

## **Scenario Development to Strengthen National Forest Policies and Programmes**

A review of future-oriented tools and approaches that support policy-making



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## SUMMARY

Forest policies require a broad perspective on land use and natural resource management, and necessitate a focus on the value of forests to society. Forest policy documents need to be updated on a regular basis and stakeholder involvement plays an important role in this process, often through workshops and interviews. A broad variety of approaches and tools exist to support policy-makers in their consideration of different future scenarios and possible responses. Many of these allow involvement of stakeholders, supported by information technology. However, the choice, availability and applicability of software tools is not always clear-cut. In consequence, participatory scenario development, with a focus on future perspectives on forests and their management, is often not undertaken when countries revise their national forest policies or programmes, despite the potential high added value. This report provides a brief overview of some selected methods and tools available for stakeholder involvement and future-oriented policy-making.

A literature and internet search resulted in a list of 80 tools for potential use in participatory scenario development. The tools are diverse and focus on policy relevant topics such as land use, climate, natural resources, water management, social aspects, poverty reduction, political settings, biodiversity and ecosystem services. They could be applied at the beginning of the policy development process to explore issues; at the intermediate phase to assist scenario development and consideration of trends; or at the end to compare different policy, land use or management options. A significant number could be used to compare alternative scenarios, but some could also assist stakeholders in eliciting a vision – a desired or ideal future – and the path to reach that future. Many of the investigated tools were open-source or freely available, while others need to be bought. Tools exist to provide information, promote stakeholder interaction, link forest issues with broader societal aspects and compare future scenarios. Some of the more complex tools can be used for a variety of purposes.

The development of national forest policies or programmes can benefit greatly from the application of appropriate foresight and participatory methods and tools. As no single available tool meets all these requirements, a combination of different methods and tools is necessary. Models can be very complex, which poses the risk that the participatory process will be perceived as non-transparent. It is important, therefore, to present the results of the chosen models to the audience in a clear manner. Without such facilitation, highly complex models have only limited value as a tool to stimulate participation, and may instead form a barrier to active stakeholder participation in the process. The biggest challenge lies perhaps in keeping the models simple. When used in the right settings and with proper facilitation, these tools can help stakeholders better understand the complexities of landscape dynamics and support better-informed decision-making and natural resource management.

The next step is to identify the modifications needed to tailor specific tools for national policy development processes and to test some of the most promising examples. Further work on this topic is required, in particular to share practical experiences on the needs and use of future-oriented approaches and tools among researchers, practitioners and policy-makers.



## 1. INTRODUCTION

Many countries develop and revise forest policies and programmes to adapt to changing circumstances and to enhance the value of the forest to society. Developing and revising forest policies is a difficult process, as it needs to take into account many different and often conflicting interests of diverse groups of stakeholders. Reaching a long-term agreement can be a major challenge despite the benefits for all concerned. Forest policies need to address key societal issues while conforming to national development goals. This requires a broad perspective on land use and natural resource management. It is important that all sectors and stakeholders are involved in achieving these goals. In particular, the participation of key stakeholders at national and sub-national levels creates joint ownership and joint responsibility for implementing the policy. It is therefore crucial that stakeholders receive sound information on the current status and future trends, not only of forest resources, but also of social, environmental, political, economic and technological factors that determine the use of forests (FAO, 2010a).

In 2010, formal forest policy statements covered 70 percent of the world's total forest area, while national forest programmes covered around 75 percent (FAO, 2010b). To remain relevant, forest policies must adapt over time to the changing demands of societies. A number of factors can influence the ways in which forests are managed. These range from shifting demand for forest products and services to increased awareness of the role of forests in regulating climate change; for example, a shift from timber production to multifunctional and people-oriented forest management. Current issues that may trigger a need for national forest policy reform include climate change (reducing emissions from deforestation and forest degradation), biodiversity, social aspects of sustainable forest management (forest certification) and good forest governance (e.g. forest law enforcement) (Evans and Guariguata, 2008; FAO, 2010a).

The Food and Agriculture Organization of the United Nations (FAO) has several decades of experience in producing global and regional outlooks.<sup>1</sup> The Organization also possesses expertise in participatory methods (FAO, 2009, 2010c) and provides guidance to its member countries on national forest policy development (FAO, 2006, 2010a, forthcoming). Ideally, forest policies and national forest programmes should be updated on a regular basis and stakeholder involvement should play an important role in this process. Many countries have systems in place that allow them to collect and compile data on forests, their benefits and use. However, these systems often fail to consider different future trends and developments and changing circumstances when formulating new policies or programmes. This can result in inadequate policies that are unable to offer strategic guidance.

A broad variety of approaches and tools exist to support policy-makers in their consideration of future perspectives on forest and forest management. These are employed in global and regional outlook studies, as well as studies on land use changes, climate change impacts, industry raw material supply, bioenergy potentials and sustainability assessments, among others. Several existing approaches promote the involvement of stakeholders – a key aspect in developing effective policies or government programmes. However, scenario and outlook development is often omitted when countries revise their national forest policies or programmes, despite the potential high added value of these different approaches and tools.

The purpose of this document is to provide an overview of future-oriented tools and methods of potential help to countries in reviewing and revising forest policies, strategies or national forest

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<sup>1</sup> For more information on outlook studies by FAO see: [www.fao.org/forestry/outlook/en/](http://www.fao.org/forestry/outlook/en/).

programmes. Given the vast variety of methods and tools available, this report focuses on a few examples, showing how these can be used to develop governance frameworks and evidence-based future-oriented policy-making. It also elaborates on the needs and requirements for using scenario approaches and tools in practice, as discussed during the workshop “Considering future trends and scenarios in forest policy-making – approaches and tools”, held on 26-27 November 2013 at FAO headquarters in Rome. In conclusion, the report highlights some of the workshop recommendations detailing steps to be taken and the need to further develop approaches.

Scenario development is essential for strategic planning. However, participatory methods are the key to planning new land and resource use management strategies and policies that take into account the value of the forest for different stakeholders. Scenario methods and participatory methods together build stakeholder engagement by creating understanding and acceptance among participants. This report focuses on participatory scenario development methods and (software) tools. It begins with a brief overview of futures approaches, detailing the series of objective scenario development exercises that have been undertaken. It then examines the state-of-the-art in participatory scenario development and explores ways in which this can be applied to forest policy formulation. Finally, it presents an overview of tools that can be useful in participatory planning and policy development. In particular, it focuses on tools that enable a combination of modelling and facilitated participation, and illustrates these with practical examples of how to promote “futures thinking” in facilitated workshops.



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*Oshampula community forest meeting in Namibia*

## 2. SCENARIO DEVELOPMENT

This chapter explains scenario development within the wider framework of futures methods and foresight. “Foresight” is an umbrella concept used to describe “*systematic, participatory, future-intelligence-gathering and medium-to-long-term vision-building processes aimed at present-day decisions and mobilising joint actions*” (Gavigan *et al.*, 2001). Thus, although foresight is often defined narrowly in terms of technological foresight, the term also refers more generally to the practical application of futures research in support of policy-making and to design actions for socio-economic transformations. This report focuses on scenario development, which looks at “future” as a plural. In other words, instead of projecting a single future based on past developments, it stimulates creative thinking about structural changes and new emerging issues shaping the future.

### 2.1 SCENARIO DEVELOPMENT: A CONCEPTUAL OVERVIEW

#### What are scenarios?

**Scenarios** are plausible descriptions of how the future may develop, based on a coherent and internally consistent set of assumptions about key relationships and driving forces (Van der Heijden, 1996). A scenario can be regarded as a story or, more precisely, a series of events leading to an end point typically answering a “What if?” question. There are different types of future story lines, which are referred to here as *probable*, *possible* and *preferred*.

A **probable** future story, often referred to as “business as usual”, describes what is likely to happen based on past developments and understanding of the present. This is typically an extrapolation or projection based on a historical trend analysis, and in many cases is strongly rooted in the analysis of available data (e.g. the FAO Forest Sector Outlook Studies).

A **possible** future story describes what can happen, taking into account structural changes and future technological advances. It looks at alternative development pathways and seeks to identify possible breaking points of present trends by scanning information about emerging issues. In most cases, it relies less on analysis of past data and trends, but does take into account future trend breaks and requires creative thinking about future scenarios.

A **preferred** future story describes a wanted (or avoidable) course of future development leading up to a preferred end point.

A **vision** is a desirable or ideal future (Wollenberg, Edmunds and Buck, 2000). This is not necessarily the same as a preferred future, which may indicate the best of two or more bad scenarios.

A **pathway** describes the route from the present to the vision through the comparison of probable, possible and preferred scenarios. A pathway scenario focuses on problem solving and creating strategies to reach the future goal (Wollenberg, Edmunds and Buck, 2000).

Scenarios may describe worst cases, preferred cases and everything in between. Clarifying the meaning of the term “scenario” is crucial to engaging stakeholders successfully in scenario exercises and may require considerable effort and time (Kok, Briggs and Zurek, 2007).

## What is scenario development? Purpose and target audience

Scenario development or scenario planning refers to the construction of plausible future stories, often reliant strongly on stakeholder input for their formulation. It is important to stress that the purpose of a scenario is not to produce accurate forecasts or predictions, but rather to consider a variety of possible futures. It does not necessarily represent an extension of historical trends, but instead considers new developments and their impacts, resulting in non-linear responses and trend breaks. Take, for example, information and communication technology (ICT). Innovations in this field have revolutionized many aspects of people's everyday lives over a relatively short period. ICTs have altered how objects are traded and exchanged, how financial transactions are conducted, and how contacts and connections are made. Building capacities to "foresee" these developments and their impact improves the capacity to act purposefully in new situations, in particular when the "unforeseeable" happens. Thus, the purpose of scenario development is not to predict how the future will unfold, but to prepare individuals, groups of people and organizations to address the uncertainties.

Scenario development exercises vary in topic and geographic scope, target audiences and objectives. They may be carried out as one-off projects with internal or external facilitation, or as regular activities built into an organization or decision-making process. Typically, these exercises combine quantitative and qualitative methods, and use data and information from a variety of sources (e.g. research and applied science, stakeholder perspectives and evidence-based data, as well as hidden tacit knowledge, notions, perceptions and expectations).

Futures are approached for several purposes: to assess the future impact of present decisions; to explore alternative development pathways, such as the effects of structural or institutional changes; and to envision common goals, for example, mobilizing action towards a specific purpose.

Many scenario exercises employ a participatory process to develop storylines. The participatory process can be a powerful tool to facilitate and increase understanding, knowledge sharing and communication among stakeholders. It can simultaneously help to negotiate commonly desired futures, especially in cases where stakeholders have conflicting interests. Participation should be emphasized for capacity-building, for ownership of the exercise and its results, and for commitment to action after the exercise. Participation among the various actors and interaction between different viewpoints can occur through facilitated workshops and expert meetings at regular intervals. An alternative option is online interaction through software tools (e.g. real-time Delphi). This can be used for an anonymous, pre-defined or open group of participants (<https://themp.org/>). Crowdsourcing can be used to collect input from an open forum and social media (e.g. a databank on wild cards and weak signals, such as <http://wiwe.iknowfutures.eu/>). The participatory process can be divided into different phases, with tools allotted for each phase (see Chapter 3).

In summary, scenario development is about collective learning, reframing perceptions, analysing causal relationships, envisioning multiple features influencing the future and dealing with uncertainty, in most cases to support policy and decision-making.

The initial mapping of tools showed that some tools could be useful at different phases of the participatory scenario development cycle, starting from the beginning of the process up to final evaluation. These are *exploration tools*, *scenario development tools* and *scenario assessment tools* (Table 1).

## Short history of scenario development

Scenario planning was developed simultaneously in the military and research sectors in the 1950s and 1960s. Herman Kahn working for the US military came up with a range of future scenarios,

TABLE 1

Tools were divided into groups according to the different phases of the participatory process: the exploration phase, the scenario development phase and the scenario assessment phase

Phase of the process	Description
<i>Exploration phase or "assessment of the current state"</i>	In this phase the "system" is conceptualized: <i>What are the boundaries of our system? What is the current situation? How did we get here? What are the main ecological/socio-economic drivers? Basic questions are then formulated: What is our problem? What are the objectives? Who are the stakeholders? What do we want to affect? What are our key indicators? This phase is used to identify the problem.</i>
<i>Scenario development phase or "exploration of probable directions of change"</i>	This phase explores the move from the current situation to the most likely devolvement of elements in the system. Questions answered in this phase are: <i>Where are we heading? What drives the direction in which the elements in our system devolve? How can we influence this? What is the role of the stakeholders involved? This phase is used to structure or model the problem.</i>
<i>Scenario assessment phase or "identification of preferred direction of change and negotiation of common action towards this"</i>	In this phase the scenarios are compared and a preferred future is negotiated among the different stakeholders. Different stakeholders may have differing preferences; to this end a trade-off analysis may be useful as part of the "negotiation process". This phase answers the following questions: <i>Which options are best to overcome the problem? Which solution is most robust under different circumstances? This phase is used to solve the problem.</i>

based on different key assumptions, to formulate strategies (Kahn and Wiener, 1967), while Gaston Berger working for a French research centre invented future scenarios to help formulate public policy (Berger, 1964).

In the 1970s, some private companies, notably General Electric and Royal Dutch Shell, adopted the method. Shell greatly benefited from the planning method, which helped them to forecast the beginning of the energy crisis in 1973, after which it became one of the world's two largest oil companies (Schwartz, 1991). As Shell further developed the methodology, the first objective of scenario planning became "the generation of projects and decisions that are more robust under a variety of alternative futures" (Van der Heijden, 1996: 17). Since 2000, scenarios have been applied for large-scale environmental assessment, such as the Millennium Ecosystem Assessment, and in regional environmental impact prediction and planning (Peterson, Cumming and Carpenter, 2003).

### Multi-scale scenarios

In a multi-scale scenario exercise, storylines are developed at several scales (e.g. global and national) and are linked to one another to some degree (Biggs *et al.*, 2007). Based on the goal, objectives and approach used, scales for scenario development can range from the global to the very local (e.g. village level). This allows stakeholders to see how global developments have regional/local impacts. For instance, the UN programme on Reducing Emissions from Deforestation and Forest Degradation (REDD+) is a result of a policy process decided at the global level, but implemented at the local level. The central motivation is climate change, an issue with global impacts; however, local, regional and national developments will affect the future trajectory of climate change and its impacts. It is important for local and regional decision-making bodies to differentiate between developments that the local level will or is able to influence, and those developments to which they simply have to adapt (Hetemäki, 2014).

Multi-scale scenarios may be developed independently and be only loosely linked, or may be developed in a tightly coupled, iterative fashion so that they are consistent across scales and incorporate cross-scale feedback. The motivation to develop multi-scale scenarios is to help understand driving forces, processes, perspectives and responses at different scales. As stated by Biggs *et al.* (2007), "Multi-scale scenarios can better maintain relevance across multiple decision-making scales than, for instance, a single-scale global exercise, and thereby potentially enhance stakeholder engagement and use of the scenario results."



Multi-scale scenarios have been applied in several participatory scenario development exercises in southern Africa, southern Europe, Indonesia and Viet Nam (Dermawan *et al.*, 2012; Kok, Briggs and Zurek, 2007; Stratigea and Giaoutzi, 2012). Multi-scale scenarios help to link scenarios at different spatial scales and challenge both those in authority and those at the grass-roots level, thereby influencing and changing attitudes and agendas. The multi-scale participatory scenario (MSP) approach may be relevant for integrating global and regional scenarios to country and local level in developing countries. Take, for example, the IPCC scenarios or the FAO African Forest Sector Outlook Studies. What are the implications of these in the United Republic of Tanzania and different regions in that country? It may be that at the national and local levels there is a lack of scenario and strategic futures thinking, at least among certain stakeholders such as foresters, local officials, and small-and-medium scale operators. They may not have been exposed to scenario work previously, and may not have a good grasp of its purpose, meaning and implications for their own work and future opportunities and challenges. Consequently, the global or regional scenarios, such as those provided by the FAO Outlook Studies, may seem remote and their implications difficult to understand at the local level. It may even be that the language and concepts used are not clear at the local level. As a result, global policy processes and strategic long-term scenarios may not reach in a meaningful way the regional or local level, even though they may have important implications (e.g. for national forest policies). Conversely, local-level concerns and thinking may not show up in global policy processes or strategic futures thinking, such as the global scenarios. In short, there is a need to better link the global and local levels, and MSP can be highly useful in this regard.

The MSP approach can also be seen as a tool for capacity building for long-term planning and strategic futures thinking (e.g. when developing countries are preparing their national forest programmes). A variety of approaches are used during the process of scenario development (e.g. stakeholder workshops, backcasting, etc.). Among these, the MSP approach has shown strong potential, but also requires substantial investment in terms of time and resources (Kok, Briggs and Zurek, 2007).

#### BOX 1

##### **Multi-scale scenarios of the Millennium Ecosystem Assessment**

Scenarios are used to explore alternative futures. The goal of the Millennium Ecosystem Assessment (MA) is to provide decision-makers and stakeholders with scientific information on the links between ecosystem services and human well-being. The approach to scenario development in MA combined qualitative storyline development and quantitative modelling, with a focus on forecasting (Millennium Ecosystem Assessment, 2005a). Scenarios were developed via an iterative process of storyline development and modelling where stakeholders could provide feedback. The storylines covered many complex aspects of society and ecosystems that are difficult to quantify, while the models helped to ensure the consistency of storylines and provided important numerical information where quantification was possible.

The MA sub-global assessments were designed to meet the needs of decision-makers at the scale at which they are undertaken, strengthen global findings with on-the-ground reality, and support local findings with global perspectives, data and models. Assessments at sub-global scales are needed because ecosystems are highly differentiated in space and time, and because sound management requires careful local planning and action. Local assessments alone are insufficient, however, because some processes are global, and because local goods, services, matter and energy are often transferred across regions. A more complete description of sub-global scenarios can be found in Millennium Ecosystem Assessment (2005b: Chapter 9).

## 2.2 STATE-OF-THE-ART OF SCENARIO DEVELOPMENT IN (FOREST) POLICY-MAKING

Scenario development in relation to forests is not a new approach. In traditional forest countries in Europe and North America, the forest sector has a long tradition of outlooks, which have typically projected developments in the resource base and the markets for forest products (Pelli, 2008). However, Hurmekoski and Hetemäki (2013) indicate that existing forest sector outlook studies have not been able to sufficiently capture structural changes in global paper markets. They also note that the studies may fail to consider possible structural changes in other markets or emerging bio-economy sectors that connect the forest sector with other fields (e.g. the chemical industry, energy sector, knowledge-intensive service activities). A broader futures approach could be utilized in the outlooks to complement current approaches, and to provide policy and decision-making with a more versatile perspective on ongoing structural and societal changes. For forest policy and governance needs, futures methods can also contribute with a more systemic approach to building capacities (including local communities, multiple stakeholders, administration, industry players, etc.), developing vision statements and commitment to sustainable development, as well as harnessing entrepreneurial opportunities.

A few examples from recent years indicate the use of a wider array of futures methods for national forest programmes or in support of forest-related policies. In Europe, interest in these methods has increased over the past 10-15 years. For example, in Finland foresight has been utilized to support design and evaluation of the National Forest Programme and regional forest programmes; in Sweden research institutes have joined forces through the interdisciplinary Future Forests Programme to support long-term development; and in Germany the Forest Futures 2100 project was carried out to inspire debate surrounding forests and land use. The next section describes these examples in more detail.

### Backcasting example: Finnish energy scenarios process

In Finland, foresight has formed part of government policy planning since the 1990s (Heinonen and Lauttamäki, 2011; Kuosa, 2011) and includes the Parliament's Committee for the Future and the Government's Foresight Reports commissioned by the Prime Minister's Office. Once each electoral period, the Government submits a foresight report to Parliament; for example, the Autumn 2013 report focused on sustainable growth and well-being in Finland in 2030.

The foresight report for October 2009 presented the Government's long-term climate and energy policy with a target horizon of 2050, which complemented the country's long-term climate and energy strategy. As part of the foresight work, the Finland Future Research Centre facilitated backcasting scenarios for the desired goal for the year 2050. In other words, the future was set *a priori*, and the backcasting scenarios describe a logical path and developments required to reach the given future (Heinonen and Lauttamäki, 2011). The four-month process was as follows:

- September 2008: literary review and environmental scanning by the foresight team and, in cooperation with the Prime Minister's Office's scenario team, defining of the expert group to be involved in the futures workshops
- October 2008: first online Delphi survey for the expert group (Webropol survey software, 140 panellists)
- October 2008: futures workshop (40 participants), a modification of Jungk's workshop formula, including the imaginary phase (futures wheel), systematic phase (futures table) and explanatory phase (drafting an array of alternative scenarios for sustainable Finland 2050)
- November 2008: second online Delphi survey testing and specification of development paths constructed in the futures workshop
- November 2008: futures workshop to assess and complete the four scenarios
- December 2008: final report.

For further information, see Heinonen and Lauttamäki (2011).

Table 2 illustrates the role of the scenarios produced in the foresight report and in the exercise of backcasting scenarios. The foresight report looks beyond “day-to-day politics” and addresses a wider time horizon, as well as more topical questions, than the climate and energy strategy. The fact that Members of Parliament are actively involved in the foresight exercise, together with scientific and technological expertise, allows them to outline opportunities presented by the future – not only in the case of long-term climate and energy goals, but also with regard to other topics handled in the Parliament’s Committee for the Future (Kuosa, 2011; Tiihonen, 2011). Although the foresight report is not literally repeated in the national climate and energy strategy, the work carried out under the auspices of the Committee for the Future is highlighted in Parliamentary debates, including the debate on the update of the Government’s climate and energy strategy in 2013.

TABLE 2

**The relationship between the Government’s foresight report (backcasting scenarios) and the climate and energy strategy**

	Climate and energy strategy (2008)*	Government foresight report on long-term climate and energy policy: towards a low-carbon Finland
Responsible	Ministry of Employment and the Economy	Prime Minister’s Office
Timeline	November 2008	Spring 2009
Time horizon	To 2020 (-2050)	(2020) to 2050 (-2100)
Geographical scope	Finland	+global
Thematic scope	Mitigation	+adaptation
Sectors	Energy and other emission sources	Factors with an impact on climate
Method	Forecasting	Backcasting

Note: \*The strategy was updated in 2013 ([www.tem.fi/en/energy/energy\\_and\\_climate\\_strategy](http://www.tem.fi/en/energy/energy_and_climate_strategy)).

Source: Ministry of Environment, National Commission on Sustainable Development (in Finnish) [www.ym.fi/download/noname/%7B22914A70-933E-498D-A70B-EE53A3AC6826%7D/26601](http://www.ym.fi/download/noname/%7B22914A70-933E-498D-A70B-EE53A3AC6826%7D/26601).

Backcasting has typically been used for climate, energy and transport scenarios, as well as sustainability issues, because it enables users to look into the future without the restrictions set by present-day structural, institutional and consumption pattern framework. As the Finnish example shows, this type of exercise and wider futures horizons can be seen to have an impact on policy-making, but this impact is indirect and takes longer than the publication of a single foresight report.

### Forest policy development in Finland: foresight in support of NFP and regional forest programmes

In Finland, foresight is distributed across several areas of forest policy-making. Forest sector foresight is carried out by private companies in the forest sector, as well as by ministries, universities and research institutes for the forest sector. Foresight is also a regular part of the work of the Finnish Forest Research Institute (METLA). The National Forest Programme uses foresight studies in several ways (Kokkonen in Pelli and den Herder, 2013); for example, within the framework of the NFP 2015 the following steps were taken in preparation, implementation and review of the forest programme:

- Survey commissioned by the Ministry of Agriculture and Forestry (2006): Welfare based on Finnish forests 2015 – Survey of trends and future options of the Finnish forest sector (scenarios based on work of 70 researchers in METLA and involvement of broad expert and background groups)
- METLA: Alternative calculations for the preparation of NFP 2015, five scenarios (2006)



- University of Joensuu/Forest Sector Foresight Unit: Study on impact of economic crisis and changes in the forest sector on the implementation of NFP 2015 (2008)
- Workshops on various topics using different methods (e.g. futures wheel, futures table, soft system methodology); for example, for identification of challenges and opportunities, or for defining research and development projects to be financed.

In addition, the North Karelia regional forest programme was supported with a foresight exercise within the framework of the University of Eastern Finland Forest Sector Foresight Unit (2008–2011). A literature review and analysis of operational environment were used for group discussions at the Regional Forest programme preparation group and the Regional Forest Council. A futures table method was used to elaborate developments in society and the regional economy and to trigger discussion about possible impacts on forests and the use of forest resources over the long term, as well as possible future forest-based opportunities in the region (e.g. how to allocate resources for research and development).

### **Future Forests in Sweden: interdisciplinary research to support long-term sustainability of forest management**

In Sweden, the Future Forests Programme collects the work of research teams in several institutes under a large research programme co-financed by the Swedish Foundation for Strategic Environmental Research, MISTRA (2009–2012 and 2013–2016). The programme established a Centre for Forest Systems Analysis and Synthesis as an interdisciplinary hub for collaboration between science and society. This provides science-based decision support tools and novel approaches to long-term sustainability of forest management. The centre has carried out several studies and investigations. Foresight studies include scenario analyses and systemic economic analyses addressing national, European and global consequences of alternative future forest management strategies ([www.futureforests.se](http://www.futureforests.se)). No explicit reference is made to national forest policy, but the programme aim is to promote the increased and yet sustainable provision of ecosystem services from forest landscapes in Sweden and elsewhere. Target groups include forest management, governmental authorities such as the Swedish Forest Agency, the Swedish Environmental Protection Agency, County Administrative Boards, and other national and local authorities, and the general public.

### **Forest Futures in Germany: inspiring debate on forests and land use**

In Germany, the Federal Ministry of Education and Research financed the Forest Futures 2100 project (2007–2008) ([www.waldzukuenfte.de](http://www.waldzukuenfte.de)). The aim of the exercise was to inspire a debate surrounding forests and land use with a time horizon to 2100. A multidisciplinary team of experts from forestry, environmental management and ethics, business management, regional studies and social sciences conducted the work. The exercise also involved futures researchers and practitioners from forest management and the wood industry. The methods employed included expert workshops, Delphi surveys, scenario analyses, impact workshops (external expertise and representatives of ministries and associations) and dissemination workshops (a wider group of participants from science, society, policy and the economy). The project resulted in a policy brief on the future of forests to 2100, and contributed to strategy processes at state and federal levels, to keep the German forest sector competitive, promote multiple-use forestry and sustainable forest management, raise public awareness and stimulate public participation. The project inspired participating institutions to become involved in futures studies. For example, the Institute for Forest and Environmental Policy launched a project entitled “Future-oriented integrated management of European forest landscapes”, INTEGRAL (2011–2015) ([www.integral-project.eu/](http://www.integral-project.eu/)).

### Scenario approach examples from developing countries: participatory modelling in Ethiopia, Ghana and Indonesia

In developing countries, scenarios have been used as a tool for adaptive forest management to anticipate the future and expand the creative capacities of those working on complex forest management situations (Wollenberg, Edmunds and Buck, 2000). The following examples of participatory modelling illustrate how scenario development can be used to explore the impact of policies and to analyse trade-offs to negotiate an acceptable scenario for all stakeholders involved.

In a case study from Chilimo in Central Ethiopia, participatory system dynamics modelling (using the modelling platform STELLA) was undertaken to explore joint forest management versus state control (Kassa *et al.*, 2009). Information collected during workshops was used to build and feed different components of a model. The components of the model were: major drivers of change (rainfall and population), the different categories of income (forest, crop, livestock, off-farm), and the growth and dynamics of different types of forests (plantations and natural forest). Two scenarios were constructed: one with participatory forest management and one without. By integrating the more quantitative model outputs with qualitative insights, information on forests and livelihoods was summarized and returned to users, both to inform them and to obtain feedback. The generated model suggests that the only hope for improving long-term conservation and development is considerable governance reform.

In Ghana, participatory modelling was used in a cocoa agroforest landscape in a southwestern district to explore whether payments to REDD were likely to promote forest conservation and what the socio-economic implications might be (Sandker *et al.*, 2010b). Scenarios were constructed by comparing business as usual (cocoa production at the expense of forest) with various REDD options. The results highlighted the risk of REDD contracts being abandoned after initial payments due to high opportunity costs. They also underlined the potential risk of REDD payments increasing community differentiation, given that the remaining forest is mainly controlled by wealthier households with negative consequences for REDD policies. The study conclusions were distributed to Ghanaian policy-makers at the national level, but also contributed to international policy dialogue on REDD+ at COP16 in Cancun, Mexico, concerning social and environmental safeguards.

Other examples include case studies investigating land use and livelihood dynamics in the Malinau district of Indonesia (Sandker, Suwarno and Campbell, 2007). In this district, participatory system dynamics modelling was used to explore the impact of proposed conversion of forest to palm oil plantations on local livelihoods and biodiversity. The model was constructed with inputs from government personnel, conservationists and local communities, and the model results were shown to the district head in Malinau. During the scenario development process, conservationists had to reconcile the limited potential of ecotourism to bring economic development to the district with the monetary inflow from oil palm. Given the low population density and large carbon resources stored in the mostly primary forest, REDD payments seemed more likely to reconcile conservation and development objectives. The district head was also concerned with the likely high inflow of migrants that would result from a large-scale oil palm concession, and chose to sign up for carbon payments shortly after the scenario exercise. In the Sumbawa district in Indonesia, participatory modelling and STELLA were used to improve partnership arrangements in community-based forest management (Suwarno *et al.*, 2009).

### Lessons learned

As the above examples illustrate, foresight approaches can be introduced to support forest policy development in several ways. In countries with strong institutions and structures for forest policy-making, foresight is used to trigger discussion about alternative development pathways, and to

build capacities for new ways of thinking – to look beyond expected future developments towards discussion of desirable futures, and to explore possible low-probability but high-impact events.

According to the Finnish Ministry of Agriculture and Forestry (Kokkonen in Pelli and den Herder, 2013), foresight is a tool that supports decision-making, enhances understanding of the operating environment and the need for change, brings forth various alternatives, and helps to prepare for uncertainty and surprises. A crucial point for foresight exercises is that the process requires careful preparation as well as follow-up and dissemination of the results. Foresight for policy support also highlights the importance of *genuine ownership* of the exercise, which means it is necessary to clearly establish how the exercise has been classified, the nature of any high-level commitment and who can use the results.



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*Mixed broadleaf forest*

### 3. A SCENARIO DEVELOPMENT TOOLBOX TO SUPPORT FUTURE-ORIENTED POLICY-MAKING

A broad variety of approaches and tools exist to support policy-makers in their consideration of future perspectives on forest and forest management. A literature and internet search resulted in a list of 80 tools for potential use in participatory planning or policy development (see Annex 2 for more details on the methodology and Annex 6 for a full list of identified tools). As explained above, scenario development typically relies on a combination of methods and tools. Tools can be divided into different groups, according to their methodological basis, general approach or expected output. However, it is difficult to find a classification system that covers and consistently categorizes all tools. Muys *et al.* (2010), for example, have reviewed different types of decision support and simulation tools. This report adopts a system based on a quantitative to qualitative gradient proposed by Popper (2008).

#### 3.1 THE QUANTITATIVE TO QUALITATIVE GRADIENT

**Quantitative methods** apply mathematical equations to information on current and past conditions. They typically result in “evidence-based” projections, in other words, projections based on historical trend analysis (the *probable* scenario).

**Qualitative methods** typically involve creative thinking about alternative futures, taking into consideration new developments and their implications.

**Semi-quantitative methods** are an intermediate category involving numerical approaches that calculate the effect of creative assumptions.

TABLE 3  
Commonly used methods in scenario development

Qualitative	Quantitative	Semi-quantitative
Methods providing meaning to events and perceptions. Such interpretations tend to be based on subjectivity or creativity and are often difficult to corroborate (e.g. brainstorming, interviews)	Methods measuring variables and applying statistical analyses, using data (e.g. economic indicators)	Methods that apply mathematical principles to quantify subjectivity, rational judgements and viewpoints of experts and commentators (i.e. weighting opinions)
<ol style="list-style-type: none"> <li>1. Backcasting</li> <li>2. Brainstorming</li> <li>3. Citizens panels</li> <li>4. Conferences/workshops</li> <li>5. Essays/scenario writing</li> <li>6. Expert panels</li> <li>7. Genius forecasting</li> <li>8. Interviews</li> <li>9. Literature review</li> <li>10. Morphological analysis</li> <li>11. Relevance trees/logic charts</li> <li>12. Roleplay/acting</li> <li>13. Scanning</li> <li>14. Scenario workshops</li> <li>15. Science fictioning (SF)</li> <li>16. Simulation gaming</li> <li>17. Surveys</li> <li>18. SWOT analysis</li> <li>19. Weak signals/wildcards</li> </ol>	<ol style="list-style-type: none"> <li>1. Agent-based modelling</li> <li>2. Benchmarking</li> <li>3. Indicators</li> <li>4. Bibliometrics</li> <li>5. Patent analysis (e.g. technology forecasting)</li> <li>6. Time series analysis (e.g. trends)</li> <li>7. Econometrics</li> <li>8. System dynamic models</li> <li>9. General and partial equilibrium models</li> </ol>	<ol style="list-style-type: none"> <li>1. Cross-impact/structural analysis</li> <li>2. Delphi</li> <li>3. Key/critical technologies</li> <li>4. Multi-criteria analysis</li> <li>5. Polling/voting</li> <li>6. Quantitative scenarios/SMIC*</li> <li>7. Roadmapping</li> <li>8. Stakeholder analysis</li> <li>9. Mixing econometrics, simulation models and qualitative methods</li> <li>10. Integrated assessment models</li> </ol>

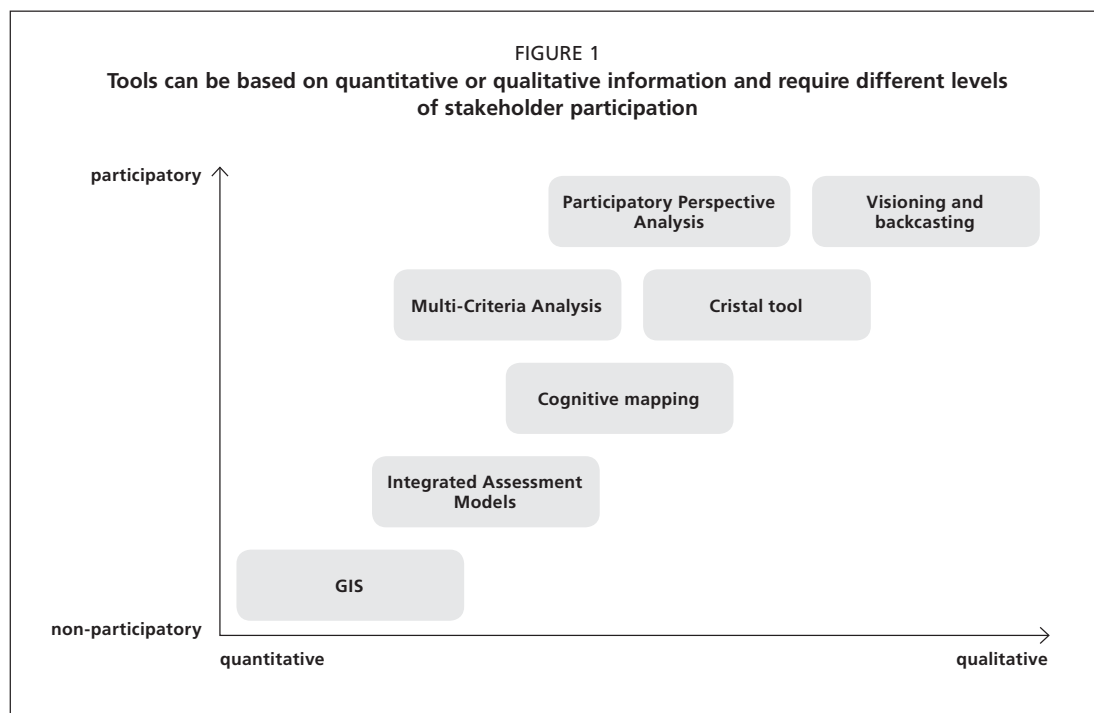
Note: \*SMIC = Cross Impact Systems and Matrices.

Source: based on a classification modified and extended from Popper (2008) by Hetemäki (2013).

Table 3 gives a brief summary of common methods used in scenario development. It is worth noting that the process can be equally or even more important than the concrete outcomes (e.g. strategy document, model, report or vision statement).

### 3.2 THE PARTICIPATORY TO NON-PARTICIPATORY GRADIENT

Several approaches and tools exist to involve stakeholders in the development of effective forest policies or programmes. The most common are interviews, questionnaires or workshops, although software tools increasingly play a major role. It is therefore possible to categorize methods on a gradient from participatory to non-participatory. Figure 1 details a selection of tools used in forest policy-making and locates them on the quantitative to qualitative and participatory to non-participatory axes. As the figure shows, quantitative methods are generally non-participatory while qualitative methods are highly participatory, although some tools bridge this division.



A participatory scenario development process in which a model is used to represent and communicate futures is referred to as **participatory modelling** (Beall, 2007; Sandker, 2010; Standa-Gunda *et al.*, 2003).<sup>2</sup> Different modelling platforms have been used in participatory modelling, including: system dynamics, Bayesian networks, fuzzy cognitive mapping and Geographic Information Systems (GIS) (see Annex 1 for a brief explanation of these terms). The participatory aspect of the modelling process may vary. In some cases, the stakeholders themselves model and build mutual understanding between science, policy-makers and other stakeholders; in others, the participants provide input to the modelling endeavour to contribute and maintain a substantive dialogue between members of these groups (Van Asselt and Klomp, 2002). This difference is illustrated by the varying positions of the different tools on the vertical axis (Figure 1).

<sup>2</sup> Synonyms that refer more or less to the same approach are: **group model building** (Andersen and Richardson, 1997; Stave, 2002; Vennix, 1996), **mediated modelling** (Van den Belt, 2004; Videira *et al.*, 2006), **cooperative modelling** (Cockerill, Passell and Tidwell, 2006) and **companion modelling** (Barreteau *et al.*, 2003; Bousquet *et al.*, 2007).



### 3.3 THE TOOLBOX

This section provides a short description of the tools (Figure 1). It provides an overview of each tool, an indication of their technicality, their applicability in participatory planning and policy-making, and some examples of their application.

#### **Visioning and backcasting**

Level of technicality: low

##### *Overview*

Backcasting is a futures method used to develop normative scenarios and explore their feasibility and implications. It has become important particularly in climate change, sustainability and energy sector studies. Backcasting is related to visioning and forms an alternative to traditional planning. In backcasting, a desirable future state or vision is first defined, and then reflected backwards to identify actions that will connect this desired state of future to the present (FOR-LEARN, 2012). The method therefore emphasizes strategies and the actions necessary for change. The method also enables development of a path towards an undesired future, thus allowing users to identify both the actions needed to reach a desired scenario and those to avoid in order to avert an unwanted scenario. In general, backcasting seems useful when complex issues are involved, when there is a need for major changes, when dominant trends are perceived as a part of the problem, or when the policy-maker or stakeholder wants to set a goal for the future.

##### *Example or case studies*

This method was applied in the Asia Pacific Economic Co-operation (APEC) Low-carbon Society Beyond 2050 ([www.apecforesight.org/](http://www.apecforesight.org/)) and for research in Canada on forest management decisions in the face of climate change ([http://andrewpark.org/am\\_webinar\\_backcast-questionnaire/](http://andrewpark.org/am_webinar_backcast-questionnaire/)). Backcasting was also used in the development of Finland's long-term climate and energy policy (see section 2.2).

#### **Participatory prospective analysis**

Level of technicality: medium

##### *Overview*

Participatory prospective analysis (PPA) is a foresight-based scenario approach applied in the agrifood chain, territory and organization. It is a tool for strengthening stakeholder capacity to: develop a common understanding of the current situation and evolution of problems, to be more active in decision-making, and to work towards constructing collective agreements on resource management and planning (Bourgeois and Jésus, 2004; Laumonier, Bourgeois and Pfund, 2008). PPA is designed to explore and anticipate changes using expert meetings to provide rapid results and to offer interaction between stakeholders in expressing, sharing and discussing their visions. The outputs from PPA help decision-makers to understand the key drivers, challenges and future consequences for exploring policy options at local, regional and national levels (Bourgeois and Jésus, 2004).

##### *Methodology, required data and skills*

The PPA tool is a component of the RAINAPOL approach (Jésus and Bourgeois, 2003), which can be considered as an adaptation of the generic method of scenarios (Godet, 1991, 1996) into an eight-step process. Each step is characterized by its purpose and is associated with a specific approach (Table 4).

A facilitator or resource person is required to ensure that stakeholders have a good understanding of the steps involved in PPA and to guide consensus building. Some steps involve qualitative

analysis while others involve quantitative analysis, using a basic software package in Microsoft Excel (Bourgeois and Jésus, 2004).

TABLE 4  
The methodology of PPA

	Stepped objectives	Associated approaches
1	Definition of the system's limits	Preliminary preparation and group discussion
2	Identification of variables	Brainstorming
3	Definition of key variables	Structured group discussion
4	Mutual influence analysis	Structural analysis and work group
5	Interpretation of influence/dependence links	Graph and table support for group discussion
6	Definition of the states of the variables	Morphological analysis and group discussion
7	Building scenarios	Brainstorming
8	Strategic implications and anticipated actions	Structured discussion

Source: Bourgeois and Jésus (2004).

#### *Applicability for participatory planning and policy-making*

A number of PPA scenarios were developed to explore possible futures and the strategies to achieve preferred or desired scenarios. The process is participatory by nature. It seeks consensus and involves a range of stakeholders comprising local government, legislative authorities, farmers, fishers, local business people, customary leaders, development practitioners and youth. This scenario-building approach can be adopted for other issues and wider geographical coverage – from national to global level. Adaptation and developing capacity for the use of foresight methodologies are crucial, so as to enhance the integration of this approach into a decision-making system. Implications of using this tool may include inducing behavioural changes and changes in planning and programme processes.

#### *Example or case studies*

The method has been applied in the CoLUPSIA project (Collaborative Land Use Planning and Sustainable Institutional Arrangements) in Indonesia (Kapuas Hulu and Central Seram districts). The objective of the foresight work was to help land use planners build a common understanding from different perspectives and to provide various options for better future land use planning.

The use of scenarios to explore “The development agenda in Kapuas Hulu by 2030” has awakened the public to the need for action to realize the desired future. The actions include revising land use planning to favour sustainable development, recognizing customary rights over land and mobilizing strong commitment from all stakeholders. Such actions would bridge conflicting interests over natural resource management at the district level (Shantiko, 2012).

In Central Seram district, important outcomes from the PPA work included policy recommendations and the perception that social variables were key drivers of the scenarios and should be considered in future land use planning decisions. PPA may also help to develop better policies and deal with social issues such as land boundaries, ownership, use of and access to forest resources, and access to markets, especially if the tools are integrated into the local decision-making process (Liswanti, 2012).

#### **CRiSTAL tool (Community-based risk screening tool – adaptation and livelihoods)**

Level of technicality: high

#### *Overview*

Climate variability is one of many challenges facing local communities. Climate change may further alter climate variability over time by increasing the frequency and intensity of extreme

weather events, by creating gradual changes in average climate conditions and by generating new climate hazards. While climate variability and change may not always be the most important factor affecting a specific community, it should always be considered when designing and implementing a development project, particularly in communities characterized by climate-sensitive and/or natural resource-dependent livelihoods. CRiSTAL is a project-planning tool that helps users to design activities that support climate adaptation (i.e. adaptation to climate variability and change) at the community level. CRiSTAL helps users to understand:

- How current and potential future climate hazards affect/may affect a project area and local livelihoods
- How men and women respond to the current and potential future impacts of these climate hazards
- Which livelihood resources are most affected by current climate hazards and which are most important for the response strategies
- How project activities affect access to, or availability of, critical livelihood resources
- Which project activities can support climate adaptation and reduce climate risk
- To what extent the project contributes to climate adaptation.

#### *Methodology, required data and skills*

CRiSTAL analysis relies on a combination of primary information gathered through participatory methods (e.g. stakeholder consultations, project team discussions) and secondary information gathered through desk-based research. CRiSTAL provides a framework for organizing in a simple and logical format the information collected both at local level (e.g. community and other local experts) and at national level (e.g. scientific information on climate change projections).

The approach and specific methods selected for engaging local stakeholders are flexible and generally left to the discretion of the user. However, CRiSTAL provides useful tips and references on how to collect information. Specific information on participatory methods used for each analytical step can be found in the CRiSTAL manual, available from the CRiSTAL tool website. For instance, information can be collected through site visits, informal meetings and/or organized workshops through the use of Participatory Rural Appraisal (PRA) tools (e.g. resource mapping, vulnerability matrix).

The tool requires a basic knowledge of climate variability and change, climate adaptation, livelihoods, community dynamics, gender, diversity and Rapid Rural Appraisal/Participatory Rural Appraisal tools.

#### *Applicability for participatory planning and policy-making*

CRiSTAL combines and relies on the knowledge and experience of communities and local experts, and applies participative methodologies to collect relevant information. This approach helps to base the analysis on local realities and empowers communities and local actors to identify climate adaptation interventions in line with local people's needs, priorities and conditions.

#### *Example or case studies*

From 2007 to 2012, various institutions and development professionals used CRiSTAL in over 20 countries in Africa, Asia and Latin America. Robledo *et al.* (2012) describe three case studies: two from Zambia and Mali focus on forest-dependent livelihoods, while the third from the United Republic of Tanzania focuses on livestock and agriculture.

#### *Further information*

Additional information can be found at: [www.iisd.org/cristaltool/](http://www.iisd.org/cristaltool/)



## Multi-criteria analysis (MCA): ToSIA tool for sustainability impact assessment

Level of technicality: high

### *Overview*

Multi-criteria analysis (MCA) tools are mainly applied in natural and forest resource management and are used to evaluate possible scenarios based on stakeholder preferences towards the end of a policy development process. ToSIA is a scenario assessment tool for forest value chains created to analyse sustainability impacts of changes in policy, technology or resource management (Lindner *et al.*, 2010). The tool was designed to be flexible in order to provide a basis for a participatory impact assessment of simple to very complex systems at local, regional or national scale (Lindner *et al.*, 2012).

### *Methodology, required data and skills*

ToSIA is a computer-based decision support tool for sustainability impact assessment of forestry-wood chains (FWC). It comprise four major steps: (i) **processes** are activities within forest value chains by which forest and wood resources are converted into services and products; (ii) **products** are mass-based inputs and outputs of processes and build linkages among processes in the FWC topology; (iii) **material flow** describes the amount of material that passes through the FWC, as well as the dispersing flows by means of input and output product shares at process level; and (iv) **indicators** are calculated in ToSIA by multiplying the input material flow for a process in the chain with the indicator value occurring at a specific process (Lindner *et al.*, 2010). ToSIA also has built-in modules for multi-criteria analysis (Wolfslehner *et al.*, 2012) and cost-benefit analysis.

ToSIA is complex as regards data needs, but also flexible for a wider array of applications due to its generic, modular construction. It requires familiarity with the production chain under investigation.

### *Applicability for participatory planning and policy-making*

Simple resource-use scenario alternatives that are common in the developing world could be developed. This would require investment, but the results could be disseminated as an open source tool for applications, thereby enabling national expert users to familiarize themselves with the method.

### *Example or case studies*

ToSIA was used in North Karelia in eastern Finland to assess the potential impacts of shifting from fossil fuel-based to wood-based energy production (den Herder *et al.*, 2012). The authors investigated local fossil and wood-based energy production chains, focusing on several economic, social and environmental indicators, which were selected by stakeholders involved in regional planning. In a follow-up project, local stakeholders were involved in developing different future scenarios for bioenergy use, nature conservation and combined objectives, to approximate the possibilities of attaining both renewable energy and biodiversity targets at the same time (Haatanen *et al.*, 2014).

The MCA approach was used in Baden-Württemberg in Germany to evaluate sustainability impacts on forest wood chains under different futures related to the IPCC scenarios (Wolfslehner *et al.*, 2012). In this study, MCA was implemented by weighting and aggregating sustainability indicators for different stages of the FWC and the entire FWC.

### *Further information*

Additional information can be found at: [www.northerntosia.org/portal/](http://www.northerntosia.org/portal/)

## **Cognitive mapping**

Level of technicality: medium

### *Overview*

Cognitive mapping uses interactive diagrams to connect problem aspects and drivers by drawing arrows of influence between elements. The technique is used frequently in participatory planning and problem structuring. Cognitive maps provide a holistic picture of an individual's overall perspective without loss of detail. They enable researchers to move beyond assumptions of internal consistency to detailed assessment of specific concepts within the map. The technique enables researchers to clarify and record people's conceptions regarding their environment in graphic form, showing the concepts and their interconnections.

Cognitive mapping can be employed to facilitate a formalized problem-structuring process, where interactions among concepts (i.e. indicators) are constructed and analysed (Eden, 1992). The approach was developed to translate cognitive pictures into a commonly interpretable network structure and to help identify crucial elements within complex networks. Cognitive maps can be analysed through interpretative coding of individual concepts, both in terms of content (the meanings they contain) and complexity of configuration of the maps (e.g. cluster analyses).

A cognitive mapping technique of potential interest for national forest policy or programme development is the “**future wheel**” method. It enables users to think through the impacts of trends, events or challenges; it can help organize thoughts and show complex relationships or just encourage the brainstorming process. The method is quite simple to apply. Participants identify the main drivers, barriers and impacts of a certain future development in order to obtain an overview of the situation. The method takes a relatively short time and encourages discussion among participants.

## **Integrated assessment models**

Level of technicality: very high

### *Overview*

Integrated assessment models integrate knowledge from several disciplines into a single framework. They are used to gain a better understanding of complex environmental problems that require expertise from more than one sector. Integrated modelling is referred to as “assessment” because the activity aims to generate useful information for policy-making, rather than to advance knowledge for its own sake.

### *Applicability for participatory planning and policy-making*

One example of an integrated assessment model is IIASA's GLOBIOM model. GLOBIOM is used to analyse competition for land use between agriculture, forestry and bioenergy – the main land-based production sectors. As such, the model can provide scientists and policy-makers with the means to assess, on a global basis, the rational production of food, forest fibre and bioenergy, all of which contribute to human welfare.

### *Further information*

Additional information can be found at: [www.iiasa.ac.at/web/home/research/modelsData/GLOBIOM/GLOBIOM.en.html](http://www.iiasa.ac.at/web/home/research/modelsData/GLOBIOM/GLOBIOM.en.html)

## **GLOBIOM**

Level of technicality: very high

### *Overview*

GLOBIOM is an economic model that aims to represent the main land use change drivers. It encompasses the major land-based sectors: crops, livestock, forestry and bioenergy. It has global coverage but represents land use at a finer resolution level. The principal advantage of the model is its capacity to represent clearly the causes of deforestation and forest degradation (e.g. food consumption, bioenergy, fuel wood, timber harvests or other factors). At the same time, it can provide projections of the future development of the agricultural and forestry sectors in relation to domestic and world markets. As such, the model can provide scientists and policy-makers with the means to assess the rational production of food, forest fibre and bioenergy, including the environmental impact and human welfare.

### *Methodology, required data and skills*

GLOBIOM is an optimization method that operates with constraints. It is written and solved using GAMS software. It requires some expertise in statistics, economics and ideally computer programming. It also requires data about all sectors covered by the model (i.e. agriculture and forestry), the supply of which is spatially allocated either on the basis of observations (existing maps, census, etc.) or through the use of downscaling techniques. For regional case studies, land use and land use change are usually represented at a 50 × 50 km grid level inside country boundaries. At the pixel level, it is then possible to know how many hectares are dedicated to each activity and how many hectares remain as natural land. In principle, the spatial resolution is quite flexible and depends on the resolution of the available spatial data. The model requires land cover and biomass maps, which function as crucial information layers. Costs and market prices for each product are also important components. Demand for different uses is represented based on population growth, GDP growth and consumption preferences. Finally, existing policies that regulate land use and land conversion have to be implemented. In some cases, statistics are incomplete for a country and assumptions have to be made.

### *Applicability for participatory planning and policy-making*

The design of the land use system, especially the main actors and the factors that influence or constrain their actions, can be undertaken in a participatory way. This can then serve as a basis for adaptation of the model to the local context. Several methodologies can be used for the design of the scenarios. Existing prospective studies, strategic documents from the relevant ministries, and workshops with policy-makers have been used in the past. These can help to validate pre-defined scenarios or to create new scenarios.

### *Example or case studies*

Work on future deforestation in the Congo Basin with the GLOBIOM model began in 2010 (Megevand *et al.*, 2013; Mosnier *et al.*, 2012). The model was refined to take into account regional characteristics, as a result of feedback from two workshops organized in the region – one at the beginning of the project and one at the end. The modelling exercise, undertaken within the framework of the REDD-PAC project, focused on future deforestation trends and ways in which REDD+ policies can influence deforestation levels and the impact on biodiversity. Regional teams of researchers are leading model development with the support and guidance of the IIASA team. Moreover, several workshops have been organized to develop the model on the basis of consensus regarding the land use system in the region, the main factors of change for the next decades and relevant policy scenarios. The last workshop took place in Douala, Cameroon, in October 2013 and was attended by 30 participants representing 10 countries of Central Africa.

### *Further information*

Additional information can be found at: [www.globiom.org](http://www.globiom.org) and [www.redd-pac.org](http://www.redd-pac.org)

## **IDRISI GEOMOD**

Level of technicality: medium–high

### *Overview*

GEOMOD is a module in IDRISI (a GIS software) used to project forest land conversion based on an empirical relationship between past forest loss and driver maps. GEOMOD permits the entry of two land use types: forest and non-forest. Another IDRISI module, Land Change Modeler, allows for multiple land uses and transitions between these uses. GEOMOD is relatively straightforward due to its simplicity, whereas Land Change Modeler has a high level of complexity, which decreases the transparency of its projection process.

The IDRISI GEOMOD module requires familiarity with modelling and ArcGIS.

### *Applicability for participatory planning and policy-making*

GEOMOD allocates future forest loss (or gain) based on an analysis of past forest loss and its relation to driver variables. The quantity of loss is entered manually and can be drawn from any quantitative scenario development exercise, thereby allowing visual depictions of forest area change under different scenarios on a map.

### *Further information*

Additional information can be found at: <http://clarklabs.org/>

## **3.4 OVERVIEW OF THEMATIC AREAS IN WHICH TOOLS HAVE BEEN APPLIED**

Software tools can be applied for various thematic areas relevant for a national forest policy or strategy. The list of thematic topics is adapted from a guide on developing effective forest policy (FAO, 2010a) and a review of REDD+ related tools (ICRAF, 2011) to cover the thematic topics most often included in national forest policy documents or forest strategies. National forest policies can be closely linked to REDD+ related issues, and it is crucial that these activities align with each other. Thematic topics, such as land use and cover, carbon stock and emissions, deforestation, poverty reduction, institutional settings, biodiversity and ecosystem services, are very relevant in both development processes. Table 5 details tools that can be applied for topics relevant to national forest policies in different phases of a policy development process.

In addition, tools can also be distinguished based on whether they are qualitative, quantitative or spatial explicit (Table 6). In a policy process, qualitative, quantitative and spatial tools can be used in concert to complement one another. Each tool can be used to answer different questions and to convey different kinds of information to the participants.

Many software tools can be downloaded free from the internet or are distributed without charge by the developers or developing institutions upon request (Table 7). In many cases, such tools are freely available because their development was financed with public funding. Commercially available tools are often also applied for commercial purposes (i.e. business activities, consultation or market research). A number of factors may decide whether a tool is freely available or has to be purchased, however, and the price of a tool is very often not a decisive indicator of the quality of outputs. Some very good tools are available for free. Moreover, the costs of a tool often represent just a fraction of the costs of the whole participatory process and the majority of financial resources will be allocated to planning, organizing, travelling, bringing participants together, analysing, reporting and evaluating the results.

Tools can have different purposes in a policy development process. In order to make good decisions, policy-makers and stakeholders need reliable up-to-date *information* on which decisions can be

TABLE 5  
Tools can be applied in various thematic areas and in different phases of a scenario development process

Topic	Exploration phase	Scenario development	Scenario assessment
Land use and cover	CALP, Quickscan, Canvas tool, GEOBENE, KLIMOS toolkit	ScenarioBuilder	
	Participatory GIS/social mapping		
			FoPIA, GLOBIOM, IMAGE
	OSIRIS, GEOMOD2, CLUE, IDRISI, InVEST, REDD Abacus, STELLA, PPA		
Carbon stocks and emission assessments	GEOBENE	CO2FIX	
	EX-ACT, G4M, GORCAM, GEMIS, SimaPro, GLOBIOM		
	OSIRIS, REDD Abacus, ARIES, IDRISI, InVEST		
Adaptation to climate change	CRISTAL tool		
Economics of land use	GEOBENE		
	GTAP, GLOBIOM		
	ENCOFOR, InVEST, REDD Abacus, STELLA		
Forestry, deforestation and natural resource management	CALP, CIMAT		AHP application, ToSIA, MCA, MESTA
	MONTE/MONSU, Silva simulator, SIMForTree, NETICA		
	FPS-ATLAS, GLOBIOM, G4M, GORCAM, PICUS, OSMOSE		
	OSIRIS, ToSIA, IDRISI, InVEST, Co-View software, STELLA, PPA		
Water management	Mappable		
	TUGAI, Aquacrop, ARIES, InVEST, WEAP, PPA		
Social guidance and community engagement	Cheering roleplay program, digital storytelling, MAS (Com-Mod), Risk indexing		
	Participatory GIS/social mapping		
			CORMAS
	CRISTAL tool, Co-View software, PPA		
Poverty reduction	Risk indexing		
	CRISTAL tool		
Institutional settings	DANA		
	Political mapping/PolicyMaker software		
Biodiversity and ecosystem services	KLIMOS toolkit		
	IBAT, ARIES, IDRISI, InVEST, STELLA		
General facilitation	Internet chat room, Question Pro, Survey Monkey, CATWOE, Risk indexing, CATpac, Mind Manager, Mind Mapping software		Rich decisions
	e-Delphi, Cognitive mapping (Journey making and SODA), DECISION EXPLORER		
	Web 2.0		

Source: Some tools can be applied in more than one thematic area. More detailed information on each tool, their full names and links to the original sources can be found in Annex 6.

based. Tools that can help present information are therefore very useful in policy development. Furthermore, a forest policy document is based on a common understanding of how society perceives the role of forests in providing goods and services to people in the near future (5–10 years) (FAO, 2010a). Therefore, tools that can be used to engage different groups of stakeholders are highly useful. In order to create joint ownership and acceptance of the policy process it is important to engage a broad group of *stakeholders*, who very often hold different opinions. Tools can also be used as way to facilitate the discussion rather than making precise predictions. Another important characteristic is the thematic focus of the tool. In the past, national forest programmes had a strong focus on forest

TABLE 6  
The nature of tools

Qualitative	Quantitative	Spatial explicit
A tool that aims to provide an in-depth understanding of human behaviour and the reasons that govern such behaviour. Qualitative tools investigate the "why" and "how" of decision-making, not just the "what", "where" and "when".	A tool that aims to provide an understanding of "what" and "how much".	A tool that demonstrates the importance of "where" in addition to "what" and "how much".
Canvas tool, Cheering roleplay program, digital story-telling, e-Delphi, Question Pro, Survey Monkey, CATWOE, CRiSTAL, Political mapping/ PolicyMaker software, Rich decisions, Risk indexing, CATPAC, DANA, PPA	AHP, FoPIA, MESTA, ToSIA, Aquacrop, CO2FIX, EX-ACT, GTAP, GORCAM, MONTE/MONSU, GEMIS, SimaPro, PICUS, Silva simulator, SIMFortree, InVEST, STELLA	CALP
GEOMOD2, Mappable, OSIRIS, Participatory GIS, Quickscan, ScenarioBuilder, TUGAI, CLUE, G4M, ARIES, IDRISI, OSMOSE, REDD Abacus, WEAP, GLOBIOM		

TABLE 7  
Some examples of freeware and commercially available tools

Freeware	Commercially available
OSIRIS, FoPIA, MESTA, GTAP, GEMIS, ToSIA, Aquacrop, CLUE, CO2FIX, SIMForTree, CRiSTAL, ENCOFOR, InVEST, PolicyMaker, REDD Abacus SP, Rich Decisions, WEAP (only in developing countries), Survey Monkey (basic), KLIMOS, DANA, CIMAT, Co-View	Mappable, SimaPro, MONTE, IBAT, e-Delphi, ArcGIS, IDRISI, CATPAC II, Excel, Survey Monkey (Plus, Gold and Platinum), Question Pro, Decision Explorer, Mind Manager, Mind-mapping tool, STELLA

resources and wood production. Currently, the number of forest policy documents focusing solely on wood production is decreasing, with most taking broader developments into account, such as land use other than forestry, energy, biodiversity conservation and ecosystem services, institutes, poverty reduction, tourism or water management. In this context, tools that can link forest issues with *broader societal issues* are very useful for policy development. Furthermore, a forest policy not only examines the present state of the forest, but also often looks ahead to the near future. In many cases, a forest policy contains a common vision for the future development of the forest sector. Therefore, tools are needed that focus on *future developments (visions, scenarios)*. Table 8 provides an overview of the general purposes of a number of tools and their possible application in forest policy development.

TABLE 8  
Possible application of some tools for different purposes relevant for national forest policy development

Presenting information	Stakeholder interaction	Linking forest issues to broader societal/ environmental aspects (cross-cutting issues)	Looking into the future (scenarios, visions)
CALP, GEOMOD2, KLIMOS, IBAT	Mappable, MONSU/MONTE, digital story-telling, MAS (Com-Mod), CATWOE, Political mapping/Policy-maker, Risk indexing, WEAP, Mind manager, Mind Mapping		GEOMOD2, Mappable, Aquacrop, CO2FIX, EX-ACT, MONSU/MONTE, PICUS, Silva simulator, SIMForTree, WEAP
	Cheering roleplay, Question Pro, Survey Monkey		
		GTAP, GLOBIOM, G4M, GORCAM, GEMIS, SimaPro, Rich decisions	
	e-Delphi, AHP, FoPIA, MESTA, Canvas tool, CORMAS, OSMOSE, Co-View		
OSIRIS, Participatory GIS/Social mapping, Quickscan, ScenarioBuilder, TUGAI, ToSIA, CLUE, ARIES, CRiSTAL, ENCOFOR, IDRISI, InVEST, REDD Abacus, STELLA, PPA			

Tools that can be applied for multiple purposes (e.g. presenting information, stakeholder interaction, linking forest issues to broader aspects, looking into the future) are likely good candidates for use in a forest policy development process (Table 8). On the other hand, these tools are generally more complicated and require relatively more preparation time on the part of experts, researchers



or organizers before they can be applied. Tools that can be used for a more specific purpose (e.g. only “stakeholder interaction”) may be easier to apply and require considerably less preparation time. It is unlikely that such tools will be suitable for the entire policy development process, and they will have to be used in combination with other tools. However, a limited range of application purposes should not be an obstacle to use of a tool, as even smaller tools can have very useful applications. Moreover, even the best multi-purpose tools cannot meet the requirements of the whole policy development process. For any process, a combination of the most suitable tools and methods has to be found, which will require considerable time on the part of the researchers, planners and coordinators.



© FAO/Sean Gallagher

*Members of the Khargistai-Bayanburd Forest User Group transporting felled trees down a hill with a small tractor in Mongolia*

## 4. DISCUSSION

### 4.1 THE USE OF SOFTWARE TOOLS IN PARTICIPATORY POLICY DEVELOPMENT AND RESOURCE USE PLANNING

The development of governance frameworks, such as national forest programmes, can greatly benefit from the application of futures approaches and participatory tools throughout the different phases of the process. National forest programmes should be regularly updated and based around stakeholder involvement, which is crucial to these processes. This can be achieved through a number of different approaches. In practice, however, a combination of methods and/or tools will be necessary to support the process, as no single available tool meets all requirements. While some facilitators of participatory policy development processes prefer to work mainly with interactive methods, others increasingly make use of software tools that provide a consistent framework and offer a connection between the collection and presentation of information and the preferences and choices of stakeholders.

Stakeholder engagement is crucial to the whole process of developing and updating forest governance frameworks. In the early stages of the planning process, stakeholders can be involved in the selection of methods and tools. Stakeholder engagement is also important in the selection of scenarios and for the choice of target variables and indicators for analysis. Acceptance of results will improve if stakeholders are involved in actual data collection, providing assumptions and other details. Local knowledge is also often useful in order to adjust assumptions (e.g. model parameters). Depending on the case, the selection of methods and tools will need to consider the available resources, existing expertise and know-how, data availability and many other aspects. Many of the methods and tools reviewed in this study were originally developed in a different context for specific purposes. It is therefore understandable that many of them require some adaptation to fit the needs of developing forest governance frameworks in developing world countries.

Tools and models can be very complex and their workings can remain opaque for many stakeholders. This poses the risk that the participatory process may be perceived as lacking in transparency. This could lead to failure of the process or what has been observed as a tendency to accept rather than interpret modelling output (Bunnell and Boyland, 2003). Participatory approaches should be responsive to both shortcomings. In reality, there is a strong tendency to overemphasize authoritative forms of scientific knowledge, such as numeric output generated by computer models. This emphasis often occurs at the cost of more tacit and informal forms of knowledge. A mutual learning process is thus proposed to overcome barriers between modellers and stakeholders during the planning process (Siebenhüner and Barth, 2005). In turn, well-designed software tools should make assumptions transparent and can facilitate the discussion process with different stakeholder groups (see Tuomasjukka, Lindner and Edwards, 2013). For example, a group mode application of the ToSIA MCA module (Wolfslehner *et al.*, 2012) provides participant information about personal indicator preferences and compares these with the preference ranges of other stakeholders participating in the same workshop. In order to increase transparency, it is important to build trust, confidence and integrity of any planning exercise by enabling direct and active participation from stakeholders. It is also important to create links between the technical expertise of scientists and the folk knowledge of stakeholders by compromising the degree of precision and scientific accuracy, typically used in scientific methods, with an open-ended structure throughout the entire planning process (Mendoza and Prabhu, 2006).



This report covers about 80 tools. Although this constitutes a good sample, there are more tools available. However, for this report only tools that are clearly “participatory” or have been used in a participatory way are included. Software tools should ideally be easily accessible, in other words, potential users should be able to buy or download them for free. Unfortunately, time constraints prevented the testing of all tools for accessibility. Nevertheless, some tools were retained because of their strong potential for further development in line with the study objectives.

There are countless other tools available that do not serve directly as participatory tools, but which could easily be used in a participatory process with stakeholders. Many models for land use (change), forest dynamics or crop production can be applied in scenarios analysis together with stakeholder interaction. However, in most cases expert users would be needed to run such models and the scenario results alone would not qualify as participatory foresight analysis. The example of STELLA demonstrates that modelling tools can be adapted and developed into participatory tools. STELLA started as a pure modelling tool at the end of the 1980s, was then applied to teach the basics of modelling, and was recently developed further as a participatory tool. Other purely quantitative, non-participatory tools include GEOMOD and GLOBIOM. These can produce scenario projections for different land uses that, in turn, can provide valuable information as an input to a participatory process. Possibly many more modelling tools have the potential to be used in a more participatory way.

#### 4.2 PROVIDING RECOMMENDATIONS FOR THE SELECTION OF TOOLS

The tools discussed here are expected to be instrumental in diffusing potential conflicts between individual objectives, land users, land use forms and other societal interests. In general, methods to synthesize aspects related to ecosystems and society are needed to strengthen policy development at the interface between these. For instance, multi-criteria methods are increasingly used to amalgamate information, preferences, expert judgements and value expressions, in support of the participatory and communicative dimensions of modern, sustainable management (Wolfslehner and Seidl, 2010). From the overview of tools it becomes clear that participatory software tools may present a number of advantages, among them increased transparency and a clear framework for gathering stakeholder preferences. However, workshops should not be overly technical as the proceedings may become overwhelming for the participants and technical solutions may be prone to technical failure. Moreover, use of modern software tools should not come at the expense of older, traditional and more established participatory methods. In fact, modern software tools can be most useful when used in combination with more established participatory methods.

It is important to select the best methods and tools (or the most appropriate combination), so as to identify real problems, gather information, foster higher commitment, support the negotiation process, and reduce conflict in forest planning and policy development. In a developing country context, the power balance among stakeholders and government administrators is a key factor, and one that should not be overlooked when planning a participatory exercise. In order to select the appropriate methods and tools for a specific case, it is important to start by acquiring an understanding of the social-cultural context and the main problems to address in local contexts. Based on this, a suitable means of participation can be identified.

When planning a participatory exercise, it is useful to maintain a balance between “models as stories” and technical modelling (Sandker *et al.*, 2010a). Good facilitation also plays an important role in transmitting the message to participants. Without good facilitation, complex models are often seen as high-tech simulation tools and lose their value as a means to stimulate participation. If too many landscape elements are included, the models become highly complex and are no longer understood by all participants, thereby becoming a major obstacle to the participatory process (Sandker *et al.*, 2010a).

It is important to note that the tools are not the aim of the exercise; they are just a means to achieving an end. The aim of many forest policy or national forest programme development processes is a good policy or programme. The tools should be selected bearing in mind their ability to assist policy-makers and organizers in reaching this aim. Futures thinking is not just about selecting the right tools, it is about developing a different mindset. It is also about changing the way one thinks about the world and what one can do about it, in particular the difference between being passive, reactive, pre-active and pro-active.

#### 4.3 RECOMMENDATIONS FOR FURTHER TOOL DEVELOPMENT

Most of the tools described in this report were originally developed for different regions or different objectives. For some tools it would be technically simple to adopt the structure so that typical land resource management questions specifically for developing world situations are well covered.

Several of the shortlisted tools have already been applied in developing world countries. However, in most cases the applications were used to target different questions. For example, participatory GIS tools would require datasets, such as satellite-derived land use maps from 1990 to the present, commonly used for national resource use planning. The Quickscan tool would be very suitable for policy application in developing countries, as it can perform multiple iterations during the timeframe of a two-day workshop. Another advantage is that it can be used as an exploratory tool early in the policy development process, prior to policy formulation. In contrast, many assessment tools are used to evaluate policies at the end of a policy process once decisions have been taken. To make the tool suitable for use in developing countries, suitable spatial databases covering land use and environmental data should first be identified. Identification of available databases (e.g. IBAT, KLIMOS, FAOSTAT, IUCN) is important when planning a participatory exercise, as these contain useful links to environmental and land use-related information relevant for policy-making.

Multi-criteria tools can also be adapted for policy development in FAO member countries. For example, some multi-criteria tools could be used to visualize the impacts of policy or technological changes in forest wood chains. This would require research into the topology of local/regional forest wood chains and pilot studies, in which stakeholders can provide input concerning the selection of data sources, the development of scenarios, the weighing of indicators and scenario assessment.

Many of the listed tools can be adapted. However, the main challenge may lie not in adapting tools, but in keeping models simple. Scientists often feel uncomfortable with simple models on the basis that they do not capture the complexity of socio-ecological systems. However, a common critique made by stakeholders is that models are so complex that they can never reflect the present reality, which in turn increases their scepticism of complicated participatory modelling processes (Sandker *et al.*, 2010a). Political decision-makers value the capacity of models to present information, rather than their ability to make accurate predictions. Sandker *et al.* (2010a) noted that these outputs should be regarded as stories rather than as an end in themselves. However, with skilled facilitation they can become a powerful tool to help stakeholders better understand the complexities of landscape dynamics and to support better-informed decision-making and natural resource management.

#### 4.4 THE WAY FORWARD

This report was developed as a background document for the workshop “Considering future trends and scenarios in forest policy-making – approaches and tools”, held on 26-27 November 2013 at FAO headquarters in Rome. During this workshop, foresight and scenario experts and country officials discussed a broad range of tools and approaches for application to assist policy-making. Policy-makers also presented national policy contexts for which foresight tools might be used.

The participants discussed the main ways in which these approaches might be usefully developed to increase their practical application. The country officials attending the meeting also noted that participatory and foresight approaches are increasingly applied in the forest-based sector, and underlined the need to further develop these approaches and involve stakeholders, as well as other related sectors. The overall conclusion was that policy-making in all countries would require a more structured use of future-oriented approaches and that a combination of both qualitative and quantitative approaches would be most suitable. It was noted that, while lack of reliable data is an issue for some tools, in practice, strategic planning and decisions are also being made in the absence of quality data. Qualitative future thinking approaches can be used to generate best estimates and to provide guidance on appropriate data collection to inform policy-making. Better use of participatory and futures thinking would lead to more robust policies, supported by people from all levels of society, and would increase the capacity to anticipate future changes. The participants underlined the importance of further work on this topic, particularly the need to raise awareness of forest-related issues and to share practical experiences among researchers, practitioners and policy-makers. FAO is well placed in this regard to facilitate and support the use of participatory and foresight approaches to support national forest policy or programme development.



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*Traditional silvopastoral systems have been restored in the Spreewald biosphere reserve in Germany*

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## ANNEX 1. BRIEF EXPLANATION OF BROADER CATEGORIES OF DECISION SUPPORT TOOLS

**Agent-based modelling**, also referred to as **multi-agent simulations**, usually comprises spatial models. The models run simulations in which autonomous agents act and interact, determining the behaviour of the whole system. Their actions may change as a result of events and interactions and simple rules may result in complex dynamics. Examples of participatory agent-based modelling include Becu *et al.* (2008) and Bousquet and Le Page (2004).

A **Bayesian or belief network** is a probabilistic static representation of conditional interdependencies between input variable states and the states of variables of interest. It is an accumulation of logical, intuitively easy conditional relations and can answer questions such as, “what is the probability of Y happening given X has happened?”. Mendoza and Prabhu (2006) evaluate their use in participatory modelling.

A **cognitive map (mental map)** is a type of mental representation which allows an individual to acquire, store and recall information about the phenomena in their everyday or spatial environment. Cognitive maps allow the “mind’s eye” to visualize images in order to reduce cognitive load, enhance, recall and learning of information. Cognitive mapping tools require high levels of stakeholder interaction and build on local and expert knowledge. They are especially used during the exploration phase for problem identification and problem structuring.

**Databases** are used to store and retrieve up-to-date and reliable information. They are crucial to the exploration phase of a policy process for presenting knowledge and facts to stakeholders.

**Decision support systems** are software-based systems intended to help decision-makers compile useful information from a combination of raw data, documents and personal knowledge to identify and solve problems and make decisions.

**Fuzzy cognitive mapping** is a way to represent complex decision problems composed of interrelated dynamic entities within which the relationships between these entities can be used to approximate the strength of impact of these entities. The complex entities are represented as nodes and the causal links are represented by arrows with the direction of the arrow representing the direction of influence. Mendoza and Prabhu (2006) provide an example of its use in forest management.

**Geographic Information System (GIS)** is any system that presents data that are linked to location. Examples of participatory modelling or participatory mapping using GIS as a platform include Brown and Reed (2009) and Castella *et al.* (2005). The most frequently used platform in participatory modelling is system dynamics modelling.

**Interactive tools** are very diverse and require a high level of stakeholder input. They are used mainly to explore related issues, but can also be used in scenario construction; for example, to identify important key factors and information that may prove essential when building scenarios.

**Life cycle analysis (LCA) tools** consider the whole life cycle of products and are used to evaluate indicators such as emissions, production cost and employment throughout manufacturing and production processes. In LCA studies of products with a major part of their life cycle in the agriculture and forestry sector, land use impacts, carbon stocks and emissions are of particular relevance.

**Modelling and simulation tools** can be used to construct and compare scenarios. They are not designed explicitly for stakeholder interaction; however, the results they produce can be used as inputs for other decision support systems. Most growth simulators are designed to model tree growth for European species, but some can be adapted for other species and regions.

**Participatory GIS (PGIS) and visualization tools** are especially useful in the exploration phase of a policy development process and are particularly suitable for stakeholder interaction because of their graphical visualization functionality. Some PGIS tools are also suitable for building and evaluating scenarios and can handle a broad variety of topics (e.g. natural resource and water management, recreation, conservation, land use, deforestation). Additionally, monitoring procedures often make use of remote sensing and GIS. PGIS has the ability to monitor terrestrial ecosystems at various temporal and spatial scales and has been widely tested for land cover mapping and forestry applications.

## **ANNEX 2. METHODOLOGY TOOL REVIEW**

### **SCOPE OF THE REVIEW**

This study is based on a review of scientific literature, national forest policy documents, and outlook and scenario studies that have used participatory methods. In addition, Google and other internet sources were scanned for approaches and tools that have not been described and published in the scientific literature or official government or governmental organization webpages.

There exist a huge number of participatory methods and tools. For the purpose of this review, the particular limitations imposed by developing country contexts dictated to a large extent the selection of tools and methods. Therefore, the review excludes very complex tools that require highly detailed forest inventory or experimental data, which are often not available. The text covers only those methods and tools without excessive data needs or those that can even be used with incomplete or missing data. This selection is by no means definitive, as many more methods and tools are available, and software tools in particular are expected to develop rapidly. It is important to regularly update the overview of software tools which are applicable for participatory scenario development.

A keyword search was performed to screen scientific literature and internet sources for participatory software tools. A “title, key word, abstract” search was performed in Scopus ([www.scopus.com](http://www.scopus.com)) and *Science Direct* ([www.sciencedirect.com](http://www.sciencedirect.com)) with different combinations of the words “forest planning tool”, “stakeholder interaction”, “software tools”, “participatory forest planning”, “participatory modelling”, “forest policy” and “national forest policy”. The search returned a sizeable list of papers potentially including the tools searched for. Hereafter, the papers were examined to see if the mentioned tools could indeed be classified as “software tools” and if the tools were “participatory”. This type of screening excluded all tools that were not software tools, but resembled instead general approaches or methods. Furthermore, tools were excluded where no form of stakeholder consultation had taken place. To find additional tools not published in the scientific literature, a similar keyword search was performed using Google. Finally, the websites of FAO, CIFOR, OXFAM and the World Bank were examined for references to participatory software tools.

### **SCREENING OF THE TOOLS**

The literature and internet search resulted in a list of 80 tools (see Annex 6) which could potentially be useful in participatory planning or policy development. The selected software tools were described in further detail based on the available information provided in the scientific literature and on the internet. The tools were tested for their applicability with particular regard to developing countries, using a number of criteria. These criteria refer to supporting requirements, expected outcomes, experiences learned from practical examples, and the ability to deal with wider land use change issues. The criteria for the comparative assessment are explained in more detail in Table A-1.



TABLE A-1  
**Criteria and descriptions for evaluating software tools and models**

Criteria	Description
Encourages participation/negotiation or stimulates discussion	The method/tool can be used to encourage people to participate and to support the negotiation process (identify needs, preference, compromise solution in the planning process). The method/tool can help to create an atmosphere that stimulates discussion.
Number of stakeholders involved	The method/tool has the potential to engage a certain number of stakeholders in working on the subject.
Complexity of the tool	The method/tool is simple or complex (e.g. level of expertise needed to apply the technique, number of stakeholders, trade-offs, cause-and-effect relationship) for the analysis/development/assessment of decision problems. This depends both on the functional properties of the tool itself and the data needed to run the application.
Expert knowledge needed	The method/tool requires expert knowledge.
Data requirements	What kind of input data are needed to make the tool work? Input data can be empirical (data from scientific experiments), statistical data, forest inventory data, detailed stand data, audio or visual data or text. This is an important criterion since some types of data may not be readily available, such as empirical data and detailed stand data.
Allows the inclusion of quantitative information	The method/tool allows the consideration of quantitative information (e.g. model output, measured data) involved in analysing/modelling/solving a decision problem.
Allows the inclusion of qualitative information	The method/tool allows the consideration of qualitative information (e.g. assumptions, preferences, beliefs) involved in analysing/modelling/solving a decision problem.
Requires IT/internet environment support	The method/tool requires a well-developed IT/web or a network. Tools that can be run from a laptop are more suitable in remote areas or areas with a relatively low level of IT infrastructure.
Technical feasibility in developing countries	This depends on the complexity of the tool, the data needs and the IT infrastructure. Generally, very complex tools that require a lot of detailed data and a highly developed IT infrastructure are not suitable for developing countries. However, this may depend on the location; for example, conference and meeting centres with the latest state-of-the art IT can be found anywhere around the world.
Preparation time for facilitator/participants	This refers to the time needed to apply the method/tool from the stakeholder participant's perspective and to prepare the material from the facilitator's perspective.
Financial input	This depends on the amount of time needed to apply the method (stakeholder and facilitator), but also on the type of data needed and the time needed for researchers/experts to analyse the data.
Proven use in policy development	Many tools have been applied from a scientific perspective, but only a few have been applied in regional, local or national policy development.

**ANNEX 3. COMPARISON OF SOME SOFTWARE TOOLS AND MODELS ACCORDING TO THE EVALUATION CRITERIA USED FOR TESTING THEIR SUITABILITY IN PARTICIPATORY POLICY DEVELOPMENT PROCESSES**

TABLE A-2  
Comparison of some software tools and models according to the evaluation criteria used for testing their suitability in participatory policy development processes

Name of the tool	Selection criteria											
	Encourages participation/discussion	Number of stakeholders involved	Complexity of the tool	Expert knowledge needed/additional technical information	Data requirements	Allows the inclusion of quantitative information	Allows the inclusion of qualitative information	Requires IT/internet support	Technical feasibility in developing countries	Preparation time for facilitator/participants	Time/financial input	Proven use in policy development
<b>Participatory GIS/social mapping</b>	Yes	Small groups	Complex	Runs under ArcGIS and ArcPad or certain free applications from the Geospatial Web	Traditional paper maps, maps drawn on the ground and GIS data	Yes	Yes	Not in the field, but will in the office	Yes	Several weeks to months	High	Local/regional planning
<b>Quickscan</b>	Yes	The usual size of a workshop	Complex	Experts needed, runs under ArcGIS	Existing GIS databases	Yes	Yes	Yes, when running group mode	Yes	Several weeks to months	High	On EU green infrastructure
<b>FoPIA (Framework for participatory impact assessment)</b>	Yes	Usual size of a workshop	Complex	Knowledge of DPSIR model, Concept of multifunctionality (Land use functions-LUFS) and assessment indicators needed	Local stakeholder knowledge, scientific and statistical knowledge, and policy instruments	Yes	Yes	No	Yes	Several weeks to months	High	EU case studies: Austria, Estonia, Germany, Malta, Slovakia and Switzerland. Non-EU case studies: China, Kenya, India, Indonesia and Tunisia
<b>PPA (Participatory perspective analysis)</b>	Yes	Small group (15-20 people)	Simple	Good facilitator trained in using and implementing the approach (one week should be sufficient)	Local stakeholder knowledge, statistical data and policy instruments	Yes	Yes	Not during implementation of group scenario building: access to internet will provide better inputs in each phase	Yes	Several weeks to months	Reasonable	EU case studies in Indonesia (Tanimbar, Central Maluku, Kapuas Hulu Regency). Case studies in Asean and Mayotte
<b>ToSIA – MCA module</b>	Yes	The usual size of a workshop	Complex	Knowledge of the production chain needed	Data on forest wood chains, statistics, empirical data	Yes	No	Yes, to connect to the database and when used in the group mode	Yes	Several weeks to months	High	Regional bioenergy case in North Karelia, Finland, and Baden-Württemberg, Germany

TABLE A-2 (cont.)  
**Comparison of some software tools and models according to the evaluation criteria used for testing their suitability in participatory policy development processes**

Name of the tool	Selection criteria										
	Encourages participation/discussion	Number of stakeholders involved	Complexity of the tool	Expert knowledge needed/additional technical information	Data requirements	Allows the inclusion of quantitative information	Requires IT/ internet support	Technical feasibility in developing countries	Preparation time for facilitator/participants	Time/ financial input	Proven use in policy development
<b>Canvas tool</b>	Yes	Usual size of a workshop	Simple	Good facilitator	Visual data and graphs, photographs, existing statistical data	Yes	Yes, when running group mode	Yes	Several days to weeks	Reasonable	Not yet
<b>CORMAS Multi-agent simulation model</b>	Yes	Small groups		Knowledge of local stakeholders		Yes		Yes			Local case study in Malinau District, East Kalimantan, Indonesia
<b>e-Delphi method</b>	Yes	100+	Simple	Experience needed in planning surveys and knowledge of the topic of investigation	No data needed, but can be used depending on the exercise	Yes	Internet-based tool	Not in areas without internet access	Several hours to days	Reasonable	Widely used in forecasting, strategic planning and identifying research priorities
<b>MAS (Com-Mod)</b>	Yes	Small groups		Researchers and facilitators should be rather multi-faceted		Yes		Yes			Local forest management case in the Philippines
<b>CRISTAL</b>	Yes	Multiple consultations for different social groups. About 10 participants per group	Complex	Users must be familiar with local climate and livelihood conditions. CRISTAL runs on Microsoft Excel, available online and in CD-Rom format	Local people's knowledge and scientific knowledge	Yes	Laptop, paper, flipchart	Yes	Several weeks to months	High	Yes, case studies in Mali, the United Republic of Tanzania and Zambia
<b>IDRISI Land Change Modeler</b>	Yes		Complex	ArcGIS-oriented software extension	Maps on historic land cover and land use transitions, species distribution, habitat suitability	Yes	Laptop	Yes	Several weeks to months	High	

TABLE A-2 (cont.)  
**Comparison of some software tools and models according to the evaluation criteria used for testing their suitability in participatory policy development processes**

Name of the tool	Selection criteria											
	Encourages participation/discussion	Number of stakeholders involved	Complexity of the tool	Expert knowledge needed/additional technical information	Data requirements	Allows the inclusion of quantitative information	Allows the inclusion of qualitative information	Requires IT/ internet support	Technical feasibility in developing countries	Preparation time for facilitator/participants	Time/ financial input	Proven use in policy development
<b>GLOBIOM</b>	Yes	Several workshops with around 30 participants each with discussion organized both in plenary and small groups	Complex	Validation of data and model assumptions, identification of model improvement requirements and potential source of additional data	Land cover and land use maps, carbon map, infrastructure map, population density, agricultural and forestry statistics, consumption levels, trade, land use policies, costs and prices	Yes	Yes	Yes	Yes, but often requires training sessions	Two months	High	GLOBIOM is used to compute the official reference level of GHG emissions from LULUCF for the European Commission
<b>OSMOSE (On-site, multi-criteria, optimization, spatial, evaluation)</b>	Yes				Data on performance measures of initial and target land use types per land unit	Yes	Yes	Yes	Yes	Several weeks to months		Yes
<b>Cognitive mapping (Journey making and SODA)</b>	Yes	Small groups	Complex	Compatible with decision explorer software	No data needed	No	Yes	No	Yes	Several weeks to months		In forest planning and regional strategic planning
<b>Co-View software</b>	Yes					No	Yes	Yes, when using the "Power to Change" game	Yes			In a local case study in Mafungautsi Forest, Zimbabwe
<b>STELLA</b>	Yes	Small groups or workshops in several sessions	Complex	Users need to be familiar with the area and system under investigation	Statistical data (biophysical and economic data, e.g. land use, human populations, employment, forest and plantation economics, district income)	Yes	No	Laptop	Yes	Several weeks to months	High	At the district level in Ethiopia and Indonesia

## ANNEX 4. DESCRIPTION OF SOME SELECTED SOFTWARE TOOLS

### e-Delphi method

Level of technicality: medium

#### *Overview*

This internet-based tool was developed for Delphi studies by a Finnish group of futures researchers ([www.edelphi.fi](http://www.edelphi.fi)). The Delphi technique is used for qualitative research and to bring anonymous expert viewpoints, values, perceptions and ideas into dialogue with one other. The Delphi expert method is a systematic, interactive forecasting method that relies on a panel of independent experts. It is useful for questions where no correct answers exist or where there is no consensus on the matter under investigation. Successive rounds of questions with structured facilitation can be used to lead a group towards one answer above others. In addition, the method can also be used for survey-style queries.

#### *Methodology, required data and skills*

The tool works in a similar manner to other survey tools with the exception that participants can see the responses of the other participants and modify their own responses accordingly within a certain timeframe. This can result in opinions converging in a certain direction and may help in building consensus. The e-Delphi tool allows online registration, grouping of participants into several parallel panels, successive rounds and anonymity, as well as real-time review of responses for the duration of the survey.

Users of the tool should have experience in creating surveys and an understanding of the topic under investigation.

#### *Applicability for participatory planning/scenario/policy development*

The Delphi method is widely applied in strategic planning, to develop research agendas and in forecasting for a wide variety of topics. It is mostly used as an exploratory tool, but can also be applied to gather qualitative information for use in scenario building and qualitative scenario assessment.

There are a few variations on the Delphi method. Traditionally, the Delphi method has aimed at a consensus of the most probable future by iteration. *Policy Delphi* is a decision support method aimed at structuring and discussing diverse views of a preferred future. *Argument Delphi* concentrates on ongoing discussion and finding relevant arguments rather than focusing on output. *Disaggregative Policy Delphi* (Tapio, 2002) uses cluster analysis as a systematic tool to construct various future scenarios in the latest Delphi round. Disaggregative Policy Delphi (DPD) classifies quantitative expert or interest group responses into similar groups, through the use of cluster analysis. These clusters form the core of different scenarios taken directly from the responses. In this way, the DPD procedure can be used to produce relevant scenarios directly from data produced by experts or interest groups ([www.edelphi.fi/en/](http://www.edelphi.fi/en/)).

#### *Example or case studies*

The e-Delphi tool was used in a foresight exercise on the future demand of forest-based products and services (Pelli and den Herder, 2013). The tool was used in two separate rounds. In the first, it was used to explore important global trends, drivers, change factors and emerging issues that could influence the future demands of forest-based products and services. In the second, the tool was used to evaluate three alternative future images for the forest-based sector in Europe.



**Further information**

**Tapio, P.** 2002. Disaggregative Policy Delphi: Using cluster analysis as a tool for systematic scenario formation, *Technological Forecasting and Social Change*, 70(1): 83-101.

**Pelli, P. & den Herder, M.** 2013. Annex 7: Back-to-back workshop on “Foresight for the forest strategies”, 12 September 2011 – Sekocin Stary, Poland. In: *Foresight on future demand for forest-based products and services*. EFI Technical Report 87 (available at [www.efi.int/files/attachments/publications/annex\\_7\\_foresight\\_f\\_forest\\_str\\_120911\\_pl.pdf](http://www.efi.int/files/attachments/publications/annex_7_foresight_f_forest_str_120911_pl.pdf)).

**Canvas tools**

Level of technicality: medium

**Overview**

The VOLANTE project (Visions of Land Use Transitions in Europe) ([www.volante-project.eu/](http://www.volante-project.eu/)) has developed a “canvas tool” software. This was used in workshops where stakeholders participated in discussions to create visions of land use in Europe in 2040. The usual outputs of such workshops take the form of text and narrative, and are generally the result of consensus and a group dynamic, which can lead to loss of valuable individual inputs. The purpose of the canvas tool is to elicit a rich vision. Rich visions are defined as multifaceted expressions of ideas about the future and include images, graphs indicating trends, explanations of relationships between elements, statements and narrative descriptions.

The canvas tool resembles a mind-mapping software and functions as an interactive visualization tool designed to stimulate the creativity of stakeholders and “out-of-the-box” thinking. A guided stepwise set of questions encourage participants to use images, graphs and texts to express their individual visions (“canvases”) for living, working, food shopping and so on in 2040 (Figure A-1), as well as their visions for the future of their work sector (“sectoral canvases”). Sectoral visions are related to different categories of land use, which in the case of VOLANTE comprise nature, primary production, housing, infrastructure, energy and water or manufacturing. In the VOLANTE project, the “sectoral canvases” were structured to deliver semi-quantitative information to an integrated land use modelling framework. The software has the option to save files of these “collages” and visions from participants and the meanings ascribed to them. In addition, crowdsourcing using the same software has been used to engage a much wider range and number of people. The results of the VOLANTE project will help to ascertain the forms of land use policies and management strategies needed in public and private sectors to balance new sustainability demands and global pressures at all geographical levels.

**Methodology, required data and skills**

Similarities exist between the canvas tool and mind mapping or cognitive mapping methods, used to structure problems and connect related problem aspects in a causal manner. Participants can create their own personal or sectoral canvas by dragging pictures, graphs and figures onto the canvas, indicating relations between different factors and giving weight to their importance, and adding explanatory text. The organizers can lend structure or focus to a specific topic by adding predefined questions to the canvas.

**Applicability for participatory planning/scenario/policy development**

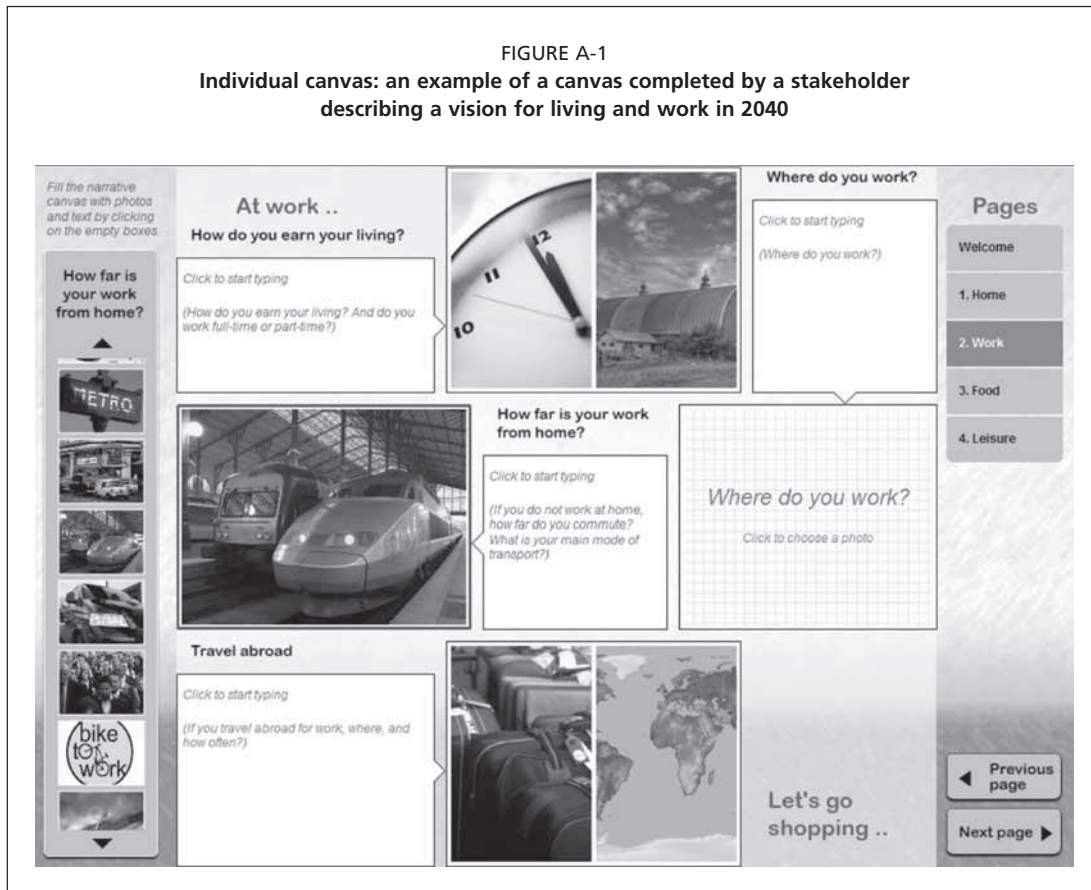
The canvas tool provides an alternative information-gathering approach to traditional methods, and it is particularly relevant in cases where language may constitute a barrier to communicating complex information, as is the case in many workshops. Moreover, the canvas tool could be developed to provide a framework for scenario or vision development in the developing world context. The tool would allow flexible adaptation to local needs and, once adapted, could be used without expert guidance.

### Example or case studies

The canvas tool has been applied in vision-building workshops on future land use in Europe. Four different workshops took place focusing on nature conservation and recreation, natural resources (agriculture and forestry), energy and water.

### Further information

Additional information can be found at: [www.volante-project.eu/news/97-eea-is-interested-in-the-volante-canvas-tool-and-crowdsourcing.html](http://www.volante-project.eu/news/97-eea-is-interested-in-the-volante-canvas-tool-and-crowdsourcing.html)



### Journey Making

Journey Making (JM) is used to facilitate and structure understanding and accommodation in the course of developing organizational strategic options (Eden and Ackermann, 1998). JM is underpinned by the assumption that all organizations have a degree of strategic direction, whether coordinated or uncoordinated, conscious or unconscious. It functions as a methodology for thinking about current strategic development in an organization, including options for different strategic directions, and how those directions could be realized. It deals particularly well with the complexities of the organizational environment (external complexity) and the complexities of formulating strategies given a wide variety of views and interests (internal complexity). In this way it is useful in situations where there is no clear consensus as to the way forward. In very simple terms JM consists of two stages:

**1. Surfacing emergent strategies.** This stage is devoted to understanding the situation, the cultural issues, the people involved and their roles. Individual cognitive maps are developed to better

understand the issues, and are then combined to produce strategy maps and analysed to identify emergent strategies.

**2. Reflecting and negotiating to gain agreement.** In this stage the most important problems are selected and a series of options and scenarios are developed to deal with them. Each option and scenario is then evaluated and a list of no more than 10 problems and their associated options and scenarios are selected for further discussion. The stage concludes with the presentation of a report to management outlining recommendations for further discussion and sets of options and scenarios that have the most realistic chance of successful implementation.

Central to Journey Making is the cognitive map. Cognitive maps are diagrams constructed by the Journey-Making practitioner in interviews with stakeholders. They are used to highlight the ways in which individual stakeholders understand and react to the situation. Strategy almost always means organizational change with accompanying advantages and disadvantages for certain members of the organization. In this context, organizational politics plays an important role with different stakeholders taking positions according to factors such as:

- whether they think they will win or lose (in their own terms) as a result of the change
- their view of their own position in the organization
- their view of the strategic direction the organization “should” be taking
- their loyalties, friendships and rivalries (and so on) within the organization
- political persuasions
- other more personal perspectives.

New alliances may form in support or opposition to a particular direction or organizational members. The cognitive maps can help to make positions clearer and available for debate and consideration.

#### *Further information*

Eden, C. & Ackermann, F. 1998. *Making strategy: The journey of strategic management*. London, Sage.

### **Strategic Options Development and Analysis (SODA)**

Strategic Options Development and Analysis (SODA) uses individual interviews to gather information from members of a group. The information gathered is represented on cognitive maps to demonstrate the relevance of the concepts (or short phrases capturing ideas) and to highlight the linkages between the concepts (Eden, Jones and Sims, 1983). Concepts within cognitive maps are generally either goals (appearing at the head/top of the map, self-evidently regarded as good things) or options (appearing at the tail/bottom of the map). Strategic options are defined as those that have no other options above them on the maps.

SODA interviews are relatively unstructured, but aim to elicit thoughts about the problem under discussion. From the discussion cognitive maps are drawn to help each individual refine their thinking. Once individual maps have been produced for an entire group, they are merged into a single map that can initially contain several hundred concepts. Similar concepts are then merged, while concepts are kept from key members of the group and a balance of concepts is maintained for all group members. To make the map manageable, the concepts are arranged into clusters containing between 15 and 30 concepts. The final merged map represents an overview at the cluster level showing links between each cluster. This serves as a focus for discussion at a concluding workshop that involves:

- analysis of the overview map’s content and structure
- identification of emerging themes and core concepts
- discussion of key goals, interrelated problems, key options and assumptions.

The key aim of SODA is to achieve understanding and agreement among the group members regarding the problem under discussion.

According to Eden (1992), the typical SODA project involves the following eight activities:

1. Initial individual interviews and cognitive mapping
2. Feedback interview where the initial maps are verified
3. Analysis for key issues
4. Formal research and interview with experts
5. Refinement of issues
6. A workshop focusing on awareness
7. A workshop focusing on orientation
8. A workshop focusing on action portfolios.

#### *Methodology, required data and skills*

The cognitive map is a tool that makes an individual's views on an issue available for others to understand, use, question or challenge.

SODA is useful for dealing with complex issues of strategy formation, where there is no clear consensus on the appropriate way forward. It utilizes opinions and knowledge already within the organization to move towards mutual understanding, accommodation and cooperation.

#### *Applicability for participatory planning/scenario/policy development*

Reasons for choosing SODA for participatory group work include its capacity to structure multiple conflicting aspects and place individual views in context, while helping to reduce levels of conflict via the advocacy of solutions that emphasize anonymity. In addition to helping users identify and structure problems, SODA can also be used to support different levels of public participation and varying conflict management techniques. Its use can culminate in a discussion and information transfer or, depending on the institutional setting, progress towards negotiation or consensus building. SODA can also be used during initiation of the planning process at the council level, despite the low level of face-to-face interaction. Initial mapping of individual perceptions provides a venue for personal involvement, which can be adjusted at a level suitable for the individual participant. In addition, a cognitive map can be made "backstage" independent of group interaction. Although not ideal, council members can be asked to work through the map on an individual basis prior to possible wider group negotiation with stakeholders. Lastly, stakeholders found SODA to be relatively easy to understand, which encouraged participation.

#### *Example or case studies*

Tikkanen *et al.* (2006) examined and described the objectives set by forest owners and managers in the form of a hierarchical cognitive map. In the case study, individual cognitive maps were derived during interviewing sessions through application of a conceptual content cognitive mapping approach. Maps were then coded qualitatively and the results from individual maps were aggregated using quantitative methods, including hierarchical clustering of objectives according to proximity. The study results indicated that cognitive mapping, when developed further, could constitute a promising means of merging qualitative and quantitative approaches in objective surveys. It could also be used as a tool for qualitative objective analysis in forest planning and applied to (regional) policy development on a more political-strategic level with some adjustment of the framework towards political decision-making.

Hjortso (2004) presented a case study that applied a modified version of SODA to enhance citizen participation in a strategic forest management planning process, managed by the Danish Forest and Nature Agency. Research showed that SODA can improve public involvement in several ways, including stakeholder perceptions of their involvement and consequent commitment, structuring of the planning context, communication of stakeholder perspectives, identification and management

of conflicts, decision process transparency, and agency accountability for final planning outcomes. The primary problems related to difficulties encountered in deciphering the cognitive maps, time requirements and the selection of a facilitator. The general impression was that SODA has the potential to improve present practice and, moreover, provide a feasible platform for wider integration of stakeholder groups in the tactical planning process.

#### *Further information*

- Eden, C. 1992. On the nature of cognitive maps. *Journal of Management Studies*, 29(3): 261-265.
- Eden, C., Jones, S. & Sims, D. 1983. *Messing about in problems*. Oxford, Pergamon Press.
- Hjortso, C. 2004. Enhancing public participation in natural resource management using Soft OR – an application of strategic option development and analysis in tactical forest planning. *European Journal of Operational Research*, 152: 667-683.
- Tikkanen, J., Isokääntä, T., Pykäläinen, J. & Leskinen, P. 2006. Applying cognitive mapping approach to explore the objective structure of forest owners in a Northern Finnish case area. *Forest Policy and Economics*, 9(2): 139-152.

#### **Co-View software**

Level of technicality: medium

#### *Overview*

Co-View (Collaborative Vision Exploration Workbench), developed by the Center for International Forestry Research (CIFOR), uses soft systems models consistent with the principles of qualitative system dynamics. It helps facilitators of natural resource management to articulate and explore a shared vision of the future and to develop a common understanding (Mendoza and Prabhu, 2005). The tool can be applied to generate a shared vision of the future by facilitating participatory modelling processes to debate, test and validate ideas, opinions and divergent views. Co-View includes five elements: a practical guide to facilitating a participatory visioning process; a manual entitled “Future Scenario, Scenarios as a Tool for Adaptive Forest Management”; a simply written illustrated guide to participatory modelling; “The Bridge”, a computer-based tool for expressing a vision and converting it into the basis for a simulation model; and “The Power to Change”, a team game which uses a model to explore various future scenarios ([www.cifor.cgiar.org/acm/pub/co-view.html](http://www.cifor.cgiar.org/acm/pub/co-view.html)). The tool helps to identify complex decision problems and uses system dynamic approaches to defining concepts and linkages and supporting related analysis.

#### *Methodology, required data and skills*

This tool integrates MCA and participatory modelling and has been used to involve stakeholders in the forest management planning process. It is aimed at strengthening the link between visioning and modelling, by making it easier to use a visioning process as the entry point for modelling the process, and to use the results of simulation modelling to help generate strategies for achieving the vision. It stimulates planning for visions and goals through the increased, active involvement of participants in the planning process, encouraging the expression of ideas, views and perceptions, and enhanced social learning. The stakeholders acknowledged the ability of graphical representations to inspire new, shared insights and joint strategies for action; to illustrate the relationships between concepts; and to improve understanding of the problem. Such mapping exercises provide a starting point for group negotiations. However, some stakeholders perceived difficulties in the modelling process including with reading maps they had not generated themselves. Thus, it became important for the facilitator to encourage simplicity and generate a common understanding, so as to clarify the connections between the modelling process and the vision.

#### *Applicability for participatory planning/scenario/policy development*

Mendoza and Prabhu (2005) followed a cognitive mapping approach, using Co-View to build a collaborative model for developing collective goals, strategies and action plans for a community



forest managed under a resource-sharing arrangement. The model follows the structure of a system-dynamics framework with elements organized around well-known strategic-planning components, namely SWOT (i.e. strengths, weakness, opportunities and threats, including indicators). The initial elements were examined, modified, revised or redefined to provide clear definitions of each element. The “Power to Change” component was then examined in order to assess the use of the model as a tool for participatory planning. This component enables participants to enter a simulated game, mimicking the behaviour and dynamics of a group of stakeholders attempting to manage a community-owned resource. Before pursuing the simulation analysis, the core participants took a closer look at the SWOT elements.

#### *Example or case studies*

The tool was used in a case study involving the management of the communal Mafungautsi Forest, located in the Gokwe District of the Midlands of western Zimbabwe. The core participants in the modelling case study consisted of six district-level government personnel who have worked and lived within the case study district for at least 10 years. In the case study, an open-thinking process, open dialogue and discussion around the topic of community-based forest management eventually led to the emergence of a shared goal. All of the core participants were actively involved in the modelling exercise as strategies were developed and SWOT elements were “unpacked” into their fundamental sub-elements. The participants learned through simulation analyses of strategies and action plans and commented on the value and usefulness of “What if?” scenario analyses for strategic planning. The computer-assisted model Co-View was used in every phase of the planning process, including to transform the cognitive map into a system dynamic model at the latter stages of the modelling process. The generated model was then used to simulate different scenarios. A similar approach seems feasible for forest policy development, given a core group of stakeholders in a workshop environment.

#### *Further information*

Free downloads of the software and manual are available from: [www.cifor.cgiar.org/acm/pub/co-view.html](http://www.cifor.cgiar.org/acm/pub/co-view.html) and [www.aseanbiodiversity.info/Abstract/51004964.pdf](http://www.aseanbiodiversity.info/Abstract/51004964.pdf)

**Mendoza, G.A. & Prabhu, R.** 2005. Combining participatory modeling and multiple-criteria analysis for community-based forest management. *Forest Ecology and Management*, 207: 145-156.

### **CORMAS (Common-pool Resources and Multi-Agent Systems)**

Level of technicality: medium

#### *Overview*

CORMAS (Common-pool Resources and Multi-Agent Systems) was developed to tailor agent-based modelling for the use in common pool resource contexts (i.e. natural resources in particular). It helps to generate frameworks for depicting agents (e.g. stakeholders) and their interactions in a system of natural resource management (Bousquet *et al.*, 1999; Le Page *et al.*, 2011). In order to view socio-ecosystems as a set of interacting autonomous entities and make corresponding decisions, these objective-driven entities refer to specific representations of their environment (Ferber, 1999). The model was developed by the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD).

#### *Methodology, required data and skills*

CORMAS can be used to create a community of practice (i.e. an interactive learning and exchange platform), fostering efficient learning through agent-based modelling and simulation for natural resource management. A community of practice (COP) is any group of people whose members have a common interest in a subject, problem or goal. Through collaboration and sharing of ideas, practices and knowledge, they improve their skills in a particular common domain. In addition, they



usually develop a common language and jargon, and concepts or tools that are typically understood by just the members (Lesser and Storck, 2001). To address natural resources issues, the initial core group of CORMAS designers started to use the platform and defined sets of contiguous elementary spatial entities filling a shared condition. To facilitate the design of realistic virtual environments, a link was established between CORMAS and the more widely used Geographic Information System (GIS) software through an asynchronous operation of functions within each system that enable file-based data exchange.

#### *Applicability for participatory planning/scenario/policy development*

A collaborative forest planning process may include the prioritization of local issues, integration of local knowledge, development of scenarios, and the review of visualizations in an interactive manner. The level of engagement with local citizens and stakeholders impacts the time and resources required. Several interactive planning tools, including multi-agent systems (MAS) and roleplay programs, have been developed to support the effort. MAS applications facilitate the representation of knowledge and the reasoning of several heterogeneous agents when addressing planning problems in a collaborative way. Stakeholders, groups of stakeholders and/or institutions (any kind of entity making decisions somehow related to the resources) are represented as computer agents interacting with both the environment and other agents (Bousquet *et al.*, 1999; Janssen, 2002). The CORMAS model is utilized for a wide range of applications in agriculture, land use/land cover changes (LUCC), water and forest management. It helps to raise awareness among stakeholders of diverse views and consequences linked to natural resource management in different socio-economic systems. In addition, it is used in agronomy, livestock management and biodiversity conservation. New application domains that have emerged since 2005 include epidemiology, fishery and urban applications (<http://jasss.soc.surrey.ac.uk/15/1/10.html>). In general, the CORMAS user community is mainly interested in context-specific participatory agent-based simulation (<http://jasss.soc.surrey.ac.uk/15/1/10.html>).

#### *Example or case studies*

Purnomo (2002) and Purnomo *et al.* (2005) provided a detailed description of a CORMAS-based model developed in a case study from the District of Malinau, East Kalimantan, Indonesia. For this MAS simulation, five basic indicators were captured, namely: (a) forest cover and standing stock; (b) the financial performance of Inhutani II; (c) income per capita of local communities; (d) the forest-related incomes of central governments; and (e) the forest-related incomes of local governments. The conceptual diagram developed in this study consisted of three modules: agents and their interactions, system dynamics and scenario simulation. Purnomo *et al.* (2005) developed multi-stakeholder forest management scenarios and highlighted the use of MAS with modelling as a collaborative learning tool. They also noted that the learning process subsequently affected the future actions and reactions of stakeholders with respect to the ultimate goal of sustainable resource management.

#### *Further information*

Additional information can be found at: [www.cormas.cirad.fr/en/outil/present.htm](http://www.cormas.cirad.fr/en/outil/present.htm) and <http://jasss.soc.surrey.ac.uk/15/1/10.html>

**Bousquet, F. & Le Page, C.** 2004. Multi-agent simulations and ecosystem management: A review. *Ecological Modelling*, 176(3-4): 313-332.

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- Purnomo, H., Mendoza, G.A., Prabhu, R. & Yasmi, Y. 2005. Developing multi-stakeholder forest management scenarios: A multi-agent system simulation approach applied in Indonesia. *Forest Policy and Economics*, 7: 475-491.

### **MAS (ComMod)**

Level of technicality: medium

#### *Overview*

ComMod (companion modelling) is a MAS-based approach in which heterogeneous, autonomous entities or agents interact with each other and with their common environment (Gilbert, 2008). Companion modelling (Barreteau, 2003) enables enquiry into the complex interactions among stakeholders as well as collaborative model building by stakeholders and researchers. It takes as its basis the approach of MAS, which recognizes the various goals of stakeholders, their mutual communication processes and varying representations of each other, and the overall problem situation (Woolridge, 2009). MAS models are thus adapted to describe dynamic and complex systems of renewable resource management, and are able to capture emergent phenomena arising from interactions among the diverse dimensions of resources and stakeholders in the systems (Janssen, 2002). Companion modelling includes the use of drama theory (Bryant, 2007) in the form of roleplaying games and, essentially, iterative computer simulations and negotiations to enable learning and model validation. ComMod makes use of roleplaying games and agent-based models, both of which are MAS-based tools (Barreteau, 2003; Bousquet *et al.*, 2002), to facilitate information sharing, collective learning and the exchange of perceptions on a given concrete issue among researchers and other stakeholders (Ruankaew *et al.*, 2010).

ComMod has two major aims: (i) to facilitate collective information sharing and learning, and (ii) to improve coordination among stakeholders for negotiation and decision-making (Barreteau, 2003; Bousquet *et al.*, 1999). Roleplaying games are MAS models implemented into playable games, usually with the help of boards, maps, cards and papers, and are often computer-assisted. This approach proved promising with observed engagement and learning among the stakeholders, an egalitarian character and support for negotiations. All this made model validation more reliable compared to ordinary interview and survey techniques. Companion modelling also served as a way to make researchers and stakeholders collaborate and interact and examine complex problems in a friendly environment. In some circumstances, the models can be rather simple and focus only upon critical interactions, such as improvement of management through negotiation and new rules. This is because participants tend to share their existing common knowledge of the features of the problem at stake (Barreteau *et al.*, 2003; Bousquet *et al.*, 2002). Companion modelling also requires time resources and multi-faceted expertise from researchers and facilitators, which may limit its diffusion (Khadka *et al.*, 2013).

#### *Applicability for participatory planning/scenario/policy development*

The tool could be used to address a wide range of forest management and policy issues with stakeholder groups in workshop settings and with small groups of participants. However, it is especially useful for multi-level communication among conflicting parties and for joint learning for adaptive and integrated sustainable management of renewable resources (Ruankaew *et al.*, 2010). It can be used to learn about agro-ecological and socio-economic dynamics and improve

mutual understanding and enhance social learning within a facilitated negotiation process. It also mediates collaborative interactions in support of improved communication and joint learning for adaptive and integrated forest management planning. However, usability is dependent on the availability of technical facilities, which may prove to be a bottleneck in some contexts, especially in developing countries.

#### *Example or case studies*

The MAS approach was applied to community forest management in the Philippines. It has also been used to address various renewable resource management issues at many locations worldwide, including 15 sites in South and Southeast Asia (Bousquet *et al.*, 2007). Ruankaew *et al.* (2010) used ComMod for integrated renewable resource management, and followed a MAS-based approach relying on synergistic effects between roleplaying games and agent-based models to facilitate collective information sharing and learning, and to improve coordination among stakeholders for negotiation and decision-making.

#### *Further information*

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### **FoPIA – Framework for Participatory Impact Assessment**

Level of technicality: medium

#### *Overview*

FoPIA is a flexible, stand-alone, participation-based tool designed for the assessment of policy impacts that are sensitive to local, national and regional sustainability priorities. FoPIA provides a structured sequence of methodological processes for engaging stakeholders and harnessing their knowledge and expertise for the assessment of land use policy impacts. FoPIA weighs sustainability impacts, giving equal consideration to the three sustainability dimensions, namely: social, economic and environmental. FoPIA is a decision-support tool for development of policy scenarios, weighing the importance of present land use functions and assessing the impacts of future non-policy and policy interventions. Sustainability indicators considered most relevant for the spatial and sustainability

context under discussion are used for quantification of impacts. FoPIA provides valuable information for determination of trade-offs and synergies between different sustainability dimensions involved in decision-making and policy-making processes. FoPIA also has an in-built mechanism within its implementation structure for double-checking and ensuring the integrity of the data collected from the stakeholder process.

#### *Methodology, required data and skills*

FoPIA is a procedural tool that is easy to understand and implement. Basic knowledge of DSPIR (driver, state, pressure, impact and response) models is needed for problem structuring and definition, and statistical data and stakeholder input are needed for policy scenario formulation. A basic understanding of the concept of multifunctionality is also needed to assess the relative importance of land use functions, and knowledge of relevant assessment indicators is needed to weigh the potential impact of non-policy and policy interventions. These can, however, be discussed and explained at the beginning of the workshop for easy facilitation of the exercise. Paper-based stakeholder weightings are needed to furnish the Excel-based work tool that is used for analysing stakeholder results. Basic knowledge of spreadsheet applications and statistical analysis is also needed to navigate around the Excel-based work tool, which will be used for numerical computation of stakeholder's weights and statistical/visual analysis of the results of the process.

#### *Applicability for participatory planning/scenario/policy development*

FoPIA has been tested and has proven to be a useful tool for land use policy scenario development and participatory assessments (Morris *et al.*, 2011). It has been applied within different spatial and sustainability contexts to a wide range of topical issues, such as agriculture, grazing, conservation, tourism and bioenergy. FoPIA stakeholder-based impact assessment results are capable of playing an instrumental role in policy-making processes through the generation of potential trade-offs and synergies within the different sustainability dimensions (i.e. social, economic and environmental).

#### *Example or case studies*

FoPIA has been applied in sensitive area case studies (SACS), such as the Maltese Archipelago (Malta), Eisenwurzen (Austria), the High Tatras (Slovakia), Silesia (Poland), the Western Estonia Coastal Zone and Saaremaa Island (Estonia), Valais (Switzerland) and Saxony Lusatia (Germany).

FoPIA has also been applied in case studies in developing countries. Examples include alternative spatial planning policies around the Merapi volcano and surrounding areas of Yogyakarta City, Indonesia; large-scale afforestation of agricultural areas to reduce soil erosion in Guyuan, China; expansion of soil and water conservation measures in the Oum Zessar watershed, Tunisia; agricultural intensification and the potential for organic agriculture in Bijapur, India; and land degradation and conflicts resulting from land division and privatization in Narok, Kenya.

#### *Further information*

Additional information can be found at: [http://tran.zalf.de/home\\_ip-sensor/newsevents/brussels/09\\_Tabbush\\_SNESOR\\_final\\_policy\\_day.pdf](http://tran.zalf.de/home_ip-sensor/newsevents/brussels/09_Tabbush_SNESOR_final_policy_day.pdf)

**König H.J., Uthes, S., Schuler, J., Zhen, L., Purushothaman, S., Suarma, U., Sghaier, M., Makokha, S., Helming, K., Sieber, S., Chen, L., Brouwer, F., Morris, J. & Wiggering, H.** 2012. Regional impact assessment of land use scenarios in developing countries using the FoPIA approach: Findings from five case studies. *Journal of Environmental Management*, 127: S56-S64.

**Morris, J.B., Tassone, V., De Groot, R., Camilleri, M. & Moncada, S.** 2011. A framework for participatory impact assessment: Involving stakeholders in European policy making, a case study of land use change in Malta. *Ecology and Society*, 16(1): 12 (available at [www.ecologyandsociety.org/vol16/iss1/art12/](http://www.ecologyandsociety.org/vol16/iss1/art12/)).

## **OSMOSE– Generator of spatial decision support systems for land use planning**

Level of technicality: medium

### *Overview*

OSMOSE (On-site, multi-criteria, optimization, spatial evaluation) is a generic conceptual framework, whose free and open-source software is designed for the generation of specific spatial decision support systems (sDSS) for spatial land use planning (De Meyer *et al.*, 2012). The specific sDSS generated with OSMOSE are intended to: (i) identify land units that meet multiple predefined ecosystem service (ES) attribute values for a specific land use type (LUT), and (ii) rank land units for a given LUT according to these multiple ES attributes. A complementary purpose is to: (i) identify and (ii) rank LUTs for a given land unit. OSMOSE can accommodate differentially weighted, continuous and/or ordinal attributes with, for the latter, equal or unequal number of classes, alternative land unit definitions, land use types and climate change scenarios. Moreover, it can perform assessments using ES levels for the land unit/LUT combinations and in terms of changes in ES levels after a particular change of LUT.

### *Methodology, required data and skills*

The OSMOSE generator of sDSS is conceived in an integrated, modular fashion. Four modules are featured: (i) a geospatial database module, (ii) a geospatial visualization and analysis module, (iii) an advanced query module, and (iv) a specific user interface module.

To produce a ranking of alternative land units or LUTs, the advanced query module uses the multi-criteria decision-making method applied by Gilliams *et al.* (2005), which they referred to as “interval goal programming” (IGP). However, to avoid confusion with the reference IGP procedure introduced by Charnes and Collomb (1972), the term “iterative ideal point thresholding” (IIPT) (as proposed by Estrella-Maldonado *et al.*, 2012) is preferred. This procedure ranks the alternatives (land units or LUT) from “best” to “less good” (or “less good” to “best”) based on the selected ES attributes and the user-defined relative importance (i.e. weights).

The modular architecture of OSMOSE enables the user to create a specific sDSS by populating the database with the location and diagnostic characteristics of land units (e.g. initial land use type, soil type, slope class, etc.) and with ES values for the different combinations of scenario (e.g. climate change scenario), land unit and target land use type, for each selected ES attribute and region in the geospatial data model.

The knowledge base and models required to assess the ES values for the different combinations of scenario, land unit and target land use type are not embedded in the OSMOSE software system. Hence, all ES data (e.g. soil carbon stock 30 years after afforestation of a land unit with *Fagus sylvatica* on well-drained silt soil, initially under arable land) must be provided.

No particular skills are required to generate a sDSS by means of OSMOSE and use it. The most delicate part of the process is the preparation of the ES data in line with the OSMOSE data model.

### *Applicability for participatory planning/scenario/policy development*

The outcomes to a “Where?” question (which land units?), a “How?” question (which LUT?) and to the (not yet implemented) “When?” question (How long after land use change?) are dependent upon the ES selected as criteria and the weights attributed to them. Selecting ES, setting weights to these ES and discussing the generated outcome can be done through a participatory process.

### *Example or case studies*

The most significant sDSS generated by OSMOSE to date is BoLa (Breure *et al.*, in press; De Meyer *et al.*, 2011), commissioned by the Flemish regional government in Belgium to incorporate soil protection issues in agricultural land use planning in Flanders. The AFFOREST-sDSS (Van Orshoven *et al.*, 2007) was designed to support decisions regarding where and how to afforest agricultural land



in northwestern Europe to maximize environmental benefits. In ongoing case studies, OSMOSE is used to generate sDSS to support afforestation in the southern Andes of Ecuador and land use planning for food and wood energy security in northern Burundi.

#### *Further information*

Additional information can be found at: [www.sadl.kuleuven.be/sadl/projectDetail.aspx?ID=35](http://www.sadl.kuleuven.be/sadl/projectDetail.aspx?ID=35)

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#### **Quickscan**

Level of technicality: high

#### *Overview*

Quickscan is a flexible and modular modelling environment currently being developed by the European Environment Agency (EEA). It allows users to explore the different implications and trade-offs that occur when developing and implementing policy options for Europe. The software tool can be applied in group-processes with policy-makers and experts to develop and explore potential policy options and assess likely impacts of those options. The approach adapted in the Quickscan tool is purely exploratory and not designed as an exact method for measuring policy impacts, but rather as a valuable way to explore the datasets and visualize possible impacts and trade-offs. The tool can be classified as a “discussion support system” rather than a “decision support system”.

Quickscan builds on concepts from participatory modelling and participatory GIS. It uses visualization and interpretation tools to support the exploration of options, thereby allowing and facilitating discussion and interaction about the definition of alternatives, analysis of their consequences, determination of trade-offs and synergies, and comparison of their consequences.



The Quicksan tool is designed to calculate fast and perform multiple iterations of a modelling exercise during a workshop. The result of each iteration feeds discussion among stakeholders and policy-makers creating input for the next iteration (Verweij *et al.*, 2012). Quicksan is capable of developing storylines, selecting indicators to measure objective achievement, gaining and processing stakeholder knowledge, and jointly creating new model(s), as is the case with participatory modelling. Quicksan offers access to spatially distributed phenomena and provides interactive zooming, overlaying, temporal comparisons and many visualization options, as used in participatory GIS. In addition, Quicksan can perform the above within the timeframe of a two-day workshop.

#### *Methodology, required data and skills*

The Quicksan software comes without spatial and statistical data, which must be supplied on an application basis. The tool is not restricted to a specific geographic location or spatial resolution. The input data sources depend on the user. At European level some examples could include NUTS administrative level, CORINE Land Cover, NATURA 2000 sites and High Nature Value Farmland. Quicksan requires some pre-processing of data in a standard GIS (e.g. ESRI ArcGIS), so as to provide data in the required ESRI GRID format (.adf).

Users of Quicksan should be familiar with modelling and ArcGIS. A workshop using Quicksan needs careful preparation. Experts for the topic at stake must be found and data gathered and made available to the Quicksan tool. Preparation also means running through likely scenarios and thinking of proxies to use for unavailable or non-existent data.

#### *Applicability for participatory planning/scenario/policy development*

Quicksan combines a range of GIS tools and analytical methods to facilitate explorations of “What if?” scenarios at a range of spatial and temporal scales. Quicksan is mainly an exploratory tool and can be used early during the policy development process, thereby helping to influence policy rather than just assessing or evaluating it afterwards.

#### *Example or case studies*

Quicksan was used in a test case for Green Infrastructure in Europe (EEA, 2011).

#### *Further information*

Additional information can be found at: <http://svn.eionet.europa.eu/projects/GisLibrary/wiki/quicks>

EEA. 2011. *Green infrastructure and territorial cohesion: The concept of green infrastructure and its integration into policies using monitoring systems*. EEA technical report 18. Copenhagen, European Environment Agency.

Verweij, P., Winograd, M., Perez-Soba, M., Knapen, R. & van Randen, Y. 2012. QUICKScan: A pragmatic approach to decision support. In: R. Seppelt, A.A. Voinov, S. Lange & D. Bankamp, eds. *Managing resources of a limited planet*. 2012 International Congress on Environmental Modelling and Software, 6th Biennial Meeting, Leipzig, Germany, International Environmental Modelling and Software Society (iEMSs).

### **Participatory GIS and social values mapping**

Level of technicality: high

#### *Overview*

Social values mapping is a public participation survey method. People attach commonly approved social values subjectively to landscape. These values vary spatially and can be studied in a geographical context. In social values mapping, participants are provided with a map and assign areas with values according to their preferences. The values may include beautiful scenery, space and freedom, or peace and tranquillity. Participatory GIS techniques combine community participation with use of

digital geospatial techniques and enable the collection, storage and analysis of stakeholder data in a geographical form. The approach can be easily understood by the general public. The participants could also themselves delineate the areas they value. The social values mapping method in planning needs further development in rural areas, where distinctive patches cannot be easily detected (e.g. Kangas *et al.*, 2008).

#### *Methodology, required data and skills*

The method enables collection, storage and analysis of social values data supplied by stakeholders in a geographical form. For the mapping and geographical analysis of social values attached to landscapes, the use of participatory GIS techniques is a particularly useful approach.

In operational forest planning, place-specific information is more useful than questions concerning general values.

The method requires maps from the planning area as well as a pre-defined set of social values. Maps can be in paper form, and values can be either positive or negative. Researchers need to have experience with Geographic Information Systems (GIS).

#### *Example or case studies*

Kangas *et al.* (2008) evaluated values of residents of Hyrynsalmi municipality concerning the nearby forests owned by UPM-Kymmene Ltd. with a questionnaire consisting of general value questions and mapping of social values of forests. The study aimed to test the social value mapping method: (i) in commercial forests in a rural-urban interface, and examine the benefits and drawbacks; (ii) for place-specific and non-specific data collection; and (iii) for different data collection methods, from the viewpoint of forest management planning.

A study by Tyrväinen, Mäkinen and Schipperijn (2007) mapped the social values of green areas in Helsinki. The social values included in the study were: beautiful landscape, area for picking berries and mushrooms, history and culture, valuable nature site, favourite forest, experience rich forest and unpleasantness. In the study, it was noted that while all respondents can claim to represent local values, different data collection methods produced statistically significantly different local values. This needs to be accounted for when planning a participatory process. In operational forest planning, place-specific information is more useful than questions concerning general values, while the latter may help in defining forest policy goals.

Fagerholm and Käyhkö (2009) applied participatory GIS techniques to the mapping and geographical analysis of social landscape values in a multifunctional cultural landscape in Zanzibar, United Republic of Tanzania. Social landscape data were collected through single-informant interviews using participatory GIS techniques. Four different social landscape values (subsistence, traditional, aesthetic and leisure) were individually mapped onto an orthoimage by 149 informants. Data were spatially and statistically analysed to construct an understanding of the community level patterns of the social landscape values. Results showed geographical differences between individually and collectively held values in their distribution and clustering across the landscape. These patterns reflect local culture and its interpretation of different social landscape values. The results addressed the importance of local stakeholder participation when realizing spatial planning and management of multifunctional cultural landscapes. The paper discussed these management implications and the methodological challenges of using participatory GIS techniques in studying cultural landscapes.

#### *Further information*

Fagerholm, N. & Käyhkö, N. 2009. Participatory mapping and geographical patterns of the social landscape values of rural communities in Zanzibar, Tanzania. *Fennia*, 187(1): 43-60 (available at [www.landscape2.org/Fagerholm\\_Zanzibar.pdf](http://www.landscape2.org/Fagerholm_Zanzibar.pdf)).

Kangas, A., Haapakoski, R. & Tyrväinen, L. 2008. Integrating place-specific social values into forest planning – Case of UPM-Kymmene forests in Hyrynsalmi, Finland. *Silva Fennica*, 42(5): 773–790 (available at [www.metla.fi/silvafennica/full/sf42/sf425773.pdf](http://www.metla.fi/silvafennica/full/sf42/sf425773.pdf)).

Tyrväinen, L., Mäkinen, K. & Schipperijn, J. 2007. Tools for mapping social values of urban woodlands and other green areas. *Landscape and Urban Planning*, 79: 5-19.

### **IDRISI Land Change Modeler**

Level of technicality: high

#### *Overview*

The Land Change Modeler is an ArcGIS-oriented software extension built to analyse the problem of accelerated land conversion and the specific needs of biodiversity conservation. Tools for the assessment and prediction of land cover change and its implications are organized around major task areas: change analysis, change prediction, impact assessment for habitat and biodiversity, and planning interventions. The software can be used for a variety of land change scenarios and contexts. Users concerned with land change, conservation and biodiversity can use a set of tools for the analysis of change and the creation of viable plans and scenarios for the future.

#### *Methodology, required data and skills*

By using past land transition information and incorporating environmental variable maps that might drive or explain such change, Land Change Modeler is able to create a GIS data layer expression of transition potential; in other words, the likelihood that a land use will change in the future. Each transition is modelled with either logistic regression or a multi-layer perceptron neural network, resulting in a potential map for each transition – an expression of time-specific potential for change.

A wide range of tools is provided to assess the implications of change for ecological sustainability. These include tools for species-specific habitat assessment, habitat change analysis, gap analysis, landscape pattern analysis, species distribution modelling and biodiversity analysis.

Users of the IDRISI Land Change Modeler should be familiar with modelling and ArcGIS.

#### *Applicability for participatory planning/scenario/policy development*

Land Change Modeler is integrated within the IDRISI system and is also available as an extension to ESRI's ArcGIS. It provides tools for the assessment and projection of land cover change and the implications for species habitat and biodiversity. IDRISI contains decision support tools for effective resource allocation, including cutting-edge techniques for multi-criteria evaluation, multi-objective land allocation modelling and suitability mapping. IDRISI also provides a consensus-seeking procedure for weighting criteria, fuzzy standardization and an extensive set of criteria aggregation procedures.

#### *Further information*

Additional information can be found at: <http://clarklabs.org/products/Land-Change-Modeler-Overview.cfm>

### **STELLA**

Level of technicality: high

#### *Overview*

STELLA can be used as a participatory modelling tool to help understand a studied system by means of “systems thinking” through diagram-based modelling. Diagram-based modelling uses a stock and flow diagram to show the dynamic relationships among variables. Stock and flow models can

be used to model almost any kind of (material) flow, from population models to economic models. The tool can be applied in a participatory process by involving local stakeholders in a series of discussions to verify the flow of variables and data.

#### *Methodology, required data and skills*

Diagram-based modelling using stock and flow diagrams can be used to show how different variables change over time and interact with each other. Data requirements depend on the topic under investigation. When investigating land use and forestry-related topics, data sources can include statistical data (available resources or economic data, data on human populations or land use data). The program can be used to build simple and complex models and is relatively easy to use, even for beginners. Users must have some experience with modelling.

The Center for International Forest Research (CIFOR) has a very comprehensive toolbox that explains how to get started with STELLA and how to use it for landscape modelling. Some case studies are described, showing some practical applications of the modelling tool: [www.cifor.org/conservation/\\_ref/research/](http://www.cifor.org/conservation/_ref/research/).

#### *Applicability for participatory planning/scenario/policy development*

Different alternative resource use scenarios can be constructed by manipulating the material flow. The program is especially useful for the study of “What if?” questions. STELLA has been applied in several cases using the concept of the “throw-away” model (Sandker *et al.*, 2010a) – a computer implemented model constructed in a short time to explore a particular problem and then discarded. The aim of these models is to explore links between landscape components and to simulate possible trends in environmental and livelihood outcomes over time. The main purpose of these “throw-away” model results is to facilitate discussion, rather than to produce accurate predictions. As with many participatory methods, the process of building the model together with stakeholders is more important than the model itself.

#### *Further information*

Additional information can be found at: [www.iseesystems.com/software/Education/StellaSoftware.aspx](http://www.iseesystems.com/software/Education/StellaSoftware.aspx) and [www.cifor.org/conservation/\\_ref/research/](http://www.cifor.org/conservation/_ref/research/).

## ANNEX 5. STRENGTHS AND WEAKNESSES OF SOME SELECTED SOFTWARE TOOLS

Table A-3 compares the main strengths and weaknesses of the selected tools. Although very different, some tools share similar strengths. For participatory tools, important strengths include ease of use, flexibility, capacity to take into account different social groups, and ability to reach a wide audience and encourage participation. Common weaknesses include the need for data and experienced researchers or facilitators, and the considerable time required for application, which makes the process expensive. Moreover, some tools can be difficult to understand and may require modelling knowledge on the part of participants to interpret the results.

TABLE A-3  
Main strengths and weaknesses of the selected software tools

Tool name	Main strengths	Main weaknesses	Comments
<b>Participatory GIS/ social mapping</b>	The social values mapping method is relatively easy to use. In operational forest planning, place-specific information is more useful than questions concerning general values. It offers the possibility to use paper maps. Method can be applied in any geographic location	Researcher needs experience with GIS	Can be used in group sessions or combined with questionnaires or interviews
<b>Quickscan</b>	Can calculate results fast and produce multiple iterations during a workshop. Can be used in the early stages of policy development	A Quickscan workshop needs careful preparation (requires experts and data)	Mainly exploratory tool
<b>Framework for participatory impact assessment (FoPIA)</b>	Flexible, process-based (procedural), easy-to-use decision-support tool. Wide range of spatial applications within different land use sustainability contexts. Adequately accounts for stakeholder's input in land use policy impact assessments. Final outputs have strong capabilities for the determination of trade-offs and synergies in decision and policy-making processes	Requires significant preparation. Diffusion of basic concepts (e.g. DPSIR model, assessment indicators, LUFs, concept of multifunctionality, etc.) often requires more time	Can be easily integrated with many other tools
<b>Participatory perspective analysis (PPA)</b>	Flexible, easy-to-use tool to analyse scenarios. Helps to engage multi-stakeholders from different social levels and backgrounds	Needs careful preparation for workshops (requires experts and data). Training for facilitator is advisable	Can be integrated with other tools
<b>ToSIA – MCA module</b>	Flexible, easy-to-use tool to create and analyse scenarios. MCA group mode enables scenario and indicator evaluation by multiple stakeholders at the same time	Needs detailed data on forest wood chains. Analysis of more complicated chains can be challenging	Includes a cost-benefit and a policy analysis
<b>Canvas tool</b>	Uses different, non-traditional methods to elicit visions from stakeholders. Tool is highly visual, bypassing language barriers. Each participant works on their own personal or sectoral canvas, lowering the possibility of participants feeling intimidated and the exercise being dominated by a few stakeholders	Participants need basic IT skills. Time is needed for the collection of relevant and interesting material (photos, graphs, data)	Tool requires some adaptation to developing world contexts (visual description of land use alternatives, suitable pictures for selection, guidance for building thematic canvases according to foreseen needs)
<b>CORMAS multi-agent simulation model</b>	Takes into account the presence of multiple agents (actors or stakeholders)		The most significant component of MAS is the agent (actor or stakeholder)

TABLE A-3 (cont.)

## Main strengths and weaknesses of the selected software tools

Tool name	Main strengths	Main weaknesses	Comments
<b>e-Delphi method</b>	May be used to reach a broad stakeholder audience and collect large amounts of qualitative data at relatively low cost. Tool is very transparent, allowing users to view each other's answers while retaining anonymity. Can be used in an interactive and iterative way, as well as for consensus building. Disaggregative Policy Delphi as a tool to construct future scenarios	Internet-based tool unsuitable for areas without internet access. Large amounts of qualitative data may be difficult to analyse. Participants must be able to express themselves in writing. Not very suitable for complex forecasts with multiple factors	Can be used as an extension in Web 2.0 applications (e.g. for crowdsourcing)
<b>MAS (Com-Mod)</b>	Roleplaying games are a useful alternative to conventional surveys and interviews. Encourages researchers and stakeholders to interact while dealing with complex issues in a friendly environment	Researchers and facilitators need to be able to guide role-playing	
<b>CRISTAL</b>	The analysis builds on combining local knowledge and scientific knowledge. Good guidance material is available	Some training is advisable before using the tool	Users may decide to combine the tool with existing participatory methods such as rapid rural appraisal or participatory rural appraisal
<b>IDRISI Land Change Modeler</b>	Flexible ArcGIS extension that provides a wide range of tools to assess the implications of land use change and to evaluate scenarios	Requires knowledge of modelling and ArcGIS	
<b>GLOBIOM</b>	Allows detailed local land use representation and flexibility to adapt to local contexts with linkage to world markets. Provides possibility to tackle both environmental (deforestation, GHG emissions, biodiversity) and economic issues (food and timber production, prices)	Requires basic knowledge of economics and knowledge/training in GAMS programming. No detailed documentation yet available	
<b>OSMOSE (on-site-multi-criteria-optimization for spatial evaluation)</b>	Flexible framework for spatial assessment of land use and climate change scenarios. Combines GIS and multi-criteria decision support	Compilation of data on ecosystem services may take time	
<b>Cognitive mapping (Journey making and SODA)</b>	Relatively easy for stakeholders to understand, thereby encouraging their participation	Difficulties may arise in reading the cognitive maps. Production of the final merged cognitive map may prove challenging	
<b>Co-View software</b>	Stimulates active involvement and social learning. Combines analytical capabilities of MCA with the open and participative nature of participatory modelling	Stakeholders may encounter difficulties in the modelling process and in reading maps they have not produced themselves	
<b>STELLA</b>	Very flexible, easy-to-learn modelling tool, which can be used for stakeholder interaction and scenario building. Can be used to construct simple and complicated models. Can be applied to almost any topic, as long as there is a (material) flow. "Throw-away" models are relatively quick to construct and are very useful in facilitating discussions	Users must have some understanding of modelling	Not a participatory tool as such, but has frequently been applied in a participatory way



## **ANNEX 6. MORE DETAILED INFORMATION ON SOFTWARE TOOLS WITH POTENTIAL APPLICATIONS IN PARTICIPATORY OR POLICY DEVELOPMENT PROCESSES**

The tools are divided into different categories and can be used during different phases of the process.

TABLE A-4  
More detailed information on software tools with potential applications in participatory or policy development processes

Tool category	Name of the tool	General information		Phase of the participatory process			
		Purpose of the tool	Topics for which the tool could be/has been applied	Exploratory phase	Scenario development	Scenario assessment	References
Participatory GIS and visualization systems	CALP visualization system	Visualizing land use in a 3D way. The CALP visualization system was used to facilitate the creation of visual representations of proposed alternative forest management plans	Land use and natural resource management	•			<a href="http://calp.forestry.ubc.ca">http://calp.forestry.ubc.ca</a>
	GEOMOD2	The tool quantifies factors associated with land use and simulates the spatial pattern of land use forwards and backwards in time	Land use/land use change (e.g. loss of closed-canopy forest in Costa Rica). Possible application in other parts of the world	•	•	•	Pontius <i>et al.</i> , 2001
	Landsat Imaginary, video documentary	Improves natural resource and forest management, forest fire management and monitoring systems	Natural resources, forest and watershed management	•			Fagerholm and Käyhkö, 2009; Kangas <i>et al.</i> , 2008; Tyrväinen <i>et al.</i> , 2007; <a href="http://www.spatial.redlands.edu/sds/downloads/McCall2006_ApplyingParticipatory-GISAndParticipatoryMapping.pdf">www.spatial.redlands.edu/sds/downloads/McCall2006_ApplyingParticipatory-GISAndParticipatoryMapping.pdf</a>
	Maptable	Stakeholders can explore ideal scenarios and different alternatives for regional water management. Can be used by individuals and for group sessions	Water management	•			<a href="http://www.maptable.nl">www.maptable.nl</a>
	OSIRIS	OSIRIS is a suite of free, transparent, open-source, spreadsheet-based decision support tools used to estimate and map the climate, forest and revenue benefits of alternative policy decisions for reducing emissions from deforestation and forest degradation (REDD+). OSIRIS helps REDD+ decision-makers to reduce greenhouse gas emissions effectively, invest resources efficiently and distribute revenues equitably	Participatory spatial planning; nature, recreation, landscape attractiveness, agriculture, integrated approaches	•	•	•	Verweij <i>et al.</i> , 2010; <a href="http://www.conservation.org/osiris/Pages/overview.aspx">www.conservation.org/osiris/Pages/overview.aspx</a>
	Participatory GIS/social mapping	This combination of mapping media allows community groups and project-affected people to work with familiar hand-drawn participatory maps and modern mapping techniques	The tool can be used for improving project information exchange, stakeholder communication and participatory decision-making in a wide variety of development programmes. Social mapping is a visual method of showing the relative location of households and the distribution of people of different types (e.g. male, female, adult, child, landed, landless, literate, illiterate, etc.) together with the social structure and institutions of an area	•			Fagerholm and Käyhkö, 2009; Rouse, Bergeron and Harris, 2005; Vajjala, 2005

TABLE A-4 (cont.)  
More detailed information on software tools with potential applications in participatory or policy development processes

Tool category	Name of the tool	General information		Phase of the participatory process			References
		Purpose of the tool	Topics for which the tool could be/has been applied	Exploratory phase	Scenario development	Scenario assessment	
Participatory GIS and visualization systems (cont.)	Quickscan	This flexible and modular modelling environment allows users to explore the different implications and trade-offs that occur when developing and implementing policy options. Its main use is in visualizing land use options. It is a Discussion Support System rather than a Decision Support System	Land use/land use change, green infrastructure	•			Verweij <i>et al.</i> , 2012
	ScenarioBuilder	This tool develops land use scenarios using complex spatial and temporal information suitable for both experts and non-expert groups	Land use/land use change and its impacts on wood supply, environment and landscape amenity	•			Smith <i>et al.</i> , 2009
Multi-criteria tools	TUGAI	TUGAI simulates hydrology and landscape dynamics and visualizes trade-offs in water allocation between the environment and other water users	Floodplain forests, river basin management decisions (Tugal are riverine forests)	•	•		Schlüter <i>et al.</i> , 2006; Schlüter and Rüger, 2007
	AHP application	The analytic hierarchy process (AHP) is a structured technique for organizing and analysing complex decisions. The approach integrates MCA approaches in forest planning. It analyses strengths and weakness of integrated MCDA approaches to produce a multiple-use forest management plan	Forest planning, strategic planning, resource allocation, business/public policy		•		Nordström, Eriksson and Öhman, 2010; www.boku.ac.at/mi/ahp/ahptutorial.pdf
	FoPIA (Framework for Participatory Impact Assessment)	FoPIA's main purpose is to conduct regional/local analyses to complement and problematize model-based Sustainability Impact Assessment Tools. FoPIA can be adapted to solve complex regional land use problems and applied to different socio-economic situations	Assessment of land use policy impact (e.g. bioenergy policy, biodiversity policy, urban area expansion)	•	•		König <i>et al.</i> , 2010; Morris <i>et al.</i> , 2011; Sieber <i>et al.</i> , 2010
	MESTA	An internet-based decision-support application for (participatory) maker strategic-level natural resources discrete choice situations	Natural resource management		•		http://mesta.metia.fi
	ToSIA – MCA module	A tool used to compare alternative scenarios for forest wood chains, MCA and Decision Support System	Forest resource management, forest wood/energy wood production chains. In the MCA module, stakeholders can evaluate scenarios by giving weight to social, environmental and economic indicators		•		den Herder <i>et al.</i> , 2012; Wolfslehner <i>et al.</i> , 2012; www.northernntosia.org

TABLE A-4 (cont.)  
More detailed information on software tools with potential applications in participatory or policy development processes

Tool category	Name of the tool	General information		Phase of the participatory process			References
		Purpose of the tool	Topics for which the tool could be/has been applied	Exploratory phase	Scenario development	Scenario assessment	
Modelling and simulation tools	AquaCrop	AquaCrop is an FAO crop-model used to simulate yield response to water of several herbaceous crops. It is designed to balance simplicity, accuracy and robustness, and is particularly suited to address conditions where water is a key limiting factor in crop production. AquaCrop is a companion tool for a wide range of users and applications, including yield prediction under climate change scenarios	The tool aims to assist users with developing agricultural water management strategies by simulating yield response to water levels, specifically for irrigation management, project planning and scenario simulations at different scales	•	•	•	www.fao.org/hr/water/aquacrop.html
	CLUE (Conversion of land use and its effects)	The CLUE model is a dynamic, spatially explicit, land use and land cover change model, and the different versions are among the most frequently used land use models globally. Applications range from small regions to entire continents	Land use change on protected areas, pasture expansion, hydrology and erosion	•	•	•	Verburg and Overmars, 2009; www.ivm.vu.nl/en/Organisation/departments/spatial-analysis-decision-support/Clue/index.asp
	CO2FIX	A modelling framework for quantifying carbon sequestration in forest ecosystems	Carbon modelling in forest ecosystems		•		www.efi.int/projects/casfor/models.htm
	DTRAN	DTRAN is a computer model designed to help analyse the forest management situation in terms of a forest's ability to supply multiple product flows over time to different market locations	Forestry				http://fp0804.emu.ee/wiki/index.php/DTRAN
	EX-ACT (Ex-ante carbon-balance tool)	The EX-ACT tool computes carbon balance with and without a proposed management/policy action. The difference represents the potential impact of a project in terms of mitigation, indicating the net amount of carbon sequestered (carbon sink) or emitted (carbon source) as a result of the project	Carbon modelling in forest ecosystems, land use and land use change, afforestation and reforestation, cropland, perennial crops, rice, grassland, livestock, inputs (e.g. fertilizer) and investment (fuel and electricity use)		•		www.fao.org/tc/exact/en/
	FORECAST	Simulating stand attributes	Forecast used to create a series of stand attribute curves for each unit, including merchantable volume, species composition, stand structure and carbon storage				Hoare, 2004
	FPS-ATLAS	A tool used to simulate landscape management scenarios	FPS-ATLAS was used to examine two alternative landscape management scenarios and a baseline natural disturbance scenario in which there was no harvesting or fire suppression		•		http://courses.forestry.ubc.ca/frst424/Modelling/ATLASModelDocumentationTutorials.aspx

TABLE A-4 (cont.)  
More detailed information on software tools with potential applications in participatory or policy development processes

Tool category	Name of the tool	General information		Phase of the participatory process			References
		Purpose of the tool	Topics for which the tool could be/has been applied	Exploratory phase	Scenario development	Scenario assessment	
Modelling and simulation tools (cont.)	Global Trade Analysis Project (GTAP) Model	GTAP has developed a series of additional variations of the original model, for specific uses and purposes. For example, the GTAP-E model can be used for analysis of climate change issues, while the GDyn Model can be used to determine how changes in policy, technology, population and factor endowments can affect economies over time	Various; climate change/economic development/bioenergy	•	•	•	FAO, 2012; <a href="http://www.gtap.agecon.purdue.edu/default.asp">www.gtap.agecon.purdue.edu/default.asp</a>
	GLOBIOM (Global Biosphere Management Model)	GLOBIOM is a global recursive dynamic partial equilibrium model integrating the agricultural, bioenergy and forestry sectors with the aim of providing policy analysis on global issues concerning land use competition between the major land-based production sectors	Various; climate change mitigation and adaptation to climate change, impacts of biofuel policies, food security, future deforestation and emissions from land use change, global outlook of timber and agricultural production	•	•	•	<a href="http://www.iiasa.ac.at/web/home/research/models/Data/GLOBIOM/GLOBIOM.en.html">www.iiasa.ac.at/web/home/research/models/Data/GLOBIOM/GLOBIOM.en.html</a>
	G4M (Global Forestry Model)	The Global Forestry Model (G4M) projects emissions and removals as well as biomass supply. G4M is a geographically explicit agent-based model that assesses afforestation-deforestation-forest management decisions	GHG emissions, biomass supply, afforestation, deforestation	•	•	•	<a href="http://www.iiasa.ac.at/web/home/research/models/Data/G4M.en.html">www.iiasa.ac.at/web/home/research/models/Data/G4M.en.html</a>
	Graz/Oak Ridge Carbon Accounting Model (GORCAM)	GORCAM is a spreadsheet model developed to calculate the net fluxes of carbon to and from the atmosphere associated with strategies on land management and biomass utilization	Carbon sequestration, afforestation, bioenergy	•	•	•	<a href="http://www.joanneum.at/gorcam.htm">www.joanneum.at/gorcam.htm</a>
	MONTE (Spanish version) or MONSU (Finnish version)	This simulation tool for forest growth and visualization of forest landscape development supports decision-making and helps the user to prioritize management alternatives	Forestry, fire risk, habitat protection, multiple forest functions and products in southern Europe	•	•	•	Kangas <i>et al.</i> , 1996; Palahi <i>et al.</i> , 2004; Pukkala, 2003; <a href="http://www.forecotech.com">www.forecotech.com</a>
	SADFLOR	SADFLOR is set of decision support tools for forest harvest scheduling designed for Portuguese forest specificities. It encompasses a management information system in forest resources, a flexible prescription writer for the most important Portuguese species, and a set of models that allow the use of different methods for solving specific problems	Forestry				Rose, McDill and Hoganson, 1992

TABLE A-4 (cont.)  
More detailed information on software tools with potential applications in participatory or policy development processes

Tool category	Name of the tool	General information		Phase of the participatory process			References
		Purpose of the tool	Topics for which the tool could be/has been applied	Exploratory phase	Scenario development	Scenario assessment	
LCA tools	<b>GEMIS – Global Emissions Model for integrated Systems</b>	GEMIS is used by many parties in more than 30 countries for environmental, cost and employment analyses of energy, materials and transport systems	Life cycle assessment/GHG emissions/bioenergy	•	•	•	www.iinas.org/gemis.html
	<b>SimaPro</b>	SimaPro covers environmental, social and economic flows associated with the life cycle of various production processes	Life cycle assessment	•	•	•	www.pre-sustainability.com/simapro-lca-software
Interactive tools	<b>Canvas tool</b>	Am interactive tool used to help stakeholders create their own personal or sectoral visions	Land use/land use change	•	•	•	www.volante-project.eu/news/97-eea-is-interested-in-the-volante-canvas-tool-and-crowdsourcing.html
	<b>Cheering roleplay program</b>	A computer-assisted platform that uses roleplaying games to better explain or demonstrate ideas and concepts rather than through oral presentations		•			Campo <i>et al.</i> , 2009
	<b>CORMAS multi-agent simulation model</b>	Multi-agent systems are used for multi-stakeholder management systems, for example, involving community managed resources and application of MAS in forest management. The MAS model is developed using the companion modelling (ComMod) approach, which allows for collaborative development of the model between stakeholders and researchers	Community-based forest management, irrigation and water management, land use change	•	•	•	Campo <i>et al.</i> , 2009; Purnomo <i>et al.</i> , 2005; Simon and Etienne, 2010
	<b>Participatory perspective analysis (PPA)</b>	PPA helps stakeholders to handle future change, increases stakeholder capacity to efficiently generate and share useful information for decision-makers, and anticipates changes in unstable environments based on stakeholder input	Land use/land use change, natural resource management, forest and watershed management, role and place in agriculture and the rural world, the future of family farming (pending). This is a versatile tool designed to explore alternative futures of complex systems in multi-stakeholder environments	•	•	•	Jésus and Bourgeois, 2003; Laumonier <i>et al.</i> , 2008; Liswanti, 2012; Shantiko, 2012
	<b>Digital storytelling</b>	Digital storytelling is an emerging method that uses new digital tools to help ordinary people tell their own “true stories” in a compelling and emotionally engaging form. These stories usually take the form of a relatively short story (less than 8 minutes) and can evolve interactively	Impacts of forestry/land use on local communities and people living at grass roots level	•			www.bbc.co.uk/wales/audiovideo/sites/about/pages/howto.shtml



TABLE A-4 (cont.)  
More detailed information on software tools with potential applications in participatory or policy development processes

Tool category	Name of the tool	General information		Phase of the participatory process			References
		Purpose of the tool	Topics for which the tool could be/has been applied	Exploratory phase	Scenario development	Scenario assessment	
Interactive tools (cont.)	e-Delphi method	Tool for making Delphi surveys	Various socio-economic subjects. Can be used to explore issues, alternative futures, research priorities, reaching consensus, etc.	•	•		www.edelphi.nl; www.edelphi.fi
	Internet chat room	Used to organize online meetings of farmers and facilitators on technical and organizational issues	Various; land use/resource management	•			Evergreen farming: <a href="http://evergreen.asn.au">http://evergreen.asn.au</a> ; <a href="http://www.fao.org/Participation/ft_show.jsp?ID=1541">www.fao.org/Participation/ft_show.jsp?ID=1541</a>
	MAS (ComMod)	ComMod is applied to facilitate collective information sharing and learning, and to improve coordination among stakeholders for negotiation and decision-making	Integrated renewable resource management (see also CORMAS)	•			Ruankaew <i>et al.</i> , 2010
Growth simulators	Question Pro	Online survey tool	Various topics	•			www.questionpro.com
	Survey Monkey	Online survey tool	Various topics	•			www.surveymonkey.com
	Web 2.0	In the public sector, web 2.0 applications are used to increase citizen participation in policy-making, often by creating discussions on topics of interest. In web 2.0 applications the full range of foresight methods can be explored, and the merit of each application for online use evaluated	Crowdsourcing through web 2.0 applications. Also market research, discussion platforms, innovation, strategies and possibly policy planning	•	•		Haegeman <i>et al.</i> , 2012
	PICUS	A tool used to simulate long-term forest succession through comparison of scenarios under different management regimes and climatic models	Actual and potential vegetation, forest carbon, nitrogen and water balance, forest disturbance	•	•		www.wabo.boku.ac.at/picus.html
	Silva simulator	A tool used to predict forest growth potential at the plot, stand, forest holding and regional level	Forestry (used mainly in Central Europe but also applied in other vegetation zones, although mainly in plantation forestry with a single or a few tree species)	•	•		Lämäs, 2010; Pretzsch, 2009; Pretzsch <i>et al.</i> , 2002
Decision support systems	SIMForTree	Simulation tool used for decision support in the forest management unit vs. whole country	Forestry, mainly in Europe. Forest simulation and harvest scheduling	•	•		www.simfortree.be
	ARIES (Artificial Intelligence for Ecosystem Services)	ARIES is a web-based technology used to assist rapid ecosystem service assessment and valuation (ESAV). Its purpose is to make environmental decision-making easier and more effective. ARIES helps users discover, understand and quantify environmental assets and the factors influencing their values, for specific geographic areas and based on user needs and priorities	Carbon, flood and sediment regulations, water supply, recreation, conservation, fisheries, coastal protection	•	•		www.ariesonline.org

TABLE A-4 (cont.)  
More detailed information on software tools with potential applications in participatory or policy development processes

Tool category	Name of the tool	General information		Phase of the participatory process			
		Purpose of the tool	Topics for which the tool could be/has been applied	Exploratory phase	Scenario development	Scenario assessment	References
Decision support systems (cont.)	CATWOE	CATWOE is a simple checklist that can be used to stimulate thinking about problems and solutions	Mostly used to resolve business problems complicated by multiple and often contrasting interests of multiple stakeholders. By allowing the consideration of different worldviews, it provides a framework to establish root definitions and promote a problem-solving approach	•			<a href="http://ccit333.wikispaces.com/CATWOE">http://ccit333.wikispaces.com/CATWOE</a>
	CRISTAL (Community-based Risk Screening Tool – Adaptation and Livelihoods)	CRISTAL is a project-planning tool that helps users to design activities that support climate adaptation (i.e. adaptation to climate variability and change) at the community level	Adaptation to climate change and livelihoods, disaster risk reduction, environmental management and poverty reduction. The approach draws on environmental impact assessment and rapid rural appraisal	•	•	•	Robledo <i>et al.</i> , 2012; <a href="http://www.iisd.org/cristaltool/">www.iisd.org/cristaltool/</a>
	ENCOFOR toolbox	This toolbox contains a tool demonstration and links to manuals, checklists and spreadsheets that can be used during different project stages (e.g. for pre-feasibility stage analysis, feasibility stage analysis, and finally tools to assist the documentation stage)	Contains tools for carbon accounting, decision support systems, social impact assessment and environmental impact assessment	•	•	•	<a href="http://www.joanneum.at/encofor/index.html">www.joanneum.at/encofor/index.html</a>
	FORMIX3 and BEFORE	Test policy ideas	C&I development and mountain forests				Brang <i>et al.</i> , 2002
	GEOBENE/Felix model	A tool used to visualize different global scenarios. The simulator incorporates six basic GEO scenarios: an energy scenario, disaster scenario, health scenario, climate scenario, agriculture scenario and water scenario (weather, ecosystem and biodiversity societal benefit areas are jointly considered under these scenarios)	Economy, energy, emissions, carbon cycle, climate and environment, population, technology, land use	•			<a href="http://www.geo-bene.eu">www.geo-bene.eu</a>
	IDRISI Land Change Modeler	This software for REDD practitioners addresses conservation strategies such as forest protection or sustainable forest production. The tool includes a complete land analysis toolkit, compatible with international requirements, for mapping historical baselines and modelling future scenarios, as well as a REDD modelling facility to estimate and monitor GHG emission reductions due to REDD project implementation	Land cover mapping, management and conservation of forest carbon, biodiversity and related ecosystem services	•	•	•	<a href="http://clarklabs.org/products/Land-Change-Modeler-Overview.cfm">http://clarklabs.org/products/Land-Change-Modeler-Overview.cfm</a>

TABLE A-4 (cont.)  
More detailed information on software tools with potential applications in participatory or policy development processes

Tool category	Name of the tool	General information		Phase of the participatory process			References
		Purpose of the tool	Topics for which the tool could be/has been applied	Exploratory phase	Scenario development	Scenario assessment	
Decision support systems (cont.)	<b>Integrated Biodiversity Assessment Tool (IBAT)</b>	IBAT aims to facilitate access to information on high-priority sites for conservation – namely protected areas and key biodiversity areas – to inform the implementation of corporate biodiversity policies and enhance environmental management systems. By incorporating IBAT into project planning, the aim is to reduce impacts on biodiversity	IBAT covers marine, plant and animal biodiversity and aggregates data from a range of sources. It has been applied for the identification of high conservation areas	•			FAO, 2012; www.ibatforbusiness.org
	<b>Integrated Valuation of Environmental Services and Tradeoffs (INVEST)</b>	This open-source software suite developed by the Natural Capital Project is used to inform and improve natural resource management and investment decisions. It enables users to quantify, visualize and compare the delivery of key ecosystem services under different scenarios of land, water and marine uses	INVEST currently includes 16 models on aesthetic quality, biodiversity, carbon, coastal protection, coastal vulnerability, crop pollination, habitat risk assessment, managed timber production, marine fish aquaculture, marine water quality, offshore wind energy, overlap analysis, reservoir hydropower production, sediment retention, water purification and wave energy	•	•	•	www.naturalcapitalproject.org/models/models.html
	<b>Internet band application and teledemocracy and GIS</b>	This tool uses information networks in participatory planning to gather people's opinions and for decision support in natural resources management	Technical information related to forest planning and updating stakeholders via the internet: enables stakeholders to express their personal views based on their experiences, knowledge and field of expertise				Kangas and Store, 2003
	<b>NETICA</b>	This software package solves problems using Bayesian Belief Networks and influence diagrams. BBNs have the ability to model real-time scenarios and can be used as tools to link environmental situations to GIS maps and visualize management changes immediately	Environmental and natural resource management, aquaculture development	•			www.norsys.com/netica.html
	<b>OSMOSE (On-Site, Multi-criteria, Optimization, Spatial, Evaluation)</b>	This tool generates specific spatial (forest) decision support systems dealing with multiple criteria	Selection of optimal sites for afforestation (AFFOREST, ForAndest); selection of optimal forest management types (AFFOREST, ForAndest, Sim4Tree); optimization of land use distribution for food security (SADeR, Burundi)			•	De Meyer et al., 2012

TABLE A-4 (cont.)  
More detailed information on software tools with potential applications in participatory or policy development processes

Tool category	Name of the tool	General information		Phase of the participatory process			References
		Purpose of the tool	Topics for which the tool could be/has been applied	Exploratory phase	Scenario development	Scenario assessment	
Decision support systems (cont.)	Political mapping/ PolicyMaker software	Political mapping is a tool for organizing information about the political landscape in an illustrative way. It provides analysis of political alliances at the macro (national or sector) level. The tool can provide an entry point to a more in-depth analysis of the political economy	The tool can illustrate the distribution and nature of support or opposition to government with respect to a given reform. The tool can be applied both at the macro, meso and micro-political scale. For example, it has been applied on a case study on liberalizing the mining sector	•	•	•	www.polimap.com/default.html; <a href="http://siteresources.worldbank.org/EXTOPPS/SOU/Resources/1424002-1185304794_278/TIPs_Sourcebook_English_PartII.pdf?&amp;resourceurlname=TIPs_Sourcebook_English_PartII.pdf">http://siteresources.worldbank.org/EXTOPPS/SOU/Resources/1424002-1185304794_278/TIPs_Sourcebook_English_PartII.pdf?&amp;resourceurlname=TIPs_Sourcebook_English_PartII.pdf</a>
	REDD Abacus SP	This tool estimates emissions from land use and land cover changes, analyses trade-offs between emissions and financial gain, simulates zone-specific policies and other emission reduction scenarios within landscapes, and estimates the potential emission reductions and opportunity costs	Developing a land use plan, assessing carbon efficiency, estimating abatement cost of emissions from land use/cover changes at a regional level	•	•	•	<a href="http://worldagroforestry.org/regions/southeast_asia/about-us/resources/redd-abacus-sp">http://worldagroforestry.org/regions/southeast_asia/about-us/resources/redd-abacus-sp</a>
	RICH Decisions	RICH Decisions is a decision support tool based on the RICH-method devised by Ahti Salo and Antti Punkka. The method gives weight to different values, which are important in making the decision	Value tree analysis decision support			•	<a href="http://www.rich.hut.fi">www.rich.hut.fi</a>
	Risk indexing	Risk indexing is a systematic approach to identifying, classifying and ordering sources of risk and examining differences in risk perception	Assesses the nature and variation of risks faced within a population and the causes of heterogeneity in risk perception. Can be used to monitor the likely impact on risks presented by a proposed policy change	•			Quinn, 2001
	SISA software for statistical analysis	This tool is used to identify policy options. It is a practical modelling exercise to acquire information from people experiencing actual conditions of forest loss on the ground	Forest loss and environment management				Mbatu, 2009
	WEAP	WEAP provides a system for maintaining water demand and supplying information for policy planning. It can also evaluate a full range of water development and management options, taking into account multiple water users	Analysis of integrated water resources planning, including economics	•	•	•	FAO, 2010d; <a href="http://www.weap21.org">www.weap21.org</a>

TABLE A-4 (cont.)  
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Databases	KLIMOS toolkit	The toolkit provides information in support of environmental mainstreaming in development cooperation. The database contains environmental information organized along three access criteria: country, theme and sector	Biodiversity, climate, land use, water	•			www.vub.ac.be/klimostoolkit
Computer software for collaborative modelling	NVivo qualitative analysis software	This tool identifies the motivating factors and facilitating conditions to encourage a high level of participation among women	Forest management				Nuggehalli and Prokopy, 2009
	Analytica	Spreadsheet with simulation and optimization option	Analysis				www.lumina.com
	Catpac II	Catpac is a computer program that analyses text samples to identify key concepts contained within the sample. It uses text files as inputs and produces outputs such as word and alphabetical frequencies, as well as various types of cluster analysis. Catpac identifies important words and patterns based on the organization of the text	Text analysis in a sociological context	•			www.galileo.com/N_catpac.asp
	Dynamic Actor Network Analysis (DANA)	The aim of DANA is to analyse information on actors (organizations, stakeholder groups or individuals) that play a role in policy situations. It helps policy analysts to identify conflicts, potential coalitions and opportunities for successful coordination when actors have conflicting preferences, but similar cognitive representations of the decision context	Analysis of information on actors (organizations, stakeholders, individuals)	•			http://dana.actoranalysis.com
	EXCEL	Spreadsheet with options for building user interface	Analysis				http://office.microsoft.com
	Exploratory attribute-based choice experiment approach, statistical package (SAS, NLOGIT for Limdep)	This tool explores regional differences in preferences of diverse groups and trade-offs between different attributes of SFM	Industrial forestry				Berninger et al., 2010

TABLE A-4 (cont.)  
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Computer software for collaborative modelling (cont.)	HEC PRM	Optimization with penalty functions	Multi-objective reservoir system optimization				www.hec.usace.army.mil/software/hec-resprm/documentation/CPD-95_HEC-PRM_UsersManual.pdf
	HEC-ResSim	This tool provides simulations with a map interface	Analysis of reservoir operations				www.hec.usace.army.mil/software/hec-resprm/
	OASIS	This tool provides simulations and optimization	Analysis of water routing				www.hydrologics.net/oasis.html
	PowerSim software	This simulation software can be used to create scenarios					www.powersim.com
	RiverWare	This tool provides simulations and optimization	Analysis of river and reservoir systems, especially hydroelectric systems				http://cadswes2.colorado.edu/downloads/riverware/releases/
	Software package CANOCO 4.5 and ordination diagrams drawn in CANODRAW	This tool analyses the perceptions of different stakeholders and their proposed management solutions with respect to forest decline and policy recommendations	Forest management				Pare et al., 2009
	Vensim, Goldsim	This tool provides system dynamics/ simulations with user-friendly interface features	Problem definition, analysis or synthesis of any system				http://vensim.com; www.goldsim.com
Cognitive mapping tools	CIMAT (Criteria and Indicator Modification and Adaptation Tool)	CIMAT is a computer software designed to help users modify, customize and adapt the CIFOR C&I (criteria and indicators) generic template and C&I sets	Natural resource management, forest management, sustainability, sustainable land use, criteria and indicators				Prahbu et al., 2000; www.cifor.org/acm/methods/toolbox3.html
	Cognitive mapping (Journey making and SODA)	Problem structuring. The key aim of SODA is to achieve understanding and agreement among team members regarding the problem under discussion	Strategic Options Development and Analysis. Used together, the Decision Explorer and Group Explorer software support the building of cognitive maps in SODA workshops				Georgiou, 2011
	Co-View software	This tool supports integration of MCA approaches and use of participative modelling to support decision-making	Community-based forest management, sustainable management of timber and other resources				Mendoza and Prabhu, 2005



TABLE A-4 (cont.)  
 More detailed information on software tools with potential applications in participatory or policy development processes

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Cognitive mapping tools (cont.)	<b>DECISION EXPLORER</b>	This cognitive mapping or mind-mapping tool manages the "soft" issues or qualitative information that surround complex or uncertain situations	Various issues from everyday problems to strategic decisions. Can be used to focus group discussions	•	•	•	www.banxia.com/dexplore
	<b>Mind Manager</b>	This software captures, visualizes and manages ideas, similar to mind mapping	Various	•			www.mindjet.com/products/mindmanager
	<b>Mind Mapping software</b>	This software captures, visualizes and manages ideas	Various	•			www.mindgenius.com
	<b>STELLA</b>	This tool simulates landscape and livelihood dynamics in order to understand synergies and trade-offs of land use change from the perspectives of different stakeholders. It supports the creation of a participatory forest management plan and can be used for building future scenarios and identifying challenges of participatory forest management	Forest conservation, wood production, conversion to plantation forest, land use change, livelihood, participatory forest management	•	•	•	Kassa et al., 2009; Sandker, Suwarno and Campbell, 2007; Suwarno et al., 2009

Forest Economics, Policy and Products Division  
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