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TARGETED SCENARIO ANALYSIS

A NEW APPROACH TO CAPTURING AND PRESENTING ECOSYSTEM SERVICE VALUES FOR DECISION MAKING

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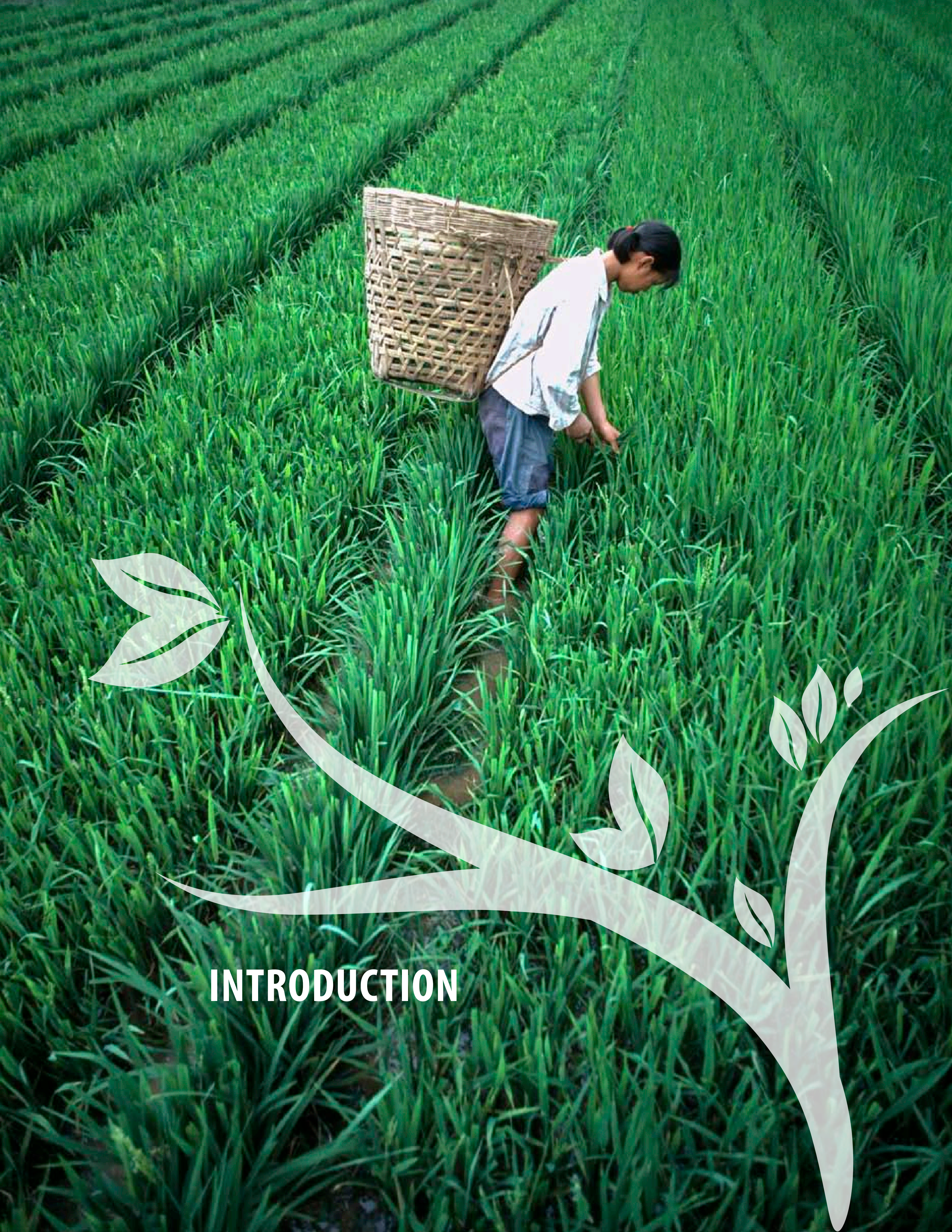
ACRONYMS

BAU	Business as usual
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal rate of return
Kwh	Kilowatt hour
NGO	Non-governmental organization
NPV	Net present value
NTFP	Non-timber forest product
PA	Protected area
PES	Payment for ecosystem services
SEM	Sustainable ecosystem management
SMART	Specific, measurable, achievable, relevant, time-bound (used to describe indicators)
ToR	Terms of Reference
TSA	Targeted Scenario Analysis
UNDP	United Nations Development Programme



INTRODUCTION

INTRODUCTION

WHAT IS TARGETED SCENARIO ANALYSIS?

This guidebook provides a step-by-step introduction to Targeted Scenario Analysis (TSA), an innovative analytical approach, developed by UNDP that captures and presents the value of ecosystem services within decision making, to help make the business case for sustainable policy and investment choices.

Through TSA, practitioners working with governments and private enterprises can generate and present data related to the management of ecosystems in a way that is more relevant to the choices facing a decision maker. This increases the likelihood that this data will be used to make policy and management decisions that result in effective and sustainable management of ecosystems and ecosystem services.

The product of a TSA is a balanced presentation of evidence, for a decision maker, that weighs up the pros and cons of continuing with business as usual (BAU) or following a sustainable development path in which ecosystems are more effectively managed. This alternate path is termed sustainable ecosystem management (SEM).

A TSA should be conducted for a particular productive sector, and with a specific decision maker in mind. Decision makers will be primarily government officials or business managers, who generally come from a specific productive sector (e.g. Minister of Agriculture, Minister of Energy, hydropower plant manager, plantation owner or cattle farmer). The results of a TSA can show the impact of certain policy options or management practices on specific ecosystem services or resources, to help decision makers understand the circumstances in which maintaining ecosystems and their services may generate greater economic benefit than promoting economic processes that degrade and deplete ecosystems.

TSA builds on and combines traditional cost benefit analysis and economic valuation methods, broadening the type of information captured. It differs from these traditional approaches in that it takes a sector-specific approach to valuation, to reflect the perspective and remit of policy makers and companies. Rather than determining the general value of a particular resource or ecosystem service, TSA looks at ecosystem services from a stakeholder point of view. So, for example, rather than coming up with a single number that estimates the overall value of a coral reef, TSA will find the value of preserving the health of that reef from a fisheries perspective or from a tourism perspective, i.e. from the perspective of those influencing the management of the coral reef. This makes the approach demand driven, rather than supply driven, asking: What information do decision makers need in order to judge the importance of a particular ecosystem service and the benefits of enacting a particular policy or management option that maintains it?

TSA differs from traditional methods in that it provides information on the results of specific decisions and management practices as a continuous, long-term analysis, showing relative change over time of key monetary and non-monetary indicators, rather than as a static single value. This is key for decision making, as decisions are rarely made based on absolute numbers in isolation, but rather by comparing at least two options over time.

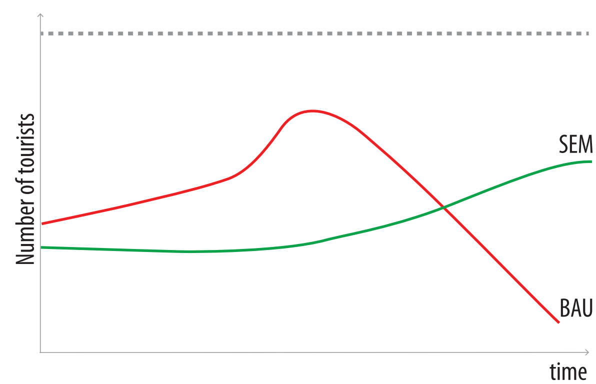
The TSA method is consistent with The Economics of Ecosystems and Biodiversity (TEEB)[1] approach, which recognizes, demonstrates and captures the value of ecosystem services through the market and different productive activities.

The main product generated using the data amassed during a TSA is a graph or graphs, with time on the horizontal axis and a measurable indicator, such as revenues or number of jobs, on the vertical axis (see Figure 1). In the graph there are two curves, one capturing and depicting BAU and one the SEM scenario. The graph should be accompanied by a narrative that explains whom it is for (stakeholders), how it was generated (assumptions, data sources) and levels of confidence and uncertainty, among other things. This complementary text will both rationalize the graphs and also act as the bridge between the graphs and policy decisions.

PURPOSE OF THE GUIDEBOOK

The purpose of this guidebook is to provide an introduction to the steps involved in constructing a TSA for policy and/or management choices available to decision makers. This guidance elaborates and builds on the TSA approach introduced in the UNDP report, *The Importance of Biodiversity and Ecosystems in Economic Growth and Equity in Latin America and Caribbean: An economic valuation of ecosystems*[2], which was launched in 2010 at the 10th Conference of the Parties to the UN Convention on Biological Diversity in Nagoya, Japan. http://web.undp.org/latinamerica/biodiversity-superpower/English_Report.htm

Figure 1: A sample TSA graph



Because this is a new approach, this guidebook is intended to be more about introducing the basic rationale, principles and approaches behind the TSA, rather than defining a rigid recipe for environmental policy or management analysis. It is expected that the first generation of studies applying this approach may well be rudimentary, and lessons will be learned to improve it or more robust second-generation studies.

Although financial and economic analyses are both generally expressed in monetary terms, the TSA approach recognizes that not all consequences of policy interventions can or should be monetized. Therefore, non-monetizable outcomes should not

1 TEEB is an international initiative focused on drawing attention to the global economic benefits of biodiversity. The initiative was launched by Germany and the European Commission in response to a proposal by the environment ministers of the G8+5 in Potsdam, Germany in 2007.

2 Bovarnick, A., F. Alpizar, C. Schnell, Editors. The Importance of Biodiversity and Ecosystems in Economic Growth and Equity in Latin America and the Caribbean: An economic valuation of ecosystems, United Nations Development Program, 2010.

be omitted from analyses. On the contrary, expert advice under the framework of this guidebook should account for all relevant consequences of policy interventions, whether or not they are monetizable. The TSA fully recognizes the value of non-monetary and non-quantifiable indicators, such as cultural values, and these indicators should be recognized and included in a TSA report to supplement the graphs, so that policy makers are advised and aware of these additional values. In this way, the TSA has priority areas of analysis that include financial, economic and employment indicators, as well as secondary areas for inclusion, such as indigenous and aesthetic values, and ethical concerns. Secondary areas are also linked to specific sectoral development values.

In addition, TSA is not about "selling" the idea of SEM. The focus is on identifying when, and under what circumstances, SEM is advantageous when compared with BAU.

The steps of a TSA

This guidebook discusses the five steps that comprise a TSA. These steps include:

1. Defining the purpose and scope of the analysis (chapter 2)
2. Defining the BAU baseline and SEM intervention (chapter 3)
3. Selecting criteria and indicators (chapter 4)
4. Constructing the BAU and SEM scenarios (chapter 5)
5. Making an informed policy or management recommendation (chapter 6)

WHO IS THE TARGET AUDIENCE FOR THIS GUIDEBOOK?

The intended audience for this guidebook is prospective analysts – from government technical staff to expert practitioners in a consultancy firm to researchers in non-governmental organizations (NGOs), universities or government think tanks – who want to make a clear and compelling argument for alternative policy, management or investment choices that take into account the value of ecosystem services. It is assumed that the readers of this guidebook will have some familiarity with economics, and some knowledge of valuation methodologies.

Because TSA is a demand-driven approach, this guidebook may be equally useful for policy makers or business people interested in contracting analysts to undertake a TSA, as this guidebook provides guidance about what to ask for from an analyst commissioned to look at these issues. It also illustrates the ways in which the decision maker should be involved during the process (for example, in crafting appropriate indicators to judge the scenarios).

AN EXAMPLE OF A TSA

The following example describes a TSA for the Guri Dam in Venezuela[3]. The dam, which is situated in the Caroni River basin, is the largest hydropower system in Venezuela. A policy maker needs a TSA because of the following situation:

1. Power generation will be reduced by about 10-15 percent by siltation resulting from a BAU scenario of moderate deforestation.
2. The hydroelectric system has an expected life of 60 years, and the loss of power generation capacity is expected to peak halfway.
3. A large investment at some point around the dam's midlife is required (in about 30 years). Investment costs would be about \$90 million to \$134 million and span five years, starting in year 25.

In order to generate these TSA results, the following steps were taken:

1. Define the purpose and scope of analysis:

Siltation of the dam used for hydropower generation is leading to a reduction of generation capacity, which will require a large investment at some point around the dam's midlife. The siltation is from high erosion rates linked to deforestation under the BAU scenario. Is there a business case for the hydropower plant manager to consider alternatives to BAU that can be offered through an SEM scenario?

2. Define the BAU baseline and SEM intervention:

BAU is understood as the current level of deforestation, resulting in the need to invest cleaning the dam in order to recover the lost capacity. The cost would be about \$90 to \$134 million and span five years, starting in year 25.

3 UNDP 2010 Superpower report (Chapter 10 on Protected Areas). Data for this example is taken from Gutman 2002

The alternative SEM scenario includes reduced deforestation, as well as land-use practices that reduce erosion rates within the dam's catchment area and hence maintains the dam's capacity.

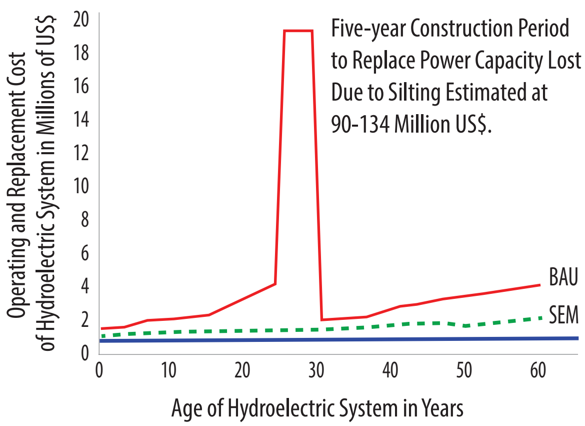
3. Select indicators:

The analysis is done at the level of the hydropower generation facility and the main indicator is the cost of maintaining the dam's generation capacity as planned by design. There is no attempt at incorporating positive or negative externalities (e.g. carbon benefits of reduced deforestation) and no attempt to value economically the benefits to society of electricity production.

4. Construct the BAU and SEM scenarios

The consequences in terms of the relevant indicator (cost, as defined above) of the BAU and SEM policy interventions are based on a projection that uses engineering principles and a dose response function that links observed deforestation to erosion rates to siltation of the dam. The change in productivity method is used to generate the costs under the two scenarios, which is specially suitable given that this analysis focuses only on financial costs.

Figure 2: Cost of maintaining hydroelectric power capacity under BAU and SEM



Source: UNDP (2010) Chapter 10, based on Gutman 2002.

5. Make an informed policy recommendation

Results are presented both graphically and numerically, and focus on the relevant stakeholder, namely the hydropower plant manager. Decision-makers can easily see the evolution of costs in time and, as such, do not have to act on a single number (e.g. NPV). Figure 2 summarizes the findings.

For a more complete example see Annex 2 which provides a case study.

1

WHAT IS TSA AND WHY IS IT IMPORTANT?

CHAPTER 1: WHAT IS TSA AND WHY IS IT IMPORTANT?

This chapter introduces the concept of a TSA and briefly discusses the limitations of traditional cost-benefit analysis techniques in capturing ecosystem value. It then goes into more detail on the characteristics of TSA that make it a more useful and robust alternative to traditional valuation approaches. These advantages include:

- placing valuation results in their relevant context;
- providing choice by comparing two alternative interventions;
- providing time-bound information;
- using a sector-centric, rather than ecosystem-centric approach;
- including ecosystem services as inputs into sectoral outputs;
- considering multiple indicators, not all of them monetary;
- accounting for complexity and uncertainty in capturing ecosystem value;
- graphically capturing irreversibility and option values;
- complementing discounted values; and
- helping to shape sector development policies at the national, regional and sub-regional levels (e.g. watershed management policy).

Targeted Scenario Analysis provides an innovative alternative to traditional valuation techniques and approaches. TSA adds value for analysts attempting to more accurately capture the value of ecosystem services, as it goes beyond cost-benefit analysis and standard economic valuation methodologies to compare the implications of two contrasting management strategies on the basis of relevant socioeconomic indicators (both quantitative and qualitative) for a specific productive sector. TSA draws from all available information, ranging from existing or newly generated data to expert opinions.

While some traditional studies do estimate sector-specific benefit values associated with ecosystems, there has not been sufficient information, presented in a manner relevant to decision makers that shows the contribution of ecosystem services to sectoral outputs in relation to the costs and benefits associated with different management approaches. This lack of perspective and information has contributed to the dominant view that the economic benefits of conventional practices outweigh the costs, and that investing in biodiversity and ecosystem conservation does not present positive returns to the economy. TSA addresses this gap by presenting decision makers with time-bound economic data on ecosystem services, their relation to sectoral outputs (e.g., profits, employment, etc.), and the existence of practical, sustainable and potentially more profitable alternative management practices. TSA can also be used to explore policies to encourage SEM.

1.1 LIMITATIONS OF STANDARD APPROACHES

Cost-benefit analysis is the standard economic tool in use today for judging whether a given policy makes sense from a social perspective. With this technique, the analyst makes a prediction of the future stream of benefits and costs that would result from implementing a prospective policy intervention or project. Using those results, the analyst next discounts all net benefits. In this step, the size of the discount rate will play a key role in the result: If the discount rate is high, future net benefits will stop being positive very quickly and the proposed project may be dropped or abandoned. The opposite holds true with a low discount rate. (See Box 1 for an example of a cost-benefit analysis.)

Box 1: A simple example of a cost-benefit analysis

Assume that a project generates investment costs equal to \$100 at present, and then a constant flow of benefits equal to \$30 and costs equal to \$10, starting in year 1 of operation and continuing for 10 years. The net present value (NPV) is equal to $-\$100+\frac{30-10}{(1+r)^1}+\frac{30-10}{(1+r)^2}+\cdots\frac{30-10}{(1+r)^{10}}$ or generally $NPV=\sum_{t=0}^{t=T}\frac{B-C}{(1+r)^t}$, where B is the benefits, C is the costs, T is the period of analysis and r is the discount rate. With a discount rate of 10%, the NPV of the project is \$23. With a smaller discount rate, say of 3%, the NPV is \$70. This marked difference will be even larger if the planning horizon of the project is extended. It is for this reason that much of the discussion about investments in mitigation of greenhouse gases revolves around the selection of a suitable discount rate, as most of the benefits of reduced emissions today are likely to occur well into the future.

Cost-benefit analysis is similar to the discounted cash flow analysis that a private firm would conduct for financial appraisal of a new investment. The difference is that, in a financial appraisal, the private firm will restrict its focus to costs and benefits (revenues) accruing to the owners of the firm, whereas a cost-benefit analysis should include the costs and benefits to all parties (stakeholders) affected by the investment. In financial appraisal, the analyst will use the firm's opportunity cost of capital to discount future cash flows. In contrast, a cost-benefit analysis uses a discount rate based on society's (not the firm's) rate of time preferences.

The end result of a cost-benefit analysis is often a single number, the net present value, NPV (or the internal rate of return or the benefit-cost ratio), of a flow of future costs and benefits. If that value is positive, it is argued that the project under evaluation will result in improved human well-being. If several mutually exclusive projects are being studied, the one with the highest NPV should be chosen. In most cases, though, the analyst is forced to make assumptions regarding numerous parameters required for the estimation of costs and benefits, and the resulting level of

uncertainty makes one single value for the result seem scarcely credible. In such circumstances, sensitivity analysis is used to capture the effect of assumptions or uncertainty on the NPV. However, there is a limit to how much sensitivity analysis can be done.

In addition, cost-benefit analysis cannot accurately convey non-quantifiable information that may be important to support reliable decision making, as it does not capture indicators in scenarios that are difficult or impossible to quantify in monetary terms, or when there is simply not sufficient information about their monetized value to yield a solid statistical prediction. TSA moves beyond this limitation by projecting the consequences of implementing a policy intervention or management strategy in terms of the changes in physical, financial, economic and social indicators used to describe the BAU and SEM scenarios as they unfold over time, and assessing these consequences according to multiple criteria. These descriptions of physical consequences and their assessment in terms of multiple criteria do not always need to be quantitative.

1.2 ADDED VALUE OF THE TSA APPROACH

The challenge with traditional academic valuation studies is that they are often not immediately policy relevant. Many such studies are of little use for policy analysis, because they were not designed from the outset to measure the economic costs and benefits of outcomes that result from specific policy interventions in which decision makers are interested. For example, many economic valuation studies generate "point estimates" of the economic value of something (a tiger, a turtle, a wetland), rather than of the consequences that could result from a specific policy intervention, such as a management plan to protect tigers or restore wetlands.

Academic researchers often feel frustrated when decision makers do not seem excited by the opportunity to use the results of their elaborate economic valuation work, but they should not be surprised: What decision makers would most like to see are studies designed from the outset to serve as an integral part of a specific analysis tailored to

assessing carefully defined policy or management interventions. The following are key characteristics of the TSA approach that make it more useful and policy relevant than standard valuation approaches.

1.2.1 Comparing two alternative interventions

TSA is a comparison of two alternative interventions, rather than an isolated estimate of the benefits and costs of just one intervention. As such, the decision maker is faced with the relative merits of two courses of action over time: the BAU and the transition to SEM

The BAU scenario is a dynamic status quo, in which decision makers continue on their current path and are presumed not to have accounted for the benefits provided by ecosystem services, the costs associated with their degradation, and the relations among production decisions, the environment and broader social goals. These choices can then lead, in various ways, to degradation of ecosystems and ecosystem services. BAU systems tend to have high environmental impacts and low levels of sustainability, yet they are often attractive for their high earnings levels (at least in the short term). Over the longer term, however, environmental degradation will cause a reduction in the social and/or private benefits derived from ecosystem services that are consumed directly or used as inputs into productive activities.

This is not meant to imply that *all* current productive and consumption practices are degrading the natural resource base. Every situation has positive and negative productive practices, and the analyst must seek an agreement of expert and local opinions regarding just what constitutes BAU.

In contrast to the BAU, the SEM intervention will always involve a change in the status quo, with actions taken to reduce or reverse the negative effects of BAU on the relevant ecosystem. The goal of an SEM policy intervention is to ensure that production and consumption activities take into account the role of ecosystems in providing benefits and services to

human society. By comparing changes to indicators between SEM and BAU scenarios, TSA can facilitate decision making even under complex circumstances.

With a clear understanding of the implications of the baseline included in the analysis (i.e. the BAU intervention), rather than just the proposed changes, the decision maker will better be able to judge the relative merits of SEM. For example, say a study finds that well-preserved coral reefs are worth $1 million annually to the tourism industry. This information is meaningless without an understanding of the benefits of alternative uses of this natural resource, including those that would lead to degradation of the reef. The value of a course of action can only be judged fully if it is compared to the value of its alternative. TSA provides that perspective.

1.2.2 Providing time-bound information

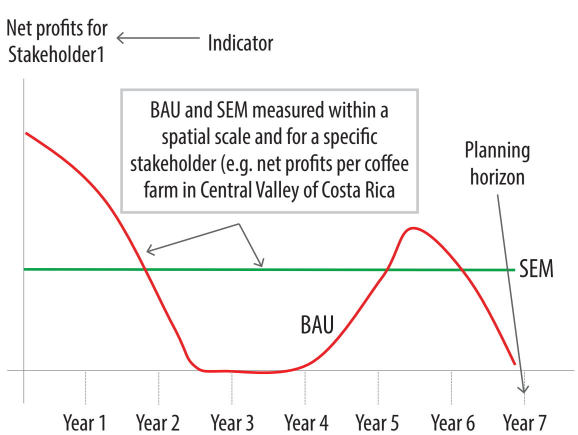
For policy makers, valuation studies generating static point data estimates are of limited value. In a situation where choices must be made between different types of land-use and development practices, data on how much an ecosystem is valued – specifically at a certain moment in time under the current management system – tells the manager nothing about how that value might change over time as a result of doing nothing or as a result of implementing a given intervention.

The results of a TSA, on the other hand, trace the evolution of key indicators over time, as opposed to providing just a single point estimate of the situation at a given time in

the future, or a discounted estimate of a flow of benefits. While decision makers do care about final outcomes, they also need to know the relative merits of the BAU and SEM scenarios as they change over time. For example, the information that a specific ecosystem's total annual worth is estimated at $X million, based on production flows, is supplemented in a TSA by data on how that value might be lowered if the ecosystem were damaged or how much that value might grow if the ecosystem were improved.

Figure 3 illustrates the importance of depicting scenarios over time as opposed to one-off data snapshots of the situation at a single given time in the future. Only by seeing the full depictions of the BAU and SEM scenarios within the given planning horizon, will the decision maker be able to have a clear picture of how this situation would unfold over time.

Figure 3: Graphic depiction of BAU and SEM scenarios over time



1.2.3 Using a sector-centric, rather than ecosystem-centric approach

Whereas traditional valuation studies concentrate on ecosystems, the TSA approach focuses on sectoral impacts, which typically transect a given ecosystem. The TSA measures the costs and benefits of specific changes resulting from the implementation of concrete BAU and SEM policy interventions in which a specific decision maker is, or several decision makers are interested, rather than attempting to value an ecosystem in its entirety.

For example, assume that a decision maker is interested in setting entrance fees such that revenue from tourism in protected areas covers all the costs of receiving tourists, plus part of the operating costs of maintaining the park itself. In this case, the focus of the TSA would be on entrance fees, not on the park itself. Every estimation of value (be it of a cost or a benefit) in a TSA must be linked to a specific stakeholder who, in principle, could put the wheels in motion to avoid the cost or enjoy the benefits by encouraging the move from BAU to SEM. Except for anecdotal purposes, an estimation of the global value of the park as a reservoir of pristine patches of biodiversity is useless to the decision maker.

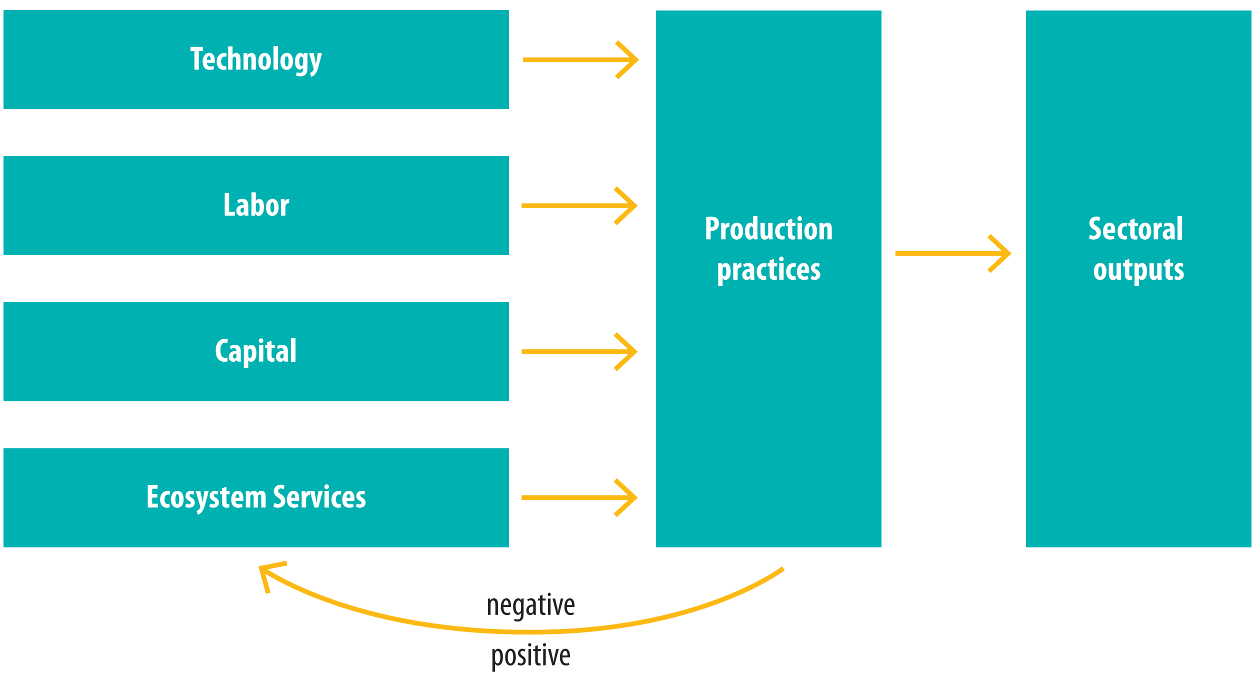
1.2.4 Including ecosystem services as inputs into sectoral outputs

In general, public and private decisions have failed to account for the value of ecosystem services (as inputs in a production function, as elements in a consumption basket or as costs due to collateral damages), which has often resulted in decisions that lead to degradation of ecosystems.

The Millennium Ecosystem Assessment (MA 2005a) provides a framework to assist in identification of ecosystem services, categorizing them into provisioning services, such as food chains, water, timber and NTFPs; regulating services that affect climate, floods, disease, wastes and water quality; cultural services that provide recreational, aesthetic and spiritual benefits; and supporting services, such as soil formation, photosynthesis and nutrient cycling. Ecosystem services are derived from both the native and managed biodiversity of a region. Conceptually, healthy, biodiverse ecosystems generate greater amounts, higher quality and more stable flows of ecosystem services over time.

TSA was developed with the assumption that ecosystem services can be analysed as an input into production practices and sectoral outputs, just like technology, labour and capital, and also as a variable that responds to changes in environment, management and production practices (see Figure 4).

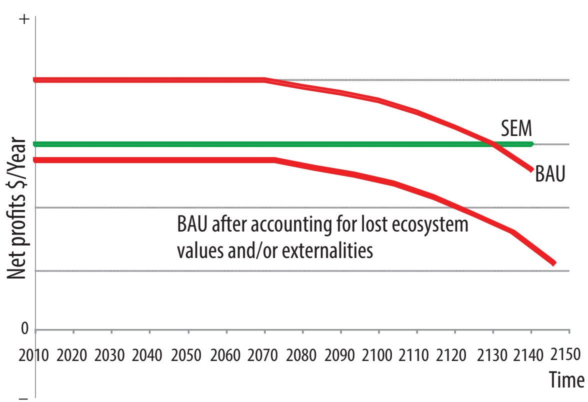
Figure 4: Ecosystem services as an input into sectoral outputs



Source: A. Bovarnick

TSA, through construction of scenarios and input of data over time, can create graphical illustrations of the net benefits of SEM, and hence the value of the ecosystem service functioning within the scenarios. For example, in Figure 5, net revenues (vertical axis) under the status quo level of ecosystem degradation (BAU, upper red line) are either constant or start decreasing only at a late date. Net profits resulting from a possible alternative future path, where SEM practices are applied, are depicted in the green line.

Figure 5: Internalizing ecosystem services into estimates of net profits



From a financial perspective, a comparison of just the upper red and green curves may favour a course of action that sticks with BAU. However, after externalities and the economic value of ecosystem services as inputs into production decisions are accounted for in a long-term, all-encompassing analysis of the costs and benefits associated with each scenario, the BAU option (the lower red curve) looks much less attractive. By incorporating ecosystem services as inputs within the analysis, TSA can give decision makers a much more accurate and realistic picture of the true costs and benefits of BAU vs. SEM.

1.2.5 Considering multiple indicators of the relative benefits of SEM vs. BAU

In most policy making, economic and financial attractiveness are only two of several criteria used to judge the advantages of a given intervention. This is particularly true for environmental public policies, but it also applies to private decisions involving the environment. For example, a decision maker in the public sector might be interested in policies that create jobs, redistribute income or increase access to natural resources for vulnerable groups of society, none of which is necessarily directly captured in NPV calculations.

In addition, although the focus of this guidebook is on how to use estimates of the economic values of ecosystem services in decisions, nature frequently does not allow itself to be valued credibly with the methods and tools currently available to economists. The great complexity of natural systems and the constant change inherent in physical, biological and social conditions can be difficult to monetize using conventional techniques. The notion that at least some monetary valuation is better than none in decision making is mistaken if it means that extreme, unreliable assumptions are used to generate the monetary estimates.

The fact that some consequences of policy inter-ventions cannot be monetized using conventional methodologies does not mean that those con-sequences have no place in decision making. To the contrary, consequences that cannot be monetized should be reported along with monetary estimates. Through the use of graphs, TSA allows the inclusion of non-monetary, but quantifiable, indicators, such as employment numbers. Additionally, TSA allows for non-quantifiable impacts, such as ethical values, to be presented in the form of a narrative/ text to support the graphical data. The overall aim is to communicate a full understanding of the choices available, which typically requires a mix of monetary, quantitative and qualitative indicators.

For example, suppose that the construction of a large hydropower plant is going to inundate an area of indigenous peoples' lands that is regarded as sacred territory. Engaging in a purely monetary exercise of the indigenous population's willingness to accept compensation to allow the project to proceed might prove to be ill-advised, if not impossible. Still, the analyst must make sure to show that there is a trade-off: Even though the conventional financial analysis and cost-benefit analysis may indicate that the proposed plant will be an attractive project, the decision makers must be made aware that this estimate excludes high social and cultural costs to the indigenous inhabitants. In a TSA, this issue would be identified and discussed alongside the financial and economic indicators used to compare BAU and SEM.

TSA can help identify policies that could help encourage the adoption of SEM. For example, in the figure [at right/ below], BAU profits exceed those of SEM in the short run, but ecosystem degradation gradually decreases those profits. SEM net revenues, on the other hand, are negative in the first years, as initial investment and transition costs take a toll; these costs are often a key factor preventing the adoption of cleaner technologies. However, after the initial investment is recouped, the SEM provides a greater rate of return.

The key factors in this example are the size of the losses in the first years and the time needed for SEM profits to exceed those of BAU. Armed with knowledge about these two factors, policy makers could design incentive schemes (e.g. payment for ecosystem services under SEM, better access to credit) to help firms cope with the first years, after which SEM is profitable on its own.

Box 2: Identifying policies that incentivize SEM

TSA can help identify policies that could help encourage the adoption of SEM. For example, in the figure [at right], BAU profits exceed those of SEM in the short run, but ecosystem degradation gradually decreases those profits. SEM net revenues, on the other hand, are negative in the first years, as initial investment and transition costs take a toll; these costs are often a key factor preventing the adoption of cleaner technologies. However, after the initial investment is recouped, the SEM provides a greater rate of return.

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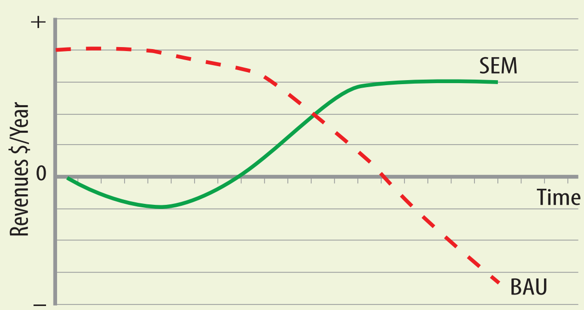
High costs of transition from BAU to SEM



Source: Chapter 2, UNDP 2010

1.2.6 Accounting for complexity and uncertainty in capturing ecosystem value

Another advantage of TSA is that it explicitly accounts for uncertainty in addressing the limited present understanding of the underlying parameters that determine costs and benefits related to ecosystem services and, as such, limit the scope of statistical predictions.[4] Obviously, uncertainty is not new to decision makers, but in the case of environmental problems, the presence of multiple layers of uncertainty is coupled with the typically nonlinear dynamics of ecosystems. Uncertainty is a fundamental challenge for a policy analyst trying to capture ecosystem values, as our understanding of the natural world is limited. In addition, it is impossible to fully foresee how individuals or the wider society might adapt to future situations. TSA accounts for this uncertainty by explicitly incorporating it in the indicators used to judge the BAU and SEM interventions. In some cases, a TSA might include a specific indicator that graphically depicts uncertainty associated with a scenario, for example the state of a given ecosystem and how close it is to full collapse. (For a more extensive discussion of uncertainty, please see Chapter 5).

1.2.7 Capturing irreversibility and option values of ecosystem services

Some decisions involving the environment will result in irreversible changes.[5] Clear-cutting of primary forest, drainage of mangrove swamps for shrimp production and desertification are all processes that are either irreversible or extremely expensive to reverse. A TSA can capture the foregone opportunities of irreversible changes to ecosystems, to aid decision making in a complex environmental setting.

As understanding of the functioning of ecosystems and their role in supporting human well-being increases, the information available to decision makers will change. For example, suppose that, given the information available a decade ago, a decision maker chose at that time to remain with policies associated with the BAU scenario and that, in the BAU scenario, land use changed from a natural to a human-dominated landscape. Now, years later, new information has been discovered that shows that the value of biodiversity and ecosystem services under SEM were actually larger than originally estimated when the decision was made to continue with the BAU policies. If it were possible to retrace steps taken in the course of intervening years, this discovery might have been a valid reason to undo the land-use changes and move back toward a natural ecosystem. Unfortunately, that option may no longer be available, because some ecosystems have been irreversibly lost to development in the BAU scenario. In that case, policy makers and stakeholders might be willing but unable to undo the consequences of pursuing the original BAU scenario.

4 See R. S. Pindyck, "Uncertainty in environmental economics, *Review of Environmental Economics and Policy* 1, no. 1 (2007): 45-65.

5 Key references include K. J. Arrow and A. C. Fisher 1974. "Environmental preservation, uncertainty and irreversibility," *Quarterly Journal of Economics* 88, no. 2 (1974): 312-319; and C. Perrings, and D. Pearce, "Threshold effects and incentives for the conservation of biodiversity," *Environmental and Resource Economics* 4, no. 1 (1994): 13-28.

A slightly different case of irreversibility comes from pollutants that accumulate in the environment and degrade only very slowly. In such a setting, even if emissions can be halted immediately, the consequences are likely to persist in the environment for a long time. For example, a carbon particle in the atmosphere contributes to greenhouse effects until it is degraded, after about 100 years. Thus, carbon emissions that occur today will have continuing consequences over the next century that are not easily countered.

As the limits of natural ecosystems are pushed to extremes never seen before, more and more information is emerging about the possible benefits associated with shifting from a BAU to an SEM scenario. If human society continues under the BAU scenario, the world will likely face ever-rising costs from environmental degradation. For some ecosystem services today, scientists call for "undevelopment," before thresholds are reached beyond which there is no return. Global warming, desertification (in Chile and Central America, for example) and deforestation in the Amazon are cases that should be analysed from the perspective of uncertainty about the full set of consequences of implementing different policy interventions and possible irreversible changes.

One concrete implication of irreversibility is the need to incorporate a precautionary principle into policy decision paths that might result in irreversible changes to ecosystems. While it is impossible to know for sure whether people in the future might need to undo some steps taken in the present, an analyst should gather evidence on the possible forgone opportunities of irreversible changes and remind the decision maker of the need to use the precautionary principle in these cases.

When it seems apparent that irreversibility is a possibility, an analyst conducting a TSA would include option values and the potential for irreversibility in his narrative presentation to the decision maker, thus allowing for more robust and informed decision making that takes into account these potentially extreme future scenarios.

1.2.8 Complementing discounted values

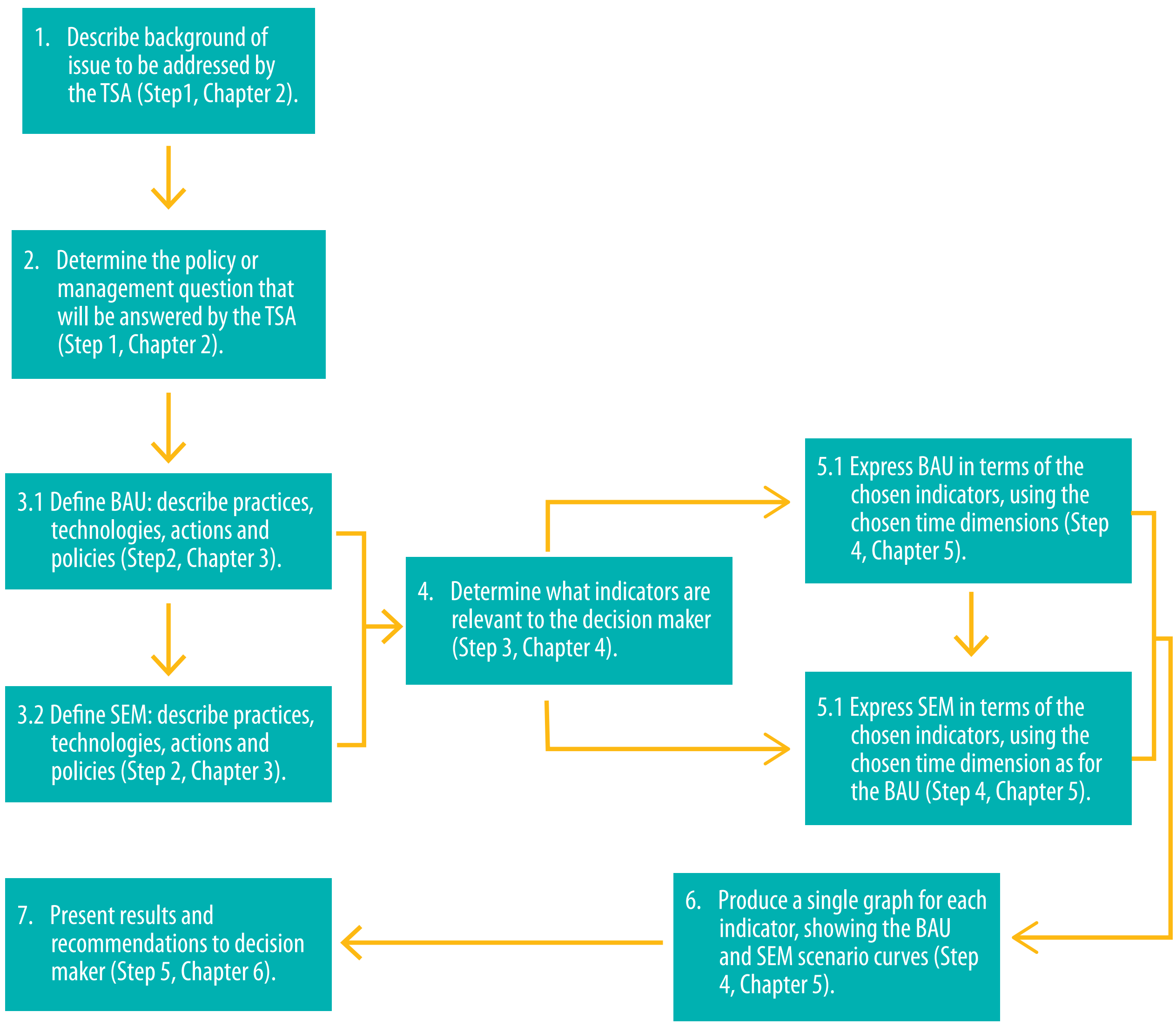
Environmental problems typically require a very long planning horizon. Investment costs (for new technology, training, initial marketing of new products) are likely to come at the beginning of the planning horizon, and the benefits of these investments are likely to accrue in the medium-to-far future. For some environmental concerns, like global warming and long-lived pollutants, or proposed courses of action, such as landscape conservation and reforestation, the planning horizons may far exceed 50 years, a much longer span than the planning horizon of a typical cost-benefit analysis (10-to-25 years). For such projects, the selection of the proper discount rate will play a huge role.

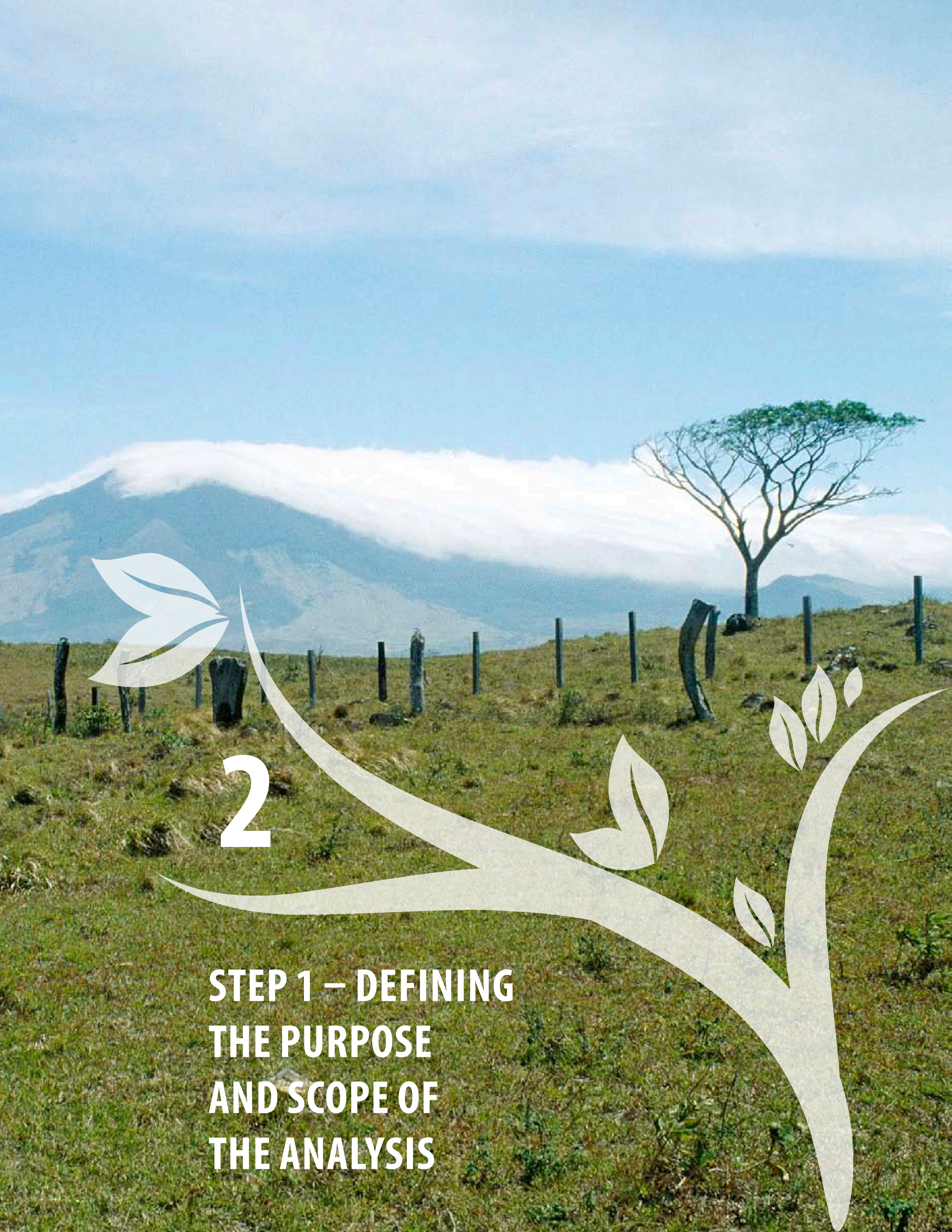
For a private firm or government, the need to discount the future is associated with the opportunity cost of capital and the financial value of the future revenue stream. In such circumstances, using an interest rate based on the firm's opportunity cost of capital is standard. Still, what interest rate should be used over a 50-year planning horizon? Uncertainty about market interest rates and the future cost of capital is likely to be significant, and firms may choose to use a higher discount rate to partially account for that uncertainty in their estimates of the net present value of future costs and revenues.[6]

TSA avoids some of this confusion by generating data beyond one single discounted number, focusing instead on the evolution of key indicators within BAU and SEM scenarios as they unfold over time. The decision maker is left to consider whether and if so how to discount future changes to the relevant indicators.

6 R. G. See Newell and W. A. Pizer (2003). "Discounting the distant future: How much do uncertain rates increase valuations?" Journal of Environmental Economics and Management 46 (2003): 52-71.

Suggested structure of a TSA





2

STEP 1 – DEFINING THE PURPOSE AND SCOPE OF THE ANALYSIS

CHAPTER 2: STEP 1 – DEFINING THE PURPOSE AND SCOPE OF THE ANALYSIS

This chapter discusses the process of defining the specific purpose and scope of a TSA. This process includes identification of the key decision maker who will be the audience for the analysis and understanding his or her objectives for the TSA. Together with this decision maker, the analyst then refines the focus of the policy question, to be sure that it is appropriate for a TSA, defines the scope of the analysis, and assesses and verifies available data to ensure that the TSA, as framed, will be feasible.

In order for research and analysis to be relevant, it has to be designed with a specific objective and with a specific decision maker in mind. Therefore, the first step in undertaking a Targeted Scenario Analysis is to carefully and exactly define the purpose of the analysis itself. This is done by suitably framing a specific policy or management practice that could be done differently, depending on whether or not it takes account of the value of ecosystem services. This requires close interaction with the decision makers targeted by this analysis, as they are the key figures who will make the eventual policy or management decisions based on the results.

This first step is important, as decision makers frequently assume that they already have all the knowledge they need to make key policy and management decisions (or at least that they already know the type of data and information required), while researchers often assume that they already know the objective of their analysis and the type of research that is needed, without consulting any decision maker. These assumptions can lead to frustration on both sides, as researchers see their supposedly relevant work go unheeded, and decision makers see their policies fail due to poor design.

Thus, the following activities should be completed before an analyst begins any research for a TSA:

- identify the key decision maker and his/her objectives for the analysis;
- together with this decision maker, refine the focus of the policy or management question so that it can be appropriately tackled with a TSA approach;
- together with the decision maker, define the scope of the analysis, including spatial scale, time frame and regulatory scale; and
- assess and verify available data, to ensure that it is sufficient to fulfil the proposed TSA objective.

This chapter discusses these four activities in more detail.

2.1 IDENTIFYING THE KEY DECISION MAKER AND HIS/HER OBJECTIVES FOR A TSA

In order to effectively define the policy or management question for the TSA, it is important to identify the relevant target audience for the analysis, as different decision makers will have different objectives.

There is a continuum of decision makers with different objectives, ranging from private decision makers concerned exclusively with profits to public decision makers concerned with wider economic outcomes. Whatever the objective of the relevant audience, it must be clearly stated and agreed upon before proceeding with the TSA, as it will have profound implications for the type of investigation required.

TIP: A TSA should be developed for one specific decision maker. Even if multiple stakeholders are included in the analysis, those stakeholders will be viewed from the perspective of the targeted decision maker. Thus, a TSA is not suitable for producing a body of information that describes a given decision from the perspective of multiple stakeholders. To achieve that, multiple TSAs would be needed.

For example, consider a given landscape, where, in a BAU scenario, widespread traditional livestock production is associated with high rates of land degradation, leading to soil compression and hence decreased infiltration of water and nutrients. Increased agricultural run-off puts additional pressure on ecosystems in rivers and water reservoirs. This current state of affairs can be compared to silvopastoral systems, which involve integrating trees, shrubs and fodder banks with crops and livestock, and can arguably enhance soil fertility, reduce erosion and improve water quality. In such an analysis, the use of silvopastoral systems can be viewed as the SEM. The following descriptions demonstrate the range of decision makers and objectives that might make up the prospective audience for a TSA based on this example. As one moves down this list, the analysis involved in a TSA becomes more complex.

1. ***Private decision makers (firms or individuals) concerned exclusively with net profits, or similar purely financial outcomes.*** These decision makers, who in this example would be individual farmers, would be concerned with diminishing net profits due to land degradation under the BAU scenario. For them, land degradation means a need for increased fertilizer use and thus higher costs per hectare, reduced capacity in terms of number of cattle per hectare, and finally reduced yield in kilograms of weight gain per animal. Accordingly, adopting silvopastoral systems would be an interesting SEM strategy to them only if the present value of net profits is higher under SEM. This group may also be interested in other indicators of success, such as reduced uncertainty about profits. In this case, the analyst would compare the costs and benefits of BAU and SEM at the farm level.

2. ***Public decision makers interested in financial outcomes only.*** Governments often act to address deteriorating productive conditions under BAU when they threaten an important industry or productive sector. In this case, the analysis requested from the analyst would be very similar to that for private decision makers, but it would also include an exploration of policies, as part of the SEM alternative, that could encourage the adoption of silvopastoral systems, especially in its early stages, as well as strategies to move toward implementation and acceptance of those policies.

Note: Throughout this guidebook, the term public decision maker refers to a representative of a group of individuals. The decisions of a public decision maker are motivated by concerns for the state of his or her constituency. Frequently, a public decision maker would be a government official in a local (e.g. a municipality, a cooperative, an association), a regional or a national government.

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3. ***Private decision makers looking for common interests with government officials.*** Silvopastoral systems have high start-up costs, and their net benefits in the first years tend to be negative, as trees and shrubs need time, space and protection from cattle to grow. Knowing this, and also realizing that these systems generate benefits that go well beyond a single farm's borders, the private farmers might be interested in exploring which external stakeholders stand to benefit from silvopastoral systems, and whether they would be willing to financially support the establishment of these systems in the landscape. For example, in the Rio Reventazon watershed in Costa Rica, the national electricity company actively encourages the adoption of silvopastoral systems in farms upstream, offering free technical assistance and machinery as a way of reducing the process of

siltation and eutrophication that was threatening one of its largest hydropower plants. In such a case, in addition to estimating the comparative financial costs and benefits of BAU versus silvopastoral systems (SEM) for the farmers that are adopting the systems (as above), the analyst would also estimate relative costs and benefits for other beneficiaries who might eventually contribute to a program to encourage adoption of the SEM path. Moreover, the analyst might be asked to evaluate policy instruments, such as payment for ecosystem services (PES) that could be used to achieve a better balance of the costs and benefits of SEM in the landscape as a whole.

4. ***Public decision makers interested in the promotion of local businesses and employment, and hence focused on purely financial indicators, including the financial costs and benefits of environmental externalities.*** This audience is very similar to the previous one, except that the impetus for the study comes from the local government or a local NGO, rather than from the private individuals or firms. For example, a local municipality might be interested in securing clean sources of surface water for its population and realize that heavily degraded pastures are incompatible with that outcome. Accordingly, the adoption of silvopastoral systems, partially supported by downstream water users, might be regarded as a possible solution worthy of analysis. In this case, the analyst would estimate relative costs and benefits for both the private downstream water users as well as the local municipality.

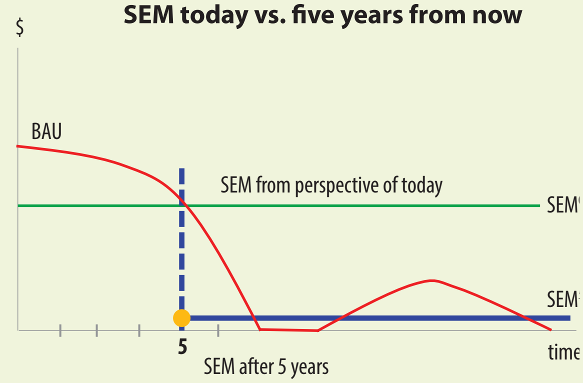
5. ***Public decision makers interested in economic outcomes.*** At this point, the decision maker is a public policy maker (in this example a representative of the local government, the water utility or the global community), for whom land degradation means higher pressure on the agricultural frontier as farmers try to move to new lands, resulting in increased agricultural runoff and higher erosion rates. These decision makers are still interested in the effect of silvopastoral systems on farm productivity but also in the generation of positive externalities to other actors in the landscape. Thus, they will want to see an evaluation of changes in outcomes due to a shift from BAU to SEM based on the effect they have on human well-being, instead of simply on changes in income. In an economic analysis, monetary units are used to measure the change in human well-being to an individual or group that results from the implementation of a policy intervention. For example, assume that the adoption of silvopastoral systems on the farms of a given watershed for a hydropower plant contributes to the generation of 1Kwh above the BAU baseline. In a financial analysis, the benefits of this increased electricity generation would be estimated simply based on the price of 1 Kwh, whereas in an economic analysis, the benefits would be estimated by measuring the increase in well-being of an average family that enjoys the additional electricity generation. In this case, economic benefits might far exceed financial benefits, though the opposite is also possible if negative externalities are present. Clearly this analysis is much more complex than the previous options, and it may be the case that the technical and analytical complexity of this analysis is not necessary if a financial analysis is enough to justify the shift from BAU to SEM.

Box 3: Now or Later

Because a TSA is based on the current state of technology, and the costs and benefits of SEM and BAU derive from the current state of the natural resource base, it is not well suited to deciding whether to invest now or postpone a decision to a later date, when income is higher and more resources or a cheaper solution may be available. This is especially relevant when the costs and benefits of SEM are expected to change a lot in the future, in which case a strategy of postponing the investment could be reasonable. Decision makers looking for help in deciding whether to invest in a particular management strategy now or wait until later will not find their answer in a TSA, which only sheds light on whether to invest now or not. In the future, the underlying conditions (technology, natural resources, etc.) would have changed, and so a new TSA would be needed then.

The figure at right illustrates the risks of using a TSA to decide whether to postpone an investment decision. From today's perspective, the adoption of the SEM intervention (the green line) will result in profits lower than BAU (the red line) for the first five years, but from then on, profits under BAU drop due to degraded environmental inputs (e.g. decreased fish stocks). Seeing this analysis, a decision maker might be tempted to wait five years and then adopt SEM practices. However, this would be a wrong interpretation of the TSA results. In five years, natural resources might be degraded to a point at which SEM is unable to generate profits (the blue line), and an entirely different recommendation would hold if the TSA were to be conducted then.

SEM today vs. five years from now



2.2 REFINING THE FOCUS AND SCOPE OF THE TSA OBJECTIVE

After defining the sector and specific decision maker(s) at the different levels who will be the target audience for the analysis, and hence the main objective of the TSA, the analyst must then work with that decision maker to refine the focus of the analysis to ensure that it can be effectively tackled by a TSA. Often, decision makers, and those advising them, require guidance on how to correctly frame a policy issue so that the right question is being asked and analysed. For example, it may be that the decision maker originally requested a total economic value of a mangrove forest, when in fact the more useful question would be: What is the value of sustainably managing that mangrove forest compared to cutting it down for coastal development? This problem is particularly apparent in economic valuation studies that are based on the assumption that just generating information about the value of an ecosystem will lead the decision maker to action. The question being asked should include the incorporation of ecosystem services into one of the policy or management interventions (the SEM) which can then be compared to the other intervention that disregards or degrades the ecosystem services (the BAU).

In general, there is a continuum in the breadth and complexity of policy or management options that could be the focus of a TSA, ranging from a general comparison of national development paths for a country or region to an exploration of whether it makes sense for an individual decision maker to adopt a specific management practice. Many decisions can be narrowed down or expanded, even while maintaining the same decision maker and objective. The following are three examples that illustrate the wide variety of focus possible in a TSA:

Example 1: Concerns about a changing climate can be tackled at different levels, each of which would provide a different focus for a TSA. On the one hand, a TSA could be used to explore whether a shift towards a carbon-neutral economy (SEM) is economically viable and to evaluate the impact on the economy of national policies that would be required to achieve a move away from the current status quo of high carbon emissions (BAU). This vision of a carbon-neutral economy requires a combination of many specific policy and management interventions (which this guidebook groups under the heading of SEM interventions), and a detailed assessment of those specific interventions and their interrelations would be part of the TSA. On the other hand, a single firm might be interested in exploring whether becoming carbon neutral is a good marketing strategy. In this case, the analysis would be limited to identifying changes in investment and operation costs, and conducting market analysis to explore the demand for carbon neutral products for that particular firm in question.

Example 2: A local official is interested in air quality in a city. One option would be to explore whether to make catalytic converters mandatory for all new cars (SEM policy) as a way to reduce dangerous air pollution in the city. Another, much more complex option, would be to use TSA to compare the status quo to a comprehensive program to reduce urban air pollution, including catalytic converters but also improved fuel efficiency standards, incentives for public transportation, etc.

At each point, the level of technical complexity and required specialized knowledge is very different, depending on how broad or narrow the question being asked is, and the analyst should allow no room for confusion regarding the purpose of the analysis and the role of TSA. Comparing the pros and cons of an incremental step along a single trajectory of development is challenging, but it is a far simpler, more manageable task than comparing two different development paths across multiple social, economic and environmental criteria.

Example 3: Consider the case of a local government official worried about increasing water scarcity, who has summoned an expert to explore how to manage the land so as to increase the provision and management of water. In this case, it may turn out that water scarcity is entirely unrelated to land-management practices. For example, if human water consumption has grown to a point that it exceeds the hydrological balance, then the problem is almost entirely from the demand side of human consumption under BAU conditions, rather than a result of land degradation. Note that, in this case, there is no real need for the application of TSA, as the root of the problem is only minimally related to the management of ecosystems.

However, if it is the case that land degradation is affecting water supply, the analyst and the decision maker will need to work together to determine the best focus for the analysis. In the terminology of TSA, the analyst has been hired to explore the pros and cons of alternative SEM interventions.

Moreover, frequently policy makers want to use a particular instrument because they saw it working somewhere else or somebody suggested it. In such cases, the objective of the analysis is already framed as the need to evaluate a particular policy instrument. Nevertheless, it is often worth it for the analyst and the decision maker to at least consider the validity of taking one step back in the decision-making process and considering other alternatives.

Box 4: Examples of TSA policy questions

The following questions have been defined in such as way to make them suitable for analysis by TSA:

- Is there a business case for restoring water quality in a degraded lake?
- Does it make sense to use payments for ecosystem services to reduce nitrogen runoff from agriculture into a particular lake?
- Is there a business case to support the diving industry as opposed to current reef-damaging activities?
- Does it make sense to conserve forests (to reduce soil erosion and land degradation) on a coffee farm, in order to increase revenues over time?
- What are the costs and benefits (from a profits and employment perspective) of establishing a fishing quota in a particular region?

On the other hand, this question is poorly framed for the purposes of TSA and would be difficult to answer with this type of analysis:

- What is the value of these protected areas in terms of their contribution to economic growth and human well-being?

This question should be reframed to something more like:

- Is it worth investing more in protected areas to increase visitation by tourists and improve off-site water quality?

2.3 DEFINING THE SCOPE OF THE ANALYSIS

Once the focus of the question has been refined, the analyst should work closely with the decision maker to more specifically define the appropriate scope for the TSA. While the previous step looked at defining the focus of just the specific policy or management question being addressed, this step looks at the broader parameters of the entire analysis. This exercise should include determining the following:

1. the spatial scale for the analysis;
2. the time frame for the analysis; and
3. the legal and regulatory scope for the analysis.

2.3.1 Determining the spatial scale for the analysis

The spatial scale describes the geophysical boundaries within which the analysis is to be conducted. The relevant spatial scale will be determined by the expected impact of the policy or management practice to be investigated, the current source of ecosystem degradation and the preferences of the decision maker who requested the analysis.

This spatial scale may vary widely, depending on the focus of the analysis. In addition, geographical characteristics, such as topography, watersheds or county limits, should be taken into consideration, but should not be the defining factor, as a decision maker's area of influence may transcend those limits to include stakeholders and sources of revenue in distant regions.

The spatial framing of the TSA is seldom obvious and might require several discussions with the relevant decision maker, as new information and evidence is added to the analysis. Consider, for example, that an analyst has been asked to conduct a TSA of an inshore fishery. In this case, the fishermen are the key stakeholders, and the spatial scale could be limited to the coast and shallow sea. However, if it turns out that deterioration of the fishery is being caused by river pollution from inland activities, the TSA should also be expanded to include the entire watershed.

In some circumstances, the spatial scale is clearly established by the decision maker. For example, if the decision maker is the owner of a farm exploring whether to move towards organic production, then it would seem obvious that the land belonging to the farm delimits the relevant spatial scale. However, because it is also true that organisms in the surrounding landscape may provide ecosystem services to the farm,[7] the analyst might still consider expanding the spatial scale of the analysis to include prevailing conditions in the relevant landscape.

In some cases, the spatial scale is defined by the stakeholders who will be affected by a potential decision. For example, efforts to manage a watershed sustainably typically involve actors located within the watershed and also beneficiaries who could be located far from the watershed, such as hydropower companies or drinking water consumers.

Whatever the spatial scale of the analysis, it is important to remember that external and exogenous factors are likely going to affect the final outcomes, regardless of the scale chosen. For example, if the focus of an analysis is on a specific coral reef, it might be affected by global warming, irrespective of actual BAU and SEM practices.

7 UNDP 2010, Chapter 6, p.55. Also: Zhang, W., Ricketts, T., Kremen, C., Carney, K. and S. Swinton. 2007. "Ecosystem services and dis-services to agriculture." Ecological Economics 64: 253-260.

2.3.2 Determining the time frame for the analysis

The analyst should also conduct the TSA with a specified time frame in mind. As with the spatial scale, the time frame should be determined in close consultation with the decision maker to be appropriate to the objective, and may need to be revised as new information emerges.

Figure 6: Alternative time scales

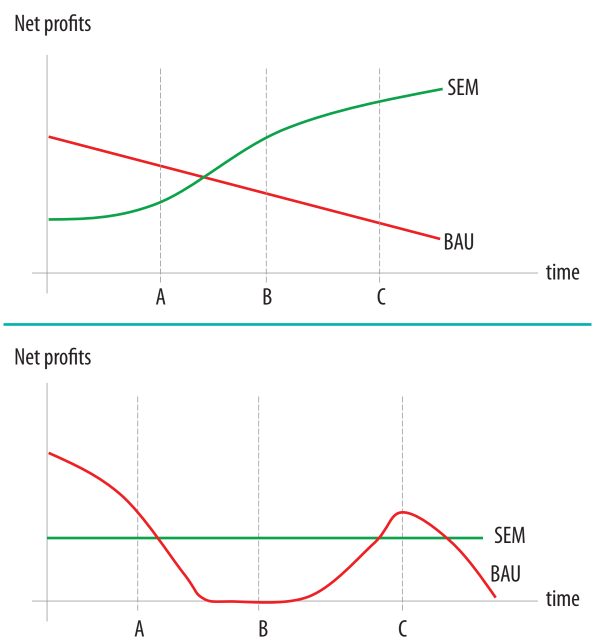


Figure 6 shows two stylized situations in which the time frame is presented in the short (A), medium (B) and long (C) term. In both graphs, defining a very short horizon for the analysis would result in an unequivocal recommendation in favour of staying under BAU, despite the fact that profits are decreasing. A medium-term planning horizon provides a much more encouraging perspective of SEM in both graphs; in the bottom graph, net profits under BAU have collapsed, as is the case when fisheries are forced to close for a few years when boats cannot even cover their variable costs. Finally, a long-term planning perspective gives a much more complete picture, showing SEM consistently greater than BAU in the top graph and a more mixed comparison in the bottom graph, which might reflect boom and bust cycles for a natural resource, such as a fishery.

The bottom graph also illustrates a key strength of TSA. By considering changes in BAU and SEM over the whole of the planning horizon, TSA is better equipped to assess both interventions. A snapshot valuation taken at a single point in time (for example, A, B or C) would fail to deliver an accurate analysis of the pros and cons of SEM when compared to BAU.

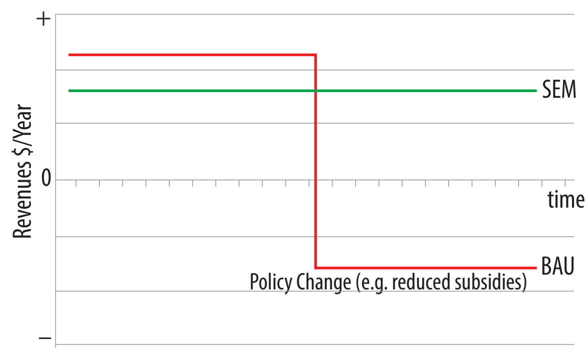
In the example of the adoption of silvopastoral systems developed in this chapter, assume that the decision maker is mostly concerned with the start-up costs of the adoption of these systems. If this is the case, then the time frame can be defined as the cut-off point in time beyond which silvopastoral systems become profitable.

2.3.3 Determining the relevant legal and regulatory scope

Finally, the decision maker and the analyst need to agree on the relevant legal and regulatory dimension of the analysis. Typically, small policy and management decisions are framed by the normative framework in the status quo. But as the policy or management questions become larger, the decision maker has to consider carefully whether restructuring laws and regulations should be part of the SEM policy intervention.

In some circumstances, poor institutions and regulations are themselves the source of deteriorating environmental conditions under BAU. This is the case with perverse incentives, i.e. market-based instruments or regulations that lead by design or in an unintended way to aggressive use of the environment. For example, subsidies to a highly polluting industry or technology might keep firms going even if profits were low and society as a whole would be better off moving those resources to alternative industries or technologies. This situation is depicted in Figure 7, where a TSA is conducted for an SEM intervention that involves the complete removal of the perverse incentives at some moment in the future, resulting in BAU immediately falling into negative numbers.

Figure 7: Removal of perverse incentives



2.4 ASSESSING AND VERIFYING AVAILABLE DATA

Successfully defining the objective of a TSA is dependent on the availability and quality of information that exists to assess the objective. In the absence of data, the analysis would be entirely normative (based on ethical principles and individual perspectives), and a different decision approach than the one suggested in this guidebook would be needed. In many cases the information needed exists, but is scattered among various institutions, programs and people. In this sense it is worth taking some time to do a search of the information available before beginning to generate new data.

During this process, the initial definition may be revised several times as new information is acquired and processed. Working closely with the decision maker, the analyst should adjust an initially proposed objective gradually towards an objective that is empirically manageable, as data availability and information are determined. In doing so, though, it is important not to lose sight of the original purpose of the analysis as related, but less relevant, data becomes available. In some cases, the identification of major data gaps and limitations can in itself be an important conclusion of the analysis.

Checklist

An analyst who has successfully defined the purpose of the TSA and identified the relevant policy or management question should be able to answer the following questions:

1. Does the objective fit with the nature of a TSA?
2. Who is the decision maker that is the target audience?
3. What is the focus of the question that is to be answered by the TSA?
4. What is the relevant spatial or geographical scale?
5. What is the relevant time frame?
6. What is the relevant legal and regulatory scale?
7. Is there sufficient and relevant data available to support all the above?

Box 5: Deciding what not to include in a TSA

In addition to defining the scope and scale of a TSA, to determine what to include in the analysis, the decision maker and the analyst should also reach agreement regarding what is not going to be considered as part of the policy or management question. An analyst never has the time or resources to study every aspect and detail of each policy question, and so must decide how to allocate time and resources in the study of policies or management interventions whose outcome is as yet uncertain. It is thus essential to know where not to invest that time and resources and to understand what is not considered to be part of the question, i.e. what is to be considered outside the scope of proposed work. For example, say that an analyst has been summoned to study how protected areas in a given landscape can be designed to protect hydrological resources, but the interested policy maker has made it clear that no new protected areas are to be created. In other words, the analysis must focus only on improving the management of existing protected areas. Knowing this in advance will dramatically reduce the scope of analysis and the analyst's workload.

3

STEP 2 – DEFINING THE BAU AND BASELINE AND SEM INTERVENTION

CHAPTER 3: STEP 2 – DEFINING THE BAU BASELINE AND SEM INTERVENTION

This chapter explains the process of defining the BAU baseline and the SEM intervention. For the BAU, the analyst should determine the mix of policies, actions and technologies that makes up the current status quo, and then identify the observed impacts of this state of affairs, as well as the technical, non-ecosystem-based strategies that are being used by relevant actors to address those impacts. For the SEM, the analyst should identify the mix of policies, actions and technologies that could be used to change the status quo and reduce or reverse the effects of BAU on the relevant ecosystem, and then determine the potential consequences of this course of action, as well as the investment and maintenance costs required to implement it.

Once the purpose of the TSA is defined, the next step in a TSA is to define the characteristics of the BAU baseline and the SEM intervention in the selected sectors/subsectors.[8] This involves describing the set of practices and/or policies associated with each of these two possible courses of action. For SEM, these may include creation of new laws, better enforcement of existing laws, business activities, use of market-based instruments, different levels of investments, management plans or other actions, all of which contribute towards maintenance of relevant ecosystem services. While the interventions are the mix of policy and management actions that make up the BAU and SEM paths, the scenarios (described in Chapter 5) are narratives of the future as it evolves under BAU or SEM, i.e. the outcomes of the actions defined in this step.

This chapter discusses what is meant by BAU or SEM interventions and the tasks typically involved in constructing these interventions. The construction of a viable, credible mix of policy or management interventions is the first phase in moving from an objective to a framework for analysing the different options for meeting that objective. Importantly, new information discovered at this stage, such as lack of data or lack of consensus on developing the interventions, may require the analyst to review the TSA objective.

8 For narrative simplicity, in this guidebook the BAU baseline and the SEM intervention will frequently be called BAU and SEM interventions. Strictly speaking, introducing no policy or management change to the status quo (i.e. sticking to the BAU baseline) is in itself an action, or intervention, i.e. a decision to do nothing.

3.1 THE IMPORTANCE OF CONSENSUS AND CLARITY

The policy and management interventions defined at this stage have to be the product of a consensus (or at least a strong agreement) of experts, both practitioners and scientists, regarding what constitutes BAU and SEM. The difficulty in reaching such an agreement should not be underestimated. Nevertheless, it is extremely important, as there is a very real danger that the entire TSA could be rejected if it is judged that the available policy or management interventions were wrongly constructed.

While it is typically easy for experts to agree on broad generalities (e.g., eating vegetables is good for your health, overfishing should be avoided), these are usually not specific enough to be of much use for a decision maker. Rather, to accurately define the interventions, the analyst will have to work with the detailed elements of the two courses of action (BAU and SEM); as it is variation in those details that will ultimately produce different outcomes. At this more detailed level, the analyst often encounters sizable disagreements among experts, and between experts and the general public, regarding the specifics of potential policies or management practices that make up an SEM intervention. In addition, every interest group or affected party may have preferred policy interventions, and the analyst should avoid being drawn into creating so many interventions that detailed examination of each becomes too time-consuming or impossible.

It is important to be able to clearly identify the causal links between the various elements of the BAU and SEM policy interventions and the outcomes that result from their implementation. For this reason, it is essential to narrow the focus of the SEM intervention to a few policy or management practices that are both feasible and relevant to the interests of key decision makers and affected parties.

3.2 DEFINING THE BAU BASELINE INTERVENTION

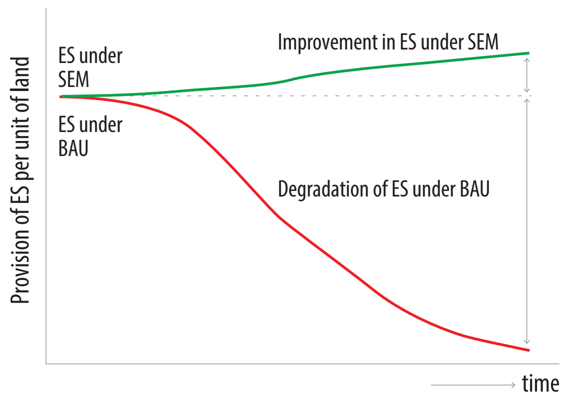
The BAU baseline intervention captures the status quo; in other words, the BAU is what will happen to the relevant indicators over time with the continuation of current practices that do not account for the role of ecosystems and ecosystem services in daily production and consumption decisions. However, it would, of course, be absurd to think that decision makers will remain passive while their businesses, be they private or governmental, are affected by deteriorating environmental conditions. In order to fully capture the BAU baseline, the analyst must understand the relationships between management practices and changes in ecosystem services that will occur under BAU. This is important, because as conditions change over time, the BAU management practices will react to those changes. For example, a farmer faced with increasingly degraded soils might choose to increase the use of chemical fertilizers on his fields. Defining the BAU requires asking three related questions:

1. ***What are the current policies, actions and technologies being used that are relevant to the description of BAU in a TSA?*** For example, in the case of a farmer facing ever-degrading soil quality, the analyst needs information regarding the current farm practices, the level of degradation and how that level has been changing over time. Policies that influence the current farming practices, such as subsidies for agro-chemicals, also need to be identified and added to the BAU intervention description. See Table 1 for a comparison of policies and practices under BAU and SEM.

In the process of defining the set of practices that make up BAU, it is also important to establish when and for how long these practices can realistically continue. For example, there are at least three situations that might lead to a full halt of status quo production in the relevant sector: (1) changes in market conditions, such as a lack of global demand for uncertified timber; (2) future governmental policies, such as a prohibition on imported tuna that is not caught with turtle- or dolphin-friendly equipment; and (3) collapse of the ecosystems that are key to production or consumption, such as desertification of agricultural lands, eutrophication of lakes or collapse of shrimp farms in converted mangrove areas. These potential situations are particularly relevant for productive sectors, as they have the ability to render the entire sector unviable. These scenarios should be supported by the monetary estimation of the forthcoming financial or economic loss in order to be relevant to politicians.

2. ***What are the observed impacts of this current state of affairs on ecosystem services?*** The BAU involves decisions and actions that are not taking ecosystem services into account. Thus these actions are highly likely to have negative impacts on the provision of ecosystem services through degradation of soil, water and/or air (see Figure 8).

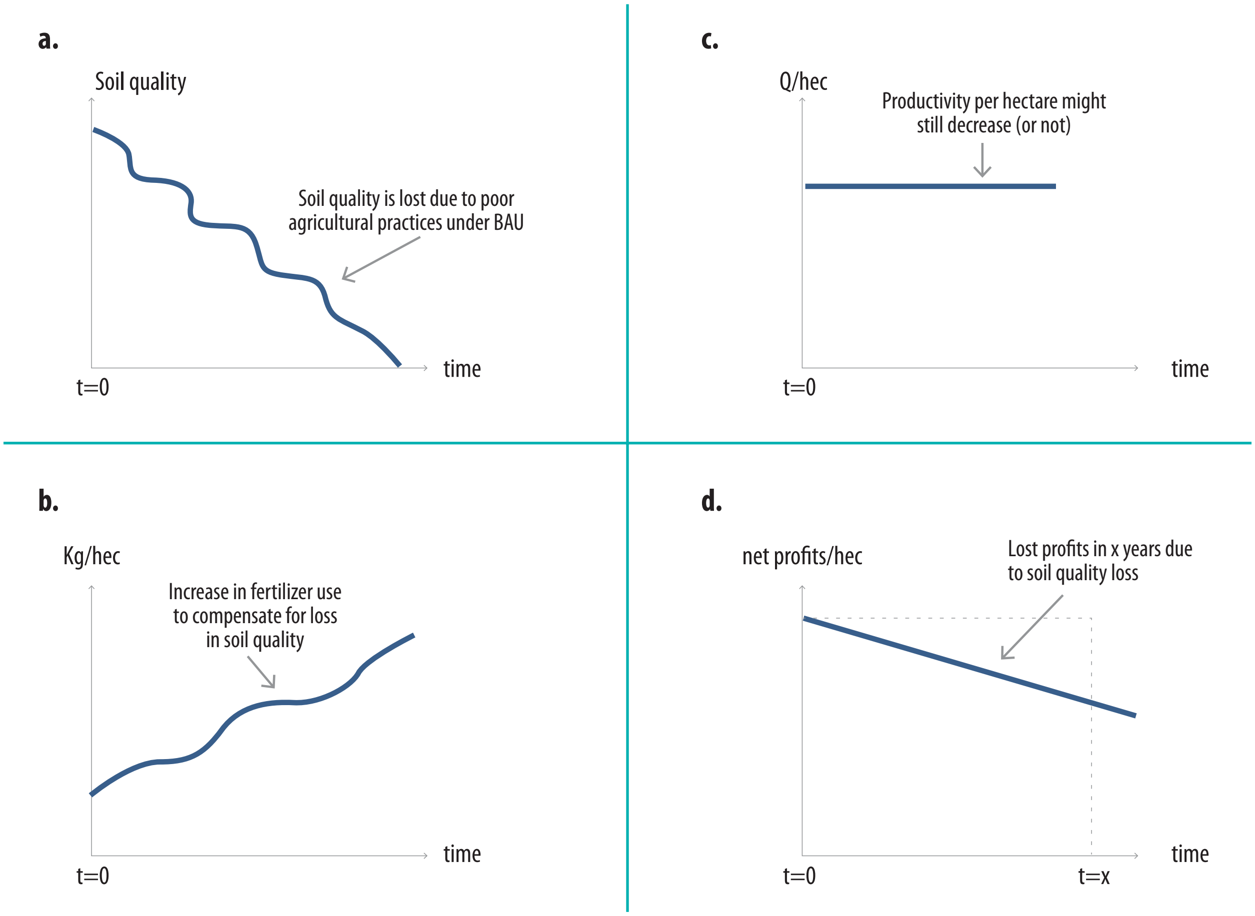
Figure 8: Changes in the provision of ecosystem services under BAU and SEM



3. ***What technical, non-ecosystem-based strategies are being used now by relevant actors to address these impacts?*** Even if the BAU intervention and its associated policies result in degradation of ecosystem services that are being used as inputs into a particular production or consumption process, it does not necessarily mean that the net financial profitability or the net economic benefits of BAU will equally decrease in time, or even decrease at all. It can be assumed that decision makers will take defensive measures, substituting technical inputs for lost ecosystem services whenever possible. Sometimes, the need to substitute technical for natural inputs could even lead to the adoption of highly efficient production technologies. It is important to be able to understand and predict these likely reactions and changes in management practices in order to be able to accurately define the true BAU intervention.

Figure 9 provides a good example of the complexity of establishing an accurate BAU intervention. In this example, poor agricultural practices are leading to degraded soil quality and loss of highly fertile top soils (graph a). If farmers do not counter this soil degradation with increased fertilizer use and technological advances, such as improved seeds and ploughing techniques, it will inevitably lead to reduced profits. However, it is more likely that farmers will incrementally change their practices in response to increasingly degraded soil. One such response would be increasing the amount of fertilizer they use (graph b). The challenge for the analyst conducting a TSA is to see how these changes affect productivity and profits. Graph c shows a situation in which the farmer is able to perfectly compensate for the loss in soil quality with technical inputs, such as fertilizer, thereby keeping productivity per hectare constant. Of course, another possible alternative is that productivity is still negatively affected by lost soil quality, despite the best efforts of the farmer to ameliorate this effect with external inputs. Finally, graph d summarizes the story told by the first three graphs, using money (net profits) as a unit of measurement. The ultimate effect on profits will depend on how quickly soil quality is lost, the price of fertilizers and the overall effects on productivity per hectare. Note that even if the farmer does manage to maintain constant productivity per hectare, as depicted in graph c, net profits would still be reduced, because of the higher production costs resulting from increased fertilizer use.

Figure 9: Observing changes in soil quality to changes in net profits



In some cases, an analyst might be tempted to go directly to establishing a relationship between soil quality and net profits, for example by surveying farmers with different soil qualities and asking them about their net profits. In such a case, the analyst must have a good understanding about the mechanisms behind the relationship, for example from secondary information, interviews with experts and focus groups with farmers, in order to be able to support and defend the causality presented in the TSA results.

The following table includes a series of BAU (and SEM) practices that help set the stage for the construction of the BAU baseline intervention. Note that the list is by no means exhaustive.

Table 1: Examples of management/policy practices under BAU and SEM for each sector		
Sector	**BAU**	**SEM**
Agriculture	• Conversion of primary forests • Habitat conversion • Monoculture • Agrochemical and pesticide use • Heavy water use • Use of Genetically Modified Species • High tillage systems • Clearing weeds through burning • Lack of medium- and long-term agricultural sector development policies/strategies that include ecosystem management • Perverse financial incentives	• Management of plantations for continuous cultivation • Reduced use of agrochemicals • Reduced N2O emissions • Adoption of agroforestry systems • Multiple cropping • Integrated pest management • Use of crop rotation and polyculture • Reduced wastes and appropriate disposal • Reduced water use • Preservation of riparian buffer zones • Maintenance of native varieties of species and cultivars • Low-tillage systems or adoption of conservation tillage • Increase in organic matter in soil • Use of cover crops • Avoidance of burning practices
Livestock	• Habitat conversion • Overgrazing • Feedlot production • Production of feed grains • Subsidies for agrochemicals • Lack of medium- and long-term agricultural sector development policies/strategies that include ecosystem management • Perverse financial incentives	• Recovery of existing habitat • Adoption of silvopastoral systems • Improvements in pasture management and rotations • Encouragement of integrated farms with higher carrying capacity and yields • Improved feed quality • Improved water management • Reduction/avoidance of agrochemicals and antibiotics • Promotion of natural pest control • Enabling microclimate regulation • Protection of riparian areas • Protection or enhancement of water bodies • Income diversification
Forestry	• Forest conversion • Exotic tree monoculture • Heavy intervention in native forests • Clear cutting: Land-use change • Heavy extraction of non-timber forest products (NTFP) • Extraction of high-value exotic and native timber	• Managed native forests • Agroforestry • Native or mixed species plantations • Subsistence use: NTFPs and fuel wood gathering • NTFP production • Selective logging • Conservation of high-value exotic and native timber
Fisheries	• Overfishing • Maximization of short-term gain • Externalization of long-run or indirect impacts, or those that are off the production chain	• Sustainable harvesting • Regulated fish stocks • Protection and conservation of underwater habitats and biota • Safeguarding of ecosystem services

Table 1: Examples of management/policy practices under BAU and SEM for each sector		
Sector	**BAU**	**SEM**
Fisheries (continued)	• Prevention of the recovery of fish stocks • Fleet overcapacity • Perverse subsidies that stimulate the development of overcapacity and/or excess fishing effort • Poor control to prevent illegal, unregulated or unreported fishing • Watersheds poorly managed • Discards of targeted species • By-catch of non-targeted species • Ghost fishing by abandoned gear	• Generation of sustainable economic yields • Regulation of fishing fleets • Reduction in sedimentation and agrochemical runoff in watersheds • Establishment of catch quotas
Tourism	• Mass tourism models • High-profile transnational companies • Over-consumption of freshwater • Inadequate treatment of wastewater and solid waste • Overdevelopment • Crowding • Massive imports • Poorly controlled visitation • High volumes of visitors • Low profit margin • Lower revenue per tourist • Over-use of attractions • Passive community participation • Short-term perspective	• Small and medium-sized enterprises • Plans for biodiversity and ecosystem conservation • Maintenance of cultural and biological integrity • Enhanced infrastructure and services for the local community • More use of local inputs • Active community participation • Impacts monitored and managed • Higher revenue per tourist • Limited access • Higher spending per tourist • Long-term perspective
Protected areas	• Threats from economic activities, including encroachment by agriculture, illegal timber harvesting, tourism development, etc. • Incomplete ecological representation • Lack of inter-sector collaboration, substantial institutional fragmentation (poor interaction of environmental agencies with agencies outside the environmental sector) • Insufficient financial management capacity and absence of diversified long-term financial-mechanisms • Isolation of institutions managing PA from national development policies • Poor PA management capacity • Absent legal and regulatory framework for PA financing • Poor compliance and no enforcement • Absence of transparency and accountability standards	• Minimized threats • Full ecological representation • Strong inter-sector collaboration, delegation of responsibilities and shared leadership • Sound PA financial planning and diversified long-term PA funding mechanisms as an integrated part of national development agenda • Institutions managing PAs aligned with national development policies • Strong PA management capacity • Coherent legal and regulatory framework for PA financing • Strong compliance and enforcement • Standards and transparency and accountability enforced • Strong PA benefit sharing within civil society, including vulnerable groups • Funding to support PA management meets medium to optimal needs

Table 1: Examples of management/policy practices under BAU and SEM for each sector		
Sector	**BAU**	**SEM**
Protected areas (continued)	• Limited participation of local communities in PA management and planning and PA benefits sharing • Funding to support PA management below basic needs or at basic level needs • Financial and economic information absent from the decision-making process	• Informed decision-making based on sound financial and economic information.

3.3 DEFINING THE SEM INTERVENTION

The SEM intervention is a set of one or several activities that represent a departure away from BAU and towards productive and consumptive activities that better sustain ecosystems. The SEM intervention is sometimes backed by a specific policy or set of policies incentivizing SEM practices. (See Table 1 for examples of practices and policies under SEM and BAU.) The definition of the SEM intervention should include specific details about the policies, actions and technologies that will be used to implement the practices included. So, for example, it is not enough to just say that the SEM intervention involves increasing the amount of riparian forest. Rather, the analyst will need to include a description of the type of riparian forest, where it is going to be planted, how quickly and what kind of habitat is there at the moment, as well as produce a list of the conversion costs that will need to be considered later, when constructing the SEM scenario.

The analyst should make sure that there is solid agreement among relevant parties regarding what is included in the set of activities in the SEM intervention. Just as with the BAU, fully capturing the definition of the SEM intervention requires asking three related questions:

1. ***What package of policies, actions and technologies could be used to change the status quo and reduce or reverse the effects of BAU on the relevant ecosystem?*** For example, the SEM could involve implementing organic farming techniques, or adopting a silvopastoral system, or imposing limits on development. A more complex SEM intervention might involve the establishment of user charges for water disposal, the imposition of a tax on highly polluting fertilizers, or the reform of perverse policy incentives that have encouraged overexploitation of a particular resource.

The decision maker, key stakeholders and experts in the field must reach an acceptable level of agreement regarding the set of policies and practices that constitutes an SEM intervention. This process should include an assessment of feasibility based on the time and budget that are available to achieve the SEM intervention. In addition, it is also important to consider what type of policy is most feasible, both politically and economically. For example, say a proposed policy intervention involves charging entrance fees to tourists who enter a protected natural area. If entrance fees have never been used before, the policy proposal may encounter opposition from public officials concerned about the need for new laws or new financial accounting systems. The analyst needs to judge whether those objections are strong enough to make it unrealistic to propose an SEM alternative that includes entrance fees for protected areas, or whether those objections simply indicate the need to include changes in legislation or improved technical expertise within the SEM intervention.

2. ***What will be the consequences associated with adopting the SEM intervention?*** These consequences can be multiple and include not only those resulting from reduced ecosystem degradation, but also those resulting from changes in production, market access and other variables that emerge during and after the SEM intervention.

Take, for example, an SEM intervention that involved imposing a government tax on agrochemicals that are proven to have a significant negative impact on key ecosystems. This policy intervention might result in a change in the relative prices of agrochemicals that pushes farmers towards reducing agrochemical usage or choosing less expensive, less damaging agrochemicals. Another impact may be that, where farmers do not adjust their purchase of the agrochemicals, the standard, non-organic, agricultural products become more expensive as the price reflects the increased costs of fertilizers, so that organic agricultural products might become relatively less expensive and gain higher acceptance among local consumers. Seeing these results, a farmer might reduce use of agrochemicals or even opt for organic production methods altogether. A TSA can analyse this chain of potential events to assess the likely impact of the introduction of a tax, and moreover might even show the likely size of the change and its effects on select indicators. In this way, policy makers will be more prepared to deal with the reactions to such a policy.

It may be the case that the type of management practices that producers and businesses adopt will be based on new policies that are implemented. For example, in a case where a more efficient and cleaner technology was previously deemed inappropriate or too costly by producers, a new government policy (e.g., a use charge on water discharge or water use) might make that technology more attractive. This then needs to be incorporated into the SEM intervention.

3. ***What are the investment and maintenance costs associated with adopting the SEM intervention?*** These costs will determine how hard it is to move from BAU to SEM, and include not just actual investments but also the costs of acquiring the necessary knowledge to operate under an SEM intervention. Frequently, high sunk costs and/or lack of technical knowhow constitute fundamental barriers to more sustainable practices. At this stage, the analyst should only focus on identifying and characterizing the needed investment and maintenance costs, so that they can be estimated and eventually included in the construction of the scenarios.

3.3.1 Simple vs. complex SEM interventions

The scope of this guidebook includes both small, single policy interventions and large packages of policy interventions that together might constitute a new development path under SEM.

In general, TSA is simpler to undertake when the SEM intervention involves small changes in policies or management strategies. The smaller the scope of the SEM intervention, the less there is to analyse and forecast when constructing the scenario. For example, a business might face the decision of whether to invest in pollution abatement technologies or a business might consider reducing its use of agrochemicals. Such analysis for each business involves a single change to BAU, so in the construction of the SEM intervention, the analyst does not have to worry about complementarities between its different elements. Moreover, the analysis can be purely financial, as the firm's CEO would be the person making the decision, and thus the constituent elements of the BAU and SEM interventions could be described in purely financial terms to the decision maker.

For interventions that are larger and comprised of a more ambitious combination of policies and practices with a multitude of consequences (e.g., changes in government policies that trigger a series of reactions by firms, or a decision by the tourist industry on whether to channel development in a particular region toward ecotourism or mass tourism) the analyst must pay special attention to the complementarities between the different elements of SEM.

Once a given set of policies and practices is defined as the SEM intervention for the TSA, it is important to avoid deconstructing it into its individual elements, as doing so might miss the synergies and complementarities created by the presence of all those actions together.

Figure 10: Sets of SEM practices and complementarities

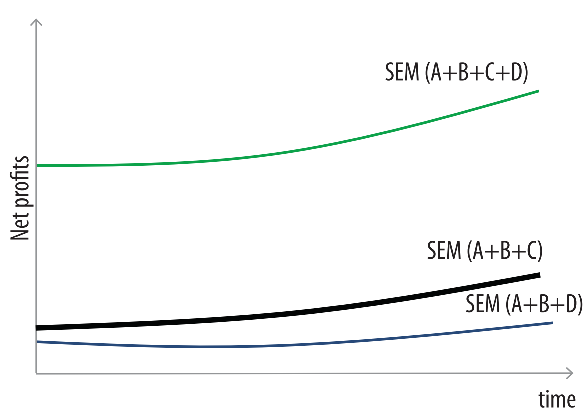


Figure 10 illustrates this issue: Assume that the decision maker and the analyst have agreed that four practices (A, B, C and D) are going to be analysed as a whole as the SEM intervention. This analysis results in the green SEM curve at the top of the graph. An obvious temptation is then to start testing scenarios that leave out one practice at a time. The results of eliminating C and then D are represented by the blue and black curves, respectively, at the bottom of the graph. Note that, although net profits are dramatically reduced in both cases, the analyst cannot confidently attribute this decline to just the elimination of either C or D. Most likely, leaving C or D out results in lost synergies that reduce profits significantly, even if C or D in isolation do not seem all that important.

3.4 REFINING THE DEFINITIONS OF BAU AND SEM

Once the analyst arrives at a preliminary selection of practices grouped under SEM and BAU for the particular policy or management question, it is important to ensure that these interventions are solidly defined, supported by experts and relevant to the appropriate stakeholders:

1. ***Careful review of existing secondary information and literature.*** Review of the available information related to the proposed BAU and SEM interventions should include careful reading and assessment of published material on the specific issue at hand. Existing data need to be identified, not least in order to judge whether there is a need for new, primary data to be collected as part of the upcoming analysis. Gaps in information that cannot be filled should be documented, as these gaps are in themselves important elements of the analysis of uncertainty. Suppose, for example, that a policy maker is concerned with reduced soil fertility and desertification that may be putting the agricultural sector in a particular region at risk. Although reduced water availability and reduced profits

have both been documented, little information is available regarding the relation between these two factors and how they may singly or together influence the prospect of desertification.

2. ***Identification of specialized information needs and open discussion with experts.*** Consultations with experts should be conducted on a regular basis from the very beginning of the analysis, as experts themselves may provide important published and grey (not peer reviewed, unpublished) literature and also serve as guides through the existing information. Most importantly, expert consultation can help achieve the maximum level of agreement surrounding the nature and scope of the policy or policies associated with the BAU and SEM interventions. For example, expert consultations should be crucial to identifying the key actors who would be involved in any change from BAU to SEM, including decision makers (besides the one requesting the analysis) with a say on policy implementation and who might understand the causal linkages between the SEM and BAU interventions and the outcomes that result from their implementation. A decision on protected marine areas, for instance, might require the involvement of regional authorities on both fisheries and tourism. The interventions might in fact require further involvement of authorities from sectors as diverse as infrastructure construction (roads, protective barriers), law enforcement and water safety, and waste management and disposal from commercial and tourism activities.

Middle-ranking employees or public servants in affected sectors should also be consulted, as they may have access to privileged information and direct field experience and may differ with the opinions of top management, community representatives or independent scientists. In turn, these experts may help the analyst identify other experts who have similar or opposing views, allowing the construction of a more balanced perspective on the problem at hand and possible solutions. It is important to remember, however, that consultation is not an end in itself. The analyst must have a clear list of questions ready to be presented to a given expert, and experts should be invited to contribute only if their knowledge can improve the final report.

3. ***Active participation of stakeholders that will be affected, positively or negatively, by the implementation of practices under the BAU and SEM interventions.*** An active and ambitious program to encourage the participation of relevant stakeholders will increase the realism of the final interventions selected for detailed examination. Participatory approaches can take many forms, and the analyst will have to decide which are most suitable to the specific context of the analysis at hand. A discussion on how to reach consensus or agreement with

stakeholders in a participatory process is outside the scope of this guidebook. However, clearly there is a need to include checks and balances in the process leading to the agreement to ensure that no individual or interest group has a disproportionate amount of influence. Moreover, although the decision-maker is the main client of the analysis, the analyst should be given enough freedom so as not to bias the analysis towards the client's preconceived ideas.

4

STEP 3 – SELECTING CRITERIA AND INDICATORS

CHAPTER 4: STEP 3 – SELECTING CRITERIA AND INDICATORS

This chapter discusses the process of choosing criteria and indicators for assessing and comparing the results of the BAU and SEM interventions. The criteria will be determined by the focus of the policy question and original objective of the TSA, as identified in Step 1 (Chapter 2). The indicators, which should be specific, measurable, achievable, relevant and time-bound, will be used to show changes over time in the chosen criteria resulting from BAU and SEM. Importantly, the same criteria and indicators should be used to evaluate both the BAU and the SEM.

Once the BAU and SEM interventions are defined, the next step is to determine how to assess and compare outcomes under BAU and SEM. The results of implementing each intervention, along with their consequences, can be assessed from the perspective of different affected parties, in order to answer the question: Which policy or management intervention is preferable? To do so, the analyst needs explicit criteria and associated indicators against which to assess and "rate" the array of prospective policy interventions under review.

4.1 DETERMINING CRITERIA FOR THE ANALYSIS

Criteria are principles that are used to judge how SEM compares to BAU. In general, criteria for a TSA will fall into one of five categories: financial, economic, equity, fairness or employment (see Box 6). Each criterion, in turn, will require one or more indicators. In the presentation of the final results of the TSA, each indicator will be measured and charted over time on a graph, with the Y axis representing the indicator and the X axis representing the time frame of the analysis.

Box 6: Types of criteria for a TSA

The following typology may be useful in guiding discussions with decision makers as to what criteria should be used to assess SEM in comparison to BAU.

Financial: Frequently, the main consideration when assessing a course of action might be a financial one. A private firm might be trying to maximize profits, whereas a public service provider (e.g., water utilities, power companies), might be simply seeking to recover costs. The important point from the analyst's perspective is that financial implications are central to the question of whether a course of action is desirable, and the analysis should focus on financial criteria.

Economic: In other cases, the decision maker might be more interested in economic criteria, basically ensuring that projects or policies that would do the greatest good for the greatest number of people are undertaken. In such a situation, the analysis would involve an assessment of net benefits, not just financial revenues and costs.

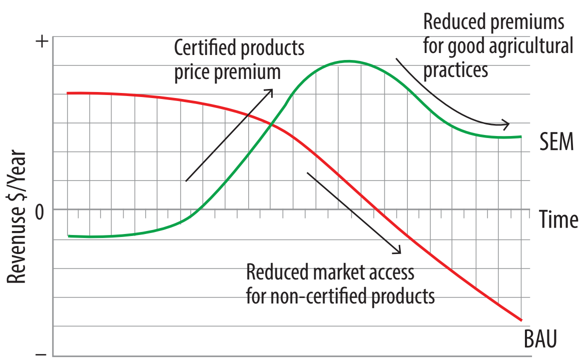
Employment: Some decision makers might be most interested in changes in levels of employment that result from a certain course of action. This can be measured in a TSA, because the analysis is not limited to monetary values. Here, the criteria would be based on effects on levels of employment.

Equity: Equity is defined here to mean that, within a given situation, people or groups in the same circumstances are treated equally and also that different groups e.g. low and high income households should be treated differently according to their different circumstances.

Fairness: Fairness of a policy or project may the most important criteria for assessing the attractiveness or desirability of a certain course of action. The concept of fairness is related to the idea of equity, but they are not the same. Fairness is more a subjective concept than equity, as fairness is determined by moral or ethical values; what is fair is often in the eye of the beholder.

An example of criteria and indicators: A farm manager might be interested in overall profitability of his farm (financial criterion) and use annual profits per hectare, profits as a percentage of capital investments and profits as a percentage of external inputs as indicators for that criterion. Figure 11 shows a stylized comparison of BAU (standard agriculture) and SEM (organically certified agriculture), using revenues per year as an indicator. This is one of several possible indicators that could be used to characterize the farm's objective of maximizing its financial criterion. Clearly, farms might consider other indicators in judging whether to move towards organic agriculture.

Figure 11: Revenues per year, as an indicator of profitability (criterion).



The selection of criteria and indicators is the final step before actually doing the analysis itself, and involves aligning the decision maker's original policy or management question, the definitions of the interventions and the eventual measures of impact. The same set of criteria and indicators will be used to analyse both the BAU and the SEM interventions.

TIP: It is important to use the same criteria and indicators to assess both the BAU baseline and the SEM intervention, in order to make the comparison between the two options most useful and accurate.

4.2 SELECTING INDICATORS

The analyst should work closely with the targeted decision maker to produce a realistic and manageable set of indicators to be used to evaluate the agreed-upon criteria. There is a vast literature on how to select indicators, but for the purposes of this guidebook, a good set of indicators would meet the SMART test: specific, measurable, achievable, relevant and time-bound. These characteristics are discussed in more detail below.

Specific: The indicators should be clearly defined, so there is no confusion as to what is being assessed and measured. They should describe a specific future condition that the analyst is seeking to assess.

Measurable: Criteria should be linked to measurable indicators, and measurements should carry no ambiguous interpretation for the decision maker and other potential stakeholders. For example, consider a decision maker who is interested in improving the health of a particular ecosystem. In this case, using a Likert scale, with three levels (good, medium and bad) as an indicator of ecosystem health would be difficult, as each level implies a hidden value judgment regarding what is good or bad. Such an indicator is of limited use when multiple stakeholders are involved. Instead, if a Likert scale is to be used, its levels need to be linked to concrete, unquestionable descriptions of the characteristics/features for each level.

Achievable: The analyst should avoid adopting so many indicators that the analysis will be overburdened with indicators to be tested. This not only complicates the analysis itself, but also, as the list of indicators used for "scoring" policy interventions grows, it becomes increasingly complicated to figure out how to use all the information presented for decision making. Decision makers, the analyst's target audience or client, may be pressed for time and decide to focus just on a few indicators and ignore the rest. Or they may become confused by the burden involved in comparing and assessing BAU and SEM interventions in terms of too many indicators. It is rarely a good idea to use more than two or three indicators.

Relevant: A good set of indicators will reflect the issues that decision makers and affected stakeholders care about, and will reveal the answers that they are seeking. Within a given criterion, different stakeholders will care about different indicators, and it is important to understand what type of decision maker the analysis is targeting (see page XX in Chapter 2 for a typology of decision makers). For example, if employment is a criterion, a fishermen's association will want to see an indicator that measures the number of fishermen who might lose their jobs due to overfishing, while a municipal authority may want to see overall employment numbers, without differentiating by sector.

Time-bound: Every indicator should be measurable at regular moments in time, and over a specified period of time, i.e. the decision maker's planning horizon. The selected set of indicators should reveal, over this period of time, if a threshold of radical change is approaching, as the horizontal axis is always time. The TSA approach described in this guidebook stresses the importance of not only the final outcome of the policy or management intervention, but also the pathway leading to that outcome. In many circumstances, the main obstacles for SEM are not in the long-run outcomes, but rather in the process of consolidating a sustainable production system. For example, large start-up costs are a significant obstacle for the adoption of interventions such as silvopastoral systems.

Table 2 presents some examples of possible indicators for various types of criteria. (Note that while the indicators in the table are meant to stimulate thinking, the list should by no means be regarded as exhaustive.)

Table 2: Sample indicators

Criteria	Indicators
Financial	• Change in productivity • Annual revenues, net profits • Costs, investment costs • Debt-to-capital ratio
Economic	• Consumer surplus (total willingness to pay) • Producer surplus • Marginal external costs • Estimated cost of sector development strategies
Employment	• Number of newly employed people • Salary level • Ratio of formal versus informal employment • Number of part-time jobs • Ratio of high-paying versus low-paying jobs
Equity and fairness	• Ratio of salaries by gender • Ratio of benefits by ethnic group • Employment by demographic category

4.3 ISSUES TO CONSIDER WHEN CHOOSING INDICATORS

Choosing the right indicators is important and not always straightforward. As discussed above, the best indicator would be capable of clearly showing changes in the chosen criteria that result from the BAU and SEM interventions. With all indicators, however, there are some additional issues to consider.

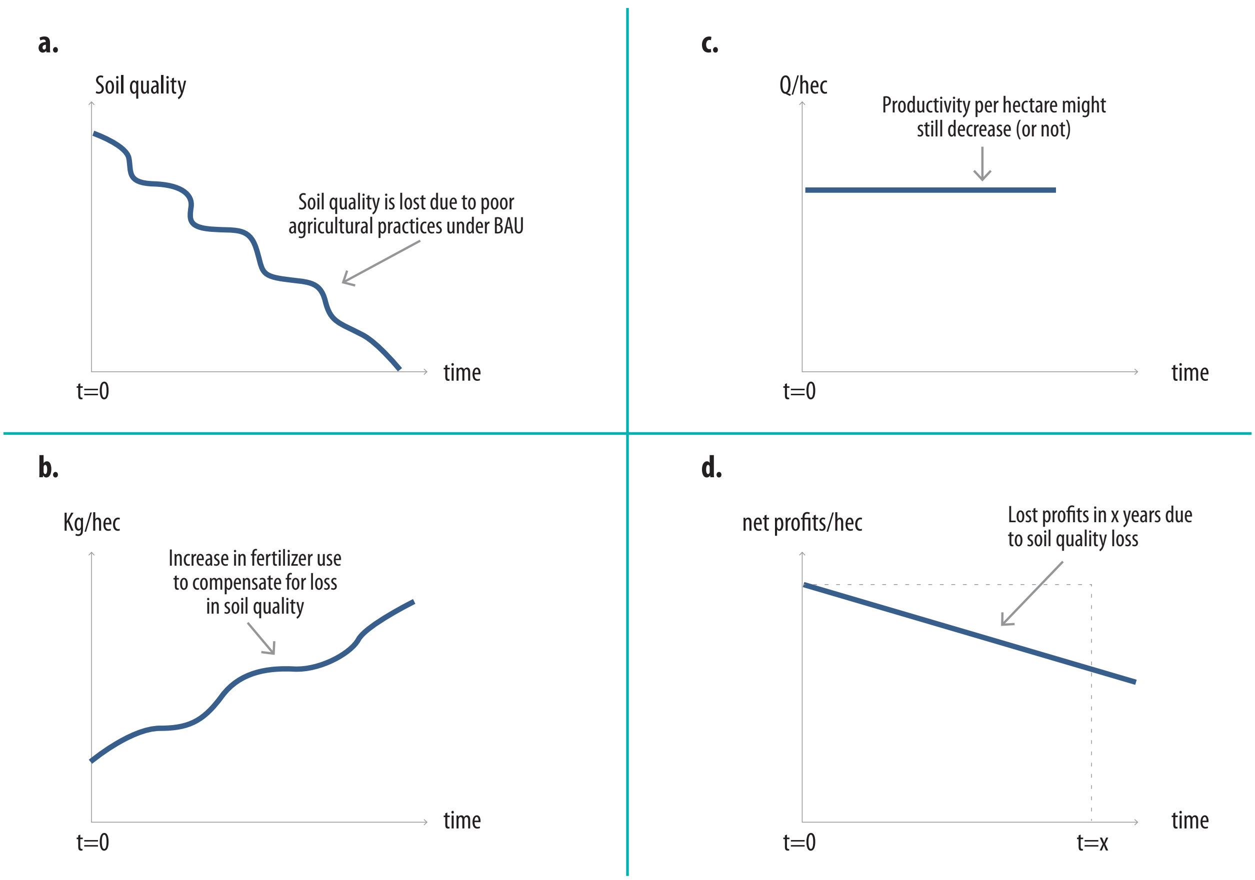
4.3.1 Intermediate vs. ultimate indicators

In some circumstances, the ultimate objective of a given policy is hard to measure, and decision makers and analysts are forced to use intermediate indicators of progress. An intermediate indicator is one that is directly linked to the ultimate criteria, but that has the added benefit of being easily measured. A typical example is biodiversity conservation. Measuring improvements in the state of the biodiversity in a given landscape is extremely difficult, so it has become customary to use forest cover or natural vegetation cover as a proxy of biodiversity. When the cover of natural vegetation in a particular landscape increases, biodiversity is said to be better conserved. This is an example of an intermediate indicator of the ultimate objective of biodiversity conservation.

Figure 12 repeats an example familiar from Chapter 2, in which the choice of intermediate indicators is much less obvious. In this example, poor land management practices are captured by the four graphs, in a progression that starts with the most immediate consequence, soil degradation, and moves on to the ultimate consequence, changes in net profits per hectare.

All four indicators depicted in the vertical axes (soil quality, kg of fertilizer used per hectare, productivity per hectare and net profits per hectare) are valid intermediate indicators that reflect, within their limitations, the effects of BAU on agriculture. The choice of indicators that reflect less intermediate and more ultimate consequences is likely to be more useful for final policy decisions, but sometimes more intermediate indicators are the key to understanding the mechanisms behind outcomes. This figure also shows the type of problems that can arise when the TSA is based on intermediate indicators. For example, the situation depicted in graph a. is unrealistically negative, as it fails to reflect farmers' responses to deteriorating conditions; TSA using soil quality as an indicator will artificially inflate the benefits of SEM compared to BAU. Similarly, graph c shows that, if productivity per hectare is used, the BAU scenario seems artificially beneficial, as no changes are expected in time. Only graph d contains all the information to judge the pros and cons of BAU and SEM for a farmer concerned principally with profits.

Figure 12: From biophysical measures of lost soil quality to changes in net profits

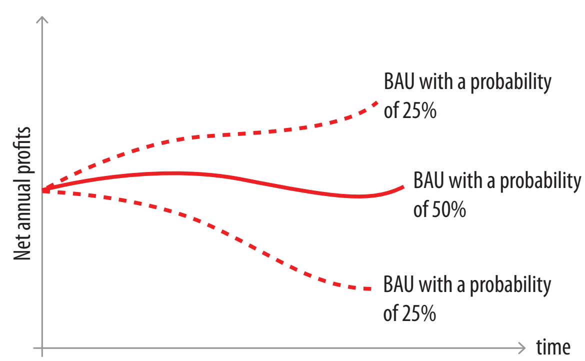


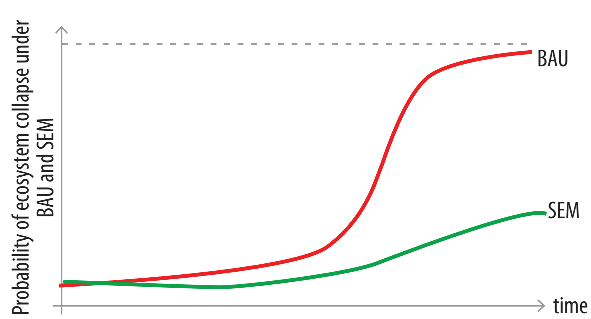
4.3.2 Criteria selection and uncertainty

Ecosystems are being increasingly pushed closer to their productive capacity, and our capacity to predict changes in those ecosystems is quite limited. Thus, being able to find an indicator that captures uncertainty regarding the effect of BAU on future productive or consumptive activities is important.

Figure 13 illustrates this point. The graph at the top shows a strategy to capture uncertainty in an indicator that is appealing and easily understandable to a decision maker. Here, three separate outcomes of the BAU policy intervention are presented to the decision maker, with a probability tag assigned to each. The indicator in this case is not just net annual profits; it is expected annual profits, according to different experts. (Chapter 5 will provide suggestions on how to estimate and describe uncertainty, including estimating probabilities as shown in this graph.)

Figure 13: Capturing uncertainty in an indicator vs. Building an indicator to capture uncertainty



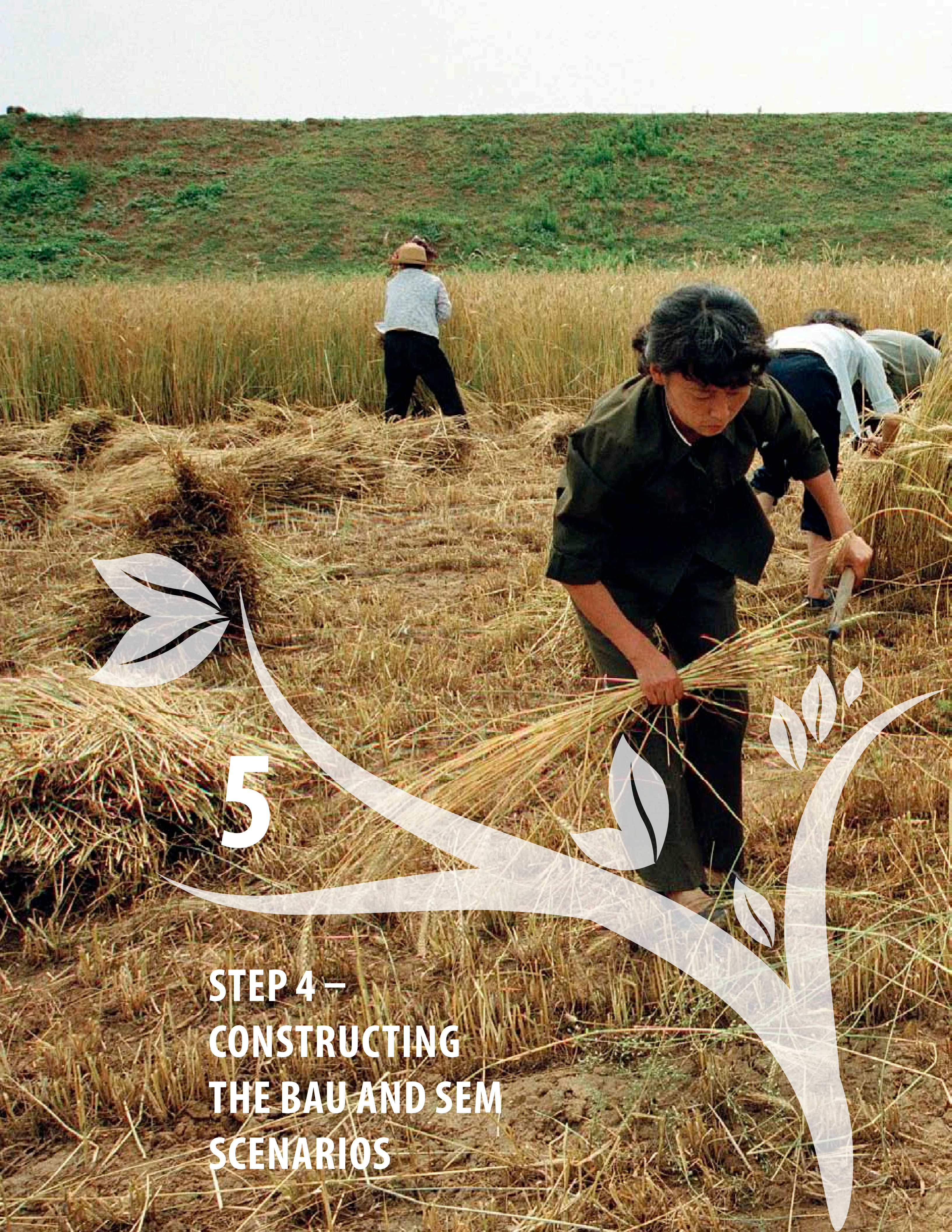


Alternatively, the bottom graph illustrates the use of an indicator that has been specifically created to capture uncertainty, in this case from ecosystem collapse under BAU and SEM. The vertical axis measures the probability of ecosystem collapse under each intervention. Such probabilities can be constructed based on expert knowledge. As can be seen in the graph, the probability of ecosystem collapse is higher under BAU and also increases at a higher rate. This information, coupled with information about the financial costs of ecosystem collapse for a given productive sector, can provide a very comprehensive scenario for a decision maker.

Checklist

To ensure that the set of criteria and indicators chosen at this point for the TSA is appropriate, the analyst should ask the following questions:

1. Is the purpose of the study properly reflected in the key criteria selected?
2. Are all criteria effectively captured by the chosen indicators?
3. Are the indicators SMART (specific, measurable, achievable, relevant and time-bound)?
4. Does the targeted decision maker agree with the selection of indicators?
5. Are the interests of all relevant stakeholders reflected in the selection of indicators?
6. How is uncertainty captured in the indicators?



5

STEP 4 – CONSTRUCTING THE BAU AND SEM SCENARIOS

CHAPTER 5: STEP 4 – CONSTRUCTING THE BAU AND SEM SCENARIOS

This chapter discusses the process of constructing scenarios for both the BAU and SEM interventions, to predict the expected outcomes of implementing the interventions over a specific period of time. These outcomes are measured by changes to the chosen indicators. The process of constructing the scenarios involves estimating how ecosystem services will be affected by the BAU and SEM interventions, considering the functional linkages between changes in ecosystem services and the chosen indicators, and finally, projecting changes in the chosen indicators.

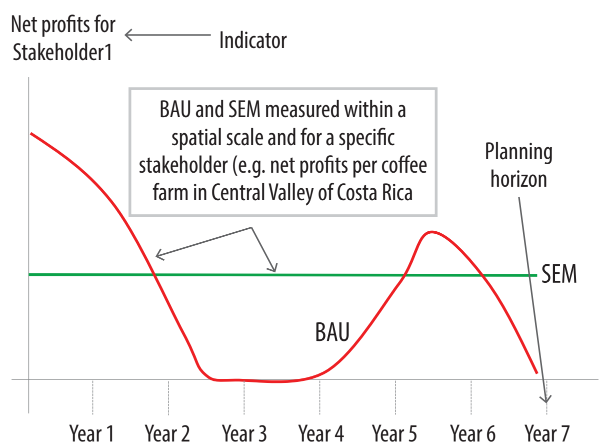
Once the criteria and indicators have been selected and agreed upon, the next step is to project the BAU and SEM interventions forward in time, in order to construct scenarios for the future. A scenario is a narrative of a future state of the world that results from the implementation of a set of policy or management interventions. The scenarios developed in a TSA will be built upon a strong understanding of the causal relationships between the BAU and SEM interventions and their respective predicted outcomes, as measured by the chosen indicators. Projections about how the two alternative scenarios will unfold over time can help the decision maker in making a policy or management decision today based on the expected future consequences of implementation of the BAU and SEM interventions that were defined in Step 2 (see Chapter 3).

Projecting these expected outcomes is a complex part of the TSA process. However, if the analyst has successfully identified the purpose of the analysis, defined the BAU and SEM policy interventions and chosen the relevant indicators, then there is a solid foundation for adding the dimension of time to the analysis.

TIP: It is important to compare BAU and SEM data and scenarios across the same time period, so that the results are fully comparable and thus most useful for decision makers.

The BAU and SEM scenarios are depicted in TSA as curves on a graph, where the x axis is always time and the y axis is an indicator (see Figure 14 for an example of a TSA graph).

Figure 14: Graphic depiction of BAU and SEM scenarios over time



Constructing credible scenarios of the projected outcomes of implementing the BAU and SEM interventions involves three basic steps:

1. Estimate how ecosystem services will be affected by the BAU and SEM interventions over time;
2. Consider how these changes in ecosystem services affect the chosen indicators (for example, between reduced soil erosion and net profits); and
3. Project changes in the chosen indicators that are due to changes in the ecosystem services which were caused by the BAU and SEM interventions.

This chapter reviews each of these three interrelated steps, including discussions on the importance of establishing a clear causal link between the BAU and SEM interventions and the expected outcomes, and the need to manage uncertainty in any estimation.

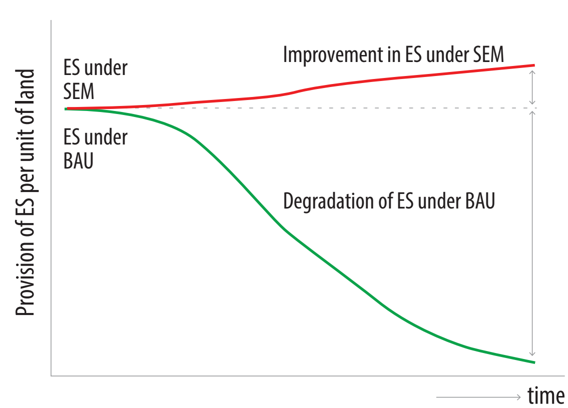
5.1 ESTABLISHING A CAUSAL LINK BETWEEN BAU AND SEM INTERVENTIONS AND CHANGES IN ECOSYSTEM SERVICES AND RELEVANT INDICATORS

The BAU and SEM scenarios constructed for the TSA need to be credible and based upon a strong understanding of the causal links between the implementation of the BAU and SEM interventions and the changes in the selected indicators. There are basically two levels of causality involved in this analysis: (1) the changes to ecosystem services caused by the policy or management intervention, and (2) the changes to the chosen indicators caused by those changes in ecosystem services. These two levels of causality correspond to the first two steps in the process of constructing the scenarios.

For example, under BAU in a given fishery, catch per unit of effort has been falling for the last five years at a rate of approximately five percent per year, and experts agree that overfishing is behind this fall in productivity. This information comes from available data at local harbours, from the local fishermen's association and from expert marine ecologists working in the area. These very same experts predict that, if no action is taken, the productivity of the inshore fishery is likely to continue falling, at increasing rates. The analyst assumes that overfishing is deteriorating the capacity of the ecosystems to generate biomass, so that catch per unit of effort and hence profits, the two relevant indicators, will decrease under the BAU scenario. The catch per unit of effort goes down at a constant rate of five percent per year. Net profits will reflect the fact that an excessively large fishing fleet (equal in size to the current fleet) is needed to catch ever-decreasing amounts of fish.[9] This completes the construction of the BAU scenario for one of the chosen indicators, namely catch per unit of effort. A similar process will be required for the other indicators until a full picture of the situation under BAU is completed.

Constructing the SEM scenario requires first establishing how the evaluated changes in management and the suggested policies are expected to stop the degradation of the marine ecosystem and how that is likely to result in improvements in the capacity of the ecosystem to produce biomass, and hence sustain a fishing community. Assume that the local fishery decides to implement a tradable fishing quota that restricts extraction to a level regarded as acceptable by experts in marine ecosystems. If the tradable fishing quota is successfully implemented, it will result in a sustainable catch per unit of effort (say at current levels for the sake of simplicity), but inevitably requires a reduction in fishing effort (less vessels and fishermen). Approximately 20 percent of the fishing fleet will have to be scrapped or sold gradually during the coming five years. This will reduce fishing costs on the one hand, but it might create unemployment and transaction costs as economic agents switch to alternative means of generating income. This illustrates the relationship between the SEM intervention, ecosystem services and the resulting consequences for the selected indicators.

Figure 15: Changes in the provision of ecosystem services under BAU and SEM



9 Many other minor assumptions, for example that today's prices are valid throughout the planning period, are obviated here for the sake of simplicity.

BAU and SEM policies and practices affect natural resources and ecosystems in both positive and negative ways, which in turn impact revenues and other indicators over time. Figure 15 shows the effect on the provision of ecosystem services of a BAU scenario and its associated policies over time, during which the flow of ecosystem services available as inputs into a particular production or consumption process falls.

Estimating the ways in which ecosystem services will be affected by the particular BAU and SEM interventions involved in the TSA will require an understanding of the relationship between their actions and the relevant ecosystem services. For example, if agricultural practices under BAU are leading to lost soil quality despite ever-increasing use of agrochemicals, and SEM involves a change in those practices toward soil conservation practices, then it is important to be able to provide a quantitative estimate of the degree at which soil quality is changing under these BAU and SEM interventions.

Figuring out such relationships is a complex task. For example: If you reduce forest cover in a particular landscape by 50 percent, will this also result in a 50 percent decrease in bee populations? And what will be the impact on pollination services? If you want to protect riparian forest, how much distance from the river needs to be protected to ensure hydrological ecosystem services? There is likely no single answer to many of these relationships as each one is highly complex, site-specific and uncertain. The analyst must understand the literature, judge how deep to go into the debate and produce the necessary consensus of experts so that credible relationships can be used as inputs for the analysis. A TSA is not about finding the perfect truth; it is about generating the necessary information for a decision maker to make a key decision with the best information available at the time of the study. See Section 5.4 for further guidance on how to address causality and uncertainty.

5.1.2 Changes to the chosen indicators caused by changes in ecosystem services

Once a relationship between the proposed interventions and changes in ecosystem services has been established, the analyst should next consider how these changes in ecosystem services will affect the chosen indicators. These linkages are not always obvious. For example, when ecosystem services are reduced, it does not necessarily mean that net financial profitability or the net economic benefits of the BAU scenario will decrease equally in time – or even decrease at all. In response to the decline in services, decision makers will take preventive measures, substituting manmade inputs for lost ecosystem services whenever possible. This is the case in the example from Chapter 2 about soil degradation (see page X). In response to increased soil degradation in that example, farmers increased their use of fertilizer, thus keeping productivity steady.

This is a good example of why a set of several different indicators is needed, rather than just one. If productivity had been the only indicator in this example, the analysis would not show the change in BAU due to increased application of agro-chemicals, and the underlying increase in costs would not be visible to the decision makers. In addition to productivity, it is also important to have indicators that reflect costs of inputs and net profits.

In another example consider a tourist destination where the quality of the beach has decreased, resulting in reduced visitor demand. If hotels compensate for this reduced beach quality and offer discounts for rooms, however, visitation may go up again. So it is important to determine the best set of indicators to capture the underlying changes occurring within a scenario.

Table 3 shows a structured framework for analysing causality for each of the chosen indicators, and describing it to the relevant decision maker. Importantly, assumptions should be transparent, and the quality of data should be critically evaluated. The analyst should follow this process for each of the chosen indicators.

Table 3: Describing causality between BAU/SEM interventions and changes to ES

Causal relationship	Assumptions	Sources of information
• For each indicator, describe the causal relationship between changes in ecosystem services and changes in outcomes. • Identify the mechanisms by which the indicator is affected by changes in environmental quality. • For each intervention, describe the causal relationship between the policy and management action and changes to all ecosystem services.	Carefully describe the main assumptions underlying the causal mechanism for each indicator. Put special emphasis on the consequences of violating the assumptions. Make note of how likely the assumptions are and whether they have been discussed with the decision maker.	Provide enough information about the sources of information to be able to judge the quality of the information and the assumptions. Highlight whether there is more agreement or dissent among experts.

5.2 PROJECTING CHANGES TO THE SELECTED INDICATORS RESULTING FROM CHANGES TO ECOSYSTEM SERVICES

The final part of the process of constructing the BAU and SEM scenarios involves projecting the expected changes to the chosen indicators (as a result of the previously estimated changes to ecosystem services) over time, in order to generate data to populate the BAU and SEM curves in the graphs that will be presented to the targeted decision maker. This stage requires an analyst to select an appropriate approach and methodology to estimate the changes to the indicators. For example, estimating changes to profits resulting from degraded soil might be the lost production multiplied by the market price. Over time this will generate data points showing changes to profit. This exercise should be done for each individual indicator.

In addition there are a number of other complexities that need to be considered when finalizing the BAU and SEM scenarios, including the degree of precision in the projections, the methodology that will be used to generate data, and the economic valuation techniques that may be used to generate monetary estimates of costs and benefits. These are discussed in more detail in the following sections.

5.2.1 Degree of precision in projections

This guidebook uses the term "projection" to mean a description of a future at multiple moments, as scenarios unfold over time. A projection does not need to be based on a statistical estimation or econometric analysis. The degree of precision in the projecting changes to indicators can range from guesswork by a few experts on the basis of loose pieces of information, to a strong consensus of experts coupled with robust sources of information, rigorous program evaluation and statistical modelling. The analyst should remember that the degree of complexity and uncertainty inherent in most policy and management decisions calls for a more elaborate, complementary narrative of the BAU and SEM scenarios. Such a narrative cannot always be achieved under the restrictive setting of statistical forecasting.

For example, suppose that a local government is considering introducing water metering and water pricing and wants to learn whether increases in the water bill linked to high consumption would result in increased efficiency of water usage at the household level. In principle, both policies (metering and pricing) create incentives for households to monitor and reduce their water consumption in order to receive lower monthly bills. Most experts will agree that high prices will lead to reduced and more efficient water consumption. This prediction falls within the category of guesswork based on expert knowledge. A more precise estimation would require knowledge of the price elasticity of water demand. The analyst might settle for transferring information on household water demand from regions with similar characteristics.

Increased precision comes at a cost in terms of time and capacity, but decreased precision reduces the internal consistency of an argument. It is for the analyst and the policy maker to decide what is feasible within the available budget.

5.3 GENERATING DATA TO POPULATE THE BAU AND SEM CURVES – PER INDICATOR

There are several methods the analyst can use to project changes to the selected indicators, including existing estimations from previous studies, econometric estimation, statistical forecasting or assumptions agreed upon by experts and based on observed patterns and relationships. Whichever method is chosen, the analyst should describe and justify the method selected and then describe the assumptions underlying the estimations. Finally, the analyst should describe the sources of information used, by identifying which data is primary and which is secondary, describing the quality of the data and noting the role of expert advice in the analysis.

The analyst should gather information and relevant results by whatever means possible and from whatever sources are available, while still ensuring that the information is relevant to the original policy or management question of the TSA. The following are the four most common approaches that can be used to populate the BAU and SEM curves – an analyst might use just one or a combination of two or more. While they are certainly not the only methods that can be used, they are by far the most common:

Collecting historic data: This is particularly important when such historic data allows a description of the changes in time of the relevant indicators under the BAU intervention. There is no attempt to establish causality; rather the aim is to thoroughly describe the situation. There are many sources for such data. Frequently the decision makers themselves may have kept records that eventually motivated them to request a TSA.

Combining historic data with predictions based on extrapolations of historic data, econometric analysis and forecasting: If data allows, a causal relationship should be established between the relevant indicators (as dependent variables) and explanatory variables that can then turn into means of changing the level of those indicators.

Making predictions based on theory and results from other places and other sources: When data is not available, the analyst can turn to a mix of theory and results obtained from other locations to produce an approximation of the relationship between the BAU and SEM interventions and the relevant indicators.

Consultation with experts and/or other stake-holders to establish relationships: A strong consensus of experts can help established the necessary technical support to relate the SEM and BAU interventions to changes in the provision of ecosystems and then to the relevant indicators.

As the analysis moves down these options, the estimation process will become less exact. The more data there is available for the analysis, the less an analyst needs to know about these relationships, and vice versa.

5.3.1 Using economic valuation techniques to find monetary estimates of the indicators

Where monetary indicators have been selected the physical units need to be converted into the monetary indicators using a suitable valuation technique. Valuation techniques range from multiplying price times quantity in some instances to more advanced non-market valuation. For example, production per hectare (an indicator measured in physical units) can be turned into revenues per hectare by multiplying it by average annual prices, which is an indicator that captures changes in financial flows. These valuations should be time bound so that they provide data points from which curves can be drawn showing how the indicators change over time. As such various studies may be needed to estimate values in different years.

If the desired indicator should capture changes in human well-being, then nonmarket valuation techniques will be needed. Estimating changes in well-being (economic changes and not just financial) is more ambitious and complicated than completing a financial analysis, and generally more expensive (see Box 7).

Box 7: Financial vs. economic analysis

Valuation methods will differ depending on whether a chosen criterion and its associated indicators are financial or economic. For example, where an indicator has been chosen to look at income, the analyst will carry out a financial analysis, but if the TSA is being used by a public policy maker who is more interested in well-being, an economic analysis will be more useful. The main differences between financial and economic criteria involve the nature of the desired change, the parties likely to be affected and the degree to which externalities are considered:

- ***Change in income vs. change in well-being:*** The projected outcomes of a financial and an economic analysis are both expressed in monetary units. For a financial analysis, those units report the change in an individual's or group's financial situation, and an analyst would use market prices to obtain the value of a given change in environmental quality. In an economic analysis, on the other hand, the monetary units are used to measure the change in human well-being to an individual or group resulting from the implementation of a policy intervention; here, the analyst would have to use economic valuation techniques to determine maximum willingness to pay for a given improvement.

- ***Affected parties:*** A financial analysis is typically done from the perspective of fewer groups or individuals (direct stakeholders) than an economic analysis. In fact, a financial analysis is often conducted from the perspective of only one individual or group (e.g., a small business owner, or the owners and stockholders of a single company). An economic analysis, on the other hand, considers all parties that will be affected by the policy interventions under study.

- ***Externalities:*** Some policy interventions may affect the well-being of various groups of individuals not through market interactions, but indirectly through the physical and biological environment. An economic analysis attempts to quantify the magnitude of changes that result from side effects and externalities of a policy intervention, in terms of how they affect human well-being, while a financial analysis would not take these impacts into account.

Monetary valuation is a key component of a TSA for several reasons: First, BAU conditions are often measured in monetary terms, and a comparison is viable only if monetary estimates of the value of effects on production and consumption under SEM are also available. Second, if the SEM policy or management intervention includes outcomes for which there is no prior experience or data, then valuation of these outcomes will be necessary. Third, the targeted decision maker is frequently interested in economic indicators, rather than just financial, and valuation exercises are the way to evaluate economic measures of impact.

Box 8 describes several different economic valuation techniques that could be used to do an economic analysis as part of a TSA, in order to generate the data needed to populate the BAU and SEM curves. This summary is meant to be a very brief introduction to the range of valuation techniques available to an analyst, rather than a comprehensive explanation of the theory or application of nonmarket valuation techniques. The interested reader who wishes to learn more should consult some of the standard references on the subject.[10]

10 The following publications will be useful for learning more about economic valuation techniques: (1) Project and Policy Appraisal: Integrating Economics and Environment. Organization for Economic Cooperation and Development, 1994, and (2) Economic Values and the Environment in the Developing World, by David Pearce, Steven Georgiou, Dominic Moran, and Dale Whittington. Edward Elgar Publishing, Ltd. UK. 167 pages. A good introduction to nonmarket valuation techniques can be found in A. Boardman, D. Greenberg, A. Vining, and D. Weimer, Cost-Benefit Analysis: Concepts and Practices, 4th ed., (Upper Saddle River, N.J.: Prentice Hall, 2011). For a more advanced treatment of these techniques see Handbook of Environmental Economics, vol. 2, Valuing Environmental Change, edited by K. Mäler and J. Vincent (New York: Elsevier, 2005).

Box 8: Economic Valuation Techniques

Experimentation: Analysts can conduct experiments to learn how people actually behave in various contexts and infer, from the results of those experiments, how much they will be willing to sacrifice for the good or service that will result from an SEM intervention. Experiments can also be used to identify the effect of changing environmental conditions or the effect of SEM on profits.

Stated preference approaches: Analysts can ask people how much they would be willing to give up (i.e. how much they would be willing to pay) to acquire or experience the consequences of an SEM intervention. This is often called the "direct approach." It is important that the subjects clearly understand both the policy or management intervention and the change that is expected to ensue.

Surrogate markets: Analysts can estimate the economic value of nonmarket goods and services by identifying a good or service that is sold in markets and is related to or "bundled with" the nonmarket good or service. The idea is that the individual who purchases the market component of the targeted "bundle" is also revealing preferences for or relating to the nonmarket component.

Damage Function: Analysts can estimate the damages individuals/communities/etc. might suffer from a reduction in environmental quality as a way to measure the expected benefits of interventions designed to reverse that trend. The idea is that the reduction in damages serves as an estimate of the economic benefits of an improvement in environmental quality.

Benefit Transfer: Analysts can estimate economic values of nonmarket goods or services by seeking out estimates for a similar good or service in other locations and then transferring those estimates, perhaps with some adjustments, to the analysis at hand. This can be thought of as an historical approach to the valuation problem, because it uses the results of past studies about individual and household willingness to pay for nonmarket goods and services.

Direct Demand Estimation: Analysts can use econometric estimation of demand for the good or service at hand to estimate the demand elasticity of the good or service, and thus the value that individuals and society place on that good or service. Moreover, price elasticities are central to the use of price instruments like taxes and subsidies to guide decision-makers toward environmentally preferred options.

5.3.2 Factors to consider when estimating outcomes

The space available in this guidebook is too limited to describe all the issues that need particular attention in constructing the BAU and SEM scenarios, and many of the main issues will be site- or question-specific. Still, this section summarizes some of the main issues that TSA analysts will have to consider in the course of conceptualizing how to construct the BAU and SEM scenarios.

Be careful when transferring results and data from other studies and/or circumstances: A TSA is conducted with a specific decision maker in mind and based on previously defined spatial and temporal scales. These parameters impose specific data and informational requirements that often entail converting data at other scales into results that fit within the scales defined in the analysis. Suppose, for example, that a TSA is focused on employment at the farm level, for small and medium-size farms. If information is only available for large farms, the analyst will have to adjust that information to fit the dynamics of small farms, paying special attention to the effect of economies of scale and synergies that are likely present for large farms, but not for smaller enterprises. Similarly, although prices can be taken as given (i.e. exogenous to the analysis) when just a few firms are involved, this assumption is less valid when the whole sector is under scrutiny. For example, a price premium is frequently associated with organic products. This assumption is valid as long as the market is not saturated with organic products, in which case the price premium will be reduced or disappear altogether.

Make sure to understand and describe the assumptions and limitations of the data used in the TSA: For example, assume that the number of tourists visiting a protected area has been decreasing by 10 percent per year, due to deterioration of the ecosystems that are the main attraction in the protected area and insufficient infrastructure to provide basic services in the park. The analyst decides to do a stated preference study, applied to a sample of prospective visitors (such as international tourists arriving at the main airport), looking at willingness to pay for entering the park under current conditions (BAU) and under improved conditions (SEM). In this case, the analyst would need to assume that, under BAU, the number of tourists will continue decreasing by 10 percent per year. But how valid is such an assumption? If under BAU the entrance fee can be lowered this may attract more visitors in spite of reduced quality of the park. Hence the analyst, during the projections of BAU, needs to investigate the assumptions on changes to visitation.

5.4 MANAGING UNCERTAINTY IN CONSTRUCTING THE SCENARIOS

Establishing causality between policy or management interventions and changes in indicators and accurately predicting the magnitude of those changes is complicated by several issues that generate high levels of uncertainty and lack of information. It is very important to recognize, consider and address these issues. Some of the key issues are discussed below:

1. *Our understanding of the natural world is limited.* Despite the best efforts of scientists around the world, humanity will never achieve a full understanding of all the physical, chemical and biological processes that affect and are affected by human activities. This problem is further complicated by the fact that ecosystems and their services change discontinuously, as pressure is applied to their capacity to function and sustain external shocks (resilience). This uncertainty has deep-rooted consequences for environmental policy problems. In many cases, painstakingly collected scientific evidence has accumulated to a point where there is close to full consensus regarding causality between the implementation of policy interventions and future conditions in the BAU and SEM scenarios; a good example is the effect of greenhouse gas emissions on global climate change. Still, the exact nature of this causal relationship is unknown and most likely will always remain so, given the complex interactions in our atmosphere.

   Problems with misunderstanding causality due to poor understanding of ecosystem functions are well-illustrated by a common misconception about the relationship between water supply and tree cover: It is commonly believed that forested land cover causes increases in the amount of water available. However, the causality is actually reversed – trees grow where water is available. In establishing a causal relationship between the policy or management interventions and outcomes under the BAU and SEM scenarios, the analyst must accept that human knowledge about the natural world will always be limited. Still, some natural processes are better understood than others, and the analyst must ensure that, to the extent practicable, all available information is assembled to make a convincing claim for establishing causality.

2. *Humans will always react to changes in environmental conditions*. Accurately predicting the adaptive response of people in the face of change and environmental stresses is very difficult. The only certainty is that humans are not passive observers of environmental change. In the process of describing the unfolding conditions in the BAU and SEM scenarios, the analyst must take into consideration the interactions between the natural world and human behaviour, asking: What is known about what would happen if BAU continues and the policy intervention associated with the SEM scenario is not implemented? The case in Chapter 2 (see page XX) of farmers adjusting to deteriorating soil quality by increasing their use of fertilizers is a good example of this. If the analyst fails to incorporate this response in the analysis would show much lower profits under BAU than would actually be the case. It may be possible to get information about potential adaptive responses by studying the responses of economic agents in other contexts. The literature on the likely effect of climate change provides a good example on how to do this. By observing agricultural practices and productivity in different climatic zones within a given country (for example, along different latitudes or at different altitudes), the analyst is able to gain an understanding of which regions in that country stand to gain and which to lose from, say, warmer average temperatures, as well as which agricultural practices need to be used to address such a change in temperature or rainfall.

3. *Unintended side-effects of policy or management decisions*. Uncertainty also arises from the reaction of people to policies and incentives themselves. Clearly, human inventiveness is not limited to finding ways of adapting to changing environmental conditions; it will also be applied to facing new regulations and economic incentives, not always with enthusiasm and compliance. Sometimes, policies designed to achieve a specific goal have achieved the exact opposite, or have generated unintended side effects. This often happens with prohibitions, which policy makers sometimes implement without considering how people will respond. For example, the prohibition against harming an endangered species or the ecosystem it has chosen as habitat, although a well-intended policy, might trigger a move among some private individuals to quickly eliminate the endangered species from their properties before the authorities notice its presence and place restrictions on how the land and its natural assets can be used. In the case of forestry, prohibitions have led to a rise in illegal logging and a reduction in the value of land under forest cover, thereby leading to increased conversion of forested land to agricultural uses. The analyst must avoid naïve predictions regarding the reaction of stakeholders to new rules.

4. *Predicting the future state of technology is difficult.* A related source of uncertainty affects projections of the costs associated with implementing the policy interventions associated with the BAU and SEM scenarios. Future technological change, for example, may bring improvements in pollution abatement technologies that might change decisions to invest today. If technology is changing rapidly, the decision to invest today must be compared to the decision to postpone the investment until new, improved technologies are at hand. Unfortunately, it is frequently hard to predict when technologies will become obsolete or innovations will arrive. A key factor contributing to the global effort to reduce the use of chlorofluorocarbons responsible for depletion of the ozone layer in the atmosphere was technological change. Armed with new patents for viable commercial substitutes for CFCs, the chemical industry actually lobbied to make a worldwide ban on CFCs part of the Montreal Protocol. Here again, although its course is difficult to predict, the analyst must include a

discussion of relevant technological changes in the construction of the BAU and SEM scenarios, drawing upon practical experience or upon interviews with industry and experts in the field.

5. *It is difficult to isolate the relation between cause and effect when a multitude of other factors also contribute to the final outcome.* Consider, for example, that an analyst sets out to identify the impact that the creation of a protected area has had on poverty and unemployment. Assume that the analyst compares the situation before the protected area was created with the situation ten years after its creation and finds no significant change in poverty and unemployment. Is this good or bad? The answer will be contingent on a comparison with other similar locations (i.e. a control group) that have not been exposed to a newly created protected area. If the economic situation has been good and poverty has decreased in the control group, then the finding is actually bad news; the opposite is also true. Obviously, the implementation of an SEM policy or management intervention is not the only factor affecting the scenarios, and productive sectors are likely to be affected by a myriad of other factors as time unfolds. Still, the analyst must make an effort to isolate a relationship between the implementation of SEM policies and the relevant indicators.

It will not be possible for a TSA to resolve all the uncertainty resulting from the factors described above. However, the TSA should not ignore uncertainty either. It is important to identify, assess and manage this uncertainty and duly recognize it within the scenario results.

5.4.1 Identifying uncertainty within the scenario projections

The following sample questions can help identify the sources of uncertainty and their likely consequences in terms of the key indicators:

1. Is there evidence of *nonlinear dynamics* in the ecosystem? If so, the analyst should describe it in detail, emphasizing the effect of such ecosystem dynamics on the productive sector. For example, a highly degraded fishery might be irreversibly lost if fishing pressure continues. What would be the effect on artisanal fishermen if this happens?

2. Do experts agree that conditions are close to (or far from) *ecosystem thresholds*? *Do experts agree that ecosystems are on a critical trend*? For example, the UNDP (2010) report mentions three examples that seem to have crossed a threshold: crop production after rainforest conversion in marginal areas in Central America or the Amazon, after two or three planting seasons; salinization of underground water reservoirs due to excessive pumping of water for irrigation; and collapse of banana plantations on the southern Pacific coast of Costa Rica, where build-up of fungicide residues in the soil led to collapse of fertility-related ecosystem services and of the industry itself.

3. Regarding the *adaptive capacity* of economic agents: How have humans (as individuals, communities, in firms or in institutions) reacted to similar environmental deterioration or improvements in other contexts? How capable are the stakeholders of investing in defensive expenditures? How vulnerable are they to environmental deterioration? Can they migrate?

4. Is there reason to expect improved *new technologies* in the near future? Can technological change be expected to influence perspectives today

regarding the different outcomes in the SEM and BAU scenarios?

5. What are the *monitoring, reporting and verification* procedures available today? For example, advanced GIS (Geographical Information Systems) technologies have dramatically changed the monitoring capacity of forestry authorities, making detection of deforestation and fires much simpler than it was a few years ago.

6. Are there experiences from other settings that might inform the analysis and the implementation of policies under consideration in the SEM and BAU scenarios?

5.4.2 Describing uncertainty

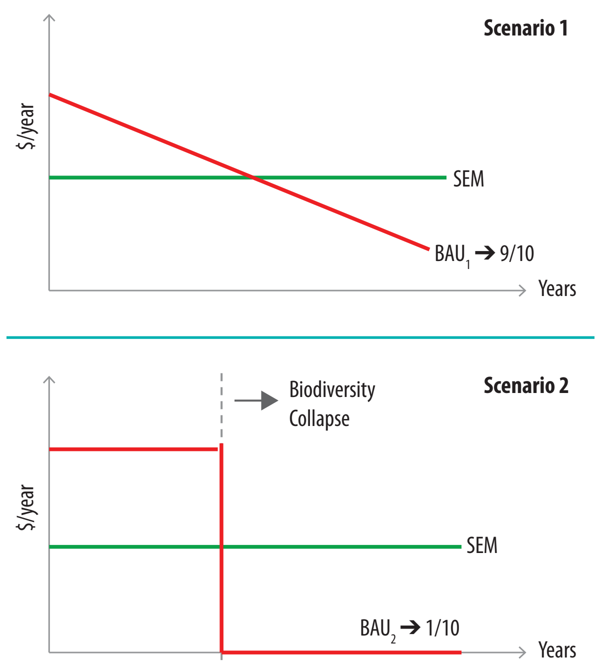
When completed, each scenario should provide information to aid in decision making, based on the decision maker's interpretation of the level of risk aversion among stakeholders. The analyst's responsibility is to provide as complete a set of policy-relevant information as possible, including clear indications about what simply is not or cannot be known. The categories of confidence and certainty described above may require the analyst to use expert judgment from practical experience or from expert advice to round out a detailed account of uncertainty for each of the relevant indicators.

The analyst must be especially careful in the way that uncertainty is described to the decision maker. Simply put, the analyst must provide a careful account of how significant the actual uncertainty is and also what information or which experts were consulted in reaching that conclusion. In recent years, the Intergovernmental Panel on Climate Change (IPCC) has made extensive use of a system of categories that denote the degree of support and certainty accruing to their predictions (see Box 9).[11]

11. This section is based on M. D. Mastrandrea, C. B. Field, T. F. Stocker, O. Edenhofer, K. L. Ebi, D. J. Frame, et al., *Guidance note for lead authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties*. Intergovernmental Panel on Climate Change (IPCC), 2010. Available at http://www.ipcc.ch.

An important type of uncertainty that deserves particular attention relates to events whose probability of occurring is very low, but whose consequences if they did occur would be extremely damaging. Ecosystem thresholds and irreversible damages fit logically with this category. Figure 16 presents an example in which uncertainty about ecosystem collapse is described to a decision maker. In this case, in the absence of quantitative information, the analyst has interviewed experts about the likelihood of ecosystem collapse in the near future, and nine out of ten agree on scenario 1, in which there is no collapse, but rather a slow decline. However, one expert has predicted a total ecosystem collapse at some point in the future.

Figure 16: Presenting uncertainty around ecosystem collapse



This type of uncertainty is important to identify, because decision makers may not necessarily be worried about what could happen on average, but rather concerned with the likelihood of an extremely negative outcome. For example, a decision maker might not be too concerned about the deterioration of a wetland, unless the wetland is close to a threshold beyond which it would lose its ability to generate ecosystem services.

Box 9: IPCC's methodology for managing uncertainty

The consistent treatment of uncertainties by the Intergovernmental Panel on Climate Change (IPCC) has become a standard reference for policy makers, particularly for those involved in climate change negotiations.

Table 4: Level of confidence in a finding described in a scenario[12]

→Agreement of experts / →Quality of information/evidence	Low evidence	Medium evidence	High evidence
High agreement			very high confidence
Medium agreement		medium confidence	
Low agreement	very low confidence		

The IPCC's reports use two ways of expressing the degree of certainty or uncertainty in a finding or outcome. The first is a qualitative estimate of the level of confidence that combines quality and consistency of the available information with evidence of the degree to which experts agree on it (Table 4). Note that the level of confidence increases as one moves up and to the right on the table, with some degree of flexibility in the cases in between the extremes.

The second method is a quantitative estimate of uncertainty whenever the event can be modelled statistically (Table 5). This treatment of quantitative uncertainty requires a probabilistic model, with a hierarchy that turns probabilities into more palatable notions of uncertainty. Clearly, the analyst is free to use a simpler version of this scheme, depending on the particular application or case at hand.

Table 5: Converting probabilities into categories

Term	Likelihood of the outcome
Virtually certain	99-100% probability
Very likely	90-100% probability
Likely	66-100% probability
About as likely as not	33-66% probability
Unlikely	10-33% probability
Very unlikely	1-10% probability
Exceptionally unlikely	0-1% probability

12 Adapted from Mastrandrea et al. 2010.

5.5 THREE EXAMPLES OF TSA SCENARIO CURVES

The three hypothetical situations in this section offer stylized examples of how an analyst would go about populating the BAU and SEM scenario curves for three different TSAs. Box 10 offers potential sources of costs and benefits associated with BAU and SEM.

Box 10: Costs of BAU vs. Benefits of SEM

The following are some examples of the potential costs of continuing under a BAU scenario and the potential benefits of switching to SEM. This is by no means an exhaustive list of all possible costs and benefits, nor is it a complete typology of the kinds of costs and benefits that may occur with these scenarios. Every TSA will have its own specific characteristics and costs and benefits, and this should not be seen as a comprehensive checklist for use in conducting a TSA.

Costs of BAU

Some of the costs that sectors face from degradation of ecosystem services as a result of BAU production practices include:

- ***Reduced productivity from decline of ecosystem services***: As ecosystems degrade and substitution effects become more difficult (e.g., soil fertility and use of fertilizers), BAU costs will increase.
- ***Off-site or downstream costs:*** Where BAU costs have no financial implications for businesses that externalize them (e.g., agricultural runoff of agro-chemicals into potable water reservoirs); there is no direct incentive for businesses to reduce such costs and for transition to SEM practices.
- ***Perverse subsidies and incentives:*** Subsidies, other incentives or lack of regulations (and enforcement) to prevent externalities can translate large BAU costs into small financial outlays, distorting market signals and prolonging or widening BAU practices beyond what markets need.
- ***Lost public-sector revenues:*** This is the cost of certain subsidies and incentives, plus the loss of public funding foregone by low rates of taxation, usage and concession fees, and other tariffs.
- ***Future increases in costs:*** Many BAU costs, where now small, will grow over time, making transition to SEM more costly in the future (for example, sedimentation of dams from continued forest clearance). Additional BAU costs may be imposed by irreversible collapse of an ecosystem and its associated products and services.
- ***Increases in public budgets:*** Many times, in cases of limited law enforcement capacity, negative externalities become internalized by society through increases in public spending (e.g. spending on public health systems, environmental remediation, decontamination of water bodies, reintroduction of native species, etc.).

As these costs of BAU show, certain resource-use patterns, while currently still generating net economic benefits, will decline in economic efficiency over time, and addressing these problems will end up costing more than would potential investment in practices that maintain ecosystem services inputs today. There are also cases where one sector impacts an ecosystem that affects a different sector — e.g., essential fish habitat may be degraded by activities originating outside of capture fisheries, including direct habitat destruction such as clearing of mangroves. Sectoral dependence on ecosystem services that, in turn, are impacted by other sectors shows the need for inter-sectoral collaboration and cooperation on ecosystem management.

Benefits of SEM

There are many SEM practices that can be financially viable, particularly with changing markets. Some of these benefits include:

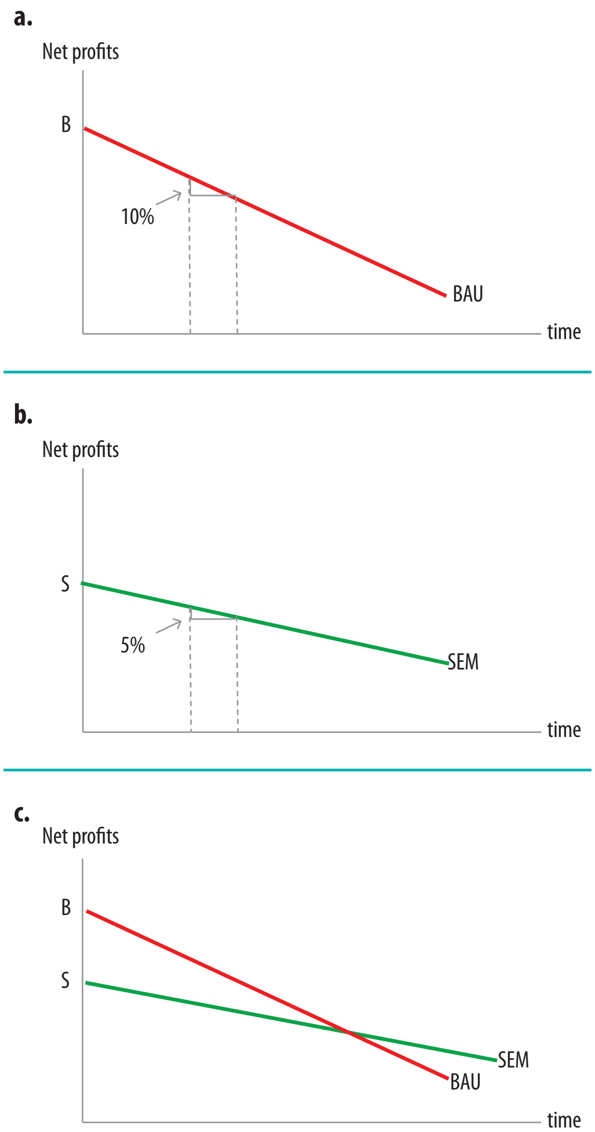
- ***Direct financial returns from increased productivity and lower costs:*** As production processes are purged of excessive use of harmful inputs (e.g. agrochemicals) and more efficient technologies are introduced as part of SEM, productivity will increase, and costs will decrease.
- ***Payment for ecosystem services (PES) and carbon storage revenues:*** Cleaner and more efficient production processes might draw incentives from national and global parties.
- ***Diversified revenue streams:*** SEM frequently involves a more diversified production system, for example combining several types of crops in a given agricultural plot.
- ***Reduced risk and avoided damage costs from natural disasters:*** An SEM approach can help to avoid damages that result from an excessively vulnerable production system based on an ever-degrading natural resource base.
- ***New green market opportunities:*** SEM might open new market opportunities to firms and industries, as is the case with certified organic products.
- ***Increases in local employment:*** The strengthening of green markets often generates local jobs, by establishing supply chains based on biodiversity products that are cultivated, harvested, transported and marketed by local populations.

5.5.1 Example 1: Soil erosion on a coffee farm

Figure 17 shows a TSA for a farmer trying to decide what to do about erosion on his coffee farm. The stated purpose of the TSA is to determine whether it makes financial sense to implement soil conservation practices (planting shrubs, live barriers and trees) on the parts of the property that are more prone to soil erosion and crevasses, which lead to lost productivity and outright loss of cultivated land. The BAU, as defined by the analyst and decision maker, is to continue as is, with the entire property planted with coffee plants. The SEM is defined as taking specific portions of the property (those identified as more vulnerable) and implementing the aforementioned practices. The criterion for the decision is financial, and the chosen indicator is net profits. Both the BAU and SEM curves will be plotted on graphs with time on the x axis (as always in a TSA) and net profits (the indicator) on the y axis.

The analyst has determined that he needs two specific pieces of information to generate the BAU scenario curve: First, he needs to know what net profits are today, based on current benefits and costs under BAU; he can get this information from the farmer. Second, he needs to estimate the effect of soil erosion and of potential crevasses on net profits. Through a literature review, he finds that erosion reduces net profits by 10 percent each year, and that crevasses in the more vulnerable areas are likely to happen once every 10 years. Using these two pieces of information, the analyst can generate a BAU scenario curve (Graph a in Figure 17) that shows net profits going down as a result of soil erosion. He could also produce a narrative on the uncertainty surrounding cultivated land in the more vulnerable areas of the farm.

Figure 17: TSA for Soil Erosion on a Coffee Farm



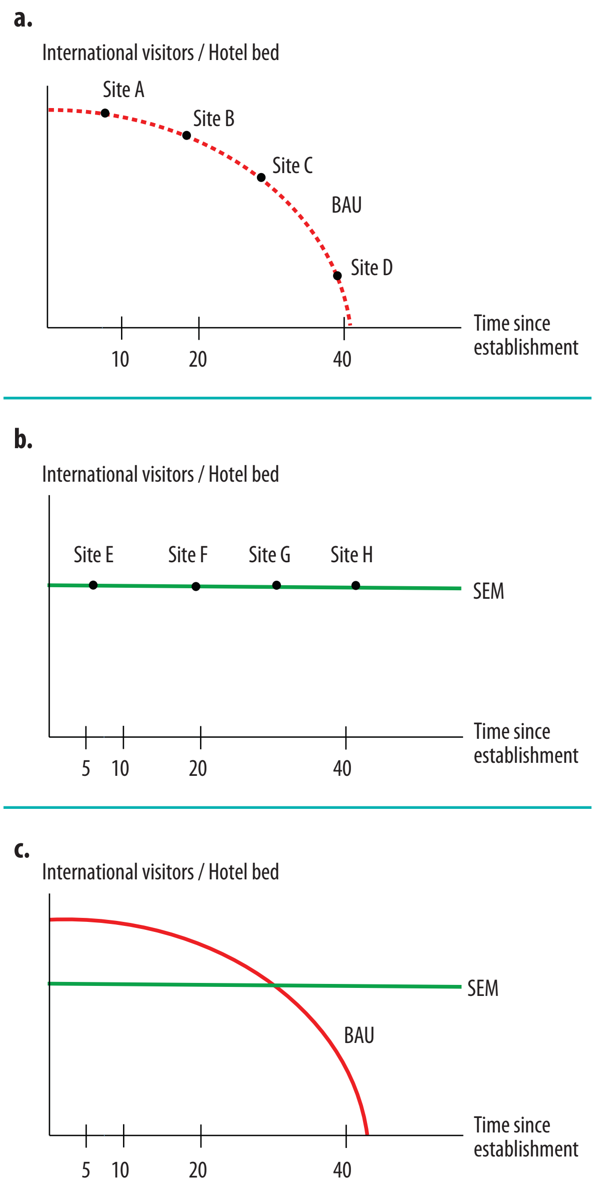
To generate the SEM scenario curve, the analyst also needs two pieces of information: First, an estimate of the investment costs necessary to move to SEM, based on the definition of SEM developed in Step 2 (Chapter 3). This information will determine the starting point of the curve, which is equal to current profits from BAU minus investment costs. Next, using expert advice, the analyst finds that, by planting trees, a farmer can reduce losses due to erosion by 50 percent annually, thereby halving the reduction in net profits without any further use of agrochemicals; in other words, profits will now decrease by only 5 percent per year. This information allows the analyst to generate the SEM scenario curve (Graph b in Figure 17) showing net profits still going down, albeit at a slower pace, as a result of SEM.

Finally, the analyst can put the two curves together (Graph c in Figure 17) to show the benefits of SEM over BAU. In this particular TSA, the analysis is based completely on a literature review and a semi-struct ured interview process, using guided conversations with the farmer and experts, and existing data at the farm level.

5.5.2 Example 2: The coastal tourism sector

Figure 18 shows a TSA for a government decision maker trying to decide if his country should develop smaller-scale ecotourism or traditional, large-scale sun and sand tourism in a particular coastal location. The stated purpose of the TSA is to determine which type of tourism would be better for the area. The BAU is defined as traditional sun and sand, large-scale tourism, while the SEM is defined as smaller-scale ecotourism. The chosen indicators include international hotel visitors per bed and net profits (based on average price per bed). To complete this analysis, the analyst does a cross-site comparison, using a number of comparable sites, preferably in the same country. By plotting the results from comparable sites on a graph, the analyst can create an expected picture of what a BAU and SEM scenario might look like. Graph a in Figure 18 shows the BAU curve, which was generated using data from existing large sun and sand destinations. This curve shows that, after many years, visitors drop off, perhaps because the area has gotten too crowded and the surrounding environment and attractions have been degraded. The SEM scenario curve (Graph b in Figure 18) uses data from existing small ecotourism sites to show that visitation stays pretty level. Putting the two curves together (Graph c in Figure 18) will show a comparison between BAU and SEM. A second set of curves with a financial indicator (for example, net profits or price/investment) could be derived using information on investment costs per hotel bed or average price per hotel bed.

Figure 18: TSA for the Coastal Tourism Sector



For this analysis, data to populate the curves can be derived with a review of existing databases and interviews with tourism institutes and experts. This type of analysis will require a lot of time and money to complete.

5.5.3 Example 3: Shrimp farming in mangroves

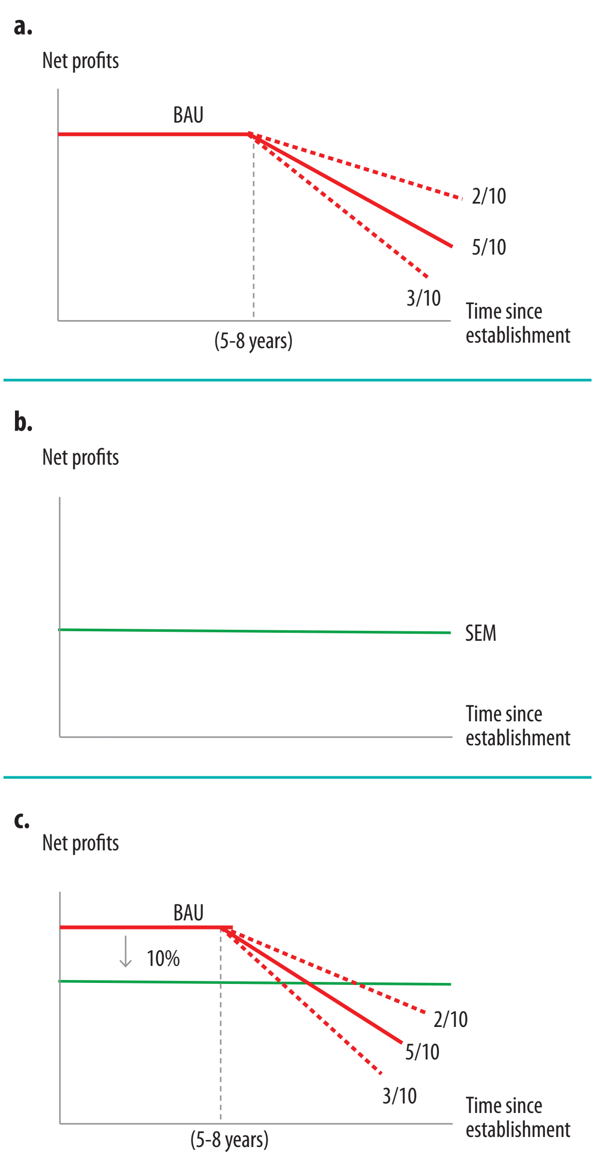
Figure 19 shows a TSA for a decision maker trying to understand the net profits of shrimp farming with and without mangroves. The stated purpose of the TSA is to determine whether it makes financial sense to keep some of the mangrove forest and proceed with a lower density of shrimp farms. BAU has been defined as clearing out all the mangroves, making lagoons and putting in shrimp farms in the entire area. SEM has been defined as keeping some of the mangroves and having a lower density of shrimp farms, and also having less aggressive use of pesticides and agrochemicals.

For this TSA, the analyst has been given only a $10,000 budget and one month. To stay within this budget, the analyst decides to interview experts about the pros and cons of shrimp farming within mangrove forests. In generating the BAU scenario curve, the analyst finds that five out of ten experts think that net profits under BAU start to decline a certain amount after a certain point (the inflection point), because the resource begins to degrade very quickly without the mangroves. Of the other experts surveyed, two out of ten think that profits decline less after that point and three out of ten think profits will decline more. Furthermore, there is also disagreement about when the inflection point is; the consensus is that it is somewhere between five-to-eight years after the establishment of the shrimp farm. This uncertainty can be reflected in the BAU graph generated for the decision maker (Graph a in Figure 19).

To generate the SEM curve, the analyst speaks with the same experts. The consensus among them is that lower use of chemicals, lower density of shrimp and smaller area of the shrimp farms will result in a reduction of profits by 10 percent. However, they also agree that, because the conserved mangrove forest will help to regulate the ecosystem, the farms will not face an equivalent reduction in profits after a certain point, as in BAU. This results in a level SEM curve, with smaller original profits, but more consistent profits over time (Graph b in Figure 19). Combining the two curves in one graph (Graph c in Figure 19) will demonstrate the benefits of SEM over BAU.

Because the analyst was only given $10,000 to do this TSA, the main information source is experts, and possibly a brief literature review. As a result, there is a certain amount of

Figure 19: TSA for Shrimp Farming in Mangroves



uncertainty in the results. However, the same TSA with a $150,000 budget could include a market study on niche markets for sustainable shrimp; a full study on SEM in shrimp farming, including an estimation of costs to give a better picture of the actual impact on profits; a willingness to pay study on associated amenities of SEM shrimp farming, such as existing mangroves and other uses of mangrove forests; and a review of historical data on shrimp farming to get a better idea of the inflection point when profits start to fall. These additional analyses would help the analyst more accurately populate both the BAU and SEM curves, better estimate where the inflection point is when profits start to fall under BAU, and provide results with less uncertainty to the decision maker.

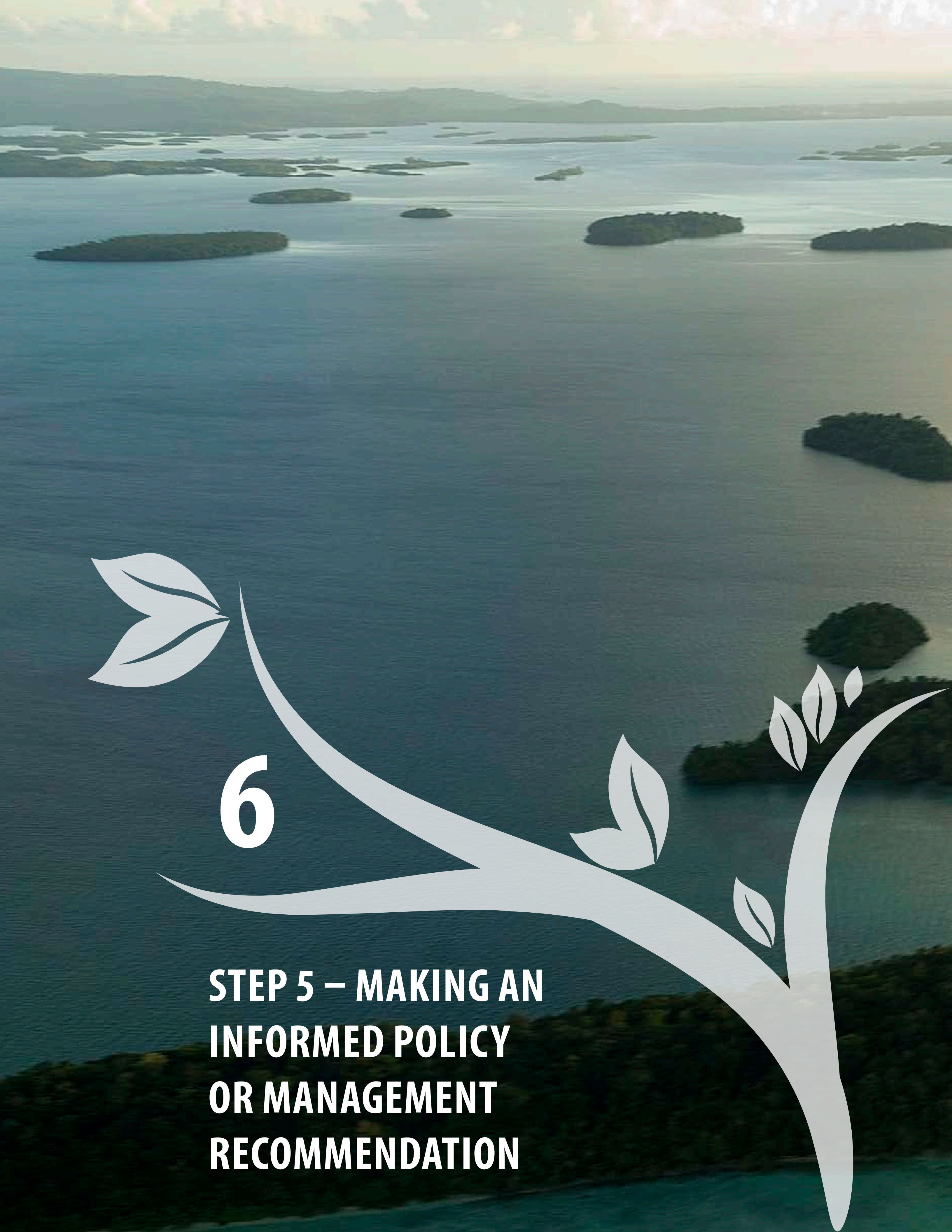
5.6 TIPS FOR ORGANIZING THE RESULTS OF THE TSA

At this point, the TSA process is nearly complete. All that is left is to present the findings in an effective format to the decision maker (see next chapter). While conducting a TSA is by no means simple, the technical complexities involved in the approach are not likely to be greater than those involved in completing a cost-benefit analysis or a complex valuation exercise that is full of difficult-to-justify assumptions. It is important to organize and present the findings effectively so that they are carefully read, considered and, hopefully, applied to policy and decision making.

The final results of the TSA may range from a very simple account of existing data and expert knowledge to a sophisticated econometric modelling and valuation exercise. In any situation, the analyst should be careful not to go further than is necessary to make the case to the relevant decision maker. For example, if the decision maker cares about financial outcomes only, then there is no need for sophisticated valuation of the changes in human well-being. At the same time, any assumptions or limitations to the analysis should be made obvious to the decision maker.

In the process of completing a TSA, an analyst is likely to gather data from many different sources. Thus, it is important to keep good track of those sources, and especially of the assumptions that have been made to fit existing data, or any previous results, to the situation at hand. It is also important to keep track of any units of measurement and conversions done to fit the data to the particular issue being analysed by the TSA (for example miles to kilometres, kilograms to pounds or 1979 dollars to 2013 dollars).

Finally, the most important tip for ensuring that the results of the TSA are well-received is to ensure that the findings tell a compelling and well-grounded story.



6

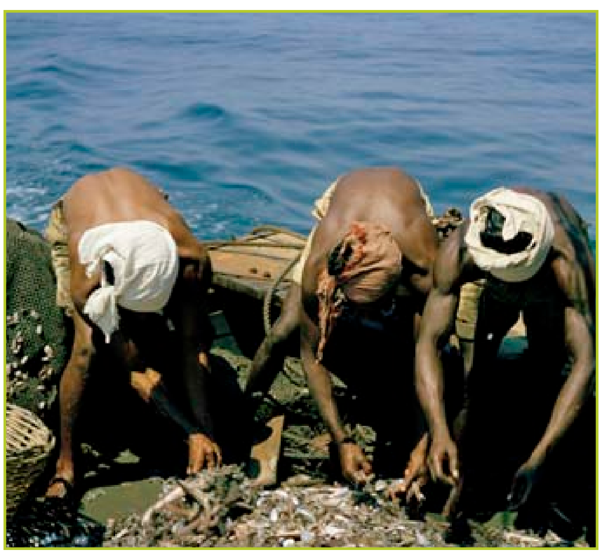
STEP 5 – MAKING AN INFORMED POLICY OR MANAGEMENT RECOMMENDATION

CHAPTER 6: STEP 5 – MAKING AN INFORMED POLICY OR MANAGEMENT RECOMMENDATION

Once a policy analyst understands the causal relationship between the policy interventions and outcomes, has calculated the magnitude of the outcomes that may result from each of the policy interventions, and has assessed these outcomes in terms of the criteria selected, the next task is to present this information to assist decision makers in choosing among the policy interventions. In other words, it is time to make a recommendation on the choice between BAU and SEM.

6.1 KNOWING WHEN TO MAKE A RECOMMENDATION

Analysts need to know their clients well in order to decide how best to present the results of their work. Some decision makers may want to know the analyst's opinion or seek a direct recommendation as to which policy intervention to choose on the basis of the TSA. They may encourage debate among their advisors and welcome a passionate argument in support of one policy intervention over another. But others may prefer a more dispassionate presentation of the "facts," leaving them to come to their own conclusions as to the choice among policy interventions.



In both cases, the analyst should present the results of all indicators, for all affected stakeholders, in a way that enables the decision maker to compare and contrast the pros and cons of the different interventions in terms of different criteria and the consequences on different groups. The main trade-offs between indicators and stakeholders should be highlighted, without presenting a dominant intervention or single number that indicates which intervention "should" be chosen. After all the information and analysis has been presented, the analyst can then make a specific recommendation if the decision maker asks for one. If the decision maker does not ask for a recommendation the TSA can end with the presentation of the graphs leaving it to the decision maker to come to his own conclusions and recommendations.

6.1.1 Additional factors to include in the final presentation of results

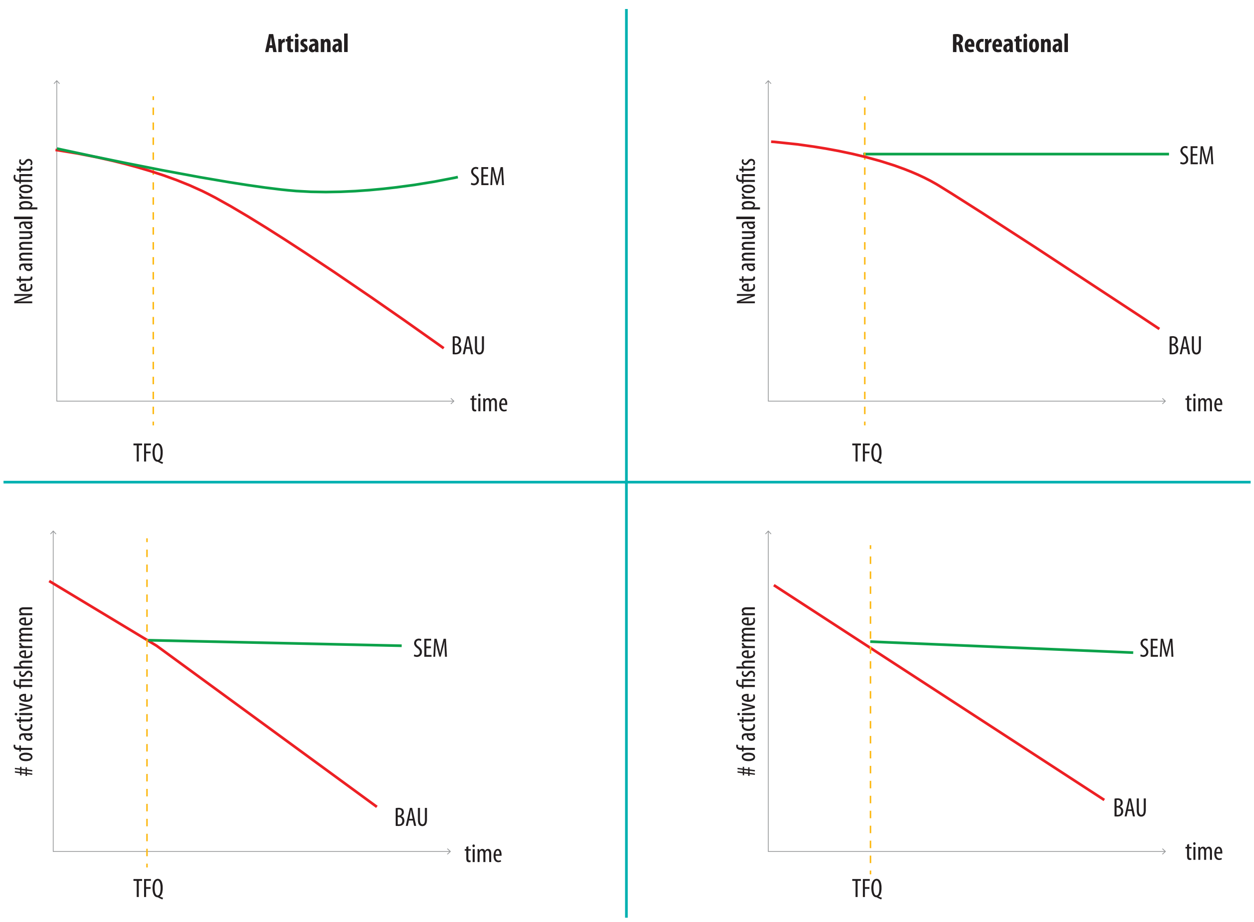
Irrespective of whether or not a decision maker wants a recommendation from his or her staff and outside policy analysts, a careful account of data limitations, major caveats in the analysis and underlying uncertainties must be part of the concluding remarks.

In addition, if the consequences of implementing a given intervention transcend the authority or mandate of the targeted decision maker, this should be noted in the TSA report. For example, if creating a regional network of protected marine areas in key sites proves to be more economic than the BAU of overfishing, the regional authority in charge of fisheries should be instructed to confer with the regional authority in charge of tourism, as protecting marine areas might bring significant benefits to the tourism sector as well. Here too, the analyst must carefully describe the proposed policy intervention and anticipate its likely consequences if implemented, emphasizing the need for close work and constant communication between the fishery and the tourism authorities.

6.2 PRESENTING CONFLICTING RESULTS

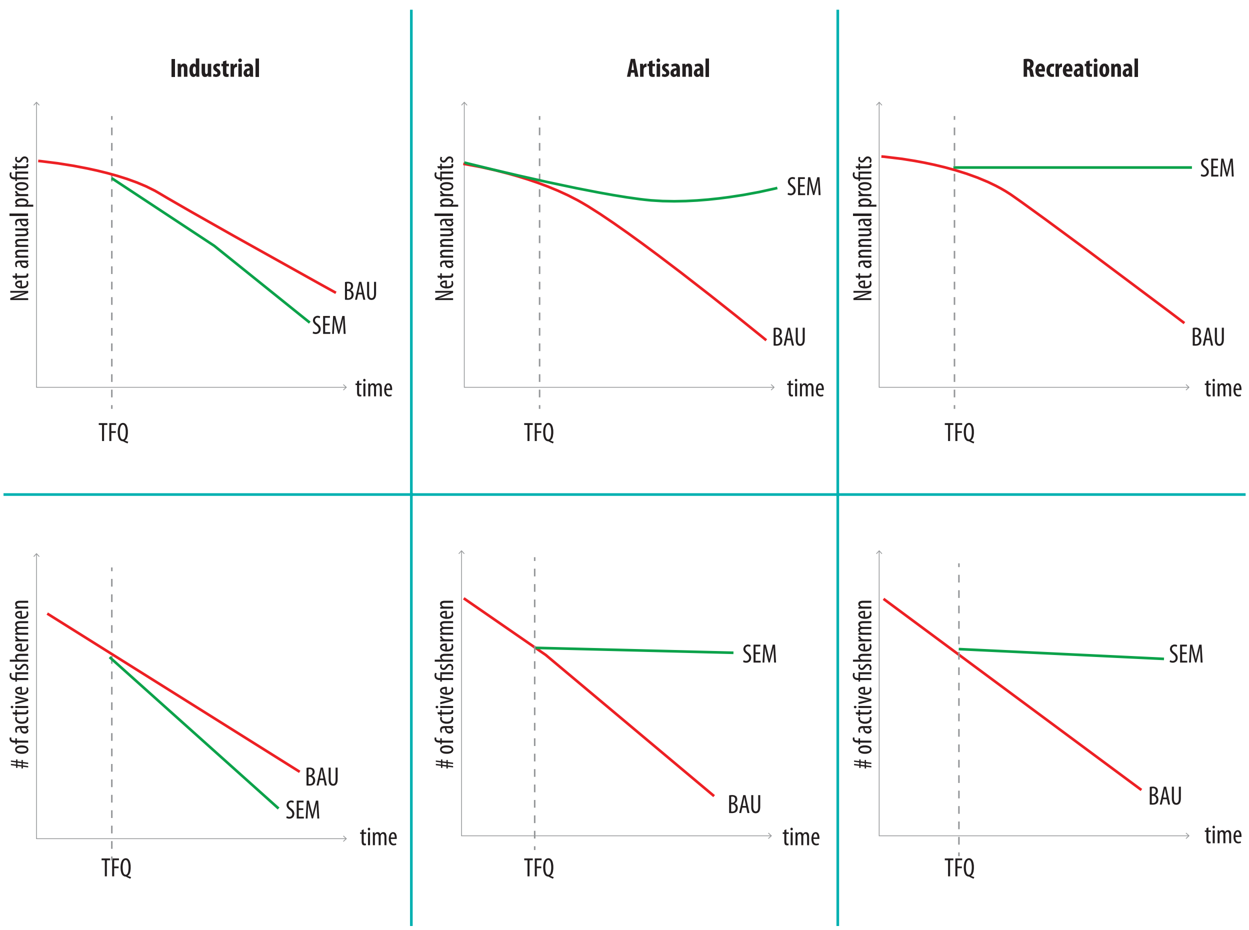
Figure 20 illustrates a situation in which an SEM policy (the implementation of a tradable fishing quota) is evaluated for a local fishery. Two stakeholders are considered, namely artisanal and recreational fishermen, and the decision maker cares about financial criteria, captured by net profits, and a non-monetary criteria related to employment. This example shows a win-win situation in which, from the implementation of the SEM policy onwards, both groups are better off on both criteria. In this case, it is pretty clear that the policy maker should implement the policy.

Figure 20: Two criteria for recreational and artisanal fishermen



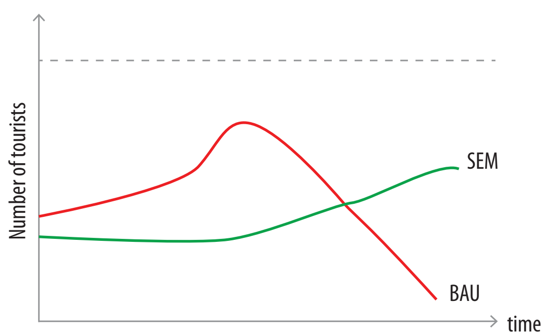
Although examples of this type of win-win situation are surprisingly abundant in environmental policy questions, they are not always the case, and the analyst must be prepared to face much more complex policy recommendations, especially as the number of groups, the number of criteria and the number of interventions all increase. Figure 21 expands the previous example to include industrial fishing. Assume that tradable fishing quotas are a real constraint to industrial fishers, resulting in less profits and a reduction in the industry itself. The policy recommendation is now much less straightforward, and might need additional information regarding new employment opportunities in other parts of the economy and money transfer to facilitate the transition away from the industrial fishery and into other productive activities, including artisanal and recreational fishing.

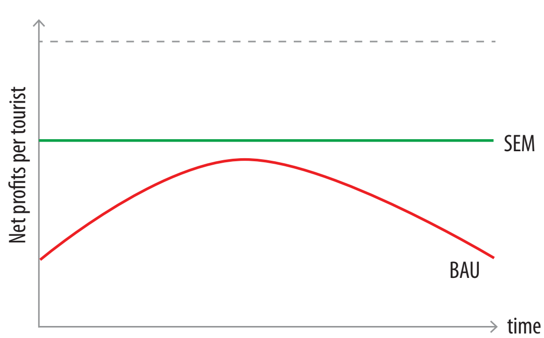
Figure 21: Two criteria for recreational, industrial and artisanal fishermen



It is also possible to find that some stakeholders receive benefits on some criteria and suffer losses on others, making the policy recommendation even less straightforward. Figure 22 presents a stylized scenario for SEM and BAU in tourism, with three indicators: revenues per tourist, number of tourists and number of people employed. The UNDP 2010 Report notes that, although ecotourism is generally on a smaller scale than standard mass tourism, profits are often higher; this fact is captured in the figure.

Figure 22: Stylized scenarios of SEM and BAU in tourism





Again, it is hard to draw a straightforward conclusion out of the summary provided in this figure, and the decision maker, a social planner in this case, needs to use his or her own value judgements to make a decision as to whether BAU or SEM tourism is the best choice for this location. Maps and visual aids may be useful to supplement or elaborate upon information provided in the BAU and SEM curves.

6.3 FINAL REMARKS FOR PRACTITIONERS AND DECISION MAKERS13

This guidebook calls for a new approach to environmental valuation. Targeted Scenario Analysis is an extension of the more traditional cost-benefit analysis approach, moving the focus from purely monetary estimates to a more integral narrative of the BAU and SEM scenarios, their outcomes in terms of key indicators, and the pathways leading to those outcomes. An analysis of uncertainty along the relevant planning horizon is key to the description of those pathways.

Clearly, doing a TSA properly requires sufficient time and funds. All too frequently, time limitations and funding restrictions cause analysts to avoid doing a cost benefit analysis and revert to doing descriptive analysis of baseline conditions using a valuation approach. If the same time and funding restrictions exist in the case of a TSA, it is highly unlikely that a proper analysis can be done.

Moreover, the targeted decision maker may be conditioned to want a valuation study of a particular ecosystem, rather than a sector-based analysis. If the client wants a standard valuation approach, it would take significant time and effort to convince him or her of the benefits of expanding the approach. In most cases, it will be the responsibility of both funding organizations and the analyst to demonstrate the

13 This section benefited particularly from conversations with Camille Bann, Marlon Flores and Andy Drumm.

advantages of a TSA to the client. And even then, there is no basis to assume that the client will welcome such an approach.

In summary, the type of analysis described in this guidebook requires a change in thinking, not only by the decision maker, but also by the organizations and institutions that typically fund ecosystem valuation studies. The analyst will need time, both in the field and also in discussions with the decision maker, if the end result is to be a report that will feed directly into decision making. If properly executed, TSA has the capacity to influence policy and management decisions by generating information in the format typically employed when decisions are made in the private sector or in governmental institutions.

ANNEXES

ANNEX 1: GUIDELINES FOR THE PREPARATION OF TERMS OF REFERENCE FOR TARGETED SCENARIO ANALYSIS

BACKGROUND

- Identify the decision maker
- Identify the sector that is the focus of the analysis
- Include other information that is relevant to the specific policy or management question

MAIN OBJECTIVE OF THE CONSULTANCY

Prepare a case study comparing two alternative scenarios of business as usual (BAU) vs. sustainable ecosystem management (SEM) for one economic activity for a period of 10 years (or more). The comparison is to be focused on criteria and indicators relevant to the decision maker.

MAIN DELIVERABLES

1. Case study comparing business as usual (BAU) to sustainable ecosystem management (SEM) for one economic activity, using real historic data plus projected future scenarios, based on the Targeted Scenario Analysis (TSA) methodology.

CONCEPTUAL BACKGROUND

Provide reference to this guidebook

MAIN TASKS

1. Prior to any field work, describe the background, including all possible interrelations between the specific production or consumption sector under study and the natural resource base.

   a. Construct a conceptual model of all existing interactions between the ecosystem under study and the productive sector under analysis. The model should be concise and descriptive, rather than analytical or mathematical.

   b. Based on the conceptual model, identify actual and potential environmental inputs that the ecosystem provides to the productive sector.

   c. Based on the conceptual model, identify actual and potential environmental goods and services that the ecosystem provides to the productive sector.

2. Based on consultations with the decision maker and key stakeholders, define the policy or management question. Provide background on how the process was conducted and how the final policy or management question came about.

   a. In consultation with the decision maker, select the main issues to analyse.

3. Based on existing information, workshops, focus groups and/or expert interviews, provide a description of the BAU intervention and proposed SEM policy or management interventions. Describe the process of reaching agreement.

    a. Provide a detailed description of BAU.

    b. Provide a detailed description of SEM.

4. Select and justify the relevant criteria and indicators for TSA for the specific question at hand.

    a. In consultation with the decision maker, select the relevant criteria and indicators that can capture change in the relevant criteria. Provide a sound and defensible justification.

    b. For each indicator, mention the expected relationship between the ecosystem under study and changes in the indicator.

5. Provide a short review of existing information and identified data gaps.

6. Construct the BAU and SEM policy or management scenarios. Do this for each indicator. Whenever primary data is collected, provide a detailed description of the valuation methodology used, and how the estimated values respond to changes in the temporal and spatial dimension. This will help provide background on how generalizable are the results.

    a. Provide an account of uncertainty in the analysis.

7. Provide a policy recommendation. The recommendation should include a set of simple but strong key take-home messages for the decision maker, backed up by credible data from the results of the analysis to be included in the conclusion of the case study.

COMPETENCIES AND CRITICAL SUCCESS FACTORS

In describing the relevant competencies, the ToR must consider that, in most cases, the analysis will be conducted by a team. An important member of that team will be someone with in-depth knowledge of the context or specific policy or management question that the team has been asked to analyse. This is essential, because the analysis of policy and/or management interventions requires that the causal relationship between the policy invention and the consequences (outcomes) be known with confidence. For example, suppose a government has commissioned the analyst to examine the pros and cons of policy interventions aimed at improving a fishery that faces increasingly diminished catch and profitability. In-depth scientific knowledge of fisheries in general and the particular fishery under study is needed to estimate how the fishery stock and potential harvests would be affected if different policy interventions were implemented to protect the fishery. Having prior experience with the sector in question would also facilitate the construction and budgeting of a suitable team of experts.

ANNEX 2: CASE STUDY OF SUSTAINABLE CATTLE FARMING, COLOMBIA

AUTHOR: IRENE MONTES LONDOÑO

STEP 1: DEFINING THE PURPOSE OF THE ANALYSIS

Pinzacuá farm is located in Alcala County, in the Colombian state of Valle Del Cauca. Owned by Olimpo Montes Botero, the 45-hectare farm is a family owned and operated business dedicated to raising high-quality female Brangus cattle for breeding or meat production. Pinzacuá also produces organic yuca and coffee, as well as charcoal, which is produced from the pruning of trees that make up the silvopastoral and agroforestry system implemented by Mr. Montes more than a decade ago.

Defining the problem

Did it make sense to implement a silvopastoral system (to reduce soil erosion and land degradation) on the cattle farm, in order to increase revenues over time?

Defining the scope of the analysis

- Spatial scale: The area of the farm (45 ha)
- Time frame: 10 years, a sufficient period of time to observe the changes
- Legal and regulatory scope: The analysis was conducted within the existing legal and regulatory framework, assuming no changes to national or regional policies.

Assessing and verifying available data

The farmer provided historic data that he had collected for the entire period covered by the analysis, including: a) the number of animals the farm maintains each year (total animals); b) the charge capacity of each hectare (animals/ ha); c) the yield in kg per animal in one month, which is the weight gained per animal in a month (kg/animal/month); d) the market price per kg (price/kg); e) the sales per hectare (sales/ha); f) the earnings from sales per hectare; g) the costs per hectare; and h) the revenues per hectare.

STEP 2: DEFINING THE BAU BASELINE AND SEM INTERVENTION

What is BAU?

Conventional cattle farming (1993-1998)

From 1993 to 1998 the entire area of the farm (45 ha) was planted with estrella grass (Cynodon plectostachium) under full sun exposure. All 45 hectares were dedicated to meat production, with no areas left for conservation.

The following practices were used when the farm followed the model of conventional cattle farming:

- Land clearance: Native vegetation was eliminated, in order to cultivate pasture under full sun exposure.
- Deforestation of riparian areas: The three slow moving streams that pass through the farm were not protected. Livestock had free access to all three streams and, as a result, they became trampled, muddy depressions.
- Intensive grazing: 400 cattle were kept on the farm, a total of about eight-ten animals/ha.
- Intensive use of agrochemicals (fertilizers, pesticides): One ton of urea was used per hectare each year.

Although the practices described above were supposed to generate higher profits, instead they were generating losses due to the high cost of fertilizers that were required to maintain the volume of grass needed to keep 400 cattle on the farm.

Reasons why BAU practices were leading to ecosystem degradation

- Intensive grazing causes soil compaction, which decreases soil fertility (Hamza & Anderson, 2005);
- Land clearance causes soil erosion, nutrient depletion, loss of biodiversity, loss of microclimate regulation and loss of pest control (Bianchi, Booij, & Tscharntke, 2006); and
- Intensive use of fertilizers and pesticides causes soil acidification, water contamination, loss of riparian buffers and greenhouse gas emissions (R. Zeckoski, et. al, 2007).

Strategies used to address these impacts

- Increasing the dose of fertilizers and pesticides;
- Irrigation; and
- Decreasing the number of cattle.

What is SEM?

Silvopastoral System (1998-present)

In 1998, Mr. Montes decided to change the whole production model after struggling with the impacts of BAU for several years. He began by planting trees dispersed in pastures and establishing riparian corridors to eliminate access of livestock to the streams. The following practices were implemented in order to move away from BAU and reverse or reduce its impacts:

- Implementing a landscape approach to plan and manage the land according to its potentialities and limitations. This led to a division of the farm into the following areas: a) pastures with high tree density (20 hectares); b) sustainable Forestry (15 hectares); c) agroforestry (5 hectares); and d) protected areas (5 hectares);

- Cultivation of native trees dispersed in pastures, including the planting of 200 native trees of various species (especially leguminous tree species) in the pastures, with the guamo tree (Inga edulis) as the main species;
- Establishment of riparian areas by fencing the streams and planting guadua (*Guadua angustifolia*)[14] and other native plants between the streams and the streamsides;
- Improved pasture management and rotations through an increase in the rest periods of the paddocks. Constant pruning of the trees also helps maintain the right amount of sunlight/ shadow in the pastures;
- Grazing according to land offer, with only four-to-five cattle per hectare;
- No use of or dependency on chemical fertilizers and pesticides;
- Harvesting of fruits, seeds, fuel wood, honey and timber; and
- Marketing of native and/or exotic species, including vanilla, shade-grown coffee, yuca, flowers and passion fruit.

Consequences associated with adopting the SEM intervention

The implementation of these practices led to an improvement in the delivery of ecosystem services that ultimately was reflected in net profits. These changes included:

- Elimination of 70 percent of production costs (agrochemicals);
- Increased productivity;
- Diversified revenue streams,
- Decreased vulnerability to market volatility and extreme weather events.

14 Guadua is a native species of bamboo with high commercial value and a strong market in the region.

Investment and maintenance costs associated with adopting the SEM intervention

The silvopastoral system has been implemented gradually each year, using the farm's own revenues. Over the years, the farm has experimented with different methods to protect the planted trees from cattle during their initial growing years (three-to-four years). In total the farm spent $60,000 USD in 10 years.

Table 1 summarizes the costs of planting the trees with the different methods experimented with during each period.

Table 1. Implementation costs[15] of the silvopastoral system

Period	Areas (ha)	# trees	Total cost	Cost/ Ha
2000-2003	3	300	2,874	64
2004-2005	5	500	1,730	38
2006-2008	17	2,040	6,783	151
2009-present	20	22,000	48,320	1,074

STEP 3: SELECTING CRITERIA AND INDICATORS

Selecting Criteria

The farmer is interested in the overall profitability of his farm.

Selecting indicators

The most appropriate indicator to compare the BAU and SEM systems of production based on the selected criteria and available data is annual revenue per hectare.

Intermediate indicators

- Yield in kg/ha was chosen as an intermediate indicator of soil fertility, with the assumption that the quality and quantity of food available for cattle is a consequence of soil fertility and is ultimately reflected in yields.
- Annual cost of pesticides was chosen as an intermediate indicator of pest control, assuming that the more pesticides that are used, the more depleted is this ecosystem service.

STEP 4: CONSTRUCTING THE BAU AND SEM SCENARIOS

In order to construct the scenarios, historical data was collected from the time periods when the farm was under conventional cattle farming (BAU) and sustainable cattle farming (SEM). Gathered data is shown in Tables 2 and 3. Both tables include: the number of animals the farm maintained each year (total animals); the charge capacity of each hectare (animals/ha);[16] the yield in kg per animal in one month, or weight gained per animal in a month (kg/animal/month); the market price per kg (price/kg); the sales per hectare (sales/ha);[17] the earnings from sales per hectare;[18] the costs per hectare;[19] and the revenues per hectare.[20]

15 Cost/Ha computes dividing the 'total cost' by 45 hectares (farm's total area)

16 This number results from dividing total animals into 45, which is the total area of the farm in hectares.

17 This number results from multiplying animals/ha by kg/animal/month by price/kg by 12 months.

18 This number is the 60 percent of the sales/ha.

19 The costs/ha include labor and administration, fertilizers and pesticides, and other inputs (vaccines, salt lick, etc.).

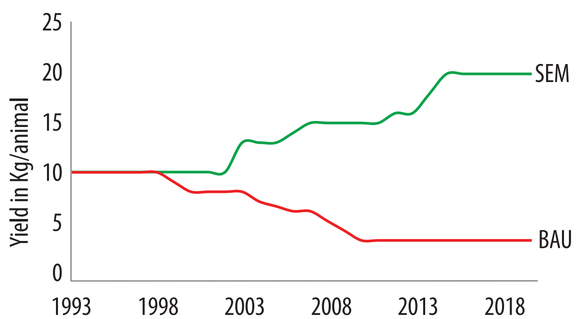
20 This number results from subtracting costs/ha from earnings from sales/ha.

Table 2. Balance sheet for BAU (US Dollars)						
Year	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Total animals	400	400	400	400	400	400
Animals/Ha	8.89	8.89	8.89	8.89	8.89	8.89
Kg/animal/month	10	10	10	10	8	10
Price/Kg	1.57	1.57	1.57	1.57	1.57	1.57
Sales/Ha	1,657	1,657	1,657	1,657	1,340	1,657
Earnings from sales/ha	994	994	994	994	804	994
Costs/Ha	759	811	837	916	1,334	1,378
Revenues/Ha	236	184	157	79	-530	-383

Table 3. Balance sheet for SEM (US Dollars)													
Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total animals	400	300	250	200	150	120	120	120	120	120	120	100	80
Animals/Ha	8.89	6.67	5.56	4.44	3.33	2.67	2.67	2.67	2.67	2.67	2.67	2.22	1.78
Yield/animal (Kg/month)	10	10	10	10	10	13	13	13	14	15	15	15	15
Price/Kg	1.57	1.57	1.57	1.57	1.57	1.83	2.09	2.09	2.09	2.09	2.09	2.09	2.09
Sales/Ha	1,657	1,243	1,036	829	622	760	868	868	953	1,002	1,002	829	669
Earnings from sales/ Ha	994	746	622	497	373	456	521	521	561	601	601	497	401
Costs/Ha	1,378	436	436	436	392	340	340	340	340	340	340	340	311
Revenue/Ha	-383	310	186	61	-19	116	181	181	221	261	261	157	90

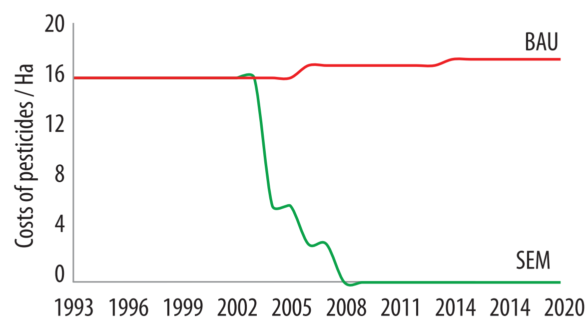
Constructing scenarios implies asking the question: What if? Figures 1 and 2 show what would have happened to soil fertility and pest control if the farmer had never changed to SEM.

Figure 1. Soil fertility measured as yield in kg/animal monthly (USD). Under SEM, the line rises in response to improvements in soil fertility. Depletion of soil fertility leads to lower BAU yields.



- In order to finalize the SEM curve, real data was used, from 1998 to 2010; accurate levels of output of kg/animal assure the curve´s reliability. After 2010, it is projected that the yield of kg/animal will gradually continue to grow, assuming that the fertility of the soil, and thus the quality of the pasture, will also continue to increase (due to the effect of the trees).
- Analyzing the graph, we can expect that by the year 2015, the maximum level of yield of 20 kg/animal will be reached, assuming that by then the system will be completely implemented and all of the trees would have reached maturity, enabling the pastures to fully benefit.
- The BAU curve was constructed using real values from 1993 to 1998, assuming that, after 1998, yields of kg/animal would have continued to diminish year after year due to the fall in soil fertility, over-pasturing and the compacting of the ground. It was also assumed that the level of chemical fertilizer use was maintained throughout the time period.

Figure 2. Pest control measured in costs of pesticides (USD). Under SEM, the line declines as a consequence of avoiding costs due to natural pest control. Simplified landscapes lead to increasing reliance on purchased inputs.



- This SEM curve was built using real values of data from the year 1998 to 2010. Data from 2010 on, was projected, assuming that the biodiversity in the farm would continue to rise and thus there would be no need to spend money on pesticides.
- This BAU curve was built using real values of data from the year 1993 to 1998. Data from 1998 on was projected, assuming that the costs of pesticide would continue to increase, since this value is economically tied to oil prices, which have continuously increased.

In order to compare revenues in both scenarios of cattle farming, the BAU and SEM curves need to start in t=0. Tables 4 and 5 show the data that was used to create the curves in Figure 3.

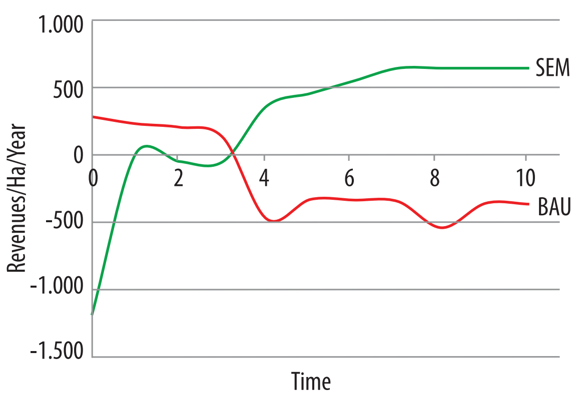
Table 4. Balance Sheet for SEM (USD)											
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Total animals	139	110	88	100	140	140	140	140	140	140	140
Animals/Ha	2.88	2.44	1.95	2.22	3.11	3.11	3.11	3.11	3.11	3.11	3.11
Yield/animal (Kg/month)	10	10	10	10	14	16	18	20	20	20	20
Price/Kg	1.60	1.60	1.60	1.60	2.10	2.10	2.10	2.10	2.10	2.10	2.10
Sales/Ha	553	468	374	426	1,097	1,254	1,411	1,567	1,567	1,567	1,567
Earnings from sales/ Ha	332	281	226	256	658	752	846	940	940	940	940
Costs/Ha	1,572	321	321	321	341	341	341	341	341	341	341
Revenue/Ha	-1,240	-40	-96	-65	317	411	505	599	599	599	599

Table 5. Balance Sheet for BAU (USD)											
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Total animals	400	400	400	400	400	400	400	400	400	400	400
Animals/Ha	8.89	8.89	8.89	8.89	8.89	8.89	8.89	8.89	8.89	8.89	8.89
Yield/animal (Kg/month)	10	10	10	10	10	8	10	10	8	10	10
Price/Kg	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57
Sales/Ha	1,657	1,657	1,657	1,657	1,657	1,340	1,657	1,657	1,340	1,657	1,657
Earnings from sales/ Ha	994	994	994	994	804	994	994	994	804	994	994
Costs/Ha	759	811	837	916	1,334	1,378	1,383	1,393	1,399	1,407	1,413
Revenue/Ha	236	184	157	79	-530	0383	0388	-399	-595	-412	-419

The SEM curve was constructed based upon data from Table 4. The data was projected based on the assumption that, when t=0, the changes were imposed immediately and not implemented gradually, as they were in reality.

The BAU curve was constructed using data from Table 5. The data in this table for t=0 through t=5 is the same as in Table 2 from 1993 to 1998. The data for t=6 through t=10 is projected based on assumptions of what could have happened to revenues if the farm had continued to implement BAU management practices.

Figure 3. BAU vs. SEM curve



Analysis

The first thing that can be observed in Figure 3 is that revenues from SEM exceed those from BAU within a short time frame, even when BAU generated its maximum value for revenues, which was \$236/ha/year (when t=0).

It is important to underline the fact that SEM achieved these values with less than half the cattle as BAU and in a smaller area, as five hectares were designated as biological corridors and conservation areas under SEM and on the 20 hectares dedicated to forestry, only two animals per ha were allowed. This means that, even though the production of meat did not increase, productivity did.

Up until the third year, SEM generates negative values, which means that, during this initial start-up period, the attractiveness of the system has to be increased via governmental or private incentives. Credits and financial programs, and government fiscal incentives are critical for the survival of any SEM-based project.

RECOMMENDATIONS

A comparison between the BAU and SEM curves shows that the projection of the BAU curve will eventually lead to a system failure. On the other hand, the SEM curve, despite low or even negative revenues in the initial start-up years, will continue to increase as a result of good sustainable growth in a balanced ecosystem, requiring minimum inputs and more labor. Therefore, from Figure 3, we can conclude that SEM is more favorable to revenues than BAU, that the farmer should continue with SEM and that other farmers should also implement SEM.

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