Chapter 11. Scenario Planning

This Chapter begins to focus on the final objective of the study, that is, engaging water supply stakeholders in water futures scenario workshops to develop water scarcity scenarios and to discuss likely water district responses to such scenarios. This chapter first provides an introduction to scenario development or planning. Following the introduction is a review of two recent water district efforts to develop a reasoned approach to alternative futures they may face. This review will help us draw similarities and differences between such efforts and the future scenario approach we followed. The next chapter will detail the process we followed and the results of the workshops.

Introduction to Scenario Planning

Scenario planning allows a community to consider a variety of plausible futures by taking into account the possible interactions among a variety of driving forces in "the socio-ecological system". Scenarios spell out plausible alternative futures and highlight the risks and opportunities associated with each. In contrast to predictive models, in which uncertainty is estimated based on probability distributions of key drivers, scenarios are effective when uncertainty about key interacting drivers is high and we do not know their probability distribution. Scenarios go beyond traditional trend extrapolation by considering hypothetical boundary conditions and using expert knowledge of various kinds to imagine radically different futures. Rather than focusing on the prediction of a single outcome, scenarios consider a large suite of alternative futures.

While the term "scenario" is used throughout science and decision-making, "scenario planning" is a specific method developed originally to assist business managers facing an uncertain and volatile future (Kahn and Wiener, 1967). Since then, scenario planning has been in wide use in business, education, environment, defense and other fields (Chermack, Lynham and Ruona 2001)(Keough and Shanahan 2008).

Scenario planning begins by identifying focal problems or decisions. The next step is to identify a large range of "driving forces." This helps to highlight important and long-term, rather than urgent, dynamics of the system. Driving forces that are predetermined (e.g., the aging of a population) are separated out to reveal the most significant uncertainties, which are then ranked by locally knowledgeable participants to determine what key driving forces are most significant and difficult to know. Based on these results, a preliminary matrix can be constructed along two orthogonal axes representing each uncertainty (Van't Klooster and Van Asselt 2006). The matrix can be used to develop a set of distinct scenarios. Each scenario must then be fleshed out by considering the role of the previously identified driving forces. Plans or decisions, which have already been proposed or are subsequently developed, are then evaluated against each scenarios.

The decisions and plans that are most robust (i.e., perform best under uncertainty) are those that play out acceptably across all scenarios. Those that play out well against only a few scenarios are noted. Each of these steps needs to be undertaken in close consultation with a representative set of officials and stakeholders to ensure that local knowledge is blended with scientific expertise.

Essential Components of Scenarios

Scenarios are built around three essential components:

- drivers or compelling influences;
- relative certainties or inevitable events; and
- key uncertainties elements.

The process of building scenarios starts with looking for compelling influences or major drivers, the forces that affect the outcome of events. Typically, these are characterized by the acronym STEEP, standing for Social, Technological, Economic, Environmental, and Political factors that affect events. STEEP is an alternative framework to SWOT (Strengths, Weaknesses, Opportunities and Threats) for the analysis of external factors in strategic planning. Social factors, for example, include demographic changes. Demographic changes, in turn, can impact a business organization by reducing or increasing labor supply or the demand for certain products. STEEP analysis can also be used to analyze issues of concern to a community, country, or the world, as in the National Intelligence Council's Global Scenarios to 2025 (2008) Demographic changes, such as increasing population will impact energy demand, or an increasingly aging population can impact demand for health services. After identifying and exploring the driving forces, scenario planners must search for the other two components. It is easy to assume that these are three separate and distinct categories, but there are overlaps among them.

Every enterprise is driven by particular strategic factors. Some of them, such as leadership and motivation, are found within the organization. Others, such as economic forces, originate outside. Many factors, particularly external ones, are not immediately obvious. Identifying and assessing these basic factors is one of the objectives of the scenario method. It is also the place to begin building scenarios.

Relative certainties, predetermined elements, or "sure things" do not depend on any particular series of things happening. With driving factors, the events will play out only if the influences continue. An event can be forecast, but not with certainty. But if the event seems virtually certain, no matter which scenario comes to pass, then it is relatively certain.

Key unknown elements exist in every plan. Scenario-planners seek them out to prepare for them. Uncertain elements are intimately related to and sometimes confused with driving factors. Planners identify uncertain elements by questioning their assumptions about "sure things".

Sometimes an inevitable event becomes an uncertain element and upsets a scenario. In the 1970s, forecasters predicted that our national oil reserves would be exhausted by the 1990s. They were right about population growth and an ongoing level of energy consumption, two inevitable events they had identified correctly. But people, organizations, and the nation changed their habits. Vehicles and housing became more energy efficient; and although the nation's oil production peaked, oil companies invested in more expensive extraction methods, and the nation imported more oil.

Driving factors, relative certainties, and key uncertain factors give structure to our exploration of the future.

Scenario Narratives

A scenario describes how certain compelling influences might reasonably behave, based on how those influences have behaved in the past. Of course, the same set of influences might behave in entirely different ways in other narratives. Scenarios usually explore three or four of those alternative ways, based on the narratives that best address the focal issues. Outlining a narrative is usually a team effort. The scenario building team is brought together because they have some understanding of the focal strategy or issue that a decision maker or manager might confront. The team engages in one or more brainstorming exercises to develop a set of initial ideas. These exercises are aimed at answering some key questions, such as:

- What are the driving factors?
- What elements do we think are uncertain?
- What is relatively certain? and finally,
- How about a scenario like ________________? Or _______________? Or ____________?

Note that scenarios often (but not always) come in threes. When business firms examine their future environment, they often construct three very different plausible narratives of what might happen to the American economy within their planning horizon. More and more frequently the "scenario set" includes these three models plus one other. But more than four scenarios tend to be too complex; the team members cannot keep track of their ramifications—to say nothing of the managers, who may become involved only in the late stages.

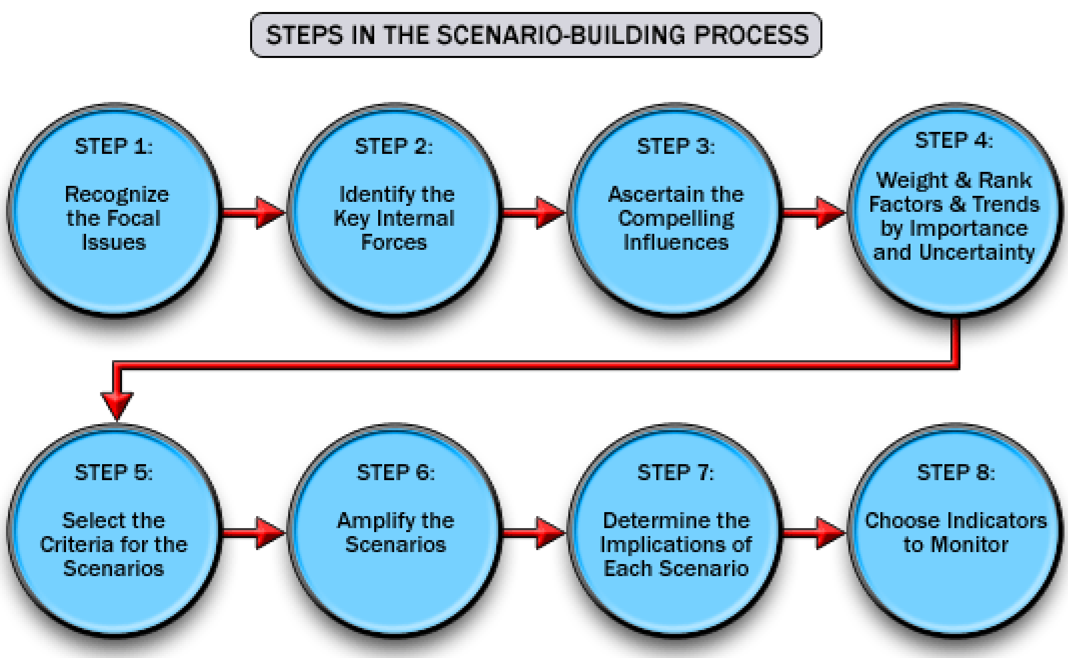
- One is the "more of the same, but better" scenario (not really a "do nothing," but a continuation of present trends with an effort to improve on some aspects). Preparing this kind of scenario resembles some aspects of long-range planning.
- Scenario two is "things are worse" (perhaps even a "disaster").
- The third common model is "fundamentally different and better" (because of some basic changes).

Typically a fourth scenario is a variation of the third scenario type. While the third model might be structurally different, the fourth scenario would depict visionary change.

Steps in Developing Scenarios

Although there are variations in the method for developing scenarios, a main school of thought that grew out of the Shell model of scenario planning characterizes the process as an eight step process, and in line with the process outlined by Peter Schwartz (1991) and Global Business Network, and also known as the Intuitive Logics approach (Chermack, Lynhamm and Ruona 2001). Figure 11.1 identifies the eight major steps in this process. The order of the steps may not be consistent in every case. For example, in some cases, the planner may start with a story line first and ask, "If this narrative plays out this way, what decisions will my managers likely want to take?" But every step is essential, and most scenario-building exercises use this process.

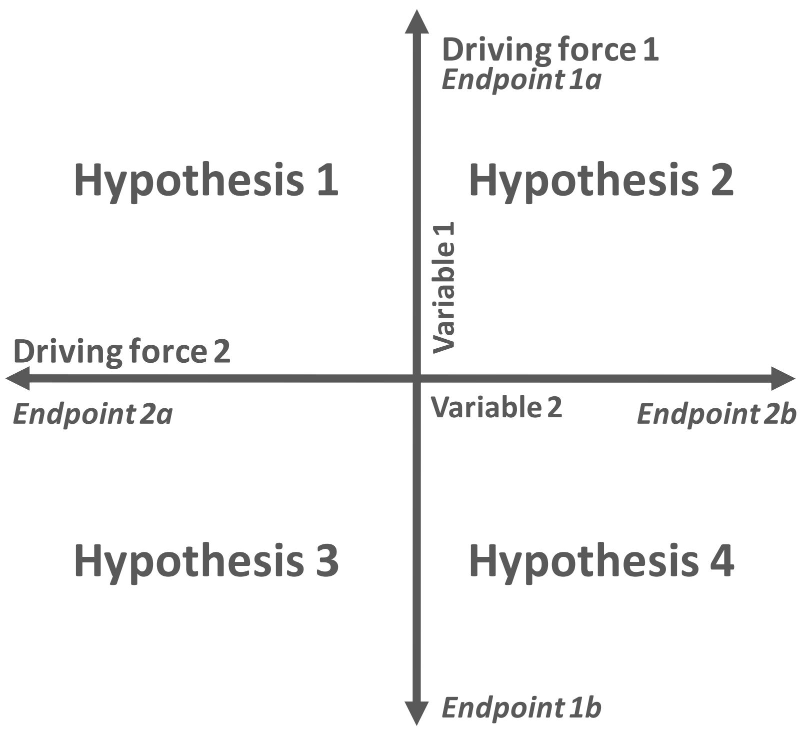
Figure 11.1 Steps in the Scenario-Building Process



Source: Adapted from Peter Schwartz (1991).

The steps in the scenario-building process are: step one, recognize the focal issues or questions; step two, identify the key forces in the local environment; step three, brainstorm the driving factors or compelling influences in the macro-environment; step four, weight and rank key forces (2) and driving factors (3) by importance and uncertainty; step five, select the criteria or general scenario logics according to the matrix drawn in Step 4; step six, amplify or flesh out by returning to (2) and (3); step seven, determine the implications of each scenario; and step eight, choose indicators to monitor the unfolding situation.

Figure 11.2 Scenario Axes as Starting Points for Scenarios



Step 5 in this process is crucial for the development of alternative scenarios. It is at this stage that the two most important and uncertain drivers are selected. These two drivers become the axes that will generate the four scenarios. See Figure 11.2 for a depiction of how the two driving forces are used to generate alternative scenarios.

These 8 steps are focused on the development of plausible scenarios. But the ultimate use of scenarios is to assess the feasibility of existing strategies to meet the challenges posed by the alternative scenarios. We will discuss this further in the next Chapter.

Recent Use of Scenarios in Water Planning in Southern California

Water infrastructure can be costly, has a long life-span, and its implementation can be lengthy. Water agencies often have to plan under uncertain conditions. In this section, we review two examples of how scenarios have been used by two Southern California water agencies in planning for their future. The Inland Empire Utilities Agency (IEUA) chose the Robust Decision Making (RDM) approach to evaluate the actions included in its 2005 Urban Water Management Plan (UWMP), by taking into account a number of possible futures in which climate change figured predominantly. IEUA's approach was based on existing modeling tools, but relies also on the "expert judgment" of the agency's staff and officials to make predictions on future uncertainties. It addressed the uncertainty by multiplying the number of possible futures (450) and by reducing the performance factor to the final cost of water production and of water shortage for the water agency.

To understand alternative future roles that it could play in Southern California's water supply, the Metropolitan Water District of Southern California (MWD) chose to compare the effect of four different bundles of investments in a variety of water sources and water management practices. This approach relied on-in house modeling tools. It addressed the institutional uncertainties of MWD, but does not consider the uncertainties related to climate change.

Robust Decision Making for the Inland Empire Utilities Agency

Similar to a certain extent to scenario planning, Robust Decision Making (RDM) is also a method for reducing uncertainty that "treat[s] uncertainty with multiple, rather than a single, views of the future and evaluates alternative strategies with a robustness, rather than an optimality, criterion"(Lempert and Groves 2010, 961). The method relies on formalized information and existing water system management models, while taking advantage of the computational possibilities of existing software to generate a wide number of possible (not plausible) futures that are than fed to its water system management model.

Lempert & Groves (2010) applied an RDM method to the long term decisions included in IEUA's 2005 UWMP and assessed how the 2005 UWMP would perform under a number of possible future conditions.

At first, the team carried out three preliminary steps:

1. Identify 6 uncertainties that might affect how the plan would perform in the future through interviews with IEUA's planners; the major uncertainties were: as future local climate, future water demand, impact of climate change on imported supply, response of groundwater basin to urbanization, future costs, degree of achievement of management strategies;
2. Define key performance metrics to use in the evaluation: annual water demand, annual supply mix, projected shortages, cost of supplying and treating water and the cost of incurring in shortages.
3. Develop a simulation model for the agency's water management system (in a well known modeling environment), that includes the most relevant characteristics of the system itself: supply sources (precipitations, groundwater, imported and recycled water), demand (indoor, outdoor, agriculture).

Then, the team developed a regionalization or downscaling of the climate models included in the IPCC 4th Assessment Report, that resulted in temperature variations from 2000 to 2003 ranging from a 0.4 °C cooling to a 2.75°C warming and in precipitation variations that ranged from a 27% decrease to a 19% increase. Subsequently they developed estimates on the possible variations of the other uncertainty factors through interviews with local officials and with IEUA staffers and they represented the major uncertainties and the assessment factors in the water management system model. By modeling the effects of the 2005 UWMP, the team highlighted its vulnerability to future climate and regional changes. At this point, new "adaptive strategies", such as improving water use efficiency, expanding the recycled water system and expanding conjunctive uses, were included in the model.

In the second part of the modeling exercise, the research team generated 450 plausible futures by combining the 6 uncertainty factors and evaluated IEUA's management strategy using the water management system model. Through this process the team identified the combination of uncertain factors that would increase IEUS's water costs the most. Subsequently, the team evaluated how adaptive strategies would reduce the agency's costs and found that adaptive strategies such as storm-water capture and conjunctive uses generate the largest costs reductions and reduce future vulnerabilities of water supply.

By comparing the water management system under a wide number of possible futures, the team and IEUA management tested how adaptive water management strategies such as water conservation, storm-water capture and conjunctive uses reduces future water costs and improve water management performances in a wide range of circumstances.

This modeling approach to planning for an uncertain future incorporated several important drivers, characteristics of the agency, and performance measures, and used the existing plans of the agency to assess its vulnerability to key uncertainties in a wide set alternative agency scenarios to engage the agency in an assessment and revision of its plans. Note that the method used has a single agency focus and there is an absence of social and political drivers.

MWD's Integrated Water Resource Plan

Since 1996, the Metropolitan Water District of Southern California (MWD) has been developing Integrated Water Resources Plans (IWRMP) that take into account the diversity of water sources that constitute Southern California's water supply and has committed the agency to a range of investments to maintain its core infrastructure, develop new water sources, and support water recycling, desalination and water conservation.

The planning process, however, had been conducted mainly by projecting demand in the future and optimizing the investments to meet that demand. To update the IWRMP in 2008, the agency initiated a participatory process that involved all the member agencies, elected officials and community groups to collectively discuss strategic directions for the future of water supply in Southern California.

After analyzing the current constraints of Southern California water supply, a wide number of water management strategies, ranging from water conservation, recycling, desalination, up to the construction of a new infrastructure that would render Northern California water conveyance system more reliable, MWD conveyed 4 strategic policy workshops to examine how different mixes of water management strategies and different levels of MWD involvement in these strategies would address the future of water reliability in Southern California more effectively (MWD 2010).

For the purpose of analysis, three different bundles of water management strategies involving MWD, imported water and local resources at different levels were assembled in the following scenarios:

- Current Approach;
- Imported Focus; and
- Enhanced Regional Focus.

Socio-demographic, water management and infrastructure variables (Table 11.1) were projected to 2035 with MWD proprietary Integrated Water Resources Plan Simulation Model (IRPSIM). The model estimates water surplus and shortage and "provides time series and probabilistic outcomes of resource use and regional surplus and shortage conditions in frequency and magnitude" (MWD 2010, 2-32).

Table 11.1 Common variables for comparing strategic policy approaches

Common to all the approaches
Demographic projections
Conservation compliance
Input from Carlsbad desalinator (starts operations in 2012)
Input from local resources as currently projected
CRA is filled at capacity
SWP hardware solution is put in place
MWD can use its 4.9MAF worth of water storage

Source: MWD, 2010

At this point MWD's staff developed investment mixes and implementation timelines for each of the strategic policy alternatives and predicted the magnitude and probability of future shortages as well as costs and rates implications for each alternative for years 2015, 2025 and 2035.

The result of the comparison is illustrated in Table 11.2.

Through this exercise led MWD's board "found that it is in the region's best interest for Metropolitan to continue to explore ways of increasing regional reliability and not limiting itself to singular areas like addressing Delta issues"(MWD 2010, p. 2-41). The agency, however, did not embrace one of the strategic paths discussed through this process, but, as a result of the process, concluded that its future strategy would include the adoption of adaptive management practices, developing its core supplies, diversifying its role in developing local water supplies and playing a catalyst role in regional collaboration.

MWD's scenario exercise was a model-based process which explored different policy strategies that the agency can pursue in the future, including roles focused on securing imported water supply or on securing regional sources of supply, can meet the demand and reliability objectives of the agency.

Table 11.2 Results of the strategic policy alternatives assessment

	• Current Approach	• Imported Focus	• Enhanced Regional Focus #1	• Enhanced Regional Focus #2
Local Supplies	Additional local groundwater recovery or seawater desalination of up to 46,000 AF are implemented beginning in 2015 and increasing to full yield in 2025, accounting for the additional $12 million in Demand Management Programs and decreased sales	Limited investments in local resources	Regional-scale local projects are implemented at 30,000 AF in 2015, increasing to 351,000 AF by 2025, and 463,000 AF by 2035	Regional Scale local projects were initiated in the interim with a implementation of only 40,000 AF in regional project in 2015.
Delta	A Delta fix is implemented in 2022, improving the SWP to yields approximating those estimated prior to the court rulings and Biological Opinions to protect Delta smelt and Chinook salmon	Metropolitan would focus on implementing an interim and a long-term Delta solution to improve the reliability of the SWP, while also improving the reliability of the CRA.	Delta improvements will not be completed by 2035	Delta improvements completed in 2022, improving the SWP to yields approximating those estimated prior to the court rulings and Biological Opinions to protect Delta Smelt and Chinook salmon.
Supply reliability in 2035 with no storage	78%	71%	74%	72%
Supply reliability in 2035 with storage	96%	95%	96%	96%
Shortage magnitude	191,000 AF	191,000 AF	249,000 AF	369,000 AF
Estimated rate in 2035	$1,501 per AF	$1,483 per AF	$2,048 per AF	$1,536 per AF

Both exercises reviewed in this section were single-agency focused and driven by specific models that incorporated much information on supply and demand factors of the respective agencies. They both facilitated discussions among agency stakeholders on the pros and cons of existing plans and alternative strategies. The scenario planning workshops that we conducted for this project followed the scenario planning methodology described in this chapter, including the identification of a broader set of driving forces, and the choice and development of scenario axes that provided the basis for the scenarios developed. We also incorporated multiple agencies and their interests in our workshops.

Findings

Scenario Planning is a Methodology for Long-Range Strategic Planning in Contexts of Uncertainty. Contexts of uncertainty typically involve situations far enough in the future that forecasts and probabilities are not available.

Focal Issues or Decisions Drive the Scenario Development Process. Scenario planning exercises are driven by a policy interest that guides the choice of drivers, and scenario narratives.

Trends and Models Form the Scientific Basis of Scenario Planning. The scientific basis of scenario planning lies in the use of empirical trends and models in the analysis of social, technological, economic, environmental and political drivers.

Choice of Most Important and Uncertain Drivers Form Backbone of Scenarios. The scenario development process typically revolves around the choice of the two most important and uncertain drivers. These two drivers are used to form the axes of a matrix that is used to generate alternative plausible scenarios. Based on the matrix, stakeholders flesh out the scenario narratives.

Ultimate Use of Scenarios: Assessing the Feasibility of Policy Options. Once plausible scenarios are developed, groups of stakeholders can use them to determine the feasibility of available policy options to address the focal issue or decision in the future.

Recent Use of Scenarios by Water Agencies in Southern California. There is an increasing use of scenarios in strategic planning, with many approaches. Two recent uses of scenarios in water management illustrate their increasing use and variation. IEUA's use of robust decision-making provided the agency with a model-based analysis that incorporated several important economic and environmental drivers, including climate change, characteristics of the agency, and performance measures, and used the existing plans of the agency to assess its vulnerability in a large set of alternative agency scenarios. The scenarios were used to engage the agency in an assessment and revision of its plans. In a separate exercise, MWD used another model based approach to generate alternative scenarios for the agency's role which varied from a central role in securing the reliability of imported water, to a central role in securing alternative regional new water supply sources. Through its modeling capacity, MWD was able to develop scenarios for alternative future roles that still ensured the reliability of water supply for the region but at varying costs.

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