

# Methods for Building Scenarios of the Environment

## Summary of Lecture

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Scenario analysis, talking about possible futures, has a history of roughly two decades now. We can not study the future, but use scenarios instead. A scenario is a plausible description of how the future may unfold based on 'if-then' or 'what-if' propositions. Scenarios are not extrapolations or predictions. A scenario describes a possible future, where a prediction gives the best estimate of the future. The key elements of a scenario are: 1) A base year (or period) and a description of the state of things in this year; 2) A time horizon (or period) and time steps – the end point in time of the scenario and a description of the state of things at that time; 3) A geographic coverage – the spatial coverage of the scenarios, e.g. city, country, global; 4) A description of step-wise changes – a description of the events between the base year and time horizon which explains how the future situation occurred from the present; 5) Driving forces or uncertainties – the main factors that influence the step-wise changes of the scenario; 6) Storyline – a narrative that presents the important aspects of a scenario, including the relationship between driving forces and events of the scenario.

Scenario analysis comprises the development of scenarios, a comparison of scenario results, and an evaluation of their consequences. The goal of scenario analysis is to imagine future states and anticipate future developments of the environment and society, to identify strategies for responding to these developments and to evaluate the robustness of strategies. Additional goals are to raise awareness about the uncertainty of the future and alert to emerging problems; and to help managers and decision-makers to think creative, comprehensive and open. Scenario analysis is most valuable when facing long-term uncertain situations, with a scarcity of data and a large number of non-quantifiable factors. Alternatives to scenario analysis are technical reports, computer simulations extrapolating current trends, expert panels, and participative methods, such as Delphi studies or focus group studies.

Scenarios can be assigned to 3 major classes consisting of opposing types of scenarios: 1) deductive vs. inductive; 2) exploratory vs. anticipatory; 3) qualitative vs. quantitative.

1) deductive vs. inductive. Deductive scenarios are derived from a framework which organises the big uncertainties or questions about the future into a logical form. First the framework is established, then scenarios are *deduced* from the framework, e.g. Scenarios of Greenhouse Gas Emissions SRES (IPCC 2000). Inductive scenarios

are derived from taking into consideration all data and ideas about the future. Scenarios are built step-wise, bottom-up. First all data are considered, then insights about the future are *induced* from this study of the data, e.g. World Water Vision Scenarios (Gallopian and Rijsberman 2000).

2) exploratory vs. anticipatory. Exploratory or descriptive scenarios start from the current situation and then describe the steps that lead to a future situation. Anticipatory or prescriptive, normative scenarios start with a prescribed vision of the future (optimistic, pessimistic, or neutral) and then work backwards in time to visualise how this future could emerge.

3) qualitative vs. quantitative. Qualitative Scenarios are either in the form of visual symbols: e.g. video clips, diagrams, pictures; or in the form of words: e.g. written phrases, outlines or storylines. The most common form is a storyline: i.e. narrative description of scenario, highlighting main features, and relationship between driving forces and main features. Qualitative scenarios are understandable, interesting, represent views and complexity of many different interests. But qualitative scenarios are often arbitrary, do not provide numerical information, and it is hard to identify or test underlying assumptions. Quantitative scenarios deal with numerical information and are commonly computed with models. This was the pre-dominant approach until 5-6 years ago. Quantitative scenarios provide numerical information with identifiable underlying assumptions, but the models used have limited view of the world and are often not transparent, and the exactness of model output gives an illusion of certainty

To use strengths and discard weaknesses qualitative and quantitative scenarios can be combined in the so-called Story and Simulation (SAS) Approach, e.g. (Alcamo 2001). The SAS Approach produces both qualitative information (storylines) and quantitative information (model calculations). It combines qualitative advantages: understandable, expression of complex dimensions of problem; with quantitative advantages: consistency check of different assumptions of qualitative scenarios, quantitative data. The SAS Approach is an iterative process engaging both stakeholders and environmental modellers, guided by a 'disinterested' moderator from outside. The SAS Approach has been used in many international scenario exercises, e.g. Intergovernmental Panel on Climate Change (IPCC 2000), Millennium Ecosystem Assessment (Carpenter, Pingali et al. 2005), UNEP Global Environmental Outlook, World Water Commission. Common procedure is to start with 0-order story lines to be used as preliminary scenarios, that need to be quantified, e.g. with land use change models. With this first result the story lines are changed. In general 2 iterations with input from modellers and stakeholders are needed to come to the final scenarios. Modellers and stakeholders need to interact to come to shared expectations.

The following 6 steps are part of scenario development: 1) Select objectives and boundary conditions; 2) Select themes; 3) Select actors & factors; 4) Develop mini-scenarios for each theme; 5) Reduce number of mini-scenarios; 6) Write full scenarios – storylines.

1) Select objectives and boundary conditions. Objectives are often lacking. What should the scenario analysis accomplish? And within which boundary conditions, e.g. base year, last year with good data, time horizon, time steps, geographic coverage.

2) Select themes. Each scenario should have a main theme or message, based on the main uncertainties or big questions about the future. The number of uncertainties must be limited by defining and contrasting the uncertainties.

3) Select actors & factors. Select a short list of main actors: institutions that will play an important role in the scenario – e.g. financial institutions, governments, special interest groups; and main factors: main variables that will play an important role in the scenario – e.g. rate of increase of market share, number of employees in the firm, rate of subsidies. In a matrix uncertainties and themes are contrasted and major actors and factors are selected.

4) Develop mini-scenarios for each theme. For each theme, construct an outline of a scenario, a ‘mini-scenario’ as a phrase or in tabular form. The mini-scenario consists of a description of step-wise changes, a description of the events between the base year and time horizon which explains how the future situation evolved from the present. The mini-scenario describes, among other things, the driving forces or uncertainties of the scenario, maintaining internal consistency and including main actors and factors.

5) Reduce number of mini-scenarios. Reduce the total number of mini-scenarios to a manageable number by eliminating implausible mini-scenarios and combining similar mini-scenarios. E.g. 2 main uncertainties with 3 possible values each already result in 9 themes/scenarios. What is the ideal number of scenarios? Two opposing views exist. As many as possible: to represent many views of the future and many possibilities of the future. Versus as few as possible: difficult to communicate results of many scenarios; no apparent upper limit to number of scenarios; the greater the number of scenarios, the more effort and resources needed for the scenario analysis. Recommendation for strategic studies, based on limitations of resources, and ability to communicate results of scenarios: 2 to 4 scenarios.

6) Write full scenarios – storylines. Elaborate step-by-step the mini-scenarios into full scenarios. An ‘influence diagram’ can give a visual representation of all influential relations between or within themes, actors and factors. Add boxes to communicate important or additional information. Finally use anecdotes and/or stories to illustrate the main messages.

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