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Experience of the European Union in Adaptation to Climate Change and its Application to Ukraine

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Prepared by *Eric E. Massey*

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This publication has been prepared in the framework of the project "Climate Change and Security Scenarios for Eastern Europe" implemented by the Organization for Security and Cooperation in Europe (OSCE) in a frame of the Environment and Security Initiative (ENVSEC) with a financial support of the Finnish government.

CONTENTS

1. INTRODUCTION

As with many other countries Ukraine is facing and will face in future various challenges resulting from a changing climate. In an effort to meet those challenges and prepare for the future, countries are beginning to adopt climate change adaptation policies and procedures. The purpose of this report is to offer practical guidance and background information to the government of Ukraine on how to undertake adaptation activities. To be sure, adaptation is fraught with uncertainties and constraints: What types of climate impacts are to be expected and where exactly? Which socio-economic sectors will be most impacted? How can we prepare? And how should we prioritize our efforts based upon limited budgets? These are questions all governments are asking. Drawing on examples from around the EU, this report hopes to shed light on what other countries are doing to answer these questions and to present a range of possible adaptation options.

Structure of the report

The report is divided among seven sections. Section 1 provides an introduction to adaptation outlining some key concepts and definitions. It also highlights the role and need for policy interventions surrounding adaptation and concludes with a broad description of the types or objectives of adaptation policies. Section 2 briefly describes expected climate impacts and vulnerabilities for Ukraine over the short and medium term. Section 3 covers multilevel governance approaches and examples of adaptation. Section 4 looks at different approaches for quantitative risk assessments related to extreme weather, human health, the environment and economy. Section 5 offers examples of current adaptation policy measures by sector. Section 6 discusses options to finance adaptation activities and Section 7 concludes the report.

Key concepts and definitions

Below is a brief list of key concepts and definitions related to climate change adaptation. The purpose of this list is to, upfront, create a clear and common understanding of the important terms that will surface throughout this report. All definitions, unless otherwise stated are taken from the Intergovernmental Panel on Climate Change's Third assessment report (2001).

Adaptation: adjustment in natural or *human systems* to a new or changing environment. Adaptation to *climate change* refers to adjustment in natural or human systems in response to actual or expected climatic *stimuli* or their effects, which moderates harm or exploits beneficial opportunities.

- **Adaptive Capacity**: the ability of a system to adjust to *climate change* (including *climate variability* and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.
- **Exposure**: the nature and degree to which a system is exposed to significant climatic variations.
- **Resilience**: the ability of communities or groups to cope with external stresses and disturbances as a result of environmental change (Adger 2001).
- **Risk**: a combination of the probability (or frequency) of occurrence of a natural hazard and the extent of the consequences of the impacts. A risk is a func-

tion of the exposure of assets and the perception of potential impacts as perceived by a community or system (ESPON 2007).

- **Sensitivity**: the degree to which a community or a system is affected by the impacts and consequences of natural hazards (ESPON 2007).
- **Vulnerability**: the degree of fragility of a (natural or socio-economic) community or a (natural or socio-economic) system towards natural hazards. It is a set of conditions and processes resulting from physical, social, economical and environmental factors, which increase the susceptibility of the impact and the consequences of natural hazards (ESPON 2007).Vulnerability can be determined based upon the exposure, sensitivity and adaptive capacity of a system.

Role of public policy for adaptation

The governments, from the local level up to the national, but most importantly the national level, have a central role to play when it comes to coordinating and undertaking adaptation activities. Previously it was often thought that adaptation would be a private endeavor, carried out only by individuals and organizations. While climate will certainly have impacts on individuals and organizations, these groups form large and complex socio-economic systems and sectors, such as agriculture, water resources and human health which ultimately fall under government review. Additionally, each sector is driven by its own interests and capabilities which are sometimes at odds with each other (a classic example being the agricultural progression vs. environmental protection debate). Given that climate will impact all sectors and that each sector may choose its own and perhaps conflicting path towards adaptation it is imperative that the national government take the lead in raising awareness of adaptation, identifying priorities and developing a coordinated approach. This sentiment is not only stressed in the EUs White Paper on Adaptation (2007) but also in many existing National Adaptation Strategies (e.g. UK, Finland).

Another key argument for national level leadership is the varying impact climate will have on different administrative regions in the country. While it is important for regional governments to be involved in the adaptation process (see section 4), as with socio-economic sectors, each region will have its own specific priorities when it comes to adaptation which may come into conflict with neighboring regions. A series of measures in one part of the country could have negative impacts on other areas. Moreover, if regional activities are not properly coordinated they may put undo strain on the national budget.

Types and goals of adaptation policy

One crucial component of taking a leading role in the adaptation process is sound understanding of why adaptation activities are being undertaken and the broad types of measures that can be employed. In essence there are different measures that can be used to tackle different aspects in the adaptation process and policy makers should be aware of them if they are to create robust and targeted policies. Below four categories of measures are detailed.

Measures aimed at building adaptive capacity

In the academic literature the term "adaptive capacity" has received much attention and comes in various guises and definitions. According to the IPCC (see above) adaptive capacity is "The ability of a system to adjust to *climate change* (including *climate variability* and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences". In the case of adaptation policy, measures aimed at building adaptive capacity relate to a country's efforts towards instituting measures that build or enhance government or societal awareness about adaptation, and build the capacity to enable action towards adapta-

tion. Thus, these measures might come in the form of government reports, information campaigns or research studies that assess *inter alia* risks and sensitivities, and inform about particular vulnerabilities to climate change. In particular, they could be vulnerability and risk assessments, climate impact studies, cost/benefit studies, floodplain mapping, disaster management plans, etc. The overall theme and purpose of these measures is to impart information so as to build awareness and promote action at a later stage: higher adaptive capacity can lead to more successful adaptation.

Measures aimed at reducing risk and sensitivity

Measures that aim to reduce risk and sensitivity to climate impacts are commonly seen as the "classic" adaptation responses. In general these are actions undertaken in order to reduce the risk of damage and disruption, and reduce the sensitivity of people, property, and natural resources under long-term climatic changes. These measures are *preparatory* in nature and focus on reducing potentially damaging impacts and increasing resilience. Such measures can be applied across all socio-economic sectors, at all administrative levels and be undertaken by a range of actors. Specific examples might include construction of sea walls to protect against long-term sea level rise, early warning systems for extreme events, the institution of new building codes to protect the built environment against extreme weather, or the introduction of new crop varieties more resilient to changes in temperature and water availability.

Measures aimed at increasing coping capacity to extreme or damaging events (disaster preparedness)

While closely related to reduction of risk, these measures focus on *extreme* events and their impacts on people, property and nature during or after an extreme event (storms, heat waves, floods or fires). They differ in that their intent is to make the response to any event more robust and ease the impact. To be sure while these measures are "implemented" during or after an event, their design and construction must take place long in advance and require adequate knowledge of the potential severity of any event. Additionally they could in some cases require large-scale mobilization of human and financial resources. These measures can take place at all institutional levels and are usually designed and carried out by administrative authorities. Specific examples include the erection of "cooling stations" during heat waves, rapid mobilization of road cleanup crews, the opening of flood plains, or the release of emergency disaster funds.

Measures aimed at capitalizing on changed climatic conditions

One often-overlooked reason to undertake adaptation is that some benefit might arise from any changed climatic condition; not all impacts from climate change will be negative. Therefore, measures that help a country locale or sector capitalize on changed conditions could also be put in place. In the agriculture sector this could mean investing in different types of cash crops for domestic use or export. For the building and/or energy sector, this could mean the installation of solar panels on houses or different types of house designs or if a study shows that there is an increase in the population of a specific fish species, measures could be put in place to extend the harvesting season of said fish species.

While all the above measures have their own distinct purpose they are closely related. Creating polices to mitigate disasters or cope with and capitalize on changed conditions requires a solid understanding of potential impacts, risks and vulnerabilities a country or a region faces. Having such understanding allows for an increase in adaptive capacity and creation of policies that support its development. The foundation for increasing adaptive capacity, as will be discussed in section 4, is good scientific research and knowledge on climate and how to transform that knowledge into robust and effective public policy.

Measures to build adaptive capacity	Measures to reduce risk and sensitivity	Measures to increase coping capacity to extreme events	Measures to capitalize on changed climate
• Build government and societal awareness to climate changes and impacts and ability to respond to changes. • **Examples:** climate impact studies, disaster management plans, floodplain maps.	• Preparatory measures to increase resilience and protect against short, medium & long-term climate change. • **Examples:** new crop varieties, sea walls, early warning systems.	• Measures taken during and after an extreme event (floods, fires, storms) to mitigate and cope with disasters. • **Examples:** "cooling stations" during heat waves, emergency disaster funds, road cleanup crews at the ready.	• Measures seeking to claim benefits from changed climate; climate change could be good for some! • **Examples:** capitalization of longer growing seasons for new cash crops.

Figure 1.1. Overview of typology of adaptation measures.

2. CLIMATE CHANGE IMPACTS AND VULNERABILITIES FOR UKRAINE

The topic of climate impacts and vulnerabilities for Ukraine is not enough researched. However, there are studies which focus on the region of Central and Eastern Europe and cover Ukraine.[1]

As with many other countries in the region, overall temperature projections show a general warming trend over the next century with the possibility of considerable temperature rises during the summer months leading to increased aridity throughout the country with the possibility of increased heat waves. Additionally it is projected that there will be fewer days of snow and frost in the winter season with some studies showing 50 days with fewer snow and 60 with fewer frost (Jylhä et al. 2008). Precipitation is expected to increase during winter and decrease during summer; with an increase in rainfall intensity during warmer periods. This could lead to more incidents of flash floods (EEA 2004). Despite a growth in rainy days groundwater recharge is expected to decrease. In the drier parts of the country which are already susceptible to dust storms, such a dynamic could lead to increased soil erosion which when combined with the possibility of flash floods could lead to overall land degradation (Etzinger et al. 2003; UK Met Office 2010). Below is a brief summary of expected impacts and vulnerabilities detailed by sector where information was available.

Agriculture and food production

Given that agriculture is one of the main economic activities for the country it is not surprising that climate change has the potential to significantly affect this sector. However, many studies suggest that the potential impacts could be positive. As winter temperatures rise and the number of frost days decrease winter crops such as wheat could expand in production and growing area. Decreased rainfall and warmer days in summer could necessitate a shift from rainfed agriculture to irrigation. Assuming irrigation schemes are sustainable a longer growing season is to be expected opening up an opportunity to diversify crop production. While this bodes well for the agricultural sector crop production might be effected by an increase in extreme events such as intense rainfall or incidences of drought (UK Met Office 2010) and by invasive species including pests. Reaping the benefits of climate change while offsetting potential damage will require suitable adaptation measures.

Water resources

Changes in precipitation and increasing temperatures driven by climate change may have an impact on water resources and dynamics. Water stress is expected to become severe with increasing periods of drought. This could increase the vulnerability of both the agriculture and hydropower sector (especially for the

[1] The consultant was supplied a very detailed scientific study on Ukraine, *Vulnerability and Adaptation of Ecological and Economic Systems to Climate Change*. Where possible this material was used. There is also a publication *Climate Change in Eastern Europe* prepared by ZOI Environmental Network and ENVSEC available at http://www.envsec.org/publications/climate_change_in_ee_english.pdf

Dnieper). River flows are expected to decrease over the long-term significantly impacting inland shipping and navigation. A decrease in river flows will also translate into less flooding. While this can be beneficial to people and property, because of warmer temperatures, incidences of flooding could lead to an increase of water borne diseases (UK Met Office 2010; Feyen & Dankers 2009).

Energy

A 2008 study suggested that over 95% of the Ukrainian electricity generation stations are or were reaching the end of their production lifetime (Herasimovich and Tsarenko 2008). Assuming this to be true this can pose significant challenges and opportunities for the energy sector in the face of climate change. As a result of warmer winters the demand for heating will be reduced; however, this could be offset by increased summer demand, especially during heat waves. In general, the aging infrastructure, unless replaced or modernized, will come under increasing stress in urban areas. Changes in precipitation patterns and reduced river flows will have a direct impact on hydropower generation and cooling capacity of both nuclear power and traditional systems (UK Met Office 2010).

Human health

While warmer winters have the potential to decrease illness and death due to cold exposure, overall human health could be vulnerable to an increase in summer temperatures. Already cardiovascular disease accounts for some 60% of deaths in the country (WHO 2005). Heat waves can create stress on human cardiovascular systems thus exacerbating incidence of heart failure. Additionally, for populations unaccustomed to intense heat there is a higher possibility of heatstroke, respiratory illness and death: the most vulnerable being infants and the elderly. Apart from the direct impacts of heat upon

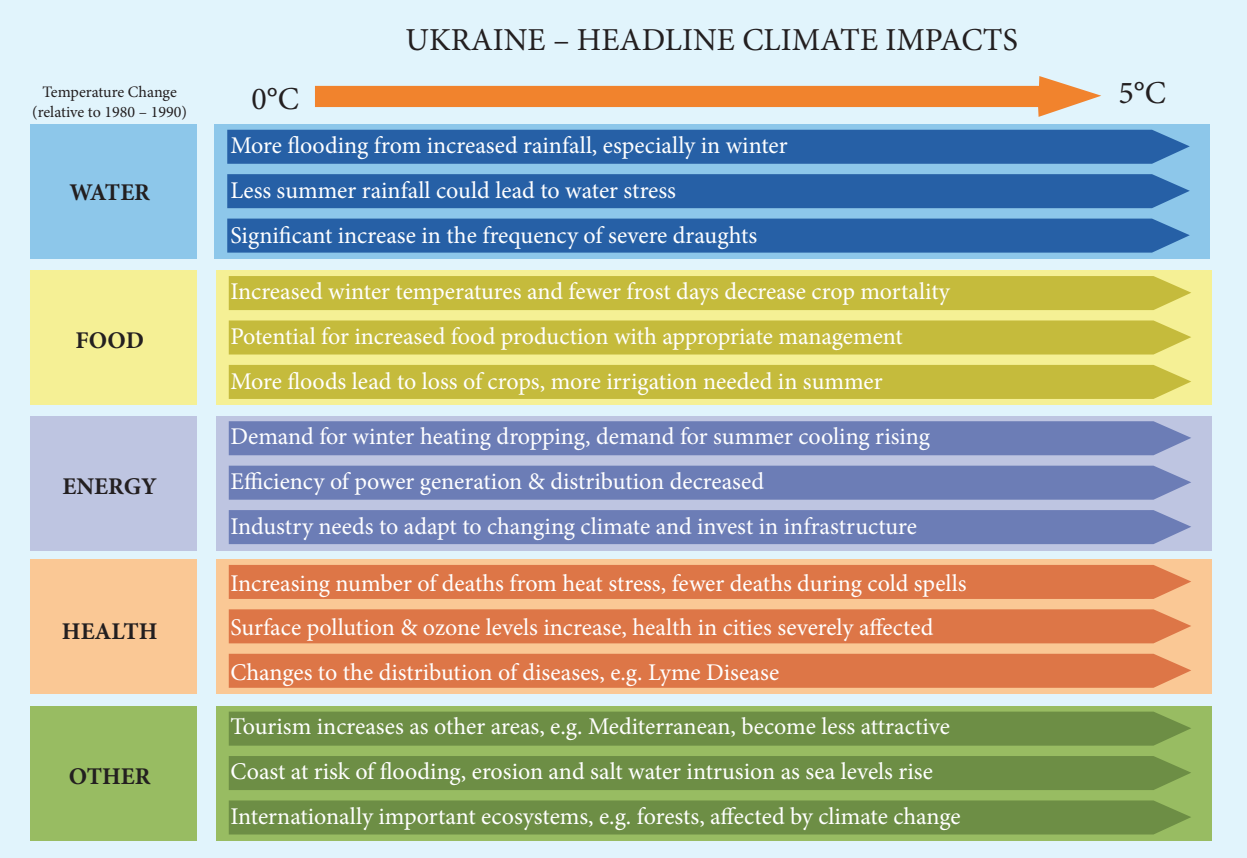

Figure 2.1. Overview of main climate impacts for Ukraine. (Source: UK Met Office 2010)

human health there is the potential for an increase in water-borne and vector-borne diseases which could affect all segments of society.

Industry/mining

According the UK Met Office (2010) given that mining is one of the major industrial sectors (along with power agriculture and power generation – see above) it too could be affected by climate change. In particular the mining sector could be vulnerable to land erosion and flash floods.

Coastal zones

Coastal erosion is already an issue facing populations living and working along the Black Sea. Increased intensity of rainfall coupled with expanded development of shoreline areas could exacerbate erosion problems. Additionally, for those inhabiting areas from 0-10 m above the sea, sea level rise could pose a significant threat. Current fishing industries could also face multiple threats. First, over the long term, if sea temperatures rise this could alter the makeup of species diversity. Second, a decrease in river runoff and changes in precipitation patterns could cause changes in salinity also altering the diversity of fish species. Third, warmer coastal waters may spawn more frequent algae blooms which could disrupt marine life (UK Met Office 2010).

Biodiversity

Ukraine has a vast array of unique flora and fauna throughout the country but especially in the Carpathians, the Crimea and the Danube Delta. According to some studies biodiversity is already being affected by climate change. This may have consequences for the timber and tourism industry in the Carpathians. With warmer temperatures and changing patterns of precipitation, forests could suffer water stress leading to soil aridity, degradation, and the potential for incidences of forest fires. A changing makeup of forests would also alter the diversity of fauna. In coastal areas (see above) and especially the Danube and Dniester Deltas, reduced upstream runoff and warmer water temperatures could alter the ecological conditions of the areas. Climate change could also lead to increase in invasive species including pests.

3. MULTILEVEL GOVERNANCE FOR ADAPTATION: PROCEDURES, INSTITUTIONS AND POLICY FRAMEWORKS

The following section explores and provides examples of bringing adaptation to bear in countries. It discusses the needs for multilevel governance (governing at the national, regional and municipal) looking at adaptation procedures, institutions and policy frameworks.

Procedures: assessing impacts, vulnerabilities and risks – National research programmes

The first and most fundamental step in effecting adaptation is having a sound understanding of the expected impacts, vulnerabilities and risks posed by climate change on key socio-economic sectors over the short, medium and long term. Having a proper understanding of the impacts, risks and vulnerabilities will allow decision makers not only to prioritize where action will be needed but also highlight where they may have suitable programs and policies in place. To this end it is recommended to create a national level climate impacts research program. National research programs can be short, fixed term institutions or standing semi-governmental organizations. Several countries have already instituted such programs, most notably Finland, and the United Kingdom.

Between 2004-2005 the Finnish government established a national research program FINADAPT.[2] With the Ministry of Environment as coordinator, FINADAPT was a consortium of 11 institutions (universities, government institutes (hydro-metrological, forest, environment) and research centers) studying how to adapt to the potential impacts of climate change. The research conducted was based on literature reviews, interactions with stakeholders, seminars, and targeted research. Topics covered included climate data and scenarios, biological diversity, forestry, agriculture, water resources, human health, transport, the built environment, energy infrastructure, tourism and recreation, a socio-economic preparatory study, urban planning, and a stakeholder questionnaire. As a follow up to FINADAPT, Finland launched a five year, Climate Change Adaptation Research Programme (ISTO).[3] Between 2006 and 2010, 30 research projects were carried out looking at further enhancing adaptation in all sectors. The program was coordinated by the national Group for Adaptation to Climate Change which is comprised of representatives from various ministries, research institutes, research financers and regional actors.

In 1997 the United Kingdom established the UK Climate Impacts Programme (UKCIP).[4] The purpose of the programme is to coordinate research on how climate change will impact the country over the short, medium and

[2] http://www.environment.fi/default.asp?contentid=365716&lan=EN

[3] http://www.mmm.fi/en/index/frontpage/climate_change_energy/adaption/adaptation_research.html

[4] http://www.ukcip.org.uk/

long term. Since its inception, apart from studying impacts and providing advice to the government on adaptation they also now aid communities, businesses and individuals plan and implement adaptation strategies. Among other things UKCIP provides tools and services for adaptation such as:

- The "Adaptation Wizard", an online five-step program that aids organizations assess their climate vulnerability and design and implement an adaptation strategy;
- "AdOpt", a companion tool to the wizard which helps decision and policy makers identify and select adaptation options;
- The "Business Areas Climate Impacts Assessment Tool" (BACLIAT), a tool for business to assess climate impacts on their individual business operations or the entire sector;
- The "Climate Adaptation Resource for Advisors" (CLARA), a resource to help managers of small and medium enterprises (SMEs) understand and prepare for climate impacts;
- The "Local Climate Impacts Profile" (LCLIP), a tool that highlights a particular locale's vulnerability and exposure to extreme weather and offers guidance to organizations on how to prepare and adapt;
- "Costings" guidance, a resource to help organizations calculate the cost of potential climate impacts and the costs for adaptation measures;
- Future socio-economic scenarios under various climate impacts.

Institutional setups

Regardless of the administrative level good adaptation begins with the establishment of solid institutions with the capabilities and mandates to address adaptation. Above national research programs were highlighted, these programs should be integrated into a larger administrative adaptation framework. Below recommendations and examples of adaptation institutions are given at various administrative levels.

National level

Climate impacts will be local; nevertheless, action at the national level will be needed in order to coordinate adaptation to address impacts.

Adaptation plans and legislation

A first step at the national level should be the establishment of a national adaptation strategy. Many European countries have already created plans and are using them as a road map for their adaptation activities.[5] Among other things a strategy can help focus attention on the issue of adaptation. It should be used to establish competencies and set priorities of both governmental and non-governmental actors. An excellent guide on developing national adaptation strategies is the UNDP publication *Adaptation Policy Frameworks for Climate Change* (2005) by Lim and Spranger-Siegfried.[6]

Apart from or in addition to national strategies, legislation can also be introduced for the purposes of adaptation. In 2008 the UK established the Climate Change Act. The Act, apart from setting legally binding actions to cut carbon emissions, is the first in the world to create a statutory framework that covers adaptation actions. Overseen and implemented by the Department of Environment and Rural Affairs's (DEFRA) "Adapting to Climate Change Programme (ACC)"[7], it requires the establishment of UK-wide climate change risk assessment procedure (including cost-benefit analysis) with mandatory reports every 5 years. The Act gives DEFRA's minister the authority to demand climate change risk assessments and responses from public sector bodies, local gov-

[5] For a good overview of national plans see http://www.peer.eu/publications/europe-adapts-to-climate-change/

[6] http://www.gsdrc.org/go/display&type=Document&id=3911

[7] DEFRA's Adapting to Climate Change Programme established in 2007 can be considered an office within the Ministry. The Ministry is no longer organized by directorates or offices but by "programmes".

ernments, and statutory undertakers.[8] The Act also calls for the creation of a National Adaptation Programme which will address the most urgent climate impacts. It is to be reviewed and updated every five years. Additionally, the Programme will submit biannual progress reports to the Parliament. Lastly, the Act stipulates the creation of the Adaptation Sub-Committee (ASC). A sub-committee to the Committee on Climate Change, the ASC, is an independent advisory body for the government, comprised of university and industry experts whose job is to provide guidance, analysis, information and advice on the implementation of adaptation activities.

Adaptation committees and inter-ministerial working groups

As stated above, the UK has instituted a so called Adaptation Sub-Committee to provide advice and counsel on adaptation to the government. Other committees that could be established are inter-ministerial meeting groups. Additionally, as in the UK, all ministries could be required to develop their own adaptation plans and strategies, outlining how climate change will impact their sectors, a review of their existing policies and measures that could be used to address impacts and the elaboration of new policies and procedures.

In order to realize its adaptation strategy, Portugal has created a number of strategic organizations, an Inter-ministerial Commission on Climate Change, sectoral working groups covering key sectors with both governmental and non-governmental participants from the local to national level, a scientific panel to support the sectoral groups, and an overall coordination group (CECAC). The overall purpose and competencies of CECAC vis a vis the adaptation strategy are *inter alia* to:

- coordinate and monitor the sectoral groups' work and consolidate results achieved by them;
- develop specific actions in the area of information and knowledge, awareness and information and international cooperation;
- monitor implementation of the adaptation strategy and report on progress;
- prepare proposals for periodic revisions of the adaptation strategy (Portugal 5th National Communication 2010).

Regional level

Regions also have an important role to play in the institutional set up of adaptation. If possible regions should also develop their own adaptation strategies, many regions in Europe have already done so.[9] Perhaps one of the most important aspects at the regional level (also at the national) is involvement and participation of all relevant stakeholders in the adaptation process. Often adaptation could be viewed at the sub-national levels as something being imposed on them by national governments; therefore, awareness raising and the communication of impacts, vulnerability and risks also need to happen among regional development authorities, public administrations, regional environmental agencies, local communities, private sector organisations, labour unions and non-governmental organisations; securing their engagement will greatly aid in the identification and implementation of adaption options.

The UK perhaps has one of the most extensive institutional setups for adaptation. Each region in England as well as Scotland, Wales and Northern Ireland has so called Regional Climate Change Partnerships. The partnerships which are comprised of a range of regional stakeholders (public, private and charitable organizations) work together to assess, prepare, and implement adaptation projects in their locales. In 2005, three regions in particular drafted a so-called "Adaptation Checklist" a guidance document aimed towards those in

[8] Statutory undertakers are public and private entities that provide essential public services e.g. utility companies.

[9] For an overview of regional adaptation strategies and guidelines for creation see http://ec.europa.eu/clima/policies/adaptation/docs/ras_final_report_en.pdf

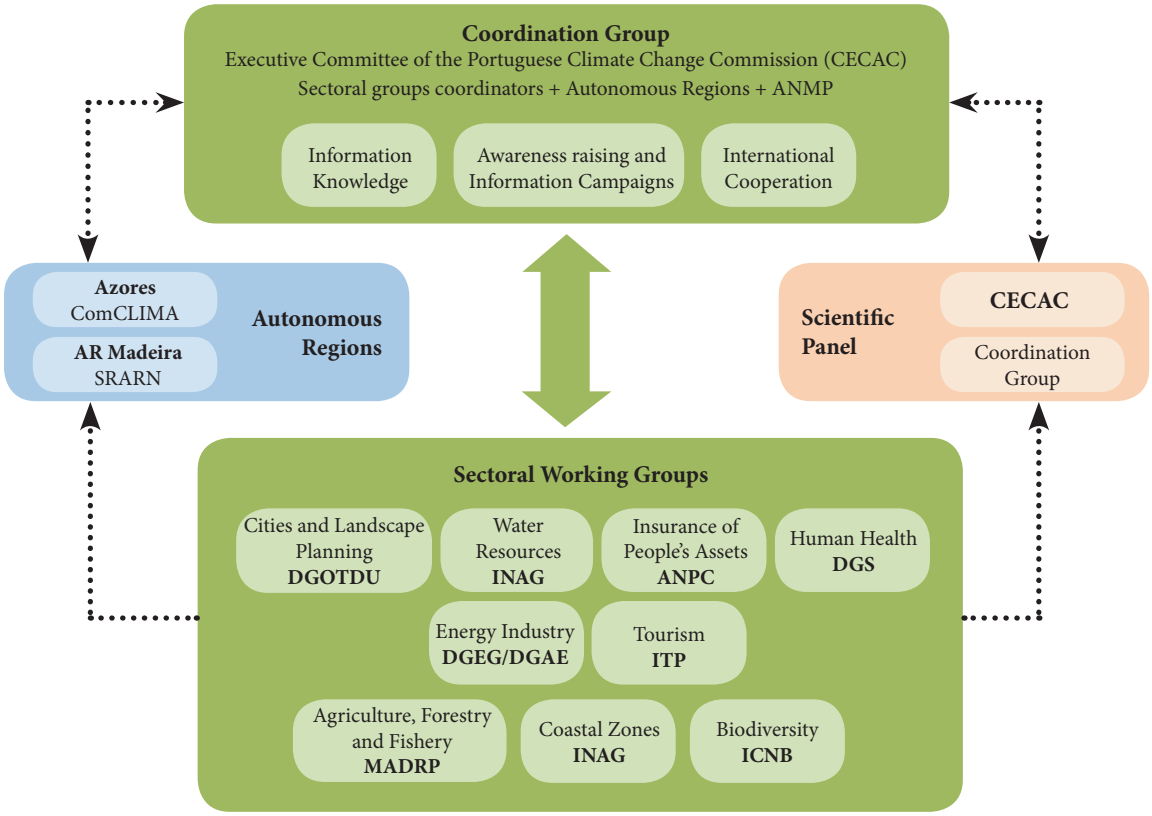

Figure 3.1. Portuguese framework of the working groups associated with the national adaptation strategy.

the building and construction community incorporate adaptation into their work (Three regions climate change group 2005). The partnerships work closely with the regional councils and leadership boards and are linked nationwide through the network "Climate UK" which is facilitated by UKCIP[10]. They are also partially supported financially by DEFRA. Additionally, a "Local and Regional Adaptation Partnership Board" was established in 2008 with a mandate to facilitate action on adaptation at the local and regional level. The Board which is chaired by Government Office for London and made up of various local, regional, and national authorities works to promote interaction between various agencies and provides toolkits and guidance.

Local level

The majority of people in Europe lives or works in urban environments meaning that cities are on the frontline of experiencing climate impacts. Already the cities of Paris[11] and London[12] have created adaptation strategies to deal with expected local impacts. As with regional levels raising awareness and securing the involvement of citizens, businesses, and local government is paramount for effecting adaption.

In the UK, the Nottingham Declaration[13] has been the primary instrument promoting adaptation in cities and towns. Established in 2000, the Declaration is a voluntary pledge taken by local governments to create climate change action plans. While the original version focused only on reducing carbon emissions an updated 2005 version of the pledge included committing actions towards adaptation. To date some 380 local authorities and city councils have signed the declaration.[14] The Nottingham Declaration Partnership, which administrates the Declara-

[10] http://www.climateuk.net/

[11] http://www.sumpa-med.net/?p=738

[12] http://www.london.gov.uk/climatechange/

[13] http://www.nottinghamcity.gov.uk/index.aspx?articleid=14385

[14] http://www.local.gov.uk/

tion, has also created an "Action Pack", a guidance document for the creation of climate action plans.

The Local Government Association (LGA), the largest lobbying organization for local governments, is also active in promoting adaptation. In 2007, they undertook a review of activities taking place concluding that local governments are, "uniquely placed to tackle climate change" and "the most important player in adaptation" (Local Government Association 2007; Local Government Association 2011a). In 2008, they launched a national campaign, "Small Change, Big Difference" to highlight the increased need for both adaptation and mitigation with a focus on presenting best practices and in 2011, they released an additional study on adaptation measures (Local Government Association, 2008; Local Government Association 2011b). The LGA also credits the work by local authorities for an additional 300,000 homes that have been protected from flooding since the year 2003 (Local Government Association 2011a).

Interactions between local governments and national level policy makers are also well established. In 2011, DEFRA helped to create a "Local Adaptation Advisory Panel" (LAAP). The Panel, which is comprised of and led by local governments, will serve as a means of communication and advice between local authorities and central government. UKCIP also assists local governments in carrying out Local Climate Impacts Profiles (LCLIP) (see above), over 100 have been done so far. Under the Department for Communities and Local Government's performance monitoring program of 2008, local authorities were required to report on their work in preparing for climate change: National Indicator 188-NI188 *Planning to Adapt to Climate Change*. As of 2011, mandatory reporting on this indicator has been phased out; however, it has proved instrumental in encouraging and promoting the uptake of adaptation actions at the local level (DEFRA 2010).

Summary – policy methodology

Regardless of the administrative level there is a generic approach or methodology to be followed when undertaking adaptation. As mentioned above the first step is to assess and analyze current and future impacts, vulnerabilities and risks. These can be done by dedicated research institutions or research consortia, either governmental or non-governmental. Second is the communication of those vulnerabilities and risks to appropriate authorities, institutions and subjects. Third is a review of existing policies and procedures that may already be suited to address climate impacts. This should happen across government ministries as well as different administrative levels. Fourth is a gap-analysis to see where policies are needed if no extant policies exist. Fifth is the conceptualization of new policies and procedures carried out with the involvement of all relevant stakeholders, with a focus on the types of polices needed and their cost and feasibility. Sixth is the implementation of chosen polices and seventh is the continual monitoring and evaluation of those polices. Figure 3.3 provides a general visual overview of the adaptation policy methodology.

The UKCIP offers further guiding principle for effective adaptation, these are:

- wok in partnership – identify and engage the community and ensure they are well informed;
- understand risks and thresholds, including associated uncertainties;
- frame objectives carefully at the outset before implementing actions;
- manage climate and non-climate risks using a balanced approach – assess and implement the approach to adaptation in the context of overall sustainability and development objectives that includes managing climate and non-climate risks;
- focus on actions to manage priority climate risks – identify key climate risks and opportunities and focus on actions to manage these;

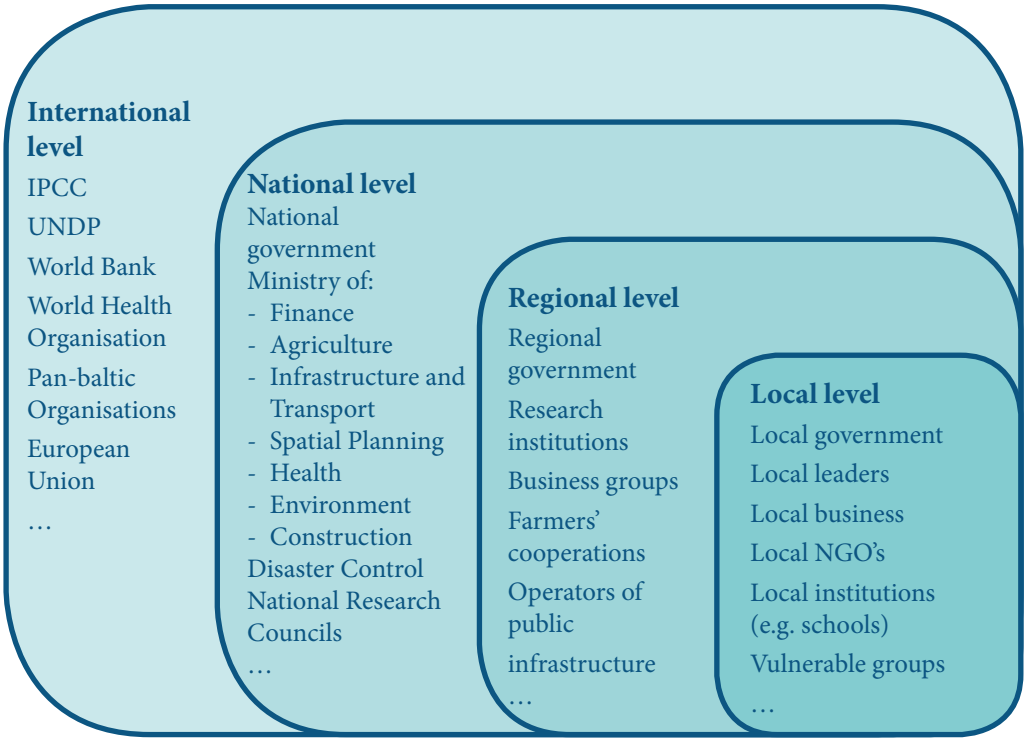

Figure 3.2. Visual map of institutions and stakeholders involved in adaptation (Source: Hilpert et al. 2007/adopted from Lim, Spanger-Siegfried 2005)

Figure 3.3. General framework for adaptation policy methodology (Source: Hilpert et al. 2007)

- try to identify so called low regret or win-win adaptation options in terms of cost-effectiveness, feasibility and those with multiple benefits;
- avoid actions that limit future adaptation options (e.g. building unnecessary infrastructure) or restrict adaptive actions of others (maladaptation);
- review adaptation strategies and actions regularly.

4. RISK ASSESSMENTS

Climate change poses and increases risk to people, capital (economy) and the natural environment; climate change risk assessments constitute one of the most important pillars of any future adaptation strategy as they can help put policy makers in a better position to adopt and implement more well-informed policy choices. While risk assessments are not a new concept, they have been continually employed in a variety of socio-economic sectors, conducting risk assessments for climate change is quite novel. Specifically, climate change risk assessments aim to "identify hazards that may be caused or exacerbated by climate change, and to assess the likelihood and relative consequence of these hazards in order to prioritize responses and mitigate risks" (NZCCO 2004). Climate risks are not static but change over time with alterations in population, land-use and economic growth or decline (Bouwer 2010). Also risks vary spatially and at different scales. Box 3.1 provides a condensed overview of the important concepts associated with climate change risk assessments.

Risk assessments can be both qualitative and quantitative. Quantitative assessments focus on calculating the probability of certain impacts by the potential losses that might be incurred where Risk = Hazard Probability x Potential Loss. This allows for a more detailed description of risks and uncertainties (UKCIP 2003; Bouwer 2010). In general quantitative assessments are time consuming; requiring substantive amounts of data and a high degree of technical expertise.

While quantitative risk assessments can be a powerful tool for informing adaptation decisions, they cannot be conducted without a broader qualitative assessment of risks. Moreover, solid methodological frameworks to quan-

- *Risks vary spatially and temporally.* At present, risks are not consistent regionally or even locally, and will differ down to the specific asset in question. Additionally, risks faced today at a given location may change in the future, dependent upon climatic changes, management decisions, and the implementation of adaptation measures, for example.
- Scale. As the ultimate goal of a climate change risk assessment is to inform the decision-making process, risk assessments need to be carried out at an appropriate scale in order to support that process-spatially (e.g., national, regional, local), temporally (e.g., present day to 2050, 2050 to 2100, etc.), and also in terms of ability to satisfy data requirements in order to complete the assessment.
- Uncertainty. Natural variability and knowledge gaps are sources of uncertainty, which should be considered in the risk assessment process.
- Communication. The outputs of a risk assessment should be communicated to relevant decision makers and to the public, as appropriate.

Box 4.1. Concepts for climate change risk assessments
(Source: ICF International 2009 / adapted from NZCCO, 2004)

Tier	Description	Purpose	Scope	Nature	Scale
1	Risk screening	To identify hazards for system, sector or area	Broad	Qualitative	National, regional, local, project
2	Qualitative & semi-quantitative risk estimation	To identify and prioritize consequences and their magnitude for system, sector or area	Specific	Qualitative, semi-quantitative	Regional, local, project
3	Detailed quantitative risk assessment	To establish the probability of consequences and the significance of the risk	Specific, detailed	Quantitative	Local, project

Table 4.1. Overview of three-tiered approach to risk assessments (adapted from UKCIP 2003 & NZCCO 2004)

titatively assess climate risks are not yet well established or instituted (IFC 201: Bouwer 2011). Perhaps some of the best examples of comprehensive risk assessment frameworks are those developed by the UK Climate Impacts Programme (UKCIP) (http://www.ukcip.org.uk/wordpress/wp-content/PDFs/Risk.pdf) and The New Zealand Ministry of Environment (NZCCO 2004) (http://www.mfe.govt.nz/publications/climate/coastal-hazards-climate-change-guidance-manual/index.html) [15]. These frameworks take holistic view to assessing risks and can be applied to a range of hazards (extreme weather, risks to human health, the environment and economy).

They take the form of a sequential three-tiered approach with each tier building on the other.

The first tier - *risk screening*- is devoted to defining the problem and establishing the context of climate risks. Here the purpose is to (1) identify the potential factors that pose as a future climate and exclude factors that are not a hazard for a system, sector or area; (2) identify the particular subjects (receptors) in the system, sector or area that are and are not at risk (e.g. portions of the population, types of infrastructure, types of ecosystems etc.); and (3) begin to identify in broad adaptation options. For specific tools associated with this tier see UKCIP 2003 – website listed above. The second tier - *qualitative & semi-quantitative risk estimation* - begins to take a closer look at the risks outlined in Tier 1 with an aim towards identifying the consequences associated with the risk and their possible magnitude on systems, sectors or areas. Prioritization of affected subjects should also be carried out. In many cases adaptation options highlighted in Tier 1 can be further developed based upon the information resulting from Tier 2.

The last tier - Tier 3 *detailed quantitative risk assessment* - is done when there is a need to establish the probability of consequences and significance of the risk on particularly defined subjects. The use of this type of analysis should be employed if stages 1 and 2 reveal that the receptors or subjects at risk are important and that possible risks are high, (e.g. a high risk to transportation, manufacturing or urban infrastructure) and when the choice of adaptation options need to be more precise so as to avoid a waste of resources or promote maladaptation. Such analysis in most cases requires significant amounts of detailed data and technical expertise relying upon the use of inter *alia* statistical, climate, hydrological and economic models tailored to specific locales. Table 4.2 provided an overview of possible approaches and tools for both Tier 2 and Tier 3 assessments. For further details please see UKCIP 2003.

[15] While the New Zealand example is a comprehensive framework it is applied to coastal zone management.

Tool/technique	Complexity	Data requirements	Comment
Uncertainty radial charts	easy to use	low	
Fault/event trees	may require specialist	high	
Decision and probability trees	may require specialist	high	
Expert judgment and elicitation	requires input from experts	low	Various methodological approaches, including: structured questionnaires and encoding methods, facilitated workshops, Delphi technique
Scenario analysis	easy to use if appropriate scenarios are available	medium	Also suitable for Tier 1
Climate change scenarios	easy to complex	medium to high	
Cross-impact analysis	easy to use with guidance	medium for simple version	Also suitable for Tier 1
Monte Carlo techniques	easy to use with guidance	high	
Modelling tools: process response models, statistical models	requires specialists	low, medium or high	Deterministic stochastic models may be used, but methods for sensitivity and uncertainty analysis will be needed to provide estimates of risk
Development and use of specific sophisticated modelling tools	requires specialists	high	
Climate typing	requires specialists	high	
Downscaling	requires specialists	high	Precise methods depend on available environmental or climate data and temporal and spatial scale of exposure unit and receptors
Bayesian methods	requires specialists	high	Can be used to determine the value of additional data or alternative models, and for reviewing risk assessments
Markov chain modelling	requires specialists	medium to high	Can be applied to event and fault trees and similar models to examine propagation of uncertainty
Interval analysis	requires specialists	low, medium or high	

Table 4.2: Tools and techniques for Tier 2 & 3 risk assessments (Source: UKCIP 2003)

5. EXISTING ADAPTATION MEASURES

While there are many concrete adaptation measures being taken by countries they are unevenly distributed across socio-economic sectors. In part this is because as adaptation increases on government agendas more and more attention is placed on bringing adaptation to bear on areas that were previously overlooked. As a result the number of reported measures in some sectors such as agriculture or biodiversity management may be high whereas examples of adaptation measures in the health, urban or insurance sectors are much less prevalent.

What follows below are examples of reported adaptation measures, by sector, being undertaken in European countries[16]. The information is based upon a national level survey of 29 countries and a review of regional policy activities in five countries conducted by the author. In many cases the examples overlap sectors so that an example detailed under "agriculture" may also be present in "water or biodiversity management". It should also be noted that in general, countries do not provide extensive detailed information for each measure but simply summarize the action taken; therefore, this report presents the measures in bullet point format. Activities across countries also overlap; for the sake of brevity similar examples are condensed into a single point. An indication of the type of measure as detailed in the introduction is also given. It will be recalled that adaptation measures can have four broad objectives, *increasing adaptive capacity* (indicated by AC), *reducing risk and sensitivity* (RRS), *increasing coping capacity* (CC) and *capitalizing of changed conditions* (CAP). In many cases as well, there can be considerable overlap with the objective of a measure, moreover given that measures reducing *risk and sensitivity* are considered "the standard" type of adaptation measures, the majority of the examples fall under this category.

Agriculture and food production

In terms of examples of measure in the agriculture sector all countries surveyed report taking some action. Measures range from the very specific to the very general.

- Review of agricultural reform policies to ensure that they are flexible for a changing climate (AC)
- Development, improvement or expansion of sustainable and efficient irrigation techniques to secure groundwater and reduce dependency upon rain. Provision of subsidies for sustainable irrigation (AC, RRS, CAP)
- Preparation of information by ministry of agriculture on good practices of irrigation. The creation of an advisory system or body for irrigation with the creation of parameters and an irrigation regime for irrigated crops taking into account meteorological conditions and weather forecasts to optimize water use (AC, RRS)
- Creation of agriculture water infrastructure, water reservoirs and intakes.

[16] Measures include "government investment". More information on solutions for adapting to climate change of EU and other countries, communities, sectors and organisations collected by the Directorate-General for Climate Action ("DG Clima") is available at http://ec.europa.eu/dgs/clima/mission/index_en.htm and http://ec.europa.eu/clima/sites/change/.

Development of water harvesting technologies. Where water storage facilities are present, develop guidelines on access based upon meteorological conditions and weather forecasts to optimize water use (AC, RRS)
- Conservation of soil water through the use of artificial soil cover (plastic wraps, non-woven textiles) or natural soil cover (grass/mulch and other agricultural by-products) (RRS)
- Reduction of the risk of water and wind erosion on agricultural land through increasing share of fodder crop in arable land, grassing of shallow soil, upgrading of protective forest belts, and adjustment of the structure and compactness of soil (RRS)
- Drought protection measures: identification of areas most vulnerable to drought in cooperation with farming communities (RRS)
- Re/construction of drainage systems to capture water runoff (RRS)
- Improving soil fertility through organic and industrial fertilizers (RRS)
- Development of crop disease and pest monitoring systems (AC)
- Changes in cultivars. Introduction of crops tolerant to biotic and abiotic stress. Cultivation of hybrid crops. Use later or earlier maturing crops. Expansion/intensification of winter crops (RRS, CAP)
- Development of new technologies and cultivation methods (RRS, CAP)
- Changes in location of cultivars in cooperation with farming communities (RRS, CAP)
- Increased support for crop and seed research in universities and institutes (AC)
- Development of animal disease monitoring systems (AC)
- Development of new animal vaccines (RRS)
- Extension of farm animal grazing period (CAP)
- Provision of shelter belt trees and hedges for outdoor livestock to provide protection from wind, and shade from sun (RRS)
- Raising public awareness for the need for adaptation in agricultural communities (AC)
- Implementing educational and training programs vis a vis sustainable water usage and drought awareness (AC)

Spain's Adaptation in Agriculture Agenda

As part of their Second Work Programme on implementing adaptation activities Spain begun the following activities for adaptation in agriculture.

- Agreements with relevant bodies to set up a collaboration framework in the agriculture and agro-insurance sectors.
- Analysis and mapping of the impacts of climate change on the availability of water resources in agricultural areas and for various crop types, including the impacts on irrigation demands in Spain's 21st century.
- Analysis and mapping of the impacts of climate change on Spain's main extensive livestock farming (sheep, goats, cows) areas.
- Development and application of methodologies to analyze the costs of climate impacts in pilot agricultural areas.
- Mobilization of key stakeholders (communication, participation and awareness-raising).
- Sectoral report on assessment and monitoring of climate change impacts, vulnerability and adaptation in relation to agriculture in Spain and production of a tri-fold brochure with the main results and recommendations

Box 5.1. Actions in Spain for agriculture
(Source: Spain's second adaptation plan)

- Subsidies to farmers, landowners and recreational organizations for their contribution to water management, including adaptation measures (RRS, AC)
- Subsidies for the employment of protective agro-forestry measures and environmentally sound agricultural practices (or mandate them in certain areas [author edition]) (RRS)

Water resources

It is often stated that adaptation in the water resources sector forms the backbone of adaptation policy. Below are examples of measures ranging from water supply and distribution to the use of water in industry and agriculture.

- Rational management of water resources including, land reclamations, enhancement of underground aquifers and emergence actions for drought, *inter alia*, making water available in affected areas via long-distance pipelines (RRS, CC)
- Development of regional drought management plans (AC, CC)
- Coating and afforesting of existing water distribution canals. Coating canals to reduce losses from filtration. Permanent canals in irrigation systems afforested on subsurface strips to utilize filtered water and to cover them so as to reduce evaporation (RRS)
- Forest conversion and general afforestation for the protection of underground aquifers (RRS)
- Construction of retention reservoirs that allow for the regulation and storage of water runoff (RRS)
- Installation of additional water pumps to help move water through canals in dry periods (CC)
- Promotion of the reduction of water consumption in industry, energy production, agriculture and households with the use of subsidies, taxes and fines. Setting limits of the amount of water to be used in certain periods (RRS)
- Elaboration and implementation of certain price and tariff systems for water according to the category of use, season and availability of resources (RRS)
- Implementing educational and training programs vis a vis sustainable water usage, water savings and drought awareness (AC)
- Where possible networking local and regional water supplies to move water to critical areas in times of drought (RRS, CC)
- Increasing the recycling degree of water for industrial needs (RRS)
- Subsidies to farmers, landowners and recreational organizations for their contribution to water management, including adaptation measures (RRS, AC)
- In urban environments construction and/or improvement of storm drains and networks to recover and distribute rainwater from heavy precipitation (RRS)
- Updating of sewer system to handle extreme rainwater flows and keep it separate form other water supplies (RRS)
- Improvement of sewer water filtration and processing systems to clean urban rainfall and make available for various uses (RRS)
- Land use planning to reduce flood risks and prohibition of construction in identified flood plains (RRS)
- Assessment of impacts of floods and droughts on groundwater pollution/release of soil contaminates (AC)
- Taking rain-induced floods into account in zoning and urban planning (RRS)
- Maintenance and fortification of flood defense measures (flood banks, dykes, etc.) (RRS)
- Creation of land areas along river banks to hold flood waters/increase natural retention capacity, construction of canals and culverts to direct water to those areas (RRS, COP)

Analysis of flood risks in Aalborg and Roskilde Denmark

An example of a climate change adaptation measure that will recur in a number of municipalities is adapting drainage systems to the expected increase in precipitation intensity. The Danish Environmental Protection Agency has performed the analyses of flood risks in Aalborg and Roskilde undertaken to illustrate the problem. The project was primarily undertaken as a workshop with selected experts in traffic, green areas, urban planning and drainage systems from the two municipalities. The procedure provided a robust and action-indicative result. Among the principal conclusions were:

- If municipalities follow the recommendations for sewer size climate change will be manageable within normal renovation/extension programmes. However, in most municipalities there are a number of hotspots that should be researched in more detail.
- Measures against flooding in cellars are optimally undertaken by individual site owners in the form of high water closures, pumps, etc.
- Municipalities must think broadly and horizontally so that the possibilities for new installations such as having recreational areas and leisure activity sites (parks, football fields, etc.) to serve a double function as temporary water reservoirs in connection with heavy rainfalls.
- Rising sea levels will be critical for most coastal cities, but this is not expected to occur in the next 10 years. Therefore, focus should be on ensuring that urban planning in these areas takes long-term climate change into account.

Box 5.2. Flood measures in Denmark
(Source: Danish Adaptation Strategy 2008)

- Regular updating of regional water regime modeling using the most recent climate data. Updated results are the basis for water management and the granting of water licenses and permits (AC)
- Assessment of water needs for main utilities under climate change (AC)

Energy

Interestingly there are not many detailed measures that deal with adaptation in the energy production sector. Only 10 countries in the survey report any action.

- Assessing impacts of climate change on energy production sector, modeling future demand, and potential peak periods. Also taking risks and impacts into consideration vis a vis scheduled investments (AC)
- Reconstruction and refurbishing of old hydropower stations to make them more resilient to climate impacts (RRS)
- Improving safety margins to protect hydropower systems from climate change (RRS)
- Improving and ensuring the security of electricity distribution by reinforcing power lines and burying cables (RRS)
- Periodic removal of sediment in and around hydropower station to maintain more steady flows of water (RRS)
- Investment into wind energy to offset/compensate hydropower (RRS)
- Investments into urban solar heating for households and buildings to reduce dependence upon energy grids (RRS)
- Promoting/encouraging the development of adaptation strategies for energy companies (AC)

Transportation

Adaptation in the transport sector is a relatively new topic for countries with only eight countries reporting any activity. Nevertheless, there are a handful of detailed measures to be considered.

- Inclusion of climate change impacts into long-term planning of transport sector with new planning norms for road and railway construction (AC)
- Analysis of potential effects of climate change on road and rail structures (temperature change, alteration around freezing point, sizing of road structures, sizing of water drainages, selection of proper materials for construction (AC, RRS)
- Implementation of extreme events and disaster warning systems (AC)
- Maintenance of the structures (road body, ditches, bridges and culverts) and condition of road network, particularly on smaller roads (RRS)
- Maintenance of railway structures (RRS)
- Protection of road and railway routes against extreme events, in the inland waterway sector technical safeguards for and control of water levels, switching waterway goods to rail, and risk spanning measures such as insurance (RRS)
- Expansion of inter-modal transportation of commercial goods (RRS)
- Use of non-salt (potassium formiate) anti-skid de icing treatments for roads and airport runways (CC)
- Reparation of storm damage to roads and railways after extreme events. Having cleanup crews at the ready with necessary equipment at hand (chainsaws, plows, tractors, etc.) (CC)
- Periodic pruning of trees and plants that could pose hazards to road and rail network in case of extreme weather. Also securing boulders and rocks that could pose hazards (RRS)
- Identification of alternative transport routes and means in case of extreme events (AC, RRS)
- Afforestation of areas affected by landslides and floods near transport routs to secure soil (RRS)
- Reinforcement of harbor structures to protect against heavier storms (RRS)
- Replacement of surface cables with underground cables (RRS)
- Promotion of certain technologies of street carpet (asphalt concrete or concrete cement) for roads and airport runways, based upon hydrocarbon pavement mixtures, to prevent deformation due to extreme temperatures. Additionally, promotion of road material that absorbs or removes water more efficiently in case of heavy rains (RRS)
- Construction of (additional) facilities for the insurance of wild animal passage in the road and rail networks (green bridges, passages) (RRS).

Health

Measures concerning human health fall under two categories, disease management and dealing with heat stress.

Disease management

- Epidemiological studies on vector migration and transmission, on introduction of tropical diseases and on relevant potential effects on endemic pathogens (AC)
- Basic research on biological strategies for combating vectors (AC)
- Basic research for characterizing possible changes in the pathogenicity and life cycles of pathogens, and of their vectors and reservoirs, and basic research on relevant treatment strategies and vaccine development (AC)
- Review of existing monitoring systems with regard to their effectiveness in detecting and following climate-sensitive endemic or imported pathogens and their animal vectors and reservoirs (AC, RRS)
- Development of suitable strategies for early detection of suspected and confirmed cases of disease caused by pathogens appearing for the first time (AC, RRS)
- Systematic study and modeling of populations (humans, animals, vectors)

with regard to numbers of new cases, and total cases, of certain climate-sensitive infections (AC)
- Via international collaborative efforts, world-wide identification and characterization of pathogens for risky infections (AC)
- Development and improvement of laboratory procedures for detecting climate sensitive pathogens, with the aim of enhancing diagnosis with regard to infected persons, contaminated blood products and infected organs (RRS)
- Experimental study of the risks of transmission, establishment and spread of risky pathogens (AC)
- Development of new therapies, vaccines and vaccination procedures (RRS, CC)
- Analysis of changes and trends in food-borne infections (AC)

Heat stress

- Development and implementation of heat wave warning systems with warning from national weather service via radio, television and internet (especially towards nursing homes) (CC)
- Public awareness campaigns on the dangers of heat waves and tips to stay cool (AC)

Heat wave plan for central and south France - Midi-Pyrenees

The Plan Canicule is in four levels, the first level automatically activated on 1 June.

These are :

- **Level 1 :** seasonal temperature watch – biometeorological watch provided by Météo-France
- **Level 2 :** warning and actions – the *Institut de Veille Sanitaire* (INVS), alerts the Prime Minister who in turn tells the prefects of the French departments concerned when weather conditions dictate. For the alert to be raised to Level 2, temperatures must reach above 34°C for three consecutive days and a minimum of 21°C at night. If it continues for longer Level 3 is activated
- **Level 3 :** a ministerial committee meets to organise crisis plans. The prefects of departments activate *plans blancs* (hospitals), *rouge* (emergency services) and *vermeil* (vulnerable people) if the heat wave is exacerbated by other factors such as power cuts, shortage of drinking water, overstretched hospitals
- **Level 4 :** reinforcement of the plans, deployment of the army, requisition of the media

The people most at risk are the elderly, infirm and those with serious illnesses and respiratory problems. Children and animals are also at risk. The five point heat wave plan is based on the following :

- Measures to protect people at risk (elderly, disabled) or hospitalised in health facilities
- Identification of individuals at risk, through the register of frail or isolated people held by the municipalities
- Alerts based on biometeorological evaluation
- Solidarity with regards to persons at risk, through the identification and permanent Summer care services, home helps and voluntary associations
- Information and communication with the general public, professionals and health facilities

Box 5.3. Details of heat wave plan for central and south France (Source: guide2midipyrenees)

- Use of public buildings as cooling stations (CC)
- Putting hospital and medical workers on alert during heat waves; increasing bed capacity in hospitals (CC)
- Organization of neighborhood watch groups to check in on elderly and distribute water (AC, CC)
- Adjustment of office hours for public services (post offices, banks etc.) to take into account the hottest periods of the day (CC)

Urban environment

The majority of measures covering urban environment are concerned with the effects of heat in cities and measures to mitigate its effects on the population. Other measures are concerned with flooding and general water management during or after extreme events.

- Mandatory urban and municipal climate change vulnerability assessments and adaptation plans (AC)
- Development of new construction standards for green buildings for the storage of and cycling of rainwater. Also the introduction of green roofs on existing building for better insulation during heat and cold and water capture (RRS, CC)
- Development of insulation standards for urban buildings (RRS)
- Revision of planning and building legislation and codes indicating where and how new buildings should be constructed so as to avoid damage from extreme events, including new design standards to protect against overheating (orientation of buildings, construction of shading walls, use of light colored materials on the outside) (RRS)
- Defining limits to housing developments in order to guarantee sufficient exchange of fresh air; fresh air corridors must remain open with minimization of development that hinders them (RRS)
- Updating sanitation systems in order to remove excess storm water in urban environment as well as guidelines on the treatment of storm water (RRS, CC)
- Regular inspections of public buildings (schools especially) in need of repair and upgrading (RRS)

Adaptation of Redhill School, England

The redevelopment of Redhill School, Worcestershire, undertook possibly the first climate change impact assessment at the start of a design process in an English school.

The £2.7 million project involves a replacement primary school on the site of the former 1960s building. The school aims to have a low carbon building that is able to cope with climate change and will provide a comfortable teaching environment over its lifetime.

Some of the adaptation features of the school to help it to withstand climate change impacts include:

- a sustainable urban drainage scheme using swales, ponds and underground box storage;
- a rainwater harvesting scheme, used for flushing toilets, takes rain from approximately half the roof area. Other roof areas have a planted roof finish (sedum) to reduce run-off;
- extra shade for pupils and teachers, provided by overhanging eaves and external canopies to the classrooms;
- zinc sheet roof coverings, with standing seams that may be less vulnerable to high winds than roofing tiles.

Box 5.4. Adaptation of Redhill School, England
(Source: UK 5th National Communication)

UK investment in Green Infrastructure

High quality places are typified by safe, attractive and well managed parks and other green spaces. They will also have ample "green infrastructure"- the "nature" between, around and on buildings, streets and squares, including trees, waterways ponds and lakes, paths, gardens, green roofs and terraces and nature reserves. The last few years have seen a growing appreciation of the value of green infrastructure and the need to do more to protect and increase it.

Existing planning guidance on biodiversity, geodiversity, landscape and green and open spaces has been revised and consolidated as a new draft Planning and Policy Statement. It aims to provide a clearer, more strategic national policy framework for the protection and enhancement of the natural environment. In bringing these policies together it provides planning policy on the provision of green infrastructure. It expects regional strategies to address biodiversity, landscape protection and green infrastructure, particularly in areas of growth and renewal where substantial amounts of development will be delivered and in areas where population will be most vulnerable to the impacts of climate change, such as flooding and overheating. It also requires local development frameworks to set out a strategic approach for the creation, protection and management of networks of green infrastructure, particularly in locations where it will assist in reducing the impacts of climate change by providing flood water storage areas, sustainable drainage systems, urban cooling and local access to shady outdoor space.

Box 5.5. Green infrastructure in UK
(Source: UK DEFRA 2010)

- Structural protection of building for heat waves: thermal insulation, solar protection by external blinds and windows, ventilation systems (CC)
- Setting limits and standards for the location of new buildings, establishing height requirements and minimum floor levels (RRS)
- Establishment of more green spaces with shade in cities, especially around urban heat island hotspots (RRS)
- Construction of fountains and other "urban water areas" (RRS)
- Establishment of better ventilation systems for underground urban rail transport (RRS)

Forests and landscape management

Measures for forests and landscape management have a strong focus on maintaining the viability of forests so as to ensure their continued service in protecting against climate change impacts. Little or nothing is devoted to the economic sector of forestry.

- Development of forest monitoring systems to identify "hotspots" where damage could occur or fires could occur (AC)
- Diversification of forest species. Forests play an important role in reducing risks of erosion and landslides. Diversification of species will help to make the forest more robust (RRS)
- Encouraging the replacement of pine conifers and spruce species that are adapted to a milder climate such as Douglas firs and broad leaved trees via financial incentives to foresters and landowners. Subsides for planting in accordance with a guide to species adapted to present and future climate (RRS)
- Identification of tree species tolerant of expected changes in climate and promotion of their propagation (RRS)
- Forest conversion and afforestation measures on suitable lands with an aim to stabilize soil and improve water balance (especially on degraded land) (RRS)

- Subsidies for the conservation of genetic resources of forests in order to prevent damage. Establishing a national register of seed tree stands on the basis of internationally defined parameters. Launching a gene conservation network. Creation of seed orchards to improve the supply of indigenous reproductive material (RRS)
- Financial support to foresters and landowners for regeneration practices in forests to prevent damage (RRS)
- Subsidies for maintaining the vitality of forests with an aim to prevent damage (SRR)
- Controlling for pests and tree diseases (RRS)
- Potential bans on wood imports from areas badly contaminated by pests (RRS)
- Creation/expansion of protected forest areas (RRS)
- Improving awareness among forest and land owners about climate change impacts (AC)
- Rapid harvesting of wind damaged trees in order to prevent consequential damage (RRS)
- Development of aerial supervision in order to reduce the risk of large fires (RRS)
- Maintenance of forest roads (RRS)
- Periodic clearing and harvesting of dead wood and debris to minimize spread of fires (RRS)
- Creation of forest protective belts (shelter-belts) around areas of critical infrastructure or agricultural areas in order to protect against wind and storm damage (RRS)
- Decrease of the impact generated by industrial activities on underground water and air quality through isolation with forest belts (RRS)

Coastal zones

Despite sea level rise, land retreat and issues of coastal erosion there are not many reported measures for coastal zone management by European countries. In general most countries except in the northern lowlands focus on employing "soft" adaptation measures as opposed to large or small scale hard coastal defense systems.

- To secure against flooding there will be a natural development of the coastline not through the construction of fixed installation but rather through the expansion of floodplains for water retention during times of flooding in delta areas (RRS, CC)
- Creation of controlled flooding zones for excessive tide flows (RRS, CC)
- Beach seeding with addition of sand; millions of cubic meters of sand are added to coastal areas to help ease erosion and buffer against sea level rise (RRS)
- Use of soft adaptation measures for coastal protection such as beach dune nourishment (addition of sand and grass to enhance and expand beach areas) and the creation of "living shorelines", the strategic placement of plants, stone, sand fill and other materials (RRS)
- Coastal wetlands restoration (RRS)
- Creation of coastal and marine protected areas for restoration and conservation of coastal and marine ecosystems; protecting commercially valuable marine species; and sustainably managing tourism and recreational activities while buffering against sea level rise (RRS)
- Limiting the development of coastal areas in danger of storm surges and sea level rise (RRS)
- Implementation of seawalls and breakwater around critical areas (RRS)
- Maintenance and upkeep of existing sea defense infrastructure (RRS)
- Relocation of industry away from coasts (RRS)

Coastal Management in UK

Sections of the flood defenses along the north of Wallasea Island were removed as part of the Wallasea Wetlands Creation Project allowing for the sea water to flood. Wallasea is a land-mark scheme for the area as it involves the managed realignment of sea defenses and the creation of 110 - 120 hectares of wetland habitat. The scheme fits in with the Roach and Crouch flood management strategy and will create a more sustainable estuary shape. The scheme will also provide valuable new intertidal habitat which will compensate for losses incurred through sea level rise and coastal squeeze. The total project cost is estimated to be in the region of £7 million

Box 5.6. Coastal Management in UK
(Source: UKCIP/ www.abpmer.net/wallasea)

Biodiversity management (also see forests above)

Many of the measures reported for biodiversity management are similar if not exact in nature to already existing measures for biodiversity protection. Additionally, they tend to also focus heavily on forest protection.

- Surveys and assessments of different ecosystems/species vulnerability to climate change effects (AC)
- Elaboration of species management plans of natural habitats in order to prevent and limit the degradation of habitats as a result of climate change (AC, RRS)
- Reducing human-induced stress on nature by controlling land use (RRS)
- Taking valuable habitats into consideration in the management and use of forests and other areas (RRS)
- Creation of protected areas and migration corridors that facilitate the migration of species following changes in their habitat (RRS)
- Creation of flexible protected area boundaries that shift in accordance with species migration (seasonally) (RRS)
- Projects for the rehabilitation and safeguarding of mountain forests with a protective function carried out with cooperation and involvement of provincial governments, interested groups, forest owners, industry and hunters (RRS)
- Restoration and management of valuable habitats (RRS)
- Increase of forest area through the rehabilitation of degraded areas and the development of other favorable areas (RRS)
- Diversification of forest composition of species. Forests play an important role in reducing risks of erosion and landslides. Diversification of species will help to make the forest more robust (RRS)
- Encouraging the replacement of pine conifers and spruce species that are adapted to a milder climate such as Douglas firs and broad leaved trees via financial incentives to foresters and landowners. Subsides for planting in accordance with a guide to species adapted to present and future climate (RRS)
- Identification of tree species tolerant of expected changes in climate and promotion of their propagation (RRS)
- Protection of gene pools of forest species (RRS)
- Creation of a national monitoring system for endangered species (AC)
- Restoration and management of wetlands (RRS)
- Decrease of agricultural activities that directly affect fauna and the implemen-

tation of appropriate measures to protect natural and semi-natural habitats existing close to agricultural areas, including the identification of compensatory measures needed for the survival of affected species (RRS)
- Conservation of traditional farmland biotopes with the help of agri-environmental schemes, support for agro-forestry measures and environmentally sound agricultural practices (RRS)
- Decrease of the impact generated by industrial activities on underground water and air quality with through isolation with forest belts (RRS)
- Control and prevention of the spread of invasive alien species (RRS)

Insurance

Climate change will impact all economic sectors and one of the most important non-governmental sectors to be affected will be the insurance industry. Despite this only a limited number of countries report current or prospective measures. In part this may be because most insurance companies are private; thus, falling out of the reporting requirements as defined by the UNFCCC. Below, however, there are a handful of measures being taken by companies and governments.

- Companies moving from retrospective underwriting based on past scientific data to prospective underwriting taking future changes in climate into account. Consequences of climate change and extreme events being included into risk modeling so as to estimate damages and risk premiums (RRS)

Spreading and sharing risks in UK housing

The Housing Corporation is proposing to use insurance or mergers between Registered Social Landlords (RSLs) to spread the financial costs associated with the impacts of climate change between a group rather than have individuals bear the cost. Those Registered Social Landlords (RSLs) with properties at sea level, near the coast, may potentially lose them due to increases in sea level and flooding. At present, insurance will cover the cost. However, if in time insurance is no longer a viable option, the Housing Corporation will seek mergers between RSLs to 'spread' the load financially or to write off stock and the grants given to produce it. If stock is written off, this would become an example of "retreat and abandon".

Box 5.7. Spreading and sharing risk in UK housing sector
(Source: UKCIP/ www.oursouthwest.com/climate/scopingstudy.htm

Bringing climate change to the Hungarian public

In 2008, Corvinus University of Budapest with the support of the national government and the private sector created a book, *About Climate Change: For all* aimed at informing the general public about climate change. This 200 page public raising awareness document covers topics such as water systems, ecosystems, human & animal health, food safety and climate policy. The book also provides guidance to individuals and communities on steps they can take to mitigate and adapt to climate change. The book was originally distributed for free throughout the country.

Box 5.8. Hungarian climate book

- Adjustments in underwriting, higher deductibles, price increases to offset higher claims. Higher insurance prices may influence behavioral change for investment in improved building material or prevent construction in high risk areas (RRS)
- Development of new products to diversify risks such as catastrophe bonds and derivatives (RRS)
- Mapping high risk zones to either exclude new construction in high risk areas or make such properties uninsurable (RRS)
- Price setting mechanism to limit premiums for constructions in high-risk areas by sharing the cost among all insured parties (RRS)
- Implementing urban planning and construction standards that would allow for property to be insured (RRS)
- Legislative changes in the coverage of flooding and other natural hazards. Cessation of state funds to cover natural disasters except when global costs exceed a threshold linked to the turnover of the insurance companies (RRS)
- State insurance for grassland farmers against yield losses due to water stress because other adaptation measures are not possible or have limited effects in grassland areas. Insurance is a viable option to lower the vulnerability of this sector (CC)

6. FINANCING OPTIONS

One of the main issues revolving around the implementation of adaptation is how to finance adaptation options. Interestingly the debate on financing is largely concerned with how the developed world will support activities in developing countries. Little information is available on how developed countries themselves are financing their own activities. Where information is available it is sparse in nature. One of the issues addressed however is whether adaptation activities will require new and additional budget lines or if projects can be covered through existing budgets. To be sure if adaptation is incorporated into existing policies there is the possibility that new money will not be needed. On the other hand if the government wishes to invest in a wide array of new measures, including costly infrastructure projects, then new sources of funding will be needed. Funds could be created from an increase in public budgets or possibly leveraged from the private sector. For countries such as the Ukraine, there is also the possibility of funding from multilateral climate funds from the World Bank/GEF, or United Nations.

What follows below are a list of options for climate funding drawn from the most recent literature.

Taxes

The creation of new taxes or the increase in various tax rates are by far the most straightforward way of increasing government revenues from the local to the nation level. Unfortunately, while taxes are effective they are not always feasible given popular resistance.

Taxes on the emissions of carbon dioxide from industry, use of bunker fuels (aviation, shipping), private use of petrol and energy consumption follow the polluter pays principle. Such taxes not only work towards increasing revenues but can also stimulate behavioral change working towards decreased CO_2 emissions. Taxes can also be levied on financial transactions. One interesting approach that can be taken at the local or regional level, as outlined by the Local Governments for Sustainability organization (ICLEI 2011), is the innovative use of value capture instruments or tax-increment financing mechanisms to create funds for the refurbishment of urban infrastructure. For the Swedish another taxation approach is to increase levies on industries that my benefit from climate change such as agriculture or hydropower companies.

Insurance and bonds

While insurance companies can play an instrumental role in encouraging adaptation (as detailed above) they may also play a role in developing new lines of funding for adaptation measures. In general private insurance companies do not reinvest their profits for adaptation; however, via partnerships with government they may be persuaded do so as increased investments in risk reduction measures may in the long term reduce the size of future insurance claims. Catastrophe bonds are already being used as a means of spreading out the risk to extreme events; additionally, proceeds from such bonds could also be used as a means of supporting adaptation measures. Similarly the creation of social impact bonds schemes could be used for investments into adaptation pro-

jects as well as other forms of public debt instruments (ICLEI 2011; Ecofys 2011)

Securitization and structured finance

Another option for adaptation financing detailed by Local Governments for Sustainability organization is the creation of structured financial instruments. As they state:

"idea is that similar investment instruments, such as mortgage loans, automobile loans, or credit card debt, can be structured into large portfolios in order to generate immediate revenues from long-term revenue streams as well as to diversify risks. For example, when a bank originates a mortgage loan it secures a stream of revenues for the term of the loan. If the bank would like to gain more rapid access to that revenue stream it might transfer the ownership of the loan to a third party in exchange for part of the long-term revenue stream (ICLEI 2011:42).

Appropriate water pricing

More often than not the price for water, especially for industries, is far too low. Developing appropriate pricing structures for all sectors of water users could be an option to increase revenues for adaptation activities (OECD 2008).

Payment for environmental/ecological services (PES)

A policy that could be instrumental in raising funds for adaptation actions as well as protecting and conserving natural areas is payment for environmental services (PES). In principle PES attempts to address the issue of environmental externalities by having beneficiaries of ecological/environmental services pay for the benefits they reap based upon the damages they incur to others as a result of their use. For example, farmers upstream from coastal river deltas who pollute the delta with fertilizers or pesticides should compensate downstream users of the delta for the environmental degradation (OECD 2011).

Multilateral funds

The following multilateral funds could also potentially be used to raise adaptation financing.

- Global Environmental Facility (GEF) Small Grants Programme;
- Global Environmental Facility (GEF) Special Climate Change Fund;
- Intangible Cultural Heritage Fund - This UNESCO led fund helps protect "intangible cultural heritage" sites. While not directly related to climate change it can be used to preserve coastlines and coastal areas;
- International Assistance Funds under World Heritage Convention - While not directly related to climate change the World Heritage Convention of 1972 offers funds to Parties of the Convention conserve sites deemed as UN world heritage sites. Coastlines and coastal areas can qualify for world heritage status and thus be eligible for funds

7. CONCLUDING REMARKS

Adapting to climate change will not be easy; it involves developing new institution, new policies, new monies, and most of all new pathways of thinking. Nevertheless, immediate investments into these challenges will have long term benefits. This report has attempted to highlight some of the main tasks that could be undertaken if a country is to embark on effecting adaptation. It has provided where possible, concrete examples of what other countries are currently doing, or recommendations of what could be done. What this report has not done is delve into specific details of how to achieve the actions listed. For that it is recommended to consult the references and websites cited. Solid and successful adaptation is founded on political will, sound scientific research and assessments as well as a diverse policy portfolio. Climate change will impact all sectors of society, some more than others, some for the better and some for the worse, as a result all societal actors have a role to play in adaptation; however, it is up to national, regional and local governments to take the lead.

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