POLICY ISSUES RELATED TO CLIMATE CHANGE IN SPAIN

Ana Iglesias

Abstract. This paper aims to provide an understanding of the potential implications of climate change relevant to policy development in the European Union and in Spain. First, the paper introduces the need to develop climate change adaptation policy. Second the paper assesses the risks of climate change to water resources providing concrete examples from Spain. Third, the paper explores the challenges and opportunities for developing adaptation policy options aiming to reduce the social vulnerability to the projected impacts of climate change. Fourth, the paper evaluates how current policy instruments – especially agricultural and water resources policies – work towards adaptation, and potential options for integrating adaptation into them. Finally, the paper draws on the results presented in the previous sections to suggest some policy implications related to climate change and water resources elsewhere.

Terms for indexing purposes: climate change, agriculture, irrigation, water resources, water management, adaptation, mitigation, impacts, risk, vulnerability, policy, policy adaptation, sustainable development, National adaptation strategies, European Union, Spain, Common Agricultural Policy, Water Framework Directive, research.

Author bio. Ana Iglesias is a Professor of Agricultural Economics at the Universidad Politécnica de Madrid. Her research focuses in understanding the relevant society strategies for adaptation to drought and climate change. She has contributed to the research programmes of UNEP, UNESCO, USAID, USEPA, and the EU. She leads the development of Drought Management Guidelines within the MEDA program of the EU. Her collaborative work has been published in over one hundred research papers.

1 Introduction

1.1 The reality of climate change

Climate change is already happening. The Fourth Assessment Report of the Intergovernmental Pannel on Climate Change (IPCC, 2007) clearly shows that the climatic variations over recent decades have had noticeable direct consequences in natural ecosystems, glaciers and agricultural systems in many regions. Many areas of the world are already struggling today with the adverse impacts of an increase in global average temperature. The scientific literature also suggests that observed changes in climate have affected the frequency and intensity of extremes (drought, floods, and heat waves). The alarming number of extreme weather events that have occurred during the last five years may be the consequence of climate change and suggest that climate change is resulting in the increase in natural climate disasters, at least in some regions. The IPCC defines climate change as a statistically significant variation in the state variables that define the climate of a region (such as temperature or precipitation) or in its variability persistent over an extended period of time (typically decades or longer periods).

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC, 1992) imposed certain reductions of greenhouse gases (GHGs) production on ratifying countries, since this accumulation of GHGs in the atmosphere was found to increase global temperatures and changes the climate (IPCCC, 2007). Two main policy interventions have been identified for combating climate change—mitigation and adaptation. According to the United Nations Framework Convention on Climate Change (UNFCCC, 1992), there is a clear difference between mitigation (reduction of greenhouse gas emissions and carbon sequestration) and adaptation (ways and means of reducing the impacts of, and vulnerability to, climate change). Until recently, UNFCCC negotiations have focused primarily on mitigation; however, it is now clear that objectives of human well-being in the future should be addressed, stressing the importance of adaptation. Regardless of international progress to reduce emissions of the greenhouse gases that cause climate change (mitigation policies), the climate system will continue to adjust for the next few decades to past and present emissions. This will bring unavoidable impacts on natural and human systems, presenting the challenge of a second response to climate change - adaptation - to prepare for and cope with these impacts.

In contrast to this clear understanding of the concepts of "climate change" and "mitigation", the concepts of impacts, vulnerability, risk and adaptation are not defined in either the United Nations Framework Convention on Climate Change (UNFCCC) or the Kyoto Protocol; the terms are used loosely by many scientific and policy communities and they also have a meaning in a common usage. It has been observed that interpretation of some of these key terms by scientific groups or policy makers can be quite different, which may lead to varied or false expectations and responses (OECD, 2006). Nevertheless, understanding and quantifying the adaptation responses to climate change is a key issue, since they are key determinants to the economic impacts to society. Stern et al. (2006) argues that "the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year. Although this has been challenged by many economists with large working experience in climate change (Tol, 2006) since it ignores and contradicts numerous unquestionable results (Nicholls and Tol, 2006; Nordhaus, 2006; Sachs, 2001; Fankhauser and Tol, 2005), the analysis in Stern et al., (2006) contributed to an open discussion about the cost that society is willing to undertake and therefore eliminating any doubt about the need to adapt in order to avoid unwanted damage.

1.2 Addressing the adaptation challenge

There is a general consensus about the unsustainability of the present model of development and about the need to reach a balance among equity, economic security and the environment. Climate change will likely affect people inside society creating or reinforcing new forms of social and economic discrimination. In particular, sustainable management of freshwater resources – especially focusing on the availability of safe drinking water – is one of the main challenges to our present social model of development.

The management of water resources needs to incorporate the principles of sustainable development in order to deal with the increasing pressure on freshwater resources. This pressure arises mainly from the following factors: (1) Population: Over the 20th century, population has tripled while water withdrawals have increased by a factor of about seven. (2) Pollution: The effects of industry and agriculture intensification have resulted in major pollution problems in many regions of the world; this is linked (together with scarcity) to degradation of aquatic ecosystems. (3) Governance: Poor governance as result of fragmented and uncoordinated management, top-down institutions and increased competition for the finite resource. (4) Climate change: The impacts of climate change in freshwater resources affect all sectors of society.

There is a high degree of social and scientific awareness about the potential impacts of climate change and the need to adapt water management to hotter and more extreme conditions. It is certain that the need for increased spending as a result of intensified damage caused by extreme weather events will lead to a loss of rural income and economic imbalances between the more and less prosperous parts of Europe and also to environmental damage. Nevertheless, adaptation policies, strategies and concrete measures are fragmented and uncoordinated in most cases. This is in part due to the diverse perception and value that different society groups place on the issue of climate change and in part due to the difficulty in evaluating potential cost of inaction.

Societies have shown, throughout history, a great ability to adapt to changing conditions, with or without a conscious response by citizens and government (Mendelsohn *et al.*, 2004). However, it is likely that the changes imposed by climate change in the future will exceed the limits of autonomous-endogenous adaptation, and that policies will be required to support and enable different sectors of society to cope with similar changes.

The European Commission has recently adopted a Green Paper entitled 'Adapting to climate change in Europe – options for EU action' (COM(2007) 354, 2007). This sets out options to help the adaptation process and focuses on four priority areas, including early action to avoid damage and reduce overall costs. Adaptation efforts may have to be stepped up at all levels and in all sectors, and may benefit from coordination across the EU. The Commission will publish a White Paper containing more concrete policy proposals in 2008.

The present paper aims to provide an understanding of the potential implications of climate change relevant to policy development in the European Union leading to formulate measures to reduce the vulnerability of the water sector to climate change. In the following section the paper assesses the risks of climate change to water resources providing concrete examples from Spain. In Section 3, the paper explores the challenges and opportunities for developing adaptation policy options aiming to reduce the social vulnerability to the projected impacts of climate change. In Section 4, the paper evaluates how current policy instruments – especially agricultural and water resources policies – work towards adaptation, and potential options for integrating adaptation into them. Finally, in the conclusion and policy implication section the paper draws on the results presented in the previous sections to suggest some policy implications related to climate change and water resources elsewhere.

2 Climate change risk to water resources

2.1 The European context

There have been several thousand studies into the potential impacts of climate change on water resources, with many different approaches (e.g. physical modelling, econometric analysis) and definitions (e.g. impacts, vulnerability, risk, adaptation). Studies have focussed on particular issues (e.g. agricultural water pressure, ecosystem services), time-frames (e.g. 2020s, 2050s, and 2100), scenarios (e.g. IPCC SRES, 2001) and spatial scales (with a focus on national and global scales). Consequently, our knowledge of the potential impacts is diverse and fragmented. Nevertheless, the projected impacts pose challenges for many water-dependent activities and magnify the regional differences in Europe's natural resources and assets. Although there is a large variation in projected impacts in each EU region, overall the studies are consistent in the direction of change and spatial distribution of effects. In general in the northern areas, most sectors of the economy are benefited by climate change, providing that projected extremes do not become catastrophic events. However, these potential opportunities will only be possible if water requirements are met. In most of the central and southern areas of Europe water availability is projected to decrease under all scenarios considered. In addition, concurrent altered carbon and nitrogen cycles may have significant implications for soil erosion and water quality.

The effects of climate changes on major water management determinants and expected social and ecological consequences are summarised in Table 1. Most studies agree that climate change will likely have the following common consequences across Europe (EEA, 2007):

- Increase demand for agricultural water in all regions due to expected increases in crop evapotranspiration in response to increased temperatures in all regions. The potential for decreasing water demand due to the direct effects of CO2 on the crop have been challenged (Long *et al.*, 2006).
- Increased water shortages, particularly in the spring and summer months, therefore increasing the water requirement for irrigation, especially in southern and south-eastern Europe.
- Increased water quality deterioration due to higher water temperatures and lower levels of runoff in some regions, particularly in summer, imposing further stress in agricultural irrigated areas.

- Increased risk of flooding in winter due to the expected concentration of precipitation in this period, affecting significant areas in Europe. The major flood events experienced in recent years (notably 2002 and 2007) demonstrate Europe's vulnerability to floods. In addition, the projected increases in sea level will also affect flooding in the low-lying coastal areas.

<TABLE 1 NEAR HERE>

2.2 The Mediterranean region

Changes in precipitation are probably the most important factor determining the likely impacts in the Mediterranean region. Despite forecasts of increased total annual precipitation in some regions, evapotranspiration is expected to increase in response to increased temperatures. Significant increased temporal and spatial variability of extreme weather is expected, increasing flooding and drought frequency leading to competition for water. Sea level rise will inundate coastal areas; rising sea levels may also lead to salination of the water supply and soil. A decrease in water availability is predicted together with an increase in water demand, leading to potential conflict between users. Decreasing water resources in some areas may affect soil structure while reduced soil drainage may lead to increased salinity. However, an increase in frequency and intensity of floods is predicted in some areas where significant winter rainfall is likely. These changes are expected to reduce the diversity of Mediterranean species. In the Mediterranean region, irrigation accounts for over sixty percent of the pressure on water resources. Box 1 provides and example of the potential impacts of climate change on irrigation in this region based on a number of studies.

<BOX 1 NEAR HERE>

2.3 Spain

In Spain, the structural water deficit of many areas in the country has been aggravated during the drought episodes of the past fifty years (Iglesias et al., 2008a; Iglesias and Moneo 2005). Past efforts to manage drought have built capacity to deal with extreme situations, but have failed to

solve the conflict among users, especially with the environment (Iglesias and Moneo, 2005; Iglesias et al., 2008b). Climate change projections indicate an increased likelihood of droughts. Variability of precipitation – in time, space, and intensity -- can directly influence water resources availability. The combination of long-term change (e.g., warmer average temperatures and possibly lower precipitation) and greater extremes (e.g., droughts) can have decisive impacts on water demand, limiting further ecosystem services. If climate change intensifies drought impacts, Spanish water delivery systems and control may become increasingly unstable and vulnerable. Water managers may find planning more difficult. Current water management strategies based on changes in mean climate variables should be revised to account for the potential increase in anomalous events.

In Spain climate change projections indicate a decrease of precipitation in the southern regions, in some cases up to -40%, by the 2050s compared to 1961-1990 levels, or a small increase in precipitation in the northern regions, with changes in the annual precipitation patterns. In all cases, temperature increases of about 1.5ºC are expected, and thereby increased evaporation and reduced soil moisture, resulting in more adverse regional climate conditions than presently experienced. Climate and hydrological experts begin to be aware of the implication of future water availability in the region (Iglesias 2002; Iglesias et al. 2002; 2007b; 2008a; Hisdal et al. 2001; Lloyd-Hughes and Saunders, 2002).

Although projected implications of changes in the climate variables depend on the scenario, the time-frame, and social pressure on water resources, and the method of analysis, most studies agree that there is a likely decrease in water resource availability and increase in water pressure, especially from agriculture (Garrote et al. 1999; Iglesias et al., 2007b; 2008a; among many others). Figure 1 shows that under climate change, reservoir water inflow and water resources availability decrease -7 and -5 %, respectively, on average in all Spanish basins considering a range of climate change scenarios in the middle of the 21st century. These results are clearly scenario dependent and may be optimistic. By 2100 the projections may be clearly more negative. The Four Assessment Report of the IPCC (IPCC, 2007) states that the reduction of precipitations in Spain may be over 20% by 2100 under the scenario of high population increase and high economic growth (SRES A1B). Under these conditions, many watersheds in the southern half of Spain (but also the right hand side effluents in the Ebro basin) will reduce flow by 40%. In contrast, irrigation demand increases in all locations under the several climate change scenarios.

The results indicate increases of water demand and reductions of water supplies that surely will affect ecosystem sustainability, implying substantial future changes in water management. Water resources systems will have to adapt to the evolution of climate. If projections become a reality, water scarcity is expected to rise in the next decades posing additional problems to water managers and users.

<FIGURE 1 NEAR HERE>

3 Adaptation policy context

3.1 Defining adaptation

Adaptation is about preparing people and their assets for the impacts of climate change. It is concerned with minimising adverse effects, or maximising new opportunities, through taking actions which either anticipate or react to changing climatic conditions. The focus of these actions is on managing risk. Investments in risk-based actions are fundamental to reducing the environmental, social and economic costs of climate change.

The need for adaptation policy stems from the overwhelming scientific consensus that climate change is a significant threat to face the world, its people, environment and economy. Strong mitigation measures are essential to make deep cuts in the greenhouse gas emissions that cause climate change, to avoid dangerous climate change and unprecedented environmental, social and economic disruption. However, as a consequence of present and past emissions of greenhouse gases and the inertia of the climate system, we are already committed to several decades of climate change that cannot now be avoided. Adaptation to cope with the impacts of unavoidable climate change is therefore also necessary as a complementary action to efforts to reduce emissions. In its Fourth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC, 2007) recognises that some adaptation action is occurring, but on a very limited basis, and affirms the need for extensive adaptation across nations and across sectors to address impacts and reduce vulnerability.

Various types of adaptation can be distinguished. Recent studies have highlighted the distinction between “autonomous adaptation” and “policy-driven adaptation”. Autonomous

adaptation describes actions "taken 'naturally' by private actors, such as individuals, households, businesses in response to actual or expected climate change, without the active intervention of policy. Autonomous/endogenous adaptations are taken naturally but their extent, direction and effectiveness are a function of existing conditions, infrastructure and technologies, that are in turn a result of existing policies, not necessarily intended for adaptation. In contrast, policy driven adaptation is "the result of a deliberate policy decision". Policy-driven adaptation is therefore associated with public agencies, either in that they set policies to encourage and inform adaptation or they take direct action themselves, such as public investment (Stern, 2006). Planned policy adaptation actions focus on the vulnerability reduction of people and societies.

Adaptation strategies are put in place to deliver adaptations. An adaptation strategy is a broad plan of action that is implemented through policies and measures. Adaptation strategies are not only reactions to posed threats of climate change, but can comprise at the same time a large number of technical, social, economic and environmental challenges (Iglesias et al., 2007a; 2007c; Olesen and Bindi, 2002).

3.2 Integrating climate and sustainable development

The capacity to adapt to environmental change is implicit in the concept of sustainable development. Climate change will add to the many economic and social challenges already being faced by European sustainable development, increasing the vulnerability of marginal areas and populations. Climate change is a real concern for sustainable policy development, raising major issues about the adequacy of current water and land resource management, both globally and within the European Union. The unavoidable impacts of climate change put current activities, certainly at the level of individual land and water managers, at significant risk, therefore making imperative the development of both private and public adaptation strategies. These strategies must evolve taking into account the overall strategy for development in the European Union.

The EU Gothenburg Sustainable Development Strategy (SDS, 2001) is the point of reference regarding the interpretation and use of the concept of sustainable development in Europe. The strategy involves a set of principles and processes for strategic planning and sustainable development, as well as a coordinated set of measures to ensure their implementation. The EU sustainable development strategy sets out a broad vision of what is sustainable (including environmental, social and economic dimensions) but does not provide an operational definition of sustainable development. It focuses on six non-sustainable trends, including global warming. The

SDS is often considered an add-on to the Lisbon Strategy (2001) that focuses on the economic and social dimensions of development. The SDS adds the environmental dimension and the long-term perspective (rights to future generations). Progress on the implementation of these two strategies is achieved formal and informally (Spring reports, by using the European Environment Agency EEA indicators, and independent academic revisions that constitute the basis of institutional revisions such as those of the OECD).

Over a decade ago, most countries joined an international treaty -- the United Nations Framework Convention on Climate Change (UNFCCC) -- to begin considering what can be done to reduce global warming and to cope with whatever temperature increases are inevitable given that climate change is already happening (IPCC, 2007). Recently, a number of nations have approved an addition to the treaty: the Kyoto Protocol, which is an international and legally binding agreement to reduce greenhouse gases emissions world wide (entered into force on 16 February 2005).

The Earth Summit in Rio (1992) ensured that the sustainable development strategy became a goal for governments around the world, by signing the Agenda for the 21st Century. This Agenda (Agenda 21) recognizes that broad public participation in decision-making is one of the fundamental prerequisites for the achievement of SD. Agenda 21 was one of the first initiatives relating to sustainable development and climate change, establishing actions and actors identified to implement strategies on poverty alleviation, provision of basic education and public services, environmental protection and components of sustainable development that have links with addressing climate change such as rational use of energy and promotion of ecologically sound technologies.

The UN programme on sustainable development Agenda 21 (1992) calls on countries to adopt national strategies for sustainable development (NSDS) that should build upon and harmonize the various sectoral economic, social and environmental policies and plans that are operating in the country. In 2002, the World Summit for Sustainable Development (WSSD) urged States to make progress in the elaboration of national strategies for sustainable development and to begin their implementation. To this moment, governments have continued to reiterate their commitment to develop and implement NSDS at subsequent UN Commissions for Sustainable Development (CSD) sessions. The UN also provides Guidelines for national

reporting. To this moment twenty six Countries (including Spain) and the European Commission have submitted SD strategies (National Reports for CSD-16/17, December 2007).

Adaptation to climate change is an essential step towards the process of sustainable development, but the policy priorities for adaptation of climate change in the different social sectors are often fragmented, unformulated, and contradictory. The EEA provides a clear excellent example of clear definition of policy priorities and adaptation strategies in relation to adaptation in the water sector (EEA, 2007). The policy priorities include: (a) reduce the vulnerability of people and societies; (b) protect and restore the ecosystems; and (c) close the gap between supply and demand. The adaptation strategies include: (a) sharing the loss; (b) preventing the effect; and (c) research and education. The EEA recognises the value of high quality information in order to formulate concrete strategies and the role of regulatory and institutional actions. Missing components of all current strategies are: (a) the lack of guidance related to responsibilities for implementing the strategies and actions; and (b) the lack of a protocol for policy evaluation.

Climate change policy is a specific policy that needs to be coordinated with the EU and national sustainable development strategy process. Climate change and sustainable development policies should be mutually enforcing, but this challenge has not been fully addressed.

3.3 European climate change policy

Adaptation is not an alternative, but a necessary complement to mitigation; this is because the climate system responds only slowly to changes in the amounts of greenhouse gases in the atmosphere. Climate changes over the next 40 years or so are inevitable as a consequence of present and past emissions. In recognition of this, the European Commission has adopted a Green Paper entitled ‘Adapting to climate change in Europe – options for EU action’ (COM, 2007) 354, 2007). This sets out options to help the adaptation process and focuses on four priority areas, including early action to avoid damage and reduce overall costs. Adaptation efforts need to be stepped up at all levels and in all sectors, and need to be coordinated across the EU.

The Green paper first evaluates the current knowledge on impacts of climate change including explicitly the results of the Peseta study (PESETA, 2008; Iglesias et al, 2007c). Second, the Green Paper analyses the challenges to adaptation for European society and European public policy. These challenges include: taking early action and saving on future costs; timing

adaptation measures; pathways to adaptation; the role of Member States, regional and local authorities; and the actions at the EU level. The third is the main contribution of the Green paper focussing on EU action and proposes priority options for a flexible four-pronged approach to adaptation (Table 2):

- The first pillar: Early action in the EU. The early action covers policy options in the following areas: integration of adaptation when implementing and modifying existing and forthcoming legislation and policies; integration of adaptation into existing Community funding programmes; and develop new policy responses.
- The second pillar: Integrating adaptation into EU external actions. This pillar refers to the climate change impacts and adaptation needs that would influence the relations of the EU with other countries and is based on an enhanced dialogue between the EU and developing countries, and also includes neighbouring countries and industrialised countries.
- The third pillar: Reducing uncertainty by expanding the knowledge base though integrated climate research. This research-based pillar focuses on the understanding of complex interactions among the climate system, environment, economic sectors and society. The process on understanding includes co-operation and networking, support to practitioners, and improved information and communication technologies.
- The fourth pillar: Involving European society, business and public sector in the preparation of coordinated and comprehensive adaptation strategies. This pillar focuses on providing guidance to society on how to make the necessary changes to adapt to climate change.

<TABLE 2 NEAR HERE>

3.4 The National climate change adaptation frameworks

Many Member States have carried out assessments of climate change impacts, including within the agriculture sector, but progress on implementing adaptation actions has been slow, due in part to the long-term nature of climate change effects or respective perceptions by policy makers and the sector alongside the complexity of the information required for decision-making and in part to the number of stakeholders involved. The focus of much of the effort made to date has been on

management of flood risk, since is the main problem in northern European countries. Immediate attention has focused on raising awareness and research activities, and these roles are often facilitated and complemented by organisations that are outside national governments, such as universities or trade and professional bodies (for example, the National Farmers' Union in the UK). National policies on adaptation in agriculture have not yet been clearly articulated.

The National adaptation strategies are currently being developed. A complete review is included in the CIRCLE project (Climate Impact Research Coordination for a Larger Europe) report on the current state of National Research Programmes on Climate Change Impacts and Adaptation in Europe (15 May 2007) (CIRCLE, 2007; Medri et al., 2007) and summarises in the Adaptation report to DG Agri (Iglesias et al., 2007a).

Table 3 summarises the broad range of adaptation actions that have been designed/planned at different governmental levels and in various sectors. From these efforts, both theoretical and practical knowledge has resulted in a wide range of possible options to adapt to projected climate changes impacts. The review of national adaptation strategies highlights the current policy focus on reducing the risk of flooding, either from sea level rise or from increased rainfall. There are also proposals, mainly from southern Member States, to increase capture and storage of water to ensure adequate supplies. As precipitation patterns change, their limited capacity for water storage may need to be increased to capture a greater proportion of winter rainfall than is currently the case.

<TABLE 3 NEAR HERE>

Since it is not possible to review all strategies, this section of the paper summarises the strategies adopted by Finland – as an example of thoroughly developed strategy -- and the strategy in preparation by the UK that builds from the recognised experience of the various programmes operating the in the country. Finland's Adaptation Strategy is part of the National Energy and Climate Strategy that was forwarded to the Parliament in November 2005. Its objective is to reinforce and increase the capacity of society to adapt to climate change. Adaptation may involve minimising the adverse impacts of climate change, or taking advantage of its benefits. While the National Energy and Climate Strategy focus on mitigation measures to

be taken in the near future, the scope of the Adaptation Strategy extends as far as 2080. The Adaptation Strategy gives a detailed account of the expected impacts of climate change and presents adaptation measures to be taken in sectors including agriculture and food production, forestry, fisheries, reindeer husbandry, game management, water resources, biodiversity, industry, energy, transport and communication, land use and planning, building, health, tourism and recreation, and insurance. Priorities identified for increasing adaptation capacities for the next 5 to 10 years include: (i) mainstreaming climate change impacts and adaptation into sectoral policies; (ii) targeting long-term investments; (iii) coping with extreme weather events; (iv) improving monitoring systems; (v) strengthening research and development; and (vi) international cooperation. The research programme on adaptation was initiated in 2006. The National Strategy also identified sector-specific adaptation measures as important priorities for 2006 - 2015.

Action to prepare the UK for climate change has already begun. A climate change perspective is incorporated into many areas of Government policy, including flood management, water resources, planning, building regulations, health, agriculture and international development. Government funds the UK Climate Impacts Programme (UKCIP, www.ukcip.org.uk) to improve the knowledge base on climate impacts and to assist stakeholders (including those in the agriculture sector) to adapt. The UK's first Adaptation Policy Framework is under development, driven by the Department for Environment Food and Rural Affairs (Defra, 2007). The recognized key priorities for adaptation for the UK over the next 30 to 50 years are described in the UK Climate Impacts Programme (UKCIP, 2008; http://www.ukcip.org.uk/): water resource management; coastal and river flood defence; enhanced resilience of buildings and infrastructure; management of wildlife, forestry and agriculture; and co-ordinated approaches to planning.

3.5 The National climate change adaptation frameworks in Spain

There is a high degree of social and scientific awareness of the need to adapt water management to hotter and more extreme conditions. In the Mediterranean region, more adaptation measures have been adopted or are under consideration here than in the other agro-climatic zones; this is consistent with the expectation that the region will be worst affected by climate change. Although climate change is a global issue, the National adaptation plans are extremely varied from the strategic point of view, reflecting – in part – past and present efforts placed into the understanding of the issues at stake.

In Spain, the Climate Change National Adaptation Plan, formally adopted by the Ministerial cabinet on 6 November 2006, is a reference framework for the coordination of public administrations in relation to the evaluation of impacts, vulnerability and adaptation to climate change in Spain. The Plan is based on knowledge development, public participation and information dissemination. The knowledge strategy ranges from the scenario development to sectoral impact evaluations. The adaptation component is not explicitly addressed. The plan establishes a complex institutional structure based in the Ministry of the Environment and coordinated by the Spanish National Office for Climate change that coordinates the Inter-ministerial Commission, the Coordination Commission for Climate Change Policies and the National Council for Climate.

4 Potential role of the current policy instruments in adaptation in the European Union

4.1 Energy and climate package

Energy is the main factor in climate change, accounting for some 80% of EU's greenhouse gas emissions. On 10 January 2007 the Commission adopted an Energy and Climate package to guide the EU towards a sustainable, competitive and secure energy policy. One of its central themes is to tackle the energy challenge by first making an effort to use energy more efficiently before looking into possible alternatives. The ambitious energy policy package proposes to pursue the objective of a sustainable, competitive and secure supply of energy.

The EU Action Plan is needed to help the EU achieve its energy goals. The European Commission has drawn up such a plan using the many contributions gathered from public consultations. The plan is comprised of several clearly defined aims which, together, will shift the EU decisively towards a more sustainable, secure and competitive low-energy economy, representing the core of a new Common European Energy Policy building on the European Strategic Energy Technology Plan (SET-PLAN) 'Towards a low carbon future' (COM(2007) 723 final, 2007).

4.2 Common Agricultural Policy

European agricultural policy faces some serious challenges in the coming decades – even without climate change. The most striking of these are loss of comparative advantage in relation to international growers, competition for international markets, declining rural populations, land deterioration (including salination), competition for water resources, and rising costs due to environmental protection policies. Demographic changes are altering vulnerability to water shortages and agricultural production in many areas, with potentially serious consequences at local and regional levels. Population and land-use dynamics, and the overall policies for environmental protection, agriculture, and water resources management, are the key drivers for possible adaptation options to climate change.

The Common Agricultural Policy (CAP) plays an important role in the areas of food production, the mainstreaming rural landscapes, and the provision of environmental services. Adjustments to the Common Agricultural Policy in the 'Health Check' of 2008 provide opportunities to examine how to integrate climate change adaptation – and mitigation – into agriculture support programmes. Consideration might be given to the extent to which the CAP can promote good farming practices that are compatible with changing climatic conditions and which contribute to protecting the environment.

The 2003 reforms of the CAP were a first step towards a framework for the sustainable development of EU agriculture. The central objective of the reforms was to promote an agricultural sector that was competitive and responsive to the market. This was founded on the principles of high standards for the environment. Decoupling brought about greater market responsiveness, whereas higher standards were achieved through cross compliance. The future direction of the CAP is clearly building on the 2003 reforms, with a continued shift from market intervention and further decoupling. Importantly however, the CAP needs to address the challenge of climate change in order to facilitate adaptation to risks and opportunities. Here overall rules for farm support, Rural Development policy and crisis management will play important roles in increasing agriculture's resilience to climate change impacts.

While the Common Agricultural Policy (CAP), currently does not contain measures aimed explicitly at adaptation, there are already opportunities to support and facilitate adaptation (such as through rural development policy, below). Since the 2003 CAP reform, which introduced the

Single Payment Scheme and decoupled direct payments from production, farmers have greater flexibility to respond to climate change.

Climate change objectives have been integrated into the framework of rural development policy for the period 2007-13 and adaptation is now recognised as one of the priorities for the EU. Member States are encouraged to incorporate climate change actions in their national strategy plans and Rural Development programmes. The Community Strategic Guidelines for Rural Development identify climate change as a priority for the environment and countryside (Axis 2), and recognise that agricultural and forestry practices have a role to play in adapting to the impacts of climate change. Climate change risk and adaptation is also a consideration in rural competitiveness (Axis 1), and diversification and rural life (Axis 3). DG Agriculture is also looking at options for management of climate change risks and tools to aid adaptation.

As the governing policy instrument for this sector, adjustments to the CAP could provide opportunities for integrating adaptation into agricultural support measures. Consideration might be given to the extent to which the current CAP framework promotes farming practices that are compatible with changing climatic conditions and which contribute to protecting the environment. Thought also needs to be given to the longer-term structural adaptations that will be required, including changes to existing farming and land-use systems, breeding to maximize yield under new conditions, and application of new technologies such as water-use efficiency techniques.

The contribution of current CAP measures towards adaptation was evaluated in a recent study (Iglesias *et al.* 2007a) in order to consider how existing policy instruments may be continued or extended to facilitate adaptation. The analysis also aimed to reveal where policies may present a barrier to adaptation or lead to 'mal-adaptation'. The strengths and weaknesses of existing CAP instruments to influence adaptation are analysed -- covering both direct income support payments and Rural Development measures. Consideration of related legislation was also included where appropriate and the measures were grouped according to the type of adaptation option they would best support – technical management, or infrastructure. The main conclusions of the Iglesias *et al.* (2007a) study are:

- The Rural Development Programmes have the potential to benefit further by guiding or placing an obligation on member states to meet or consider the impacts of future climate change.

- Agri-environment schemes have the potential to support many adaptation initiatives.
- To ensure investments made through CAP bring benefits in terms of adaptation, linking funding to cross compliance should be explored.
- Mitigation to climate change is explicitly mentioned throughout the Rural Development regulations. This could be expanded to include adaptation.
- Adjusting the criteria for those eligible for rural development support for areas with high vulnerability to climate change may be an option to facilitate their adaptation.
- Adaptation to climate change will be needed at all spatial levels. The Rural Development measures can do this through careful co-ordination from the grassroots Leader programme all the way up to integration with river basins through the Water Framework Directive.

Supplementing current Statutory Management Requirements with new legislation that addresses climate-related impacts would create stronger incentives for Single Payment Scheme claimants to adapt. The flexibility that Member States can exercise in determining Good Agricultural and Environmental Condition (GAEC) standards allows for highly appropriate and localised management practices that assist with adaptation. The potential of GAEC's would be maximised by requiring member states to identify major environmental pressures, which may include climate impacts, and justify the inclusion or exclusion of corresponding standards. Member States should be required to make provision for training farmers on climate change issues, particularly new entrants such as young farmers. Developing the role and scope of the Farm Advisory System would be a feasible option for effective knowledge transfer. In addition to existing CAP instruments, insurance needs to be considered and encouraged to allow farmers to increase their resilience to climate change. This may provide further incentives for farmers to adapt their business and buildings in order to reduce their premiums.

4.3 Water Framework Directive

The EU Water Framework Directive (WFD) sets out clear output targets for each of the requirements and includes a concrete timetable (Table 5). Some aspects of the implementation are very clear; e.g., the Directive recognized the importance of leveraging a mix of policy initiatives and established a target for the introduction of pricing policies by 2010. The effectiveness of the pricing policies may be limited, especially in areas with large groundwater withdrawals for irrigation. The WFD provides a consistent framework for integrated water resources

management, but does not include climate change directly. The challenge will be to incorporate the measures to cope with climate change as part of its implementation, stating the first cycle for 2009 (See Table 5).

In many regions of Europe, inconsistent land-use planning, incorrect water allocation, and inadequate water pricing and automatically leads to overuse. Making water saving a priority, improving efficiency in all sectors, and applying efficient pricing policies, are already included in the WFD and are essential elements for climate change adaptation. The initial first steps for the implementation of the WFD could provide incentives to reduce water consumption and increase efficiency of use in all sectors.

<TABLE 4 NEAR HERE>

4.4 Floods Directive

The recent EU Floods Directive 2007/60/EC on the assessment and management of flood risks entered into force on 26 November 2007 (Floods Directive, 2007). This Directive now requires Member States to assess if all water courses and coast lines are at risk from flooding, to map the flood extent and assets and humans at risk in these areas and to take adequate and coordinated measures to reduce this flood risk. With this Directive also reinforces the rights of the public to access this information and to have a say in the planning process. The Directive shall be carried out in coordination with the Water Framework Directive, notably by flood risk management plans and river basin management plans being coordinated, and through coordination of the public participation procedures in the preparation of these plans. All assessments, maps and plans prepared shall be made available to the public.

4.5 Initiative on drought and water scarcity

The Communication from the Commission to the European Parliament and the Council addressing the challenge of water scarcity and drought in the European Union (COM(2007) 414 final, 28 July 2007) is closely linked to climate change and adaptation. The Communication “presents and initial set of policy options at European, national and regional levels to address and mitigate the challenge posed by water scarcity and drought within the Union”. “The Commission

remains fully committed to continuing to address the issues at international level, in particular thought the United Nations Convention to Combat Desertification and the United Nations Convention on Climate Change".

4.6 Indicators for evaluating climate change policy

As reported in the previous section, climate change policy is likely to be fragmented and included in many European and National strategies. This framework complicates the evaluation of the policy and therefore limits the capacity of society for revising and improving the policy. The Commission developed a set of indicators to monitor the implementation of the EU SD strategy. The framework for indicators designed by the Commission is based on themes (12) and sub-themes (45) and area (98) directly linked to the EU policy priorities. This framework intends to provide with a clear and easily communicable structure for the SD strategy.

The Eurostat (2005) headline indicators for the 10 themes: economic development (GDP per capita); poverty and social exclusion (at risk-of-poverty rate after social transfers); ageing society (current and projected old age dependency ratio); public health (Healthy life years at birth by gender); climate change and energy (Total greenhouse gas emissions; Gross inland energy consumption by fuel); production and consumption patterns (Total material consumption); management of natural resources (Biodiversity index; Fish catches outside safe biological limits); transport (Vehicle transport); good governance (Level of citizens' confidence in EU institutions); and global partnership (Official development assistance). Some of these indicators are already useful to evaluate climate change policy, but others – especially related to social vulnerability – have to be further developed.

4.7 The 7th Framework Programme

On 18 December 2006, the Council adopted decisions establishing the Seventh Framework Programme of the European Community (EC) for research and technological development for the period 2007 to 2013, and the FP7 for nuclear research activities (Euratom) for 2007 to 2011. The atmospheric sciences, land use, and water resources research in the 7th Framework Programme is more locally orientated and more focused on climate change (European Union research policy, 2008).

5 Conclusion and policy implications

5.1 Vulnerability of water resources in Spain

Water resources in Spain are increasingly unstable and vulnerable, but climate change is only one of the determinants of their vulnerability. The issue is even more pertinent where 'at risk' regions and social groups are already economically marginal or at the edge of climate tolerance. To reduce the vulnerability of water resources to climate change across Spain and the EU, robust policy options or adaptation response strategies are required. The risks are not just long-term; in the short-term, extreme weather events could cause major damage and loss of ecosystems, especially in marginal areas. The proportion of rural population with limited water resources is highest in Spain and other southern regions of the EU – regions that are projected to face the greatest risks and have the fewest opportunities (from climate change). These regions are the most vulnerable. The northern regions, where water resources are less limited, rural and urban population may be at risk of increased flooding; these regions typically have integrated the flooding-control actions reasonably into the land and water resource management plans at the national level and have the potential to invest in adaptation. If climate changes continue to intensify, many southern European regions may become increasingly unstable and vulnerable to changing climate patterns and extreme events. European society may find planning more difficult.

5.2 Coordination between National and EU policy instruments

EU policies are main determinant of water, land and natural resource policy in Spain. Adaptation is unlikely to be facilitated through the introduction of new and separate policies at the National level, but rather by the revision of existing local policies that undermine adaptation and the strengthening of policies that enhance it. If adaptation is to become "mainstreamed", it will be necessary for relevant EU wide polices, such as the Common Agricultural Policy and the Water Framework Directive, to address the issue more directly. Existing agreements also have a part to play.

Existing policy instruments can be used to stimulate and facilitate adaptation and other mechanisms must also be utilised, such as insurance, capacity building, networks and partnerships. Adjustments to the Common Agricultural Policy (CAP) and the 'Health Check' of 2008 could provide opportunities to examine how to integrate adaptation into agriculture support

programmes. Consideration might be given to the extent to which the CAP can promote good farming practices that are compatible with changing climatic conditions.

Both the reformed CAP and Rural Development measures can assist in adapting European populations to climate change. This paper proposes that adaptation to climate change impacts in agriculture and related water management issues could be included within revised cross compliance requirements of the CAP. This will certainly modify the irrigation pattern of extensive crops. Nevertheless, the effects on largely degraded areas of fruits and vegetable production may not be accomplished. In this case, local policies may play an important role. It also proposes how options for rural development spending could include incentives for farmers and rural communities to adapt to climate change. These might include support for improved water management through the Water Framework Directive, and training and capacity building through the Farm Advisory Service and Leader.

To minimize the negative impacts of climate change and to take advantage of the potential benefits, adaptation efforts will need to be introduced at all levels and may need to be coordinated across the EU. The importance and benefits of community-wide adaptation were recognised when the European Commission published its first policy document 'Adapting to climate change in Europe – options for EU action' (COM(2007) 354, 2007). This Green Paper sets out options to facilitate the adaptation process and focuses on four priority areas, including early action to avoid damages and reduce overall costs. An emphasis is also placed on need for EU coordination.

5.3 Lessons learned form the climate change policy in Spain

The vulnerability of water resources to climate change in Spain is a main component of the dissemination campaign at the National and local levels. Climate change will have both negative and positive implications and it is important that communities are given the capacity to recognize, understand and act on these. Knowledge transfer between scientists, political decision makers and the people directly affected by climate change is currently weak, and existing information is poorly used. Nevertheless, Spain is making efforts at all levels to ensure communication and dissemination of climate change knowledge. Some difficulties challenging this knowledge transfer include: The number and range of stakeholders involved in adaptation; the inherent uncertainty in climate science and impacts projections -- uncertainty can lead to confused messages and inertia if it is not communicated in the right way; and the lack of credible socio-

economic scenarios required to improve climate change impacts and provide a framework for adaptation decision-making for practitioners.

Water managers in Spain have always carried out adaptive changes based on the weather and respond in the short-term by altering management practices. Nevertheless, national and sectoral polices and management actions in isolation offer limited opportunities for adaptation since large changes in management may require public-funded programs to help drive the changes.

The sectoral approach to impacts and adaptation has provided a pragmatic solution to a wide-ranging problem. However, adaptations often involve combined effort across many sectors. Water resources are sensitive to the responses in other sectors, particularly agriculture, tourism and biodiversity conservation. Adaptation measures for water resources should take account of policies in other sectors. Wider influences on water resources, such as changes in non-climate driven pressures, must be considered alongside climate change. It is important to consider whether adaptations are sustainable, or rendered irrelevant by other drivers. This holistic approach should also ensure that adaptation decisions and investments are both cost-effective and proportionate to the risks or benefits that may be incurred. The main challenge of climate change policy in Spain is a clear definition of poly priorities and responsibilities for implementing the strategic measures.

References

Bindi M, Fibbi L, Maselli F, Miglietta F (2000) Modelling climate change impacts on grapevine in Tuscany In: Downing, T E, Harrison, P A, Butterfield, R E, Lonsdale, K G (Eds), Climate Change, Climatic Variability and Agriculture in Europe Environmental Change Unit University of Oxford, UK, pp 191-216

CIRCLE (2007) (Climate Impact Research Coordination for a Larger Europe) http://www.circle-era.net/

COM(2003) 85 final (2003) EU Action Plan on Climate Change and Development (2003). Brussels, 11.3.2003. Communication from the Commission to the Council and the European Parliament "Climate change in the context of development cooperation"

COM(2004) 416 final (2004) European Environment and Health Action Plan (2004-2010). Brussels, 9.6.2004. Communication from the Commission to the Counci, the European Parliament, the European Economic and Social Committee, {SEC(2004) 729}

COM(2006) 302 final (2006) Communication from the Commission to the Council and the European Parliament on an EU Forest Action Plan. Commission of the European Communities Brussels, 15.6.2006

COM(2006)231 final (2006) Communication form the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions on a Thematic Strategy for Soil Protection. Commission of the European Communities Brussels, 22.9.2006

COM(2007) 354 (2007) Adapting to climate change in Europe – options for EU action. Brussels, 29 June 2007. Green paper from the Commission to the Council, the European Parliament, the European Social Committee and the Committee of the Regions.

COM(2007) 414 final (2007). Water scarcity and drought (2007) Communication from the Commission to the European Parliament and the Council addressing the challenge of water scarcity and drought in the European Union (COM(2007) 414 final, 28 July 2007)

COM(2007) 723 final (2007) Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. A European Strategic Energy Technology Plan (SET-PLAN) 'Towards a low carbon future' Brussels, 22.11.2007

CSD-16/17 (2007) Status of national reporting for CSD-16/17 December 2007 The third cycle of the UN Commission on Sustainable Development (CSD)

Defra (2007) Climate Change and biodiversity in agri-environment schemes (2007) Project AC0304. www.defra.gov.uk

EEA (2007) Climate change and water adaptation issues. EEA Technical Report No. 2/2007, 110 pp.

Energy and climate package (2008). On 23 January 2008 the European Commission put forth an integrated proposal for Climate Action. Available at: http://ec.europa.eu/energy/energy_policy/index_en.htm; last visited on March 2008.

Environmental Impact Assessment (EIA) Directive. EIA Directive (EU legislation) on Environmental Impact Assessment of the effects of projects on the environment was introduced in 1985 and was amended in 1997

European Union research policy (2008) The Seventh Framework Programme. http://ec.europa.eu/research/fp7/index_en.cfm

Eurostat (2005) Indicators for monitoring the EU Sustainable Development Strategy. http://ec.europa.eu/eurostat/sustainabledevelopment, Visited March 2008

Fankhauser S, Tol RSJ (2005) On Climate Change and Economic Growth. Resource and Energy Economics, 27, 1-17.

Floods Directive (2007). EU Directive 2007/60/EC on the assessment and management of flood risks published in the Official Journal on 6 November 2007; entered into force on 26 November 2007,

Garrote L, Rodríguez I, Estrada F (1999) Una evaluación de la capacidad de regulación de las cuencas de la España peninsular. VI Jornadas Españolas de Presas. Libro de Actas, Madrid, [An evaluation of the regulation capacity of continental Spain. Sixth Conference Spanish of Dams], 645-656.

GMES (Global monitoring for environment and security) http://www.gmes.info/

Hisdal H, Stahl K, Tallaksen LM, Demuth S, 2001, Have streamflow droughts in Europe become more severe or frequent? International Journal of Climatology 21(3): 317-333

Iglesias A (2002) Climate Changes in the Mediterranean: Physical aspects and effects on agriculture In: Bolle, H J (ed) Mediterranean Climate Springer New York, 372 pp.

Iglesias A (2003) Water availability for agriculture under climate change: understanding adaptation strategies in the Mediterranean. Pages 75-93 in Climate change in the Mediterranean, socio-economic perspectives of impacts, vulnerability and adaptation. Giupponi, C. and M. Shechter (eds). Edward Elgar, United Kingdom

Iglesias A, Rosenzweig C, Pereira D (2000) Agricultural impacts of climate in Spain: developing tools for a spatial analysis. Global Environmental Change, 10, 69-80.

Iglesias A, Ward MN, Menendez M, Rosenzweig C (2002) Water Availability for Agriculture Under Climate Change: Understanding Adaptation Strategies in the Mediterranean, pp 75–93. In Climate Change and the Mediterranean: Socioeconomic Perspectives of Impacts, Vulnerability and Adaptation. Edited by Giupponi, C. and M. Shechter. Edward Elgar Publishers, Cheltenham, United Kingdom, 318 pp.

Iglesias A, Moneo M (Eds) (2005) Drought preparedness and mitigation in the Mediterranean: Analysis of the Organizations and Institutions. Options Méditerranéenness, CIHEAM, Centre international de Hautes Etudes Agronomiques Méditerranéennes, Paris.

Iglesias A, Avis K, Benzie M, Fisher P, Harley M, Hodgson N, Horrocks L, Moneo M, Webb J (2007a) Adaptation to Climate Change in the Agricultural Sector. AGRI-2006-G4-05. Report to European Commission Directorate -General for Agriculture and Rural Development. ED05334. Issue Number 1. December 2007. AGRI/2006-G4-05

Iglesias A, Garote L, Flores F, Moneo M (2007b) Challenges to mange the risk of water scarcity and climate change in the Mediterranean. Water Resources Management, 21(5), 227-288.

Iglesias A, Garrote L, Moneo M, Quiroga S (2007c) Projection of economic impacts of climate change in sectors of Europe based on bottom-up analysis (PESETA), Lot 4: Agriculture, Physical Impacts on Agriculture, Universidad Politécnica de Madrid

Iglesias A, Cancelliere A, Cubillo F, Garrote L, Wilhite DA (2008a) Coping with drought risk in agriculture and water supply systems: Drought management and policy development in the Mediterranean. Springer, The Netherlands (in press)

Iglesias A, Moneo M, Garrote L, Flores F (2008b) Drought and water scarcity: current and future vulnerability and risk In: Garrido, A and M R Llamas, eds Issues in Water Resource Policy, Resources for the Future, Washington, DC (in press)

INSPIRE (Shared environment information system) (2007). Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

Integrated Coastal Zone Management (ICZM) Recommendation (2002). (2002/413/EC)

IPCC (2007) Climate Change 2007: Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

IPCC SRES (2001) Special Report on Emission Scenarios. Intergovernmental Pannel on Climate Change. (http://sres.ciesin.org).

Lisbon Strategy (2000). Lisbon European Council 23 and 24 March 2000.

Lloyd-Hughes B, Saunders MA (2002) Seasonal prediction of European spring precipitation from ENSO and local sea surface temperatures International Journal of Climatology, 22, 1-14

Long S, Ainsworth EA, Leakey ADB, Nösberger J, Ort DR (2006) Food for Thought: Lower-Than-Expected Crop Yield Stimulation with Rising CO2 Concentrations. Science 312: 1918-1921

Medri S, Castellari S, Konig M (Eds.) (2007) Report on the current state of National Research Programmes on Climate Change Impacts and Adaptation in Europe, CIRCLE (Climate Impact Research for a Larger Europe)

Mendelsohn R, Dinar A, Basist A, Kurukulasuriya P, Ajwad MI, Kogan F, Williams C (2004) Cross-sectional Analyses of Climate Change Impacts. World Bank Policy Research Working Paper 3350, Washington, DC.

Moriondo M, Bindi M, Giannakopoulos C, Corte Real J (2006) Impact of changes in climate extremes on winter and summer agricultural crops at the Mediterranean scale. Climater Research 31:85-95

National Reports for CSD-16/17 (2007) National reports to the UN Commissions for Sustainable Development. Available at: http://www.un.org/esa/sustdev/natlinfo/natlinfo.htm, visited March 2008

Nicholls RJ, Tol RSJ (2006) Impacts and responses to sea-level rise: A global analysis of the SRES scenarios over the 21st Century. Philosophical Transaction of the Royal Society A – Mathematical, Physical and Engineering Sciences, 361 (1841), 1073-1095

Nordhaus WD (2006) Geography and macroeconomics: New data and new findings. Proceedings of the National Academy of Science (www.pnas.org/cgi/doi/10.1073/pnas.0509842103)

OECD (2006) Organisation for Economic Co-operation and Development (2006) Levina E and Adapmas H. Domestic policy frameworks for adaptation to climate change in the water sector. OM/ENC/EPOC/IEA/SLT(2006)2, Paris.

Olensen JO, Bindi M (2002) Consequences of climate change for European agricultural productivity, land use and policy. European Journal of Agronomy, Vol. 16, 239–262.

PESETA (2008) (Projection of Economic impacts of climate change in Sectors of the European Union based on boTtom-up Analysis) (http://peseta.jrc.es)

Sachs (2001) Tropical Underdevelopment, Working Paper 8119, National Bureau of Economic Research, Cambridge.

SDS (2001) EU Gothenburg Sustainable Development Strategy. "A Sustainable Europe for a better world: A European Strategy for Sustainable Development"

Stern N, Peters S, Bakhshi V, Bowen A, Cameron C, Catovsky S, Crane D, Cruickshank S, Dietz S, Edmonson N, Garbett SL, Hamid L, Hoffman G, Ingram D, Jones B, Patmore N, Radcliffe H, Sathiyarajah R, Stock M, Taylor C, Vernon T, Wanjie H, Zenghelis D (2006) Stern Review: The Economics of Climate Change, HM Treasury, London.

Strategic Environmental Assessment (SEA) Directive (2001) European Directive 2001/42/EC (the SEA Directive) on the assessment of the effects of certain plans and programmes on the environment

Tol RSL (2006). The Stern review of the economics of climate change: A comment. Economic and Social Research Institute Hamburg, Vrije and Carnegie Mellon Universities November 2, 2006. http://www.fnu.zmaw.de/fileadmin/fnu-files/reports/sternreview.pdf

UKCIP (2008) UK Climate Impacts Programme http://www.ukcip.org.uk/

UNFCCC (1992) United Nations Framework Convection on Climate Change. FCCC/INFORMAL/84. GE.05-62220 (E) 200705

WFD (2000) Water Framework Directive, Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy (EU Water Framework Directive, WFD).

Table 1: Effects of climate changes on main water management determinants and expected social and ecological consequences

	Expected intensity of negative effects	**Potential consequences for agro-ecosystems and rural areas**	**Confidence level of the potential agricultural impact**
Water resources	Changes in hydrological regime. Differences in water needs. Increased water shortage.	Variations in hydrological regime. Decreased availability of water. Risks of water quality loss. Increased risk of soil salinisation. Conflicts among users. Groundwater abstraction, depletion and decrease in water quality.	High
Irrigation requirements	High in areas already vulnerable to water scarcity	Increased demand for irrigation Decreased yield of crops	High
Changes in water and soil salinity and erosion	High for southern countries.	Decrease in water quality from nutrient leaching. Decreased crop yields. Land abandonment. Increased risk of desertification. Loss of rural income.	High
Land use	Depends on region.	Shift in optimal conditions for farming. Deterioration of soils. Loss of rural income. Loss of cultural heritage. Land abandonment. Increased risk of desertification.	High
Increased expenditure in emergency and remediation actions	High for regions with low adaptation capacity.	Loss of rural income. Economic imbalances.	Medium
Biodiversity loss	High for vulnerable regions	Loss of natural adaptation options Modified interaction among species	Medium

Table 2: Proposed priority options for a flexible four-pronged EU approach to adaptation (Source: own elaboration based on the Green paper on adaptation COM(2007) 354 (2007) and other sources)

Pillars of the approach	Relevant policy instruments and actions
The first pillar: Early action in the EU	**Existing policies:** • Common Agricultural Policy (CAP) • European Environment and Health Action Plan (2004-2010)(COM(2004) 416 final, 2004) • Water Framework Directive (WFD, 2000) • Floods Directive (2007) • Communication on water scarcity and droughts (COM(2007) 414 final, 2007) • EU Maritime Policy, Marine Strategy and related legislation, Common Fisheries Policy • Biodiversity Communication and its EU Action Plan to 2010 and beyond (2006) • Forest Action Plan (COM(2006) 302 final, 2006) • Soil Strategy (COM(2006)231 final, 2006) • Energy and climate package (2008) • Sustainable Consumption and Production Action Plan (forthcoming) • Environmental Impact Assessment (EIA) Directive (1985, amended in 1997) • Strategic Environmental Assessment (SEA) Directive (2001) • Integrated Coastal Zone Management (ICZM) Recommendation (2002) **Planned policies:** • Industry and services Action Plan (2008) • Strategic Energy Technology Plan leading to the creation of a Common European Energy Policy **Funding programmes:** • Common Agricultural Policy (CAP) • EU Cohesion policy • European Social Fund • Fisheries Structural Fund • LIFE+
The second pillar: Integrating adaptation into EU external actions	• EU Common Foreign and Security Policy (CFSP) • Contribution of the EU to the UNFCCC effort for integrating adaptation into the national development plans though the National Adaptation Programmes of Action (NAPA) • Support the 2004 EU Action Plan on Climate Change and Development (COM(2003) 85 final, 2003) • Forthcoming EU strategy on Disaster Risk Reduction
The third pillar: Reducing uncertainty by expanding the knowledge base though integrated climate research	• EU 7th Framework Programme • INSPIRE (Shared environment information system) Directive (2007) • GMES (Global monitoring for environment and security) • Community-supported information systems (floods, forest fires, MIC (monitoring and information centre for civil protection) • European data centres • Promote cooperation with international programmes
The fourth pillar: Involving European society, business and public sector in the preparation of coordinated and comprehensive adaptation strategies.	• European Climate Change Programme (EPCC) • Possible establishment of a European Advisory Group for Adaptation to Climate Change • Stakeholder consultation

Table 3: Summary of the National adaptation strategies in the EU-27 and other European countries

Status of the National Adaptation Strategies	Countries
Developed	Finland (published in 2005 by the Ministry of Agriculture and Forestry of Finland) Spain (PNACC is ongoing) France (National Adaptation Strategy) published in 2007 Sweden (National Adaptation Strategy) published in 2007
Under preparation, to be published in the near future (EU-27)	Netherlands (most developed in the water sector) UK (Adaptation Policy Framework is already in progress, under the guidance of the Department for Environment Food and Rural Affairs, Defra)
Under preparation, to be published in the near future (other European countries)	Norway (currently in the process of developing adequate response strategies to the impacts of climate change, both sector by sector and as an overall strategy)
First steps in including climate change adaptation within the framework of their National Climate Policy in addition and complementarily to mitigation	Rest of the countries

Table 4: EU Water Framework Directive (Source: based on the EU WFD, 2000)

Year	Issue
2000	Directive entered into force (Art. 25)
2003	Transposition in national legislation (Art. 3) Identification of River Basin Districts Authorities (Art. 23)
2004	Characterization of river basin: pressures, impacts and economic analysis (Art. 5)
2006	Establishment of monitoring network (Art. 8) Start public consultation (at the latest) (art. 14)
2008	Present draft river basin management Plan (Art. 13)
2009	Finalize river basin management plan including programme of measures (Art. 13 and 11)
2010	Introduce pricing policies (Art. 9)
2012	Make operational programs of measures (Art. 11)
2015	Meet environmental objectives (Art. 4)
2021	First management cycle ends (Art. 4 and 13)
2027	Second management cycle ends, final deadline for meeting objectives (Art. 4 and 13)

Box 1 Potential impacts of climate change in irrigation in the Mediterranean region

Background: Irrigation accounts for over 60% of the total water abstraction, is used on about ten percent of the agricultural area, and gives rise to about 90% of the total value of crop production. Water resources vary greatly among basins.

Problem: The studies focus on the evaluation of the potential impact of a change in climate on the potential crop production and irrigation demand. The aims also examine the potential increase in irrigation demand in areas already vulnerable to water use conflicts.

Methods: Several methods including process-based agronomic models were used to estimate crop yields and crop water requirements at site and regional levels. Crop yield and irrigation demand functions were derived from the validated site results to evaluate spatial water demand and potential change in irrigation areas.

Each of the models used in the study was validated against local data.

Scenarios: The current baseline adopted for the socio-economic projections was 1990 and the climatic baseline, 1951-1980. Scenarios of climate change were projected for the 2050s with several global climate models driven by a range of socio-economic conditions.

Impacts: Under climate change irrigation demand is expected to increase in all southern Mediterranean regions, especially the ones with the largest current irrigation areas. The increase in irrigation demand is due to a combination of increased temperature that leads to higher evapotranspiration and decreased precipitation.

Adaptive responses: Improvements in water delivery systems are able to supply the demand for increases in irrigation supply and the projected increase in the irrigated area in the northern half of the region, but do not achieve the same results in the south-eastern part of the region.

Source: Bindi *et al.,* 2000 ; Moriondo et al., 2006; Iglesias *et al.*, 2000; 2002 ; 2007b; 2008; Iglesias 2002 ; 2003 ; Salinari *et al.,* 2006; Tubiello *et al.,* 2000, 2002.

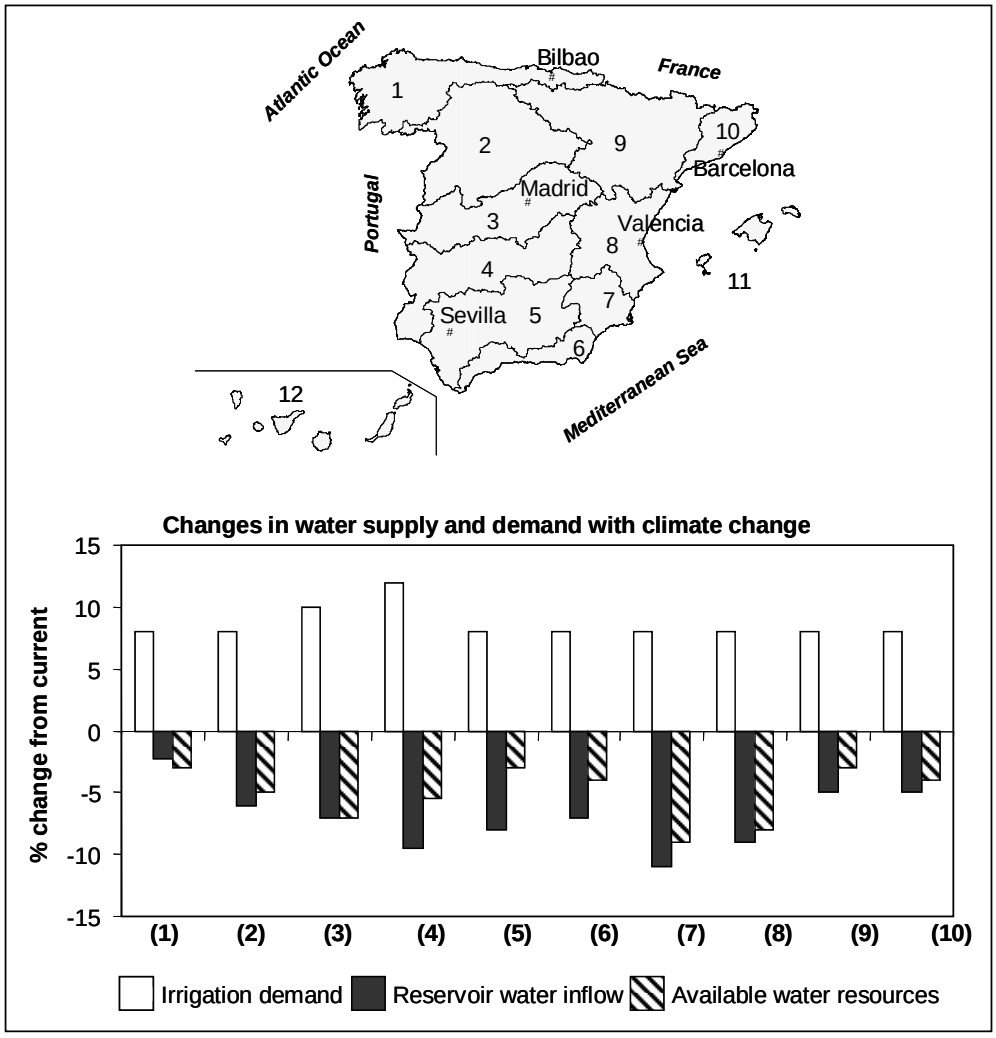

Figure 1: Changes in available water resources, reservoir inflow, and irrigation water demand in the hydrological basins in Spain (Source: modified from Iglesias et al., 2008b)