Future Forests | Working Report

Scenarios in the context of Future Forests

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Future Forests analyzes conflicting demands on forests systems
to enable sustainable strategies under uncertainty and risk

Content

1. Introduction

Scenario development (analysis, planning etc) is a branch of futures studies. In this report we will start by describing futures studies in general, and then move on to scenario analysis in particular. We will also discuss strengths and weaknesses with scenarios. The aim of this report is to serve as a basis for discussions and method development within the research program Future Forests. In the program we have decided to start working with scenarios in the form of possible futures based on qualitative, narrative methods. Thus, most of the discussion is directed towards this scenario methodology, but we also briefly mention other methods.

2. Futures studies

The purpose of futures methodology is to systematically explore, create, and test possible (and sometimes desirable) futures to improve decisions (this section is taken from Glenn 1999). It includes analysis of how future conditions might change as a result of the implementation of policies and actions, and the consequences of these policies and actions. Futures research can be directed to large or small-scale issues, in the near or distant future; it can project possible or desired conditions. Its methods can be highly quantitative or qualitative, with the aim of providing a framework to better understand the present and to expand mental horizons. For instance, businesses use futures methods to enhance understanding of future markets. Social leaders use them to develop and test both possible and desirable future visions. Future visions can help generate long-term policies, strategies, and plans, which help bring desired and likely future circumstances in closer alignment.

The value of futures research is less in forecasting accuracy, than in usefulness in planning and in opening minds to consider new possibilities and changing the policy agenda. Its purpose is not to know the future but to help us make better decisions today via its methods which force us to anticipate opportunities and threats and consider how to address them. And strategically it is better to anticipate, rather than just respond to change.

Perhaps the most commonly understood reason for the use of futures methods is to help identify what you don't know, but need to know, to make more intelligent decisions. For example, one might write a scenario to see how a particular future might occur. In the process of writing, it becomes clear that no easy transition from the present to the future exists for some developments. This difficulty focuses the mind on the important questions to resolve in order to design better policy. It forces us to think about the future and helps identify assumptions to examine and change, if necessary. If our mental models of how the world works are incorrect, our forecasts will also be wrong regardless of technique.

There are some philosophical assumptions behind futures research that most futurists would accept such as (Glenn 1999):

1. You cannot know the future, but a range of possible futures can be known;

2. The likelihood of a future event or condition can be changed by policy, and policy consequences can be forecasted;

3. Gradations of foreknowledge and probabilities can be made; we can be more certain about the sunrise than about the rise of the stock market;

4. No single method should be trusted; hence, cross referencing methods improves foresight;

5. Humans will have more influence on the future than they did in the past.

3. Futures methodology

Futurists distinguish normative forecasting from exploratory forecasting. Normative work is based on norms or values. Hence, normative forecasting addresses the questions: what future do we want? What do we want to become? Exploratory forecasting explores what is possible regardless of what is desirable. This general division of futures work into normative and exploratory can be misleading when applied to methodology. Many techniques can be used for both normative and exploratory forecasting, but some tend to be used more for one than the other. Futurists' "tools" are often quite flexible and adaptable to specific purposes. (Glenn 1999)

To exemplify the range of methods that are used in futures studies, we present a simple taxonomy of Futures Research Methods (Glenn 1999), and divide them into mainly quantitative or qualitative, and into normative or exploratory methods. We will not go through all of these methods, this is just for illustration. More details about each method can be found in Glenn & Gordon (1999a).

Method	Quantitative	Qualitative	Normative	Exploratory
Agent Modeling		X		X
Causal Layered Analysis		X		X
Cross-Impact Analysis	X			X
Decision Modeling	X			X
Delphi Techniques		X	X	X
Econometrics and Statistical Modeling	X			X
Environmental Scanning		X		X
Field Anomaly Relaxation		X		X
Futures Wheel		X	X	X
Genius Forecasting, Vision, and Intuition		X	X	X
Interactive Scenarios		X	X	X
Multiple Perspective		X	X	X
Participatory Methods		X	X	
Relevance Trees and Morphological Analysis		X	X	
Road Mapping		X	X	X
Scenarios	X	X	X	X
Simulation-Gaming		X		X
State of the Future Index	X	X	X	X
Structural Analysis	X	X		X
Systems Modeling	X			X
Technological Sequence Analysis		X	X	
Text Mining		X	X	X
Trend Impact Analysis	X			X

Another way of organizing and comparing methods is by areas of use, as shown in the following list (Gordon & Glenn 1999). Futures studies thus incorporate many methods that all have their own specific advantages and disadvantages.

When You Want to:	**Use**
Collect judgments	Genius Delphi Futures Wheel Group meetings Interviews
Forecast time series, and other quantitative measures	Econometrics Trend Impact Analysis Regression analysis Structural Analysis
Understand the linkages between events, trends, and actions	System Dynamics Agent Modeling Trend Impact Analysis Cross Impact Analysis Decision Trees Futures Wheel Simulation Modeling Multiple perspective Causal Layered Analysis Field Anomaly Relaxation
Determine a course of action in the presence of uncertainty,	Decision Analysis Road Mapping Technology Sequence Analysis Genius
Portray alternate plausible futures	Scenarios Futures Wheel Simulation Gaming Agent Modeling
Reach an understanding if the future is improving	State of the Future Index
Track changes and assumptions	Environmental scanning Text Mining
Determine system stability	Non linear techniques

Factors required for successful implementation of Futures research in decision making

An international assessment of foresight and decision-making was conducted by the Millennium Project (Glenn & Gordon 1999). Some of the central conclusions of the study are listed below. It is not reasonable to expect that all of the following recommendations can be implemented in every application of futures research for decision-making. Nevertheless, the more of these that can be done, the greater the likelihood of successful implementation of futures research in decision-making will be (if that is the goal of the exercise). These conclusions can be seen as a motivation of including our Panel of Practitioners in the scenario process.

1. Make sure leaders or decision-maker(s) to whom the information is intended know what futures research is and is not, are interested in the process, have requested the activity, and all those involved in the process are clear about the objectives and mission of the activity. Ideally, this would include a statement of what the decision-maker(s) would consider to be a successful outcome.

2. Confirm that futures research has or will have a formal connection to the strategic planning process that is understood by all involved and that they understand that futures research provides a framework for thoughtful discussion, rather than predictions.

3. Integrate the producers of futures research and the decision-maker(s) into the overall process as much as possible.

4. Information should not be limited to quantifiable projections, but include rich subjective descriptions of alternative futures that make future possibilities more real for the decision maker(s).

5. Include diverse different interests groups and key actors in the research process to make sure that the information is created about how a contemplated decision may affect stakeholders and to reduce subsequent political impediments. Enlist the support of people in this process who will use or be affected by the activity.

6. Include the decision maker(s) in the research process to counter any lack of a long-term views and short-term dominance over more distant future considerations.

7. Use at least one formal method that is understandable to all involved.

8. Make options or recommendations simple, clear, and precise and deliver them in political, cultural and social (non-technical) terms, connected to goals and strategies.

9. If the information and data are inaccurate, unreliable, conflicting, and/or insufficient, then expose the problem, collect best judgements, and suggest ways of making decisions within the uncertain environment.

10. Be innovative in the method of presenting findings to avoid information overload.

11. In addition to more analytic methods, include a workshop toward the end of the research to give time for individuals, including the decision maker(s), to integrate the concepts in their thinking in a group setting.

12. Make the work continuous and cumulative so that what is learned in one iteration is carried over to the next. It should not be a one-time event, but an on-going process of feeding information to the decision process and responding to feedback from impacts.

4. Scenario methodology

A scenario is a story that connects a description of specific future to present realities in a series of causal links that illustrate decisions and consequences (this section is from Glenn et al. 1999). A specific year should be stated, such as 2050, and a specific system or subject focus, such as a country, an industry, peace and conflict, etc. A scenario is not a single prediction or forecast, but a way of organizing many statements about the future. It should be sufficiently vivid that a planner can clearly see and comprehend the problems, challenges, and opportunities that such an environment would present. A scenario is not a prediction of specific forecast per se; rather, it is a plausible description of what might occur. Scenarios describe events and trends as they could evolve. No scenario is ever probable; the probability of any scenario ever being realized is minute. Scenarios should be judged by their ability to help decision makers make policy now, rather than whether they turn out to be right or wrong. "Good" scenarios are those that are: 1) Plausible (a rational route from here to there that make causal processes and decisions explicit); 2) Internally consistent (alternative scenarios should address similar issues so that they can be compared; and 3) Sufficiently interesting and exciting to make the future "real" enough to affect decision-making.

Scenarios take over where forecasting capabilities decline (Fig. 1; Postma & Liebl 2005), i.e. where uncertainties start to dominate over predetermined processes. However, scenarios also have limitations as time periods become longer.

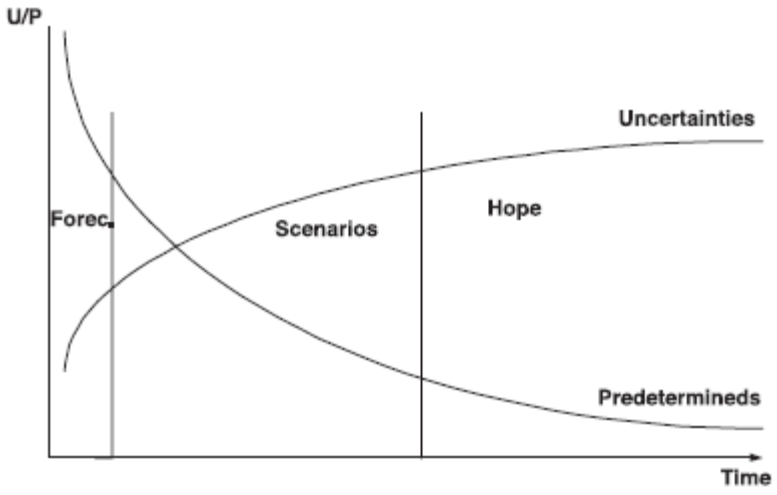

Fig. 1. The relationship between forecasting (prognosis, predictions), scenarios, and hope as the balance between uncertainties and predetermined processes and factors change (from Postma & Liebl 2005).

As have already been mentioned for futures studies in general, scenarios can be of many types. An important classification is based on the principal questions a user may want to pose about the future, such as: *What will happen*?; *What can happen*?; or *How can a specific target be reached*? (Fig. 2; Börjesson et al. 2006). *Predictive scenarios* aim to answer the question *What will happen*? Predictive scenarios consist of two different types, distinguished by the conditions they place on what will happen. Forecasts are conditioned by what will happen if the most likely development unfolds, i.e. when making a forecast the basic supposition is that the resulting scenario is the most likely development. What-if scenarios respond to the question: What will happen, on the condition of some specified events? What-if scenarios can be said to consist of a group of forecasts, where the difference between the forecasts is more than a matter of degree regarding a single exogenous variable. The difference is fundamental and obvious. The *explorative scenarios* are defined by the

fact that they respond to the question *What can happen*? The authors distinguish between two types: (i) External scenarios which respond to the users' question "What can happen to the development of external factors?", and (ii) Strategic scenarios, responding to the question "What can happen if we act in a certain way?". *Normative scenarios* aim to answer the question "*How can a specific target be reached*?". Normative scenarios consist of two different types: Preserving scenarios, responding to the question "How can the target be reached, by adjustments to current situation?", and Transforming scenarios, responding to the question "How can the target be reached, when the prevailing structure blocks necessary changes?".

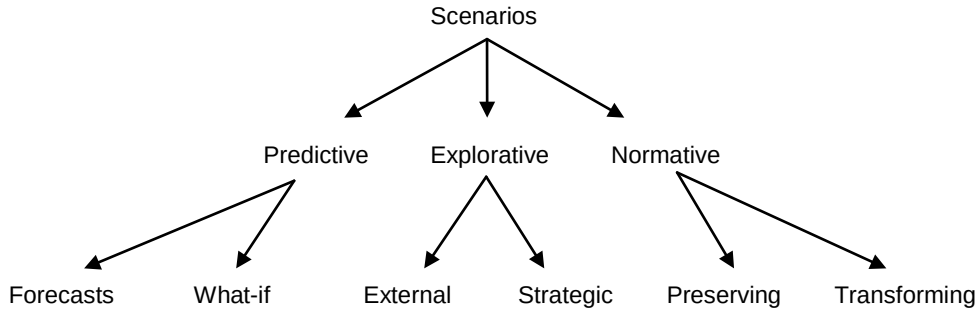

Fig. 2. Classification of scenarios, *sensu* Börjesson et al. (2006).

In general, the term scenario has been used in two different ways: first, to describe a snapshot in time or the conditions of important variables at some particular time in the future; second, to describe a future history—that is, the evolution from present conditions to one of several futures. The latter approach is generally preferred because it can lay out the causal chain of decisions and circumstances that lead from the present. The most useful scenarios are those that display the conditions of important variables over time. In this approach, the quantitative underpinning enriches the narrative evolution of conditions or of the variables; narratives describe the important events and developments that shape the variables (Glenn et al. 1999).

Numerous methods have been developed to create scenarios, ranging from simplistic to complex, qualitative to quantitative. Many methods have similarities, although they may have unique features and use different terminology. Most approaches recognize the need to understand the system under study and identify the trends, issues, and events that are critical to this system. Descriptions can, for instance, also be found in Duinker & Greig (2007), Schwartz (1991), Peterson et al. (2003), Alcamo & Henrichs (2008), Carpenter et al. (2005), and Coates (2000). Here we just give two examples:

The scenario process according to Brummel & MacGillivray (online):

1. Clarify the focus of the scenarios
2. Examine past changes to identify ongoing trends and forces
3. Identify future changes and the forces driving those changes
4. Identify the critical uncertainties which could lead to distinctly different futures
5. Create a logical framework based on the critical uncertainties
6. Flesh out the major characteristics and develop stories for each scenario
7. Identify the major implications of the scenarios with the stakeholders.

The scenario process according to Postma & Liebl (2005):

1. Identify focal issue or decision
2. Identify key forces in the local environment
3. Identify driving forces
4. Rank driving forces by importance and uncertainty
5. Select the scenario logics
6. Flesh out the scenarios
7. Develop implications for strategy
8. Select leading indicators and signposts
9. Feed the scenarios back to those consulted
10. Discuss the strategic options
11. Agree on the implementation plan
12. Publicize the scenarios

An important step is to go from drivers to uncertainties as that step defines the following scenarios. Postma & Liebl (2005) suggests focusing on drivers that have a high impact and a low predictability (Fig. 3). However, other approaches are certainly possible. For instance, one could define more complex uncertainties in terms of groups of drivers, or decide on uncertainties based on stakeholder or project objectives, i.e. uncertainties that are more important or interesting than others to analyze. It is important to remember that there is not one set of scenarios that are "correct"; the value of the scenarios lies in the strategic discussions they generate. The drivers that are not used in defining the uncertainties can still be used in the descriptions of the scenarios. For instance, drivers that have a high predictability could be used in all scenarios to provide internal consistency.

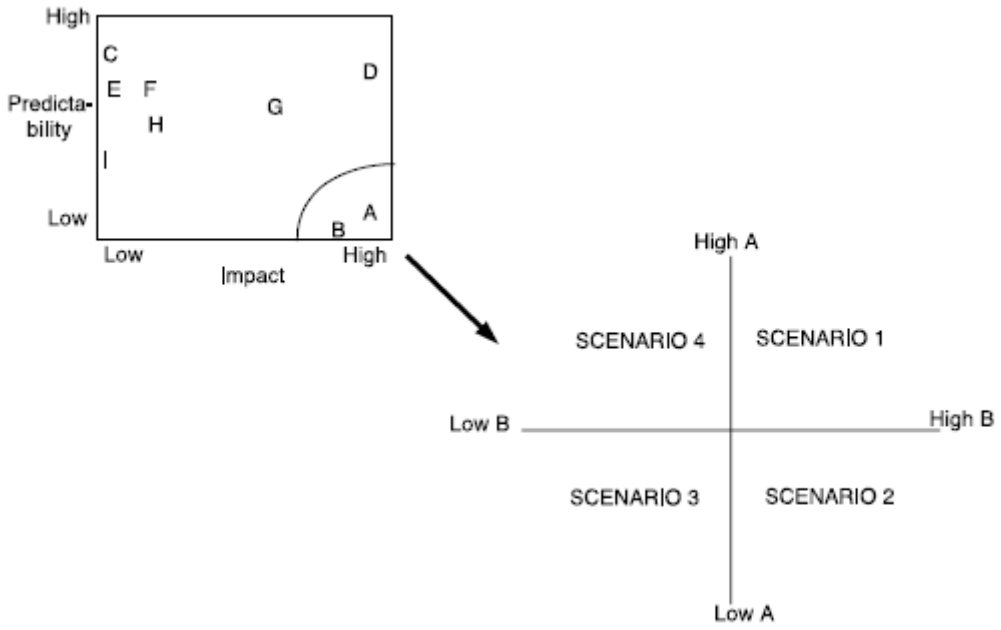

Fig. 3. A possible approach of going from drivers to uncertainties (Postma & Liebl 2005).

Some key points in scenario construction

The most useful scenarios are sharply focused (this section is from Glenn et al. 1999). They focus on critical issues facing the organization or the system. The number of issues for consideration and the number of possible scenarios are almost endless. Without a clear direction, the discussion of drivers is difficult to limit. The number of alternative worlds expands exponentially, and the list of variables can become unworkably long. The best defense is to define the focus from the outset. Ask yourself: "What planning questions need to be addressed? What variables are we most likely to forecast in order to address these concerns?"

Be careful NOT to get caught up too much in the structure of making a logical set of scenarios so that you become prevented from writing potential future conditions that you know have to be addressed. If a scenario is important for decision makers to face, but somehow it does not fit in the scenario space, then write it anyway and add as an extra scenario.

Emphasize qualitative analysis at the start. While numbers and formal models are often valuable sources for understanding future prospects, they can be distracting at the early stages of scenario development. Quantification can be valuable in later stages. Formal models also can provide an effective way of separating the many parts of a complex system for close consideration.

Most futurists advise against finding a "most likely" scenario. The best scenarios reflect many variables and possible turns of events that shape the dynamics of a system under study. Any single scenario that purports to define the most likely particular path through this maze is unlikely. Fortunately, the scenario-building process does not focus on uncovering the "most likely" forecast but, rather, on identifying the range of feasible outcomes.

Writing scenarios is only the beginning. Using them to assess policies is the only way they become useful.

According to Brummel & MacGillivray (online), good scenarios are:

1. Plausible: Are the scenarios believable?
2. Grounded: Are the scenarios linked to events in the past or present?
3. Challenging: Do the scenarios challenge our thinking? Do they expand our mental maps?
4. Relevant: Do the scenarios cast light on the important strategic issues facing the stakeholders?
5. Internally consistent: Are there any contradictions in the scenario logic or scenario outcomes?

Other important aspects to consider, according to Swart et al. (2004):

1. A sufficiently large and diverse group of participants should be included
2. An adequate time for problem definition, knowledge base development, iterative scenario analysis, review and outreach should be set aside
3. Give a full account of available scientific knowledge and rigor of methods
4. Discuss explicitly about any normative scenario elements
5. Develop coherent, engaging stories about the future
6. Explore the possibility of surprise events and address possible seeds of change
7. Place the focal problem in a broader context

Typical pitfalls that may hamper the process and make the product less useful (summarized from Mahmoud et al. 2009; Duinker & Greig 2007; Shoemaker 1998):

1. Lack of diverse inputs
2. Failing to gain early high-level support
3. Unrealistic goals and expectations of the process and product
4. Failure to develop a clear road map. Set clear milestones and deliverables for the process
5. Developing too many scenarios
6. Insufficient time for learning scenarios; learning takes time.
7. Failure to link into the planning process. Scenarios must be relevant or else they will be ignored.
8. Inappropriate time frame and scope
9. Too limited range of outcomes

10. Too much focus on trends

11. Internal inconsistencies in scenarios. Test by asking: 1) are the main trends mutually consistent with each other?, 2) can the outcomes postulated for the various key uncertainties co-exist?, and 3) are the presumed actions of stakeholders compatible with their interests?

12. Insufficient focus on drivers

13. Confusion about roles. Create a core group that keeps the process on track, have others play supporting roles by summarizing key viewpoints etc

14. Not breaking out of the paradigm. Confront conventional wisdoms.

15. Failure to tell a dynamic story. Scenarios should be thought of as a movie and not a snapshot.

5. Discontinuities

A key issue in scenario analyses is dealing with uncertainties. This involves handling surprises, or discontinuities, i.e. sudden shifts, phase changes, crashes, unique events, catastrophes etc. This is no trivial task (see e.g. Ayres 2000, van Notten et al. 2005, Toth 2008 for a deeper discussion).

A discontinuity can be defined as "a temporary or permanent, sometimes unexpected, break in a dominant condition in society" (van Notten et al. 2005). Toth (2008) divides discontinuities ("surprises") into those that are unknown and those that are known, but unexpected. The unknown can be further divided into "out-of-the-blue" surprises and conjecturable surprises. This gives a gradient of difficulties in incorporating discontinuities in scenarios. Out-of-the-blue surprises are, by definition, impossible to incorporate in scenarios, and should serve as recognition that there will always be events and outcomes that are beyond imagination and remain inconceivable until they happen. Conjecturable surprises are a category of changes that no one thought of before, but that appear perfectly conceivable once they are brought to light. They could be incorporated with a good mixture of expert knowledge, imagination, and luck (there are methods for "structured brainstorming" that could be used; Toth 2008). The known, but unexpected surprises are perhaps the easiest to deal with. This could, for instance, deal with cases where the trend or event is expected but the magnitude turns out to be far from expected, or when the risk of a possible sudden change turns out to be higher than expected. However, a concerted effort of looking at drivers, indicators, and trends is still needed to identify or incorporate these surprises.

To examine how scenario studies have addressed discontinuities, van Notten et al. (2005) reviewed 22 different studies conducted after 1985. These were selected from a larger database based on details of documentation, variety of organizational context, and a variety of topics. The results showed that half of the studies did not address discontinuities at all. This omission was due to methodological decisions , a focus on desirable futures, or an assumption that the system is operating in a stable environment. Of the studies that did include discontinuities, several developed scenarios that included an abrupt discontinuous event at the beginning of the scenario which in turn set off a chain of other events. The studies that included discontinuities were all based on narrative, qualitative approaches. Model-based scenarios did not include abrupt changes. The authors concluded that the concept of discontinuities in scenarios is poorly defined, and that the inclusion of discontinuities in scenarios needs to be further developed.

In the words of Ayres (2000): "a formal theory capable of forecasting discontinuities in these domains seems both urgent and distant". However, theoretical developments outside of the scenario literature may be worth examining. For instance, theory on regime shifts and alternative stable states is rapidly emerging within the resilience literature (see e.g. Brock et al. 2008, Sheffer 2009).

6. Strengths and weaknesses

Scenarios are one of the easiest ways to present complex information to decision makers that makes future possibilities seem more real, i.e. they operate as a complexity-reducing device (Aligica 2005). Scenarios are very effective devices dealing with biases of the human mind, such as overconfidence, availability, and anchoring. Overconfidence is reduced by depiction of futures not yet thought of and by challenging those too easily presumed likely. The availability bias means that people tends to undervalue that which is hard to imagine or recall from memory. Finally, scenarios can shift the anchor, or reference, point from which people tend to form their views of the future.

Specific forecasts, whether they are projections of established trends or inspired hypotheses, can provide planners with only one point estimate of these many possibilities. A strength of scenarios is to help develop plans that are viable over the wide range of possible futures—with both plans and a process that manage uncertainty. Scenario-based planning meets this strategic challenge (Glenn et al. 1999). The process of developing scenarios with decision makers helps them to develop anticipatory awareness. Since change continues to accelerate, plans can change. The mind that is able to better anticipate change is more able to manage change. The scenario construction process itself can radically alter the way participating planners think about the future. Optimization against a specific future target is replaced by a balanced evaluation of the range of strategies that may be required. The process changes the planners' perceptions and evaluations of the full range of events and trends that may actually occur. Instead of each possibility being a potential threat to a rigid plan, they tend to be evaluated as sign posts, indicating paths along the way to alternative and anticipated futures.

A weakness of scenarios is that if and when they are given to non-participants, these can then tend to see the scenarios as the "official set of possible futures" and hence, control or limit their thinking to some degree. scenarios have great ability to influence the reader in subtle ways due to the writer's assumptions about cause and effect. The writer's mental model of how the world works is transferred to the reader, and possibly unconsciously accepted. In the struggle to be interesting and the dynamic of the story can make it difficult to include important, but boring details of connecting cause and effect (Glenn et al. 1999).

Although much of the future studies' methodology and ideas have been institutionalized, relatively little documentation, evaluation, and agreement exists about how methods are successful under various conditions and requirements. Futures research and studies have not built on their past in any systematic fashion as have the hard sciences, medicine, and engineering. Futures research and studies do have a body of assumptions that can be tested, edited, and made systematically available for critical evaluation to improve the quality of forecasting in general. However, this is seldom done. Much of the necessary material exists, but in an unorganized fashion spread out through many entities around the world (Glenn et al. 1999).

Some argue that futures research is not a science because it does not have controlled experiments, like physics and chemistry, and because two groups with different values, experiences and knowledge, using the same methods to explore the future of the same subject, will yield different scenarios. However, if should be remembered that the value of scenarios is not whether or not they are "correct" but if they increase awareness of surprises and change. Others argue that it futures research is a science in that it uses and creates systematic bodies of knowledge, and uses methods in a systematic fashion without pre-determining the conclusions. The empirical base of the futures field of knowledge is all sciences, whereas the empirical base of anyone science is only that science's domain. A value of futures research is not in discovering new factual knowledge as the sciences do, but in producing perceptions and insights to that body of knowledge (Glenn et al. 1999). New knowledge is produced through deductive arguments, where two premises with known

epistemic (knowledge) content are put together and lead in a necessary way in conclusion to a changed knowledge situation (Aligica 2005). This is analugous to a mathematical argument leading to "mathematical discoveries". The new knowledge is not factual and empiric, but conditional on the input, and it allows for reconfiguration of information about actors and phenomena in ways that instruct about the situation in question. That in itself is enough to legitimize scenarios as a viable epistemic procedure (Aligica 2005). However, an important task for improving the quality of scenarios is to bolster the scientific credibility (Alcamo 2008). All types of scenarios could achieve a higher level of scientific acceptance if they address the two important keystones of the scientific method – transparency and reproducibility. This could be done by increasing the rigor of definitions and methodology used, to provide documentation of the process or model, and by using a consistent procedure for evaluating scenarios with stakeholders.

Advantages and disadvantages of scenarios

(from Alcamo & Henrichs 2008)

Qualitative scenarios

Advantages:

- The scenarios can incorporate the views of several different stakeholders and experts at the same time
- They can describe a complex system
- Well-written storylines can be an understandable and interesting way of communicating information about the future, at least as compared to dry tables of numbers or confusing graphs

Disadvantages:

- Mental models are used to derive the scenarios, and the assumptions behind these mental models are usually not articulated
- It is difficult to test underlying assumptions of these scenarios
- By definition, these scenarios do not satisfy the possible need for numerical information

Quantitative scenarios

Advantages:

- These scenarios provide the numerical information needed for some environmental studies and assessments
- Sometimes the assumptions behind the scenarios are transparent because their equations, coefficients and inputs can be documented and examined
- These scenarios are often based on models that are already published in the scientific literature and have therefore received some degree of scientific scrutiny
- They can be used to check the consistency of qualitative scenarios

Disadvantages:

- The preciseness of their numbers is sometimes misinterpreted to mean that we know more than we actually do about the future
- These scenarios are commonly based on results of computer models or other calculation schemes which bury many assumptions about the future

- They are often based on models that tend to represent only one point of view about how the world works, and in this way produce scenarios that are likewise narrow in point-of-view
- The basics of modeling are difficult for the non-specialist to understand
- There is a risk of limiting the focus of scenario-based assessments on dynamics that are well understood and for which models exist

Some words of caution on forecasting the future

Accuracy and precision are two separate concepts. (This section is from Gordon & Glenn 1999.) Quantitative forecasts can be very precise, but quite inaccurate, particularly in this age of computers. Forecasts can also be accurate but imprecise, such as: the high likelihood of an earthquake in California.

Extrapolation is bound to be wrong. Simply taking historical trends and extending them into the future is easy, but the projection suggests that nothing new will come along to deflect the trends, that the only forces shaping the future are those that exist in history. Ultimately, even for planets in their orbit, this assumption must be wrong.

Forecasts will be incomplete. Forecasts based on discoveries not yet made are exceedingly difficult to include. For example, who could have forecasted nuclear generated electricity before fission was known? Descriptive forecasts about ESP, antigravity, or a cure for aging are "out on a limb" because no fundamental understanding exists about the phenomena that underlie the forecasts. As Herman Kahn once said, "The most surprising future is one which contains no surprises." This axiom is certainly pertinent to any domain in which change can be rapid and without apparent precedent - for example, politically in the Middle East, and the Persian Gulf, or with respect to terrorist attacks, or in health, the advent of SARS.

Planning must be dynamic. Because of inaccuracies and incompleteness, any plans based on forecasts are subject to error. Therefore, as new information is gained, forecasts should be revised and plans based on those forecasts reviewed. This recognition of the dynamics of planning implies the need for constant scanning of future possibility, developments, and new ideas.

Futures depend on chance. The consequences of developments initially seem unimportant and unconnected but later, through tenuous inter-linkages, become dominant in their effects.

Forecasting is not value free. Beliefs, right or wrong, color one's view of the future. These beliefs may or may not be codified; they also affect questioning about the future as well as the answering.

Accurate forecasts of some complex and nonlinear systems may be impossible. Examples: weather two weeks in advance, the stock market tomorrow, turbulent fluid flow in the next minute, etc.

Forecasts can be self-fulfilling or defeating. By forecasting the possible existence of a new gas cleaning technology, that technology may become more likely. The mechanism is clear enough: others reading about the possibility, work to bring it about. A forecast of famine may make the famine less likely if it triggers action. Thus, forecasting itself can have political consequences. Furthermore, if a self-defeating forecast triggers action to avoid the forecasted problem, then the forecast may have been highly inaccurate, nevertheless, extremely useful.

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