways: sea level rise; storm surges; increased coastal erosion; and warmer coastal sea temperatures.

The rise in global temperatures is expected to lead to higher sea levels around the globe due mostly to melting glacier and continental ice and thermal expansion of oceans. In its latest report, the IPCC confirms that the rate of sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia, with a significant acceleration over the last two decades. Rises in sea levels will cause coastal flooding and the loss of low-lying coastal areas through increased inundation and erosion. If greenhouse gas emissions continue to increase, the average rise in sea level in Europe is predicted to be more than 0.37 metres by 2080. Unless additional coastal protection measures are taken, this rise in sea level is expected to result in damages of approximately €25 billion annually[1].

Across Europe, coastal erosion already costs several tens of millions of Euros per year through property losses, damage to infrastructure, and the need for beach restoration. This in turn negatively impacts tourism and recreation opportunities and can cause damage to coastal biodiversity. The increase in frequency of storms and the changes in prevalent wind and wave directions predicted as a result of climate change will further increase erosion of coastal beaches and cliffs over time.

Increased coastal erosion and rising sea levels will increase the risk of storm surges and related flooding, with Member States bordering the North Sea being at greatest risk. These storm surges can lead to the flooding of coastal areas. This can lead to seawater entering freshwater areas and draining into underground freshwater stores. The introduction of seawater into freshwater areas can negatively affect the living conditions of animal and plant species. Additionally, if underground water stores are used for farming and human consumption, the result may be decreases in crop yields and negative human health effects respectively.

An increase in the frequency and intensity of extreme rainfall, and associated flooding, can also indirectly affect coastal regions by increasing surface run-off from agricultural land and sewage. This could mean an increase in the levels of water pollution and a decrease in the levels of oxygen available in coastal waters. This can result in the death of large number of marine animals and plants. Areas affected in this way are called ‘marine dead zones’. A number of such zones can already be found in Europe’s coastal areas. Seven

of the world's ten largest marine dead zones are found in the Baltic Sea, for example, along Skagerrak and Kattegat, parts of the Gulf of Riga, and parts of the Gulf of Finland[2].

Increases in average global air temperatures are expected to lead to changes in coastal water temperatures. These temperature changes will affect coastal ecosystems and the related fishing industry. As sea temperatures increase, the migration patterns of fish are expected to change as they seek to offset the change by moving to deeper, cooler regions and by avoiding warmer ones that may be uncomfortable for them. Such migration patterns, and any reduction in fish stocks, could negatively affect existing fishing industries and the coastal economies that rely on them. Warmer water temperatures could also enable aquatic species to thrive in regions that would have previously been too cold for them to survive in. However, this could also have a negative impact on native species through increased competition for food and predation.

Climate change may also affect tourism in coastal areas across Europe due to predicted warmer temperatures. In the Mediterranean region, this may lead to a shift away from summer tourism, but more business in the spring and autumn months. Northern regions of Europe may experience warmer summer months and benefit from increases in coastal tourism.

Examples of adaptation in coastal areas

Planning for climate change in coastal areas

The planning and management of coastal areas has been a focus of European policy since the 1970s. The European Commission adopted a recommendation for Integrated Coastal Zone Management in 2002, which recognises the threats to coastal areas posed by climate change. Integrated coastal zone management recognises the environmental, social and economic importance of these areas, and their multiple pressures and vulnerabilities. Planning also builds the foundations for delivering the most appropriate climate adaptation responses in coastal areas. In March 2013, a new joint initiative on integrated coastal management and maritime spatial planning was adopted.

In the UK, a *National Strategy for Flood and Coastal Erosion Risk Management has been developed by the Welsh Government.* The plan recognises that climate change will increase current rates of coastal erosion in Wales. It identifies communities that are at risk from coastal erosion and outlines a national strategy to manage this risk. Awareness raising, flood preparation and the fostering of community cohesion are focal actions.

The Azores region of Portugal has recognised the need to manage climate change impacts and risks sustainably in order to harness the benefits of economic growth. In 2008, it integrated climate change impacts into coastal zone management plans. These plans are legally binding and establish potential land uses in coastal areas. Internet forums and public meetings were used to encourage public participation, and a monitoring system devised to enable on-going and flexible management of climate change adaptation measures.

Under legislation adopted in 1991, Poland's coastal areas are considered vulnerable areas with special protective requirements, where principles of integrated and sustainable management must be followed. This formal, institutionalised approach has since gained broad approval among decision makers and the public, despite possible trade-offs with short-term gains. Within this context, consideration of climate change impacts is seen as crucial to sustainable management of coastal regions. Thus adaptation to climate change is one of the leading objectives of a national Programme of coastal protection. The programme came into effect after the passing of a 2003 legal act that ensures programme financing until 2023. Accordingly, the coastal regions of Pomerania and West Pomerania have developed strategic documents for coastal management that consider climate impacts, specifically sea level rise, increase in precipitation and an increase in the incidence of storms.

In Cork County, Ireland, authorities and the academic community have come together to develop an Integrated Harbour Management Strategy. The strategy recognises the potential climate change impacts on Cork Harbour, the second largest port in Ireland and a hub for global pharmaceutical and food-processing industries as well as for recreational use and the local fishing industry. Recognising that sea level rise and coastal erosion associated with climate change could negatively affect Cork Harbour, the municipal authorities created a plan focusing on managing these impacts; safeguarding the resilience of coastal systems; and balancing economic, social, and cultural development whilst also enhancing the environment. One aim was to strengthen the link between science and policy in the implementation of local climate adaptation actions. This was achieved through a targeted and interactive partnership between Cork County Council and a research group from the University College Cork. Cork County Council benefited from the opportunity to use knowledge on managing coastal risks from the University College Cork, while university researchers and students were able to better understand local policy frameworks.

Delivering adaptation actions in coastal areas

Concrete adaptation actions in coastal areas focus predominantly on the development of physical measures to reduce the effects of coastal erosion and sea level rise. Such measures include the restoration of sand barriers, beach nourishment strategies and the construction of beach protection structures.

In France, the Lido sand barrier, located between Sète and Marseillanin, in the region of Languedoc-Roussillon, is used to help reduce the impact of storm surges. The sand barrier was losing an area of sand equivalent to 1 hectare every year, and some experts predicted that the barrier could disappear entirely by 2020 if nothing was done, which would increase the risk posed by storm surges. The project to restore the sand barrier lasted from 2007 to 2010 and involved the addition of 60,000m^3 of sand to this area of the Sète coast. This restoration strengthened the sand barrier and will reduce the impact of sea level rise and storm surges in the future. By providing a natural buffer between the sea and the coastline, the sand barrier also helps to protect the coastline from erosion.

Friesland Province in the Netherlands has employed an innovative approach to improving coastal defences against sea level rise. The 'soft sand engine' technique involves the deposit of a large volume of sand near the shore, which, over a period of years, is brought onshore naturally through winds and waves. This helps to minimise the impacts of sea level rise and coastal erosion by ensuring maintenance of sand levels on beaches along the targeted area of coastline. This use of natural coastal cycles is a cost-effective and long-term solution to beach erosion.

In Bulgaria, the Shabla area on the Black Sea is an important area for tourism, fishing and agriculture. The community has taken a proactive approach to address the threat of current and projected sea level rise and coastal erosion. The municipality has begun constructing rock embankment dikes, a high pier and a concrete wall to protect the coastal area from these projected impacts. These infrastructure developments are reducing the risk to local homes and businesses located along the coastline and will pave the way for increased investment in the local economy.

Useful resources:

- **Climate-ADAPT Website Coastal areas sector website**
- **CoastAdapt Project**
- **European Commission Climate change adaptation, coastal and marine issues**
- **European Environmental Agency (EEA) SOER 2010 Marine and Coastal Environment**
- **EUROSION Case study on Shabla – Krapetz**
- **Friesland province The Soft Sand Engine**
- **IMCORE Project**
- **Le Pôle-relais lagunes méditerranéennes The Lido Sand Barrier**
- **Ourcoast Protecting the coast from erosion using hard rock measures**
- **Ourcoast Towards a more balanced management of a harbour through a Local Authority – Academic Couplet, Cork, Ireland**
- **The BaltCICA Project Climate Change: Impacts, Costs and Adaptation in the Baltic Sea Region**

1. European Commission, 2013b.
2. WWF, 2008.

Disaster Risk Reduction

Extreme events – such as floods, storms and heat waves – have made climate chance more visible across the globe. As sea level rise continues, more areas are at risk from coastal flooding. Warmer average temperatures increase the likelihood of droughts, forest fires and heat waves.

In Europe the 2003 heat wave resulted in more than 70,000 mortalities, with an estimated 19,000 mortalities in France alone. Flooding of the Elbe and Danube rivers in 2013 caused damage valued at over €12 billion.

Disaster risk reduction is a systematic approach to identifying, assessing and reducing the risks of disaster. It aims to reduce socio-economic vulnerabilities to disaster as well as dealing with the environmental and other hazards that trigger them. Effective disaster risk reduction requires efforts across all sectors. Climate change will continue to bring about an increase in frequency of some natural disasters, and this poses an important challenge for disaster risk reduction overall.

In 2010, the European Commission issued a working paper *Risk assessment and mapping guidelines for disaster management* to improve coherence among Member State assessments, and enable better cooperation in risk management overall. Disaster insurance also plays an important role in the ability to recover from extreme events. A *Green Paper* process on disaster insurance was issued with the *EU Adaptation Strategy* in 2013 to explore ways to increase the uptake for such insurance in the Member States.

Examples of adaptation in disaster risk reduction

Many authorities and Member States are looking at how climate change impacts will affect their disaster risk reduction capacities; this is linked to the EU-level work on mapping and managing risks.

Spain has mapped climate change effects and flood risk for its entire coast. The project, carried out by the Ministry of Environment and the University of Cantabaria, developed a flood atlas to improve long-term coastal planning and to support coastal managers in including climate change impacts into their plans. Drawing on historical evidence of flood events, the flood atlas combines mapping tools with modelling of predicted future flood levels along the coastline to identify areas at increased risk due. The results of this 'stress test' were incorporated into the revision of local coastal management plans.

In Dorset, a county in the South West of England, several municipalities are jointly addressing the risk from heathland fires. Reduced rainfall and increases in average summer temperatures will increase the likelihood of heathland fires, which can cause loss of life and assets, and damage the natural environment. The *Joint Interim Planning Framework* will shift residential development away from at-risk areas whilst improving the management of the heaths. The framework is supported by activities to reduce the frequency of fires. For example, a local nature group works with volunteers and users of the heaths through their *Heathwatch* initiative to identify and manage areas prone to fires. Combining regulatory initiatives with local community-led initiatives is a successful way to reduce the risk of fire events in the area.

Transnational cooperation on disaster risk reduction

Disasters cross borders; administrative responses to managing risks must be effectively coordinated across EU regions and Member States. Through EU-funded programmes such as Interreg, some Member States and regions are developing joint initiatives on disaster risk reduction and learning from each other to improve capacities to integrate climate change impacts into disaster risk reduction plans and procedures.

The *F:ACTS!* project aims to build the capacity to respond and recover from climate change-related disasters such as forest fires, floods, droughts and extreme temperatures. Co-financed by the Interreg IVC programme, *F:ACTS!* includes pilot projects covering the development of territorial strategies to increase resilience to climate-related disaster risks; cross-sectoral education; training and awareness raising; and coordinated action across different organisations and agencies. Led by the Government Service for Land and Water Management from the Netherlands, the project has 14 public sector partners from eight EU Member States.

In the Alpine Space regions, climate change is expected to reduce the ability of forests to protect against avalanches, flooding and landslides. The affected regions in Germany, Austria, France, Italy, Slovenia and Switzerland have created management strategies to adapt forests to climate change and to reduce disaster risks through the *MANFRED* project. Co-financed by the EU's Alpine Space Programme, the *MANFRED* project has developed a 'knowledge bank' on climate change impacts on the Alpine forests. It includes maps, handbooks, guidelines, manuals and a database of possible climatic events. These resources are used by policy makers, forest owners and other stakeholders to find managerial responses that minimise the risks posed by avalanches, flooding and ground slides in Alpine forests.

In South East Europe, the *SEERISK* brings together nine countries facing similar climate change risks to share experiences and develop coordinated approaches to risk management and disaster recovery. The project partner countries are located in the middle and lower parts of the Danube basin, and face risks from flash floods, storms and frequent droughts. Common problems are low levels of awareness of climate change impacts, institutional gaps and weak territorial planning. Managed by the Hungarian Directorate General for Disaster Management, the project plans to jointly develop geographic information system (GIS) maps, risk assessments, a common emergency communication strategy and policy recommendations as well as awareness raising activities for the public. The overarching aim of the three year project (2012-2014) is to enhance the quality of decision-making in disaster management.

Useful resources:

- **Centre for Research on the Epidemiology of Disasters – CRED EM-DAT The International Disaster Database**
- **Climate-ADAPT Website Disaster risk reduction website**
- **Dorset Wildlife Trust Upton Heathwatch launch**
- **ECORYS Good practices in disaster prevention**
- **European Commission Green Paper on the Insurance of Natural and Man-Made Disasters**
- **F:ACTS! Project Forms for: Adapting to Climate change through Territorial Strategies!**
- **GRaBS Project Adaptation to climate change using green and blue infrastructure, A database of case studies**
- **The Manfred Project Management Strategies to Adapt Alpine Space Forests to Climate Change Risk**
- **SEERISK Project**

Human health

There are four main areas of concern for human health related to climate change: increases in the frequency and intensity of extreme weather events; changes in the distribution of infectious diseases; changes in air quality; and impacts on food and water security.

Predicted changes in the intensity and frequency of extreme weather events such as heat waves, cold spells, storms, floods, droughts and fires will directly and indirectly affect human health. Direct impacts could include loss of housing and livelihood, physical injury and death. Extreme weather events can also damage or disable key infrastructure such as transport routes, energy production and distribution hubs as well as medical facilities, reducing access to healthcare and adversely affecting human health in the short-term. The impact of extreme weather events on heat-related morbidity and mortality will be a particular challenge. In the EU, it is estimated that mortality will increase by 1-4% for each 1°C rise in temperature, with predictions of an additional 30,000 heat related deaths per year by the 2030s[1].

Extreme weather events can also indirectly affect the physical and mental health of individuals. Such events can lead to outbreaks of medical conditions such as stomach and intestinal illness, through disruption to sanitation facilities and lack of clean drinking water in affected communities. Mental health impacts of extreme events may include depression, post-traumatic stress disorder, serious mental illness and suicide· due to the deaths of family members or friends, or from damage to material possessions.

Climate change is also expected to lead to changes in the incidence and distribution of infectious diseases. Temperature-sensitive infectious diseases are likely to thrive in warmer conditions. For example, food-borne Salmonella infections could increase by an extra 20,000 cases per year by the 2030s, according to a 2013 study for the EU[2]. Warmer temperatures may also allow vector-borne tropical diseases to spread into Europe, such as the 2007 Chikungunya virus outbreak in southern Europe. This virus is normally confined to Africa, Asia and the Indian subcontinent, but in 2007 mosquito vectors of Chikungunya spread to north-eastern Italy and are known to have infected 217 people[3].

Changes to Europe's climate will also affect major determinants of human health and well-being such as air quality or food and water security. Warmer temperatures are predicted to reduce air quality due to increases in the formation of ground-level ozone, which can damage lung tissue and is linked to several respiratory diseases. Europe's food security will also be affected in that higher temperatures are likely to bring about changes in growing conditions and in the distribution of plant pests and diseases. The predicted increase in droughts, especially in southern Europe, will also have an impact upon food and water security.

However, not all climate change impacts will be negative for human health. Some temperate areas will benefit from decreases in cold weather-related fatalities due to warmer winter temperatures.

Examples of adaptation in the health sector

Planning for climate change in the health sector

The foundation for delivering the most appropriate climate adaptation responses in the health sector is planning. An example of successful planning for adaptation can be seen in the Swedish region of Stockholm Län, which has developed a publication to raise awareness of climate change and related impacts in the region. The publication, *Health Effects of Climate Change – risks and actions in Stockholm County*, from Sweden's Meteorological and Hydrological Institute, outlines appropriate human health-related actions based on climate scenarios for the region until the year 2100.

Four main factors contribute to the success of the approach in Stockholm. Firstly, the plan clearly defines management responsibilities, thus allowing quick action and response. It recognises that leadership and management structures are important for the effective coordination of climate adaptation work. Secondly, support mechanisms are in place across multiple levels of governance, to make coordination more effective. The plan highlights the coordinating role of the regional government in regional climate adaptation work and supports local authorities and other stakeholders to facilitate planning and implementation of appropriate measures. Third, the plan recognises the need for additional measures for vulnerable areas and social groups, and proposes focused measures for this purpose. Last but not least, the plan was developed with a view to raise awareness and thereby facilitate better individual preparedness.

An important planning activity has also been carried out in the UK by the North West Climate Change Network, resulting in a plan entitled *The Impact of Climate Change upon Health and Health Inequalities in the North West of England.* The plan notes that climate change is expected to have impacts on respiratory diseases including asthma, cardiovascular diseases, skin cancer, thermal illnesses, gastro-intestinal illness (including food poisoning and water-borne diseases), mental health and well-being, insect-borne diseases, and access to healthcare. The plan sets out a framework for action to assess, strengthen and build capacity to manage the impact of climate change on health in the North West region of England. The framework promotes:

- Improving knowledge about the impact of climate change on health
- Developing strong partnerships and ensuring leadership
- Advocating for action and engaging with people and communities
- Communicating the importance of the impact of climate change on health
- Adhering to an evidence-based approach

Raising awareness concerning health impacts

Delivery of adaptation actions can combine awareness-raising activities with participation strategies. This approach helps to raise awareness of climate change impact on human health and reduces risks and impacts by encouraging appropriate individual responses (such as changing behaviour in response to higher temperatures, or preparing for extreme weather events or floods) and public input in planning for climate change.

To raise awareness of climate change impacts, the Italian region of Piemonte has developed a web portal called *Il cambiamento climatico in Piemonte* (Climate Change in Piemonte). The web portal section on health describes how Arpa Piemonte (the local environmental regulator) is helping to improve forecasting along with environmental monitoring to support the implementation of 'soft' adaptation measures.

This focus on awareness raising and participation is seen across Europe. For example, in the Spanish region of Catalonia, the Catalan Office for Climate Change (OCCC) has carried out a five phase *Participation Strategy for Adaptation to Climate Change 2013-2020*. The process engaged members of the public to raise their awareness of climate change and to encourage them to consider possible climate change adaptation measures. This was done across several sectors, including health. It began with mapping stakeholders, presenting climate information to the public and encouraging public debate on each sector. As part of this participation strategy, a day was dedicated to briefings and contact with health experts for the general public.

Another example can be seen in the South East region of England, United Kingdom, where the region hosted a program of local workshops during spring 2013 as part of their *Local Health and Wellbeing in a Changing Climate* strategy. The health workshops were open to members of local Health and Wellbeing Boards (a national group of organisations tasked with improving health and wellbeing) and others who were engaged in the delivery of health and social care, business planning, local commissioning, resilience planning, sustainability, and environmental management. The sessions provided an overview of local climate change challenges and the potential for climate adaptation, and also looked at designing and delivering options for resilience in the health sector.

While awareness raising on climate change impacts is vital in all vulnerability sectors, awareness raising is especially important in the health sector. This is because the majority of climate-related health impacts are not gradual – such as heat waves and extreme weather events – but require a fast and effective response.

As the examples above demonstrate, a number of factors can contribute to successful awareness raising in the health sector. Awareness raising materials that clearly demonstrate possible effects on individuals, e.g. heat waves, can trigger independent adaptation preparedness actions, such as stocking up on fresh water reserves. Dedicated web platform and other information support tools facilitate public access to information. Participatory approaches, such as debates among stakeholders or cross-sector workshops allow participants to voice specific concerns that might be overlooked in materials aimed at broad audiences. In addition to exchanging knowledge, participation also encourages co-ownership and co-responsibility for adaptation, and helps create formal and informal networks, thus building the cooperation necessary for rapid response to climate change threats to human health. Finally, support for awareness raising at the policy level – through a strategy or action plan – provides a certain leverage and helps to dedicate expertise and financial resources to awareness raising activities.

Looking for opportunities from climate change

Activities related to the health sector generally focus on management of risks and prevention of negative health outcomes. For this reason, no specific actions were identified in relation to the potential opportunities for the health sector, due to climate change in Europe. However, positive health effects in Europe may develop, particularly as a result of warmer temperatures during winter months; this may be beneficial in colder Member States and lead to reduced winter deaths, especially among the elderly and those living in fuel poverty. Warmer winters may also decrease ice and snow cover and lead to a decrease in related injuries and fatalities in groups vulnerable to cold weather. Warmer, drier summers in Northern Europe may also encourage more people in these regions to participate in outdoor activities such as walking and cycling, which could also have positive health effects.

Useful resources:

- **Catalan Office for Climate Change Participation Strategy for Adaptation to Climate Change 2013-2020**
- **Climate-ADAPT Website Health sector information**
- **European Commission Adaptation to climate change impacts on human, animal and plant health**
- **JRC-IPTS (PESETA project) Impacts of climate change on human health in Europe**
- **North West region of England, UK The Impact of Climate Change upon Health and Health Inequalities in the North West of England**
- **Piemonte region, Italy Climate Change in Piemonte web portal**
- **South East region of England, UK Local Health and Wellbeing in a Changing Climate**
- **Stockholm county Health Effects of Climate Change – risks and actions in Stockholm County**
- **United States Environmental Protection Agency Climate Impacts on Human Health: Impacts from Extreme Weather Events**
- **World Health Organisation (WHO) Regional Office for Europe Climate Change and Health: a Tool to Estimate Health and Adaptation Costs**
- **World Health Organisation (WHO) Regional Office for Europe Climate, Environment and Health Action Plan and Information System (CEHAPIS)**

1. European Commission, 2013a.
2. European Commission, 2013a.
3. Liumbruno G. M. et al., 2008.

Infrastructure

Infrastructure is the foundation of our modern lives and includes the systems and networks which allow us to produce and distribute the goods and services that form the basis of Europe's economy.

Infrastucture includes transport (e.g. roads and railways); energy and water (e.g. power stations, transmission cables and pipe networks); buildings (e.g. houses, offices and industrial installations) and communications (e.g. telephone and internet networks). Infrastructure also physically and digitally connects European countries, regions, cities, towns and individuals to each other, and to the rest of the world.

Infrastructure faces many threats from climate change. It can be damaged by flood waters. Lack of water due to reductions in precipitation and runoff may mean power plants have to close. Warmer water can mean a reduction in the efficiency of power generation. Increased drought conditions can cause changes in ground levels (as land rises or falls due to different moisture levels) potentially damaging railways, roads, pipes and transmission infrastructure for energy and telecommunications. Excessive heat can cause roads to malfunction. Because much of our infrastructure is meant to last for many decades, and therefore must be able to function in future climatic conditions. Uncertainty about climate change and the need to maintain cost-effectiveness complicates the development of future infrastructure.

This translates to a pressing need to factor climate risks into the design and choice of materials used in infrastructure. Roads and railway lines, for example, should be built and maintained with materials that are able to withstand the hotter summers that are predicted across Europe. This would reduce the risk of buckling of train lines or damage to road surfaces, something we are already seeing. Location is also important – future development of housing, businesses and other built environment must take into account flood risk and other climate-related considerations.

Finding cost-effective ways to build climate resilience into infrastructure is a major challenge. In response to this, the European Commission has produced a staff working document on *Adapting infrastructure to climate change*, and has also published detailed *Guidelines for Project Managers: Making vulnerable investments climate resilient*. These documents aim to support policy-makers and project developers to be more aware of the threats that long-term climate change poses to infrastructure, and guide them in finding concrete solutions for making current and future infrastructure better able to withstand the impacts of future climate change.

Examples of adaptation in infrastructure

Planning for climate change

In the UK, the environment authority has made strategic plans for building greater climate resilience into the country's infrastructure. The planning document *Climate Resilient Infrastructure: Preparing for a Changing Climate* developed by the Department for the Environment, Food and Rural Affairs (Defra) assesses the likely consequences of climate change and its impact on infrastructure.

The document provides a detailed analysis of what climate change means for infrastructure in the UK and of the vulnerabilities for different types of infrastructure, such as information technology, energy, transport and water. It also developed guidelines that are used in more detailed infrastructure planning across the UK. One recommendation is the use of planning applications that set out how the impacts of climate change have been considered in every stage of infrastructure development or refurbishment.

Delivering adaptation actions

In 2005, a major storm (cyclone *Gudrun*) in Sweden caused energy transmission companies to review the resilience of their infrastructure, and in particular how climate change might affect their networks. The frequency and intensity of such storms is expected to increase in future as a result of climate change, as are high snowfall events, which can cause overhead lines to collapse. In response the transmission companies are increasing investment in underground cables, which are more expensive initially, but are more resilient to expected climate change impacts. Increasing system maintenance is another adaptation response, along with insulating overhead lines so that they are stronger and more resistant to snow. Such actions are being included in long-term infrastructure management plans to help ensure the resilience of this essential infrastructure.

Buildings are particularly vulnerable to temperature increases, including instances of extreme temperature such as heat waves, which are expected to become more frequent across Europe. This will negatively affect the comfort and health of those living and working in buildings. One way in which these impacts can be reduced is through the introduction of green spaces within building construction. Green spaces help to reduce the impact of heat waves and high temperatures. They provide shade and help to capture cooler air. Green spaces can also reduce flood risks exacerbated by the concrete surfaces around buildings by absorbing water. Examples include:

- Green roofs – where a roof of a building is partially or completely covered with a growing medium (e.g. soil) and vegetation;
- Green walls – are horizontal arrangements similar to green roofs;

Some authorities are taking a proactive approach – for example, the Italian municipality of Faenza requires a certain amount of green space within each construction project. Slovakia has developed a set of national standards for land use planning with detailed requirements for green space, tree cover and other aspects. Malmo, Sweden is promoting the use of green infrastructure in retro-fitting existing built environment to increase climate resilience.

Railway systems are vulnerable to a changing climate as the railway lines are fixed and often cover large distances. The *Adaptation of Railway Infrastructure to Climate Change (ARISCC)* project assessed expected climate impacts on railway lines across Europe. The results found that increased flooding would cause the greatest damage, followed by significant risks from storms and high intensity rainfall.

Road systems across Europe face similar threats. The EU-funded project *Risk Management for Roads in a Changing Climate (RIMAROCC)* project looked at the most significant impacts for road systems in selected European regions and developed possible adaptation measures to be incorporated into maintenance of the road systems. For northern France, the project recommended improved drainage to reduce flooding from high intensity rainfall; and better repair and crisis management procedures to reduce the consequences of any significant climate event.

Inland navigation – canals and navigable rivers – will also be affected. Conditions are expected to become drier in many parts of Europe, and reduced water levels threaten both the capacity and efficiency of this infrastructure (less water means less space for boats). The EU-funded research project *Weather Extremes: Assessment of Impacts on Transport Systems and Hazards for European Regions (WEATHER)* explored historical cases of droughts for mapping climate change vulnerabilities. Adaptation options identified include: maintaining water levels by pumping water from other areas; increasing the size of navigation channels; altering the design of ships and improving the coordination of traffic on the river; and increased monitoring of water levels.

Useful resources:

- Acclimatise and COWI Guidelines for Project Managers: Making vulnerable investments climate resilient
- ARISCC Project The Adaptation of Railway Infrastructure to Climate Change
- Climate-ADAPT Website Infrastructure sector website
- European Commission, DG Climate Action Adapting Infrastructure to Climate Change
- RIMAROCC Project Risk Management for Roads in a Changing Climate
- UK Department for Environment, Food and Rural Affairs (DEFRA) Climate Resilient Infrastructure: Preparing for a Changing Climate
- WEATHER Project Weather Extremes: Assessment of Impacts on Transport Systems and Hazards for European Regions
- Adaptation to climate change using green and blue infrastructure (GRaBS): A data base of case studies

Water management

Water is essential for life. It plays an indispensable role in all parts of Europe's economy and environment. However, water sources (such as rivers and ground water) and water demand (from cities, agriculture and industry) are not equally distributed across Europe or even within Member States.

In order to provide water where and when it is required in a way that is sustainable and efficient, governments have developed systems of water management. These systems include infrastructure such as dams, canals, irrigation, and pipes for abstraction, delivery and sewerage.

Climate change has very direct impacts on water availability and as a consequence affects approaches to water management. Rainfall patterns (where it rains and at what time of the year) and intensity will change across Europe. Flood risk is anticipated to rise across much of the continent, particularly in the wetter areas of central Europe and the North-West. The drier regions – notably Southern Europe – are expected to become significantly drier, reducing water availability. The temperature of naturally occurring water is also likely to increase. These impacts will put further stress on water resources, which are already over-exploited and polluted in many parts of Europe.

Water use varies significantly across Europe and within Member States. The greatest demand for water comes from the agriculture sector, (44% of total water), with industry and energy production at a similar level (40%). Public water supply (i.e. water for drinking and washing) accounts for a smaller but substantial part (15%) of the total water we remove from the environment.

Climate change impacts on water availability and use will have serious repercussions. Some of the most important are for agriculture, hydropower production, industry, and tourism. Climate change will also affect domestic water use. Water management systems will need to be adapted to respond to these climate change impacts. Actions to support adaptation include planning of water allocation, measures to increase efficiency of use and reduce demand, and improved cooperation and coordination between actors and sectors

Examples of adaptation in water management

Climate change models for Southern Europe suggest that existing water shortage problems will worsen. Many Member States in this region are already over-abstracting groundwater. This is making existing water shortages worse, in particular for agricultural users.

In recognition of existing risks, including those associated with climate change, Malta's Water Services Corporation undertook a review of its water management network, with support from other government authorities and research institutions. The review identified existing problems with water supply and found that these problems were likely to get worse as demand for water is expected to increase, due to growth in the population and in visitor numbers. At the same time climate change is expected to reduce water availability. The review suggested increasing water use efficiency as the main adaptation strategy. To do so, it proposed an extensive leak reduction programme, with a target of reducing leakage by 50% over five years. This will require investment in physical upgrades and modifications to existing water management, tourism and other sectoral development strategies, including efforts to reduce demand in areas of particular water scarcity. However, implementing these suggestions will have multiple benefits: the actions are expected to build resilience to water shortages caused by climate change and, at the same time, save the authority €37 million over a period of 20 years.

In the South-East of England, forecasts suggest climate change will result in reduced precipitation and hence reduced availability of water resources in the region. Meanwhile demand for water is increasing, mainly linked to population growth. At the same time more high intensity rainfall events are expected, which is likely to increase the risk of flooding in the region. Thames Water (the regional water company) is therefore working to increase the resilience of their water management systems in three key areas:

- Water resource planning: this is focusing on identification of new water sources and how these can be secured and protected in the long term, including the creation of new reservoirs and options for transferring water from other, more water abundant regions. Options for increasing the efficiency of water use, through reductions in water leakage and demand, are also being examined.
- Sewerage design and capacity: the higher volumes of water from intense rainfall events will put additional strain on storm water drainage systems. Thames Water has identified areas where existing sewerage systems might not be able to cope with these higher volumes and is working to increase capacity as required. The Thames Tideway Tunnel, a multi-billion Euro project aimed at meeting current and future sewerage capacity needs in London, has been specifically conceived to take climate change into account.
- Resilience of assets to flooding: sea level rise and flooding threaten water infrastructure, such as pumping stations and water/wastewater treatment works. Planned actions include flood walls and early warning and contingency systems, where back-up capacity is available in the event of damage to a pumping station or treatment plant.

The energy sector is one of the sectors with close links to water management systems. For example, the primary source of power for many parts of the Italian region of Trento is hydroelectricity. Climate impacts, including changes in regional precipitation patterns combined with reduced snowfall in the Alps, have the potential to decrease the water flows used for power production. The EU-funded *OrientGate* project is working with local authorities to assess the impact that climate change will have on existing and planned hydroelectric power generation. The region has found that diversification of power generation to other renewable sources such as wind and solar power, and increasing water storage capacity can provide the flexibility the power sector will need to cope with unpredictable changes in hydropower capacity related to climate change. These actions will have costs and benefits, however, which the project is also investigating.

A project which focuses on ways to reduce water use by the agricultural sector is currently underway in the Tisza river basin in Hungary, a region characterised by a very high density of irrigated fields and fish farms. Current levels of irrigation and water supply are down from historical highs, in part due to less water being available to use – a problem that is expected to worsen with climate change. This is compounded by heavy use of fertilisers, which contaminate water and further reduce availability of water for public consumption. Through the *EU.WATER* project, local authorities and farmers have piloted actions to improve the efficiency of water use. Among them are testing the efficiency of large linear systems, use of smaller hoses and systems to re-use water from fish ponds. The findings suggest that re-use of fish pond water is particularly effective at reducing overall water use, whilst also reducing the amount of nitrates that enter the water systems. Integrated approaches such as this, which simultaneously address water quantity and quality issues, deliver multiple benefits, including building resilience to expected future water shortages.

A project in Serbia is also using forward-looking climate change research to determine ways to adapt to changes in precipitation

patterns. With support from the EU-funded *CC-WaterS* project, researchers are considering how climate change might affect drinking water supply in the Pek catchment, a tributary of the Danube. The research suggests that within 20-30 years, demand is likely to exceed supply, due to predicted reductions in rainfall combined with population increase.

The project in Serbia identified and analysed various options for meeting this demand, including increased water storage in the catchment and new water transfer systems to bring in water from other areas. Each of these options also posed significant costs, both financial and potentially environmental and social. For example water transfer may impact on water availability in other areas. The project suggested that the most effective and efficient adaptation action would be to prioritise local solutions to improve water efficiency, because the high and varied costs associated with increasing water storage or transferring water were considered too high. The project showed that in many cases the most appropriate measures may be those that can be achieved at a low-cost and with 'no regrets', meaning that they would be justified under all plausible future climate scenarios.

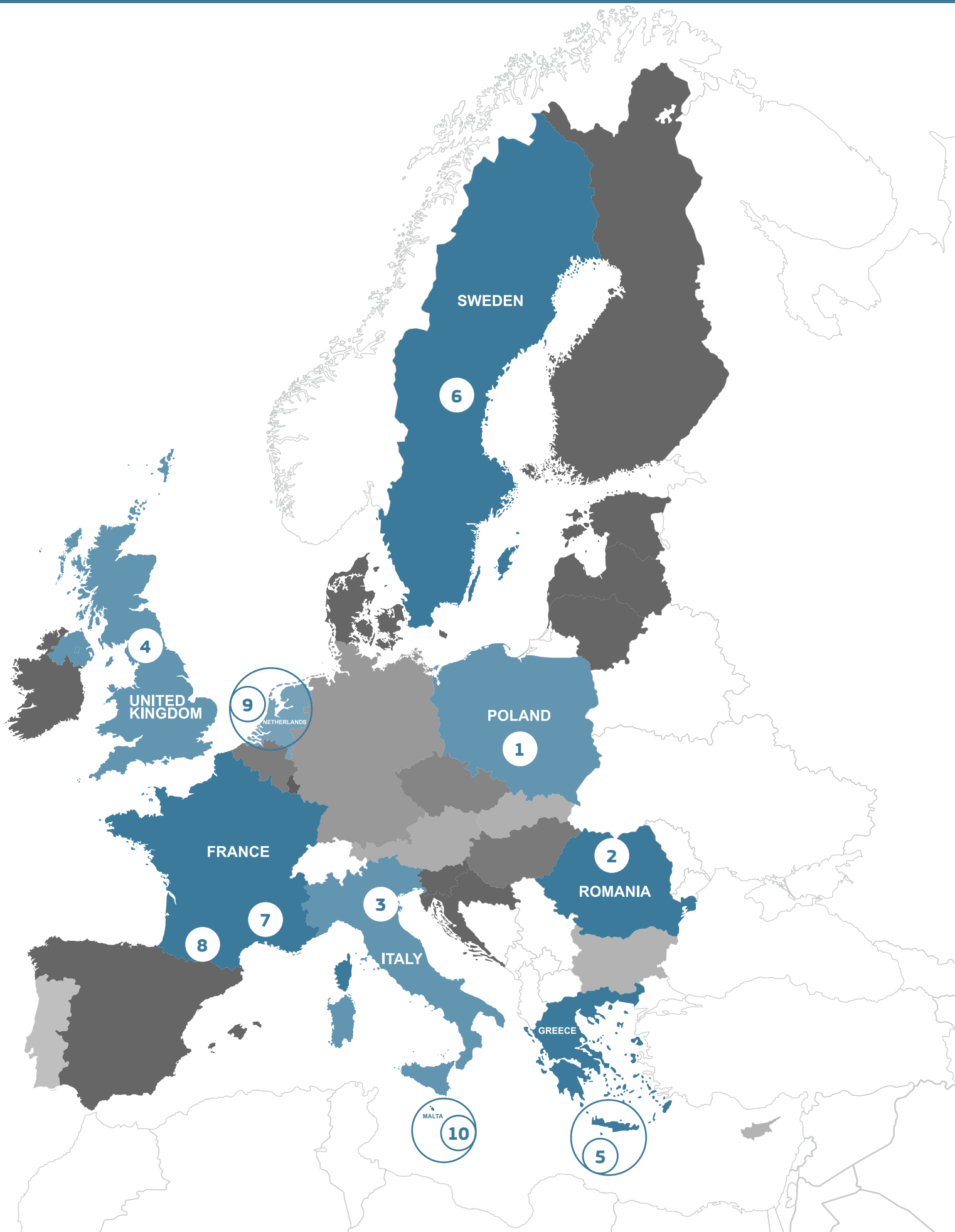
Useful resources:

- **Ourcoast Improved water resource management in areas with acute water shortage**
- **OrientGate Project**
- **CC-WaterS Project Output documentation**
- **Thames Water Adapting to climate change**
- **EU.WATER Project Jointly for a new European agricultural water management**

CLIMATE CHANGE ADAPTATION PRACTICE ACROSS THE EU

SELECTED PRACTICES IN RESEARCHING, PLANNING AND DELIVERING ADAPTATION

SELECTED PRACTICES IN RESEARCHING, PLANNING AND DELIVERING ADAPTATION


SWEDEN
6
4
UNITED KINGDOM
9
NETHERLANDS
POLAND
1
FRANCE
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8
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ITALY
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ROMANIA
GREECE
MALTA
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5

Polish counties get help starting the climate change debate

The climate respects no tidy administrative boxes. No one official – or even department – holds all the information or has all the answers to climate change. How then do authorities on the ground anticipate and respond? The Polish powiats show a way. They listened to those in the front line. By joining the project Good climate for the counties in 2010, they raised awareness of climate change in their communities and strengthened their capacity to adapt.

- Creating a network of *powiats* to exchange experience and to enhance their capacity to adapt to climate change
- Authorities listening to their communities and reaching out to external experts
- Joining-up a wide range of stakeholders and giving them a space in which to be heard
- Securing funding from both the EU level (LIFE+) and the national level (the National Fund for Environment and Water Management) to support local planning and action on climate change
- Creating a project plan and actions that can be modelled and transferred to other EU regions

Climate-driven events – such as floods, fires and strong winds – are becoming increasingly more visible in Poland. Powiats (counties) are in the front line of defence. They oversee emergency services, respond to floods, and coordinate environmental protection actions. All of these responsibilities are impacted by climate change.

The Polish national strategy for adaptation to climate change, under preparation in 2013, states that adaptation priorities at the national level should be supported by measures adopted at the regional level. However, authorities at the powiat level frequently have insufficient knowledge about climate impacts and lack the capacity to act. Research suggests also that their communities neither know much about climate change nor about their role in tackling it. So there is a clear need to raise everyone's awareness and to build a common understanding of the challenges. This was the thinking behind joining the project Good climate for the counties in 2010. It seeks to inform everyone – in particular local officials – about climate change; and to provide practical tools and mechanisms to support adaptation and mitigation activities. As a result, powiat leaders and communities will be better equipped to address climate change impacts in the coming years.

Listening and reaching out to the community: *The Good climate for the counties project*

The *Good climate for the counties* is an on-going five-year project, scheduled to last until 2015. Two Polish and one British NGO established it. The Institute for Sustainable Development, a non-governmental Polish ecological organisation, is the lead partner. The second Polish Partner is the Association of Polish Counties. The British side is led by Community Energy Plus (CEP). CEP brings experience from Cornwall, where a similar project was run recently – it offers valuable lessons and fits well in the Polish context. Furthermore, the more active participants from the Polish project will soon take a study trip to see the Cornish example on the ground.

The project has a wide coverage – it involves about one third of Poland's 379 *powiats*. It encompasses a wide range of activities, including: creating a network of *powiats*; organising public debates and conferences; monitoring *powiats*' climate activities in the field and developing tools for decision-making. The project is managed by a team of experts with diverse skills, drawn from education, climate change campaigning, scientific monitoring and government. In addition, there is a separate team preparing information materials, another managing the web site and a local law firm offering legal support as necessary. The development of the projects is regularly monitored, including financial audits, and implementation can be adjusted as necessary. The total cost of the project is €1.8 million. It is co-financed by the LIFE+ instrument and the Polish National Fund for Environment and Water Management.

Getting a network of powiats going...

The first step was to see who among the local authorities might be interested in knowing more about climate impacts and participating in the project. Information about the project was put in local newspapers and a letter sent to all *powiats* telling them about it. These were accompanied by a phone call. Particular follow-up was given to regions where negative climate impacts are anticipated (e.g. in mountain regions or areas threatened by floods).

To date, 115 out of a total of 379 *powiats* have joined the network; 22 of them have drafted and signed a declaration whereby they voluntarily commit to take certain actions. These include raising awareness in the community (e.g. informing schools, local media); integrating climate change impacts into planning documents (e.g. for crisis management); and considering climate change in tendering procedures. The main aim of the network is to foster day-to-day cooperation and exchange of experience between authorities on climate change issues, both within Poland and across the EU. While the project was initiated by NGOs, the role of the county-level authorities is critical and the project is an excellent example of cooperation between local authorities and the civil society sector.

POLAND

- **Area: 312,679 km²**
- **Population: 38.5 million**
- **16 regions (voivodships)**
- **The voivodships are subdivided into 379 counties (powiats)**
- **National Strategy for Adaptation to Climate Change adopted in November 2013**

Keeping the network alive – The role of the Local Initiators

'Local Initiators' – climate activists in each participating powiat – also play a vital role in keeping the network alive. Their main task is to examine how *powiats* are dealing with climate change mitigation and adaptation. They monitor and manage the project's day-to-day activities. Some have prior knowledge and experience of climate change topics; all were nevertheless trained at the start, receiving guidance on the technical and managerial issues relevant for climate change at the *powiats* level.

The Local Initiators' first step was to carry out a public survey to establish a reference point for awareness and understanding among *powiats* officials and stakeholders. It revealed that climate awareness among local leaders was low. The information gathered during the survey was subsequently used to tailor activities. At the end of the project, a similar survey will be carried out to see how awareness has evolved over the course of time. It will also give the team a tool to evaluate the project's success with stakeholders.

The Initiators are also responsible for organising project events, (e.g. public debates); and for monitoring local news reports, to see how the project is changing opinion on climate change issues. Initiators are also members of an on-line network where they communicate and exchange ideas with the general public on climate change issues.

Raising awareness, taking the debate public

Public debates and other awareness-raising events have been the focus of most of the activity to date. Debates are an effective way for local *powiats* authorities to voice concerns and discuss climate change with representatives of the private sector and civil society. In addition to collaboration, this helps to identify tailored solutions for each region's challenges. Climate change experts are also present at the debates to help clarify any technical questions. The feedback from participants has been positive; the debates are seen as a great opportunity for local leaders and stakeholders to learn about the issues, formulate opinions and raise concerns. Debates are also a very effective awareness raising tool, because participants are actively involved. So far, 90 debates have been held and 1900 people have attended.

Results of each debate are written up in a document, which summarises the main location-specific climate concerns, lists local capacities and resources and suggests practical measures that can address the problems identified. Subsequently, the document is sent to *powiats* authorities as input to the development of local climate strategies and plans.

In addition to public debates, numerous countrywide conferences are being planned. They aim to gather representatives from all levels of governance in Poland: regional *(voivoidship)*, county *(powiat)* and municipal *(gmina).* The objective is to foster cooperation and build a consistent approach towards climate change across Poland.

To increase awareness, a wide array of information materials about climate change have been prepared and sent to stakeholders. The materials include posters, press releases, leaflets, bulletins, and an information film. There is also a project website with regular updates on the project's activities and outputs. This provides easy access to the public and encourages learning about climate change topics.

A range of other useful activities and outputs are expected over the course of the project's life. For example, a *Powiat Climate Package* is currently being developed in consultation with *powiat* level authorities. The document is expected to contain information on the specific climate change impacts in Poland. It will give advice on developing climate change mitigation and adaptation strategies at the *powiat* level and will be particularly useful for *powiats* where debates have not yet taken place.

The network effect – how the powiats are succeeding

One key to success for the *Good climate for the counties* project was the management team. It was selected carefully to cover a full range of technical and managerial skills. Another key was the role of the Local Initiators in supporting the *powiat* authorities and in planning and coordinating actions across the network. Furthermore, the project covered a wide range of stakeholders including NGOs, local industry and government. Such an active engagement eased the flow of information, knowledge and expertise around the network.

The structural set-up of *Good climate for the counties* and its activities can be applied in other EU Member States, particularly those where local authorities and communities lack awareness and knowledge about climate change. The *Good climate for the counties* was itself based on a similar initiative carried out in Cornwall. So the concept is proved, the model is being refined and the potential is there for the project to be successfully repeated elsewhere in Poland and across the EU.

Useful resources:

Many of the tools and guidance materials are available in English on the project website www.chronmyklimat.pl

For further information you can also contact the project coordinator directly:
> Wojciech Szymalski
Institute for Sustainable Development

Protecting agriculture in Romania

For Romania, agriculture is a key economic sector. Agriculture is highly vulnerable to climate change. Lacking sufficient local resources to fully adapt – how does it cope with climate vulnerabilities? Romania's scientific community has an answer: forging a partnership between researchers, local farmers, authorities, and a European network of experts.

- Reducing uncertainty about climate change impacts in a key economic sector
- Bringing together scientific expertise with local knowledge to test out practical adaptation solutions
- Transferring scientific and technical knowledge and linking national adaptation strategies to local needs
- Engaging stakeholders early in the adaptation process

Agriculture is a critical economic sector in Romania – it accounts for around 30 per cent of employment, by far the highest share in the EU1. Moreover, the sector is expected to experience harsh climate impacts, such as water scarcity and droughts, which will threaten agricultural productivity, and thus the country as a whole. The National Meteorological Administration of Romania, one of the lead bodies looking at climate change in the country, predicts a sharp increase in air temperature and decreased rainfall. However, not much is known about where and how often these impacts may occur, due to the lack of specific studies.

A pilot study discussed here focuses on two agricultural areas – Covasna in central Romania and Caracal in the south. Both are vulnerable to water scarcity and drought, as shown by historical climatic data. However, they have different soils and agro-climatic conditions; they grow different crops (Covasna is good for potatoes and sunflowers, Caracal for winter crops and maize), implying a potential need for different options for adaptation to climate change.

The Romanian answer was to conduct a pilot study that would explore different aspects of the climate change challenge in agriculture across varying conditions (both Covasna and Caracal do that) and combine it with expertise from outside

Putting the Pilot together: joining the OrientGate Project

The *OrientGate* project, led by the Euro-Mediterranean Center on Climate Change (CMCC), is an EU-funded research project that aims to gather and communicate up-to-date climate knowledge relevant to key economic sectors; and to implement adaptation across South Eastern Europe in a coordinated way. OrientGate, which will run from 2012 till 2014, is carrying out six pilot studies across three themes: 1) forestry and agriculture; 2) drought, water and coasts; and 3) urban adaptation and health. Two Romanian partners proposed their pilot study Climate change adaptation measures in Romanian agriculture as part of the first theme.

The two bodies leading the work from the Romanian side: the National Meteorological Administration of Romania and the Environmental Protection Agency (EPA) of Covasna. It is a further example of the importance of combining local-national bodies in tackling adaptation in key economic sectors vulnerable to climate change.

To perform the study, researchers are applying a comprehensive and consistent methodology, developed jointly among the *OrientGate* project partners. For instance, the division of Impacts on Agriculture, Forest, and Natural Ecosystems of the lead partner CMCC developed a platform to apply crop simulation models at particular spatial scales. Crop models were developed using observed field data and were then used to assess climate change impacts.

Whilst the methodology is developed centrally, it is applied on a local scale; and will be replicable in other locations. The local municipalities in Covasna and Caracal are also critically involved. They provide technical support and contacts with local farmers for testing techniques and implementing results.

From the ground to the government: the importance of connecting the local to the national

Farmers traditionally keep excellent records of weather and track their climates daily. However, they are, naturally, rooted in their localities. The government and national institutions can see the big picture but lack the detail on the ground to bring adaptation to reality. Somehow the two must be brought together; and the wider public kept in the picture.

First, the Romanian government played its part, by drafting and adopting in July 2013 its second Romanian *National Climate Change Strategy* for the 2013-2020 period. Chapter 4 of the strategy calls for supporting action at the regional and local levels. This gives political and legislative support to the pilot and to the work of the National Meteorological Administration. Moreover the pilot complements the strategy, particularly since it will help update climate scenarios, make recommendations and raise awareness.

Secondly, the pilot is creating direct linkages between the researchers and the farmers. It is seen as an opportunity by the scientific community at the National Meteorological Administration to share findings and learn from the practical implementation and extensive knowledge on the ground, in Covasna and Caracal. This synthesis of skills and capacities is helping to create comprehensive adaptation measures and plans. It will unite particular local knowledge to a rigorous analysis of the full agricultural chain linking crops, water, and soil. The pilot study is expected to provide an enhanced crop management system that can both preempt and respond to a changing climate.

Thirdly, there has been a strong effort to communicate with the wider community. To ensure transfer of knowledge, the exchange of experience and the implementation of the findings, several seminars have and will take place over the course of the project both within Romania and among *OrientGate* partners. In Romania, preliminary findings have been presented in meetings in the two locations. These brought together a wide range stakeholder: local, regional and national level authorities in the sectors of agriculture, water, environment, emergency response, health, education and public administration; urban planners; academic institutions; and representatives from civil society. Follow-up meetings announcing further findings and preliminary recommendations are planned for March and June 2014.

Early signs of growth: the results of the pilot to date

The pilot study is currently in its second year. As a first step, the researchers evaluated the different agro-climatic conditions that affect different crops (e.g. winter wheat, maize, sunflowers, and potatoes). The approach was site-specific. Local data, for example on soil moisture, water demand and precipitation, were recorded in regional geographic information systems (GIS) maps.

Preliminary findings on climate impacts on selected crops in the Caracal region:

- The average monthly air temperature will increase by 0.4°C to 0.8°C, mostly in the warm season (May – September).
- Precipitation amounts will decrease, especially during the warm season. For example, the precipitation in July will decrease by 15.8 mm over the 2021-2050 period and by 35.9 mm in the 2071-2100 period.
- Considering these changes, the growing season will decrease by 13-19 days for winter wheat and by 13-25 days for maize.
- This means that compared to the current climate (1961-1990) the maize yield will decrease by 14.4% over the 2021-2050 period and by 36.5% over the 2071-2100 period.

ROMANIA

> **Area: 238,391 km²**
> **Population: 22.2 million**
> **National Climate Change Strategy covering the period 2013-2020 adopted in July 2013. The strategy has an adaptation component**

The second step was to model future climate effects over the medium (2021-2050) and the long term (2071-2100). These projections confirmed the vulnerabilities and highlighted the trends towards the increased duration, frequency and intensity of heat waves and decreasing precipitation – which will only exacerbate water scarcity and droughts, mainly in the summer time.

The third step has been to test some responses to the climate threats. In the two locations of Covasna and Caracal, different technological sequences and farming solutions are have been tried out. These include changes in the application of irrigation, using different classes of soil and changes in sowing dates. The testing will show the performance of the techniques in a changing climate; and will allow selected crop varieties to be measured according to a range of criteria, most importantly productivity and soil and water use efficiency.

The methodology of the pilot capitalizes on the expertise of the scientists and the local knowledge of the farmers. Results obtained from researchers in the first step of the study were applied and tested by farmers in the subsequent steps. The same approach was applied to both locations, but solutions tested on different crops – winter wheat and maize in Caracal, sunflower and potato in Covasna. Climate conditions are also monitored throughout the testing stages. For example, the EPA Covasna used a weather station and computer software to gather and analyse daily meteorological data.

The future of the pilot and sources of its success

The pilot will be finalised at the end of May 2014 and its output will be uploaded on the *OrientGate* project website. The findings will be summarized in two adaptation documents: an Action Plan and a *Good Practice Guide* for local authorities and farmers. The two main project partners (the National Meteorological Administration and EPA Covasna) plan to develop new projects in Romania and to take part in other EU-funded projects to further replicate, develop and monitor adaptation in agriculture.

The pilot study shows the importance of cross-fertilizing expertise and knowledge from all sources: local farmers and authorities, national scientific bodies and EU networks. Success also came from practical work on the ground, which tested out adaptation techniques, helped transfer skills and built awareness.

Building the pilot on robust science and having the initiative of a leading scientific institute were also key: it brought credibility to the case for adaptation; provided evidence-based facts on which policy-makers can make informed judgments; and helped 'size' the climate risk, by providing a sense of where, when and by how much the agricultural sector would be affected. Such information is vital to the practical activities carried out by farmers, such as developing planting schedules, selecting crop varieties and adapting technologies.

The wide involvement of stakeholders, civil society and the farmers themselves was also important to the pilot's success. The fact that the two project partners, following the pilot, are now gearing up to take their adaptation learning out to other regions – and to other parts of the EU – is a testament to the positive momentum they generated and the engagement they fostered.

Useful resources:

Information on this and other project pilot studies is available on the *OrientGate* website.

For further information you can also contact the pilot study coordinator:
> Elena Mateescu
National Meteorological Administration of Romania

1. FAO EBRD, 2011.

Roadmap to a regional adaptation strategy in Lombardy, Italy

Once aware of the climate risks, the challenge turns to planning a response using dependable data. Many regions have begun assessment and planning tasks; but the result is often a patchwork of different studies split across sectors and institutions. Who brings it together? The Lombardy region shows how: bringing together existing studies and information into a set of guidelines that serve as a 'roadmap' for a regional adaptation strategy. This document is tailored for the region yet useable by others.

- Reviewing comprehensively available information on climate change and developing it further
- Providing expert advice in easy to read form, winning the attention of key audiences and getting climate change onto decision-makers' agendas
- Weaving in other countries' and regions' adaptation strategies and experiences to strengthen the guidance and help style the regional adaptation plan
- Drawing in all parts of the regional administration and integrating climate change into other sectoral policies

In Italy regions share responsibilities with national and local governments for responding to climate change impacts, although they have no legal requirement to carry out risk assessments or to develop adaptation plans. However, officials and scientists in Lombardy, one of Italy's most populous and wealthy regions, started considering adaptation some time ago. They recognised that the region – with mountainous areas and river valleys – was exposed to both extreme events and longer-term impacts from climate change. Action was called for; and over the past seven years three vulnerability studies and several supporting analyses have been undertaken by various regional bodies.

These studies are robust and scientifically tight. They provide a strong starting point for raising awareness and making concrete adaptation plans. However, the impacts of climate change are complex; they affect a wide range of policy sectors. Individual authorities and departments often lack the means for planning and coordinating adaptation across sectors and the region.

La Fondazione Lombardia per l'Ambiente (FLA, The Lombardy Foundation for the Environment), is a scientific foundation that supports activities in the region. The FLA is taking up the challenge of pulling things together. Commissioned by the regional Department for Environment,

Energy and Networks, the FLA is bringing together the patchwork of research and data already out there on climate impacts into the *Guidelines for a regional plan for adaptation to climate change.* The Guidelines are the first of their kind in Italy; they knit together the main adaptation elements that need to be considered both across the region and within every local government sector and serve as the basis for the regional adaptation strategy currently under development.

A solid basis in climate science

Climate science is the basis for adaptation planning and action; and in Lombardy three vulnerability studies have been carried out since 2006. The *RICLIC-WARM project (2006)* analysed the effects of natural and anthropogenic processes linked to climate change on water resources in the region. The *Kyoto Lombardy Project (2008)* looked at climate impacts on wildlife, agriculture, and tourism as well as climate mitigation aspects. The *PRIM project (2010)* analysed the most significant climate risks in Lombardy as a whole.

The team of experts from FLA and the regional Department for Environment, Energy and Networks built upon this basis and strengthened it. They reviewed the climate scenarios over different time periods: the short, medium and long-term. They identified additional, vulnerable areas. And they drew in adaptation advice from outside the region and outside Italy – for example, using the European Commission's 2009 Guidelines for regional adaptation. They pulled together all this science and research into the first part of the *Guidelines for a regional plan for adaptation to climate change.*

Weaving in the sectors

With this strong, clear, science, the FLA team then sought to weave in another important strand: the officials working across the region in all affected sectors.

The regional Department for Environment, Energy and Networks, and the FLA team organized preliminary meetings with senior officials in the regional administration, as well as other interested regional bodies such as the Regional Agency for Environmental Protection, the Energy Efficiency in Building Certification Body and the Agriculture and Forestry services. With each group the FLA presented their research and took care to make their findings clear and understandable. This created immediate interest and support.

Next the team identified a liaison within each department and established a bilateral relationship. Throughout 2012 a string of bilateral and cross-sectoral meetings were held, tightening the strand between the team and officials. All the vulnerable sectors were pulled in: Agriculture, Trade, Tourism and Services, Infrastructure and Mobility, Civil Protection, local Police and Security, Health, Biodiversity Protection, Sport and Youth, and Territorial and Urban Planning.

Putting together the Guidelines

The FLA team used nine key points to structure the Guidelines:

INVOLVE ALL RELEVANT STAKEHOLDERS	The FLA team has already begun this; and it is work in progress. Stakeholders beyond the regional authority (e.g. NGOs, civil society bodies) have yet to be fully woven in.
REDUCE UNCERTAINTIES	Take the science and the climate scenarios down to the regional level and provide continuous monitoring of the data.
IDENTIFIFY PRIORITIES	The FLA team has made an excellent start here in combining and adding to the existing vulnerability studies and in targeting officials responsible for vulnerable sectors.
MANAGE AND COORDINATE	Most officials focus, naturally, on the substance of their sectoral portfolios. The plan needs someone - even a department - to coordinate action between sectors. The FLA's liaison in each department is a first step.
CONSIDER OTHER GOVERNANCE LEVELS	The EU Adaptation Strategy and any national strategy must also be borne in mind (the Italian strategy is in preparation.) The roles of local authorities are also important.
INTEGRATE INTO SECTORAL POLICIES	Use the tools that help integrate climate change into sectoral plans, such as Strategic Environmental Assessment (SEA.) This work is on-going - see the 'tailoring' below.
ENSURE FUNDING	Integrate climate adaptation measures into sectoral budgets where possible, and consider sources at the European level, such as Interreg, LIFE+ and HORIZON 2020, as well as national funds.
MONITOR PROGRESS	Establish indicators for the continuous monitoring of the effectiveness and efficiency of the measures implemented and have periodic reviews and updating of the plan. Again, the frequent meetings held between the FLA team and officials throughout 2012 are a good example of this.
COMMUNICATE OUTPUTS	Organise and share results with the stakeholders and train officials where required. The wide initial consultation and the clear reporting of the FLA's vulnerability assessment, in the first part of the Guidelines, show this.

LOMBARDY, ITALY

> Area: 23,844 km²
> Population: 9.7 million
> National climate change strategy to be adopted in 2014
> Regional climate change strategy in progress

Tailoring the Guidelines: refining adaptation to suit each sector

The final step was to tailor the Guidelines to the specific needs of the vulnerable sectors. This entailed some detailed recommendations; for example in the Tourism sector's forward planning, the Guidelines advocate the diversification of winter tourism from a focus on mountain skiing to other activities such as hiking or spa services. Looking at the technical impacts of climate change for the Tourism sector, the Guidelines lay out highly specific actions, for instance, reallocating skiing sites; using more dry slopes; improving and mapping vulnerabilities to avalanches and mud slides; improving the evacuation procedures during adverse weather events etc.

In the Health sector, the Guidelines first specify that climate change concerns need to be integrated to relevant plans and strategies, such as the *Regional Social Health Plan, Air Quality Plan and the Plan for Infrastructure and Mobility.* Recommended actions include adaptation of surveillance systems such as microbiological contamination control; expansion of early warning systems for events (e.g. floods, heat waves, epidemics); and upgrading the knowledge and skills of health care management professionals.

The Lombardy Model: What fits and how it can be copied

There are many reasons behind the success in developing the Guidelines in Lombardy. First, the Guidelines were based on rigorous science and a comprehensive review of existing adaptation work. This was the thread that holds the Guidelines in place; it supports evidence-based policy making and offers best-practice knowledge to officials. It enabled the FLA to get the attention of decision-makers and built FLA's credibility with stakeholders.

Secondly, the FLA led an open, wide and frequent series of consultations with officials; and by establishing a liaison person in each department, they enabled adaptation thinking and awareness to be integrated into any future planning.

Thirdly, the Guidelines were finely tailored to the needs of the sectors. Of course, as time goes on and the next phase of planning takes place, and the strategy is developed, those details and features will be adjusted; but the level of detail mattered. It was sufficient to prompt engagement from officials, who otherwise might have found the notion of climate change impacts a bit abstract.

Can the Lombardy model be copied? Absolutely. The dedication of one institution to the multi-faceted task of pulling together a 'roadmap' to a regional adaptation strategy is an approach that can work in many regions.

For regions with similar climate challenges, the proposed actions can be considered as a basis for developing similar strategic plans. And even for those regions that face a different mix of climate impacts, the FLA *process* is useful: the nine design features, the approach to consultation, the attention to the detail of the Guidelines.

Meanwhile, the success in Lombardy has led to the next step in the adaptation process: creating a full regional adaptation plan, based upon the solid backing of the FLA Guidelines.

Useful resources:

Many of the tools and guidance materials are available on the FLAnet website

Other sources:
> The Lombardy region website
> RICLIC-WARM Project website
> Kyoto Lombardy Project website
> Ribeiro et al., Design of guidelines for the elaboration of Regional Climate Change Adaptations Strategies (2009)

For further information you can also contact the project coordinators directly:
> Gian Luca Gurrieri
Director of U.O. Air Quality – Industrial Emmissions and Noise, Lombardy Region
> Mita Lapi
Scientific expert – The Lombardy Foundation for the Environment
> Juan Terradez Mas
Scientific expert – The Lombardy Foundation for the Environment

Other information:
> Nadia Carfagno
Environmental technician – Lombardy Region

Dedication to transparency and participation brings results in Scotland

Strategies and action plans are only valuable when they can be carried out in practice. When different institutions and groups are expected to assist in carrying out a plan, it is only logical that they should be involved in its development. It can be challenging for public administration to reach out to all these people during the planning process. A case from the Highland region in Scotland shows, very practically, how this can be done.

- Understanding the importance of stakeholder engagement in adaptation planning
- A systematic and coordinated approach to gathering stakeholder input
- Effective use of detailed climate projections within public and stakeholder engagement events

Climate change adaptation is a complex issue, partly because its impacts are diverse and affect so many different groups within a community. To effectively understand these impacts and plan a strategic response, authorities need to communicate extensively across the broad range of groups and individuals who will be affected by climate change and any related adaptation responses. In Scotland, the Highland region developed an approach to informing and engaging regional stakeholders in the process of preparing its regional adaptation strategy. The process took time but it has resulted in a plan for adaptation that has the support of those who will implement it.

The Highland Council is the regional government body in the Highland region of Scotland. The Council has a statutory duty to act in response to climate change as required by the *Climate Change (Scotland) Act* of 2009. In the Highland region, climate change is expected to result in hotter, drier summers; milder, wetter autumn and winters; increased frequency of summer heat waves and extreme temperature; reduced occurrence of frost and snowfall; and sea-level rise. In response, the Council set up a Climate Change Working Group to create an adaptation strategy and a detailed action plan for the region.

The need for adaptation is also outlined in the Council's 2012-2017 Programme Working together for the Highlands, in which the Council commits to support communities to be more resilient through implementation of the adaptation strategy. The Council also recognised from the start that the identification, prioritisation and development of specific actions for adaptation had to involve those who would deliver and be impacted by them. This, the Council believed, was critical to creating a robust and feasible adaptation strategy.

Reaching out through dedicated workshops

The Highland Council's adaptation planning process included a series of 25 'adaptation workshops' to be conducted over a two-year period. The workshops addressed:

- All of the Highland Council's departments
- Regional community interest groups, including groups that were identified as particularly vulnerable (older people and young children), as well as an elected youth body established to provide a voice for young people in the region
- Regional land owners and land management organisations
- National and regional sector representatives including transport, water management, and agriculture and forestry
- Voluntary organisations and environmental groups

The Council recognised that it would not be able to reach all relevant individuals and developed a pragmatic response. Participants were invited by the Council, but the events were also open to other interested organisations or individuals to attend. The Council arranged the workshops during different seasons, times of the day and publicised them in different ways. The Council also had a policy of transparency so that those who were not able to engage directly with the process could see the results. The Council wrote up and published workshop results were along with relevant reports and relevant discussions of the Council's committee were streamed live on the website.

The initial challenge was introducing the stakeholders and public to climate science and its potential impacts on the region. A particular difficulty was the need for participants to think long-term, as most climate change impacts in the region are expected to occur in 20 – 50 years or even longer. Explaining the relevance of taking action now to cope with change so far in the future required the testing of various approaches to presenting the climate scenarios within the workshops. The Council had access to existing region and local climate projections, which had been developed by the *UK Climate Impacts Programme*. The use of existing climate change projections were an important aspect in the delivery of the workshops and are considered a key success factor.
The workshops were structured around the following topics: positive and negative impacts of climate change in the Highlands; acknowledgement of long-term trends and extreme events; recent weather related events and future scenarios; vulnerability to such events and what could change to help climate change responses. The Council made efforts to tailor the workshops based upon the background of the participants, to keep the events relevant.

Each of the above topics was discussed and explored through a series of exercises:

- **Group perceptions exercise:** This consisted of a questionnaire with two sections of identical questions, with the first section to be completed at the start of the workshop and the second section to be completed at the end. It allowed the Council to assess changes in participant perceptions regarding climate change.
- **Media exercise:** Participants read articles from a local Climate Impact Profile project. This provided an opportunity for attendees to gain an appreciation of the causes, effects and wider implications of weather related incidents using real examples.
- **Scenario exercise:** This centred on threats and opportunities relating to climate change and was based on the scenario tools developed by the UK Climate Impacts Programme scenarios – a nationally derived set of climate forecasts.

The results of the different exercises across the 25 workshops were combined and analysed in order to provide useable results. They improved the Council's understanding of climate change impacts across different sectors and groups, both in terms of vulnerabilities and potential opportunities. Based on the various experiences and lessons learned reported at the workshops, the Council was able to gather additional data for input to climate change projection models. The process also increased awareness within the Council and among stakeholders of toolkits and supporting information available. Crucially it also allowed for the identification of potential adaptation actions and lessons learned from existing adaptation initiatives.

Solid input produces and robust and workable strategy

The strategy – *Adapting to Climate Change in Highland* – was made public in 2012 and is now being implemented. The role of the workshops is recognised in the strategy. The main direct contribution of the workshops was to inform the understanding of current and likely future climate change impacts and the identification and prioritisation of possible cross-cutting adaptation actions. For example, the *Future impacts of a changing climate in Highland* section of the Strategy uses the results of the workshops to describe the identified climate change risks and opportunities. This understanding of likely impacts is then used in the Building Resilience section of the strategy.

The adaptation strategy also introduces an action plan. The plan sets out specific actions, implementation timescales and responsibilities, as well as indicators and benchmarks for monitoring and measuring progress. Many of these actions were identified through the workshops and are based on the inputs and experiences of those who are going to implement them.

Overall, the participatory approach taken through the adaptation workshops carried out by the Council as part of the adaptation strategy and action planning process increased public and stakeholder support and ownership, which is felt to ultimately lead to more efficient implementation.

The Highland model – what worked and how it can be replicated

The Highland Council's focus on transparency and engagement has meant that there is ownership and trust in the adaptation strategy and actions it has proposed to tackle climate change adaptation.

There are many reasons behind the Council's success in developing these documents.
Firstly, the Council set out with a firm belief that stakeholder and public input and acceptance were critical if the adaptation strategy and action plan were to be workable. To achieve this they developed a transparent consultation process.

Secondly, the process of stakeholder engagement itself was considered and aimed at delivering specific objectives. This was facilitated through the use of climate change projections tailored to the regional and local level. In developing the process the Council also adopted a learning approach, which adapted the process based on experience of what worked well, and what worked less well.

Finally, the Council was realistic about what it could achieve in terms of reaching out to as many groups and individuals as possible, and it made efforts to maintain a transparent and open approach.

This open approach to stakeholder engagement, as well as the specific workshop-style process can be used in other European regions who are preparing adaptation strategies.

Useful resources:

Many of the materials produced across the Strategy development process are available on the Council's website including the Strategy and Reports of the individual workshops at www.highland.gov.uk

For further information you can also contact the Highland Council directly.

HIGHLAND, A REGION WITHIN NORTHERN SCOTLAND, UNITED KINGDOM

- **Area: 26,484 km²**
- **Population: 230,000**
- **National Climate Change (Scotland) Act adopted in 2009**
- **Adapting to Climate Change in Highland, strategy published in 2012**

Learning from others in Crete, Greece

Authorities in the Greek region of Crete show how a proactive approach to climate change adaptation can be taken even in times of economic upheaval. They combined their own skills with expertise from other EU regions; built awareness amongst local stakeholders; drafted a strategic adaptation plan; and successfully accessed European funds to help do it.

- Exchanging experience and knowledge on adaptation with other EU regions
- Drafting an adaptation strategy using best practice guidelines, providing clear direction and leadership
- Mobilising and communicating early with stakeholders, raising awareness and preparing them for future action
- Building local know-how and capacity at a time of administrative and political change

Nearly every part of Crete's economy and environment is at risk from climate change. Like much of the Mediterranean, it faces intensifying problems: drought, lack of water, scorching summer temperatures, wildfires and biodiversity loss. Crete is the largest and most populous of the Greek islands and the fifth-largest island in the Mediterranean Sea. It forms one of the thirteen administrative regions of Greece. The island is famed for its rugged mountains, outstanding flora and fauna and many environmentally -protected areas. It is also home to many archaeological sites of world importance, including those of the Minoan period, considered one of the earliest of European civilizations. Tourism and agriculture are the economic mainstays.

As part of administrative reforms begun in 2011, Greek regions are expected to take on greater duties for protecting the environment, including planning and managing land use and water resources. Realising the impact that climate change may have on an already fragile economy, the Cretans took the bull by the horns and responded to the challenges. The first move was to seek out expertise and add it to their in-house talent. This was done through the *RegioClima* project.

Sharing experience, adding expertise: harnessing the *RegioClima* project to Crete's response

The *RegioClima* project, supported by the EU's Interreg IVC funding programme, specifically aimed to support regions in tackling climate change. It sought to assist regions both in minimising the risks from damaging climate effects and in

seizing new opportunities that may arise. It was a partnership of eight local and regional authorities from across the EU and ran for three years (2008-2011).

Two of the programme's core activities were of vital interest to Crete: supporting climate change policy-making; and exchanging examples of adaptation. And two of the team, the Veneto region in Italy and the Larnaca a Development Agency in Cyprus, proved to have experience and solutions directly applicable for Crete. (See later.) So the Regional Energy Agency of Crete, on behalf of the Cretan region, joined the project, to access support for its own strategic planning on climate change.

Spreading awareness and building skills as the project evolved

The second important step the region took was to recognise that climate change threats touch – and might overwhelm – most administrative departments. No one sector or expert can handle the magnitude of climate impacts or plan adaptation on their own. There has to be coordination and a strategic perspective amongst authorities and beyond, engaging all stakeholders.

This is of course, no easy task. The Cretan approach was throughout to involve as many other bodies as possible, at every step along the way. The Decentralized Administration of the Region of Crete, the Regional Council of Crete, the Municipal Councils, and the Unions of Municipalities were all engaged. At the national level, the Ministry of Environment, Energy and Climate Change also took part in some of the activities related to the project. This involvement of the different levels of government was essential. It helped raise awareness; it fostered political commitment; and it primed the various parts of the administration for future action.

There was a further significance to the leadership shown by the Cretan authorities. They were engaging with climate adaptation *before* the Greek government reforms of 2011 took place. So when the extra responsibilities did fall to them, they had already began to plan and had established good relationships between local municipalities, the region and the central government in the climate area.

Writing an adaptation strategy and incorporating experience from other regions

RegioClima supported Crete in the development of a first strategic policy document on climate change adaptation. The first part of this involved, with the project team, drafting the *Good Practice Guide on Climate Change Adaptation Strategies for Regional Authorities and Institutions.* The Guide collected best practices on climate change adaptation from all the project partners. Each submitted a number of proposals. The best were chosen jointly, based on a set of criteria, with a particular focus on adaptation and sustainability at the local and regional levels. The chosen options were then developed further and for each one the responsible partner defined a set of key characteristics (e.g. objectives, usefulness, possibilities for improvement).

With these best practices as a key policy-making input, the Regional Energy Agency of Crete was able to go further and draft specific adaptation advice for its region. The resulting *Strategy for the Promotion of Climate Change Adaptation: recommendations to policy makers in Crete* can be seen as the first adaptation policy document of its kind for the region. It identified the need to assist local and regional authorities in responding to climate change; it also highlighted the importance of giving authorities capacity building tools to enable adaptation, including training on climate change impacts and their specific relevance for different sectors. Critically, it sought to have adaptation included in all regional sectoral policies.

The Strategy first summarised the climate change impacts in Crete; then identified priority sectors for action and sectoral adaptation measures. Lastly, it laid out a step-by-step process for the implementation of the strategy at each level of governance, emphasising the role of the region.

For the sector covering biodiversity, ecosystems and water, the strategy document identified six impacts for the depletion, extinction or loss of habitats; changes in species distribution; sea level rise; change in local microclimate; changes in species' biosphere and niches; and increase in groundwater contamination due to higher concentration of pollutants. To these six impacts, it offered seven specific measures, including the establishment of an observatory to monitor the status of water, biodiversity and protected areas.

Learning from others with similar challenges

Crete's strategic approach to adaptation also benefited from the experience of other regions. Two of partners in the project had specific best practices applicable to Crete. One came from the Larnaca Development Agency in Cyprus, which has climate change challenges similar to Crete's: managing water in a semi-arid land, where as a scarce resource it competes for use in drinking and irrigation. Cyprus has developed valuable lessons in saving water with re-use schemes. This will be extremely valuable for managing wastewater in Crete, where water re-use schemes are still at an early stage.

The Veneto region in Italy has wine producing areas similar to those in Crete. The Italian approach to adjusting planting times for new varieties based on changing climatic conditions, as well as new strategies for water, land and disease management are relatively simple, inexpensive technical solutions that have proven to be transferable to Crete.

CRETE, GREECE

> Area: 8,336 km²
> Population: 623,065

In conclusion: the reasons for success

The region of Crete demonstrated early and firm leadership in tackling climate change. Even before the 2011 administrative reforms, Crete had already taken action on climate change and joined the *RegioClima* project. With the new competences falling on the region, the possibility – and responsibility – for regional action has now increased and Crete is getting prepared.

Secondly, the region of Crete learned from the experience of similar regions and was able to incorporate the lessons from others in their adaptation strategy. The importance of such regional networks in sharing and spreading best practice – and the transferability of solutions – was a key to success and a major benefit of the *RegioClima* project.

Thirdly, the willingness to work with and involve other levels of government has been important in raising awareness, winning support politically and getting stakeholders primed for future action.

Lastly, the structure and guidance provided by *RegioClima* was essential in shaping the Cretan approach. By being part of drafting the *Good Practice Guide on Climate Change Adaptation Strategies for Regional Authorities and Institutions,* the Regional Energy Agency of Crete picked up clear guidance for formulating their own strategy; advice on what legislation may be needed; the importance of working with multi-levels of government; and the need to share information with the public and private sectors. In the end, however, it was the Cretans themselves who 'owned' their approach, taking the advice and best practice from elsewhere and combining it into their own strategy chapter.

Useful resources:

The website of RegioClima provides further information about the project.

For further information and project outputs you can also contact the project partners directly:
> Eudokia Balamou
Larnaca District Development Agency
> Dr Nikolaos Zografakis
Regional Energy Agency of Crete

Working together to take up the challenge of rising water in Sweden

Sweden's biggest lake, Lake Vänern borders two Swedish counties (regional governments) and is the source of a major river, the Göta river. The whole area is at high risk of flooding; and climate change is increasing the dangers. The counties have coordinated their response and developed a joint strategy and handbook for local-level use in flood prone areas.

- > Partnering across regions and working with scientific bodies and the private sector to deliver a water strategy now working on the ground
- > Providing a handbook and a common framework for action that is used in the day-to-day management of rising water levels
- > Basing adaptation on a solid knowledge base and building in flexible options for future
- > Acting within the framework of the Swedish National Strategy for Adaptation to Climate Change

Sweden's National Climate Change Analysis identifies the western part of the country as an area expected to be hit hard by the impacts of climate change, which will increase rainfall and floods. A major flood in 2000/2001 reached peak water levels. It acted as a wake-up call and prompted the start for taking serious adaptation measures. Two counties, Västra Götaland and Värmland, the ones most directly affected by such events, began to mobilise. To effectively address the problem, they had to work together.

The two counties share Lake Vänern, Sweden's biggest lake. The lake is also the origin of the Göta River which flows south through Västra Götaland, before entering the Sea of Kattegatt. In 2009, all 21 counties in Sweden became directly responsible for adaptation in their areas, through their 'County Administrative Boards' (CABs). The CABs have a range of supervisory responsibilities, including reviewing municipal spatial plans and ensuring that the risks from floods, erosion and climate change, as laid down in the *Planning and Building Act* are planned for and acted upon. Whilst financing for the adaptation projects is provided centrally, the leadership, planning and action rests on with the regions.

Creating a flexible, adaptive Water Diversion Strategy

In 2008, acting under the *National Strategy for Adaptation to Climate Change*, the CAB of Västra Götaland began the task of creating a Water Diversion Strategy for Lake Vänern.

There are five important points to note here. First, Västra Götaland brought in its neighbouring county, Värmland to help drive the process. Together they formed working groups and boards, with experts in the field from the two CABs participating. The working groups met regularly, approximately once a month. This model was also replicated for the creation of the Handbook (see later).

Secondly, the counties involved Vattenfall AB, Sweden's biggest electricity company, in developing the Strategy and implementing the eventual technical solution. The Strategy sets the maximal levels of water in the lake and outflow into the Göta River; Vattenfall each week adjusts the water level according to the current water level and an eight week prognosis.

Thirdly, the Strategy has flexibility built in. The current levels were negotiated in 2008 and are being revised; the aim is to map and analyse the impacts and consequences of the water diversion to develop an even better solution post 2014.

A fourth key point is that the counties used robust data and scientific advice from a national source: The Swedish Meteorological and Hydrological Institute (SMHI), who provided expert simulations and models of the water flows in the catchment area of Lake Vänern. These simulations were vital in convincing and mobilizing other stakeholders to adopt the Strategy and to play their part.

Lastly, the counties involved a wide range of other players in the process. The working groups and management board**s** were open to a number of bodies, including the Swedish Maritime Administration, Swedish Civil Contingencies Agency, the Swedish National Board of Housing, Building and Planning, the Federation of Swedish Farmers as well as representatives from the municipalities along the coast of Lake Vänern. Additionally, the project tapped the expertise and experience from work done in managing flooding near Lake Mälaren (Sweden's third biggest lake in the middle of the country). And crucially, the SMHI also participated, as well as contributing its data. Putting this diverse talent and thinking together gave the Strategy more expertise and added more credibility than would otherwise be the case for a more modest county project.

So far, the results have been excellent: The water flow in the winter 2012-2013 was high by historical standards; yet, there was no flooding in contrast to comparable flow rates before the strategy was implemented.

There is of course, no room for complacency; the counties are revising the strategy currently. Moreover, they saw the need to supplement the strategy with more general guidance: hence the creation of a Handbook to tackle flooding…

The Rising Water Handbook: Providing guidance to municipalities in adapting to flood risks

Similar to the Strategy, the Handbook *Rising Water – handbook for physical planning in flood prone areas* was initiated by the CAB Västra Götaland, in cooperation with Värmland and completed in 2011.

The *Handbook* was developed to help municipalities in the two counties adapt to the challenges of rising water levels and to strengthen the management of flood risks, particularly regarding building work and physical planning. It is a first for Sweden. It provides a common framework and detailed guidance for new construction projects in flood risks areas. Concrete recommendations on elevation levels for future construction projects are the focus of this work. The *Handbook* provides background to the problem, various approaches for addressing the risks, inspirational adaptation measures taken from other countries and a five-step model for physical planning. Moreover, the Handbook's approach is scalable. It can be used to develop plans and take preventive measures at different levels – for municipalities, neighborhoods, even private homes.

Similar to work with the Strategy, the counties organised the project with the active participation of working groups and a board drawn from a diverse set of bodies. Moreover, they engaged and communicated widely with stakeholders: consultations were held with all the 65 municipalities in the area as well as with relevant regional and national authorities. Once published, they took the Handbook 'on the road', holding an awareness raising tour across the region. The tour also helped kick-started the implementation of the Handbook's recommendations.

Success factors and lessons learned

A confluence of three factors enabled the counties' success. First, national authorities played an important role. Central government created the framework and the national adaptation strategy in which the regions were then able to plan and in turn engage municipalities, citizens and the private sector. Secondly, national scientific bodies, principally the Swedish Meteorological and Hydrological Institute were key, providing robust scientific advice and simulations that the counties could leverage with their local communities. Thirdly, the open and wide engagement by the counties of stakeholders, the frequent meetings of boards and working groups – created commitment to adaptation, political support and well-thought through solutions. In the case of the Handbook, the participative approach generated

wide respect and won the approval for its recommendations – municipalities are using the handbook in their daily work and flooding is to a large extent integrated into the planning process. In the case of the Strategy, the involvement of Vattenfall, a key private sector player, in the water diversion plan was also vital to success.

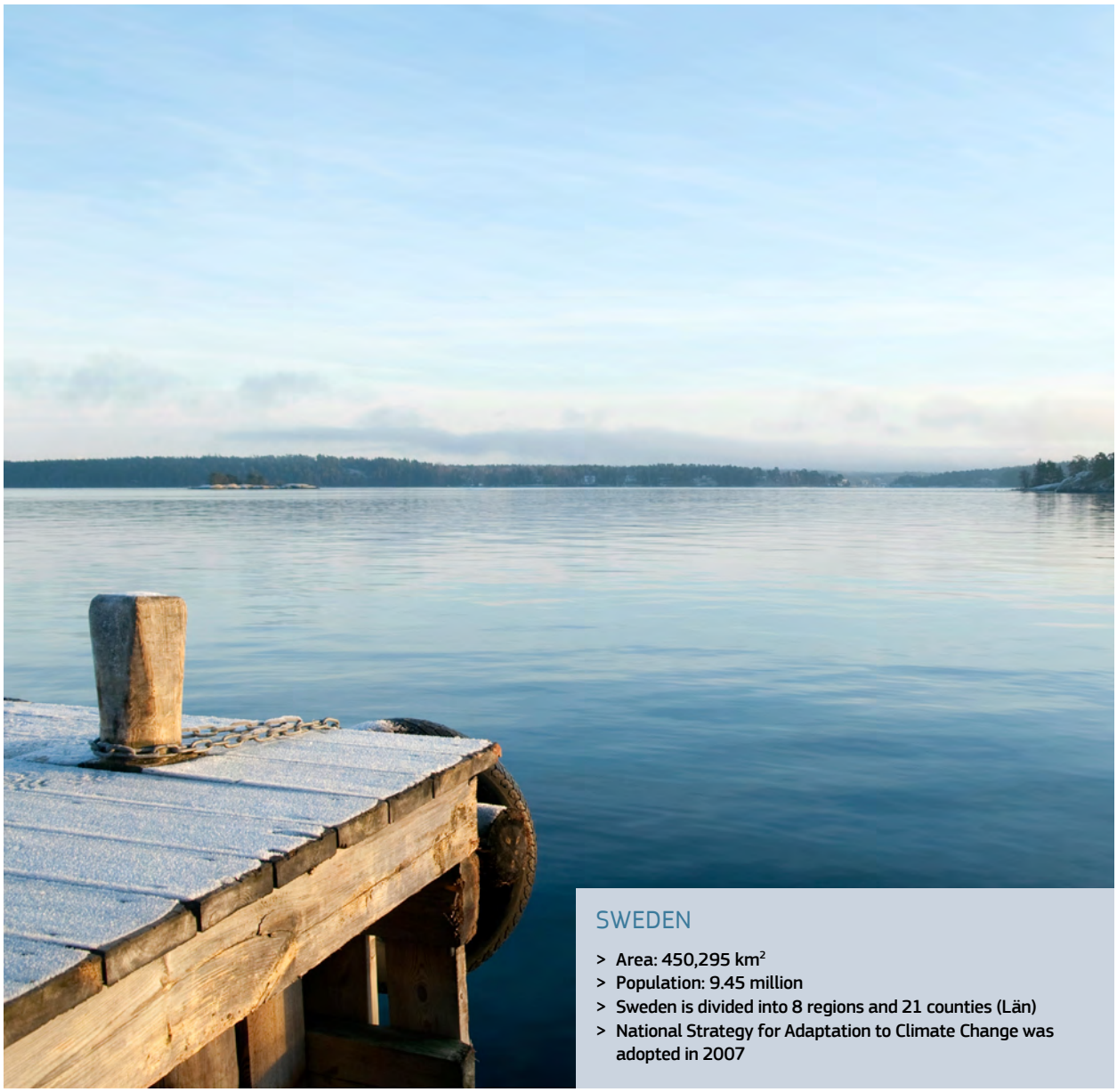
Underpinning all the actions, Strategies and Handbook lies one important lesson: the need to cooperate, learn and partner with regions beyond oneself. Västra Götaland county teamed up with Värmland; and both absorbed the experiences from flooding near Lake Mälaren region. In turn, the counties' contributions can be shared, scaled and transferred to other Swedish regions and further afield in the European Union.

Useful resources:

County Administrative Board of Västra Götaland
County Administrative Board of Värmland

For further information you can also contact:

> Lisa Nordahl
Chief of unit, Safety and Security Department
Country Administrative Board of Västra Götaland Södra
> Matti Lagerblad
Department of Spatial Planning
CAB Västra Götaland
> Anna Georgieva Lagell
Coordinator climate adaptation



SWEDEN

- **Area: 450,295 km^2**
- **Population: 9.45 million**
- **Sweden is divided into 8 regions and 21 counties (Län)**
- **National Strategy for Adaptation to Climate Change was adopted in 2007**

Adaptation at every level: the French model

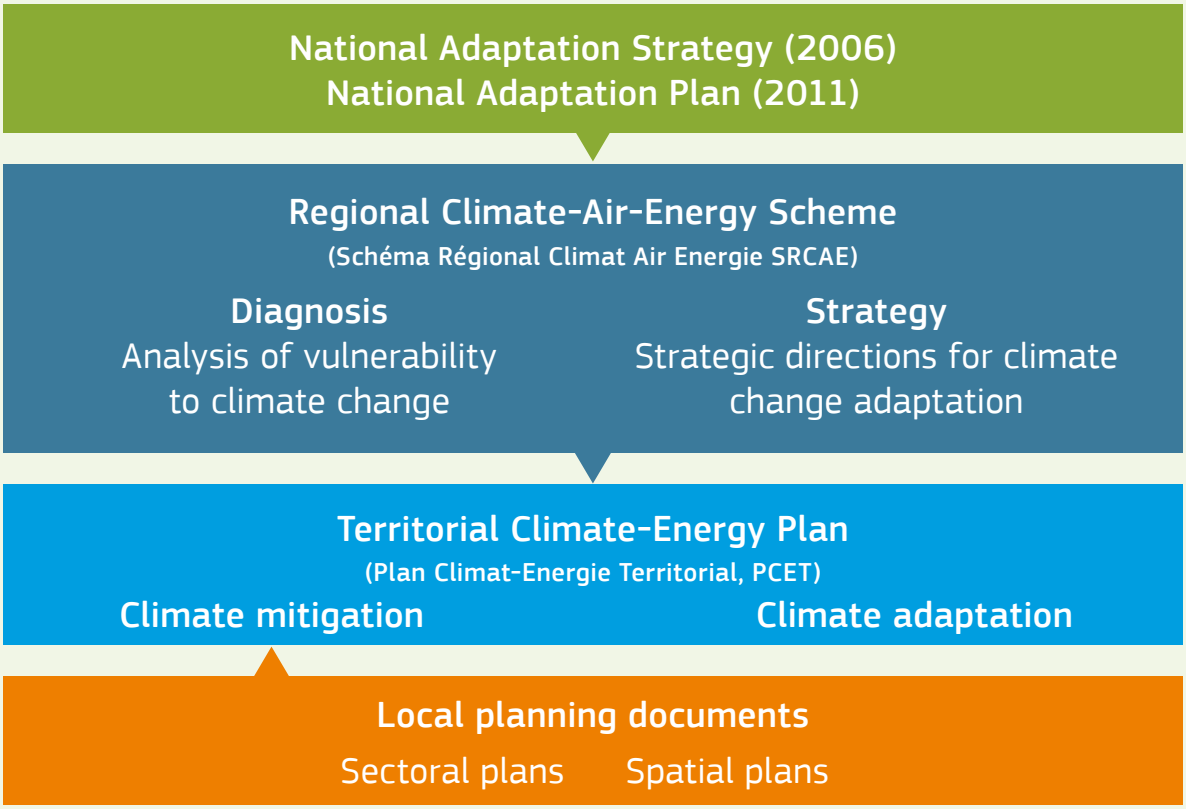
Climate change adaptation requires complex technical and political skills that local and regional authorities frequently lack. In France, the energy and environment agency coordinates this work across levels of government and provides valuable technical support so that regions can approach climate change adaptation with confidence.

- Legally required planning documents and processes for local and regional authorities clarify adaptation responsibilities and requirements up front
- A tailored climate change impact assessment tool enables authorities to get a first overview of climate impacts and the sensitivity and vulnerability of key sectors to climate change
- Regional administrations receive support from the French environment and energy agency on technical issues and stakeholder coordination
- Emphasis on political acceptance and technical input from all relevant parties results in high-quality strategic plans

The impacts of climate change are complex and affect a wide range of policy sectors and stakeholder groups. Local and regional authorities frequently lack the capacity to understand and cooperate successfully across these groups, and to facilitate their technical input. In France, adaptation planning is coordinated between the national, regional and local governments by the French Agency for Environment and Energy (ADEME). Planning documents for climate change are legally required, and ADEME coordinates contacts with stakeholders and technical experts to support the planning process. Regions also receive technical guidance, including climate impact assessment tools, to facilitate the process. As a result, nearly all French regions have either adopted or begun preparation of strategic actions plans for climate change adaptation.

In 2010, *the Grenelle II* law on environment made local and regional level planning for climate change and energy a legal requirement. France's 22 mainland regional administrations set out their main climate change adaptation objectives within *Regional Schemes on Climate, Air and Energy (SRCAE).* Strategically linked to these are *Territorial Climate-Energy Plans (PCETs),* which are more specific and are required for all territories above 50,000 inhabitants.

NATIONAL, REGIONAL AND LOCAL CLIMATE CHANGE PLANNING RESPONSIBILITIES IN FRANCE



ADEME has an important support function in addressing climate change at the different governance levels in France. ADEME has 26 regional branches and three branches in France's Overseas Territories. The branches work together with the ADEME national office to provide technical, political and guidance support to regions in planning for climate change adaptation. The combination of the legal requirements for local/regional climate change planning and targeted support from ADEME has had impressive results: not only do most local and regional administrations in France have strategic adaptation plans, but administrations and stakeholders are more aware of climate change impacts and what needs to be done to address them.

Getting started: assessment tools

A mandatory first step for any climate change adaptation planning process is getting a good understanding of project climate impacts and key vulnerabilities a territory can expect to face. To support this first stage within the PCET process, ADEME has developed *Impact Climat* – a toolkit for assessment of the impact of climate change on a specific territory and prioritizing actions for adaptation. It targets regions and municipalities at the beginning of the climate change adaptation planning process. The tool integrates information on past extreme weather events from the French *Gaspar* database and uses the climate scenario of Jouzel (2011). It reviews past climate patterns and events and future climate scenarios for 2030, 2050 and 2100. It then evaluates sensitivity of existing resources and socio-economic sectors to climate change and classifies priority vulnerabilities. So far more than 100 regional and local authorities have used the tool to prioritize their climate change adaptation actions.

In addition to the dedicated vulnerability assessment tool, the French government has carried out specialised research projects on climate change impacts. One of these is *Climator,* which studies the impact of climate change on agriculture and forestry. After three years of multi-disciplinary study, the project developed possible impact scenarios according to different future climate hypotheses. The results have been published in a document that provides detailed, easy-to-use information about climate change impacts. It covers both positive and negative impacts and aims at guiding agricultural stakeholders to choose the most pertinent adaptation measures.

FRANCE

> Area 632,834 km^2
> Population 65.6 million
> 27 regions, 22 mainland and 5 overseas; 101 departments, 96 mainland and 5 overseas
> National climate change adaptation strategy adopted in 2006
> National climate change action plan for 2011-2015 adopted in 2011

Ensuring participation and technical support

Understanding and planning for climate change adaptation is a complex undertaking that requires active support and input from a wide range of stakeholders, experts and authorities. As many regional authorities lack the capacity and political clout to effectively coordinate and secure the input of all the relevant parties, significant support from ADEME is provided for this part of the process. This includes ensuring consistency in climate change adaptation policy and action between the regional and local administrative levels.

ADEME therefore has a standardised process that it uses to support administrations in climate change adaptation planning. The process is applied flexibly within the different administrations depending on capacity and needs.

The mobilisation of relevant experts, authorities and other stakeholders is critical to the adaptation planning process. ADEME takes the lead on coordinating adaptation planning with the regional branches of sectoral authorities such as those for environment, planning and research. ADEME also assists in the formation of dedicated technical expert groups. These are comprised of representatives of ADEME, regional and local authorities and sectoral authorities, and may also include representatives of academia or specialised technical institutions such as laboratories or meteorological institutes. Technical expert groups are combined across regions and/or localities where practical. ADEME also sets up thematic workshops for sectors which the administration defines as important (health, urbanism, infrastructure, buildings, energy, water, economic activities, agriculture, biodiversity, etc.)

The coordination and facilitation of climate change planning meetings, which may include a wide range of stakeholders, can be challenging for local and regional administrations. ADEME supports the process with a standard approach. Generally, the first stakeholder meetings are dedicated to assessing regional/local vulnerabilities. In the second stage of discussion stakeholders propose avenues of action for climate change adaptation in their respective sectors of activity. These actions are to be prioritised by the authorities. At a next stage, the partners are asked to discuss the operational details for their actions.

ADEME also has funds for supporting specific projects proposed by local or regional authorities; these have included more detailed climate and environmental impact studies. It also facilitates networking and sharing of experience across the French regions. A national climate change adaptation web portal – *Wiklimat* – serves as a collective database of available information and allows for direct exchanges between key players in adaptation.

Success factors

According to ADEME, the legal requirement for climate change adaptation planning in all regions and larger municipalities means that there are now dedicated counterparts in these administrations who understand and take responsibility for climate change adaptation issues. This is an important factor in the success of the support and guidance provided by ADEME to these authorities.

The centrally designed procedure for regional and local adaptation planning processes in France has maximised coherence across these levels of governance and enabled authorities to take action with confidence. The existence of a national adaptation strategy since 2006 and action plan since 2011 has further encouraged a consistent approach. Regions have been able to overcome technical and political capacity challenges through targeted support from the national energy and environment agency, and develop strategic adaptation documents that serve as the basis for coordinated local action across the country.

Useful resources:

Many of the tools and guidance materials that ADEME provides for local and regional authorities are available (in French) on the ADEME website.

For further information you can also contact ADEME directly:
> Céline Phillips
Animateur de Secteur Adaptation au Changement Climatique – Service Climat, ADEME

Adaptation in trans-boundary regions – the Pyrenees

The Pyrenees straddle three different countries and several regions. Yet people face similar climate threats. Decision-makers therefore look for common approaches; but sometimes local structures obscure their view. L'Observatoire Pyrénéen du Changement Climatique (OPCC, The Pyrenean Observatory of Climate Change) seeks to solve this. It provides a kind of climate change 'telescope' offering people a shared perspective of climate threats. And having created common climate indicators, the OPCC allows stakeholders from different countries to look in the same direction and to focus on joint adaptation action.

- Collecting data on climate impacts in the transboundary Pyrenees region using a common approach
- Supporting decision making at regional and national level
- Leveraging the long-standing partnership arrangements of the Working Community of the Pyrenees and the complementary Interreg IVA funding programme
- Providing a 'telescope' of common indicators that can be shared with other transboundary areas

How you see the problem is the problem

Having a clear view of the likely impact of climate change events is vital for adaptation. What might happen in a region? And understanding how well habitats, economies and societies will cope is the other perspective. How will they respond to the impacts? Hard evidence is critical to answer these points. But in a trans-boundary area like the Pyrenees, each country has evolved its own approach to data gathering over many years, linked to specialised climate models that are not completely compatible. At the same time, the climate threats faced by those living in the Pyrenees remain similar: a decrease in water supply, the loss of snow cover, and adverse effects on selected tree species.

To overcome this, *L'Observatoire Pyrénéen du Changement Climatique* (OPCC The Pyrenean Observatory of Climate Change) was created in 2010 to map and address the potential climate vulnerabilities of the Pyrenees as whole. It is an exciting example of what trans-boundary adaptation can look like; and builds on structures established over many years.

Looking back, to look forward

Cooperating across borders in the Pyrenees is not, of course, a new phenomenon. There is a long-standing tradition of working together, between the three countries and seven regions of France (regions Aquitaine, Midi Pyrénées, Languedoc Roussillon), Spain (regions Euskadi, Navarra, Aragón, Catalunya) and Andorra. *La Communauté de Travail des Pyrénées* (CTP, The Working Community of the Pyrenees) was created in 1983 under the aegis of the Council of Europe. The CTP's twin objectives are to develop and to protect the Pyrenees. Since 2007, the CTP has managed the EU-*funded Operational Programme for Territorial Cooperation Spain-France-Andorra,* a cross-border programme financed under Interreg IVA. In this role, the CTP has been backing cross-border development projects for some years. As climate change impacts began to be linked to socio-economic development and the need to invest in infrastructure, the ground was laid for undertaking future adaptation projects; and the CTP was accumulating both expertise in trans-boundary investments and the political capital to ensure support.

Meanwhile the realities of climate change increased the need to cooperate across this region. The report of the Intergovernmental Panel on Climate Change (IPCC) in 2007 identified mountainous areas as particularly vulnerable. Consequently, the member institutions of the CTP agreed to monitor the Pyrenean region's climate as a whole, as they considered this the most effective way of facing the climate challenge.

The idea of setting up an observatory was discussed by the CTP in the following months. With partial funding already available through the EU's Interreg IVA programme for adaptation projects and with a strong consensus within the CTP's Guidance Council to take action, the then rotating President, the Midi Pyrénées region, proposed in 2009 to take the observatory idea to the next level. There was strong support. Detailed planning began and the OPCC opened its doors in January 2010.

The OPCC in operation

Gathering views, creating a shared perspective: the complex process of combining data. The observatory's first achievement was to provide a comprehensive overview of the available data on climate change impacts in the Pyrenees for both the natural habitats and key economic sectors. To develop a common approach one had first to understand the starting point, to take stock of the possible climate change impacts in the trans-boundary region.

The process required multiple steps over two years of work: gathering existing data; reviewing and sorting them, at both local and regional levels; and installing a monitoring process covering six priority areas. Next, the databases and information were harmonised – a complex task – to create a common set of indicators which all the partners later endorsed. Behind the indicators sit a wealth of supporting data. For instance, the OPCC has now in the biodiversity area, an *atlas* of the distribution of more than 4,500 species across the region.

These indicators and data are vital for coordinated action. Looking at the same data in the same way can help stakeholders plan. One example is the monitoring of the impacts of climate change on the dwarf willow tree. Sensitive to temperature increase, the dwarf willow tree has been shifted to higher altitudes; measuring and reporting this provides a common indicator that all stakeholders can use to assess their plans and progress. In another priority area, building on shared weather indicators, is a plan to create a network of meteorological services across France, Spain and Andorra.

In May 2013 the OPCC had its second achievement, presenting a comprehensive study on adaptation across the Pyrenees. The study was in two parts. The first half looked at the vulnerability of the Pyrenees to climate change; at adaptation initiatives already under way; and at how those initiatives might be integrated into the decision-making of relevant authorities (specialised institutions and sectoral departments). The second half reviewed adaptation work in other European regions, particularly mountainous ones. It concluded with a set of recommendations for mainstreaming climate change into policies and the decision-making process.

The study is making a major contribution to building a shared understanding of the climate challenges amongst Pyrenean stakeholders and authorities; it also offers insights for other mountainous and trans-boundary regions to use.

Pointing the way forward: from common views to common action

The process of writing the adaptation study yielded many benefits. It brought together disparate regional authorities, research bodies and policy associations from across the Pyrenees; it focussed them on common climate issues; it gave them a shared perspective. People are now looking down the same end of the 'telescope'. This in turn has improved the exchange of information between stakeholders and it has given policy-makers data they need for making adaptation plans. Furthermore, it has promoted additional, location-specific action. For instance, the Midi-Pyrénées region is now carrying out a study on mountain tourism in cooperation with the private sector.

Where does the OPCC look next? It will continue to monitor the common indicators and to collect examples of best adaptation practices. In the long term, the OPCC will support the development of an adaptation strategy for the Pyrenean region as a whole.

Furthermore, the work of the observatory was always intended to be viewed by a wider audience. The CTP signed a partnership agreement with the European Environmental Agency (EEA) in 2011 to share information; and the OPCC's knowledge will be added to the Climate-ADAPT portal, the European Commission's Climate Adaptation Platform maintained by the EEA.

Beyond the Pyrenees: seeing the potential in other mountainous regions

Other mountainous and trans-boundary regions, especially where adaptation is at an early stage, can benefit from the experience of the OPCC. Some exchange of experience and knowledge is already taking place. For example, OPCC members are in touch with the *Alpine Convention and the Carpathian Convention.* The work of the observatory has also been showcased at conferences on adaptation in mountain regions. In November 2013, the OPCC will organise an international conference on the topic of climate change in mountainous areas. One of the main objectives of the conference is to discuss common issues between mountain regions and to present initiatives that can be transferred from one region to the other.

Cooperation extends further. The OPCC has been contacted by two French regions to help set up a similar observatory. They want to learn more about the structure of the observatory, the indicators used and the monitoring process. The 'Pyrenean telescope' may soon be peering at the Alps, the Massif Central and other nearby regions.

Looking successfully: how the OPCC did it

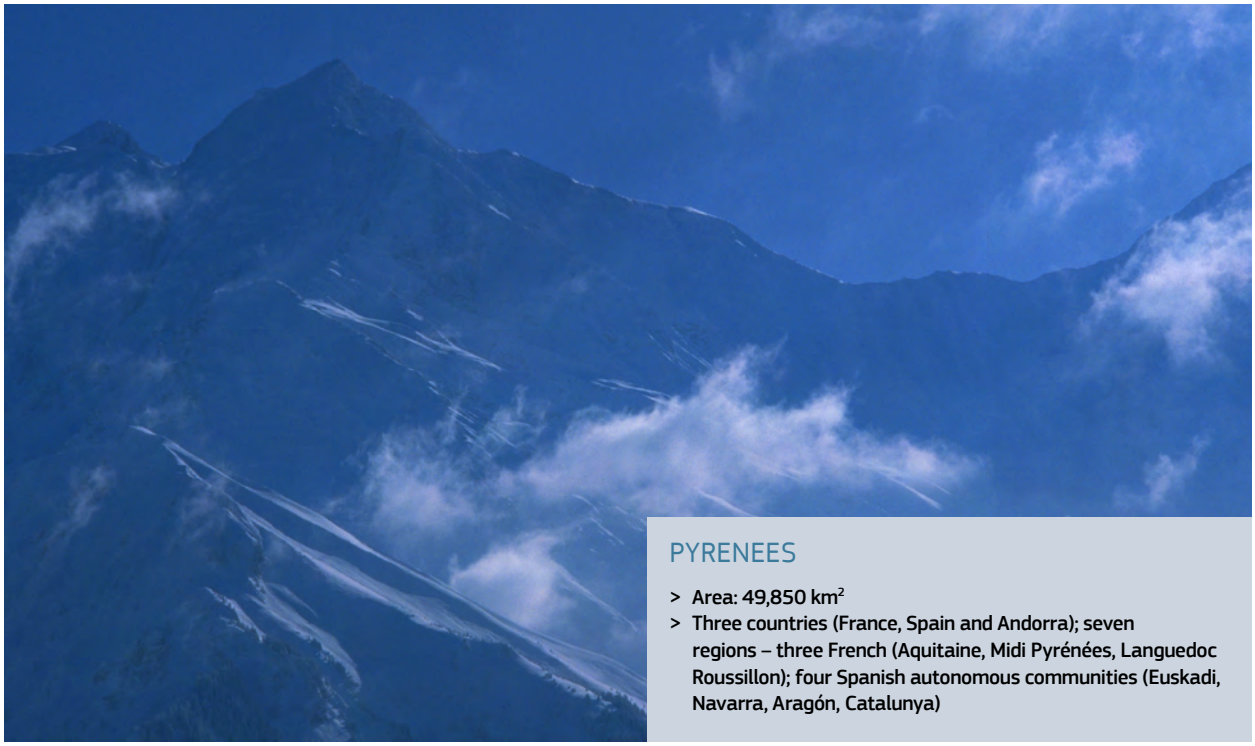
Behind the OPCC's success lies the initiative and enthusiasm of the CTP members. Their commitment, built upon existing relationships, is significant; as is the political support they mobilised at the start. Moreover, having a long-established trans-boundary organisation behind them, the CTP – backed by money from the EU's Interreg programme – has also been vital. Finally, the continuous involvement of member institutions and stakeholders in the activities of the observatory has kept the issue of adaptation in the public debate and generated support for its work. The main challenge now is to turn the observatory's knowledge and understanding into adaptation actions: to put down the 'telescope' and pick up the 'spade.'

Useful resources:

Guidance materials and information on the Pyrenees Climate Change Observatory are available on the OPCC website

The OPCC study on adaptation is available here
> Information on the La Communauté de Travail des Pyrénées (CTP) is available here

For further information you can also contact the OPCC directly:
> Anne Sota
Coordinator of the OPCC
> Stéphane Leroy-Therville
OPCC member from Midi-Pyrénées



PYRENEES

- **Area: 49,850 km^2**
- **Three countries (France, Spain and Andorra); seven regions – three French (Aquitaine, Midi Pyrénées, Languedoc Roussillon); four Spanish autonomous communities (Euskadi, Navarra, Aragón, Catalunya)**

Natural processes complement flood infrastructure in the Netherlands

In many cases concrete infrastructure, such as dykes and storm surge barriers, is needed to protect coastal areas from flooding disasters. But such infrastructure is not the only solution for reducing flood risk from sea level rise, storms and other impacts of climate change. Adaptation solutions that use natural processes to build resilience to climate change can provide win-win situations, as in the case of the Oosterschelde estuary.

- Understanding the complex relationships between natural habitats and climate change risk
- Dealing with climate uncertainty through flexible, low-cost measures and dedicated monitoring
- Coordination with international, national, regional and local stakeholders to build support for innovative, non-traditional approaches
- Adaptation that delivers multiple benefits including environmental and economic

The Oosterschelde (Eastern Scheldt) estuary lies in the Zeeland Province in the south-western delta of the Netherlands. The estuary is part of the EU's Natura 2000 network of protected sites and is the largest national park in the Netherlands. Zeeland province has a long history of dealing with floods, sea level rise and the erosion of coastal habitats; planning for and addressing climate impacts, both immediate and long-term, is business as usual for this region. But infrastructural solutions that have prevented costly floods are starting to have negative consequences on habitats in an area rich in birds and other valuable natural resources. Increasingly, the authorities are exploring options that improve flood protection without requiring large hard engineering projects – such as sea walls and dykes. Within the Oosterschelde, the Zeeland province and the national water authority *Rijkswaterstaat* have been cooperating with local stakeholders to identify and test flood protection solutions that work with the natural environment to simultaneously protect coastal areas from flooding and preserve the natural habitats.

In 1986, a storm surge barrier was constructed in the mouth of the estuary to protect the surrounding area from flooding. A consequence of this barrier was a change in the dynamics of tidal flows in the estuary. These changes have increased the

erosion of the intertidal areas which make the Oosterschelde such an important area for biodiversity. These habitats also face pressure from climate change which is expected to increase the rate of loss of these areas as the sea level rises and storm surges become more frequent.

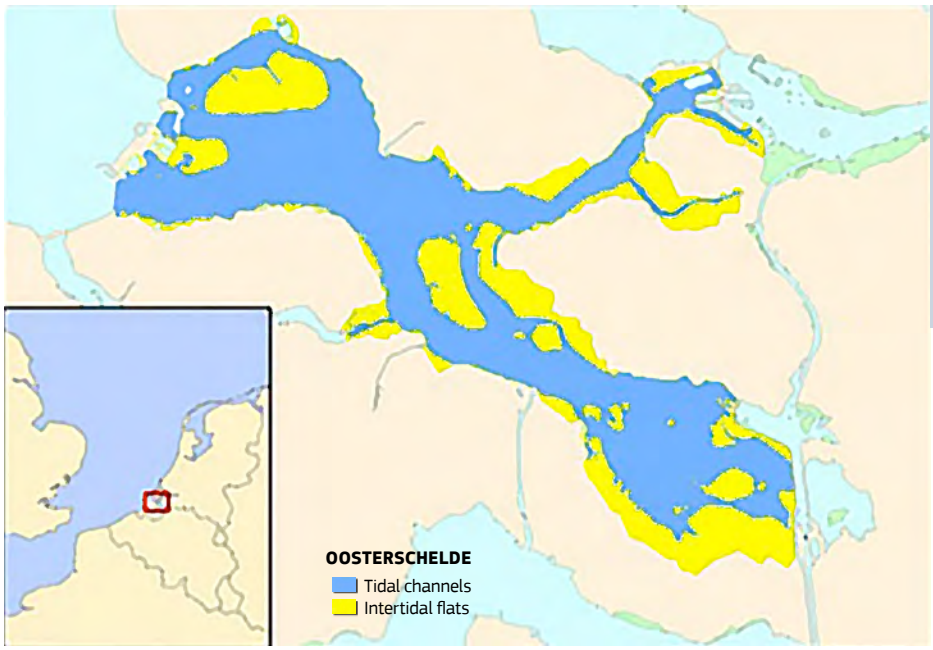
In 2004, the *Rijkswaterstaat* published research indicating that as a result of the tidal flow changes, the intertidal areas of the Oosterschelde were at high risk from coastal erosion. This would ultimately threaten the livelihood of the local community, and the existence of intertidal habitats. Computer models suggest that by 2075 approximately 90% of these habitats would have been lost. These habitats have a flood protection role and their loss would make it necessary to raise or strengthen existing protective infrastructure, meaning new engineering works would be required at potentially huge expense. The alternative was to see how these areas could be better protected. In 2008, the Zeeland Province obtained funding support from the EU's transnational North Sea Region Programme (Interreg IVB) and technical support from a wide range of partners. Working within the *Climate Proof Area*s project (see box), the *Rijkswaterstaat,* the Zeeland province, the national park and other stakeholders were able to identify and test possible solutions for the protection of intertidal areas.

After investigating climate change impacts on the site and developing scenarios for sea level rise the project identified a number of activities to 'pilot' – or test for effectiveness. These pilot activities were developed to protect the intertidal areas against erosion whilst retaining their biodiversity. Each was tested in a small area of the Oosterschelde, and all brought positive initial results, based on yearly monitoring.

Storm surge barrier Oosterschelde

EU funding for sustainable adaptation: the Climate Proof Areas project

The Interreg IVB project *Climate Proof Areas* ran from 2008 – 2011 with the aim of understanding climate impacts in vulnerable areas of the North Sea region and developing innovative and sustainable methods to 'climate proof' these areas. The overall objective was to contribute to the long-term viability of the natural environment and its role in supporting local economies and communities. The project partners looked for adaptation solutions that would not only build resilience to future climate change impacts, but also provide sustainable long-term benefits to communities. The project included partners from Belgium, Germany, Sweden, the Netherlands and the United Kingdom. It involved scientists, water experts and authorities to investigate and test adaptation options in ten locations in the North Sea region. To do so, it carried out pilot projects in areas threatened by rising water levels, using 'natural processes' to develop adaptation actions. The project used the partners' experiences to develop a toolkit to help others in the North Sea region understand the effects of climate change, to learn about proven adaptation measures and to understand how to build political consensus for adaptation planning and action.



OOSTERSCHELDE ESTUARY AND NATIONAL PARK

> South-western delta of the Zeeland Province, Netherlands
> Area: 370 km²; total shore length 175 km

The Oosterschelde with its intertidal areas in 2010.

Sand nourishment. One potential solution was artificially adding sand to the intertidal area to raise the bed level directly. The question was how long the sand would remain on the sandbank and how long it would take the creatures living there (worms, snails and shellfish) to recover and use the habitat properly? In 2008, 130,000 cubic meters of sand were added to nourish 20 hectares of intertidal area. Three years later, the trial was considered successful, as the sand had become a stable part of the intertidal area, expected to last for about ten years under current conditions.

Shore protection. There were three aspects of the shore protection work: protecting saltmarshes; creating new beaches; and building oyster beds.

- **Saltmarsh perimeter protection**: a three kilometre section of the perimeter of a salt marsh was ringed with stones to reduce wave energy and hence erosion.
- **'Hanging beaches':** this approach consists of nourishing an intertidal foreland of a dyke with sand and then using several ridges of stones at different heights to protect it.

Construction of the pilot sand nourishment at the Galgeplaat

Hanging beach test site at Schelphoek

- **Oyster beds:** Tightly packed colonies of oysters have the capacity to trap sand, slow waves and reduce erosion. To create these new habitats large metal racks were filled with oyster shells and then placed on the site. Oyster larvae then colonize these shells resulting in reduced erosion, improved water quality (oysters filter water) and a source of income from harvests of young oysters.

The actions above were presented as 'pilots', which could be stopped or altered depending on the results of the monitoring. One action that was dropped was an 'ecobeach' where attempts were made to increase drainage from the beach to reduce erosion. Monitoring at a coastal site elsewhere in the Netherlands suggested that this was not effective, so the work was stopped and the resources reallocated to other parts of the project.

Getting it right – what worked well in Oosterschelde

There is a long tradition of flood awareness and flood protection measures in Zeeland. But to date, solutions have mainly been hard engineered infrastructure. And while these defences have provided flood protection, they have resulted in some unintended consequences, including damage to the valuable habitats in the Oosterschelde. Recognising the complexity of the environment, regional and local authorities, knowledge institutes, water companies, contractors, nature groups and the fisheries sector worked together to find alternative solutions. The work carried out in Oosterschelde involved these groups early in the process of identifying and testing possible adaptation measures, bringing together their varied experiences to ensure the successful implementation of the pilot activities.

Another important part of the success in the Oosterschelde pilots was the input of partners with experience from outside the Netherlands. The *Climate Proof Areas* project brought more than just funding from the EU: it brought project partners who both inspired the ideas for solutions as well as new ways of looking at the problem. For example, the UK has extensive experience with habitat restoration and in particular the protection of salt marshes. It also has a tradition of understanding and incorporating the economic value of natural assets into policy decisions, which was instrumental in building local stakeholder and political support for a more natural approach to solving flooding problems.

The fact that the adaptation actions suggested here have multiple benefits for different groups is also important. This enables them to appeal to different stakeholder groups, creating a larger support base.

The situation in Oosterschelde is complex: the projected climate scenarios are uncertain and varying types of impacts can have many possible cumulative effects. To cope with this, possible options have been tested for their effectiveness and this has been monitored on a regular basis. Another positive aspect of these approaches is that they are relatively low cost, and therefore can be easily modified or replaced as conditions or projected scenarios change.

Useful resources:

The Climate Proof Areas website provides more information on the specific projects referred to as well as the work of the Province of Zeeland. Information is also available on the other project sites where a similar process was used to develop adaptation options across Europe.

For further information you can also contact Zeeland Province and Rijkswaterstaat directly:
> Leo A. Adriaanse / Eric van Zanten
Rijkswaterstaat
> Ruben Akkermans
Zeeland Province

Combatting floods and droughts with an integrated approach in Malta

The island nation of Malta faces big climate challenges. It has been increasingly expected to extreme weather events, such as flash floods and storms. Yet climate change is also depriving Malta of water. How does a region respond to this? The** National Flood Relief Project **provides a good answer, showing how by cleverly mixing technology, funding, and the support of local authorities, adaptation is possible in the face of the toughest odds.

- > Delivering a complex project through a holistic, multi-level governance structure
- > Tackling two climate risk in one project: managing floods and conserving water
- > Leveraging EU funding sources and advice
- > Building a flexible, adaptable technical solution

Stopping Water, Saving Water

Flooding in Malta is a familiar problem, and climate change is increasing flood risks. The frequency of severe storms is on the rise, and urban drainage systems are often unable to cope. Increased economic growth and urbanization adds concrete and steel, and reduces the ground cover available to absorb excess water, creating worse conditions for flooding. It damages property, roads, communications and even human life; indirect effects include health and pollution risks as sewers swell; and erosion of the coast and damage to harbours.

At the same time, there is a need for more water on the islands. Climate change is causing rainfall to be more unpredictable; and ground water levels are falling. Moreover, localities each operate their own, isolated water catchment systems – which hamper saving and sharing water between them.

This has posed a big challenge to Maltese authorities. The situation came to a head after massive storms in September 2003; the then existing small-scale flood and water projects were deemed inadequate. Instead, a major integrated response was needed. The outcome was, in time, the *National Flood Relief Project* (NFRP).

The National Flood Relief Project: a flexible solution to multiple climate risks

The NFRP is a complex, four phase infrastructure project. It simultaneously addresses both flood relief and water shortage. The project's motto is 'to manage water away from where it is a hazard to where there is a shortage of it' and in doing so 'to transform existing threats into opportunities'. This approach to water management is an excellent example of the integrated thinking required to address climate change risks.

The technical requirements are demanding: building 11 km of underground tunnels, to be completed within 18 months (from October 2012) to relieve the flooding problems in central Malta while increasing the national water reserve with 700,000 m^3 of water. Tunnels will have a height that varies from three to six metres and a maximum depth of 50m from street level in places; 52 water separators along the tunnel will help filter rainwater. The tunnels will be fed by over 80 'across the road grills'. The underground system will be lined with concrete to prevent water seepage.

Apart from this feat of engineering, the project has been planned and built explicitly with climate adaptation in mind. The infrastructure was designed to withstand future flood events, and the water catchment system planned to connect drainage solutions of adjacent basins together to manage surface runoff.

Managing the flood: good governance keeps the project afloat

Such a complex project, running across a number of municipalities, has required a holistic approach. The project has numerous legal implications in terms of planning and land use. It also impacts issues of cultural heritage, biodiversity protection and water, soil and waste management (because of the excavation of inert waste). The project itself needed a full Environmental Impact Assessment (EIA) to be carried out before any of the proposed technical solutions could be finalised.

The project required an integrated governance structure. The Ministry for Resources and Rural Affairs recognized this and began considering broader national solutions back in 2008. For the NFRP, the Ministry made the Malta Environment and Planning Authority (MEPA) the lead organization in managing the multi-level agreements and decisions such a project requires. MEPA has not only managed the design and construction of the infrastructure, but is also developing a new administrative mechanism for managing storm water. The physical system is being re-worked; and so is the governmental one.

The role of European law, policies and money

The NFRP was neither created overnight nor in a vacuum. The Maltese authorities have followed EU advice and legal framework at every stage. They have also received financial support from the EU Cohesion Fund.

The legal and policy advice has taken two forms. First, as a response to the European Floods Directive, Malta adopted its *Storm Water Master Plan* (SWMP) in 2008. It seeks to assess and manage flood risks. In preparing the plan, the Maltese authorities acknowledged the importance of managing the impacts from uncontrolled street surface runoff as a result of intense rainfalls. The plan identified the main priority areas and proposed a number of engineering solutions for the management of the surface runoff. Secondly, the SWMP as a flood risk management plan must be coordinated with the river basin management plans required by the Water Framework Directive. Fulfilling both Directives gave Malta a legal and policy framework in which to undertake the NFRP.

MALTA

- **Area: 316 km^2**
- **Population: 417,617**
- **National climate change adaptation strategy adopted in May 2012**

The tunnel from outside © [Di-Ve]

The Maltese authorities have also accessed EU funds to help finance the project. The total project cost is €52.8m; 85% of the money comes from the Cohesion Fund, through the Operational Programme *Investing in Competitiveness for a Better Quality of Life*, Priority Axis 5 *Safeguarding the Environment*; and 15% comes from national sources.

What worked in Malta can work in other places

The combined threat of flooding and water scarcity, made more severe by climate change, is not unique to Malta. An integrated approach to water management that considers both supply and drainage issues, as well as urban flooding more broadly, is required in many parts of Europe. EU water legislation, in particular the need to prepare dedicated management plans for river basins and flood protection and to coordinate them, applies across the EU. So there is broad scope for application of what worked for Malta with the NFRP.

One of the key success factors of the NFRP has been the dedicated approach to the governance and administrative aspects of the project. Even when technical solutions to complex problems exist, another challenge is getting the required authorities to agree to implement them in a coordinated manner. This usually means that each authority (e.g. municipality, local water company) must give up some autonomy and control to the collective project. It therefore requires consensus building – convincing the various parties of the necessity to work together. The appointment of a single, national-level institution for horizontal coordination, in this case MEPA, was an important starting point for the work.

The technical characteristics of the project, including the unique approach to considering both floods and water shortage in an integrated solution, can also be useful in other regions. Furthermore, the project successfully accessed EU funding to support the majority of capital costs, as it was part of a wider national development plan. Other EU Member States looking to access EU funds for large infrastructural climate change solutions can look to the example of Malta in this regard. Overall, a clever combination of technology, money and institutions has come together to result in an optimal solution.

Useful resources:

> The National Flood Relief Project (NFRP) website
> The Malta Environment and Planning Authority (MEPA) website
> The Malta Resources Authority website

For further information you can also contact:
> Manuel Sapiano
Water Policy Directorate
Ministry for Energy and the Conservation of Water

The tunnel from inside © [Di-Ve]

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