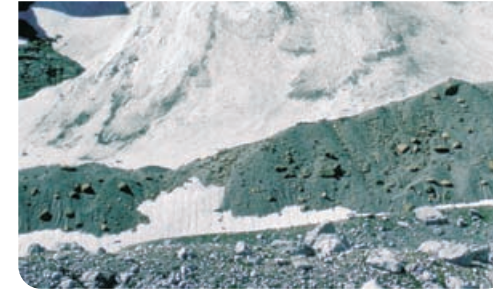




# PNACC The Spanish National Climate Change Adaptation Plan



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· FOREWORD ·

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*The evidence that climate change is actually happening has raised general awareness of the need to take action long in advance to be able to anticipate adaptation to its effects. Adaptation is not an alternative to reduce the factors causing climate change, but a necessary, complementary action to those mitigation policies that target greenhouse gas emissions with a global warming effect.*

*The UN Climate Change Conference held in Bali, Indonesia, last December 2007 put at the same level, for the first time, mitigation and adaptation as key building blocks to successfully fight against climate change.*

*Since 2004 Spain has taken major steps towards the definition of a coherent set of public policies to deal with climate change. One of the cornerstone of this institutional response is the National Climate Change Adaptation Plan (PNACC in Spanish). This programme was adopted in October 2006 after endorsement by the Cabinet of Ministers. The text has been discussed within the main national coordination and participation bodies dealing with climate change issues: the Commission of Climate Change Policy Coordination, the National Climate Council and the Environment Sectoral Conference. The Plan was also subject to a wide process of public consultation.*

*The PNACC is the reference framework tool for the coordination of Public Administrations' efforts dealing with the assessment of impacts, vulnerability, and adaptation to climate change in the Spanish sectors acknowledged as potentially affected (water management, agriculture, forests, biodiversity, coasts, health, tourism, etc.). The National Adaptation Plan provides tools for the elaboration of diagnosis analyses and the development of more efficient measures for adaptation.*

*Adaptation to climate change is a challenge for several management sectors (public and private) and requires a permanent updating of the base knowledge on potential effects at local level, and of the most advisable strategies to successfully address them. To that end, it is essential to pave the way for sharing the knowledge and experience coming from different Spanish agents. As a result, the Plan has been conceived as a process to guide the activities of Public Administrations, enterprises and stakeholders towards a common objective, committing themselves to the fight against climate change.*

*In order to be successful, the Plan requires efficient dissemination, assessment and assumption of its objectives, achievements and results by those concerned: administrations, organizations and the Spanish society. This publication, wishing to be a contribution to the required informative effort, summarizes the PNACC contents, as well as the key results of the preliminary diagnoses and the first working areas defined for every analyzed sector.*

*Elena Espinosa Mangana  
Minister of Environment and Rural and Marine Affairs*



## · THE SPANISH NATIONAL CLIMATE CHANGE ADAPTATION PLAN ·

Climate change constitutes one of the main global threats we must face this century. Even when considering the most optimistic previsions on future GHG (greenhouse gas) emissions, scientific studies reveal that some climate change is inevitable. This is due to the fact that the main GHGs, such as carbon dioxide, methane or nitrous oxide, are chemically stable and they persist in the atmosphere for periods ranging from decades to centuries. Consequently, GHG emissions have a long term influence on climate.

The increased concentration of GHGs in the atmosphere causes alteration of several climate parameters, which in turn are responsible for environmental changes that might result in shifts in the ecosystems and the social and economic systems and sectors. The direction, amount and intensity of the climate alterations, will in the end determine the definitive trends and magnitudes of the impacts at the local, regional and planetary levels.

Tackling the impacts of climate change is not a matter of future, as they are already being observed and their effects felt worldwide. Therefore, it is necessary to adopt and implement whatever adaptation measures are adequate, aimed at reducing the vulnerability of our systems and sectors, at the relevant scales and decision levels, in order to minimise its negative impacts.

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## RESPONSES TO CLIMATE CHANGE

Spain, as a result of its geographical situation and socioeconomic characteristics, is very vulnerable to climate change, and hence the need to respond urgently and properly.

Responses to climate change must face two complementary challenges:

- **Mitigation** of the phenomenon: restraining the accumulation of GHGs in the atmosphere, by reducing the emissions and by removing the already emitted gases by the so-called carbon "sinks".
- **Adaptation** to the phenomenon: minimizing risks and impacts derived from climate change and taking as much advantage as possible of the new conditions.

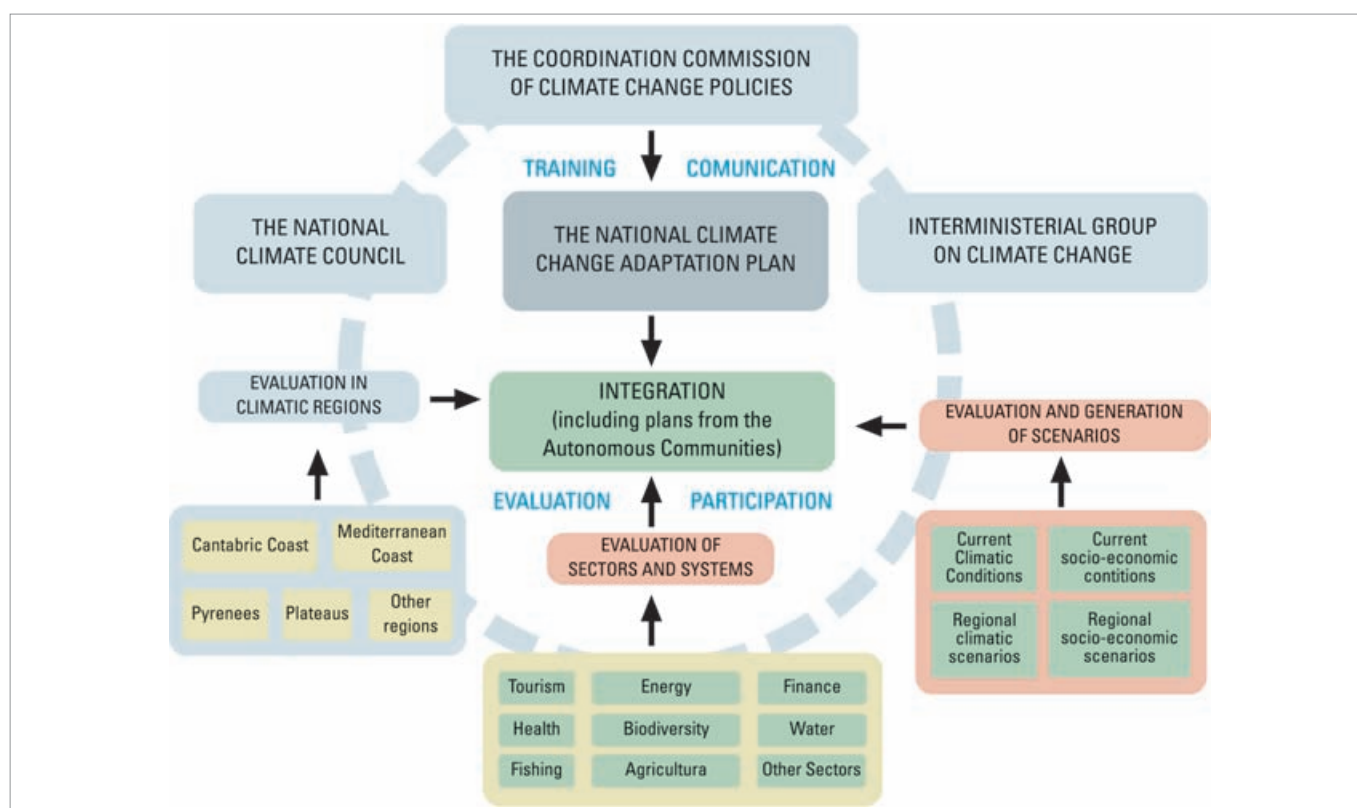
Both objectives are closely linked. On the one hand, the possibilities of the adaptation process will depend on the degree of change, and this, on the other hand, will depend on the success of the mitigation policies that will condition the concentration of GHGs in the atmosphere.

## CLIMATE CHANGE **IMPACT** ASSESSMENT

Though it is widely accepted that climate change is a potential source of impacts (for several sectors and systems), the assessment of such impacts is very complex and prone to uncertainty.

A great number of experts and research teams in Spain are currently working to assess the foreseeable impacts of climate change on a variety of socio-economic sectors and ecological systems. The first report that summarizes and integrates these studies was published in 2005 under the name: *A Preliminary Assessment of the Impacts in Spain due to the Effects of Climate Change*. The full report is available on the website of the Spanish Climate Change Office: [www.marm.es/oecc](http://www.marm.es/oecc)

The process of defining the PNACC and main institutions involved



## THE NATIONAL CLIMATE CHANGE **ADAPTATION** PLAN (PNACC)

Adaptation to climate change requires forecasts and strategies for the medium and long term. And, throughout the process of designing the different options, the participation of all interested sectors is required.

The National Climate Change Adaptation Plan provides the current framework for carrying out assessment actions to evaluate impacts, vulnerability and adaptation to climate change in Spain. The Plan's objective is to mainstream adaptation to climate change in the planning processes of all the relevant sectors or systems. To achieve this, it is important that the development of the Plan becomes a major collective project with the participation of all institutions and key players.

The Plan was adopted in July 2006 after a wide consultation process channelled through the main coordination and participation bodies dealing with Climate Change; the National Climate Council, The Coordination Commission of Climate Change Policies and the Environmental Sector Conference. The process had a wide participation, engaging representatives of the public administrations, non-governmental organizations and other stakeholders.

Finally, the Plan was submitted to the Council of Ministers in October 2006.

## THE PLAN'S OBJECTIVES

The Plan was conceived as a continuous process of knowledge generation and strengthening of the capacities needed for its application. It aims at becoming a useful tool for the policy makers on the key topics related to the adaptation to climate change.

The Plan's initial objectives are:

- To develop the regional climate scenarios for the Spanish geography.
- To develop and apply methods and tools to evaluate impacts, vulnerability and the adaptation to climate change for all the relevant socioeconomic sectors and ecological systems.
- To incorporate to the Spanish R&D&i system the most relevant needs for climate change impact assessment.
- To carry out continuous information and communication activities about the projects.
- To promote the participation of all stakeholders involved in the different sectors and systems, for purposes of mainstreaming adaptation to climate change to sector policies.
- To prepare specific reports on the results of the evaluations and projects, and periodical follow-up reports about the projects and the National Adaptation Plan as a whole.

### COORDINATING AND PARTICIPATING BODIES INVOLVED IN THE PLAN

#### THE NATIONAL CLIMATE COUNCIL

The National Climate Council, linked to the Ministry of Environment, involves different Departments of the National Administration, the Autonomous Communities, the Spanish Federation of Municipalities and Provinces, representatives from research institutions, social actors and non-governmental organizations. Among its tasks, the Council draws proposals and recommendations to define policies to fight against climate change in the areas of climate change science, impacts and adaptation strategies, as well as strategies to limit GHGs emissions.

#### THE COORDINATION COMMISSION OF CLIMATE CHANGE POLICIES

The Coordination Commission of Climate Change Policies is a coordination and collaboration body between the National and Regional Administrations for all matters related to climate change. Local entities are also represented in this Commission.

Some of the functions entrusted to the Coordination Commission of Climate Change Policies are:

- Follow-up of climate change and adaptation to its effects.
- Prevention and reduction of GHGs emissions.
- The promotion of carbon absorption capacity of vegetation.

#### THE ENVIRONMENTAL SECTOR CONFERENCE

The Environmental Sector Conference is a political high-level cooperation body with a multilateral composition that brings together members of the Ministry of the Environment, on the State General Administration, and members of the Environmental Council, representing the Administrations of the Autonomous Communities.

## FUTURE CLIMATE SCENARIOS

One of the first activities carried out to facilitate the development of the National Climate Change Adaptation Plan was to prepare a series of regional climate change scenarios for Spain throughout the 21st century. The scenarios estimate the possible features of the climate in the future and they serve as a reference to prepare specific impact and vulnerability assessments for different ecological, economic and social sectors and systems.

The said scenarios are built from global climate models that are adapted to the particular features of our country. For this purpose, downscaling techniques are applied so as to incorporate the regional physiographic characteristics (topography, vegetation, coast line, etc.). To produce these scenarios represents a complex technique that very frequently requires supercomputer systems and highly specialized staff.

Notwithstanding, regional climate change scenarios are one of the fundamental starting points to assess impacts, vulnerability and the future needs of adaptation to climate change. Thus, one of the challenges faced by this Plan is to have sufficient operational capacity, continuously progressing, to carry out the production of the successive scenarios at the regional level.

The first report on the "Generation of Regional Climate Change Scenarios for Spain" may be downloaded from the website of the State Meteorological Agency of Spain ([www.aemet.es](http://www.aemet.es)).

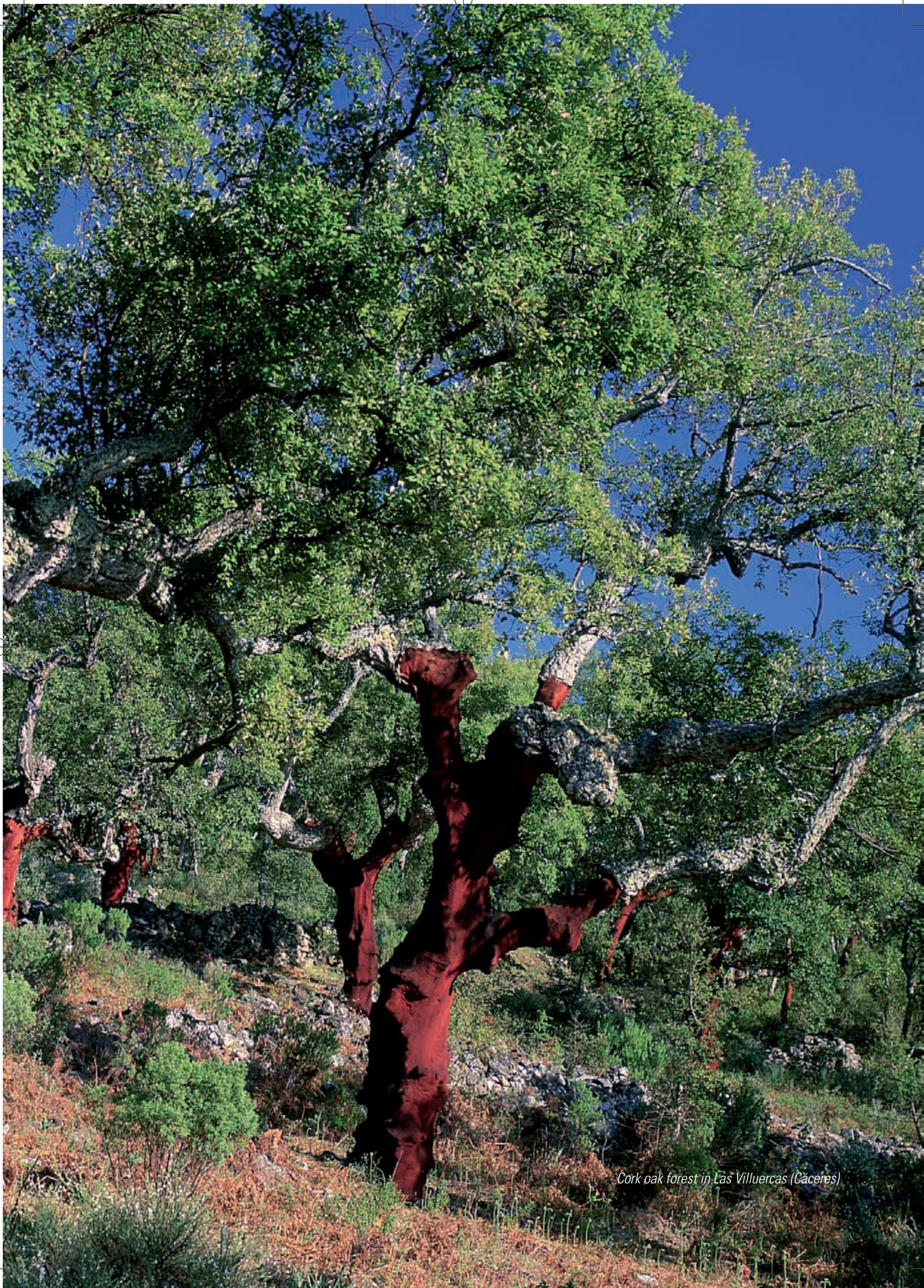
## SECTORS AND SYSTEMS DEALT WITH IN THE PNACC

Many ecological, economic and social sectors and systems in Spain are vulnerable to climate change. The National Adaptation Plan has defined an initial set of 15 sectors and systems to start the assessment of their vulnerability and their possibilities of adaptation:

- Biodiversity
- Water resources
- Forests
- Agriculture
- Coastal areas
- Inland hunting and fishing
- Mountain areas
- Soils
- Fishing and marine ecosystems
- Transport
- Human health
- Industry and energy
- Tourism
- Finance - Insurance policies
- Urban planning and construction







*Cork oak forest in Las Villuercas (Cáceres)*

Each of these sectors and systems shall be subject to impact and vulnerability assessments, that will target aspects such as the effects of climate change on food safety, social inequalities or human safety, as well as the factors that might condition the adaptation options (existing institutions, available technologies, culture and social values...)

It is important to bear in mind that sectors and systems are strongly interdependent from each other, which implies a challenge for the coordination and integration of disciplines, expert groups and institutions responsible for the different areas.



## DEVELOPMENT OF THE PLAN

The Coordination Commission of Climate Change Policies is the body responsible for the adoption of the National Climate Change Adaptation Plan in Spain, and thus it establishes the priority action lines.

The Spanish Climate Change Office, a General Directorate of the Ministry of Environment and Rural and Marine Affairs, is in charge of the coordination, management and follow-up of *The National Adaptation Plan*.

The Plan will be implemented through work programmes that will determine the activities and projects to be carried out, as well as their schedules.

The First Work Program, approved in 2006, targets the development of regional climate scenarios and the impacts of climate change on water resources, biodiversity and coastal areas.

## COMMUNICATION, TRAINING AND PUBLIC AWARENESS

The National Adaptation Plan shall only be effective if its existence, its progress and results are disseminated and communicated to all the relevant stakeholders. For this purpose, the plan comprehends a set of information and communication activities.

In addition, adaptation will require new capacities. In this regard, training needs, as well as specific training actions shall be identified for each sector and/or system considered.

Outline of the adaptation planning process



## IMPACTS ON SECTORS AND SYSTEMS. ACTION LINES

As previously mentioned, one of the main goals of the PNACC is to evaluate the vulnerability of the different sectors and sensitive systems and to study the adaptation options for each one.

What follows is a summary of the most relevant impacts expected for the sectors considered, according to the information from the *Preliminary Assessment of the Impacts in Spain due to the Effects of Climate Change* (Ministry of Environment, 2005) and other sources. Furthermore, a preliminary list of tasks to be carried out within the PNACC for each sector and system, in order to strengthen the knowledge about the impacts, the vulnerability and the adaptation to climate change, is also presented.

### 1. BIODIVERSITY

The impact analysis has been carried out considering different categories of ecological systems. Some of the main threats foreseen for each of them are the following:

#### Inland Aquatic Ecosystems

- Most of the inland aquatic ecosystems will change from permanent to seasonal, and some others will disappear.
- The most vulnerable habitats are the endorheic, wetlands, high-mountain lakes, lagoons, rivers and streams, and coastal wetlands depending on groundwater.
- The biodiversity of wetlands and freshwater ecosystems -very singular in the European context- will be reduced, and their biogeochemical cycles will be altered.
- Emblematic conservation areas such as the Doñana marshes or the Ebro Delta will suffer changes, and their ecological richness will be reduced.
- The adaptation possibilities of these systems are limited.

#### Terrestrial Ecosystems

- The effects will vary if we consider Atlantic ecosystems -limited by temperature- or Mediterranean ecosystems, limited by water. While productivity could increase in the first, it will decrease in the second.
- Phenology will be altered, as well as the interaction among species; altitudinal migrations will occur as well as the extinction of local species.



- Pests and invasive species will be favoured.

- Major impacts are expected in the ecosystems with ecological or geographical restrictions, such as high mountains or some arid areas.

#### Plant Biodiversity

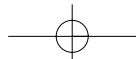
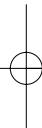
- Direct impacts are expected by way of two main drivers: global warming and the decrease of water resources, from which two main trends will result: the "mediterrization" of the northern regions and the "desertification" of the southern regions.
- The most important indirect impacts will derive from changes in soils, in fire patterns and sea level.
- The loss of flora diversity and the prevalence of local extinction over recolonization will govern the general trends.
- Highest vulnerability will be felt in the high-mountain vegetation, deciduous forests and bushes sensitive to draughts, sclerophyllous and laurel forests of the country's south and south east areas and the coastal vegetation.

#### Animal Biodiversity

- Phenological changes will affect populations, thus causing changes in the equilibria and ecological relations among species, such as predator-prey interactions, pests, competition or pollination.
- Another foreseeable effect is the displacement of the distribution of terrestrial and aquatic species.

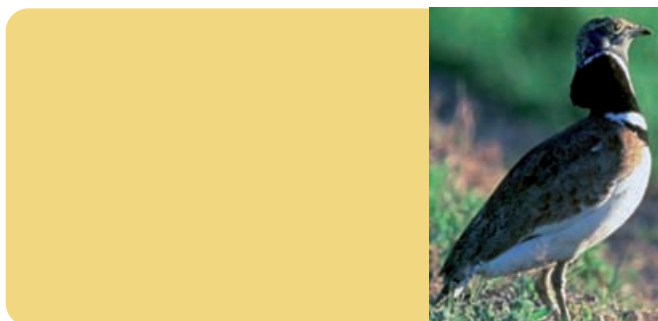


*Monte Perdido Glacier (Huesca)*  
*Fototeca CENEAM / Carlos Valdecantos*



- Likewise, a higher virulence of parasites is expected as well as an increase in invasive alien species.

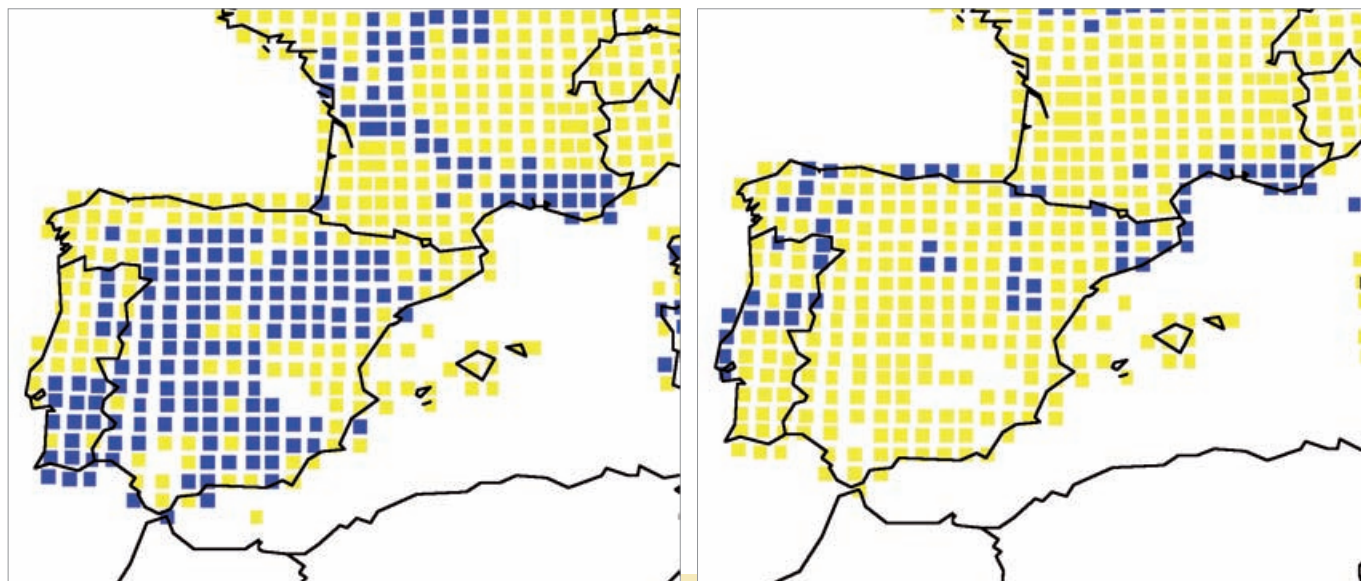
- Maximum vulnerability is expected to affect animal populations of highly threatened habitats, particularly mountain areas.



#### FIRST ACTION LINES IN BIODIVERSITY

- Mapping the vulnerability of Spanish biodiversity.
- Consolidation of ecological monitoring networks.
- Development of a system of biological indicators for impact assessment.
- Assessment of the protected areas -including the Natura 2000 Network - under different climate change scenarios.
- Evaluation of the potential of ex-situ conservation measures.
- Assessment of the impacts on ecosystems goods and services.

*A Climatic Atlas of European Breeding Birds. RSPB/Birdlife – Lynx, 2008.*



*Figure 3. Present and simulated distribution of the Little Bustard (*Tetrax tetrax*) by the end of the 21st century. At present, Spain has the most important nesting population of this bird in Europe. According to the simulation carried out in the "Climatic Atlas of European breeding birds", most of the present breeding locations of the Little Bustard may prove to be inadequate for the species in the future.*

*Simulations may help us to better understand the potential impacts of climate change on animals and plants, as well as to look for formulae to enable their adaptation. With these aims, one key activity within the PNACC will be mapping the vulnerability of the Spanish Biodiversity.*

## 2. WATER RESOURCES

Climate change in Spain will be expressed by means of a general trend towards increases in temperature and decreases in precipitation with the following effects:

- A decrease of the general availability of hydric resources. Previous estimates for Spain as a whole –horizon 2030, considering temperature increases of 1 degree C and 5% decreases in rainfall-, calculate a 5 to 14% decrease in water supplies, which may reach 20 - 22% for the scenarios of the last part of the 21st century.

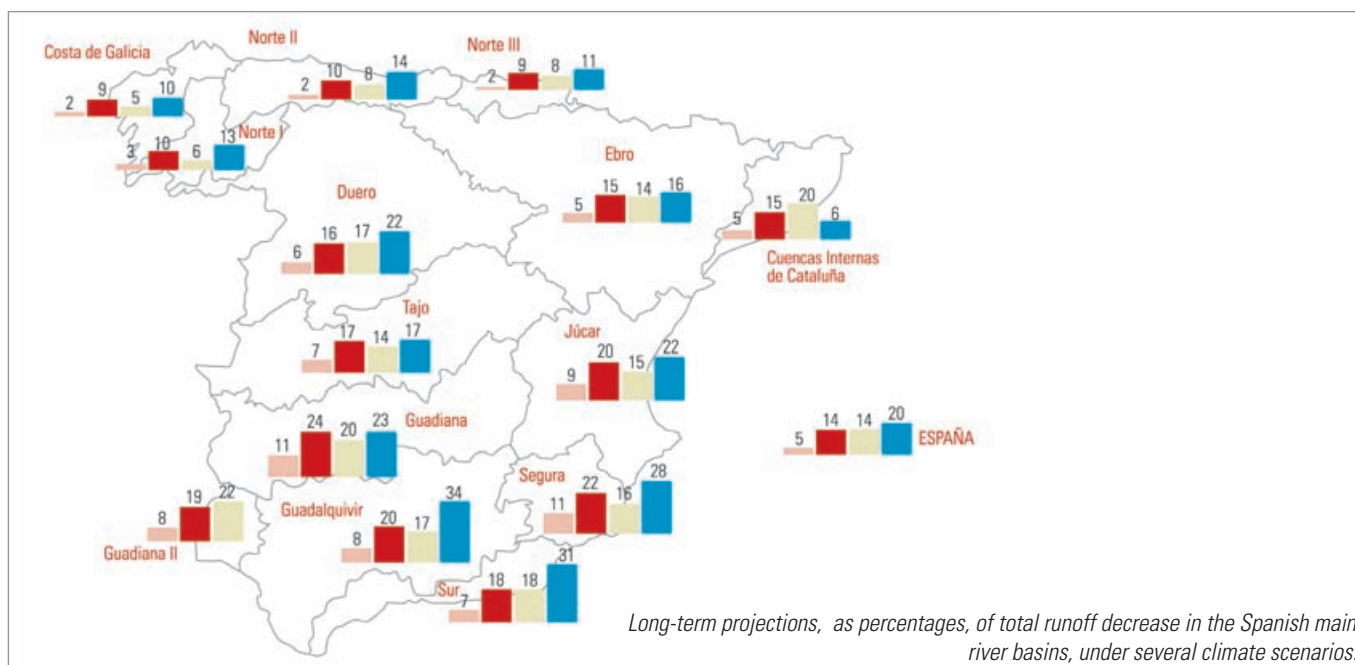
- Severe impacts are expected in arid and semi-arid areas (approximately 30% of the national territory), where water yields may decrease by 50%.

- Hydrological variability will increase in the Atlantic basins, while more irregularity is expected in flood patterns of the Mediterranean basin.

### FIRST ACTION LINES IN WATER RESOURCES

- Development of coupled climate-hydrology models to obtain reliable scenarios of all aspects of the hydrological cycle, including extreme events.
- Assessment of water management options in terms of the hydrological scenarios generated for the 21st century.
- Application of the foreseen hydrological scenarios to other sectors highly dependent on water (energy, agriculture, tourism, etc.).
- Identification of climate change indicators under the implementation scheme of the Water Framework Directive.
- Development of guidelines and regulations to incorporate the foreseen impacts of climate change into the processes of Environmental Impact Assessment and Strategic Environmental Assessment of Plans and Programmes within the hydrological sector.

Study	Reference	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Year 2030 CEDEX Libro Blanco de España Fermández C.P.	CEDEX (1988) MIMAM (2000) Fermández (2002)	T = (+1 C) P = (without change)	T = (+1 C) P = (-5%)	T = (PROMES model) P = (without change)	T = (+2.5 C) P = (-8%)
Year 2060 Ayala-Carcedo	Ayala et al (1996)				





### 3. FORESTS

Effects on forests will be accompanied by direct effects on plants species, as well as indirect ones such as: habitat regression, erosion, etc.

- The physiology of species will be deeply affected.
- The decrease in water reserves in soils will be a major hydric stress factor that will derive in a trend towards decreasing forest density, and in extreme cases, towards its substitution by shrubs.
- The flammability of forests will increase, and hence, the frequency, the intensity and the magnitude of forest fires.
- The impact of forest pests and diseases is expected to increase.
- The most vulnerable forest systems are found in high-mountain areas, dry ecosystems and riparian woodlands.

### 4. AGRICULTURE

The expected effects of climate change over agriculture and livestock will not be uniform; while they will be negative in some Spanish regions, they might be beneficial in some others:

- The negative effect of high temperatures and lower precipitations may be compensated by higher photosynthetic rates, due to the increase of CO<sub>2</sub> in the atmosphere. In addition, softer winter temperatures will permit higher yields, compensating for the losses of other seasons.
- Irrigation needs will increase in certain regions.
- The distribution and impact of pests and diseases will shift, causing new effects to the crops important for the Spanish economy.
- The effects of climate change on livestock are still uncertain, but significant impacts on animal health are expected.

#### FIRST ACTION LINES IN FORESTS

- Drafting of guidelines and evaluation of the techniques and models needed to implement an adaptative forest management to climate change.
- Development and application of forest growth models under different climate change scenarios.
- Assessment of the response of vegetation to a variety of adverse situations (draughts, fires, etc.).
- Evaluation of a system of climate change indicators for forests and implementation of an early warning system.
- Evaluation of the carbon balances for different types of forest ecosystems.
- Evaluation of above and below-ground biomass of Spanish species and forest systems.

#### FIRST ACTION LINES IN THE AGRICULTURE SECTOR

- Atlas of the agroclimate areas under different climate change scenarios.
- Development of response simulation models of the different crops under different regional climate scenarios.
- Development of behaviour simulation models of pathogen agents under different climate conditions.
- Risk maps for the most relevant parasitoses.
- Evaluation of irrigation demands according to different climate scenarios.
- Drafting guidelines for the management of agricultural systems for purposes of ensuring adaptation to climate change in the short term.
- Identifying long term and minimal cost climate change adaptation strategies, specifically for fruit trees, olive trees and vineyards.
- Evaluation of the needs to reduce the farms' stocking rate, change the management of grazing systems, and other options to adapt to climate change in the livestock sector.

## 5. COASTAL AREAS

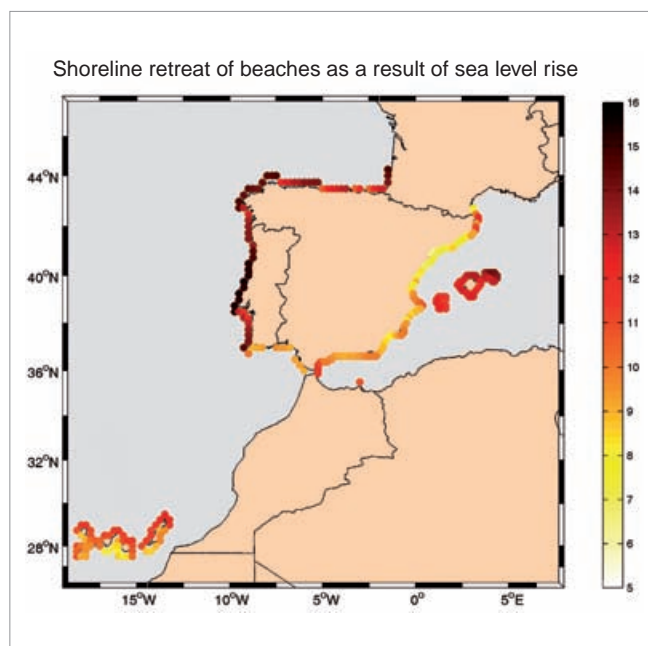
The main problems in these regions are related to the foreseeable changes in the coastal dynamics and the increase of the mean sea level (MSL). In this context the most significant likely impacts are the following:

- The increase of MSL will mainly affect deltas and confined beaches, while coastal cliff areas do not seem to face particular risks.
- With maximum projected increases of 0.5 m, the most threatened low-lying coastal areas are located in the Ebro and Llobregat Deltas (Cataluña region), the Manga del Mar Menor (Murcia), or the lagoons of Cabo de Gata, the Cádiz Gulf and Doñana (Andalucía).
- Another region that could be affected is the Eastern Cantabria region, with 40% of its beaches under the risk of flood.

## 6. HUNTING AND INLAND FISHING

The analysis of this sector is justified by its economic importance and by the extension of land used in Spain for these activities.

- Game and angling species will be affected by climate change, together with the wild species sharing the hunting and angling habitats.



Source: Coastal and Oceanographic Engineering Group from the University of Cantabria.

Estimation of shoreline retreat of Spanish beaches as a result of sea-level rise by 2050.

	Retreat aprox.
<b>Galician, Cantabric and Balears coasts</b>	15 metres
<b>Cádiz Gulf and Alborán Sea</b>	10 metres
<b>Northern Mediterranean Coasts</b>	8 metres

### FIRST ACTION LINES IN COASTAL AREAS

- Development of morphodynamic and ecological response models of the main Spanish coastal units, according to different climate scenarios.
- Implementation of monitoring systems and systematic data input.
- Mapping the Vulnerability of Spanish coasts to MSL rise, according to several climate change scenarios.
- Evaluation of the abandonment and retreat, or protection strategies under different scenarios of MSL rise.
- Evaluation of the effect of MSL rise over coastal urban areas.
- Evaluation of the adaptation options by means of actions related to coastal stability.

### FIRTS ACTION LINES IN HUNTING AND INLAND FISHING

- Cartography of effects of climate change on game and angling species, including at the population level, according to several scenarios.
- Assessment of the potential adaptation measures to climate change in hunting and fishing management.
- Evaluation of measures to control the carriers of invasive species.





## 7. MOUNTAIN AREAS

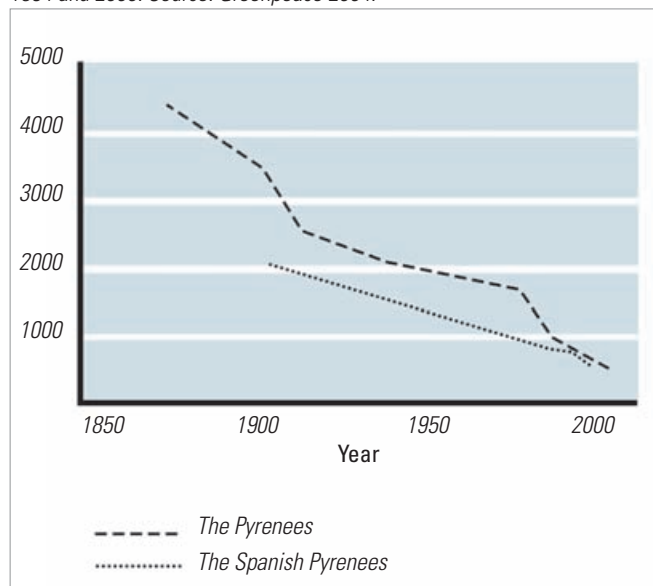
Spanish mountains areas are especially rich in biodiversity, endemisms and traditional management systems of ecosystems with high cultural value.

- All assessments carried out to date point out that mountain areas are among the systems most vulnerable to climate change.
- Changes have already been registered in terms of the altitudinal distribution of vegetation communities, which can be attributed to climate change.

### FIRST ACTION LINES IN MOUNTAIN AREAS

- Cartography of climate change impact for the main Spanish mountain ranges.
- Development of a climate change monitoring network for Spanish high mountain ecosystems.
- Impact monitoring and characterization over glaciers and their effects on the associated hydrological dynamics and biocenosis

*Evolution of the glaciated surface in the Pyrenness. Glaciers in the Spanish Pyrennees are estimated to have diminished by 85 % between 1894 and 2000. Source: Greenpeace 2004.*



## 8. SOILS

Desertification is already a real problem and a threat for a great part of the Spanish territory. To traditional factors –fires, erosion and salinisation- we have to add now the effects of climate change.

- The main effect related to climate change will be the reduction of organic carbon content of Spanish soils, with negative consequences for their physical, chemical and biological properties.
- The most affected areas will be humid areas of the north and the more vulnerable land uses will be those requiring higher organic carbon content, such as prairies and forest.

### FIRST ACTION LINES IN SOILS

- Mapping of areas vulnerable to desertification and modelling of erosion processes according to different climate scenarios.
- Monitoring of land degradation and desertification, and follow-up of erosion and organic carbon evolution.
- Assessment of the effects of reforestation in marginal land and soil-conservation farming practices.

## 9. FISHING AND MARINE ECOSYSTEMS

Even though the effects of climate change will differ according to the ecosystems and areas, a general decrease of productivity of Spanish waters is expected. Some of the expected impacts are as follows:

- Many groups of organisms will be affected, from phyto and zooplankton, to fish and seaweeds, altering trophic chains.
- Changes in the distribution of several species are foreseeable, as well as an increase of species from temperate waters and a decrease of boreal species. Also foreseeable are an increase in invasive species and evidences of negative effects on species whose life cycle has a marine and river phase.
- Effects are also expected on marine farming.
- The most vulnerable species will be the Mediterranean red coral and the Canary Isles black coral, the fields of algae and the fields of marine phanerogams.

## 10. TRANSPORT

The Transport sector, in general, does not seem to be seriously affected by the increase in temperatures, although it will be affected by changes in the precipitation, wind and fog patterns.

- It might be necessary to modify infrastructure works: bridges, runways, etc.
- Impacts may be highly significant specifically in ports due to sea level rise and the modification of other climate-related parameters.

## 11. HUMAN HEALTH

Interactions between climate change and human health are multiple and complex. They can be summarized as follows:

- Morbimortality changes related to the increase in temperatures. In Spain, the expected increase will affect mainly the population older than 65 years, and it will be provoked by heat waves that will grow in frequency and intensity.
- Effects on health related to extreme meteorological events (storms, extreme precipitations, etc.).
- Health impacts related to the increase of atmospheric pollution.
- Greater frequency of diseases transmitted through dirty water and spoiled food.

### FIRST ACTION LINES IN FISHING AND MARINE ECOSYSTEMS

- Development of marine circulation models according to different climate change scenarios.
- Cartography of marine biodiversity vulnerability.
- Evaluation of the marine protected networks (including the Natura 2000 Network) under different climate change scenarios.
- Assessment of ex-situ conservation measures of threatened marine species.
- Evaluation of the effects of climate change over invasive marine species, over marine commercial species and over the carrying capacity of ecosystems for marine farming in Spain.
- Evaluation of the carbon balance and pH in Spain's coastal and marine waters
- Consolidation of the environmental and ecological monitoring network.

### FIRST ACTION LINES IN TRANSPORT

- Cartography of vulnerability of land, air and marine transportation systems, in terms of infrastructures' safety

### FIRST ACTION LINES IN HUMAN HEALTH

- Assessment of the effects over health and cartography of vulnerable areas under different climate scenarios.
- Development of action plans in public health based on early warning systems.
- Surveillance programs and control programs for vector-borne diseases
- Awareness and public participation campaigns on climate change and health.



- Extension of infectious diseases transmitted by rodent and vector-borne, already established or having a subtropical origin.

## 12. INDUSTRY AND ENERGY

The main effects in this area are as follows:

- A decrease in the generation capacity of hydraulic energy, effects on the functioning of thermal power plants and nuclear power plants with open-circuit cooling systems, and biomass contribution decrease.
- Solar energy, on the other hand, will benefit from the sun exposure increase, while the increase in strong wind episodes would derive in an increase of wind energy potential.

## 13. TOURISM

Tourism sensitivity to climate change is very high in Spain in many of the aspects that are particular to this sector: attraction areas, calendar of events, infrastructure and conditions. Some of the foreseeable effects are as follows:

- Geographical impacts shall derive in alteration of ecosystems, and hence, existing social, economic and environmental benefits. Coastal and mountain areas are the most vulnerable areas, especially snow-based tourism.
- The increase in temperatures may modify the calendar of events or change the decision about the destination or the duration of the stay.

### FIRST ACTION LINES IN INDUSTRY AND ENERGY

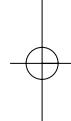
- Cartography of climate potentialities (positive and negative) of Spanish regions to produce renewable energies under different climate change scenarios.
- Evaluation of the effects of the projected climate change scenarios over energy production systems depending on water resources and air cooling systems.
- Evaluation of the effect of climate change on energy demand in Spain, per region and economic sectors.

### FIRST ACTION LINES IN TOURISM

- Climate change impact assessment in the sector by areas and tourist products.
- Cartography of critical and vulnerable areas according to different climate change scenarios
- Development of a system of indicators about the climate change -Tourism relationship.
- Development of management models to implement the most significant adaptation measures.
- Assessment of the potential impacts of climate change in the cultural heritage and their effect on Tourism.

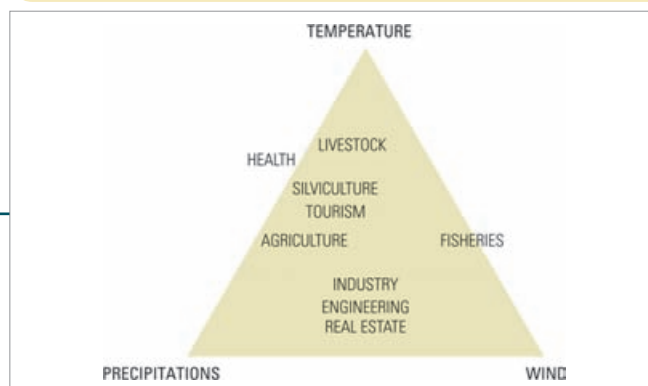


*Erosive landscape in Bardenas Reales (Navarra)*





*Relationship between the three variables of climate change and the most sensitive branches of insurance*



- Water shortages could endanger the functional or economic viability of certain tourist areas.

- The sea-level rise could threaten certain settlements and tourist infrastructures.

#### 14. FINANCE - INSURANCE POLICIES

This will be one of the economic sectors suffering the fastest and most intense effects of climate change:

- At the international level, the most affected areas will be physical damages, and at a lesser scale, health, life and civil responsibility.

- In the eastern half of Spain, the farming insurance policy shall be particularly sensitive.

- Storms and floods are the higher occurrence events, and the most expensive for the sector.

#### 15. URBAN PLANNING AND CONSTRUCTION

The strategies for land and urban planning must carefully consider the effects of climate change so as to make sure that the decisions on the occupation and distributions of activities can adapt to the new circumstances and contribute, at the same time, to prevent the degradation of natural resources, and their negative influence over the climate. The most significant impacts in the sector can be summarized as follows:

- Within the urban areas, the most direct effects will fall on the so-called green areas: parks and gardens.

- Impacts of climate change shall have consequences on the habitability of buildings.

- It will be necessary to incorporate information on the climate scenarios both to prepare technical guidelines adapted to the new circumstances and to ensure the proper execution of the projects.

- It is important to consider the negative synergies occurring between climate change impacts and the consequences of extensive urban planning in Spain: land consumption, higher needs of transport, energy, water and resources in general.

#### FIRST ACTION LINES IN FINANCE - INSURANCES

- Cartography and risk assessment for the different insurance branches in Spain according to different climate change scenarios

- Proposal to review the legal framework for construction and design, land planning and land use.

- Development of specific models for the insurance sector

- Evaluation of the vulnerability to extreme meteorological and climate phenomena of infrastructures and crops in the different geographical areas.

- Promotion of the insurance market as a prevention instrument.

- Analysis of the economic viability of the agricultural policy under the different climate scenarios.

#### FIRST ACTION LINES IN URBAN PLANNING AND CONSTRUCTION

- Development of basic studies for the urban and construction adaptation to the new climate conditions.

- Promotion of bio-construction, especially for public buildings.

- Evaluation of the new needs of plant species and varieties in parks and gardens according to the different climate scenarios.

- Impact evaluation of extensive urban planning over the Transport and energy sectors and water resources.

# GLOSSARY

(Source: IPCC Fourth Assessment Report 2007 and UKCIP 2003)

## Adaptation

Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation:

- *Anticipatory Adaptation*: Adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation.
- *Reactive Adaptation*: Adaptation that takes place after impacts of climate change have been observed.
- *Autonomous Adaptation*: Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation.
- *Planned Adaptation*: Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state
- *Private Adaptation*: Adaptation that is initiated and implemented by individuals, households or private companies. Private adaptation is usually in the actor's rational self-interest.
- *Public Adaptation*: Adaptation that is initiated and implemented by governments at all levels. Public adaptation is usually directed at collective needs.

## Climate scenario

A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships, that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change, often serving as input to impact models. A "climate change scenario" is the difference between a climate scenario and the current climate.

## (Climate) Impacts

Consequences of climate change on natural and human systems. Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts.

- Potential impacts: All impacts that may occur given a projected change in climate, without considering adaptation.
- Residual impacts: The impacts of climate change that would occur after adaptation

## Uncertainty

An expression of the degree to which a value (e.g., the future state of the climate system) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined concepts or terminology, or uncertain projections of human behavior. Uncertainty can therefore be represented by quantitative measures (e.g., a range of values calculated by various models) or by qualitative statements (e.g., reflecting the judgment of a team of experts).

## Mitigation

An anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks

## Risk

Risk is a combination of the chance or probability of an event occurring, and the magnitude of the consequences associated with that event. Risk includes the occurrence frequency of certain events or states and the magnitude of the probably consequences associated to the exposure to those events or states.

## Risk assessment

Process whereby risk components are probabilistically -quantitative or qualitative-assessed. Frequently, when existing data allow it, the probability is expressed in return or recurrence periods of a phenomenon and/or its consequences.

## Vulnerabilidad

The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Vulnerability= Risk (adverse climate impacts) - Adaptation

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Full text of the Spanish National Climate Change Adaptation Plan

[http://www.marm.es/portal/secciones/cambio\\_climatico/areas\\_tematicas/impactos\\_cc/pnacc.htm](http://www.marm.es/portal/secciones/cambio_climatico/areas_tematicas/impactos_cc/pnacc.htm)