CHAPTER 4

Assessing Ecosystem Services at Different Scales in the Portugal Millennium Ecosystem Assessment

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The Portugal Millennium Ecosystem Assessment (ptMA) (http://ecossistemas.org) is analyzing the condition of ecosystem services in Portugal, recent trends in those services, available policy responses, and scenarios for the next fifty years, following the conceptual framework of the Millennium Ecosystem Assessment (MA) (Millennium Ecosystem Assessment 2003). It is a multiscale assessment, carried out at the national, basin, and local scales. The assessment started in 2003, published a status report after two years (Pereira, Domingos, and Vicente 2004), and will publish the final results in 2006.

Of the thirty MA subglobal assessments, ptMA and the Southern African Millennium Ecosystem Assessment are the only two comprehensive multiscale assessments. As illustrated elsewhere in this volume, multiscale assessments allow the evaluation of the robustness and persistence of findings across scales and provide information benefits: more and better data, ground-truthing of data, and better analysis of the causes of change (Zermoglio et al. 2005).

Here we present the findings that resulted from conducting ptMA as a multiscale assessment and from ptMA itself being nested in the global MA. We start by describing how the different scales were analyzed in ptMA and how the MA framework was adapted. Next, we discuss how epistemologies were bridged within the assessment, including what barriers existed in the communication among experts in different fields, how the users interacted with the scientists, and how the scientists interacted with the local population in one of the case studies. We then present an overview of the findings of ptMA, including a discussion of the indirect drivers of ecosystem change, direct drivers and trends in ecosystems and their services, and future scenarios. The findings overview section provides a context for the next section, where we contrast the findings at multiple scales, from the local scale in ptMA to the global scale in the MA. The multiscale findings section also discusses how responses analyzed in ptMA at the local scale are related to changes in drivers and ecosystems at a larger scale.

Scales in the Portugal Assessment

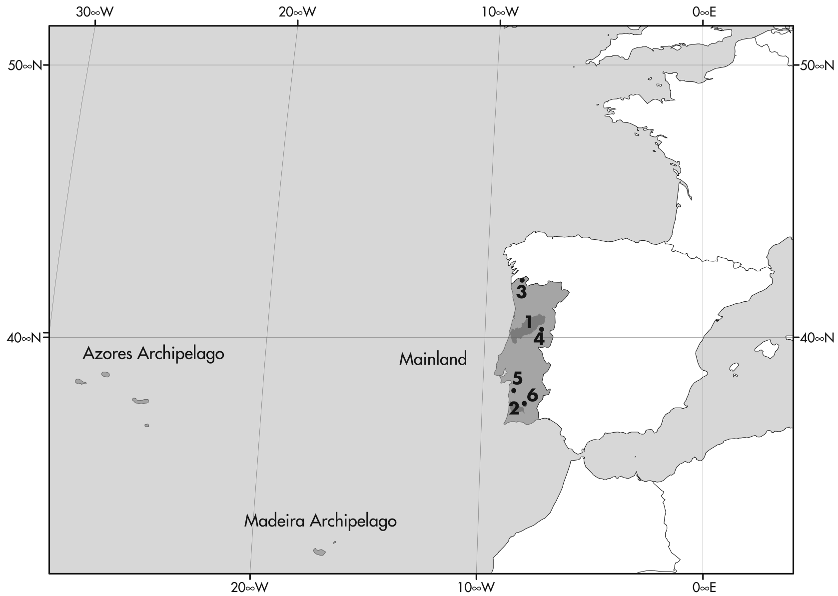
At the national scale, ptMA is organized into ecosystems based on the global MA systems: marine, coastal, inland water, forest, *montado,* island, mountain, cultivated, and urban. *Montado,* which is not a global MA system, is an ecological and economically important ecosystem of Portugal and Spain (where it is called *dehesa*). *Montado* is an agroforestry system in which the main activities are cork, livestock, and cereal crop production. It is an evergreen oak woodland; the predominant tree species are the cork oak (*Quercus suber*) and the holm oak (*Quercus ilex*). *Montado* corresponds roughly to the intersection of the dryland and forest systems in Portugal.

The assessment has two case studies at the basin scale: the heavily human-influenced Mondego basin and the more pristine Mira basin. At the local level, the assessment has four case studies: Sistelo is a parish (about 340 inhabitants) located in a mountain range, where the main economic activity is agropastoralism; Quinta da França (QF) is a farm with an ongoing research program on agricultural sustainability; Herdade da Ribeira Abaixo (HRA) is a biological research station in an area of *montado*; and Castro Verde is a municipality (about 7,500 inhabitants) with a farming area of cereal steppes. (See the map in figure 4.1.)

Scales and study cases at each scale were chosen to balance relevance to users, availability of data, and coverage of different ecosystems (table 4.1). This constraint reduced the possibility of "nestedness" of the different case studies within each other (this was achieved, however, by integrating the case studies within the ecosystems at the national scale). It should also be noted that the case studies are not fully representative of the country but instead are designed to provide particular insights into ecosystem changes at each scale.

Figure 4.1.

Geographic situation of Portugal (mainland and islands) and of the case studies of the Portugal Assessment. Basin-level case studies: Mondego basin (1) and Mira basin (2). Local-level case studies: Sistelo (3), Quinta da França (4), Herdade da Ribeira Abaixo (5), and Castro Verde (6).



Adapting the MA Framework for the Portugal Assessment

The Portugal Assessment joins more than thirty-five scientists from the natural and social sciences, including subteams of two or three scientists for each study case. The scientists work together with the primary audience of the assessment: a group of ten users representing different societal sectors, including national and local government, nongovernmental organizations (NGOs), agriculture, and industry. However, the intended audience of the assessment is broader, including all professionals whose work depends on ecosystems or affects ecosystems as well as the general public. The assessment was also designed to provide feedback to the global MA and to validate the global MA results at a subregional scale. At the national level, most of the data were assembled from the literature and from expert opinion. This approach was also followed in the study cases, complemented with fieldwork by the assessment team at the local level.

Table 4.1

Case studies of the Portugal Assessment

(M = municipality, SM = submunicipality)

Case Study	Type	Area (km^2)	Ecosystems	Justification
Mira	Basin	1,576	Coastal, inland water, forest, dryland, cultivated	Institute for Nature Conservation (national user) requested an estuary in Southern Portugal
Mondego	Basin	6,670	Coastal, inland water, forest, mountain, cultivated, urban	Intensively studied by a research group at University of Coimbra (Portugal)
Castro Verde	Local, M	567	Dryland, cultivated (pseudo-cereal steppe)	League for the Protection of Nature (national user) has a bird conservation program here
Sistelo	Local, SM	27	Mountain, cultivated, forest	National Park of Peneda-Gerês (local user) interested in protecting agricultural terraces
QF	Local, farm	5	Forest, cultivated	Pilot farm of ExtEnSity (national user)
HRA	Local, farm	2	*Montado*	Biological research station of CBA (leader of the assessment)

The MA approach consists of identifying the major direct and indirect drivers of ecosystem change, assessing the impacts of those drivers on biodiversity and ecosystem services, and establishing the linkages between ecosystems and human well-being. A *driver* is a natural or human-induced factor that directly or indirectly causes a change in ecosystem services (Petschel-Held et al. 2005). The condition of an ecosystem service is defined by ptMA as *the current capacity of the ecosystem to provide the service relative to the capacity at which the service could be maximized in a sustainable way* (Pereira, Domingos, and Vicente 2004). This definition emphasizes the status of the natural capacity of the ecosystem to continue to provide the service into the future, which can be equated with the economic "stock" in some instances.

The Portugal Assessment takes two different approaches to analyze the condition of ecosystem services at the national scale: (1) an analysis of the condition of a set of ecosystem services nationally and (2) an integrated analysis of each ecosystem. In a sense, the ecosystems approach is spatially nested within the services approach and could be seen as an intermediate scale of assessment between the national and the basin/local scale. However, in the services approach, the focus is on each ecosystem service, and on the most important areas for each service, while the ecosystems approach emphasizes how each ecosystem is functioning.

Socioecological scenarios are being developed by ptMA. Looking fifty years into the future at a spatial scale as small as Portugal means that the main drivers will likely have an external component. This can limit the usefulness of the scenarios for policy makers because national actors have little control of external drivers. Nevertheless, scenarios are potentially useful instruments for testing national policies. Early in the process, the most important and uncertain drivers of ecosystem change were identified. These drivers were to be used as axes for defining the scenarios, but it turned out that they were quite analogous to the axes of the global MA scenarios, which hinted to the assessment team that it was possible to use the work already done by the MA Scenarios Working Group. Adopting the global MA scenarios would also provide a regional calibration and validation of the global scenarios. Thus the assessment team decided to adopt the global scenarios as boundary conditions for the Portugal scenarios.

Because using global scenarios as boundary conditions can somewhat constrain the development of scenarios, a slightly different approach was followed at the local level in the Sistelo case study. The scenarios were first developed with the local stakeholders and are now in the process of being integrated by the research team into the national-scale scenarios.

We consider primarily responses as actions taken by people following an ecosystem change, or following a perception of threats and opportunities associated with an ecosystem change (Malayang, Kumar, and Hahn 2005). The purpose of a response, as an act, is to improve human well-being.

Bridging Epistemologies

The assessment's first epistemologies issue was how to bring scientists from very different areas of expertise to a common ground with user representatives. The latter group consisted of decision makers and officials with a technical background, so the technical gap between the users and the scientists was at most as wide as the gap between natural and social scientists. The actual gap that existed was more of a stakes gap (e.g., a representative from the paper and pulp industry has a different perspective from a conservation biologist), because a user and a scientist may place priorities on different ecosystem services. These divergences also occurred among the user representatives themselves, who represented different societal sectors.

Two exercises were key in bridging these gaps: the scenarios development and the qualitative assessment of conditions and trends. The emphasis placed on creating descriptive narratives for the scenarios allowed for easy communication. Further, the scenarios' "if . . . then . . . " approach allows for exploring different possibilities and trade-offs. Identifying these trade-offs is a good starting point for the open discussion of compensation mechanisms, including financial mechanisms. Surprisingly, it is the scientific basis of the narratives that often causes more disagreement. Socioecological systems are extremely complex, and we frequently lack the scientific knowledge to predict how they will evolve. Therefore, scientists may disagree on the future trajectory for a socioecological system, even when the evolution of such drivers as market regulation and society's behavior is well defined. These disagreements may be difficult to solve when the narratives are based on expert opinion (as in our case), which often mixes scientific knowledge with the experts' personal preferences and beliefs. We found that it is important to have team members with contrasting points of view, as long as the members are also flexible.

The qualitative assessment of conditions and trends also contributed to identifying and bridging gaps between participants. Scientists and users had to agree in plenary on the condition of each service in each ecosystem—on a scale of 1 (bad) to 5 (excellent)—and on the trend for that condition (decreasing, stable, or increasing). Our definition of *condition* emphasized the sustainability of the service, and we found that it is not simple even for two natural scientists to agree on how sustainable the management of a given service is. For instance, the sustainability of marine fisheries depends on the subset of the stocks being evaluated and on the criteria used to evaluate the condition of each stock. A further problem occurs when discussing trends. For example, water production has been increasing in Portugal, but the sustainability of the service has been decreasing.

In the Sistelo study case, the assessment focused on understanding the linkages between human well-being and ecosystem services. A participatory approach was used, in which people were asked in interviews and small discussion forums to assess their well-being, the importance of ecosystem services, and the linkages between the two (Pereira et al. 2005). Here, the challenge was twofold. On the one hand, a degree of trust needed to be established with the population so that people could freely express their opinions. On the other hand, communicating with the local people, who had little formal training, proved challenging. The local assessment team approached the first task by participating in community daily activities during the field visits. This also allowed the team to learn more about the community and add direct observation data to the assessment. The team addressed the second challenge by asking the local people, sometimes using pictures as an aid, to use their own terms and expressions to explain a given reality. Overall, this approach empowered the local people—that is, instead of having the researchers dominate the assessment and define the key issues, the local people played a strong role in defining what should be assessed and how.

Finally, let us give an example of how scales interact with epistemologies. A major challenge in an assessment is for experts at a given scale to contextualize their findings within a broader scale (for instance, to understand how biodiversity change in response to agricultural abandonment at the hectare scale will scale to the national level). Part of this difficulty is intrinsically related to not knowing enough about the situation at the larger scale: the detail obtained at the smaller scale is often lacking at the larger scale.

Findings of the Portugal Assessment: An Overview

The following drivers of ecosystem change in Portugal were identified as the most important: fire regime, land use changes (including abandonment of agricultural fields, afforestation, urban expansion, and development of transportation infrastructures), European Union (EU) common agricultural policy (CAP), global markets, and economic growth (table 4.2). Other important drivers include environmental legislation, social attitudes toward the environment, tourism, demographic change, and exotic species. Each driver's importance differs with the site at the local or basin scale. The different drivers interact and control conditions and trends in ecosystem services in Portugal.

Table 4.2
Drivers at multiple scales.

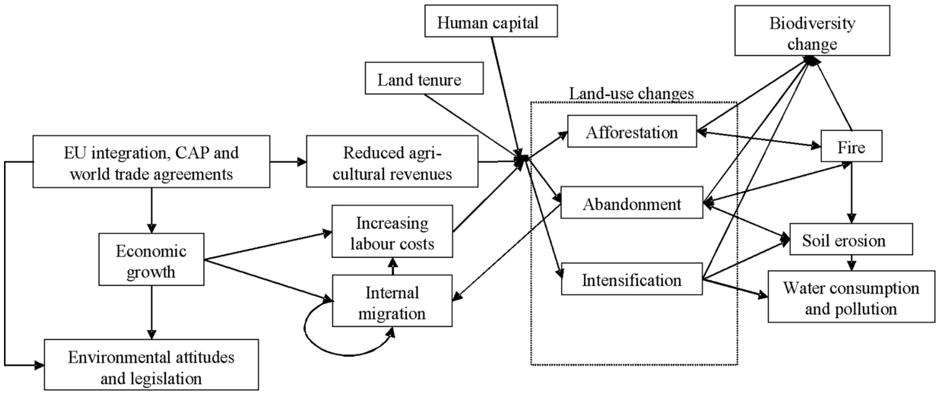
Driver	National	Basin		Local		
		Mondego	Mira	QF	HRA	Sistelo
Fire regime	X			X		
Land tenure and farm structure	X					X
Land use changes	X					
Tourism	X		X		X	
Exotic species	X	X				
Economic growth	X			X		X
Population distribution and migration	X			X		X
Environmental legislation and attitudes	X			X	X	
EU common agricultural policy and global markets	X			X	X	X

Indirect Drivers

Economic growth, first in the 1960s and then after the integration of Portugal into the EU in the 1980s and 1990s, made activities in the industrial and services sector increasingly attractive, which led to increased labor costs in agriculture—both hired labor costs, for agricultural companies, and opportunity costs, for farmers exploiting their farms directly. At the same time, entry into the EU's Common Market and changes in international trade agreements implied decreased agricultural prices (figure 4.2), which were only partially compensated for by subsidies.

Hence, maintaining economic viability of agriculture has required an increase in labor productivity, through either extensification (i.e., substituting labor by land) or intensification (i.e., substituting labor by machines and production inputs, such as water, fertilizers, and improved seeds).[1] If farm size is large and soil quality and water availability are low, as occurs in the South of Portugal, extensification occurs. This is observed in the Castro Verde and HRA study cases. If farm size is small, soil quality and water availability are high, and investment capacity and technical expertise are high, as occurs in the Coastal Center and North of Portugal, intensification will occur. This is seen in the Mondego basin study case, mainly with rice cultivation, leading to a high input of nutrients into estuarine waters. If neither of these conditions is fulfilled, as in many mountain areas in the North and Center (e.g., the Sistelo study case), abandonment will occur.

Figure 4.2
Illustration of interactions and feedbacks among drivers of Portugal ecosystems. Indirect drivers are on the left (the major one is economic growth), direct drivers are in the middle and to the right (mostly grouped as "land use changes"), and changes in ecosystem services are on the right.



This set of effects is clearly seen for QF, in which the nominal price of sheep milk (the main production of the farm) has remained roughly constant since 1995 (implying a significant decrease in the real price) and maize, rye, and oats have shown significant decreases even in nominal prices. At the same time, labor costs have risen faster than inflation, in fact even faster than growth of the gross domestic product. The response has been intensification: increased mechanization (both for crops and for sheep milking), increased fencing, and increased stocking rates, through the replacement of natural pastures with sown ones. However, given the integration of QF in the project ExtEnSity (described below), intensification has been achieved in an environmentally friendly way.

Direct Drivers and Trends in Ecosystem Services

Intensification in general leads to increased water consumption and pollution risk. Extensification can mean a transition from arable crops to livestock production, but also to afforestation or simply abandonment. Abandonment leads to the establishment of shrubs corresponding to initial stages of the ecological succession, and to decreased landscape compartmentalization. One particular type of transition is related to fast-growing forest plantations: it is extensification in the sense of being a forest and decreasing labor input per unit area, while it is intensification in the sense of increased economic productivity per unit area. Most of this afforestation occurred with monocultures of maritime pine and, more recently, of eucalyptus, which, in contrast with the fire-resistant native oak forests (Nunez-Regueira, Anon, and Castineiras 1999), are very fire prone. The creation of vast plantations of these monocultures, together with the invasion of their surroundings by fire-prone scrubland in abandoned farm fields and the lack of forest management (partially because of the small average holding size), has led to a fast increase in wildfire frequency, with looming consequences for soil and water protection.

The importance of the industrial and services sectors also expanded the attractiveness of urban areas, which have evolved with little land planning. Additionally, the construction sector plays a disproportionate role in economic activity, a characteristic dating back to at least the 1960s. For example, within the EU, Portugal is second only to Luxembourg in per capita consumption of cement, this value being double the EU average (Vieira 2003), and the construction sector is the major driver of the increasing materialization (defined as the total material throughput per unit of economic output) of the Portuguese economy (Canas 2002). This gives the sector disproportionate political power, influencing land planning legislation and inducing heavy government investment in infrastructure. All this adds up to fast urban and infrastructure growth (e.g., highways). The former, taking place in coastal areas, places strong pressures on estuaries and coastal areas. The latter affects important terrestrial ecosystems.

The importance of construction carries over to a construction-based approach to tourism that intensively exploits coastal areas, decreasing their attractiveness, which is itself the basis for tourism (an effect identified by the global MA as the major negative effect of tourism; see Nelson et al. 2005). This leads to a downward spiral, with decreasing value added per tourist, leading to an ever-increasing need for additional tourists and to the "colonization" of new tourist areas in what might be called "slash-and-burn tourism." At smaller scales, however, as for QF and HRA, low-intensity, environmentally friendly tourism constitutes a major opportunity for the economic viability of landscape maintenance and biodiversity protection.

Scenarios

The two drivers chosen to delineate orthogonal axes for scenarios were society's attitude toward the environment and the evolution of agriculture. As explained above, these axes were integrated with the global MA scenarios. This process is ongoing, and here we discuss preliminary results for two scenarios: Order from Strength (a regionalized world with a focus on security) and Technogarden (a globalized world with a focus on environmentally sound lifestyles and policies). The other two scenarios are Global Orchestration (a globalized world with a focus on economic development) and Adapting Mosaic (a regionalized world with a focus on adaptive management of ecosystems).

In all scenarios, it is clear that external drivers have a predominant role. Because Portugal is a member of the EU, European policies and lifestyle contexts will largely determine the country's future. The global nature of the scenarios further reinforces the role of external drivers. In the Technogarden scenario, the EU's increased awareness of the problems associated with oil dependence leads to a push for renewable energies and training of environmental scientists and engineers. Marginal agricultural areas are abandoned, while farming practices are intensified in the best soils (two of the land use changes shown in figure 4.2). Biodiversity associated with agricultural habitats decreases as a result of intensification, but forest biodiversity increases in the forests growing on abandoned fields (see the right-hand side of figure 4.2). In contrast, in the Order from Strength scenario, Portugal's cultural traditions undergo a renaissance. The government promotes a policy of food self-sufficiency, which causes soil erosion, pollution of water resources, and biodiversity loss. Later in the scenario, the environmental impacts become so serious that the self-sufficiency food policy fails.

Contrasting Findings at Multiple Scales

In this section we perform a multiscale analysis of some of the assessment results, contextualizing national findings with global findings and complementing the national findings with data from the local scale.

Forest Policies and Biodiversity

Over 3.3 billion cubic meters of wood are delivered by forests, and numerous nonwood forest products figure significantly in the lives of hundreds of millions of people (Schvidenko et al. 2005). However, the world's forests as a whole are not managed sustainably, and the world's forest capital is being exhausted more rapidly than it is regenerated (Schvidenko et al. 2005).

In Portugal, as worldwide, forests have a high value: the annual economic value of ecosystem services of forest in 1998 was at least 939 million euros (Pereira, Domingos, and Vicente 2004). However, in contrast to the global situation, forests are not being overlogged in Portugal. Annual fellings for wood and pulp supply are smaller than the net annual increment of forests with the same main function (Direcção Geral de Florestas 1999). But historically this has not always been the case. After centuries of logging for fuel, timber, and agricultural expansion, by the nineteenth century forest cover in Portugal had decreased dramatically. As shown in figure 4.3, reforestation policies have more than quadrupled total forest cover over the past 120 years, bringing forest cover to 36 percent of the total land area (Direcção Geral de Florestas 2003).

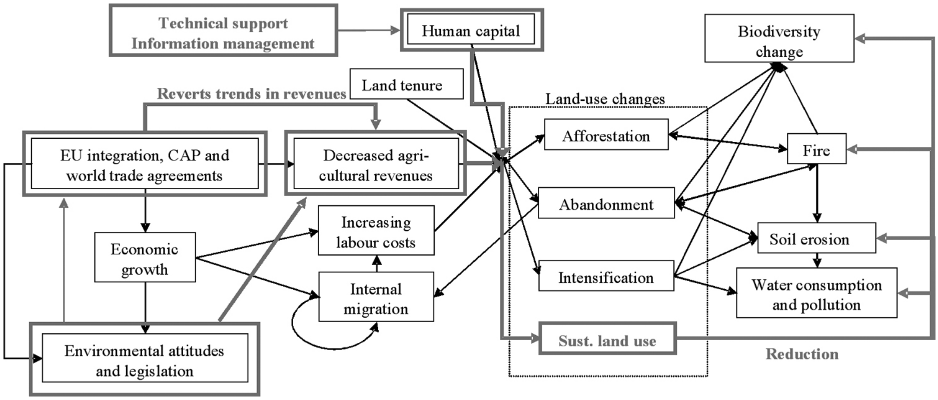
Unfortunately, much of this expansion was achieved through eucalyptus and pine plantations. These two types of forest—in particular, the exotic eucalyptus—differ greatly from the native oak forest. When poorly managed, eucalyptus forests especially can experience soil erosion problems, excessive nutrient extraction, excessive soil tillage, and loss of hydrological regulation (Pereira, Domingos, and Vicente 2004) and have very low biodiversity (Blondel and Aronson 1999).

Interestingly, the importance of the native oak forest is often better recognized by local populations than by national authorities. A set of ecosystem services provided by native oak forest is particularly valued by the local population of Sistelo. In the Sistelo assessment, people ranked oak forest as the second most preferred landscape (immediately after agricultural fields), referring to such services as provisioning of high-quality timber, provisioning of fuel wood, aesthetic beauty, recreation and resting amenity, and contribution to a healthier environment (Pereira et al. 2005). Fuel wood production is particularly important at the local scale. Unfortunately, some uncertainty exists as to how much native oak forest will be a part of the future program of reforestation in Sistelo. As in the past, the focus of the national forest authority on timber production seems to favor pine plantations.

Drylands and Forestry: The Case of the Montado

While most drylands are experiencing desertification processes, such as vegetation destruction and soil degradation, which deteriorate the capacity of those ecosystems to provide goods and services (Safriel et al. 2005), the xerophytic Portuguese *montado* is performing relatively well (Pereira, Domingos, and Vicente 2004). The resilience of the xerophytic rangelands of the Mediterranean to

Figure 4.3.
Area of main forest types (by dominating tree species) through time.
(From Pereira, Domingos, and Vicente 2004.)



human impacts has been recognized in the global MA assessment (Safriel et al. 2005), but a full assessment of that ecosystem is being carried out only by ptMA.

The economic importance of *montado* is largely due to the production of cork, a renewable resource that is sustainably extracted. The cork is debarked from each tree in intervals of about ten years by skilled laborers. The national cork production is almost as valuable as all other Portuguese wood products together, at 222 million euros per year, with Portugal producing 50 percent of the world's cork (Pereira, Domingos, and Vicente 2004). Portugal had a cork oak *montado* area of 712,800 hectares in 1995–98 (Mendes 2005), which averages to a production value of about 300 euros per hectare per year. In the case study of HRA, cork production yields 768 euros per hectare per year (Pereira, Domingos, and Vicente 2004) and is the area's most important source of income.

Another important economic activity in the *montado* is bovine, swine, caprine, and ovine production, which is often improved by cultivating fodder plants under the tree layer or in the open spaces between the trees. The economic value of forage from the *montado* is estimated at 125 million euros per year (Pereira, Domingos, and Vicente 2004). These open spaces are also used to raise cereal crops, particularly wheat. Unfortunately, the "Wheat Campaign" of the midtwentieth century, aimed at ensuring the country self-sufficiency in staple cereals, led to a degradation of the *montado* due to a reduction of the tree density and the impacts of tillage on the root system of trees. The fragile soil, typical of dryland regions, was eroded and soil microbiota were affected, increasing susceptibility to insects and parasitic fungi. Fortunately, these damaging agricultural practices have since been abandoned in most areas.

The cultural services associated with the *montado* were studied at the local level in the HRA site. Cork oak *montado* provides important habitat for birds of prey and carnivore mammals, and its conservation value is recognized at the European level by the European Habitats Directive. Thus many students and researchers develop their fieldwork in the well-preserved HRA *montado*. Other activities, such as bird-watching and hiking, are also gaining importance.

Biodiversity Consequences of Abandonment versus Conversion to Agriculture: Contrasting Scale-Dependent Results and Perceptions

More land worldwide was converted to cropland in the thirty years after 1950 than in the 150 years between 1700 and 1850 (Cassman et al. 2005). This is not the case with Mediterranean forest, however; by 1950 only 30 percent of the original forest cover remained, but little change has occurred since then (Mace et al. 2005). Mediterranean regions show that agricultural habitats are not hostile to all biodiversity, particularly when species and agricultural habitats coevolved over millennia. In the Mediterranean countryside, extensive agriculture (e.g., agricultural terraces, cereal steppes, and agroforestry systems) and even, in some cases, intensive agriculture (e.g., rice fields) have been the preferred habitat of many species for centuries (Pereira, Domingos, and Vicente 2004).

The scenarios developed for Sistelo (Pereira et al. 2005) present an excellent example of the contrast between scales in the advantages and disadvantages of abandonment for biodiversity and other ecosystem services. One of the Sistelo scenarios can be broadly characterized by the abandonment of agricultural fields and the extinction of the farmer community. In this scenario, the agricultural terraces disappear and are replaced by oak forest and scrubland, with the loss of local provisioning services and of biodiversity associated with low-intensity farming (including hot spots of plant diversity, such as pastures and fallow fields). However, forest biodiversity, including such species as roe-deer, wild-boar, and wolf (Pereira et al. 2005), increases, and regulating services, such as climate regulation, improve. Some of these changes are also occurring at the national scale (see figure 4.2).

The other Sistelo scenario consists of rejuvenating the population while maintaining the agricultural terraces. In this scenario, the cultural landscape of the terraces is preserved and the local food products are sold as organic products with profitable margins (however, as established by figure 4.2, this requires some intervention from outside the system, e.g., agri-environmental measures).

For the local policy makers, the undesirable scenario is abandonment. However, in a national or global context, this scenario could be a part of the globalization trends in the Technogarden or Global Orchestration scenarios, which for many would be desirable scenarios. In contrast, the preferred scenario by local policy makers, the rejuvenation scenario, would occur if local communities were empowered, as in the Adapting Mosaic, or if self-sufficiency food policies were implemented, as in the national Order from Strength scenario. The latter would clearly have overall negative consequences for ecosystems and human well-being at the global scale.

Addressing Afforestation Threats on Biodiversity: The Cereal Pseudo-Steppe

The cereal pseudo-steppe is an agroecosystem consisting of arable crops in rotation with fallow land, occurring mostly in Castro Verde and created during the Wheat Campaign. It is environmentally problematic with respect to soil erosion and desertification, but very important for biodiversity, functioning as a preferred habitat of such vulnerable bird species as the great bustard (*Otis tarda*) and the lesser kestrel (*Falco naumanni*).

In the 1980s, this area was threatened by afforestation with eucalyptus. In response, the municipality of Castro Verde forbade the planting of forests with rapid-growth trees in about 85 percent of its area, to avoid agricultural abandonment and to maintain control of the land by the municipality's inhabitants. This measure led to a strategy for obtaining public funds to subsidize farmers adopting practices compatible with nature conservation. The strategy was first proposed by Nature Protection League (LPN), an environmental NGO, and then taken up by ERENA, a consulting company, and the local farmers' association, leading to the creation of the Castro Verde Zonal Plan (CVZP), financed by the agri-environmental measures of the CAP. This was the first, and is still the only, implemented plan of its kind in Portugal.

LPN continued its intervention by contributing to improvements in the zonal plan (e.g., by changing the dates of plowing, which were inadequate for bird nesting). This intervention was based on LPN's integration of information obtained by scientists working in this area. The CVZP has significantly improved the conservation of the target bird species (Pereira, Domingos, and Vicente 2004).

In parallel, from 1994 to 1997, LPN acquired farms at risk of eucalyptus afforestation using a 75 percent funding from the Life Program of the European Community, with the remaining support coming from individual donations and from the pulp and paper companies that originally owned the farms. The farms have been rented to local farmers on condition of their compliance with strict bird protection regulations.

However, since 2000, farmers have been progressively abandoning the CVZP because of a significant reduction in subsidies for areas larger than 100 hectares, precisely those areas that provide the most significant bird habitat (Pereira, Domingos, and Vicente 2004). The CVZP was also ineffective in preventing soil erosion and desertification. However, recent research suggest that subsoiling, injection of wastewater sludge, and use of direct seeding can reduce erosion by up to 90 percent (Pereira, Domingos, and Vicente 2004).

This response has clear multiscale and multiuser components: the threat to conservation at the regional scale (the Castro Verde municipality in Alentejo) of important bird species (which provide a global-scale biodiversity service) led to the acquisition of farms at a local scale by a national-scale environmental NGO (LPN), using funds at the EU (Life Program) and national (corporate and individual donors) scales.

Acting on Multiple Drivers: ExtEnSity

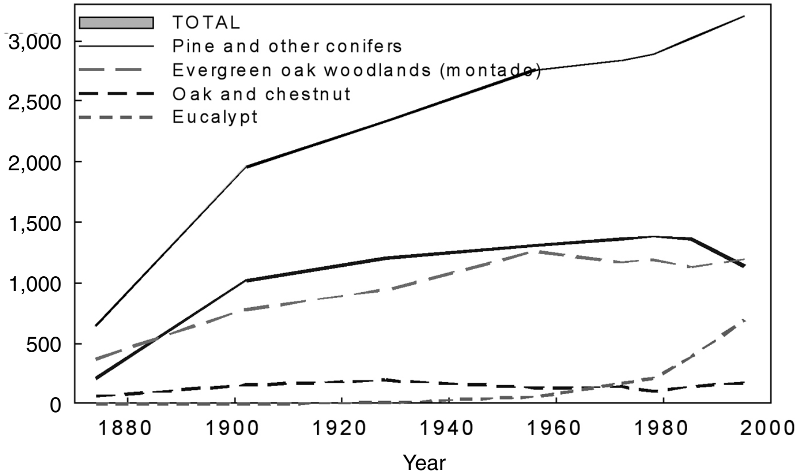
The shortcomings of the Castro Verde response, together with the current trends in drivers of ecosystem change in Portugal, have led to the development of the project ExtEnSity (Environmental and Sustainability Management Systems in Extensive Agriculture; see figure 4.4). ExtEnSity is a demonstration project financed by the Life Program that involves multiple types of organizations at different societal levels:

- research organizations
- NGOs, including farmer associations, LPN, and a consumer association
- private companies
- Ministry of Agriculture agencies.

The major thrust of ExtEnSity is the creation of a prototype for "sustainable land use" in the agricultural sectors of extensive livestock production and arable crops, with three main components: (1) optimized irrigation, (2) no tillage, and (3) biodiverse, legume-rich pastures with increased animal

Figure 4.4

Intervention by ExtEnSity on the causal structure in figure 4.2. (Thick boxes and lines indicate intervention.)



stocking rates. Components 2 and 3 lead to increased soil organic matter, thereby reducing soil erosion and increasing water retention. All three components reduce water consumption and nitrate leaching, also leading to reduced soil erosion and reduced water pollution.

Components 1 to 3 all lead directly to increased economic viability of agricultural activities, thereby promoting "sustainable land use" instead of afforestation, abandonment, and intensification. This transition is also promoted by compensating low human capital with technical support and information management.

Additionally, the transition to "sustainable land use" is addressed by counteracting "reduced agricultural revenues" through two interventions associated with an increase in rewards for the private (food quality and safety) and public (other ecosystem services) goods provided by "sustainable land use." The project directly increases the rewards for private goods by promoting the commercialization, at higher market prices, of the project farms' products. This addresses the environmental attitudes component of the "environmental attitudes and legislation" driver. Increasing the rewards for public goods requires a higher scale of intervention. The Ministry of Agriculture is in charge of developing and proposing to the EU agri-environmental plans. Thus ExtEnSity is collaborating with the Ministry in developing a specific agri-environmental measure for "sustainable land use." This addresses the CAP component of the "EU integration, CAP and world trade agreements" driver.

ExtEnSity is an example of an integrated response that addresses degradation of ecosystem services across multiple systems simultaneously, explicitly includes objectives to enhance human well-being, occurs at different scales and across scales, and uses a range of instruments for implementation (Brown et al. 2005). ExtEnSity has a strong multiscale, multiuser, multiknowledge system approach. Three of the project's partners are involved in managing some of the pilot farms, ensuring a smooth flow of knowledge from the local to the national level. Also, two different approaches are taken for interacting with farmers: direct interaction and through a local farmers' association. ExtEnSity acknowledges multiple forms of knowledge through its integration of scientific and "civil society" actors. Traditional knowledge is integrated mostly for a single region, through the local farmers' association, which has a large number of older farmers. The younger farmers do not have traditional knowledge, although they do have extensive local knowledge.

ExtEnSity addresses first the farm scale and builds on this to influence large scales through policy intervention. This is done through the three national level NGOs, which belong to "umbrella" organizations at the EU level. In the early stages of the project, these NGOs will bring information from their umbrella organizations. At the dissemination and policy-influencing stage of the project, they will transmit to the EU level the results of the project. The participation in the project by two government agencies also enhances this wider policy influence. In this way, ExtEnSity aims to solve a problem with integrated responses: they are often deemed successful at a small scale or in a particular locality, but their effectiveness is limited when constraints are encountered at higher levels, such as in legal frameworks and in government institutions (Brown, Mackensen, Viswanathan et al. 2005).

Should this citation be the same as in paragraph above?

Conclusions

Performing a multiscale assessment requires a large team (roughly proportional to the number of case studies), an engagement of users at different scales, and more funds (Zermoglio et al. 2005).

The relationship between the national findings of ptMA and the global MA findings demonstrates the importance of having a larger-scale context. For instance, many of the drivers of ecosystem change are exogenous to the Portugal scale, and the analysis of the condition of Portugal ecosystems is best understood in the regional context of the Mediterranean. The global scenarios laid out the context for the development of the Portugal scenarios, a context that was particularly important given the long-term nature of the scenarios, which implies an analysis of the evolution of global drivers.

Local-scale assessments are powerful case studies of processes or systems relevant at the national scale. Data at the local scale can be collected by the assessment team directly. This is not possible in most instances for data at the national scale, where data are usually assembled from existing sources. For instance, in the Sistelo study case, field surveys showed the importance of the native oak forest for the well-being of the local population. Assessing the effectiveness of responses such as agroenvironmental measures and sustainability certification that are implemented at the local level requires local assessments.

Distributional and equity issues become apparent when comparing scenarios at different scales. What is a good scenario at a given scale when impacts on well-being are averaged across that scale may be an undesirable scenario at a smaller scale for a given portion of the population. The importance of the drivers differs across scales, and responses targeting a driver should be implemented at the scale where that driver is most important.

In conclusion, at any given scale, socioecological systems are open systems, with fluxes from scales above and below. A full understanding of those fluxes can be best obtained by using a multiscale approach.

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