The Spanish National Ecosystem Assessment (SNEA), supported by the Biodiversity Foundation of the Ministry of Environment, is the first analysis conducted on the status and trends of ecosystem services in terrestrial and aquatic ecosystems of Spain. The results of the SNEA are expected to help build bridges between interdisciplinary scientific knowledge and decision making to visualize the complex relationships that exist between the conservation of ecosystems and human wellbeing.

The SNEA has involved approximately 60 scientists from the biophysical and social sciences. This report presents a synthesis and integration of the key findings of the project presented in the Technical Report of which was completed in 2012 (**www.ecomilenio.es**).

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SPANISH NATIONAL ECOSYSTEM ASSESSMENT

Ecosystems and biodiversity for human wellbeing

Spanish National Ecosystem Assessment

Synthesis of key findings

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EVALUACIÓN
DE ECOSISTEMAS
DEL MILENIO
DE ESPAÑA

ECOSYSTEMS AND BIODIVERSITY FOR HUMAN WELLBEING

GOBIERNO
DE ESPAÑA

MINISTERIO
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Foreword

There is an increasing awareness and each day becomes more and more evident that biodiversity provides a long list of ecosystem services that sustain life on Earth. Among those key ecosystem services are the regulation of climate, air and water quality as well as food, energy, medicines, enjoyment and other vital and strategic resources that build the basis of the economic growth, security, health and wellbeing of our society.

The Ministry of Agriculture, Food and Environment aware of this fact and convinced that the project of the Spanish Ecosystem Assessment (SNEA) would facilitate the interface between scientific knowledge in different disciplines and decision making, has promoted, through the Biodiversity Foundation, its support to this initiative.

Since its initiation, the SNEA has provided scientific information on the value of biodiversity and has promoted its dissemination and consideration in sectoral decision-making processes. The results and future developments of the project are being particularly helpful in providing responses that pave the way for the fulfillment of new obligations and commitments assumed in the context of multilateral environmental agreements and the European Union environmental policy. In that regard, it is a great pleasure to disseminate the Spanish experience that could help other countries as a reference point for their own national projects.

It is interesting to note how the evidence of these links between biodiversity, development and human wellbeing progressively generates changes in attitude and enables new forms of dialogue with some of our partners, especially from the private sector. Nevertheless, one of the biggest challenges that remain is to increase knowledge and public awareness regarding the importance of preserving our rich natural capital.

The preservation of Spanish ecosystem services is everyone's responsibility. Hence, we are obligated to communicate to society the need for a more sounding development and provide familiar examples.

It is therefore necessary to continue to work on the Spanish NEA, and in particular on the valuation of ecosystem services, as it is an important tool that can contribute to the better management of biodiversity conservation and policy integration and can improve the understanding of the links between biodiversity and human wellbeing and increase their visibility among managers, companies and society as a whole.

Dª. Guillermina Yanguas Montero
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Preface

The Spanish National Ecosystem Assessment (SNEA), supported by the Biodiversity Foundation of the Ministry of Environment, provides the first analysis conducted at the national level that evaluates the ability of Spanish ecosystem and biodiversity to maintain our human wellbeing. Following the initiative of the Millennium Ecosystem Assessment promoted by the United Nations, Spain initiate this process in 2009, with the aim to generate robust, scientifically validated information that can help to move the debate on the conservation of ecosystems and biodiversity beyond the academic world and link it to the goals of a good life to which all actors in society aspire.

This report presents a synthesis and integration of the key findings of the biophysical presented in the Technical Report of which was completed in 2012, which consists of 37 chapters that are available at our web site (www.ecomilenio.es). This synthesis report is organized around the core questions originally posed to structure the assessment: How is biodiversity changing? How have ecosystems and their services changed? What are the main direct and indirect drivers of change? How these changes affect our human wellbeing? How can we integrate a multi-scalar approach? What is the public´s current understanding of ecosystem services? How might ecosystems and their services change in Spain under plausible future scenarios? How can we initiate a transition to socio-ecological sustainability in Spain?

This assessment would not have been possible without the extraordinary commitment of the more than 60 scientists from the biophysical and social sciences and who contributed their knowledge, creativity, time, and hard work to this process. We would like to express our gratitude to the Lead Authors of individual chapters, Contributing Authors and Expert International Reviewers who contributed to this process, and we wish to acknowledge the support of their institutions, which enabled their participation.

The results of the SNEA in Spain are expected to help break down barriers and build bridges between interdisciplinary scientific knowledge and decision making to visualize the complex relationships that exist between the conservation of ecosystems and human wellbeing based on empirical data. It is also expected to increase the awareness of Spanish society, including the business sector, regarding the importance of ecosystems and biodiversity for different components of our human wellbeing.

Dr. Carlos Montes, Dr. Fernando Santos-Martin and ***Dr. Javier Benayas***
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KEY MESSAGES

1. In the last 50 years, the ecosystems and biodiversity of Spain have undergone through a rapid and unprecedented changes as a result of the unsustainability of the prevailing socio-economic development model and the lifestyle associated with it.

2. The synergistic interactions between economic and demographic patterns have promoted dramatic land use changes. These were identified as the main drivers underlying the deterioration of ecosystems and the loss of biodiversity.

3. The evaluation process revealed that 45% of the ecosystem services assessed at the national level have been degraded or are being used unsustainably, with regulating services being the most negatively affected.

4. Coastal and inland aquatic ecosystems have suffered the greatest deterioration in ecosystem service flow and thus in their ability to contribute to human wellbeing. Forests and mountains are the best-conserved ecosystems in relation to their capacity to delivery services.

5. The growing urban population and its unsustainable demand of certain provisioning and cultural services, is negatively affecting to important regulating and cultural services associated with rural areas, increasing our vulnerability to disturbances such as climate change.

6. The wellbeing of the current and future generations depends on the supply of essential provisioning (eg. food and clean water), regulating (eg. air quality or erosion control) and cultural services (eg. local ecological knowledge or recreational activities), all of which are supplied by ecosystems and their biodiversity. Some dimensions of human wellbeing are being negatively affected by the progressive degradation of those services flows.

7. There is still sufficient critical natural capital in Spain to provide this and future generations a positive environment to maintain the wellbeing of its inhabitants. However, unless we take urgent steps to halt and reverse the degradation of ecosystems and the loss of biodiversity, we will approach a new threshold of change that, once exceeded, may bring us into an unpredictable and undesirable situation of socio-ecological unsustainability.

8. The transition towards a sustainable model in Spain that maintains the wellbeing of its inhabitants requires the adaptive management of natural capital. For this, we need to adopt structural measures to build a new governance framework that modulates the interactions between human society and ecosystems and to redefine the true role of the economy in a socially just and ecologically sustainable model.

9. Times of crisis are times of opportunity. The current financial crisis is, paradoxically, a "window of opportunity", which might change our development model to begin a genuine transition towards sustainability. It is critical to promote the processes of creation, innovation and experimentation to support the sustainable management of ecosystems and foster the skills of individuals, society and institutions to manage real change and transformation.

The National Ecosystem Assessment of Spain

The socioecological dimension of ecosystems and its biodiversity in Spain

Introduction

The ultimate goal of the Spanish National Ecosystem Assessment (SNEA) stands as an instrument for laying the foundation for a new generation of environmental policy in Spain, focusing on the relationships between ecosystems, biodiversity and human wellbeing, as well as complying with various regulations, agreements and international initiatives that link the conservation policies of Spain and Europe (Box 1). The SNEA represents the first attempt at the national level to understand the complex interactions between nature and society in our country.

The overall objective is to evaluate and provide to society (policy makers, NGOs, environmental managers, the business sector, the scientific community and civil society in general) with interdisciplinary information on the consequences of changes in aquatic and terrestrial ecosystems and the loss of biodiversity for human wellbeing during the past five decades in Spain (SNEA, 2011).

Based on the hypothesis that if this objective can be empirically demonstrated, it could break the traditional dialectical conflict and find the "balance between conservation development" that has come to dominate forums on conventional conservation strategies and the management practices of policy makers, which are based on the new paradigm of the "Conservation of ecosystems and its biodiversity for human wellbeing" (Santos-Martín and Montes, 2013).

In addition to addressing a series of policy questions (Box 3), the SNEA attempts to convey, using empirical data, that ecosystems and its biodiversity are in large part the basis of our future because they constitute the “natural capital” of our country. It is also taken into consideration that the current economic model has traditionally ignored the links between nature and society, which is one of the main causes of ecosystem degradation and biodiversity losses. Following this reasoning, the conservation of ecosystems and its biodiversity of Spain does not represent a luxury for a few individuals, but a social, cultural and economic need of society (Montes et al., 2012).

Box 1. The Spanish NEA is seen as an opportunity to:

- Improve the understanding of the relationships between ecosystems, biodiversity and human wellbeing.
- Identify priorities for action in problems related to biodiversity-ecosystem interactions.
- Design a conceptual and methodological framework as an essential tool for environmental planning and management.
- Create a baseline of the interdisciplinary knowledge of the nature-society interface under the framework of sustainability science.
- Characterize and prioritize response options to implement strategies grounded in the social dimension of ecosystems and its biodiversity.
- Help to build the adaptive capacity of individuals and institutions facing the challenge of global change.
- Establish research priorities under a new international scientific agenda focused on the interactions of nature and society.
- Serve as a benchmark for future evaluations.

General Conceptual Framework

The main challenge faced by the Millennium Assessment (MA, 2005) was to give meaning to the available information, showing varying degrees of heterogeneity and dispersion, related to ecological systems, social systems and their interactions. Moreover, it was considered necessary to present the results in a simple and pedagogical manner so that they could be understood and applied by a large number of groups and individuals.

The framework adapted by the SNEA (Figure 1) represents a significant change in perspective in Spanish conservation policies, as in addition to the intrinsic value of nature, the proposal also promotes its instrumental value (such as provisioning service related to food, clean water, pollination and soil formation), thus linking the conservation of ecosystems with different components of human wellbeing. This approach can also address the complex interactions established in the exploitation of ecosystems when priority is given to a particular service to the detriment of another (trade-off).

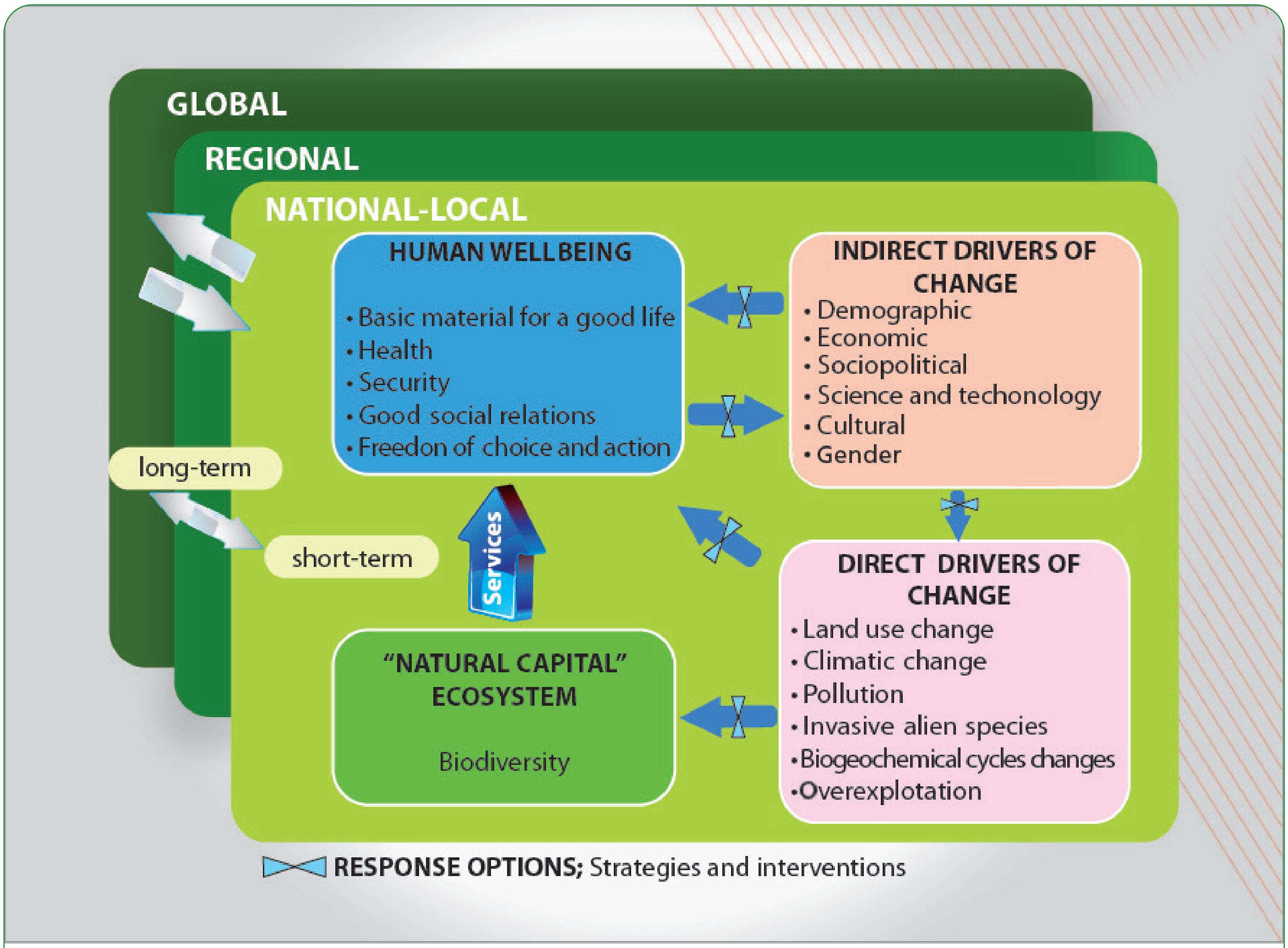


Figure 1. The conceptual framework has been the main tool for organizing the available information for Spain from different disciplines to address the complex interactions that exist between ecosystems, biodiversity and human wellbeing. It shows how the synergistic effect of direct and indirect drivers of ecosystem change affect the flow of ecosystem services affecting human wellbeing at different spatial and temporal scales. It places human wellbeing in the center of the assessment, and all of its components are directed toward that point. (Modified from MA, 2005).

The conceptual framework of the SNEA is based on six basic components:

1. **Ecosystem:** defined as a functional unit consisting of living and non-living components, linked by a web of biophysical relationships involving the exchange of matter and energy that self-organize in time. Ecosystems have also been conceptualized from a socio-approximation standpoint as representing natural capital with ecological integrity (structure, function, dynamics) and therefore have the ability to perform functions and provide services to society.
2. **Biodiversity:** the number, variety and variability of living organisms as well as the relationships established between them, including diversity within species (genetic diversity), between species (species diversity) and between communities (diversity of communities).
3. **Human wellbeing:** the adopted definition is a good life within the biophysical limits of ecosystems. To evaluate this parameter, the five dimensions proposed by the MA (2005) were assessed: freedom of choice and action, health, security and stability of life, good social relationships and the basic material for a good life.
4. **Ecosystem services:** are the direct and indirect contributions of ecosystems and its biodiversity to human wellbeing.
5. **Direct drivers of change:** refers to any factor that directly alters ecosystems. These drivers are natural or induced by humans acts and unequivocally impact the biophysical processes of ecosystems and therefore affect the flow of services.
6. **Indirect drivers of change:** sociopolitical factors and processes

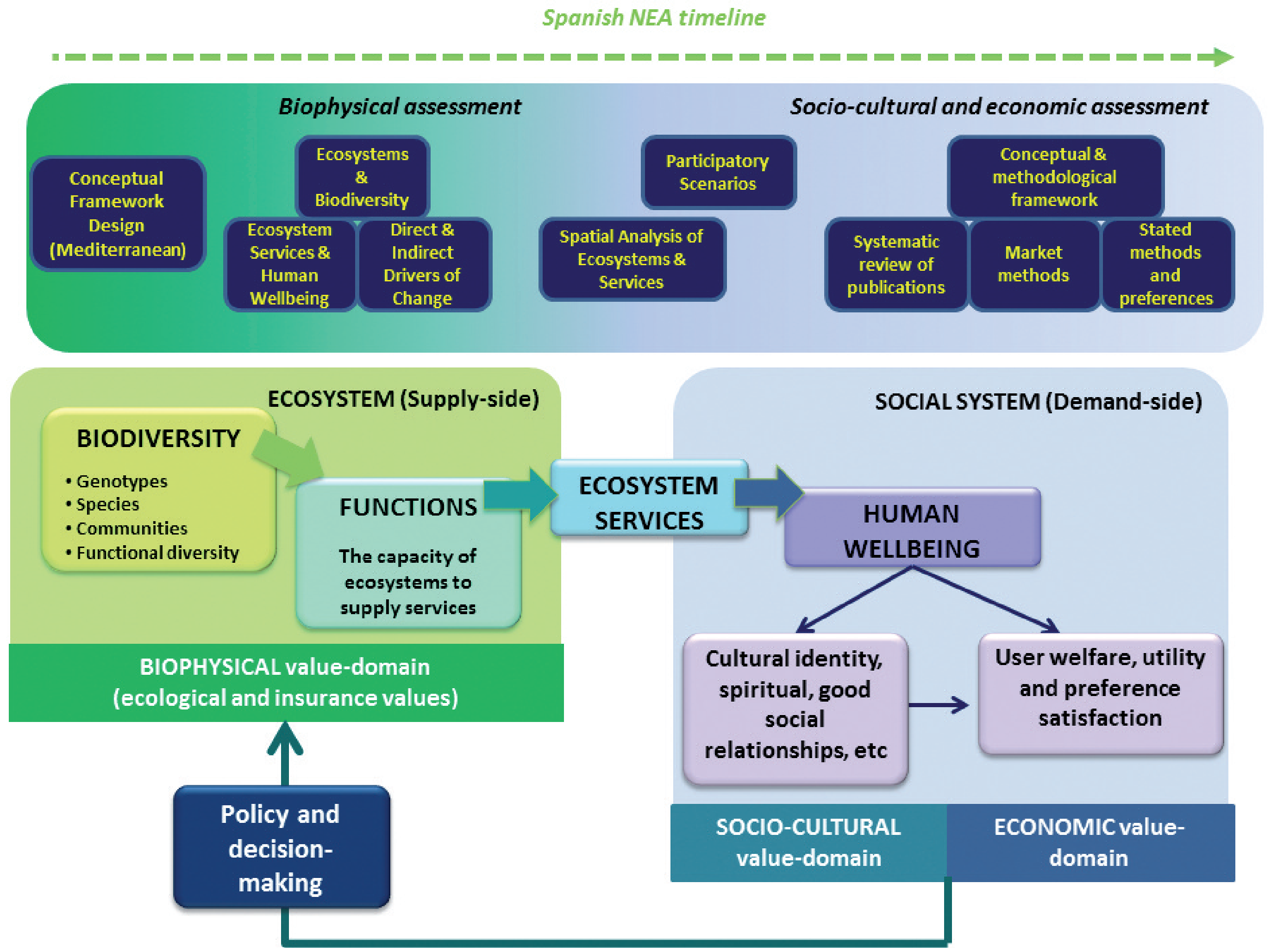


Figure 2. Multidimensional framework for assessing ecosystem services, including methods ranging from biophysical (supply-side) to socio-cultural and economic approaches (demand-side), and how this approach has been incorporated into different steps during the Spanish NEA timeline. Based on Haines-Young and Postchin (2010), de Groot et al. (2010), and Martín-López et al. (2013).

that act in a more diffuse way by altering ecosystems through their action on one or more direct drivers of change.

Towards mulidimensional and pluralistic valuation frameworks

Within the field of ecosystem services science, economic valuation is one of the most commonly used approaches in the academic and political arenas. The continued decline of biodiversity has led to the consideration of not only intrinsic values but also instrumental values, to reveal ecosystem services that are ignored in markets (understood as positive externalities) because an appropriate price is not placed upon them. This is the case for a large number of regulating and cultural services deteriorated in Spanish ecosystems. In this context, decision makers demand the operationalization of ecosystem services to allow them to make more informed decisions when setting priorities, analyzing trade-offs or synergies between biodiversity and ecosystem management options and allocating budgets as well as including them in the national accounting. Examples of this strategy include the EU Biodiversity Strategy for 2020 and the international TEEB (The Economics of Ecosystems and its Biodiversity) projects, which quantifies the cost of biodiversity losses and the degradation of ecosystem services.

This enthusiasm that has raised economic valuation is not free from controversy and entails significant conceptual and methodological limitations, which should be considered. The ecological complexity underlying the supply of ecosystem services

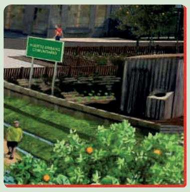
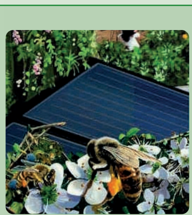
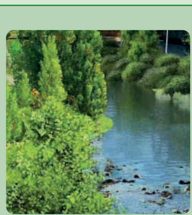
Figure 3. Two posters designed within the communication strategy that identifies the ecosystem services associated with different types of rural (top) and urban (down) landscapes.

cannot be completely translated into economic value, and the hegemony of such value could be counterproductive if the final objective is understood in terms of the commodification of nature. At the same time, socio-cultural (also called non-monetary) techniques are required to bring to the table the multiple values of ecosystem services (i.e., cultural, educational, ethical, moral, historical, spiritual, inspirational, or therapeutic values), increasing the visibility of the intangible and incommensurable contributions provided by nature, which could be obscured under simplification into the metric of money.

The Spanish NEA understands human wellbeing as a good quality of life within the ecosystem's biophysical limits, following the postulates of Ecological Economics. Then, once the biophysical dimension has been covered, we complete the

ecosystem service valuation from the demand side (Figure 2). An ecosystem's capacity to supply services determines its range of potential uses by society, which influence its socio-cultural and monetary value. Socio-cultural values also have an influence on monetary value because preferences and ethical and moral motivations determine the 'utility' a person obtains from a particular service. These interdependencies (and the different information provided) explain why research on ecosystem services should combine the three value domains (biophysical, socio-cultural, and economic) to properly inform the environmental decision-making process. The Spanish NEA attempts to build a common language between scientists and policy makers as well as a discussion forum around the idea of how to make the human dependence on ecosystems and their biodiversity explicit, working under a pluralistic and multidimensional framework.

Table 1. List of ecosystems services evaluated

Type of services	Services	Examples
Provisioning services  	1. Food	Crops, livestock, wild plants and animals and their products, aquaculture product
	2. Water	Agriculture and domestic water use
	3. Biotic Materials	Non-food vegetal fibers
	4. Geotic Materials	Continental and marine salt
	5. Renewable Energy	Hydropower production
	6. Gene pool	Livestock breeds, varieties of crops, varieties and biotechnological genetic information
	7. Natural medicine	Oils, plant acids, alkaloids
Regulating services  	8. Local & Regional climate regulation	Carbon capture and storage, microclimatic regulation
	9. Regulation of air quality	Retention of pollutants by plants and microbes
	10. Water regulation	Water purification and oxygenation
	11. Maintenance of soil erosion	Attenuation of runoff and discharge rates
	12. Maintenance of soil fertility	Maintenance of nutrients cycles and organic matter
	13. Regulation against hazards	Habitat refuges
	14. Biological control mechanisms	Regulation of pests and pathogens vectors
	15. Pollination	Symbiosis between certain organisms resulting in pollen transport and reproduction
Cultural services  	16. Scientific knowledge	Ecosystems as laboratories for experimentation and knowledge
	17. Local ecological knowledge	Knowledge of the basic functioning of ecosystems and social function
	18. Sense of place or cultural identity	Certain forms of use of the service and landscape management
	19. Spiritual and religious experience	Sacred places or species
	20. Aesthetic enjoyment of landscapes	Landscape character for recreational opportunities
	21. Recreational activities	Nature tourism
	22. Environmental education	Sensibilization and awareness of the importance of ecosystem services

Typology of Ecosystem services

The applied conceptual framework is valid for any type of ecosystem or classification of services. Under the Spanish NEA, 22 services were selected (Table 1) to evaluate each of the 14 types of ecosystems (Table 2 and Figure 3) identified in Spain. We followed the guidelines of the MA (2005) classification of ecosystem services because it provided the first classification that was globally recognized and applied in other national, sub-global assessments.

The MA also considers a fourth type of ecosystem service: supporting services, defined as the ecological processes underlying the maintenance of other services. The Spanish NEA has overlooked this category mainly for two reasons: (i) it generates confusion between services, functions and ecological functioning; and (ii) it generates double counting problems associated with economic valuation.

In this context, it is also important to note that biodiversity, including all of its dimensions (genetic, species and community diversity, functional diversity as well as habitat maintenance), is the leading provider of ecosystem services and was therefore not included as a service per se in the assessment, as occurs frequently in certain other evaluations.

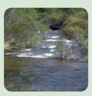
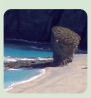
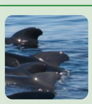
Ecosystem Typology

The selection of the ecosystem types to be evaluated in Spain was based on a set of general operational issues appropriate for articulating the assessment at a national scale (Table 2). Therefore, no attempt has been made to define a typology based on the specific composition or dominance of certain species or physiognomic types. Instead, the goal was to identify the main areas of the expression of nature of Spain (Figure 3). However we made an effort to integrate national-scale ecosystem classifications with the existing european-level classification (Box 2). The considerations that guided the selection of ecosystem types were as follows:

- The number of ecosystem types evaluated (14) should be sufficient to effectively sample the original natural character of Spain.
- The selection must consider the importance of the chosen ecosystem services (22) in relation to the wellbeing of the Spanish population and therefore representative of our natural capital.
- The classification of ecosystem types was performed based on two main characteristics: geophysical conditions (mainly macroclimatic characteristics and the presence or absence of water to support life) and the influence of human control (the contrast between urban and rural ecosystems dominated by agricultural uses).

Ecosystem mapping is the spatial delineation of ecosystems following an agreed upon ecosystem typology (ecosystem types), which strongly depends on the purpose and scale of mapping (Figure 3). Under the Spanish NEA, the mapping of ecosystems was conducted with the purpose of providing a spatial sense to each expert group that could be considered through the process of ecosystem assessments.

Table 2. Classification of the 14 ecosystems types assessed in the SNEA

	ECOSYSTEM TYPE	Definition
Terrestrial	 Sclerophylous forest and shrub	Occupy about 7 million ha in Spain and are part of the mediterranean *monte*. The *monte* comprises marginal agrarian lands that also contain pastures (another 7 million ha). These include the *dehesa* (nearly 2 million ha) lawns of therophyte plants with scattered pruned trees which look savanna (*montado* in Portugal).
Terrestrial	 Mediterranean continental forest and shrubs	Extremely originals ecosystems and almost exclusive of the Iberian Peninsula (Spain contains about 75% of its European area). It occupies 2.7 million ha (about 15% of forest area). It most characteristic tree species are: Quercus rotundifolia, Quercus faginea andJuniperus thurifera.
Terrestrial	 Atlantic forest	It is located in the northern area of Iberian Peninsula, with an area of approximately 3.3 M ha. Its more characteristics trees species are: *Castanea sativa, Quercus robur, Quercus petraea, Fagus sylvatica* and *Betula sp.*
Terrestrial	 Alpine mountain	Situated on the north of the Iberian Peninsula (Cantabrian Mountains, Pyrenees and Iberian Range) occupy approximately 1.5M ha (3% of state territory). Includes mountain forests, grasslands, crops, and high mountain pastures and rocky areas.
Terrestrial	 Mediterranean mountain	Present in the central and southern Mountain Systems territories they take about 2 M ha (4% of the state area). Ecosystems subtypes include: high mountain pastures and forests, natural bushland, high mountain scrub.
Terrestrial	 Arid zones	Broad representation in the Southeast of Iberian Peninsula, some low areas of the Ebro basin and the two eastern Canary Islands (Fuerteventura and Lanzarote). They occupy an area of approximately 1.6 M ha (3% of the state area). Because of its random productivity and fragility, have become marginal area.
Terrestrial	 Insular	Island included in the Macaronesian biogeographic region. They occupy an area of 772 512 ha (1% of the state territory). Unlike the two eastern islands they have a wide altitudinal range of ecosystems.
Terrestrial	 Agroecosystems	Distributed throughout the peninsula. Is the ecosystem most widely represented in Spain occupying approximately 50% of the state area. The main services provide by agroecosystems are provisioning services related to food production and livestock, but these ecosystems also generate many other essential regulating and cultural services.
Acuatic	 Rivers and riverbanks	Flowing water ecosystems that connect all the terrestrial ecosystems through water cycle.
Acuatic	 Wetlands and lakes	Wetlands or shallow water ecosystems (› 8-10m) and Lakes or deep standing water ecosystems (› 10 m).
Acuatic	 Aquifers	Found in effluent streams and wetlands or shorelines that act as drop zones. Identified a total of 740 groundwater bodies.
Acuatic	 Coastal	Reflect the interaction between the terrestial and marine ecosystems with presence or influence of human activities.
Acuatic	 Marine waters (sea and ocean)	Area contained between the outer limits of the coastal ecosystem and the Exclusive Economic Zone (EEZ) of Spain. Represents about 103 M ha (about twice the terrestrial surface of Spain).
Urban	 Urban	Represents a total of 1,053 municipalities (13%) with a 80.7% of the population and 4% of total area.

Methodological procedures

We used the Driver-Pressure-State-Impact-Response (DPSIR) framework to analyze the complex relationships established between ecosystems and human systems in Spain from a holistic point of view (Figure 4). The DPSIR framework is a common approach for exploring the relationships of human and natural systems because it provides an organized structure to analyze the causes and consequences of and responses to changes. Here, we

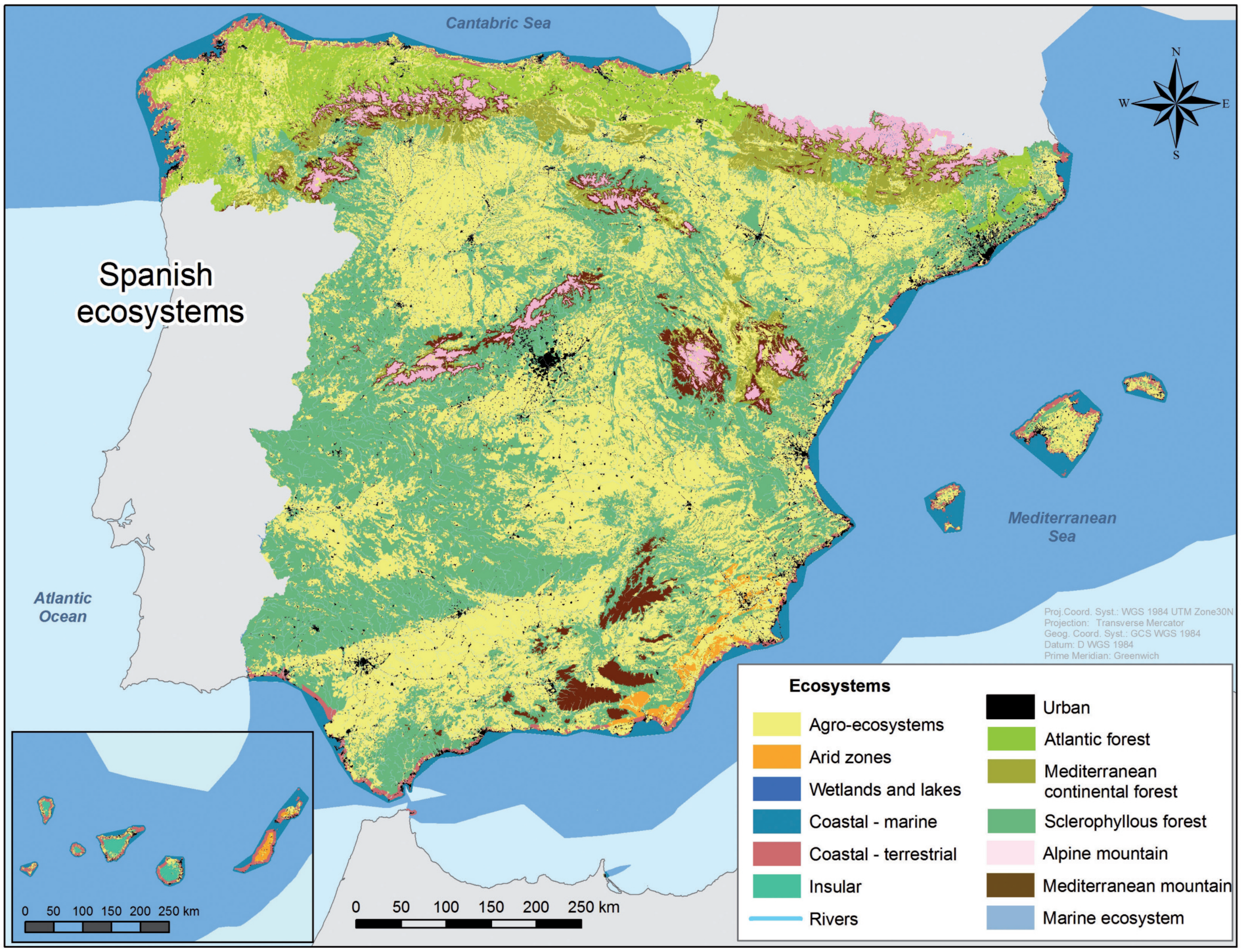


Figure 3. Spatial representation of ecosystem types assessed under the Spanish NEA.

Biodiversity Fundation

Box 2. Integrating national-scale ecosystem classifications with the existing european-level classification

The proposed European-scale ecosystem classification (EEA, 2012) is compatible with ecosystem classifications conducted for the Spanish NEA (Table 2) and allows consistent assessments from the national to the European scale (Table 2). Information obtained from more detailed classifications performed at a local scale and at a higher spatial resolution should be compatible with these classifications and could be aggregated in a consistent manner.

Ecosystem category	EU TYPE (EEA, 2012)	Spatial representation, and definitions	SNEA TYPE	Spatial representation and definitions
Terrestrial	Urban	Constructed, industrial and other **artificial** habitats	Urban	Artificial surfaces associated with urban areas
	Cropland	Regularly or recently cultivated agricultural, horticultural and domestic habitats	Agroecosystems	I. Systems with woody elements II. Monospecific arable III. Polycultures IV. Industrial agriculture
	Grassland	Land dominated by forbs, mosses or lichens		Grasslands
	Woodland and forest	Woodland, forest and other wooded land	Atlantic forest Mediterranean continental forest	Bioclimatic Eurosiberian Region: Colino and Montano floors Matches bioclimatic supramediterranean floor
	Heathland and shrub	Moors, heathland and sclerophyllous vegetation	Sclerophylous forest and shrub	Matches bioclimatic mesomediterranean and thermomediterranean floors
	Sparsely vegetated land	Open spaces with little or no vegetation (bare rocks, glaciers and inland dunes and sand plains included)	Alpine mountain Mediterranean mountain Arid zones	Bioclimatic Eurosiberian Region: altitudes above 1,500 m Bioclimatic Mediterranean Region: altitudes above 1,300 m Less than 300 mm annual rainfall
	Inland wetlands	Mires, bogs and fens (freshwater wetland habitats)	Wetlands and lakes Aquifers	Wetlands: shallow water (> 8-10m) Lakes: deep water (> 10 m) Identified a total of 740 groundwater bodies
	Coastal	Coastal habitats (characteristic coastal wetlands and open spaces)	Coastal Insular	- Coastal plain and islands. - Coastal and intertidal shoreline: tidal influence ecosystems - Coastal Marine: shallow water ecosystems (isobaths 50) Macaronesian bioclimatic region
Fresh water	Rivers and lakes	Inland surface waters Water courses and bodies	Rivers and riverbanks	Vector lines distributed over the entire surface of the state territory
Marine	Benthic photic Benthic non-photic Pelagic photic Pelagic non-photic	Littoral and shallow sublittoral habitats Shelf sublittoral and deep sea habitats Coastal, shelf and oceanic marine water habitats Coastal, shelf and oceanic marine water habitats	Marine waters (sea and ocean)	Area within the outer limits established in the coastal ecosystem and the Exclusive Economic Zone (EEZ) of Spain

adapted the DPSIR framework to analyze the connections between environmental change, ecosystem services, human wellbeing and the response of society to preserve the flow of ecosystem services.

In this context, drivers are the underlying factors (i.e., demographic, economic, cultural, sociopolitical or technological factors) promoting environmental change. They are equivalent to indirect drivers of change in the MA (2005). These drivers produce different pressures that tend to affect ecological integrity. These pressures correspond to the direct drivers of change (i.e., land-use change, climate change, pollution, invasive alien species, and overexploitation) included in the Millennium Ecosystem Assessment framework (MA, 2005). These pressures alter the state of ecosystems and biodiversity and thus affect the delivery of ecosystem services to society. Therefore, their impact can be understood as changes in both the supply of ecosystem services and human wellbeing. Finally, depending on the social perception of wellbeing, governments and society carry out different actions (responses) to control the effects of drivers or preserve the ecosystem's capacity to supply services.

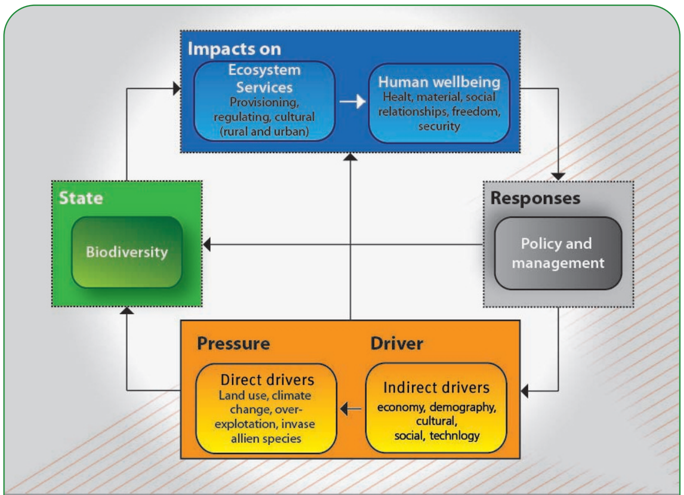


Figure 4. Driver-Pressure-State-Impact-Response (DPSIR) framework for analyzing the complex relationships established between ecosystems and human systems under the Spanish NEA (Santos-Martín et al., 2013).

Selection of indicators

The assessment of the status and trends of ecosystem services in Spain was performed using multiple indicators (Table 3). The criteria for the selection of indicators were as follows: (1) being understandable and widely accepted among the multiple types of stakeholders involved in the Spanish National ecosystem assessment; (2) having the ability to express information (being unambiguous and sensitive to changes); (3) being temporally explicit (trends can be measured over time), scalable (can be aggregated to different scale levels) and quantifiable (the information obtained can be easily compared); and (4) having available data during the last five decades (since 1960) and showing credibility (being obtained from official statistical datasets).

Multiscale analysis

One of the main challenges addressed by the Spanish NEA has been the integration of results obtained at different scales with the same conceptual approximation but using assessment methodologies

Table 3. Number of Indicators selected for each ecosystem and service type included in the Spanish NEA

Ecosystems / Service Type	Provisioning	Regulating	Cultural	Total
Agroecosystems	19	22	12	53
Atlantic forest	28	31	22	81
Mediterranean continental forest and shrubs	24	14	21	59
Sclerophylous forest and shrub	16	9	6	31
Alpine mountain	23	14	22	59
Mediterranean mountain	25	33	33	91
Arid zones	21	7	19	47
Wetlands and lakes	28	15	24	67
Aquifers	11	7	7	25
Coastal	5	7	9	21
Insular	14	11	11	36
Rivers and riverbanks	50	55	33	138
Marine	44	13	31	88
Urban	7	8	7	22

that are not directly associated with the present project. Thus, the SNEA has examined five case studies conducted by different research teams at different spatial scales and have compared with the same approximation conceptual framework.

Therefore, this framework of analysis has been applied at various scales: a) at the national level; b) at a regional scale, as in the case of Biscay (www.ehu.es); c) at the ecosystem level (14 types); d) at the local level: two cases in southeastern semiarid regions; the socio-ecological systems of Doñana and transhumant area systems have been chosen as singular demonstrative examples in the context of the overall assessment.

Policy-science interface: national and international linkages

Approaches based on the evaluation of ecosystem services are becoming a common reference and integration tool for the development of conservation policies at global, national and local scales. For instance, the National Ecosystem Assessment of Spain has helped to guide **strategies and regulations related to the conservation of nature in Spain** as follows:

- Providing information for the implementation of the Spanish Strategic Plan for Biodiversity and Natural Heritage (2011-2017). In particular, the Spanish NEA is collaborating in the following actions:
  - Establishing monitoring indicators of the main drivers of change in ecosystems.
  - Promoting coordinated projects to connect basic research and the development policies applied for biodiversity conservation.
  - Promoting studies addressing the economic valuation of biodiversity and conducting systematic reviews and analyses of available studies in Spain.
  - Creating lists of and mapping ecosystem services in Spain.
  - Improving mechanisms for communication with society related to biodiversity.
  - Promoting the consideration of biodiversity and ecosystem services, including their economic value, in the design of the policies of the General State Administration.
  - Encouraging the consideration of biodiversity and ecosystem services, including social and economic values, in the activities of Spanish institutions.
  - Developing environmental indicators related to human

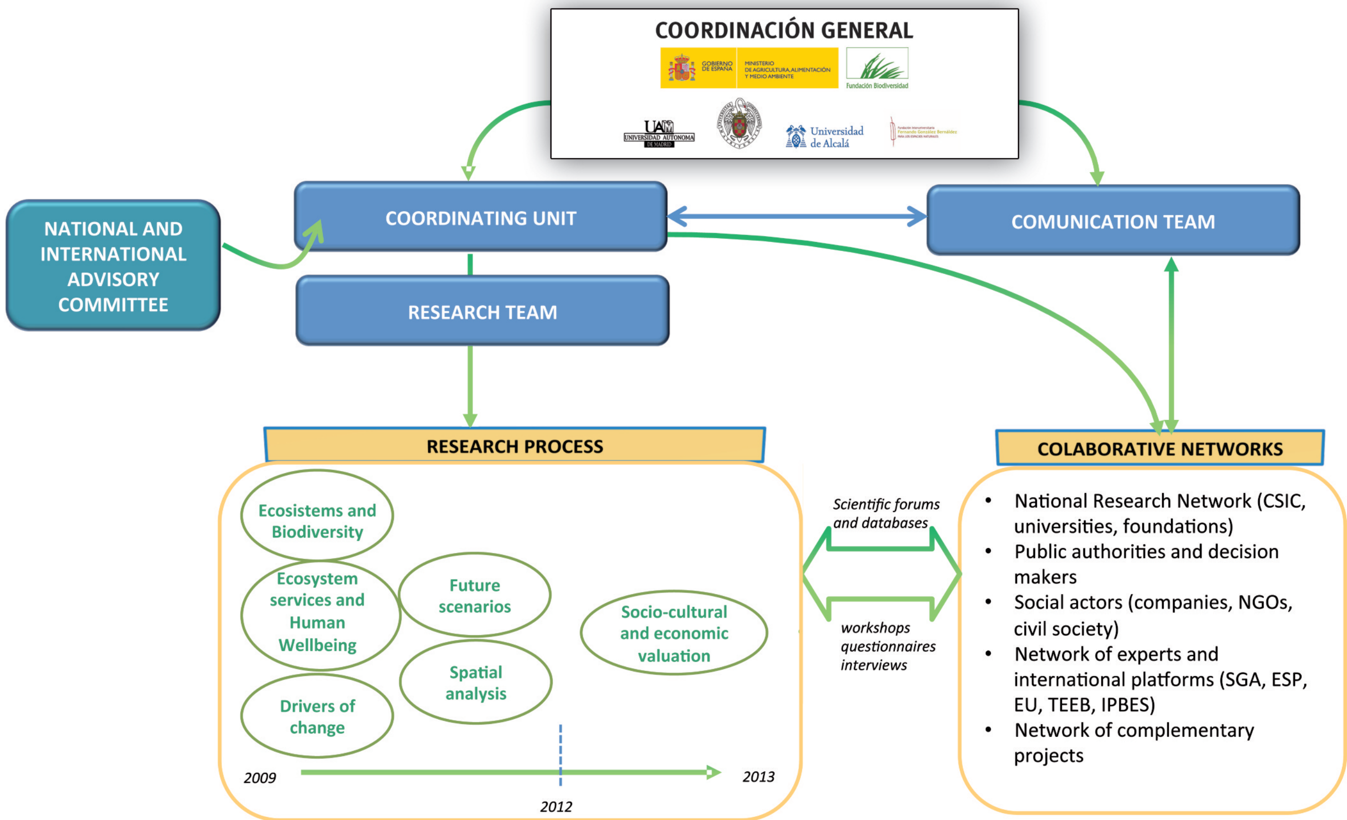


Figure 5. The organizational structure designed to achieve the objectives of the project, including social communication and public awareness at different levels. The results are designed for managers, the business sector, association networks, NGOs and civil society in general.

wellbeing in addition to the gross domestic product for incorporation into social and political debates.

- Providing information for the implementation of Law on Natural Heritage and Biodiversity 42/2007 and Law for Sustainable Rural Development 45/2007.
- Providing socio-ecological information on specific habitat types to establish Special Areas of Conservation in communities under Natura 2000.
- Providing information for the development of the Water Framework Directive of the EU.

It also fits into an evolving **international policy** framework for compliance with a number of obligations conventions and agreements, including the following:

- **European Biodiversity Strategy (2020):** Action 5 of the EU Biodiversity Strategy extending to 2020 calls Member States to map and assess the state of ecosystems and their services in their national territory with the assistance of the European Commission. A Working Group on the Mapping and Assessment of Ecosystems and their Services (MAES) was established in 2011 as an important element to link National Strategies and Action Plans (NBSAPs) with the European-level Biodiversity Strategy extending to 2020. Since its implementation, representatives of the Spanish NEA have been actively collaborating with the objectives of the MAES Working Group to support the implementation of Action 5. The first action of the Working Group was to support the development of a coherent analytical framework to be applied by the EU and its Member States to ensure that consistent approaches are applied (EU, 2013). The results of this mapping and assessment should support the maintenance and restoration of ecosystems and their services.
- **Intergovernmental Platform on Biodiversity and Ecosystem Services:** At a future date, a sub-global assessment will be undertaken as a contribution to the development of the IPBES process. The work of the Spanish NEA has already been included in the "Assessment Catalog" and is an important stepping stone for the future assessment, including strengthening the science-policy interface, building on existing knowledge and institutions.
- **Convention of Biological Diversity:** invites the parties to promote and support national assessments of ecosystems and

biodiversity, including response frameworks based on existing experience, such as the MA. The Spanish NEA provides up-to-date information for the country to follow the process and meet international goals.

- **Millennium Ecosystem Assessment Follow-Up.** Since the MA's completion in 2005, a variety of initiatives have been implemented to follow-up on the findings and achievements of the MA. A global Strategy for on MA Follow-up has been developed by a group of partner organizations, with overall coordination being provided by UNEP. Within the context of the global strategy for MA follow-up and taking account the lessons learned from the original MA process, the Spanish NEA was approved as a new sub-global assessment in 2012 and has been in constant collaboration with the SGA network.

Organizational structure

Approximately 60 researchers from different disciplines in the ecological and social sciences and from more than 20 universities and research centers working under the same conceptual and methodological framework have contributed to the assessment, providing scientific information on the consequences of changes in ecosystems and biodiversity for human wellbeing in Spain during the last five decades. The assessment also promotes a process involving multiple parties and interest groups, such as the government, academics, expert staff, NGOs and the private sector, thus contributing to the development of the project through generating ideas, providing information and reviewing documents or disseminating their results.

The overall coordination of the National assessment is organized around two main units: a scientific unit and a communication and management unit. Both of these units are in constant communication and, in turn, are interconnected with a collaboration network of research centers, government agents, policy makers, companies, NGOs, civil society, experts and international platforms as well as the networks of complementary projects.

A national and international scientific advisory committee for the project has been put in place to ensure the robustness of the results. This unit has developed a research process that is being carried out by a large team of scientists and experts from both the biophysical and social sciences and draws on several lines of inquiry. These lines of inquiry have been followed since 2009, starting from the biophysical basis of the investigation of ecosystems, biodiversity, the ecosystem services provided, their impact on human wellbeing and the effect of the drivers of change. In the second phase, future scenarios and spatial analyses have been developed. Presently, the project is working on the socio-economic valuation of ecosystem services in Spain. As shown in the Figure 5, the research process has been fed by databases, workshops, interviews and questionnaires as well as interactions with existing scientific forums and networks conducting ecosystem service assessments.

BOx 3. Questions addressed under the Spanish National Ecosystem Assessment

Ultimately, the Spanish NEA must address a broad range of policy questions. This list of questions has been selected with the purpose of helping society in general and decision makers in particular to better understand the links between Spanish conservation policies and international and European policies.

1.- How is biodiversity changing in Spain?

2.- What is the status of trends occurring in Spanish ecosystems and the services they provide to society?

3.- What are the main direct drivers of change for Spanish ecosystems and their services?

4.- What are the underlying causes of ecosystem degradation in Spain?

5.- How do ecosystem services affect human wellbeing, and who are the beneficiaries?

6.- How can we integrate a multiscalar approach into national ecosystem assessments?

7.- What is the Spanish public´s current understanding of ecosystem services, and how can we communicate our main results?

8.- How might ecosystems and their services change in Spain under plausible future scenarios?

9.- How can we initiate a transition to socio-ecological sustainability in Spain?

1 HOW IS BIODIVERSITY CHANGING IN SPAIN?

Revealing the values underlying biodiversity conservation in Spain

KEY FINDINGS

- **Biodiversity is an essential component of ecosystems and is therefore key to the wellbeing of Spanish society due to its ability to generate services. Among the components of biodiversity, the functional diversity associated with microorganisms, vegetation and invertebrates is the most important because it contributes most to the provision of ecosystem services in Spain.**

- **The goal of biodiversity conservation from the perspective of intrinsic values has led to political, social and scientific attention being focused on particular taxonomic groups, especially on large vertebrates, hence, ignoring those taxa (microorganisms, fungi, vegetation and invertebrates) that are responsible for providing most ecosystem services and agro-biodiversity (genetic diversity associated with human uses).**

- **Spain failed to achieve the goal of reducing the rate of biodiversity erosion for 2010, despite the significantly improvement of conservation policies in response to increased social awareness of the problem. In fact, the rate of biodiversity losses in Spain in the last 50 years have been similar to those found at a global or European scale.**

- **Spain has a great responsibility to preserve ecosystem services in a European context, as it is the largest reservoir of wild species in Western Europe.**

How we perceive biodiversity determines how we conserve it. In Spain, the conservation debate has mainly been guided by the intrinsic value of biodiversity, that is, the human moral obligation to preserve nature because of the right of non-human species to exist. Intrinsic value indicates that biodiversity has value in itself and is valued as an end in itself, independent of its usefulness. This motivation for conserving biodiversity usually obscures its instrumental value, which assumes that biodiversity is valuable only as a means or tool for achieving human welfare and wellbeing. Instrumental value lies not in the object itself but in its current uses or potential uses. This dichotomy of biodiversity values constitutes the core of modern environmentalism in western cultures. However, the conservation debate in Spain is moving away from biocentric ethics, which refer to the promotion of conservation on the basis of the idea that all living beings possess intrinsic value, to anthropocentric arguments, which indicate that biodiversity conservation should be supported as a tool for improving human quality of life through the delivery of ecosystem services.

In this debate, the main issue is whether the two approaches for biodiversity conservation are complementary (Martín-López and García-Llorente 2013). Here, if we consider that our relationship with nature is innate to human evolutionary history, then we should conclude that all humans have an innate need to connect with nature from both dimensions, that is, utilitarian and ethical. In fact, the Millennium Ecosystem Assessment (MA 2005) acknowledges that people can make decisions concerning biodiversity based on their own wellbeing and that of others as well as based on ethical concerns related to species, thus recognizing both instrumental and intrinsic values.

Therefore, biocentric and anthropocentric arguments should coexist in strategies aimed at biodiversity conservation. However, biodiversity conservation policies in Spain have mostly been guided by biocentric arguments that, ultimately, depend upon certain factors promoting human affection towards species. If intrinsic values have been responsible for most Spanish biodiversity conservation policies, have these conservation policies been biased towards those species that evoke positive feelings in humans?

Recent scientific research has demonstrated that specific likeability factors, such as particular physical traits (e.g., body size or eye size) as well as whether a species is phylogenetically closed to humans, play an important role in defining species conservation policies in Spain (Martín-López et al. 2011). In fact, during the years 2003-2007, 89% of total species conservation funds were invested in vertebrates, particularly in birds and

mammals, which received 79.6% of the total budget. As a consequence, the majority of species (i.e., invertebrates, vegetation, fungi and microorganisms) that are critical for maintaining ecosystem services are underrepresented in priority-setting schemes for conservation.

STATUS AND TRENDS OF BIODIVERSITY IN SPAIN

Systematic national assessments of threatened species have only been carried out for a few taxonomic groups, such as vertebrates and vegetation, in recent years, and the proportion of species evaluated in each taxonomic group differs greatly from their representation in Spanish specific diversity. Vertebrates are the taxonomic group in which the highest proportion of species has been assessed based on the criteria of the Red Lists. Assuming that it is impossible to assess extinction risks for all taxa, the Spanish Ministry of Agriculture, Food and the Environment has recently expanded its assessments of endangered status to more taxonomic groups, such as bryophytes.

Despite the fact that vertebrates are the taxonomic group receiving the most political and scientific attention, their extinction rates in Spain are slightly higher than global trends. While the proportion of vertebrates threatened at a global scale in 2010 was approximately 20% (Hoffmann et al. 2010), in Spain, 23.6% of vertebrate species are categorized as critically endangered, endangered or vulnerable based on national assessments (Figure 1.1). Most of these threatened terrestrial vertebrates occur in Mediterranean forests and mountain ecosystems or agroecosystems (see Box 1.1).

The Red List status of species provides a snapshot of what is happening to the assessed taxa at a given time, but it cannot provide information about trends. However, the Red List Index can be used to compare the proportion of species in different categories over time. Calculation of the Red List Index for vertebrates shows an increase in the proportion of threatened species since 1986 (Figure 1.2).

While much less is known about other taxonomic groups as well as marine organisms, on the basis of the National Catalogue of Threatened Species and the National Red List Assessment, we found that of the species assessed in Spain, between 40% and 68% are threatened, respectively.

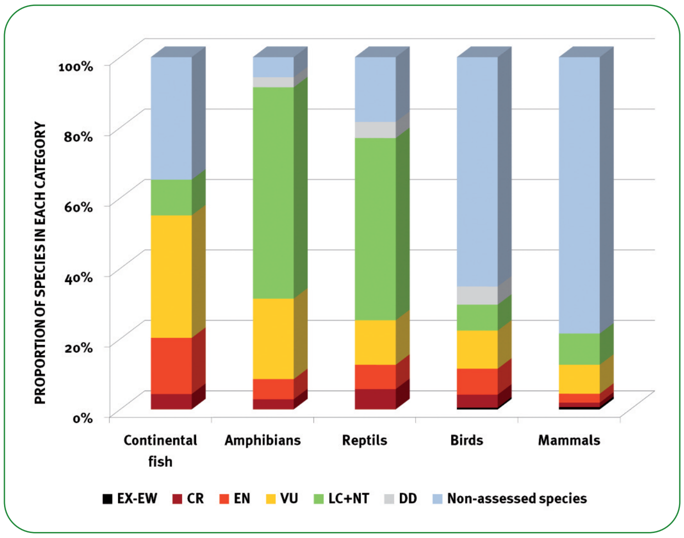


Figure 1.1 Proportion of endangered vertebrates in Spain according to national assessments. (EX: extinct; EW: extinct in the wild; CR: critically endangered; EN: endangered; VU: vulnerable; LC: least concern; NT: near threatened; DD: data deficient). (Sources: Doadrio et al. 2001, Martí and del Moral, 2003, Pleguezuelos et al. 2004, Palomo et al. 2007).

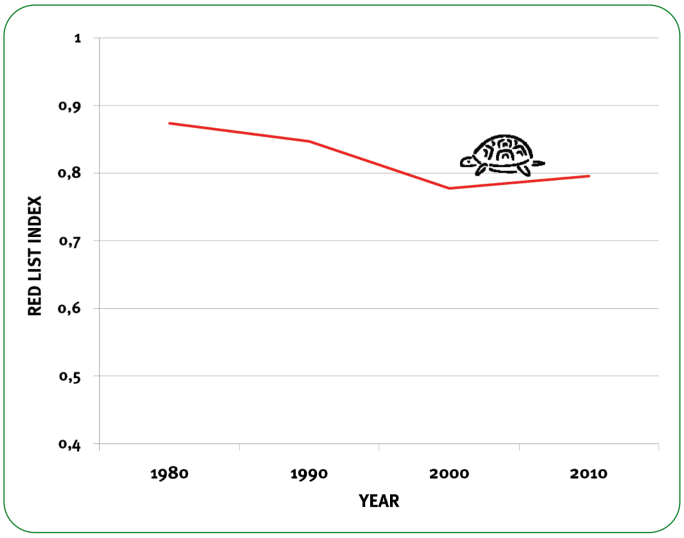
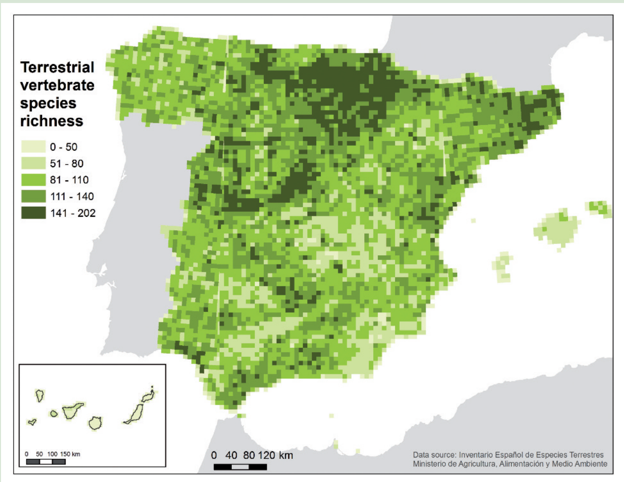
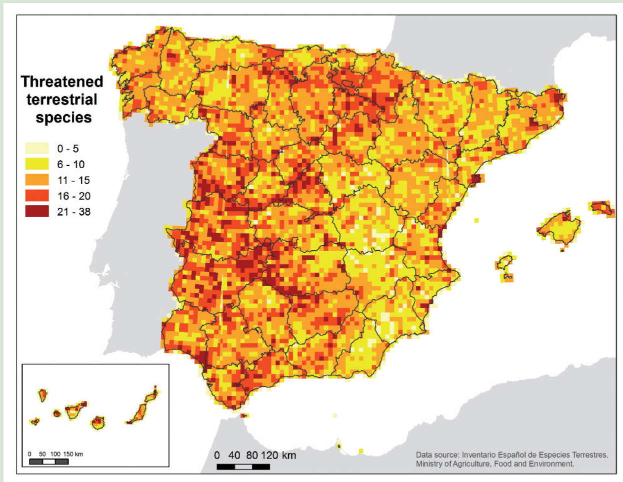


Figure 1.2 Trend of the Red List Index for Spanish vertebrates (N=233). (Data Sources: 1.Blanco and González (1992) 2. Bubb et al. (2009) 3.Doadrio I (2001) 4.ICONA (1986) 5. Martí R, Moral JC (2003) 6. Morales J, Lizana M (2011) 7.Palomo JL, (2007) 8.Pleguezuelos JM, Márquez R (2004).

Box 1.1. Spatial distribution of terrestial Spanish biodiversity

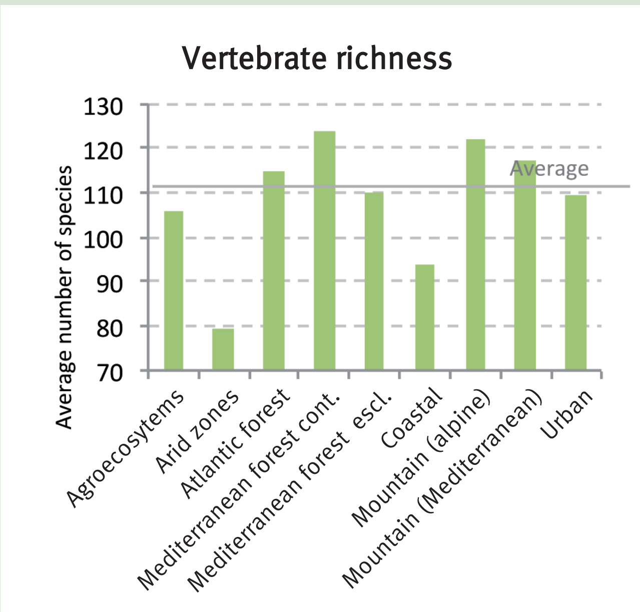
Based on data from the National Inventory of Biodiversity **(Ministry of Agriculture, Food and Environment, 2007)**, the spatial distribution of biodiversity by taxonomic groups is presented. This distribution shows the species richness and the number of threatened species of terrestrial vertebrates in each grid of 5 km x 5 km covering the Iberian Peninsula and the Balearic and Canary Islands.

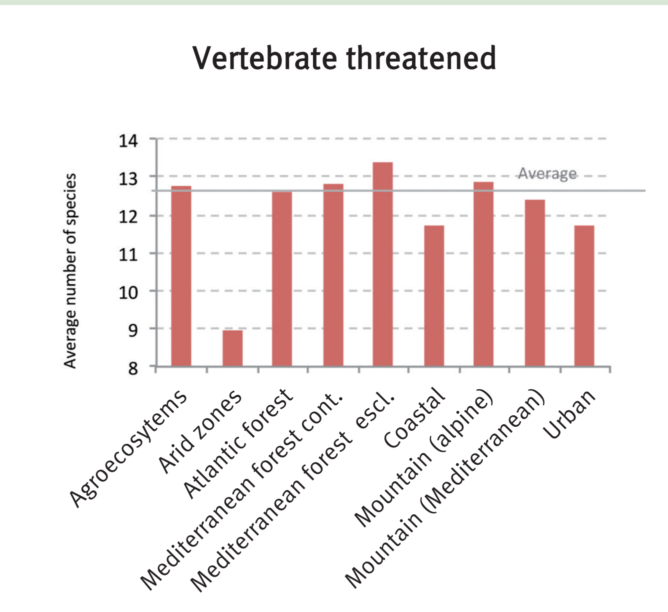




Spatial distribution of terrestrial vertebrates in Spain. (Source: Spanish inventory of terrestrial species. Ministry of Agriculture, Food and Environment, 2007).

There is a positive association between the above two maps, indicating that in areas where there are many species of vertebrates, there are also many endangered vertebrate species. These results highlight the fact that there is a clear bias in the spatial biodiversity data because there are some areas in which there have been a greater efforts to study biodiversity than others. This spatial pattern shows that forest and mountain ecosystems exhibit the greatest species richness and number of threatened species of vertebrates. In contrast, coastal and arid ecosystems display the lowest levels of vertebrate richness and threatened species.





The figure was developed through an GIS-analysis that based on an overlay of the map with ecosystem types with the map of species occurring calculated the average richness and number of threatened species occurring in each ecosystem.

In addition, the **genetic diversity of domesticated animal species has suffered considerable erosion.** According to the UN Food and Agriculture Organization's Global Databank for Spain, of the approximately 215 autochthonous animal breeds for which sufficient data are available, **48% are considered at risk, and a further 8% have become extinct** (Figure 1.3). Most of this deterioration of genetic diversity has occurred because of the intensification of farmland systems, in addition to the abandonment of traditional farming practices. In fact, we found that land-use change is the most important direct driver of change affecting the state of biodiversity in Spain. Thus, in line with global assessments (MA, 2005; Pereira et al. 2012), **the driver of land-use change has a much greater effect than the impacts of the other four drivers of change (i.e., pollution, over-exploitation, invasive alien species, or climate change)** (Figure 1.4).

In addition, it is well-known that in Mediterranean ecosystems, intermediate conditions of disturbance (i.e., multifunctional landscapes) are related to high levels of species diversity (García-Llorente et al. 2012). However, the multi-functionality of Mediterranean agro-silvo-pastoral systems is declining due to landscape homogenization as a result of landscape intensification, rural abandonment, and strict conservation policies, which, in turn, can result in decreases in biodiversity and ecosystem services (Box 2.1) (García-Llorente et al. 2012). **Consequently, biodiversity management policies should stimulate the revitalization of traditional rural practices and value the role of local communities as 'sculptors' of landscapes that promote high levels of species diversity, maintenance of genetic diversity, and the preservation of a diverse set of ecosystem services.**

RELATIONSHIPS BETWEEN BIODIVERSITY AND ECOSYSTEM SERVICES

This loss of specific and genetic diversity is inextricably linked to the deterioration of ecosystem services because of the important functional role that biodiversity plays in the processes that underpin ecosystem services. A review of the evidence of links between biodiversity and the delivery of ecosystem services shows that the **functional role of microorganisms, fungi, vegetation and invertebrates is the main component of biodiversity that influences the delivery of ecosystem services** (Table 1.1). However, this is the component of biodiversity receiving the least social, scientific and political attention (Martín-López et al. 2011). Consequently, **there is a need to improve Spanish monitoring, scientific, and conservation programs to incorporate the components of biodiversity with a high capability to supply ecosystem services.**

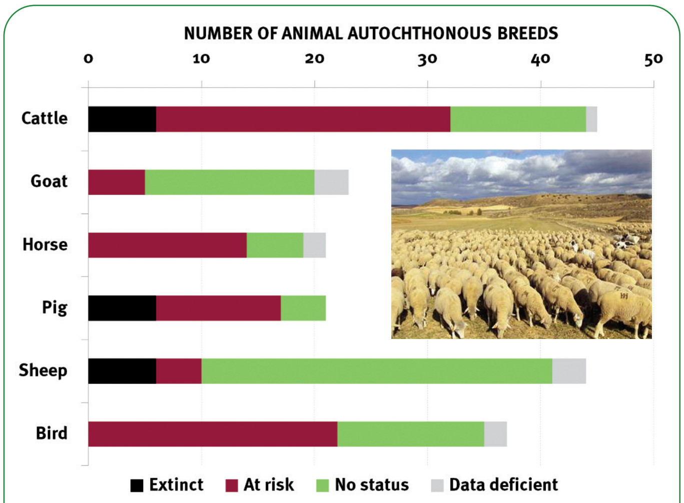


Figure 1.3 Proportion of threatened autochthonous animal breeds in Spain according to the UN Food and Agriculture Organization's Global Databank (www.dad.fao.org/).

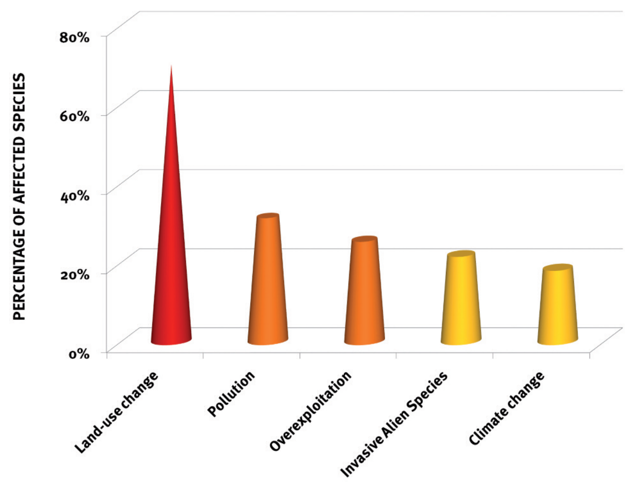


Figure 1.4. Proportion of species in Spain affected by the direct drivers of change.

Berta Martín-López

Table 1.1 Links between the delivery of ecosystem services and biodiversity, considering both the organizational level of biodiversity and the main taxonomic groups involved. Modified from Martín-López and García-Llorente (2013).

Ecosystem services	Organizational level at which biodiversity is involved	Main taxonomic groups involved
Provisioning		
Food	Genes, species populations, communities	Mainly vegetation (plant crops, wild fruits, etc.), fish, birds, mammals. In specific cases, fungi, invertebrates, and other vertebrates
Medicine	Genes, species populations	Microorganisms, fungi, vegetation, and animals
Regulating		
Micro-climate regulation	Communities, functional groups	Vegetation
Air purification	Species populations, functional groups	Microorganisms, vegetation
Water depuration	Communities, functional groups	Microorganisms, vegetation, and aquatic invertebrates
Hydrological regulation, erosion control and flood mitigation	Species populations, communities, functional groups	Vegetation
Soil fertility	Communities, functional groups	Soil microorganisms, nitrogen-fixing plants, soil invertebrates, and waste products of animals
Pollination	Species populations, functional groups	Insects, birds and mammals
Cultural		
Recreation activities and nature tourism	Species populations, communities.	Vegetation, fish, birds, mammals.

DEPICTING THE FUTURE OF BIODIVERSITY CONSERVATION IN SPAIN

Justifying conservation exclusively based on ethical considerations about the right of species to exist (i.e., intrinsic value) ignores an important motivation for preserving species: the importance of biodiversity as a source of human wellbeing through the delivery of ecosystem services (i.e., instrumental value). Consequently, **the two approaches should co-exist in Spanish policies aimed at biodiversity conservation.**

Despite the large body of evidence indicating strong links between biodiversity and ecosystem services, the taxonomic bias in the available scientific information prevents us from assessing the specific role of the different components of biodiversity in the delivery of ecosystem services. Therefore, **there is a need to extend the research objectives of scientific programs to less-studied taxonomic groups as well as to emphasize the functional role of biodiversity (i.e., functional diversity).** In addition, conservation programs should focus on preventing the continued effects of drivers of change, particularly those related to land-use change. **Thus, conservation programs should be embedded within landscape management policies to preserve multifunctional Mediterranean landscapes that promote not only high levels of biodiversity but also a diverse flow of ecosystem services.**

2 WHAT IS THE STATUS OF TRENDS OCCURRING IN SPANISH ECOSYSTEMS AND THE SERVICES THEY PROVIDE TO SOCIETY?

Evaluating our ecosystems and their services, evaluating our wellbeing

KEY FINDINGS

- Spanish ecosystems have changed dramatically over the past 50 years as a result of the uneven transformation of aquatic and terrestrial land uses, resulting in a disproportionate increase of artificial areas, rural abandonment and the intensification of some provisioning services via technology.

- Coastal, rivers and wetland ecosystems have been the most affected ecosystem types in terms of their original surface area. Within these types of ecosystems, alluvial plain forests and *Posidonia* sea grasses are the most threatened systems in terms of disappearance. Regarding ecosystem services, continental aquatic ecosystems and coastal areas are the systems that that have suffered the largest deterioration in their their ability to generate a flow of services contributing to human wellbeing. Forest and mountain ecosystems are the best conserved in terms of their functions in generating services.

- The failure of current conservation policies to manage the functions of ecosystems has resulted in the degradation or unsustainable use of 45% of the evaluated services. The most strongly affected type of services are regulating (87%) and provisioning (63%) services, while the least affected are cultural services (29%), especially those demanded by cities.

- A decoupling effect exists between urban and ecological systems that is promoting unsustainable use of services. Increasing urban population is promoting unsustainable demands for food, water, and cultural services related to recreation. Consequently, important regulating services and traditional cultural services associated with rural areas are declining.

- The "natural capital" of Spain should be conceptualized as a mosaic of interdependent terrestrial and aquatic ecosystems, to be managed as a whole under a holistic approach based on the recognition of the secular co-evolution of natural and cultural processes.

The rapid and intense transformations that Spain has undergone during the past 50 years have led to important losses of species as well as to alterations of most types of ecosystems and their functions, which have reduced their capacity to generate services to society. Some ecosystems have shown rapid increases in surface area, as in the case of artificial urban systems and the associated infrastructure, while other natural systems have increased at a more moderate rate, as in the case of forest and mountain ecosystems. However, some ecosystems have shown a dramatic reduction of surface area, such as wetlands, alluvial plain forests and coastal ecosystems, whereas others have decreased in a more moderate manner, such as arid zones and agroecosystems. Figure 2.1 shows the impact the degradation of different types of ecosystems has had on their capacity to generate services for society.

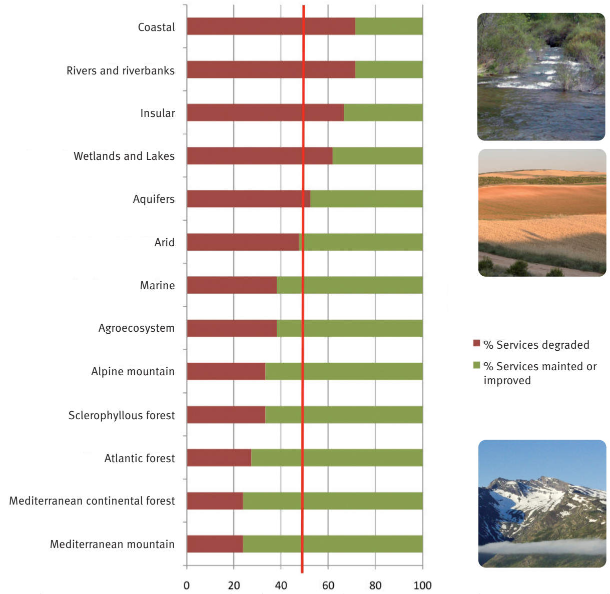


Figure 2.1 There is a clear relationship between the alteration of the structure and functioning of the ecosystems of Spain and their capacity to generate services, expressed as the percentage of services that have been degraded or are being managed unsustainably (in red) and those that have been maintained or improved (in green). The red line represents the 50% level.

The Appendix summarizes the assessment of the status and trends of services provided by the 14 ecosystem types considered. The following is a summary of the most relevant characteristics of each of the ecosystem types assessed in the SNEA.Results of the assessment for each ecosystem type, can be shown in Table 2.1 with the actual status and trends of the 22 ecosystem services evaluated.

Atlantic and Mediterranean forests currently cover 22.5 Mha (44%) of the national territory. In recent decades, this area has increased due to rural abandonment. These ecosystems provide a diverse and varied flow of ecosystem services, with an increasing trend being observed in most of the assessed services and the only exception being cultural services enjoyed by the rural population, which have shown a clear declining trend. Although these areas have been protected by different policies in recent years, the main drivers of change in these ecosystems are associated with land-use transformations associated with the introduction of plantations of exotic species, especially in the northern part of the Iberian Peninsula.

Mountain ecosystems cover a total area of 3.3 Mha (7%) of the national territory and were assessed as one of the better-conserved systems due to the high rates of protection of these areas. Therefore,

Table 2.1 Results of the assessment for each ecosystem type, showing the actual status and trends of the 22 ecosystem services evaluated. Arrows represent the relative importance and the trends of the flows of the 22 ecosystem services evaluated for the last five decades (1960-2010). The information was obtained through a specific analysis of individual indicators for each ecosystem type, together with expert judgments.

Type of Service	Service	Atlantic forest	Sclero-phyllous forest	Medit. contin. forest	Alpine mountain	Medit. mountain	Rivers and riversbanks	Wetlands and Lakes
PROVISIONING	1. Food	↘ High	↗ High	↔ High	↔ High	↗ High	↘ Low	↘ High
	2. Water	↗ High	↔ High	↗ High	↗ High	↑ High	↘ High	↓ Medium-High
	3. Biotic Materials	↗ Medium-High	↔ Medium-Low	↘ Medium-High	↓ Medium-High	↗ Medium-High	↑ Medium-Low	↓ Medium-High
	4. Geotic Materials	↓ Low	↔ Low	↘ Medium-Low	↘ Medium-Low	↔ High	↓ Medium-Low	↗ Low
	5. Renewable Energy	↑ High	↔ Medium-Low	↗ Medium-High	↗ Medium-High	↗ Medium-High	↔ High	↔ Medium-Low
	6. Gene pool	↔ Medium-High	↘ High	↔ High	↗ High	↓ High	↘ High	↓ Medium-Low
	7. Natural medicine	↓ Low			↘ Low	↘ Low	↓ Low	↗ Medium-High
REGULATING	8. Local & Regional	↗ High	↑ High	↑ High	↔ High	↘ Medium-High	↘ High	↓ Medium-High
	9. Regulation of air quality	↗ Medium-High	↗ Medium-High	↗ Medium-High	↔ Medium-High	↔ Medium-High	↘ High	↓ Medium-High
	10. Water regulation	↔ High	↘ High	↔ High	↘ High	↘ High	↘ High	↓ High
	11. Maintenance of soil erosion	↗ High	↘ High	↔ High	↔ Medium-High	↔ Medium-High	↘ High	↓ Medium-High
	12. Maintenance of soil fertility	↔ Medium-High	↘ High	↔ High	↘ High	↗ Medium-High	↘ High	↓ Medium-High
	13. Regulation against hazards	↔ Medium-High	↔ Medium-High	↔ High	↔ High	↔ High	↘ High	↓ High
	14. Biological control	↔ Medium-Low		↗ Medium-Low	↘ Medium-Low	↓ Low	↘ Medium-High	↓ High
	15. Pollination	↔ Medium-High		↗ Medium-Low	↗ Low	↔ Medium-Low		↓ Medium-Low
CULTURAL	16. Scientific knowledge	↑ Medium-High	↗ Medium-High	↗ Medium-High	↑ Medium-High	↗ Medium-Low	↑ Medium-High	↗ High
	17. Local ecological knowledge	↑ High	↔ High	↑ High	↑ High	↗ High	↑ High	↑ High
	18. Sense of place or cultural	↔ High	↔ High	↘ High	↗ High	↔ Medium-High	↑ High	↑ Medium-High
	19. Spiritual and religious	↑ Medium-High	↗ Medium-High	↗ Medium-High	↗ Medium-Low	↔ Medium-High	↗ Medium-High	↗ Medium-High
	20. Aesthetic enjoyment	↓ Medium-High	↘ High	↓ High	↘ High	↘ High	↘ Medium-High	↘ Medium-High
	21. Recreational activities	↘ Medium-High	↔ Medium-High	↘ Medium-High	↗ Medium-High	↗ Medium-High	↓ Medium-High	↓ Medium-High
	22. Environmental education	↑ Medium-High	↔ Medium-Low	↑ High	↗ Medium-High	↑ Medium-High	↑ Medium-High	↑ High

Importance of service: Low Medium-Low Medium-High High

Trend of service: ⇧ Improvement ⇗ Tendency to improve ⇔ Mixed trend ⇘ Worsening trend ⇩ Worsens

Blank cells mean that the service has not been assessed or is not applicable to a particular type of ecosystem

most of the ecosystem services assessed have either been maintained (i.e., provisioning) or improved (i.e., cultural services, such as recreational activities) during the last several decades. Direct drivers, such as land-use change, are decreasing due to this level of protection, although climate change is taking on particular relevance as a factor underlying change in these ecosystems.

Agroecosystems are the largest type of ecosystem, covering 22 Mha (43%) of the national territory. In recent decades, these areas have undergone major transformation as a result of political and economic changes at the European level. While agricultural areas in Spain have decreased since its entry into the EU, total production has increased slightly. This process has been possible due to the intensification of agricultural production, which has led to changes in the nitrogen cycle, soil and water pollution and over-exploitation of groundwater. All of these factors have resulted in a significant impact on the flow of traditionally managed provisioning services and cultural services enjoyed by the rural population.

Inland aquatic ecosystems only represent 0.5% of the national territory (252,322 ha), as these systems have been the most affected in terms of their original surface area and the disappearance of ecological functions (i.e., 60% of the original areas of wetlands have been degraded, and 93% of alluvial flood plains have been deforested). Therefore, these systems have undergone considerable degradation of most of their services, with the only exception being cultural services enjoyed by the urban population. In fact, they are the only ecosystems that have suffered the intense synergistic effect of at least three direct drivers of change: land-use change, pollution and over-exploitation of water.

Type of Service	Service	Aquifers	Coastal	Marine	Insular	Arid	Agroeco-systems	Urban
PROVISIONING	1. Food		↓ High	↓ High	↓ High	↓ Low	↑ High	↓ Medium-Low
	2. Water	↘ High	↓ Medium-High	↑ High	↓ High	↔ Low	↔ Low	↔ Medium-Low
	3. Biotic Materials	↓ Medium-Low	↓ Low	↗ Low	↔ Medium-Low	↓ Medium-High	↘ Medium-Low	↔ Medium-Low
	4. Geotic Materials	↗ High	↘ Medium-Low	↔ Medium-Low	↓ Medium-Low	↓ Medium-High		↘ Low
	5. Renewable Energy	↗ Medium-High	↔ Medium-High	↗ Medium-Low	↗ High	↔ Medium-High	↔ Medium-Low	↘ Medium-Low
	6. Gene pool		↓ Medium-High			↓ Medium-High	↓ High	
	7. Natural medicine	↔ Low		↗ Low		↓ Medium-High	↓ Low	
REGULATING	8. Local & Regional	↔ High	↔ High	↔ High	↓ High	↔ Medium-Low	↔ High	↓ Low
	9. Regulation of air quality		↔ High	↔ Low		↔ Medium-Low	↔ Low	↓ Medium-High
	10. Water regulation	↘ High	↓ High	↔ High	↓ High	↔ Medium-Low	↑ Medium-High	↓ Medium-High
	11. Maintenance of soil erosion	↘ Medium-High	↓ High	↓ High	↓ High	↓ Low	↓ High	↓ Medium-Low
	12. Maintenance of soil fertility	↘ Medium-High	↘ Medium-High	↘ High	↓ High	↓ Low	↓ High	↓ Low
	13. Regulation against hazards	↘ High	↓ High	↘ Medium-High	↓ High	↓ Medium-High	↔ Medium-Low	↓ Low
	14. Biological control	↘ Low	↓ High	↘ Medium-Low	↓ High	↓ Medium-High	↑ Medium-High	
	15. Pollination						↘ High	
CULTURAL	16. Scientific knowledge	↑ High	↑ Medium-High	↑ Medium-High	↑ Medium-High	↗ Medium-High	↗ Medium-High	↔ Medium-Low
	17. Local ecological knowledge	↑ Medium-High	↑ High	↑ High	↑ Medium-Low	↗ Medium-High	↑ High	↓ Medium-High
	18. Sense of place or cultural	↗ Medium-Low	↘ Medium-High	↑ Medium-High	↓ High	↗ High	↗ High	↓ Medium-High
	19. Spiritual and religious	↗ Medium-High	↘ Low	↗ Medium-High	↓ High	↔ Low	↗ Medium-High	
	20. Aesthetic enjoyment	↓ Medium-High	↘ Medium-High	↘ Medium-High	↔ High	↓ Medium-High	↘ Low	
	21. Recreational activities	↗ Medium-Low	↘ Medium-High	↘ Medium-High	↑ Medium-High	↑ High	↓ Medium-High	↑ Low
	22. Environmental education	↑ Medium-High	↗ Low	↗ Medium-Low	↑ Medium-High	↔ Medium-High	↗ Medium-High	↑ Medium-High

Importance of service: Low Medium-Low Medium-High High

Trend of service: ⇧ Improvement ⇗ Tendency to improve ⇔ Mixed trend ⇘ Worsening trend ⇩ Worsens

Arid zone ecosystems currently represent 1% of total national territory, though all forecasts estimate that their area is going to increase in the following decades. These ecosystems have suffered progressive degradation of all services, with regulating services being particularly severely degraded, despite the high percentage of their area protected, and provisioning services have been increasingly dependent on external ecosystems. This may be due to the synergistic effects of land-use changes and climate change.

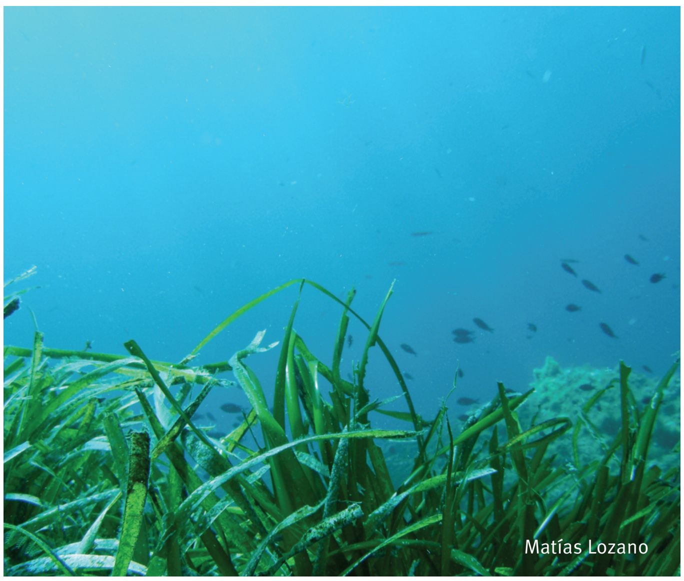
Coastal and island ecosystems represent 2.5% (1.4 Mha) of the total national territory. Land use changes and alterations have been the most important drivers associated with the massive coastal urbanization process (i.e., almost 60% of the coastline has been artificialized), resulting in a considerable impact on their capacity to provide ecosystem services to the surrounding people. The evaluation results show that these areas have suffered important pressures, manifested in the loss of traditional provisioning services and cultural services enjoyed by the local population.

Marine ecosystems represent 71% of the territory under Spanish jurisdiction and constitute a source of valuable services. However, the knowledge we have of these systems is very limited. There is inertia regarding considering the sea to be an endless source of services and an unlimited waste dump. Therefore, the oceans have experienced increases in the use of 80% of the services assessed, such that the capacity of marine ecosystems to perform functions that provide services to the human population has been altered, potentially affecting the same services. In particular, more than half of Spanish fishing grounds are fished beyond safe biological limits of sustainability, and 5% of the area of Posidonia sea grasses is lost annually.

Urban ecosystems represent 2% (1.1 Mha) of the national territory. Their area has grown exponentially in the last five decades. This ecosystem was included in the assessment with the other ecosystems due to its importance as a place where decisions can be made and ideas can be generated regarding changes in socio-ecological management. This system was assessed differently, merging the balance between the flow of ecosystem services and the level of consumption. As a result, it was concluded that we are increasing our dependency on ecosystems outside our borders for both provisioning and global regulating services. Pollution and urban expansion are the main drivers of change underlying the degradation of this ecosystem.

At the national level (integration of all ecosystem types), it can be summarized that 45% of the ecosystem services assessed show a declining trend, among which the most affected are the regulating (87%) and provisioning (63%) services, while cultural services are the least affected (29%). These results are consistent with those of other similar evaluations conducted (Portugal NEA, 2004), for example, in the United Kingdom (where 30% of the services assessed were found to be degraded, UK NEA, 2011) or globally (60%, MA, 2005). All of these studies agreed that market forces and globalization have heavily impacted the ecosystem and its capacity to generate services.

By assigning numerical values to each service according to the trends presented in Table 2.1 and thinking of these trends as the relative importance assigned to each service for a specific ecosystem type, results were simplified and synthesized into Figure 2.2, which shows the current status of individual ecosystem services at a national scale. Regulating services are the most affected group, with all services (with exception of climatic regulation) showing a declining trend. In particular, water quality and erosion control appear to be the most critical services. In contrast, some provisioning (i.e., intensified production of food and biotic materials) and cultural services associated with urban demand (i.e., recreational activities, scientific knowledge and environmental education) have improved in Spain over the last several decades (Figure 2.2). There is a clear trade-off of services depending on their demand: those that are associated with an urban lifestyle (i.e., production of biotic materials, recreation or environmental education) are increasing, while those that have traditionally been associated with the rural population have shown a reduced flow (i.e., traditional provisioning services, local ecological knowledge).


Matías Lozano

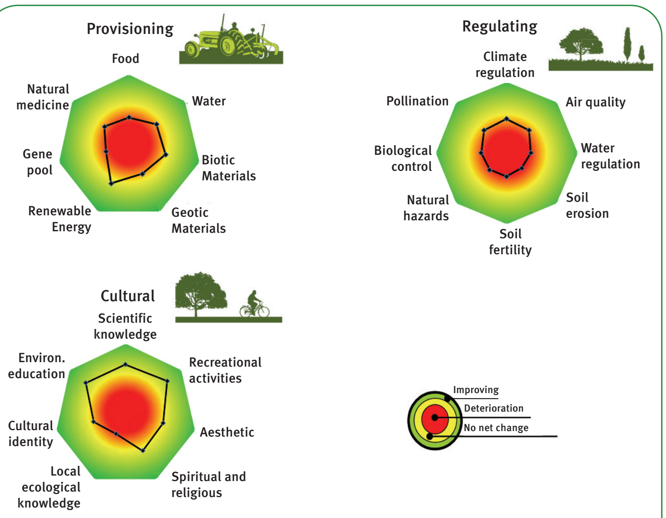


Figure 2.2 Synthesis of ecosystem services assessed at a national scale. The location of each point in the polygon represents the actual status of the service regarding its reference state (yellow band), which experienced either a greater increase (green band) or decrease (red band). With the exception of biotic materials and renewable energy, the provisioning services are either being degraded or do not show a clear trend. Regulating services are the most affected type, with nearly all such services being degraded. Cultural services associated with an urban lifestyle are the group that has experienced the greatest increase in the last several decades.

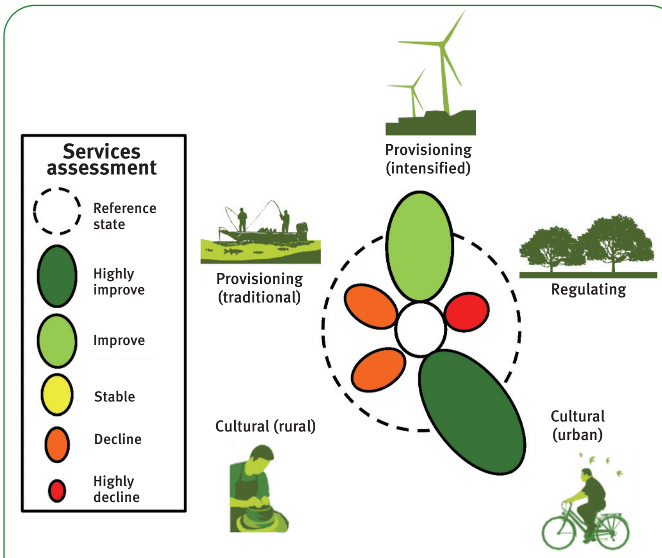


Figure 2.3 Summary of the assessment of ecosystem services at the national level grouped by categories. The dotted line represents the reference state for the period considered (1960-2010), and each color indicates the final status of each category, falling either below the reference line (orange and red) or above it (green). Those categories that have not experienced substantial variation in time are considered to have been stable during this period (yellow).

To detect general patterns in the trends and possible trade-offs of ecosystem services in the SNEA, we classified five types of ecosystem services: (i) traditional provisioning services (i.e., extensive agricultural production systems, such as organic agriculture, transhumant systems); (ii) technology-based provisioning services (i.e., intensive agricultural systems, such as greenhouses or fish farms); (iii) regulating services; (iv) rural cultural services (i.e., local ecological knowledge, cultural identity); and (v) urban cultural services (i.e., recreational activities, scientific knowledge). Following this classification, a synthesis of the general trends in these types of services at a national scale is provided in Figure 2.3 We can conclude that during the last 50 years, Spanish landscapes have been intensively altered due to human impacts on ecosystems, with land-use change being the most important driver of this transformation. The urban population has demanded increases in technology-based provisioning services and cultural services from cities, thereby degrading essential regulating and cultural services associated with spiritual enrichment, culture, local knowledge and rural populations and, most recently increasing our vulnerability to extreme events (water flows, fires, droughts or plagues). Thus, the loss of local ecological knowledge and the alteration of ecological processes and structures have an effect on the conversion of multifunctional landscapes (see box 2.3) into simpler and more monofunctional ones.

PROVISIONING SERVICES: SOURCES OF FOOD, WATER AND BASIC MATERIALS

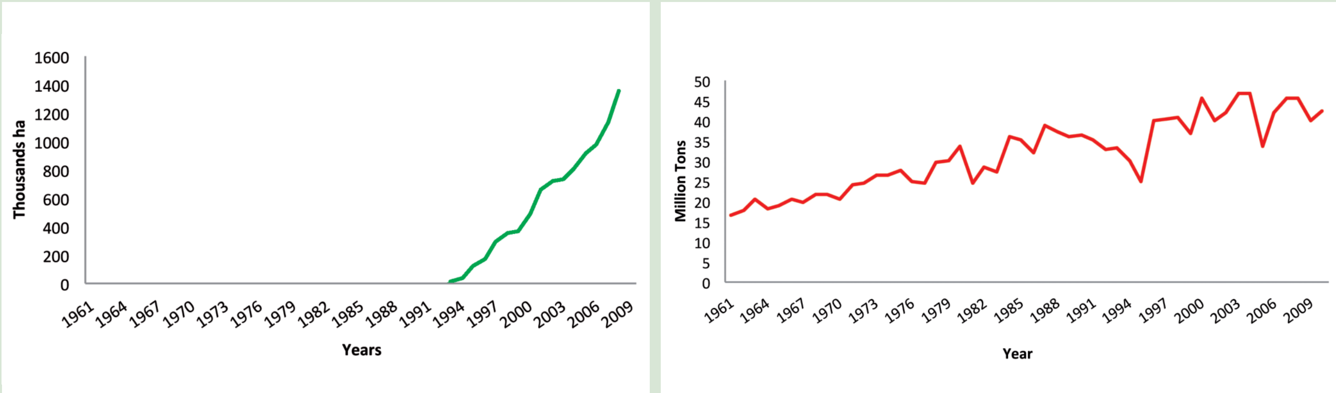
Provisioning services have experienced different trends depending on their base production systems (Box 2.1). Technology-based provisioning services (intensive agriculture and livestock, aquaculture and forestry) have progressively increased, while traditional provisioning systems based on traditional ecological knowledge (extensive agriculture and livestock production, traditional fishing, gathering wild foods) have deteriorated considerably in the last 50 years. Based on their level of importance, provisioning services were assessed differently for each ecosystem. However, the traditional provisioning services associated with nutrition and water were identified as the most important.

The ability of agroecosystems to provide a variety of food to the Spanish population appears to be secure, but with an important appers to be secure, but at the cost of the capacity to generate other ecosystem services, especially regulating services associated with water and soil. Spain has opted for an intensive agricultural model that is heavily subsidized, energy inefficient, and very demanding of provisioning services such as providing water, which is extracted in large amounts from river ecosystems and aquifers and is a major source of water and soil pollution.

Box 2.1 The need to change the agricultural model

Organic production systems are oriented at increasing the quality of products and processes related to the cultivation and processing of their products. However, restrictive legislation associated with this activity raises the costs of production and marketing. Consumers buy organic products mainly because they perceive benefits for their health, food safety and the environment (MARM, 2009).

Despite its limited importance compared to conventional agriculture, the area devoted to organic farming is increasing markedly, reaching over 1,400,000 ha in 2009 compared to only 17,200 ha in 1994. Cereal crops predominate (33%), followed by olives (22%), nuts (15%) and vines (9%), which suggests that this practice is being actively adopted as a means of adding value to more extensive Spanish agroecosystems, mainly in the region under a Mediterranean climate. Ecological livestock farms are also increasing. Their most prominent product is cattle, followed by sheep and goats. Andalucia, Baleares and Catalonia are the regions with the highest percentage of ecological farms.



Trends in the total production of (A) organic agriculture and (B) conventional agriculture regarding cereals, fruits and olives from 1960 to 2009 in Spain (Data source: Spanish national statistic institute, 2012).

REGULATING SERVICES- THE BASIS OF ECOLOGICAL FUNTIONING

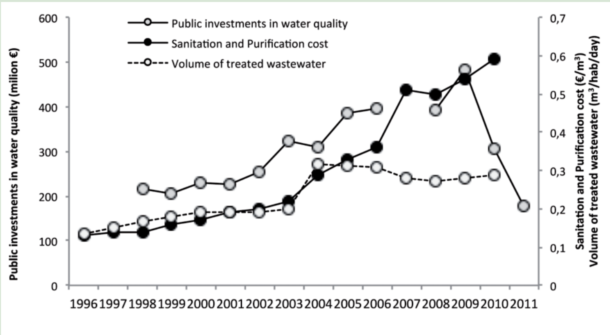
The analysis of the trend of regulating services indicated that all ecosystems, except for forest and mountain systems, are being degraded, most likely due to the pressure exerted by land use changes and pollution associated with human activity (Table 2.1). However, forest ecosystems have shown improvements in recent decades due to increases in non-productive areas as a result of the abandonment of rural agricultural areas. The improving trend of some basic regulating services (water quality, erosion control, water regulation, disturbance control) observed in recent years is mainly due to large capital investments of human origin that have come from both the public and private sectors to ensure conditions that provide for basic wellbeing in urban centers. Therefore, this process involves the technification of some regulating services due to the strong degradation they have suffered, which has been performed at a high cost for something that was previously provided free-of-charge by nature (Box 2.2). The constant and progressive degradation of ecosystem services is serious and alarming, as both provisioning and cultural services ultimately depend on the depend on the regulating services because they are related to the functioning of ecosystems, including the maintenance of their biodiversity. The loss or degradation of these services indirectly affects the link between ecosystems and human wellbeing, making it more vulnerable to crises and disruptions of natural or human origin.

BOX 2.2 Technology can provide some regulating services but at a high monetary cost

Technology attempts to compensate for the degradation of regulating services that would be performed naturally and free–of-charge by well-preserved ecosystems. Regulating services are the type of services that are declining most dramatically in Spain. For example, changes in land use, artificial surfaces and increases in irrigated land in flood plains in Spain have profoundly altered the natural mechanisms for controlling flooding as well as the ability of a river and its banks to act as "natural purification" system. In the last 20 years, the amount of urban waste has increased by 66%, while that of industrial waste has increased by 82%. Despite the 1,710 wastewater treatment plants that currently exist in Spain, it is barely possible to maintain an acceptable quality level in rivers because they fail to

control the pollution caused by fertilizers and pesticides applied to agricultural lands.

Investments made by the government over the last 10 years to maintain the water quality of rivers, have increased by 224%, and the cost for depuration has increased by 415%. In 2009, the Ministry of Environment, Rural and Marine Affairs spent almost 500 million Euros (41.7% of total investments of the Ministry) on infrastructure to improve water quality and treated waste water at a cost of 0.54 €/ m3. However, the current economic crisis in which we are immersed, leading to austerity, is already affecting public investment, resulting in the difficulty of maintaining the water quality of our rivers.



Trends of public investments in water quality; sanitation and purification costs and volume of water treated by wastewater treatment plants from 1996 to 2011. (Source: Spanish Ministry of Agriculture Food and Environment, 2011).

CULTURAL SERVICES: THE RESULT OF THE MEDITERRANEAN IDENTITY

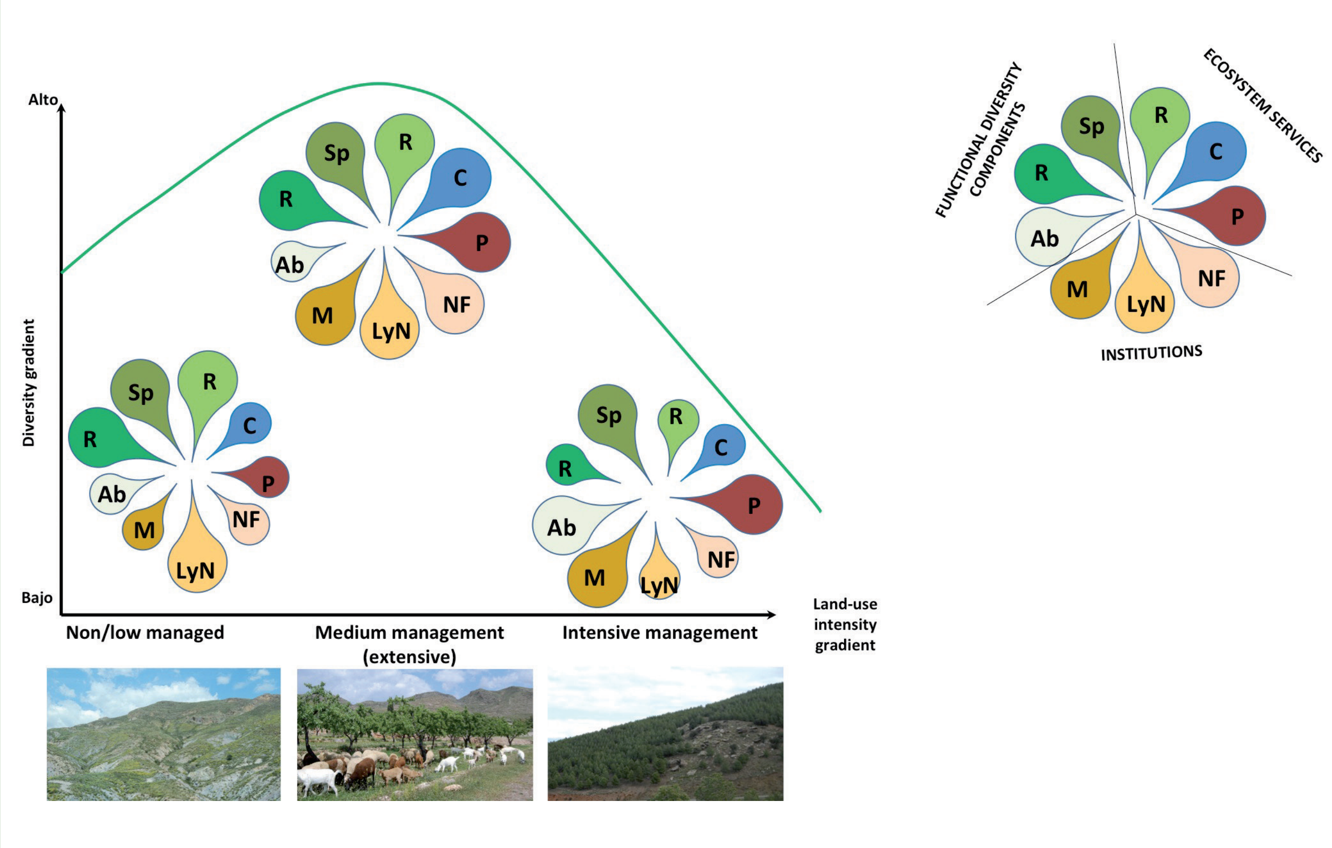
The economic development model of the last half century in Spain has promoted three processes with a negative influence on the flow of services: i) urbanization, which has promoted a strong demand for cultural services associated primarily with large cities; ii) rural abandonment, which has caused a significant loss of cultural services linked to local knowledge and traditional provisioning services; and iii) agricultural intensification, which has increased technical food production processes associated with agriculture, livestock and fisheries. The same general pattern holds for trends at a local scale, although with some differences.

The large increases in all ecosystems regarding cultural services enjoyed by the urban population (i.e., recreation, environmental education, scientific pursuits) perfectly exemplifies the course of the Spanish economy in recent decades. While these services have grown exponentially, traditional cultural services (i.e., local ecological knowledge or cultural identity) are suffering widespread degradation in all ecosystems, mainly due to rural abandonment and changes in the scale of the values of society. Based on their level of importance, there is a significant difference between ecosystems that due to their nature are closer to urban populations (i.e., coastal, marine, Atlantic forest systems) and those that are more associated with rural people (i.e., continental Mediterranean forests, agroecosystems).

The increasing urbanization of the Spanish population, associated with rural abandonment, has brought about the loss of essential cultural services involved in maintaining the integrity and ecological resilience of nearly entire ecosystems, such as local ecological knowledge. The disappearance of the traditional management models associated with these services greatly jeopardizes the conservation of biodiversity and the services to society that the services to society that these traditionally-managed ecosystems provide. provide. It should be kept in mind that Spanish ecosystems are the result of the coevolution of various sectors, potentially over millennia, including their biophysical and cultural characteristics; therefore, their conservation value is closely linked to their traditional agro-forestry-pastoral operating models.

Box 2.3 Looking for territorial vocation and diversty: multifunctionality as a key point

In the Mediterranean basin, landscapes are characterized by the historical co-evolution of social systems and ecosystems promoting the existence of coupled social-ecological systems. Thus, the loss of local ecological knowledge and the alteration of ecological processes and structures have an effect on the conversion of multifunctional landscapes into more simple and monofunctional ones. Multifunctional landscapes have been built from local knowledge, practices and non formal institutions. They are characterized by being reservoirs of biodiversity and functional diversity, and by the high capacity of its ecosystems to supply a diverse flow of ecosystem services to society. Multifunctional landscapes represent an example of an ecosystem with an intermediate level of disturbance, where ecosystems with certain degrees of extensive human management could reach a peak of services diversity. However, this kind of land-use planning has been substituted by productive objectives with low capacity to supply a diverse flow of ecosystem services to maintain human wellbeing.



Graphical representation of the associations between delivery of ecosystem services-functional diversity components-institutions (diversity gradient) and human interventions in terms of land-use intensity. The colored petals represent the three key aspects associated with multifunctional landscapes: ecosystem services (R-regulating, C-cultural, P-provisioning), institutions (NF-non-formal, L-laws and formal norms, M-markets) and functional diversity components (Ab-relative abundance, Ra-range, Sp-presence of specific species). The extensive and multifunctional area is related to a balance among the different components. Smaller sizes indicate a decrease in a given component, whereas larger sizes indicate an increase (e.g., intensively managed areas are characterized by increasing provisioning services, the role of markets and the value of specific species). Targeted landscape views are shown as an example for guidance. This illustration is a theoretical and simplified example of some of the possible connections established (Inspired by: Díaz et al. 2011; García-Llorente et al. 2012).

Important strategies urged to be taken to halt this tendency, reforming the policy instruments used in landscape planning. To do that, some thoughts should be considered. First, the vocation of the territory should be taken into account when plans are developed, bearing in mind which ecosystem services are mainly supply and which alterations should be assumed after a given transformation. Second, we should understand that a diversity of land uses and functional diversity components increase the ability of the social-ecological system to cope with undesired changes because more options are available in a diverse system. Third, we should recognize the social importance of the ecological components and processes behind a landscape, beyond profitability unique criteria. Finally, the role of local populations and its institutions on keeping and shaping rural landscapes should be emphasized empowering local communities.

Socio-ecological planning promotes a mosaic of interdependent ecosystems

Socio-ecological planning promotes the construction of resilient territories characterized by a mosaic of ecosystems that show different degrees of conservation and ecological maturity that generates high ecological heterogeneity and a high degree of socio-ecological interconnections (Figure 2.4).

Spain shows a good representation of ecosystems from three biogeographic regions, which is one of the reasons why our natural capital (including biodiversity) stands out in the European context. The Spanish territory provides opportunities to encounter and manage diverse ecosystems over short distances and, thus, benefit from the flow of services they provide. The complementarity between high and low altitude areas, including mountains and valleys, has played a role throughout history, where one can pass from arid systems to Atlantic forest in less than 200 km. This complementarity also occurs at the socio-economic level, where one solution for extending the productive period of Mediterranean pastures, that is, the use of silvopastoral systems with scattered trees, mainly oaks is characteristic of the Iberian Peninsula.

The many mountainous regions of Spain act as recharge areas for water supplies for human use and irrigation, showing great economic and social importance in the development of Mediterranean areas of Spain. Traditional orchard systems and the associated diversity have relied on traditional practices regarding water. Along the coast, the contributions of many rivers have been the basis of the wealth of the inhabitants and the rich tradition of fishing, extending along almost the entire periphery of the country.

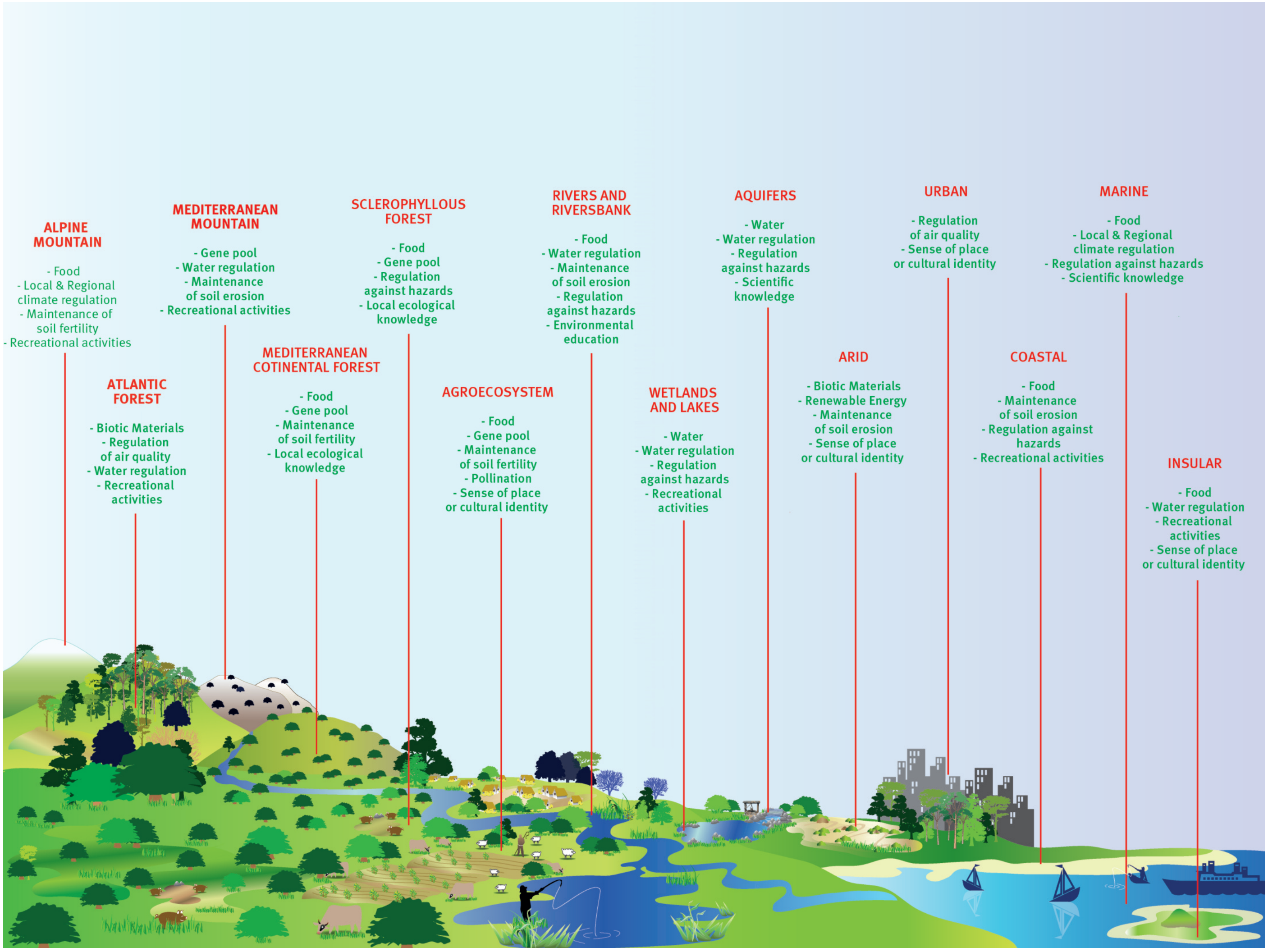


Figure 2.4 The natural capital of Spain should be viewed as a mosaic of different types of aquatic and terrestrial ecosystems, which have traditionally been managed in an integrated manner for centuries or millennia to create bundles of services that contribute to human wellbeing. Examples of the most important services for each types of ecosystem are represented: blue, provisioning services; red, regulating services; and green, cultural services.

3 WHAT ARE THE MAIN DIRECT DRIVERS OF CHANGE FOR SPANISH ECOSYSTEMS AND THEIR SERVICES?

Spanish ecosystems and its biodiversity under pressure

KEY FINDINGS

- The main direct driver of Spanish ecosystems over last 50 years has been land-use change, followed by pollution and overexploitation of provisioning services to increase the living standards, although not the quality of life, of Spanish societies. During the last few decades, climate change and invasive alien species have demonstrate increasing importance.

- Land use changes in recent decades have been driven by two main processes (intensification and rural abandonment), which have generated the following changes simultaneously: expansion of artificial surfaces and intensified agriculture and the abandonment of rural areas.

- The gene pool, water regulation and local ecological knowledge were identified as the ecosystem services that were most affected by the synergistic effects of the direct drivers of change. These essential services are critical and require priority management actions and conservation.

- The conservation of ecosystems and their biodiversity is conditioned by the effects of multiple drivers that alter them both directly and indirectly. Their rates of change impact ecosystems and their ability to generate services and therefore effect human wellbeing. Understanding how these drivers act is essential to develop response options and environmental policies that are efficient and are able to halt the deterioration of our natural capital.

MAIN PRESSURES

Similar to the MA, the SNEA has evaluated **six drivers of change (land-use change, climate change, pollution, biochemical cycles, over-exploitation and invasive alien species)** that directly affect the functions of Spanish natural capital or its capacity to generate ecosystem services. Table 3.1 shows the relative importance and trends of the six drivers of change for the 14 types of ecosystems assessed. Additionally, Figure 3.1 presents an integration of these effects at the national level.

Table 3.1 Relative importance and trends of the six direct drivers evaluated in the different ecosystems assessed. The color indicates the intensity of the current impact of each driver on the flow of ecosystem services, and the arrows represent the trends that have followed in the last several decades. This information was obtained through the synthesis of specific analyses of each ecosystem type, together with expert judgment. Blank cells mean that the driver is not applicable to a particular type of ecosystem.

OPERATING SYSTEM TYPES	DIRECT DRIVERS					
	Land use change	Climate change	Pollution	Invasive alien species	Changes biogeochemical cycles	Overexploitation
Atlantic forest	Very high ↗	Moderate ↗	Low →	High ↗	Low →	Low →
Sclerophyllous Forest	Very high ↗	Moderate →	Low →	Moderate →	High ↗	Low ↘
Mediterranean continental forest	Very high ↗	Low ↗	Low →	Low →	Low →	Low ↘
Alpine Mountain	Very high →	Moderate →	High ↘	Low →	High →	High ↘
Mediterranean Mountain	Very high →	Very high ↑	Moderate ↗	Moderate →	Moderate →	Moderate ↗
Rivers and riversbanks	Very high ↑	Moderate ↗	Moderate →	High ↑	High ↗	Very high ↗
Wetlands and Lakes	Very high ↑	High →	High ↗	Moderate ↑	Moderate ↗	Very high ↗
Aquifers	Very high ↑	Moderate ↗	Very high ↑		High ↗	Very high ↑
Coastal	Very high ↑	Moderate ↗	High →	Moderate ↑	High ↗	Very high ↗
Marine	Very high ↑	Moderate ↗	Very high ↑	High ↑	Moderate ↗	Very high ↑
Insular	Very high ↗	Low ↑	High →	High →	Moderate →	High →
Arid	Very high ↗	Very high ↗	Moderate →	Moderate →	Moderate →	Moderate →
Agroecosystem	Very high →	Moderate →	High ↑	Moderate →	Very high ↑	High ↑
Urban	Very high ↑	Moderate ↗	Very high ↑			

Intensity of the direct drivers of change

Low Moderate High Very high

Tendencies

⇧ Increases very fast ⇗ Increases ⇨ Continue ⇘ Decreases ⇩ Decreases very fast

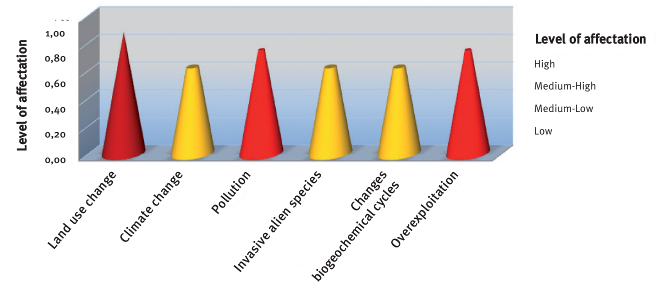


Figure 3.1 With the intention of determining and prioritizing the most important drivers at a national scale, the results presented for each ecosystem were integrated. This analysis shows the level of each direct driver that was calculated, integrating the level of intensity (expressed as values between 0 and 1) and its trend (expressed as values between 0 and 1). On the horizontal axis, the different direct drivers of change are listed, while the vertical axis shows the level of impact.

The six direct drivers of change considered in this analysis act synergistically, and management plans to minimize their impacts must therefore integrate the complex interactions that exist between them, carried out from a systems analysis perspective. The emerging concept of Global Change involves an integrative conceptual framework that would aid in the development of this task. Table 3.1

establishes criteria for prioritizing management actions for specific ecosystems that are threatened by all direct drivers and are essential for human wellbeing. Based on these results, the gene pool, water regulation and local ecological knowledge were identified as the three ecosystem services that were most affected by the synergistic effects of the direct drivers of change.

Table 3.2 Direct drivers of change synergistically affecting the supply of ecosystem services. The relative importance of services for human wellbeing and conservation trends in relation to the presence of impacts generated by one or more direct drivers of change allow us to establish a state or degree of vulnerability that helps to prioritize strategy actions aimed at halting the degradation of vulnerable services

	Ecosystem servicices	Trend	Importance	Status*	Indicators	Direct drivers of change: Land use change	Climate change	Pollution	Biochemical cycles	Over - exploitation	Invasive alien sp.
PROVISIONING	Food – Agriculture	Increases	High	Good State	Production of cereals, fruit and olive	√	√		√	√	√
PROVISIONING	Food – Livestock	Increases	High	Good State	Production of meet		√		√	√	√
PROVISIONING	Food – Beekeeping	Remains	High	Vulnerable	Production of *Apis mellifera*		√				√
PROVISIONING	Food – Aquiculture	Increases	High	Good State	Total aquaculture production					√	
PROVISIONING	Water	Remains	High	Vulnerable	Water harvesting for human use	√	√	√	√	√	
PROVISIONING	Biotic materials – Wood	Increases	Low	Vulnerable	Wood production	√			√	√	√
PROVISIONING	Biotic materials – Paper	Remains	Low	Vulnerable	Paper pulp production	√			√	√	√
PROVISIONING	Geotic materials	Remains	Low	Vulnerable	Cement production	√				√	
PROVISIONING	Energy	Remains	Low	Vulnerable	Installed hydroelectric power		√			√	
PROVISIONING	Gene pool	Decreases	High	Critic	Based on Ecosystem Assessment	√					√
PROVISIONING	Natural medicines	Decreases	Medium-Low	Vulnerable	Based on Ecosystem Assessment		√			√	
REGULATING	Clima regulation	Decreases	High	Critic	CO_2 Ratio of emissions and sequestration	√	√	√	√	√	
REGULATING	Air quality	Remains	Medium-High	Vulnerable	Greenhouse gas emissions	√	√	√	√	√	
REGULATING	Hydrological control and water purification	Decreases	High	Critic	Water in soil, snow, groundwater and self-cleaning capacity	√	√	√	√	√	√
REGULATING	Erosion control	Decreases	High	Critic	Based on Ecosystem Assessment	√	√				
REGULATING	Soil fertilization	Decreases	Medium-High	Critic	Nitrogen fertilizers	√		√	√	√	√
REGULATING	Disturbance regulation	Decreases	High	Critic	Forest fires	√	√		√	√	√
REGULATING	Biological control	Decreases	Medium-High	Critic	Number of alien exotic sepecies	√	√	√	√		√
REGULATING	Pollination	Remains	Low	Vulnerable	Based on Ecosystem Assessment	√	√	√			√
CULTURAL	Scientific knowledge	Increases	Medium-High	Good State	Number of Spanish scientific publications on ecosystems	√	√	√			
CULTURAL	Recreational activities	Increases	High	Good State	Number of tourist accommodations, visitors and overnight stays	√	√	√			
CULTURAL	Aesthetic value	Remains	High	Vulnerable	Based on Ecosystem Assessment	√	√				
CULTURAL	Environmental education	Increases	Medium-High	Good State	Equipment for environmental education		√	√		√	√
CULTURAL	Local ecological knowledge	Decreases	Medium-High	Critic	Traditional use of cork and sheep transhumance	√				√	√
CULTURAL	Spiritual value	Increases	Medium-High	Good State	Based on Ecosystem Assessment	√		√			
CULTURAL	Sense of belonging	Decreases	Low	Vulnerable	Based on Ecosystem Assessment	√					√

ECOSYSTEM SERVICES

Trend	Importance	State
Increases	High	Good State
Remains	Medium-High	No priority
Decreases	Medium-Low	Vulnerable
	Low	Critic

* The state of the ecosystem services is the result of an analysis of trends and the importance of services.

Land use changes in recent decades have been the main direct drivers of change in Spanish ecosystems, followed in importance by pollution and climate change. Two main processes have produced these changes simultaneously: the expansion of artificial surfaces and the abandonment of rural areas (Figure 3.2). The increase in artificial surfaces (6.9 million hectares, or 14% of the total area), were especially important in Spanish coastal areas and urban systems between 1990 and 2006, accounting for almost a third of everything built in previous centuries. Rural abandonment has led to bush encroachment in large areas previously devoted to agricultural use (6,2 million hectares, or 13% of total area) and has been accompanied by agricultural intensification involving the irrigation of lands that were traditionally rain fed. Figure 3.2 shows these changes in land use spatially, including the intensification (orange and red) and abandonment (in blue) that occurred between 1990 and 2006.

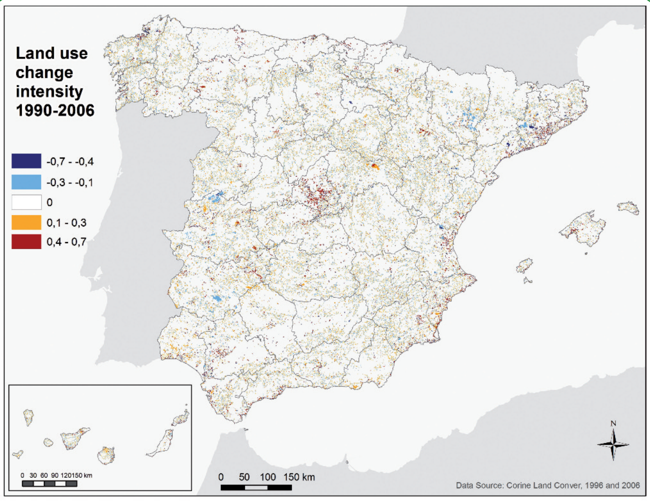


Figure 3.2 Spatial representation of the artificialization (orange and red areas) and abandonment (blue) processes that occurred in Spain due to land-use changes between 1990 and 2006. (Source: Corine Land Cover).

Over-exploitation of provisioning services. The economic model that Spain has followed for its development during the last several decades, involving intensive activities regarding the use of ecosystem services, has generated unsustainable use patterns because the renewal fees for their flows have been overcome. Overfishing in rivers and marine ecosystems of species of commercial interest and the intensive exploitation of aquifers for irrigation are two good examples (Figure 3.3).

Climate change. Spain, due to its geographical location and its economic model, is considered one of the most vulnerable countries of the EU to the anticipated effects of climate change.

Box 3.1 Destruction of coastal ecosystems: Spanish littoralization

The concentration of human activities in certain types of ecosystems is especially associated with a great capacity to generate provisioning and cultural services that contribute to short-term economic benefits. The unique biophysical characteristics of Spanish coastal ecosystems have caused the clumping together of such activities in confined spaces, including intensive urban growth and tourism, industrial activities, and intensive agriculture and aquaculture production. This new coastal settlement model has been referred to as "littoralization".

The percentage of the population living in Spanish coastal towns has experienced rapid growth over the past five decades. Thus, despite representing only 7% of the territory of the state, the percentage of the population that lives in these areas has risen from 24% in 1960 to 44% today (INE, 2010). There are approximately 45 million foreign tourists each year who choose this type of ecosystem for their holidays, as do 90% of European pensioners living in Spain (over 1,200,000 people).

It is expected that climate change in Spain will play an important role in causing biodiversity losses, which will affect the functions of ecosystems and thus the flow of their services. The ecosystem evaluation described herein found that the

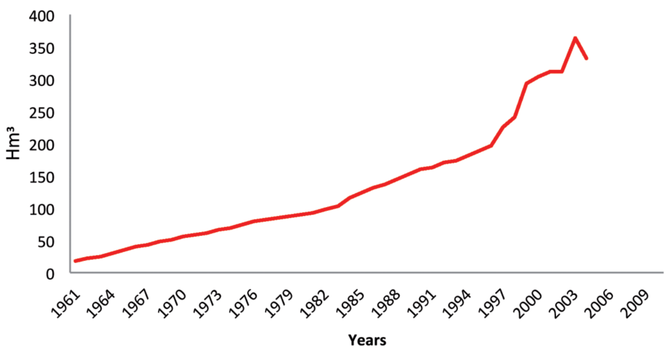


Figure 3.3 Groundwater extracted for irrigation in Spain since 1960. (Spanish National Statistical Institute, 2010)

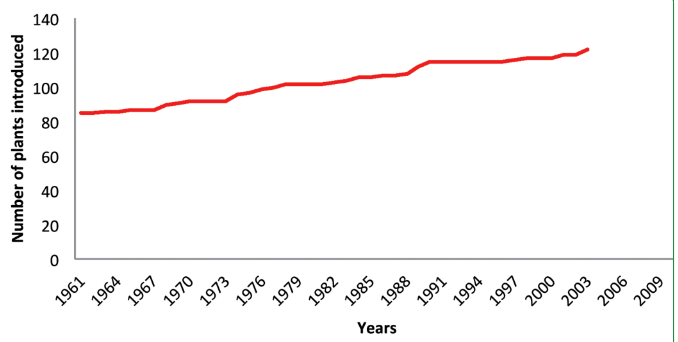


Figure 3.5 Number of plant species introduced in Spain since 1960. (Sanz Elorza et al., 2004)

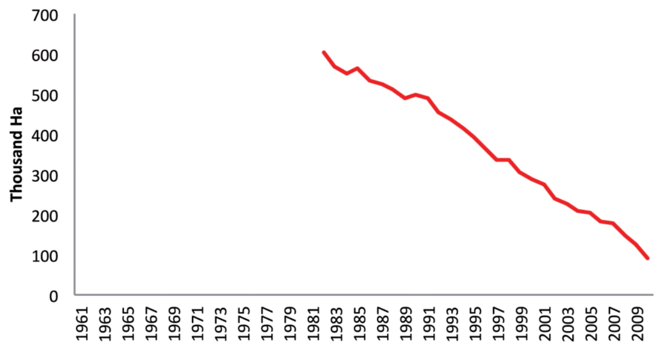


Figure 3.4 Loss of permanent glaciers in Spain. (European Environment Agency, ERHIN Program, 2010)

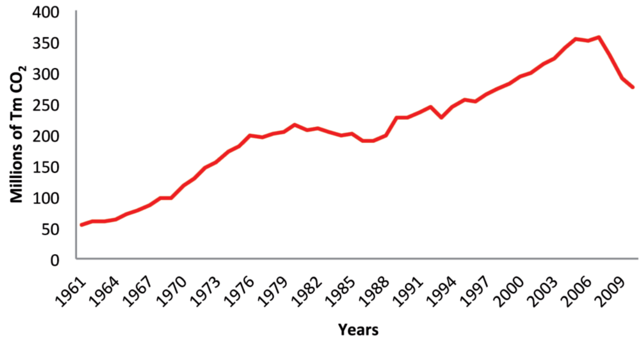


Figure 3.6 Total emissions of CO2 in Spain since 1960. (Source: FAOStat, 2010)

intensity of the effects of climate change effects at the state level is moderate (Figure 3.1) and is not able to fully explain the change that has occurred in Spanish ecosystems in the last 50 years. Nevertheless, we expect an increasing trend in the context of new climate scenarios being developed. However, the degree of impact and trends are different depend on the type of ecosystem considered, where major effects are expected in aquatic and mountain ecosystems (Table 3.1). Figure 3.4 shows the loss of permanent glaciers in the last several decades.

Invasive alien species constitute one of the main drivers of change, being recognized as the second most important cause of biodiversity losses in the Mediterranean context. In Europe, there are more than 10,000 registered exotic species, 1,400 of which are found in Spain. This is a particularly important driver for certain types of ecosystems, such as wetlands, rivers and marine systems (Table 3.1). For example, the number of introduced and invasive species in Spanish rivers affects all groups of organisms, but especially vertebrate species, as 32% of all vertebrate species have been introduced (Figure 3.5).

Contamination and changes in biochemical cycles

In Spain, the contamination of water is one of main drivers affecting many ecosystems (Table 3.1). The levels of nitrates in water employed for of intensive agricultural uses involving fertilization can high enough to constitute a serious threat to human health. The contamination of Spanish rivers by organic pollution is highly evident at present. With respect to the soil, which is considered a vital resource for ecosystems and human activities, this resource is currently threatened by erosion, salinization, biodiversity losses and pollution. The activities that contribute most to soil pollution are industrial pollutants, such as heavy metals, hydrocarbons and mineral oils. The main causes of air quality deterioration are emissions of pollutants into the atmosphere. High levels of pollution are causing significant negative effects on human health, especially in large cities and in areas where industrial and energy production occur. The continued increases in air pollutants such as carbon dioxide (CO2) are particularly related to other drivers, such as climate change (Figure 3.6).

4 WHAT ARE THE UNDERLYING CAUSES OF ECOSYSTEM DEGRADATION?

The need to focus on managing the real causes (indirect drivers) and to not only minimize their impact (direct drivers)

KEY FINDINGS

- **The SNEA has promoted a paradigm shift in conservation policy toward not only addressing the effects (direct drivers) of the deterioration of ecosystems and its biodiversity but also characterizing the causes (indirect drivers) or sociopolitical factors that lead to undesirable changes in the "natural capital" of Spain and, ultimately, call into question the future of our human wellbeing.**
- **The economic development model followed by Spain in the last 50 years has been shown to be socially and ecologically unsustainable. The transition from a production economy system to an acquisition economy has significant impacts on ecosystems (Spain uses approximately four times more energy and materials per unit of GDP today than were used in 1960).**
- **Spain is not self-sufficient in the supply of some provisioning services, currently depending on ecosystems in other countries for approximately 30% of these services .**
- **The Spanish economic model has generated a major impact on the demographic patterns of Spain, favoring urban versus rural areas and the coast versus the interior. The abandonment of rural areas promoted by this model has led to aging and masculinization of the population, which has a direct impact on the conservation of traditionally managed ecosystems.**
- **Paradoxically, in the context of the current economic crisis, we have been witnessing variations in the drivers of change, which clearly show that the current economic crisis has had some positive effects on the natural capital of Spain. This situation presents novel opportunities for building a new social and economic system that accepts the finite nature of the planet and its progress based on respect for the biophysical limits of ecosystems.**

On a national scale, most of the completed assessments have focused on explaining the relationship between the state of ecosystem services and the direct causes (i.e., pressures) of their degradation. In many cases, other components, such as indirect drivers of change, have been empirically excluded from such analyses because their relationships with ecosystem services are not obvious, and time series data at the scale of assessment are often absent.

Indirect drivers operate as a result of decisions made by different stakeholders (e.g., individuals and local groups, industry, private companies, governments, NGOs) at various levels (local, regional, national, global). New environmental policies should address all of these factors as the only effective way to halt the alarming rate of biodiversity losses and ecosystem degradation. In addition to the five indirect drivers proposed by the MA (demographic, economic, socio-political, science and technology, and cultural), the SNEA also included gender issues, considering that to sustain the current socioeconomic system, it is essential to recognize that a large number of jobs, especially in rural areas, are generally performed by women, which has not been acknowledged.

Although important political efforts have been made to respond to direct effects (pressures), in most cases, there have been no clear efforts to address indirect drivers because they would require greater institutional changes. The main policies aimed at conserving biodiversity in Spain have mostly been focused on creating protected areas that promote conservation of the habitats of threatened species as well as on legislation related to endangered species (i.e., the National Catalogue of Threatened Species). However, recent studies have concluded that the components of biodiversity that ensure the delivery of ecosystem services are functional diversity and the species diversity of taxonomic groups of microorganisms, vegetation and invertebrates. The main strategies for biodiversity conservation do not include the conservation of these key components that ensure the capacity to deliver ecosystem services. To resolve this issue, land-use planning decisions should be made to support previous efforts and guide indirect drivers of change, such as economic, demographic, cultural and sociopolitical factors.

Losses of biodiversity and the deterioration of the flows of certain ecosystem services are a result of numerous drivers acting synergistically (CDB, 2010). This pattern has been recognized worldwide based on various publications demonstrating our failure to meet the 2010 biodiversity targets (Rands et al. 2010). We represent this undesirable situation (Figure 4.1) as a feedback loop

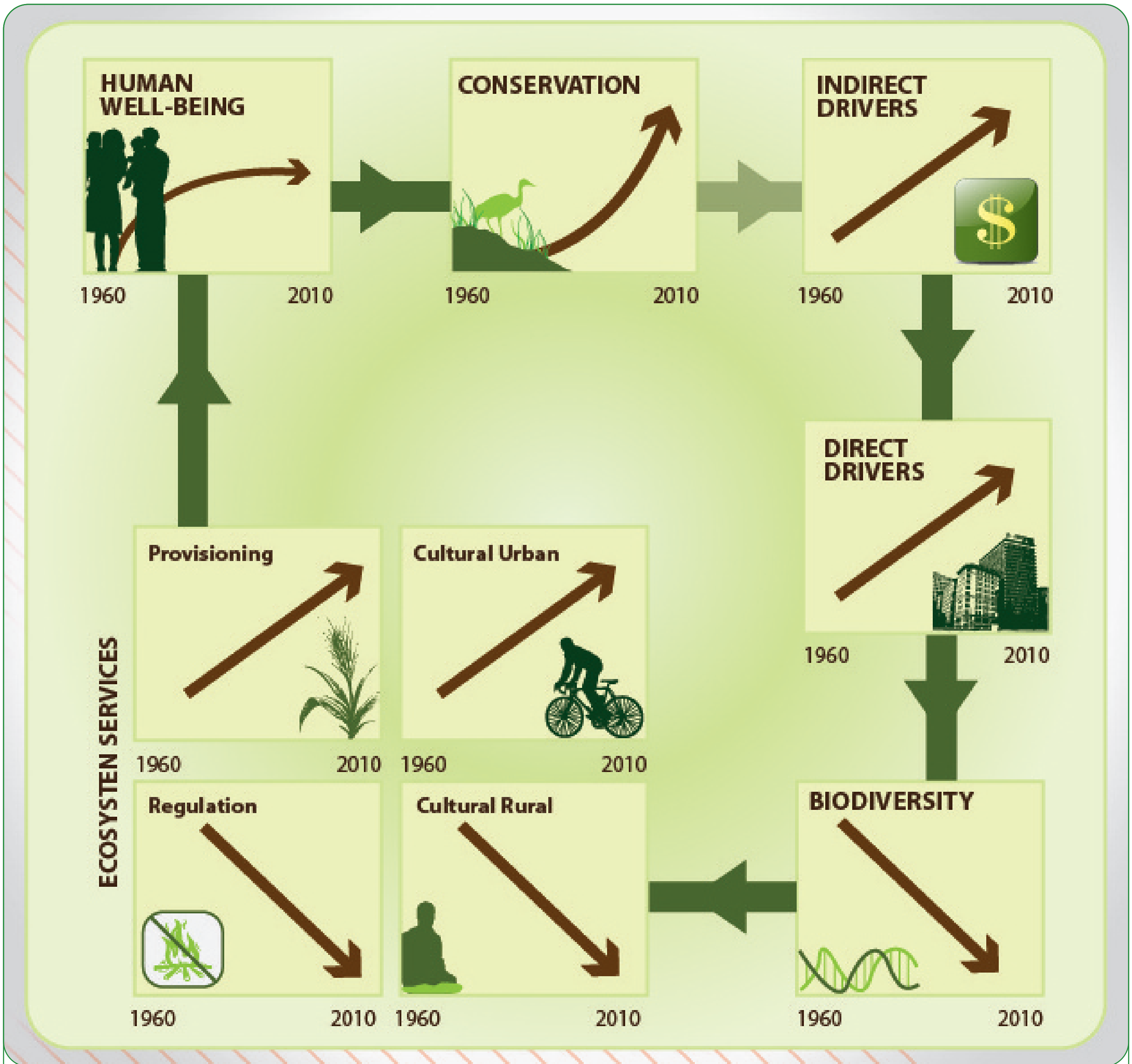


Figure 4.1 Integrative results from conceptual framework in the SNEA. It represents trend evolution of aggregate indices and relationship among the DPSIR components. It was identified a constant linear loss of biodiversity as well as the services it provides (mainly regulating the cultural services associated with rural areas), while pressures (direct drivers) and causes (indirect drivers) maintain a linear growing trend. The arrow between conservation and the indirect drivers (in light green) indicates that there are no clear institutional strategies to address the indirect drivers. (Inspired in Butchart et al., 2010).

involving a loss of biodiversity, trade-offs among ecosystem services demanded by urban or rural groups, a decoupling effect between material and non-material dimensions of human wellbeing, a rapidly growing trend of responses in recent years and a growing linear trend of pressures and drivers.

To learn more from these complex relationships and to scientifically address the nature-society interface, an individual analysis of the six indirect drivers considered in the SNEA was initially conducted. Subsequently, the complex interactions established between these drivers were analyzed. Factor analysis yielded scatter plots showing all of the study years (Figure 4.2). The horizontal axis (Factor 1) represents the urban vs. rural socioeconomic transformation. The vertical axis (Factor 2) is explained by transformation at the social level of human wellbeing in

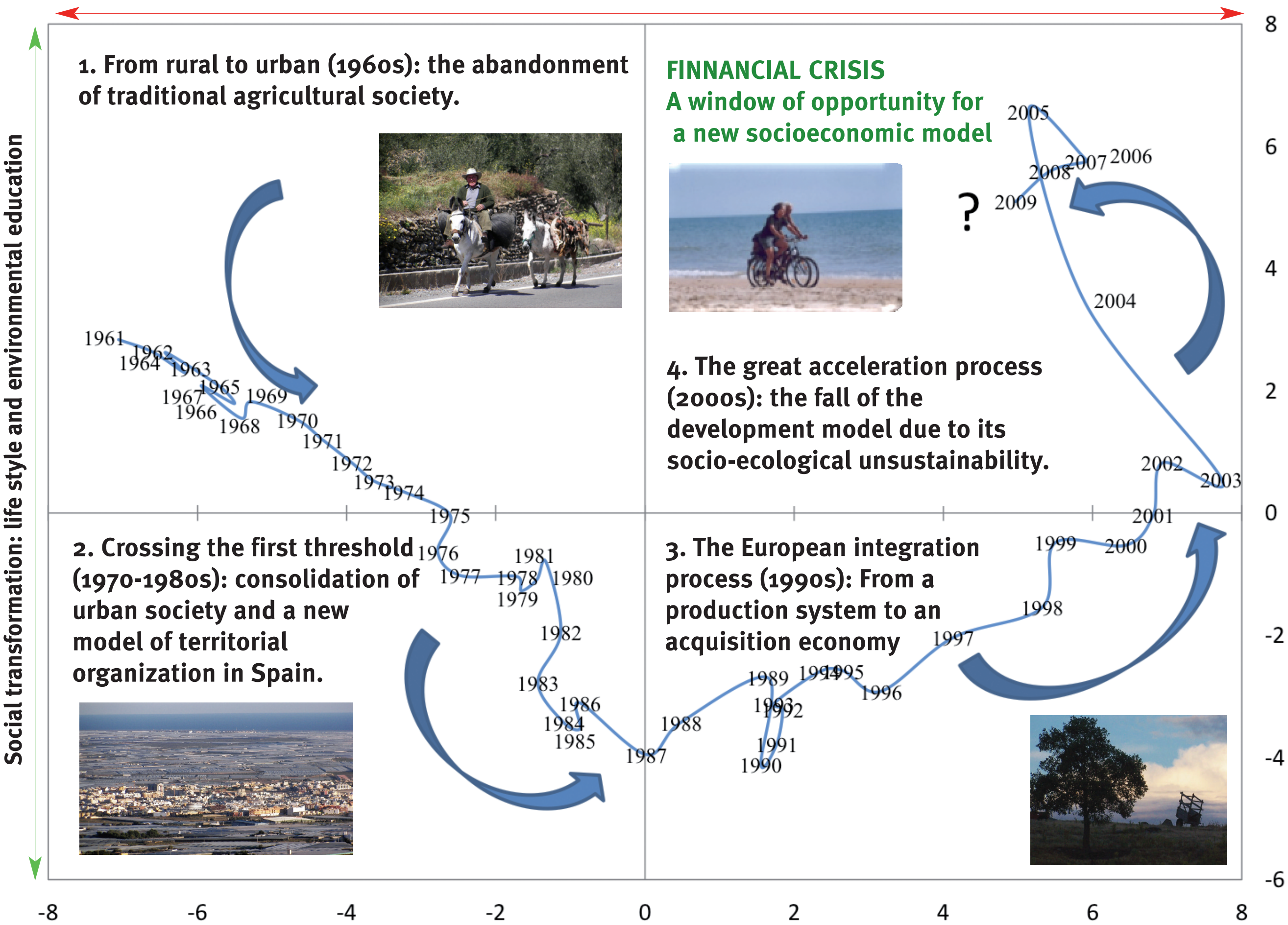


Figure 4.2 Results of a multivariate scatterplot analysis of 40 biophysical, socioeconomic, cultural and sociopolitical indicators. The diagram shows how all of the study years (1961-2009) arranged in five periods explain the evolution of the nature-society interface in Spain from a socio-ecological perspective.

Spanish society. The first two factors accounted for 68% of the variability in the data from the 41 indicators used.

Based on these results, four different time periods were identified in Spain from a socioecological point of view since the 1960s, **which can be summarized as follows:**

1. From rural to urban (1960s): the abandonment of traditional agricultural society.

During the 1960s, Spanish society exhibited a clear rural character based on traditional agrarian production systems. This lifestyle was linked to ecosystems, and regulating and cultural services were of great importance in maintaining human wellbeing. The household represented a system of self-production and consumption, and its organization rested on a fundamental complementarity between male-female work. This represents a key decade in relation to the dramatic changes that occur in the following decades in the productive structure of the Spanish economy, mainly as a result of the failure of traditional agrarian society in favor of the tourism industry, construction and especially the service sector. During this decade, the myth of unlimited economic growth of the GDP was introduced. Therefore, the biophysical constraints on the intensification of provisioning and cultural services were removed, obviating production processes based on regulating ecosystem services.

2. Crossing the first threshold (1970-1980s): consolidation of urban society and a new model of territorial organization in Spain.

Figure 4.2 demonstrates that there are two thresholds of change, with the first corresponding to the period from the late 1980s-early 1990s. The 1970s were a time of great abandonment of rural areas, and the final consolidation of urban society occurred during the 1980s, resulting in a way of life that was increasingly disconnected from ecosystems. The growth rate and distribution of the population in an area are

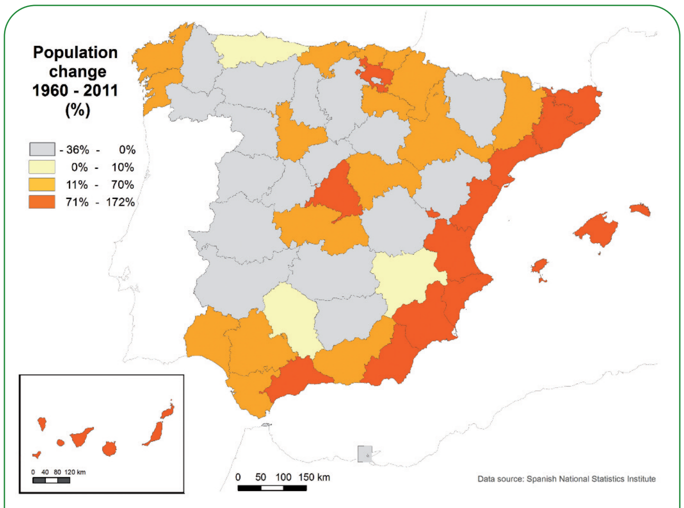


Figure 4.3 Demographic changes in the population between 1960 and 2011, in which the increasing population in coastal areas and emptying of the interior provinces with the exception of big cities, such as Madrid, can be observed.

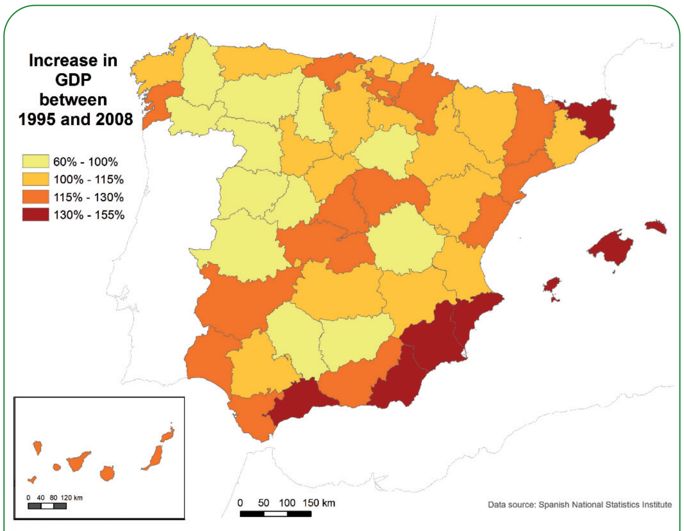


Figure 4.4 Change in the GDP of each province between 1995 and 2008 (the percentage of increase or decrease in the value of GDP compared to 1995 values).

two of the main factors driving the demand for ecosystem services. In Spain, the concentration of the population in large urban areas and coastal ecosystems is especially evident (Figure 4.3). Over 80% of the Spanish population lives in municipalities with more than 10,000 inhabitants. Long-term projection of the Spanish population identifies a scenario where natural growth is negative from 2020 onward, and the population over the age of 64 will double in just 40 years, accounting for over 30% of the total population.

Following the adoption of the 1978 Constitution, the so-called State of Autonomies was introduced, corresponding to a quasi-federal form of state, which established a new model of territorial organization in Spain based on 17 regions (while maintaining the divisions into provinces implemented in 1811). This produced a decentralized administrative state, associated with important changes in the management of ecosystems.

3. The European integration process (1990s): From a production system to an acquisition economy

Spain's entry into the European Economic Community (EEC) in 1986 resulted in a significant opening of its economy and a sharp increase of foreign investment. This led to emergence from the crisis of the 1970s. The international integration of the Spanish economy and its growth in European markets paved the way for a service economy. This process finally consolidated an acquisition economic model that is currently causing alarming socio-ecological consequences.

For example, the Spanish economic model over the past five decades has revealed our special dependence on the production of ecosystem services. The economy has changed from a production economy, primarily supported by the sustainable use of renewable ecosystem services (services associated with supplies obtained through net primary production), to an acquisition economy, which is largely based on non-renewable resources (fossil fuels, minerals) from ecosystems from both Spain and around the world. Far from diminishing, this dependence has been increasingly growing since the 1960s with a surprising result: the Spanish economy used four times more energy and materials per unit of GDP at 2010 that it used in 1960. That is, we are generating more goods and services, but we are producing them in a more inefficient way. Taken together, this situation leads to the conclusion that losses of agricultural, mining and industrial production, coupled with the increasing outsourcing of our economy, make our model especially vulnerable to global crises, such as the one we have been experiencing over the last five years. Regarding economic changes, the gross domestic product (GDP) between 1995 and 2008 at the provincial level shows a similar trend to the demographic drivers, largely increasing, mainly in coastal areas and in big cities, such as Madrid (Figure 4.4).

4. The great acceleration process (2000s): the fall of the development model due to its socio-ecological unsustainability and a window of opportunity

The second change threshold shown in Figure 4.2 occurred in the

early 2000s, coinciding with the second housing bubble suffered by the Spanish economy between 1996 and 2007, which had a particular impact on the Mediterranean coast through the process of intense coastal urbanization (see Box 3.1). This "culture of the new rich" marked a fifteen-year economic boom that was abruptly disrupted by the crisis, beginning in 2007.

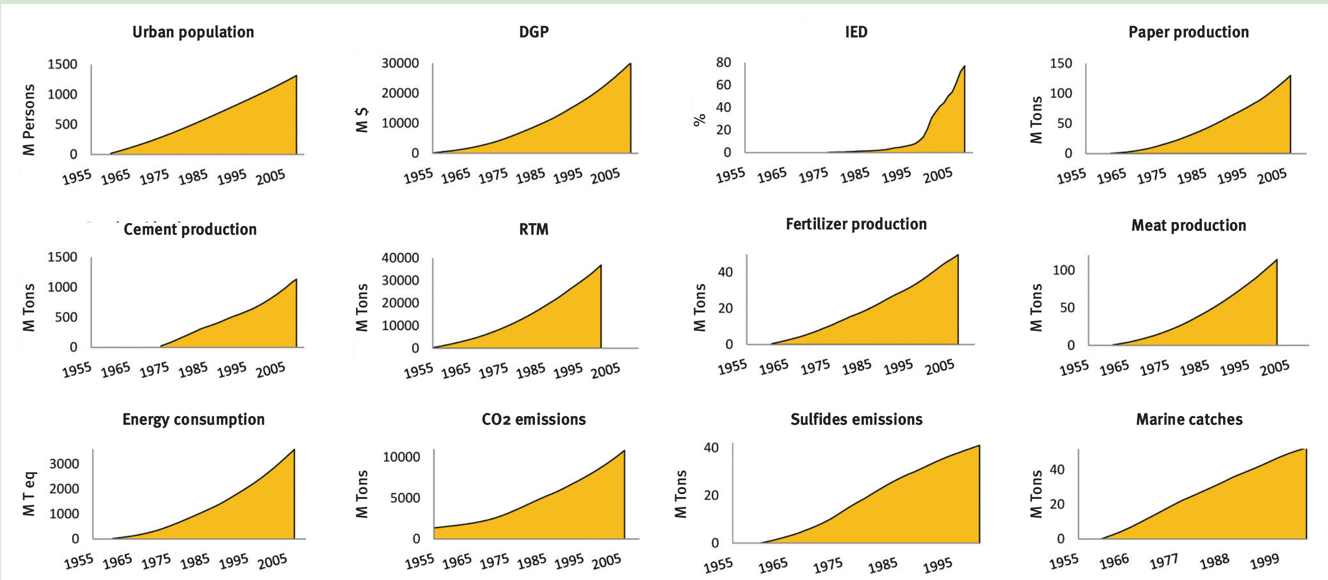
Taken together, this state of affairs highlights the growing unsustainability of the Spanish development model in the way that goes beyond our territorial and biophysical limits. These processes are manifested in a gradient that is explained on one side by the rural abandonment process and on the other by significant land-use changes (agricultural intensification and urbanization), associated with a low or no capacity for ecological restoration. This undesirable situation has serious consequences for the conservation of ecosystems and its biodiversity and thus their flow of services.

Paradoxically, in the context of the current economic crisis, the trends of the examined indices reveal that since 2007, we have witnessed variations in the drivers of change, clearly showing that the current economic crisis has had some positive effects on the Spanish natural capital. This result reinforces the idea that the underlying causes of biodiversity degradation are the drivers because although the potential response options have significantly declined in recent years, biodiversity and some ecosystem services are recovering under this socio-economic situation. This situation presents opportunities with which new conservation strategies should be managed in coordination with policies in other sectors at different organizational scales and should consider the key components of biodiversity that guarantee the delivery of ecosystem services.

Box 4.1 The great acceleration process of Spain

As noted by the Global Millennium Ecosystem assessment (MA, 2005), in the past 50 years, humans have changed natural systems more rapidly than in any other period of human history, promoted by the need to meet growing demands for food, fresh water, timber, fiber and fuel. This period, which has mainly been marked by the set of alterations caused by human activity in the fundamental processes that regulate the functioning of ecosystems, has been referred to as the Anthropocene (Crutzen, 2000). For example, over the last one hundred years, the human population has quadrupled; the world economy has multiplied 14-fold; energy use, 16-fold; atmospheric CO_2 levels, 13-fold; water consumption, 9-fold; and industrial emissions, 40-fold.

This great acceleration process has also occurred in Spain. However, due to the particular causation in Spain, the acceleration time is somewhat different from that observed in all of the countries of the North. For example, in Spain, since 1960, energy consumption has increased more than 5-fold; CO_2 emissions more than 6-fold, the consumption of meat more than 7-fold; fertilizer use approximately 4-fold; paper production more than 16-fold; and our ecological footprint, 2.5-fold.



Graphical representation of the great acceleration process in Spain based on 12 selected indicators. (Data sources: European Environment State and Outlook 2010; Global Footprint Network, 2010; International Energy Agency, 2010; National Statistic Institute, 2011; Spanish Ministry of Agriculture, Food and Environment, 2010. World Bank, 2010; World Resources Institute 2010.

5 HOW DO ECOSYSTEM SERVICES AFFECT HUMAN WELL-BEING AND WHO ARE THE BENEFICIARIES?

A multidimensional analysis of the quality of life in Spain

KEY FINDINGS

- The SNEA has shown, based on empirical data, that the different components of human wellbeing depend largely on the ability of ecosystems and its biodiversity to generate services for society.
- Changes in ecosystems always entail parallel changes in human wellbeing. Given the progressive degradation process that Spanish ecosystems are suffering, human wellbeing is negatively affected within Spanish society.
- While some aspects such as physical health, education and social freedoms have improved markedly in recent decades, other more intangible factors, such as good social relationships and mental health, have been negatively affected.
- There is traditionally confusion between standards of living and quality of life, which has had serious implications for the conservation of ecosystems. An increased quality of life should not have a negative impact on ecosystems. However, increases in the standards of living largely lie in increasing consumption behaviors, thus degrading the capacity to generate ecosystem services in Spain.
- The current prevailing urban lifestyle in Spain is causing us to forget the sense of community and dependence on ecosystems that characterized the Mediterranean lifestyle for centuries. It is necessary to promote healthy lifestyles closer to the multidimensional concept of human wellbeing, shifting from focusing on standards of living to quality of life, that s, aiming at a good life within the biophysical limits of ecosystems.

Human wellbeing has grown from a concept that was mostly addressed by philosophers, extending in recent years into the social, political and even public domains. The growing social interest in this concept has begun to be incorporated into political agendas in initiatives that seek to explore alternative or complementary strategies to the GDP for assessing the social progress of the nations.

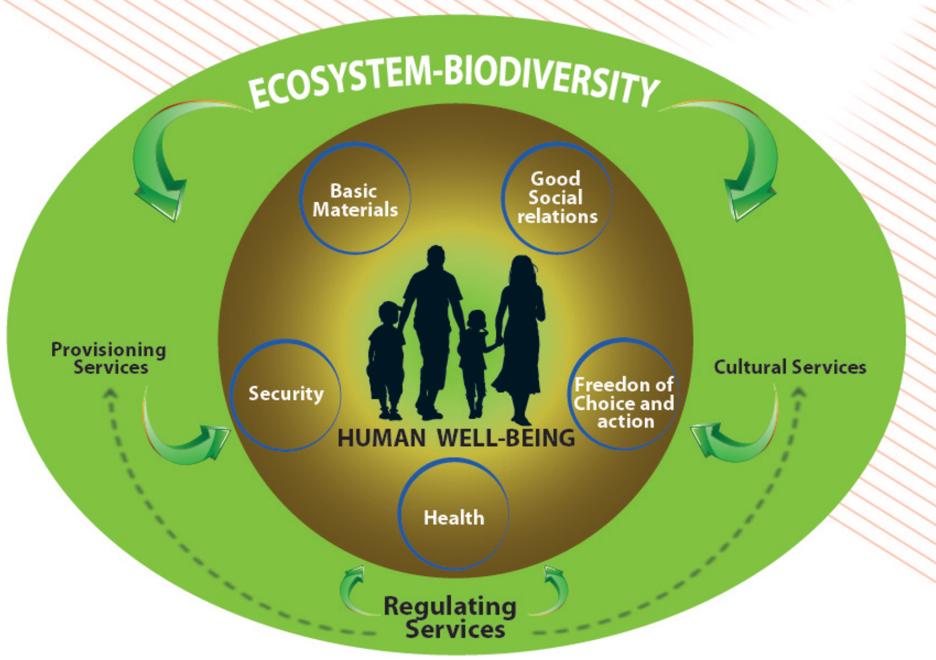


Figure 5.1 The five dimensions of human wellbeing depend directly and indirectly on the three types of services that are provided by ecosystems and its biodiversity: provisioning, regulating and cultural services. Sustainable human wellbeing demands respect of the biophysical limits of ecosystems. (Modified from MA, 2005).

Since 2005, following from the Millennium Ecosystem Assessment, the initial concerns of the socio-ecological sciences related to the concept of human wellbeing and its link to the state of the conservation of ecosystems through their services has been globally accepted. The most important message of the MA is that human wellbeing depends directly and indirectly on ecosystems through their ability to generate different types of services for humanity. That is, it conceptualizes social systems as a subsystem of the biophysics sphere on which it depends (Figure 5.1).

However, the MA also provided two other conclusions of transcendental importance:

1) Ecosystem services have suffered a process of degradation on a global scale in recent years.

2) Human wellbeing is increasing globally, primarily due to the intensification of provisioning services (e.g., food, fiber, fuel) required by humanity.

Based on the SNEA, we disagree with these conclusions of the MA because supporting them would mean accepting that global human wellbeing has increased at the expense of the degradation of ecosystems and loss of biodiversity. This conclusion fits popular perceptions and was defined by Raudsepp-Hearne et al. (2010) as the paradox of the environmentalist.

Based on this paradox, the SNEA evaluates human wellbeing differently than the MA. While the MA exclusively evaluates human wellbeing globally based on the Human Development Index (HDI), the SNEA performed a multidimensional analysis using 90 indicators for each of the five dimensions of human wellbeing identified by the MA (Figure 5.1). The answer to the paradox of the environmentalist, at least in part and from the viewpoint of SNEA, therefore lies in the confusion that exists between the concepts of standards of living and quality of life (Figure 5.2). In assessing human wellbeing through the HDI, what the MA is really measuring is not quality of life but standards of living through an economic approach incorporating economic bias into the GDP. Alternative measures of human wellbeing, other than the HDI, that counteract the economic bias involved in including the GDP, moving towards quality of life index, should result in a decline of this measurement and the revelation of a parallel trend between ecosystem services and human wellbeing indicators.

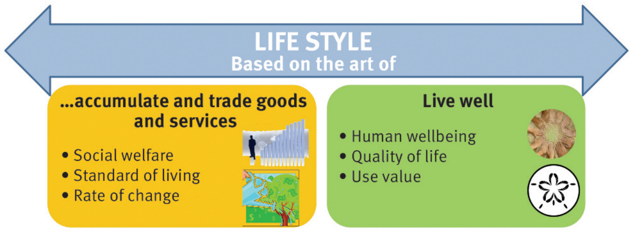


Figure 5.2 Definitions of terms related to the concept of human wellbeing around which there is usually confusion. These terms are presented not as antagonistic but as ends of the same gradient (lifestyle), and their application has serious implications for the conservation of ecosystems and its biodiversity.

Indicators selected to independently analyze the five dimensions of human wellbeing (i.e., basic materials for a good life, health, good social relationships, security and freedom of choice and action) show different trends during their temporal evolution (Figure 5.3). Regarding the basic materials required for a good life (such as access to food, water and a home), the trends of the indicators show that they have all experienced a significant increase in recent years in Spain, especially after the economic crisis of 2008, which allows us to detect a decrease in this dimension. This is the case for indicators such as the unemployment rate, the rate of poverty risk, the price of housing relative to the average income, and the rate of evictions.

César López Santiago

The indicators used to assess the health dimension show two different trends. While the indicators of physical health (e.g., life expectancy and infant mortality) have constantly increased, indicators of healthy habits (such as the rate of reported cases of cholesterol, diabetes, hypertension, allergies and obesity) and mental health (such as the number of suicides and the number of psychological treatments) have shown negative trends. Together, these findings suggest that while our life expectancy is increasing, the quality of life has not necessarily improved during these years, either physically or psychologically. Meanwhile, the indicators used to evaluate social relationships show a clear erosion of this dimension of human wellbeing. Indicators such as separation and divorce, complaints of family abuse or the percentage of people living alone have constantly increased, while indicators such as the availability of free time and time for relationships and a social life has suffered serious declines. The security dimension has also suffered negative development in recent decades, examples of which are found in indicators related to public safety (e.g., the number of homicides) or deaths from global natural disasters, whose tendencies have adversely affected human wellbeing.

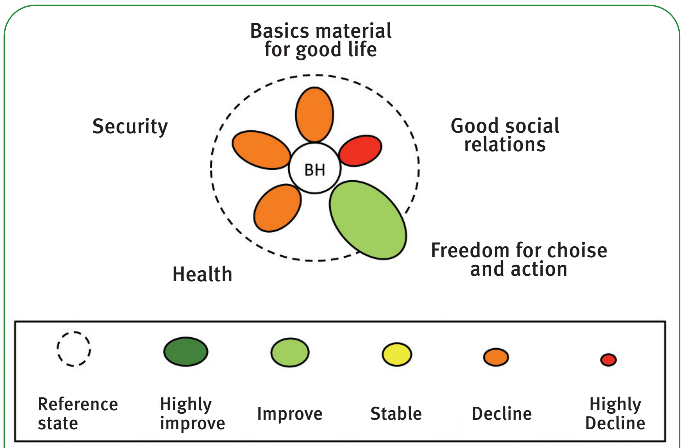


Figure 5.3 Diagram of the synthesis of the five dimensions of human wellbeing assessed in Spain, graphically showing the ascent / descent of each dimension.

Finally, freedom of action and choice (despite the complexity of their evaluation) are most likely the only dimensions of human wellbeing that have made good progress in recent years in Spain. This reflects the growing trends of indicators of gender parity, education and civil liberties (Figure 5.3).

Table 5.1 Synthesis of human wellbeing trends assessed in Spain

DIMENSIONS	SUB-DIMENSIONS	Indicators	Trends	
			Sub-dimension	Dimension
I. BASICS MATERIAL FOR GOOD LIFE	———	Poberty rates	↓	↓
II. FREEDOM FOR CHOISE AND ACTION	Civil freedoms	Civil freedoms index	↑	↑
	Education	% Iliteracy	↑	
	Gender	% of women in congress	↑	
	Economic equaty	Unequal wealth distribution across households	↓	
	Freedom from time	% Hours of holidays	↓	

Table 5.1. Synthesis of human wellbeing trends assessed in Spain

DIMENSIONS	SUB-DIMENSIONS	Indicators	Trends	
			Sub-dimension	Dimension
III. HEALTH	Life expectancy	Life expectancy	↑	↓
	Morbidity and healthy habits	Obese population	↓	
	Mental health	Hypnosedatives treatment	↓	
IV. GOOD SOCIAL RELATIONS		TV consumption, Divorce	↓	↓
V. SECURITY	Material	House prices on average income	↓	↓
	Health	Number of doctors per 100.000 inhabitants	↑	
	Citizen	Deaths from homicide	↓	
	Vial	Number of traffic deaths	↑	
	Social protections	Social security affiliations	↑	
	Political	Untrust in political parties	↓	
	Familiar	Home violence complaints	↓	
	Existential	Maternity age	↓	
	Global changes	Natural hazards	↓	

The standard of living in Spain has continued to increase year after year under a system that has supported economic growth and material consumption as an end in itself. A good example of this is our ecological footprint, which has doubled since the 1960s, reaching 5.4 global hectares per capita. This means that every Spanish citizen exhibits an ecological deficit equivalent to 3.8 hectares (because Spain exhibits a biocapacity of only 1.6 global hectares per capita), which means that Spain would currently need approximately 3.5 times its current area to meet the consumption demands of its population.

That the standard of living in Spain has increased considerably in recent decades is no surprise. However, human wellbeing in Spain, unlike what was observed in the global MA, appears to have undergone a process of deterioration in recent decades, as among its five dimensions, only one appears to have improved: freedom of action and choice. This indicates that the progressive ecosystem degradation occurring in Spain (45% of Spanish ecosystem services have been degraded or used unsustainably in recent decades) is associated with a parallel deterioration of human wellbeing, as the two entities (human wellbeing and ecosystems) are in constant dynamic interaction.

According to the results of the analysis of human wellbeing based on the SNEA, the endless promotion of economic growth and material consumption as an end in itself is detrimental to human wellbeing because while it tends to increase the standard of living and material aspects more closely related to the economic sphere, it seriously erodes more non-material dimensions, such as healthy habits or good social relationships.

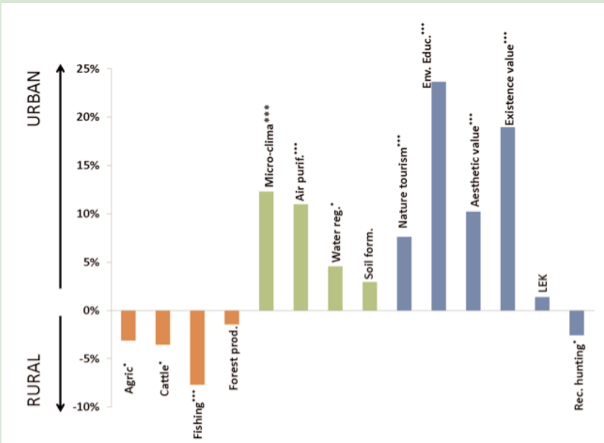
In this context, it appears that an individualistic lifestyle is arising in Spain, in which people are sedentary and isolated, supported by a social organization that revolves around cities, causing us to forget the sense of community life and dependence on ecosystems that for centuries have characterized the Mediterranean lifestyle.

The decision of where to we choose to live our lives in the coming years within the wide range between focusing on the standard of living and quality of life (Figure 5.2) will determine the future socio-ecological situation in Spain. The alternative to the current unsustainable economic model largely depends on our ability as a society to shift our lifestyle toward focusing on our quality of life, that is, the ability to adapt the Spanish population to a type of human being who is ecologically sustainable and socially equitable, resulting in a good life within the biophysical limits of ecosystems.

Box 5.1 Exploring the diversity of viewpoints regarding wellbeing based on the cultural value of ecosystem services.

The diversity of social preferences towards ecosystem services in Spain demonstrates the different perspectives and viewpoints of stakeholders perceiving human wellbeing. A scientific study examining eight different case study sites representing various ecosystems (i.e., mountains, forests, wetlands, rivers and streams, coastal systems, semi-arid systems, agroecosystems, and urban areas) showed that the importance of ecosystem services for human wellbeing is perceived differently by stakeholders depending on specific socio-cultural factors, such as their formal education, environmental behavior, gender or the place of residence (i.e., rural or urban areas).

However, the social factor most strongly influencing preferences towards ecosystem services and the understanding of human wellbeing is the place of residence, which can be summarized as a rural-urban gradient. This study found that while rural people relate their wellbeing to provisioning services (e.g., food obtained from agriculture, cattle rearing, and fishing) as well as recreational hunting, urban people relate it to regulation of the micro-climate and air purification as well as specific cultural services (i.e., environmental education, existence value, aesthetic value, and nature tourism). In fact, the different social means of understanding the importance of ecosystem services for human wellbeing could be the cause of the common trade-off between provisioning services (and recreational hunting) versus regulating services and almost all cultural services. More specifically, this study found that the maintenance of specific regulating services is strongly linked to the preservation of the rural population's local ecological knowledge (LEK). Consequently, the wellbeing of the urban population strongly depends on the maintenance of the LEK of rural communities, associated with soil and water management.



Significance at *p≤ 0.10; **p≤ 0.05; and ***p≤ 0.01.
Source: Martín-López et al. (2012)

6 HOW CAN WE INTEGRATE A MULTISCALAR APPROACH INTO NATIONAL ECOSYSTEM ASSESSMENTS?

From national to local and vice versa

KEY FINDINGS

- One of the main challenges addressed by the Spanish National Ecosystem Assessment was the integration of results obtained at different spatial scales using the same conceptual approach, but with different assessment methodologies.
- The five case studies analyzed show different trends in terms of the evolution of both the services and drivers of change and are consistent with the general pattern of trends observed at the national level. This may be due to the application of different analytical methods and to different geographical, ecological and socioeconomic characteristics.
- The cultural services demanded by urban people tend to increase in all of the studied cases. There is also a general trend of an increase or maintenance of technified provisioning services, while traditional provisioning services and regulating services are declining in four of the five cases.

While the ecosystem service analysis of the 14 ecosystem types at a the national scale was mainly based on the identification of indicators from available databases and through the use of expert judgment, the regional/local case studies attempt to address trade-offs in ecosystem services at a finer level of detail using different methodologies, such as participatory assessment techniques based on the social perception of local actors, modeling of future scenarios, and biophysical evaluations of services and trends through local-scale indicators. The specific approach and methodology applied in each of the five regional/local case studies are presented in Table 6.1.

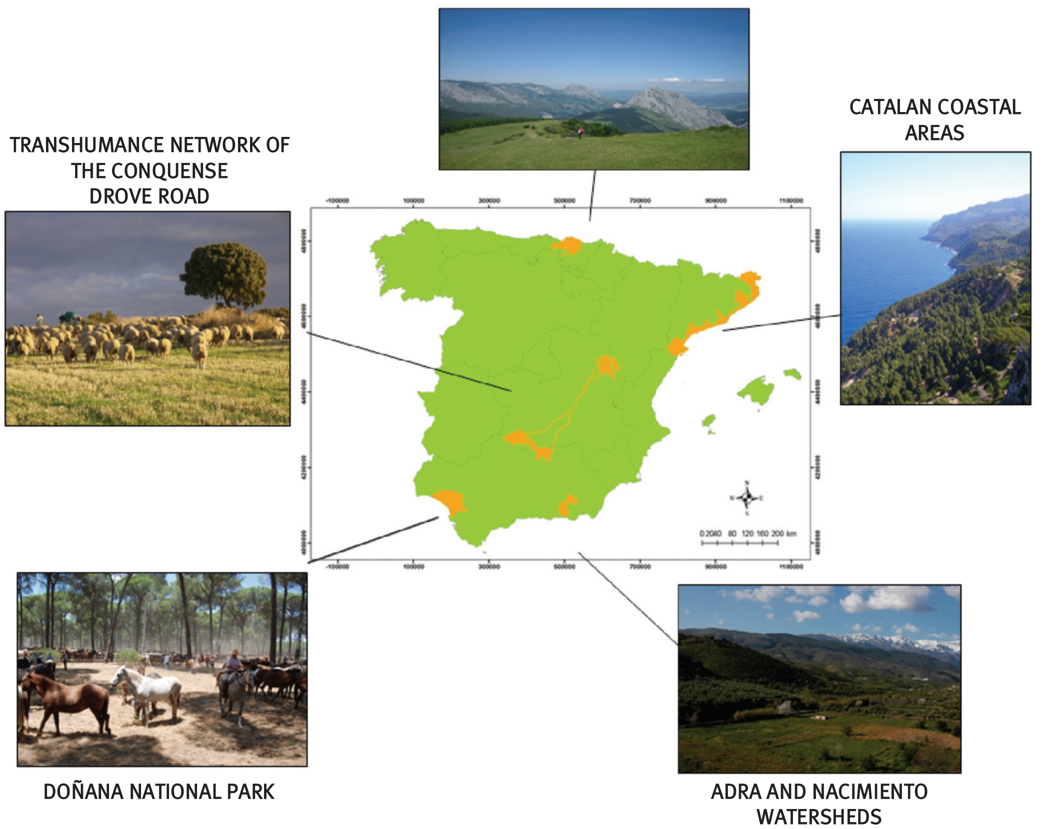


Figure 6.1 Geographic location of the five case studies selected to investigate different possible socio-ecological processes at regional and local scales and to explore different methodologies for evaluating ecosystem services at different spatial scales.

One of the main challenges addressed by the Millennium Ecosystem Assessment in Spain was the integration of results obtained at different spatial scales using the same conceptual approach, but assessment methodologies that are not directly comparable. Thus, the SNEA developed five assessments of ecosystem services at local/regional scales. The specific methodologies used in each case study were adapted to the biophysical reality of the socio-ecological system assessed and the interests of local stakeholders. At the regional level, the case studies included the Millennium Ecosystem Assessment of Bizkaia, the coastal ecosystems of Catalunya, and the transhumance network of the Conquense Drove Road. At the local scale, the case studies included two watersheds in Almeria and the Doñana National Park and its surroundings (Figure 6.1).

Table 6.1 General description of the five case studied assessed in SNEA

	Doñana National Park	Adra and Nacimiento Watersheds	Transhumance network of the Conquense Drove Road	Bizkaia	Catalunya Coastal ecosystems
Spatial scale	Local: National park and sorrounding	Local: Watersheds	Local: Drove Roads	Provincial: with four local studies	Regional: Coastal areas
Area (km²)	3.115	1.341 (744 Adra and 597 Nacimiento)	2.400	2.217	6.930
Population (inhabitants)	213.000	66.400 (54.000 Adra and 12.400 Nacimiento)	44.700	1.151.113	682.718
Location (province and municapalities)	Provinces: Huelva, Sevilla y Cádiz (16 municipalities)	Provinces: Granada and Almería (24 municipalities)	Provinces: Teruel, Cuenca, Guadalajara and Jaén (28 municipalites)	Province: Bizkaia (112 municipalities)	Province: Girona, Barcelona and Tarragona (39 municipalities)
Socio-economic characterization	Intensive agriculture and international tourism	Extensive agriculture and local tourism	LIvestock, extensive agriculture, hunting and forestry	Industry and international tourism	International tourism, intensive agricultura and fhising
Ecosystems	Wetlands and coastal	Arid zones, agroecosistems, rivers and mediterranean mountains.	Continental forest and mediterranean sclerophyllous srub and forest and agroecosystems	Atlantic forest, agroecosystems and urban areas	Wetlands and coastal
Protected areas	National Park and (1969), Sourrondin Natural Park (1989) UNESCO Biophere Reserve (1980), Ramsar (1982)	National and Natural Park (1999) UNESCO Biosphere Reserve (1985), Natura 2000 (1992)	Natural Park and UNESCO Biosphere Reserve	Natural Park and UNESCO Biosphere Reserve	Natural Park, Ramsar, ZEPA
Land management	Protected areas vs. Intensive agriculture	Protected areas vs. Intensive agriculture	Public land use vs. Private large land holders	Industrial areas vs. Periurban natural areas	Protected vs. Costal urbanization
Asssessment methodology	Social preferences, future scenarios, biophysical indicators	Social preferences and, water flows (green and blue) modeling	Social preferences and perceptions, future scenarios, biophysical indicators	Social preferences and perceptions, future scenarios, biophysical indicators, expert opinion	Spatial analysis and Social preferences

GENERAL PATTERNS

Despite the significant differences among the five analyzed case studies, a number of general trends were observed in both the services and drivers that are consistent with the general pattern of trends observed at the national level (Table 6.2). For example, the results of grouping services into the five major categories used in the SNEA to analyze trends show how the cultural services demanded by urban people tend to increase in all of the regional/local cases studied. There is also a general trend of an increase or maintenance of technified provisioning

Table 6.2 Results of the ecosystem services assessment for each case study included in the SNEA

Type of service	Service	Drove Roads	Semiarid watersheds	Doñana	Bizkaia	Catalan coastal
Provisioning	Food	↓	↔	↑	↓	↓
	Water		↓	↓	↑	↓
	Biotic material	↓	↓		↑	
	Geotic material		↓		↓	
	Energy		↑			
	Gene pool	↓		↔	↓	
Regulating	Climatic regulation	↓	↔		↑	↑
	Air quality	↓	↔		↑	↑
	Water depuration	↓	↔	↓	↑	↔
	Erosion control	↓	↓	↓	↓	↓
	Soil fertility	↓	↓	↓	↓	↓
	Disturbance control	↔		↓	↓	↓
	Biological control	↓	↓	↓	↓	
	Pollinization	↓	↓	↓		
Cultural	Scientific knowledge	↑	↑	↑	↑	↑
	Recreation activities	↑	↑	↓	↑	↑
	Aesthetic landscape	↔	↓		↓	↔
	Spiritual value	↓	↔	↔	↓	↑
	Local ecological knowledte	↔	↓	↓	↓	
	Cultural identity	↔	↔			↔
	Environmental education	↔	↔	↑	↑	↑

(↑: increase; ↔: no clear trend; ↓: decrease; blank cells indicate that the service has not been evaluated).

services, while traditional provisioning services and regulating services are declining in most cases (four of the five cases analyzed).

Regarding the direct drivers of change underlying the current observed trends, the five case studies clearly show that changes in land use are the main drivers in terms of importance, showing a clear tendency to increase rapidly in four of the five cases. The relative importance of the other drivers varies among cases, with over-exploitation, pollution or invasive species being the second most important driver. Overall, direct drivers of change showed a clear tendency to increase in the five case studies (70% of the drivers analyzed).

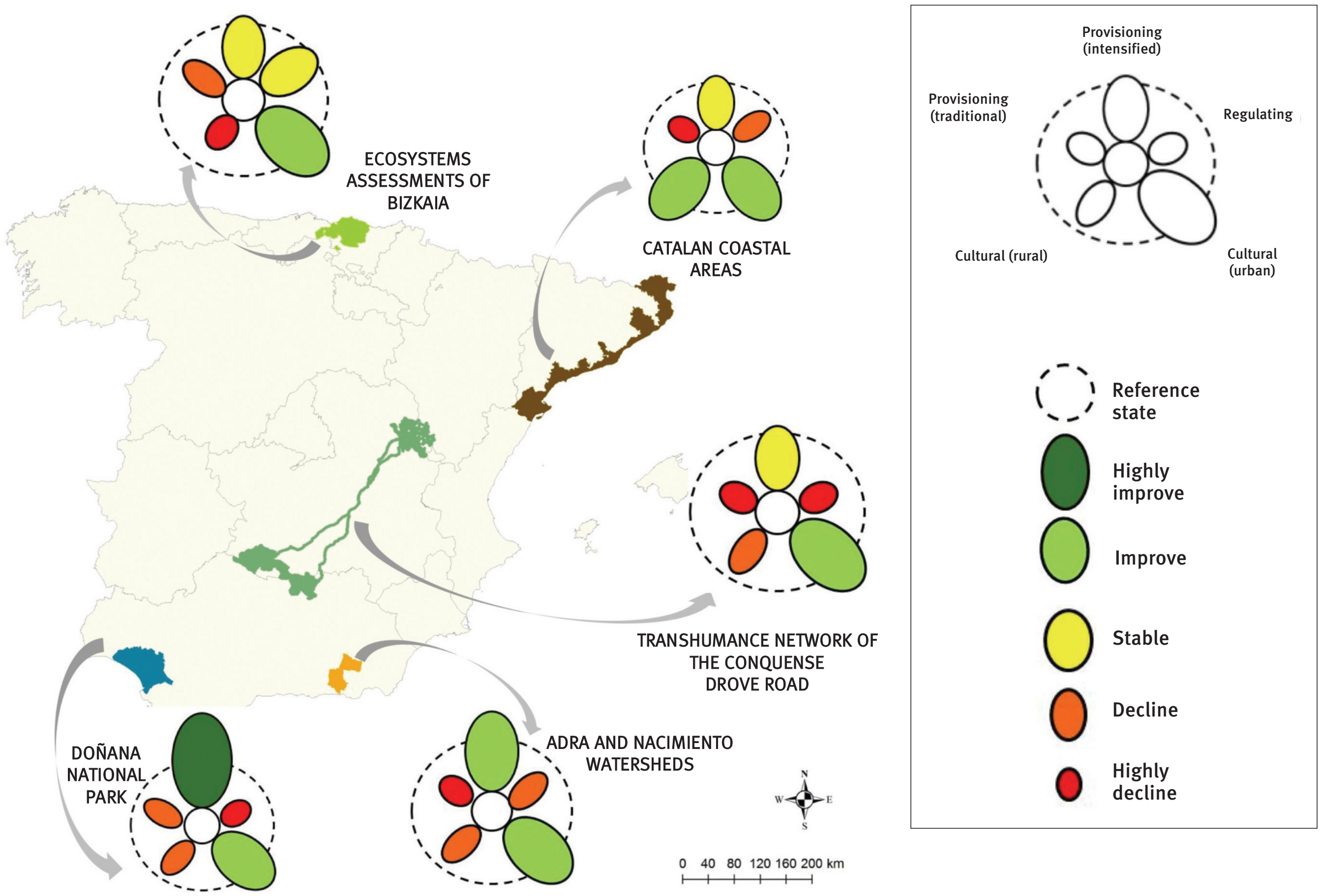


Figure 6.2 Synthetic evaluation of the status and trends of ecosystem services in the five case studies included in the SNEA.

In the transhumance network of the Conquense Drove Road, all of the regulating and provisioning services showed a declining trend, with the only exception being disturbance control, which mostly referred to the prevention of forest fires due to the removal of biomass by transhumant livestock. Regarding cultural services, all such services remained stable or improve, except spiritual value, which was affected by rural abandonment and the loss of traditional practices. It is interesting to highlight the deterioration of services related to traditional food production, caused by rural abandonment and the perceived loss of quality of agricultural products.

In the Adra and Nacimiento watersheds, a decrease in provisioning services was observed, including that of water, fibers and other biotic materials. Food provisioning is maintained because while traditional agricultural activities have decreased significantly, intensive farming systems (e.g.,

Box 6.1 Evaluating ecosystem services in transhumance cultural landscapes[a]

An interdisciplinary and participatory methodological framework for ecosystem services assessment was applied between 2009 and 2011 to the landscapes associated with transhumance in the Conquense Drove Road[b] (CDR), one of the major livestock drove roads still in use in Spain. A total of 33 ecosystem services (10 provisioning, 11 regulating, and 12 cultural services) were identified and evaluated using biophysical, socio-cultural and/or economic valuation methods. Three examples are provided below.

Type of evaluation / ecosystem service evaluated	Methodological approach	Main results
Biophysical evaluation: Structural and functional connectivity provided by the presence of the drove road 	A GIS polygon file was built with current land cover in the CDR network. Structural connectivity was evaluated through polygon counts under three different scenarios (absence of drove road, drove road with its actual width and a hypothetical drove road with the legal 75-m width). Functional connectivity was evaluated using the travel cost index (a GIS tool based on resistance). Three types of matrices (forest, drove road and agrarian) and three theoretical matrix resistance values for different wildlife species (low, medium and high) were explored.	The current drove road physically connects seven forest patches comprising 9,350 ha, while a drove road with its legal width would connect 25 forest patches totaling 77,180 ha. Regarding functional connectivity, the presence of the drove road reduces resistance to wildlife movement by 0.2-1 percent on the whole trip between summering and wintering areas (up to ten percent in the case of the drove road with legal width). However, this effect is particularly important in those stretches that cross a highly transformed agrarian matrix, where the resistance reduction effect can reach 62 percent.
Socio-cultural evaluation: Aesthetic value of the drove road and livestock presence as perceived by different stakeholders 	Questionnaires (n=286) were applied to local inhabitants and non-residents, asking them to express their aesthetic preferences when comparing 30 photographic pairs. Pictures in every pair were very similar except for the presence/absence of a drove road, or the presence/absence of livestock. Differences were analyzed using Kruskal-Wallis tests and multivariate analyses.	Overall, no significant effect was observed regarding the presence of the drove road in the landscape, but differences were found among certain groups of stakeholders. The presence of livestock in the landscape was positively selected by all consulted stakeholders. Livestock herders (either transhumant or not) and neo-rural people were the stakeholders with a higher preference for the presence of the drove road and livestock in all the landscapes.
Economic evaluation: Soil fertility provided by sheep manure in stubble fields of the summering area 	Total manure production of sheep was estimated by multiplying the number of transhumant sheep heads by the average daily rate of manure deposition and the number of days sheep spent feeding in stubble fields in the summering area. The equivalent monetary value of fertilization using sheep manure as fertilizer was calculated at current market prices.	Over 1,000 tons of manure are produced every year by transhumant sheep in the summering area, and distributed over 19,000 ha of stubble fields (ca. 54 kg/ha). The monetary investment needed to replace this fertilization service would reach over 35,500 Euro at market price (not including the labor necessary to distribute manure, another service also provided by sheep).

a Modified from Oteros-Rozas et al. (2012).
b The drove road consists of a 75-m-wide (in most parts) corridor that crosses the agricultural lands in the central Iberian plateau for approximately 410 km, connecting summering and wintering pasturelands.


Marina García Llorente

greenhouses) have increased in terms of both area and production. Regulating services have also been negatively affected in these watersheds, particularly erosion control, soil fertility, biological control and pollination. This decline is driven by an abandonment of rural mountain areas and a degradation of terraced crops as well as subsistence farming. Finally, cultural services linked to scientific and recreational activities (e.g., nature tourism) have improved, while others linked to the maintenance of local ecological knowledge and aesthetic values have declined.

In the Doñana National Park case study, the only services that showed an increasing trend were those related to food provision (e.g., fruit crops) and certain forms of formal knowledge (the cultural services of scientific and environmental education). In general, regulating services were degraded, particularly those associated with water quality and agricultural intensification (e.g., loss of soil fertility, increased erosion, decreased shock damping).

In the Bizkaia case study, there was an overall decrease in agricultural practices related to traditional knowledge and an increase in the forest area, mainly due to the proliferation of intensive pine forest plantations in recent decades. This increase, together with the reduction of industrial pollution over the past two decades, explains why certain regulating services have improved, including air and water quality, local and regional climate regulation and carbon storage. However, due to heavy anthropogenic pressures, there was a loss of many other services. Regarding cultural services, an increase was observed in scientific knowledge and environmental education as well as in recreational activities associated with the development of tourism and recreation, while traditional ecological knowledge declined.

Finally, on the Catalan coast, there was a general tendency to decrease provisioning services as well as most regulating services (except for the climate control and air). Cultural services associated with recreation activities, education and scientific knowledge have increased significantly.

7 WHAT IS THE SPANISH PUBLIC´S CURRENT UNDERSTANDING OF ECOSYSTEM SERVICES AND HOW CAN WE COMMUNICATE OUR MAIN RESULTS?

From theory to action

KEY FINDINGS

- **The majority of the Spanish population does not perceive the links between ecosystems, biodiversity and wellbeing. Based on an online survey, the Spanish population believes that the degradation of ecosystems and its biodiversity losses are problems that do not affect them, and they do not know what role they should play as citizens to address these issues and provide a solution.**

- **The SNEA communication strategy has been planned from the beginning in parallel with research to create a dialogue between researchers, decision makers and the general public. The impact of the SNEA on public awareness is increasing, and its concepts and theoretical frameworks are taking root in society.**

- **The information we receive daily regarding the conservation of ecosystems and its biodiversity will be valuable if people are able to apply it in their daily lives. Messages proposed based on the SNEA follow this direction.**

- **Environmental education implies new ways of seeing, thinking and sustainable acting in relation to the consumption of goods and services in the economic system based on ecosystems and its biodiversity.**

SNEA COMMUNICACION STRATEGY

The general aim of the communication strategy is to **build a social network around the vision of nature conservation as a necessary action for human wellbeing.** Therefore, the focus of this strategy is to attempt to overcome the social perception of nature conservation as something elitist or exclusive and build a shared vision of the vital links between human needs and nature conservation.

To achieve this general aim, the SNEA communication strategy has set the following objectives:

- Coordinate internal communication elements that allow proper scientific exchange between the research teams involved in the project under the integrated and inclusive framework of the Millennium Ecosystem Assessment.
- To bring the development of the SNEA to the attention of stakeholders and listen to their needs and contributions regarding ecosystem services to ensure that the results will be useful to them as well as taking into account the different actors involved in or dependent on ecosystem services.
- Develop external communication tools tailored to the needs of different target audiences or stakeholders as well as innovative formats and channels for the dissemination of the results of SNEA in different social spheres, such as the media, school communities, NGOs and social movements.
- Characterize the messages that define the approach of the project regarding the human-nature relationship as well as building a graphic identity for the project and amplifying its messages through existing channels and networks.
- Contribute to the international dissemination and projection of the Millennium Assessment (included the participants in the Sub-global Assessment Network) and other national and international collaboration channels associated with the project.
- Increase the interaction and information flow between the scientific community, policy-makers, businesses and society in general to improve decision making in the management of ecosystems according to the project's objectives.

According to these objectives, the approach regarding the message on ecosystem services moves away from the classical conservationist view and attempts to construct a message that includes the interaction between society and nature and chooses not to present the usual catastrophic vision linking the everyday life of people with their environmental impact. The message content is focused on the contribution of ecosystem services to wellbeing, revealing its high social importance. It is a positive message, offering the chance to appreciate the relationship between the conservation of nature and a human lifestyle that is possible and worth living.

SNEA COMMUNICACION PLAN

The actions that derive from these objectives and this approach are threefold: i) generic public communication elements; ii) communication tools, participation and education tailored to different specific population segments (e.g., political and technical staff, students, scientists, NGOs and social movements); and iii) the organization or participation in events (e.g., workshops, conferences, meetings, forums). These actions are contained in the SNEA Communication Plan:

I) Generic public communication elements:

- Website: www.ecomilenio.es.
- Facebook: Ecomilenio España.
- Quarterly Newsletters: quarterly newsletters mailing.
- SNEA video.
- Ecosystem videos (available on web site and SNEA YouTube channel).
- Brochures.
- Other materials: Postcards, notebooks, etc.

II) Specific public communication elements:

a) SNEA Reports: Results and Synthesis.
b) Teaching materials.
   i) Teachers guide.

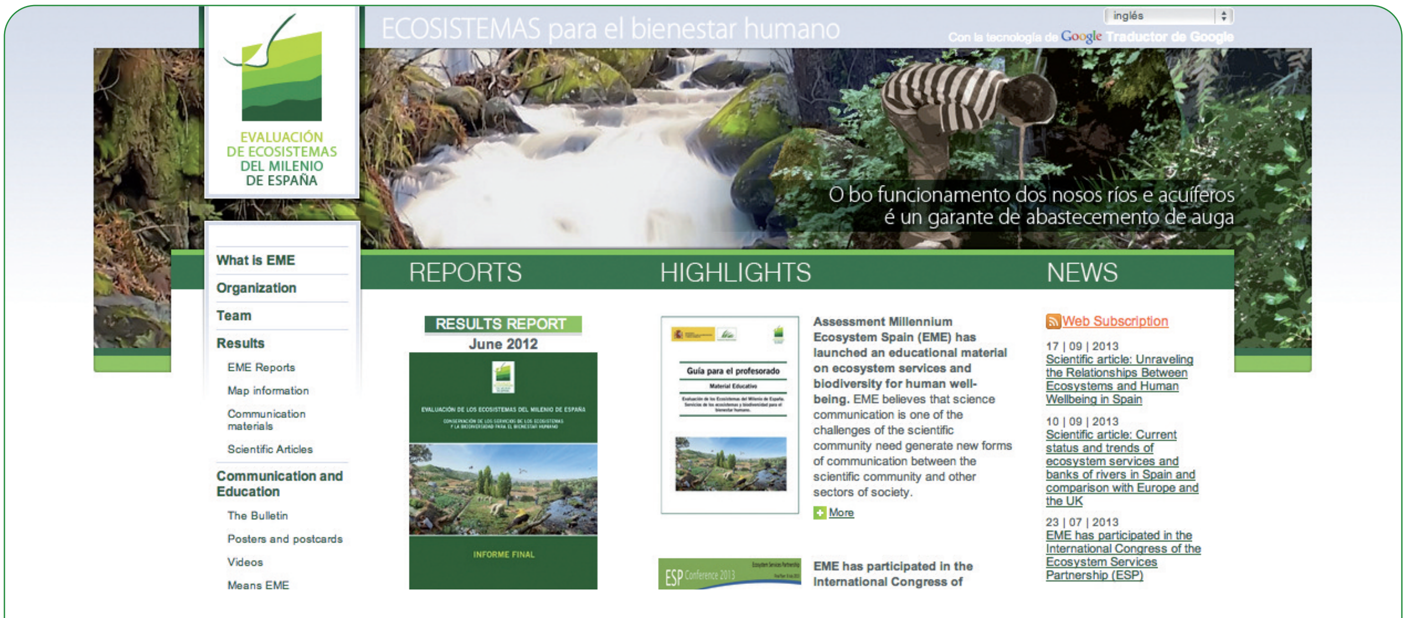


Figure 7.1 SNEA website: www.ecomilenio.es

Box 7.1 Main comunications impacts of the SNEA

The Plan has developed a two-way communication for evaluation. First, there is an internal assessment based on the monitoring and implementation of evaluation criteria. Second, there are specific assessments of each of the elements of the communication plan:

a) The resources applied in the field of formal education are subjected to their own method of evaluation, designed within the materials.
b) The **website** offers an analysis system from Google Analytics that allows us to track web visits. Thus, it is possible to determine how many times materials have been downloaded, which currently cannot be evaluated because the materials have been freely disseminated. From its launch, until September 1, 2013, the website received **30.066 unique visitors and a total of 43.068 visits to 101.576 pages.**
c) There are **231 subscribers** to the newsletter. It also receives **2.125 visitors** from the web.
d) There is a separate display counter for **videos.** They have been viewed **15.680 times**.
e) The impact of the project in the media has been monitored, which is also reflected in the SNEA media section of the website, where a total of **158 appearances in the media are posted**.
f) The NEA had **522 friends in Facebook** as of 01/09/13.

ii) Slide presentation.

iii) Posters: one general poster identifies the ecosystem services associated with different types of ecosystems and another poster is specific to urban ecosystems (See pages 13. Figure 3)

c) Stakeholder surveys: providing the basis for a participatory process for the construction of future scenarios.

d) Communication materials for the Thematic Workshop on future scenario construction.

CEPA FRAMEWORK

The CEPA (Communication, Education and Public Awareness) toolkit has guided the framework for the design of communication interventions in the SNEA. It is promoted by the IUCN as a proposal for improvement of the communication of biodiversity conservation as part of the work program of the Convention on Biological Diversity. This toolkit includes a wide

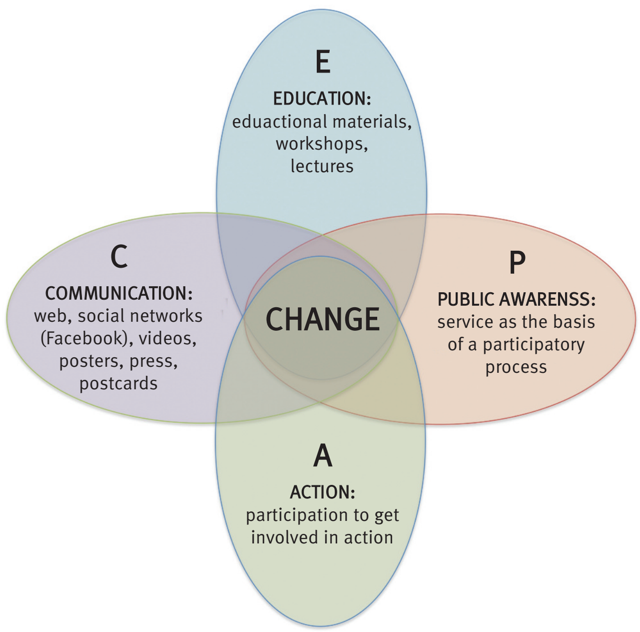


Figure 7.3 Elements of the SNEA communication strategy under the CEPA framework, committed to the use of different tools to achieve its goals synergistically.

range of social instruments, such as information sharing, participatory dialogue, education and social marketing, to highlight common interests for the stakeholders and to manage change (Hesselink *et al.*, 2007).

The CEPA strategic model is the framework for the design of social interventions and is clearly a key tool for achieving social change. However, although it has come a long way, there are significant challenges ahead. One of these challenges is increasing the involvement of those less-sensitive sectors and social groups in the collective design of future scenarios that are more committed to sustainability.

COMMUNICATION OF SCIENTIFIC MESSAGES: NEW TARGET GROUPS FOR ACTION

Since its initiation, the SNEA has created a specific strategic line of communication that aims to bring the project objectives to its various stakeholders (e.g., political and technical staff, environmental organizations, businesses, social movements) and the research teams who are developing the scientific work and searching for a new type of relationship between science and society. This science-society interface is about building bridges and breaking down barriers between the world of researchers, decision makers and the general public. Communication is planned in parallel with research, considering the opening of various channels and communication elements (e.g., websites, social networks, quarterly newsletters, surveys, posters, videos) to reach different target groups to be very important. The first step has been to introduce the concepts and results of the project among social sectors with some degree of expertise on the subject. At the same time, the information generated by these social sectors is collected to be taken into account in the assessment. This priority given to communication aims to achieve the principles of legitimacy, credibility and relevance in the Spanish NEA, as recommended by the international process of the Follow-up to the Millennium Ecosystem Assessment.

Figure 7.4 Educational materials available for download at the website www.ecomilenio.es.

There is a clear projection of the SNEA to society to generate a dialogue between different social groups whose interests or decision-making capacity are bound in ecosystem conservation. The aim is to generate messages to involve the general public in the project's objectives.

EDUCATION AS A POSSIBLE ANSWER

The SNEA has provided the design of teaching materials for different educational levels and profiles of students in universities and during secondary education and at other levels (Figure 7.3) It is intended that teachers and environmental educators will play a key role in spreading the concepts, results and achievements of the scientific research project to all areas of environmental education. An educational workshop was designed according to various activities that facilitate the learning process among students based on the objectives of the SNEA. The basis of the workshop is a presentation in the classroom, including a program involving various educational activities, work groups, discussions, games, and additional resources designed under the project, such as the aforementioned posters and videos. The workshop is designed so that educators can adapt it in one-to-three hour-long sessions, according to their needs. To facilitate the circulation and application of the workshop, all of the materials that have been produced are available to teachers and the interested public from the website.

Environmental education implies new ways of seeing, thinking and sustainable action in relation to the consumption of goods and services within the economic system arising from ecosystems and its biodiversity.

We need to connect to a movement of informed and trained people who can adopt this critical attitude and are committed to the creation of new lifestyles based on the search for human wellbeing. Thus, the quality of life would be based on the search for new ways to enjoy life and maintain the ties that bind us to natural systems.

SPANISH
NATIONAL
ECOSYSTEM
ASSESSMENT

Gruber

PUBLIC AWARENESS

The Eurobarometer surveys conducted in 2007 and 2010 by the European Commission on the attitudes of Europeans towards Biodiversity provides an excellent picture of the social situation in Europe and in Spain and is an essential reference during the initial stages of designing a communication intervention for environmental communication.

It may be observed from the great quantity of data collected by the Eurobarometer in 2010 that a significant percentage of the Spanish population (70%) has occasionally heard the term biodiversity, but it is noteworthy that only 39% know what it means. Other suggestive data indicate that only 24% of Spaniards believe that current biodiversity losses have a direct effect on their daily lives, while the majority, 78%, believe that they will not be affected by this problem or that it will have only a slight impact on the future. It is also of note that 97% of Spaniards agree that nature and biodiversity are a source of wellbeing and quality of life, and 92% indicate that they are essential for the production of goods and services to society. On the other hand, only 34% of the Spaniards report having made any effort to protect biodiversity.

As indicated by the report of the Observatory for Sustainability for Spain in 2011, the International Year of Biodiversity did not help to change this trend. Instead, this report shows that a change in the applied strategy is urgently needed. If a disease progresses, it is urgent to alter the treatment and medication that is being applied. There is therefore a major challenge regarding identifying and implementing new strategies to involve the population in this task. It seems clear that the present social situation in Spain has relegated many environmental messages to the background in the media. These messages have lost their social presence and capacity to raise awareness.

Communication techniques are more effective when they are more active and participatory and when more senses are involved in the process of the transmission of information. The environmental information we receive will be valuable when people are able to apply it in their daily lives, to build sustainable consumption patterns.

In this context, we may move toward the use of ecosystem services linking nature and society. People tend to consider the conservation of ecosystems as something that is relevant only to scientists and conservation associations, who are considered social elites who are quite separate from their own interests and concerns. The population can identify with very specific campaigns linked to the conservation of flagship species (whales, bears, lynx). However, they are still far from understanding and participating more actively in global visions to address these problems. This is the current challenge.

PARTICIPATION IN ACTIONS

Participation is the basis of social action and intervention. For this reason, one of the main objectives of the SNEA communication strategy has been to promote social networking and the involvement of organizations and individuals in the project's objectives. It is essential to encourage involvement and participation to achieve this objective, particularly among those entities and actors who share the same vision for action in relation to the management of the capacity of ecosystems to generate services. Therefore, SNEA communications are open and adapted to different possibilities for relationships between social agents.

A survey carried out among one hundred entities identified the degree of interest shown by several social sectors in the project. Among the obtained responses, it was interesting to find that the major concerns stakeholders in the SNEA regarding the impacts on ecosystems reflect a priority interest in the changes in land use. This equates to the results shown in the chapter on the evaluation of the direct drivers of change.

This study shows that 92% of the organizations who responded to the survey are willing to be a part of the SNEA. More specifically, these collaborations would take the form of subscribing to the newsletter of the SNEA (78%), writing an article for the newsletter (36%) or broadcasting via communication channels (58%). Even more gratifying, 50% of these organizations would be willing to establish a permanent working group to go into greater depth regarding ecosystem services or the definition of future scenarios. There is a great potential for involving entities that share the same goals, which could be the basis for changes being proposed by the SNEA.

The participatory definition of possible future scenarios for ecosystem services and human wellbeing is certainly one of the challenges faced in this respect (see Chapter 8). The joint construction of future scenarios has generated dialogue on trends in ecosystem services and the potential for change in society towards sustainability, building proposals along these lines that can have greater impact and social acceptance.

The participation of stakeholders was very satisfactory, as it is showed in the following data.

8 HOW MIGHT ECOSYSTEMS AND THEIR SERVICES CHANGE IN SPAIN UNDER PLAUSIBLE FUTURE SCENARIOS?

The necessity of a long view

KEY FINDINGS

- **The results of future scenarios of the SNEA show similarities and differences compared to other scenarios at different territorial scales (globally, regionally and locally). The identification of winners and losers in each scenario is an important step in guiding acceptable future responses.**

- **The economic model in all of the scenarios appears to be inextricably linked to direct drivers of change, such as climate change or land-use change.**

- **In the scenarios, an economic model based on local production and consumption circuits appears to be more sustainable and to improve ecosystem services. In contrast, a global economic model that does not establish proactive environmental policies can have serious consequences in terms of social inequality and insecurity.**

- **The differences between rural and urban areas are one of the main conflicts identified under the five examined future scenarios. There are two scenarios that are completely polarized and two in which a mutual understanding of needs is finally achieved.**

- **As a result of the survey one of the most common response options is related to changes in food consumption and distribution. This may involve changes in other services, such as genetics and local ecological knowledge, but it must take into account the need to protect the services of soil fertility and erosion control.**

- **The technification of ecosystem services is already nearly inevitable in all scenarios, coming into conflict with biodiversity conservation in some cases. It is essential to note that under these scenarios, the key aspects are not only technological but also social. Therefore, it appears that the political dimension of governance and the importance of the role of different stakeholders under a new social pact show a differential trend compared to other technological scenarios.**

APPROACH AND OBJECTIVES OF THE SCENARIOS

Scenarios can be defined as 'a consistent and plausible picture of a possible future's alternative reality that informs the main issues of a policy debate' (EEA, 2009). The four examined global scenarios are structured around assumptions, discussions on rationale and drivers.

The Millennium Ecosystem Assessment presented four internally consistent scenarios that explore aspects of plausible global futures and their implications for ecosystem services and human wellbeing. Scenario development is a way to explore possibilities for the future that cannot be predicted by the extrapolation of past and current trends. The future could be far better or worse than any of the scenarios, depending on choices made by key decision makers and other people in society who bring about change (Figure 8.3). Their purpose in developing stories is to encourage decision makers to consider certain positive and negative implications of the different development trajectories (MA, 2005).

The objectives for conducting a scenario analysis were as follows:

- To support scientific study and the exploration of driving trends under the SNEA through dialogues involving the knowledge of different stakeholders.
- To generate future storylines that can contribute to increasing awareness of the relationships between ecosystem services and human wellbeing, especially among decision makers.
- To obtain proposals for response options to address global change and to test their social support.

STAKEHOLDERS AS PARTICIPANTS AND TARGETS

The selection of participants followed from the selection conducted in the previous phase of the project for participation in a survey in 2010: 1. Other agents considered in the Millennium Ecosystem Assessments were reviewed. 2. Classification criteria of importance and influence (de Groot et al., 2006) were taken into account. 3. Those who answered the survey and wanted to participate in this workshop were taken into consideration. 4. Proportional balance between different stakeholders was achieved (Table 8.1).

Stakeholders were selected to develop an interdisciplinary, multi-sector approach. A total of 138 individuals participated in the study : (i) preliminary survey (Study 1), 32 people from 28 organizations; (ii) workshop, 49 people from 42 organizations; and (iii) final survey 2, answered by 57 people from 55 organizations. This constitutes **a total of 87 different individuals from 78 different organizations.**

Table 8.1. Stakeholder participation during the future scenarios under the SNEA

	Survey 1		Workshop		Survey2		TOTAL (Different)	
STAKEHOLDER	Persons	Organizations	Persons	Organizations	Persons	Organizations	Persons	Organizations
Academia	12	9	15	13	18	16	25	22
Public administration	3	2	8	4	9	9	14	10
NGO and foundations	6	6	8	8	8	8	12	12
Companies	3	3	5	5	9	9	13	13
Professional associations	4	4	6	6	6	6	11	10
Natural protected areas managers	3	3	5	4	3	3	6	5
Environmental Media	0	0	1	1	1	1	2	2
Other	1	1	1	1	3	3	4	4
TOTAL	32	28	49	42	57	55	87	78

BUILDING THE SCENARIOS

As a first step, the two axes based on the most important and uncertain indirect drivers of change were characterized in terms of their future development (EEA, 2009). Based on the results of the Spanish biophysical ecosystem assessment and according to stakeholders' opinions Survey 1), economic and socio-political drivers of change are the most important and less influenceable (Figure 8.1). Therefore, the first axis proposed was economic governance (global vs. local), representing the degree and scale of connection between and within institutions, especially economic connections; one end of this axis corresponded to the trend towards globalization and the reduction of trade barriers and the other to the trend towards regionalization or localization of the economy. The second axis consisted of environmental policies (proactive vs. reactive), explaining whether the policies are designed to prevent undesirable ecological consequences (proactive) or to respond to environmental problems when they become apparent.

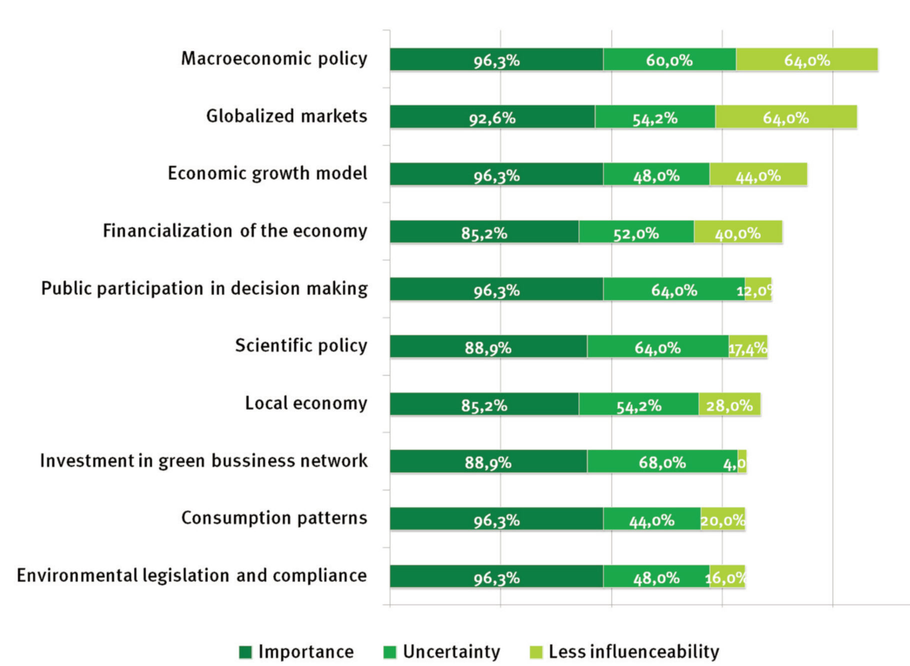


Figure 8.1 SNEA scenarios were identified based on the most relevant indirect drivers. Each stage of the four selected scenarios included a brief description based on the most relevant aspects of the corresponding MA scenario (2005). Thus, the scenarios for Spain can be related to global scenarios. The control or desired scenario did not initially identify drivers of change.

The preliminary survey revealed the ranking of the 22 most significant drivers according to their degree of importance, uncertainty and lower capacity of influence (Figure 8.1).

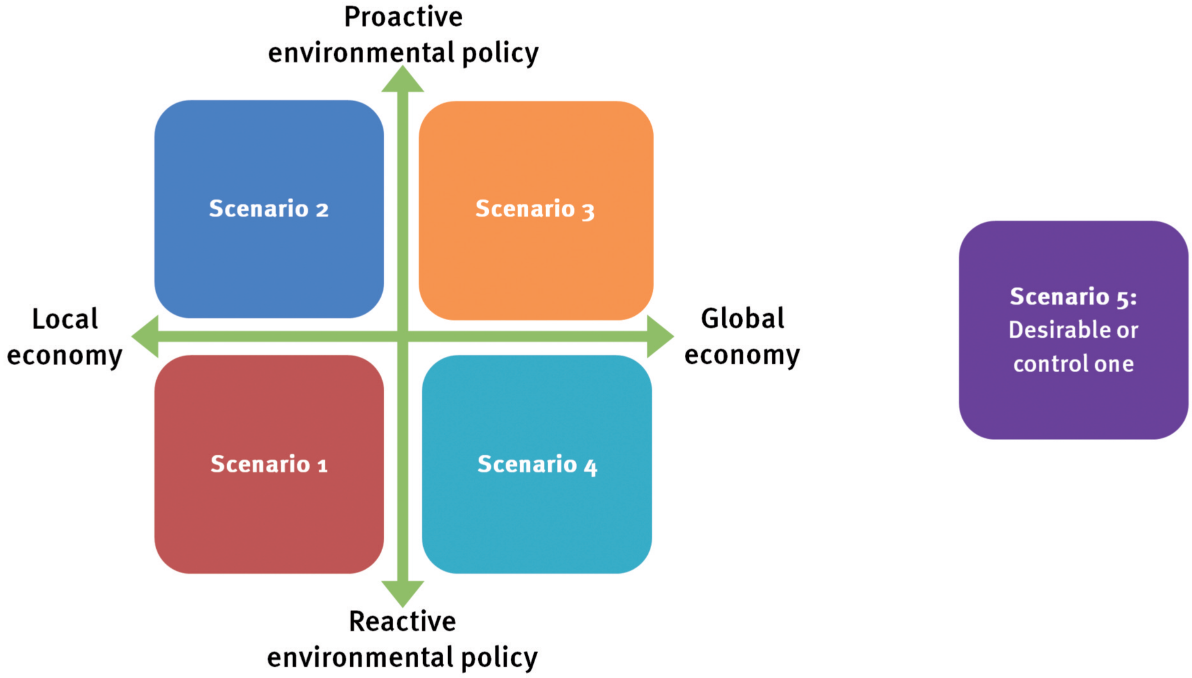


Figure 8.2 Main axes (based on the most relevant indirect drivers) that defined the five future scenarios used in the SNEA (Modified from MA, 2005).

DESCRIPTIONS OF THE SCENARIOS

1. Technopolarized

There is a high polarization of territorial, demographic, economic and human wellbeing-related conditions under this scenario (Figure 8.4). Movements of goods and people are infrequent. In rural areas, there has been a concentration of the population in the main villages (usually more than 5.000 people). The majority of the population lives in urban areas. Technology plays a "repairing" role for environmental impacts. Comfort and economic growth are more important values than sustainability.

2. Eco well-being

This is a scenario involving an extremely local economy and participatory governance as well as proactive environmental policies, such as a social pact aimed at a zero ecological deficit (Figure 8.4). A more balanced urban-rural distribution of the population is reached by means of a paradigm shift from economic growth to a new paradigm of care. There has been a radical change in energetic and consumption models, decreasing consumption rates. These changes are rooted in a cultural change, promoted by grassroots movements. Lifestyles show a time distribution that

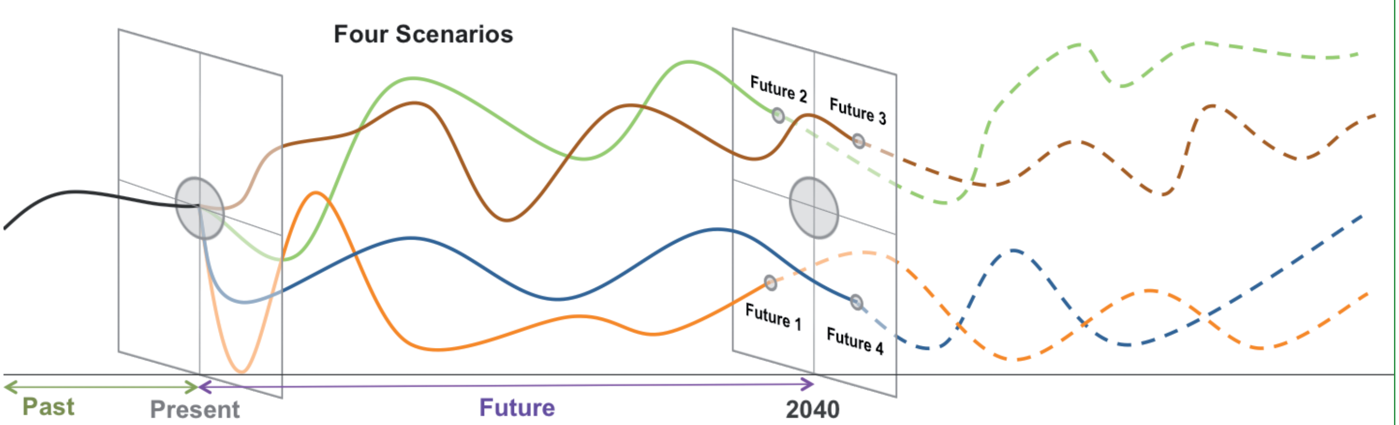


Figure 8.3 Graphical representation of the four future scenarios assessed in the SNEA.

goes beyond work and commuting. Less daily transport and more telecommuting are keys for a slower lifestyle.

3. Homo eco-technologicus

This scenario involves a predominantly urban society structured around what is "environmentally correct" in technological terms but with the social and rural market functioning as a service factory for the city (Figure 8.4). Services have been intensified, especially those related to commodities, such as agricultural products, water and renewable energies. Cities are modern and designed to be totally efficient. The population is still growing in global terms, which has led to conservation policies in cities. Strong international regulations protect production and manufacturing to de-carbonize the global economy.

4. Conflict in sight

In the context of the global economy and reactive environmental policies, this scenario predicts environmental degradation, vulnerability, dependency, inequality and social conflict in Spain in 2040 (Figure 8.4). The coastline is highly urbanized. Much of the population has migrated to the North due to climate conditions. There is not a great deal of technological development occurring at the Spanish scale. The economic elite live in green areas or enjoy holidays there. Rural areas are like a 'museum' or are used as leisure areas. Most of population lives in cities with few resources. There is a great deal of social unrest due to inequity. Large infrastructures have increased because mobility and seasonality are key to understanding life in 2040.

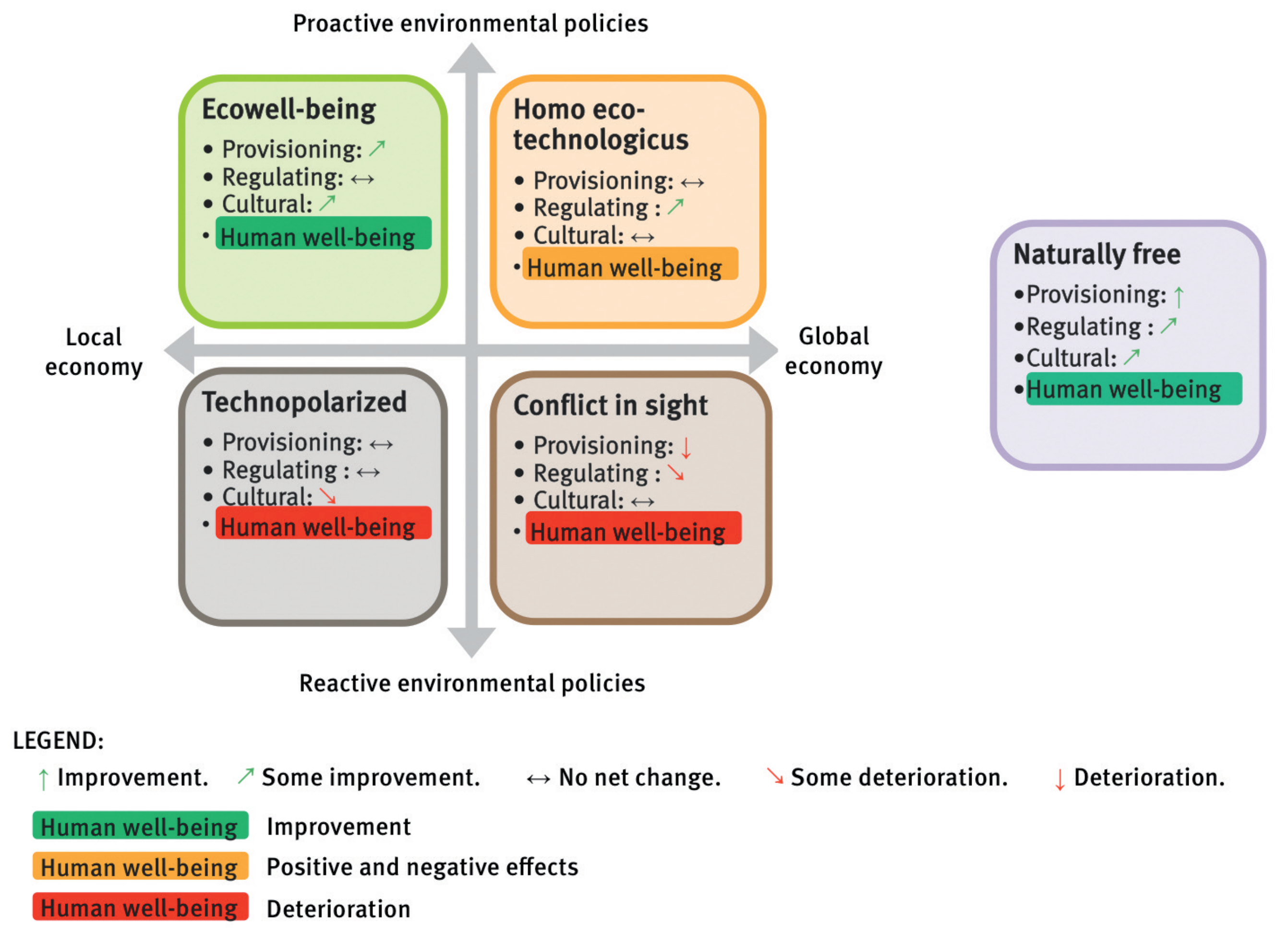


Figure 8.4 Synthesis of scenarios descriptions presenting main trends in ecosystem services and human wellbeing in 2040.

5. Naturally free

Sustainability, social equity, good health, culture and the valuable understanding of the interdependence between humans and ecosystems naturally provide us with a great deal of freedom.

At the Spanish scale, bioregions represent the new administrative and organizational units. Participatory democracy is the governance system in this scenario, in which every social actor is involved. Ecological production and consumption as well as collaborative consumption are mainstream practices. Social environmental awareness influences companies and their practices. The urban and rural population distribution is in balance. Working hours are also distributed amongst the population.

RESULTS OF THE SCENARIOS

When considering ecosystem services and human wellbeing, the 'Eco well-being' and 'Naturally free' scenarios (2 and 5) are the most favorable for human well-being. The application of technology in provisioning services makes a difference. In the 'Technopolarized' and 'Conflict in sight' scenarios, intensifying provisioning services due to the progress of technology linked to reactive environmental policies have consequences for the environment and social inequity.

Regulating services are sensitive to other changes in provisioning services, such as intensification. The worsening trends of these services require more time to revert and improve, according to the dialogue of the scenario. Erosion control and maintenance of soil fertility as well as the urban-rural distribution of the population are related to land-use change, which is the main direct driver in the Spanish baseline scenario. Therefore, facing land-use change requires effective measures in terms of erosion control and the maintenance of soil fertility based on a complex rational that drives new models of cities and new relationships between rural and urban ecosystems.

Among cultural services, local ecological knowledge is currently an endangered ecosystem service (in the baseline scenario), and declines in this service represent a major trend; its aggravation is a major trend within different scenarios. This worsening trend can be reverted only by consistent policies and initiatives. This ecosystem service is one of the key co-evolutionary links between cultural diversity and biodiversity. It plays a critical role in ecosystem resilience and human

wellbeing. Only the combination of these diverse types of knowledge leads to increased human wellbeing and improving trends in ecosystem services.

These scenarios identified possible trends of ecosystem services and human wellbeing for the future. In the scenarios where human wellbeing is improved (Eco well-being, naturally free), the resilience of ecosystems also increases, and social networks (e.g., social movements, NGOs) play a key role in changing the economic growth paradigm toward a paradigm of care.

RESPONSE OPTIONS

To increase resilience in ecosystems, response options are needed. Backcasting is a method for developing proposals considering the 5 scenarios as well as current trends and the status of ecosystem services. As a result of the workshop, 205 proposals were included in a questionnaire. This final survey (Survey 2) revealed the social support for different types of options, which allowed us to develop new means of encouraging different stakeholders into action. There are specific response options for every ecosystem service that was discussed in the scenarios as well as specific actions for every social actor.

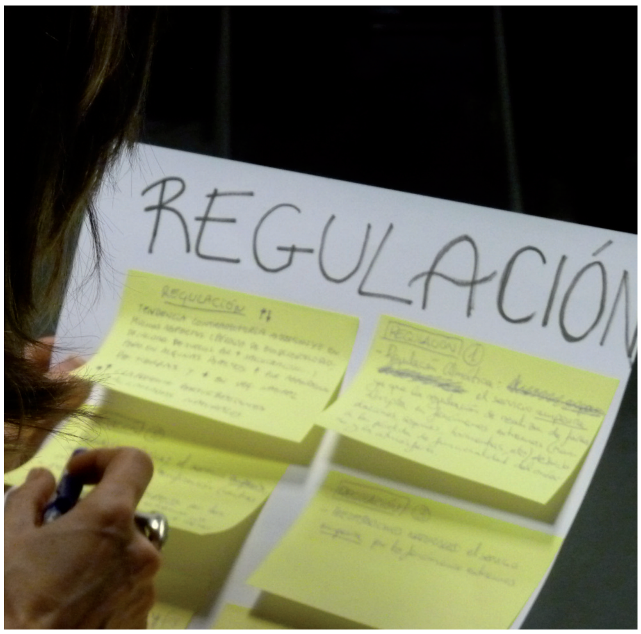
Nine out of the ten least-valued response options attempt to set stronger boundaries for different stakeholders in relation to factors such as consumption, property, working hours, public administration and personal carbon emissions.

The identification of winners and losers in each scenario is an important step for guiding future responses. The sub-global scenarios highlighted the importance of scale in determining winners and losers.

The exercise of running future scenarios can contribute to the ongoing dialogue regarding alternatives for emerging from the current recession in Spain. The consequences of actual decisions can indicate interesting parallels in the future scenarios collected here.

Table 8.2 The 10 proposals valued as most important *(1=extremely important, 2=important, 3=moderately important, 4=not at all important)* by the different stakeholder involved in the fuutre scenarios process

	1	2	3	4
Designing a new strategy to combat forest fires, more focused on prevention rather than extinction	32	18	1	0
Development of demographic and economic policies to resettle the rural population to stop the abandonment of rural areas	30	16	2	0
Promoting environmental education aimed at adults, specially programs for decision makers	28	18	3	0
Promoting reconciliation between work and personal life	24	15	3	0
Monitoring and compliance obligations with existing environmental legislation in water	26	23	1	0
Development of mechanisms for demand management (not only the supply) of water supply services applicable to all sectors, not only in the domestic one, to encourage saving and efficient use of water	33	18	5	0
Searching and implementing of new development and welfare indicators that go beyond GDP and achieve capture the degree of human well-being	26	13	5	0
Changing the current Spanish legislation on genetic material, ensuring the conservation of native seeds and the right of farmers to save, use and commercialize traditional varieties.	31	13	7	0
Progress in achieving the environmental objectives of the Water Framework Directive	28	19	3	1
Ensure appropriate transfer of technology and the fair and equitable sharing of benefits arising from the sustainable use of genetic resources under the CBD, ensuring that local and traditional populations are not excluded from these uses.	26	23	1	1



9 HOW CAN WE INITIATE A TRANSITION TOWARD SOCIO-ECOLOGICAL SUSTAINABILITY IN SPAIN?

From applied science to the application of science

KEY FINDINGS

- **The SNEA shows that there is still sufficient critical natural capital in Spain to provide this and future generations a positive environment that contributes to the wellbeing of its inhabitants. However, we also warn that unless we take urgent steps to halt and reverse the degradation of ecosystems and loss of biodiversity, we will approach a new threshold of change that, once exceeded, may cause us to enter into an unpredictable and undesirable situation of socio-ecological unsustainability.**
- **The territory should be conceptualized as a social-ecological system in which complex biophysical and human interrelations exist at different spatial and temporal scales, where the sustainability science could provide a new context for managing these territories and relationships.**
- **The mapping of ecosystem services constitutes one of the most promising tools for socio-ecological planning, as it allows us to go beyond administrative limits and characterize the degree of coupling or uncoupling that occurs between the biophysical basis of ecosystems and the social system it sustains.**
- **The fact that ecosystem services are generated at local to global scales implies that the management of social-ecological systems should be carried out by multilevel institutional systems, where each local operating unit enjoys independence to create and strengthen local rules and regulations, while at higher organizational scales, institutions should ensure the rights and duties of local institutions and the transmission of information between organizational levels and between institutions at the same level.**

The failure to meet the 2010 biodiversity targets [CDB, 2010] stimulated a set of new targets for 2020 (the Aichi targets), and in conjunction, governments have been negotiating the establishment of a new assessment body, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). At the national scale, the Strategic Plan on Natural Heritage and Biodiversity (MARMM, 2011) recognizes the social role of ecosystems and its biodiversity due to their influence on human health and quality of life but also based on their contribution to social and economic development through the supply of essential ecosystem services. It emphasizes the social and economic value of ecosystem services and the importance of their inclusion in policies.

However, significant efforts in both the science and policy domains need to be made in the next several years if the Aichi targets are to be met (Cardinale 2012). As highlighted by Perrings et al. (2010), the first strategic goal to meet the 2020 targets is to "address underlying causes of biodiversity loss by mainstreaming biodiversity across government and society". The SNEA has shown that there is no clear institutional response to address these underlying causes (indirect drivers of change) in Spain, and we believe that responses are necessary to fill this political gap and to meet the 2020 targets. To meet these targets, further structural changes are required that recognize biodiversity as a global public service as well as integrating biodiversity conservation into policies and decision frameworks for resource production and consumption and focusing on wider institutional and societal changes to enable more effective implementation of policies [Rands et al, 2010]. Additionally, sustainability demands cultural changes in society as a whole and in individual human behavior.

The SNEA proposes a basic "toolbox" to enable the transition from the current model of development towards social-ecological sustainability in Spain (Figure 9.1). The instruments that this "toolbox" proposes to stop the degradation of ecosystems and loss of biodiversity are classified into three major groups, each of which exhibits advantages and limitations: (i) environmental legislation applicable to the conservation of biodiversity and ecosystems, (ii) economic incentives and market-based strategies, and (iii) adaptive governance strategies based on community and education strategies for sustainability (Figure 9.1). The set of response options is integrated into three levels of action, to be addressed in an integrated manner to facilitate a genuine transition toward a new model of living based on sustainability.

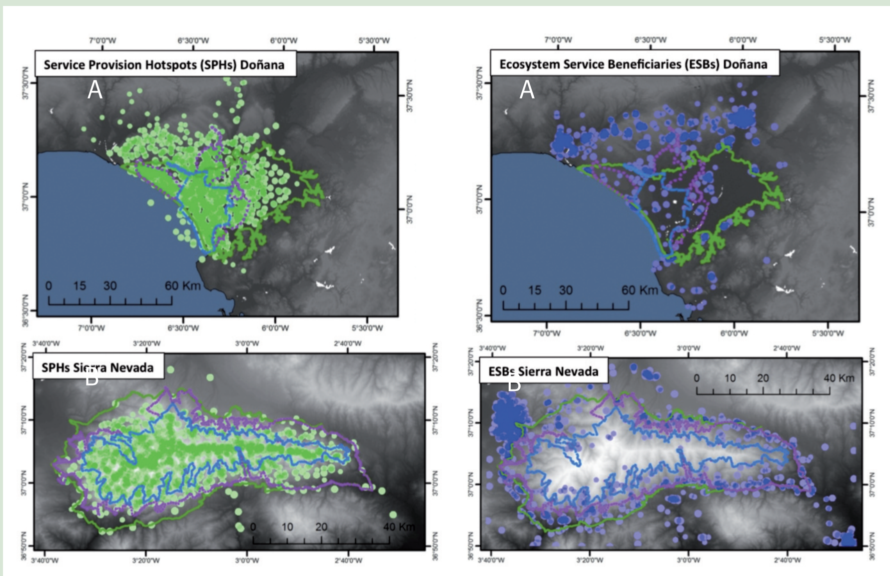
The first level of action is aimed at developing the main principles of a new paradigm of sustainability to correct management actions of the past that have been proven to be inappropriate and offer new insights into the development of a legal framework that respects the role that ecosystems play in human wellbeing. The SNEA serves as a step forward in responding to this policy demand and can be used to reach agreements on biodiversity and ecosystem services at national, EU and global levels. For instance, the EU Biodiversity strategy calls on member States to map and assess the state of ecosystems and their services in the national territory [EU, 2011]. Maps are useful for spatially explicit prioritization and identification of problems, especially in relation to the synergies and trade-offs among different ecosystem services and between ecosystem services and biodiversity. Furthermore, maps can be used as a communication tool to initiate discussions with stakeholders, visualizing the locations where valuable ecosystem services are produced or enjoyed and explaining the relevance of ecosystem services to the public in their territory. Maps can, and to some extent already do, contribute to the planning and management of biodiversity protection areas and, implicitly, of their ecosystem services at a sub-national level (Box 9.1). The political-institutional model in Spain is far from the proposed multi-level governance model by the MA. Thus, the model proposed by the SNEA presents practical problems difficult to solve because the way institutions are functioning in Spain. However, pointing necessary and realistic goals in the sense of strengthening the coordination mechanisms between the different levels of government and the involvement of different actors in the management and implementation of public policies, could be a way forward from present situation.

The second level refers to fundamental market-based instruments for building a framework or governance institutional architecture that is suitable for sustainability. The interactions between human society and ecosystems must be modulated by large-scale rules consistent with values, social attitudes and the role

Box 9.1 Mapping the demand side of ecosystem services

The success of the ecosystem service mapping has recently been fostered through several participative approaches (Burkhard et al., 2012), and the variety of ecosystem service mapping approaches has led to the proposal of a blueprint for ecosystem service mapping (Crossman et al., 2013).

Here, we present a deliberative mapping approach that attempts to fill the main current gap in ecosystem service mapping: mapping demand. To this end, as the evaluation of ecosystem services should be "inspired by" and "useful to" users, the authors organized a deliberative workshop involving researchers and policy-makers to map ecosystem service flows in Doñana and Sierra Nevada. During the workshop, several ecosystem services were mapped, allowing further examination of ecosystem service trade-offs and bundle analysis, in which the spatial mismatch between ecosystem services supply and demand was highlighted.



Spatial representation of Service Provision Hotspots (green) and Ecosystem Service Beneficiaries (blue) in Doñana (A) and Sierra Nevada (B). The figure highlights the spatial mismatch between the two entities.

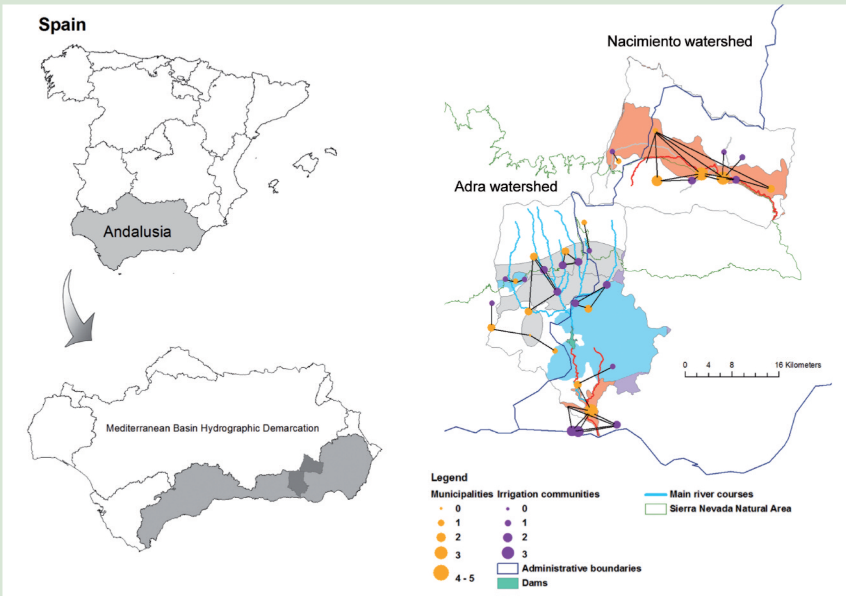
As Sierra Nevada and Doñana are both National Parks, the ecosystem service flow maps highlight the different benefits provided by the ecosystems covered by the protected areas, which will foster support for the conservation of these areas. These maps also provide insights to establish priority areas for conservation and show how protected areas, rather than being isolated entities, are connected in many ways to society and ecosystem service beneficiaries. (Palomo et al, 2013 for full details).

Box 9.2 Strengthening mechanisms of collective action through the study of collaboration networks to improve the governance of two semi-arid watersheds.

Social network analysis (SNA) is being increasingly used as a heuristic tool for modeling social-ecological systems. One of the recent applications of SNA is to natural resource governance, understanding governance as the management of natural resources as well as the structures and processes that provide the social and institutional environment in which management can occur (Bodin & Crona 2009). Within the governance process, multiple actors (i.e., individuals, communities or organizations) are involved.

Here, SNA has been applied in a case study of two semi-arid watersheds in the SE of Spain to investigate the factors underlying collective action in water and agriculture management and how collective action can be promoted. The Adra and Nacimiento watersheds are two social-ecological systems where traditional irrigation systems and modern intensive agriculture are interlinked. This setting results in a complex scenario where different organizations, ranging from local user associations to local municipalities, have to coordinate with different regional organizations to achieve sustainable watershed management. The figure shows the different collaboration networks among local user organizations (in purple) and local municipalities (in orange) involved in the management of irrigation projects. The size of each dots shows the indegree (the number of times that an actor has been nominated by others) that has been received. The main river courses and aquifers are shown in the image in blue or red, depending on whether their ecological state is good or bad, respectively, according to the European Water Framework Directive.

The results show the current state of collaboration networks and how they relate to the state of the main rivers and aquifers in both areas. Collaboration networks show many different patterns; one general characteristic is that there is a lack of a general network. It can be observed that the social actors in the upper areas show lower levels of connection than the social actors in the lower areas. Therefore, the results indicate key players for establishing a strategy to promote collective action in both areas.



Collaboration networks established among local user associations (irrigation communities) (purple dots) and local municipalities (orange dots) during the development of water management and agricultural projects in the Adra and Nacimiento watersheds. Source: Irene Iniesta-Arandia, unpublished data.

of the economy in a socially fair development model that is ecologically sustainable.

It is assumed that ecosystem management is extremely complex and therefore requires institutional complexity. In general, Spanish institutions have approached the conservation of biodiversity and ecosystems either indirectly or directly using market strategies and planned conservation and restoration strategies. However, this process is much more complex, and to complete the institutionalization of the conservation of ecosystems and its biodiversity, multilevel coordinated institutional organization will be required.

In any case, it should be noted that this set of tools only make sense when applied together at different spatial and temporal scales, and never when considering each individual tool as an end in itself. Ultimately, greening sectorial policies with a territorial impact are required to build an adaptive governance model based on the coupling between human and ecological systems.

The third level refers to the importance of non-formal institutions, which have been and are currently a key aspect in the conservation of ecosystems and its biodiversity in Spain. Maintaining local social capital generates and contributes to empowering traditional ecological knowledge and maintaining a workforce of rural people. We propose a multi-level governance model defined by a number of features related to the relationships between formal and non-formal institutions and the public and private actors. The fundamental objective is to achieve good

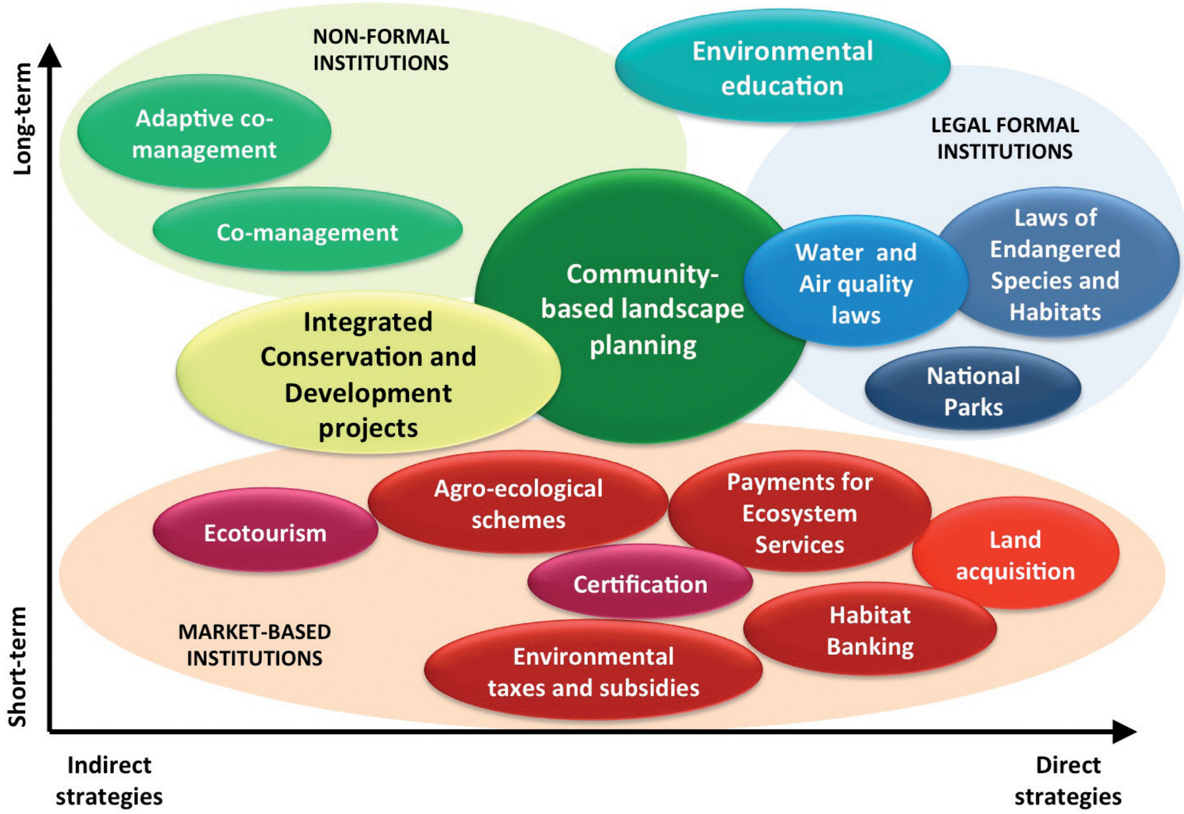


Figure 9.1 In the context of conserving biodiversity and ecosystem SNEA develop a "toolbox" of response options on three levels, based on institutional diversity that includes non-formal and formal institutions (legal and market-based). These "toolbox" was developed specially for managers and thus breaking the decoupling between meeting the long term needs of community-based management and short-term needs of the population that impacts on ecosystems and affects decision making.

environmental policy coordination between both central and regional European administrations through advisory bodies to obtain good articulation of the different policies for ecosystem management and biodiversity conservation.

Currently, the political-institutional model in Spain is far from the multi-level governance model proposed by the MA. The SNEA proposes not only integration of the different levels of government but also that the decision process should respond to the complexity of ecosystem management. Thus, the model proposed by the SNEA presents practical problems that are difficult to solve because of the way institutions function in Spain. However, indicating necessary and realistic goals in the context of strengthening the coordination mechanisms between the different levels of governance and the involvement of different actors in the management and implementation of public policies could be a way forward from the present situation (Box 9.2).

Designing a governance system encourages reflection on current management strategies and the conservation of biodiversity and ecosystems in combination as well as the need to move towards strategies designed based on an inclusive (including both formal and non-formal institutions) and polycentric (incorporating different organizational levels) governance model.

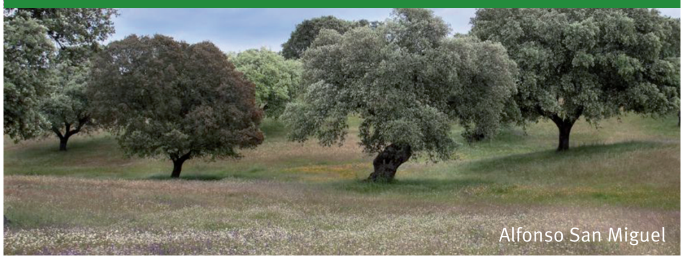
The SNEA proposes different management tools with short-, medium- and long-term effects applied at different scales. Finally, the "toolbox" incorporates an interconnected component for communication, education and participation for achieving sustainability, which is considered a cornerstone of the three levels of performance (Figure 9.1)

In summary, the SNEA considers the conservation of ecosystems and its biodiversity in Spain not as a luxury of developed societies or a desire of the elite sector of society associated with scientific or conservation organizations but as a pressing need to secure the wellbeing of the entire population. The debate on the conservation of ecosystems and biodiversity cannot be separated from the social debate. Under the framework of uncertainty and unpredictability created by Global Change, the future of the natural capital of Spain should become a matter addressed by the state.

A ANNEX. SUMMARY OF KEY FINDING FROM ECOSYSTEMS

Status and trends of ecosystems in Spain

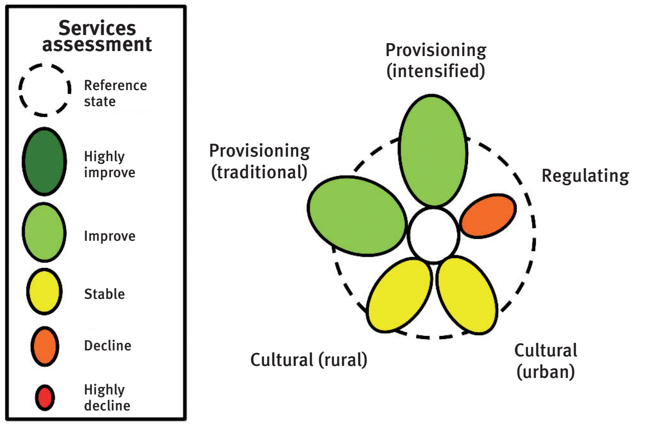
sclerophyllous forests and shrubs



Alfonso San Miguel

''Sclerophyllous forests and shrubs'' occupy approximately 7 million ha in Spain and are part of the Mediterranean “monte”, which is most likely one of the wildest landscapes of the Mediterranean Basin. The “monte” comprises marginal agrarian lands that also contain pastures (another 7 million ha). These include the “dehesa” (lawns of therophyte plants with scattered pruned trees similar in appearance to savanna (montado in Portugal). The “dehesa” occupy nearly 2 million ha. Spatially, these areas correspond to the bioclimatic mesomediterranean and thermomediterranean zones. Although seasonal drought and the poverty of these soils determine their relatively low productivity and small associated human population, this ecosystem functions in a manner that is historically conditioned by local ecological knowledge. These areas maintain a high biodiversity index and present some highly emblematic species, such as lynx and imperial eagles. They also support a large number of livestock breeds and generate important traditional provisioning services, in addition to providing a basis for water cycle regulation, which is currently decisive in the Mediterranean.

Despite the recognized ecological value of this type of ecosystem, the assessment revealed that 25% (5 of 20) of its ecosystem services are declining in effectiveness (Díaz Pineda et al., 2012). For example, the control of soil erosion is decreasing by an average of 20 t/ha/year. This represents a major decrease in water regulation services. Land-use changes (mainly rural abandonment) and associated forest fires were identified as the main drivers that have contributed to the nearly irreversible conditions of some regulating services. Intensive agriculture transformation and the development of timber production have led to various changes in the soil surface over approximately 10 million ha. Additionally, approximately 85,000 ha of this environment has been burned annually during the last decade.



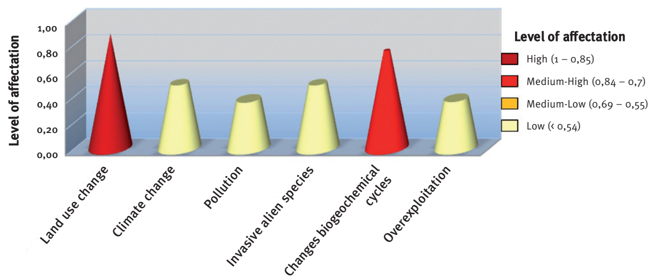
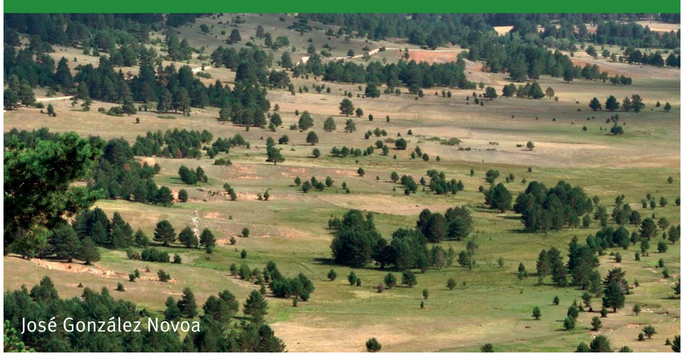


Figure A1. Synthesis of assessments of ecosystem services for Sclerophylous forest and shrubs, grouped by service categories and the direct drivers of change affecting them.

The implementation of management methods that support soil, biodiversity and landscape conservation via rural activities is a challenge, representing goal to be addressed by regional administrations and the state. The promotion of cultural services through cultural rural tourism is one relevant alternative for exploiting this ecosystem associated with a lower cost and greater potential benefits.

Continental Mediterranean forests and shrubs



José González Novoa

These ecosystems are extremely exceptional in both the European and global context and are nearly exclusive to the Iberian Peninsula (Spain contains approximately 75% of the European area of these systems). Human management has shaped these ecosystems over centuries, adapting them to the harsh environment and selecting important agrobiodiversity and production models characterized by their extensiveness, diversification, efficiency and sustainability. As a result, this type of system has become a cultural landscape showing a high ecological value and biodiversity index.

During the last several decades, these ecosystems have recovered in territories where they had not existed for centuries. However, the services they provide to society have not evolved as favorably: 28% (6 of 21) the assessed services show a declining trend. Provisioning services are generally the group showing the clearest deterioration (3 of 6). Regulating services have been moderately enhanced by the clear increase of their surface areas. Cultural services have shown two very different trends: all services related to urban recreation demands have increased very rapidly, whereas a dramatic loss of traditional management models and associated cultural services has persistently endangered landscapes (San Miguel et al., 2012). Unlike other types of ecosystems, depopulation, reduction of farmland, maintenance or reduction of arable pastures and increases in forest and scrub are the main direct drivers of change.

The best strategy to ensure a constant flow of ecosystem services is to maintain extensive management models that are efficient and diversified and enable sustainable rural development and ensure the persistence of the structures, functions and basic ecological processes of the ecosystem, as proposed by Law 45/2007 for Sustainable Rural Development. This requires in-depth scientific knowledge of the structure and functions of the ecosystem as well as economic and social aspects related to the use of its services.

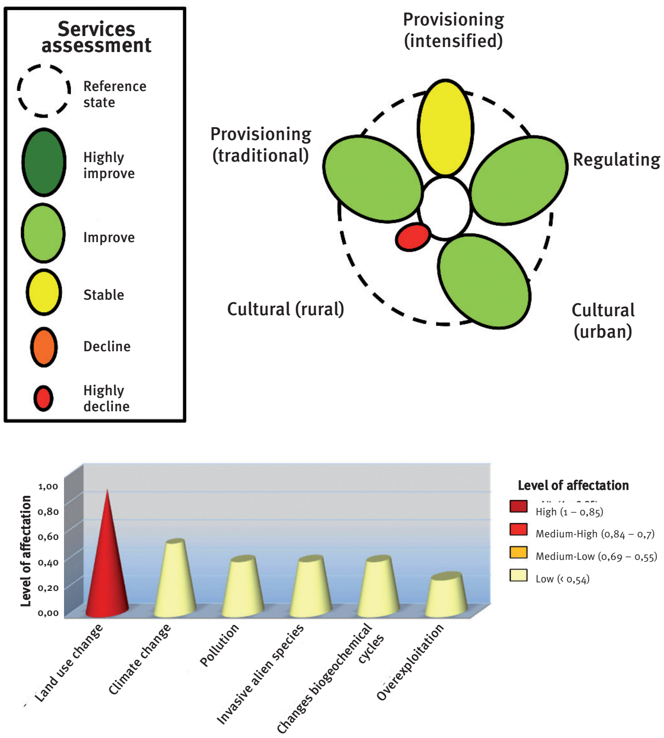


Figure A2: Synthesis of assessments of ecosystem services for Continental Mediterranean forest and scrub systems, grouped by service categories and the direct drivers of change affecting them.

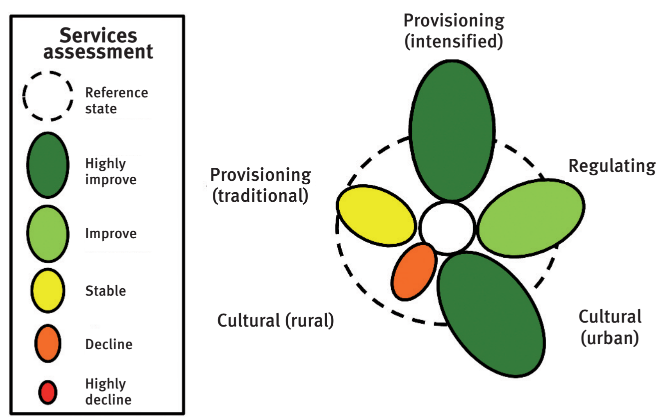
Atlantic forest

Atlantic forests encompass the various forest and shrub ecosystems located in the north-Atlantic Spanish territory, usually sharing this territory with other ecosystems. Atlantic forests are the most

characteristic ecosystems in the northwest of the Iberian Peninsula, occupying approximately 6% of the total area of the state. Their area of these forests has increased significantly in recent years due, in large part, to the forest plantations that have been implemented with rapidly growing exotic species (i.e., Eucalyptus), which provide more than 50% of the wood extracted annually in Spain and play a key role in the local economy. Within this type of ecosystem, there is important plant biodiversity, due primarily to the variety of environments present in this area (topography, lithological substrates, anthropogenic influence). However, there are several key populations facing a high degree of threat, and specific conservation instruments are therefore required for some species of animals and plants.

Ecosystem assessment revealed that the 23% of the 22 services evaluated are experiencing a declining trend (Álvarez García, 2012). Overall, the services showing a positive tendency mostly include provisioning services for biotic materials (such as wood and paper pulp) and energy, several regulating services (such as climate regulation and erosion control) and other cultural services associated with recreational activities and rural tourism that provide an important endogenous factor for local inhabitants and economies. Among the services showing a negative trend, the provisioning services associated with traditional nutrition systems and cultural services associated with local demands (such as local ecological knowledge and cultural identity) can be highlighted, all of which are primarily motivated by the progressive depopulation of rural areas within these ecosystems.

Land-use changes caused by the loss of traditional agricultural and livestock uses (surfaces that have been transformed into forest plantations and surfaces that have been transformed by ecological succession in recent decades) are the main direct drivers affecting these ecosystems. The introduction of non-native forest species with



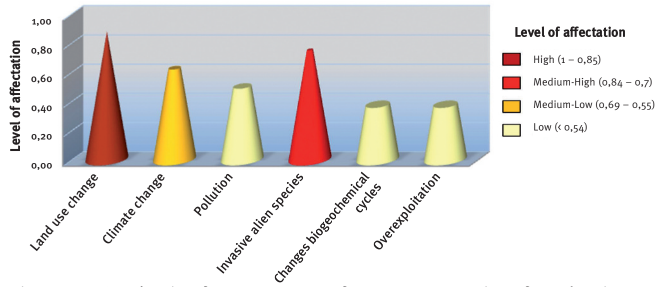
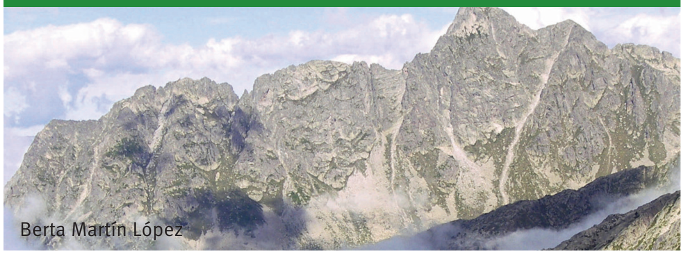


Figure A3: Synthesis of assessments of ecosystem services for Atlantic Forests, grouped by service categories and the direct drivers of change affecting them.

rapid growth rates (as Eucalyptus and Pinus) represents another important direct driver. Additionally, climate change is gaining importance, as it has been demonstrated that it may ultimately become a limiting factor for some of the species showing the greatest presence in the Atlantic Region.

Among the measures being implemented to maintain these ecosystems and the services they provide to society, different strategies aimed at the sustainable economic development of rural areas and diversifying the activities taking place have been highlighted, such as the establishment of forest certification practices and promotion of origin designations for organic products.

Alpine Mountain


Berta Martín López

Despite the small area occupied by this type of ecosystem (only 3% of the national total) and the small population living permanently within it (approximately 173,000 inhabitants), it provides some important cultural services for which there is growing demand among the human population, receiving more than 7 million visitors throughout the year. Additionally, much of the hydropower generation capacity of Spain is found in valleys within these systems. The population densities within this ecosystem are the lowest in Spain (6.8 inhabitants/km2 versus the national average of 91.4 hab/km2), which means that large natural areas remain within their territories (forests, scrub/pasture and open space account for 87.2% of their surface area). These characteristics have resulted in the conservation policies of the European Union (Natura 2000), which established protected areas covering a total area that occupies 75% of the territory of these ecosystems (Fillat et al, 2012).

However, 45% (10 of 22) of the ecosystem services assessed are being degraded or used unsustainably. The most strongly affected groups are regulating services and provisioning services. However, traditional food-provisioning services (i.e., for meat, milk, cheese and honey) have maintained their trend because many of these products have been protected by designations of origin, and many of them are being produced in environmentally friendly breeding programs. The gene pool found in this type of ecosystem is particularly important because most Spanish breeds of cattle have remained in the mountains, which now offer new regulating services, such as fire prevention in forest ecosystems. On the other hand, the cultural services demanded by urban people have increased exponentially over the last few decades, with the trade-off of losing traditional cultural services, such as local ecological knowledge. Land use changes are the main direct driver of change that is limiting the natural capital of these systems. The loss of productive fertile soil due to urbanization directly affects regulating services, such as water infiltration or soil erosion control.

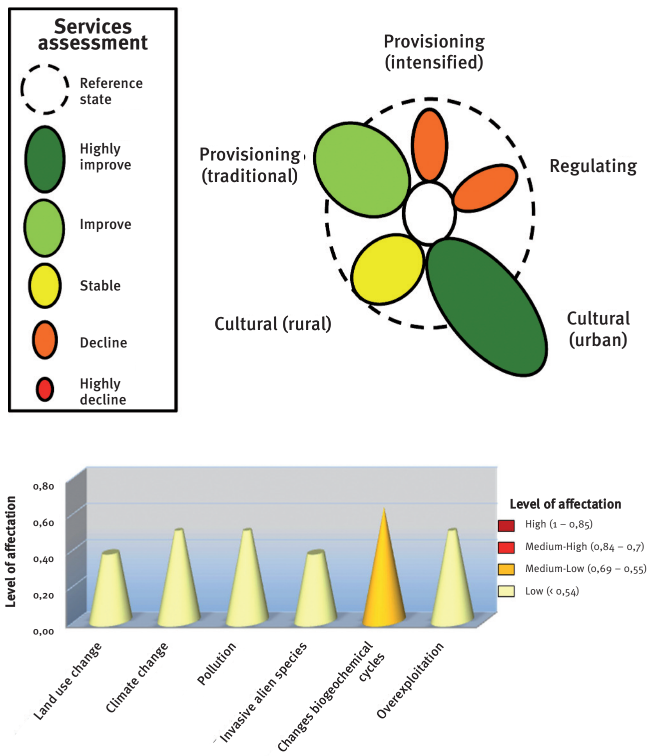


Figure A4: Synthesis of the assessments of ecosystem services for Alpine Mountains, grouped by service categories and the direct drivers of change affecting them.

The real interactions between scenarios involving the local, regional and national sectors, in which media and information transfer are very dynamic, can serve as the basis for fostering and framing the action plans that are necessary to revitalize and preserve these ecosystems. Once limitations are expressed by the inhabitants of different towns and regions, new investment officers and relevant legal regulations should be planned, adapting to favor and address the limiting factors presented by the inhabitants.

Mediterranean Mountains

Mediterranean mountains, which occupy approximately 4% of the area of the state, have experienced a recovery of vegetation cover and a decrease of human impact through agriculture, livestock and mining over the past 40 years due to the control of exploitation and traditional uses, coupled with a significant increase in protected areas in mountainous regions. This has resulted in maintenance of regulating services (climate regulation and water) and a decrease of landscape and biological diversity.

The assessment process revealed that 54% (12 of 22) of the ecosystem services evaluated are being degraded or are being used unsustainably. However, a clear positive trend has been observed in recent years, especially in cultural and provisioning services. This progress has been largely due to the poor accessibility of this ecosystem and increased legal protection. Provisioning services involving the direct basis for maintaining livestock farming in mountain areas sometimes represent up to 40% of the local economy. Therefore, a decrease in the provision of these services would result, at a practical level, in the disappearance of these traditional activities. Regulating services present a trend that is more heterogeneous and often negative. This result is mainly due to the effects of climate change, which could significantly alter the dynamic equilibrium of vulnerable areas, such as Mediterranean mountains. Here, high peaks of endemicity will be strongly conditioned by future rising temperatures, and a dramatic reduction in their distribution is expected. Other drivers play an important role but are restricted to certain specific aspects, such as invasive species that can cause problems, especially in aquatic and mountain systems.

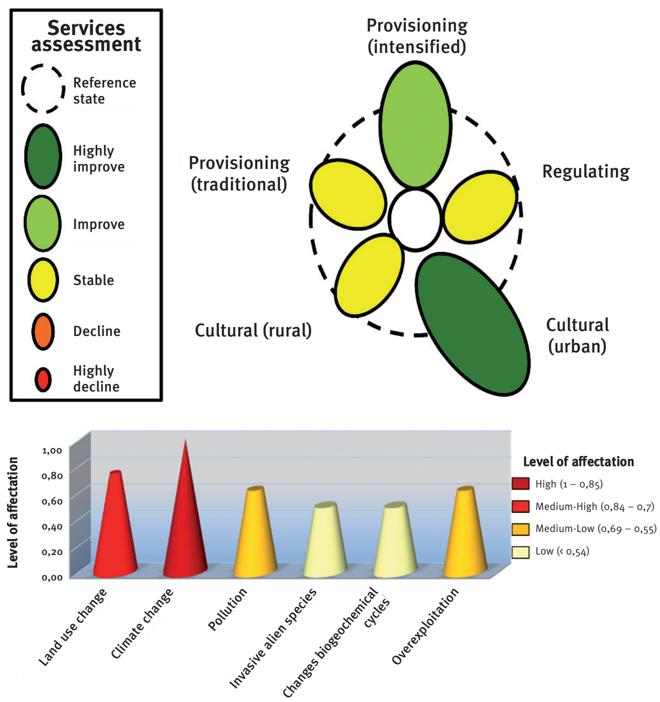


Figure A5: Synthesis of assessments of ecosystem services for Mediterranean Mountains, grouped by service categories and the direct drivers of change affecting them.

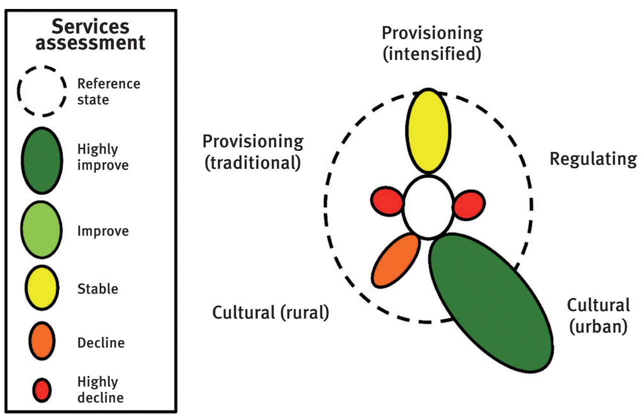
Within an adaptive management framework, it is necessary to implement management measures focused on the following challenges: (1) finding a dynamic equilibrium between provisioning and regulating services and using the analysis of trade-offs as a basis for ecosystem management, (2) ensuring that provisioning services are used efficiently and effectively to maintain the profitability of cultural services related to the maintenance of traditional activities, (3) including the participation and evaluations of local people in the management of the services provided, and (4) conducting tracking and monitoring of the evolution of the different types of services and drivers, requiring the collection of information that is useful for management.

Rivers and riverbanks

Despite the small surface area covered by rivers and riverbanks in the Spanish territory (1.1% of total area), these ecosystems are vital to humans. They provide many provisioning services, such as water, food, energy and biotic and abiotic materials as well as cultural services related to recreation, cultural identity and local ecological knowledge. Spanish rivers provide more than 110,000 Hm3 of water annually, and the recharge of aquifers is estimated at approximately 30,000 Hm3. However, above all, these systems serve as connecting ecosystems constituting the remainder of the circulatory system of the country. Water flows and the redistribution of sediment, organic matter and nutrients operate biogeochemical cycles that benefit humans.

The assessment process revealed that 65% (15 of 23) of the ecosystem services evaluated are being degraded or are being used unsustainably (Vidal-Abarca and Suárez, 2013). This has resulted in a considerable loss of biodiversity and a decreased ability to generate regulating services (soil fertility, water regulation and biological control) and cultural services (local ecological knowledge, cultural identity and a sense of belonging and spiritual and religious enjoyment). On the other hand, provisioning services and cultural services responding to urban demands are improving.

Land-use changes, primarily aimed at developing intensive irrigated agriculture, and the alteration of natural flows for energy production are the main direct drivers of change within the rivers and riverbanks of Spain. In fact, the maintenance of two strategic regulating services, water purification and flood control, that are provided free-of-charge by rivers is currently costing millions of Euros. For example, in 2009 the government invested more than 500 million Euros to improve the water quality of rivers, and between the years 2004-2010, over 190 million Euros were invested in mitigating the effects of floods.



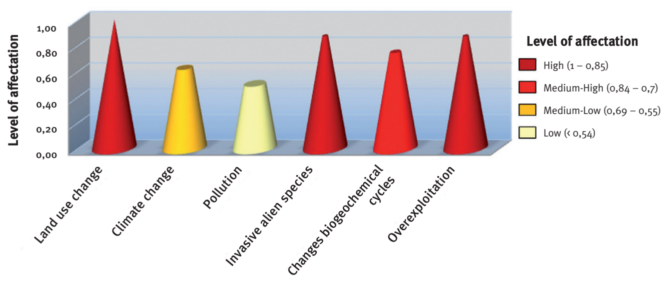


Figure A6: Synthesis of assessments of ecosystem services for rivers and riverbanks, grouped by service categories and the direct drivers of change affecting them.

The Water Framework Directive (WFD) makes assumptions leading to a more integrated view of aquatic ecosystems. However, there is a clear need to undertake a restructuring of the management of the interdependence of fluvial and terrestrial aquatic ecosystems. A deeper understanding of how rivers and their basins form a functional unit between rainwater, ecosystem services and human wellbeing would contribute to the proposal of more sustainable and equitable models of water and soil management. In this context, social participation is vital to design strategies for cooperation between all stakeholders, regardless of their location in the watershed.

Wetlands and lakes

Lakes and wetlands are true islands of life, especially in a context such as that of the dry Mediterranean, forming a network in which there is a flow of propagules and organisms, primarily through the movement of birds, thus contributing to the maintenance of a high biodiversity. However, in Spain, these ecosystems have experienced a secular process of degradation and disappearance that reached its peak in the middle of 20th century. As a result, a loss of over 60% of the area primarily occupied by these ecosystems has occurred, declining from approximately 280,000 ha of wetlands larger than 0.5 ha to the current 114,000 ha. This area accounts for only 0.23% of the national territory, which from a purely quantitative perspective, represents an almost anecdotal figure in terms of the contribution to natural ecosystems. However, their significance lies in the large number of values, attributes, and ecosystem services that distinguish them from other types of ecosystems, especially those related to the operation of the hydrological cycle at different spatial and temporal scales.

The assessment process revealed that 67% (15 of 22) of the ecosystem services evaluated in this study are being degraded or being used unsustainably (Barrera et al., 2012). The most affected group was found to be regulating services, mainly related to water, climate and soil regulation, which are also the least visible to society, along with a number of other traditional provisioning services, such as food production and supplying water and biotic material or contributing to the gene pool. The services showing increases are mainly cultural services demanded by the urban population, such as recreational activities (i.e., bird watching), and scientific knowledge. These types of ecosystems are very sensitive to the action of direct drivers such as changes in traditional land uses, hydrological alterations derived from unsustainable uses in a semiarid environment, and pollution. The shift from traditional agriculture to fully mechanized development has caused high rates of erosion,

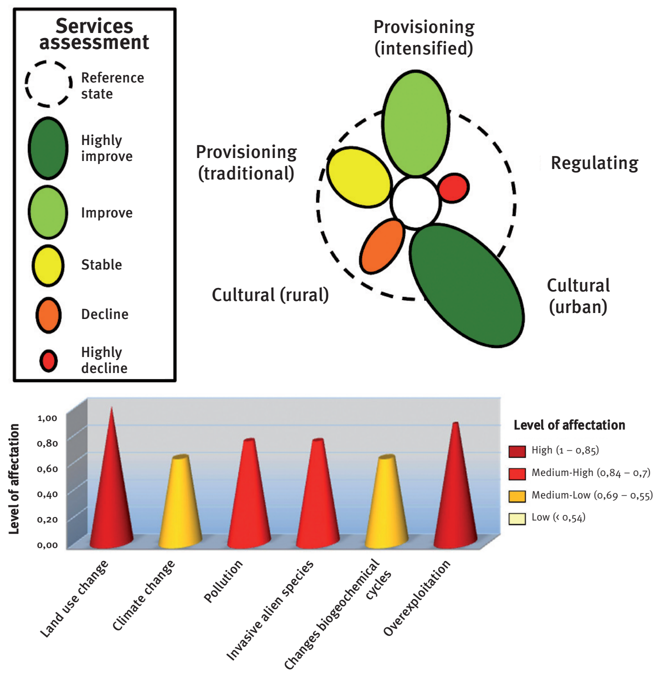


Figure A7: Synthesis of assessments of ecosystem services for wetlands and lakes, grouped by service categories and the direct drivers of change affecting them.

circulation of large volumes of sediment and increased pollution by pesticides and fertilizers, and land reclamation for agricultural uses and urbanization has led to the destruction of many wetlands. Another major driver of change is the balance between biogeochemical cycles, which are also related to climate change in the short-medium term.

Despite significant legislative deployment in recent decades at all levels (European, national, regional and local) and a specific international convention (Ramsar), the process of alteration of these ecosystems in Spain has not stopped. The reason for this situation is that the conservation and maintenance of their ecosystem services depends largely on the sustainable use of water, which must be viewed from the perspective of integrated management of water resources, including groundwater, considering the health of these essential ecosystems as a restriction on the use of water at non-sustainable levels.

Aquifers and groundwater

Approximately 350,000 km2 of the area of Spain (≈70% of the country) is officially considered to be aquifers. Following the ecosystems approach, these aquifers could be classified as aquatic ecosystems formed by a geological substrate, with water occupying the pores and fissures of the substrate and organisms being found in the water. These aquifers provide many basic services supporting human wellbeing. The most-visible services are the provisioning of basic goods required for life, such as good quality water for various uses or food through the irrigation of farming systems. The less-visible services include the regulation of water flows and water quality in rivers, streams and wetlands; the regulation of floods and climate change effects; and the environmental education, recreation, tourism, cultural identity, social relationships and spiritual enjoyment.

The conducted assessment revealed that approximately 48% of the services evaluated (11 of 25) are being degraded or have shown a clear tendency toward degradation in the last three decades (Manzano and Lamban, 2012). The most strongly affected services are traditional provisioning services (good quality water for all uses, natural fibers), followed by regulation control (water, climate, soil erosion), services contributing to mitigating the effects of natural hazards (floods, dryness), and cultural services (local ecological knowledge). On the other hand, approximately 40% of groundwater services (10 of 25) have shown a tendency to improve, led by cultural services demanded by the urban population (scientific, recreational, environmental education), followed by provisioning services

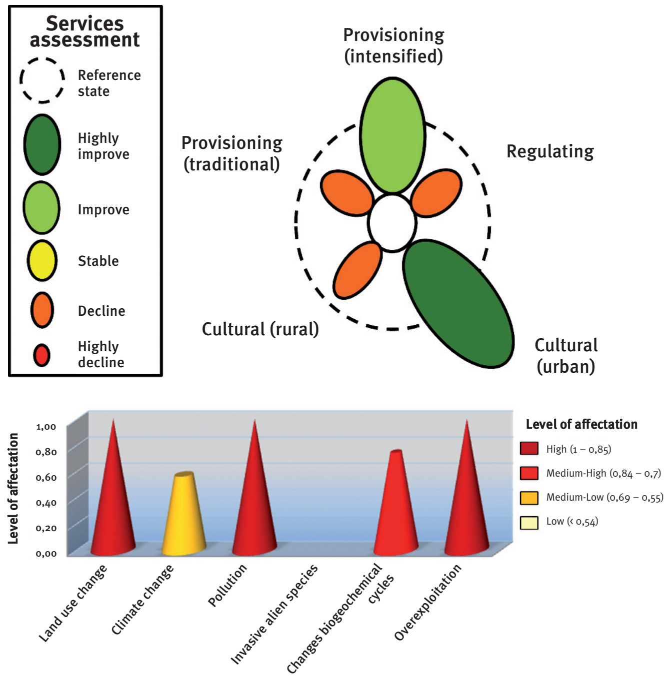


Figure A8: Ecosystem services assessment for aquifers and groundwater, grouped by service categories and the direct drivers of change affecting them.

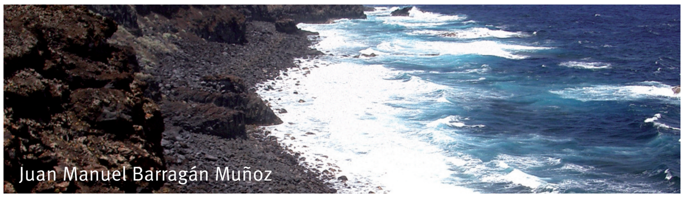
(geothermal, mineral water, medicines and active ingredients), and regulating services (as climate change, through CO_2 storage). The main direct drivers of changes in services are intensive exploitation, diffuse pollution and changes in land use, followed by climate change and changes in biogeochemical cycles. Intensive farming has direct impacts, mainly on provisioning and regulating services.

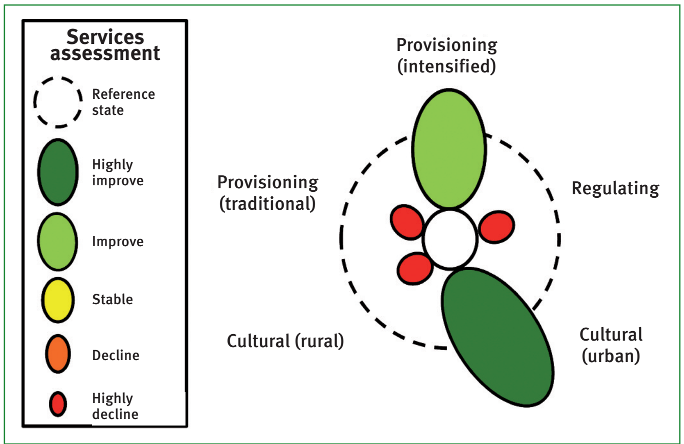
Any action involving groundwater management should take into account the close relationship between quantity and quality. Demonstrated low quality or a risk of deteriorating quality should be taken as a limit for groundwater withdrawal and recharge. Spanish law 1514/2009 represents a significant advance in protecting groundwater quality against pollution and deterioration, but it does not address the important role played by the biota of the aquifers in the quality of groundwater and the base flow to rivers. In our opinion, to make decisions about the magnitude of the groundwater flow to be preserved, it is necessary to know both the aquifer's structure and function and the value of the services it provides.

Coastal

Coastal ecosystems are considered among the most complex, dynamic, interdependent, productive and biodiverse natural systems on the planet. However, at present, dunes, beaches, marshes, lagoons and estuaries are among the most degraded or threatened ecosystems in Spain. The myriad of services provided by these ecosystem explains, to a large extent, the large number of human activities based here in the last fifty years. These activities have been the main cause of the current serious deterioration of these areas. For example, nearly 60% of the area of coastal wetlands have been lost, while only 20% of dune systems are in good condition, and 70% of coastal lagoons have disappeared or has been altered. Furthermore, much of the Spanish coast, especially its beaches, is suffering significant erosion problems.

The assessment process revealed that 62% (13 of 21) of the evaluated coastal ecosystem services are being degraded or are being used unsustainably (Barragan et al., 2012). The most affected services are regulating services (i.e., water, erosion control, natural disturbances and biological control) and traditional provisioning systems (i.e., fishing, shellfish collection). However, there are some services that have improved in recent decades, such as cultural services demanded by urban people (recreation, research and education) and some provisioning services (aquaculture, intensive agriculture). The main direct driver of change is clearly land-use change, which have altered or transformed original ecosystems or simply caused them to disappear or lose their structure and function during the last decade due largely to excessive urbanization of the





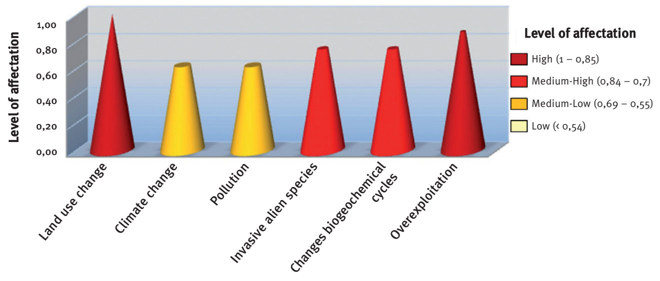


Figure A9: Synthesis of the assessments of ecosystem services for Coastal ecosystems, grouped by service categories and the direct drivers of change affecting them.

Spanish coastline. Overfishing is impacting much of the coastal ecosystem services that are critical to human wellbeing (with a greater intensity on islands and in the Mediterranean in the North of the Peninsula), especially due to extractive fishing.

The current model of public administration, which is fragmented and uncoordinated, is not the best suited to manage the coastal environment and its ecosystem services. Governance should enhance its role in marine coastal areas based on the principles of Integrated Coastal Areas. One of the most significant of these principles is that the coastal system should be interpreted as a whole, that is, a geographical area that is home to many ecosystems and is fragile from the point of view of its biophysical limits, but extremely valuable for human wellbeing. Furthermore, the interdependence in the functioning of the different subtypes of coastal ecosystems makes a different conception for new management strategies unviable. Matters related to the management of coastal ecosystems in Spain deserve a more prominent place on the political agenda.

Insular (Macaronesian)

The insular Macaronesian ecosystems consist of an oceanic archipelago that represents 1% of the area of the state. Because of their isolation and heterogeneity, these systems are hotspots of biodiversity with a high level of endemism (contributing 27% of the national endemism). However, their isolation and fragmentation make them one of the most vulnerable ecosystems, and small changes have greater impacts on their ability to generate services

than in the more resilient continental ecosystems. Therefore, if ecosystem-based management practices are not introduced, their population will become increasingly dependent on external ecosystems to maintain basic services required for human wellbeing, as providing water, food, biotic materials, and some regulating services as well as the ability to mitigate the effects of climate change could be permanently lost. Despite the high ecological value of these systems, during the last 50 years, their rate of degradation has increased exponentially. Their population has doubled, while the number of tourists has increased 178-fold and energy consumption by 10-fold, thus shifting impacts from the midlands to the coast.

The assessment revealed that 61% (11 of 18) of the evaluated ecosystem services have been degraded (Nerilli, G. and Fernández-Palacios, 2012). The most strongly affected services are regulating services (83%), which show a high level of degradation, especially water regulation, soil fertility and erosion control and the ability to address threats due to increasing natural disturbance. Provisioning services (67%) have also been degraded, including the available gene pool and basic nutrition provisioning services, which are being supplied by massive imports from continental ecosystems. Only cultural services (33%) have shown an increasing trend, arguably because of their demand by urban inhabitants and for tourism and recreational activities. The main and most evident direct driver has been changes in land use, influenced by a growing population and the massive urbanization process due to the adoption of mass-tourism development patterns. Finally, the over-exploitation of aquifers (with more than 50% being over-exploited and others seriously threatened) and introduction of alien invasive species, thereby altering basic ecological processes, are undermining the generation of strategic services required for the wellbeing of the islands' inhabitants. This threatened trend does not appear to be undergoing reversal or reduction.

During the last several decades, various actions have been launched at all administrative levels. However, this has not stopped the degradation of ecosystems, which continued to increase during the same period. Thus, it is necessary to place the vulnerability of island ecosystems in the center of the decision-making process and to engage all stakeholders in the adoption of a sustainable development model for the islands, including both their current and future inhabitants.

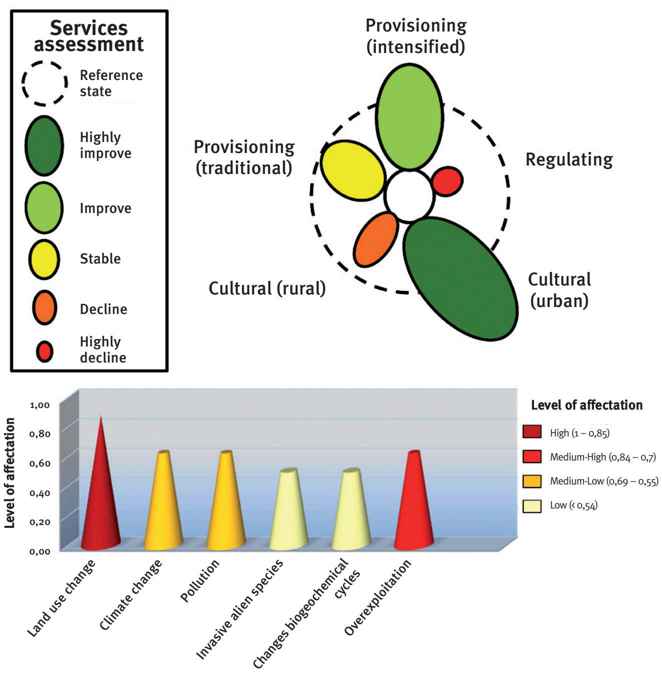


Figure A10: Synthesis of the assessments of ecosystem services for insular ecosystems, grouped by service categories and the direct drivers of change affecting them.

Marine

Although marine ecosystems represent 71% of the territory under Spanish jurisdiction and a source of valuable services, our knowledge of these systems is incomplete and insufficient. There is inertia regarding consideration of the sea as an endless source of services and an unlimited waste sump. Therefore, the use of 80% of the services assessed has increased, and the capacity of marine ecosystems to perform functions that provide services to the human population has, thus, been altered, potentially affecting the same services. In particular, more than half of Spanish fishing grounds are fished beyond the safe biological limits of sustainability. The catches of the state fishing fleet decreased significantly, on the order of 35% between 1985 and 2004. The most strongly affected species are of high commercial value and the species associated with them that are caught accidentally.

The assessment process revealed that 40% (11 of 27) of the services evaluated are being degraded or are being used unsustainably (Royo et al., 2012). The most strongly affected services are traditional provisioning services and regulating services (climate

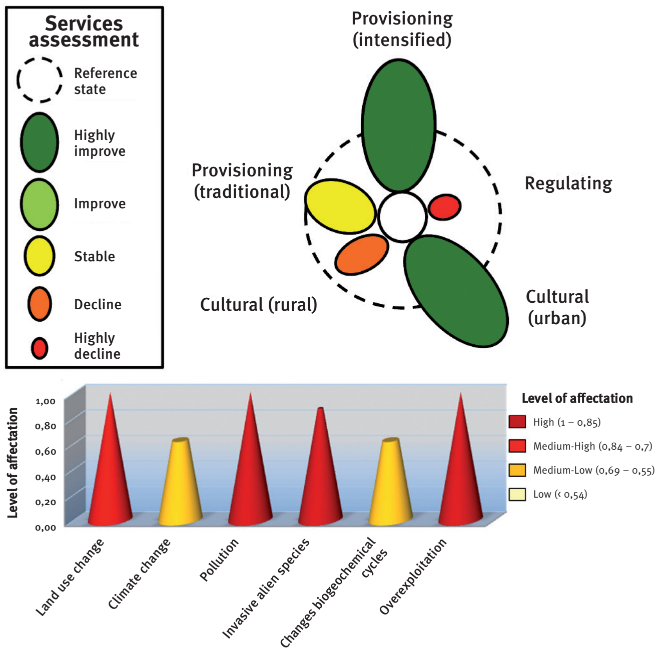
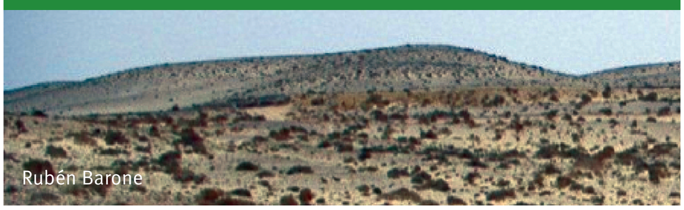


Figure A11: Synthesis of the assessments of ecosystem services for marine ecosystems, grouped by service categories and the direct drivers of change affecting them.

regulation and water quality). Cultural services associated with rural people (local ecological knowledge and sense of belonging) have also worsened significantly. The improvement of some cultural services is closely linked to the development of urban societies. The most important drivers of change related to the degradation of marine ecosystem services are overexploitation and the entry of external inputs into the system, to which invasive species and the global effects of climate change must be added.

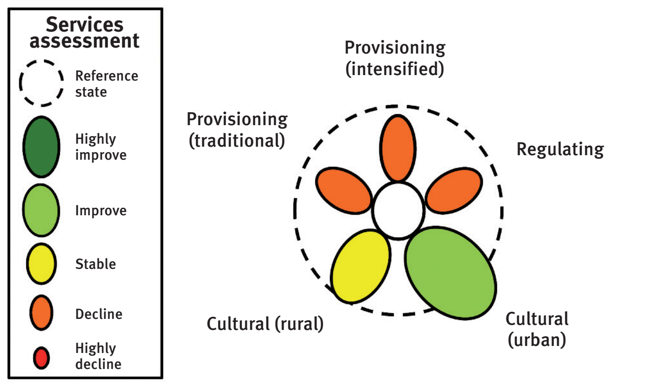
Management responses related to the conservation of marine ecosystems and their ability to provide services that are necessary for human wellbeing integrate many factors (not only economic aspects) to incorporate an authentic approach to achieve sustainability. In turn, it is essential to provide society with clear and accurate messages about the value, status and problems of these ecosystems and generate a participatory processes involving all sectors involved in management decisions, where the views of the individuals who are most closely linked to traditional practices and display a lower ecological impact (e.g., fishermen) are prominent.

Arid zones



The arid ecosystems of Spain cover 2.6% of the territory of the state, two-thirds of which are on the Peninsula, while one-third is in the Canary Islands. The best-preserved areas of this type of ecosystem consist of thermo-Mediterranean scrub and succulent species adapted to drought and atmospheric humidity. The main contribution of arid ecosystem to human wellbeing lies in their capacity to provide regulating services, which requires good conditions. These services include water regulation, erosion/sedimentation control, and an important role in the organic carbon cycle. In addition to maintaining a high biodiversity index, given the uniqueness and rarity of many species, the ecosystem of the arid zone provide further important cultural services. Due to the intrinsic characteristics of these ecosystems, they can indicate the relationships between geological and ecological processes better than other ecosystems.

The assessment process revealed that 48% (10 of 21) of services have deteriorated in the last 50 years. All provisioning and regulating services are being negatively affected (Puigdefábregas, 2012). Agricultural and livestock production are in a clear decline. Arid zone agriculture has always been marginal compared to other areas with more favorable climates. During the last quarter of a century, this characteristic has been worsened by EU policies, which have caused the abandonment of marginal land that many have adjoined arid ecosystems, such as wastelands and pastures. Unlike other ecosystems, the cultural services linked to the unique character of arid ecosystems are being increasingly valued by people. Nevertheless, there is a decrease in the aesthetic enjoyment of such places outside of protected areas. The impact on landscapes generated by industrial agriculture (greenhouses landscapes) and by the systematic abandonment of farmland results in a contrast in most of the arid areas studied regarding this aspect of degradation against the grandeur of some of their traditional cultural landscapes when they are in full operation.



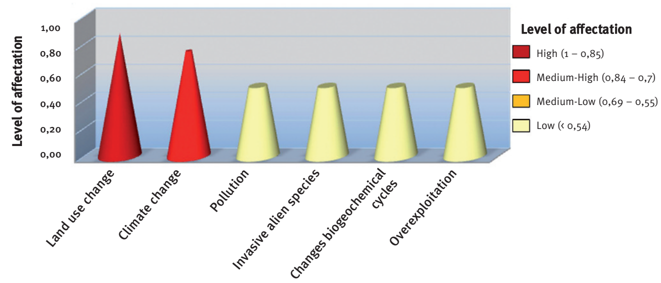


Figure A12: Synthesis of the assessments of ecosystem services for arid ecosystems, grouped by service categories and the direct drivers of change affecting them.

The management policies aimed at maintaining the integrity of arid zones and their ability to provide services are very limited. Such policies are mainly restricted to stimulating cultural infrastructure services and short-range programs that seek justification through the management of large projects that usually end in the mere occupation of space for economic purposes. More integrated planning of management measures that also considers the public is lacking. We detected a positive trend in the sense of moving away from mono-disciplinary research aimed at issues relevant to social impacts, such as desertification.

Agroecosystems

This is the most important type of ecosystem in terms of area among the ecosystems of Spain, covering more than 60% of the country, although figures vary according to the data examined, especially for grassland and silvopastoral systems. The main secular services provide by agroecosystems are provisioning services related to food production and livestock, but these ecosystems also generate many other essential regulating and cultural services. Although over the past 50 years these ecosystem services have undergone considerable changes, the structure of agricultural areas has remained fairly stable. The largest class is "arable land and permanent crops", which accounts for 31.6% of the total area. Other subclasses based more on the management of biodiversity (traditional landscapes and orchards, and polycultures) still account for only approximately 7% of the total area. Finally, the class "natural grassland and shrub land", representing 17.6% of the area, has decreased by 2.9% due to land abandonment.

The assessment process revealed that 64% (16 of 25) of the examined services are showing a declining trend or being used in an unsustainable way (Gomez Sal, 2012). Overall, Spanish agroecosystems are maintaining their provisioning services but with a significant loss of agrobiodiversity and with increasing external inputs being required, such as seeds, pesticides and fertilizers and energy. Although the ability to produce food is assured, rural development strategies are not taking advantage of the enormous potential of the vast areas available for organic production and as an attractive option for cultural services. However, there has been an increasing trend among some provisioning and cultural services due to an increasing demand for quality products and environments among urban populations. Land-use changes due to land abandonment and intensification, leading to the declines of the rural population, have had an important impact on the dynamics of the agricultural systems. However, the most important direct drivers of change are overexploitation and contamination through intensive land-use systems.

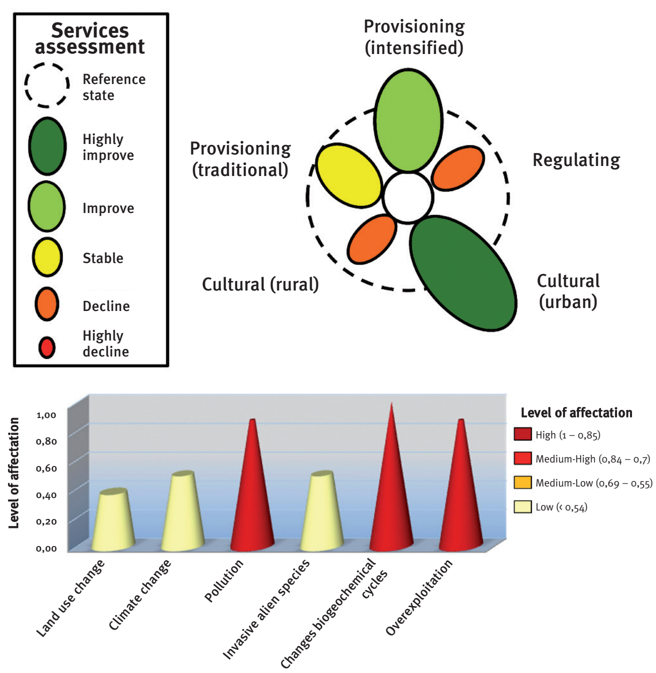


Figure A13: Synthesis of the assessments of ecosystem services for agroecoecosystems, grouped by service categories and the direct drivers of change affecting them.

To strengthen the resilience of agroecosystems, it is essential to maintain some basic processes, such as the formation of functional soil with organic activity, the role of herbivores in the removal of excess fuel, and the adequate levels of biodiversity.

Finally, there is increasing interest in topics related to development at local scales, including organic farming and agroecology, encompassing the various social, ecological, cultural and economic factors involved.

Urban

Urban systems remain the preferred model of settlement for the Spanish population, and the increases in the inhabitants of such systems reflect the fact that 80% of the population lives in municipalities with more than 10,000 inhabitants, such that approximately 36 million people are settled within 2% of the territory of the country. Increased consumption of materials and energy over the required needs has been the main reason for the increasing demand for ecosystem services, in both national and international territories. Additionally, the internal ability of urban ecosystems to provide services to people has decreased, coinciding with the increase in external demand.

In recent years, ecosystem services in urban areas have shown clear trends, such as the decline of provisioning services, resulting in greater dependence on external ecosystems (Barrios, 2012). The lack of regulating services in itself has resulted in an inability of these systems to absorb these situations and a clear improvement of cultural services demanded by its inhabitants. During the last decade, the growth of urban ecosystems (increasing by approximately 50% in terms of surface area) has altered many natural areas near cities, especially in coastal ecosystems, and generated great pressure on the remainder of ecosystems to ensure the supply of materials, water and energy. In addition, urban ecosystems are more vulnerable to direct drivers of change, such as floods (over 7,000 million Euros have been paid from insurance policies in the last 40 years), heat wave episodes (resulting in approximately 70,000 deaths in Europe in 2003), water supply shortages (which were especially important in the 1990s and abundant in coastal areas), air pollution episodes and invasive species, many of which are due to climate change and will likely worsen over the coming decades.

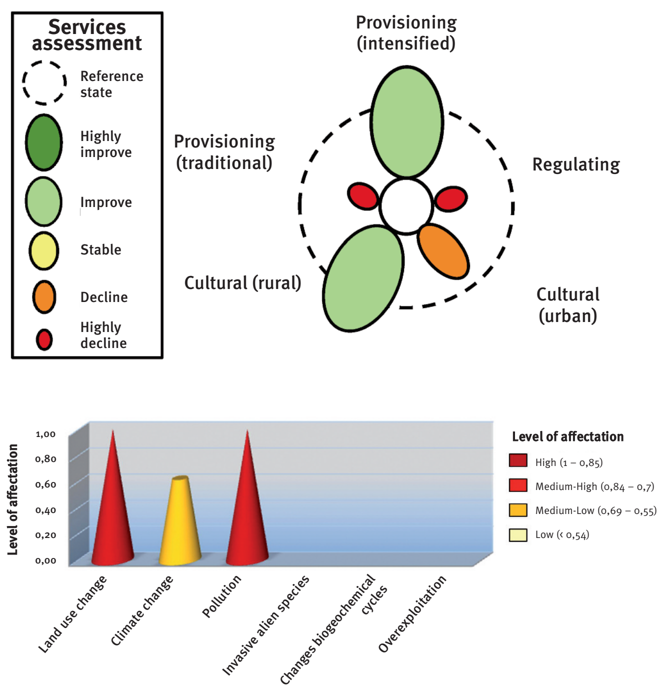


Figure A14: Synthesis of the assessments of ecosystem services for urban areas, grouped by service categories and the direct drivers of change affecting them.

There are numerous initiatives to rehabilitate urban areas by incorporating these considerations and this administrative framework to create tools to improve the quality of urban life (e.g., action plans addressing climate change, mobility plans, urban sustainability strategies and local plans). However, it is necessary to incorporate urban ecology and to consider urban areas as ecosystems into new planning methods for cities. The management model we adopt for urban ecosystems will directly influence not only the wellbeing of its inhabitants but also many other ecosystems driven by the demand for services, thereby compromising their ability to provide them. Therefore, the management of urbanization both internally and, especially, littorally will constitute the main obstacle or opportunity for achieving sustainable management strategies to integrate the natural capital of Spain as a whole.

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WWF:
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ACRONYMS

CAP: Common Agricultural Policy

CBD: Convention on Biological Diversity

CEPA: Comunication, Education and Participation

DPSIR: Driver-Pressure-State-Impact-Response

EEA: European Environment Agency

EU: European Union

EURECA: European Ecosystem Assessment

FAO: Food and Agriculture Organization of the United Nation

FB: Biodiversity Foundation

GDP: Gross Domestic Product

HDI: Human Development Index

HPI: Happy Planet Index

INE: National Statistic Institute

IPBES: Intergovernmental Platform on Biodiversity and Ecosystem Services

IPCC: Intergovernmental Panel on Climate Change

IUCN: International Union for Conservation of Nature

MA: Millennium Ecosystem Assessment

MAES: Mapping and Assessing Ecosystem Services

MARM: Spanish Ministry of Agriculture, Food and Environment

NASAPs: National Strategies an Actions Plans

NGO: Non-governmental organization

ONU: United Nations

OSE: Observatory of Sustainability in Spain

SGA: Subglobal Assessments

SNEA: Spanish National Ecosystem Assessment

TEEB: The Economics of Ecosystems and Biodiversity

UK NEA: UK National Ecosystem Assessment

UNEP: Programa de las Naciones Unidas para el Medio Ambiento (siglas en inglés)

GLOSSARY

Agrobiodiversity: Is the type of biodiversity induced by human uses. In its composition include livestock breeds, varieties of crops, varieties and semi-domesticated plant ecotypes grassland and meadows, as well as cultural landscapes associated with agricultural uses.

Biodiversity: the number, variety and variability of living organisms as well as the relationships established between them, including diversity within species (genetic diversity), between species (species diversity) and between communities (diversity of communities).

Direct drivers of change: refers to any factor that directly alters ecosystems. These drivers are natural or induced by humans acts and unequivocally impact the biophysical processes of ecosystems and therefore affect the flow of services.

Ecosystem: defined as a functional unit consisting of living and non-living components, linked by a web of biophysical relationships involving the exchange of matter and energy that self-organize in time. Ecosystems have also been conceptualized from a socio-approximation standpoint as representing natural capital with ecological integrity (structure, function, dynamics) and therefore have the ability to perform functions and provide services to society.

Ecosystem services: are the direct and indirect contributions of ecosystems and their biodiversity to human wellbeing.

Functional diversity: The type, range and relative abundance of functional traits present in a given community.

Global Change: Set of environmental changes induced by human activity, especially that affect biogeophysical processes that determine the functioning of the Earth system.

Human wellbeing: the adopted definition is a good life within the biophysical limits of ecosystems. To evaluate this parameter, the five dimensions proposed by the MA (2005) were assessed: freedom of choice and action, health, security and stability of life, good social relationships and the basic material for a good life.

Indirect drivers of change: sociopolitical factors and processes that act in a more diffuse way by altering ecosystems through their action on one or more direct drivers of change.

Institution: The set of rules, standards, and strategies adopted by individuals within an organization or across organizations.

Littoralisation: Process in which population, infrastructure, equipment and production capacity are concentrated in coastal ecosystems.

Local ecological knowledge: Cumulative body of knowledge, practice and belief, evolving by adaptive processes and is connected by cultural transmission for generations.

Multilevel Governance: Governance takes place at different institutional levels.

Natural capital: Those ecosystem with integrity and ecological resilience and thus, able to perform functions and provide services that contribute to our human wellbeing. It refers to the socio-ecological dimension of the different components of ecosystems including biodiversity.

Quality of life: The ability of a social group to meet their needs with the available services on a given ecological system. It includes the necessary elements to reach a decent human life. It's equivalent to human wellbeing.

Resilience: Ability of a system to deal with disturbances without collapsing, ie without change to an undesired state.

Scenario: A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about key driving forces and relationships. Scenarios are neither predictions nor projections and sometimes may be based on a 'narrative storyline'.

Socioecosystem: Ecological system, that in a complex way, relates and interacts with the social systems. The ecosystem includes the biophysical basis ("natural capital") over which develops cultural and socioeconomic system includes all dimensions related to human welbieng.

Suppliers Services Unit: The components of populations, communities and functional groups which have the capacity to generate ecosystem services to society.

Sustainability Science: Science which studies social-ecological systems. It focuses on working with dynamic and complex relations between nature and society.

Trade-off: Management choices that intentionally or otherwise change the type, magnitude, and relative mix of services provided.