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ARANGE Deliverable D3.2

Mountain Forests and Land Use Scenarios – a review and scenario development

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Aggestam, F. & Wolfslehner, B.

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Abstract:

ARANGE Deliverable D3.2 provides a review of different approaches to scenario development, based on an evaluation of several projects and reports having developed scenarios. The purpose of the review was in part to identify current and upcoming challenges facing mountain areas and forests as well as to define the best approach for developing a scenario for ARANGE. Using results from the review, the deliverable then sets out to develop a baseline (or business-as-usual) scenario, in the form of a narrative, that addresses the main environmental concerns facing European mountain areas and forests as a whole. The baseline scenario narrative is centred around driving forces identified in the review that in turn have been analysed by each case study group as regards the direction of change these may take. This has also allowed for the development of regional specific scenarios and the basis for understanding how key drivers may have an impact on mountain forests and relevant ecosystem services. Using the scenario development process as a framework, Deliverable 3.2 explore plausible future pathways in more detail; provides a qualitative framework for the modelling of ecosystem service provision; think about management alternatives for the case studies; and provide a basis for the models to describe future developments.

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1 Introduction

ARANGE deliverable D3.2 intends to develop a scenario addressing main environmental and socio-economic concerns facing European mountain areas in the future. Thinking about the future for European mountain areas provide a background from which a discussion on land use options and how our environment (or mountain landscapes) may look in the upcoming decades amy emerge. For example, climate change, land abandonment and rural depopulation are some of the key drivers changing the European mountain landscape today as well as the provision of key ecosystem services (Soliva et al., 2008, Verburg et al., 2010). European mountains are also characterised by a natural diversity, and a range of issues that make them particularly susceptible to environmental changes (Briner et al., 2012). But is it reasonable that these drivers remain as important in the future, or can we expect other alterations to European mountain areas? Addressing questions of this nature highlights that we need to consider future developments and their potential environmental impact (Rounsevell et al., 2006, Verburg et al., 2006). Particularly as the analysis of historic and possible future forms of land use and landscape changes can help us to prepare for what may come to pass.

Mountain areas are vulnerable to human activities. Building on different assumptions about social, economic, political, technological and environmental changes that may take place, it is foreseen that this deliverable will consider land use changes and impacts on the environment and to trigger thinking about key challenges that mountain areas in Europe will be facing in the upcoming 30 to 40 years. Driving forces, including population growth, the economic downturn, technological change and political factors, have frequently been suggested as drivers of change in mountain areas and forests (Cocca et al., 2012). Complex interrelationships do however exist between these driving forces and serious problems can arise when attempting to explain how they will develop in the future (Reed et al., 2009). This is predominant because the same driver can have different effects in different mountain areas, particularly as many areas have their unique climatic, demographic, economic and political conditions. Even more, identifying the main drivers of change is often complex, as the interactions of different driving forces can be strong, both at a given point in time and over time (Rounsevell et al., 2006, Setten and Austrheim, 2012). This deliverable will therefore, aside from the development of a scenario for European mountain areas, provide an overview based on present scientific understanding of the current and upcoming challenges facing mountain areas and forests across the case study regions represented in the ARANGE project.

The emphasis in this deliverable will be on scenario development for landuse, agriculture, rural development and the environment in mountain areas. Scenario development is seen as a useful tool to support decision making in the context of uncertainties that are beyond our control (Mazzorana et al., 2012). In this case it is seen

that narratives, or storylines, will be developed to illustrate the impact of possible events and developments that cannot be represented easily with models. This will complement the other, more quantitative modelling efforts, being pursued within the ARANGE project. The deliverable will draw its results from a range of supporting projects and reports that have also developed scenarios. Within this framework, this deliverable will explore plausible future developments in more detail for Europe, its mountain areas and mountain forests, and it will thus complement the overall assessment of the current state of the environment. The review of scenarios and the scenario development itself provides the basis for understanding:

- different approaches to scenario development that may have an impact on mountain forests and the provision of ecosystem services,
- explore key drivers and potential developments facing European mountain areas,
- provide a framework for the quantitative modelling of ecosystem service provision,
- provide a narrative that these models can use to describe future developments.

The structure of the deliverable is as follows: the next part (section 2) will focus on reviewing and discussing different approaches to scenario development, while section 3 will focus on the development of a scenario for ARANGE. There is also a substantial annex (particularly annex II and III) attached to the deliverable that provides more in-depth details of the projects and reports reviewed.

2 Reviewing Past Scenario Studies

Mountain areas and forests face ever-greater challenges. The rate of change and the increase in uncertainties for many environmental, social and economic issues are affecting not only how the future may look but also puts into question the effectiveness of current policy measures across Europe. To make informed decisions, we must therefore try to think about what lies ahead and to analyse on-going and emerging developments that are foreseen to affect the European mountain landscapes. One way to do this is to use tools, such as scenario studies, as a way to conduct a "forward-looking" analysis. Scenario studies can be used to manage complexity and to handle uncertainties for long time periods. Scenarios do in fact provide a structured approach that allow us not only to reflect on different options for the future (and to identify uncertainties) but it helps us to identify priorities for policy, check if targets are being met, analyse cause-effect relationships (e.g. driving forces affecting mountain areas) and to anticipate possible changes in a structured way (Rounsevell et al., 2006, Briner et al., 2012). The aim of this section will be to provide an overview of some of the tools that have been applied to develop scenarios in past projects and reports. The objective is to provide information that improves our understanding and insights into possible tools for scenario development. This is relevant as the approach selected for the ARANGE

scenario development needs to fit not only the project aim itself but also to make sense for existing policy making in mountain areas and forests.

2.1 Scenario Development

European mountain areas provide multiple services and have multiple functions (and users) at any point in time. Mountain systems are in themselves dynamic and constantly affected by several driving forces (e.g. climate change, changes in agricultural land use and/or demography) that can interact in unpredictable ways (e.g. generating extreme weather). Because of this uncertainty, the knowledge upon which to base decision-making in mountain areas can never be fully complete, but it is also why scenario construction and its analysis provide a way to investigate future developments and to prepare or suggest policy options to address these developments and uncertainties. Scenario studies are however not the only ways of exploring the future. There are many approaches and methods that can be used to explore the future for mountain areas, such as through environmental scanning, backcasting, road mapping, system dynamics, sensitivity analysis and probabilistic analysis (Mazzorana et al., 2012, EEA, 2007). Some are statistical and economic forecasting (or quantitative) tools, some apply a qualitative approach, while others are based on probability theories.

The emphasis in this deliverable is however on scenario development. There are two types of scenarios that are broadly accepted distinctions, namely, normative or explorative scenarios. A normative scenario aims at creating a story that brings alive a desirable future or to set a specific goal. Similar to a vision statement, a normative scenario focus attention on issues that are within reach (or possible) and will have an impact on realizing the specific goal/future. Explorative scenarios describe how the future might develop, according to known processes of change, extrapolations of past trends, or the possible effect of specified measures or driving forces (e.g. policy developments and technological changes). Explorative scenarios often look at more visionary or less likely options (McCarthy et al., 2001). Other important factors that characterise scenarios include different thematic foci, spatial and temporal scales, links to other scenario families (e.g. using other scenarios as a baseline) and different types of target audiences (e.g. research or policy).

The above-noted factors can be used to distinguish between different types of scenarios and the method by which they were developed and applied (with different aims and degrees of success). The aim of the following section will be to provide results from our review of scenario studies principally concerning land use and decision-making in Europe. The basis for this review is that it would be unwise not to learn from previous experiences and results in deciding a way forward for how scenario development should be achieved in ARANGE. This will be done by reviewing how other projects have constructed their scenarios, for example, in terms of scenario types and sectoral focus. Other characteristics that will be looked at is the thematic focus, drivers, spatial scale and temporal scale and links to other scenarios.

2.2 Approach

This review aimed to identify an appropriate selection of projects and/or reports covering relevant scenario development options for the ARANGE scenario. The selection of case examples was achieved by conducting a screening of different online databases (e.g. http://cordis.europa.eu/fp6/projects.htm) focusing on projects (or reports) having been completed within the last 10-15 year period.

Reports and/or cases were first and foremost screened based on topics, using key terms, such as mountains, forest, and/or more generally, land-use. Some reports and/or cases were also included based on references given in the literature.

A literature review, covering the same thematic topics as for the project selection was also conducted to check for recent publications concerned with scenario development for mountain areas, and more generally for land use, in Europe. This was done using search engines, such as Science Direct (http://www.sciencedirect.com).

2.3 Scenario studies and reports

After an initial online screening, 36 cases (projects and reports) were selected for inclusion. Out of these 36 cases, 21 were projects and 15 were reports (see Annex I). The main criteria for inclusion were that the cases had to focus on, or dedicate at least one part to scenarios and/or scenario development. The earliest project included in the review is from 2001 and the most recent is from 2013 (including still on-going projects). A majority of the reviewed cases focused on scenarios for the environment, biodiversity, climate change and sustainability, but some cases that focused on territorial development, urban development, energy and transport were also included. For a full list of all the reviewed projects and reports see Annex I. It should also be noted that the level of detail available on the different scenarios used in the various project and reports varied greatly, ranging from very detailed to only providing the title of the scenarios developed.

2.3.1 Types of Scenarios

When considering different types of scenarios, a scenario could be defined as a snapshot, or as a set of novel insights, about the future. There is however not one prescribed method for how a project should develop this snapshot of the future. Instead one finds a wide range of diversity in the types of scenarios that have been developed for different projects and reports. They are typically developed with a project specific purpose in mind and consequently numerous scenario approaches exists, some reoccurring types can however be found.

Several of the projects in this review apply pre-existing storylines (or scenario families), such as the four marker storylines (A1, A2, B1 and B2) of the Intergovernmental Panel on Climate Change (IPCC), special report on emission scenarios (see Annex II for a

summary of all scenarios) (Nakicenovic et al., 2000). Some projects have adopted the four Global Environment Outlook 4 (GEO-4) scenarios on future global environmental changes (market first, policy first, security first & sustainability first) (UNEP, 2007). These scenarios (IPCC or GEO-4) are then adjusted to fit the specific purposes of the project or report in question. In the case of IPCC, this is frequently quantitative and model-based projection for climate change (e.g. ENSEMBLES or EFORWOOD). In the case of GEO-4, it is often more qualitative and applied to scenario-based analysis (or developments) in case studies (e.g. EACH-FOR). It often takes the form of narrative texts or storylines.

Aside from adopting already pre-existing scenario families, many projects also define one form of baseline scenario anchored in current trends or practices (e.g. EEA outlook and SENSOR). Many other terms are being used instead of ''baseline scenario'', but the meaning is roughly the same, such as ''reference scenario'', ''business-as-usual'' or ''best guess scenario''. They all serve the purpose to mimic the current state of play as closely as possible, from which then adjustments can be made to project specific pathways into the future. Baselines are useful to evaluate the consequences of no new policy developments, accounting for the uncertainty of environmental conditions, or of the driving forces of environmental change. "Policy scenarios" are in turn developed as a basis for comparison against the baseline scenario. They are often developed to illustrate extreme developments, such as an exclusive focus on economic growth, so as to clearly demonstrate the impact this may have in the short- and/or long-term. In effect "policy scenarios" describe the impact of alternative policy measures. These are often not realistic futures, but they are rather designed to initiate discussions on policy options (e.g. illustrate the risks of different policy pathways).

The use of scenarios may furthermore be exploratory, in that they explore future trends (e.g. ALARM), or they may be anticipatory, in that they investigate what factors would realise a specific scenario (e.g. Getting into the right lane for 2050). All scenarios do however share some common elements. The principal elements that define a scenario are the type of change (e.g. emphasis on economic growth); the driving forces underlying the change (e.g. high unemployment); base year (the starting time of the scenario); and the spatial and temporal scale of the scenario.

2.3.2 Driving forces

Each scenario foresees a specific future and is "driven" by a range of driving forces, covering everything from social to demographic and economic developments. This section will briefly consider some of the more important (and reoccurring) scenario drivers. It should be noted that a full representation of drivers was rarely provided in the respective projects and reports. For this reason a more generic (or thematic) approach had to be taken to represent driver families. It was at times also difficult to distinguish between trends, drivers and impacts in different types of scenarios. Climate change is the perfect example to demonstrate this difficulty. On the one hand, our

changing climate is a trend that is driven, in part, by anthropogenic factors (e.g. release of green house gasses) with impacts that vary from increasing temperatures to changing rainfall patterns, etc. On the other hand, increasing green house gase emissions is a trend that is driven by a range of policy developments (e.g. industrial policy in connection to the economic downturn) that in turn have an impact on the climate through increased industrial activity. In one case, climate change is clearly labelled as the trend or driver, in the other, it is an impact. See Annex III for more details on each project/report and its trends, drivers and impacts.

The scenarios furthermore cover a wide range of assumptions as regards driving forces. Scenario drivers reflect the uncertainty of the future as well as provide a perspective of the future as seen at the time of its development. This can be illustrated using the recent financial crisis as an example. Prior to the economic downturn, scenarios did not factor in the type of financial development we have seen, while afterwards economic recovery (or stimulus) is featured as a strong element in certain scenarios. This demonstrates the time-specificity of scenario development as well as the clear uncertainties about the future we are facing.

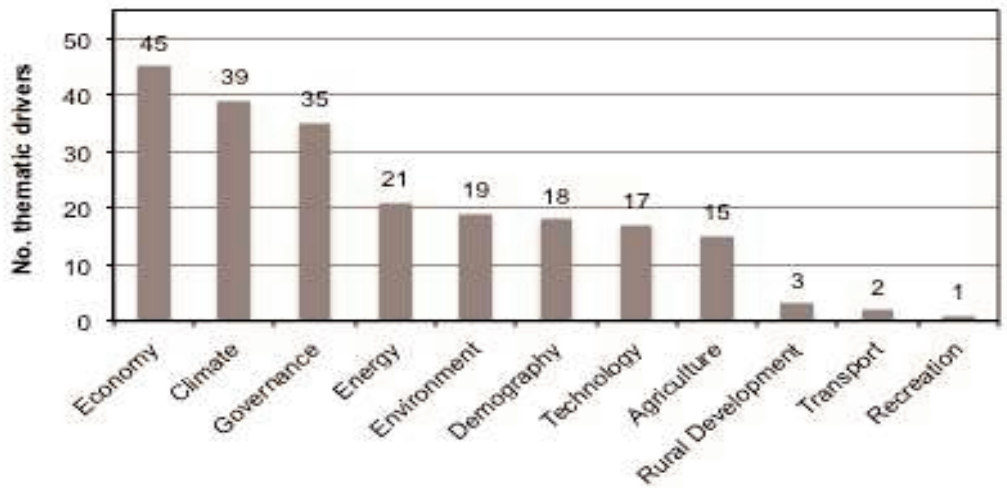

Figure 1. Thematic focus of grouped driving forces based on the review of projects and reports in this Deliverable.

In general there are many driving forces that can play out differently in the future. Developing scenarios for all possible future pathways would be impossible. This is why each scenario most often has a single focus, such as sustainability or climate change (as an example the GEO-4 scenarios are even labelled market first, policy first and sustainability first, etc) that is then compared to a baseline scenario. So even if most of the projects and reports did not provide a detailed list of drivers, it was possible to derive the thematic focus of the driving forces from the scenario focus and storyline (see Figure 1).

As can be seen in Figure 1, the most commonly reoccurring family of driving forces are connected to economic, climatic and policy drivers. This is followed by energy,

environmental, demographic, technological and agricultural driving forces. In this case the types of drivers within the respective themes varied greatly. For example, economic drivers were everything from increasing or decreasing economic growth, market liberalisation and trade barriers, etc, and climatic drivers were everything from decreasing or increasing GHG levels, mitigation and adaptation measures, etc. On the whole, it is clear that the drivers (indirect and direct) applied in the scenarios vary in complexity and span a wide range of types (see Table 1). It is further clear that the direction of the driver (e.g. increasing, decreasing or stable) depends entirely on the scenario storyline and application. If the emphasis in a scenario is on the economy, then it most often presupposes an increase in economic growth, but a decrease in environmental health, etc.

Table 1. Some examples of driving forces from the reviewed projects and reports.

Economy	Climate	Governance	Energy
• Economic growth is the main priority	• GHG emissions increasing/decreasing	• Increasing/decreasing policy intervention	• Energy security
• Short-term financial returns	• Global climate change	• Equal weight to envi. and socio-economic policies	• Substitution of food production by energy production
• Free-market	• Increased support for renewable energies	• Decreasing societal solidarity	• Energy flows.
• Fractionalization of the global economy	• Transport permitted only if green and clean	• Support for a strong coord. of policies at EU level	• Sharp and savage energy shock
• Economic insecurity	• Carbon quotas	• Empowerment of local groups	• Exploding energy prices
• Globalisation	• Heavy floods	• Top-down policy programs	• Increasing/decreasing energy demand
• Market liberalism	• EU climate change target	• Erosion of EU	• Gasoline use increase

Table 1 provides examples of some driving forces that were identified across the projects and reports. The driving force can be seen as the symptom of the trend (or transformation) in the scenario. For example, unemployment can be driven by forces in the labour market, which in turn are affected by the rate of productivity, etc. These drivers would in turn connect with a network or interrelated driving forces that evolve over time, which may in turn generate new driving forces over time (sometimes replacing the old ones) and so on. In essence, the key to scenario development is thus to identify the driving forces that define the current environment. This is also why the types of scenarios have such different sets of driving forces, as they are all defined by the focus of the scenario itself. Broadening the scope of the scenario would thus also increase the number of driving forces, complexity of possible relationships between

driving forces and uncertainties. The number of driving forces could actually become to high to process within a given scenario process. This demonstrates the importance of evaluating how relevant a driving force actually is and how uncertain its development is within the scenario process.

One part of this review was to help define an approach for scenario development within ARANGE. With this purpose in mind, it is relevant to ask what are the primary forces that will shape European mountain areas in the short- and long-term? Addressing a question like this can help to define a set of drivers and provide a solid framework for an ARANGE scenario. Based on the thematic focus of the driving forces, this process could be structured according to the driver families identified. These can be roughly re-defined as five categories: social driving forces (covering demographics and recreational demands, etc), economic driving forces (also covering energy, rural development and transport), environmental driving forces (also covering climate and agriculture), political and institutional driving forces (e.g. legislative and regulatory changes) and technological driving forces (e.g. foreseen investments in research and breakthroughs). Of course these categories should only act as a guide when considering the type of driving forces that define a scenario, especially since many drivers connect across the categories.

2.3.3 Spatial and temporal scales

The cases that were selected also have different focus and operate on both different spatial and temporal scales. The projects and reports were therefore divided into three categories for the spatial scales that were covered. This was the global-, EU- and regional-level. For regional scenarios this ranged from national to regional case studies in Eastern Europe, Asia, Africa and North America, etc. As this represents a rather diverse set of case studies, the categories are only meant to be indicative of the scale that the scenarios in this review focus on.

Eight (or 22%) of the cases focused on global scenarios. This predominantly included reports such as the Millennium Ecosystem Assessment, Global Trends 2025: A Transformed World and the World Energy Outlook 2009, etc. The majority of cases in this review focused at the EU level. 18 (or 50%) of the cases developed scenarios for the EU27 and are mostly represented by FP6 projects, such as SENSOR (Tools for Impact Assessment), EFORWOOD (Tools for Sustainability Impact Assessment), ALARM (Assessing Large Scale Risks for Biodiversity With Tested Methods) and ESPON (Territorial futures: spatial scenarios for Europe). The remaining 10 (or 28%) cases developed regional scenarios and represents a mix between projects and reports, such as, BIOSCENE (Scenarios for Reconciling Biodiversity Conservation With Declining Agricultural Use in the Mountains of Europe), Intelligent Infrastructure Futures: The Scenarios — Towards 2055, and SCENES (Water scenarios for Europe and for Neighbouring States), etc. The spatial scale is in all cases adapted to the aim of the project or report. In many cases global scenarios, such as the four storylines (A1, A2, B1

and B2) of the Intergovernmental Panel on Climate Change (IPCC), special report on emission scenarios (SRES) or the GEO-4 scenarios and scenarios of the Netherlands Bureau for Economic Policy Analysis (CPB) provide a baseline that is adapted to the national, regional or European level.

Table 2. Spatial and temporal scales and classification of reports and projects reviewed in this Deliverable..

		Temporal Scale			
Spatial scale		*(2020) 2030*	*(2040) 2050*	*(2080) 2100*	**Total**
	Regional	7 (15.9%)	7 (15.9%)	3 (6.8%)	**17 (38.6%)**
	EU 27	12 (27.3%)	5 (11.4%)	4 (9.1%)	**21 (47.7%)**
	Global	2 (4.5%)	3 (6.8%)	1 (2.3%)	**6 (13.6%)**
	Total	**21 (47.7%)**	**15 (34.1%)**	**8 (18.2%)**	

Three categories were also created for the temporal scales, namely, covering the near future (2020 to 2030), near distant future (2040 to 2050), and the distant future (2080 to 2100). The temporal scale is represented by the projects and reports mostly focus on the near future (≈48%) to the near distant future (≈34%), see Table 2. Several projects do however cover 2 or even 3 temporal scales (e.g. Assessing Large Scale Risks for Biodiversity With Tested Methods (ALARM), and Environmental Change and Forced Migration Scenarios (EACH-FOR)) within the same study, so as to represent different storylines over a period of time, rather than just representing one moment in time. To illustrate, there are many projects that have at least one scenario that has an emphasis on economic growth. Most often, this simply implies that economic factors are prioritised over social and environmental factors. This can, for example, result in increasing human welfare and high economic growth in the near future, but in the distant future, the impact is often the opposite due to effects from climate change and environmental degradation, etc. In this sense considering a longer time-scale allows the storyline to develop fully.

2.3.4 Relevance to ARANGE

It was furthermore relevant to review which of the scenarios were (more or less) important for the ARANGE scenario development process. For this reason, a rating of 1 (low importance) to 3 (high importance) was assigned to each project and report to indicate its direct relevance. This made it easier to focus on a limited number of scenarios that could be used as a basis for continued development and application within ARANGE. As such, the relevance score is simply an indicator of how "useful" the project and/or report was in relation to ARANGE, not its overall relevance (see Figure 2).

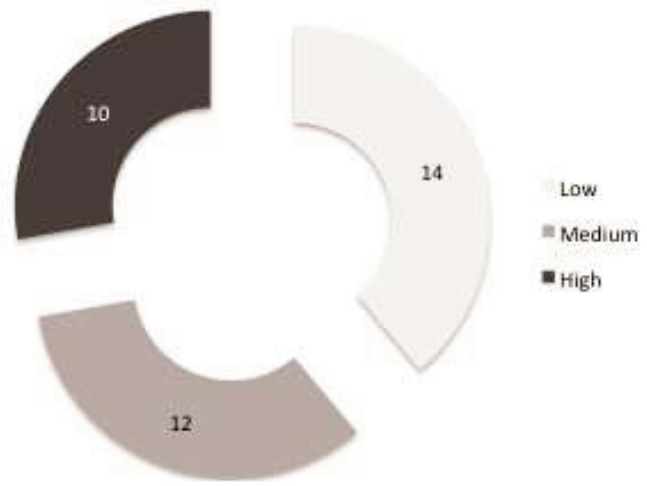

Figure 2. Relevance of projects and reports reviewed for the ARANGE project.

Figure 2 demonstrates that 10 projects and reports (approximately 28%) were considered as highly relevant for ARANGE. These were:

Projects	• CARBOMONT – Effects of land-use changes on sources, sinks and fluxes of carbon in European mountain areas • CAMELEON – CArbon dynamics in Mountain Ecosystems: analyzing Landscape-scale Effects Of aNthropogenic changes (climate and land use) • MOUNTLAND – Sustainable Land Use Practices in Mountain Regions • BIOSCENE – Scenarios for Reconciling Biodiversity Conservation With Declining Agricultural Use in the Mountains of Europe • Prelude – Land Use Scenarios for Europe • Scenar 2020 – Scenario study on agriculture and the rural world • EFORWOOD – Tools for Sustainability Impact Assessment
Reports	• Millennium Ecosystem Assessment • European Forest Sector Outlook Study II • GEO4: Global Environment Outlook

The cases were assessed in a similar manner, namely, in how the scenarios were developed and how this could be applicable to mountain areas and forests. Some projects are simply considered highly important because they focus on mountains, such as CARBOMONT, CAMELEON, BIOSCENE and MOUNTLAND, which is rare. In this case, a scenario summary is unfortunately only available for the CARBOMONT and BIOSCENE projects (see Annex II). The remaining cases either represent useful scenario storylines or approaches (e.g. GEO4) and/or tackled relevant topics, such as rural development, agriculture and biodiversity (e.g. BIOSCENE, EFORWOOD and Scenar 2020). This is by far not an exclusive list, all projects included in the review were already considered as being relevant to some extent.

2.4 Developing a Scenario for ARANGE

A scenario for ARANGE needs to tell a story of developing driving forces affecting the provision of ecosystem services in Europe, set within a context of mountains forests. Based on the findings from the review, this would have to include social, economic, environmental, political and technological driving forces specified for all of the EU (as a baseline scenario) as well as cover some of the inherent differences for the 7 regional case study areas covered by ARANGE, namely, the Iberian mountains, Alps (Western and Eastern), Dinaric mountains, Scandinavian mountains, Carpathians and Rhodopes. Developments at the EU level should comprise assumptions on biodiversity, agriculture, environmental legislation, population size and mobility, etc, that filter down to the regional level (or case study level). The projects and reports identified as highly relevant will provide the basis for current and future drivers of change in mountain areas, and utilised to assess how these affect ways in which land is used as well as the provision of ecosystem services. This will be the basis for the main storyline for European mountain areas.

Provided the scope of this deliverable, a quantitative and model-based approach will not be taken. On the one hand, several projects and reports included in this review do combine quantitative and model-based approaches from several fields of study, such as ENSEMBLES, ATEAM and ALARM. This is done to, for example, study future impacts on biodiversity covering a range of driving forces, including land use and climate change. Qualitative approaches, on the other hand, do not provide any quantitative analysis, but rather a narrative description of future trends and uncertainties. Qualitative methods have also been used in many of the projects reviewed, ranging in focus from environmental to social developments. One example is ESPON (Territorial futures: Spatial scenarios for Europe) in which a trend scenario highlights the impacts of the most relevant driving forces in an unchanged policy context. On the basis of this trend scenario, two policy scenarios are elaborated. In one, policy is oriented towards enhancing the competitiveness of Europe in the global context. In the other, the policy focus is oriented towards economic, social and territorial cohesion. This report uses qualitative methods to analyse plausible directions for territorial developments. Taking this type of qualitative approach has the advantage of being able to present complex developments in an understandable and interesting way, and also making it easier to communicate to the public and stakeholders. In fact, qualitative approaches often rely on participatory methods to collect information from experts and stakeholders. The obvious drawback of a qualitative approach is that it does not provide any numerical estimates. However, as the focus in ARANGE is also on the quantitative assessment of ecosystem services, this will complement the more qualitative approach foreseen for its scenario development.

Furthermore, as the ARANGE project is focusing on timber and biomass production, carbon sequestration, the maintenance of biodiversity and nature conservation as well

as protection against gravitational hazards, the emphasis should be on drivers which may affect these ecosystem services. It further makes sense to focus on drivers of change in the near future (2030) and near distant future (2050), with some consideration given to the distant future (2100 and beyond).

3 The ARANGE Scenario Process

3.1 Back to the Future

European mountain areas and forests are diverse, with each region featuring a distinct set of environmental conditions, tree species, risks and uncertainties, etc. Also factors, such as the demand for ecosystem services, landownership structures and management goals, vary significantly across regions. For this reason, it is relevant that the ARANGE scenario reflects some of these specificities for the different European mountain regions. For example, social, political and technological changes are often directly related to regional and cultural variations. Also environmental differences, such as biodiversity, depend on the way in which it is conceptualised (e.g. species, habitats or ecosystem processes) and how biodiversity priorities and objectives are defined (e.g. different emphasis can be given to keystone or culturally valuable species across Europe).

The drivers considered in the review section fall into five distinct categories: social, economic, political and institutional, environmental, and technological driving forces. These thematic categories of drivers have been identified based on the significance of their potential (and actual) influence on ecosystem services (timber production, carbon sequestration, nature conservation and the protection against gravitational hazards), playing a fundamental role in land use development and change in the relevant regions (Iberian mountains, Alps, Dinaric mountains, Scandinavian mountains, Carpathians and Rhodopes). The focus will be on general developments and direct impacts on the 4 ecosystem services. Direct impacts refer to, for example, changes in timber production or the potential for carbon sequestration. These can in turn have knock-on effects on other land-use relationships and ecosystem services, which are considered as part of the thematic range of driving forces and pressures (e.g. biodiversity loss or changing recreational demands). For example, the status of the primary ecosystem services can have an impact on climate change, urbanization processes and water supply, etc. Although there can be many driving forces and pressures impacting the provision of ecosystem services, the aim here will be to focus on the most relevant and significant in the context.

It is foreseen that the current state-of-play and status of ecosystem services on a European scale is explored within a baseline scenario. This scenario will be presented in the following sections (see 3.2.1), including regional sub-scenarios (see 3.2.2 and

onwards). The purpose of the baseline will be to provide a European context to the rest of the regional sub-scenarios, particularly as regards environmental drivers, impacts on the provision of ecosystem services, and the relationship to general land-use. This scenario will furthermore support the overall aim of ARANAGE by enhancing our understanding of the driving forces that impact on ecosystem services in mountain areas. It will help to provide a more solid framework for the quantitative modelling of ecosystem service provision and it will provide a useful narrative that these models can use to describe future developments.

The methodology for the construction of the baseline scenario in general and the regional scenarios described in this deliverable in particular is based on three levels: (1) global driving forces, (2) European driving forces, and (3) regionally-specific driving forces. These will form the basis for the baseline narrative covering Europe as a whole, as well as feed into sub-storylines covering the respective case-study regions. The focus here will be on the provision of the 4 main ecosystem services and how these may be affected by future developments. Given the characteristic uncertainty associated with scenario development, the purpose of this exercise will be to focus on raising questions for European mountain areas, rather than providing a strict and plausible future. On the whole, driving forces will be considered in terms of changes in the near future (2030) and the near distant future (2050/2100), where land use changes are predicted to be specifically influenced by climate-driven environmental changes and changes in regional/local economic conditions. Input in terms of the direction of change of the drivers for the sub-storylines has been provided by the respective case study groups as described in the following section (see 3.1.1.).

3.1.1 Data collection from case study groups

Part of the process to develop a baseline scenario and regional sub-scenario was to collect data from all the respective case study groups (Iberian mountains, Alps, Dinaric mountains, Scandinavian mountains, Carpathians and Rhodopes). The purpose of the questionnaire (sent to all case study groups) was to gain regional input on a list of driving forces developed for the baseline scenario. These driving forces (see Table 3) had been identified as important drivers in the review of past projects and reports (see section 2). As such, it is a list of potential key factors that will affect the future development of mountain areas and forests and that will feed into the continued development of alternative management strategies. More specifically, the questionnaire was developed to find out how the case study groups see developments of specific drivers up until 2030 and its continued development up until 2050. In total, 51 drivers were provided in a list and the case study groups were asked to provide a direction of change (increasing (+), stays the same (0), or decreases (-)) for two periods, the present to 2030 and 2030 to 2050, respectively. The respondents were also asked to select the 10 most important drivers for each region. Results from this questionnaire will be presented below (see 3.2.2 and onwards).

3.2 Setting the stage for a European and regionally adapted narrative

Mountains areas cover close to 50 per cent of Europe. In total, around a fifth of people living in Europe live in mountain areas. However, different demographic changes are taking place across this diverse area. In some mountain areas, populations are increasing, while in others, they are decreasing. The topography also varies significantly, from high mountains, such as the Alps and Carpathians, to low mountains, such as the Scandinavian mountains. In connection to this topographical (and geographical) diversity comes climatic differences as well, ranging from the cold north to the warm south. These differences have an impact on the type of land cover and use that is found across Europe. In most mountain areas, except for southern Greece, Italy and the United Kingdom, forest cover dominates. In northern Europe, grassland is more important, while a significant part of the mountains in the United Kingdom are covered by moorland. In southern and central Europe, agriculture is of greater importance in mountain areas. However, generally speaking, agriculture has played an important role in defining mountain landscapes throughout Europe through the management of habitats and species. This is connected to the relevance of agriculture and forestry to the economy, as well as, for the type of cultural identity found in the different regions. Traditionally, agriculture and forestry has been the major form of employment, even though the greatest proportion of employment nowadays is in service sectors, such as tourism.

At the EU level, there is a long history of public policy intervention having an impact on mountain areas and forests. For mountain areas this principally means the Common Agricultural Policy (CAP). The CAP provides compensation to less-favoured areas, agricultural and environmental measures as well as providing a market for products from mountain areas. There are policy measures within the Common Rural Development Policy (RDP) focused at improving conditions (social, economic and environmental) for mountain communities. These are designed to, for example, slow down depopulation and land abandonment. Measures have been developed under the RDP to aid farmers in areas with natural handicaps (or so called less favoured areas). Natural handicap payments in mountain areas, which aims at improving the environment and the countryside by supporting sustainable land management, is now part of the CAP. These types of measures have been specifically designed to support farming populations and to preserve mountain landscapes by linking ecosystem services (e.g. biodiversity) and nature conservation directly with farming activities. Other examples are initiatives concerned with rural development and cross-border, transnational and inter-regional cooperation, such as, the INTERREG IV (covering the period 2007–2013) aiming to stimulate cooperation between regions in the EU, and LEADER, aiming to supports rural actors to consider the potential of their region.

Also EU forest policy have (and will continue to have) an impact on the mountain landscape. An example of this is the EU Forestry Strategy and the EU Forest Action Plan (concluded in 2012). Under the general principle of multifunctionality put forward by the Strategy, forests in mountains are principally seen as having a protective role. This may mean that mountain forest areas will become increasingly managed with specific objectives in mind. Other important areas to consider are the Directives on water, habitats, birds and soil that are linked to a common environmental policy between all EU Member States. Also the importance that cohesion policy and research and technological development policy can play for communities in mountain areas is clear. For example, the territorial aspects of EU cohesion policy requires that particular attention be paid to areas with natural handicaps, as such, more support is foreseen to be provided to areas with particular development difficulties, such as mountain areas in the near future. The on-going discussions for a new EU Forestry Strategy and negotiations for a legally-binding agreement (LBA) through the Forest Europe process will most likely continue this trend in the near to near distant future. Other policy developments are also foreseen to have an impact on mountain areas and forests, such as the reform of the CAP, which may result in a restructuring of agricultural sectors across the EU as well as a changing cohesion policy, which may change the availability of different funds (including rural development funds). More details on recent policy developments that may be affecting mountain areas and forests can be found in deliverable D3.1.

Thinking about a future scenario for mountains has to take into account the permanent natural and economic handicaps inherent in mountain areas as well as the lack of an integrated and flexible policy framework that can address this complexity. This also applies to the forest sector, which suffers from the lack of a common policy, at least as regards to actions taken at the EU-level. For mountain areas, the key is however to recognise this great diversity and the specific challenges that characterises mountains, namely, competing demands in terms of environmental concerns (e.g. nature conservation and water supply), economic interests (e.g. tourism and timber production) and social interests (e.g. recreational and cultural interests) as well as the protective function of mountains and forests (Cocca et al., 2012, Marini et al., 2011). It should also not be forgotten that the pressure on mountain areas are expected to continue to increase as a consequence of changing incomes from agriculture, climate change and the loss of biodiversity (Kelemen et al., 2009). Key questions of interest for any scenario concerned with mountain areas and forests are what impact all of these developments may have?

3.2.1 Picturing a future European mountain landscape: A Baseline Scenario

European mountain areas (principally referring to areas within the EU) will be affected by a number of primary driving forces, namely, EU rural and agricultural policies, demographic patterns, agricultural and forestry technologies, markets, constraints on land use (natural and social) and effects from climate change, that are likely to exist in 2030 and 2050, respectively (see Table 3). Social and economic factors, as influenced by technology, will have an affect on these driving forces. Technology will essentially determine what is "possible" and social demand will determine what is "economically feasible". Social demand, such as its effects on the agricultural sector (e.g. demand for organic produce), will reflect consumer preferences as regards to food as well as environmental and health concerns. This will be influenced by the degree of environmental awareness (e.g. sustainable use of natural resources, such as water and biodiversity) in the general public, which is expected to vary significantly across Europe. Environmental and health concerns will effectively define some of the constraints on land use (not taking into account natural constraints). Markets (local and global) and production costs will in turn also influence what is feasible in the agricultural and forestry sectors (including the provision of key ecosystem services).

Table 3 provides the list of 51 driving forces sent out to all case study groups to gain input on the direction of change on each driver for the respective regions (see 3.1.1). To gain some impression for how the direction of change may be for Europe as a whole, and to provide some input to the baseline scenario, the aggregate direction of change is indicated in the table as well.

Table 3. List of driving forces for the baseline scenario. The arrows indicate the direction of change. ↑ implies an increase (+), = implies that the driver stays the same (0), while ↓ implies that the driver decreases (-). This is from the present to 2030, and then from 2030 to 2050.

		2030	2050
Economic	Economic growth	=	↑
	Consumption levels	=	↑
	Global trade	=	↑
	Market liberalisation	↑	=
	Trade intensity in the EU	↑	=
	Tax levels	↑	↑
	Energy prices	↑	↑
	Road transport	=	=
	Price of food	↑	↑
	Food shortage	=	=
	Energy consumption	↑	↑
	Demand for bio energy	↑	↑
	Demand for wood products	↑	↑

	Profitability for forest owners	=	=
	Infrastructure developments	↑	↑
Social	Population growth	↓	=
	Urbanization	=	=
	Aging population	↑	↑
	Education levels	↑	↑
	Nature-based tourism	↑	↑
	Employment in rural areas	=	=
	Environmental awareness	↑	↑
	Qualified human resources	↑	↑
	Number of ICT users	↑	=
	Job mobility	↑	↑
	Brain drain from rural communities	=	=
	Individual entrepreneurship	↑	↑
Tech.	Investment in research and technological development	=	=
	Innovation rates	=	↑
	Developments in energy technology	↑	↑
	Developments in agricultural technology	=	↑
	Developments in forestry technology	=	↑
	Rise of new industries	=	=
Political	EU Enlargement	=	=
	Energy regulation	↑	↑
	Increasing self-regulation	=	=
	Environmental regulation	↑	↑
	Greater regulation of infrastructure	↑	=
	Rise in international conflicts	=	=
	Coordination of policies at EU level.	↑	↑
	Equal weight to environmental and socio-economic policies	↑	=
Environmental	Greenhouse gas emissions	↑	=
	Global climate change impacts	↑	↑
	Natural disturbances in the forest	↑	↑
	Numbers of extreme weather events	↑	↑
	Availability of water	↓	↓
	Conversion of agricultural land to forest	↑	=
	Biodiversity	=	=
	Nature conservation	↑	↑
	Nature restoration	=	↑
	Flooding in mountain areas	=	=

Key assumptions for the Baseline Scenario

In relation with the list of driving forces provided in Table 3, a number of general key assumptions are made for the baseline scenario, covering each of the thematic areas covered by the drivers:

(1) **Economic**: The current economic framework will return to a state of recovery with modest economic growth across Europe in the upcoming 5-10 years, particularly as regards to southern Europe. This will be followed by a steady state (e.g. characterised by low growth) until 2030. Globalisation is foreseen to continue in its current pace until 2030 and will put increasing pressure on European markets (e.g. today's emerging economies will be collectively bigger than the European market), increasing even more by 2050. It is highly likely that another economic downturn takes place in Europe prior to 2050, driven by increased global competition. Demographics (e.g. increasing population size) will in part help to offset the downturn.

(2) **Environmental**: Europe's transition towards a "green economy" (e.g. improving resource efficiency) or "low carbon economy" will continue with some positive environmental implications (e.g. increased biodiversity through reforestation coupled with species reintroductions and conservation) for certain mountain regions. This will in part be driven by environmental targets and objectives established by EU legislation (e.g. carbon sequestration). This will however not stop effects driven by climate change (e.g. changing vegetation patterns, glacier retreat and reduced snow cover) and increasing demands for renewable energy (e.g. biomass). For mountain areas, these changing demands and climatic conditions will particularly affect ecosystem services, such as water availability, biodiversity, recreation and timber, negatively. Europe will as such make more progress in improving resource efficiency than preserving ecosystem services and resilience by 2030. This will also have a detrimental impact on protective functions (e.g. landslides and flooding) and the main threat to the protective functions of forests (e.g. storms and fires) in mountain areas.

(3) **Social**: Social structures in mountain areas will continue to change based on demographic changes (e.g. urbanization, migration, and aging). Increased demand for food, water and energy (as driven by climate change, technological innovation and population growth) will change employment opportunities in mountain communities (e.g. energy developments will create new opportunities). Land ownership configurations will however largely remain the same. The rural "ideal" or "image" will remain a strong cultural force in many European regions. This will generate a demand for preserving the cultural landscape as it is currently managed across most mountain areas. Tourism will consequently continue to increase (agri- and nature-based). Technological innovations will have a significant impact on

mountain communities (e.g. social impact of ICT) and will increasingly define social and business life.

(4) **Political and institutional**: The transition to non-oil based economies (or green economies) will continue and the EUs climate and energy policy framework will increasingly influence developments in mountain areas (e.g. wind power and wood for energy). It is likely that the Emissions Trading System (ETS) will fail. Based on the failure of the ETS's market-based approach will pave the way for strong EU legislation by 2030 for energy savings and renewable energies. Large-scale investment in renewables will increase following these developments, with implications for rural and mountain areas where most of the forest occurs. Environmental legislation, as developed by the EU (e.g. Water Framework Directive, Bird and Habitat Directives and Pesticide Policy, etc.) will be kept in place and reinforced. Europe's structural and cohesion fund is assumed to expand slowly and it is expected that it will have an increasing impact on mountain communities. This will be particularly relevant for the provision of protective services, biodiversity and recreation in mountain areas.

(5) **Technological**: Agricultural productivity and forestry will continue to increase in terms of effectiveness (e.g. labour required per unit output) and efficiency (e.g. outputs) as a result of new technologies that are introduced. Changing demographics will in part drive these technological developments as Europe struggles to encourage young people to stay in rural and mountain areas, while the demand for agricultural and forestry outputs increase over the scenario timeline. The demand for renewable energy (e.g. biofuels) will also continue to increase and is in part expected to drive technological change. Renewable energy breakthroughs will be forced by climate change. This will also affect innovations for climate change adaptation.

Baseline Scenario: The narrative

Many European mountain landscapes have been shaped by cultural and traditional management practices and the geomorphological characteristics of the mountain in question. This combination has created a wide range of landscapes that are (more or less) open, structurally diverse, and with varying vegetation types across different mountains areas. Each area is often characterized by a distinct biodiversity that vary across countries and regions, such as the Alps and Carpathians, etc. The image that we hold of a mountain landscape (whether as an individual or a society) is however gradually changing due to agricultural developments. Many mountain areas in Europe will see an increasing agricultural decline and abandonment until 2030. This development will have a major impact not only on how the landscapes actually look but also the types of biodiversity that dominate the respective mountain areas. We will increasingly see impacts, such as increasing forest dominance and landscape closure. There will also be a loss of species that are adapted to open habitats. In terms of nature

preservation, the abandonment of agricultural land is however not only bad news. The ecosystems that are returning to a more "natural" state also offer opportunities for re-introducing some species, such as the wolf and bear, which are currently not part of many European mountain landscapes.

In general, continued forest expansion is expected in most European mountain areas, but it does not represent a dramatic development for the upcoming decades, at least not up until 2050. At the landscape level, there is not a general transformation of agricultural land into forests, but there is rather a continuation in the reduction of management of the mountain landscapes. At the species level, this general development will also be reflected. With some changing landscape patterns across Europe (not consistent across all mountain areas) forest species are likely to increase. In contrast, the effects on farmland species will be negative. The species composition will depend on the type (and intensity) of management of the landscape. In areas where the landscape is not closed up by forests due to farmland abandonment (e.g. as a consequence of an ageing population and reduced earning potential) the effects on the species composition will be neutral and more dependent on changing climatic conditions.

Changing demographic patterns (driven primarily by urbanisation and an aging population), changing agricultural and forestry practices (driven by technological innovations, land abandonment and the demand for energy), and the gradual increase in effects from climate change on mountain areas, will drive the EU to develop more effective and integrated policies for the preservation of mountain biodiversity and other key ecosystem services by 2030 (e.g. radically changed subsidies and funding schemes). These developments will be driven by more binding legislation and will bring opportunities for the integration of knowledge and expertise for sustainable solutions for mountains areas within the EU (e.g. improved farming practices). This refers particularly to the livelihoods of people working in mountain areas. EU-level policy intervention and management measures will in this sense play an important role in sustaining and promoting multifunctional and sustainable agriculture and forestry.

While mountain areas at a higher altitude may benefit from increased forest productivity in the short term (due both to climate change and forest expansion), mountain areas will increasingly be under threat from energy developments (primarily due to steadily increasing energy prices). European mountain areas will gradually develop its wind and solar energy potential. Also developments, originally driven by the renewable energy directive, will expand and grow in importance by 2030. Increasing demand for energy will drive landscape developments, both in terms of the type of agriculture (e.g. growing oilseeds for biofuels) and forestry (e.g. extraction of biomass) being practiced. These developments will also generate conflicts, most notably from other important sectors such as tourism, particularly in areas having a high cultural value and in which tourism is becoming an increasingly common form of employment for mountain communities.

Underlying the developments in the energy sector are new developments in technology. It is foreseen that R&D expenditures will be slowly growing across all of Europe, with an increasing focus on renewable energy (driven by energy demand) and food production (driven by population growth and increasing food prices). The type and intensity as regards to food productions (e.g. conventional vs. organic) will also differ radically across Europe, depending largely on the degree of environmental awareness in the respective regions. Climate change impacts will lead to a global breakthrough for technologies that will cut down energy consumption. Also ICT technologies will become more important, allowing for an aging population and a changing labour market in mountain areas. Taken together, all these factors will have a significant impact on the opportunities for mountain communities, but the uptake of these technologies are expected to vary significantly across Europe (depending on the type of forest ownership and degree of public environmental awareness).

3.2.2 Iberian Mountains (Montes de Valsain)

The Iberian Peninsula, commonly called Iberia, is a peninsula located in the south-west of Europe and includes Spain, Portugal, Andorra and parts of France, as well as the British Overseas Territory of Gibraltar. The terrain of the Iberian Peninsula is largely mountainous, including mountain systems, such as the Pyrenees.

Main tree species: Scots pine, Pyrenean oak

Table. 4. Direction of change for driving forces affecting the Iberian sub-scenario. The arrows indicate the direction of change. ↑ implies an increase (+), = implies that the driver stays the same (0), while ↓ implies that the driver decreases (-). This is from the present to 2030, and then from 2030 to 2050.

		2030	2050
Economic	Economic growth	↑	↑
	Consumption levels	↑	↑
	Global trade	=	=
	Market liberalisation	=	=
	Trade intensity in the EU	=	=
	Tax levels	↑	↑
	Energy prices	↑	↑
	Road transport	=	=
	Price of food	↑	↑
	Food shortage	=	=
	Energy consumption	↑	↑
	Demand for bio energy	↑	↑
	Demand for wood products	=	=
	Profitability for forest owners	↓	↓
	Infrastructure developments	↑	↑

Social	Population growth	=	=
	Urbanization	↑	↑
	Aging population	↑	↑
	Education levels	↑	↑
	Nature-based tourism	↑	↑
	Employment in rural areas	=	=
	Environmental awareness	↑	↑
	Qualified human resources	=	=
	Number of ICT users	↑	↑
	Job mobility	↑	↑
	Brain drain from rural communities	=	=
	Individual entrepreneurship	↑	↑
Tech.	Investment in research and technological development	↑	↑
	Innovation rates	=	=
	Developments in energy technology	=	=
	Developments in agricultural technology	=	=
	Developments in forestry technology	=	=
	Rise of new industries	↓	↓
Political	EU Enlargement	=	=
	Energy regulation	=	=
	Increasing self-regulation	=	=
	Environmental regulation	↑	↑
	Greater regulation of infrastructure	=	=
	Rise in international conflicts	=	=
	Coordination of policies at EU level.	↑	↑
	Equal weight to environmental and socio-economic policies	↑	↑
Environmental	Greenhouse gas emissions	↑	↑
	Global climate change impacts	↑	↑
	Natural disturbances in the forest	↑	↑
	Numbers of extreme weather events	↑	↑
	Availability of water	↓	↓
	Conversion of agricultural land to forest	↑	↑
	Biodiversity	↑	↑
	Nature conservation	↑	↑
	Nature restoration	↑	↑
	Flooding in mountain areas	=	=

Top 10 Drivers

Driving forces considered to be the most relevant in the upcoming 40 years, as ranked by the case study group representing their area (see also Table 4).

1 Nature conservation
2 Nature-based tourism
3 Environmental awareness
4 Biodiversity
5 Global climate change impacts
6 Profitability for forest owners
7 Availability of water
8 Investment in research and technological development
9 Employment in rural areas
10 Equal weight to environmental and socio-economic policies

Summary of key developments

Future developments, covering the period up until 2050 in the Iberian mountains, are foreseen to be dominated by three overarching and interconnected issues, namely, **nature conservation, environmental change and employment** (see Table 4). Within the context of conservation, it is expected to include increases in ecosystem services (such as increasing biodiversity) and forest cover, while environmental changes, as connected to climate change and services (such as the reduced availability of water) are also expected to have an increasing impact. This is in turn connected to employment opportunities in the Iberian mountains. Nature tourism is increasingly seen as an important driver for employment in relation to a decrease in the profitability of timber production for forest owners.

Considerations for alternative management

Economic implications: The Iberian mountains are expected to see continuous economic growth in the next decades. This will however be challenged by an **increased emphasis on conservation and nature-based tourism** (linked to increased environmental awareness) as well as a foreseen decline in the profitability for forest owners (e.g. **increasing energy costs**). The main challenge for any alternative management scheme will be to harness the potential in this expected change, namely, to develop capacities for other products (e.g. in **tourism** and for **non-wood forest products**) that boosts economic growth, profitability, and creates new employment opportunities.

These considerations may imply:

- Spatially specified patterns of areas for increased timber production and other areas with extensified forest management (for nature-based tourism)
- Energy-saving harvest and transport schemes

Environment and Climate Change: Effects from climate change (e.g. increasing natural disturbances) and environmental regulations as coordinated by the EU will change attitudes towards the environment. This changing legislative basis and awareness will drive an increase in conservation and restoration (**increased areas set aside**) and agricultural land conversion (**increased forest cover**). The impact from this change will be an increase in ecosystem services, such as biodiversity and carbon sequestration, but may also result in a **reduction in timber and biomass production** in the overall region.

Spatial Implications and Management: Any management scheme for the Iberian mountains will have to incorporate more **conservation and restoration measures**, and consider the implications of **new forms of employment** in the region (e.g. more emphasis on service provision, such as tourism). Aside from spatial effects, for example increased forest cover and set aside areas, another priority areas may be to **increase wood mobilisation** (preferably coupled with investments to reduce harvesting costs) **in dedicated stands/compartments of the region.** This may offset effects from changing management practices and declining profitability for forest owners and meet the increasing demand for wood products.

Product mix: The future will see an **increase in the available product mix** (e.g. increased NWFP utilization) and will require improved capacities to manage and market these non-wood goods and services (e.g. how to explore new markets). This will have to be coupled with efforts to maintain (or even increase) current supplies for **bio energy and wood products** (e.g. high quality timber). The challenge will be to find a functional balance for the different types of goods and services generated by the region.

Management alternatives to respond to this aspect may imply:

- Increased use of slash and stumps as well as previously non-commercial thinning material for bioenergy material (spatially defined)
- Improved tending measures such as more frequent thinning measures

3.2.3 Western and Eastern Alps (Vercors Quatres Montagnes and Montafon)

The Alps are one of the great mountain range systems of Europe stretching approximately 1,200 kilometres across eight Alpine countries from Austria and Slovenia in the east, Switzerland, Liechtenstein, Germany, and France to the west, and Italy and Monaco to the south.

Western Alps

Main tree species: Silver fir, Norway spruce, European beech

Table. 5. Direction of change for driving forces affecting the Western Alps sub-scenario. The arrows indicate the direction of change. ↑ implies an increase (+), = implies that the driver stays the same (0), while ↓ implies that the driver decreases (-). This is from the present to 2030, and then from 2030 to 2050.

		2030	2050
Economic	Economic growth	=	=
	Consumption levels	↑	=
	Global trade	=	=
	Market liberalisation	↑	=
	Trade intensity in the EU	=	=
	Tax levels	↑	↑
	Energy prices	↑	=
	Road transport	↓	=
	Price of food	↑	=
	Food shortage	↑	=
	Energy consumption	↓	=
	Demand for bio energy	↑	↑
	Demand for wood products	↑	↑
	Profitability for forest owners	↑	↑
	Infrastructure developments	↑	=
Social	Population growth	↑	=
	Urbanization	↑	=
	Aging population	↑	=
	Education levels	=	=
	Nature-based tourism	↑	=
	Employment in rural areas	↓	=
	Environmental awareness	↑	=
	Qualified human resources	↑	↑
	Number of ICT users	↑	=
	Job mobility	↑	↑
	Brain drain from rural communities	↓	↓
	Individual entrepreneurship	↑	↑

Tech.	Investment in research and technological development	=	=
	Innovation rates	=	=
	Developments in energy technology	↑	=
	Developments in agricultural technology	=	↑
	Developments in forestry technology	=	↑
	Rise of new industries	=	=
Political	EU Enlargement	=	=
	Energy regulation	↑	↑
	Increasing self-regulation	↑	=
	Environmental regulation	↑	=
	Greater regulation of infrastructure	↑	↑
	Rise in international conflicts	=	=
	Coordination of policies at EU level.	=	=
	Equal weight to environmental and socio-economic policies	↑	=
Environmental	Greenhouse gas emissions	=	=
	Global climate change impacts	=	↑
	Natural disturbances in the forest	=	↑
	Numbers of extreme weather events	=	↑
	Availability of water	↓	↓
	Conversion of agricultural land to forest	↑	=
	Biodiversity	=	=
	Nature conservation	=	=
	Nature restoration	=	=
	Flooding in mountain areas	=	=

Top 10 Drivers

Driving forces considered to be the most relevant in the upcoming 40 years, as ranked by the case study group representing their area (see also Table 5).

1 Population growth
2 Economic growth
3 Employment in rural areas
4 Energy prices
5 Nature-based tourism
6 Greater regulation of infrastructure
7 Availability of water
8 Demand for bio energy
9 Environmental regulation
10 Nature conservation

Summary of key developments

Future developments for the Western Alps, covering the period until 2050, are foreseen to be dominated by demographic changes, employment, energy and environmental issues (see Table 5). With stagnant economic growth, continued demographic changes (in the form of reduced populations size and continued urbanisation in the near future) employment opportunities are foreseen to continue to be reduced in rural mountain areas. This will in part be offset by an increased demand for energy (linked to increasing energy prices), creating opportunities in the energy sector, as well as increasing nature-based tourism and its link to nature conservation and environmental regulation. A key challenge will be to find a balance between interests for pristine mountain areas and demands from the energy sector. This is also linked to increasing impacts (in the long term) from climate change (e.g. reduced availability of water).

Considerations for alternative management

Economic implications: Increasing population growth, an aging work force, continued urbanisation, brain drain, an increasing tax burden and energy costs, will **reduce employment opportunities** in rural areas and generate an unfavourable economic climate that will not grow in the upcoming decades. There are however several opportunities present that could alter this trend, namely, an increasing interest in **nature-based tourism** and the **increasing demand for bio energy and wood products**, which could be further encouraged to generate more employment opportunities. Smart policies within these priority areas could be introduced to stimulate economic growth For example, improved **educational service for vocational change** (for tourism) and **investments in technologies** that reduces key costs (e.g. logistics) for forest owners, to increase profitability and get the economy to grow.

Management alternatives to respond to this aspect may imply:

- Mechanised harvesting operations that respond to lack of labour force and need of reducing costs, especially in pre-commercial thinning's. In steep terrain this implies the introduction of novel harvesting technologies.
- Increased use of slash and stumps as well as previously non-commercial thinning material for bioenergy material

Environment and Climate Change: Environment, energy and infrastructure regulations will increase in the near future (until 2030), primarily this will focus on improving **protection against gravitational hazards** and climate change mitigation/adaptation. Increased natural disturbances are only foreseen for the near distant future (until 2050). This means that challenges in the Western Alps are expected to stay the same for the upcoming years, with climatic changes affecting the region more significantly only by 2050. Conservation and restoration efforts are expected to remain the same. However, moving away from the business-as-usual approach, investing more in

conservation measures may help to harness opportunities in the nature-based tourism sector for rural communities.

In the light of protection needs, however, conversation has to harmonised with needs to:

- Regenerate mature stands and foster resilience of stands by enhanced tending and tree species selection
- Foster tree species that respond to climate change adaptation demands

Spatial Implications and Management: The Western Alps will not see any significant spatial changes until 2050, aside from increased agricultural abandonment resulting in increased forest cover. Priority areas for an alternative management scheme should focus on generating employment opportunities. Provided that environmental regulations (and awareness) are expected to increase, investing in nature-based tourism may generate favourable results. As well, ensuring that the region **increase wood mobilisation** to meet increasing demands for wood products is key. The emphasis for management is however to **reduce costs, such as for harvesting.**

Product mix: The **provision of bio energy** (e.g. biomass) and **wood products** (e.g. high quality timber) will increase over time to meet increasing demands. Other non-wood goods and services (such a **tourism and NWFP utilisation**) will principally remain at the same levels, unless efforts are made to change this trend. The potential for growth in these "non-wood based" sectors would make the development of available and new products a favourable alternate strategy for the region as a whole.

Moving towards NWFP and tourism will imply small-scale forest management operations and spatially specific planning of forest management and operations

Eastern Alps

Main tree species: Norway spruce.

Table. 6. Direction of change for driving forces affecting the Eastern Alps sub-scenario. The arrows indicate the direction of change. ↑ implies an increase (+), = implies that the driver stays the same (0), while ↓ implies that the driver decreases (-). This is from the present to 2030, and then from 2030 to 2050.

		2030	2050
Economic	Economic growth	=	=
	Consumption levels	=	=
	Global trade	↑	↑
	Market liberalisation	↑	↑
	Trade intensity in the EU	↑	↑
	Tax levels	↑	=
	Energy prices	↑	↑
	Road transport	=	↓
	Price of food	↑	↑
	Food shortage	=	=
	Energy consumption	=	↓
	Demand for bio energy	↑	=
	Demand for wood products	=	=
	Profitability for forest owners	=	=
	Infrastructure developments	=	=
Social	Population growth	↓	↓
	Urbanization	=	=
	Aging population	↑	↑
	Education levels	↑	↑
	Nature-based tourism	=	=
	Employment in rural areas	=	=
	Environmental awareness	↑	↑
	Qualified human resources	↑	↑
	Number of ICT users	↑	=
	Job mobility	↑	=
	Brain drain from rural communities	↑	=
	Individual entrepreneurship	=	=
Tech.	Investment in research and technological development	↑	=
	Innovation rates	↑	↑
	Developments in energy technology	↑	↑
	Developments in agricultural technology	=	=
	Developments in forestry technology	=	=
	Rise of new industries	n/a	n/a

Political	EU Enlargement	=	↓
	Energy regulation	↑	↑
	Increasing self-regulation	n/a	n/a
	Environmental regulation	↑	↑
	Greater regulation of infrastructure	n/a	n/a
	Rise in international conflicts	n/a	n/a
	Coordination of policies at EU level.	↑	↑
	Equal weight to environmental and socio-economic policies	n/a	n/a
Environmental	Greenhouse gas emissions	↑	=
	Global climate change impacts	↑	↑
	Natural disturbances in the forest	=	↑
	Numbers of extreme weather events	↑	↑
	Availability of water	=	=
	Conversion of agricultural land to forest	↑	=
	Biodiversity	=	=
	Nature conservation	↑	↑
	Nature restoration	=	=
	Flooding in mountain areas	=	=

Top 10 Drivers

Driving forces considered to be the most relevant in the upcoming 40 years, as ranked by the case study group representing their area (see also Table 6).

1 Economic growth
2 Energy prices
3 Energy regulation
4 Developments in energy technology
5 Demand for wood products
6 Consumption levels
7 Environmental regulation
8 Nature conservation
9 Aging population
10 Profitability for forest owners

Summary of Key Developments

Future developments for the Eastern Alps, covering the period until 2050, are primarily foreseen to be dominated by problems associated with economic growth, demands for energy and environmental interests. Finding a balance between economic and environmental interests is a major challenge facing the Eastern Alps (see Table 6). Getting the sluggish economy to grow is made more difficult with demographic changes, mostly linked to reduced populations sizes and aging populations in rural mountain areas. Increasing demand for wood products and developments in energy technologies

are however seen as a solution to these problems and as a source of future employment. These developments will however increasingly also be challenged by new environmental regulations, interests to preserve and conserve mountain areas, as well as, increasing impacts from climate change. As for the Western Alps, one key challenge will be to find a balance between interests for pristine mountain areas and demands from the energy sector in the near to long term future.

Considerations for alternative management

Economic implications: The Eastern Alps (similarly to the Western Alps) are also expected to suffer under **limited economic growth** in the upcoming decades. In contrast to the West, the population size is however expected to decline, coupled with an increasingly aging (and educated) population. This implies **decreased labour force** available and high costs arising from responding to environmental regulations and managing the mountain landscape.

Management implications could focus towards:

- Higher amount of mechanised harvesting (new technologies)
- Stronger use of small-diameter biomass for bio-energy
- Focus timber production on high-value stands and assortments
- Extensify forest management in less profitable stands and seek new business opportunities (e.g. eco-tourism, nature conservation)

Environment and Climate Change: With increasing environmental and energy regulations the Eastern Alps will see more **areas set aside for conservation** and more investments into the development of **bioenergy technologies** and increasing demand for renewables. These opposing drivers will generate conflicts as regards to the use of forest areas, and highlights the opposing drivers underlying policies geared towards environmental protection and those towards climate changes. Alternative management schemes could focus at finding a more balanced (sustainable, integrated or multifunctional) approach for contradictory drivers affecting the mountain landscape.

Spatial Implications and Management: **Increased agricultural abandonment, demand for energy, and more conservation measures** will dominate the Eastern Alps in the upcoming years. The spatial effect will **be increased forest cover**, on the one hand, areas set aside for conservation, and on the other hand, **areas used for intensive forest management.** Aside from increasing effects from climate change (e.g. extreme weather events) other ecosystem services (e.g. biodiversity) are considered to remain the same. It may be relevant to ensure that the forest sector does not become dominated by the energy sector (e.g. reducing the production of high quality timber), or to ensure that cultural landscape maintained and not overly converted into forestland. This would also have implications for the type of biodiversity that is prevalent in the region (e.g. maintenance of meadows).

Product mix: The Eastern Alps will increasingly focus on economic growth, which will result in products that focus more on the use of wood for bioenergy and/or high quality timber. This will conflict with environmental regulations that increasingly push for setting aside more areas for conservation. However, if managed properly, areas that are protected may gain from increasing from compensations for protection and the provision of non-wood forest products, which would help to diversify the product mix.

3.2.4 Dinaric Mountains (Sneznik)

The Dinaric mountains forms a mountain chain in Southern Europe, spanning Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Serbia, Kosovo, Albania and Macedonia. The mountains extend for 645 kilometres along the coast of the Adriatic Sea, from the Julian Alps in the northwest down to the Sar-Korab massif, where the mountain range direction changes to north-south.

Main tree species: Silver fir, European beech, Norway spruce.

Table. 7. Direction of change for driving forces affecting the Dinaric sub-scenario. The arrows indicate the direction of change. ↑ implies an increase (+), = implies that the driver stays the same (0), while ↓ implies that the driver decreases (-). This is from the present to 2030, and then from 2030 to 2050.

		2030	2050
Economic	Economic growth	↑	↑
	Consumption levels	↑	↑
	Global trade	↑	↑
	Market liberalisation	=	=
	Trade intensity in the EU	↑	=
	Tax levels	↑	↑
	Energy prices	↑	↑
	Road transport	=	↓
	Price of food	↑	↑
	Food shortage	↑	↑
	Energy consumption	↑	↑
	Demand for bio energy	↑	↑
	Demand for wood products	↑	↑
	Profitability for forest owners	=	=
	Infrastructure developments	=	=
Social	Population growth	↓	=
	Urbanization	=	=
	Aging population	↑	↑
	Education levels	↑	↑
	Nature-based tourism	↑	↑
	Employment in rural areas	↑	↑
	Environmental awareness	↑	↑
	Qualified human resources	↑	↑

	Number of ICT users	=	=
	Job mobility	=	=
	Brain drain from rural communities	=	↓
	Individual entrepreneurship	↑	↑
Technological	Investment in research and technological development	=	=
	Innovation rates	=	=
	Developments in energy technology	↑	↑
	Developments in agricultural technology	↑	↑
	Developments in forestry technology	=	↑
	Rise of new industries	=	=
Political	EU Enlargement	↑	↑
	Energy regulation	↑	↑
	Increasing self-regulation	=	=
	Environmental regulation	↑	↑
	Greater regulation of infrastructure	↑	↑
	Rise in international conflicts	=	=
	Coordination of policies at EU level.	=	↓
	Equal weight to environmental and socio-economic policies	=	=
Environmental	Greenhouse gas emissions	↑	↑
	Global climate change impacts	↑	↑
	Natural disturbances in the forest	↑	↑
	Numbers of extreme weather events	↑	↑
	Availability of water	=	=
	Conversion of agricultural land to forest	↓	↓
	Biodiversity	=	=
	Nature conservation	↑	↑
	Nature restoration	=	↑
	Flooding in mountain areas	=	=

Top 10 Drivers

Driving forces considered to be the most relevant in the upcoming 40 years, as ranked by the case study group representing their area (see also Table 7).

1 Equal weight to environmental and socio-economic policies
2 Energy prices
3 Demand for bio energy
4 Nature conservation
5 Biodiversity
6 Developments in energy technology
7 Profitability for forest owners
8 Natural disturbances in the forest
9 Population growth
10 Nature-based tourism

Summary of key developments

The Dinaric Mountains will in the future primarily be dominated by two major issues, namely, nature conservation and energy (see Table 7). Essentially the main challenge will be to find a balance between, on the one hand, environmental interests, and on the other hand, economic interests. While the economic outlook for the future looks positive, with increasing employment foreseen both within nature-based tourism and in the energy sector, these developments will also increase the contrasting demands on communities living in the Dinaric Mountains. With global climate change impacts on the rise and a public interest for preserving mountain areas, conflicts will arise as regards the conservation of ecosystem services, such as biodiversity. It is however expected that equal weight will continued to be given to environmental and socio-economic policies, making room for multifunctionality of forest areas in the Dinaric mountains.

Considerations for alternative management

Economic implications: The economic outlook for the Dinaric Mountain region is seemingly positive until 2050, with **increasing growth and demand for wood products**, **energy and nature-based tourism.** With this range of diverse drivers (or demands) on mountain landscapes, the key factor to ensure continued economic growth in the region is to find a balance between these environmental and socio-economic driving forces. Potential gains by one sector can only come at the cost of another sector, and finding a balance will become increasingly important.

For alternative management this would imply:

- More spatially specific forest management with target areas for different leading targets, where these compete (e.g. areas of extensification vs. intensification of management)
- Stronger wood mobilisation in areas dedicated for timber production (both pre-commercial material and high-value timber)

Environment and Climate Change: With increasing impacts from climate change, in the form of extreme weather events and natural disturbances, environmental, energy and infrastructure regulations will be increasingly imposed in the region. This development will go align with more **nature conservation and restoration measures**, increase environmental awareness and generate opportunities for nature-based tourism. There could be potentially contradictory incentives by climate change policies (e.g. **carbon sequestration**), driven in part by the energy sector (e.g. **biomass production**), which need to be balanced.

For alternative management this may imply

- Spatially specific areas for carbon sequestration and conservation
- Areas of intensified timber and bioenergy supply
- Measures to adapt to climate change such as alternate tree species selection

Spatial Implications and Management: In contrast to the other case study areas, the Dinaric Mountains expect to see a reduction in the abandonment of agricultural land. This reflects developments in the energy, forest and nature conservation sectors noted above and, more specifically, increasing demands placed on the mountain landscape (e.g. increasing food prices are for example also expected to play a role here, etc). Forest management is expected to intensify, coupled with areas set aside for conservation. For management, these changes imply allocating **priority areas for the range of diverse services** the region has to provide. Management could be modelled according to these differing functions and vary the intensity to determine the best balance in terms of land use.

Product mix: The range, or mix, of products to be provided by the region presents a challenge in finding an optimal balance as regards to land use. The challenge will be to maintain the supply for bio energy (e.g. biomass) and for wood products (e.g. high quality timber) while introducing capacities for new non-wood goods and services (e.g. tourism).

3.2.5 Scandinavian mountains (Vilhelmina)

The Scandinavian Mountains are a mountain range that runs through the Scandinavian Peninsula. The western sides of the mountains drop precipitously into the North Sea and the Norwegian Sea, while to the northeast they gradually curve towards Finland. To the north they form the border between Norway and Sweden, still reaching 2,000 m high at the Arctic Circle. The mountain range just touches north westernmost Finland.

Main tree species: Scots pine, Norway spruce

Table. 8. Direction of change for driving forces affecting the Scandinavian sub-scenario. The arrows indicate the direction of change. ↑ implies an increase (+), = implies that the driver stays the same (0), while ↓ implies that the driver decreases (-). This is from the present to 2030, and then from 2030 to 2050.

		2030	2050
Economic	Economic growth	=	↓
	Consumption levels	=	↓
	Global trade	↓	↓
	Market liberalisation	↑	=
	Trade intensity in the EU	↑	=
	Tax levels	=	=
	Energy prices	↑	=
	Road transport	↓	=
	Price of food	↑	=
	Food shortage	↓	=
	Energy consumption	=	↓
	Demand for bio energy	↑	=
	Demand for wood products	↑	↑
	Profitability for forest owners	↑	=
	Infrastructure developments	↑	↑
Social	Population growth	=	↑
	Urbanization	↑	=
	Aging population	=	↓
	Education levels	↑	↑
	Nature-based tourism	↑	↑
	Employment in rural areas	↑	↑
	Environmental awareness	↑	=
	Qualified human resources	↑	↑
	Number of ICT users	↑	=
	Job mobility	↑	↑
	Brain drain from rural communities	↑	=
	Individual entrepreneurship	↑	↑

Tech.	Investment in research and technological development	↑	↑
	Innovation rates	↑	↑
	Developments in energy technology	↑	↑
	Developments in agricultural technology	↑	↑
	Developments in forestry technology	↑	↑
	Rise of new industries	↑	↑
Political	EU Enlargement	=	=
	Energy regulation	↑	=
	Increasing self-regulation	↑	=
	Environmental regulation	↑	=
	Greater regulation of infrastructure	↑	=
	Rise in international conflicts	=	=
	Coordination of policies at EU level.	=	↓
	Equal weight to environmental and socio-economic policies	↑	↑
Environmental	Greenhouse gas emissions	↓	↓
	Global climate change impacts	↑	↑
	Natural disturbances in the forest	↑	=
	Numbers of extreme weather events	↑	=
	Availability of water	=	↓
	Conversion of agricultural land to forest	↓	=
	Biodiversity	↑	↑
	Nature conservation	↑	=
	Nature restoration	↑	↑
	Flooding in mountain areas	=	=

Regionally-specific driving forces

In Vilhelmina, Sweden, a stakeholder workshop was recently conducted to investigate what the regional stakeholders believe to be the most important factors impacting the future local landscape in the coming 30 years. This workshop was held by the research project INTEGRAL. 14 persons voted, and they were able to choose 10 of 44 factors. This list shows which factors had the highest number of votes:

Urbanisation	8	Local and regional planning	2
National laws and regulations	7	Population dynamics	2
The global climate and population development	7	Transport costs	2
Forest product market dev and innovations	7	Forest estate market	2
In- and out migration	6	Forest social values	2
Resource distribution	6	Ownership structure	1
Locally accessible technique	6	Costs for harvest and forest	1

		management	
Weather conditions	5	"Green" values	1
Ownership rights	5	Economic situation of forest owner	1
Forest owner knowledge and competence	5	EU-rural and agricultural policy	1
National rural politics	4	Income from timber and pulp	1
Forest owner goals, attitudes and traditions	4	Association development	1
Consulting and management	4	Organised tourism	1
Income from NTFPs	4	Work conditions and environment	0
National welfare development	3	Certification	0
Culture, tradition and history	3	Subsidies	0
Energy costs	3	Management costs	0
Dialogue	3	Biological disturbances	0
Information and social media	3	Hunting and wild life management	0
Tax policy	3	EU economic policy	0
EU-environmental policy	3	EU energy policy	0
Rights of Public Access	3	Tax policies of other countries	0

Top 10 Drivers

Driving forces considered to be the most relevant in the upcoming 40 years, as ranked by the case study group representing their area (see also Table 8).

1 Employment in rural areas
2 Urbanization
3 Equal weight to environmental and socio-economic policies
4 Profitability for forest owners
5 Demand for wood products
6 Infrastructure developments
7 Individual entrepreneurship
8 Energy regulation
9 Increasing self-regulation
10 Global climate change impacts

Summary of Key Developments

The Scandinavian mountain areas will continue to be affected by urbanisation and stagnant population growth in the near future, up until 2030 (see Table 8). This development will change in the near-distant future (from 2030 and onwards), but presents a number of challenges linked to increasing employment opportunities in the energy sector and nature-based tourism, coupled with an increased demand for wood products. The main challenge will be to maintain a qualified and sufficiently large work force in rural areas in the Scandinavian mountains, so as to be able to meet the increasing demands on forests (from both energy and tourism). While effects from

climate change are also foreseen in the long-term, its immediate impact (e.g. water availability) is not expected to be as significant as in mountain areas located in central and southern Europe.

Considerations for alternative management

Economic implications: The outlook for economic growth is bleak. In the near future it will stay the same (2030), but in the near distant future (2050) it is expected to decrease. This is in part offset by increasing demand from the **energy and nature-based tourism sector** that offers new employment opportunities for the region. Also **investments in innovation and technological developments** will increase. However, continued **population decline and urbanisation** are key drivers that will make the exploitation of these opportunities more difficult. Alternative management approaches should address these barriers to economic growth by e.g.

- Extensification of forest management in non-profitable areas and develop new business models (e.g. NWFP, tourism)
- Intensify wood mobilisation in dedicated areas where logistics allow for a profitable forest management
- Apply new harvesting and logistic technologies

Environment and Climate Change: The Scandinavian Mountains are, on the one hand, expected to be affected by climate change in the near future (e.g. natural disturbances in the forest and extreme weather events), on the other hand, **increasing environmental regulation** (primary driven at the national level) are expected to increase conservation and restoration measures and improve biodiversity. This may relate to the above issue of extensifying forest management and enhanced marketing of other ecosystem services (e.g. compensation, subsidies, tourism):

Spatial Implications and Management: The Scandinavian Mountains (as with the Dinaric Mountains) expect to see a reduction in the abandonment of agricultural land. This reflects developments in the energy (e.g. demand for bioenergy) and forest (demand for wood products) sectors as well as in nature conservation (demand for nature-based tourism). Collectively these drivers will **increase the demand for varied and more intense forms of land use** (e.g. intensified food production). Forest management is for this reason also expected to intensify, coupled with an increase in the areas set aside for conservation. For management, these changes imply allocating priority areas for the range of diverse services the region has to provide. Management could be modelled according to the differing functions and the intensity could be varied to establish the optimal form of land use in the region.

Product mix: Maintain the supply for bio energy and for wood products (e.g. high quality timber) while introducing capacities for new products and services. Non-wood goods and service (e.g. tourism) will provide the region with new product options (e.g. provision of edible forest products) and further diversify the current product mix.

3.2.6 Western Carpathians (Kozie Chrbty)

The Western Carpathians are a mountain range that forms the western part of the Carpathian Mountains. The mountain stretches from the Low Beskids range of the Eastern Carpathians along the border of Poland with Slovakia toward the Moravian region of the Czech Republic and the Austrian Weinviertel. In the south the North Hungarian Mountains cover northern Hungary.

Main tree species: Norway spruce, Silver fir

Table. 9. Direction of change for driving forces affecting the Carpathian sub-scenario. The arrows indicate the direction of change. ↑ implies an increase (+), = implies that the driver stays the same (0), while ↓ implies that the driver decreases (-). This is from the present to 2030, and then from 2030 to 2050.

		2030	2050
Economic	Economic growth	=	=
	Consumption levels	=	↑
	Global trade	=	↑
	Market liberalisation	↑	↑
	Trade intensity in the EU	↑	↑
	Tax levels	↑	↑
	Energy prices	↑	↑
	Road transport	=	↑
	Price of food	↑	↑
	Food shortage	=	↑
	Energy consumption	↑	↑
	Demand for bio energy	↑	↑
	Demand for wood products	=	=
	Profitability for forest owners	↓	↓
	Infrastructure developments	=	↑
Social	Population growth	=	↑
	Urbanization	=	=
	Aging population	↑	↑
	Education levels	=	↑
	Nature-based tourism	↑	↑
	Employment in rural areas	=	=
	Environmental awareness	↑	↑
	Qualified human resources	=	↑
	Number of ICT users	↑	↑
	Job mobility	↑	↑
	Brain drain from rural communities	=	↑
	Individual entrepreneurship	=	↓

Tech.	Investment in research and technological development	=	↑
	Innovation rates	=	↑
	Developments in energy technology	=	↑
	Developments in agricultural technology	=	↑
	Developments in forestry technology	=	↑
	Rise of new industries	=	=
Political	EU Enlargement	=	↑
	Energy regulation	=	↑
	Increasing self-regulation	=	=
	Environmental regulation	=	=
	Greater regulation of infrastructure	=	=
	Rise in international conflicts	=	=
	Coordination of policies at EU level.	↑	↑
	Equal weight to environmental and socio-economic policies	=	↑
Environmental	Greenhouse gas emissions	↑	↑
	Global climate change impacts	↑	↑
	Natural disturbances in the forest	↑	↑
	Numbers of extreme weather events	↑	↑
	Availability of water	=	↓
	Conversion of agricultural land to forest	=	↑
	Biodiversity	=	=
	Nature conservation	=	↑
	Nature restoration	=	↑
	Flooding in mountain areas	↑	↑

Top 10 Drivers

Driving forces considered to be the most relevant in the upcoming 40 years, as ranked by the case study group representing their area (see also Table 9).

1 Global climate change impacts
2 Natural disturbances in the forest
3 Numbers of extreme weather events
4 Environmental awareness
5 Investment in research and technological development
6 Demand for wood products
7 Profitability for forest owners
8 Economic growth
9 Qualified human resources
10 Environmental regulation

Summary of key developments

For the Western Carpathians, the main concern for the future is climate change and to a somewhat lesser extent economic aspects of the forest-based sector (see Table 9). It is expected that effects from climate change will increase the prevalence of natural disturbances in the forest as well as extreme weather events, affecting the profitability of the forest-based sector negatively, despite an increase in demand for wood products in the near and near-distant future. The Western Carpathians will also be affected by a lack of qualified human resources in the near-distant future as an affect of urbanisation.

Considerations for alternative management

Economic implications: The region will experience an **increased demand for bio-energy**, but the demand for wood-based products, as well as for conservation and restoration, will remain the same. One result from this development will be a decline in the profitability for forest owners. The main challenge for the Western Carpathians will be to develop capacities for other products (e.g. non-wood forest products) that boost economic growth, profitability, and creates new employment opportunities. Prospects for supporting economic growth is possible through the **increased demand for nature-based tourism**. Also addressing increasing energy costs (e.g. logistics) and climate change costs (e.g. mitigation) may help to get the economy growing.

Environment and Climate Change: Environmental regulations will not increase significantly. The impact from climate change and natural disturbances on forests are expected to have a negative impact on the environment, timber and biomass production (e.g. decreased stock and dead wood), while land abandonment and an increased demand for bio energy will result in **increased forest cover,** also associated to increased land abandonment in the near distant future. Management. The main concern for alternative management and modelling will be to tackle effects from climate change, such as extreme weather events and reduced availability of water, for the near distant future.

Spatial Implications and Management: Demand from the energy sector is expected to **increase the intensity of forest management**, while the demand for nature-based tourism will result in **areas set aside to provide associated services**. Alternative management could be modelled according to the differing functions for the distinctive areas and the optimal form of landuse could be decided accordingly. For example, wood mobilisation may be a priority area given increased demand for energy, deciding where it is best to have more intensive forest management may therefore be beneficial.

Product mix: The demand for energy and nature-based tourism are expected to increase continuously over the scenario period, while wood products (e.g. high quality timber) and other non-wood goods and services are expected to remain stable. To increase the resilience of the region, alternative management should focus on the introduction of capacities for new products and service.

3.2.7 Western Rhodopes (Shiroka Laka)

The Rhodopes are a mountain range in South-Eastern Europe, with over 80% of its area in southern Bulgaria and the remainder in Greece. Rhodopes are part of the Rilo-Rhodope massif, which is the oldest landmass on the Balkan Peninsula.

Main tree species: Norway spruce, Scots pine.

Table. 10. Direction of change for driving forces affecting the Rhodopes sub-scenario. The arrows indicate the direction of change. ↑ implies an increase (+), = implies that the driver stays the same (0), while ↓ implies that the driver decreases (-). This is from the present to 2030, and then from 2030 to 2050.

		2030	2050
Economic	Economic growth	=	↑
	Consumption levels	=	↑
	Global trade	↑	↑
	Market liberalisation	↑	↑
	Trade intensity in the EU	↑	↑
	Tax levels	↑	=
	Energy prices	↑	↑
	Road transport	↑	↑
	Price of food	↑	↑
	Food shortage	=	=
	Energy consumption	↑	↑
	Demand for bio energy	↑	=
	Demand for wood products	↑	↑
	Profitability for forest owners	=	=
	Infrastructure developments	↑	↑
Social	Population growth	↓	↓
	Urbanization	=	=
	Aging population	↑	↓
	Education levels	=	=
	Nature-based tourism	=	↑
	Employment in rural areas	=	=
	Environmental awareness	↑	↑
	Qualified human resources	=	=
	Number of ICT users	↑	↑
	Job mobility	=	=
	Brain drain from rural communities	=	=
	Individual entrepreneurship	↑	↑

Technological	Investment in research and technological development	=	=
	Innovation rates	↑	↑
	Developments in energy technology	↑	↑
	Developments in agricultural technology	↑	↑
	Developments in forestry technology	↑	↑
	Rise of new industries	=	=
Political	EU Enlargement	=	=
	Energy regulation	↑	↑
	Increasing self-regulation	↑	↑
	Environmental regulation	↑	↑
	Greater regulation of infrastructure	↑	↑
	Rise in international conflicts	=	=
	Coordination of policies at EU level.	↑	↑
	Equal weight to environmental and socio-economic policies	=	=
Environmental	Greenhouse gas emissions	=	↓
	Global climate change impacts	↑	↑
	Natural disturbances in the forest	↑	↑
	Numbers of extreme weather events	↑	↑
	Availability of water	↓	↓
	Conversion of agricultural land to forest	↑	=
	Biodiversity	↓	↓
	Nature conservation	=	↑
	Nature restoration	=	↑
	Flooding in mountain areas	↑	↑

Top 10 Drivers

Driving forces considered to be the most relevant in the upcoming 40 years, as ranked by the case study group representing their area (see also Table 10).

1 Population growth
2 Demand for wood products
3 Aging population
4 Environmental regulation
5 Coordination of policies at EU level.
6 Road transport
7 Price of food
8 Energy prices
9 Global climate change impacts
10 Natural disturbances in the forest

Summary of key developments

Looking into the future for the Western Rhodopes, there are several important drivers that will shape the upcoming decades. The foremost among these is a decreasing and aging population, which will have a significant impact on the type of employment in rural communities (see Table 10). This will be particularly important as employment opportunities in the area are expected to increase until 2050. It will thus become a challenge to meet the demand for wood products and biomass in the near future. Economic growth will also be hampered by increasing food and energy costs in the near future, as well as an increase of natural disturbances in the forest (as an effect from climate change) and a decrease in biodiversity in the near-distant future.

Considerations for alternative management

Economic implications: Despite an increased demand for wood products, most of the top drivers will have a **negative impact on economic growth** in the Western Rhodopes region, particularly due to a general population that is aging and reducing in size. This will have a serious impact on economic opportunities for the region. Also increasing food, energy, and transport costs will feed into this development, offsetting any potential gains provided by increasing market prices for wood products. Any alternative management option would have to take these socio-economic developments into account, such as lack of human resources/labour and/or investing in technologies (e.g. increased mechanisation) that can counterbalance these developments.

Environment and Climate Change: Environmental regulations are likely to increase in the upcoming decades (principally coordinated from the EU level), in part for conservation purposes, even though biodiversity is expected to decrease in the region, and in part to combat climate change, such as to increase efforts for carbon sequestration. The impact from climate change and natural disturbances on forests are expected to have a declining impact on timber and biomass production (e.g. **reduced growing stock**), while **land abandonment and an increased demand for wood products** will result in **increased forest cover that may in part offset** this change. Alternative management will have to respond to this trends and apply regimes that improve resilience of forest ecosystems.

Spatial Implications and Management: Main concerns for the management of the Western Rhodopes are demographic changes, meaning that any land use scenario and/or management regime would have to account for the impact from the decreased labour force as an effect of a smaller and aging population. Also increasing environmental regulations and land abandonment will have spatial implications (e.g. forest areas set aside for conservation). **Identifying priority areas** to increase wood mobilisation may be necessary to meet demand, as well as, measures to reduce harvesting costs (e.g. logistic) due to increasing energy costs.

Product mix: The challenge will be to maintain the supply for bio energy and for wood products (e.g. high quality timber) while introducing capacities for new products and service, such as in tourism. Areas that are protected may gain from increasing the provision of non-wood forest products (e.g. cultural services or food).

Following below is an overview of all regional sub-scenarios and the expected direction of change for the driving forces.

Table 11. Overview of the direction of change for all driving forces and regional sub-scenarios.

		2030							2050						
		Sc.	Rh	Ca.	Di.	E.A.	W.A.	Ib.	Sc.	Rh	Ca.	Di.	E.A.	W.A.	Ib.
Economic	Economic growth	=	=	=	↑	=	=	↑	↓	↑	=	↑	=	=	↑
	Consumption levels	=	=	=	↑	=	↑	↑	↓	↑	↑	↑	=	=	↑
	Global trade	↓	↑	=	↑	↑	=	=	↓	↑	↑	↑	↑	=	=
	Market liberalisation	↑	↑	↑	=	↑	↑	=	=	↑	↑	=	↑	=	=
	Trade intensity in the EU	↑	↑	↑	↑	↑	=	=	=	↑	↑	=	↑	=	=
	Tax levels	=	↑	↑	↑	↑	↑	↑	=	=	↑	↑	=	↑	↑
	Energy prices	↑	↑	↑	↑	↑	↑	↑	=	↑	↑	↑	↑	=	↑
	Road transport	↓	↑	=	=	=	↓	=	=	↑	↑	↓	↓	=	=
	Price of food	↑	↑	↑	↑	↑	↑	↑	=	↑	↑	↑	↑	=	↑
	Food shortage	↓	=	=	↑	=	↑	=	=	=	↑	↑	=	=	=
	Energy consumption	=	↑	↑	↑	=	↓	↑	↓	↑	↑	↑	↓	=	↑
	Demand for bio energy	↑	↑	↑	↑	↑	↑	↑	=	=	↑	↑	=	↑	↑
	Demand for wood products	↑	↑	=	↑	=	↑	=	↑	↑	=	↑	=	↑	=
	Profitability for forest owners	↑	=	↓	=	=	↑	↓	=	=	↓	=	=	↑	↓
	Infrastructure developments	↑	↑	=	=	=	↑	↑	↑	↑	↑	=	=	=	↑
Social	Population growth	=	↓	=	↓	↓	↑	=	↑	↓	↑	=	↓	=	=
	Urbanization	↑	=	=	=	=	↑	↑	=	=	=	=	=	=	↑
	Aging population	=	↑	↑	↑	↑	↑	↑	↓	↓	↑	↑	↑	=	↑
	Education levels	↑	=	=	↑	↑	=	↑	↑	=	↑	↑	↑	=	↑
	Nature-based tourism	↑	=	↑	↑	=	↑	↑	↑	↑	↑	↑	=	=	↑
	Employment in rural areas	↑	=	=	↑	=	↓	=	↑	=	=	↑	=	=	=
	Environmental awareness	↑	↑	↑	↑	↑	↑	↑	=	↑	↑	↑	↑	=	↑
	Qualified human resources	↑	=	=	↑	↑	↑	=	↑	=	↑	↑	↑	↑	=
	Number of ICT users	↑	↑	↑	=	↑	↑	↑	=	↑	↑	=	=	=	↑
	Job mobility	↑	=	↑	=	↑	↑	↑	↑	=	↑	=	=	↑	↑
	Brain drain from rural communities	↑	=	=	=	↑	↓	=	=	=	↑	↓	=	↓	=
	Individual entrepreneurship	↑	↑	=	↑	=	↑	↑	↑	↑	↓	↑	=	↑	↑
Tec	Investment in research and technological development	↑	=	=	=	↑	=	↑	↑	=	↑	=	=	=	↑
	Innovation rates	↑	↑	=	=	↑	=	=	↑	↑	↑	=	↑	=	=

	Developments in energy technology	↑	↑	=	↑	↑	↑	=	↑	↑	↑	↑	↑	=	=
	Developments in agricultural technology	↑	↑	=	↑	=	=	=	↑	↑	↑	↑	=	↑	=
	Developments in forestry technology	↑	↑	=	=	=	=	=	↑	↑	↑	↑	=	↑	=
	Rise of new industries	↑	=	=	=	n/a	=	↓	↑	=	=	=	n/a	=	↓
Political	EU Enlargement	=	=	=	↑	=	=	=	=	=	↑	↑	↓	=	=
Political	Energy regulation	↑	↑	=	↑	↑	↑	=	=	↑	↑	↑	↑	↑	=
Political	Increasing self-regulation	↑	↑	=	=	n/a	↑	=	=	↑	=	=	n/a	=	=
Political	Environmental regulation	↑	↑	=	↑	↑	↑	↑	=	↑	=	↑	↑	=	↑
Political	Greater regulation of infrastructure	↑	↑	=	↑	n/a	↑	=	=	↑	=	↑	n/a	↑	=
Political	Rise in international conflicts	=	=	=	=	n/a	=	=	=	=	=	=	n/a	=	=
Political	Coordination of policies at EU level.	=	↑	↑	=	↑	=	↑	↓	↑	↑	↓	↑	=	↑
Political	Equal weight to environmental and socio-economic policies	↑	=	=	=	n/a	↑	↑	↑	=	↑	=	n/a	=	↑
Environmental	Greenhouse gas emissions	↓	=	↑	↑	↑	=	↑	↓	↓	↑	↑	=	=	↑
Environmental	Global climate change impacts	↑	↑	↑	↑	↑	=	↑	↑	↑	↑	↑	↑	↑	↑
Environmental	Natural disturbances in the forest	↑	↑	↑	↑	=	=	↑	=	↑	↑	↑	↑	↑	↑
Environmental	Numbers of extreme weather events	↑	↑	↑	↑	↑	=	↑	=	↑	↑	↑	↑	↑	↑
Environmental	Availability of water	=	↓	=	=	=	↓	↓	↓	↓	↓	=	=	↓	↓
Environmental	Conversion of agricultural land to forest	↓	↑	=	↓	↑	↑	↑	=	=	↑	↓	=	=	↑
Environmental	Biodiversity	↑	↓	=	=	=	=	↑	↑	↓	=	=	=	=	↑
Environmental	Nature conservation	↑	=	=	↑	↑	=	↑	=	↑	↑	↑	↑	=	↑
Environmental	Nature restoration	↑	=	=	=	=	=	↑	↑	↑	↑	↑	=	=	↑
Environmental	Flooding in mountain areas	=	↑	↑	=	=	=	=	=	↑	↑	=	=	=	=

3.3 Concluding remarks

Europe's mountain area, forests and biodiversity face an uncertain and critical future. The ARANGE baseline scenario and sub-scenarios have aimed to illuminate some of the complex social, economic and ecological processes affecting mountain regions across Europe. There is a great responsibility to highlight the risks and the potential opportunities of these areas to maintain rural landscapes but also to provide some thoughts on new opportunities for changing mountain landscapes, as well as reflecting on impacts on the provision of ecosystem services.

From the input provided by case study groups, it can be noted that some commonalities exists between all the areas. These relate, first and foremost, to expected environmental changes associated with climate change. For example, all areas agree that there may be a shortage of water available in the near future (excluding the Scandinavian mountains that see it more as a problem for the near distant future). Most areas also agree that all rural mountain areas will be facing reduced population size, as associated with continued urbanisation, as well as aging populations. This will put an increased demand for skilled labour in rural mountain areas to account for the general increasing demand for wood products and biomass for energy. While these commonalities across the mountain areas are relevant to consider, the case study areas do also differ significantly in what is perceived as the most relevant driving forces for the future. For instance, the Western Alps prioritise problems associated with population growth, while the Eastern Alps prioritise economic growth. Some areas, such as the Iberian Mountains, emphasise the importance of nature conservation and protection from increased impacts from climate change. These differences will be relevant to consider as regards to how the future will develop on a regional level. There will thus be multiple and different factors and driving forces influencing mountain and forest land use change in the respective regions, which in turn will impact the provision of key ecosystem services.

The benefit of the input provided by the case study areas furthermore relates to the difficulty to express some changes (e.g. socio-economic factors) in exact quantitative form for the inclusion into the foreseen ARANGE model for land-use change. Considering and discussing the direction of changes provides a qualitative basis for the model as well as a descriptive analysis of foreseen land use change in mountain areas across Europe. It provides a more understandable description of what may happen in the future. The results in this report can therefore provide a good starting point – set the stage so to speak – for continued discussion on the approach for the development of ARANGE's quantitative model and provide a basis for a common understanding of the future in the modelling phase of the project.

Understanding the drivers of land use can finally lead to the definition of key assumption for modelling approaches in ARANGES, e.g.:

- Economic implications
  - Economic considerations are a main driver for management decisions, and can lead assumptions for modelling accordingly. This includes
    - Market prices for different product groups, e.g. sawn timber, energy wood, slash etc.
    - The socio-political environment incl. subsidy systems, e.g. extensified management, eco-tourism, etc.
    - Logistical costs, such as harvest and transport costs, energy costs (e.g. oil price) will have major impact on the choice of logistical systems
- Spatial implications
  - Set aside of forest area for conservation purposes
  - "Segregational" approaches to identify priority areas of intensified forest production, areas for nature conservation, areas for tourism, etc. in one landscape/region
  - A mix of altered management regimes in a landscape/region as compared to one BAU regime
- Intensity of management
  - Modelling can implement variable management intensity according to different drivers, e.g.
    - Intensify harvest for wood mobilisation incl. rendering thinning's from pre-commercial to commercial activities, whole-tree processing, and use of slash and debris (i.e. reduction of deadwood)
    - Extensify to increase dead wood, bird habitat, and touristic amenities
    - Responding to demographic developments as sketched in the land use scenarios by population pressure/land abandonment, and availability of labour and skills (FM, harvest, mechanisation, etc.)
- Modify product mix
  - Altering assortments, harvest scheduling, and technology with regards to stronger use of wood for bioenergy (bioenergy scenario) or vice versa for high quality timber (product scenario)
- Climate change and disturbances
  - Climate change scenarios to be implemented according to IPCC scenarios
  - Recognition of disturbances may lead to altered management scenarios such as reduction of growing stock, shortened rotation periods (in storm-prone areas), and decreased stock and dead wood in dry and water-scarce areas

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5 Annexes

5.1 Annex I. Projects and/or reports reviewed

	Name	Year
1	VISIONS: Integrated Visions for a Sustainable Europe	2001
2	CARBOMONT - Effects of land-use changes on sources, sinks and fluxes of carbon in European mountain areas	2002
3	Energy to 2050: Scenarios for a Sustainable Future	2003
4	Trends In Vehicle and Fuel Technologies: Scenarios for Future Trends	2003
5	Mobility 2030: Meeting the Challenges to Sustainability	2004
6	Eurasia 2020: Global Trends 2020 Regional Report	2004
7	Caucasus Environmental Outlook	2004
8	ATEAM - Advanced Terrestrial Ecosystem Analysis and Modelling	2004
9	Arctic Climate Impact Assessment	2005
10	Millennium Ecosystem Assessment	2005
11	BIOSCENE — Scenarios for Reconciling Biodiversity Conservation With Declining Agricultural Use in the Mountains of Europe	2005
12	EEA Outlook	2005
13	Intelligent Infrastructure Futures: The Scenarios — Towards 2055	2006
14	GEO4: Global Environment Outlook 4	2007
15	Prelude — Land Use Scenarios for Europe	2007
16	European Energy and Transport: Trends to 2030 — European Energy and Transport: Scenarios on Key Drivers	2007
17	ELME - European Lifestyles and Marine Ecosystems: Exploring challenges for managing Europe's seas	2007
18	ESPON - Territorial futures: spatial scenarios for Europe	2007
19	Scenar 2020 – Scenario study on agriculture and the rural world	2007
20	Global Trends 2025: A Transformed World	2008
21	Shell Energy Scenarios to 2050	2008
22	World Energy Outlook 2009	2009
23	ALARM: Assessing Large Scale Risks for Biodiversity With Tested Methods	2009
24	Getting in the Right Lane for 2050	2009
25	ENSEMBLES - Climate change and its impacts at seasonal, decadal and centennial timescales	2009
26	EACH-FOR: Environmental Change and Forced Migration Scenarios	2009
27	SENSOR - Tools for Impact Assessment	2009
28	The European environment – state and outlook 2010	2010
29	EFORWOOD - Tools for Sustainability Impact Assessment	2010
30	SCENES - Water scenarios for Europe and for Neighbouring States	2011
31	PLUREL: Peri-urban Land Use Relationships – Strategies and Sustainability Assessment Tools for Urban-Rural Linkages	2011
32	Ecochange - Challenges in Assessing and Forecasting Biodiversity and Ecosystem Changes in Europe	2012
33	CAMELEON - CArbon dynamics in Mountain Ecosystems: analyzing Landscape-scale Effects Of aNthropogenic changes (climate and land use)	2013
34	MOUNTLAND - Sustainable Land Use Practices in Mountain Regions	Ongoing
35	Forest outlook study	2011
36	EU wood on the future use of wood	2010

5.2 Annex II. Summary of scenario trends, drivers and impacts

	Project	Scenario	Trends	Drivers	Impacts
1	**VISIONS**	Economic growth ("Money Maker")	Economy: Cultural Variables and Economic Change	Unclear	Unclear
		Environmental protection ("Think Green")	Environment: Conflict and Calamity and Environmental Rupture	Unclear	Unclear
		Limited policy action ("Wait and See")	Technology / Social cultural: Survival of the weak, Methuselah on drugs, Fragmentation and dematerialisation, and Benign Technology	Unclear	Unclear
		Pessimistic future outlook ("Doom Monger").	Regional tensions: Tension and Release – A tortuous path, Regional Tension	Unclear	Unclear
2	**CARBOmont**	Status quo	Reduction of farm price support by CAP	CAP modification occurs on an incremental path	Less production-related support
			Restrictive planning controls on development	Encourage the rural economy	Agricultural support is maintained
		Reduce farm prices	Reduction of agricultural price support	Decoupling of farm support from farmer's production decisions	Environmental or area-based payments
					Further CAP reform
			Restrictive planning controls on development	Pressure from the World Trade Organisation	Justify any payments that are made in terms of the public goods produced

		Rural Diversification	Enhanced rural development policy	Empowerment of local groups	Enabling framework of national and EU policies
			Central governments issue planning guidance	Rural economy	Partially decoupled CAP
3	**Energy to 2050**	Clean, but not Sparkling	Strong concern for the global environment	Overzealous policy intervention	Environmental goals are largely met
					Low economic growth
			Slow rate of technological change	Pessimistic perceptions about technology	Insufficient investment in R&D
					Limited technological progress
		Dynamic but Careless	Dynamic technological change	Economic growth is the main priority	Rapid economic growth
			Low priority for climate change mitigation	Energy security	Fossil fuel demand grows rapidly
					Increase in GHG emissions
			Technologies will take care of all problems	Low energy costs	Worsening environmental conditions
			No policy interventions		Less regulated markets
		Bright Skies	Rapid technological change	Environment and energy security	Attainment of environmental goals
					Enhance energy security
			Strong concern for the global environment	GHG emissions	GHG emission control and reduction
			Robust trade and market liberalisation trends	Economic growth	Medium economic growth
4	**Trends In Vehicle…**	Baseline scenario	Combined result of the improvement of conventional technologies	Slow introduction of alternative technologies	
		Oil price and fuel tax scenarios	Increase of the price of oil	Slow down growth in transport demand	

				Reductions in CO2 emissions	
				Alternative technologies	
			Decrease of the price of oil	Opposite of above	
		Carbon tax	Carbon tax 50	Gasoline use increase	
			Carbon tax 100	Alternative technologies	
		Subsidy scenarios	Subsidy for electric, hybrid and/or fuel cells	Decrease of the purchase cost of each alternative technology	
		Emission limits scenario	Prohibition of conventional technologies in urban areas.	Alternative technologies	
		Technology focus scenarios	The case of none of the alternative technologies being attractive enough is tested	e.g. no hybrid, no electric, etc.	
5	**Mobility 2030**	The Price is Right	Increasing economic interconnectedness	Free-market	Free flow of capital and goods across national borders
					Increasingly homogeneous global culture
					Widening gap between rich and poor
				Short-term financial returns	Environment management requires immediate financial reward
					Lack a long-term perspective
		The Global Citizen	Collective approach to addressing world problems	Global climate change	Floods
					Food shortages
				World security concerns	Fuel supply disruptions
			Promoting technological innovation	Innovation in renewable energy sources	Technical innovation in fuels and transportation systems
			Shift in consumer mind-set	Climate change	Change in how individuals and goods are transported

		We'll Do It Our Way	Increasing desire for self-identification and nationalism	Growing security fears	Innumerable approaches are adopted
				Desire for increased control over local economic, social, and environmental agendas	Decisions are highly localized
				Fractionalization of the global economy	Protectionism
6	**Eurasia 2020**	Economic Prosperity and Political Stability	N/A		
		Muddling Through	N/A		
		Decline and Isolation	N/A		
		Central Asian Meltdown	N/A		
7	**Caucasus Environmental Outlook**	Status quo	N/A		
		Downfall	N/A		
		A Caucasus market world	N/A		
8	**ATEAM**	Socio-economic and emission scenarios	Changing urban areas with different spatial patterns	Economic development	Increasing/decreasing depending on population growth
		Climate Change Scenarios	Use of wood for producing energy	Substitution of food production by energy production and the planting of trees, or an acceptance of overproduction (as with the current EU's CAP)	Increasing agricultural areas
				Increasing biofuel production and forest land use	Negative impacts on ecosystem service supply

					Continued urban expansion, recreational areas and forest land use would all be likely to take up at least some of the surplus
		Land use change scenarios	Forests and areas protected for conservation and/or recreation	Demand for near urban recreation areas	Tourism increases/decreases and recreation increases/decreases
			Policy mechanisms that seek to limit crop productivity	Extensification of organic production (particularly in the environmental scenarios)	Increasing agricultural areas
			Large reductions in agricultural areas for food production (except for B1 and B2)	Technological development	Surplus land in the A1f and A2 scenarios
		Nitrogen deposition scenarios	NOx emission	Fossil fuel combustion due to road transportation and power generation	Increasing emissions
9	**Arctic Climate Impact Assessment**	Cryosphere	Climate change	GHG emissions	Changes and impact to the arctic
		Terrestial Freshwater ecosystems Economic Social impacts			
10	**Millennium Ecosystem Assessment**	Global Orchestration	Global cooperation	Climate change	Deal with global environmental problems

			Fisheries	
		Global markets	Improve the social and economic well-being	Problems that have little apparent or direct impact on human wellbeing are given a low priority in favor of policies that directly improve wellbeing.
		Supra-national institutions	Protect and enhance global public goods and services	Focus on the individual
	Order from Strength	Security and protection	Economic insecurity	Securing natural resources Environment is secondary
	Adapting Mosaic	Strengthening of local institutions	Local ecosystem management strategies	Improving knowledge about ecosystem functioning and management
			Managing socioecological systems	Failures in managing the global commons
	Technogarden	Relying strongly on technology	Climate change	Technology and market-oriented institutional reform
			New policy initiatives	
		Highly managed and often-engineered ecosystems	Reduce the environmental impact of goods and services	Improvements in ecological engineering that optimize the production of ecosystem services
11	**BioScene**	Landscape change	Population trends	Tree colonisation Loss of cultural landscapes
		Agricultural decline and abandonment	Socio-economic conditions	Negative impacts on mountain biodiversity Loss of locally adapted species and semi-natural habitats Positive impacts: New successional pathways

					providing opportunities for restoration of some of the large predators
12	**EEA Outlook**	Baseline scenario	Demographic	Population	Increasing populations
				Number of households	Increasing no. households
				Average household size	Increasing household size
			Economic	Macro and meso-economic (i.e. sectoral) activity	Changing economy
				Household expenditure	Reduced household expenditure
			Technological	Energy flows.	Waste and material flows
				Climate change	Air pollution
					Water stress and quality
		Alternative scenarios	Key uncertainties around economic and technological issues	High/Low economic growth	A weaker/stronger Euro
				Decelerated/Accelerated penetration of renewables	Increased/reduced emissions
				Decelerated/Accelerated decommissioning/adoption of nuclear	Increased/reduced emissions
			Key uncertainties around policy levers	Policy variants:	
				Extended CAP reform	Liberalisation of animal product markets
13	**Intelligent Infrastructure Futures: The Scenarios — Towards 2055**	Perpetual Motion	Constant information, consumption and competition	Instant communication and continuing globalisation	Hypermobility
			Development of renewable energy sources	New, cleaner, fuel technologies	Reduced dependence on carbon-based fuels
		Urban Colonies	Technology investment and development	Minimising environmental impact	Compact, sustainable cities
			Rural areas have become more	Transport is permitted only if	Acting as food and biofuel

			isolated	green and clean	sources for cities
			Consumption has fallen	Resource use is a fundamental part of the tax system	Disposable items are less popular
		Tribal Trading	World has shrunk to their own community	Sharp and savage energy shock	Global recession
					Global economic system is severely damaged
		Good Intentions	No realistic alternative energy source	Reduce carbon emissions	Constrains personal mobility
				Carbon quotas	Mass transportation is used more widely
14	**GEO4**	Markets First	Pursue maximum economic growth	Economic growth to improve the environment and human well-being	Narrow focus on the sustainability of markets
					Technological fixes to environmental challenges
		Policy First	Top-down approaches to policy implementation	Strong policies to improve the environment and human well-being	Promoting sustainable development
					Rapid progress on key targets
		Security First	Government and private sector compete for control	Focus on a minority	Sustainable development only in the context of maximizing access to and use of the environment by the powerful
		Sustainability First	Government, civil society and the private sector work collaboratively to improve the environment and human well-being	Equal weight is given to environmental and socio-economic policies	Effective public-private sector partnerships
					Focus on inclusiveness
15	**Prelude**	Great Escape	Economic globalisation	Increased importance of international trade Decreasing societal solidarity	Technological innovation rates are high Societal tension

				Strong reduction of policy interventions	Agriculture is market-oriented
		Evolved Society	Environmental awareness	Heavy floods	Environmentally sustainable regional development
			Rural development	Exploding energy prices	Eco-efficient technologies
				Increased support for renewable energies	Land-use changes are not dramatic
		Clustered Networks	Globalisation	Economic growth	Environmental and health conditions get worse
			Aging society	Coherent spatial planning policies	Migration away from polluted urban areas
			Strong marginalisation of agriculture	Large-scale land abandonment	Cropland and grassland strongly decrease
		Lettuce Surprise U	Food security crisis	Reduction of agricultural area	Europe's food supply decreases strongly
					Increase in biodiversity and improvements in soil, water and air quality
			Political decentralisation	Increase of environmental awareness	Self-regulation becomes more important
			Open-source technological breakthrough	New communication technologies	Development of innovative technologies
		Big Crisis	Environmental disasters	Support for a strong coordination of policies at European level	New policies for sustainable and regionally balanced development
				Social solidarity	Efficient public transport systems
				Top-down policy programs	Agricultural intensification is largely reversed
					Land-use changes are limited
16	**European Energy and Transport**	Baseline scenario	Development of the EU energy system	Population development	Alternative policy approaches
				Economic downturn	
			6		

		7		Volatile energy import price environment Technology progress	Energy efficiency measures
		Reference scenario	Same as baseline		Assumes that national targets are achieved in 2020.
17	**ELME**	National enterprise	Protectionist	Erosion of EU	Protectionist policies limit economic growth
			Market-based	Little concern for social equity or environmental protection	Trade diminished within EU
			Low inward migration	Low birth rates	Diminished longevity
		Local responsibility	Social equity	Local governance	Fragmented policy
			Environmental protection	Slow growth	
		Worlds Markets	Growth more important than social equity	Corporate governance starts to displace government	Environmental policy limited to correction and support of the market
				Materialist consumerism	Rapid growth
		Global Community	Increasing globalisation of governance systems	Balancing of economic, social and environmental welfare	EU more centralised
					Growth constrained by tax levels and social & environmental objectives
					Environmental policy expands across policy sectors
18	**ESPON**	Trend scenario	Globalisation	EU enlargement	Liberalisation of international trade
			Slowly growing R&D expenditures	Climate change	Increase of energy prices
			Low policy coherence	Decreasing public expenditure	Reduction of CAP budget
		Competitiveness-oriented Scenario	Policy mix to boost EU competitiveness	Reduced EU budget	CAP and ERDF budgets are reduced significantly
				Focus of EU-policies on strongest regions	Funding towards R&D increased
				Liberalisation and privatisation of	

				public services	
			Enlargement	Competitiveness	Immigration for labor
			Environmental measures undertaken only if market efficient	Climate change	Adaptation measures implemented only when cost efficient
		Cohesion-oriented Scenario	Policy mix to improve cohesion	Maintaining EU budget	Reinforcement of the Structural Funds
				Focus of EU-policies on weakest regions	More public intervention and more decentralised and coherent governance
			No enlargement	Restrictive policy on immigration	Active multi-level territorial governance
			Environmental measures	Promotion of decentralised energy production & renewables	Strict climate change mitigation measures
19	**Scenar 2020**	Baseline scenario	Development of agricultural and rural policy according to current policy objectives	Moderate growth	Continuation of existing environmental legislation
			Successful outcome of the Doha Round negotiations	Labour market liberalisation	
		Regionalisation scenario	Doha Round not successful		Reinforcement of environmental legislation
			Production of commodities in the internal market	Further bilateral and multilateral negotiation	No WTO agreement is reached
		Liberalisation scenario	More open markets	Globalisation	Market and trade policies and income support will be abolished Removing direct agricultural payments Partial withdrawal of environmental legislation
20	**Global Trends 2025**	A World Without the West	New global players	Diverse interests and competition over resources	New powers supplant the West as leaders on

					the world
				Sustaining economic development Preoccupied with domestic issues	Competition over resources
		October surprise	Climate change	Mitigation Environmental disasters No technological solution	Extreme weather events Water scarcity Food scarcity Cutbacks in carbon emissions Major dislocations
			"Growth-first" mentality		Widespread environmental neglect and degradation.
		BRICs Bust up	Increasing resource constraints	Disputes over resources Nationalist sentiments	New trade barriers Conflicts
		Politics Is Not Always Local	Dispersion of power and authority away from nation-states Global communication	Increasingly decentralized world Individuals affiliate directly with identity-driven groups/networks	Social and political movements Governance transcend geographic boundaries
21	**Shell Energy Scenarios to 2050**	Scramble	National energy security	Secure energy supply	Negotiation of bilateral agreements Local resource development Growth in coal and biofuels
			Climate change	Major climate events stimulate political responses	Energy price spikes and volatility GHG increase Research to limit impact
		Blueprints	New coalitions of interests Climate change	Supply concerns Environmental interests Entrepreneurial opportunities	Carbon trading markets Response to climate stresses Market-driven CO2 management practices New alliances promote action

22	**World Energy Outlook 2009**	Reference scenario	No changes to existing policies and measures	China and India are the main drivers of growth Economic growth	Global primary energy demand rising Low tech dev.
		450 Scenario	Collective policy action	Climate change Restrict the global temperature increase	Limit the long-term concentration of GHG National emissions-reduction commitments for 2020 Emissions credits trading
23	**ALARM**	Business as might be usual	Globalisation Environmental policy	Market liberalism Technological challenge	Free trade Deregulation and privatization Innovation, market incentives and some legal regulation
		Growth Applied Strategy	Growth-focused Policy-driven Climate change	Globalisation Market liberalism Damage repair	Free trade Deregulation and privatization Liability legislation Preventive action
		Sustainable European Development Goal	Backcasting Sustainability of societal development	Competitive economy Healthy environment Gender equity	International cooperation Integrated social, environmental and economic policy
24	**Getting in the Right Lane for 2050**	Vision for 2050	Land resources, food and biodiversity Climate change mitigation and energy security Transport and mobility	Population growth Biodiversity loss Climate change Security of supply from imports Reducing carbon dioxide	Improving agricultural productivity Strategy of diversity in EU land and agriculture policies Low-carbon energy system Emission control policies Low-carbon transport

				emissions from all transport modes	
				EU climate change target	Improving air quality
25	**ENSEMBLES**	Applied the IPCC scenarios A2,A1B and B1 to modelling.	Emissions scenarios, with land-use change and adaptive capacity, with and without international climate policy	Conducted critical review of the economic assumptions of SRES scenarios, reaching the conclusion that more realistic and theoretically sound scenarios could be adopted, but this would not significantly modify the order of magnitude of global GHG emissions	Produced stabilization scenarios, which are used as inputs in climate models
26	**EACH-FOR**	Market First	Private sector widens its influence into previous governmental areas	Increase economic investment	Privatisation of education, security, research, health and other social services
			Free trade	Expand trade	Growing economy
			Globalistaion		International trade accelerates
			Commoditization of nature	Economic exchange of goods	Ecosystem services are turned into commodities
					Terrestrial and marine biodiversity decrease
					Agriculture is intensified
		Security First	Authority of international institutions declines	Security	Public participation gets marginalized
			Increased limits on how people live	Restrictions on migration	Reduce the movement of people
				Trade barriers	Reduce trade
			Environmental degradation	Severe water stress	Conflicts over resources
			Climate change		Terrestrial and marine biodiversity decrease
		Policy First	Holistic government	Balancing economic growth with social and environmental issues	Subsidies that encourage the overexploitation of resources are

					reduced or eliminated
					Public investments in science and technology grow
			International cooperation	Increase energy efficiency and induce a move to more low carbon and renewable sources	International agreements
				Preventing land-use change	Number of protected areas increases
			Growing populations and economic activities	Demand for bio-fuels	Increase in land devoted to pasture
					Decrease of forest land
					Energy consumption increase
				8	
			Climate change and agricultural practices	Same as the trend	Loss of biodiversity is dramatic
					Severe water stress
		Sustainability first	All sectors (government/civil/private) address environmental and social concerns	International trade is reformed	Public resources are shifted from military to social and environmental issues
			Climate change	Efforts to reduce biodiversity loss	Significant warming and sea level rise
					Significant species loss in some areas
				Demand for bio-fuels	Increase in land devoted to pasture
					Decrease of forest land
					Growth in the level of CO2 is limited
27	**SENSOR**	Baseline	Absence of any change in policy intervention	Defines baseline drivers (see below)	
		Policy scenarios	CAP revision		Continuing income support to farmers, or

					cutting expenditures
			Socio-economic trend analysis	Demographic change within Europe The rate of participation in the labour force Growth of world demand (outside Europe) The price of petroleum on the world market	
				Expenditure on research and development	Increasing/decreasing support for research and development
28	**The European environment – state and outlook 2010**		Two scenarios are analysed, based on the IPCC's A2 and B1 emission scenarios.		
29	**EFORWOOD**	Forest conservation scenario to be applied to the whole of the EU	Multifunctional orientation	Protection of biodiversity	European network for conservation of biodiversity Multi-functional forest management
		Bio-energy scenario to be applied to the Baden Württemberg, Germany case	Climate change	Demand for bioenergy	Increased extraxction of biomass
		Technology change scenario to be applied to Vasterbotten, North Sweden	New technologies	Increase the value added of wood-based products	Increase the use efficiency of raw material Higher quality products
		Consumption change scenario to be applied to the Iberian peninsula	Increasing houshold/individual wealth	Economic growth	Global trade is increased

				Global trade Moderate population growth	Increase in consumption
30	**SCENES**	Sustainability Eventually	Globalisation	Strong top-down policies	Trade offs at the expense of economical development
			Market-oriented to environmental sustainability	Bottom-up approach	Slow growth Internal migration
			Climate change	Environmental impacts of changes in water resources	Water scarcity issues in water poor countries Landscape policy Develop environmental technology
		Policy Rules	EU gains a stronger hold on policy	High energy costs, access to energy supplies, meeting increasing water demands and adaptation to climate change Top-down approach	Policies to decarbonize Europe Lack of coordination
			Climate change	EU policies becoming slowly more ineffective	Low economic growth Ecosystem services deteriorate Increasingly scarce water and migration/urbanization
		Fortress Europe	Conservative attitude	Focus on security	Protectionist agricultural policy EU strives for self-sufficiency
			Climate change	Water scarcity	Migration Effective agricultural techniques Social unrest
		Economy First	Globalization and liberalization	Economic growth	Reduce barriers to trade Cutbacks in social security systems Innovation Income inequality

					Multinational companies dictate environmental standards/progress
31	**PLUREL**	Hypertech	Rapid spread of more efficient technologies	Rapid economic growth	Information and communications technology (ICT), nano-technology and bio-technology, transform lifestyles and working patterns
	Based on IPCC scenarios			Population growth	
		Extreme water	Heterogeneous world of self reliance, local enterprise and preservation of local identities	Climate change	Population growth due to climate-induced migration
					Costly adaptation strategies
		Peak oil	Future of environmental and social consciousness	Climate change	Reduced individual liberties and local enterprise
				Rising energy prices	Remote rural areas decline
		Fragmentation	Fragmentation of society, in terms of age, ethnicity and international distrust..	Increased in-migration	Urban form redistributes its population and activities
32	**ECOCHANGE**	Business-as-might-be-usual	N/A		
		Neoliberal growth approach	N/A		
		Sustainable pathway	N/A		
33	**CAMELEON**	Intermediate growth with local solutions to sustainability	Based on IPCC4 scenarios (B2)	N/A	
		Rapid economic growth	Based on IPCC4 scenarios (A1)	N/A	
34	**MOUNTLAND**	Policy and market	Based on storylines of the IPCC	N/A	

		scenarios			
		Climate scenarios	Based on IPCC4 scenarios	N/A	
35	**Forest outlook study**	Reference scenario	Local solutions to economic, social, and environmental sustainability Based on IPCC scenario B2 Only the quantitative aspects of this storyline were used for the Reference scenario	Increasing global population, Intermediate economic development No rapid and diverse technological change	
		Maximising biomass	Carbon stocks in forests	Changes in the silvicultural methods	Highest carbon stock in biomass Carbon credits Changing rotation lengths and thinning shares Rotation lengths were increased
		Priority to biodiversity	Priority to biodiversity conservation in forest management	Quantify the trade-offs between this policy goals (e.g. increasing carbon storage and furthering wood production and trade)	Political framework for the forest sector according to the goal to conserve and enhance biodiversity Preference give to biodiversity
		Promoting wood energy	Renewable energy targets	Achieve target share of renewables in total energy Price of fossil energy rises	High demand for wood Emerging scarcities
		Fostering innovation and competitiveness	Striving for a more innovative future	Strategy of innovation	Improved competitiveness Changes how the forest sector operates (high uncertainty)
36	**EU wood on the future use of wood**	Two baseline scenarios, based on IPCC A1 and B2	Use of wood for producing energy	Climate change	Decreased / Increased mobilisation of wood
		High mobilisation Medium Mobilisation		EU RES Directive Energy consumption	Wood energy Changing wood market

Low Mobilisation		Energy demand	Negative environmental effects of intensified use of forest resources
	Cascade use	Industrial wood residues	Mechanisation of harvesting
		Higher added values	Technological developments
	Changing environment	Environmental concerns	Biodiversity protection
			Impacts on the harvests
			Wood availability

8.1 Annex III. Scenario Summaries

IPCC: Main Characteristics of the 4 SRES Storylines

By 2100 the world will have changed in ways that are hard to imagine - as hard as it would have been at the end of the 19th century to imagine the changes of the 100 years since. Each storyline assumes a distinctly different direction for future developments, such that the four storylines differ in increasingly irreversible ways. Together they describe divergent futures that encompass a significant portion of the underlying uncertainties in the main driving forces. They cover a wide range of key "future" characteristics such as population growth, economic development, and technological change. For this reason, their plausibility or feasibility should not be considered solely on the basis of an extrapolation of current economic, technological, and social trends.

1. The A1 storyline and scenario family describes a future world of very rapid economic growth, low population growth, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building, and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into four groups that describe alternative directions of technological change in the energy system. Two of the fossil-intensive groups were merged in the SPM.
2. The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in high population growth. Economic development is primarily regionally oriented and per capita economic growth and technological change are more fragmented and slower than in other storylines.
3. The B1 storyline and scenario family describes a convergent world with the same low population growth as in the A1 storyline, but with rapid changes in economic structures toward a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives.
4. The B2 storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with moderate population growth, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented toward environmental protection and social equity, it focuses on local and regional levels.

1. VISIONS

1. Living on the Edge: N/A
2. Europe in Transition: N/A
3. Shadows of Europe Ltd: N/A

2. CARBOmont

1. Status quo - gradual reduction of farm price support by CAP; continuing restrictive planning policies: The basis of this scenario is that the process of CAP modification occurs on an incremental path where the current basis of agricultural support is maintained but with

increasing amounts being channelled away from production-related support, towards agri-environmental and direct income measures. There is a continuation of the gradual introduction of policies to encourage the rural economy but with little change in existing restrictive planning controls on development. In summary this scenario represents a minimalist change policy

2. Reduce farm prices (rapid reduction of agricultural price support and a switch to environmental or area-based payments); continuation of restrictive planning): Under this scenario the decoupling of farm support from farmer's production decisions is taken to its logical conclusion through the phasing out of price guarantees and their replacement by production-neutral, decoupled payments, under pressure from the World Trade Organisation. The key assumption is that income transfers to farmers are made on strictly defined environmental or social grounds and that increasing transparency brings with it strong pressure to justify any payments that are made in terms of the public goods produced. Policy is still on a voluntary basis with some farmers choosing to enrol land into the decoupled environmental schemes now widely on offer, or producing at world market prices. Such changes would be signalled during the forthcoming WTO negotiations, possibly with agreement in 2002/3 and followed by further CAP reform and implementation of decoupling over 5 - 10 years
3. Rural Diversification - enhanced rural development policy with positive planning: This scenario assumes that rural land use policy is driven less by further changes in agricultural policy and more by greater emphasis being given to EU rural development policy. This policy is taken to imply the empowerment of local groups in line with the principle of subsidiarity and in accordance with recent community pilot initiatives embodying processes of community-led rural development (i.e. LEADER). The defining principle is one of local control of resources and land use policy, within a broad enabling framework of national and EU policies. Beside this, it is assumed that central governments issue planning guidance which gives greater priority to the development of the rural economy and less to countryside preservation. Such a scenario provides an alternative to the agricultural-policy-led scenarios which have been criticised as relics of agricultural fundamentalism, at a time when the importance of agriculture to the rural economy has diminished. It is assumed that this proceeds in the context of a partially decoupled CAP, as outlined in Scenario 1 (the current trend scenario). In this scenario it is assumed that both national governments and the EU are prepared to cede much more power to local or regional representative bodies. This is not likely to happen until a minimum of 5-10 years have elapsed and could vary greatly across Europe.

3. Energy to 2050: Scenarios for a Sustainable Future

1. Clean, but not Sparkling: This scenario is characterised by a strong concern for the global environment by both the public and policymakers but a relatively slow rate of technological change. Contrary to a common wisdom for which strong pro–environment policies would lead to a rapid development of environmental friendly technologies, a number of other factors could put such an outcome at risk. In this scenario a combination of pessimistic perceptions about technology and overzealous policy intervention do not allow for the full potential of technological development to be released. Furthermore, insufficient investment in R&D or failure of these research efforts to produce results leads to limited technological progress. As in this scenario technologies fail to deliver, environmental goals are largely met through induced changes in behaviour, and likely only at rather high costs.
2. Dynamic but Careless: This scenario is characterised by very dynamic technological change, low priority for climate change mitigation and a generalised belief that sustained growth and rapid progress in technologies will take care of all problems without need for much policy intervention. As a corollary, this scenario has more rapid economic growth than the first one, including more open but less regulated markets. Unhindered economic growth is

the main priority, shared by developed and developing countries alike. However, not all countries are able to achieve fast growth rates and some lag behind. Global threats such as climate change take a back seat in the concerns of both citizens and politicians. Although energy represents a relatively small share of production inputs or household spending, low energy prices and security of supply are considered an important condition for economic growth. At the beginning, progress is faster in fossil fuel based technologies, helping to maintain low prices. In both developed and developing countries local environmental problems are not ignored but are dealt with at the local level and consistently with the economic resources of the affected communities or individually through pollution impact averting behaviour. As a consequence of these initial conditions, fossil fuel demand grows rapidly, followed by an increase in GHG emissions. These two factors increase the likelihood of energy security of supply crises and worsening environmental conditions. To deal with security of supply, and in the continuous quest for low energy costs the system accelerates the development of new technologies. While the first phase of this scenario is therefore heavily oriented towards fossil fuel-based technologies, in the second part of the scenario horizon, non-fossil technologies emerge too.

3. Bright Skies: This scenario is characterised by both rapid technological change and strong concern for the global environment by both the public and policymakers. Other features of this scenario include a (global) GDP growth rate somewhere in between the first two cases but closer to the second, robust trade and market liberalisation trends, a narrowing down of income differences across regions and countries. As a result, overall, energy prices will be somewhat higher than in the second scenario but lower than in the first. In this scenario, governments of developed countries agree to deal with the threat of climate change in a co-ordinated fashion and to take action to slow down and reverse current trends in GHG emissions. In due time they are joined in this process by developing countries, who agree to take increasingly stringent commitments for GHG emission control and reduction. Domestically, developed country governments set out to design and implement policies that will, on the one hand, encourage a reduction of energy-related GHG emissions and, on the other, channel both government and private resources towards development of new technologies for climate change mitigation. These efforts produce a host of positive technological outcomes, which allow the attainment of environmental goals, and also enhance energy security while keeping prices relatively low.

4. Trends In Vehicle and Fuel Technologies: Scenarios for Future Trends

1. Baseline scenario: The baseline scenario is used as the reference case. It corresponds to the outlook for each technology if the current trends in demand are sustained, if fuel and vehicle prices and fuel economy follow the path predicted by current surveys of trends in vehicle technologies, and if no significant policy measure is implemented. According to the baseline scenario, no clear winner among the non-conventional technologies is identified.
2. Oil price and fuel tax scenarios: Two scenarios corresponding to higher and lower oil prices. These scenarios describe a potential development in external conditions, but could also result in the case of changing the taxation levels of oil based products (gasoline and diesel).
3. Carbon tax: Tax proportional to the carbon content of each fuel is applied. In the carbon tax 50 scenario, the carbon content related tax that is imposed is the equivalent of 50 euros per ton of CO2, while in the carbon tax 100 scenario it is the equivalent of 100 euros per ton of CO2. The main difference from the high oil price scenario (that also corresponds to imposing a fuel tax) is that carbon tax affects gasoline and diesel in a different manner.
4. Subsidy scenarios: Three scenarios on subsidy for electric, hybrid and fuel cells correspond to a decrease of the purchase cost of each alternative technology by 2000 euros. This would decrease the price differential of these technologies compared to conventional technologies and accelerate their introduction.

5. Emission limits scenario: The zero emissions scenario assumes the prohibition of conventional technologies in urban areas. This would favour hybrid vehicles in the medium term and all alternative technologies, in a proportional way, in the longer term. The main losers would be the light gasoline (and in the longer term, the light diesel) cars, since their predominantly urban role would be played by alternative technologies.
6. Technology focus scenarios: Car market is currently dominated by one technology (internal combustion engine) with two variants (diesel and gasoline) and that increasing the spectrum of technologies that a manufacturer should be able to offer would not be a feasible option. Under this hypothesis, car manufacturers would decide to invest in a technology only if the potential market for it would be large enough to justify the additional investment needed, i.e. manufacturers would select the winning technologies and would abandon the laggards.

5. Mobility 2030: Meeting the Challenges to Sustainability

1. The Price is Right: There is increasing interconnectedness in the world as businesses, governments, and the general population operate in a more global, free-market oriented context. The World Trade Organization, World Bank and IMF continue to develop global economic standards, paving the way for multi-national corporations to increase their access to markets and their influence on global affairs. The free flow of capital and goods across national borders brings with it an increasingly homogeneous global culture. At the same time there is a widening gap between rich and poor within and among nations. With short-term financial returns a priority, in this free-market scenario decisions regarding urbanization, transportation, and the environment require immediate financial reward and often lack a long-term perspective.
2. The Global Citizen: Shocks in the early 2000s including fuel supply disruptions, world security concerns, as well as floods and food shortages due to global climate change, lead to a collective approach to addressing world problems. With a mission from the citizenry, governments act with a heavy hand to support social, economic, and environmental responsibility by using tax incentives and policy to promote technology innovation. This leads to innovation in renewable energy sources. Global movements of inter-connected individuals and institutions have achieved preliminary success addressing grand challenges such as poverty, social inequity, local air quality, and sustainable mobility. The combination of deliberate urban planning, technical innovation in fuels and transportation systems, and a fundamental shift in consumer mind-set bring about a radical change in how individuals and goods are transported.
3. We'll Do It Our Way: The ease with which information travels combined with the proliferation of multi-national corporations and retail chains around the globe was leading the world down a path of commonality. This force was aggressively disrupted in the early 2000s as an increasing desire for self-identification and nationalism surfaced around the world. Prompted by growing security fears and a desire for increased control over local economic, social, and environmental agendas, a fractionalization of the global economy takes place – along with an increasing push toward self-reliance, sometimes even leading to protectionism, among individual nations. Local communities adopt their own goals, objectives and strategies to achieve them. As a result, decisions are highly localized and innumerable approaches are adopted to address to the unique problems distinct communities, nations, and regions face.

6. Eurasia 2020: Global Trends 2020 Regional Report

1. Economic Prosperity and Political Stability: N/A
2. Muddling Through: N/A
3. Decline and Isolation: N/A

4. Central Asian Meltdown: N/A

7. Caucasus Environmental Outlook

Use GEO3 scenarios as a starting point.

1. Status quo: N/A
2. Downfall: N/A
3. A Caucasus market world: N/A

8. ATEAM

ATEAM's primary objective was to assess the vulnerability of human sectors relying on ecosystem services with respect to global change. We consider vulnerability to be a function of potential impacts and adaptive capacity to global change. Multiple, internally consistent scenarios of potential impacts and vulnerabilities of the sectors agriculture, forestry, carbon storage, water, nature conservation and mountain tourism in the 21st century were mapped for Europe at a regional scale for four time slices (1990, 2020, 2050, 2080).

See table 3 in the final report: "Summary of scenarios for cross-cutting drivers at the European scale" on page 16.

Distinguish between the four SRES "marker" scenarios across the following categorisation of scenarios:

1. Socio-economic and emission scenarios. The scenario assumptions are described in a consistent qualitative way by summarising two major dimensions. The first major dimension focuses on 'material consumption' (A) versus 'sustainability, equity and environment' (B). The second major dimension distinguishes 'globalisation' (1) versus 'regionalisation' (2). The narratives specified typical aspects, processes and their dynamics for each of the four quadrants identified by these dimensions (A1, B1, A2 and B2).
2. Climate change scenarios. The climate scenarios of the 21st century replicate observed month-to-month, inter-annual and multi-decadal climate variability of the detrended 20th century climate. The climate data used in this study are the European observed climate 1901-2000, 16 climate scenarios for 2001-2100, and a single 'control' scenario of unforced climate (1901-2100) based on the detrended 1901-2000 historical record.
3. Land use change scenarios. Recognises three levels in the derivation of land use scenarios that move from qualitative descriptions of global socio-economic storylines, over European sector driving forces (see Table 3), to quantitative projections of regional land use change.
4. Nitrogen deposition scenarios. The scenarios were derived using a framework of two integrated models: RAINS (Regional Acidification Information and Simulation) and IMAGE (IMAGE team 2001). The main NOx emission source is fossil fuel combustion due to road transportation and power generation. The basic assumptions underlying the scenarios are that all European NOx-deposition stems from European emissions, and that its distribution across European countries does not change in the future (the 2000 shares are taken to distribute emissions).

9. Arctic Climate Impact Assessment

Based on one set of projections, not a worst-case scenario. This projection covers aspects, such as, the cryosphere, terrestial, freshwater ecosystems, economic and social impacts.

10. Millennium Ecosystem Assessment

1. Global Orchestration: Depicts a worldwide connected society in which global markets are well developed. Supra-national institutions are well placed to deal with global environmental problems, such as climate change and fisheries. However, their reactive approach to ecosystem management makes them vulnerable to surprises arising from delayed action or unexpected regional changes. The scenario is about global cooperation not only to improve the social and economic well-being of all people but also to protect and enhance global public goods and services (such as public education, health, and infrastructure). There is a focus on the individual rather than the state, inclusion of all impacts of development in markets (internalization of externalities), and use of regulation only where appropriate. Environmental problems that threaten human well-being (such as pollution, erosion, and climate change) are dealt with only after they become apparent. Problems that have little apparent or direct impact on human wellbeing are given a low priority in favor of policies that directly improve wellbeing. People are generally confident that the necessary knowledge and technology to address environmental challenges will emerge or can be developed as needed, just as it has in the past. The scenario highlights the risks from ecological surprises under such an approach. Examples are emerging infectious diseases and other slowly emerging problems that are hard to control once they are established. Other benefits and risks also emerge from the inevitable and increasing connections among people and nations at social, economic, and environmental scales.
2. Order from Strength: Represents a regionalized and fragmented world concerned with security and protection, emphasizing primarily regional markets, and paying little attention to the common goods, and with an individualistic attitude toward ecosystem management. Nations see looking after their own interests as the best defense against economic insecurity. They reluctantly accept the argument that a militarily and economically strong liberal democratic nation could maintain global order and protect the lifestyles of the richer world and provide some benefits for any poorer countries that elect to become allies. Just as the focus of nations turns to protecting their borders and their people, so too their environmental policies focus on securing natural resources seen as critical for human well-being. But, as in Global Orchestration, people in this scenario see the environment as secondary to their other challenges. They believe in the ability of humans to bring technological innovations to bear as solutions to environmental challenges after these challenges emerge.
3. Adapting Mosaic: Depicts a fragmented world resulting from discredited global institutions. It sees the rise of local ecosystem management strategies and the strengthening of local institutions. Investments in human and social capital are geared toward improving knowledge about ecosystem functioning and management, resulting in a better understanding of the importance of resilience, fragility, and local flexibility of ecosystems. There is optimism that we can learn, but humility about preparing for surprises and about our ability to know all there is to know about managing socioecological systems. Initially, trade barriers for goods and products are increased, but barriers for information (for those who are motivated to use it) nearly disappear due to improving communication technologies and rapidly decreasing costs of access to information. There is great regional variation in management techniques. Some local areas explore adaptive management, using experimentation, while others manage with command and control or focus on economic measures. Eventually, the focus on local governance leads to failures in managing the global

commons. Problems like climate change, marine fisheries, and pollution grow worse, and global environmental surprises become common. Communities slowly realize that they cannot manage their local areas because global problems are infringing, and they begin to develop networks among communities, regions, and even nations to better manage the global commons. The rebuilding is more focused on ecological units, as opposed to the earlier type of management based on political borders that did not necessarily align with ecosystem boundaries.

4. Technogarden: Depicts a globally connected world relying strongly on technology and on highly managed and often-engineered ecosystems to deliver needed goods and services. Overall, eco-efficiency improves, but it is shadowed by the risks inherent in large-scale humanmade solutions. Technology and market-oriented institutional reform are used to achieve solutions to environmental problems. In many cases, reforms and new policy initiatives benefit from the strong feel for international cooperation that is part of this scenario. As a result, conditions are good for finding solutions for global environmental problems such as climate change. These solutions are designed to benefit both the economy and the environment. Technological improvements that reduce the environmental impact of goods and services are combined with improvements in ecological engineering that optimize the production of ecosystem services. These changes co-develop with the expansion and development of property rights to ecosystem services, such as requiring people to pay for pollution they create or paying people for providing key ecosystem services through actions such as preservation of key watersheds. These rights are generally created and allocated following the identification of ecological problems. Because understanding of ecosystem function is high, property rights regimes are usually assigned long before the problem becomes serious. These property rights are assigned to a diversity of individuals, corporations, communal groups, and states that act to optimize the value of their property. We assume that ecological management and engineering can be successful, although it does produce some ecological surprises that affect many people due to an over-reliance on highly engineered systems.

11. Bioscene

1. Business As Usual (BAU) – Assumes current trends continue with support payments for agriculture.
2. Agricultural Liberalisation (LIB) assumes withdrawal of all support to the agriculture sector and removal of export aids.
3. Managed change for biodiversity (MCB) assumes withdrawal of agricultural support as in LIB but here these funds are diverted to public and private nature conservation programmes designed to halt biodiversity loss and to encourage landscape management to meet biodiversity objectives.
4. A Wilding (WLD) scenario (in the Scottish and French CSAs only), which describes a future in which natural processes are allowed to determine biodiversity and landscape outcomes.

The impacts of the scenarios on the landscape as a whole were captured through a division of landscapes into land-use / agricultural types. A number of 'settings' were identified because they were seen to be typical of the different types of agricultural use in the CSAs and because the impacts of the scenarios would be different in each.

12. EEA Outlook

1. Baseline Scenario: Follows a conventional definition and expands on current expectations regarding macro-economic, sectoral, technological and societal developments, as well as

including those policies that have been implemented and/or adopted, which typically refer to pieces of legislation such as EU directives (e.g. on urban waste water treatment and on landfills) or political agreements (e.g. mid-term review of the common agriculture policy). The analysis presented extends to the 2020s and beyond, with particular attention to long-term developments for climate change issues (up to 2100). The EEA baseline assumptions expand on the socio-economic assumptions developed for the DG TREN baseline projections 'European energy and transport trends to 2030', which are also being used within the Clean Air for Europe (CAFE, DG ENV) programme. Additional assumptions have been made where appropriate and necessary to arrive at a broader environmental outlook, for example with regard to structural and technological changes (e.g. water sector), commodity prices or the implementation of EU policies (e.g. mid-term review of the CAP). The same set of baseline assumptions is used across the whole range of sectors and themes addressed, and in most cases constitute the key driving forces behind the projections.

2. Alternative scenarios: Address key uncertainties around economic and technological issues as well as policy levers, complements the baseline scenario. The marginal or relative changes attributed to different assumptions often give sound insights into the comparative advantage of choosing one option vis-à-vis another (e.g. as analysed by contrasting baseline and policy variants), even where it is clear that the absolute values presented in this outlook carry significant uncertainty. For key issues, alternative scenarios (i.e. assumptions) to the baseline scenario and policy variants have been analysed, including: Energy, transport and climate change (Low GHG emissions' scenario; Economic and technological variants (e.g. low economic growth, accelerated penetration of renewables, accelerated decommissioning/adoption of nuclear), Air pollution (Maximum technically feasible reductions' scenario), Agriculture (Best practices for fertiliser handling, Liberalisation of animal product markets — extended CAP reform, A stronger Euro), Waste and material flows (Low GHG emissions' scenario (for fossil fuels only; see climate change outlooks); Low economic growth variant; Impacts of the landfill directive for biodegradable municipal waste), Water stress (Low GHG emissions' scenario (see climate change outlooks); Low economic growth variant; Non-convergence of per-capita water use in the New-10).

13. Intelligent Infrastructure Futures: The Scenarios — Towards 2055

1. Perpetual motion: Describes a society where the norm is constant information, consumption and competition. Instant communication and continuing globalisation have fuelled growth: demand for travel remains strong. New, cleaner, fuel technologies are increasingly popular: road use causes less environmental damage, although the volume and speed of traffic remains high. Aviation still relies on carbon fuels and remains expensive. It is increasingly replaced by telepresencing technology (for business) and rapid train systems (for travel). Increased nuclear capacity and the development of renewable energy sources have further reduced dependence on carbon-based fuels. Work, however, is intensive: stress is a growing problem in the developed economies. Many workers are considering ways to downshift, raising questions over the long-term viability of continued economic growth.
2. Urban Colonies: Technology investment and development is primarily focused on minimising environmental impact. Good environmental practice is at the heart of the UK's economic and social policies and sustainable buildings, distributed power generation and new urban planning policies have created compact, sustainable cities. Transport is permitted only if green and clean – and car use (still energy-expensive) is restricted. Different cities have developed their own public transport – electric or lowenergy – which is efficient and widely used. Competitive cities have the IT infrastructure needed to link high-value knowledge businesses, but poor integration of public systems means that private networks are most trusted. Rural areas have become more isolated, effectively acting as

food and biofuel sources for cities. Consumption has fallen – resource use is now a fundamental part of the tax system and disposable items are less popular.

3. Tribal Trading: A world that has been through a sharp and savage energy shock. The world has now stabilised, but only after a global recession that has left millions unemployed. The global economic system is severely damaged: infrastructure is falling into disrepair. Long-distance travel is a luxury that few can afford: for most people, the world has shrunk to their own community. Cities have declined: local food production and services have increased. Canals and sea-going vessels carry freight: the rail network is worthwhile only for highvalue, long-distance cargoes and trips. There are still some cars, but local transport is typically by bike and by horse. Local conflicts recur over resources: lawlessness and mistrust are high. The state does what it can – but its power has been eroded.
4. Good Intentions: A world in which the need to reduce carbon emissions constrains personal mobility. A tough national surveillance system ensures that people only travel if they have sufficient carbon quotas; intelligent cars monitor and report on the environmental cost of journeys; and in-car systems adjust speeds automatically to minimise emissions. Traffic volumes have fallen and mass transportation is used more widely. Businesses have adopted energy-efficient practices and use highly sophisticated wireless identification and tracking systems to optimise logistics and distribution. Some rural areas are able to pool community carbon credits for local transport provision, but many are struggling. There are concerns that the world has not yet done enough to respond to the human activity that has caused the environmental damage. Airlines continue to exploit loopholes in the carbon enforcement framework. The market has failed to provide a realistic alternative energy source.

14. GEO4: Global Environment Outlook 4

1. Markets First: the private sector, with active government support, pursues maximum economic growth as the best path to improve the environment and human well-being. Lip service is paid to the ideals of the Brundtland Commission, Agenda 21 and other major policy decisions on sustainable development. There is a narrow focus on the sustainability of markets rather than on the broader human-environment system. Technological fixes to environmental challenges are emphasized at the expense of other policy interventions and some tried-and-tested solutions.
2. Policy First: government, with active private and civil sector support, initiates and implements strong policies to improve the environment and human well-being, while still emphasizing economic development. Policy First introduces some measures aimed at promoting sustainable development, but the tensions between environment and economic policies are biased towards social and economic considerations. Still, it brings the idealism of the Brundtland Commission to overhauling the environmental policy process at different levels, including efforts to implement the recommendations and agreements of the Rio Earth Summit, the World Summit on Sustainable Development (WSSD), and the Millennium Summit. The emphasis is on more top-down approaches, due in part to desires to make rapid progress on key targets.
3. Security First: government and private sector compete for control in efforts to improve, or at least maintain, human well-being for mainly the rich and powerful in society. Security First, which could also be described as Me First, has as its focus a minority: rich, national and regional. It emphasizes sustainable development only in the context of maximizing access to and use of the environment by the powerful. Contrary to the Brundtland doctrine of interconnected crises, responses under Security First reinforce the silos of management, and the UN role is viewed with suspicion, particularly by some rich and powerful segments of society.
4. Sustainability First: government, civil society and the private sector work collaboratively to improve the environment and human well-being, with a strong emphasis on equity. Equal weight is given to environmental and socio-economic policies, and accountability,

transparency and legitimacy are stressed across all actors. As in Policy First, it brings the idealism of the Brundtland Commission to overhauling the environmental policy process at different levels, including strong efforts to implement the recommendations and agreements of the Rio Earth Summit, WSSD, and the Millennium Summit. Emphasis is placed on developing effective public-private sector partnerships not only in the context of projects but also that of governance, ensuring that stakeholders across the spectrum of the environment development discourse provide strategic input to policy making and implementation. There is an acknowledgement that these processes take time, and that their impacts are likely to be more long term than short-term.

15. Prelude — Land Use Scenarios for Europe

1. Great escape: Economic globalisation increases global competition pressure. Market concerns dominate the political agenda. Governments do not intervene in markets and cut back welfare policies. Technological innovation rates are high. Social protection becomes more and more individualised. Societal tension builds up as the impoverished and poor immigrants move to urban city centres. Rich gated communities in the countryside stand in sharp contrast to urban ghettos. Agriculture is market-oriented and maximises profit. Production intensifies but total agriculture diminishes, affecting almost 75 percent of the total European landscape. Many grasslands are abandoned or converted into arable land. Agricultural intensification and urban sprawl affect the rural environment negatively. Many nature reserves and extensive farmland areas with high nature value are lost. However, in some areas of agriculture cessation, soil and water quality improve and more diverse natural habits may develop. Key developments in this scenario concern the increased importance of international trade (economic globalisation), the decreasing societal solidarity and the strong reduction of policy interventions.
2. Evolved society: Heavy floods and exploding energy prices reinforce environmental awareness. Many people come to believe that lifestyles and economy should change. A revival of the countryside takes places as many people move away from densely populated (lowland) areas and settle in more rural and safe areas, especially in Eastern Europe. Local community action is getting new impetus by concerns for social equity. Policies focus on rural development and eco-efficient technologies at the expense of structural change. Farming is high-tech and increasingly organic. Agricultural area remains approximately the same size while farming intensity decreases. In areas that are prone to repeated flooding, cropland is reduced considerably. Overall land-use changes are not dramatic, and extensive farmland with high nature value is relatively well conserved. Key developments in the scenario concern a far-reaching energy crisis, which triggers increased support for renewable energies. A strong increase in environmental awareness sets off broader life-style changes and ambitious policies by European and national institutions in favour of environmentally sustainable regional development.
3. Clustered networks: Globalisation propels economic growth but environmental and health conditions, especially in the urban centres, get worse. People in the countryside struggle as many local shops and services close down. The needs of an ageing society lead to the development of coherent spatial planning policies. Migration away from polluted urban areas is encouraged. New cities with a service economy are founded as economic and social focal points in peripheral regions. Urbanisation is concentrated and rural development focuses on green belts around urban centres. Agriculture marginalises. Because of large-scale land abandonment, cropland and grassland strongly decrease. Biodiversity, water, soil and air quality benefits from receding agriculture and creation of green belts. Natural habitats develop in the wider countryside, but to the detriment of high nature value farmland. Key developments in this scenario concern the impacts of population dynamics (ageing of society), the effects of deepened international trade relations which lead to a

strong marginalisation of agriculture and the occurrence of strong spatial planning interventions to cope with the challenges of the ageing of the society.

4. Lettuce Surprise U: A major food security crisis hits Europe. As crisis management fails, faith in central government and in the safety of Europe's food supply decreases strongly. An alternative food production and control regime as well as regional self-sufficiency with regard to food and energy are strived for. Political decentralisation becomes prominent. New communication technologies facilitate local participatory decision-making and open-source development of innovative technologies. Migration is limited and urbanisation patterns do not really change. Environmental awareness grows, leading to wide demands for environmentally friendly, produced food. Technological innovations offer new opportunities in this regard: New crop varieties are invented that enable higher yields with lower inputs. Agriculture in the core production areas is high-tech, clean and relatively small-scale. Due to increased productivity, cropland decreases strongly. Grassland decreases at a slower rate. The reduction of agricultural area and input leads to an increase in biodiversity and improvements in soil, water and air quality. Land abandonment affects high nature value farmland, but only moderately. Open-source technological breakthrough innovations play a prominent role in this scenario. Other key developments concern a strong increase of environmental awareness and far-reaching decentralisation of political decision-making. The degree of central policy interventions is reduced, self-regulation becomes more important.
5. Big crisis: A series of environmental disasters highlights Europe's vulnerability and inability to effectively adapt. There is widespread support for a strong coordination of policies at European level and new concerns for solidarity and equity arise. A whole set of new policies for sustainable and regionally balanced development is consolidated at European level. Efficient public transport systems are strongly promoted as environmental awareness grows. Agricultural intensification is largely reversed after 2015. Agricultural oversupply diminishes; the main focus of agriculture is on landscape stewardship. Land-use changes are limited. The population in current urban core areas decreases slightly. Cropland and grassland decrease moderately. The initial environmental pressures are relieved. Soil, water and air quality benefit from agricultural extensification and limited land abandonment. The loss of high nature value farm-land remains relatively small. Key developments in this scenario concern the growing environmental awareness and social solidarity resulting from an increased number of environmental disasters. Key changes are mainly triggered by ambitious, top-down policy programs.

16. European Energy and Transport: Trends to 2030 — European Energy and Transport: Scenarios on Key Drivers

1. Baseline scenario: The Baseline scenario determines the development of the EU energy system under current trends and policies; it includes current trends on population and economic development including the recent economic downturn and takes into account the highly volatile energy import price environment of recent years. Economic decisions are driven by market forces and technology progress in the framework of concrete national and EU policies and measures implemented until April 2009. This includes the ETS and several energy efficiency measures but excludes the renewable energy target and the non-ETS targets. These assumptions together with the current statistical situation derived from the Eurostat energy balances represent the starting point for projections which are presented from 2010 onwards in 5 years' steps until 2030. In addition to its role as a trend projection, the Baseline scenario is a benchmark for scenarios on alternative policy approaches or framework conditions (e.g. higher energy import prices, renewables and climate policies).
2. Reference scenario: The Reference scenario is based on the same macroeconomic, price, technology and policy assumptions as the baseline. In addition to the measures reflected in the baseline, it includes policies adopted between April 2009 and December 2009 and

assumes that national targets under the Renewables directive 2009/28/EC and the GHG Effort sharing decision 2009/406/EC are achieved in 2020. The Reference scenario, which includes the mandatory emission and energy targets set for 2020, can serve as a benchmark for policy scenarios with long term targets.

17. ELME - European Lifestyles and Marine Ecosystems: Exploring challenges for managing Europe's seas

A Baseline scenario depicts future trends based upon what we know now and expectations from a variety of sources, and is described relative to the present. Four alternative scenarios arising from the combinations of the scenario dimensions are then described relative to the Baseline. The title and slogan attached to each alternative scenario are intended to capture the most distinctive features of each scenario. At the heart of each of the alternative scenarios is a description of the underlying values and policies that define it, and their broad socio-economic implications, which are summarised below.

1. National Enterprise: Values & Policy - Individualistic, high personal consumption, low taxes, market-based, but strong commitment to national culture and interests. Little concern for social equity or environmental protection. Sovereignty retained or taken back to national level. Erosion of EU and protectionist measures weaken WTO. Demography - Population affected by little inward migration and relatively low birth rates, though age distribution balanced to some degree by diminished longevity. Migration to internal growth 'hot spots' and average household size stable, but with household numbers increasing more slowly than under Baseline. Economy - Priority of growth undermined by protectionist policies. Focus on meeting internal demand and security of supply. Trade diminished within EU but not as much as extra-EU. Considerable variation in regional development.
2. Local Responsibility: Values & Policy – Communitarian, co-operative selfreliance. High levels of public services funded by high local taxation. Strong emphasis on social equity and environmental protection at the local level. Local government replaces national and supra-national governance. EU becomes more diverse with regional autonomy and fragmented policy. Demography – Population size stable, but relatively low birth rates and increased public health provision increases average age. General migration away from cities, with household size increases and household number reductions. Economy – Slow growth, exacerbated by tax levels, with increases in smaller scale production. Trade greatly diminished, but with some preference fro intra-EU over external trade. Growth more even across communities.
3. World Markets: Values & Policy – Libertarian, techno-centric, materialist consumerism. Presumption in favour of market provision. Growth more important than social equity, with environmental policy limited to correction and support of the market. Increased global interdependence and governance, through WTO and multinational corporations. Corporate governance starts to displace government. Policy determined at regional trading bloc and international level. Rapid enlargement of EU. Demography – Population growth slow overall but migration increases to meet demand for labour reduces proportion of older people. Growth uneven across regions. Smaller and more numerous households. Economy – Rapid growth, with dismantling of trade barriers increasing intra and extra-EU trade. Service sector dominates others, with decline of agriculture and manufacturing. Benefits of growth spread to some extent through 'spill over' effects.
4. Global Community: Values & Policy – Communitarian, with internationalist values and increasing globalisation of governance systems, to deal global, interconnected problems. , with preference for latter and willingness to accept high tax levels. Policy coordinated at EU and international level, but implemented at local level. EU more centralised, with less

regional autonomy, and slower expansion. Environmental policy expands across policy sectors and prioritised. Powerful, green WTO favours environmental protection in trade disputes Demography – Low birth rates offset by migration increases to meet demand for labour, with some increase in average age and relatively static distribution. Household size declines slowly and numbers grow at historic rates. Economy – Growth constrained by tax levels and social & environmental objectives. Shift to services is slower than in Baseline. Growth in intra and extra-EU trade, but with some inhibition through 'footprint' concerns. Development evenly distributed, though with some transitional variations.

18. ESPON - Territorial futures: spatial scenarios for Europe

1. Trend Scenario: Spatial structure and urban hierarchy in 2030 - A simplified image of the European territory, based on the continuation of current trends and policies illustrates the probable result of this "trend" scenario. The following assumptions regarding autonomous trends and policy decisions were used to produce the trend scenario: 1. Total EU population increases only through enlargement. 2. Increasing, but globally controlled external migration. 3. Slowly increasing total activity rate. 4. Slowly growing R&D expenditures, but technological gap with the US persists. 5. Decreasing public expenditure. 6. Steady increase of energy prices. 7. Further liberalisation of international trade. 8. Progressive reduction of CAP budget. 9. Little coherence between policies devoted to innovation and competitiveness and those devoted to cohesion. 10. Moderate overall climate change (+1° C) but increased frequency of extreme local events. 11. Enlargement: Western Balkans (with Croatia acceding first) by 2020 and Turkey by 2030.
2. Competitiveness-oriented Scenario: Spatial structure and urban hierarchy in 2030 - In the competitiveness-oriented scenario, most of the autonomous developments (i.e. globalization, climate change) identified in the trend scenario were held constant. The difference lies in the policy response. In this scenario a 'policy mix' is created which is aimed at boosting Europe's competitiveness. This 'policy mix' comprises the following measures. 1. Strong reduction of the total EU budget, and a retargeting of funding towards R&D, education, ICT and strategic external accessibility. CAP and ERDF budgets are reduced significantly. 2. Focus of EU-policies on regions with strongest potentials. 3. Further liberalisation and privatisation of public services. 4. Priority given to enlargement. 5. Immigration promoted to enlarge labour-force. 6. Investments in infrastructure are performed according to market demand. 7. Mitigation measures related to climate change are based on flexible schemes, adaptation measures implemented only when cost efficient. 8. Environmental measures undertaken only if market efficient. 9. Wider application of the Open Method of Coordination.
3. Cohesion-oriented Scenario: Spatial structure and urban hierarchy in 2030 - In the competitiveness-oriented scenario, most of the autonomous developments (i.e. globalization, climate change) identified in the trend scenario were held constant. The difference lies in the policy response. In the cohesion-oriented scenario, a 'policy mix' is created which is aimed at improving cohesion in Europe. This 'policy mix' comprises the following measures. 1. Maintaining the volume of the EU budget, reinforcement of the Structural Funds. 2. Concentration of European policies on the weakest regions. 3. More public intervention and more decentralised and coherent governance. 4. No new EU enlargements: priority given to deepening EU cooperation. 5. Restrictive policy on external immigration. 6. Peripheral regions given priority for infrastructure investments. 7. Promotion of decentralised energy production, particularly renewables. 8. Strict climate change mitigation measures, wide range of adaptation measures. 9. Strict environmental measures. 10. Active multi-level territorial governance in areas supported by the Structural Funds.

19. Scenar 2020 – Scenario study on agriculture and the rural world

1. Baseline scenario: There are two types of drivers governing the development of the economic, social and environmental conditions in Europe, and elsewhere in the world. The first are those drivers that operate basically independently of policy-making, or over which policy-making will have an influence on fairly long time scales. Two examples are population growth and climate change. This is not to say that policy-making will not have an impact, but the impact will not take place in an immediate manner. The second type of drivers are those which are the instruments of policymaking, and which will have immediate or medium term implementation effects (on a 5-10 year horizon), and which of course may set in motion derived effects that will last for quite some time. The farm-level structural change induced by the Guidance measures of the Common Agricultural Policy have led to land re-allocation and field drainage on an immense scale, and this has altered the landscape and the biodiversity over large areas of rural Europe. In order to highlight the possible impact of policy decisions, the general approach to constructing scenarios in Scenar 2020 has been to keep constant all exogenous drivers or assumptions except those relating to policy-making. So the world-view portrayed for the baseline scenario is the same which applies to the regionalisation and the liberalisation scenarios. The policy measures, once again, are what are modified in the regionalisation and the liberalisation scenarios. These are placed within a global context which gives them their sense. The Baseline situation is based on the continuation of the trends in exogenous drivers, and assumes the development of agricultural and rural policy according to current policy objectives, including the successful outcome of the Doha Round negotiations.
2. Regionalisation Scenario: Regionalisation is a policy framework which refers to the possibility that, in the absence of a successful conclusion of the Doha Round, then not only will further bilateral and multilateral negotiations will continue but also at the same time more encouragement will be given to promoting the production of commodities in the internal market. No WTO agreement is reached, neither for agriculture nor for other trade aspects.
3. Liberalisation scenario: Liberalisation – also a policy framework – implies that the current context of moving towards more open markets at the international level will be strengthened. In this scenario, all forms of market and trade policies and income support will be abolished in the EU and the rest of the world.

Scenar 2020-II (scenarios updated in 2009).

1. Reference' scenario: Policy decisions are carried forward in the time period of the study. For illustrative purposes it assumes a 20% reduction of CAP budget in real terms, the implementation of a Single Payment System (SPS) as of 2013, full decoupling, a 30% decrease in direct payments (DP) in nominal terms and a 105% increase of the European Agricultural Fund for Rural Development (EAFRD). Trade agreements are synthetically represented, e.g. the WTO Agreement is based on the December 2008 Falconer paper. To some extent this reflects similarities with the 'baseline' scenario of the first study.
2. Conservative CAP scenario: Overall level of the budget devoted to agriculture but changes the balance between pillars. It assumes a continuation of the results of the Health Check (HC) after 2013, a flat rate (regional model) implemented at national level, coupling as HC, and a 15% decrease of direct payments in nominal terms, a reduced (45%) increase of EAFRD. Trade policies are maintained as in the Reference scenario.
3. Liberalisation' scenario: Agricultural trade-related measures are discontinued. The CAP budget is reduced by 75% in real terms, all direct payments and market instruments are removed, and there is a 100% increase of EAFRD. Like in the previous study extreme scenarios were chosen in order to test what would be the maximum range of impacts the agricultural sector would be faced with over the medium term.

20. Global Trends 2025: A Transformed World

1. A world without the west: New powers supplant the West as leaders on the world stage. This is not inevitable nor the only possible outcome of the rise of new states. Historically the rise of new powers—such as Japan and Germany in the late 19th and early 20th centuries—presented stiff challenges to the existing international system, all of which ended in worldwide conflict. More plausible in our minds than a direct challenge to the international system is the possibility that the emerging powers will assume a greater role in areas affecting their vital interests, particularly in view of what may be growing burden fatigue for Western countries. Such a coalition of forces could be a competitor to institutions like NATO, offering others an alternative to the West. As detailed, we do not see these alternative coalitions as necessarily permanent fixtures of the new landscape. Indeed, given their diverse interests and competition over resources, the newer powers could as easily distance themselves from each other as come together. Although the emerging powers are likely to be preoccupied with domestic issues and sustaining their economic development, increasingly, as outlined in this chapter, they will have the capacity to be global players.
2. October surprise: Global inattention to climate change leads to major unexpected impacts, thrusting the world into a new level of vulnerability. Scientists are currently uncertain whether we already have hit a tipping point at which climate change has accelerated and whether there is little we can do—including reducing emissions—that will mitigate effects even over the longer term. Most scientists believe we will not know whether we have hit a tipping point until it is too late. Uncertainties about the pace and specific vulnerabilities or impacts from climate change are likely to persist over the next 15-20 years even if our knowledge about climate change deepens, according to many scientists. An extreme weather event—as described in this scenario—could occur. Coping with the greater frequency of such events, coupled with other physical impacts of climate change such as growing water scarcities and more food crises, may preoccupy policymakers even while options for solving such problems dwindle. In this example, relocating the New York Stock Exchange to a less vulnerable location is considered, but serious consideration also would be given to relocating other institutions to ensure continuity of operations. Although this scenario focuses on an event that occurs in the US, other governments have been caught by surprise with different types of environmental disasters and have suffered a loss of standing. Mitigation efforts—further cutbacks in carbon emissions—are unlikely to make any difference, at least in the short run, according to this account. Such a world involving potentially major dislocations could threaten both developed and developing countries.
3. BRICs Bust Up: Chinese fears of disruption of China's energy supplies spark a clash with India. With increasing resource constraints likely out to 2025, disputes over resources appear to us to be a growing potential source of conflict. The sense of vulnerability is heightened by the dwindling number of energy producers and increasing concentration in unstable regions such as the Middle East. A world in which there are more confrontations over other issues—such as new trade barriers—is likely to increase the potential for any dispute to escalate into conflict. As outlined in this scenario, misperceptions—along with miscommunications— could play as important a role as any actual threats. Also illustrated by this scenario is the competition by rising powers for resources. Both China and India—though rich in coal—have limited and dwindling oil and gas reserves and must rely on foreign sources. In thinking about the increased potential for conflict in this multipolar world, we need to keep in mind the scope for the emerging powers to clash with one another.
4. Politics is not always local: A new world emerges in which nation-states are not in charge of setting the international agenda. The dispersion of power and authority away from nation-states has fostered the growth of sub-national and transnational entities including social and political movements. Growing public concerns about environmental degradation and

government inaction come together in this example to "empower" a network of political activists to wrest control of the issue out of country-level officials in capitals. Global communications technology enables individuals to affiliate directly with identity-driven groups and networks that transcend geographic boundaries. Environmentalism is an issue for which there is a widespread confluence of interests and desires.

21. Shell Energy Scenarios to 2050

1. Scramble: Reflects a focus on national energy security. Immediate pressures drive decision-makers, especially the need to secure energy supply in the near future for themselves and their allies. National government attention naturally falls on the supply-side levers readily to hand, including the negotiation of bilateral agreements and incentives for local resource development. Growth in coal and biofuels becomes particularly significant. Despite increasing rhetoric, action to address climate change and encourage energy efficiency is pushed into the future, leading to largely sequential attention to supply, demand and climate stresses. Demand-side policy is not pursued meaningfully until supply limitations are acute. Likewise, environmental policy is not seriously addressed until major climate events stimulate political responses. Events drive late, but severe, responses to emerging pressures that result in energy price spikes and volatility. This leads to a temporary slowdown within an overall story of strong economic growth. Although the rate of growth of atmospheric CO2 has been moderated by the end of the period, the concentration is on a path to a long-term level well above 550 ppm. An increasing fraction of economic activity and innovation is ultimately directed towards preparing for the impact of climate change.
2. Blueprints: Describes the dynamics behind new coalitions of interests. These do not necessarily reflect uniform objectives, but build on a combination of supply concerns, environmental interests, and associated entrepreneurial opportunities. It is a world where broader fears about life style and economic prospects forge new alliances that promote action in both developed and developing nations. This leads to the emergence of a critical mass of parallel responses to supply, demand, and climate stresses, and hence the relative promptness of some of those responses. This is not driven by global altruism. Initiatives first take root locally as individual cities or regions take the lead. These become progressively linked as national governments are forced to harmonise resulting patchworks of measures and take advantage of the opportunities afforded by these emerging political initiatives. Indeed, even the prospect of a patchwork of different policies drives businesses to lobby for regulatory clarity. As a result, effective market-driven demand-side efficiency measures emerge more quickly, and market-driven CO2 management practices spread. Carbon trading markets become more efficient, and CO2 prices strengthen early. Energy efficiency improvements and the emergence of mass-market electric vehicles are accelerated. The rate of growth of atmospheric CO2 is constrained leading to a more sustainable environmental pathway.

22. World Energy Outlook 2009

A Reference Scenario, which provides a baseline picture of how global energy markets would evolve if governments make no changes to their existing policies and measures; and a 450 Scenario, which depicts a world in which collective policy action is taken to limit the long-term concentration of greenhouse gases in the atmosphere to 450 parts per million of CO2-equivalent (ppm CO2-eq), an objective that is gaining widespread support around the world.

The projections for each scenario are underpinned by assumptions about a range of factors that drive energy demand and supply. Chief among these are population growth, macroeconomic

trends, energy prices, technological developments and government policies. The population and economic growth assumptions are the same for both the Reference and 450 Scenarios. The principal difference between the scenarios is that new policies are assumed in the 450 Scenario, along with some differences in technology. Prices are also assumed to be affected by these changes.

1. Reference scenario: The Reference Scenario is a baseline picture of how global energy markets would evolve if governments make no changes to their existing policies and measures. It sees global primary energy demand rising by 1.5% per year on average between 2007 and 2030, an overall increase of 40%. China and India are the main drivers of growth, followed closely by the Middle East. Projected demand growth is slower than in last year’s Outlook, reflecting the impact of the financial and economic crisis.
2. 450 Scenario: Analyses how global energy markets could evolve if countries take co-ordinated action to restrict the global temperature increase to 2°C. OECD+ countries are assumed to take on national emissions-reduction commitments for 2020. All other countries are assumed to adopt domestic policies and measures, and to generate and sell emissions credits. After 2020, commitments are extended to Other Major Economies, including China, Russia and the Middle East.

23. ALARM: Assessing Large Scale Risks for Biodiversity With Tested Methods

1. Business as might be usual: Is a policy projection scenario, i.e. a scenario extrapolating the expected currrently known and foreseeable socio-economic and policy trajectories in EU decision making and assessing their sustainability and biodiversity impacts. Policy decisions already made in the EU are implemented and enforced, new ones follow the same development path. Thus BAMBU is not a business as usual (BAU) scenario, based on extrapolation of past trends, since recent or upcoming changes in EU policies would have been ignored in that case. At the national level as well, deregulation and privatization continue except in ‘strategic areas’. Internationally, there is free trade. Environmental policy is perceived as another technological challenge tackled by innovation, market incentives and some legal regulation. The result is a rather mixed bag of market liberalism and socio environmental sustainability policy.
2. GRowth Applied Strategy: Is a coherently liberal, growth-focused policy-driven scenario. It describes a future world based on economic imperatives like primacy of the market, free trade and globalization. Deregulation (with certain limits) is a key means, and economic growth a key objective of politics actively pursued by governments. Environmental policy focuses on damage repair (supported by liability legislation) and some preventive action. The latter is designed based on cost– benefit calculations and thus limited in scale and scope.
3. Sustainable European Development Goal: Is a backcasting (inverse projection) scenario, and as such is necessarily normative, focused on the achievement of a socially, environmentally and economically sustainable development. Based on the primacy of policy it is designed to meet specific goals and derive the necessary policy measures to achieve them, for example ending biodiversity loss. It aims at enhancing the sustainability of societal development by integrated social, environmental and economic policy. Policy priorities under SEDG include a competitive economy and a healthy environment, gender equity and international cooperation. SEDG represents a precautionary approach, taking measures under uncertainty to avoid not yet fully known future damages.

24. Getting in the Right Lane for 2050

Focus on three themes in a single vision for 2050: (1) Land resources, food and biodiversity; (2) Climate change mitigation and energy security; and (3) Transport and mobility. The vision is set against a baseline of no change.

The first theme is land resources, including water, and the EU's role in a world providing food for all, without further loss of biodiversity. This implies improving agricultural productivity in order to close 'yield gaps' in all regions, and containing biodiversity loss worldwide on the way to 2050. It also implies a strategy of diversity in EU land and agriculture policies. The second theme is energy and envisages a low-carbon energy system in the EU in 2050. This amounts to 80% decrease in domestic emissions of greenhouse gases by 2050, and connects with the EU's need to improve energy security. The third theme is mobility, with a vision for 2050 of low-carbon transport in Europe.

25. ENSEMBLES - Climate change and its impacts at seasonal, decadal and centennial timescales

Applied the IPCC scenarios A2, A1B and B1 to modelling. A new baseline emission scenario was also developed in ENSEMBLES, called E1. This was calibrated with purchasing power exchange rates and uses a 'new growth' model to originate dynamics, i.e., it endogenises technical progress. Moreover, it uses a population model to project population dynamics based on more recent information. In this sense, it is superior to the SRES scenarios. The E1 scenario was developed using the IMAGE 2.4 integrated assessment model, which simulates in detail the energy system, land use and carbon cycle.

26. EACH-FOR: Environmental Change and Forced Migration Scenarios

1. Markets First: The private sector widens its influence into previous governmental areas, i.e. privatisation of education, security, research, health and other social services, together with a continued movement towards free trade and the commoditisation of nature. International trade accelerates, although no global free trade zone is achieved. Existing regional agreements are strengthened, and new South-South cooperations emerge. Formal environmental protection is limited by efforts to increase economic investment and expand trade. The Kyoto Protocol sees no significant international follow up after 2012. Ecosystem services are turned into commodities. The economic exchange of goods like water, genetic material, knowledge and culture increases dramatically. Terrestrial and marine biodiversity decrease. Agriculture is intensified in all regions, which increases the potential of soil degradation. Water use efficiency increases in most regions (due to privatisation and better technologies), but the number of people living with severe water stress grows significantly because of growing populations and climate change.
2. Security First: Can be also described as 'Me First' and brings a fairly narrow notion of security that implies increased limits on how people live, both physically and physiologically. Restrictions on migration reduce the movement of people and trade barriers that of goods. Governments are strong in decision making, but multinational corporations and private interests increase their influence. The authority of international institutions declines, and public participation gets marginalized. Total energy use increases significantly, while energy efficiency slowly improves. A dramatic resurgence in the use of coal results in strongly rising levels of atmospheric CO2. The combination of climate change, growing populations and greater economic activity strains freshwater resources (both

quantity and quality) and brings a dramatic increase of people facing severe water stress; conflicts on shared resources result. Both terrestrial and marine biodiversity are under great pressure (UNEP, 2007).

3. Policy First: A highly centralised approach with a move to a more holistic government balancing economic growth with social and environmental issues. National governments and international organisations (e.g. United Nations) lead in those efforts. Subsidies that encourage the overexploitation of resources are reduced or eliminated. Public investments in science and technology grow, and the number of protected areas increases with more or less effective efforts in preventing land-use change in these areas. International agreements increase energy efficiency and induce a move to more low carbon and renewable sources (i.e. biofuels). However, total energy consumption continues to increase. The higher demand for bio-fuels results in a significant increase in land devoted to pasture and a decrease of forest land. Growing populations and economic activities still put pressure on resources, particularly in developing regions. The number of people living under severe water stress continues to rise, but institutional efforts to better share resources help limit the impacts. The increased demand, however, places a strain on the quality of water resources. The loss of biodiversity is dramatic, mainly due to climate change and agricultural practices.
4. Sustainability First: Actors from local, national, regional and international levels and from all sectors (government/civil/private) address environmental and social concerns. The rules of international trade are reformed and public resources are shifted from military to social and environmental issues. Climate change remains a persistent problem. Even though the growth in the level of CO2 is limited, it is not possible to avoid potentially significant warming and sea level rise. In the energy sector, total energy use increases, but the mix of fuels change significantly with wind, solar and modern bio-fuels becoming an important fraction beside natural gas as the dominant source. The expansion of agricultural land comes at the expense of forest land, but the loss of the latter slows significantly over time. The growth of water stress is reduced, but some regions still face increasing problems, both with quantity and quality. Efforts to reduce biodiversity loss are high, but the challenges are strong and there is significant species loss in some areas.

27. SENSOR - Tools for Impact Assessment

1. Baseline: The conditions that would be expected to develop in the absence of any change in policy intervention (baseline scenario). Defines a number of **baseline drivers**: demographic change within Europe; the rate of participation in the labour force; growth of world demand (outside Europe); the price of petroleum on the world market; and expenditure on research and development.
2. Policy scenarios: Socio-economic trend analysis based on linking socio-economic trend scenarios and policy options with land use changes via coupled model simulations; linking land use changes with environmental, social and economic impacts via indicator analyses and; valuating these impacts in light of sustainable development targets by applying an expert- and stakeholder-based valuation framework.

28. The European environment – state and outlook 2010

Two scenarios are analysed, based on the IPCC's A2 and B1 emission scenarios.

1. A2: Describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population. Economic development is primarily

regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines.
2. B1: Describes a convergent world with the same global population, that peaks in mid-century and declines thereafter, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate initiatives.

29. EFORWOOD - Tools for Sustainability Impact Assessment

There are two baseline scenarios (defined by IPCC):

1. A1: Describes a future of intensive globalisation both economically and technologically, with a mid-century peak and subsequent decline in world population; and
2. B2: Describes a future where social, environmental and economic sustainability is addressed at a local level with local solutions. Even though global populations would be steadily rising, the economic and technological development occur on a less rapid and diverse scale.

These are projected across four main scenarios/storylines.

1. Forest conservation scenario: Forest management in Europe is changing towards a more multifunctional orientation. Forest in each EU country is managed with the protection of biodiversity as a prime objective. The policy further implementing this demand from society under the Habitats Directive from 1992 is Natura 2000. It aims to establish a European network for conservation of biodiversity and to promote sustainable activities. It is intended that the network will eventually grow to cover 15% of EU territory. thus further integrating multi-functional forest management (ecological, economic, protective and social functions) into the EU forestry strategy.
2. Bio-energy scenario: The bio-energy scenario only deals with the increased use of bio-energy with consequences for production. On the production side, biomass from the forest (e.g. harvest residues, stumps, industrial wood) and from the industry (sawdust, chips, bark, black liquor, rejects and downgraded assortments) are covered.
3. Technology change scenario: The scenario comprises a set of new technologies in the wood products value chain that will increase the efficiency of using of raw materials and/or at the same time increase the quality of end products, including the production of more value added wood components and the upgrading of sawn timber.
4. Consumption change scenario: Based on the following presumptions: Scenario description based on A1 reference futures drivers; Time scale 2015-2025; World economic growth (GDP) is high; Population growth is moderate; Global trade is increased. High world economic growth together with well developed global trade, as well as adopted global standards enables access to cheap raw material for high quality mass production of newspapers.

30. SCENES - Water scenarios for Europe and for Neighbouring States

1. Sustainability Eventually: Sketches the transition of a globalizing and market-oriented to environmental sustainability. Local initiatives are leading and the landscape becomes a basic unit. This fundamental change in human behaviour, governance structures and the level of decision making is exerted by a phase of strong top-down policies. Quick change measures are accompanied by slow change measures for the long run. The attempt to address multiple goals – economic, environmental as well as social – results in trade offs at

the expense of economical development. Economy is thus characterized by slow growth, with most growth being in the northern part of Europe. The multiple goals will not be reached at the same speed and through the same path however, due to regional and spatial differences, resulting in a split between water poor (especially the South) and water rich countries. This is partly due to very different water related issues. This split will not be carried through to political levels, but does involve Socio-economic and environmental impacts of changes in water resources close collaboration between water poor countries on water related issues, but some devastating effects from climate change cannot be prevented. Internal migration to areas with favourable climatic conditions will intensify, especially when above mentioned water scarcity issues in water poor countries are addressed. The shift towards a more landscape policy, will lead to better management of Natura 2000 sites, with farmers contributing to management of farmland with high nature value. This and a decrease in food demand will lead to land use changes. Regional EU initiatives to develop environmental technology for the purpose of for example water saving will increase and efforts are made to share these technologies, resulting in introduction in Eastern Europe as well. Water demand is thus strongly reduced by water savings and a decrease in water demand. In 2050, a balance is reached between water supply and demand: especially less water is needed for industrial activities.

2. Policy Rules: Explores the implications if government and policy dominate the trajectory of water use in Europe. The emphasis on a top down approach contrasts with the largely (accept for the first phase) bottom-up approach in Sustainability Eventually. Planning and direction, which are coordinated by governing bodies, prevail over spontaneous initiatives of the markets whose effectiveness is hampered by lack of coordination. EU level government and policy play an increasingly dominant role over national and provincial law. In this scenario, the EU gains a stronger hold on policy at a European level, resulting from high energy costs, access to energy supplies, meeting increasing water demands and adaptation to climate change. Political integration remains a challenge due to the obligation to comply with various EU directives, especially the WFD. Integration of candidate EU members is challenged by shifts in political directions, climatic conditions, economic (food and energy prices) processes, consumption of increasingly scarce water and migration/urbanization. This leads to EU policies becoming slowly more ineffective. The EU responds by setting different but narrowed priorities regions. This in turn leads to disparity in economic growth prospect and intensification of its causes. Ecosystem services begin to deteriorate as well. These processes reinforce public awareness and the EU seizes the chance to raise awareness even more and act upon it. Policies to decarbonize Europe expand river basin planning to encompass multiple objectives and to address local and regional issues. These acts are met with massive support. In the end, this finds Europe at the forefront of this new socio-economic paradigm of public/private partnership and leads a global shift in this direction while its own economic growth recovers.
3. Fortress Europe: Describes the conservative attitude and focus on security of Europe against non-EU countries in general. After the financial crisis in the first decade of 21rst century, many countries and economic pacts try to protect their market against influences from other parts of the world. The EU expands its border on the Balkans but enlargement in general is always evaluated in the light of security and remains a point of discussion up to 2050. EU funding, legislation and policy such as the WFD is re-evaluated and weakened at points where it does not contribute to solving security issues. National governments increase their strength but still feel the need to cooperate. Environmental and social research suffers a lack of funds. The development of technological innovations will be hampered as well and as such, Europe relies on existing fossil fuel (coal and oil) and nuclear power plants. In the middle period, Europe increases its protectionism as regions like Russia and Chine increase their power and implements strong policies. This leads to a more protectionist agricultural policy as the EU strives for self-sufficiency; especially in regions were crop production is high. Farming is also subsidized in areas with high nature value and food is spread over countries. A switch to more effective agricultural techniques and

renewable energy sources comes as environmental losses are increasingly perceived as security issues. Industries and businesses pay little attention to these issues. Water pricing is implemented and water poor countries have a strict upper limit on the amount of water that can be purchased and conflicts over water are on the rise. Europe keeps on getting stronger and when water scarcity problems arise, nature often comes last as security related sectors are favoured. Trade outside the EU is hampered by diminishing trust and taxes, but inside the EU, trade increases. Resources in the EU are strictly managed, leading to fading out agriculture and industry in general in areas where it uses too many resources, leading to increased sustainable land and resource use. This however, leads to social unrest since water poor countries are struggling, inside as well as outside the EU. This leads to migration from poor to rich regions, but high security makes this difficult. At the end consumption patterns start to improve somewhat and climate change issues are seen as a threat, so adaptation measures are taken. Public unrest arises as they bear the burden of strong regulation. In response the EU invests in non-security related sectors and opens up the trade barriers. This increases economic strength.

4. Economy First: Globalization and liberalization is embraced in order to reduce barriers to trade and create new enterprises and opportunities. Technological and business innovations spread quickly, both within the region and around the globe. Economic growth rates are promising, but income inequality grows over time due to massive cutbacks in social security systems. Less people can afford university education, resulting in shortages in the high-skilled labour force. This trend is exacerbated by the ageing population. Increased immigration fills gaps in the workforce but creates social and ethnic tensions. The ability of governments to regulate markets and respond effectively to societal and environmental problems diminishes. European integration remains restricted to the completion of the internal market; and regulatory competencies are cut back. International institutions and regimes are weakened. Governments rely mainly on market based instruments (voluntary agreements, tax incentives) rather than legislation. Multinational companies dictate environmental standards/progress. With growing income inequalities, a relatively few rich people enjoy their lives while it becomes harder and harder for the majority to keep their living standards. In the first half of the scenario, there is a rapid diffusion of knowledge and innovations around the globe, but basic research in some areas struggles with lack of funds. High levels of education are achieved, but there is some targeting of opportunities to people who can afford to pay. This is seen in part by the increasing number of private universities. There are no equal opportunities for education. Europe experiences a brain drain to other regions later in the period.

31. PLUREL: Peri-urban Land Use Relationships – Strategies and Sustainability Assessment Tools for Urban-Rural Linkages

Four scenarios for future development based on the global scenarios of the IPCC:

1. Hypertech (A1): This describes a future world of rapid economic growth, global population that peaks in mid-century, and the rapid spread of more efficient technologies. Information and communications technology (ICT), nano-technology and bio-technology, transform lifestyles and working patterns. For peri-urban areas in Europe, this scenario is likely to see small 'polycentric' towns and cities become even more popular. New transport technologies lead to more rapid journeys and the expansion of the commuting distances around towns and cities. New ICT enables people who prefer country life to work from home or the neighbourhood centre, and this leads to peri-urbanisation and 'metropol-ization' of rural areas on a massive scale.
2. Extreme water (A2): This shows a more heterogeneous world of self reliance, local enterprise and preservation of local identities. While population growth and technology innovation are slower, the effects of climate change come on more rapidly than expected.

Peri-urban areas are strongly affected; affluent yet vulnerable city-regions such as London or the Dutch Randstad spend huge sums of money on defence and adaptation strategies. Population growth due to climate-induced migration puts more pressure on urban infrastructure and services.

3. Peak oil (B1): This describes a future of environmental and social consciousness – a global approach to sustainable development, involving governments, businesses, media and households. To achieve this some sacrifices have to be made, such as individual liberties and local enterprise. For peri-urban areas, rising energy prices have an enormous effect on location choices as transport costs limit commuting distances. Although tele-working is encouraged, most people attempt to return to larger cities and towns, and many of the more remote rural areas decline.
4. Fragmentation (B2): Although local community cohesion is high, across Europe there is a fragmentation of society, in terms of age, ethnicity and international distrust.. The ethnic division of cities is driven by the increased in-migration of the working-age population from outside and within the EU. Cities become more dispersed as younger migrants dominate city centres and older natives populate the outskirts and enclaves outside the cities, so that peri-urban areas become 'peri-society' areas. New development slows down but much existing urban form redistributes its population and activities.

32. Ecochange - Challenges in Assessing and Forecasting Biodiversity and Ecosystem Changes in Europe

2050 under different assumptions of climate, agricultural, economic and societal changes. In all case studies, scenarios explored a business-as-might-be-usual trajectory (this is a business as usual scenario where all European laws and directives are implemented), a neoliberal growth approach and a sustainable pathway. An agent based model (ABM) was developed to gain an understanding of how land management decisions and the mechanisms that underpin them might change and subsequently influence the provision of ecosystem services under the different scenarios.

1. Business-as-might-be-usual: N/A.
2. Neoliberal growth approach: N/A.
3. Sustainable pathway: N/A.

33. CAMELEON - CArbon dynamics in Mountain Ecosystems: analyzing Landscape-scale Effects Of aNthropogenic changes (climate and land use)

1. Intermediate growth with local solutions to sustainability (B2): N/A
2. Rapid economic growth (A1): N/A

34. MOUNTLAND - Sustainable Land Use Practices in Mountain Regions

Ongoing project. Limited information available.

1. Policy and market scenarios: Based on storylines of the IPCC
2. Climate scenarios: Based on IPCC4 scenarios

35. Forest outlook study

A reference scenario and four policy scenarios have been prepared for the European forest sector between 2010 and 2030, covering the forest resource (area, increment, harvest, silviculture) and forest products (consumption, production, trade).

1. Reference scenario: Provides a picture of a future without major changes from the past: current policies remain unchanged, and current trends continue. The B2 storyline was chosen to represent and quantify the Reference scenario in EFSOS II. The widespread use of the IPCC storylines enables direct comparison of the EFSOS II projections with other studies, most notably the North American Forest Sector Outlook Study (NAFSOS). The B2 storyline describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with continuously increasing global population, intermediate levels of economic development, and not so rapid and diverse technological change. Only the quantitative aspects of this storyline were used for the Reference scenario.
2. Maximising biomass carbon: Explored the amount of carbon which could be stored in the forest by changing silvicultural methods, without affecting the total harvest level. This scenario does not address carbon stocks in harvested wood products. Projections of soil carbon stocks were not included in the optimisation due to the associated uncertainties. Scenario assumptions: Changes in the silvicultural methods were implemented in EFISCEN by changing rotation lengths and thinning shares. Rotation lengths were increased in 5-year steps to a maximum increase of 25 years. The maximum age of thinning was increased accordingly. The thinning shares were varied between 25 and 100% of the total required harvest, with 5% steps. All combinations of rotation lengths and thinning shares were tested in EFISCEN for each country, with the same demand as in the Reference scenario. The combination that gave the highest carbon stock in biomass, while still supplying the required demand, was selected as the final one. This scenario assumes there is an incentive for the forest owner to maximise the carbon in his forest, for example through a subsidy or carbon credits at a sufficient level to cover the extra costs of the modified management regime.
3. Priority to biodiversity: This scenario explores possible consequences for the forest sector of forest management, which gives priority to biodiversity conservation, and it tries to quantify the possible trade-offs between this policy goal and others, notably increasing carbon storage and furthering wood production and trade. The Priority to biodiversity scenario aims to provide the forest sector and political decision makers with a sound information basis that enables them to develop evidence based strategies and policies. It should thus serve to meet the challenges in improving biodiversity conservation while being economically and socially sustainable under strong economic and budgetary pressures, and to facilitate win-win solutions in the trade-offs, which maximise benefits for society and attract the support of all interest groups. Scenario assumptions: The Priority to biodiversity scenario assumes that political decision makers give priority to the protection of biological diversity and shape the political framework for the forest sector according to the goal to conserve and enhance biodiversity. In particular, when there are trade-offs between biodiversity and other functions, preference is given to biodiversity.
4. Promoting wood energy: Explores how the sector could contribute to meeting the renewable energy targets and what would be the consequences for other parts of the sector, of this policy priority. This scenario therefore takes as its starting point that the ambitious targets for consumption and production of renewable energy in 2020 are achieved, and that the trend continued to 2030. It then analyses how this objective might be achieved and how other parts of the sector would respond to this strong growth. To construct this scenario, the targets for the share of renewables in total energy, agreed by all EU countries as well as

most other countries in Europe, were added to the projected demand for products, which led to a very high aggregate demand for wood. To satisfy this demand, EFISCEN was used to estimate the highest possible sustainable supply of wood from Europe's forests, and estimates were made of the highest realistic potential supply of wood from outside the forest, including landscape care wood, post-consumer wood and industry residues. The consequences of this situation for product demand and for trade were estimated by EFI-GTM, which also supplied indications for price development. Europe in this scenario is characterised by strong demand for wood, emerging scarcities, and concern about sustainability of wood supply, inside and outside Europe. These tensions inside the forest sector should be put in the context of a world where energy scarcity is a major preoccupation, as the price of fossil energy rises, nuclear power encounters major opposition, and other renewable energies have difficulty expanding fast enough to satisfy demand. Scenario assumptions:

5. Fostering innovation and competitiveness: Explores the consequences for the sector of a successful strategy of innovation, leading to improved competitiveness. The projection methods used for the other scenarios are not appropriate here, as, by definition, the technical and cost relationships used to construct the projections cannot be assumed to remain unchanged in a more innovative future. The scenario is therefore based on qualitative reasoning only. There is a high degree of uncertainty in analysing the outlook for innovation, which, by definition, changes the fundamental ways in which the sector works.

36. Project: EUWood

There are two baseline scenarios (defined by IPCC):

1. A1, which is a more globalised and economy oriented world, and
2. B2 which sees slower, more regional growth and more sensitivity to environmental issues.

Coupled with three mobilisation scenarios:

1. In the high mobilisation scenario there is a strong focus on the use of wood for producing energy and for other uses. Recommendations by the above mentioned processes have been successfully translated into measures that lead to an increased mobilisation of wood. This means that new forest owner associations or co-operations are established throughout Europe. Together with existing associations, these new associations lead to improved access of wood to markets. In addition, strong mechanisation is taking place across Europe and existing technologies are effectively shared between countries through improved information exchange. Biomass harvesting guidelines will become less restricting, because technologies are developed that are less harmful for the environment. Furthermore, possible negative environmental effects of intensified use of forest resources are considered less important than the negative effects of alternative sources of energy (i.e. fossil fuels) or alternative building materials (e.g. steel and concrete). Application of fertilizer is permitted to limit detrimental effects of logging residue and stump extraction on the soil.
2. The medium mobilisation scenario builds on the idea that recommendations are not all fully implemented or do not have the desired effect. New forest owner associations or co-operations are established throughout Europe, but this does not lead to significant changes in the availability of wood from private forest owners. Biomass harvesting guidelines that have been developed in several countries are considered adequate and similar guidelines are implemented in other countries through improved information exchange. Mechanisation of harvesting is taking place, leading to a further shift of motormanual harvesting to mechanised harvesting. To protect biodiversity forests are being protected, but with medium impacts on the harvests that can take place. Application of fertilizer is permitted to limited extent to limit detrimental effects of logging residue and stump extraction on the soil.

3. In the low mobilisation scenario, the recommendations do not have the desired effect, because the use of wood for producing energy and for other uses is subject to strong environmental concerns. Possible negative environmental effects of intensified use of wood are considered very important and lead to strict biomass harvesting guidelines. Application of fertilizer to limit detrimental effects of logging residue and stump extraction on the soil is not permitted. Forests are set aside to protect biodiversity with strong limitations on harvest possibilities in these areas. Furthermore, forest owners have a negative attitude towards intensifying the use of their forests. Mechanisation of harvesting is taking place, leading to a shift of motor-manual harvesting to mechanised harvesting, but with little effect on the intensity of resource use.