Forest futures: Linking global paths to local conditions

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Abstract: The chapter establishes links between elements of long-term global scenarios and the prerequisite conditions of sustainable forest management (SFM), as discussed in Parts I and III. It uses a component from a new global scenario exercise: the shared socio-economic pathways (SSPs), which are narratives that cover a spectrum of climate change mitigation and adaptation challenges. The chapter tests how different SSP narratives relate to the prerequisite conditions for SFM through two approaches: 1) by analysing how the prerequisite conditions are represented in the SSP narratives, and 2) by postulating prerequisite condition scenarios and linking those to the SSPs. Two SSPs that foresee high adaptation challenges foresee deteriorating social cohesion and reduced international cooperation in addressing shared global challenges linked to climate change. The narratives of these two SSPs both suggest several challenges for SFM. The SSP that foresees high mitigation challenges generally suggests positive trends for the prerequisite conditions but also progressive influence of market mechanisms with unpredictable outcomes for environmental management. A three-tier scenario for the prerequisite conditions and testing them against the SSP narratives suggests a fairly comprehensive alignment but also indicates a marked difference between the two SSPs that foresee adaptation challenges and prerequisite conditions of tenure rights and public administration.

Keywords: Shared socio-economic pathways, sustainable forest management, prerequisite conditions, MaxQDA Qualitative Data Analysis, scenarios

5.1 Introduction

Chapter 4 of Part IV makes clear that the current state of knowledge limits the scope of a multi-scale scenario analysis on how best to achieve the objectives of sustainable forest management (SFM). Nevertheless, the case studies in Part II of this book can help fill some of the gaps. In this chapter, we link global processes to local forest management in the context of different global futures by using the prerequisite conditions identified in Part I and analysed in Part III. Prerequisite conditions are social, economic, cultural, political, environmental and biophysical conditions that need to be in place for SFM to occur. We approach the connection between global paths and local conditions from two directions. First, we postulate that different global scenario narratives imply different trajectories for the prerequisite conditions, which suggest trends toward or away from sustainable use of forests. Second, we generate scenarios by specifying trends in the prerequisite conditions and verifying whether these are more or less consistent with one or more global scenario narratives. The approaches yield consistent but distinct results and are likely to be useful for different purposes. The second approach is called for in studies that begin with a community of forest experts creating its own set of scenarios in a participatory manner, while the first approach can be useful in multi-sectoral studies using a set of global scenarios.

Several well-known sets of global scenarios have been constructed. These include the Millennium Ecosystem Assessment (MA) scenarios (MA Scenarios Working Group 2005), the scenarios of the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (SRES) (Nakićenović et al. 2000), and the Global Environment Outlook (GEO) scenarios of the United Nations Environment Programme (UNEP) (UNEP 2007), which were themselves based on the scenarios of the Global Scenario Group (GSG) (Gallopín and Raskin 2002, Raskin 2008). These global scenario studies have been used as the basis for several regional and global scenario exercises (Rounsevell and Metzger 2010), including in the forestry sector (FAO 2003). The MA, in particular, was concerned with

cross-scale issues and explored methods for linking scenarios across scales (MA 2003), and there has been considerable discussion of the need for cross-scale scenarios when considering possible futures for linked ecological and social systems (Wilbanks and Kates 1999, Cash et al. 2006, Biggs et al. 2007). Zurek and Henrichs (2007) provide a classification for cross-scale scenario exercises, where the degree of linkage can range from "hard" links using models to "no" links. The hard-link approach, in the context of land-use change, has seen considerable methodological development (Veldkamp and Lambin 2001). In contrast, while there have been several exercises that use a soft-link approach, methodologies are still in the early stage of development. In Zurek and Henrichs' classification scheme, many existing studies seek "coherence across scales," in that they use the same scenario framework at different scales, and sometimes "consistency across scales," in that they use identical drivers.

Chapter 4 (Part IV) also made clear that scenarios should be participatory if they are to address local and regional challenges in SFM. In general, local and regional scenario exercises are used more often for insight in participatory settings, while in global exercises the scenarios are more often an end in themselves (Stratigea and Giaoutzi 2012), so not only social and biophysical processes but also the goals of the exercise may change. This chapter applies two methods to link global scenarios to local and regional ones, one top-down and the other bottom-up. The top-down approach aims for coherence across scales in the typology of Zurek and Henrichs (2007), in that it takes a global scenario frame and applies it to the forestry sector. In this approach, we use qualitative data analysis to analyse narratives, an approach that has rarely been applied in foresight studies (Stratigea et al. 2012 being the only exception we found). This is a bit surprising, given the popularity of textual analysis – to discover trends (e.g. Kostoff et al. 2001) – and discourse analysis (e.g. Burt 2010). The bottom-up approach is an example of complementarity across scales, in that a scenario framework for the forestry sector is developed independently of the global scenario and subsequently linked to it.

While any of the existing global scenario studies cited provide a wide range of socio-economic scenarios, we have chosen to use one component of a new framework for generating climate scenarios (Ebi et al. 2014), the shared socio-economic pathways (SSPs) (O'Neill et al. 2014). For brevity, in this chapter we will sometimes refer to the SSP narratives as "scenarios," but it is important to note that they are part of a scenario framework for generating scenarios and not a set of scenarios proper. The SSPs build on the experiences of previous scenario activities, are being developed with substantive input from researchers from diverse fields, and are intended to provide a common basis for future work on impacts, adaptation, and vulnerability (van Ruijven et al. 2014). The SSPs are currently being created as one component of a new round of climate scenarios intended to replace the SRES scenarios (Moss et al. 2010). Unlike the SRES scenarios, the SSPs and other components of the new round of scenarios are being elaborated by the global research community rather than under the auspices of the IPCC. However, they are being developed in consultation with the IPCC and are likely to be used in future IPCC publications. One innovation of climate scenarios currently being developed is that they keep greenhouse gas and socio-economic pathways separate, reflecting the reality that there is not a one-to-one correspondence between socio-economic trends and greenhouse gas emissions, only a more or less plausible interconnection (van Vuuren et al. 2012). In contrast to SRES, which includes socio-economic conditions and greenhouse gas trends in a single scenario, each SSP, which describes socio-economic conditions, can be combined with one or more representative concentration pathways (RCPs) to reflect greenhouse gas trends (Kriegler et al. 2012, O'Neill et al. 2014).

Using the SSPs has additional advantages over using other global scenarios. Many of those involved in SSP development were previously involved in the SRES, MA, GEO, and GSG scenario exercises, bringing the lessons they have learned to the development of the SSPs. The analysis will take advantage of developments in scenario methodology and thus should remain fresh for several years. Also, the SSPs are following a more open and dynamic process of development than previous global scenario exercises (O'Neill et al. 2014). These advantages can be weighed against the climate focus of the SSPs, which may not align with SFM. However, as previously noted, the SSPs are socio-economic pathways that are distinct from climate trends. They have already been applied in a study on health futures (Ebi 2014), in which narratives were constructed for the health sector that were consistent with the global SSP narratives (an example of coherence across scales; see Zurek and Henrichs 2007). As will be seen later in this chapter, adaptive capacity aligns well with potential for SFM. The SSP narratives should therefore be relevant for forest futures, and since they are likely to be widely used in the future, it can permit forest futures to be more easily integrated with other studies.[1] Also, unfortunately, including greenhouse gas

[1] There is also a database of quantitative drivers at national level that is being maintained by the International Institute for Applied Systems Analysis (IIASA): https://secure.iiasa.ac.at/web-apps/ene/SspDb.

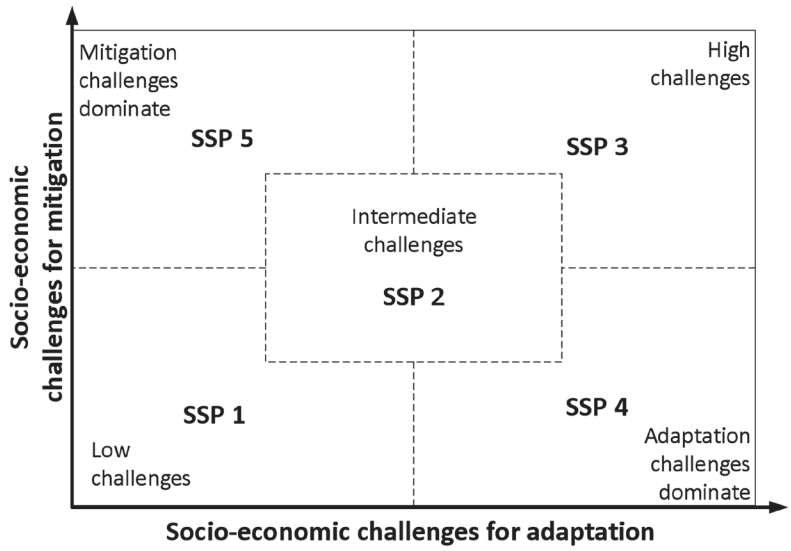

Figure IV 5.1 Scenario framework for the shared socio-economic pathways (SSPs) (from O'Neill et al. 2014).

trajectories (RCPs) may be essential in future work because the possibility of disruptive climate change seems increasingly likely (World Bank 2013).

For the SSPs, a core scenario set (the "basic SSPs") provides a common reference point for disparate studies on society and climate change while allowing particular studies to elaborate on the framework itself for different social, economic, and ecological systems at various scales by developing multiple "extended SSPs." For example, a study may focus on the management of a fishery, a major river system, or the socio-economic development of a city, country, or region. By using the SSPs in this volume, which explores possible ways to foster SFM, it is possible to inform the global process of climate-change-scenario development. The openness of the SSP process to local and topical specificity was adopted in large part to overcome the difficulties of applying global scenario narratives to impact, adaptation, and vulnerability (IAV) studies (Rothman et al. 2014, van Ruijven et al. 2014), including IAV studies related to forests.

The IAV community works at a wide range of scales and with diverse methods (Wilbanks and Ebi 2014). The benefit of a common framework should be a greater degree of comparability between studies. If combined with a multi-scale, participatory scenario technique (Part IV, chapter 4), the SSPs can be used in a participatory approach to generate locally relevant scenario narratives.

5.2 The scenario space

The SSPs fill a scenario space as illustrated in Figure IV 5.1. As shown in the figure, the scenarios are framed in terms of socio-economic challenges to both mitigation and adaptation. This framing reflects their origin in the climate community, as the scenario narratives are meant to span a range of uncertainties relevant to climate studies on both mitigation and adaptation. Importantly, the scenario space is defined along outcome axes, a departure from past studies that focused on inputs, such as technological change. However, the framing in terms of socio-economic challenges for mitigation and adaptation is also a fruitful starting point for elaborating more general socio-economic scenarios for environmental and natural resource futures, which is how we use the SSP framework in this chapter. The climate emphasis of the SSPs is incidental to our purpose – the focus of this chapter and of the book as a whole is SFM.

The SSPs are still in development although a great deal of work has already gone into defining them. We use narratives that were drafted at an international meeting (O'Neill et al. 2012); these drafts are currently being revised in response to critiques and suggestions from an open comment period. In this chapter we use the full narratives from O'Neill et al. (2012) to explore possible future trends in prerequisite conditions. The summary versions from the same paper are shown in Box IV 5.1.

Box IV 5.1 The SSP Summary Narratives

SSP1: Sustainability

This is a world making relatively good progress towards sustainability, with sustained efforts to achieve development goals while reducing resource intensity and fossil-fuel dependency. Elements that contribute to this are rapid development of low-income countries, reduction of inequality (globally and within economies), rapid technology development, and a high level of awareness regarding environmental degradation. Rapid economic growth in low-income countries reduces the number of people below the poverty line. The world is characterised by an open, globalised economy, with relatively rapid technological change directed towards environmentally friendly processes, including clean-energy technologies and yield-enhancing technologies for land. Consumption is oriented towards low material growth and energy intensity, with a relatively low level of consumption of animal products. Investments in high levels of education coincide with low population growth. Concurrently, governance and institutions facilitate achieving development goals and problem-solving. The Millennium Development Goals are achieved within the next decade or two, resulting in educated populations with access to safe water, improved sanitation, and medical care. Other factors that reduce vulnerability to climate and other global changes include, for example, the successful implementation of stringent policies to control air pollutants and rapid shifts towards universal access to clean and modern energy in the developing world.

SSP 2: Middle of the Road

In this world, trends typical of recent decades continue, with some progress towards achieving development goals, reductions in resource and energy intensity at historic rates, and slowly decreasing fossil-fuel dependency. Development of low-income countries proceeds unevenly, with some countries making relatively good progress while others are left behind. Most economies are politically stable, with partially functioning and globally connected markets. A limited number of comparatively weak global institutions exist. Per-capita income levels grow at a medium pace on the global average, with slowly converging income levels between developing and industrialised countries. Intra-regional income distributions improve slightly with increasing national income, but disparities remain high in some regions. Educational investments are not high enough to rapidly slow population growth, particularly in low-income countries. Achievement of the Millennium Development Goals is delayed by several decades, leaving populations without access to safe water, improved sanitation, and medical care. Similarly, there is only intermediate success in addressing air pollution or improving energy access for the poor, as well as other factors that reduce vulnerability to climate and other global changes.

SSP 3: Fragmentation

The world is separated into regions characterised by extreme poverty, pockets of moderate wealth, and many countries that struggle to maintain living standards for a strongly growing population. Regional blocks of countries have re-emerged with little coordination among them. This is a world failing to achieve global development goals and with little progress in reducing resource intensity and fossil-fuel dependency or in addressing local environmental concerns such as air pollution. Countries focus on achieving energy and food security goals within their own region. The world has de-globalised, and international trade, including energy resource and agricultural markets, is severely restricted. Little international cooperation and low investments in technology development and education slow down economic growth in high-, middle-, and low-income regions. Population growth in this scenario is high as a result of the education and economic trends. Growth in urban areas in low-income countries is often in unplanned settlements. Unmitigated emissions are relatively high, driven by high population growth, use of local energy resources, and slow technological change in the energy sector. Governance and institutions show weakness and a lack of cooperation and consensus; effective leadership and capacities for problem-solving are lacking. Investments in human capital are low and inequality is high. A regionalised world leads to reduced trade flows, and institutional development is unfavourable, leaving large numbers of people vulnerable to climate change and many parts of the world with low adaptive capacity. Policies are oriented towards security, including barriers to trade.

SSP 4: Inequality

This pathway envisions a highly unequal world both within and across countries. A relatively small, rich global elite is responsible for much of the emissions, while a larger, poorer group contributes little to emissions and is vulnerable to impacts of climate change in both industrialised and developing countries. In this world, global energy corporations use investments in research and development as a hedging strategy against potential resource scarcity or climate policy, developing (and applying) low-cost alternative technologies. Mitigation challenges are therefore low due to some combination of low reference emissions and/or high latent capacity to mitigate. Governance and globalisation are effective for and controlled by the elite but are ineffective for most of the population. Challenges to adaptation are high due to relatively low income and low human capital among the poorer population and to ineffective institutions.

SSP5: Conventional Development

This world stresses conventional development oriented towards economic growth as the solution to social and economic problems through the pursuit of enlightened self-interest. The preference for rapid conventional development leads to an energy system dominated by fossil fuels, resulting in high greenhouse gas emissions and challenges to mitigation. Lower socio-environmental challenges to adaptation result from attainment of human development goals, robust economic growth, highly engineered infrastructure with redundancy to minimise disruptions from extreme events, and highly managed ecosystems.

Source: O'Neill et al. 2012

5.3 Matching prerequisite conditions to scenarios

The SSP narratives do not specifically mention forests. Neither do they mention any particular resource other than energy, as they are meant to be used in a wide range of applications. Nevertheless, they do have implications for forests, as well as other resources and social-ecological systems, through such general phrases as "a high level of awareness regarding environmental degradation" and "little progress in reducing resource intensity." To make the connection, we match narrative elements from the SSPs with the prerequisite conditions identified in Part I and analysed in Part III, which are narrative elements relevant to SFM. We take two approaches: the first starts from the SSPs and explores their linkages with forest management while the second explores the same linkages the other way around, starting from a forest management perspective, and scaling this up to the SSPs. In the first approach, we carry out a textual analysis of the SSP narrative sketches. Using the MaxQDA Qualitative Data Analysis (QDA) software (VERBI Software 2014), we coded excerpts of the SSP narratives with the prerequisite conditions for SFM. In the second approach, we developed a consistent scenario framework for SFM, with no reference to the SSPs, using the cross-impact balance (CIB) method (Weimer-Jehle, 2006). We then connected the scenario framework to the SSPs. The CIB method has been applied to the SSPs themselves by Schweizer and O'Neill (2014).

5.3.1 From SSPs to prerequisite conditions

When applying the first approach that explores the presence of prerequisite conditions in the SSPs, we coded the narrative sketches for SSPs 1, 3, 4, and 5 with the prerequisite conditions developed in Parts I and III. The SSP2 (middle of the road) narrative has ambiguous implications for each of the prerequisite conditions, so while it might well be a useful scenario for discussing SFM, the description was compatible with divergent trends for each of the prerequisite conditions. Because the prerequisite conditions themselves do not (with rare exceptions) appear explicitly in the narrative sketches, the coding unavoidably requires personal judgment. What the QDA method supplies is a degree of rigour, in that the analyst codes individual passages (Table IV 5.1), focusing on their wording rather than reporting an impressionistic account of the narrative. Also, the assignments are traceable – the codes for each excerpt are recorded and can be reviewed and scrutinised by others.

The coding is provided in Table IV 5.1, which shows the assignments of prerequisite conditions to narrative excerpts. Generally, challenges to SFM align with challenges to adaptation. Unsurprisingly, the SSP1 (sustainability) narrative implies largely positive outcomes for SFM; however, we note some ambiguity in the impact on forests. It is possible, for example, that a push for biofuels could initially place pressure on forest resources, with a need for strong, forest-specific policy responses in order to maintain forests (Pacheco et al. 2013).

The SSP3 (fragmentation) and SSP4 (inequality) narratives generally imply a more challenging environment for SFM. Both scenario narratives feature high challenges for climate change adaptation, and the conditions required for high adaptive capacity are generally also the conditions that could result in improved forest management. The SSP5 (conventional development) narrative generally correlates well and shows positive trends with the prerequisite conditions of SFM, yet it has negative effects on the long-term commitment to SFM and ambiguous effects on long-term ecosystem management. This ambiguity arises because SSP5 features a drive towards sustainable development that relies heavily on market mechanisms that may not necessarily proved effective for managing environmental effects.

Another way to look at the same information is shown in Table IV 5.2. There it can be seen that SSP3 (fragmentation) features negative impacts on livelihoods combined with worsening inequalities and the poor enforcement of laws and regulations, both of which are associated with negative outcomes for SFM (Part III). SSP3 also features a lack of access to capital and influence. In contrast, SSP5 (conventional development) emphasises technology, human capacity, and leadership, consistent with its focus on technological and management solutions to problems. The SSP1 (sustainability) narrative does not strongly emphasise any one prerequisite condition; rather, it suggests a broad improvement across many prerequisite conditions.

The general conclusions from Table IV 5.2 are illustrated in Figure IV 5.2. As shown in the figure, negative trends for prerequisite conditions for SFM are more strongly aligned to the SSP axis "socio-economic challenges for adaptation" than they are to "socio-economic challenges for mitigation." This makes sense because of the relationship between mitigation and adaptation challenges as pictured in the SSPs and constraints on SFM. Within the SSPs, challenges to mitigation are higher mainly because economic development is more material-intensive. In contrast, the mitigation challenge in forests is to maintain carbon pools in standing stock and soils, which has more to do with forest management than

Table IV 5.1 Matching SSP narrative elements to prerequisite conditions.[a]

SSP	Segment	Category	Enabling condition	Direction
SSP1	A world making relatively good progress towards sustainability, with sustained efforts to achieve development goals while reducing resource intensity	Policies, institutions, governance	Long-term commitment to SFM	Positive
	Countries cooperate to achieve common development and environmental goals		Influence of regional and global processes	Positive
	Governance and institutions facilitate achieving social, environmental, and economic development goals and problem-solving			Positive
	High level of awareness regarding environmental degradation	Natural resource base		Positive
		Policies, institutions, governance	Long-term commitment to SFM	Positive
	High levels of diversity that confer resilience to societal and environmental changes	Natural resource base	Extent and condition of forest resources	Positive
	Improved regional livelihoods, a renewed emphasis on regional production	Livelihoods, cultural, socio-economic	Contribution of forests to livelihoods	Positive
	Natural resources used efficiently, with high awareness of the environmental consequences of choices		Landscape and ecosystem management	Positive
			Technical, managerial, leadership	Positive
	Rapid economic growth in developing countries		Access to capital	Positive
			Commercial opportunities	Positive
	Reduction of inequality (globally and within economies)	Policies, institutions, governance	Land tenure	Positive
	Strong investment in research and development	Research and monitoring	Research programmes	Positive
	Technology development directed towards environmentally friendly processes, including clean energy technologies and high productivity of land	Livelihoods, cultural, socio-economic	Technical, managerial, leadership	Positive
		Research and monitoring	Research programs	Positive
SSP3	A world failing to achieve global development goals and with little progress in reducing resource intensity	Policies, institutions, governance	Long-term commitment to SFM	Negative
	Development proceeding slowly, with high inequalities	Livelihoods, cultural, socio-economic	Access to capital	Negative
		policies, institutions, governance	Land tenure	Negative
	Disadvantaged populations continuing move to unplanned settlements around large urban areas	Livelihoods, cultural, socio-economic	Contribution of forests to livelihoods	Negative
	Governance and institutions relatively weak	Policies, institutions, governance	Enforcement of laws and regulations	Negative
			Public administration	Negative
	Low investments in research and development and in human capital	Research and monitoring	Research programs	Negative
	Little international cooperation	Policies, institutions, governance	Influence of regional and global processes	Negative
	Low investments into technology development	Livelihoods, cultural, socio-economic	Technical, managerial, leadership	Negative
		Research and monitoring	Research programs	Negative
	Policies oriented towards security	Livelihoods, cultural, socio-economic	Security and conflict	Negative
	Serious degradation of the environment	Natural resource base	Extent and condition of forest resources	Negative

Table IV 5.1 Continued.

SSP	Segment	Category	Enabling condition	Direction
SSP4	Absence of sustainability regulations	Policies, institutions, governance	Long-term commitment to SFM	Negative
	Access to markets limited, increasing vulnerability for non-connected population groups	Livelihoods, cultural, socio-economic	Commercial opportunities	Negative
			Contribution of forests to livelihoods	Negative
	Corporations acquiring the necessary land-resources in developing countries to grow energy crops,	Policies, institutions, governance	Land tenure	Negative
			Reconciliation of land uses	Negative
	Governance dominated by regulatory capture		enforcement of laws and regulations	Negative
			Public administration	Negative
	Hedging against resource scarcity perhaps a strong push for bioenergy by global energy corporations		Influence of regional and global processes	Negative
	Land ownership unevenly distributed and land-use management also left to the global elite		Influence of regional and global processes	Negative
			Land tenure	Negative
			Reconciliation of land uses	Negative
	Low social cohesion	Livelihoods, cultural, socio-economic	Security and conflict	Negative
		Policies, institutions, governance	Participation	Negative
	Poor people having the hope, and sometimes the opportunity, to become a member of the elite but mostly trapped in their conditions	Livelihoods, cultural, socio-economic	Access to capital	Negative
			Commercial opportunities	Negative
	Productive areas of the world dominated by industrialised agriculture and monocultural production		Role of industrial forestry	Negative
		Natural resource base	Trees outside the forest and agroforestry	Negative
	Reduced options for adaptation for local communities and for nature conservation	Livelihoods, cultural, socio-economic	Contribution of forests to livelihoods	Negative
			Landscape and ecosystem management	Negative
	Vulnerable to the impacts of climate change in both developing and industrialised countries, and concentrated in rural areas and large mega-cities		Contribution of forests to livelihoods	Negative

Table IV 5.1 Continued.

SSP	Segment	Category	Enabling condition	Direction
SSP5	A global "development first" agenda enforced		Access to capital	Positive
			Commercial opportunities	Positive
			Security and conflict	Positive
		Policies, institutions, governance	Influence of regional and global processes	Positive
	Preference for individual mobility, meat-rich diets, and tourism and recreation	Livelihoods, cultural, socio-economic	Commercial opportunities	Positive
			Landscape and ecosystem management	Positive
	Agro-ecosystems highly managed, building on strong technological progress in the agricultural sector		Contribution of forests to livelihoods	Negative
			Role of industrial forestry	Positive
			Technical, managerial, leadership	Positive
	Environmental consciousness on the local scale and focused on end-of-pipe engineering solutions for local environmental problems, such as air pollution	Policies, institutions, governance	Long-term commitment to SFM	Negative
	Very high investments in technological innovation, with a focus on increasing labour productivity, fossil energy supply, and managing the natural environment	Livelihoods, cultural, socio-economic	Landscape and ecosystem management	Positive
			Landscape and ecosystem management	Negative
			Technical, managerial, leadership	Positive
		Research and monitoring	Research programmes	Positive
	Land-use management generally very resource intensive	Livelihoods, cultural, socio-economic	Landscape and ecosystem management	Positive
			Landscape and ecosystem management	Negative
	Regional governance improving in parallel, leading to effective governance structures	Policies, institutions, governance	Enforcement of laws and regulations	Positive
			Public administration	Positive
	Social cohesion strengthened	Livelihoods, cultural, socio-economic	Security and conflict	Positive
		Policies, institutions, governance	Participation	Positive
	Strong push for development in developing countries that follow the fossil- and resource-intensive development model of the industrialised countries	Livelihoods, cultural, socio-economic	Access to capital	Positive
			Commercial opportunities	Positive
			landscape and ecosystem management	Negative

[a] The segments have been modified slightly for readability (e.g. by changing the tenses of verbs) without changing the meaning.

Table IV 5.2 Frequency of occurrence of prerequisite condition code in SSP narrative.[a]

		Enabling condition	SSP1	SSP3	SSP4	SSP5
Positive	Policies, institutions, governance		5			4
		Influence of regional and global processes	1			1
		Long-term commitment to SFM	2			
		Reconciliation of land uses				
		Enforcement of laws and regulations				1
		Participation				1
		Public administration				1
		Land tenure	1			
	Livelihoods, cultural, socio-economic		6			13
		Landscape and ecosystem management	1			3
		Role of industrial forestry				1
		Security and conflict				2
		Access to capital	1			2
		Technical, managerial, leadership	2			2
		Commercial opportunities	1			3
		Contribution of forests to livelihoods	1			
	Natural resource base		2			
		Trees outside the forest and agroforestry				
		Extent and condition of forest resources	1			
	Research and monitoring		2			1
		Monitoring programmes				
		Research programmes	2			1
Negative	Policies, institutions, governance			5	10	1
		Influence of regional and global processes		1	2	
		Long-term commitment to SFM		1	1	1
		Reconciliation of land uses			2	
		Enforcement of laws and regulations		1	1	
		Participation			1	
		Public administration		1	1	
		Land tenure		1	2	
	Livelihoods, cultural, socio-economic			4	9	4
		Landscape and ecosystem management			1	3
		Role of industrial forestry			1	
		Security and conflict		1	1	
		Access to capital		1	1	
		Technical, managerial, leadership		1		
		Commercial opportunities			2	
		Contribution of forests to livelihoods		1	3	1
	Natural resource base			1	1	
		Trees outside the forest and agroforestry			1	
		Extent and condition of forest resources		1		
	Research and monitoring			2		
		Monitoring programmes				
		Research programmes		2		

[a] Note that in some cases the total category score is greater than the sum of scores for each enabling condition within the category. This is because a passage was coded with the category as a whole, rather than with a specific enabling condition within the category.

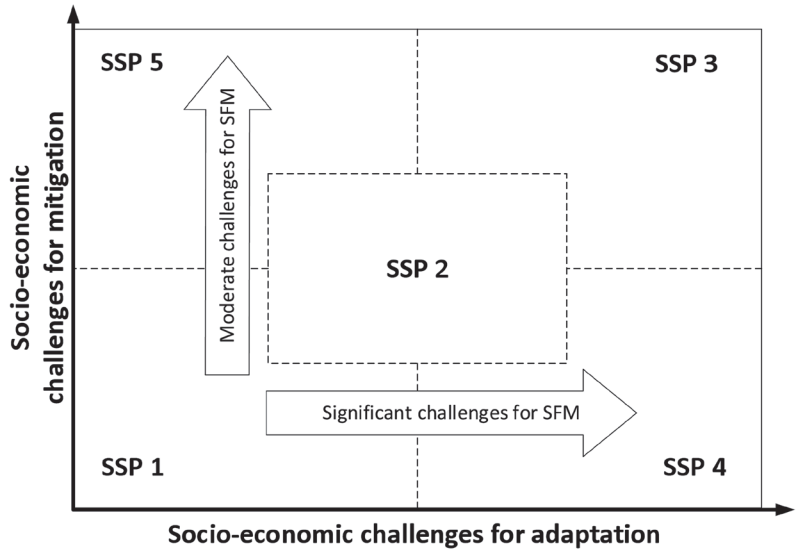

Figure IV 5.2 Challenges for sustainable forest management in the SSPs.

it does with more or less carbon-intensive lifestyles outside the forest sector. Thus the challenges to (global) mitigation in the SSPs are only weakly aligned with the potential for adopting SFM practices. In contrast, the challenges to adaptation in the SSPs align strongly with challenges to implementing SFM: pressures on ecosystems, weak social and institutional capacity, and high levels of inequality.

5.3.2 From prerequisite conditions to SSPs

In the second approach introduced earlier, we started with the prerequisite conditions. To each of the prerequisite conditions, we assigned three possible states. We then constructed a scenario "kernel" or "logic" (Bishop et al. 2007) by creating separate combinations of states for different prerequisite conditions. This does not represent an entire scenario development process. Rather, it generates a central output from such a process using an approach similar to that of the popular method developed within Royal Dutch Shell in the 1970s and 1980s (Wack 1985, Schwartz 1996) and applied within a forest context by Dermawan et al. (2013).

The SSP space shown in Figure IV 5.1 can be thought of as representing a scenario kernel, in that there are two conditions – challenges for adaptation and challenges for mitigation – and each has three states: low, medium, and high. In fact, the SSP space is richer than that implies, because each combination defines a zone within which a large number of scenarios can be placed. However, the scenario space of Figure IV 5.1 provides a useful example of the scenario-kernel approach. With two conditions, each with three states, there are $3^2 = 9$ possible combinations, yet there are only five SSPs. This illustrates an important step in constructing a scenario kernel, to filter the large number of possible combinations to a manageable set of interesting scenarios. What is interesting depends on the particular application, but generally the scenarios should be internally consistent and span a broad space of possibilities (Kemp-Benedict 2012).

In contrast to the two conditions that label the SSP axes, a total of 11 prerequisite conditions were identified in Part I of this volume. With three possible states each, the number of possible combinations is $3^{11} = 177\ 147$. This is a daunting number of possible scenarios to examine for consistency, breadth, and interest. However, we observed that the prerequisite conditions are somewhat imbalanced, in that some tend to dominate others. We therefore chose six, leaving $3^6 = 729$ combinations. The six selected prerequisite conditions and their possible states are shown in Table IV 5.3.[(2)] This number of possible combinations is less daunting but still quite challenging to evaluate. To assist in the task, we used the cross-impact balance analysis (CIB) (Weimer-Jehle 2006), a technique for constructing consistent scenario kernels that specify the degree of direct influence of each possible state of each condition on each state of every other condition, using the scores shown in Table IV 5.4.

[(2)] In Weimer-Jehle (2006), the enabling conditions are called "descriptors" and the states are called "variants." We chose terminology that better matches that used in the rest of this book.

Table IV 5.3 States for prerequisite conditions.

Category of prerequisite condition	State 1	State 2	State 3
Tenure rights	Clear diversified tenure rights	Ambiguous tenure rights	Corporate land appropriation
Law enforcement	Effective and legal law enforcement	Sector poorly regulated and poor enforcement	Sector largely deregulation and auto-regulation
Public administration	Improved capacity, little bureaucracy, and minimal corruption	Inadequate administration and persistent corruption	Over-regulation but less effective and efficient
Market opportunities	Increasing demand for diversified forest-related goods and services	Demand for timber and some NTFP but stagnation for other services	Forest products substituted and forest services replaced by others
Industrial forestry	Sector diversified, including complementary subsectors	Sector diversified, but subsectors compete among each other	Dominance of few conglomerate-like players characterised by vertical integration
Technical managerial leadership	Effective self-organization and adequate capacity of forest owners	Mercantilisation of forestry services limiting access to the services	Vertical integration of sector, including production and services and top-down leadership

Table IV 5.4 Cross-impact judgments and scores.

Score	Cross-impact judgment
+3	Strongly promoting direct influence
+2	Promoting direct influence
+1	Weakly promoting direct influence
0	No direct influence
–1	Weakly restricting direct influence
–2	Restricting direct influence
–3	Strongly restricting direct influence

For consistency of the method, the scores for each condition must sum to zero. If they do not, it is an indication that the states listed for each condition do not exhaust the possibilities. For the states given in Table IV 5.3, filling in the CIB table involves a total of $(3\times6)^2 - (3\times6) = 306$ assignments. This is less than half the number of possible combinations, and the cognitive requirements are much less; rather than evaluate an entire scenario, the analyst only specifies how the conditions influence one another. Also, as for the QDA technique described earlier, the assignments are traceable and do not depend on the analyst's overall impression of a scenario.

After each of the judgment scores was entered in the table, the CIB software ScenarioWizard (Weimer-Jehle 2014) was used to generate a ranked set of internally consistent scenarios. From these, we chose scenarios that were either fully or marginally consistent and that tended to span the space delimited by the states in Table IV 5.3. For each scenario, the ScenarioWizard calculates the total impact score for each state as a sum of the cross-impact judgments. The sum of the impacts across states is the scenario's total impact score. Every state has a best alternative to the one in the scenario, with a corresponding impact. To calculate a scenario's consistency, the impact score for the best alternative for each state is subtracted from the impact score for that state, and then the minimum of the differences is selected. That is, a scenario's consistency is determined by the consistency of its least-consistent state. More details can be found in the ScenarioWizard technical documentation (Weimer-Jehle 2014).

The results are shown in Table IV 5.5. We selected three scenarios, two of them featuring two variants that differed in the state of only one of the prerequisite conditions. With the variants included, all but one of the states shown in Table IV 5.3 appear in the scenarios. The one exception is the state "deregulation and auto-regulation" for the law enforcement prerequisite condition. That state did not appear in any consistent or marginally consistent scenario, perhaps because the states for other prerequisite conditions implied a degree of institutional capacity that is inconsistent with deregulation and auto-regulation. In Scenario 3, all but one of the

Table IV 5.5 Selected scenarios.[a]

Prerequisite condition	Scenario 1	Scenario 2	Scenario 3
Consistency score	1/–1	1/–1	–1
Total impact score	70/56	42/42	19
Closest SSP	SSP1 (sustainability)	SSP4 (inequality)/ SSP3 (fragmentation)	SSP3 (fragmentation)/ SSP4 (inequality)
Tenure rights	Clear diversified tenure rights	Ambiguous tenure rights	Corporate land appropriation
Law enforcement	Effective and legal law enforcement	Poorly regulated and poor enforcement	*Effective and legal law enforcement*[a]
Public administration	Improved capacity, less bureaucracy, and corruption	Inadequate administration and persistent corruption	Over-regulation but less effective and efficient
Market opportunities	Increasing demand for diversified forest-related goods and services	Demand for timber and some NTFP but stagnation for other services	Replacement of forest-related goods and services largely replaced
Industrial forestry	Diversified sector with complementary subsectors	Dominance of fewer players and much vertical integration/ *Diversified sector but with increased competition*[a]	Dominance of fewer players and much vertical integration
Technical managerial leadership	Self-organization and capacity of forest owners / *Mercantilisation of forestry services limiting access*[a]	Vertical integration of sector and top-down leadership	Vertical integration of sector and top-down leadership

[a] Text in italics represents states that received weak support, in that they had a (small) negative impact score. They are the reason that some consistency scores are negative.

states for the prerequisite conditions were consistent. The (marginally) inconsistent state was "effective and legal law enforcement" for the law enforcement prerequisite condition.

Also shown in Table IV 5.5 are assignments of forest scenarios to the SSPs. The assignments were developed using the summary information in Table IV 5.1 and Table IV 5.2. The most consistent scenario, Scenario 1, is closest to SSP1 (sustainability). It features effective institutions and equitable access to resources. Scenarios 2 and 3 can each be seen as consistent with either SSP3 (fragmentation) or SSP4 (inequality). However, Scenario 2 is closer to SSP4, while Scenario 3 is closer to SSP3. The fit between the scenario structure proposed here and the SSPs is not perfect. This is partly a reflection of the origin of the SSPs in the climate community. As noted in the previous section, the axis "socio-economic challenges to adaptation" is more strongly aligned with SFM than is the axis "socio-economic challenges to mitigation." This can be seen in Table IV 5.5, where there is a distinct difference between SSP1 and a cluster aligned with SSPs 3 and 4, with a weaker distinction between SSP3 and SSP4 and no clear representation of SSP5. More generally, a local set of scenarios does not have to perfectly align with a set of global scenarios in order to use the global scenarios as a frame. Indeed, it can be interesting and a valuable exercise to explore local developments that diverge from global developments.

5.4 Discussion

As emphasised in chapter 4 of Part IV, it is important for scenarios to be participatory in order to achieve meaningful outcomes and to be acceptable by con-

stituencies that will be guided by the scenarios; forest scenarios should also take cross-scale interactions into account. In this chapter we have demonstrated two techniques that can be used to link global-scale scenarios to forest scenarios meant to be applied at a local scale. The approach that starts with generating scenarios of prerequisite conditions is suitable for a participatory scenario activity. The multi-scale nature of the exercise can come in a second step, not carried out here, in which the implications of the local scenarios are explored in the context of global scenarios defined by, for example, the shared socio-economic pathways (SSPs). This step also opens the way to linking with earlier scenarios, because the SSPs have been mapped onto existing scenario sets by van Vuuren and Carter (2014). Thus local scenarios can be aligned with the recent SSPs as well as the more familiar GEO, MA, or SRES scenarios. The prerequisite conditions defined elsewhere in this volume provide a useful frame for local scenario studies. The scenario kernel developed here and shown in Table IV 5.5 may also be interesting in its own right. Either the scenarios of Table IV 5.5 or scenarios developed through a longer process could provide a common set for regional and global forestry foresight studies. Having a common set allows for greater comparability between different studies.

The exercises described in this chapter provide examples of linking global to local scenarios, an important goal of the current round of climate scenarios. These examples address three of five future research directions identified by Ebi et al. (2014) regarding the SSPs: 1) determining the relevance of the SSP narratives for different problems, scales, and research questions; 2) downscaling socio-economic scenarios; and 3) linking local and sectoral scale scenario development to global narratives. This chapter is therefore an early, and concrete, example of how the SSPs can be used in a sectoral analysis.

The bottom-up scenarios demonstrate a path towards improving the coherence and comparability of forest resource scenarios. Existing forestry scenarios make divergent, or at least quite different, assumptions from each other, making it difficult to compare or combine their outputs (Hurmekoski and Hetemäki 2013). As shown in this book, an organising framework that focuses on causal links (the prerequisite conditions) naturally supplies the raw material for a scenario kernel. The steps involved are, first, to decide on possible states for each of the elements of the organising framework and then to use a method such as CIB to construct an internally consistent scenario kernel. That kernel can then be used in diverse studies. If the scenario alternatives within the scenario kernel can be linked to global scenarios, as we attempted in this chapter, then it makes it easier to embed forestry scenarios into other scenario activities at different scales. Indeed, this is the approach taken by the Forestry Outlook Study for Africa (FAO 2003), which used the GEO scenario framework (UNEP 2007) as a scenario kernel (see also Part IV, chapter 3).

There remains the question of how the prerequisite conditions scenario kernel as developed in this chapter could be used. There are many options. Scenario 1 can be seen as a desirable future from the point of view of SFM and could be elaborated as a possible end-state in a participatory backcasting exercise (Robinson 2003, Vergragt and Quist 2011, Kok et al. 2011). In such an exercise, participants explore strategies for reaching a desired end-point and consider the challenges that may arise when implementing those strategies. Alternatively, a community that wishes to implement an SFM plan may wish to consider external trends that could either support or thwart that ambition. In other words, they want to know how the prerequisite conditions might change in future. In that case, they might consider all of the scenarios in a wind-tunnel exercise, in which participants seek policies or strategies that are robust against external changes (Wack 1985, Kass et al. 2011). Such an exercise might ask how the community could successfully implement an SFM programme even when the prerequisite conditions are not favourable. Qualitative scenarios can also be used to select values for quantitative parameters in models (Alcamo 2008, Kemp-Benedict 2010). Finally, a scenario kernel can form the basis of a set of scenario narratives. Such narratives can be used to communicate alternative possibilities for the future, whether by creating memories of the future that shape people's responses to changing conditions (Allan et al. 2002, Rasmussen 2005) or by drawing attention to possibilities outside the range of current experience (Booth et al. 2009).

5.5 Conclusions

Scenarios are popular because of their flexibility and applicability to different purposes. The essential core of a set of scenarios is the scenario kernel, or "logic," and using a common kernel across scenario exercises increases their coherence. This chapter demonstrates techniques for using a sector-specific conceptual framework and a global scenario kernel to generate a scenario kernel for SFM exercises. The techniques can be used in future participatory exercises to develop a common platform for forestry scenarios that can be linked to other scenario activities at diverse scales.

The particular set of global scenarios, the shared socio-economic pathways, or SSPs, were chosen because they are very recent, likely to be used in the future, and are the result of a large community effort.

Many of the people who helped develop previous global scenarios are involved in SSP development. However, this chapter found only partial alignment with the SSPs. Generally, adaptation capacity was found to correspond strongly to positive prerequisite conditions for SFM, while the link to mitigation capacity is weak. This is not a serious problem because, as this chapter also demonstrates, it is possible to develop sector-specific scenarios that make no explicit connection to the global scenarios and subsequently demonstrate how the sector-specific scenario kernel corresponds to the global scenario kernel. That is, the outcome of a bottom-up, participatory process for the forestry sector, as described in the previous chapter, can then be mapped onto a global scenario framework, making it easier for global, multi-sector studies to incorporate scenario elements appropriate to the forestry sector.

The chapter also demonstrates that the prerequisite conditions developed throughout this book are a useful starting point for developing scenarios for the forestry sector. The essential steps were to first assign possible states for the prerequisite conditions and then explore the causal links between different prerequisite conditions. That was sufficient to identify a consistent scenario kernel.

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