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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

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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.

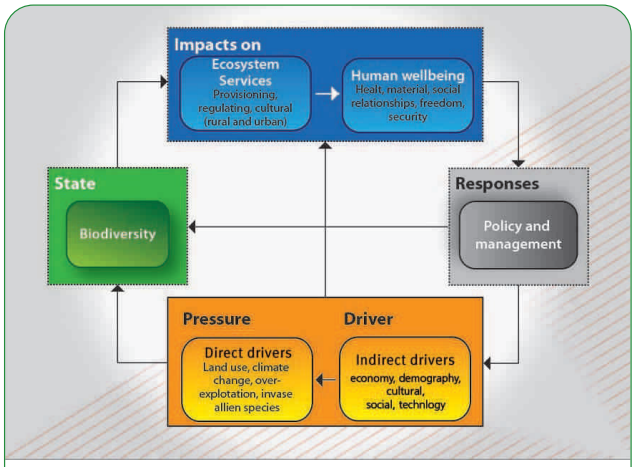

Figure 4. Driver-Pressure-State-Impact-Response (DPSIR) framework for analyzing the complex relationships established between ecosystems and human systems under the Spanish NEA (Santos-Martín et al., 2013).

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

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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

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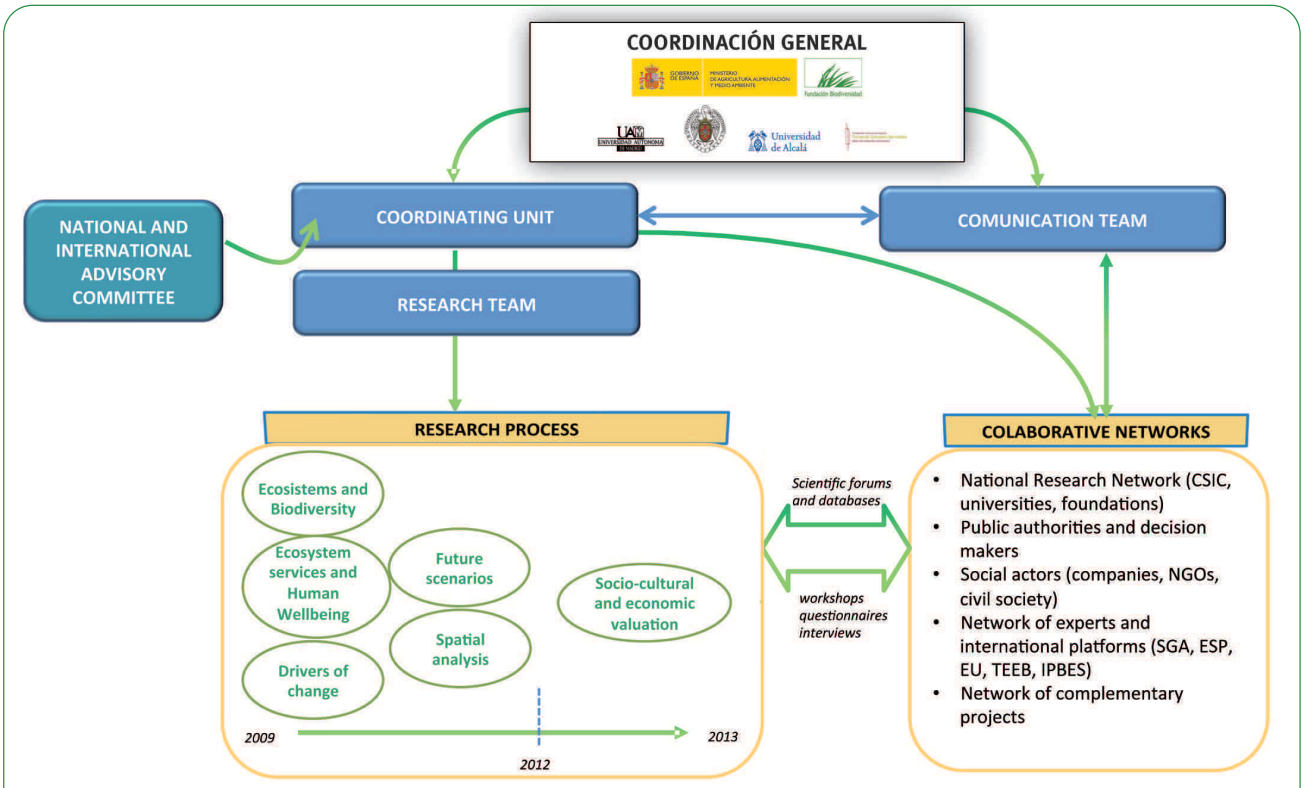

Figure 5. The organizational structure designed to achieve the objectives of the project, including social communication and public awareness at different levels. The results are designed for managers, the business sector, association networks, NGOs and civil society in general.

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

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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.

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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?