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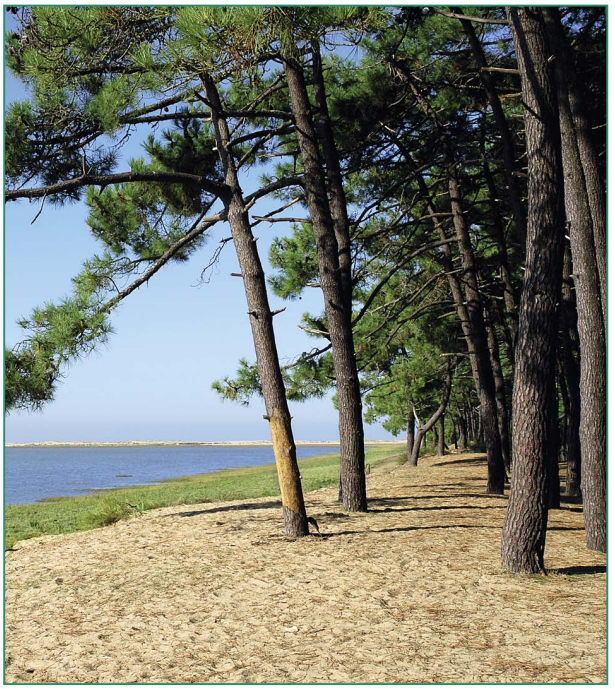

EUROPEAN FOREST INSTITUTE

# Are MCPFE Indicators Suitable for Planted Forests?

## Summary and comparative analysis of the FORSEE project results: assessment and relevance of criteria and indicators for sustainable forest management in cultivated forests

**Jean-Louis Martres[1], Jean-Michel Carnus[2] and Christophe Orazio[3]**

[1] Centre d'Analyse Politique Comparée, Université Bordeaux IV, France
[2] Institut National de la Recherche Agronomique, INRA, Pierroton, France
[3] European Forest Institute, Regional Office EFIATLANTIC, France

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Authors: Jean-Louis Martres, Jean-Michel Carnus, Christophe Orazio

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Torikatu 34
FIN-80100 Joensuu
Finland

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Tel: +358 10 773 4300
Fax: +358 10 773 4377
Email: publications@efi.int
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Editor's contact information

**Christophe Orazio**
firstname.lastname@efi.int

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# Foreword

This paper provides a constructive critique of indicators for sustainable forest management and aims to show their value and their limitations. According to the interpretation of the definitions, the way to collect data, and the ecological and economical context, the realities described by these indicators are not homogeneous and comparable at the inter-regional level. By applying the same set of indicators with the same protocols scientifically based in eight Atlantic regions, we obtained various results extracted from the regional studies and outlined below (all reports cited in this paper can be downloaded from: http://forsee.iefc.net). We demonstrate the variability in the quality of indicators and the limits of their comparability. In this work, therefore, we illustrate the diversity of indicators to assess Sustainable Forest Management, the weaknesses of the existing ones and the benefits of new ones that were tested during the project.

# Acknowledgements

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# Executive Summary

- Current indicators of sustainable forest management are not necessarily sensitive to forest diversity.
- Governments therefore have a role to play in protecting forests. In order to complement the existing data on forest resources, there is a need to collect additional data to monitor efficiency of policy for forest protection and timber enhancement.
- The different states need to agree on common means by which to establish forest inventories in order to facilitate comparison and maintain method of inventory to keep them comparable over decades.
- An efficient monitoring of wood consumption for energy is missing.
- In most FORSEE regions, the existing carbon estimation tools were underestimating the carbon storage in forest. Improved cost efficient methods have been developed by FORSEE to get more accurate carbon assessment at regional level, with a significant impact for potential carbon market.
- In managed forests, the health status assessment is influenced by forestry activity (removal of unhealthy or dead trees). This improves global health status but reduces the capacity to monitor the evolution of pest attack and die-back agents. In a context of climate change and new threats, a global strategy to monitor dying trees and biotic or abiotic responsible agents at European level is missing.
- New ICP protocol (2006) introducing monitoring of timber damages and agents identification was considered as a significant improvement of the previous ICP protocol. The major change needed is to monitor a fixed area instead of a fixed number of trees to be able to extrapolate volume and mortality rates.
- Monitoring of growing stock is one of the main aims of the national inventories, but improvement in detail is needed.
- Dealing with resources, significant improvement can be gained using indicators such as “standing wood value” and “distance from wood processing sites”, “timber quality” “woodland market” or any other driver for wood producers.
- Non wood products generated by forests are still difficult to quantify.
- The volume of deadwood found was higher than anticipated for cultivated forests.
- Protocols and thresholds have a marked influence on results.
- Species richness in one taxonomic group is not systematically associated with richness in another one, so assessment of biodiversity based on only one group, such as vascular plants, is biased.
- Habitats of interest depend on local context and identifying a unique indicator set without regional adaptation to monitor biodiversity at national or international level, may limit the global applicability of the conclusions.
- Thus the set of indicators for the criterion “protective functions” shows that forests play a key role for ecosystem protection and have to be updated continuously according to new knowledge and in the context of other criteria.

- The decisions of planning authorities and of tourist interests can have a significant impact on the sustainability of the forest. Efforts should be made to increase the understanding of the importance of criteria and indicators among policy advisors in these sectors. Regional authorities should be encouraged to promote a willingness and interest in sustainable forest management and increased timber harvesting.
- The influence of legislative, policy and economic decisions on sustainability are not adequately covered by existing indicators.

The global concern for the protection of the environment has led to multiple initiatives from governments and environmental NGOs. Their shared eagerness to set up instruments for sustainable management has led to the appearance of multiple yet uncoordinated procedures. On the one hand, states have attempted in the framework of multilateral conventions to come to an agreement with regard to a certain number of indicators capable of attesting to this character. On the other hand, different private initiatives have moved towards competitive certification systems, requiring that forest managers respect detailed obligations in return for official recognition that would facilitate their access to the wood markets.

Although innovative, these developments have had little impact on the data that European states, in particular, have collected for many years. These data have been gathered with a view to developing standards for the protection of forests. Research on forest ecosystem processes is important for development of criteria and indicators. A considerable body of knowledge has already been accumulated and validated, although this knowledge is not well known to some well-intentioned environmentalists. However, progress is inevitably incremental – gradually mitigating errors and overcoming shortcomings.

The diversity of constraints imposed on the management of forests is a source of confusion to managers as they endeavour to fulfil multiple management objectives. In many cases, these forests, established for a single commercial objective, must now be managed under newly imposed environmental constraints for multiple societal objectives. On the one hand, they are expected to manage their forests in a financially viable manner, while on the other hand, they must meet the management objectives arising from the demands of society. It is often overlooked that for centuries, forests in Europe have been managed in a sustainable manner (sustained yield management) and as such, foresters are the inheritors of a long tradition of natural resource conservation. Current indicators of sustainable forest management are not necessarily sensitive to forest diversity. While field case studies can support them, they can also refine, amend or enhance them. In that spirit, the FORSEE project was presented to the EU authorities. The strength of the project was that the full complement of internationally agreed criteria and indicators were tested over a network of pilot zones established on large areas of private forests in the participating regions (described in the Annexes). The indicators were subjected to scientific study in order to examine their local relevance and scientific validity. Resulting from this, the amendments for research protocols are proposed.

As the only organisation responsible for the project partners, the IEFC (organisation hosting EFIATLANTIC since 2009) coordinated a group of researchers combining competences from the greatest possible variety of domains. Two comments can be made in this respect.

First, different countries and regions have high-level scientific resources concentrated in institutions of very different nature. Some form part of public bodies, universities

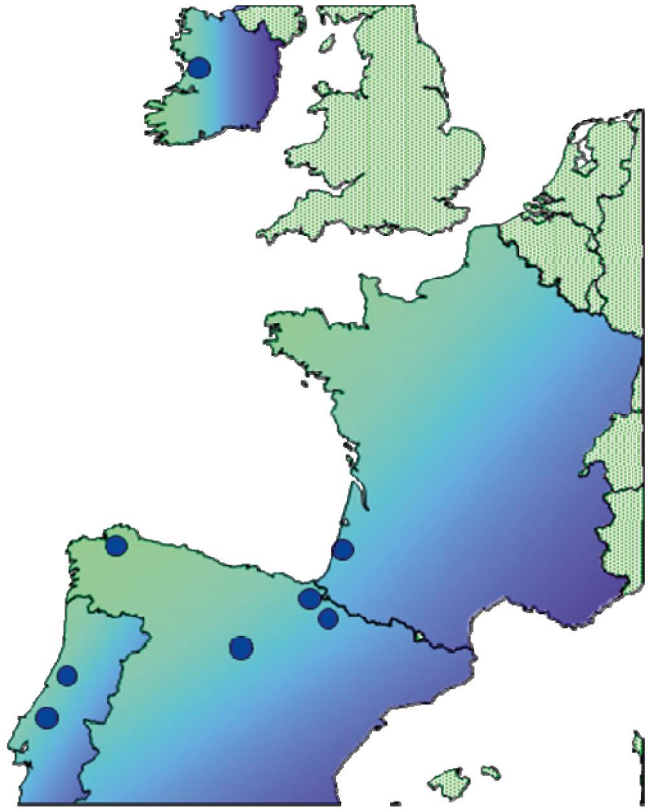

**Figure 1.** The eight FORSEE pilot zones for the assessment of the indicators.

or independent research and development centres such as INRA, CRPF and FCBA in France, and CELPA, the cellulose association in Portugal. It is also interesting to note that in addition to each local group, members of USSE introduced representatives of forest owners associations as they were in a position, based on their knowledge of the specific nature of the properties in question, to contribute original and complementary insights to the scientific study.

Second, the FORSEE project gave to the researchers the opportunity to work in a network. The extended collaboration gave it a stability that now surpasses their relative isolation, sufficiently in any case to enable them to avoid redundancy in their work and to be ready to respond to all new demands.

It is essential to proceed in three stages in order to do justice to the results: first, by presenting all regional summaries in a comparative report; secondly, by analysing the nature of the knowledge gained through the project; and finally, by suggesting modifications or validating the methods used.

# 1. Report on cultivated forests based on the indicators

Cultivated forests are subject to negative, often erroneous opinions which tend to discredit them in the eyes of public opinion. They are considered to be monotonous, lacking in biodiversity, subject to disease and fire, and to be of limited aesthetic value. The common perception is that they are suitable for one purpose only – wood production – with little opportunity for multifunctional management. However, the general results of the studies in the FORSEE project tend to contradict these presumptions.

## Criterion 1. Surface area of forests and carbon storage: the indicator assessment reveals stability and growth

A vast panorama covering different regions ranging from Ireland to Central Portugal and stretching along the Atlantic seashore provides an overview of cultivated forests in a variety of different states and stages of development. There are very old forests, like those in Aquitaine, Galicia and Portugal, and others recently established such as those found in Ireland.

Although climatic and geological factors have played an essential role in the choice of species to be cultivated – most of them native, sociological considerations seem to be equally important in the decision to plant trees.

For the most part, the chosen terrain is very poor and unsuitable for agriculture. For example, the forest of the Landes of Gascony is the result of a systematic plan in the 19th century to dry up the marshes with the help of maritime pine to make the land suitable for agriculture. Sandy soils were inappropriate for anything else. Similarly in Ireland, the study clearly reveals that farmers contributed only the poorest part of their lands such as peatland, rocky outcrops or soil that was barely suited for cultivation or otherwise unusable. Forest land use, therefore, depends on the possibilities of the terrain; however, the situation can change over time such as in Spain or Aquitaine where certain areas, abandoned to the maquis or irregularly wooded, for example, can return to agriculture in periods when the price of raw materials increases. State control or intervention in the form of legislative instruments to protect forest resources or to encourage afforestation, for example, may be required in these cases in order to maintain the sustainability of the forest estate[1]. Government therefore has a role to play in protecting forests. In order to complement the existing data on forest resources, there is a need to collect additional data in order to monitor efficiency of policy for forest protection and timber enhancement.

Moreover, species-specific silvicultural practice brings about variation in forest cover through the life cycle of the forest. It is difficult to take these factors into account when the frequency of inventories is low. Cleared forest lands awaiting reforestation were found to slip through forestry statistics, thus distorting the analysis.

1 For example, a ban on clearing forests imposed in France in 1930.

**Table 1.** Pilot zones where indicators of Criterion 1 were assessed. O: no improvement needed, n minor: improvement needed, N major: improvement needed. FORSEE contribution to improvement: c: minor, C: significant

| Criteria assessed in | | Mayo | Aquitaine | Navarre | Basque region | Castille | Galice | Portugal N | Portugal C | Improvements |
|---|---|---|---|---|---|---|---|---|---|---|
| C1.1 | Forest area | x | x | x | x | x | x | x | x | o.c |
| C1.2 | Growing stock | x | x | x | x | x | x | x | x | n.c |
| C1.4.1 | Carbon stock in woody biomass | x | x | x | x | x | x | x | x | N.C |
| C1.4.2 | Carbon stock in the soils | x | x | x | | x | x | | x | n.C |
| C1.4.3 | Carbon in the dead wood stock | x | x | x | x | x | x | x | x | N.C |
| C1.4.4 | Carbon in the litter stock | x | | x | | x | x | x | x | N.C |
| C1.4.5 | Carbon in the understorey | x | | x | | x | | x | x | N.C |

This comment is linked to the question of the systematic character of a dominant species. Because it is the most visible species, forest stands may be considered monospecific when, in fact, they are not. In reality, many other species may occur either at the edge of the forest or in mixture with the principal species. A study of National Forest Inventory and additional collected data yielded some surprising results. (Cf. Portugal and Aquitaine) In the test zone in Aquitaine, which is devoted exclusively to maritime pine, of the 12,743,659 $m^3$ recorded, 361,819 $m^3$ have been inventoried as consisting of a variety of other species. The question becomes even more pertinent when the sample plots used for the inventory are located in mixed forests in which eucalyptus, maritime pine and oak coexist as in the case of Portugal and Galicia.

Similarly, the detailed analysis for the Basque region provides surprising data insofar as a considerable increase in deciduous trees was observed on the ground between the two NFI inventories due to the threshold effect on diameters. Over a period of ten years, there was an increase in area of 40% although it only represented a growth of 3% in volume.

Overall, forested surface areas remain stable in Aquitaine and show a slight annual increase in the other pilot zones in Galicia, Castilla y Leon, and Ireland. Serious forest fires in Portugal, however, tend to invalidate the inventory and there are fears that forested areas may decrease.

However, it would be recommended to define an optimum forest area or at least a minimum target in addition to the inventory of the present forest estate; this implies the use of quantitative methods and improved land-use planning. Land unreclaimed by agriculture or pieces of land so small that their owners have forgotten their existence

are found close to existing plantations. Only a strong state initiative could lead to land exchanges and regrouping that would facilitate a return to cultivated forests. This obviously implies that from the start of the operation, a cadastral inventory of owners should be carried out to determine both the divisions and sizes of the plots.

However, observers from the FORSEE project have commented that although globally satisfactory and necessary, the indicator relative to surface area requires two types of adjustment. First, the different states need to agree on common means by which to establish forest inventories in order to facilitate comparison, as initiated for example in the COST action E43. Secondly maintaining method of inventory on long times series is needed to avoid problems; for example in the database between the two Spanish inventories prevented any real monitoring when evaluating woodland. Consequently, over and above the surface area, an increase in volume is a decisive indicator linked to several factors (improved forestry techniques, species-site match, climatology, genetic improvement, etc). For example, a considerable increase in growth has been observed in Galicia (+ 62% for conifers, + 95% for deciduous). Thirdly, even when statistical data or cartographic results are available, the scale of the analysis plays an important role. The more the criterion is applied to a small area, the greater is the need for precision and thus new measuring techniques instruments, which are unfortunately onerous in terms of time and money.

Today, however, the question of forested areas is closely related to the issue of carbon storage. The methodological contribution of the FORSEE project is significant in this context, through the specific studies conducted in Galicia, Navarra, Ireland and Portugal. Carbon evaluations conducted at different territorial scales attempt to include the role of forests and cultivated forests in particular, which are characterised by regular exports of part of their stock. However, these efforts are still in their infancy.

A detailed analysis for each component in the forestry system (plantation, soil, deadwood, undergrowth, wood products) was repeated in each region in accordance with harmonised protocols. This has enabled researchers to suggest means of improving, in a cost-efficient manner, the calculation of this new function in relation to mitigating climate change.

Although scientific rigour demands reliable calculations, the conclusion is nonetheless the same in almost all pilot zones: an underestimation (from 5 to 100%, Primicia et al., 2007) of the capacity for $CO_2$ storage in forestry plantations and of the positive impact of forestry management on carbon storage in forest. Cultivated forests are therefore thought to contribute more to a reduction in greenhouse gas (GHG), particularly when we take into account the $CO_2$ stored in wood products, compared to those forests that do not produce timber.

As for soils, their composition highlights the difference between the Landes podzol (in Aquitaine), which is relatively low in carbon and forest soils that are much richer in organic matter.

## Criterion 2. Forest health: satisfactory health status in the FORSEE regions but improvable indicator

An evaluation of this criterion with regard to the proposed indicators raises several questions, even when taking the improved ICP protocol for forest damage assessment as reference. A strict quantitative analysis of damage is insufficient to define the exact

**Table 2.** Pilot zones where indicators of Criterion 2 were assessed

| | | Mayo | Aquitaine | Navarre | Basque region | Castille | Galice | Portugal N | Portugal C | Improvement |
|---|---|---|---|---|---|---|---|---|---|---|
| C2.4 | Damages | | | x | x | x | x | | x | N.C |
| C2.4.a | Key factors for damages | | | x | x | x | x | | | N.C |
| C2.4.1 | Types of damages | x | x | | | x | | x | | n.c |
| C2.4.2 | Damage frequency according to tree age | x | x | | | x | | x | | N.C |
| C2.4.3 | Damages intensity | x | x | | | x | | x | | N.C |
| C2.4.4 | Defoliation | | x | | | x | | | | n.c |
| C2.4.5 | Stand susceptibility to abiotic agents | | x | | | | | | | N.C |

cause of the damage, even though a pathogenic agent may be identified to facilitate adaptive and preventive actions. The health of a tree or forest depends on a series of converging factors, such as the quality of the soil, exposure, the frequency of forestry operations and droughts, all of which may explain the appearance of parasites. However, it is essential to monitor changes because recorded plagues may vary depending on the time of observation as well as on their possible disappearance since trees can regenerate themselves, depending on their own vigour and circumstances. This should not obviate the need to establish correlations between, for example, defoliation and seven environmental factors retained as significant (Cf. Castilla y Leon, Summary, p. 48).

In spite of these preliminary precautions, the usefulness of the samples chosen by the FORSEE project becomes evident when we compare the results from the eight regions. Apart from the variety and number of cultivated species, and in spite of the different types of plagues, the state of health of forests from Ireland to Portugal is overall satisfactory. In some recent forests (average of 20 years old), however as in Ireland, their health is remarkable – mainly due to a particularly effective supervision service in the region. In fact, although certain phenomena can affect all the FORSEE regions, like storms, others vary greatly according to climate (snow and hail), which are found in Aquitaine, Navarre, Basque region and Castilla y Leon but not in County Mayo and Portugal.

Looking at the health status by age in cultivated forests, we observe that the state of health improves with maturity – mainly due to cultivation techniques which progressively eliminate unwelcome, diseased or dead trees. Thinning is a general practice in overcrowded forests to give trees greater access to light, water and nutrition.

It is thus not surprising to observe that adult trees, whether conifers or deciduous, are healthier, except for those exposed to severe bad weather during their growth period (Cf. for the period of the 1970s: Basque region Summary). The observed damage level of about 25% corresponds to the European average.

Moreover, it is interesting to note that the scientific observers – conscious of the partial and subjective nature of their brief observations – also consulted managers to draw on their longer experience.

Inventories that are carried out within a limited time period and in inappropriate time slots leads to a more cautious approach to the health indicator. While not questioning the quantitative results provided by the different indicators, it is important to qualify them.

In certain countries (e.g. Ireland and France), supervisory bodies are in place to constantly monitor forest health. The FORSEE project thus cross-referenced various sources of long-term forest health data to obtain a greater validity of the results.

Certain signs, like discolouration or defoliation, may be the result of several causes and thus require careful study. In some cases, as in Castilla y Leon, it is possible to eliminate the observer effect by using automatic systems. In most cases, however, drought, exposure or competing vegetation can cause water stress with delayed effects. The proximity of industrial sites may also cause perturbations linked to air and soil pollution. Precise measurements, therefore, remain uncertain (Cf. Galicia Summary).

With regard to the varied guilds of forest parasites, limited damage does not necessarily have an effect on the longevity of trees. For example, ambiguous results have been observed in the case of attacks by the processionary caterpillar: healthy trees suffer the same degree as nest-bearing trees (Cf. Aquitaine). Trunk attacks are difficult to detect and require more refined methods. By analysing statistics in various regions, we can see that damage to the trunk contributes a significant amount of all the observed damages, directly affecting wood quality and tree prices. This trunk damage assessment is the major improvement made in the new ICP protocols and should remain.

It is also useful to bear in mind that soil fertility plays a major role in tree health. However, as previously mentioned, general observations indicate that only poor or difficult-to-access land is allotted to the cultivation of trees. In the Basque region, there is a strong correlation between damage and exposure to shallow and sloping terrain or chalky soils.

Another refinement to this indicator concerns the means of access and the inventory. Some observers have commented that a high forest road density is not necessarily favourable. There is a need to delimit an optimal density, region by region, bearing in mind that human intervention can be equally damaging for fauna and flora, and have a negative effect on cultivation (Cf. Navarre Summary). Access routes that permit excessive human traffic may damage the ecology of the system.

One point must be considered in order to appreciate the real importance of plagues affecting forests: the primary aim of most cultivated forests is wood production and it is therefore in terms of economic criteria that the importance of the collected data should be evaluated. These criteria can be used to determine the threshold beyond which an excessive loss in value prevents commercialisation under normal conditions (Cf. Aquitaine Summary). There is thus a clear benefit in using improved ICP protocol as defined in 2006. It is surprising, therefore, that Europe cut the subsidies of a forest health assessment tool in 2007 that was under improvement.

Although biotic factors may cause severe damage to forests, abiotic factors must also be taken into account. However, insofar as the cultivation of trees is long term, the risk

increases correspondingly. The increased incidence of major climate perturbations in the form of storms, for example, necessitates meteorological monitoring in order to measure the frequency of these accidents. This could influence the direction of genetic research with a view to improving resistance to wind or drought in certain species and reducing the rotation length. It could also modify plantation or regeneration techniques to anticipate new climatic constraints.

Another factor affecting mainly southern regions is the question of forest fires. Fire is a special case since fire prevention is partly based on human activities. New indirect indicators based on infrastructures and landscape characteristics should be developed. Using these indicators as bases for rural planning, scale economies and synergies could be implemented in order to limit if not eradicate this problem.

Unfortunately, 20-tree sampling plots as defined in the ICP protocol are not appropriate for detailed monitoring as we cannot identify the agents that are killing trees. Thus, the FORSEE project could not provide the volume or areas of trees dying because of biotic damage; rather, it only provided the percentage of leaving trees affected by a plague and is not consistent with figures from abiotic damages with volumes or areas of dead trees. A relevant forest health monitoring technique, therefore, must be able to monitor tree mortality and rely on fixed area plots with tree density monitoring. Such a sample technique is somewhat different from the actual ICP protocol and is supposed to identify what agent caused the mortality, including biotic and abiotic agents.

## Criterion 3. Productive functions: this set of indicators provides incomplete and inconclusive results

The purpose of this criterion is to establish, via a certain number of quantitative indicators, a link between the management of cultivated forests and their sustainable production. The data gathered is particularly interesting as it covers very different cases, since in some instances it refers to forests with an old tree-growing tradition and, in others, recently planted forests as in the case of the young forest in Ireland or the Basque radiata pine forests. Because the data refers to states and regions with different tree-growing traditions, it enables us to appreciate the legal systems established, the owners' behaviour, whether they are private or public, and the existence or non-existence of the means of measurement required by the indicators (Cf. Criterion C6).

The questions submitted to the experts were designed with a view to determining the available wood resources, making sure that harvest is compatible with tree growth and annual increment, and that the road system provides adequate access for cutting at harvest time. They also cover non-wood products likely to provide additional income for owners.

Although the proposed results generally provide a positive response to the concerns expressed in the questions, they nevertheless require discussion. A general overview would indicate that all the regional case studies present a satisfactory result because all respect and maintain the resource, and all provide a suitable access system capable of meeting the needs of cutting, extraction and transport. The only exception to this is in Ireland, where the means of access have not yet been established because the plantations are young and are not part of larger, mature forests. However, this example is of little

**Table 3.** Pilot zones where indicators of Criteria 3 were assessed

| | | Mayo | Aquitaine | Navarre | Basque region | Castille | Galice | Portugal N | Portugal C | Improvement |
|---|---|---|---|---|---|---|---|---|---|---|
| C3.1 | Increment and felling | x | x | | x | x | x | x | x | n.c |
| C3.2.1 | Roundwood harvested (Volume) | x | x | x | x | x | x | x | x | N.C |
| C3.2.2 | Roundwood (Value) | | x | | | | | | | N.C |
| C3.3 | Non Wood Products | x | x | x | | x | | x | | N.c |
| C3.5 | Forest under management plans | x | x | x | x | x | x | x | x | n.c |
| C3.6 | Accessibility | x | x | x | x | x | x | x | x | n.c |
| C3.7 | Harvestability | x | x | x | x | x | x | x | x | N.c |

significance because we may suppose that, given the high quality of the road system in Irish forests in general, the access network will follow as soon as exploitation begins.

A detailed review of each case reveals the insufficiency, or rather the ambiguity, of this criteria. First, the measuring instruments, although multiple, are neither consistent nor coordinated, with the result that they provide random figures. This makes it essential to cross-reference the different data and then check the veracity of the information on the ground. While this work is no doubt possible on a small scale, though time-consuming, it is difficult to transpose to a large forest. Although the National Forest Inventory no doubt provides reliable annual data for Aquitaine, it is nevertheless based on small samples, which reduces its value. Moreover, in some states like Portugal, the published figures only relate to public forests. Private forests are the subject of an empirical study conducted with paper manufacturers, middlemen and owners.

All agree that new means of observation, aerial photos and digital maps, are likely to lead to more exhaustive and precise data. These are of capital importance given the indispensable prospect of planning the future of Europe's forests. It is therefore time to establish a system capable of generally harmonising the measuring techniques.

The same holds for accessibility and exploitability, which are calculated only as a function of access routes. If we use the FAO criterion of 20 metres/ha, the results obtained are far superior. In certain cases, road density can approach 78 metres/hectare for radiata pine forests in the Basque region or Galicia, with 72 metres/ha, and between 80 and 100 in northern Portugal. These figures, however, hide a complex reality: it would be considered

unwise to imagine from reading them that they describe an optimal situation in terms of accessibility. This is not the case. In countries with an old forestry tradition, the roads first served dwellings dispersed over hamlets while others are linked to hunting or leisure activities. They thus depend on history and traditions but also on the orographic situation and climate, although the network may also meet production needs (Cf. Basque region). In fact the question could be reversed to apply to the density threshold beyond which too many inroads damage sustainable management. The Basque Country and Navarre are cases in point since we can observe damage to the landscape, ecosystem, fauna and flora as well as soil erosion. Taking this concern further, the low value that planners set on forests causes them to cut through forest zones with motorways, electricity lines and railways, all of which are no doubt useful in terms of human communication but with little regard for the conservation of the forest resource. This threat is exacerbated by intensive housing development in the countryside in the form of dispersed dwellings, the result of decisions made by public authorities.

Another criterion manifests its equivocal character by setting value on submission to a forest management plan. Overall, with the exception of France where it is mandatory for unfragmented properties of 10 to 25 ha and more, a management plan seems to be the exception rather than the rule in other regions. In northern Portugal, it is used by the public domain and the paper industry yet less frequently by private owners. It seems that the constraints imposed by certification systems (FSC in Ireland, PEFC elsewhere) are sufficient for the present, although European Union financing, in Portugal and Spain for example, is increasingly linked to planning and management procedures. Some observers have pointed out that a forest management plan is not in itself a guarantee of good management since it may not be respected or quite simply distorted by upheavals caused by storms or fires (Cf. Portugal).

As for resources derived from non-wood products, they do not seem likely to constitute a sufficiently significant added revenue to encourage sustainable management. With the exception of honey, a veritable trade in northern Portugal, or pine wreath in Ireland, other resources such as essential oils, herbs and mushrooms are still not taken into account. Cork is part of another economy, being the principal product in the southern half of Portugal (world leader) and in some regions in Spain and the south of France.

However, some hold out hopes for the profitability of amenities that were hitherto provided free of charge to the public. Efforts have been made to quantify this. It is by no means sure that making these advantages into heritage items is a good idea because heritage is very difficult to individualise into discrete commercial acts. On the other hand, these collective services, such as walking, hiking or gathering the fruits of nature, are products of the forest in general and, as such, should prompt the state to realise that it needs to invest in them, in the same way as it maintains public services.

National forest inventories provide data on growing stocks. It is thus possible to estimate approximate figures for harvesting and the future of cultivated forests. However, this indicator very quickly reveals its limits insofar as it represents only a small part of the production chain, all of its links being indispensable. A comment in the report for the Basque Country highlights this insufficiency. A fall in the price of wood caused a drastic reduction in cutting (2000–2005) and disturbed the totality of the chain. It is necessary, therefore, to take all the elements of the system into consideration and monitor an improved indicator – "Standing wood value" – (See C3.2.2) on the long term while incorporating values and volumes.

So the first question to be addressed should be "Who is the manager (see criteria C6.0.2)? This question was broached by Aquitaine and should address his/her legal status and not so much their characteristics. Is the owner a public, private or a multinational body; or a co-owner as we find in Spain and Portugal? Is there an associational movement capable of encouraging and spreading innovations? How many foresters are there? How many jobs depend on the industry? What are his/her rights and obligations? Public authorities no doubt play an important role in sustainable management by making it mandatory to replant five years after cutting, forcing owners to submit to a Simple Plan of Operations in France, for example; or by wielding subsidies and tax exemptions. These are, however, no substitute for the motivation of the owner who expects an income from his/her work and investments.

This implies a detailed analysis of topics that have a direct influence on the behaviour of the forester and associated indicators such as:

- The distance from factories and the size of their catchment areas are just as important as the number of access roads.
- The social status of the forest workers and their difficult working conditions thus constitute a significant added dimension to the question.
- the wood market: as it is important to be aware of the nature of the products manufactured, their end-use and the competition capable of limiting the expansion of industries since they have a direct influence on trade.
- Energy market: in a period of energy shortage, and based on available data, the role of wood in the world energy supply cannot fail to have an effect on the forests themselves.
- Woodland market: Forests, which are subjected to numerous crises during their development, are also subject to demographic pressures. The public, although indifferent to the fate of the forests, are also their consumers.

## Criterion 4. Biodiversity: limited results for an ambiguous set of indicators

It seems to be established in the specialised literature that the more natural the forest, the more capable it is of fostering maximal biodiversity. By definition, this presupposes an environment that is not disturbed by management. The FORSEE project focused on comparisons between extremely diverse regions located far apart from each other and each with its specific characteristics. This also facilitates an evaluation of the criteria at the regional level. The pooling of the regional results constitutes a sort of 'super-sample' enabling us to draw some pertinent conclusions.

First, there is a great variety of cultivated tree species from north to south – both native and exotic. These range from Sitka spruce in Ireland to eucalyptus in Galicia and Portugal, including the beech forests of Navarre, oak in Castilla y Leon, maritime pine in Portugal and Aquitaine, as well as poplar and chestnut. By its very nature, this diversity bears witness to the multiplicity of cultivation possibilities in the context of soil and climate. This first characteristic implies a great variety of modes of regeneration, usually natural, whether for native species like beech in Navarre or exotic such as eucalyptus.

The panorama provided by the analysis of deadwood is also very varied. In certain regions, it is removed in order to reduce the fire risk; in others, it surpasses the thresholds

**Table 4.** Pilot zones where indicators of Criterion 4 were assessed

| | | Mayo | Aquitaine | Navarre | Basque region | Castille | Galice | Portugal N | Portugal C | Improvement |
|---|---|---|---|---|---|---|---|---|---|---|
| C4.1 | Tree species composition | x | x | x | | x | x | x | x | n.c |
| C4.2 | Regeneration | | x | x | | x | x | x | x | N.c |
| C4.3 | Naturalness | x | x | x | | x | x | x | x | N.c |
| C4.4 | Introduced tree species | x | x | x | | x | x | x | x | n.c |
| C4.5 | Deadwood | x | x | x | | x | x | x | x | N.C |
| C4.6 | Genetic resource preservation sites | | x | | | | | | | n.c |
| C4.7 | Landscape pattern | | x | x | | x | x | | x | N.C |
| C4.8 | Area of protected forest for biodiversity | x | x | | | | | | | o.c |
| C4.10a | Vascular plant diversity | | x | | x | x | x | | x | n.c |
| C4.10b | Carabid diversity | | | | x | x | | | x | N.C |
| C4.10d | Arachnids diversity | | | | | | | | x | N.c |
| C4.10c | Birds diversity | | | | | x | | | x | N.c |
| C4.11 | Habitat parameters | | x | | | | | | | N.C |

recommended by WWF studies. The volume of deadwood, comprising branches and debris on the ground (diameter > 2 cm), from windfall or breakage, however, greater than anticipated. We thus find 20 $m^3$/ha of deadwood in the maritime pine forest in Aquitaine and, depending on the species, management and age of plantations, 40 to 76 $m^3$/ha in Galicia and 54 to 75 $m^3$/ha in central Portugal. Many insect species have also been observed in numbers exceeding usual populations.

It is more difficult to form an idea of types of landscapes because the question of scale does not facilitate the study. And in cases where there is a dominance of fragmented forests lands, this does not necessarily lead to more heterogeneous coverage. The hypothesis

whereby these two variables converge is linked to forests where several species coexist. Conversely, in places where a multiplicity of owners would suggest variety, the concentration on a single species balances and restores the unity of the landscape. However, the problem is of a more general nature. Once we accept the idea that heterogeneity, fragmentation and connectivity play a role, it is difficult to decide which of these characteristics is the most pertinent. Similarly, when species generate a plurality of types of landscapes the response with regard to its ideal quality will vary. This makes it difficult to propose a typology or models that could be considered as most favourable to biodiversity.

Second, subtlety is called for when it comes to biodiversity since no clear conclusions can be drawn. Some studies recommend a deliberate progressive return to the natural state. As biodiversity is supposed to be greatest where man does not intervene, syllogistic reasoning strongly tempts us to recommend human withdrawal. As the final Aquitaine report stresses, there is no room for extrapolation in this domain: "Let us not forget that the red list of threatened species on Earth, as listed by the World Conservation Union, is based on a monitoring of 3% of the total number of known species and, in all probability, only 50% of the total number of species are known." The question is not so clear because the presence of only one species, or even a single dominant species, does not automatically mean a loss of biodiversity. It would seem rather that each type of tree is associated with a type of flora and fauna. And poverty in terms of one does not necessarily have negative consequence for the other. We thus find protected and threatened animal species in Navarre, whereas the variety of plant species is limited in the old dark pure beech stands. In Aquitaine, 145 species of carabids have been inventoried solely around maritime pines, some being discovered in the course of this study. Regardless, results change as a function of two variables, both of which are extremely onerous to analyse: on the one hand, we have the scale of the Aquitaine report; on the other hand, comparison with an optimal state that can only be presumed to exist in sufficiently large natural forests. It therefore seems difficult to draw definitive conclusions for regions like Castille y Leon with nearly 140,000 ha of abandoned land and only 60,000 or 70,000 ha of actual forest, most of which is semi-natural. It is obvious that habitats change from one period to another, depending on the time and season, thus generating studies that continue through time in the form of regular monitoring of samples.

The aim of these comments is not to elude the relationship, considered to be deficient, between cultivated forests and biodiversity. Rather, what it calls into question is the quality of the indicators designed to evaluate it. The very different cases observed call for greater rigour, at least with regard to drawing over-hasty conclusions. Quantitative criteria yield no real results as general model that is applicable to all case does not exist. This is an impossible requirement because a hypothesis based on an entirely natural forest – which is rare if non-existent in Europe – is of no use for a type of silviculture that is based on other paradigm. In fact, monoculture does not eliminate native species, which reappear in the undergrowth or on neglected land. It may even strengthen them when these species themselves are chosen for cultivation, as we find with maritime pine in Aquitaine, chestnut oak in Castilla y Leon and beech in Navarre. On the other hand, exotic species are not necessarily invasive; radiata pine in the Basque region, for example, requires planting after each felling. The presence of human beings and urbanisation also constitute a threat which, by means of the multiple pathways linked to habitats and hiking, break the continuity of forest masses and hamper the reproduction and dispersion of species.

Another factor that is rarely taken into account and has a favourable influence on this type of forest relates to the different ages of the trees and the felling and pruning times, since these factors increase diversity by distributing light in different ways. The FORSEE project clearly highlights these variations, supporting the trend of developing indirect indicators of biodiversity in the forest.

Another observation seems to contradict our earlier statement: biodiversity increases with the heterogeneity of the forest cover. The same analysis, however, indicates that this biodiversity is generated by the accumulation of species associated with each tree variety and not by the appearance of specific flora and fauna. Moreover, we still need to determine, based on an exhaustive inventory, which of these species are of particular interest in terms of fauna and flora, in order to establish an actual hierarchy of the issues at stake on which protection strategies could then be based. A purely quantitative analysis is insufficient as rareness may be transitory in one place whereas the same plant may exist in abundance at other locations.

Independently of this, it seems vain to establish an opposition between those who prefer to rely on nature to re-establish an ideal order and those who prefer to defend cultivated forests. In fact, the crux of the problem lies elsewhere. While some claim that in the first case fires, plagues and diseases have no effect, or even a beneficial effect, others present the opposite argument and recommend active defence as the only means of overcoming the problem. To choose cultivated forests is to make a political decision based on economic and social advantages, as in the case of Portugal, Spain, France and Ireland as well as in Finland, Sweden and many other countries around the world. This is not to say that the goal of having available wood resources does not rule out the desire to protect the soil and the water systems: the contrary is true because trees contribute considerably to this. In this respect, the Irish decision could serve as a model insofar as it acts as an incentive not to abandon an idealised natural state, but to further perfect cultivation by integrating a maximum of human ingenuity. The Irish government made this decision because it realised that less than 1% of the territory was covered by forest and that no native species was capable of constituting a new forest, hence the choice of a conifer from the North West of America, Sitka spruce. The only soils devoted to afforestation were infertile soils of the hills and lowland peatlands, neither of which were suitable for agriculture. Perfectly aware of the effect of this monoculture on biodiversity, the authorities decided to devote at least 20% to a variety of species and recommended leaving open ground and undergrowth in certain areas.

In other words, the scale of the problem needs to be changed in order to refine the scope of indicators based solely on a quantitative analysis of forest sites. All have an environment that is both natural and human, and acts as an adjustment variable. The solutions are thus to be found in an increasingly well-thought-out silviculture capable of determining, for each situation, the particular critical thresholds that must not be crossed, and choosing the necessary adjustments. Science provides both the questions and the answers that the authorities need to be familiar with. Some species require no particular attention after plantation, while others demand regular monitoring in order to protect them from natural or man-made dangers. Hitherto undetected defects can only be minimised by managers taking biodiversity issues into account. In fact, they are guided by the role assigned to forests because if they have to cater for hunting or honey-harvesting, or for energy and industry purposes, the methods of intervention will change accordingly and create a unique profile for each territory.

## Criterion 5. Protecting water and soil: cultivated forests seem capable of fulfilling this role

This is one of the most important criteria, but also one of the most difficult to manage as shown by the long list of candidate indicators. Given the pilot sites, the diversity of species, geological considerations and climate, it is rarely possible to find common standards of reference for all the regions. Moreover, the data lack historical depth as it has only been collected over short periods, thus making it impossible to measure changes. In spite of this, the role of forests in storing carbon and soil filtering in producing pure water is well known and attested by the different FORSEE regional studies. The advantage of this research in terms of validating criteria based on limited plots is that it introduces an extremely variable reality according to the terrain and in relation to time – climatic perturbations affect the proposed results within a very short period of time. It only takes an episode of torrential rain to modify the sediment content of waterways, in the same way as forestry management operations temporarily disturb riverbeds.

The truth is not to be found solely in the figures provided by this study. It attests to the efficiency of the general protocol when applied to the terrain and facilitates the drafting of more refined specifications for forest management. This poses the central question for European countries: do cultivated forests cause specific damage that threatens long-term ecosystem sustainability?

In the Basque region summary, a list of negative aspects of forest exploitation highlights certain risks for the natural cycle of water purification and soil maintenance. The following reservations are taken directly from the analysis:

- Certain installation techniques, like drainage and the use of exotic species, enable the establishment of cultivated forests on sensitive soil, thus potentially altering natural dynamics.
- There is a preference in cultivated forests for fast-growing species whose nutritional needs may surpass the soil's capacity, thus leading to nutrient imbalances and potentially accelerated soil acidification. In addition, the use of exotic species may lead to changes in the dynamics of decomposition, nutrient cycling and water uptake and movement.
- The forest cover disappears with clear-felling and a lot of biomass is extracted at the same time. The export of nutrients can be significant, especially if whole-tree harvesting is practised. The loss of the forest canopy exposes the soil to higher levels of rainfall, increasing the risk of erosion. Susceptibility to erosion varies significantly with soil composition as well as with regional variation in rainfall erosivity, rainfall distribution by season and slope conditions.
- Skidding work compacts the soil and alters its superficial horizon. We find the same stress during work to prepare sites. Shrubs and grass are also eliminated, leaving the soil over-exposed to rain.
- The construction of pathways and extraction routes, particularly in sloping zones, facilitates water run-off with foreseeable consequences for erosion. Forest road construction, unless very carefully engineered, is often a major source of soil erosion.
- There is also the risk of changing the chemical status of the soil if fertilisation becomes customary and periodic.
- Heavy mechanical machinery causes compaction, reducing non-capillary porosity which can result in a deficiency in soil oxygen and potential waterlogging.

**Table 5.** Pilot zones where indicators of Criterion 5 were assessed

| | | Mayo | Aquitaine | Navarre | Basque region | Castille | Galice | Portugal N | Portugal C | Improvement |
|---|---|---|---|---|---|---|---|---|---|---|
| C5.1.1 | % and length of stream length with appropriate riparian buffer | x | | x | | x | | | x | N.C |
| C5.1.2 | Potential erosion risk | | x | x | | x | x | | x | N.C |
| C5.1.2.1 | Water table depth | | x | | | | | | | N.c |
| C5.1.2.2 | Percentage of watershed area forested | | x | | | | | | | n.c |
| C5.1.2.3 | Drainage ratio of geohydrographic units | | x | | | | | | | N.c |
| C5.1.2.4 | Agricultural lands ratio | | x | | | | | | | n.c |
| C5.1.2.5 | Clearcut ratio | | x | | | | | | | N.c |
| C5.1.3 | Percentage of appropriate riparian areas | | x | x | | x | x | | x | N.C |
| C5.1.3.1 | Percentage of river crossing anthropised areas | | x | | | x | | | | n.c |
| C5.3.1 | Carbon soil stock and Water Holding Capacity | | | | | x | | x | | n.c |
| C5.3.2 | Nutritive Status / total depth- water table depth | | x | | | x | | | | n.c |
| C5.3.2.2 | Soil bulk density | | x | | | | | | | n.c |
| C5.3.2.3 | Soil water capacity | x | x | | | | | | | n.c |
| C5.3.2.4 | Litter stock | | x | | | x | | | | N.C |
| C5.3.2.5 | Nutrient stock | | x | | | x | x | x | x | n.c |
| C5.3.2.6 | C/N | | x | | | x | | | | n.c |
| C5.3.2.7 | Cation exchange capacity | | x | | | x | | | | n.c |
| C5.3.2.8 | Water PH | | x | | | x | | | | n.c |
| C5.3.2.9 | Phosphate status | | x | | | x | | | | n.c |
| C5.3.3 | Total nutrient stocks & nutrient Balance | | | | | x | x | | | n.c |
| C5.3.4 | Fast visual assessment of soil disturbance | | | x | | x | x | | x | N.C |
| C5.4.2 | Physical characterisation of soil disturbance categories | | | | x | | | | | N;c |

The analysis of soil and rivers can provide valuable information on the impact of the processes described above. This is clearly a potentially fruitful matter for scientific investigation. In this precise case, although this limited (in area) damage has been observed, it has not profoundly disturbed natural balances to the point of destroying the water purification and soil protection potential of the forest. Rather than denying the evidence of negative impacts, it is more constructive to draw the appropriate conclusions for future management. This evaluation can only become effective in a political framework because it presupposes a collective choice that involves establishing a hierarchy of social goals. It is therefore interesting to balance out the advantages and disadvantages in order to determine the options.

However, cultivated forests respond to an obvious economic need, being a source of wealth and employment, regardless of their role as carbon pumps and water purifiers. In other words, there is no real conflict between short-term human interest and long-term ecological interest. In fact, a common feature of the negative impacts that puts them in perspective is that all are episodic, taking place at precise times in the life of a plantation as all result from management interventions carried out at predictable times through a rotation of several decades. The natural resilience of the forest ecosystem has thus the opportunity to mitigate negative impacts in most of the cases. However, this observation does not give managers a free hand. On the contrary, it informs them of potentially negative consequences of their management interventions and therefore obliges them to modify their actions taking into account the latest scientific results. Thus the set of indicators for this criterion plays a key role for ecosystem protection and has to be updated continuously according to new knowledge and in balance with other criteria. Another question leads to a convergent analysis while illustrating the complexity of the role of forests in European countries. The access to and use of rivers has nothing to do with forest cultivation, any more than the building of roads and paths does. It follows a different logic, such as providing access to dwellings or the creation of tourist routes, which derive from community needs and has nothing to do with forest servicing and exploitation paths.

It is possible that particular constraints for managers derive from the multiple uses of forests in Europe. If the ecological risk is great, it is caused by a plurality of social impacts – exactly as in the case of forest fires. These have nothing to do with forest exploitation; they constitute a risk linked with anthopogenic pressure in general, not only with forestry activity.

These comments open up another horizon for indicator C5, introducing the role of forest decision makers, mayors and authorities that grant building permission, tourists in search of landscapes or fruit-gathering, etc. This view emerges in the supposed dialogue between the forester and the environmentalists because in this case, it obliges them to join forces in order to jointly evaluate and minimise the risks.

Finally, all regional studies stress the positive role of forests for the protection of fragile and erosion-sensitive soils. The maintenance of a wooded vegetal cover is beneficial for these soils, as it is to retain tree stumps and residues from felling, such as in Galicia and Aquitaine.

## Criterion 6. Socio-economic functions: multiple benefits for society, but incomplete indicators

Forest owners and foresters are agents that implement state policies while simultaneously making independent decisions within the limits of the law. Planting and cultivating trees thus generates one or more industries depending on the uses they are put to. Traditionally, the most obvious of these relates to industrial uses of wood. Observers recognise the importance of this economic sector and tend to give precedence to it because it is the easiest to quantify.

It is indisputable that by virtue of its long-lasting nature, ongoing development and innovation, this sector constitutes an encouragement for forest production. The relationship between sustainable management and forest economics is well established. However, this relationship starts to pose problems as soon as it is considered to be exclusive. The market is a powerful stimulus insofar as payment for sales encourages foresters to continue their work. As least that is how trade rules are defined in the rational part of capitalism.

The location of a forest, although not completely exempt from these rules, cannot be reduced to them except in zones like Aquitaine, which has a significant wood industry that at least gives the impression of complying with classic trade mechanisms. However, even in this case, it is still easier to count the jobs created by the forest than to pinpoint foresters that do not fit under any statistical heading. This comment can be extended to all the regions analysed by the FORSEE project, either by virtue of the absence of statistical, geophysical or fiscal instruments, or due to a lack of interest from the national authorities. Logically, if a forest generates employment and supports industry and trade, this cannot be the result of spontaneous generation. However, forestry has often been compared to mining, as if the wealth existed in a crude state until the work of the trader transforms it into a raw material. History and reason contradict this vision because forests are subjected to processes and necessitate human intervention in order to take plantations to term. In the absence of this primary identification which sheds light on the first link in the chain, no investigations of sustainable management can have any firm basis, one that depends primarily on recognition of the forester as both master and decision maker.

This is significantly lacking from all the analysed statistical systems. In some sense, different experts have been searching for the missing forester. The reasons for this absence are multiple and sometimes cumulative. Most of the time there is a double or even triple system of property: double for public and private forests and triple when, as in Spain and Portugal, municipal forests "held in common" come into play with their systems and management changing from region to region. Although the state supervises its property – which is often inherited from the domains of the Crown or the feudal system as in the case of communes – it manifests certain indifference with regard to private property. Perhaps this can be explained by a sort of instinctive and exclusive attachment to its own goods – a feeling that is no doubt linked to the mode of ownership of the old European monarchies. A sort of recurrent domain attitude has thus developed that is peculiar to Latin countries and which is not found in the more empirical tradition of Anglo Saxon states. The FORSEE programme highlights this cultural boundary between northern and southern countries.

It is true that the eyes of the state will often see only agricultural proprietors who, in addition to their farming activities, allot a share to forestry. This idea of forestry as an accessory to agriculture does nothing to facilitate the emergence of the autonomous

**Table 6.** Pilot zones where indicators of Criterion 6 were assessed

| | | Mayo | Aquitaine | Navarre | Basque region | Castille | Galice | Portugal N | Portugal C | Improvement |
|---|---|---|---|---|---|---|---|---|---|---|
| C6.01 | Forest holdings | x | x | | x | | | x | | n.c |
| C6.01.1 | Forest owner types | | x | | | | | | | N.C |
| C6.03 | Net revenue | x | | | x | | | x | | N.c |
| C6.04 | Expenditure for services | x | | x | x | | x | x | | N.C |
| C6.05 | Forest sector workforce | x | x | x | x | x | x | x | x | N.C |
| C6.06 | Occupational safety and health | | x | x | x | x | | x | x | n.c |
| C6.01 | Forest holdings | | | x | | x | x | | x | N.C |
| C6.02 | Forest economy | | | | | x | | | | N.c |
| C6.03 | Service value | | | x | | x | x | | | N.c |
| C6.03.1 | Enquiries | | | x | | | | | | N.C |
| C6.10 | Accessibility for recreation | | | x | x | | | x | x | N.c |
| C6.11 | Forest of spiritual and cultural interest | | | x | | | | | | n.c |
| C6.12 | Total economic value of forest production | | | x | x | | | x | | N.C |

category of the forester. The question arises in Spain (in Galicia and the Basque region, for example) and Portugal. This difficulty is further compounded by the fact that old systems of tenure are perpetuated in systems of joint ownership and the division of assets through equal sharing between children. Legal owners will often have only small plots of a hectare or less, areas that do not adapt easily to the idea of cultivation or management. Attachment to family roots, nonetheless, dissuades these owners from selling such plots. In this respect, the case of Navarre is quite significant. The forest is 84% public with the abbey of Roncevaux being the only significant private estate; the rest is divided between multiple mini-owners who are not identifiable by official census methods. Before even trying to use surveys to identify them as individuals and outline their profiles, it is essential to realise that the basic revenue from forests goes to third parties because it is the countryside itself, as in the case of the Forest of Iraty or the routes to Compostela, that feeds the tourist industry. This question of revenue is important because although attention is focussed on the wood market, it is only secondary since it is only relevant during felling; and as felling only carried out infrequently, it thus cannot be considered as regular income. As forestry revenue is usually included directly in revenues of physical

persons, income tax searches are unproductive. The industry functions thanks to the multiplicity of tree felling without the forester being considered to play the active role that is normally accorded to those who provide a market product. Land owners may thus believe that hunting, mushroom-picking, berry-picking or honey-harvesting are more lucrative than wood. In certain cases, the ecological values that are progressively gaining ground in public opinion will guide forest development toward tourist consumption or as conservatories for possible flora and fauna heritage. In Portugal, some figures facilitating the comparison of public grant and environmental services have been provided. Although these intentions are praise-worthy, it is probable that legislation, which is programmed toward goals other than cultivation, will constrain or overshadow the work of the forester.

The indicators of sustainable management must lead public opinion to identify active forest managers. However, in spite of these handicaps, the fact that the forest resource exists is proof that it has been created, maintained, protected and renewed.

The studies conducted in the context of criterion C6 have created a need to define classifications of foresters based on the profiles provided by sociological studies (Cf. Aquitaine, the Basque region, Galicia). However, depending on the region, an essential division appears between true foresters whose training and investment respond to industry requirements and those who, because of the size of the property, or the secondary character of the revenue compared to that from animal breeding or agriculture, have lost interest in cultivating trees, irrespective of age or proximity of the forest to their home. Although both of these cases can be found in all regions, the second category seems to be more frequent in Spain and Portugal, where it seems to be more difficult for forest professionals to gain a footing. This may be due to the history of agricultural domination, the equal division of assets, etc. However, in reality the reason is to be found less in the psychological profile of foresters and their motivations than in policies, the low value set on forests and short rotation length.

This point needs to be stressed in order to highlight one of the shortcomings of the research indicated by criterion C6. It lacks an essential element of a qualitative nature that was not taken into consideration in the FORSEE project, but that can have a decisive influence on the sustainable nature of management. Politics and culture come to the fore or, more often than not, their absence appears at this level of the analysis.

Their role is far from insignificant. When, as in France, legislation states that all felling must be replanted within a period of five years, or that the owners of unfragmented plots of more than 25 ha must have a Management Plan that meets with official approval, it is clear that these measures are driven by a desire to perpetuate the cultivation of trees and to punish any failure to do so.

The case of Ireland is particularly notable by virtue of the public desire to "build" a forest, which did not previously exist in the country with the help of a system of evolving standards that overcame all the barriers that appeared progressively. A decision was made following a study of the social and economic impact of a forest. Although the result was predictable in terms of employment and industrial and commercial activities, the indirect contribution to social progress was correspondingly unpredictable. The effects of afforestation were studied in later research that revealed its high contribution to local economy (Cf. Ireland). In order for the experiment to succeed, farmers had to be convinced to lend their support. A system of bonuses and various financial and other incentives encouraged them to devote the least productive parts of their land or areas that

were totally unsuited to agriculture to the programme. They did not, therefore, infringe on arable lands, although some older owners who no longer wished to devote their time to a less and less remunerative form of agriculture were likely to convert their lands.

It was then time to face public opinion, which seemed to be notably curious, an interest that facilitated an analysis of public feeling with regard to a novelty. The initial reaction was fairly negative – regret of losing traditional landscapes and the invasion (quite relative because of the extremely limited area of 5–7%) of an exotic species: Sitka spruce and lodgepole pine were the only species to thrive on some infertile soils. The state immediately decided to integrate the demand, although the criticism took no account of the advantages of a forest for the community and limited its judgement to a mere user's "right to inspect". The introduction of deciduous species, the conservation of certain zones, and opening area to public for recreation, progressively reduced prejudice and reassured the public.

Similarly, farmers began to favour the conversion to this new form of cultivation. This is reminiscent of the role Montesquieu accorded to the state with regard to the peasants: by giving them the desire for supplementary revenue, either by producing more in order to emerge from self-sufficiency, or by substituting a more profitable cultivation for another less profitable one, it encourages them to produce more and better for the overall good of the community. There is no doubt that the enlightened behaviour of the state won out over the prejudices of farmers and public opinion, and succeeded in imposing an activity that is beneficial to all. With regard to sustainable management, the failure to take political initiatives and deliberate innovations by foresters into account falsifies the terms of the problem, ignoring a highly decisive factor and neglecting the first link in the chain.

The analyses for Spain and Portugal stress the essential character of the associationism in which they find a sure means of overcoming the problem of the size of properties and promoting the dissemination of technical progress. However, encouragement of another sort may be found in the new attachment of European peoples for Nature, of which they consider themselves to be both protectors and users.

We thus find other services and amenities provided by forests. Several studies in different regions have been devoted to these. They pose two questions: the first relates to how the importance of amenities can affect the production from cultivated forests; the second concerns the means of evaluation and remuneration of those services.

It is probable that excessive tourist pressure, although profitable to the industry devoted to it, may be harmful in terms of the desire to cultivate trees. In its current state, public opinion relates to land use essentially in the form of landscape or an imaginary return to a virgin state of nature. This impression is by no means definitive. It relates purely to circumstances and deserves to be surpassed, as we have seen in the Irish example. Only an understanding of the multiple roles of forests in their economic and social aspects, fed by ongoing information, can overcome this obstacle. This leaves the problem of how to avoid dissuading owners from devoting their efforts to cultivation. The solution comes through the progressive development, transmissible from generation to generation, of an attachment to perpetuating forests. It supposes a fusion between man and trees that makes them interdependent. Economic motivation is insufficient since slow turnover and long rotations may well dissuade new investors, as in the case of Canada. It is therefore essential to find other ways to make forest management sustainable; this, however, can only come from a culture that bonds individuals to the idea of a community devoted

passionately to a task that outlives them in time. Forestry deals with long periods of time and the long view is fundamental to the sustainable management of cultivated forests, the benefits becoming apparent over time.

Moreover, the hope of added revenue generated by the apparent development of activities – linked to wood as energy, the question of amenities and the role of forest as carbon pump – poses as many problems as it seems to solve. It will no doubt facilitate the disappearance of small out-dated factories characterised by manual labour, non-permanent employment and subject to work accidents (Cf. Spain and Portugal summaries) and will, in turn, raise the question of remuneration for the owners. While the desire for added income tends to attract these new resources on an individual basis, it would be wiser to take them collectively in the interest of developing cultivated forests in Southern Europe, a fertile hope that is still in the embryonic stage. In this regard, politics needs to reassert itself in the interest of society at large.

# 2. Evaluation

One of the most important goals of this project lies in the critical approach to sustainable management indicators in order to determine their suitability to their declared purpose. However, although most of them are formulated in general and abstract terms, suggesting that they might not fulfil their objectives perfectly, their suitability to macro-physical criteria in no way detracts from their general quality. They do, however, require specific adaptations each time they are applied to particular zones or regions: very often this operation will necessitate a veritable redefinition in order to meet the demands of sustainable management.

Moreover, they presuppose, at least each time that statistical elements are required for quantitative approaches, that uniform measuring instruments are employed in each state and in each region. However, this uniformity is far from complete. The measurement criteria used by the relevant authorities lead to heterogeneous indices that make comparison very difficult. The duration of statistical time series is important for the analysis of trends. Problems arise when the base data changes from one inventory to the next, as in Spain between N II and N III of the NFI, and in France after 2005.

While the indicators no doubt take qualitative aspects into account in the appreciation of the duration of forests, refinements are required in this domain. Social sciences are curiously absent from the tools designed to evaluate the sustainability of forest plantations yet there is every reason to believe that they are of decisive importance. First, state policy plays an important role insofar as it chooses or neglects instruments to encourage cultivation, whether regulatory or financial. This highlights the need for a comparative table describing the legislative apparatus and presenting the standards regulating cultivation, either with a view to protecting it or limiting their development[2]. The case of Ireland is particularly clear in this respect, as the state incentive for plantation was the best means of encouraging farmers to take an interest in this form of cultivation. France's very old conservation policy and its tax system have facilitated the maintenance and then the extension of forested surfaces over the centuries. However, although this role may be decisive in certain cases, it must not overshadow the role of managers. Only a study of the people involved can take this into account.

Certain facts continue to remain puzzling; for example, the case of foresters who, having been the long-term and repeated victims of catastrophes such as storms or fire, still continue to plant trees in spite of all economic logic. Here we have a form of behaviour that escapes the traditional rules of profit as described by current econometric models. An effort was made in Aquitaine to classify owners and deserves to be renewed in a later survey in order to study the deciding factors in human conduct as a basic condition for the sustainable management of forests. If there are no persons devoted to cultivating forests, there will be no need for statistical indicators to measure forest permanence because there will be no way to orient forest management. These comments can be applied downstream at the level of the markets. The mechanisms that regulate the markets are not well known and difficult to comprehend because they require a general knowledge of world fluxes, relationships of power both in terms of the state and industries and can influence

2 Cf. Compostela Forests Study 1996 – USSE / Seminar on Forest Taxation 2008 – USSE

prices. However, these players can act as an important encouragement and incentive that is capable of attracting new investors in a sector that is more notable for its hereditary permanence than for the mobility and number of transactions. Certain plantations, like poplars for example, nearly disappeared because the leading buyers relocated the processing site. In other words, we need to involve political economy and legal experts because there is no doubt that these disciplines would lead to new indicators, which would be as relevant as the others, in order to determine the real mechanisms of forest sustainability.

In addition, another difficulty should be taken into account – that of time. The sustainable character of a forest can only be evaluated over a medium or long period and its purpose is based more on ideological optimism than scientific analysis. All current analyses provide only one picture of a present state that could certainly provide information in the function of the historic origin of a forest and thus estimate whether, other things being equal, the conditions for normal renewal have been achieved. Linear predictions can only result in approximations, given the current climatic changes and ongoing modifications demanded by the public and industry. It is essential to measure the reactions to these different disturbances by a whole group. Thus, any analysis at time T acts as a survey and it is therefore desirable, more so than previously, to renew measures of the network of the chosen plots and samples in an ongoing monitoring system. It is also important that the network of experts gathered for FORSEE continue to do the same work. Sustainable management indicators need to be seen as the beginning of a learning process that generates new tools and corrects repairable errors as it progresses; however, this also implies an ongoing redefinition of these same indicators.

These indicators are still charged with considerable ideological connotations that no amount of systematic recourse to detailed figures and quantitative data can belie. It would be an illusion to believe that they are capable of providing a universal truth that applies on all fronts. However, a critical analysis reveals that value judgements have been eliminated, thus presenting each concept for what it is and no more. As an illustration, we can take the hierarchy of forests as explicitly presented and defined, thus constituting a sort of official doctrine for public authorities.

Although this type of classification is acceptable on the level of the planet, where vast primary forests still exist, the hierarchy established between natural, semi-natural forests and plantations loses its relevance on the European continent. Some geographers like G. Rossi contest its relevance for tropical forests and even for the American prairie, because here again the hand of man has left its mark, though somewhat differently from the geometric western order. We find it in the tropical forests and in the way the Indians of the United States have influenced the prairie in relation to grazing for bison.

This classification implies an incontestable superiority for forests untouched by man and being devalued as soon as he begins to cultivate them. In Europe, where forests have been subjected to functional layout in the interests of the community for hundreds of years, it is meaningless to speak of the superiority of untouched forests for the simple reason that they have not existed for a long time. This attribution of merit leads to a false conclusion insofar as it suggests a possible return to virgin nature. There is no evidence for this. Abandoned forests do not always recover their primary vegetation (depending on the surrounding forest), past management or resilience of the soil. This illusive ideal is reminiscent of a lesson on fractals, in which we learn that the simplicity of a

distant vision is replaced by complexity as soon as we encounter the real terrain. This is exactly what the evaluations of the FORSEE programme suggest, revealing a specific logic for sites and variability in time and place. This discovery calls for greater caution and prudence, demanding evaluations for every action and appropriate behaviour. Thus plantation forests, or even better cultivated forests because of the variation in approach to establishment, call for even more refined and more demanding silviculture practices in order to counterbalance the disadvantages of human actions without recommending the regression that would "naturally" result from human withdrawal.

This hierarchical classification is the result of an ideological framework. It generates a false awareness in which perceived reality is only the envelope of a deeper decisive influence that is invisible to the naked eye. Thus, in Aquitaine, the omnipresent visibility of maritime pine is linked to a long history dating back to antiquity and proving that only this native species is capable of growing well there. In terms of surface, it only occupies a sandy triangle where its development coincides perfectly. If there is something "scandalous" about the physical monoculture of a tree, it is mainly due to soil constraints. However, this presence on 1 million ha should not lead us to forget that the Aquitaine forest occupies 1,750,000 ha, the rest of which is devoted to deciduous varieties. Another example illustrates this point. In the Basque Country, conifers like the radiata pine have taken over from the indigenous vegetation, which took the form of discontinuous clumps of oak that bore no resemblance to a production forest. The criticisms raised are based more on local mythology that sees the oak as a sacred tree, the symbol of the region's autonomy. However, this excludes the option of choosing a profitable species. The presence of various varieties of conifers thus corresponds to a tactical necessity that reflects their ability to thrive on poor terrain and, in spite of this, generates hope of a possible harvest. One part of the local sociological culture, however, is not convinced by arguments based on economic profitability. This conflict of beliefs, one linked to tradition and the other to modernity, deserves our full attention.

Nothing can be gained by fostering an antagonism between natural and cultivated forests, except that it resurrects the old quarrel of Nature and Nurture. Man's choices are inseparable from the fate of the planet, for better and for worse. However, history teaches us that the pathways suggested by linear prospects are always refuted by our capacity to correct them. The utility of a vision based on scientific instruments lies in its capacity to evaluate and encourage changes in our behaviour in relation to nature – changes that are increasingly demanding if only as a result of demographic pressure. Who else could implement this except forest managers?

The question arises in the same terms with regard to biodiversity. The construction of the concept deserves some attention as it is apparently of a scientific order and thus respectable. However, it is based on a mirage that falsifies our perspectives. First of all it is linked to fear; the very disappearance of this biodiversity induces a negative reaction with regard to human behaviour in relation to this catastrophic vision. It encourages withdrawal in the hope of saving species in danger of extinction. These species are not chosen at random but for their capacity to provoke an emotional response. This primary gloom-mongering is the contrary of deliberative thought and the capacity for action. First, only an estimated 50% of species are known and only 3% of these are monitored. Moreover, the notions of an optimum and a critical threshold for large forests have not yet been determined. The main questions here are: What is the optimum? and How to

achieve it? Nature is more subtle than the statistics that describe its capacity to enable certain species to proliferate and to destroy others. Why? Here again we have to consider the research on the subject as points of departure toward a different horizon – a beginning rather than an end. Inventories will result at a given time in practices designed to preserve the heritage. Here again, who better than forest managers to manage this task? Rather than exclude them as a convenient scapegoat for cause of a catastrophe, it would be better to recognise their role and to inform, encourage and motivate them. The conservation of biodiversity demands both an enormous scientific effort and a technological vulgarisation of the means to be implemented. Similarly, it supposes a profound change in the concept of use. All through the human experiment, the choice of species to cultivate has revolved around the quest for maximum profitability regarding the capacities of the terrain and market. Is it now time to extend the notion of interest to include social considerations relating to a broad redefinition of our heritage?

# 3. Shortcomings and suggestions

With few exceptions, the criteria and indicators approved by the Helsinki Conference (Cf. MCPFE) seem suited to assess the sustainable management of forests. However, at the present state of knowledge, it is unrealistic to assume that they represent a blueprint for true sustainable forest management.

The first difficulty derives from the heterogeneity of forest inventories in the different regions analysed. The system may be national or regional, causing conflicts with regard to sources as soon as the central model fails to match the accounting modes already practised locally. This is the case for Spain, which has problems adapting data on precise plots thus making inter-regional comparison almost impossible while Ireland and France have good national inventory systems in place. This demonstrates the weakness of a Europe-wide assessment of sustainability.

Second, the criteria and indicators are not of the same nature. Some are based purely on quantitative analyses, like the number of trees, their variety and production – figures that are more or less immediately accessible. Others aim to determine the sustainability of management modes that presuppose a complete knowledge of data over long periods. For the most part, however, there is a lack of statistics and thus in a certain sense, FORSEE is inaugurating surveys whose relevance can only be seen in the medium term, with the condition of having the financial means to ensure the continued application of the established tools. Others concern the evaluation of immaterial benefits provided by forests; however, the means of calculating these are still an ongoing topic of debate. The same applies to $CO_2$ storage, which supposes long-term studies which some regions have already begun but which remain incomplete. Furthermore, their conclusions would have to be integrated at national and European levels in order to become an acceptable basis for internationally agreed accounting procedures. With regard to biodiversity, it is the subject of theoretical discussions that require a rapid conclusion and the extrapolation of precise protocols capable of being used for comparisons – a issue that all indicators share. The experience of the FORSEE programme demonstrates that each region is competent in appreciating the posed questions; however, as the results are established on different bases, comparison rapidly becomes difficult, even impossible.

If the monitoring tools in Criteria 1 apparently provide complete satisfaction in Ireland, shortcomings in other regions need to be rectified. In the case of Spain, the change in scale and size of plots between NFI standards II and III makes it impossible to monitor forest evolution. This has repercussions on the sub-indicators of C1 such as the total volume of wood, the commercial stock and carbon evaluation.

Improvements are also needed to evaluate the understorey, which continues to be significant oversight. In Castille, the presence of erica represents 140 t $CO_2$ /ha, boxwood 44 t /ha in Navarre, which continues to increase with the impenetrable marquis of rushes in Galicia. It is interesting to note, however, that this is an adjustment variable because the nature of the flora itself varies considerably from region to region: moss, for example, is preponderant on certain dry soils in Aquitaine while eucalyptus neutralises the growth

of any significant understorey, except in cases where eucalyptus itself constitutes the understorey for maritime pine as in Portugal. In any event, additional finer studies need to be conducted in order to make this indicator more precise.

It would also be interesting to give greater consideration to certain aspects of biodiversity – that of the living chain that constitutes the ecosystem. Certain links seem to have little or no effect on the survival of the whole. There is therefore no question of limiting ourselves to a purely quantitative inventory of species. Besides, it is infinite and often results in unexpected discoveries in the world of insects. Rather, we need to evaluate the decisive relations that unite species, in which the absence of a single link would cause devastation for the whole.

A new protocol would be necessary in order to compensate for the shortcomings in the evaluation of damage leading to the death of trees. The I.C.P. method is based solely on an analysis of living crowns. However, in order to grasp the totality of the damage and dieback, we have to consider the tree itself and rely on the analysis of fixed plots of a fixed area, monitored even when all the trees have died. Otherwise it is impossible to have real-time monitoring for outbreaks and to intervene rapidly.

Moreover, the analysis should be continued with complementary criteria relative to the effect of the damage on the value of the forest. Webworm holes depreciate value more than defoliation, yet the real effect is unknown to us. Does 20% defoliation really threaten a forest? Would 30% be a more accurate evaluation? This question of thresholds is essential. However, it is impossible to base an evaluation in the present state of our knowledge. Here again, we encounter the necessity for complementary studies and ongoing monitoring. The relationship between cultivating trees and the market poses the question of economic value and thus the effect of damage as a function of this criterion, insofar as the measurement of the quantitative threshold of the threat to the species is absent.

These questions could be pursued with a view to gaining knowledge of the precise use of harvested wood. In France, for example, the volume of firewood is only known by deducting the total amount of wood used for other purposes from the NFI growth figures, as revealed by the annual ministerial survey, and thus only provides approximate figures. It is only by evaluating consumption that we can get an estimate of these figures.

The value given to trees does not really emerge from available sources or customs in this domain. The essential problem, as a condition for sustainable management for wood production, depends on the interest of managers in continuing to cultivate trees. In this respect, the economy, legislation and taxes are dominant variables.

The incentive power of the state in the reforestation of Ireland deserves to be stressed. It succeeded in encouraging farmers to dedicate part of their lands to this purpose, albeit the least fertile parts. This is not a disadvantage for species like Sitka spruce which can grow on unfertile soils and produces timber.

A study integrating biology, economy and policy would have the advantage of revealing the multiple variations in the means of calculating the value of trees and would, in the longer term, facilitate homogenisation within the European Union.

In conclusion, while the set of criteria established by MCPFE is very relevant for the monitoring of sustainable forest management, many indicators require further development. The regional heterogeneity of forestry in Europe is such that the currently formulated MCPFE indicators cannot be considered adequate as normative tools in international regulations; to succeed, adaptations are needed at the local level.

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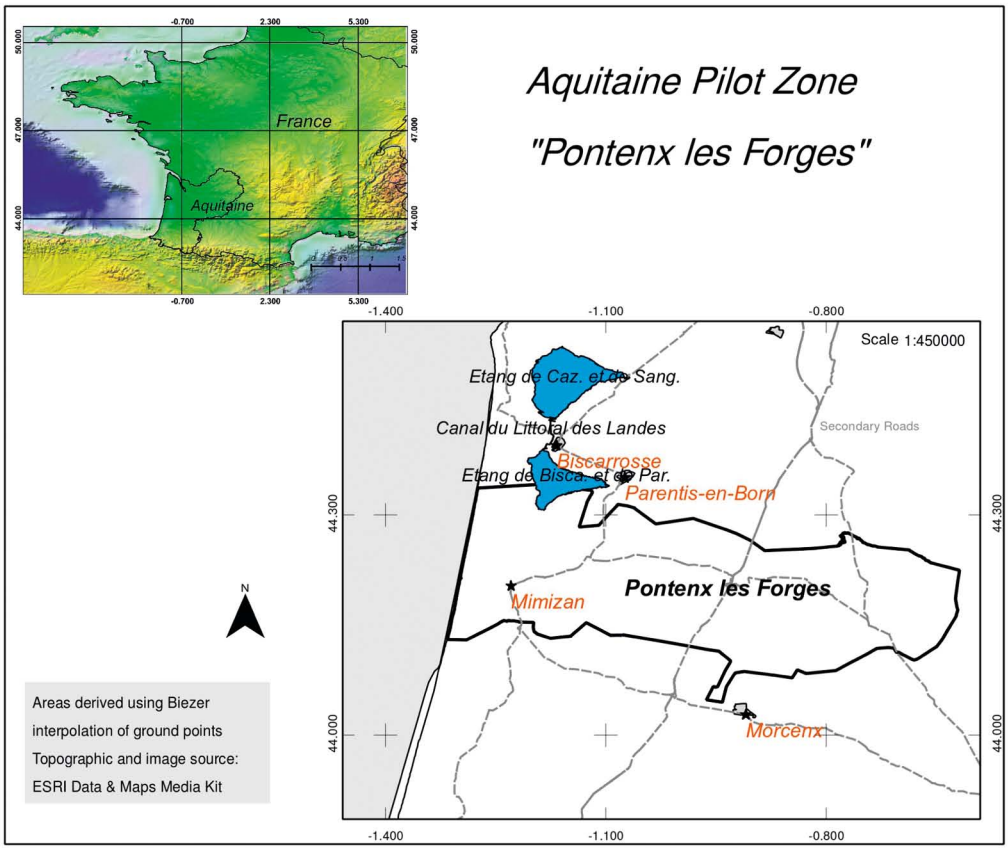
# Annexes



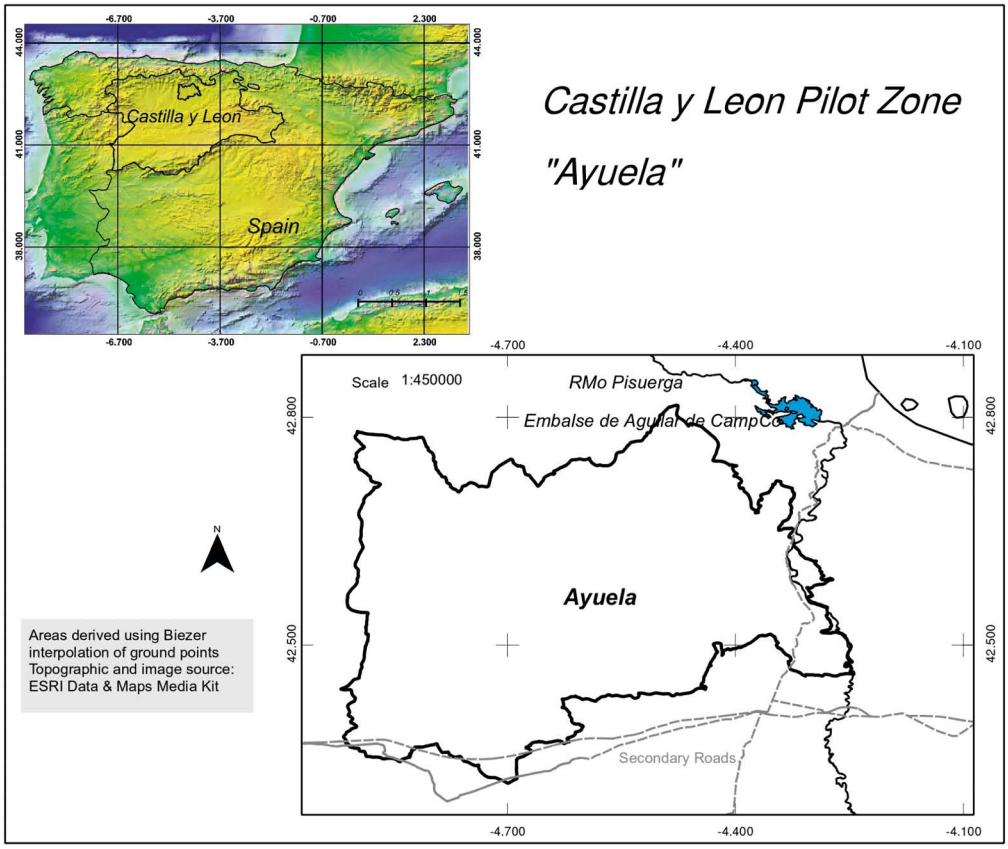

MAP OF FOREST SURFACE

| Surface Attribute | Area (ha) |
|---|---|
| Forest Surface | 84,600 |
| Other Surfaces | 16,400 |
| TOTAL AREA | 101,000 |

REGIONAL TEAM

*Poissonnet Mikaël, Orazio Christophe,*
*Carnus Jean-Michel,*
*Amélie Castro, Sébastien Drouineau*
*Laurent Augusto, Hervé Jactel,*
*Inge Van Halder, Jean-Charles Samalens,*
*Guillaume Chantre, Mohamed Najar*
*Dominique Piou, Julia Morin*
*Rémi Teissier du Cros*
*Françoise Vernier*

*February 2007*




MAP OF FOREST SURFACE

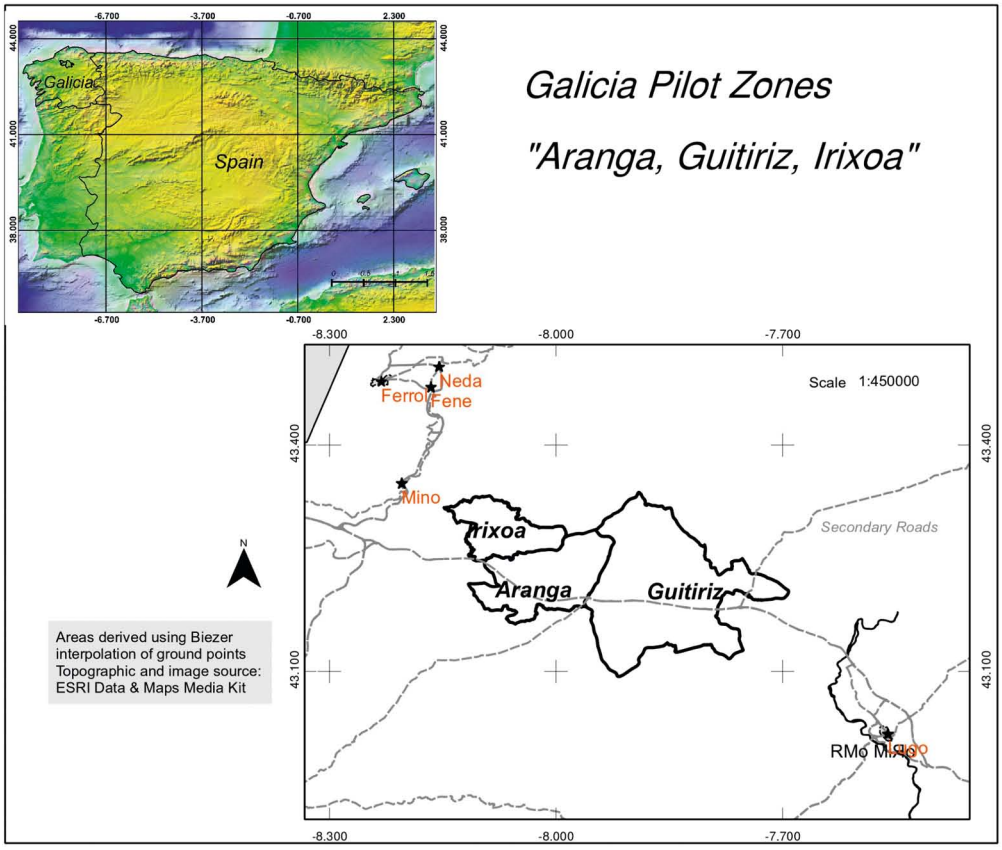
| Surface Attribute | Area (ha) |
|---|---|
| Forest Surface | 55,471 |
| Other Surfaces | 131,171 |
| TOTAL AREA | 186,642 |

REGIONAL TEAM

*Antonio V. Sanz-Ros, Jorge Martín-García, Celia Herrero de Aza, Liliana Fernández, David Francés, Félix Pinillos, Alvaro Picardo, Felipe Bravo Oviedo, Julio J. Diez Casero*

*March 2007*

IEFC

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|---|---|
| Surface Attribute | Area (ha) |
| Forest Surface | 48,186 |
| Other Surfaces | |
| TOTAL AREA | 48,186 |

REGIONAL TEAM

*Fernando Solla-Gullón*

*Pedro Alvarez*

*Emilio R. Diaz Varela*

*Manuel Marey*

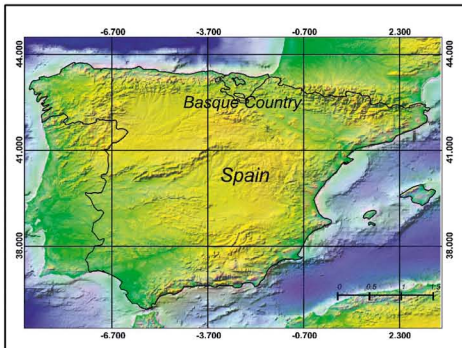
*Roque Rodriguez-Soalleiro*

*Agustin Merino*

*December 2006*

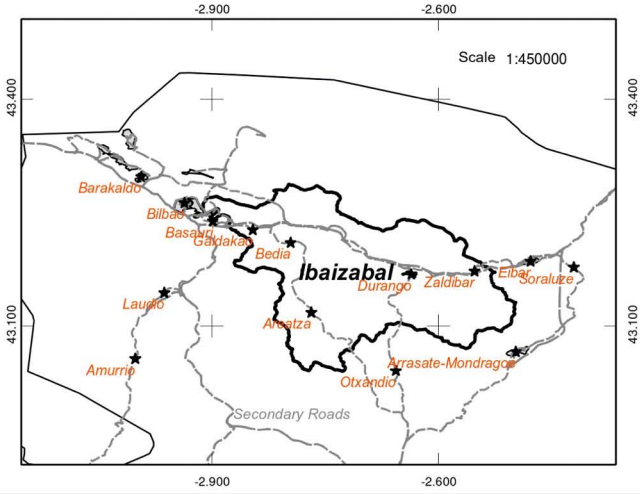
Xunta de Galicia

USC UNIVERSIDADE DE SANTIAGO DE COMPOSTELA




## *Basque Country Pilot Zone*

## *"Ibaizabal"*

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Areas derived using Biezer interpolation of ground points
Topographic and image source: ESRI Data & Maps Media Kit

| MAP OF FOREST SURFACE | |
|---|---|
| Surface Attribute | Area (ha) |
| Forest Surface | 31,889 |
| Other Surfaces | 16,431 |
| TOTAL AREA | 48,320 |

REGIONAL TEAM

*Inazio Martínez de Arano*

*Nahia Gartzia Bengoetxea*

*Alejandro Cantero*

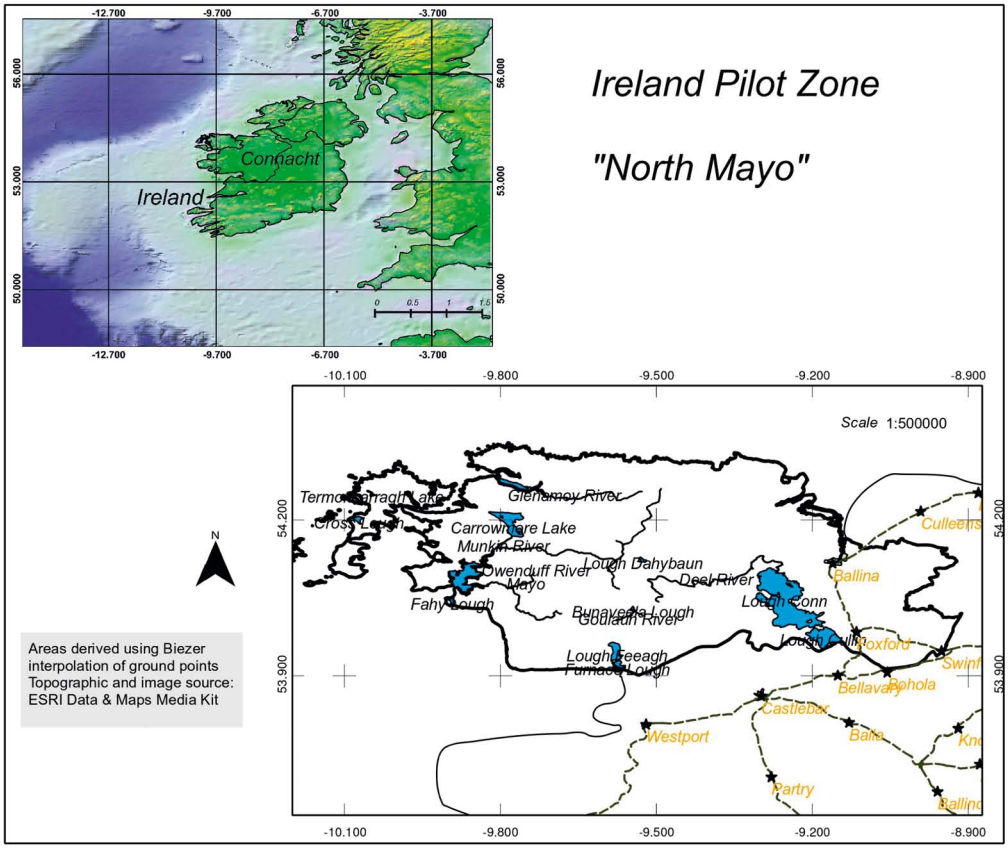
*Ander González Arias Miren Onaindia*

*October 2007*

IEFC

EUSKO JAURLARITZA GOBIERNO VASCO

neiker tecnalia

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| Surface Attribute | Area (ha) |
| Forest Surface | 37,365 |
| Other Surfaces | 205,635 |
| TOTAL AREA | 243,000 |

REGIONAL TEAM

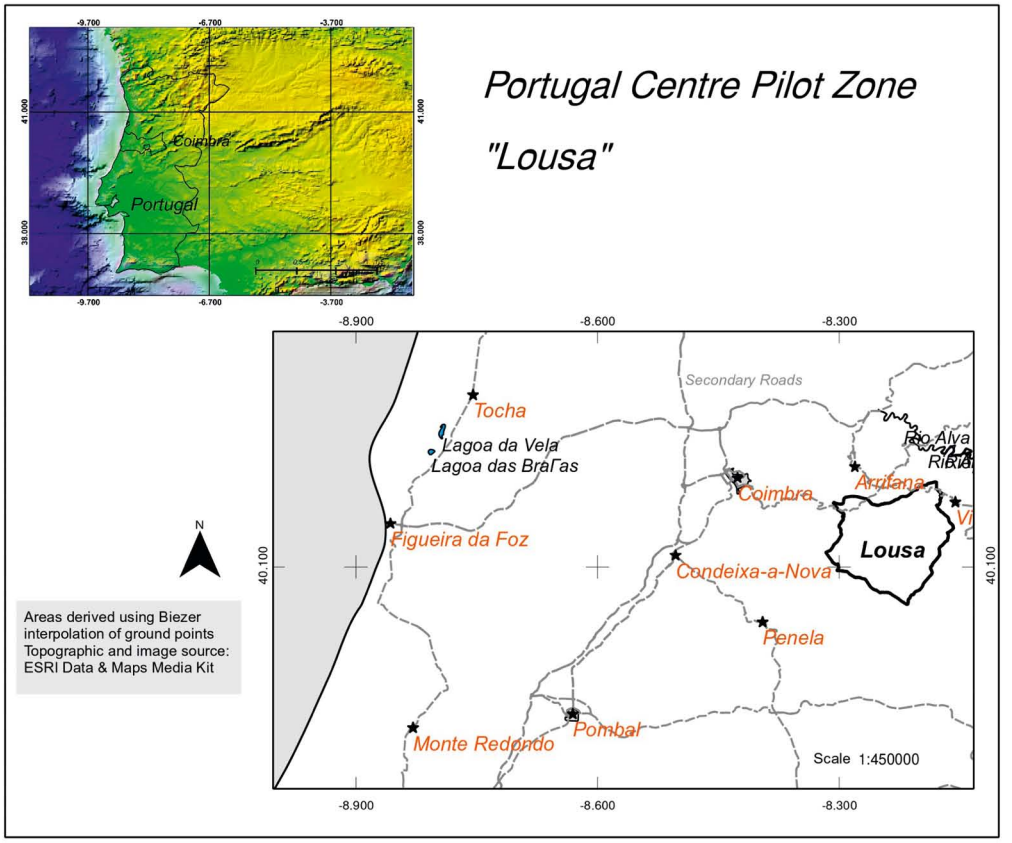
*Marina Conway*

*Carly Green*

*Edward P Farrell*

*Ray Gallagher*

*December 2006*

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| Surface Attribute | Area (ha) |
| Forest Surface | 8,435 |
| Other Surfaces | 5,406 |
| TOTAL AREA | 13,841 |

REGIONAL TEAM

*Sònia Pacheco Faias, Paulo Morais*

*Susana Dias, Sara Morão*

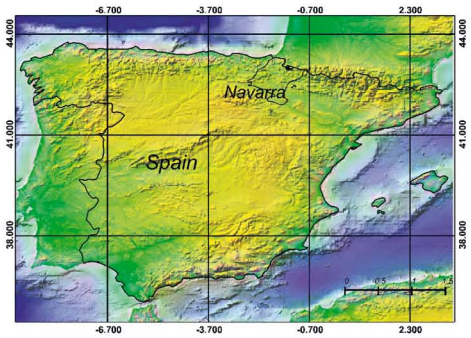
*Raul Salas, Margarida Tomé*

*Fernando Páscoa, Pedro Ochoa*

*April 2007*

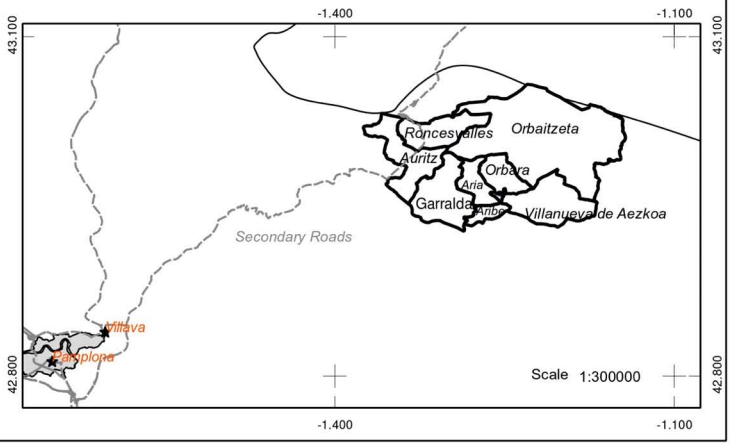
IEFC

Instituto Superior de Agronomia
Universidade Técnica de Lisboa




## *Navarra Pilot Zone*

*"Aria, Aribe, Avritz-B., Garralda, Orbaitzeta, Orbara, Hiriberri-V., Orreaga-R."*




Areas derived using Biezer interpolation of ground points
Topographic and image source: ESRI Data & Maps Media Kit

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| Surface Attribute | Area (ha) |
| Forest Surface | 12,335.3 |
| Other Surfaces | 5,761.2 |
| TOTAL AREA | 18,096.5 |

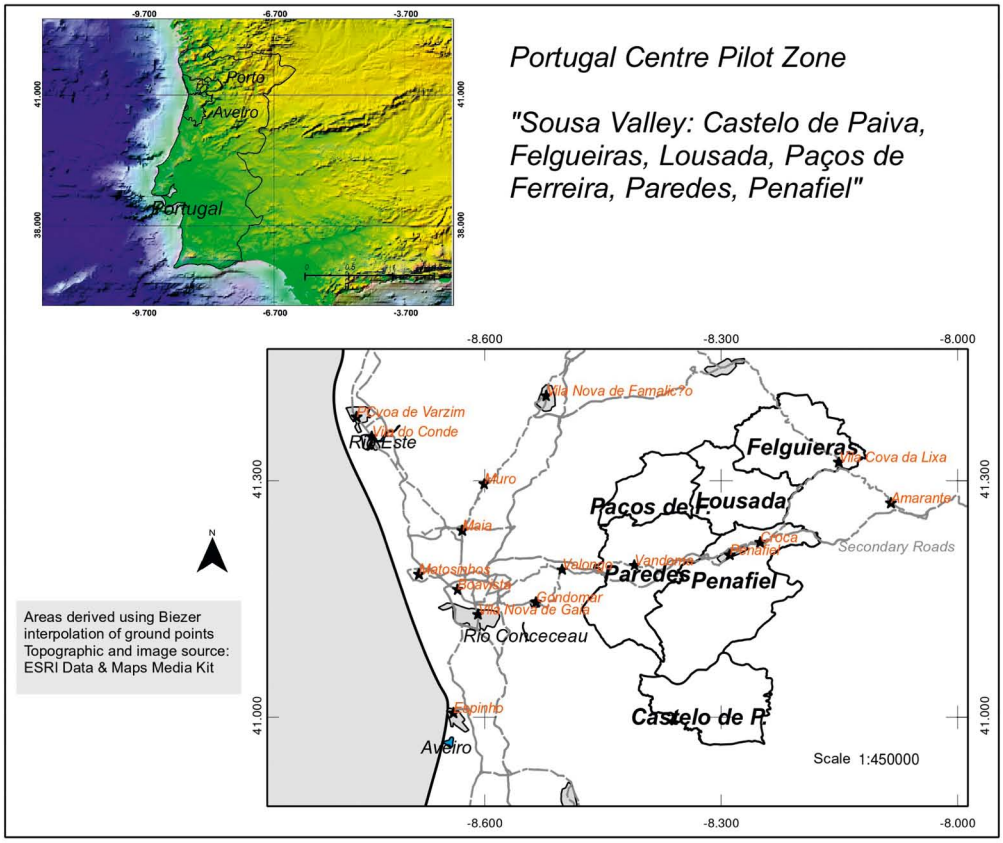
REGIONAL TEAM
*M. Carmen Traver*
*Fernando Puertas*
*Irantzu Primicia*
*Ainara Pueyo*

*April 2007*

IEFC

Gobierno de Navarra

GESTION AMBIENTAL, VIVEROS Y REPOBLACIONES DE NAVARRA S.A.




| MAP OF FOREST SURFACE | |
|---|---|
| Surface Attribute | Area (ha) |
| Forest Surface | 4,956.07 |
| Other Surfaces | 3,212.71 |
| TOTAL AREA | 8,168.78 |

REGIONAL TEAM

Américo Mendes,

Diana Feliciano,

Domingos Lopes,

Teresa Fonseca

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This Discussion Paper provides a constructive critique of indicators for sustainable forest management and aims to show their value and their limitations. According to the interpretation of the definitions, the way to collect data, and the ecological and economical context, the realities described by these indicators are not homogeneous and comparable at the inter-regional level. By applying the same set of indicators with the same protocols scientifically based in eight Atlantic regions, the authors obtained various results extracted from the regional studies, and demonstrated the variability in the quality of indicators and the limits of their comparability. In this paper, therefore, the aim is to illustrate the diversity of indicators to assess Sustainable Forest Management, the weaknesses of the existing ones and the benefits of new ones that were tested during the FORSEE project.

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