Roadmaps for the future: Pontenx case study (France)

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ROADMAPS FOR THE FUTURE
Pontenx case study (France)

WP3.3 BACKCASTING
WP2.3 ANALYSIS OF IMPLICATIONS

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1 Introduction

This report describes the work carried out in the INTEGRAL project for Pontenx case study (France) in Work Packages 3.3 and 2.3. Within the overall research design of the INTEGRAL project, WP3.3 is dedicated to identify and propose ways and means of governance that have the potential to trigger substantial policy changes and human actions that promote integrated and future-oriented forest management in Europe. WP2.3 plays a supportive role carrying out a quantitative evaluation of the suggested policy actions.

Twenty case studies in 10 European countries have been conducted to achieve this objective, using participatory backcasting as the main tool. Backcasting "involves working backwards from a particular desired future end-point or set of goals to the present, in order to determine the physical feasibility of that future and the (policy) measures that would be required to reach that point" (Robinson, 2003).

The rationale for backcasting approach (adapted from Robinson (2003)) is:

1. The ability to predict the future is limited by:
    a. Uncertainty on system conditions and underlying dynamics
    b. Uncertainty on possibilities of innovation and surprises
    c. Uncertainty due to the intentional nature of human decision-making
    d. Therefore we need to look at multiple futures
2. The most likely future might not be the most desirable future and vice versa
3. **Therefore we need to discuss on how to reach or avoid a certain future**

In the context of the method that is being followed in INTEGRAL in WP3.3, backcasting focuses on the fourth and final step. The earlier steps have been covered by other activities.

Looking back from the "future" (backcasting), questions regarding the policy objectives, policy instruments and their specifications that are needed and/or could be applied for addressing the alternative (or desirable) future scenarios will be addressed in this WP. Specifically, coherent policy, institutional and economic arrangements, including collaborative institutions as well as consistent policy instrument mixes (e.g., good practice regulations, market-based payments for ecosystem services, information and new modes of governance and networking), will be explored and developed.

This report presents the results of the backcasting process and the findings that have been made throughout the backcasting process in the 'Pontenx' (France) case study area of the INTEGRAL project. Specifically, this report describes:

- the participatory and problem-solving oriented policy back-casting process carried out in [case study area, country],
- the research findings from the policy back-casting processes.

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The applied research design and the individual research steps are described in detail in Milestone 34. In this report the operational proceedings are only reported insofar as they are necessary for understanding the meaning and scope of the achieved results. Other references of importance are:

- The descriptions of the case study areas that have been created in WP2.1 (see also 2.1 of this report for a short summary)
- The scenario's developed in WP3.2 and WP2.2 (see also 2.2 of this report for a short summary)

Last but not least, the backcasting process integrates the assessments of Ecosystem Services (ES) that are expected to be realized given the outcomes of the backcasting workshops within the different scenario's, i.e. they are the product of interdisciplinary cooperation between WPs 2 and 3, namely between WPs 2.3 and 3.3.

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2 Background Information

2.1 Description Case Study Area (WP3.3 and WP2.3)

The 'Pontenx' case study area (CSA) is the landscape selected by Irstea and EFIATLANTIC for their common work in INTEGRAL. Defined by the boundaries of 13 municipalities (or communes, i.e. LAU2: local administrative units Level 2), it is built around an E-W oriented watershed, covering 102 000 ha. Located in the heart of the 'Landes of Gascony' forest region (or *Massif des Landes de Gascogne*), this area was chosen because it encompassed a diversity of forested landscapes that was representative of this 1.5 Mha greater forest area.

'Landes of Gascony' is bordered by the Atlantic Ocean on the west and the large urban areas of Bordeaux and Bayonne respectively north and south. From an administrative perspective, 'Landes of Gascony' is located in the NUTS-2 region of Aquitaine, intersecting three NUTS-3 regions: Gironde, Landes and Lot-et-Garonne . It is composed of 52 local administrative units Level 1 (LAU1) and 400 LAU2s. While not an administrative region in itself, it is a predominantly wooded area of which identity and coherence are built around three main features:

- A biophysical unit with podzolic sandy soils and shallow ground water levels.
- A dominant forest cover of 66%, compared with agricultural and built-up areas respectively amounting to 18% and 7% of the area in 2009 (Teruti data in [1]). Primarily composed of maritime pine (*Pinus pinaster* Aiton), the forest is often described as the largest cultivated and privately owned (92%) forest in Europe.
- A significant economic weight throughout a regional forestry-wood chain, based on a large number of SMEs (logging, sawing, furnishing and packaging) co-existing with major international industries (pulp and paper, panel). The specificity of this forest-based sector is that the two processing stages are almost entirely connected to the local wood resource of maritime pine and localized in the same territory.

For the reasons mentioned above the main ecosystem service is clearly the **timber production**, which could be interpreted by using indices such as the total standing and harvested volumes and the average volume per tree. However there are other important ecosystem services; studies done on forest perception in 'Landes of Gascony' show clearly that tourists and people leaving in the area appreciate the mixed **landscape** made of pine forest and oak patches. The **mushroom** pickers appreciate the harvesting activities (roads and open spaces), because they can collect mushrooms (boletus) as long as the foresters let oaks along roads and in patches. **Recreation** plays also an essential role in this region, there are many bicycle paths, lakes, fishing facilities, etc. and most important the 'dune of Pilat', the tallest sand dune of Europe (between 100 -115 meters high), which is visited every year by about 2 million people. In order to get a quantitative indicator of the value of this landscape attractiveness, a new index based on the Shannon diversity formula was built.
Carbon sequestration could be very positive ecosystem service if foresters keep tree long rotations and it is calculated by the total standing carbon per stand; long rotations can reduce forest activity

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too close from rivers and contribute to the positive role of forests on **water quality** (filtering, limiting erosion, etc.).The forest **biodiversity** increases thanks to the variety of forest cover (pine forest of different ages, oaks, open spaces, wetlands, etc.) and it can be calculated by the Shannon diversity index. In addition, dead wood found in the 'business as usual' context is favourable for many taxonomic groups and it is calculated by a saproxylic index.

2.2 Scenarios developed for the Case Study Area (WP3.3 and WP2.3)

WP 3.3 builds on the results of WP 3.2 and WP 2.2. WP 3.2 developed the raw future scenarios as well as identified and involved key actors and stakeholders, while WP 2.2 identified the landscape level impacts of different scenarios. The outcomes of WP3.2 and WP2.2 were combined and resulted in so-called full scenarios for the case study. As these scenarios form the starting point for the work in WP3.3, the 5 developed for Pontenx (France) in WP2.2 and WP3.2 are summarized next.

Scenario 1: Unfinished bioenergy

The pulpwood industry has also become involved in generating energy, taking advantage of a variety of demand-side measures (energy and climate). There is also greater cooperation with large forest operators. This is accompanied by a more innovative approach to silviculture, using genetic selection and shorter rotation times for maritime pine trees. However, these changes are not entirely complete. Friction surrounding the question of wood resources has adversely affected the industry's competitiveness and reduced its investment capacity. Many forest owners have been reluctant to sign up to this new intensive production strategy, which is driven by a growing need for fuel wood.
In effect, there has been a two-tier development in silviculture. On one side, there is the growing need for biomass, while on the other, more traditional styles of forest management remain in place. Ecosystem services have not been extensively developed, except in coastal and suburban areas.
The traditional forest management leads to a continuous increase of standing volumes and prices until 2048 with a light decrease afterwards, this allows the standing carbon a increment follow by a decrease due to the new biomass management options. Biodiversity remains as in S0 (BAU-Business as usual) but the wind and fire vulnerability will lightly increase because of the tree height and the density respectively (see **Erreur ! Source du renvoi introuvable.**).

Scenario 2: Biorefinery innovation & land-use tensions

The fabric of local industry has been transformed by the growth of biorefinery and green chemistry. This industrial restructuring is based on increased sectoral coordination, which in turn is a product of supply-side policies and a more intensive approach to silviculture. Ecosystem services are developed as joint products of wood-based activities.
In many areas, farmers and forest owners are producing the same kinds of products, meaning that they are competing to gain ownership of land. In addition to this, increasingly intensive forest management practices lead to trees essentially being treated as crops. This causes a "deterritorialisation" of the forestry wood chain, and serves to alienate the general public.
The wood prices fluctuate, they never go down or very high while the standing volumes increase slowly. This scenario presents a high fire vulnerability at the beginning then it goes down but it

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progressively increases after year 2040. There is an increment in biodiversity due to the diversification of forest cover; on the other hand saproxylic biodiversity does not go up (see **Erreur ! Source du renvoi introuvable.** & **Erreur ! Source du renvoi introuvable.**).

Scenario 3: The European biomass sink

Activity in the region's wood industry has plummeted. A number of "breakthrough" innovations have utterly transformed the energy sector. New industrial strategies have led to huge biorefineries being constructed close to major European transport hubs. These initiatives are supported by the EU, through new competition policies focused on energy transition and industrial transformation. Thanks to its size and dynamic management practices, the Landes forest area has managed to adapt to these changes, and remains an attractive source of wood.
As more and more wood is "mined" across Europe and shipped through major supply networks, the resulting empty land can be considered as new space on which to build housing, leading to diffuse urban sprawl.
The ecosystem services behave similar as scenario 2, wood prices fluctuate and the standing volumes increase slowly. The biomass production needs short tree rotations causing an increment in fire vulnerability. Biodiversity increases due to the diversification of forest cover but for saproxylic biodiversity is hard to remain stable and it has a tendency to go down.

Scenario 4: The 'Green' innovative cluster

The forestry wood chain is centred on innovative industries and small businesses, especially in terms of green chemistry, green building, and wood-derived materials. Advances in silviculture have focused on the potential of maritime pine for use as timber, and increased use of hardwood timber.
Increased sectoral coordination is guaranteed through regulation and market-based instruments that call for a certain level of "eco-friendliness". Despite the development of designated areas open to the public and special biodiversity zones, there is still an element of segregation between different types of forest management.
In this scenario all ecosystem services are more or less equilibrated, it integrates different types of forests, the ecosystems try to get more resilient, there are special biodiversity zones and the risk management is more efficient. Nevertheless, the saproxylic biodiversity suffers a decrease after year 2040 probably caused by the harvesting activity (see **Erreur ! Source du renvoi introuvable.** & **Erreur ! Source du renvoi introuvable.**).

Scenario 5: The territorial partnership

As the industrial fabric of the Landes region has become more fragile, local authorities are attempting to maintain demand, notably by supporting energy wood projects. They are also trying to promote an approach to silviculture that will contribute to the development of their respective territories through the provision of goods and services. This pro-active initiative undertaken by local authorities has been spurred on by their becoming responsible for a wider range of issues, as well as increased regulatory powers given to them as a result of decentralisation.
The supervision of forestry activities differs depending on the objectives laid down by local authorities, working in cooperation with newly-created groups of forest owners and operators. In

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many cases, these objectives are defined based on what would most benefit forest owners and managers. Ecosystem services are recognised by public bodies, but their main support comes in the form of private initiatives, with varying degrees of success from one territory to another.
The behaviour of scenario 5 is similar to S0 but with a big difference concerning the total harvesting volumes (see **Erreur ! Source du renvoi introuvable.Erreur ! Source du renvoi introuvable.** & **Erreur ! Source du renvoi introuvable.**): before year 2048 the standing volumes, prices, carbon sequestration and biodiversity go up as well the wind vulnerability (related to tree height), then the harvest activity explodes and it induces a decrease for almost all indicators except for the fire vulnerability (new plantations equal high densities).

Figure 1. Situation of Ecosystem Services according to each scenario for the year 2048.

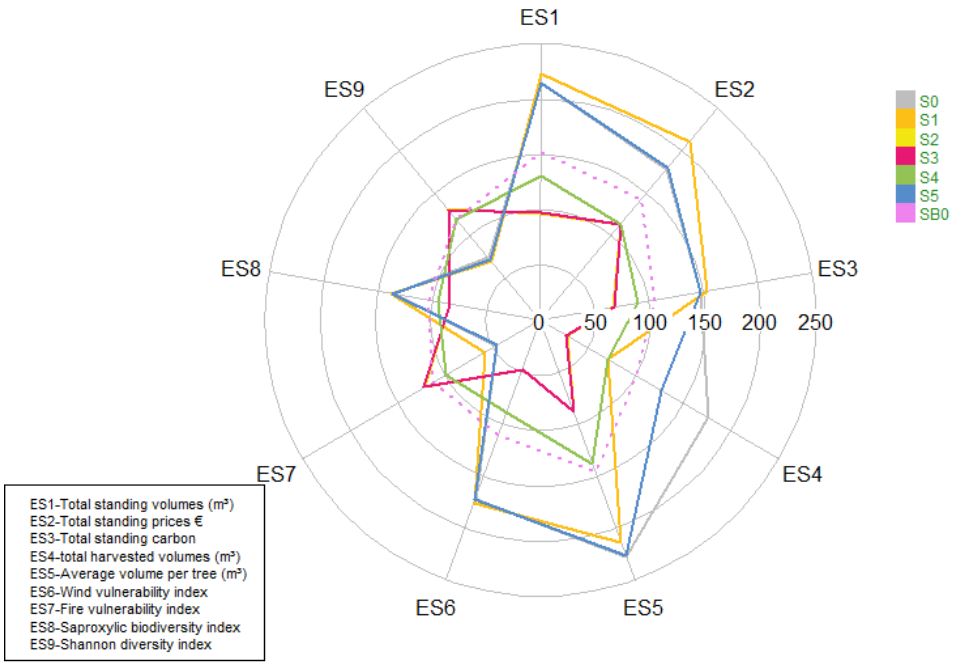

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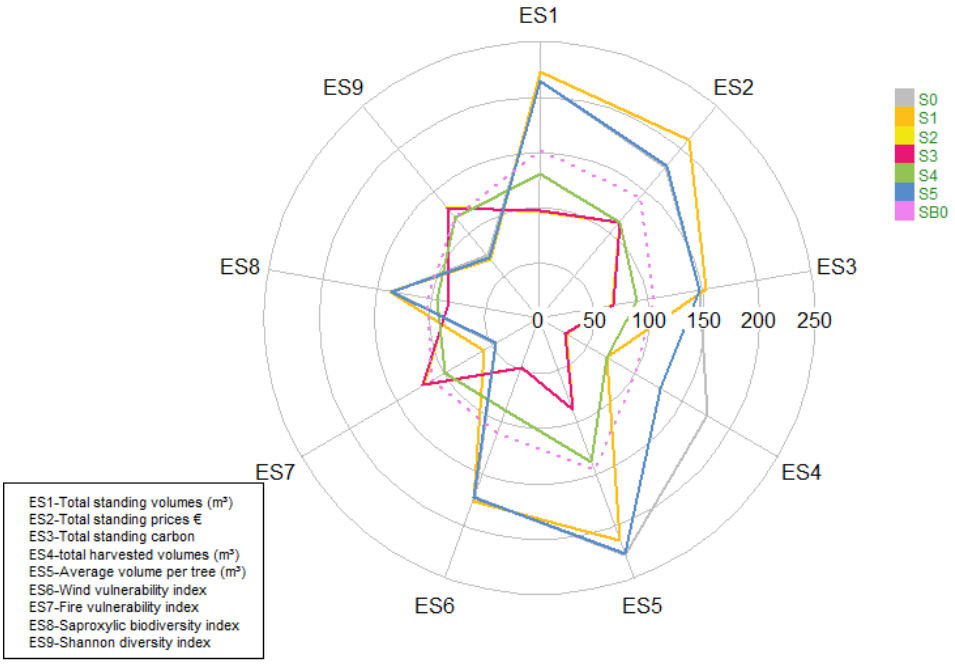
Figure 2. Situation of Ecosystem Services according to each scenario for the year 2060.



2.3 Comparison of all ES between scenarios before backcasting (WP2.2 and WP2.3)

In this chapter we will present first the results in terms of ES (indicators) for each scenario before the backcasting steps. The improvements done during phases 2.2 and 2.3 have allowed us to obtain more accurate outputs: the saproxylic biodiversity, wind and fire indices have been improved thanks to scientists' help who are experts in those domains, and as explained before a Shannon diversity index was created. Our purpose is to compare the ES between the BAU (Business as usual) and the other scenarios; results will show also a new scenario called SB0, which shows the reaction of the BAU (S0) if all actions are applied. New outputs reflect better the reality of each scenario and this will help to understand easily the behaviour of new scenarios after applying the list of robust actions.

It is important to point out that simulations begin from an initial state with huge damaged areas, those areas were replanted thanks to government grants after the storm, resulting in a peak of production (timber, biomass, both) followed by a depression which is not favourable for sustainable resource management; the average age (Figure 3**Erreur ! Source du renvoi introuvable.**) illustrates this peak, it is one of the outputs closely related on the provision of Ecosystem Services.

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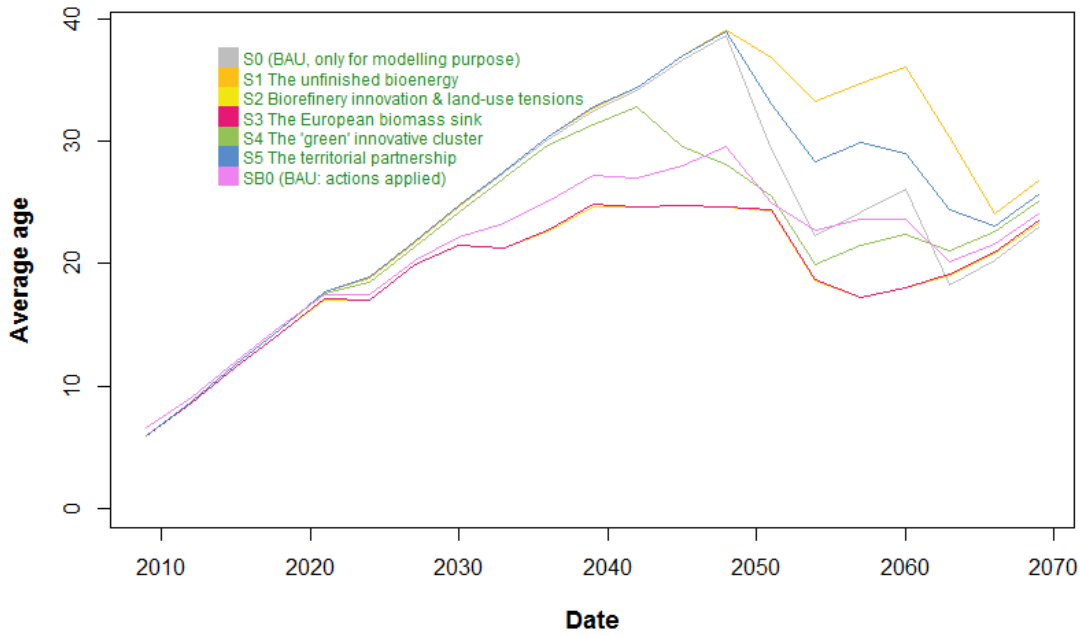
Figure 3. Average age for all scenarios in the Pontenx xase study.



***Total standing volume (Erreur ! Source du renvoi introuvable.)*:** in *scenario 1*, the traditional forest management leads to a continuous increase of standing volumes, having two peaks at year 2048 and 2060 then volumes go down. Indeed after the storm, affected areas were replanted but then there was difficulty concerning the mobilisation of the resource which explains those two peaks.

Scenario 2 and *scenario 3* have more o less the same behaviour, standing volumes are not very high compare to the BAU (S0) and the SB0. In *scenario 2*, forest owners are encouraged to cut down more trees and short term rotations increase, the authorities have been helping by applying supply-side policies, the objective is to satisfy the changing need of locals business. *Scenario 3* has the same short term rotations panorama but it exports also roundwood, this scenario is perceived as a "wood mine" with a particular focus on biomass production.

Scenario 4 is close to SB0, the forest multi-functionality is a priority, maritime pine remains the tree of choice for green building and green chemistry but broadleaved species are planted in greater areas as well.

Finally, in *scenario 5* the standing volume stays high and close to the BAU (until 2048) due to a reduction in local industrial demand, however local authorities have tried to counter this stagnation by developing new energy projects for supplying local collective boilers and surroundings and creating wood pellets factories.

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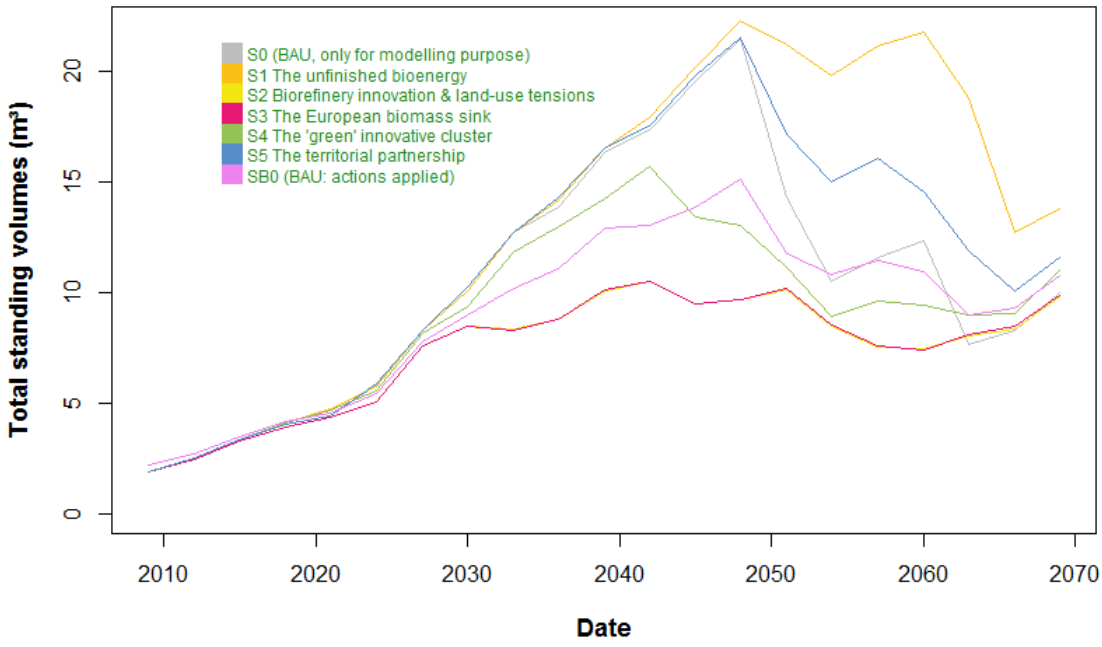
Figure 4. Total standing volume for all scenarios in the Pontenx case study.



Total harvested volume (**Erreur ! Source du renvoi introuvable.**): during the first 15 years, the harvested volume was very low as areas were replanted in 2009 (many of them at the same time), so trees were not mature enough for thinning or clear-cuts; that is why all scenarios follow almost the same trend, having one peak near year 2050 (when plantations were matured) and ten years after that, another peak. The ***average volume per tree*** graph (Figure 6), upholds the context for each scenario, it is easy to visualise how actions and FMA affect the resource over time, short term rotations for example will drop the average volume per tree and at the same time the carbon standing sequestration.

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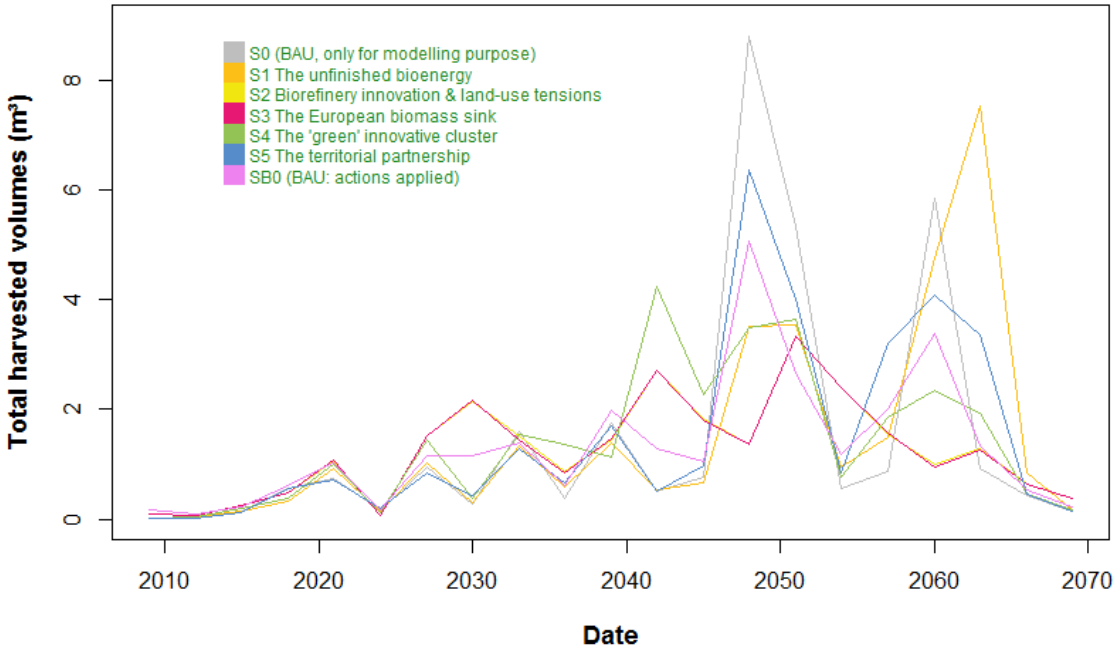
Figure 5. Total harvested volume for all scenarios in the Pontenx case study.



The BAU scenario will have the greatest harvesting peak at year 2050 as a result of its 'high quality' and 'classic' management options, it will be difficult then to recover from this unsustainable situation; *scenario 5* will follow a similar trend, however regional and European authorities will try to keep a balance and encourage the forest multi-functionality and rural development.

Scenarios 4 and *SB0* will have a more regular trend, it is important to have the resource available all the time, yet it is also important to maintain the landscape attractiveness and the quality of the environment. On the other hand, *scenarios 2* and *3* exhibit a more continuous harvest, in order to supply the energy factories. Yet, in the later stages of these scenarios (near 2050) the resource will decrease and it will be difficult to keep a sustainable forest management.

The wood mobilisation in *scenario 1* will finally work as it was wanted, additionally the increasing need of wood resource will result in a peak of harvested wood during years 2060-2065.

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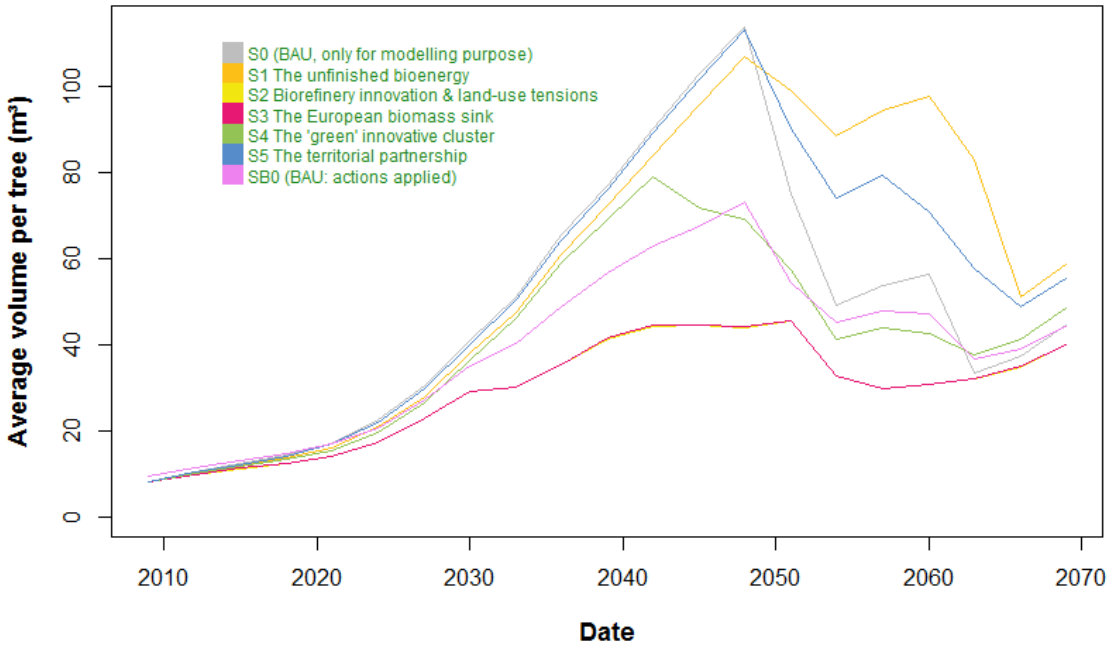
Figure 6. Average volume per tree for all scenarios in the Pontenx case study.



Total standing carbon (**Erreur ! Source du renvoi introuvable.**): this indicator depends on the standing volumes. The BAU scenario, the S5 and the S1 have an important increase in carbon standing sequestration until year 2048, the BAU will then decrease after the clear-cuts of all mature plantations; S5 will have a decrease as well but less important, old trees are not profitable for energy production because prices are higher than the young trees stands; still there is a desire to increment the timber industry, subsequently old trees become a key product. *Scenario 1* has a very small decrease, after 2048 standing volumes increases again so the carbon, but the situation does not last long, the harvest activity and wood mobilisation will take over the standing volumes and carbon standing sequestration will decrease.

The standing carbon for *scenarios 2* and *3* will follow the same standing volume path, short term rotations will take over the classic management options, stands will be continuously harvested to supply the energy new markets, so carbon sequestration in standing trees will be much less important.

The growing influence of eco-labelling, a greater regulation of forest management, the new energy and climate policies, and the new environmental charters in *scenarios 4* and *SB0*, have been key factors for developing carbon and wood markets that are subject to ecological certification, in these scenarios the standing carbon remains important for the environment quality of the Landes region.

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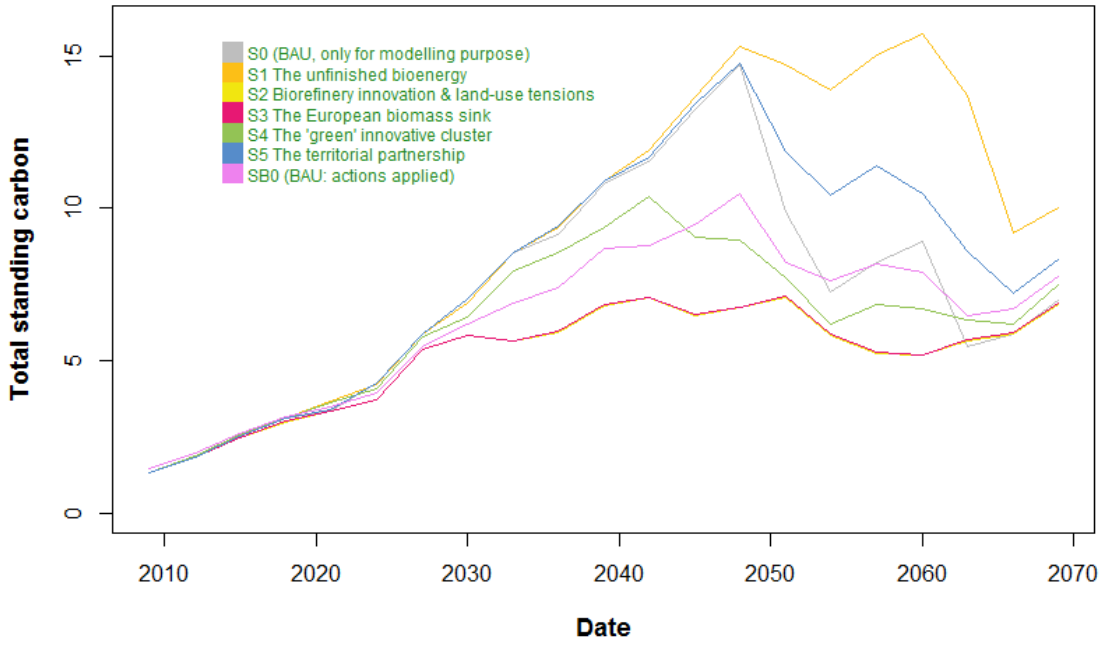
Figure 7. Total standing carbon for scenarios in the Pontenx case study.



Total standing prices (Figure 8): prices outputs should be interpreted carefully because simulations are based on a price reference from 2013 and they did not take into account their evolution over time. Clearly at the beginning prices will not go up or at list not very high, but after ten years they will increment, the average volume per tree will increase as the wood demand; despite each scenario context there is a trend towards lower prices.

The increase demand of industrial and energy wood in *scenario 1* have also increased the prices, however, by year 2045 the competitiveness of the regional wood and paper industries seems to have a negative impact on timber prices, they continue to drop reaching the same level as pulpwood; as a consequence foresters were reluctant to be involved in the new silviculture approaches. *Scenario 2* should have better prices thanks to worldwide increase demand for energy and the desire of producing high-added value products, but the intensification of the harvest activity will not let entirely prices to have an exponential increase; *scenario 3* will undergo the same situation even if the wood market diversification will try to improve price competitiveness. Those two scenarios have the lowest prices compare to other scenarios but it should be noted that the price reference for biomass was taken from its earlier stages (2013), probably prices will be higher in 2020.

The economic panorama seems to work better for *scenario 4* and *SB0* which have greater regulation in forest management, there are fairly lucrative contracts as part of new energy and climate policies, and the carbon and wood markets can be easily access after signing a particular environmental charter; S4 will follow a decrease in prices by year 2045, the Landes region becomes an attractive place to live, the revenue generated by residential economy will take over the forest but the forest economy will recover quickly its balance by 2055.

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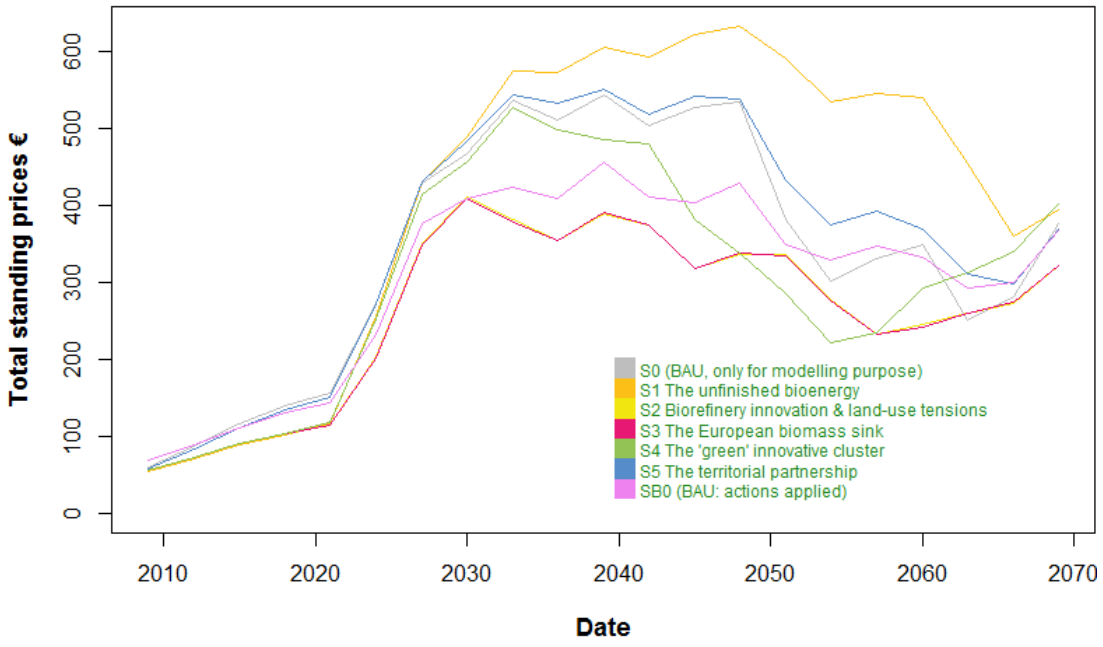
Scenario 5 remains close to BAU scenario, the effort from local authorities to counter the stagnation by developing new energy projects for supplying local collective boilers and surroundings, and creating wood pellets factories have worked out well, also the creation of forest owner collectives allows foresters to supply large volumes of wood to companies and organisations under long-term contracts; all these actions have improved the economic condition of S5.

Figure 8. Total standing prices for all scenarios in the Pontenx case study.



Wind vulnerability index (**Erreur ! Source du renvoi introuvable.**): this index will be directly related to the stand height and density, and it will be enforced after a thinning, it is well documented that in the 2 years following a thinning stands are more prone to wind-throw (Landmann *et al.,* 2010 & Bouchon, 1987).

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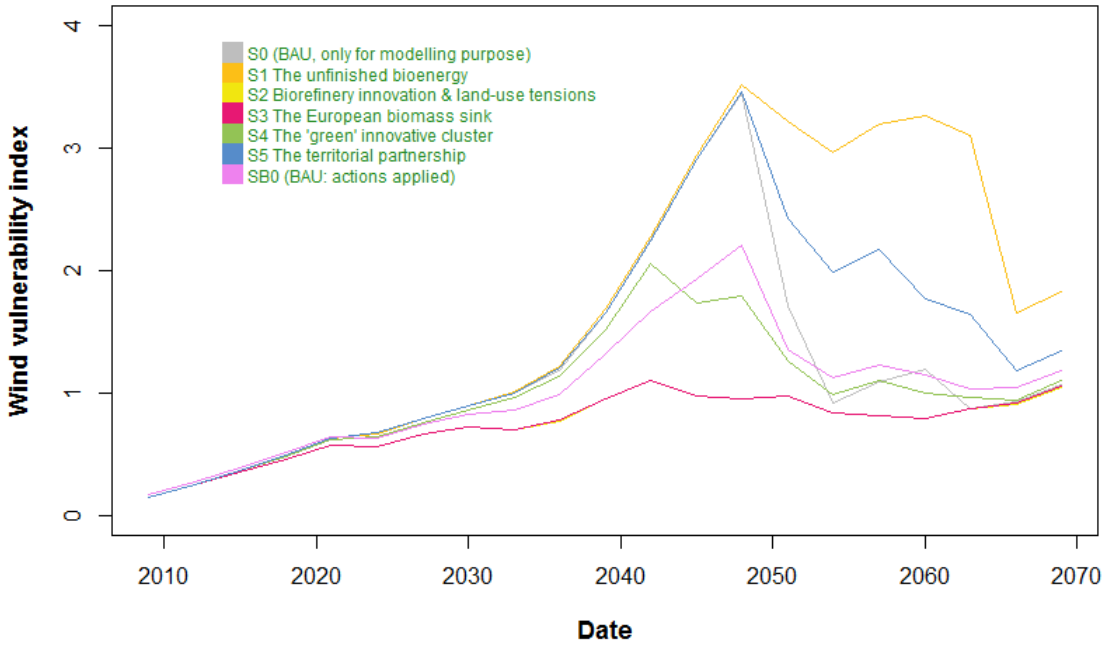
Figure 9. Wind vulnerability index for all scenarios in the Pontenx case study.



Fire vulnerability index (Figure 10): this index is related specially to stand density but also the stand age. Independently of the FMA and the final wood product, the site clearing and weed control are the best guaranty of fire safety (Macé and Laquerre, 2010).

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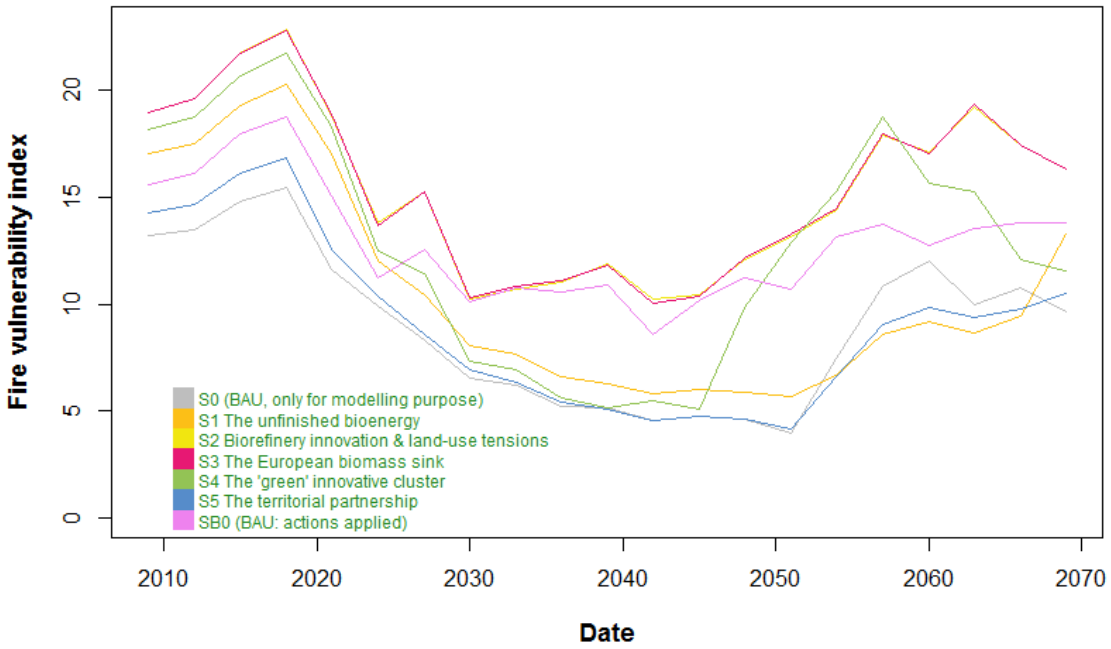
Figure 10. Fire vulnerability index for all scenarios in the Pontenx case study.



Scenarios 2 and *3* will definitely have the lowest *wind vulnerability index*, thanks to short term rotation management, trees will not have the "opportunity" to grow very high and there will be no thinning (or only a few) thus reducing the risk of wind-throw. On the contrary, *fire vulnerability index* will be a serious problem for S2 and S3, they have the highest index among the scenarios. Indeed, an increase of short term rotation management results in a high ratio of young stands, besides the biomass FMA does not include any kind of clearing and there is a strong horizontal and vertical continuity in young ages which increases the risk of fire.

Scenarios 1, 5 and the BAU will behave similarly, fire risk will be lower but the wind risk higher. In S1 most of the stands are managed in a traditional way which means that trees are very high and the stand density is low (150-200 trees/ha), as a consequence the *wind vulnerability index* is very high. In *scenario 1*, the two-tier development has affected even fire management institutions, wood production areas are being managed privately (due to reduced state funding) while the subsidies provided by municipalities reflect their priority of protecting forests around built-up areas, luckily for S1 the fire vulnerability is low yet not the lowest. *Scenario 5* has a high vulnerability wind index, standing volumes were increasing and so the tree heights, by 2045 the risk decreases thanks to wood market and mobilisation; fire risk remains very low, the fire prevention institutions have varying levels of success, depending on the level of support received from local authorities. In addition, a number of new privately-led initiatives are springing up, looking at ways to derive profit from forests on the back of a growing residential economy (private hunting estates, firewood, theme parks, etc.).

Wind vulnerability in *scenario 4* and *SB0* is not very high nor very low, the forest multi-functionality enables a balance between all FMA and reduces the risk. Fire risk is better managed in *SB0* than in

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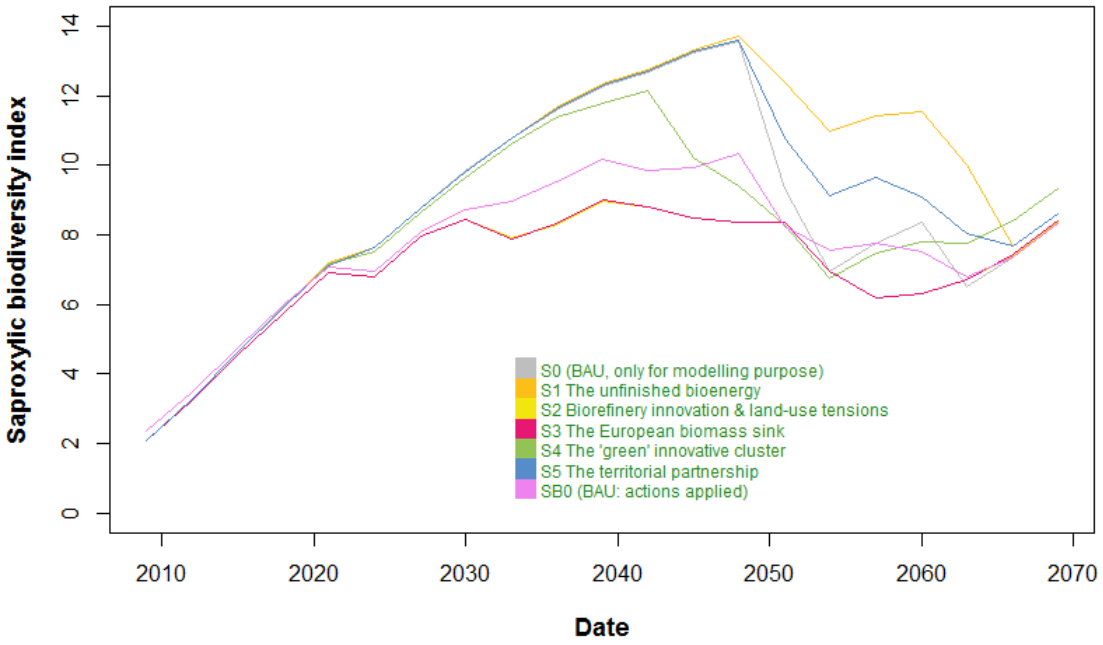
S4, however *scenario 4* becomes more efficient concerning the risk management strategies due to the new kind of governance, based on coordination between market-based and regulatory instruments (e.g. making forest insurance policies tax deductible, or by creating a dedicated investment fund paid by taxes levied on both producers and consumers).

Saproxylic biodiversity index (Figure 11): besides its major role for the conservation of saproxylic species, deadwood also contributes to carbon sequestration, nutrient supply and natural regeneration. Management practices that promote deadwood should be organized on large scales as the influence of deadwood on saproxylic species increases with increasing spatial scales. The temporal dimension should also be considered because the continuity of forest cover and deadwood availability might play a major role in the protection of saproxylic biodiversity (Kraus and Krumm 2013).

Figure 11. Saproxylic biodiversity index for all scenarios in the Pontenx case study.



The short term rotation management does not have a positive impact on saproxylic biodiversity, this FMA produces small quantities of residues because thinnings are inexistent and stumps are very small or removed which is not profitable for saproxylic species, that is the case of *scenarios 2* and *3* having the lowest index amongst the scenarios.

The BAU and *scenarios 1* and *5*, will have a high index during the first 3 decades but after that the clear-cuts will increase and the balance between standing and harvested volume will be affected, by 2045 these scenarios will have troubles keeping up the diversity of deadwood in terms of diameter and age. Nevertheless, the new silviculture approaches of *scenario 1* (energy market) will help it not to have an abrupt decrease.

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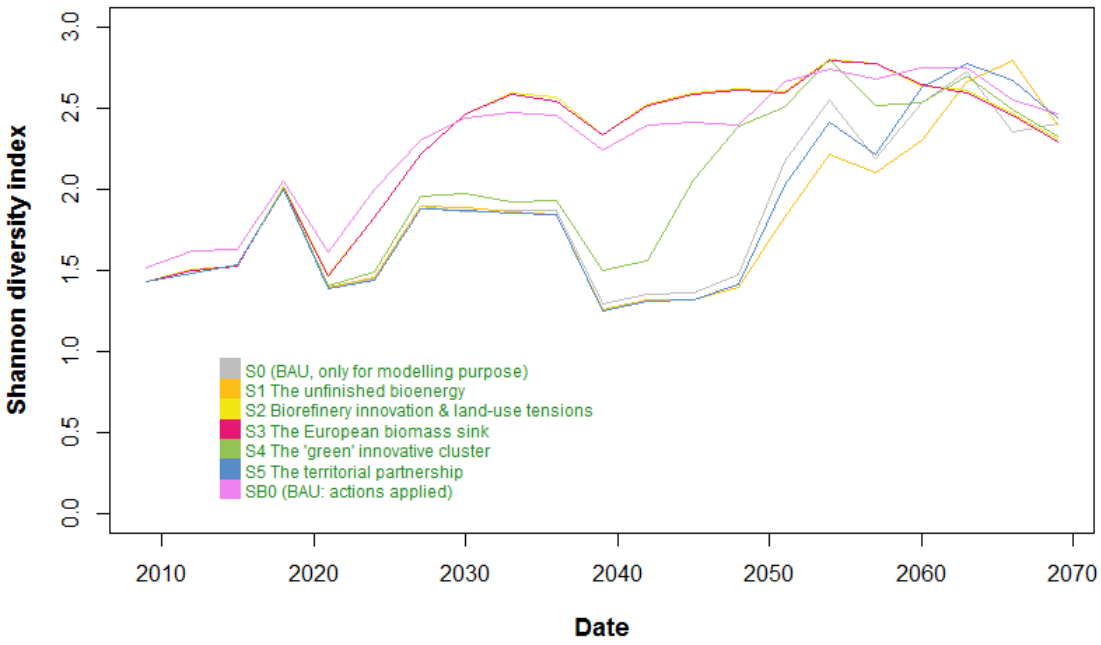
Again, *scenarios 4* and *SB0* seemed to be the most balanced. Both have tree species diversity thanks to the introduction of new broadleaved species, but also a good mixture of tree ages and diameters as a result of the different FMA applied within the case study, these factors have a positive impact on the conservation of saproxylic species.

Shannon diversity index-SHDI (Figure 12): this index quantifies the countryside diversity taking into account its richness and evenness, richness refers to the number of patch types (compositional component) and evenness to the area distribution of classes (structural component). The SHDI increases as the number of different patch types (classes) increases and/or the proportional distribution of the area among patch types becomes more equitable. For a given number of classes, the maximum value of the Shannon Index is reached when all classes have the same area (The European Commission, 2000).

Figure 12. Shannon diversity index for all scenarios in the Pontenx case study.



The SHDI was used to calculate the diversity within the countryside but also to visualise the landscape attractiveness of the Pontenx case study. People tend to think that the Landes region has no diversity because of its homogenous landscape of maritime pine, however there is a mixture of land cover classes: patches of common alder and chestnut, open space areas, wetlands, oak stands and maritime pine stands, which allows diversity to be preserved. It is important to notice that maritime pine plantations are quite heterogeneous, depending on the FMA they follow; for the calculation of SHDI, pine plantations were divided into 3 different categories: PP3 young pine stands (<7 m), PP4 mid-class pine stands (7–15 m) and PP5 older pine stands (>15 m) (van Halder *et al*. 2008) to better capture their role within the landscape diversity.

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The biodiversity conservation in plantation landscapes will however also depend on the presence of more natural habitat elements, such as wetlands or late successional stages of remnant forest, within the plantation matrix (Lindenmayer and Hobbs 2004; Fischer *et al*., 2006).

Scenarios 2, *3* and *SB0* have encouraging results. Even if short term rotation FMA affects the saproxylic biodiversity, the SHDI demonstrates that there is a balance between the richness and the evenness for S2 & S3. Coastal areas are more attractive than inland forest and they serve as 'examples of biodiversity' (especially in S3).

On the contrary, the BAU along with *scenario 1* and *5* are less positive. There is a lack of FMA diversity, consequently the distribution of the area among the land cover classes is not equitable (large areas were planted at the same time after the Klaus storm). By 2045, different kinds of FMA come into play increasing the Shannon diversity index: in S1 more “modern” developments are beginning to appear along the coast and in S5 the Ecosystem services are becoming more commonplace.

Scenario 4 will follow BAU's trend at the beginning, by 2040 new silviculture approaches and policy actions will take over the BAU, in consequence the SHDI will join the trend of the desired endpoint scenario. S4 will display a higher extent of specific zones dedicated to biodiversity and recreational use, as they generally tend to be located in coastal areas or around lakes and rivers. The planted forest continues to play a role in maintaining the territorial equilibrium, helping to preserve natural resources, and protecting a variety of ecosystems.

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3 Methodological approach

3.1 Overall design (WP3.3 and WP2.3)

The overall design developed for WP3.3 and WP2.3, and the connection of WP3.3 with WP2.3 is shown in Figure 13. After a general description of this overall design, a reflection is given how the design was applied for Pontenx CSA in France.

Overall design

The starting points for WP3.3 are the full scenarios (1) developed in WP2.2 and WP3.2. These full scenarios form the input for participatory backcasting workshops (2), resulting in a list of (policy) actions, which fit all the scenarios (2a), and which should result in a desired future as regards Ecosystem Services (2b). The list of policy actions (2a) is subsequently the basis for the combined research team to model/formulate the behavioural landscape/FOT-FMA matrix for EACH raw scenario (3). With this behavioural landscape/FOT-FMA matrix forward simulation model runs are carried out (4) in WP2.3, resulting in a set of realised Ecosystem services for EACH scenario (4a). These sets of realised ecosystem services are then compared to the desired endpoint (5), which was determined in the participatory backcasting workshop (2a). Based on an expected discrepancy between realised and ideal endpoint, there might be a need for some expert consultation (6) in WP3.3. Based on this expert meeting, the list of actions or the behavioural matrix can be revisited, or a partial –per action- analysis of the effect of the actions on the ecosystem services are carried out (7). This is a re-iteration that can potentially be repeated, based on resource availability etc. Based on the results of this exercise a set of robust actions (the roadmap) is recognised and bundled within robust pathways, strategies or roadmaps towards integrated forest management within the regional or national forest landscape (8).

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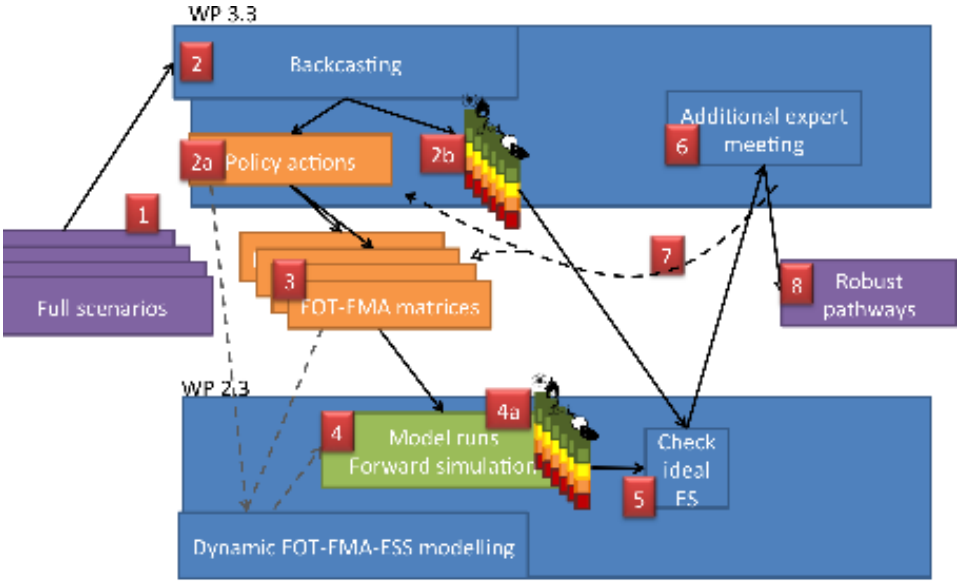

Figure 13. Structure of WP3.3, and the interaction of WP3.3 with the other WPs.

Design applied in Pontenx CSA, France.

In the following sections of this chapter, the different steps taken within the responsibility of WP3.3 is described in more detail.

3.2 **Backcasting: the workshops**

The policy backcasting analysis has been conducted as a participatory process which included two one-day workshops. The first workshop was centred on the STEP 1 of the backcasting method and focused on the definition of a 'desired endpoint'. The second has concerned STEP 2 & STEP 3 and was dedicated to the definition of obstacles and opportunities and then to the discussion about milestones and interim objectives. All the member of the research team (from Irstea and EFIATLANTIC) has helped to the animation of these meetings.

Workshop n°1

The meeting was held the 20th of June 2014 in Saint-Paul-en-Born (near to Pontenx-les-Forges) with an attendance of 6 local stakeholders: two 'managers' (regional forest cooperative, national public forest company), two 'planners' involved in local development strategies, the Mayor of Saint-Paul-en-Born and the representative of the General Council of Landes (40) in charge of forest affairs. In the morning the results of the research conducted in Phase 2 and the scenarios were presented and discussed. In the afternoon the discussion was focused on the definition of a common 'desired endpoint'.
All the participants played the game and were really supportive. Each participant was invited to define its own 'desired endpoint' by positioning a Post-It on large papers representing the different

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matrices of indicators. After that, we had a collective discussion where each stakeholder was able to provide arguments to justify his/her choices.

Workshop n°2

The meeting was held the 25th of June 2014 in Cestas-Gazinet (at the Irstea research centre) with an attendance of 6 regional stakeholders: one industrialist (pulp and paper company), one 'manager' (regional forest cooperative), one representative of the forest owners association (SYSSO), one representative of a forest research institute (INRA), two representatives of forest administrative services (DRAAF and CRPF).
First, we presented the results of the workshop n°1 and had a discussion on the objectives needed to reach the "desired endpoint" defined by local stakeholders. The 'desired endpoint' could not be modified but participants were asked to translate it in terms of objectives to be achieved.
Then, the group was invited to identify obstacles and opportunities that the scenario n°1 and the current situation present to reach/avoid the specific issues related to the 'desired endpoint'.
Finally, the group had a discussion to define all the milestones and interim objectives that have to be reached in order to achieve the 'desired endpoint'. At this step we started to discuss the policy option with regard to the objectives defined.

For practical reasons (only 6 participants) all the workshop has been conducted in a plenary session and we did not have time to deal with other scenarios. The full backcasting analysis for scenarios 2/3/5 has been completed by the researchers from Irstea who followed the same methodological approach and were inspired by the discussion with experts on Scenario 1 during workshop n°2.

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3.3 **Expert involvement**

The meeting was held the 18th of December 2014 in Cestas-Gazinet (at the Irstea research center), with an attendance of 5 regional experts: one industrialist (pulp and paper company), one 'manager' (regional forest cooperative), one representative of the forest owners association (SYSSO), one representative of a forest research institute (FCBA) and one representative of forest administrative service (CRPF).
Considering that the experts had not been involved in the full backcasting analysis (they only contributed to the work on Scenario 1) we decided to dedicate this last 'expert meeting' to the discussion on the end-results of the backcasting analysis performed by the Irstea team. The aim of this step was to test the robustness of the strategy by confronting the list of actions to their opinion.
During the 'experts meeting' all actions were evaluated. Based on the experts' suggestions and comments, WP3.3 team re-evaluated the policy actions to keep only the most robust groups of actions.

3.4 **Translating the (policy) actions to the FOT-FMA matrices (WP3.3 and WP2.3)**

It is important here to notice that modelling has not been used specifically in this step to test the robustness of actions. We considered indeed the modelling outcomes to be inappropriate to assess the relevance of the different actions because of the impossibility to isolate the effect of each action on the provision of Ecosystem Services.

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After the workshops and the last expert meeting, the Irstea team (WP3.3) compiled a list of robust policy actions; it was tested for robustness and translated into a matrix by EFIATLANTIC team (WP2.3). Each policy action was discussed and graded (level of importance) for each FMA and FOT. The same procedure was replicated with EFIATLANTIC staff that were not involved in the project in order to have another point of view. Both matrices' grades were then transformed into percentages (based on the T0 matrix and their degree of importance) to better visualise the changes. A meeting between project partners was held for discussing the matrix and its coherence with the policy actions.

3.5 **Assessment of the ES (only WP2.3)**

The Decision Support System for the Pontenx CSA: CAPSIS is a java collaborative platform that can run many types of growth models. Each growth model is embedded in an independent module that can be run by the kernel of the program, taking advantage of all the visualization and stand management option (thinning, clear-cut, economic data, etc.) tools included in the common platform. The tool can be run with a GUI interface or by script. In 2012, more than 80 growth models have been developed by the modelers who joined the community (some of them are listed in FORMODELS database). The software is open source but growth models are distributed only if modelers agree. The main advantage of this tool is that most of European species are already available and can be connected to landscape simulator thanks to SIMMEM module developed by Patrick Vallet at IRSTEA, giving us possibilities to adapt many outcomes of WP3. The main limitation is that the tool is still in its early stage and does not allow optimizations.

The Ecosystem Services included in the assessment are also integrated in the DSS tools, and provided directly as indices associated with each stand in the case study area. The following indices are then summed or averaged at the landscape level using R (© The R Foundation) scripts: total standing volumes, total standing prices (from 2013), total standing carbon, total harvested volumes, average volume per tree, wind and fire vulnerability and biodiversity (saproxylic) and Shannon diversity index. Once the simulations done, the DSS outputs were compared to the workshops' results in order to quantify each ES and the impact of the policy instruments identified during the back-casting. Indeed there are some ES like the total standing volumes, total standing prices, total standing carbon and the average volume per tree that are very dependant, however they respond well to the different scenarios, ES3 (carbon) for example will respond better to scenario 5 than the others because of the increment of long tree rotations. The saproxylic biodiversity index depends on the type of forest management, scenarios 1 and 5 have the greatest indices which is translated in a great amount of dead wood. Biodiversity can also be demonstrated by the diversity of land cover, for this a new index has been constructed based on the Shannon diversity formula and it can be used as a proxy for the landscape attractiveness.
Wind and fire vulnerability indices (ES6 & ES7) show how those risks can behave depending on the behaviour of the FMP: clearly the scenario 3, where the principal FMA is the biomass production, increments the risk of fire.

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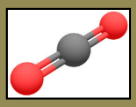
4 Results

4.1 Participatory workshops

4.1.1 *Desired end point (WP3.3 and WP2.3)*

We have established a set of indicators which partly incorporate ES defined previously in WP 3.2 and 2.2, but also introduce new ones.
ES related to risks vulnerability (wind and fire) have not been used for the backcasting analysis. In fact, we have considered that at this stage the criteria used for their evaluation still have to be refined and that they are not really ES but rather forest ecosystem attributes which are correlated to the provision of the others ES. Nevertheless after the workshops these indicators were improved and corrected by EFIATLANTIC team, based on the advices coming from scientists working on wind and fire within the region; it was essential to have these indicators updated since the stakeholders give a lot of importance to these risks before making any decisions concerning the forest.
A new indicator concerning social function of forest landscapes which focus on attractiveness of forest areas for recreation and for the quality of the living environment has been provided. This indicator has two essential components: the first one refers to the level of quality of the forest in terms of accessibility, recreation facilities, and attractiveness of forest scenery; the second one evaluates the share of attractive forest areas at the scale of the landscape. Similarly, the indicators related to biodiversity and timber resource have two components. Biodiversity indicator distinguishes between 'ordinary' biodiversity, which is associated with silvicultural practices, and 'remarkable' biodiversity which evaluate the ecological and biological significance of forest landscape (rare species and ecosystems). Wood production indicator estimates volumes of wood harvested for biomass uses (pulpwood, firewood) and for the timber industry.

Wood production indicator	**Carbon sequestration indicator**	**Forest attractiveness indicator**	**Biodiversity indicator**
			
Volume of wood harvested for biomass uses (pulpwood, firewood) & for the timber industry	Level of carbon stored in forests & in wood products	Level of attractiveness of forest landscapes ('quality' of attractiveness) & share of attractive forest areas	Level of ordinary biodiversity & level of remarkable biodiversity

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The aim of the Step 1 is to define a desirable endpoint as a 'balanced' set of forest ecosystem goods and services. This can be done by setting a value for each indicator presented above. This result can be presented as absolute or relative value. However, considering that the ranges of potentialities of these indicators are very difficult to assess, we have chosen to define them in relative terms. This procedure avoided the discussion with stakeholders on the qualitative assessment of the present situation in terms of provision of ES. In fact, following a 'relative' approach of ES valuation, the present situation has been defined as the reference point against which indicators levels have been set. More precisely, the reference point has not been defined on the basis of the present situation (2014), but on the basis of the situation in 2008, it was important to choose a context which will allow standing trees to be visualised, as opposed to a post-storm situation (even if the workshops reference point is 2008, all simulations have started from a post-storm Klaus condition in 2009).

During the workshop n°1, stakeholders were asked to define their 'desired endpoint' by determining the level of provision of each ES in relation to the situation in 2008. Almost everyone agreed with the need to increase wood production and to preserve attractiveness and ecological quality of the forest.
On the wood production indicator, opinion was divided over the issue whether biomass production should be developed to meet the increasing demand for bioenergy or whether timber production should be reinforced to increase added value from forest economy.
On the biodiversity and attractiveness issues, the discussion was more centred on the problem of resilience and adaptability of forest ecosystem to natural risks like storm or tree pests and diseases. After discussion, it has been stated collectively that resilience and adaptability of forest ecosystems issues can be partly expressed through indicators related to 'Biodiversity' and 'Forest attractiveness'.
Finally, it appeared that the indicator on carbon sequestration did not receive much attention, certainly because it is highly correlated to the indicator of timber production.

The comparison between provision of ES within the different scenarios and the desired endpoint shows the latter is really close to the Scenario n°4. In fact, the discussion with the stakeholders confirmed that the balance of ES in the S4 displays substantial similarities with their desired end point. As a consequence, for the backcasting analysis we will consider the balance of ES provided by S4 as the desired end point.

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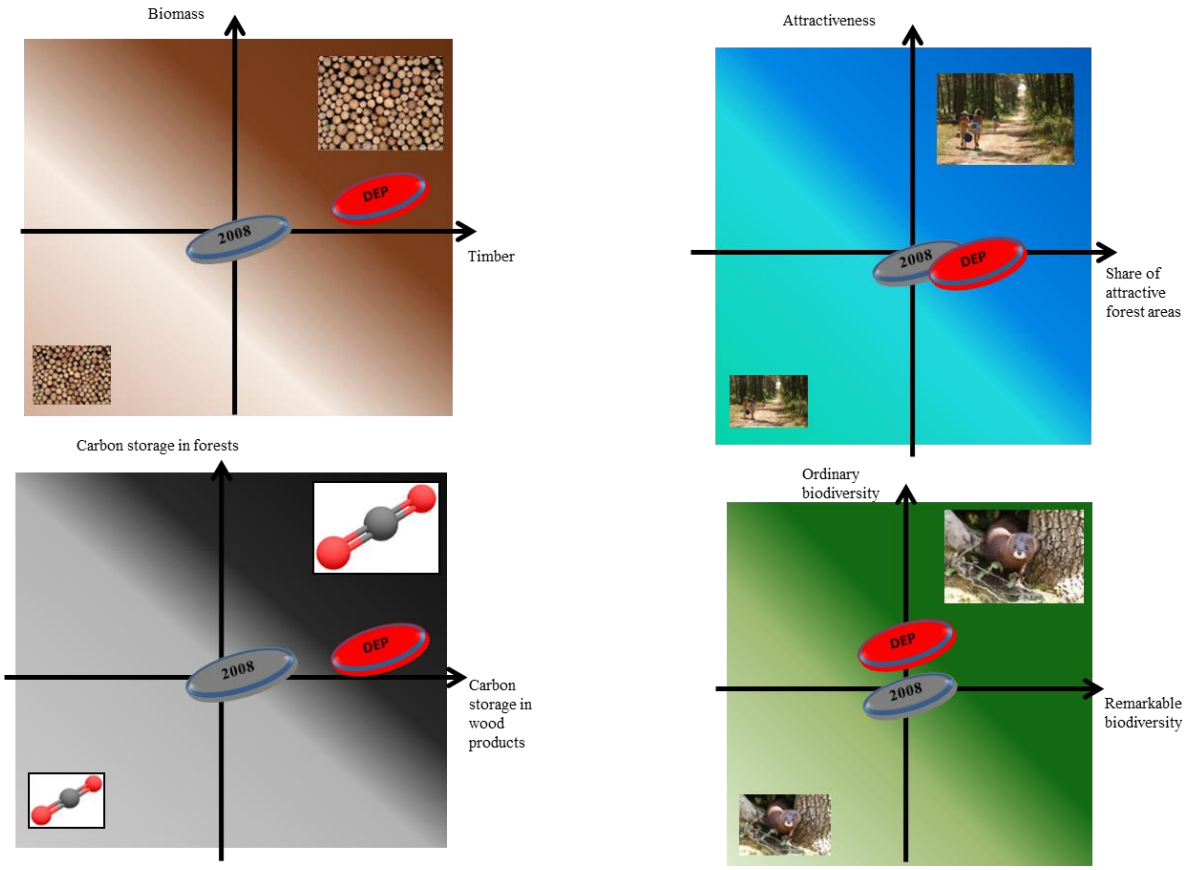

ES in desired endpoint (Workshop n°1)

It should be noted that the current provision of ES in the Pontenx case study area has been limited after the storms, specially the one from 2009 (Klaus storm) which has destroyed more than half of the standing forest. As a result, simulations were run from an initial state which can be improved very easily; the **desired endpoint of ES** is subsequently somehow positive as you can see in the picture above. Timber will continue its increment but new forest management options will appear, increasing the share of attractiveness (Shannon diversity index) and keeping a balance on the ordinary biodiversity (saproxylic biodiversity index). Carbon has a tendency to be storage in wood products than in the standing forest, yet the total standing carbon will increase as well due to a great quantity of new plantations in 2009.

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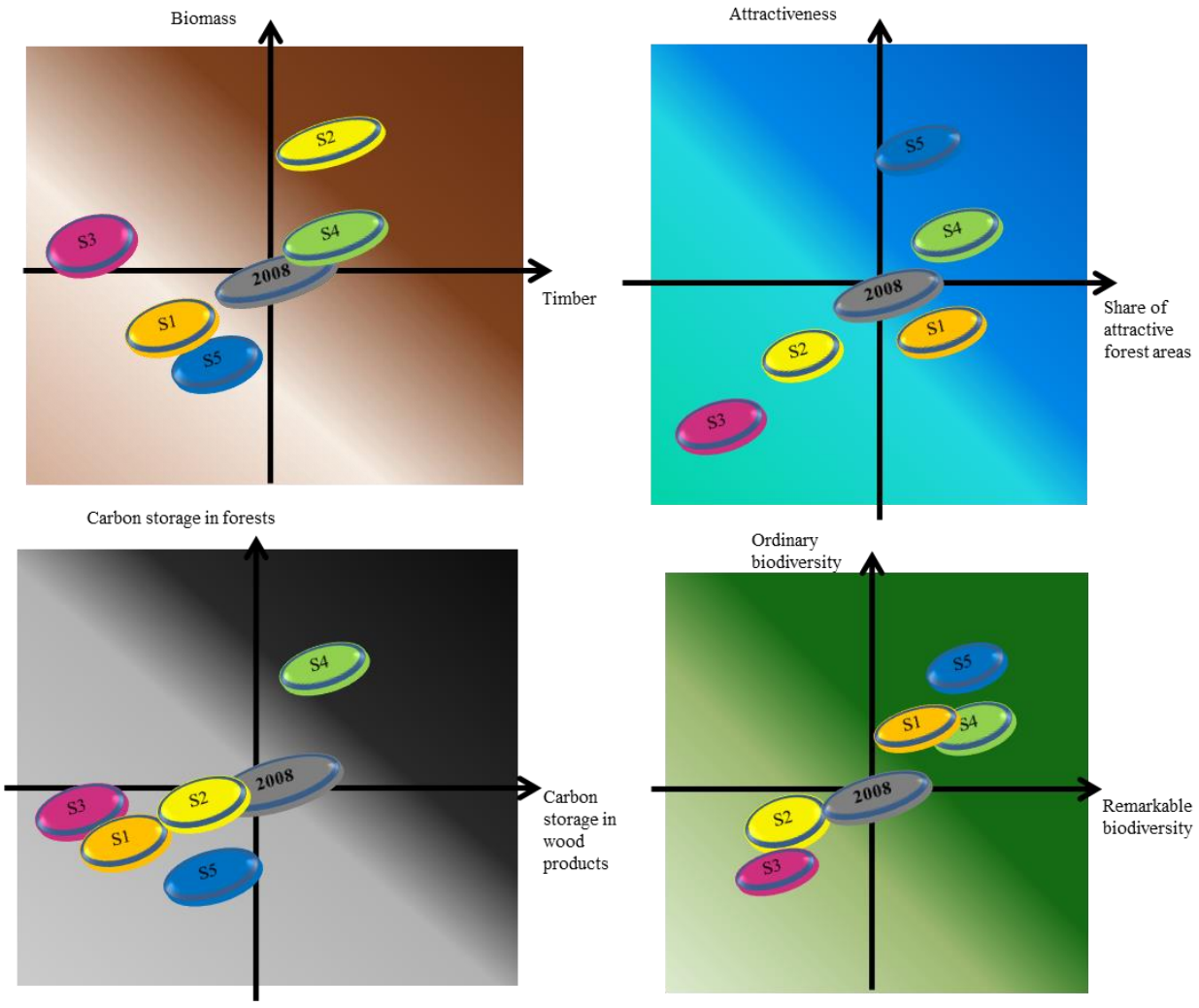

ES within the different scenarios

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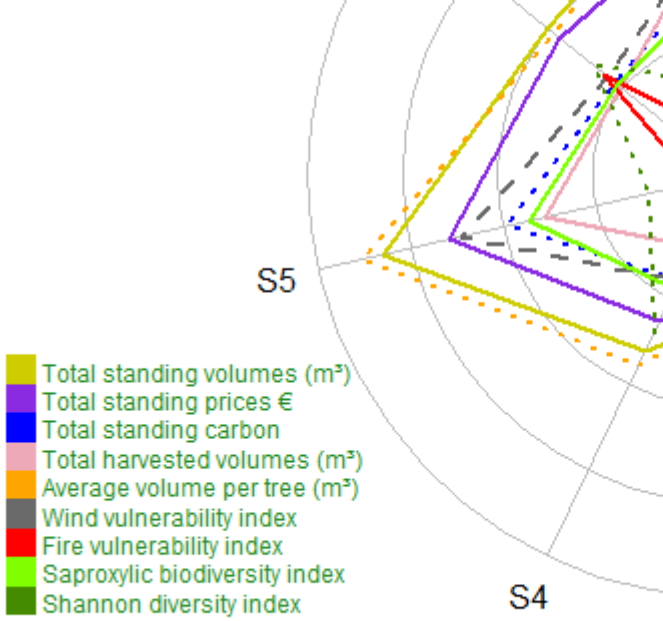
The desired endpoint of ES in relation to the provisio
be balanced. The actions of the *desired endpoint* sce
the ES. During years 2040 to 2050 scenarios S4 & SB
advanced silviculture, the use of maritime pine and ha
environment and landscape is a priority, etc. In fact
landscape users in terms of ES. An example of the pr
two different years is presented in Figure 14 and **Erreu**



case study (year 2048).

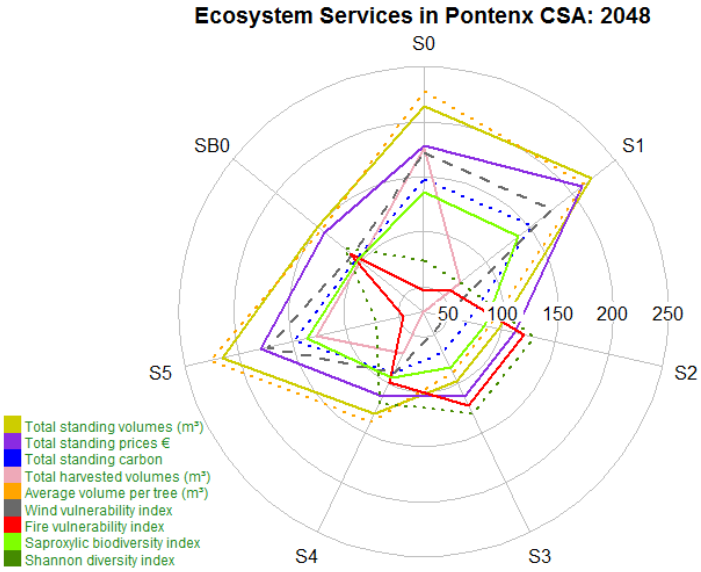
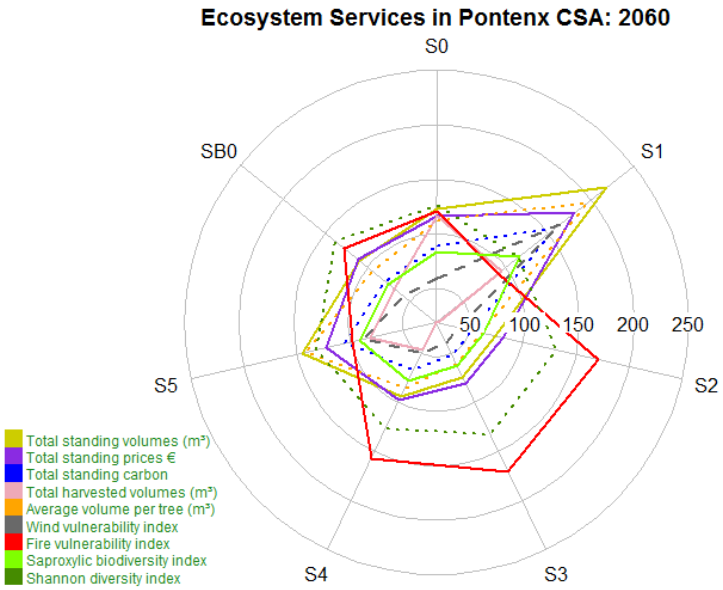


Figure 15. The desired endpoint of ES in relation to the provision of ES within the different scenarios for the Pontenx case study (year 2060).



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4.1.2 *Scenario specific results*

This section deals with specific back casting results for scenarios 1, 2, 3 and 5. Scenario 4 is not analysed considering that it is a possible roadmap to reach the desired end point.

Scenario 1: Unfinished bioenergy

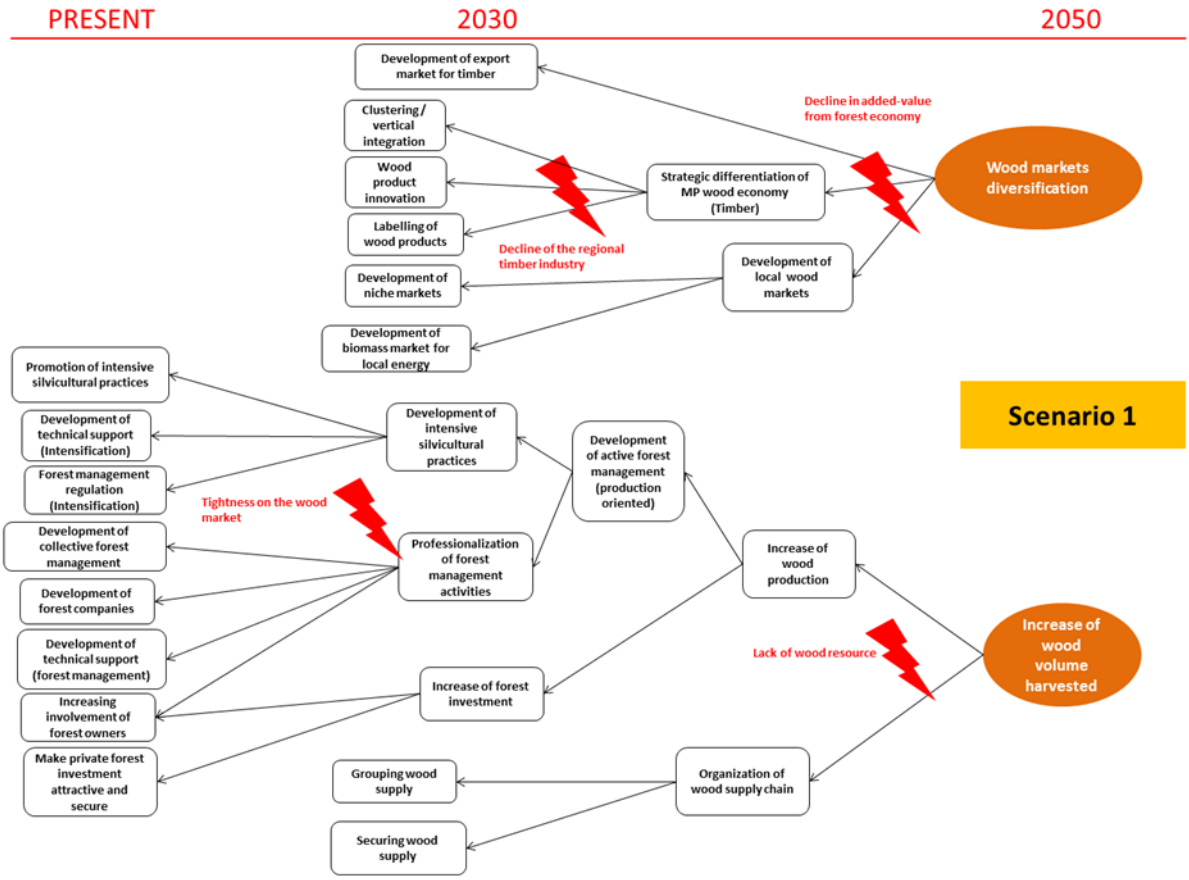

Figure 16. Overview of the results for Scenario 1

In the scenario 1, innovations and technological developments in the biorefinery industry and forestry sector are contributing factors to improve the added value from forest economy. But most of these developments remain centered on the promotion of pulp & energy wood production. Many forest owners are reluctant to follow this technical orientation promoted by forestry operators. In this scenario the lack of investments in timber-based industry – and the lack of demand for timber – and the weak wood prices are critical obstacles to forestry investments and to the implementation of innovative forest management programmes.

In this context, we suggest (i) promoting diversification of wood market by encouraging a competitive timber industry and (ii) increasing the harvest (for timber use) by supporting active forest management and wood supply activities. In fact, forest owners and professional organisations

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should lead collective actions in order to stimulate entrepreneurship and to establish common strategies (e.g. grouping investments, create a trade mark). National and regional authorities are intended to increase their support to forestry (supply side of the forest sector) through subsidies, tax reliefs and technical support. Concerning the demand side, they should shift from supporting wood energy industry to developing the timber sector (e.g. construction market). Regional authorities can more specifically undertake measures in favour of Maritime Pine markets and its specific silvicultural developments. They should also assume political support to collective actions and local professional organisations.

Considering the situation in the case study (with the impacts of the recent storm), priority should be given to actions dedicated to forest management and forest investments. But in order to achieve medium-term milestones related to wood market diversification (by 2030), an early implementation of long-term strategies is also needed, with actions in favour of timber industry.

Table 1: Overview of obstacles and opportunities in Scenario 1

CATEGORY	OBSTACLES	OPPORTUNITIES
Social	• Segregation of 'nature' and 'productive' visions • Land-use tensions (agricultural uses)	• High coastal attractiveness
Technological		• Biorefinery developments • Improvement of Pines plantations productivity
Economical	• Wood prices are weak • Lack of investment in wood-based industry • No market for ecosystem services	
Political	• Weak land-use regulation • Lack of public subsidies for forest investment	

Table 2: Policy actions in Scenario 1

Milestone/objective	**Action**	**Responsibility**	**Type of action**	**Time**
Development of export market for timber	Create forest owners associations (wood sale and forest management)	Forest owners	Collective action	*Now*
Clustering/ Vertical integration	Groupings of financial investment by forest owners in wood-processing companies	Forest owners	Collective action	*Now*
	Fiscal incentives for financial investment by forest owners in wood-	National government	Economical/Financial	*Now*

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	processing companies			
Wood-product innovation	Funding of R&D projects (MP wood for chemistry and building elements)	National and regional governments	Economical/Financial	*Now*
Labelling of wood products	Create a regional trade mark	Professional organisations	Collective action (Private regulation)	*Now*
Development of niche markets	Create forest owners associations (wood sale and forest management) Adapt French public procurement code to promote use of local harvested wood	Forest owners National government	Collective action Laws/regulation	*Now*
Development of biomass market for local energy	Create a biomass marketing association Adapt Heat Fund eligibility rules (Biomass supply conditions)	Forest owners National government	Collective action Laws/regulation	*Now*
Promotion of intensive silvicultural practices	Incentives (direct payments for intensive practices)	National and regional governments	Economical/Financial	*now*
Development of technical support (Intensification)	Funding of R&D projects (Forest genetics, MP silvicultural practices)	National and regional governments	Economical/Financial	*Now*
Forest management regulation (Intensification)	Promote production-oriented guidelines for forest management plans	National government	Laws/Regulation	*Now*
Development of collective forest management	Create forest owners associations (wood sale and forest management)	Forest owners	Collective action	*Now*
Development of forest companies	Extend the scope of ONF to private forests management (management contracts)	National government	Laws/Regulation	*Now*

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Development of technical support (forest management)	Increase support to private forest agency (CRPF) Increase support to 'Massif development plans' (PDM)	National and regional governments National and regional governments	Economical/Financial Economical/Financial	*Now* *Now*
Increasing involvement of forest owners	Increase property taxes	National government	Laws/Regulation	*Now*
Make private forest investments attractive	Fiscal incentives for production-oriented forest investments Labelling forest investments (socially responsible investment)	National government Investors	Economical/Financial Private regulation (Collective action)	*Now*
Make private forest investments secure	Improvement in the forest insurance system (Fire, storm, diseases etc.)	Insurance companies	Economical/Financial	*now*
Grouping wood supply	Create forest owners associations (wood sale and forest management) Incentives for logistics investment (storage platform)	Forest owners National and regional governments	Collective action Economical/Financial	*2030* *2030*
Securing wood supply	Promote wood supply contracts Create a regional wood sale committee	Professional organisations Professional organisations	Economical/Financial Collective action	*2030* *2030*

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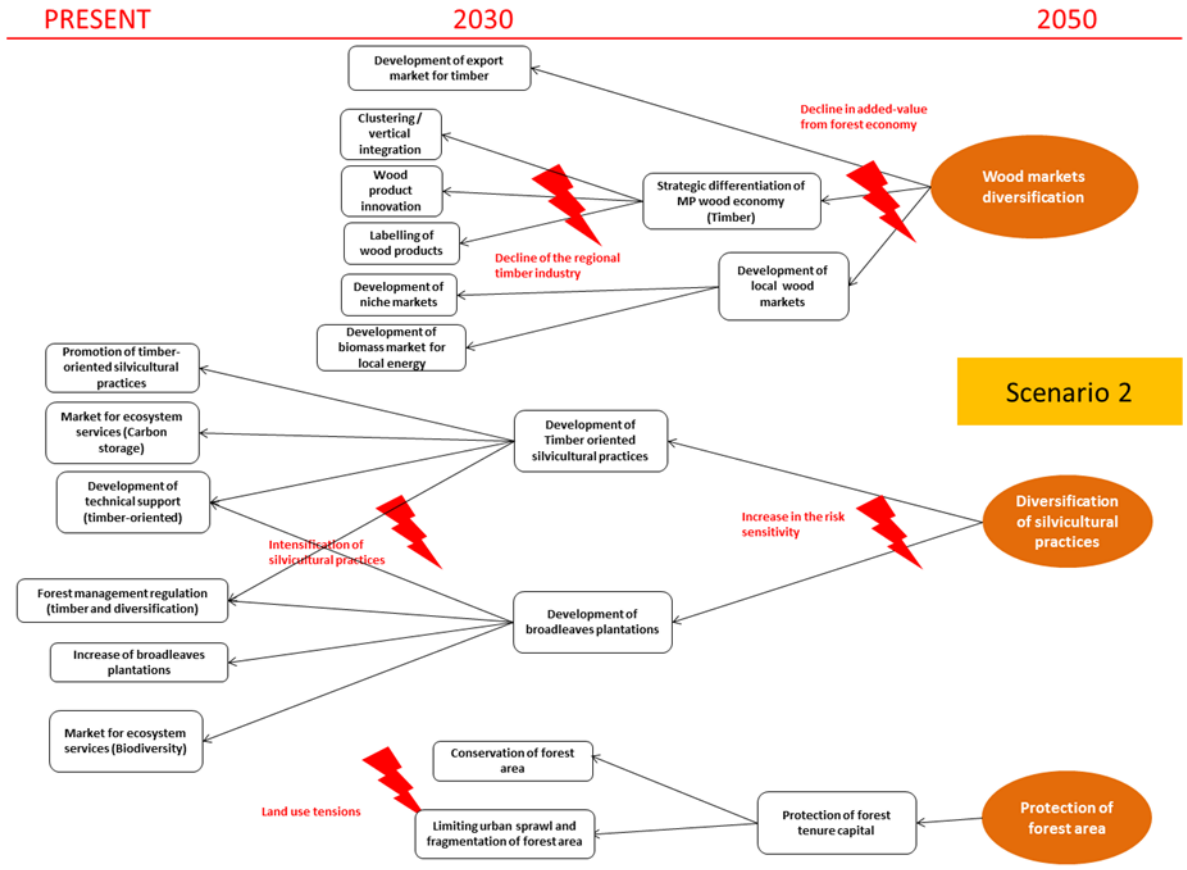
Scenario 2: Biorefinery innovation & land-use tensions



The Scenario 2 is characterised by a high level of forestry entrepreneurship, which is a consequence of the growth in the market of pulp wood. The competiveness of the biorefinery model has here been enabled by a restructuring of pulp and paper industry in face of new market conditions. This development of forestry entrepreneurship has also been supported in the 2020s by public authorities who implemented supply-side policies. But the high intensification of silvicultural practices and the decrease of the timber market (due to a demise of the timber industry) are significant obstacles to the preservation of a diversified, attractive and resilient forest landscape. Similarly the weakness of land-use regulation – in a situation where land use tensions have arisen with agriculture – is a threat for the conservation of forest area.

In this context, we suggest (i) promoting diversification of wood market by encouraging a competitive timber industry, (ii) promoting diversification of silvicultural practices, and (iii) ensuring conservation of forest land use. Forest owners are expected to lead collective actions – supported by public authorities – in order to invest in timber companies, compensating thus the move of capitalistic investments to the biorefinery industry. In addition, national and regional authorities are supposed to deliver a supply-side policy promoting timber oriented management programmes and broadleaved species plantations. Professional organisations – supported by regional authorities – should develop a programme for the certification of voluntary offsetting forest projects. This action

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would also contribute to promote timber oriented management programmes. Finally, forest areas should still be protected by law (clear-cutting regulation) and better integrated into land planning documents.
Considering the situation in the case study (with the impacts of the recent storm), priority should be given to actions dedicated to forest management (diversification of silvicultural practices). But in order to achieve medium-term milestones related to wood market diversification (by 2030), an early implementation of long-term strategies is also needed, with actions in favour of timber industry. Actions related to the protection of forest land use can be implemented only in 2030 when land use tensions have increased significantly.

Table 3: Overview of obstacles and opportunities in scenario 2

CATEGORY	OBSTACLES	OPPORTUNITIES
Social	• Segregation of 'nature' and 'productive' visions • Land-use tensions (agricultural uses)	• Development of forest entrepreneurship (forest owners)
Technological		• Biorefinery developments • Improvement of forest plantations productivity (new species)
Economical	• Timber prices are weak • Lack of investment in timber industry	• Pulpwood prices are high
Political	• Weak land-use regulation	• Public investments in forest management (supply-side policy)

Table 4: Policy actions in Scenario 2

Milestone/objective	**Action**	**Responsibility**	**Type of action**	**Time**
Development of export market for timber	Create forest owners associations (wood sale and forest management)	Forest owners	Collective action	*now*
Clustering/ Vertical integration	Groupings of financial investment by forest owners in wood-processing companies Fiscal incentives for financial investment by forest owners in wood-processing companies	Forest owners National government	Collective action Economical/Financial	*now*
Wood-product innovation	Funding of R&D projects (MP wood for chemistry and building elements)	National and regional governments	Economical/Financial	*now*
Labelling of wood products	Create a regional trade mark	Professional	Collective action	*now*

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		organisations	(Private regulation)	
Development of niche markets	Create forest owners associations (wood sale and forest management) Adapt French public procurement code to promote use of local harvested wood	Forest owners National government	Collective action Laws/regulation	*now* *Now*
Development of biomass market for local energy	Create a biomass marketing association Adapt Heat Fund eligibility rules (Biomass supply conditions)	Forest owners National government	Collective action Laws/regulation	*Now* *Now*
Promotion of timber-oriented silvicultural practices	Incentives (direct payments for timber-oriented practices)	National and regional governments	Economical/Financial	*Now*
Market for ecosystem services (carbon storage)	Certification of voluntary offsetting forest projects	Professional organisations	Collective action	*Now*
Development of technical support (timber-oriented)	Increase support to private forest agency (CRPF) Increase support to 'Massif development plans' (PDM)	National and regional governments National and regional governments	Economical/Financial Economical/Financial	*Now* *Now*
Forest management regulation (timber and diversification)	Promote guidelines for forest management plans (promotion of timber and diversification)	National government	Laws/Regulation	*Now*
Increase of broadleaved species plantations	Incentives (direct payments for broadleaved species plantation)	National and regional governments	Economical/Financial	*Now*
Market for ecosystem services (biodiversity)	Implementation of biodiversity offset schemes	Forest owners	Collective action	*Now*
Conservation of forest area	Strengthening clear-cutting regulation	National government	Laws/Regulation	*2030*
Limiting urban sprawl and fragmentation of forest area	Improving integration of forestry issues in territorial planning documents (SCOT, PLU)	National, regional and local governments	Laws/Regulation	*2030*

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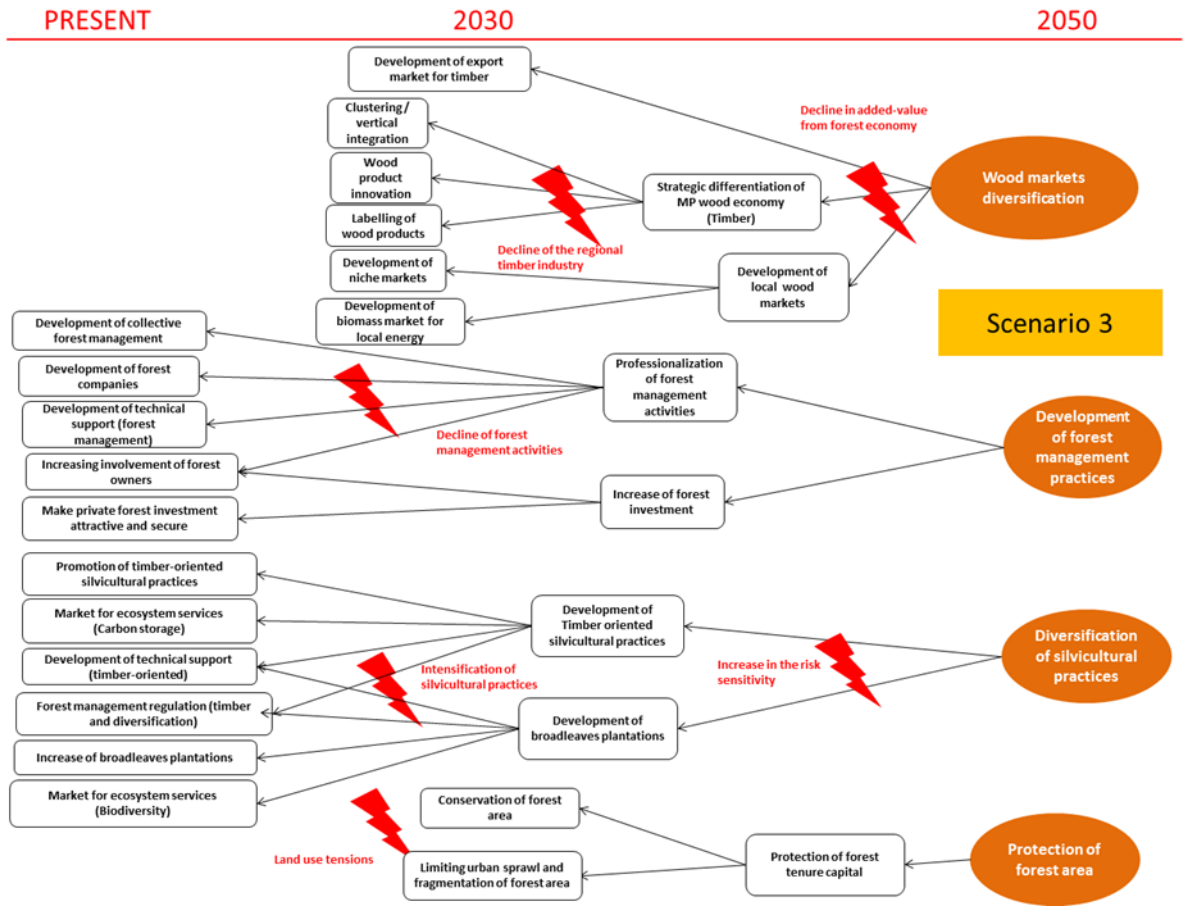
Scenario 3: The European biomass sink



In the Scenario 3 most of the wood-based industries have disappeared and the contribution of the forest economy to the regional GDP is weak. This leads to a financial and political disengagement from regional authorities with respect to wood & forest policy. In this situation wood prices are weak and the forestry sector is dominated by forest companies specialised in the wood-supply of large biorefinery and energy firms located outside the region. Consequently some forest owners disengage from forestry investments while others implement more intensive silvicultural practices to produce wood fuels. Since regional authorities are less concerned by the forestry sector and less committed to protecting forest landscapes, there is an increase of urban pressure on forest areas.

In this context we suggest (i) restoring a competitive timber industry, (ii) promoting forestry entrepreneurship, (iii) promoting diversification of silvicultural practices, and (iv) ensuring protection of forest tenure capital. To curb the decline in the wood based economy, regional authority should support professional organisations, collective actions and technological developments dedicated to the timber industry. We assume that global/structural drivers (international markets and European policy) – which caused the decline of the pulp & energy industry at the regional scale – are too strong to be compensated by policy actions. In order to correct the balance of power in the wood chain, forest owners must collaborate and support actions for forest management and timber marketing.

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National and regional authorities are supposed to deliver a supply-side policy promoting timber oriented management programmes and plantations of broadleaved species. These actions should be implemented for risk prevention and environmental reasons.
Finally, forest areas should still be protected by law (clear-cutting regulation) and better integrated into land planning documents.
Considering the situation in the case study (recent storm), priority should be given to actions dedicated to forest management (diversification of silvicultural practices). But in order to achieve medium-term milestones related to wood market diversification (by 2030), an early implementation of long-term strategies is also needed, with actions in favour of timber industry. Actions related to the protection of forest land use can be implemented only in 2030 when reaching significant levels of urban sprawl.

Table 5: Overview of obstacles and opportunities in scenario 3

CATEGORY	OBSTACLES	OPPORTUNITIES
Social	• Scattered urbanization	• Production vision is dominant • Disengagement of forest owners
Technological		• Biorefinery developments • Improvement of forest plantations productivity
Economical	• Wood prices are weak • Industry concentration in Europe • No market for ecosystem services	• High potential for investment in wood based industry • High development of wood supply chain
Political	• Disengagement of public authorities • Liberalization of European policies (competitiveness and energy transition)	

Table 6: Policy actions in Scenario 3

Milestone/objective	**Action**	**Responsibility**	**Type of action**	**Time**
Development of export market for timber	Create forest owners associations (wood sale and forest management)	Forest owners	Collective action	*Now*
Clustering/ Vertical integration	Groupings of financial investment by forest owners in wood-processing companies Fiscal incentives for financial investment by forest owners in wood-processing companies	Forest owners National government	Collective action Economical/Financial	*Now*
Wood-product	Funding of R&D projects (MP wood	Regional	Economical/Financial	*Now*

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innovation	for chemistry and building elements)	governments		
Labelling of wood products	Create a regional trade mark	Professional organisations	Collective action (Private regulation)	*Now*
Development of niche markets	Create forest owners associations (wood sale and forest management) Adapt French public procurement code to promote use of local harvested wood	Forest owners National government	Collective action Laws/regulation	*Now* *Now*
Development of biomass market for local energy	Create a biomass marketing association Adapt Heat Fund eligibility rules (Biomass supply conditions)	Forest owners National government	Collective action Laws/regulation	*Now* *Now*
Development of collective forest management	Create forest owners associations (wood sale and forest management)	Forest owners	Collective action	*Now*
Development of forest companies	Extend the scope of ONF to private forests management (management contracts)	National government	Laws/Regulation	*Now*
Development of technical support (forest management)	Increase support to private forest agency (CRPF) Increase support to 'Massif development plans' (PDM)	National and regional governments National and regional governments	Economical/Financial Economical/Financial	*Now*
Increasing involvement of forest owners	Increase property taxes	National government	Laws/Regulation	*Now*
Make private forest investments attractive	Fiscal incentives for production-oriented forest investments Labelling forest investments (socially responsible investment)	National government Investors	Economical/Financial Private regulation (Collective action)	*Now* *Now*

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Make private forest investments secure	Improvement in the forest insurance system (Fire, storm, diseases etc.)	Insurance companies	Economical/Financial	*Now*
Promotion of timber-oriented silvicultural practices	Incentives (direct payments for timber-oriented practices)	National and regional governments	Economical/Financial	*Now*
Market for ecosystem services (carbon storage)	Certification of voluntary offsetting forest projects	Professional organisations	Collective action	*Now*
Development of technical support (timber-oriented)	Increase support to private forest agency (CRPF) Increase support to 'Massif development plans' (PDM)	National and regional governments National and regional governments	Economical/Financial Economical/Financial	*Now* *Now*
Forest management regulation (timber and diversification)	Promote guidelines for forest management plans (promotion of timber and diversification)	National government	Laws/Regulation	*Now*
Increase of broadleaved species plantations	Incentives (direct payments for broadleaved species plantation)	National and regional governments	Economical/Financial	*Now*
Market for ecosystem services (biodiversity)	Implementation of biodiversity offset schemes	Forest owners	Collective action	*2030*
Conservation of forest area	Strengthening clear-cutting regulation	National government	Laws/Regulation	*2030*
Limiting urban sprawl and fragmentation of forest area	Improving integration of forestry issues in territorial planning documents (SCOT, PLU)	National, regional and local governments	Laws/Regulation	*2030*

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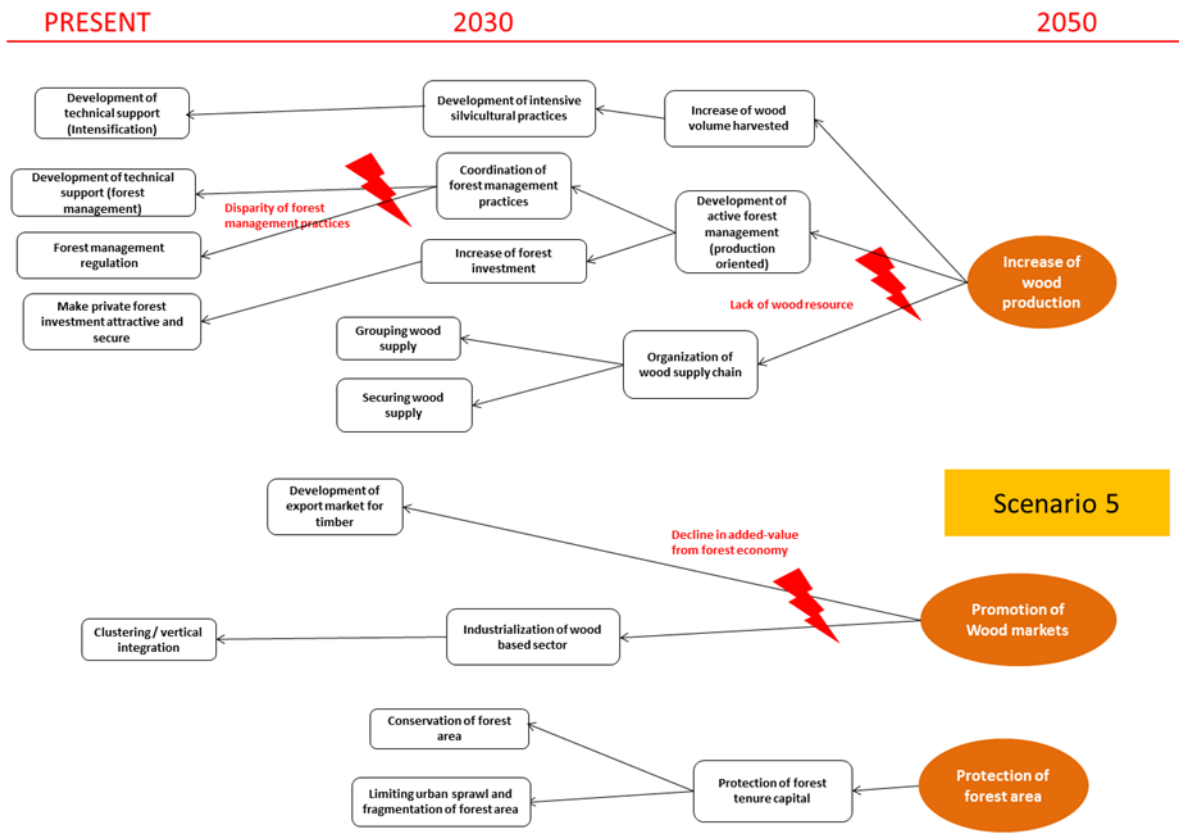
Scenario 5: The Territorial partnership



In the scenario 5 there is potentially a high diversity of forest related territorial strategies at the regional scale. The creation of forest owners associations and the development of niche markets for timber products are opportunities to stimulate forest investments and forestry entrepreneurship. But there a lack of technical skills is still prevalent among forest owners. They implement low-productivity silvicultural programmes and most of them are not involved in the wood supply chain. Local authorities provide fuelwood market opportunities through their support to district heating systems but market opportunities for others forest products remain limited.

In this context we suggest (i) increasing wood production and (ii) promoting development of timber market opportunities. Authorities should increase their technical support to forest owners, to encourage them to invest in forestry and to implement innovative management programmes. In addition, actions should be led by forest owners and local authorities to foster technical innovation and equipment in the timber industry, developing a more competitive wood-based economy.

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Table 7: Overview of obstacles and opportunities in scenario 5

CATEGORY	OBSTACLES	OPPORTUNITIES
Social		• Development of forest owners associations
Technological		• Product innovation (new types of uses for Pines wood)
Economical	• Lack of timber market opportunities	• Niche markets for Pine wood products
Political		

Table 8: Policy actions in Scenario 5

Milestone/objective	**Action**	**Responsibility**	**Type of action**	**Time**
Development of technical support (Intensification)	Funding of R&D projects (Forest genetics, MP silvicultural practices)	National and regional governments	Economical/Financial	*Now*
Development of technical support (forest management)	Increase support to private forest agency (CRPF) Increase support to 'Massif development plans' (PDM)	National and regional governments National and regional governments	Economical/Financial Economical/Financial	*Now* *Now*
Forest management regulation	Promote guidelines for forest management plans	National government	Laws/Regulation	Now
Make private forest investments attractive	Fiscal incentives for production-oriented forest investments Labelling forest investments (socially responsible investment)	National government Investors	Economical/Financial Private regulation (Collective action)	*Now* *Now*
Make private forest investments secure	Improvement in the forest insurance system (Fire, storm, diseases etc.)	Insurance companies	Economical/Financial	*Now*
Grouping wood supply	Create forest owners associations (wood sale)	Forest owners	Collective action	*2030*

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	Incentives for logistics investment (storage platform)	National and regional governments	Economical/Financial	*2030*
Securing wood supply	Promote wood supply contracts Create a regional wood sale committee	Professional organisations Professional organisations	Economical/Financial Collective action	*2030* *2030*
Development of export market for timber	Create forest owners associations (wood sale and forest management)	Forest owners	Collective action	*Now*
Clustering/ Vertical integration	Groupings of financial investment by forest owners in wood-processing companies Fiscal incentives for financial investment by forest owners in wood-processing companies	Forest owners, local authorities National government	Collective action Economical/Financial	*Now*
Limiting urban sprawl and fragmentation of forest area	Improving integration of forestry issues in territorial planning documents (SCOT, PLU)	National, regional and local governments	Laws/Regulation	*2030*

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4.1.3 *List of (policy) actions (step 5)*

The table below list all the actions provided by the different scenario-specific backcasting results (30 actions). In the last column it is mentioned which scenarios are concerned by each action.

Actions can be grouped according to the objectives they are intended to achieve in the backcasting process. Three main objectives have been identified:

Objectives		
Diversification of forestry practices and conservation of forest area	**Increase of wood production**	**Increase of added value from forest economy**

Actions can also be grouped according to their policy aims and targets. This form of categorization is not specific to the backcasting process.

Types of action							
Marketing measures		**Land use regulation**		**Promotion of forest investments**		**Support for forestry modernization**	
Market regulation	Supply chain organization	Land use planning	Regulation of forest management practices	"diversification" investments	"Intensification" investments	Development of technical support	Entrepreneurship of forest owners

Table 9: List of (policy) actions

Actions	Objective	Responsibility	Target group	Type of action	Scenarios
Marketing measures					
Market regulation					
Funding of R&D projects (MP wood for chemistry and building elements)	Wood-product innovation	State / Regional council	R&D institutes	Economical / Financial	1,2,3
Labelling of wood products "*Pin maritime du Sud Ouest*"	Wood-product differentiation	Professional organizations	Wood-processing companies	Collective action	1,2,3

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Groupings of financial investment by forest owners in wood-processing companies (e.g. Business Angels association)	Clustering/ Vertical integration	Forest owners	Forest owners / Wood-processing companies	Collective action	1,2,3,5
Fiscal incentives for financial investment by forest owners in wood-processing companies	Clustering/ Vertical integration	State	Forest owners	Economical / Financial	1,2,3,5
Create forest owners associations (wood sale and forest management)	Development of niche markets	Forest owners	Forest owners	Collective action	1,2,3
Adapt French public procurement code to promote use of local harvested wood	Development of niche markets	State	Public actors	Laws / regulation	1,2,3
Adapt Heat Fund eligibility rules (Biomass supply conditions)	Development of biomass market for local energy	State / Energy agency (ADEME)	energy and wood-processing companies	Laws / regulation	1,2,3
Create a biomass marketing association	Development of biomass market for local energy	Forest owners	Forest owners	Collective action	1,2,3
Supply chain organization					
Create forest owners associations (wood sale and forest management)	Development of export market for timber	Forest owners	Forest owners	Collective action	1,2,3,5
Incentives for logistics investment (storage platform)	Grouping wood supply	State / local authorities	Forest owners / Wood-processing companies / Forest entreprises	Economical / Financial	1,5
Create forest owners associations (wood sale and forest management)	Grouping wood supply	Forest owners	Forest owners	Collective action	1,5
Create a regional wood sale committee	Securing wood supply	Professional organisations	Forest owners / Wood-processing companies / Forest enterprises	Collective action	1,5
Promote wood supply contracts	Securing wood supply	Professional organisations	Forest owners / Wood-processing companies / Forest enterprises	Collective action	1,5
Land use regulation					
Land use planning					

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Improving integration of forestry issues in territorial planning documents (SCOT, PLU)	Limiting urban sprawl and fragmentation of forest area	State / Municipalities	Forest owners	Laws / regulation	2,3,5
Regulation of forest management practices					
Strenghtening clearcutting regulation	Conservation of forest area	State / local authorities	Forest owners	Laws / regulation	2,3,5
Promote oriented guidelines for forest management plans	Forest management regulation	State	Forest owners	Laws / regulation	1,2,3
Promotion of forest investments					
Fiscal incentives for production-oriented forest investments	Make private forest investments attractive	State	Forest owners	Economical / Financial	1,3,5
Labelling forest investments (socially responsible investment)	Make private forest investments attractive	State	Investors	Economical / Financial	1,3,5
Improvement in the forest insurance system (Fire, storm, diseases etc.)	Make private forest investments secure	State / Insurance companies	Forest owners	Economical / Financial	1,3,5
"diversification" investments					
Incentives (direct payments for broadleaved species plantation)	Increase of broadleaved species plantations	State / local authorities	Forest owners	Economical / Financial	2,3
Incentives (direct payments for timber-oriented practices)	Promotion of timber-oriented silvicultural practices	State / local authorities	Forest owners	Economical / Financial	2,3
Implementation of biodiversity offset schemes	Market for ecosystem services (biodiversity)	Investors	Forest owners	Economical / Financial	2,3
Certification of voluntary offsetting forest projects	Market for ecosystem services (carbon storage)	Investors	Forest owners	Economical / Financial	2,3
"Intensification" investments					
Incentives (direct payments for intensive practices)	Promotion of intensive silvicultural practices	State / local authorities	Forest owners	Economical / Financial	1
Support for forestry modernization					
Development of technical support					
Increase support to private forest agency (CRPF)	Development of technical support (forest management)	State / local authorities	Forest owners	Economical / Financial	1,3,5

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Increase support to 'Massif development plans' (PDM)	Development of technical support (forest management)	State / local authorities	Forest owners	Economical / Financial	1,3,5
Funding of R&D projects (Forest genetics, MP silvicultural practices)	Development of technical support (Intensification)	State / local authorities	R&D institutes	Economical / Financial	1,5
Entrepreneurship of forest owners					
Increasing property taxes	Increasing involvement of forest owners	State / local authorities	Forest owners	Economical / Financial	1,3
Create forest owners associations (wood sale and forest management)	Development of collective forest management	Forest owners	Forest owners	Collective action	1,3
Extend the scope of ONF to private forests management (management contracts)	Development of forest companies	State / Forest agency (ONF)	Forest owners	Laws / regulation	1

4.2 Reflection/expert involvement (WP3.3 and WP2.3)

The definition of the robust strategy was not based on the outcomes of the modelling resulting instead from the discussion with experts on the relevance of each action for the future. We decided to consider as robust actions only those which were identified in at least 3 scenarios. This subset of 16 actions was later proposed as the robust strategy.

4.3 List of (policy) actions to be analysed (WP3.3 and WP2.3)

Table 10: List of (policy) actions to be analysed

Actions	Objective	Responsibility	Target group	Type of action	Time frame
Marketing measures					
Promotion of wood product market					
Funding of R&D projects (MP wood for chemistry and building elements)	Wood-product innovation	State / Regional council	R&D institutes	Economical / Financial	Now
Labelling of wood products "*Pin maritime du Sud Ouest*"	Wood-product differentiation	Professional organizations	Wood-processing companies	Collective action	Coming 10 years

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Groupings of financial investment by forest owners in wood-processing companies (e.g. Business Angels association)	Clustering/ Vertical integration	Forest owners	Forest owners / Wood-processing companies	Collective action	Coming 10 years
Fiscal incentives for financial investment by forest owners in wood-processing companies	Clustering/ Vertical integration	State	Forest owners	Economical / Financial	Coming 10 years
Adapt French public procurement code to promote use of local harvested wood	Development of niche markets	State	Public actors	Laws / regulation	Now
Adapt Heat Fund eligibility rules (Biomass supply conditions)	Development of biomass market for local energy	State / Energy agency (ADEME)	energy and wood-processing companies	Laws / regulation	Now
Create a biomass marketing association	Development of biomass market for local energy	Forest owners	Forest owners	Collective action	Coming 10 years
Land use regulation					
Land use planning					
Improving integration of forestry issues in territorial planning documents (SCOT, PLU)	Limiting urban sprawl and fragmentation of forest area	State / Municipalities	Forest owners	Laws / regulation	Coming 10 years
Regulation of forest management practices					
Strengthening clear-cutting regulation	Conservation of forest area	State / local authorities	Forest owners	Laws / regulation	Now
Promote oriented guidelines for forest management plans	Forest management regulation	State	Forest owners	Laws / regulation	Now
Promotion of production-oriented forest investments					
Fiscal incentives for production-oriented forest investments	Make private forest investments attractive	State	Forest owners	Economical / Financial	Now
Labelling forest investments (socially responsible investment)	Make private forest investments attractive	State	Investors	Economical / Financial	Now
Improvement in the forest insurance system (Fire, storm, diseases etc.)	Make private forest investments secure	State / Insurance companies	Forest owners	Economical / Financial	Now
Support for forestry modernization					
Development of technical support					
Increase support to private forest agency (CRPF)	Development of technical support (forest management)	State / local authorities	Forest owners	Economical / Financial	Now

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Increase support to 'Massif development plans' (PDM)	Development of technical support (forest management)	State / local authorities	Forest owners	Economical / Financial	Now
Promotion entrepreneurship forest owners					
Create forest owners associations (wood sale and forest management)	Development of collective forest management & Development of export market for timber	Forest owners	Forest owners	Collective action	Now

Objectives :	**Diversification of forestry practices and conservation of forest area**	**Increase of wood production**	**Increase of added value from forest economy**

4.4 Translating the (policy) actions to the FOT-FMA matrices (WP3.3 and WP2.3)

The list of policy actions given by the Irstea team (WP3.3) was translated into a SB0 matrix by EFIATLANTIC team (WP2.3) using the following table (Table 11). Each action group was discussed and analysed giving it a note (level of importance) for each FMA and FOT based on the BAU scenario, same procedure was made a second time with EFIATLANTIC staff not working on the project in order to have another point of view, then both matrices (notes) were transformed into percentages to better visualise the changes.

Table 11: Robust policy action groups chosen after backcasting.

Action groups	Effect on Forest owners Types	Effect on Forest management Programmes
1. Promotion of wood products market		Actions mainly support timber market All forest owners are encouraged to promote long rotations (>35 years) : P2/P4/P7
2. Land use planning		Action provides extension of conservation areas (riparian areas and peri urban zones) Some forest owners have to give up Pine plantation. They stop management (P6) or they can promote broadleaved species (P8a&P8b)
3. Regulation of forest management practices	Forest owners are more involved in forest management (From G2b to G2a)	Forest owners are encouraged to diversify management programmes implemented at the scale of their property. This action concerns all forest owners, except those who don't have management plans (G3)

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4. Promotion of production-oriented forest investments		High productivity and innovative management programmes are promoted (P4 & P5b). Effect on large private forest owners (G1a & G2)
5. Development of technical support	Forest owners are more involved in forest management (From G2b to G2a)	High productivity and innovative management programmes are promoted (P4 & P5b). Effect on traditionalist forest owners (G2)
6. Promotion entrepreneurship of forest owners	Forest owners join together and are more involved in forest management (From G2b to G2a)	

Table 12: Behaviour matrix for the BAU scenario based on the robustness of policy actions (Pontenx case study).

FMP/FOT	P1	P2	P3	P4	P5	P6	P7	P8a	P8b	No forest
G1A	≈	≈ +	+++	+++	++	+	+	+	++	-
G1B	≈ +	≈ +	++	++	+	+	+	+	++	-
G2A	≈ +	≈ +	+++	+++	++	+	+	+	++	-
G2B	≈ -	≈ +	++++	++++	+++	≈	++	+	+++	-
G3	≈ (+)	≈ +	++	++	++	- -	+	≈	+	≈
G4	≈ -	++	+++	++	++	- -	+	≈	+	≈

A meeting between project partners was held for discussing the matrix and its coherence with the policy actions. Same methodology was applied for the others scenarios.

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Table 13: Behaviour matrix (SB0) for the BAU scenario in Pontenx case study.

		% of area under management programmes inside types												
Owner type	% of total area	P1	P2	P3	P4	P5a	P5b	P6	P7	P8a	P8b	No forest	No MGT	Sum
G1A	30	3,4	40,9	15,2	10,8	6,4	5,7	2,9	3,9	3,6	6,4	0,3	0,4	100
G1B	13	47,5	14,5	6,2	4,9	3,1	0	3,9	4,9	0	15	0	0	100
G2A	26	15	35,4	12,1	8,2	5,5	4,8	3,4	2,3	7,3	4,9	0	0,9	100
G2B	17	12,6	37,4	10	9,5	3,6	2,6	1,9	4,1	8,3	9,2	0	0,8	100
G3	12	8,1	28,9	4,4	2,1	4,1	0	25,2	2	16,4	7,3	1,1	0,3	100
G4	2	46,4	3,9	7,9	4,5	7,4	0	13,2	1,2	10,4	4,5	0,2	0,4	100
Sum	100	14,9	33,4	10,9	8	5	3,4	5,9	3,4	6,6	7,7	0,2	0,6	100

Table 14: Behaviour matrix (SB1) based on robust policy action groups for the S1 in Pontenx CSA.

SB1[1]		% of area under management programmes inside types										
Owner type	% of total area	P1	P2	P3	P4	P5a	P5b	P6	P7	P8a	P8b	No forest
G1A	30	3	44.1	3.9	35.5	2.7	2.5	0	1	4.4	2.1	0,3
G1B	13	66	13.6	6.2	0	2.9	0	1.8	0	0	9.5	0
G2A	25	7.2	39	1.8	34.1	1.5	0.9	2.6	1.6	7.3	2.7	0,4
G2B	17	13.7	40	2.2	23.4	1.9	2.8	1.5	1	8.4	3.7	0,2
G3	13	3.8	15.2	9.7	8.4	2.6	2.5	34.8	0	14	8	0,8
G4	2	71.5	2.1	0	0	0	0	15.1	0	9.4	1.2	0,2

Table 15: Behaviour matrix (SB2) based on robust policy action groups for the S2 in Pontenx CSA.

SB2[1]		% of area under management programmes inside types										
Owner type	% of total area	P1	P2	P3	P4	P5a	P5b	P6	P7	P8a	P8b	No forest
G1A	30	0	5.3	22.6	39.9	10.9	6.8	5	1.5	5.7	1.5	0,4
G1B	13	64.4	7	7.9	5.9	4.5	0	1.8	0	2.3	6.1	0
G2A	25	0.5	2.1	19.7	51.4	9.8	6.8	0	0.4	6.7	1.4	0,5
G2B	17	15.1	0	19	34.5	10.3	7.8	2	0	8.3	1.8	0,2
G3	13	0	0.5	11.9	34.5	0	1.1	29.1	0	17.5	3.9	1,3
G4	2	41.1	0	0	31.9	0	0	15.4	0	9.4	1.5	0,2

[1] Red FMPs lose area percentage and the green ones gain area percentages.

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Table 16: Behaviour matrix (SB3) based on robust policy action groups for the S3 in Pontenx CSA.

SB3[1]		% of area under management programmes inside types										
Owner type	% of total area	P1	P2	P3	P4	P5a	P5b	P6	P7	P8a	P8b	No forest
G1A	30	2	27.2	25.6	6.7	14.1	8.7	8.5	1.6	3.6	1.3	0,3
G1B	13	74.4	5.9	0	0	5.7	4.8	1.8	0	1.3	6.1	0
G2A	25	1.2	35.4	20.4	4.6	9.3	6.7	12.6	0.1	6.7	1.5	0,5
G2B	17	6.5	24	25.6	3.2	10.4	6.9	12	0.4	8	1.8	0,2
G3	13	4.1	19.6	11.1	0	1.8	3.3	41.9	0	13.8	3.2	0,7
G4	2	68.1	0	0	0	0	0	9.2	0	9.4	12.6	0,2

Table 17: Behaviour matrix (SB5) based on robust policy action groups for the S5 in Pontenx CSA.

SB5[1]		% of area under management programmes inside types										
Owner type	% of total area	P1	P2	P3	P4	P5a	P5b	P6	P7	P8a	P8b	No forest
G1A	30	24	44.3	3.2	9.3	2.7	1.6	0	0.5	3.6	10.1	0,3
G1B	13	75.9	5.9	0	3.8	0	5.5	1.8	0	0.9	6.1	0
G2A	25	21.8	48.2	1	2.2	1	0.7	3.1	0.7	7.9	12.1	0,5
G2B	17	24.4	48.8	0.9	2.7	0	0.8	1.8	0	8	11.5	0,2
G3	13	14.6	20.3	0.2	0.6	0	0.5	31	0	17.1	14.3	1,2
G4	2	8.5	52.1	0	0	0	0	4.8	0	9	24.7	0,3

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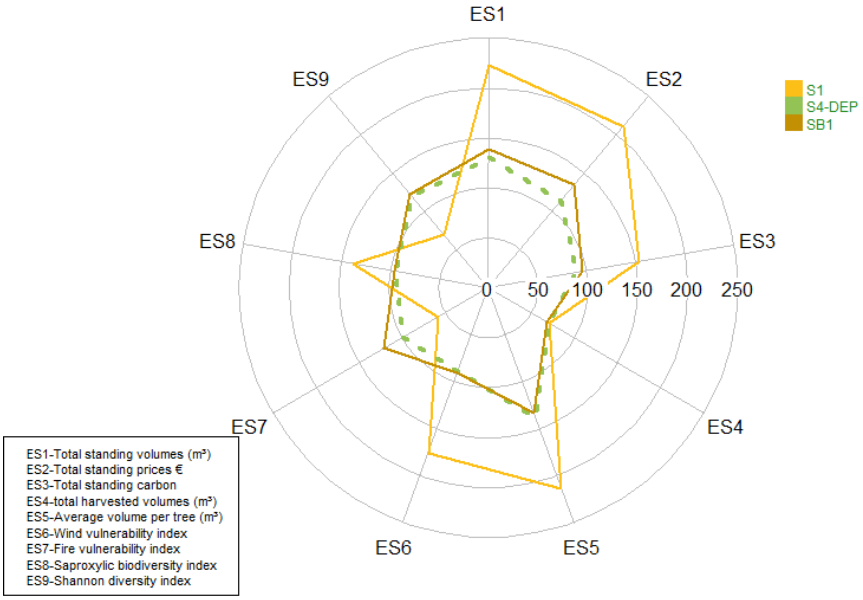
4.5 Simulation results (WP3.3 and WP2.3)

In the Pontenx case study, the Ecosystem Services are integrated in the DSS tools and provided directly as indices associated with each stand, there are also other indicators which allow to interpret in a easier and better way the impacts of scenarios on the provision of Ecosystem Services.

The most robust policy action groups applied to the initial matrices will show the effect of these actions into the ES. Scenarios should follow the trend of scenario 4, chosen as the *desired endpoint*, nevertheless there are some scenarios which are far away from this trend since the beginning; it is then very complicated to bring them "back". A radar for year 2048 was created for each scenario in order to better visualize the connection between S4 (called S4-DEP from now on) and the other scenarios:

Figure 17. Ecosystem Services situation for *scenario 1* (before and after backcasting) compared to the *desired endpoint*. Pontenx case study, year 2048.



The policy action groups applied to *scenario 1* did have an impact on the ES. We can see that at the beginning the total standing volume was very high, traditional forest management was leading but the market was not very successful, then the promotion of wood products took place and a positive effect on the timber market was created. Same impact on the wind vulnerability risk, the regulation of forest management practices has generated a diversification of the FMPs and forest owners are more involved followed by a reduction of the wind risk.

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Figure 18. Ecosystem Services situation for *scenario 2* (before and after backcasting) compared to the *desired endpoint*. Pontenx case study, year 2048.

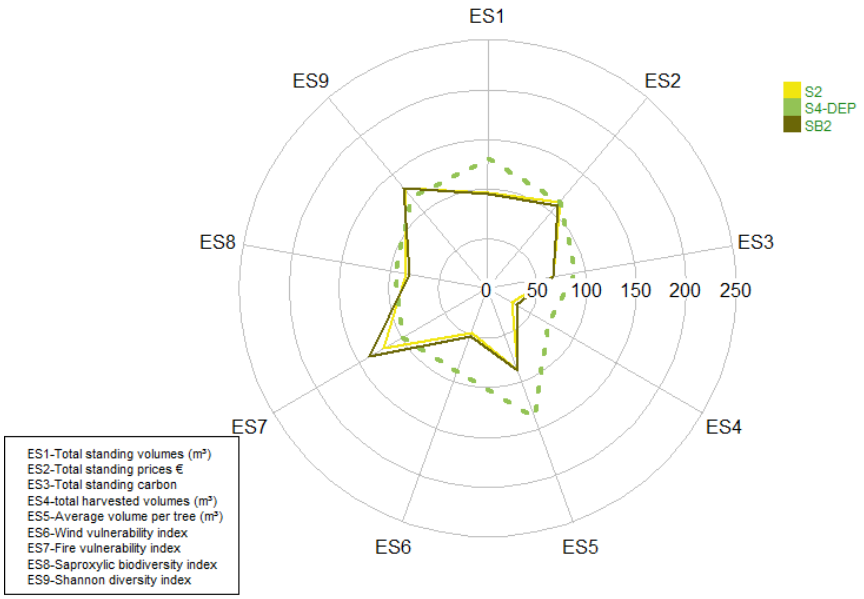
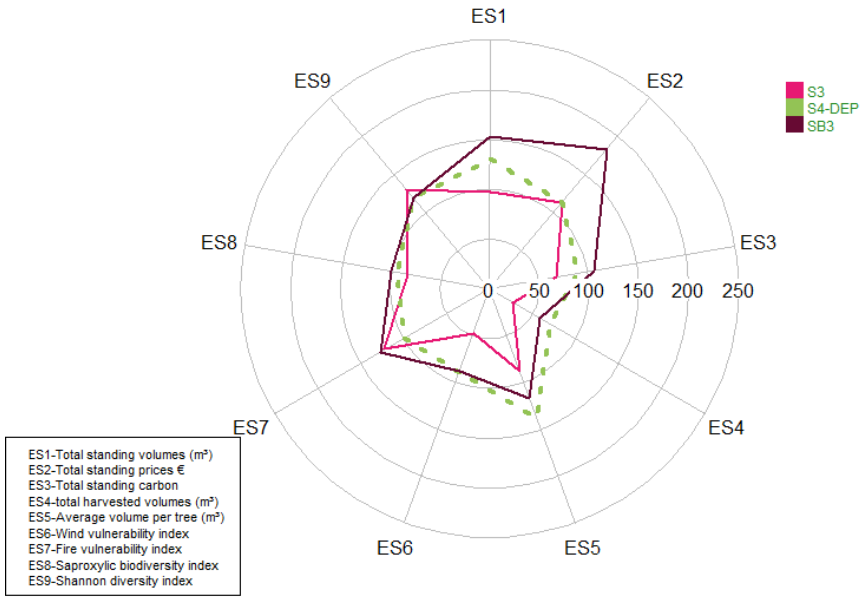


Figure 19. Ecosystem Services situation for *scenario 3* (before and after backcasting) compared to the *desired endpoint*. Pontenx case study, year 2048.



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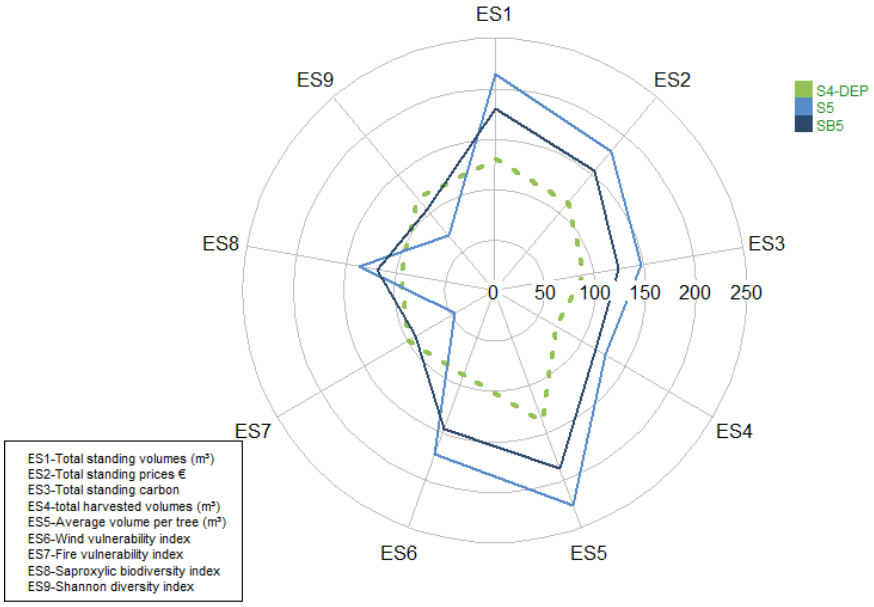
For *scenario 2* the situation does not change much, we can clearly see that the policy action groups have no impact on the ES, this does not mean that the action groups are not robust but as it was said before, the *scenario 2* was already far away from the *desired endpoint*, the behaviour of FOT and FMPs could be modify but the changes are not sufficient enough to bring back the scenario into the desired endpoint trend.

A different panorama can be observed in *scenario 3*: before the action groups were applied, the situation of ES was similar to *scenario 2*, then instead of get closer to the desired endpoint, it gets farther. However, there are some ES which are impacted by some of the actions, for example, the land use planning and the diversification of FMPs have a positive impact on biodiversity (ES8 & ES9).

Figure 20. Ecosystem Services situation for *scenario 5* (before and after backcasting) compared to the *desired endpoint*. Pontenx case study, year 2048.



Ecosystem services in scenario 5 are more balanced compared to the situation before the backcasting, the action groups did have an impact then. Yet, the initial situation did not allow a drastic change of this scenario trend.

For a better understanding of each scenario behaviour, a comparing table (Figure 21) with all Ecosystem services for all scenarios was created, and in chapter 2.3 there is a detailed explanation about the initial situation of the ES for all scenarios.

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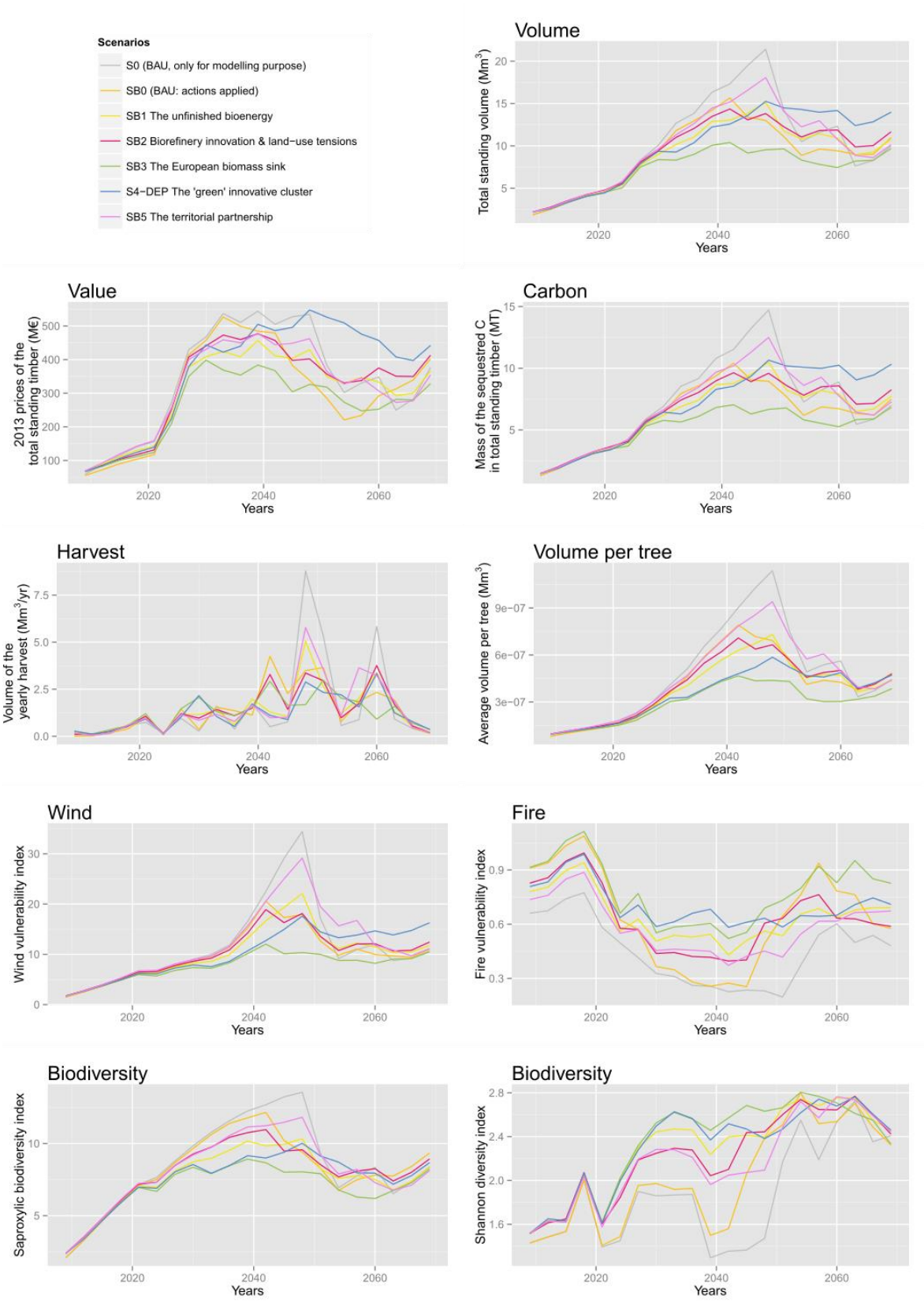

Figure 21. Comparison of ES between scenarios after application of the most robust policy action groups in the Pontenx case study.

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4.6 Assessment of the integrativeness of forest management under different scenarios and policy actions (WP2.3)

The word integrativeness in this chapter is understood as how all the ecosystem services are maximised over all the area, and the risk indices are minimised. This segregated use of space is more theoretical, than practical at the scale we are working on, as shown in the Pontenx CSA maps (Figure 22 to Figure 28), and in addition the coastal zone with less productive dunes generate a natural segregation.

Comparing the management options proposed in the study, we can consider that the various management options are not serving in the same way the different indicators. The ranking bellow is less meaningful at the stand level than at the landscape level (as explained in previous chapter) but it can contribute to understand the integrativeness of the diverse management options. The table below, tries to summarise if a management option is rather neutral, positive or negative a the stand level for each ES: standing volume (ES1), stumpage price (ES2), carbon in trees (ES3), harvested volumes (ES4), stem volume (ES5), wind vulnerability (ES6), fire vulnerability (ES7), saproxylic biodiversity index (ES8), Shannon diversity index (ES9).

Table 18: Ranking of the Ecosystem services according to each forest management option.

Management option	ES1	ES2	ES3	ES4	ES5	ES6	ES7	ES8	ES9
P1-Pine/high-quality: high-quality timber. 60 years. Broadleaved species preservation, diversified wooded undergrowth	+	+	+	-	+	-	+	+	+
P2-Pine/standard:'classic' silvicultural scenarios. 45 years	+	+	**N**	**N**	+	-	**N**	**N**	**N**
P3-Pine/short term: management dedicated to pulpwood, 25 years	-	-	-	+	-	+	-	-	-
P4-Pine/half-dedicated to biomass: biomass at 9 years, Timber at 35 years	**N**	**N**	-	**N**	**N**	**N**	-	**?**	-
P5a-Pine/biomass: high-density, short term silvicultural scenario aimed at biomass production. 8-12 years.	-	-	-	+	-	+	-	-	-
P6-Pine/no management: site preparation and regeneration, followed by a minimal involvement (no thinning, erratic harvest).	+	-	+	-	-	-	-	+	+
P8a-Broadleaved species /riparian oaks: even-aged management of *Q. pedunculata* (and other oaks) in riparious areas.	+	**N**	+	**N**	+	-	+	+	+
P8b-Broadleaved species /lowland oaks: even-aged management of *Q. pedunculata* (and other oaks) on the sandy plateau.	-	-	-	-	-	+	+	+	+

+ : better, - : worse, N : neutral, ? not known

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As a consequence of this table, the ratio of the management options according to the scenario implemented will affect significantly the results on the Ecosystem Services. As we can see, none of the option is fully integrative at the stand level, so the only way to assess if there is a specialisation is to look at how the management plans will be applied at the landscape level using maps. In each scenario, the random sampling to affect a management plan was stratified on existing stands, forest owner type, and suitability of sites.

As a result of this visual assessment, we can see that we have three types of situations, a group of scenarios leading to an integrative system resulting from a large diversity of management programmes all over the landscape, as in the case of the *scenario SB0* to scenarios such as the business as usual (BAU) where the use of land is very segregated with only one type of management option on large contiguous areas.

Scenario	**Policy action/strategy**	**Spatial integrativeness of forest management**
S0 (Business as usual)	*no (initial matrix)*	*Prevailingly segregative with large areas dedicated to the same silvicultural regime (P2), the only heterogeneity will come from discrepancies in thinning ages and sites indices.*
S1-S4	*Action supporting biomass market and intensive silvicultural practices*	*Prevailingly segregative in this scenario, the situation is quite similar to the S0, with large areas dominated by P4. But P4 management will generate lot of diversity in the landscape. In S1 types scenario, the landscape is split in 3 areas, but again P4 is widely used.*
S2-S3-S5	*Action grouping wood supply and making private investment attractive, promoting diversification of silvicultural practices*	*Prevailingly integrative, big patches with the same type of management.*
SB0	*Action promoting diversification of silvicultural practices*	*Extremely integrative: a large diversity of management options scattered all over the landscape with a fine grain, even in the dune stands.*

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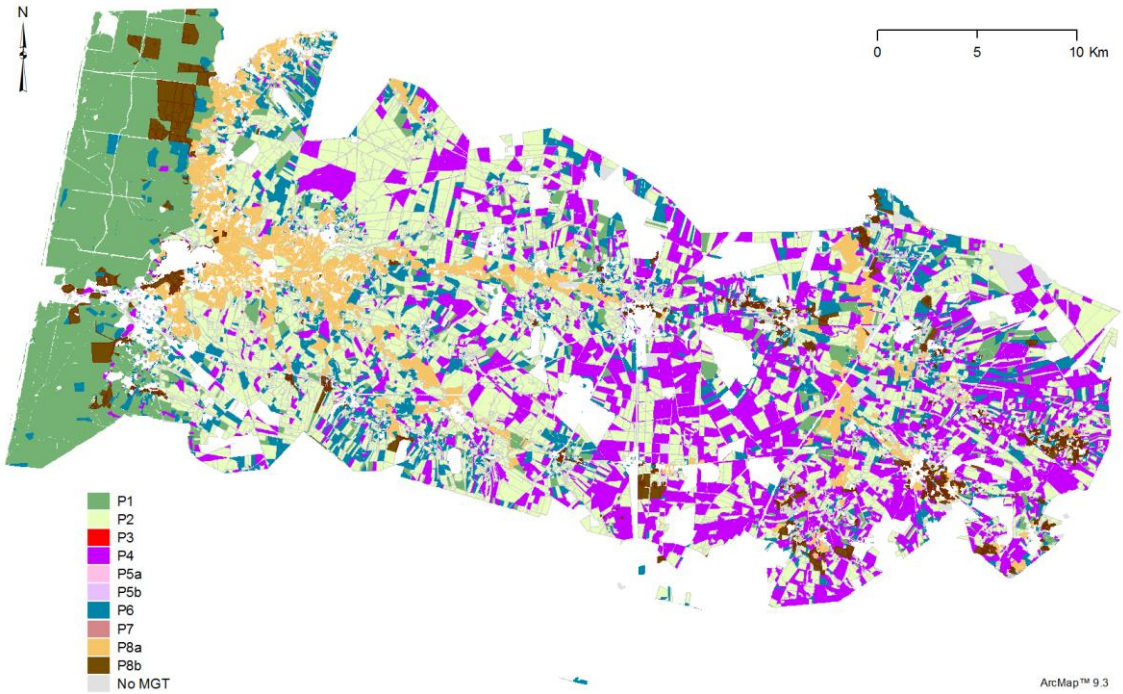

Figure 22. Reshuffle of the Forest Management Programmes for scenario 1 (Pontenx case study).

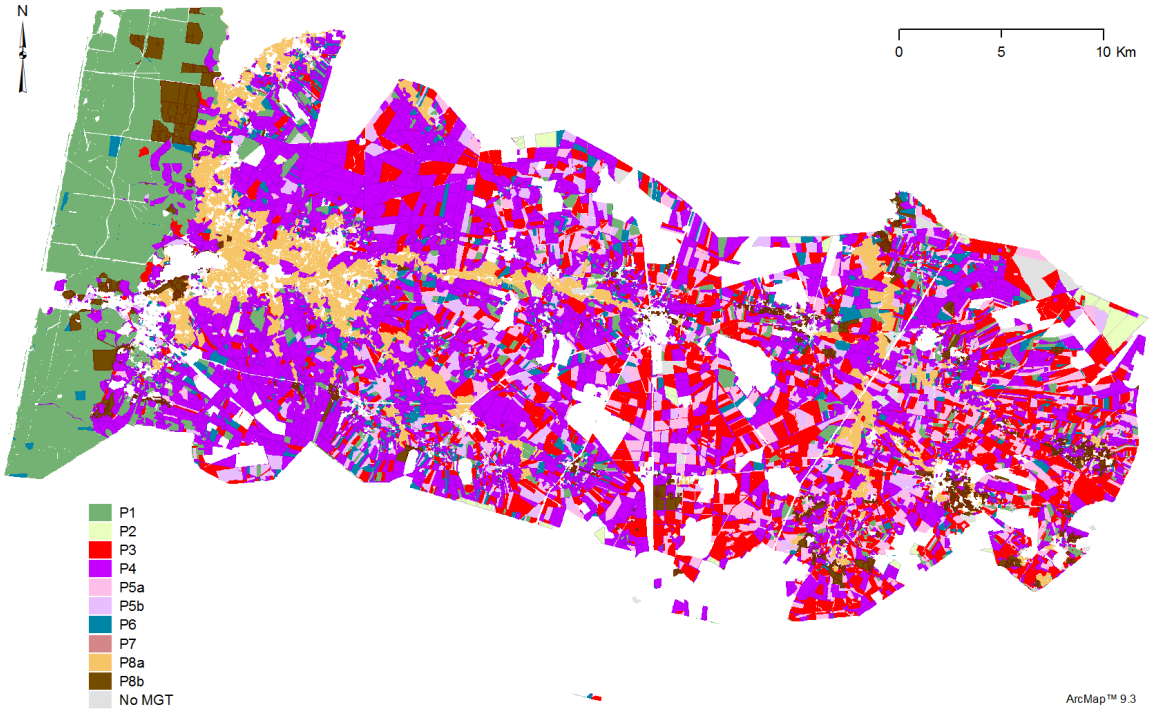

Figure 23. Reshuffle of the Forest Management Programmes for scenario 2 (Pontenx case study).

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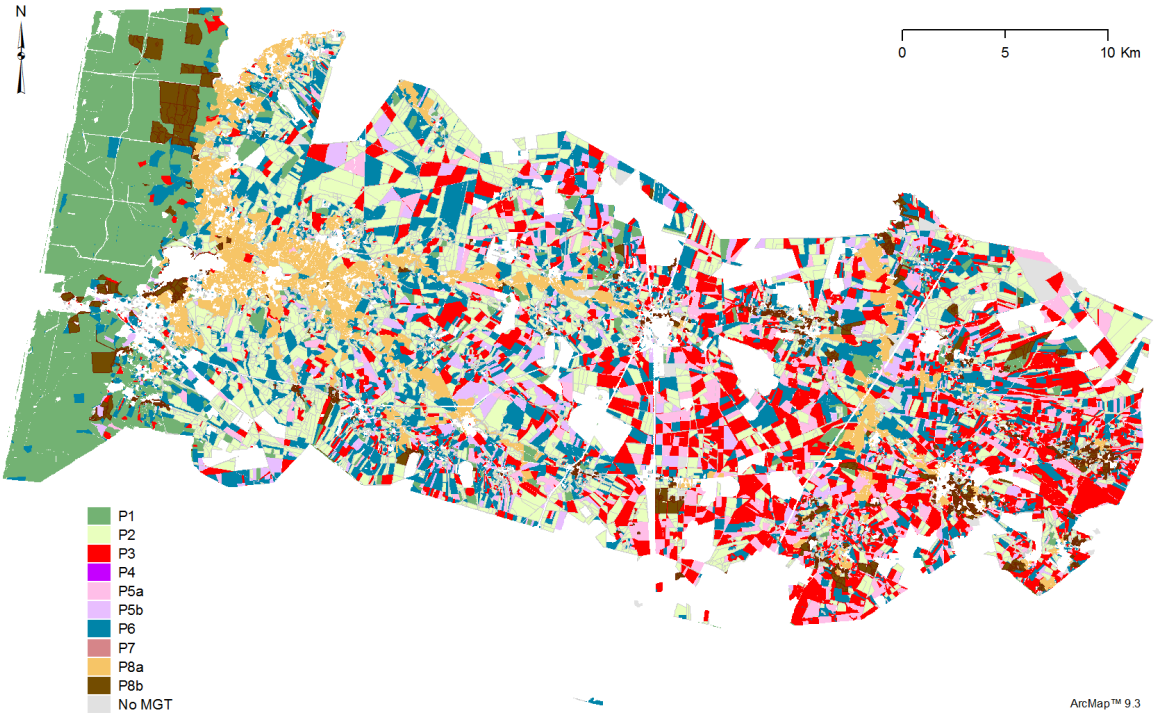

Figure 24. Reshuffle of the Forest Management Programmes for scenario 3 (Pontenx case study).

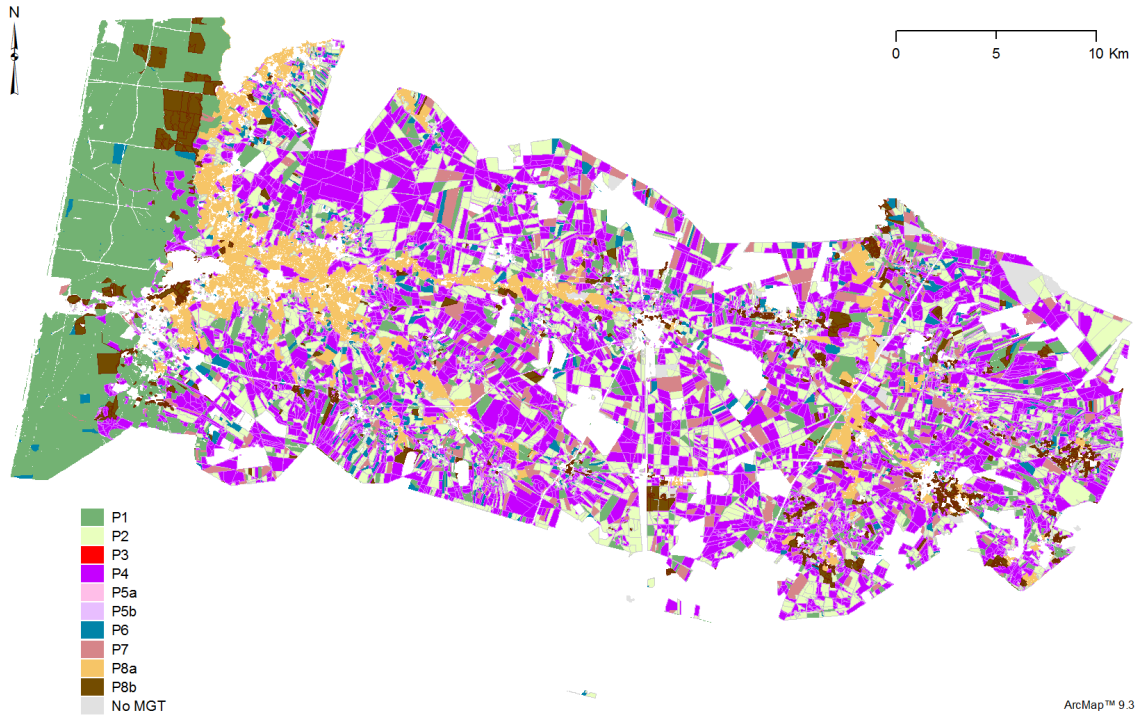

Figure 25. Reshuffle of the Forest Management Programmes for scenario 4 (Pontenx case study).

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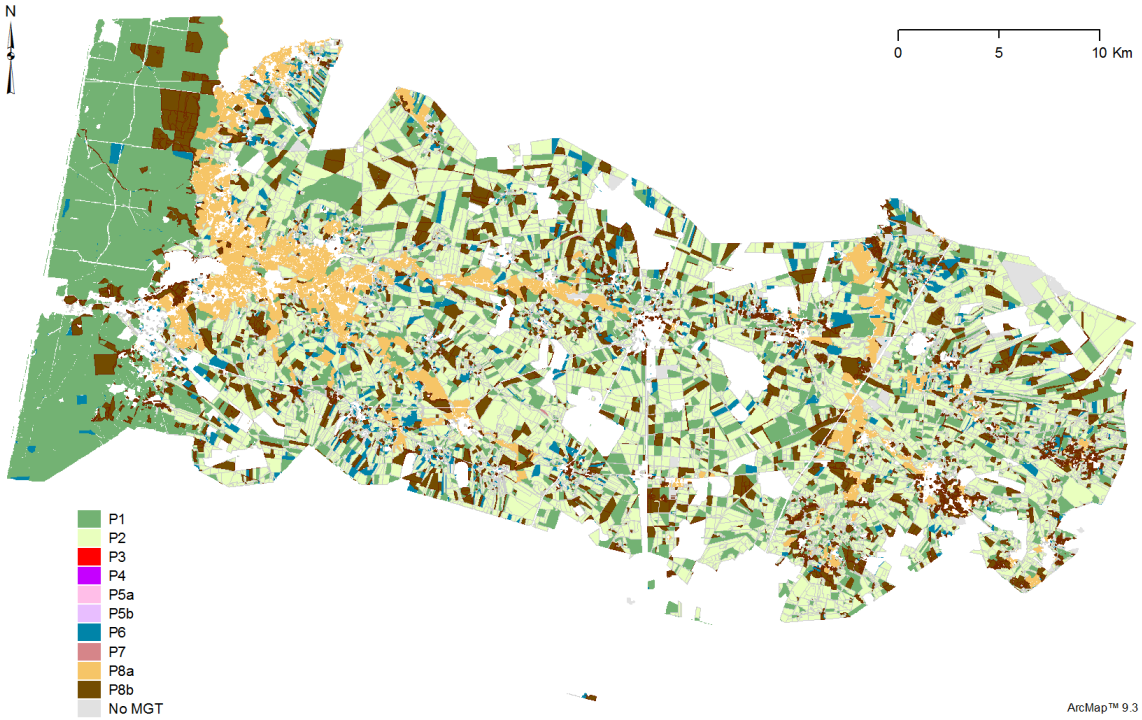

Figure 26. Reshuffle of the Forest Management Programmes for scenario 5 (Pontenx case study).

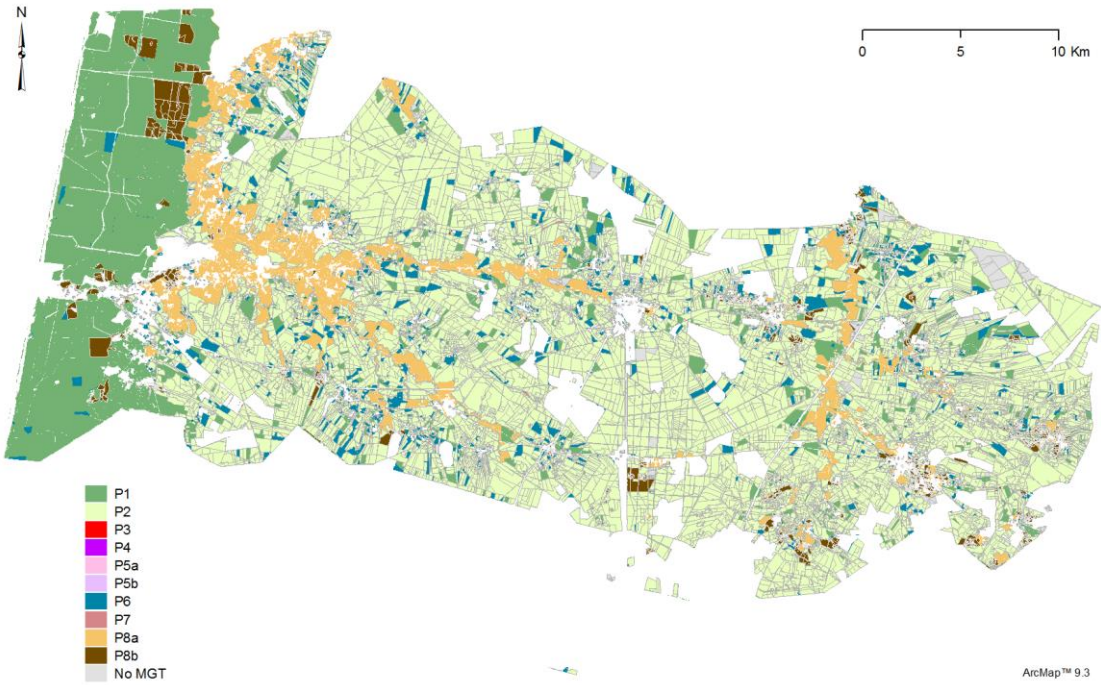

Figure 27. Forest Management Programmes at S0 (BAU), for the Pontenx case study.

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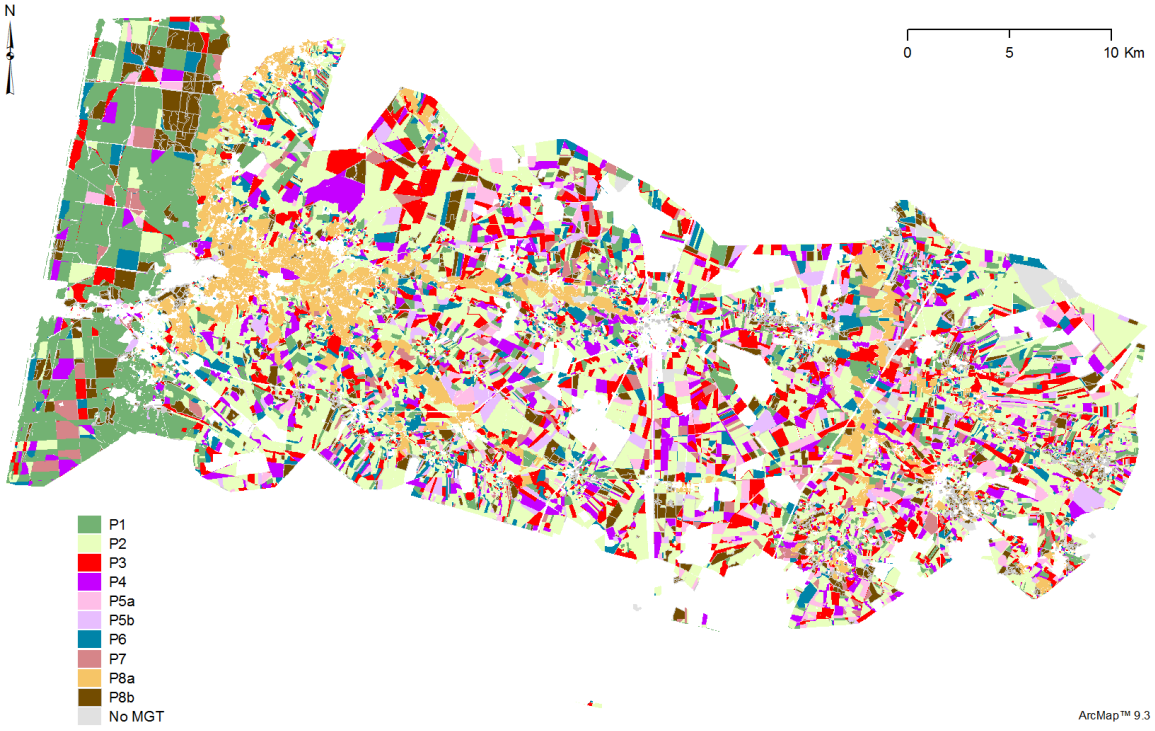

Figure 28. Reshuffle of the Forest Management Programmes for the desired endpoint (Pontenx case study).

In addition to the maps assessment, it is interesting to look at the Shannon diversity index based on the different types of land cover (pine age classes) and their proportion, it gives a proxy for the landscape heterogeneity. As we are in a situation with most of the forest having been devastated by the storm, the case study area will evolve a lot over time depending on plantation regimes. The Shannon diversity index graph (Figure 12) shows that scenarios SB0, S2 and S3 present a clear advantage on the early stages, but after time, the benefit of this heterogeneity is not captured anymore by our indicator.

4.7 **Robust roadmaps & strategies (WP3.3 and WP2.3)**

Two different roadmaps have been identified. The first one corresponds to the scenario 4 as during workshop n°1 the stakeholders confirmed that the balance of ES in the S4 displays substantial similarities with their desired end point (cf. 2.2 for a short description of the S4 and section Appendices for a description of the full scenario). The second one is the result of the backcasting process. This robust roadmap is composed by the set of actions transmitted to WP2.3. Despite simulation results demonstrate that effects of these actions differ from scenario to scenario, we have no way of modifying this set of action to improve its efficiency. In fact, the modelling exercise evaluates the whole strategy and not each action one by one.

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Table 19: Roadmap of actions for 'Pontenx (France)' case study

Actions	Responsibility	Type of action	Time frame	Influences
Funding of R&D projects (Maritime pine wood for chemistry and building elements)	State / Regional council	Economical / Financial	Now	R&D institutes
Labelling of wood products	Professional organizations	Collective action	Coming 10 years	Wood-processing companies
Groupings of financial investments by forest owners in wood-processing companies	Forest owners	Collective action	Coming 10 years	Forest owners / Wood-processing companies
Fiscal incentives for financial investments by forest owners in wood-processing companies	State	Economical / Financial	Coming 10 years	Forest owners
Adapt French public procurement code to promote use of local harvested wood	State	Laws / regulation	Now	Public actors
Adapt Heat Fund eligibility rules (Biomass supply conditions)	State / Energy agency (ADEME)	Laws / regulation	Now	energy and wood-processing companies
Create a biomass marketing association	Forest owners	Collective action	Coming 10 years	Forest owners
Improving integration of forestry issues in territorial planning documents	State / local authorities	Laws / regulation	Coming 10 years	Forest owners
Strengthening clear-cutting regulation	State / local authorities	Laws / regulation	Now	Forest owners
Promote oriented guidelines for forest management plans	State	Laws / regulation	Now	Forest owners
Fiscal incentives for production oriented forest investments	State	Economical / Financial	Now	Forest owners
Labelling forest investments (socially responsible investments)	State	Economical / Financial	Now	Investors
Improvement in the forest insurance system	State / Insurance companies	Economical / Financial	Now	Forest owners
Increase support to private forest public agency	State / local authorities	Economical / Financial	Now	Forest owners
Increase support to 'Massif Development plans'	State / local authorities	Economical / Financial	Now	Forest owners
Create forest owners associations (wood sale and forest management	Forest owners	Collective action	Now	Forest owners

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5 Discussion and conclusion

5.1 Backcasting workshops (WP3.3)

In practice, it has been really difficult for the attendees of the backcasting workshops to fully take into account the frame of the scenario and to project themselves in the future. By construction, most of the items identified as obstacles or opportunities were related to the present situation and experts acknowledged they remained more concerned by the short term issues than by hypothetical future changes in the forest management context. Moreover, it has also been difficult to consider the development of wood based industry as a structural factor (and thus as an independent variable) given that most of them estimated that it is the main issue in the regional context.

5.2 Assessing impacts using models (WP2.3)

Since 1983 foresight studies have been presented to the stakeholder in the Aquitaine region. In most cases, the theoretical framework was based on changes in the economic drivers and could only conclude on qualitative impacts, without very rough hypothesis on the wood supply and landscape consequences base on the actual situation. With the INTEGRAL project, a significant progress has been achieved, giving to the stakeholders the opportunity to visualise the consequences of major changes in policies and in behaviour, taking into account the spatial and social heterogeneity of actors.

This lead to a better understanding of the possible consequences of the political decision, and also it allows to imagine a diversity of potential future trajectories that are not always considered as in most cases, the business as usual is foreseen as the main option; one of the tool weakness proposed at the moment is that climate change impact should be included when making projections on 50 years.

On the technical side, this project has demonstrated the relevance of the SIMMEM tools and the CAPSIS platform to achieve such a work. Some improvements are still needed to reach a higher level of precisions if we want to use the tool for real resource assessment, but in relative approaches to compare scenarios between others, it has provided a reliable set of information.

New landscape indicators have been produced within the project, revealing the relevance of landscape modelling to address the complexity of territorial changes.

So the INTEGRAL project added value is clearly in the quantitative assessment of the impacts from policy changes thanks to the models, even if the use of these simulation outcomes could not always been used as intensively as wished due to the constraints of backcasting method.

5.3 Expert involvement (WP3.3 and/or WP2.3)

The experts have contributed to the discussion on the relevance of the different actions and they have been involved in the definition of the robust strategy. During this step we faced two main challenges.

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Firstly, too many actions were identified for each scenario and these actions were too specific. Therefore it has been really difficult to have a strategic thought identifying the key issues in terms of policy orientation. Probably the discussion with the experts would have been more interesting had we selected a short list of less-specific actions. The debate could have focused on the priority actions (e.g. demand-side or supply-side policy, increasing entrepreneurship of forest owners or developing forest companies, regulating forest management practices or promoting support to forestry innovation etc.) and on the governance design (e.g. state/regional or local government, market-based measures or command-and-control, empowerment of professional organizations etc.).

Secondly, some confusion remained between the actions that were supposed to be implemented in the scenarios and the actions we suggested to curb the trajectories of the scenarios (which was the purpose of the backcasting exercise). In fact the robust roadmaps deal with corrective actions but many actions –considered by experts as essential – are not mentioned in this roadmap, considering that they will be implemented in most of the scenarios. This methodological feature of the backcasting process has been difficult to explain to the experts.

5.4 **The robust roadmaps (WP3.3 and WP2.3)**

The robust roadmap which results from the backcasting analysis for 'Pontenx' case study provides element for reflection for further developments of the French forest policy.

- Forest related policies have long been criticized for being more focused on the demand side (wood consumption for energy uses) than on the supply side (forest production). Here, it is suggested that demand-side policy is needed in the future but it has to support all wood processing companies (not only energy plant) and it should involve forest owners to a greater extent in the industrial process.
- The public funds devoted to forest investments are decreasing and will certainly remain very low in the coming years. In this context, public means should be focused particularly on technical support in order to compensate for the lack of investment of a part of the forest owners. Alongside this action, entrepreneurship of forest owners should be promoted through clustering arrangements and private investment in forestry should be encouraged.
- Forest landscape is supposed to be a rather well protected area but, in some places, land use tensions still exist and are expected to increase further in the future. To prevent these forest landscapes from fragmentation, and more broadly, to improve coherence between forest management orientations and urban development or environmental conservation plans, forest areas should be better integrated in territorial planning documents.
- Regarding governance related issues, the robust roadmap indicates that the state is going to remain the key political authority in the future. In fact, many actions need institutional reforms (e.g. law, fiscal rules etc.) to be implemented for which the state is responsible. In this situation, we assume that regional authority will be responsible for monitoring forest policy but especially for adapting the national framework to local situations (e.g. promoting Maritime pine wood in Aquitaine etc.). The robust roadmap also suggests that forest owners and professional organization should be more involved in the policy framework through collective actions.

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7 Appendices

(Full) Scenario 4: The 'Green' innovative cluster

By 2045, the local forestry wood chain is mainly focused on green chemistry and a number of innovative small-scale sawmills and green building contractors. These changes are accompanied by a strengthening of sectoral coordination, and the institutionalisation of "eco-friendliness" requirements, supported by both regulation and market-based instruments. Support from European and local authorities is also focused on promoting sustainable silviculture, the use of wood materials in construction, protecting biodiversity, and communicating with the general public. In Aquitaine, these changes were monitored particularly closely by the authorities, because of the corresponding drop in demand for pulpwood and increase in revenue generated by the residential economy. As the Landes forest region has become more and more of an attractive place to live, maintaining its landscape attributes and environmental quality has become a priority for the regional authorities.

The growing influence of eco-labelling has increased production costs, and there is greater regulation of forest management. Looking at this situation from a sociological perspective, there have been clear changes: forest owners, attracted by fairly lucrative contracts awarded to them as part of new energy and climate policies, have seen their influence grow. In addition to this, those who have signed up to particular environmental charters can now access carbon and wood markets that are subject to ecological certification.

The effects of these changes are accentuated by the arrival of younger, more urban entrepreneurs looking to earn money by developing new ecosystem services. The maritime pine remains the tree of choice, with most development work aimed at improving its reliability as timber for use in both green building and green chemistry (particularly in terms of its long fibers, used to produce specialty pulp). There is also growing emphasis on hardwood timber, which has resulted in greater numbers of broadleaf species being planted, especially black locust.

The forest is now one of the main reasons why the Landes region is so attractive, mainly due to its contribution to mitigation strategies, its role in making ecosystems more resilient, and the general quality of life it brings to local residents. While this represents a certain synergy between users and stakeholders in terms of ecosystem services, it does not represent full-scale multifunctionality.

While there are more and more specific zones dedicated to biodiversity and recreational use, they generally tend to be located in coastal areas or around lakes and rivers. The inland part of the Landes region is still seen as a sanctuary for traditional forestry activities, with its own set of production targets. The "cultivated forest" in the region continues to play a role in maintaining the territorial equilibrium, helping to preserve natural resources, and protecting a variety of ecosystems. This is achieved through contracts between forest owners and various local authorities in coastal areas.

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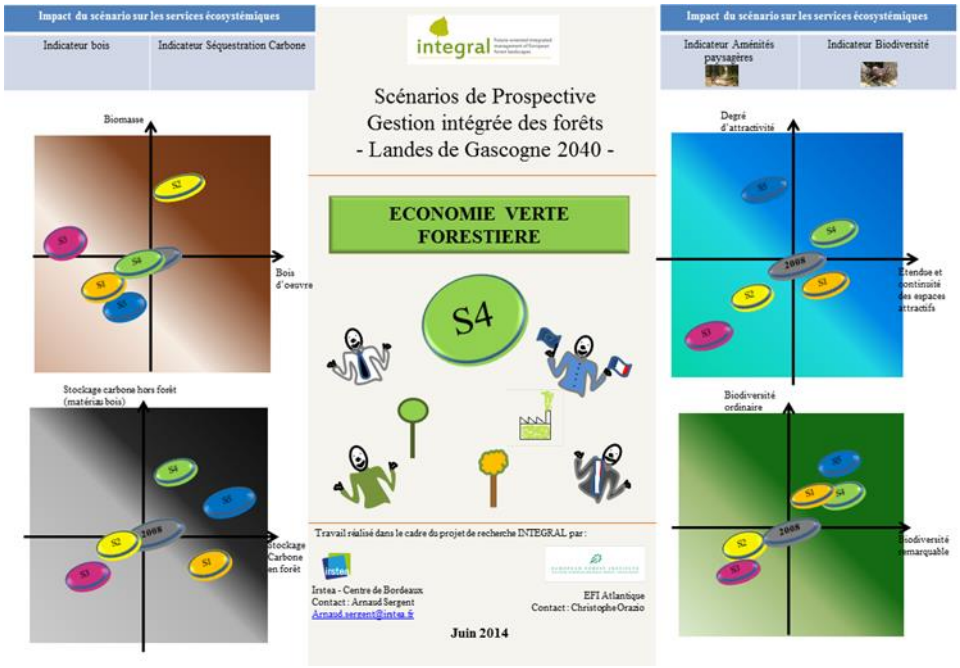
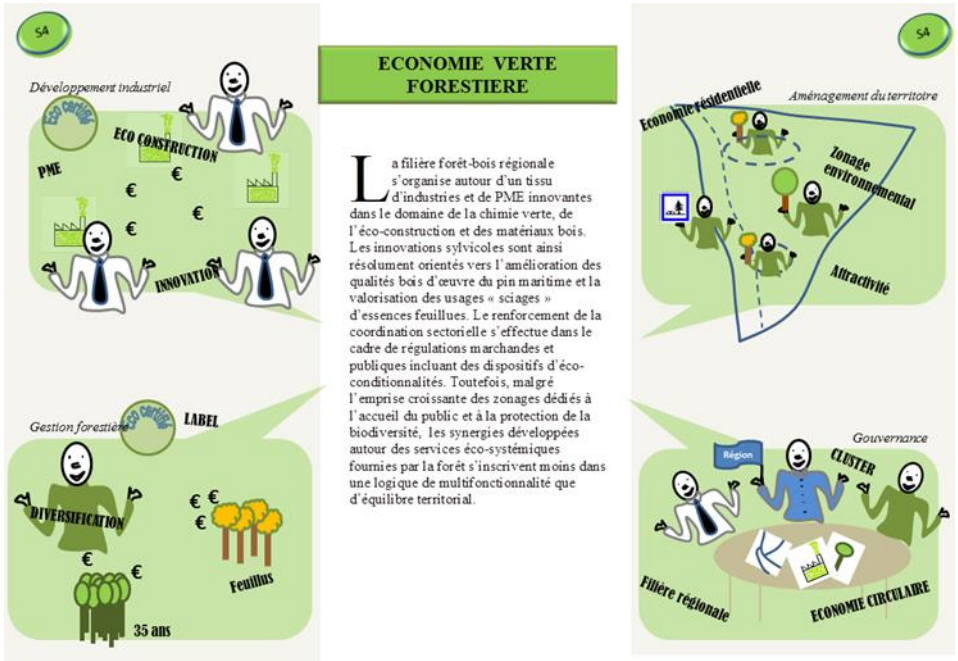
The continued efficiency of risk management strategies (fire, storms, etc), is also a result of a new kind of governance, based on coordination between market-based and regulatory instruments. These can be both direct and indirect in nature, such as making forest insurance policies tax deductible, or by creating a dedicated investment fund paid for by taxes levied on both producers and consumers.

Flyers for the presentation of the scenarios (e.g. S4) to the stakeholders





This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 282887.

8 List of Abbreviations

BAU: Business as usual
S0: Initial situation (BAU)
S1: scenario 1
S2: scenario 2
S3: scenario 3
S4: scenario 4
S5: scenario 5
SB0: initial situation (BAU) after backcasting
SB1: scenario 1 after backcasting
SB2: scenario 2 after backcasting
SB3: scenario 3after backcasting
SB5: scenario 5 after backcasting
S4-DEP: scenario 4- Desired endpoint
FOT: forest owner type
FMP: forest management Programmes
CSA: case study area
ES: ecosystem services
SHDI: Shannon diversity index
MP: Maritime Pine

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