Scenario development at the science-policy interface: A suitable tool for finding robust, long-term policy strategies?

Axel Volkery, Teresa Ribeiro

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Contact:

Dr. Axel Volkery
Scenarios and Forward Studies Group
European Environment Agency
Kongens Nytorv 6
1050 Copenhagen K
Denmark
T. +45 3336 7174
axel.volkery@eea.europa.eu
www.eea.europa.eu

1 Introduction

Our environment is changing at faster speed than ever. Decision-making has become far more complex and uncertain since socio-economic developments are no longer as stable and predictable as in the past. At the same time, many of today's pressing policy problems are of long-term nature, for example climate change or the ageing of societies in Europe. Designing policy strategies that are robust against a set of different framework conditions over the long term is a key challenge for decision-makers and researchers.

Over the last years, much progress has been made in understanding future trend developments and their implications. Many facts about the long-term impacts of climate change or of demographic developments are known by now, for example. Long-term studies have been developed to scan the future of agriculture, transport and energy, climate change and air pollution. And more and more governments are starting to assess the impacts of their policy proposals in a systemic manner (Jacob, Hertin, Volkery, 2007).

However, there are still major shortcomings. Most studies focus only on one sector or one dimension of a problem and miss inter-linkages of problems or sectors. Moreover, most studies are still built around the extrapolation of current trends to a distant future – the so called 'business-as-usual' or 'baseline scenario' against which alternative policies are tested. While this approach is handy for short-term assessments, it is doubtful, whether it is sufficient for devising robust long-term policy strategies. In the long run, trend discontinuities or surprising disruptive events (like September 11th or the abrupt increase in oil prices) may become the norm, rather than the exception. Business-as-usual scenarios struggle to represent the complexity of future dynamics and its potential for disruptive change. A second problem from our point of view is that most of the studies focus on the problem analysis, but leave out – or say little – about the strategic implications.

In an increasingly changing and uncertain world, we need tools to address discontinuity and map out uncertainties against a set of alternative futures, both with regard to the problem and strategy analysis. We argue in this paper, that developing alternative, long-term scenarios at the interface of science and policy offers promising opportunities in this perspective.

Scenario development like this creates a "learning space" for policy-makers, societal stakeholders and scientists. This "learning space" allows for challenging assumptions, thinking about different institutional options and discussing potential robust strategies. Such an approach blurs the boundaries between decision-makers and scholars to a certain extent, as they are engaged in a joint learning process. Successful scenario development at the interface of science and policy is dependent on certain rules that concern mutual trust and openness of thinking among participants. Except for creating a climate of trust and openness in a protected environment, another, even more difficult, challenge is to put the scenarios into action afterwards, i.e. ensure that their findings are used within processes of political decision-making.

We use findings from an ongoing land use scenarios project of the European Environment Agency (EEA) to further investigate the conditions, potential and problems of linking long-term scenario development with long-term strategy analysis

and putting the scenarios into action. In the PRELUDE project (*PR*ospective *E*nvironmental analysis of *L*and *U*se *D*evelopment in *E*urope), policy-makers, researchers, representatives of interest organisations and independent thinkers from across Europe were brought together to develop five different scenarios how Europe's environment could change until 2035. Their storylines were analysed with the help of quantitative land use simulation models that produce land use/cover maps for the EU-25 plus Norway and Switzerland (*problem analysis*). In the second phase of analysis, which has just been started, selected representatives of European institutions, Member States and interest organisations have been invited to analyse and discuss potential implications for the design of robust strategies to preserve areas of high nature value (*strategy analysis*).

The article is structured as follows: In the next chapter we use a short analysis of the problems related to the change in land use and cover as a starting point for discussing the related requirements of long-term scenario development. Accordingly, we propose a methodological framework for participatory scenario development. In the next chapter we provide an overview of the PRELUDE scenarios, whereas the chapter afterwards contains a comparison of the scenarios findings. Because the strategy analysis of the project has just been started, we can only snapshot of the policy implications of the scenarios in the next chapter. We end this paper by discussing in how far participatory scenario development can help us to better cope with long-term policy challenges.

2 A methodological framework to develop participatory scenarios to assess implications of long-term land use change

Changes in land cover and use are a pressing challenge to sustainable development in Europe. Rich mosaic landscapes, often shaped by traditional farming practices, are part of the common cultural and natural heritage of Europe. As an attraction for tourists, they also play an important economic role. Land is a limited as a resource in Europe. The need for resources and space and the capacity of the land to absorb and support this need can lead to use conflicts. Change in land cover and use can endanger the integrity of natural resource systems and the output of ecosystem goods and services, which can impact on the well-being of people (EEA, 2006: 6). HNVF, for example contains many hot spots of biodiversity; its conservation is thus an essential contribution to the declared goal of the European Union of halting biodiversity loss by 2010 (EEA, 2004).

The need to preserve the European landscape is an accepted topic on the political agenda by now. A range of policies has been set up at the European level and within the Member States, most notably the European Landscape Convention, the Habitats Directive or the Water Framework Directive (EEA 2005). A cross-section of EU policy areas ranging from agriculture to transport and environmental protection to regional development will be affected by the need to preserve European landscape. The sustainability of agriculture and regional development, for example, has become a key objective of recent reforms of the European Common Agricultural Policy or the new guidelines for the European rural development policies (see Swinbank, Daugbjerg, 2006).

However, these reforms - and related impact assessments - still tend to operate within the confines of a five-to-seven-year cycle at best. This is at odds with the long-term

consequences that many decisions in agriculture, transport or housing policies will have. Currently, Europe is at the crossroads of major policy reforms that will have a decisive influence on the socio-economic and environmental development in Europe's regions over coming decades. This concerns, for example, the implementation of the new European Agriculture Fund for Rural Development (EAFRD), that entered into force 2007 or the announced "health-check" of the Common Agriculture Policy for 2008, which will probably lead into a major reform discussion in 2009. Against this background, long-term alternative scenarios can provide a framework in which potential effects and effectiveness of different policy options can be discussed and assessed (see Busch 2006 for an overview of existing scenario studies on land use policies).

Scenarios are neither a forecast nor a prediction but should be understood as a "coherent, internally consistent and plausible description of a possible future state of the world" (Nakícenovíc et al., 1994). Scenarios come, however, in many variants (Godet et al., 2004, van Notten et al., 2003, EEA, 2000). For example, the IPCC scenarios stem from a highly formalised process that involves only expert scientists from specific disciplines. Here, a clear distinction between scientists and political stakeholders is drawn (EEA, 2001a). On the other hand, exercises like the Millennium Ecosystem Assessment of the United Nations involve political and other societal stakeholders into the process of scenario development (MEA, 2005).

Over the last years, a number of arguments in favour of participation in scenario development have been developed in the literature, according to which participation helps to (Welp et al., 2006; Kok et al., 2006; Pahl-Wostl, 2002a; van Asselt, Rijkens-Klomp, 2002; van Kerckhoff 2001):

- give access to practical knowledge and experience, learn about new problem perceptions and identify new challenging questions,
- bridge gaps between the scientific communities and governments, businesses, interest groups or citizen, thus providing a reality check for research assumptions and methodology,
- improve communication between scientists and stakeholders and facilitate collaboration and consensus-building on problem-solving and
- increase the salience and legitimacy of the scenario and thus the acceptance among end-users.

Participation in scenario development is, however, extremely complex (see the discussion in van Kerckhoff, 2001). Of particular concern are two aspects that can be labelled the *advocacy-discourse dilemma* and the *science-policy dilemma*.

The *advocacy-discourse dilemma*: Diverging interests, conflicting views and possible hidden agendas of participants can lead a scenario process easily into a stalemate, where an open-minded discourse would be needed instead. Stakeholders often have clearly defined interests in the outcome of a scenario exercise, especially if the scenario exercise deals with a contested issue where policy decisions are to be shaped. They might not subscribe to an open-minded discussion about future developments (Berk et al., 1999). The process then can be easily perceived as too "politicised" which might undermine the credibility and legitimacy of the assessment. At this stage new thinking beyond prevailing mind-sets is utterly hampered. Rather than building consensus, participants tend to defend their positions and dismiss others rather. The consequence is a locked-in thinking that fails to challenge strategic paradigms.

It is therefore important to select stakeholders who are able to abstract from their background to a certain extent and are open for discussing new perspectives, but still obtain a relevant decision-making position. There are, however, no success criteria for this and this task may take quite some time. It is also necessary to engage a competent, professional facilitator who can win the trust of participants and can reveal and sort out interest conflicts in the beginning (Toth, 2001) [1]. Otherwise, trust relationships among participants are difficult to build, which is a key success factor: if single stakeholders manage to manipulate or even capture the process, it will loose its credibility for other participants and they might even disengage from the process. If there is a lack of consensual support, ownership and rules of engagement, scenarios loose their trustworthiness and authority (Selin, 2006). To build trust, several iterations of the process are needed, which can be a time-consuming endeavour too.

The *science-policy dilemma*: It is a well-described fact that the role of scientific support for decision-making changes, if problem complexity and uncertainties are high and the prospects of reducing uncertainties with additional scientific research are rather low: Instead of producing "objective" assessments, scientists then have to join other actors to co-produce relevant knowledge (see Pahl-Wostl, 2002b). This means that scientists have to accept that other actors can have an equal, sometimes maybe even more important, role to play in the conduct of assessments.

Managing these interactions between stakeholders and scientific experts can be difficult, as they attribute different weight to the credibility, salience and legitimacy of a scenario exercise (Eckley, 2001). Stakeholders usually tend to be more concerned with the political salience of the exercise, i.e. they focus on wider assessments, incorporate a broader range of factors and usually pay less attention to quantitative modelling requirements. This can encounter resistance by scientific experts who tend to be more concerned with the credibility of the exercise. They tend to focus the assessment more narrowly and avoid considering input factors that are difficult to measure, and might therefore reject creative scenario input by stakeholders as unreasonable and not complying with scientific standards. Scenarios might loose, however, their legitimacy for stakeholders and end-users, if they feel that their input has not been taken properly into account (Eckley, 2001).

It is therefore important to think carefully why and to which extent stakeholders should be involved and clarify the roles and responsibilities of scientific experts and stakeholders before starting the process. If one looks at participation of stakeholders in decision-making processes, one can identify different levels of involvement (Bouzit, Loubier, 2004; Hare et al, 2004)[2]:

- stakeholders can simply receive information at the end of the process (*information*)

[1] Stalemates can be caused by unrealistic goals and expectations, confusion about roles and failures to develop a clear road map for the scenario generation process. Participants can expect too much from scenarios and are disappointed if the final results don't match their expectations (Schoemaker 1998). Developing too many scenarios dilutes the attention and energy of participants. An experienced facilitator can help to define clear goals, clarify roles and concentrate on reviewing few, but key questions in greater depth (Schwartz, Ogilvy, 1998).

[2] This typology follows the often cited "ladder of citizen participation" (Arnstein) that distinguishes the following levels of participation: a) information, b) consultation, c) do-design, d) co-decision, e) decision (see Pahl-Wostl, 2002b).

- stakeholders can comment and provide information on drafts before decisions are taken (*consultation*)
- stakeholders can contribute to the design of the process and the structuring of the analysis, but don't take decisions (*co-design*)
- stakeholders co-decide on the design of the process, the analysis and recommendations on possible actions (*co-decision*).
- stakeholders are fully responsible for the design of the process, the analysis and recommendations on possible action (*decision*).

This typology can be usefully applied to participation in scenario development. The influence of stakeholders increases with each higher level, whereas the role of science changes with each higher level from a leading towards a more supportive role. Different methodological approaches are required for steering the process at each level.

The level, but also the timing of stakeholder involvement is highly context-dependent. If the problem, and its corresponding problem solution, is quite uncertain or potentially laden with conflicts, it appears useful to involve stakeholders actively from the early phase on to maximise the available knowledge, avoid a too narrow problem perception and broaden the support for action measures that stem from the scenarios[3].

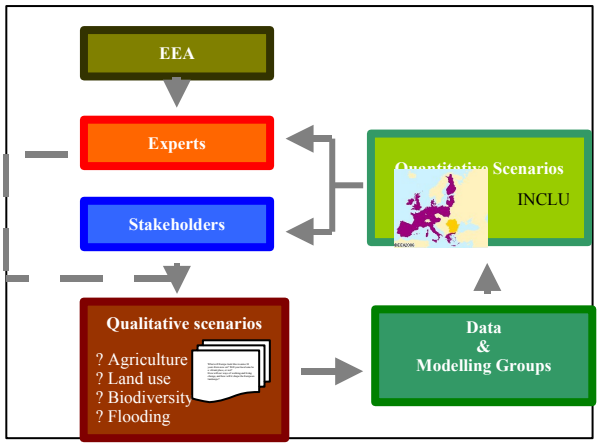
An approach that has been designed to combine the strengths of participatory qualitative scenario development with quantitative model analysis is the 'story-and-simulation' (SAS) approach (see EEA, 2001)[4]. Its main parts are (Figure 1):

- A group of stakeholders develop qualitative storylines, based on in-depth discussions about key uncertainties and underlying driving forces of social, technological, economic, environmental and political development.
- Experts translate this information into quantitative model input and underpin the qualitative storyline with quantitative results.
- Stakeholders and experts engage in an iterative process of refining storylines and quantification until a set of compelling, plausible and relevant stories and simulations about the future is reached.

Figure 1: The Story-and-Simulation Approach

[3] In two interesting papers, *Galtung* reports results from reviewing assessments made by a panel of experts and panel of non-experts thirty years ago that were exposed to the question of what the next thirty years could like. As it turns out, the assessments of the experts were rather wrong whereas the assessments of the non-experts were rather accurate (Galtung, 2003a, 2003b).

[4] See for a comprehensive discussion of the advantages and disadvantages of the Story-and-Simulation approach Volkery et al., 2007.



Source: EEA 2007

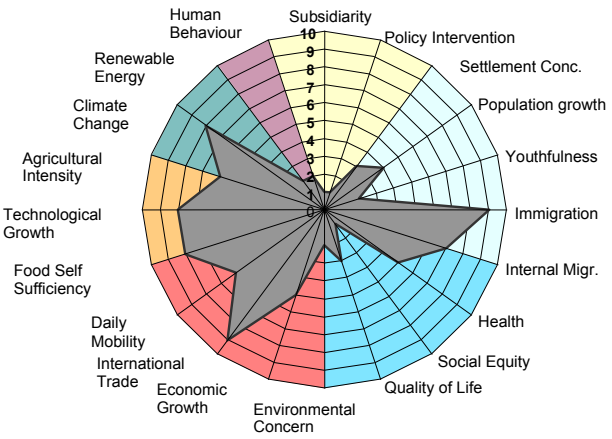
3 Scenario development in the PRELUDE project

Following the SAS-approach, a stakeholder panel was set up in the beginning of the PRELUDE project. The panel consisted of up to 30 stakeholders and experts from across Europe with a broad diversity of backgrounds. This included policy-makers, academic researchers, representatives of interest groups and independent thinkers. Stakeholders met three times for three-day events within a year to build the scenarios. The whole process was moderated by external partners (see Volkery et al., 2007). The EEA as the sponsoring organisation took a deliberate decision to let stakeholders develop the scenarios, i.e. it took a step back and did not try to control the outcomes.

Stakeholders categorised a broad variety of driving forces that influence different land use types and land use change in Europe. Consequently a common basis for comparison was needed. This was done in the following step wise approach:

- "Influence chains" were generated by the group. Influence chains and general driving force categories were used to derive a consistent set of 20 driving forces.
- The magnitude of change of the driving forces was qualitatively valued for each scenario on a scale from 0 (minimum value) to 10 (maximum value).
- Qualitative values were transformed into quantitative values as model input, based on past data and existing authoritative scenarios for other issues (i.e. IPCC SRES scenarios).

Figure 2 Driving forces in the PRELUDE project (base year 2005, 0=minimum, 10=maximum)

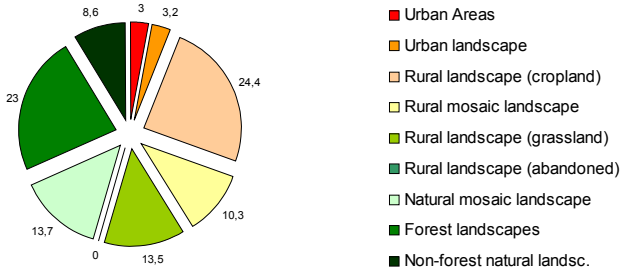


Source: EEA 2007

The Louvain-la-Neuve land use/cover change model was used for assessing the changes in land use/cover at the European level (see: Ewert et al., 2005; Rounsevell et al., 2005; Kaukaanpää, Carter, 2004). The model uses data from the PELCOM database as a starting point[5]. It produces maps and data tables for Europe (EU-25 plus Norway and Switzerland) with the percentage change of each land use/cover class as compared to the total area of the 10 minute (latitude and longitude) grid.

Figure 3 shows the composition of the European landscape in the base year 2005 according to the landscape typology of the model. Rural landscapes (particularly those that are cropland-dominated) present a majority of landscapes in Europe. In comparison, urban areas and landscapes present a minority of landscapes in Europe, although the vast majority of European citizens lives in towns and cities.

Figure 3: Analysis of landscape types in 2005 in the EU 25 +2



Source: EEA, 2007

Stakeholders developed a set of five very different, yet consistent storylines of how Europe could evolve until 2035. The five PRELUDE scenarios are:

1. Great Escape - Europe of contrast
2. Evolved Society - Europe of harmony
3. Clustered Networks - Europe of structure
4. Lettuce Surprise U - Europe of innovation
5. Big Crisis - Europe of cohesion

Following, we give a very brief overview of the key characteristics of the scenarios. A full description can be found in EEA, 2007.

Great Escape: This scenario is driven by globalisation, decreasing solidarity and passive government. Societal tension builds up as relatively poor immigrants move to urban city centres. Climate change affects the growing conditions for agriculture. The agricultural market is liberalised and only large-scale farms with intensive management survive the pressure from the world market.

Evolved Society: Main ingredients in this scenario are an energy crisis, growing environmental awareness and active rural development. Serious flooding occurs and people leave the most vulnerable areas. They rediscover the countryside where small-scale organic farming, supported by strong policy measures, increases.

[5] PELCOM is a 1 km^2 pan-European land cover database developed mainly from remotely sensed data for the year 2000. To adjust this database to 2005, statistical data as well as existing scenario work was used (see EEA, 2007).

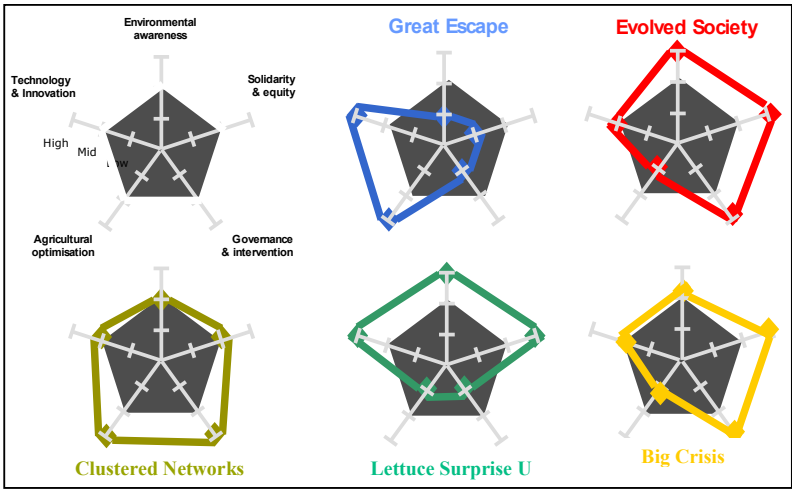
Clustered Networks: This scenario is all about optimization of land use and strong spatial planning in response to an ageing of society and a declining agricultural sector. Climate change is a less prominent driver in this scenario.

Lettuce Surprise U: The essential drivers here are growing environmental awareness, technological innovation and decentralisation. Agriculture revolutionises, facilitated by open source mentality and propagation of knowledge. Production becomes small-scale and less intensive.

Big Crisis: In this scenario climate change related disasters and increasing solidarity are all-important. Floods and droughts affect many people and trigger strong European policy interventions, aimed at a balanced social, economic and environmental development.

The scenarios cover a wide spectrum of possible developments of drivers of change in society, economy, governance, environment and technological invention.[6] Figure 3 shows simplified spider diagrams (developed on the basis of the 20 driving forces that were initially developed) that illustrate the key characteristics of each scenario.

Figure 3: Simplified spider diagrams of key drivers in the PRELUDE scenarios



Source: ZEA, 2007

4 Comparison of scenarios

The rate of internal migration is a main influence for urban change. High rates of internal migration trigger high rates of urban change in the Clustered Networks and Evolved Society scenario. The spatial patterns of urban change are different for all scenarios, but for the majority of them, rural areas or small cities are more attractive than large cities. All scenarios show some diffuse urban growth patterns. Diffuse urb-

6 The objective of the PRELUDE scenarios is to challenge current mind-sets and to explore implications of events with low probability, but far-reaching impacts. Accordingly, stakeholders prepared storylines that sometimes work with far-reaching assumptions, as for example groundbreaking technological breakthroughs or substantial changes in consumption patterns and governance approaches. Some of them might seem unconceivable at first. However, a closer look at the environment reveals the interesting facts, that some bits and pieces can be seen already today. Gated Communities, for example, are already spreading across Europe. Planners are already discussing how to adapt cities to the needs of an ageing population.

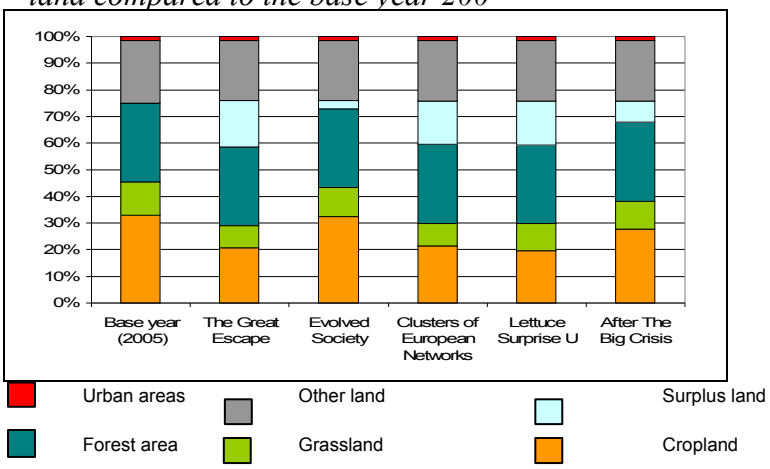
an sprawl, which is recognised as an important environmental problem, thus continues to be a problem even in scenarios that work with strong assumptions on the effectiveness of spatial planning.

The highest *agricultural changes* are in the "Great Escape", "Clustered Networks" and "Lettuce Surprise U"-scenarios. The first two are global market-oriented scenarios, and changes are brought by the pure profit orientation in optimal locations in the first scenario and the large imports of agricultural products in the second scenario. The high decrease of cropland in the "Lettuce Surprise U" occurs due to a strong importance of high-yield and self-fertilizing plants and partly due to a transfer of cropland to grassland. Fewer changes are observed for the more environmentally-oriented scenarios due to the extensification of agricultural land and landscape preservation, i.e. the "Evolved Society" scenario and the "Big Crisis" scenario after 2015.

The *surplus areas* stemming from abandoned agricultural land are very high for the three scenarios "Great Escape", "Clustered Networks", and "Lettuce Surprise U". Some of this land is used to grow biofuels (crops or forest plantations); however, this constitutes a small fraction of the surplus land for four of the five scenarios.

Forest land increases only slightly for all scenarios, based mainly on current trends of afforestation, which are low and are assumed to continue. Succession time in forests is rather long so that the surplus land that is just left to turn to scrubland (and later forest land) will not have produced much new forest after the 30-year scenario period.

Figure 4: *Major land cover types in 2035 for EU-25 plus Norway and Switzerland compared to the base year 200*



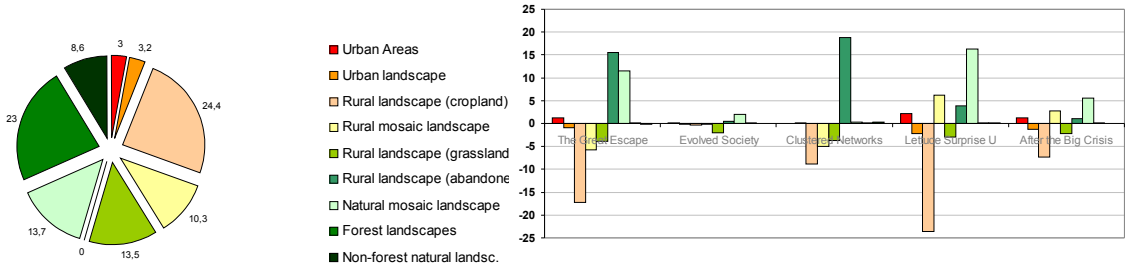
Based on this comparison, we can use the concept of landscape types to compare the land use intensities in the scenarios (see Figure 5).

As regards landscape type changes, *urban land* increases slightly in all scenarios. The main difference between the scenarios is the shift between urban areas and urban landscapes. *Agricultural land* is decreasing in all scenarios with exception of "Evolved Society". Whereas in 2005, rural landscapes (particularly those that are cropland-dominated) present a majority of landscapes in Europe, in 2035 this is only true for the "Evolved Society" scenario. Forest land increases only slightly for all scenari-

os, based mainly on current trends of afforestation, which are low and continue in all five scenarios.

Shifts in land use patterns do not occur homogeneously throughout Europe. Whereas Scandinavia remains almost unchanged in all five scenarios, changes are particularly large for Eastern Europe, the Iberian Peninsula, and some Central European countries.

Figure 5 Landscape type change between 2005 and 2035 in EU 25 plus Norway and Switzerland



5 A first snapshot of the policy implications of the scenarios

The first project phase was about the development of the scenarios and the analysis of environmental consequences of potential future land use change. In the current second phase of the project, the scenarios and scenario findings are used to "wind-tunnel" the existing policy strategies and instruments that are in place for the protection of areas of high nature value, especially in the sphere of the Common Agricultural Policy and the Rural Development policy of the European Union. As this analysis has just started we can only provide a first snapshot of potential policy implications that necessarily has to remain rather broad.

The PRELUDE results lead us to expect a further decrease of agriculture area in Europe that can have serious consequences for the socio-economic stability of some regions. This trend development is shown in all five scenarios, and in only one scenario that works with very strong assumptions on policy effectiveness and value changes, the magnitude of change is rather low.

Abandonment of agriculture land will most likely endanger many of our traditional landscapes, especially in Eastern and Southern Europe. Rural development and environmental policies may slow down this trend, but are unlikely to fully stop it. Even in the most optimistic scenarios we see land abandonment taking place. Europe's landscape is going to change, and it is probably going to change very significantly.

One important driver is the ageing of population that concerns many rural regions. There is already a large share of elderly in the rural population. Current demographic data suggests a general decline of population in the long-term. This might aggravate the situation, especially after 2030. Another important driver is climate change, especially in Eastern and Southern Europe.

Many habitats and species that depend on extensive agriculture will decline considerably. The conservation of high nature value farmland will probably require a more concentrated effort in core areas, which implies higher budgets for this area. One the other hand declining impacts of agriculture can promisingly contribute to halting

biodiversity loss. Land abandonment offers also considerable opportunities for targeted nature development.

Given the magnitude of change, the ability to conserve all areas of interest, which is the current main objective of relevant European policies, is highly unlikely. A first educated guess suggests that the current policy regime that is in place to protect areas of high nature value is not robust in all scenarios. It is strongly based on a regulatory approach which is combined with subsidies for extensive and environmental friendly farm practices. This approach is, however, depending on effective European regulation, and the availability of sufficient European funding. Both assumptions are not viable in some of the scenarios. Furthermore, current funding activities are rather not prioritised, and no real coordination with other policies takes place that can have large impacts on the integrity of ecosystems and landscapes, such as for the example the European transport policy.

To use existing resources most effectively, it may be necessary to set stricter intervention priorities and target funding for areas of high concern. In some situations, all efforts might be needed to conserve a valuable landscape. In other situation it could be the right decision to let change happen as it cannot be prevented in the long-term. Ongoing analysis of the EEA suggests that funding to preserve areas of high nature value in Europe is quite often not efficiently used, and often targeted in the wrong regions. The repercussions for the current design of the Common Agricultural Policy and the Rural Development Policy are quite strong: a better targeting of approaches is likely to increase the speed of re-nationalisation which has already been started with the 2000 and 2003 reforms of the Common Agricultural Policy, where funds have been shifted from the 1st pillar (income support of farmers) to the 2nd pillar (rural development) which is co-financed by the European Member States. However, our analysis of robust policy strategies has just started.

6 Scenario development at the science-policy interface: A suitable tool for finding robust, long-term policy strategies?

The paper started with the assumption that the participatory development of long-term alternative scenarios is a useful tool to support decision-making and increase the robustness of policies by providing a framework in which the potential of different policy options can be tested. We cannot give a final answer with regard to the testing of the robustness of different policy options since the respective phase of analysis in the project has only recently started.

However, our experiences with two outreach workshops illustrate the value of interesting and innovative long-term alternative scenarios. The scenarios were presented in two workshops and several presentations to policy-makers (European Commission, European Member States), interest organisations (representing agriculture, transport, environment) and researchers. Participants were invited to explore potential environmental and policy implications of the scenarios. After some scepticism in the beginning, more and more intensive strategic conservations emerged, and participants found themselves challenging their own beliefs with regard to the usefulness and desirability of existing policy approaches.

Although the process of developing the PRELUDE scenarios was quite cumbersome, the benefits of running such a broad participatory approach to scenario development are clearly visible. The fact that policy-makers, representatives of interest organisa-

tions and researchers had developed the scenarios increased the legitimacy and acceptability of the scenarios in the outreach workshops. Bringing together a broad group of stakeholders from different backgrounds also ensured that a set of interesting and innovative scenarios could be developed since all stakeholders brought different perspectives and ideas into this process.

Furthermore, the stakeholders did not only managed to create interesting stories, but moreover they developed a strong trust into the validity and suitability of the own problem analysis and the scenarios. Nearly all stakeholders felt a strong feeling of ownership for the scenarios in the end and did not leave the process. Insofar the project has been successful in bridging gaps and improving communication and collaboration between quite different actors.

One of the necessities right in the beginning was to create an atmosphere that allowed stakeholders to gain trust into the overall process, but also into each other. This required from the involved scientific experts, but also from the European Environment Agency as the sponsoring organisation to take a backseat and give input and support into the process rather than to lead it. This behaviour together with a competent facilitation of the working process helped to avoid the advocacy-discourse dilemma. Of course, stakeholders had diverging interests and conflicting views with regard to single issues. However, because it was their process and finally also their responsibility for the content, they abstained from toughing it out and aimed rather at a common solution for the problem. Thus, creating ownership early on in the process helps to level out contrary discussions and avoid hard bargaining.

Problems arose, however, with the formalisation and quantification of the scenarios. The overall Achilles heel was the time it needs to align the output of the stakeholder meetings with the requirements of the modeling, and vice versa. Time was limited in the PRELUDE project and the round of iterations could only run once. This complicated the translation of the qualitative assumptions on driving forces into quantitative model input, since stakeholders and modellers were not always able to find to a common understanding. It created problems of ensuring overall consistency between the qualitative assumptions and quantitative input. The stakeholders also worked with assumptions that could not always be brought into a meaningful quantitative format (like for example the driving forces human behaviour or health concern) or appeared to be not consistent. At this point, concerns of the scientific experts grow who focused more on the scientific credibility of the exercise.

Thus, managing effectively the interface of science and policy occurred to be more difficult than avoiding stalemates in discussions between the different stakeholders. The strength of the scenarios is that they convincingly illustrate the need to think broader and in longer timeframes. They can animate decision-makers to re-think existing policy strategies and instruments. This, however, takes place on a rather abstract level of strategic conservation. The problems of aligning the outputs of strategic conversation with the requirements of formalisation and quantification are a major challenge for further research. It remains to be seen whether the scenarios can be effectively used as a tool for finding long-term robust strategies. However, raising awareness for the necessity of thinking in alternative long time-frames among policy-makers is already a substantial accomplishment.

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