IWR Institute for Water Resources

May 2012

Guide to Constructing the Without Project Scenario (Condition)

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Institute for Water Resources

The Institute for Water Resources (IWR) is a Corps of Engineers Field Operating Activity located within the Washington DC National Capital Region (NCR), in Alexandria, Virginia and with satellite centers in New Orleans, LA and Davis, CA. IWR was created in 1969 to analyze and anticipate changing water resources management conditions, and to develop planning methods and analytical tools to address economic, social, institutional, and environmental needs in water resources planning and policy. Since its inception, IWR has been a leader in the development of strategies and tools for planning and executing the Corps water resources planning and water management programs.

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The Institute's Hydrologic Engineering Center (HEC), located in Davis, CA specializes in the development, documentation, training, and application of hydrologic engineering and hydrologic models. IWR's Navigation Data Center (NDC) and its Waterborne Commerce Statistical Center (WCSC) in New Orleans, LA, is the Corps data collection organization for waterborne commerce, vessel characteristics, port facilities, dredging information, and information on navigation locks.

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Section 1: The Short Story

1.1 Introduction

Forecasting the future is an essential part of water resources planning. The most important recurring forecasts in the Corps planning process are the without condition and with condition scenarios. Previously called *conditions* the terminology for these forecasts has been updated to call these conditions scenarios to be consistent with the evolving planning and risk analysis jargon. Decades of experience in the preparation, review and implementation of water resources plans has often revealed the preparation of the without condition scenario to be the single-most critical analytical task in the planning process. This guide focuses on the preparation of the without condition scenario and the forecasts and analysis done within that scenario. Thus, a scenario is the story planners tell about the future. Then they conduct analyses and make forecasts within the framework of that story to flesh out the relevant details of that future and to quantify the story.

The primary audience for the guide is practicing water resources planners. The secondary audience for this guide includes the Corps' interested stakeholders and publics. Its purpose is to explain the nature, use, and preparation of the without condition scenario in the planning process. To do this the guide is organized into seven sections.

This introductory section includes a brief overview of the Corps planning process and its current state of practice to provide a context for understanding the without condition scenario. The short story of this scenario is told and illustrated with an example. The long story is detailed in the remaining sections.

Section Two addresses the uncertainty that confronts planners. It is uncertainty that makes forecasting both difficult and important. A major purpose of the without condition scenario is to identify the uncertainty that is most relevant for solving problems and seizing opportunities that can steer watersheds and communities to more desirable futures. Scenarios have alternative plot lines and dialogues precisely because of uncertainty. This section summarizes the language and concepts of uncertainty that are essential to scenario preparation, forecasting, and analysis in planning.

Section Three discusses scenarios in greater detail. It begins with a general discussion of scenarios and what other planners say about them and proceeds to describe the most common scenarios encountered in the planning process. The without condition scenario is the most important of these scenarios for the purposes of this guide.

Section Four describes an approach for building a without condition scenario. Scenario analysis and scenario comparisons are the topics of Section Five. The with and without condition scenario comparison is the principle idea of this section.

Section Six addresses the manner in which uncertainty can be addressed in the without condition. This includes consideration of uncertain details for a given scenario as well as the use of scenario planning when the scenarios themselves are uncertain. Section Seven provides a summary and a few conclusions.

1.2 Planning in the Corps of Engineers

Planning is an organized effort to anticipate and prepare for the future before it unfolds. When possible, planning influences and shapes the future by prescribing and/or taking actions in the present. Planning is enmeshed in complexity and uncertainty.

We live in an uncertain world. Dealing with the unknown is a challenge. Even in a world of perfect certainty–where we knew the truth of climate change, the price of energy next year, the strength of materials in a structure, the date and time of the next major flood, the outcome of the next election–planning for that future would be a difficult challenge because the world is so complex. We would still have to deal with differing and often conflicting social values. But the world is not certain. We do not know the truth of climate change, or any of these other things.

How many of us foresaw and planned for the dawn of ethanol, containerization of cargo, introduction of an invasive species (Asian Carp), natural disasters (Katrina, Rita), the war on terror, the rise of China, and how many of us have simply reacted? And there are more surprises to come, of that we can be certain. Thus, planning is also standing in the present and peering off into a vast array of uncertain futures that stretch ahead of us for the purpose of choosing the direction that best suits the needs of those for whom we plan. Planning is thinking carefully about the future and how best to get there from the present. It is acting on that thought process to shape the most desirable future. Done well it empowers us to choose a better future.

A Scenario Is Not…

A scenario is not a bundle of analytical results and forecasts. The most likely alternative future is not the sum total of all the best estimates of the variables and conditions of interest. Scenarios do not consist of a series of model run results.

Thus, the without condition is a not an HEC2 run(or any other analysis) assuming no protective works are present. The without condition identifies what we know and what we don't know about the future and it structures a view of the uncertain future in a simple story form. It is a narrative description of what the future could be if the planning partnership takes no action to intervene. The HEC2 run is then done consistent with the without condition scenario. It is analyses done within the scenario framework.

We describe the present and envision the future through the use of scenarios. Scenarios are the stories we tell about conditions found or anticipated in our planning investigations. They are narratives. Think of them as you might a newspaper article. A scenario is not so much a specific prediction as a cause and effect narrative that describes future water and related land resources conditions relevant to decision makers.

In practice, water resource planners contrast undesirable scenarios of the future, i.e., what could happen if we take no deliberative action, with visions of a more desirable future scenario. In the Corps' jargon this is the without and with condition comparison. Constructing future scenarios is a critical and challenging task, because the future is unknown and the futures we describe are complex.

The Oxford English Dictionary describes scenario as "an Italian term, meaning a sketch of the scenes and main points of an opera libretto, drawn up and settled preliminary to filling in the detail." It is, then, in a sense a synopsis of a play. Planning scenarios can be used to describe the present or the past. They are most often used to describe possible futures. The without condition scenario is a synopsis of the study area in the future if the planning partners decide to take no action to intervene in the course of future events. Just as the synopsis of a play is brought to life by the details of dialogue and action, a planning scenario is brought to life by the analytical details of the scenario. Once a planning scenario is constructed it is then quantified through the analysis of the problems, opportunities, objectives, and constraints identified earlier in the planning process.

The Corps' planning process is summarized in Figure 1.1. The Principles and Guidelines (1983) specific a six-step planning process as seen in the figure[1]. Rectangles identify planning steps that are primarily process tasks; the parallelograms are primarily data and analysis tasks, while the diamond is principally a decision task. Although iterations of this process can occur in every imaginable way the heavy arrows indicate the usual linear direction of the process. The lighter arrows indicate the more common iterations.

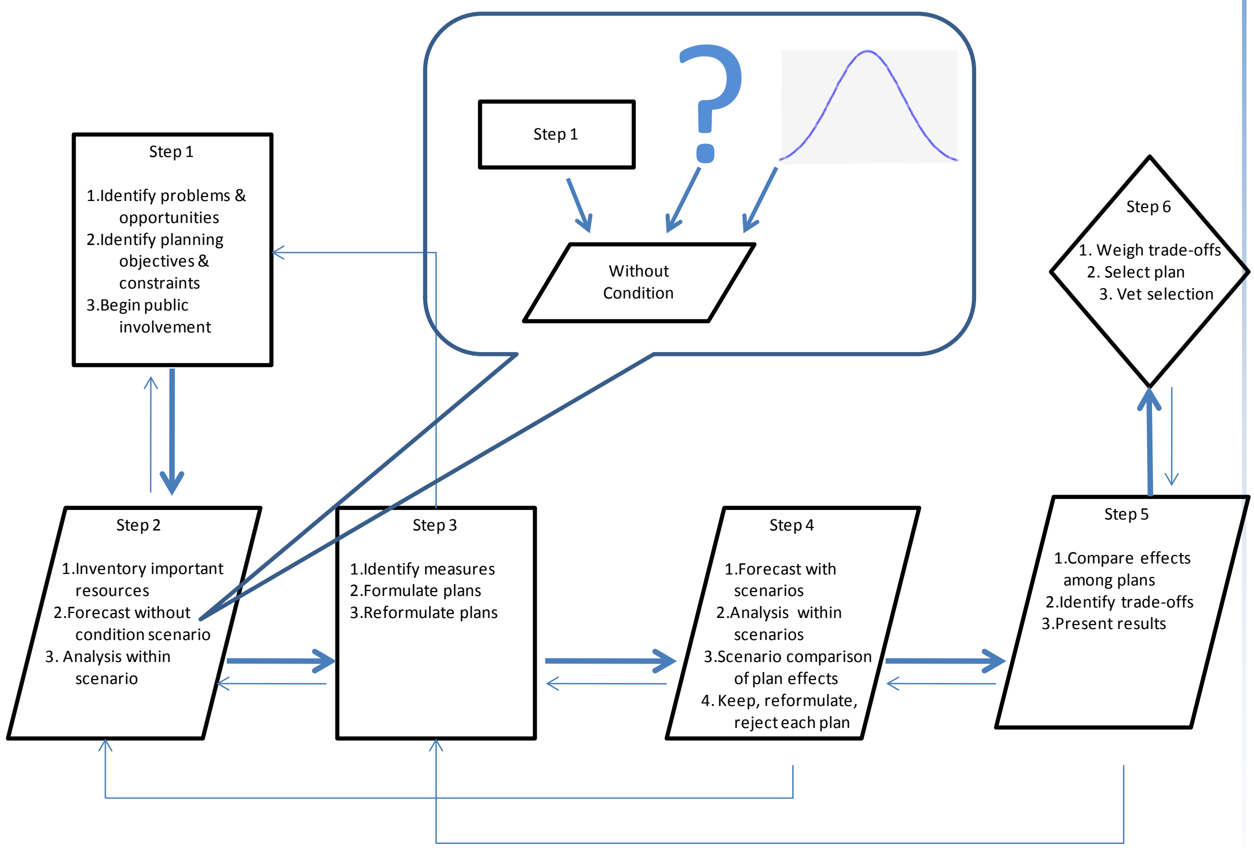

Figure 1.1: The Corps' Planning Process and the Without Condition Scenario

The callout shows that building the without condition scenario is part of Step Two, the inventory and forecast conditions step. The without condition scenario is most heavily influenced by the decision context established in the first planning step. Verifying the existence of the problems and opportunities and quantifying the without condition scenario are the principle reasons for data collection and analysis at this stage of the planning process.

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[1] At the time of this writing the Secretary of the Army has been directed by Section 2031 of the Water Resources Development Act of 2007 to revise the Principles and Guidelines. Thus, this planning model could be revised at some point in the near future. Those interested in more information about this planning process are directed to the *Planning Manual* (1996).

The without condition describes the problems and opportunities in the future as well as the conditions surrounding the values, resources, and conditions reflected in the planning objectives and constraints. Other significant influences on the without condition, shown in the figure, are knowledge uncertainty (?) and natural variability (the distribution). For the moment let us call both these things uncertainty. Uncertainty is the reason we use scenarios. If there was no uncertainty we would use simple analysis to describe what will be.

The without condition, developed in Step Two, goes a long way toward providing the basis for formulating plans in the third step. Planners formulate plans to steer away from undesirable conditions in the without condition scenario and toward more desirable with condition scenarios. In the evaluation step (4) the without condition scenario is compared to a separate with condition scenario for each plan formulated. The results of that evaluation are compared in Step Five and the results of that comparison normally form the basis for selecting a plan in the sixth and final step. Consequently, the without condition scenario plays a cornerstone role in the planning process.

Uncertainty makes scenario descriptions challenging to prepare. Ordinarily, the planning process proceeds by identifying a single most likely without condition scenario. When the uncertainty encountered in the planning process is large and significant it may be impossible to designate any one possible future as the most likely one. If this happens a set of without condition scenarios may be needed. In the more common circumstances the basic without condition scenario is reasonably well understood but there can be substantial uncertainty about specific details of that scenario. The former situation, with uncertain scenarios, is best served by scenario planning. The latter situation, with uncertain details within a scenario, is best served through risk analysis, which is designed for decision making under uncertainty.

Once a scenario is constructed, planning analysts use the structure of the scenario to frame their analyses. The hydraulics and hydrology, the economics, the environmental science, the real estate, civil engineering, cost estimation and all other investigations and analyses are conducted within the framework of the scenario, which has challenged us to consider all the relevant uncertainties we face in the planning investigation.

1.3 A Simple Example

To anticipate the discussion in the later sections consider the following hypothetical existing scenario for a flood risk management problem in a small East Coast town shown in Figure 1.2. The river runs north and south and is seen on the right side of the figure in the lightened flood plain. Consider the following description of the area.

Figure 1.2: Elliott City Floodplain

Elliott City was founded in the late 18th century and is home to several original buildings, many of which are built on or incorporate natural rock features in their architecture. Its business district has experienced a revival in recent years and consists of day tourist shops, taverns and restaurants at the street level. It is home to 500 or so full-time and part-time jobs. Upper levels of the buildings that line Main Street (perpendicular to the stream) are apartments usually for shop owners and younger renters. There are only three side streets which climb steeply upward from the Main Street.

There are seven structures on the National Historic Register and many more of local importance culturally, including many unique old public buildings. Elliot City was the terminus for the famous race between a train, Ignatius Index, and a horse drawn cart. There are no longer any resources of environmental significance in the town proper. The town is located within one of the Nation's wealthiest counties.

The small town is subjected to flooding from two sources. Town Creek is a local drainage area of two square miles. It floods frequently with low elevations that disrupt traffic flow and affect a small number of houses. The town is also flooded by 38 square miles of the Patapscohon River drainage basin. This river caused major flooding seven times in the last century and once in this one. There have been incidents of coincident flooding from both sources. The Patapscohon River runs through a state park system that stretches upstream and downstream of the town. The Town Creek watershed is as developed as it is ever likely to be. Upstream development is possible in the Patapscohon drainage area.

Note that there are few details. The details will be provided in the analysis of the flood problem. For example, to estimate expected annual flood damages it will be necessary to inventory the elevations of the flood plain development and to measure the cross sections of the waterways. A flow-frequency curve must be estimated and an inventory of structures and their flood damage potential is necessary. A sophisticated hydro-economic model will be used to combine much of these data in order to calculate expected annual damages. Numerous sources of uncertainty will be encountered along the way. This is all part of the work of describing present conditions, which verify the existence of problems and opportunities for gain.

The point to be taken here is that the scenario is the basic narrative description, it is as factual as possible but it is not detailed. The details follow in the analysis. All the analyses are consistent with the framework or structure provided by the scenario.

Once a scenario is devised planners move into that scenario and live within in, conducting the necessary technical work to produce the desired detailed information. As the scenario changes the analyses will change as well. It is by comparing the results of these analyses across different scenarios that significant impacts of plans are identified.

Now, consider the without project scenario, suspending for now the how to do it questions that may arise as you read this. What does the future of Elliott City look like if the planning partners take no action to address its flood risk? The basic approach is to separate what we know, much of which is detailed in the inventory of existing problem/opportunity/resource conditions, from what we do not know, i.e., the key uncertainties.

Imagine the two key uncertainties for the Elliott City flood risk management problem are the conditions of the economy and the economy's effects on the Patapscohon's hydraulics and hydrology (H&H) via upstream land development. How will the economy behave in the years ahead? Will it be a discretionary income tourist friendly world or not? Will the historic tourist town flourish with occupied stores filled with high end antiques and trendy restaurants or will tattoo parlors and fortune tellers take up the spaces between empty storefronts?

How much upstream development will take place? Will the county continue to build high density homes upstream or McMansions? How will new development affect the H&H? Just these several questions sketch plotlines of scenarios that range from increased runoff with denser economic development and more valuable property at risk of flooding to no change in the flood problem and a declining damageable property base, with every possible permutation in between these extremes. What do planners assume when constructing their without condition scenario?

It is not difficult to imagine how the scenarios might twist and turn if we consider a few more uncertain circumstances. Suppose an upstream reservoir was authorized in the past but its construction is uncertain due to lack of funding and opposition from Mallards Unlimited. If the economy turns for the worse this is a shovel-ready project and that could override environmental concerns if the Federal government seeks to stimulate the economy through public works projects. Throw in a citizens' group that is advocating that this very wealthy county take its own actions to manage the watershed, and it is easy to see the challenge of telling a coherent and honest story about this study area.

Here is the point to understand. The without condition scenario focuses on this big picture level of storytelling. In this instance, the without condition is the basic story we will tell about the future of Elliott City. The details and the analyses come later when we quantify the scenario.

Expected Annual Damages (EAD) are an important part of a flood risk management analysis. What will EAD look like in the future? Well, that depends; does it not? If the economy is booming, there is a lot of high value property at risk in the flood plain, and upstream development is intense we can expect EAD to rise. On the other hand, if the economy grows slowly or declines the town could be effectively abandoned as a tourist destination and if the upstream reservoir is built we would expected EAD to fall. The details of the EAD calculation will depend on the without condition scenario. If there is insufficient evidence to determine a single scenario, multiple calculations may have to be performed.

Once a scenario is devised, it is time for the planners to place themselves conceptually within that scenario and make the necessary specific forecasts (e.g., population and income growth and land use forecasts) and conduct the important analyses (e.g., future H&H analysis and EAD calculations). In many studies when the scenarios do not vary drastically from one another it is both possible and desirable to identify one scenario as most representative of the future, as long as the important differences that arise due to uncertainty are not ignored. These differences among the possible futures can, at times, be handled by alternative forecasts of a few key variables, e.g. consider high, medium and low land use development forecasts. This can be done appropriately within a sensitivity analysis. When the uncertainty is great and planners cannot legitimately identify one scenario as the most representative then scenario planning may be most effective.

The without condition(s) is the one (set of) scenario(s) that is used in the evaluation of every alternative plan. It is the one common element in all planning evaluation, and, consequently, in all comparison and selection tasks. An error in the without condition(s) will be reflected in the evaluation of every plan and it will carry through the decision-making process. It is essential to the success of the planning process to carefully develop a realistic, credible and science-based (set of) without condition scenario(s) in every planning study.

1.4 Summary and Look Forward

Planning is standing in the present and trying to choose a more favorable future for society. Planning is always conducted under conditions of uncertainty. The Corps currently follows a six-step planning process that relies heavily on the use of scenarios. Constructing the without condition scenario is generally regarded as one of the most critical tasks in the planning process.

The without condition scenario is a narrative description of the significant water and related land resources conditions and their impacts that could exist if the planning partnership takes no action. In best practice all scenarios are constructed after careful consideration of what is known and what is not known about the future. When most alternative futures are relatively similar, differing only in the details, some of which may be significant, it both possible and desirable to use a single most likely without condition scenario. Uncertainties in such a scenario can be explored using sensitivity analysis and other risk-based analytical techniques in the analyses done within the framework of that scenario. When uncertainties are so great as to produce significantly different future scenarios (e.g., sea level rise with economic prosperity vs. no sea level rise with economic decline) it is not reasonable to single out one scenario as most likely. In these instances scenario planning with multiple without condition scenarios may be advisable.

A simple example of a without condition narrative was provided to aid the distinction between a scenario and the analysis that is subsequently done to quantify the scenario. A scenario is not a collection of best guess analyses bundled together. The analyses do not drive the scenario construction, scenario construction drives the analyses.

Uncertainty is the sole reason planners use scenarios. Absent uncertainty planners would simply describe the future and calculate knowable values. Thus, uncertainty is the root cause for much of planning's complexity. Section Two is devoted to developing an understanding of uncertainty in the planning environment. We will look at how uncertainty affects planning at both the macro- and micro-levels. The primary focus of the next section is being honest about what we do and do not know when preparing without condition (and other) scenarios

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Section 2: Uncertainty

2.1 Introduction

If there was no uncertainty there would be no question about whether or when a flood, storm or infrastructure loss would occur and how big it would be. Likewise, we would always know how an opportunity would turn out. We'd know the future fleets, their drafts, and the cost savings that would result from a deeper channel. We could calculate everything with precision and make rational decisions. Planning would be a lot easier.

Our world is uncertain. When we are not sure we are uncertain. Uncertainty arises at two fundamentally different levels in a planning study. First, there is the macro-level of uncertainty. Planning takes place in a complex, changing and uncertain decision environment. Second, there is the micro-level of uncertainty. This is the uncertainty that concerns specific scenarios, models, variables, relationships and situations in a planning investigation. Each level is discussed in turn below.

2.2 Uncertainty at the Macro-Level

Characterizing future social values, especially changing values, for planning scenarios is especially difficult. Growing social complexity and an increasingly rapid pace of change are normal parts of the planning landscape and they contribute a great deal to the uncertain environment in which planners operate. The world grows more complex. Think of complexity in a social sense. It refers to such things as the size of a society, the number of its parts, the distinctiveness of those parts, the variety of specialized social roles that it incorporates, the number of distinct social personalities present, and the variety of mechanisms for organizing these into a coherent, functioning whole. Augmenting any of these dimensions increases the complexity of a society (Tainter, 1996).

For over 99 percent of human history we lived as low-density foragers or farmers in egalitarian communities of no more than a few dozen persons with even fewer distinct social roles. In the 21st century we live in societies with millions of different roles and personalities. Social networking, for example, is fundamentally altering the ways we communicate. Our social systems grow so complex they defy understanding. Consequently, our systems of problem solving have developed greater complexity.

We face an increasingly rapid pace of change in almost every arena. Scientific breakthroughs make things, once impossible to conceive, commonplace. Much of this change is driven by rapid advances in technology. Technology changes social values and beliefs as well as the way we live and work. The level of complexity in our social, economic, and technological systems is increasing to a point that is too turbulent and rapidly changing to be wholly understood or predicted by human beings.

Although most of us live and work in nations our interactions and our problems are increasingly global in nature. We see rapid increases in social, economic, and technological connectivity taking place around the world. Social movements, e.g., environmentalists, women's rights, opposition to the WTO and the like are global in their pervasiveness. We are increasingly a global economy. Fashions are designed in New York, approved in London, patterns are cut in Honk Kong, clothes are made in Taiwan, and sold in Europe and North America. A computer virus spreads around the world in hours. A human virus spreads in weeks or months.

Relentless pressure on costs is now a fixture in all public decision making. Patterns of competition are becoming unpredictable. We see quickly increasing and diversified public demands. We have entered a world where irreversible consequences, unlimited in time and space are now possible. Decades after the accident at Chernobyl some of the victims have not even been born yet. Many of the wicked problems[2] planners face can have a long latency period. Landscape scale ecosystem restoration problems like those in the Florida Everglades, Coastal Louisiana, and the Columbia River basin, as well as global concerns like greenhouse gases and climate change provide clear examples of problems that took decades to emerge and be recognized. The implications of the solutions being formulated may similarly take decades to be understood.

Despite the world's rapid advances in all kinds of sciences we are increasingly dominated by public perception. One result is that possibility is often accorded the same significance as existence in the public's view. Facts are not always more convincing than feelings. Responsibility in this more connected world has become less clear. It becomes increasingly difficult to affix responsibility for problems and their solutions. Who is destroying the ozone, causing global warming, or polluting local resources? Who has to prove what? What constitutes proof under conditions of uncertainty? What norms of accountability are being used? Who is responsible morally? And who is responsible for paying the costs? These questions plague decision makers nationally and transnationally.

We all live and operate in this uncertain reality. Yet many organizations and individuals cling stubbornly to a deterministic approach to decision-making that belies the experience of public and private sectors the world over. Planning needs a *culture of uncertainty*. The future is fundamentally unknowable. There must be recognition of the central importance of demonstrating the collective will to act responsibly and accountably with regard to our efforts to grapple with this fundamental uncertainty and the inevitable losses that will occur despite every best effort to account for it. In an uncertain world we cannot know everything and we will make mistakes despite our best efforts to the contrary. Social values satisfied by one decision can quickly fall prey to criticism as values continue to evolve. This is the challenge that planners must confront at the macro-level of their jobs.

2.3 Uncertainty at the Micro-Level

Think of part of the planner's job as separating what we know from what we do not know (see Figure 2.1). There are always things we know with certainty. We can measure distances, identify plant and animal species, define the geology of an area, our physical world is loaded with facts. Nonetheless, every planning investigation comes with a *pile* of things we do not know.

[2] Wicked problems are complex problems that lack right and wrong solutions. Instead there are many candidate solutions and some are better and some are worse than others.

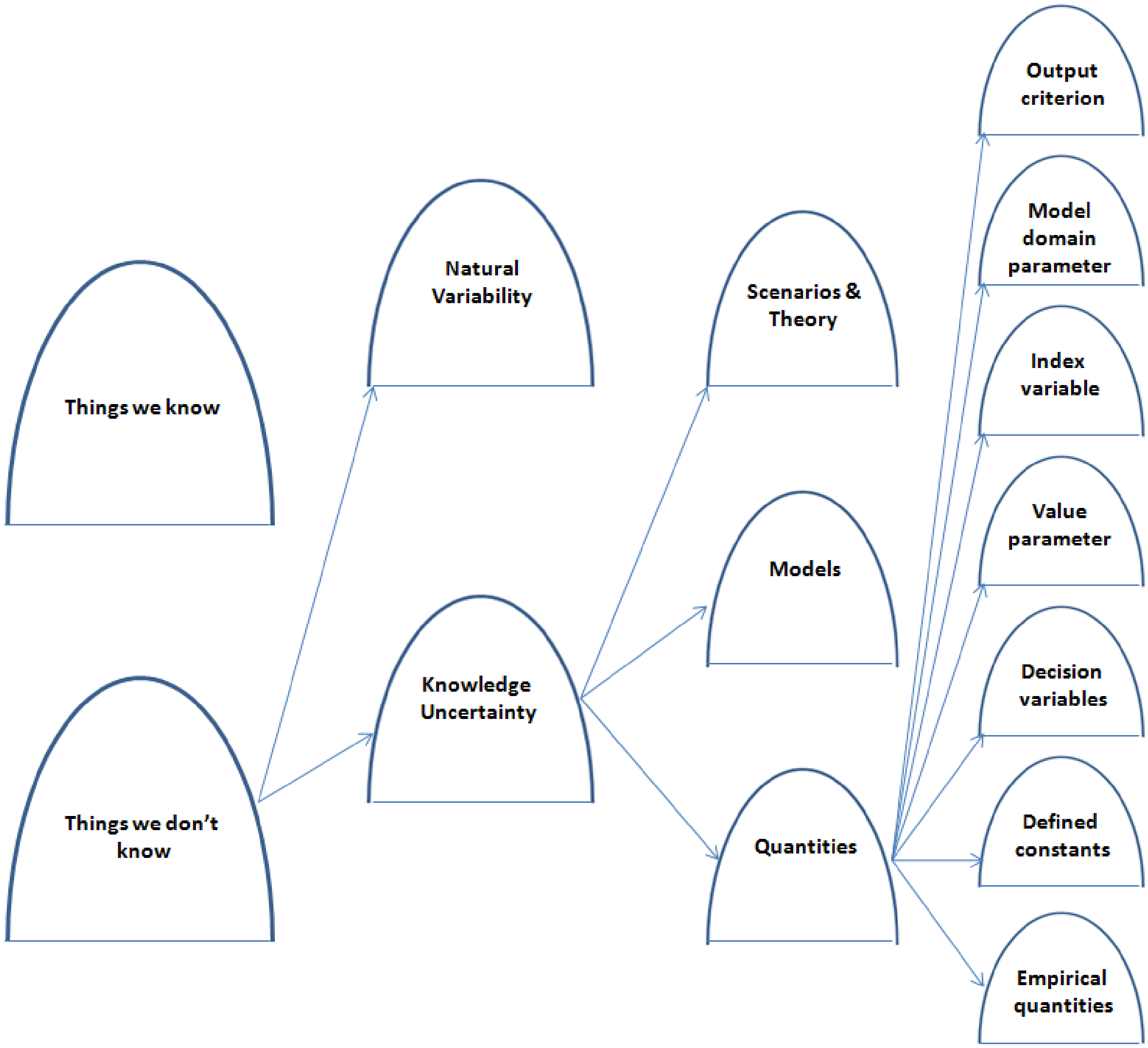


Figure 2.1: Separating What We Know From What We Do Not Know then Sorting Out Why and What We Do Not Know

When we start a planning study the pile of things we do not know can be quite large, at times larger than the pile of things we know. As we come to understand problems, opportunities, objectives, constraints and the like through the planning process and then start to gather data and do some analysis we systematically begin to learn things. This reduces the size of the pile of things we do not know while it grows the pile of things we do know.

One thing we know with absolute certainty is that the pile of unknowns never disappears. There will always be things we do not know. Two basic kinds of uncertainty can be defined for the purposes of this discussion.

At the micro-level of uncertainty the planner's job is to identify what is in the pile of things we do not know so that planners can discern what uncertainty is important for decision making. Now let us sort the original pile of things we do not know into two piles with distinct reasons for not knowing, call them natural variability and knowledge uncertainty. Knowledge uncertainty is, in turn, divided into three main piles: scenarios and theory, models, and quantities. The quantities are in turn separated into types of quantities first proposed by Morgan and Henrion (1990). The purpose of this conceptual sorting is to better understand the nature of our knowledge uncertainty. We have different tool and techniques and some are more appropriate for one source of uncertainty than another.

Now let us distinguish between knowledge uncertainty and variability. It is an important distinction to understand. Imagine you are looking for ways to improve fish habitat on a stream. One of the first things you may be interested in knowing is the mean high daily summer water temperature on the stream. This value is a parameter, a constant, with a true and factual value. If you begin with no information about the stream you do not know this fact and that makes the situation one of uncertainty. Suppose you speak to local resource agency personnel and learn they do have data that shows this value is 25°C. The uncertainty has been reduced.

A new problem now emerges. Even though you know the mean high daily temperature is 25°C you have no way of knowing what the high temperature will be on any given day. In fact, you wisely expect the high temperature to vary from day to day. The high temperature tomorrow is uncertain but for a very specific, common and recurring reason; there is natural variability in the universe. Hence, we would say you are no longer uncertain about the mean high daily temperature but you still do not know the high temperature on any given day because of natural variability. The temperature varies from day-to-day due to variation in the complex system that produces a high temperature each day. For more formal definitions of these two concepts we introduce the terms epistemic and aleatory uncertainty.

Epistemic uncertainty is the uncertainty attributed to a lack of knowledge on the part of the observer. It is intrinsic to the observer. It is reducible in principle, although it may be difficult or expensive to do so. Epistemic uncertainty, also known as knowledge uncertainty, arises from incomplete theory, incomplete understanding of a system, modeling limitations and/or limited data. Some generic examples of knowledge uncertainty include: lack of data about natural conditions in a study area, poor understanding of the linkages between inputs (water quality) and outputs (habitat) in a system, and thinking an area has had five significant floods but being unsure of that.

Aleatory uncertainty is uncertainty that deals with the inherent variability in the physical world. Variability is often attributed to a random process that produces natural variability of a quantity over time (e.g., rainfall) and/or space (e.g., soil types) or among members of a population (e.g., income). It can arise because of natural, unpredictable variation in the performance of the system under study. It is, in principle, irreducible. In other words, the variability cannot be altered by obtaining more information, although one's characterization of that variability might change given additional information. The term adopted for usage in this guide is natural variability. Some generic examples of natural variability include: variation in the size of an adult whitetail deer, variation in the response of an ecosystem to a change in the physical environment, and variation in peak annual flows on a stream.

Sometimes it will be convenient to use the term uncertainty to encompass both knowledge uncertainty and natural variability. That is the convention adopted in this guide. However, this is by no means the usual convention and the reader is advised to always clarify, when possible, and to try to carefully discern, when it is not, what the user of these terms means from the context of their usage.

The reason for paying so much attention to uncertainty is that scenario forecasts depend on how we resolve issues of uncertainty. This is important because the things we do not know may make a difference to how we decide an issue. To consider the types and sources of uncertainty planners are most likely to encounter see Figure 2.2 that depicts a conceptual risk to an ecosystem.

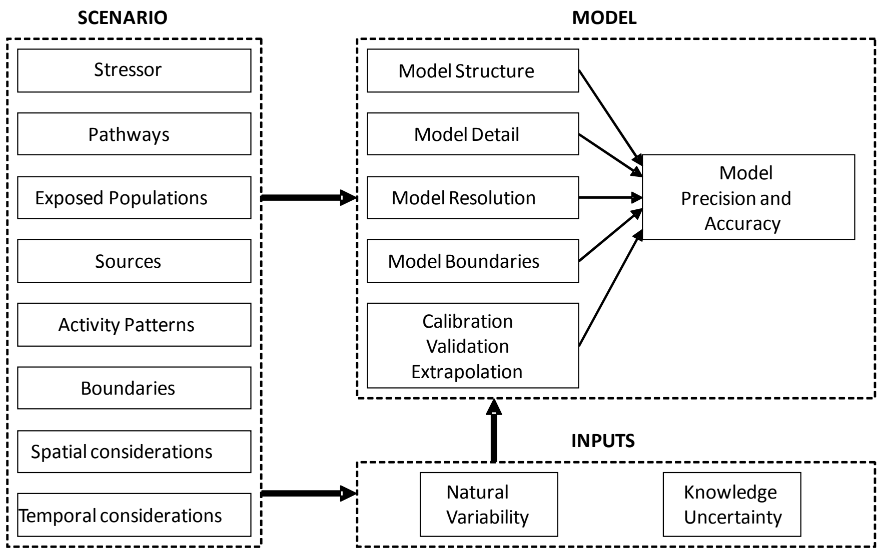


Figure 2.2: Common Categories of Knowledge Uncertainty

In general, natural variability will apply to input quantities only. Knowledge uncertainty is more complex. So far we have been thinking of scenarios as the stories we tell about the present or future. Scenarios can also be used to tell smaller stories. We can, for example, offer a scenario for why navigation tonnage will increase if we deepen a channel. We can develop a scenario to explain the disappearance of the mottled duck from a marsh area. This is where theory and knowledge of processes are most important. Models are used to give structure to and to perform calculations for the scenarios based on the inputs provided.

Scenario uncertainty results when the elements of a scenario or their relationships are unknown or incomplete. Gaps in theory and understanding are most likely to occur in the stories we tell about what can go wrong, how it happens, how likely it is to happen and the consequences of it happening.

In the case of an ecosystem scenario we might misunderstand the stressors that affect a habitat. Not knowing the relevant activity patterns of a locally threatened species could be another source of scenario uncertainty. We may also fail to understand all the relevant pathways in an ecosystem.

Model uncertainty reflects the bias or imprecision associated with compromises made or lack of adequate knowledge in specifying the structure and calibration (parameter estimation) of a model. Model structure typically refers to the set of equations or other functional relationships that comprise the specified scenario for the model. Model detail refers to the inclusion or omission of specific phenomena as well as the simplicity or complexity with which they are represented. Model resolution refers to the temporal or spatial scale at which information can be distinguished e.g., minutes vs. hours vs. years. Model boundaries describe the fidelity with which the desired scenario is captured by the model. Ideally the precision and accuracy of the model predictions will be assessed as part of the model validation exercise. In other words, how well does our model capture reality?

Quantity or input uncertainty is encountered when the appropriate or true values of quantities are not known (knowledge uncertainty). These quantities are of enough importance to warrant additional discussion. That discussion will briefly revisit natural variability.

Quantity uncertainty can include both natural variability and knowledge uncertainty. Some quantities have a true or factual value others do not. Instead they have a best value or a most appropriate value that reflects some subjective judgment. Morgan and Henrion's (1990) classification of uncertain quantities is useful here and is summarized below.

Empirical quantities are the most common quantities encountered in a planning investigation and they have a true value. They have exact values that may be unknown but are measurable in principle (although it may be difficult to do so in practice). Examples include stream flows, wildlife population sizes, distances between things, the time it takes for something to happen, the value of a house, the draft of a vessel, water temperature, and so on.

Defined constants have a true value, but they may not be known to the planner. For example, there are 43,560 square feet in one acre, 325,851 gallons of water in one acre-foot, 11 counties in the watershed, and 28 berths in the port. These constants are not uncertain but the planners may not know them. These are simple matters of knowledge uncertainty that can be resolved by consulting references or experts.

Decision makers exercise direct control over decision variables, they have no true value. This is a quantity which someone must choose or decide. That person may or may not be a member of the planning team, depending on the nature of the variable. Decision variable values are sometimes set by decision makers external to the planning process. Examples include mitigation goals for specific resources, water quality standards, determination of a tolerable level of risk or an appropriate level of protection, reasonable cost and the like.

Value parameters represent aspects of decision makers' preferences; they also have no true value. They are subjective assessments of social values that can describe the values or preferences of stakeholders, planners, or other decision makers. Examples include the value of a statistical life, the discount rate, user-day values for recreation, and weights assigned to criteria in a decision analysis.

Index variables identify elements of a model or locations within spatial and temporal domains; they may or may not have a true value. A point in time can be referenced as a time step in a model or a grid cell can be referenced using coordinates. If a very specific point in time or place in space are desired, there is a true value. Random or representative choices of index variables do not have true values. Examples of these include a specific year in a multi-year model, the location of a grid cell in a geographic model.

Model domain parameters specify and define the scope of the system modeled in a planning study. These parameters describe the geographic, temporal and conceptual boundaries (domain) of a model. They define the resolution of its inputs and outputs; they may or may not have true values. Scale characteristics are chosen by the modeler and most often have no true value in nature. They reflect judgments regarding the model domain and the resolution needed to address planning objectives adequately. Some investigations, however, may be restricted to specific resources, towns, timeframes and so forth. These may have true values. Uncertainty about domain parameters could also be considered a form of model uncertainty. Examples include the definitions of the study area, planning horizon, climate range, industry segment and so on.

Outcome criteria are output variables used to rank or measure the desirability of possible model outcomes. Their values are determined by the input quantities and the models that use them. Uncertainty in these values is evaluated by propagating uncertainty from the input variables to the output variables using one of several different methods. Examples can include things like the benefit-cost ratio, habitat units, and the probability of an event.

2.4 Uncertainty and the Future

Planners make strategic decisions and they can be the most difficult to make. They involve longer time frames and more uncertainty. Figure 2.3 conceptually illustrates how the importance of uncertainty increases as the time frame grows longer. When making decisions in the present the influence of uncertainty is not as significant as it is in the future. We are more capable of forecasting the number of floods over the next week than we are the next three years or the next 50 years. Near term forecasts for water resources planning may be hours or days, e.g., forecasting a flood crest or the movement of an oil spill plume. Short term forecasts may cover a period of months. The mid or medium term is a strategic planning period, typically 3 to 5 years but perhaps as many as ten. Long term is more than ten up to 25 years or so. A time period over 25 years is extremely long term.

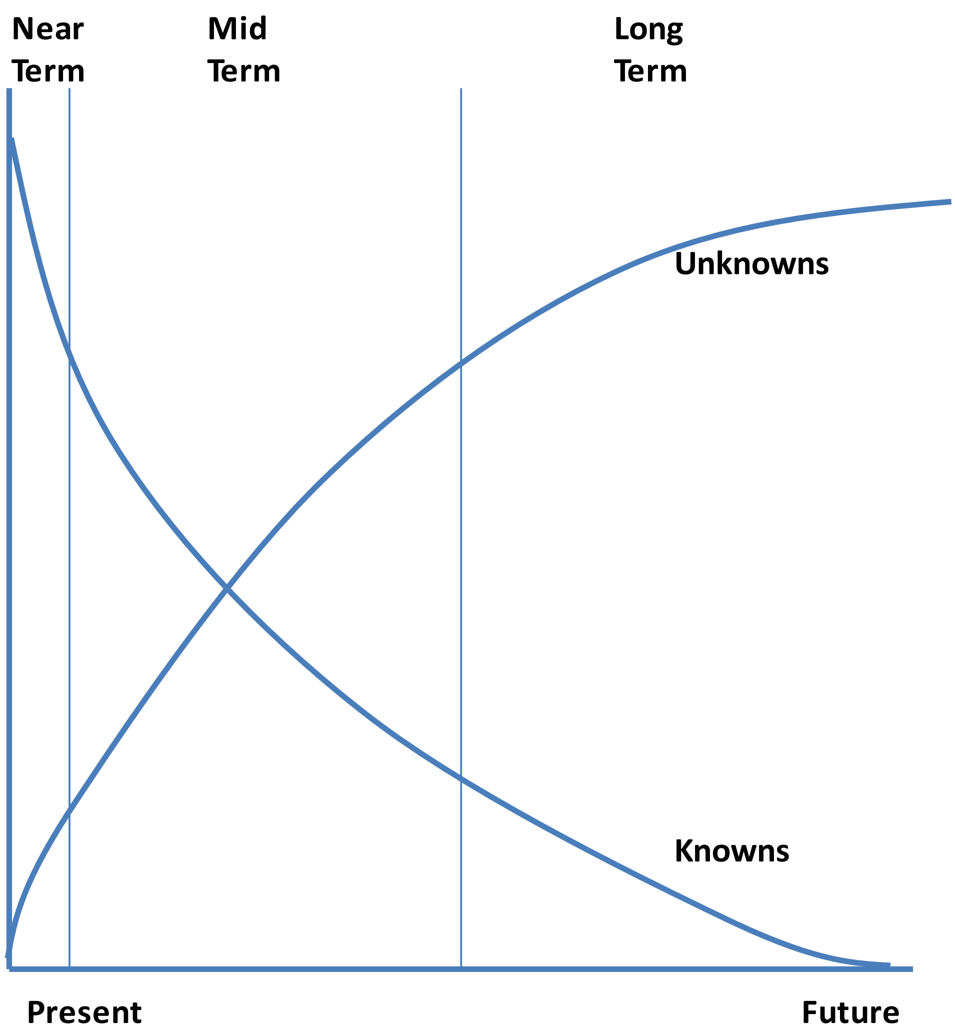


Figure 2.3: Trade-off Between Certainty and Uncertainty Over Time

Corps planners are most often dealing with time frames in excess of 25 years and virtually everything is uncertain in such a time frame. As we look further and further into the future the number of predetermined (known) things decreases rapidly as the uncertainty (unknowns) approaches a point where it includes virtually everything.

Planning is type of public decision making. It is a deliberative process of formulating sets of actions and measures to change the future course of events for some public purpose. Plans that assume certainty and simplicity frequently cause unanticipated outcomes, because the world is neither certain nor simple. Failure to recognize the uncertainty in the future can cause problems to persist and errors to continue.

One response to the increasing complexity in the planning environment has been increasing specialization. Many studies are staffed by well-educated specialists and experts who use increasingly costly and sophisticated models. In a perverse and ironic twist, this has contributed to a delusion of certainty. Models that require a great deal of data and special training to use can make the analyses seem more certain than they are. When complex models have been adopted for organizational use this can institutionalize the inability to think effectively about uncertainty.

Stakeholders with organizational goals (e.g., resource agencies) or strong opinions (e.g., local sponsors) can also preclude careful consideration of uncertainty. An organization that operates on laws, regulations and standards or an organization intent on protecting one thing or another can quickly become ensconced in their own pseudo-certain. Knowledge uncertainty is often at odds with the values of stakeholders. It is certainly at odds with the public's expectations of effectiveness and efficiency. In truth, the future course of events is uncertain and so is the efficacy of our alternative courses of action. We have no choice but to be honest brokers of information in our planning studies. We need to say what we know that is certain and what is uncertain. If the future is uncertain there are, in fact, multiple plausible futures, which we call scenarios. The most important of these for planners is the without condition scenario.

2.5 Uncertainty and Planning

The uncertainties encountered in the planning process are not all equally important. It is the planners' responsibility to identify and address those sources of uncertainty that could significantly affect plan outcomes. These are the uncertainties that can affect decision making. Planners must identify and intentionally address them, taking great care to convey the significance of these uncertainties to decision makers.

To summarize the importance of uncertainty to the planning process and the without condition, consider the ideas pulled together in Figure 2.4. The planning space is divided by two axes, the amount of uncertainty and the consequence of making a wrong decision.

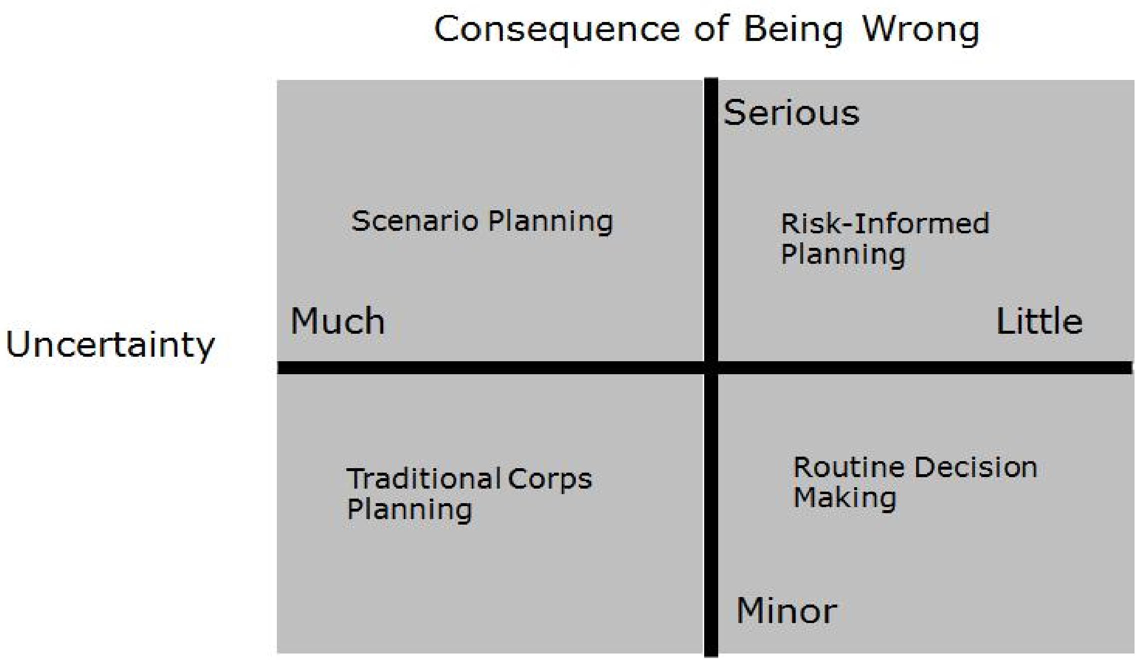


Figure 2.4: Consequence of Being Wrong

There can be very little to a great deal of uncertainty. Uncertainty increases the likelihood of making a mistake during decision making. The consequences of being wrong can range from trivial to grave. These two notions identify four planning subspaces. When there is little uncertainty and being wrong does not much matter, we can use any kind of routine decision making processes. When the amount of uncertainty increases but the consequences of a wrong decision are not too serious, the Corps traditional planning processes are adequate. This process is represented by the best practices of the last 30 years or so.

As the consequence of a wrong decision becomes more serious, traditional planning is no longer adequate. Even when there is relatively little uncertainty, risk-informed planning, which intentionally accounts for uncertainty in all steps of the planning process, including the without condition scenario, is warranted. When the uncertainty is great and the consequences of a wrong decision are serious, scenario planning, i.e., multiple without condition scenarios is needed.

2.6 Summary and Look Forward

Uncertainty makes planning complex. Increasing social complexity and a rapidly increasing pace of change contribute to constantly evolving social values and a frequently volatile environment in which planners plan. The most common and vexing sources of uncertainty occur at the micro-level of planning in the scenarios, models and inputs planners rely on.

Uncertainty can be divided into knowledge uncertainty and natural variability. When there are knowable facts unknown by planners, they face knowledge uncertainty. There can be many different sources of knowledge uncertainty. There is a different set of tools and techniques to be applied to each source of uncertainty.

When the facts are largely known and a system produces variable outcomes planners face natural variability. Sometimes a system can be modified to obtain a more favorable pattern of variability. This is the reason channels were straightened and deepened for navigation.

Uncertainty increases the further into the future we look. The greater the consequence of an uncertainty-related decision error the more rigorous the planning methodology for addressing uncertainty should be. All significant uncertainty in the without project condition scenario should be adequately addressed either through the application of risk-based methods to a single most likely without condition scenario or through scenario planning.

Following this introduction to uncertainty, it is time to consider scenarios more formally. The discussion begins in a general fashion by considering some of what the professional literature says about scenarios. Moving from the general to the specific a wide variety of scenarios used in planning are considered before the discussion zeroes in on the without condition scenario. The section ends by considering some generic qualities of a good without condition scenario.

Section 3: Scenarios

3.1 Introduction

Scenarios are the stories we tell about the future. They describe the major trends, events, and activities that frame the uncertain future in such a way as to provide a coherent storyline. The most important scenario in the planning process is the without condition scenario. This is the story of your study area's water and related land resources future if the planning partnership takes no action.

The without condition is a scenario. Think of it as a detail-free outline that describes the future. For a navigation project it may include such things as a slowly growing international economy increasingly dominated by trade with China, the new locks of the Panama Canal bring larger container vessels and normalization of relations with Cuba redistributes trade in the Caribbean. An urban ecosystem restoration without condition scenario might include things like continued estrangement of surrounding communities from the natural environment, an increasing trash load along the waterway with continually degrading water quality and concomitant loss of habitat and species.

The without condition scenario does not include the analysis that is subsequently done to analyze and forecast specific conditions within that scenario. The without condition scenario frames the analysis. Given the framework of the navigation scenario above planners will then forecast the composition of the future fleet and future commodity forecasts based on the assumptions framing the without condition. Habitat units and water quality will be analyzed for the ecosystem restoration project consistent with the scenario constructed for it.

This section examines a number of considerations about scenarios in general. It begins with a brief review of the planning and futurist literature on the subject of scenarios. That discussion is rather academic but it is useful to know what other planners have to say about the subject of scenarios. The language used in this literature is quite different from that found in the Principles and Guidelines (1983). Following this abbreviated literature review the most common scenarios used by water resource planners are described. The without and with condition scenarios will be of most interest to planners. The section concludes by considering the characteristics of a good planning scenario.

3.2 What Others Say About Scenarios

To continue the analogy of scenarios as the stories we tell about the future, think of them as plot outlines with just enough details to understand the scenes and situations that will tell the basic story. The details of the story, the dialogue, the character development and the action scenes all come later in the analysis. First, planners identify the scenarios then they do all of their analytical work within the context of that scenario.

Scenarios have been defined in the literature as “descriptive narratives of plausible alternative projections of a specific part of the future” (Fahey and Randall, 1998) and tools “for ordering one’s perspectives about alternative future environments in which decisions might be played out” (Schwartz, 1991). Wilson (1998) has described them as pictures or mental maps.

Scenarios are not facts, they are not even knowledge. They are propositions about the range of possible futures that we use to help stimulate our creative thinking to design actions to help us influence and shape our future. A scenario is a hypothesis about the future. The future does not become a fact until it becomes the new present and fades then into the past (Walton, 2008). Walton says that scenarios enable us to identify possible, probable, preferable and undesirable futures. The without condition scenario would be a possible future and with condition scenarios identify preferable futures. Whether a without condition is undesirable or not will be a matter of subjective judgment for the planning community. In general, water resource planning studies are not initiated unless there is tangible evidence of problems or opportunities for improvement. Thus, we expect them to be undesirable futures.

Godet (2001) differentiates proactive and preactive scenarios. Proactive scenarios are improvement conditions that describe futures that might not happen, but for proactive measures taken by planners. With condition forecasts are proactive scenarios. The without condition is a preactive scenario that describes the future with anticipated changes.

Börjeson et al. (2006) have identified three basic ways of thinking about the future. These are based on the kinds of things a planner, for example, may want to know about the future. They are characterized by the following questions (and the scenarios the answers produce):

1. What will happen? (predictive scenarios)
2. What can happen? (exploratory scenarios)
3. How can a specific target be reached? (normative scenarios)

Questions of the first type are answered by predictive scenarios. Predictive scenarios are predicated on two views of what will happen in the future. One of these is based on the assumption that a most likely future develops the other is based on what can happen following the occurrence of certain specific events. The former is called a predictive forecast scenario by Börjeson et al. the latter is called a predictive what if scenario.

A single most likely without condition would be a predictive forecast scenario, when the uncertainties are not so great as to create markedly different alternative futures. Substantial uncertainties like sea level rise, normalization of trade with Cuba, a successful terrorist attack and the like can give rise to predictive what if scenarios. Scenario planning would rely on the use of such scenarios.

Exploratory scenarios usually involve more uncertainty than predictive scenarios would. They are also divided into two types, external scenarios and strategic scenarios. External scenarios focus on what can happen to external factors, i.e., factors decision makers cannot control. So, for example, if we do not know what effects climate change might have on a study area we would be exploring futures rather than predicting them. This is closer to the standard application of scenario planning, which has been used to generate these exploratory scenarios for business strategies. In instances of great uncertainty the without condition is more of an exploratory scenario. Walton (2008) points out, it is common to merge predictive and exploratory scenarios in planning and without condition forecasts are often a blend of these two types.

Exploratory strategic scenarios differ by focusing on what can happen if we act in a certain way. Whereas the exploratory scenarios focus on factors that are beyond the decision maker's control, strategic scenarios explore the futures that can result from taking specific actions. Thus, strategic scenarios enable planners to explore the effects of measures on the issues of interest. With project condition scenarios are exploratory strategic scenarios. Strategic scenarios can be used to describe how the consequences of a plan can vary depending on how the uncertain future unfolds.

Normative scenarios address what the future ought to be like by identifying ways to reach specific normative targets. Thus, they answer the third question, how can a specific target be reached? Two types of normative scenarios are distinguished, preserving and transforming scenarios. Whereas strategic scenarios focus on the action taken, normative scenarios focus on aspects of a desirable future and how they can be realized. So think of strategic scenarios as focusing on outputs (if we do this) and normative scenarios as focusing on outcomes (what we want to happen). When the target future can be reached within the prevailing structure of the system, preserving scenarios are used. When the structure of the system must be changed to realize the target future a transforming scenario is used. These scenarios are a little different from the with condition scenario. They envision a desirable future, which can then be used to guide the formulation of plans that can help realize this desired future.

Preserving scenarios often seek the most cost effective means of reaching a target, cost-effectiveness being the norm in this instance. Experienced planners may recognize incremental cost analysis and cost effectiveness approaches to ecosystem restoration as examples of this sort of scenario. Optimizing or satisfying models are sometimes used for these scenarios. Transforming scenarios are used when the current system is not capable of taking us to the desired future. Transforming scenarios are, in essence, seeking new pathways into the future. They are sometimes described as backcasting scenarios that begin with a high priority target and work backward toward the present time identifying new pathways and trends while doing so.

There are two important points to take away from this abbreviated discussion. The first one is that the planning and futurist literature have devoted a great deal of thought and attention to the notion of scenarios. The interested planner can access this literature through the usual search methods. Elsevier's journal *Futures* is an excellent starting point. Find a recent article and start working backwards through the references. The second point is that the Corps has developed its own terminology and methodologies that do not always match up well against the jargon of the literature. For simplicity, we will work with the Corps' jargon, but recognize that conceptually the Corps approach to planning is, jargon aside, well aligned with the best practice of planning.

3.3 Scenarios in Planning

Scenarios provide a common background for every group and individual involved in the planning process. What do planners do with their scenarios? It is really quite simple, in a figurative sense. They steer by them as they sail into the future. They aim away from undesirable futures and they aim at desirable futures. When the future without condition is undesirable they try to avoid that future. If they simply aimed away from it, however, they might inadvertently hit another thing that would produce undesirable consequences. And so, they aim at the most desirable future with condition. This, it should be noted, is different from identifying a conceptual ideal future toward which to steer.

For this simplistic analogy to have value in practice it is essential that planners be honest brokers of information in their scenarios. They must honestly construct scenarios based on what they know and what they do not know. Then they must address those things they need to know in order to make good decisions. This always requires them to deal intentionally with critical uncertainties.

3.4 Common Planning Scenarios

If a scenario is an outline for a play it stands to reason, then, to think in terms of well-established plot lines to begin to consider the different types of scenarios in most common use. Several types of scenarios come up over and over again in planning. They are existing/before, historical, without a plan, with a plan, and target/ideal scenarios.

Some scenario conditions are inventoried others are forecast. Existing and historical conditions are generally inventoried or described as they are or were. Occasionally a target or ideal condition might be described. Other times, the target, like all other scenarios commonly used by planners, will be forecast.

Inventoried scenarios are usually more certain that the forecasted ones. Because it is impossible to describe the future with certainty, best planning practice always considers multiple versions of every forecasted scenario. Whether you use the multiple without condition scenarios of scenario planning or the most likely one it is not good planning practice to consider only one future scenario. In the paragraphs that follow the scenario types most commonly encountered in water resources planning are described.

3.4.1 Existing and Baseline Condition Scenarios

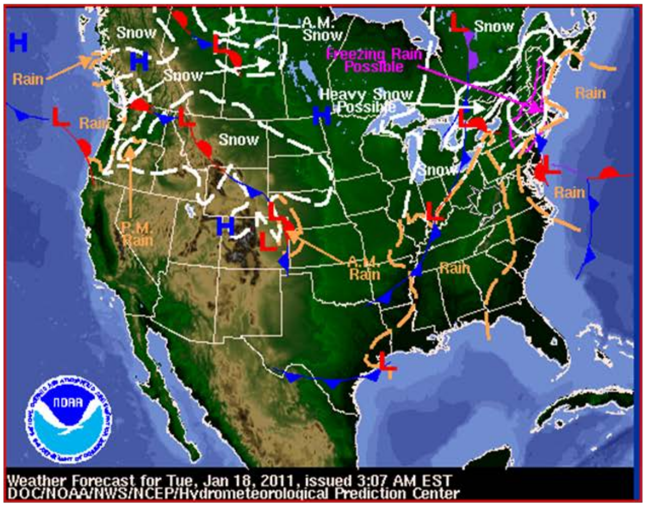
The first *story* planners might want *to tell* about their planning area is the existing condition. This scenario describes the system the team is interested in as it exists at the time of the investigation. It is a result of an inventory of the relevant variables and relationships for the study area and the models used to analyze it. Relevance is defined by the problems, opportunities, objectives and constraints identified in the first planning step. Existing and baseline scenarios are described in Step Two of the planning process.

The existing condition scenario should accurately reflect conditions as they exist and it should be based on the best available evidence. An alternative to the existing condition is the baseline condition. Although the two are sometimes identical, the baseline for Corps planning is sometimes the existing condition accelerated forward in time to a base year reference point. The base year scenario is a slightly accelerated version of the existing condition, meaning a forecast of conditions a few years into the future.

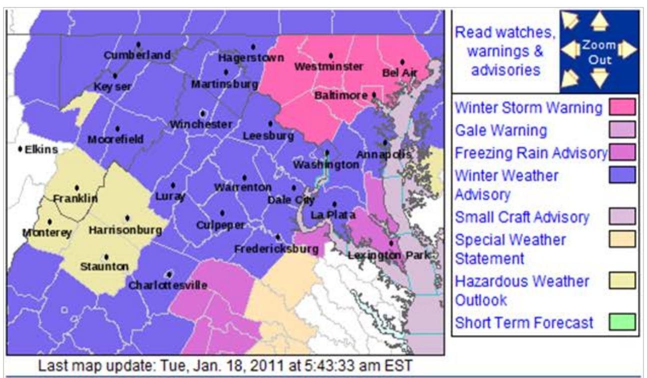
In dynamic systems where conditions are constantly changing conditions at the time of the planning study may be less relevant for decision making than are the conditions at the time the project is to be completed. That time in the future is called the base year. It is that year in the future when a plan recommended for implementation can be considered operational. A plan is operational when it is either completed or it is completed enough that it is producing the intended outputs to a significant extent.

As with any other scenario, recall this is the basic narrative description or plotline for your story. Section One includes a simple example of an existing conditions scenario. Weather conditions provide an effective analogy for this description (see Figure 3.1). The big picture is provided in the map in the upper left. It has limited details and basically tells the story, winter weather. Given these large trends meteorologists can then quantify the weather forecast scenario for selected areas of interest and time.

This pattern holds for all the descriptions that follow. Once a scenario is devised planners move into that scenario and live within in, conducting the necessary technical work to produce the desired information. This is quantifying the scenario. As the scenario changes the analyses will change as well. It is by comparing the results of these analyses across different scenarios that significant impacts are identified. In general, inventoried scenarios are easier to construct.



1. Top left winter weather scenario
2. Bottom left zeros in on area of significant interest
3. Bottom right quantifies the scenario for the area of interest



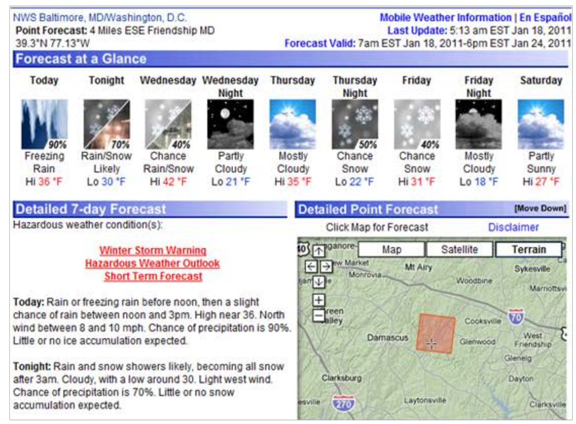


Figure 3.1: Weather Forecast Analogy for Existing Scenario

3.4.2 Historical Condition Scenarios

The past is sometimes important to planners. It is not easy to understand the present without some knowledge of the past. In some planning investigations it may be helpful or necessary to consider past conditions of the study area. This is especially true in restoration investigations that intend to restore conditions from some particular historical period. A good example of this is the Comprehensive Everglades Restoration Project (CERP), which, in part, seeks to restore the functionality of water quantity and quality conditions of the 19th century. There are many studies that seek to correct or mitigate adverse impacts due to some anthropogenic or, occasionally, natural disruption. These pre-disturbance conditions are examples of historical conditions. Historical conditions are typically described in Step Two of the planning process.

A Common Without Condition Scenario Problem

Many people think of the without condition as the collection of quantified analyses and individual forecasts done by planners in the course of a study. Too often this quantitation of a scenario is not based on any common plotline. Engineers, economists, environmentalists and other analysts too often work in isolation of one another with different or unarticulated views of the future and its uncertainty.

It is absolutely essential that the scenario be completed first and that all subsequent quantitation be consistent with the scenario's big picture view of the critical uncertainties.

There are no hard and fast guidelines for choosing a less specific historic condition, other than that that condition must be relevant to the planning process. A town may want to restore stream vegetation to what it was like *before*. Where before might mean nothing more specific than before it started to disappear. In such a case the historic condition is nonspecific and it simply refers to a reversal of a generally recognized negative trend in an ecosystem.

In the sense described here, historic conditions may function as a sort of target for planners to aim at in their planning efforts. Historic conditions do not usually play an explicit role in most of the Corps' planning investigations. When they do, historic conditions can often be inventoried.

3.4.3 Without Condition Scenario

Without a doubt the single most important scenario is the scenario that describes the future condition without a plan, which we have shortened to the without condition scenario. The without condition describes what the future will look like if the planning entity takes no new action to correct the problems and realize the opportunities identified in the planning process. It is used as the basis for comparison for every planned solution the planning team formulates. It is constructed in Step Two of the planning process.

No one can say with certainty what the future of a study area will be like if the planning partnership takes no explicit action. The future is not knowable with certainty. Nonetheless, it is common planning practice to select one of these potential futures and identify it as the *most likely scenario* that will prevail in the absence of any specific intervention to solve problems or realize opportunities as a result of the planning process. This is often reasonable when the range of different scenarios (it may help to think of the plotlines analogy here) is limited. The future is not so much in doubt in broad terms but there are some very specific conditions or details that are uncertain. Specific forecasts of variables or uncertain conditions can often be adequately handled within a single most likely without condition scenario. Nonetheless, that most likely scenario cannot be identified with any confidence if it was the only scenario considered. In addition, there will be instances when it becomes clear the fundamental direction of the study area's future is in doubt because of significant uncertainties. This is when multiple without condition scenarios are considered.

There are always many possible future without conditions if nothing is done by the planning team. These conditions must be described before the most likely of them can be designated. Then, once this basic scenario is identified, forecasts of important variables and relationships as well as model runs can be made within the framework of the scenario. The specific forecasting techniques can be qualitative or quantitative.

Our focus is not on the techniques used to forecast a specific value; they are too vast and varied and remain more properly the content of discipline specific discussions. Instead we focus on the overall scenario, the story of the study area's future if no new action is taken. In the language of the National Environmental Policy Act (NEPA) this is equivalent to the No-Action scenario.

Things That Can Make a Without Condition Scenario Complicated

How often do our without conditions consider things like: terrorist attacks, nuclear war, hazardous chemical spills, huge toxic algal blooms, higher cost of fuel/energy, more stringent regulations, a hurricane that wipes out agriculture or housing that is not replaced, earthquake related changes to land use, drought impacts on wetlands and flooding, significant climate changes, sea level fall, tidal wave destruction of study area, catastrophic fire/ground sterilization, large scale water contamination, extinction of species, flu pandemic that kills one billion people, planetary collision, irreversible economic collapses, repeal of major environmental laws, changes in national priorities, or a dam break with major loss of life, nanotechnology, genome mapping?

The central idea here is to consider a variety of possible futures that include many of the important uncertainties in the system we are studying, rather than to try to focus on the accurate depiction of a single future. How does one do that? A hint was given in the simple example of Section One a detailed description is provided in Section Five.

The one common element in every without condition scenario is that it is premised on the assumption that the entity doing the planning takes no new action to address the problems and opportunities identified by the study. In other words, the without project condition describes the study area's future without a plan implemented to solve the problem(s) or attain the opportunities at hand. Thus, the without condition represents the future without a response by the planning entity.

3.4.4 With Condition Scenario

In contrast to the one (set of) without condition(s) we will have a separate and distinct with condition scenario for each plan that is evaluated. Each formulated plan is designed to help achieve the planning objectives, thus it is expected to alter the future. We would not expect the future to look the same with a planned solution in place as it would if we did nothing. Each plan formulated by the planning team will have a different impact on the study area. Consequently, each plan will lead to a different set of conditions in the future. This forecasted scenario is called the with condition or the with-project condition. There is a unique (set of) with condition(s) for each plan formulated by the planning team. No two of them should be alike. Each (set of) with condition(s) will be evaluated against the same (set of) without condition(s). The with condition is not any less important than the without condition, except for the fact that its impact is less pervasive in the planning process. It is used in the evaluation of only one plan.

Plans formulated while cognizant of the uncertainty in the future are often able to reduce that future uncertainty to the point that it is ultimately possible to represent the future reasonably with a single representative (or most likely) with condition scenario. Planners would, then, make their improved condition forecasts and do their analysis against the backdrop of this scenario. It is possible that multiple with conditions would have to be considered when uncertainty about the plan's efficacy and performance are significant.

With conditions are actually devised in Step Four, the evaluation step, of the planning process. The idea is introduced here along with the discussion of other scenarios. We will revisit it in Section Four. Planners are looking for differences between without and with condition scenarios that are important, i.e., they make a difference to people in the study area and decision makers.

3.4.5 Other Scenarios

Planners may from time-to-time encounter the need to develop scenarios for other kinds of uncertain conditions. Several possibilities are briefly discussed below.

3.4.5.1 Target or Ideal Condition Scenario

In some instances, planners may be provided with a set of target conditions they must meet. These conditions may be prescribed by a higher authority, set by international treaty, established in law or they may be offered formally or informally by stakeholders. A target condition identifies one or more desired outcomes. The scenario that describes the level of plan outputs that achieves these outcomes is the target condition. When the target is realized the desired outcome level will be achieved. Thus, a target condition is a goal to be achieved. Target conditions are more likely to be specified for specific variables or conditions in the study area rather than as a plotline or logic for the future. Examples of targets might include a prescribed level of biodiversity, a water quality goal, a salinity level, a mitigation goal, a tolerable level of risk or any other appropriate target.

If we generalize and extend the notion of a target it becomes more of an ideal scenario. This idea is much more faithful to the notion of a scenario offered above. An ideal condition scenario would be appropriate to develop before the planning team begins to formulate plans and it would stand in direct contrast to the without condition scenario. Using the planning objectives and constraints and everything learned about the problems and opportunities during the analysis done in Step Two, planners should devise an ideal scenario for the study area. Think of it as a Utopian view of the study area with all objectives achieved, constraints avoided, problems solved and opportunities attained.

What does that look like? Describe it. It is the ideal condition. Planners then *move into this ideal condition* to devise and formulate plans that would come closest to making it a reality. The Corps does not routinely use an ideal condition scenario in its planning studies. The ideal future state is useful to identify, it forces people to consider and weigh alternative perspectives and values. It also gives planners something to aim at when they develop plans. Target or ideal conditions would be developed in Step Two of the planning process.

3.4.5.2 Before Condition Scenario

More an inventory than a true scenario, perhaps, is the before condition scenario. It is common practice in some decision contexts to describe conditions that existed before an action was taken. National Environmental Policy Act regulations rely on a before and after comparison instead of a without and with comparison for some actions. The more uncertain we are about those conditions the more like a scenario and the less like an inventory this condition becomes. It is described in Step Two of the planning process.

3.4.5.3 After Condition Scenario

Very similar to the before condition is its opposite, the after condition. If the actual conditions after an action is taken are described this is an inventory. When the after condition is described as a future condition that does not yet exist it is equivalent to the with condition scenario. So if it is to be differentiated at all from the with condition we would consider it an after the fact inventory or description of the effects of an action. To the extent that this inventory is plagued by uncertainty it becomes more scenario than inventory. It is described in Step Two of the planning process. Ecosystem restoration planning might involve the use of before and after inventories in addition to without and with conditions scenarios.

3.4.5.4 As-Planned Scenario

The *as-planned* scenario, sometimes called the surprise free scenario, describes a future in which the system under consideration (e.g., a waterway, a landform, an ecosystem, public works infrastructure, a park or wildlife reserve) functions exactly as it is supposed to function. Or, in the case of manmade systems, it functions as it was designed to function.

The as-planned scenario is free of any failures. Every feature of the system functions as it was planned to function. Scenario analysis, different from scenario planning, often begins by defining the success or *as-planned* scenario where every endpoint is a successful conclusion. Once the *as-planned* scenario has been defined failure scenarios can be constructed and investigated.

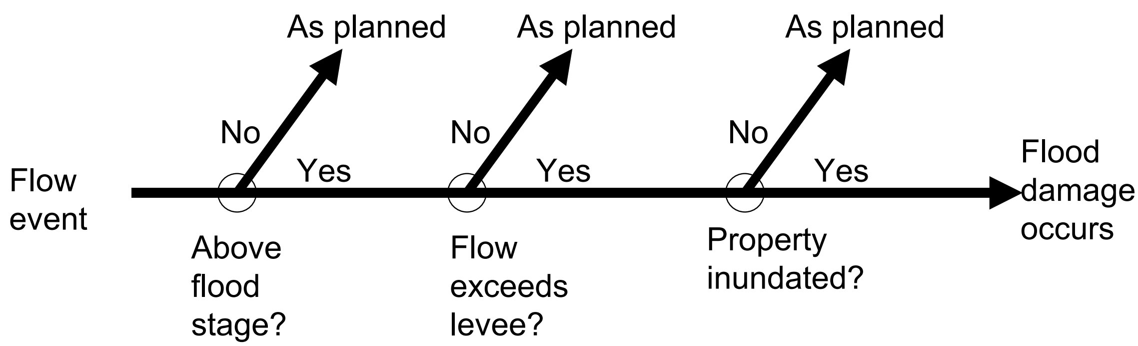


Figure 3.2: The As-Planned Scenario for a Levee

Consider the simple illustration of an as-planned scenario in Figure 3.2.

Three end states of the model define the *as-planned* scenario. There is one failure scenario in this example. If a flow is at flood stage, exceeds the levee and inundates property then the system has failed. Otherwise, the system functions exactly as planned and flood damages are avoided. As-planned scenarios are more likely to be used in risk assessments and operation and maintenance investigations than in planning investigations.

3.4.5.5 Conventional Wisdom Scenario

Sometimes a stakeholder will want to see their vision of the future reflected in the deliberations. The conventional wisdom scenario, also called the surprise-free scenario by some, reflects the common traditional wisdom of the organization. It is a scenario likely to be recognized by everyone in the organization. It is usually based on a *business as usual* set of assumptions. This scenario is as often as not the result of inertia and it is unusual to find an honest treatment of uncertainty in such a scenario. Nonetheless, it can be used as a platform for developing more challenging futures.

Planners may sometimes place too much faith in structural solutions to flood risk management problems for example. The tendency to look first at levees and channels as solutions to flood problems may be an example of a traditional wisdom strategy.

3.4.5.6 Challenge Scenario

A challenge scenario is often a reasonable first response to the conventional wisdom scenario. It is designed to challenge the traditional wisdom by showing the flaws in the conventional wisdom. Inconsistencies in logic are common in conventional wisdom scenarios. Challenge scenarios are often built to highlight the errors in other scenarios. Challenge scenarios are used to encourage clients to move away from their traditional wisdom and are rarely going to be the end product in a planning process.

3.4.5.7 Failure and Worst-Case Scenarios

Scenarios that present alternatives to the *as-planned* scenario are called failure scenarios. They are developed to illustrate the different failure modes. One of the most familiar failure scenarios is a levee that breaches before the river stage exceeds its design level. Less familiar, but easily imagined is the ecosystem restoration project that fails to restore ecosystem function. Any aspect of the as-planned scenario may be challenged. One of the most common failure scenarios is better known as the *worst-case* scenario.

Engineers and public health officials, to name just two professions, are trained and programmed with an irresistible drive to design systems conservatively. H.S. Lewis (1990) says of conservatism, “It is the accumulation of centuries of experience that the conditions of the real world are not always predictable and that it makes good sense to provide some margin of error for unforeseen events." This drive toward conservatism has led to the widespread propagation and use of worst-case scenarios. There is no real formal definition of a worst-case scenario. It is simply that future in which everything than can reasonably go wrong does go wrong.

If the worst-case scenario yields an acceptable or even a tolerable result there is no need to manage the situation in a different manner. If we can live with the worst-case we're in good shape, the logic goes. On the other hand, worst-case scenarios that result in unacceptable consequences often have lead managers to take precautions to preclude the worst-case scenario from occurring. To an extent the National Dam Safety Program in the 1980s and 1990s was so directed.

Despite its widespread usage the worst-case scenario is not without its problems. First, among these is that to introduce conservatism into an analysis is to introduce a deliberate error if the true intent of the investigation is to provide objective analysis. Second, given any worst-case scenario an even worse case can, paradoxically, usually be defined. Third, the likelihood of a worst-case scenario may be so small as to lead to the waste of labor, materials and other resources in efforts to reduce it. Fourth, there is an almost hypnotic appeal to thinking that if we have covered the worst-case we have covered everything. Failure in less than the worst-case world is often still possible and may be overlooked. Nonetheless, worst-case scenarios are likely to remain useful and popular failure scenarios to devise and investigate.

Disaster scenarios and shock scenarios are useful variations of failure scenarios that may be less than worst-case. These scenarios have proven especially useful for developing contingency plans.

3.5 Characteristics of a Good Without Condition Scenario

Here in no special order beyond the top five are some desirable characteristics of a good without condition scenario. The top five characteristics are:

1. It tells the story of study area's problems and opportunities, goals and constraints in the future if the planning entity takes no action.
2. It quantifies that story in ways that support planning from formulation through plan selection.
3. It tells the truth.
4. It is based on evidence and good science.
5. It identifies what is uncertain and how that might affect decision making.

Some additional characteristics found in the works of Fahey and Randall (1998), Meadows, et al. (2005), Smith and Deemer (2003), Walton (2008), and Wilson (1998), include:

- It is not a prediction.
- Its preparation examines different perspectives and provides useful insight into the future of the study area.
- It has decision making utility and contributes sufficient insight into the future to influence planning and decision making.
- It has internal validity, meaning it identifies true causes of outcomes, i.e. other causes can be ruled out. The cause and effect relationships of the scenario are true for the specific study.

- It is externally valid, thus planners can legitimately generalize results from the scenario to other situations.
- It is reliable. The measurements, data, methods and models are high quality.
- It is objective. The analysis is impartial, unbiased and avoids conflicts of interest. It is not the result of any value judgments.
- It is challenging. A good scenario challenges the planning entity's conventional wisdom about the future when appropriate.
- It is plausible. The claims of the narrative are plausible and fall within the limits of what could conceivably happen.
- It is credible. The future described is based on credible evidence. There is a convincing reason for the forecasted conditions to develop.
- It is relevant. The scenario tells us things about the world that we need to know.
- If multiple scenarios are used they are differentiated. Each scenario is different enough that no one thinks they are variations of a base case.
- It is consistent. There is no built-in inconsistency in the logic that undermines its credibility.

"Plausible evidence should indicate that the projected narrative could take place (it is possible), demonstrate how it could take place (it is credible) and illustrate its implications for the organization (it is relevant)" (Fahey and Randall, 1998).

3.6 Common Mistakes in Constructing Without Condition Scenarios

There are a number of commonly recurring flaws in the construction of without project scenarios. Several of these are the topic of this section. These are mistakes that planners want to be sure to avoid.

3.6.1 Scenario as Analysis

Some without condition scenarios are simply the bundled up best estimates of analysts working independently of one another and without the benefit of a shared and common vision of the future. Environmentalists offer their best estimate of the future of environmental resources, H&H does the same for their analysis of the without condition scenario, and economists, cultural resources experts and the like all do likewise. All of these individual analyses are bundled together and the result is labeled the without condition scenario. A scenario is not analysis.

The starting conditions and working assumptions of the different analysts are often unknown and may or may not constitute a coherent whole when taken together. Consequently, the scenario may lack internal consistency. Some analysis may be based on a forecast of high population growth another may be based on a forecast of declining population. A good without condition scenario is based on a common view of the future. This included a common set of starting conditions and working assumptions as well as closely coordinated analyses.

3.6.2 The Future is Like the Past

Many without condition scenarios are simple extrapolations of the past into the future. The watershed will continue to develop as it has been developing, tonnage at the port will continue to grow at the same rate, and habitat units will continue to disappear until none are left are three examples of potentially unrealistic extensions of past trends. What if the future is not like the past? This is a question a planner must ask when the without condition scenario begins to look like a linear extrapolation of the past. What could make the future look different? This is the second necessary question. The planning team needs to identify specific drivers that could make the future look different from the past so they can consider them.

The rise of scenario planning in the last quarter of the 20^{th} century has been specifically attributed to the fact that the future is not always or even often like the past. The increasing complexity of society requires us to consider how values are changing or will change. The increasingly rapid pace of change makes predicting the future an increasingly difficult activity. Think twice or three times before you sign off on a without condition future that looks like an extension of the past. It is not impossible it is just going to be accurate far less frequently than it is used. The without condition scenario should reflect careful consideration of abrupt breaks from the past as well as turning points in trends.

3.6.3 Without is Not No Action

The without condition refers to the absence of any action taken as a direct result of the Corps planning study. It refers to the future is the planning partnership takes no intentional action. That is not the same as assuming no action will be taken to solve the problems and attain the opportunities identified. If a Federal flood risk management project cannot be constructed local interests may pursue a modest buy out of the most vulnerable properties. If so, this ought to be reflected in the without condition scenario. A Federal project is often the best option but not the only option. In such cases the without condition scenario ought to reflect the most likely course of action in the absence of a Federal project. Be sure the without condition scenario honestly reflects the actions that will or could be taken in the absence of an intentional action by the planning team.

3.6.4 Narrow Focus

There are times when the pile of things we do not know about the future of the study area includes a source of uncertainty the planning team recognizes as extremely important. One common error is to focus on a single large uncertainty to the exclusion of everything else. For example, imagine there is one or more Federally-authorized but unfunded and unconstructed projects that would affect the study area. The planning team can sometimes be distracted by resolving such a potentially critical issue. For example, do the hydrologic and economic analyses assume the upstream flood risk management dam is constructed and functioning or not? When there is one overwhelming uncertainty it can overshadow other lesser but cumulatively important uncertainties. Do not focus too narrowly or too quickly on a single source of uncertainty that drives a scenario.

3.6.5 Failure to Consider Alternatives

The future is not written. Any without condition scenario is going to be inaccurate to some degree. A common error is for planners to consider only the without condition scenario they construct. The most likely without condition scenario can only be properly chosen from a number of candidate without condition scenarios.

In the pile of things we do not know in a planning study are many things. Some of them have more influence on the without condition scenario plotline than others. These are the uncertainties that should be carefully examined and considered when future scenarios are being constructed. Planners sometimes fail to consider a full range of potential futures and proceed with a single most likely alternative without condition scenario that is not ripe or fully evolved because it was not developed from a comprehensive view of the future. These single-shot scenarios are at times naively optimistic, pessimistic, or otherwise too naïve in construction. Be sure to consider multiple without condition scenarios before choosing one as most likely.

If we use a house as an analogy, the scenario comprises the bricks, mortar, and timbers that form the structure itself. The analyses are like the furnishings and other finishing touches. Some of them are bricks, mortar, and timbers. The great majority of them are furnishings and finishing touches.

3.6.6 Failure to Identify What Is Not Known

Dealing intentionally with uncertainty is a relatively recent emphasis in planning. Perhaps because of this new emphasis it is unusual for a plan to identify the important things that are not known in an explicit and intentional fashion. The preamble to every without condition scenario should begin with a list identifying the uncertainties of greatest concern to the planning team and decision makers. The without condition scenario should then reflect an appropriate resolution of or means of addressing these uncertainties for purposes of the planning study.

3.6.7 Unreasonable Assumptions

Assumptions are one of the most common ways to address uncertainty in a planning study. All assumptions that underlay a scenario should be reasonable, transparent, supported by the available evidence or a compelling rationale, and they should be explicitly identified and listed with the scenario.

Planners can be subjected to considerable pressure to help develop an implementable plan. It is easy to become emotionally engaged in the plight of a community or to misjudge the mission of an agency, or the purpose of a planning investigation. In that circumstance it is tempting, when dealing with uncertainty, to make assumptions that give the benefit of the doubt to the viability of a project or plan. One or much such assumption can render a without condition scenario incredible.

One such recurring assumption relies on the presumption that non-Federal interests are unable or unwilling to follow a rational course of action. This assumption might be subtitled the terminally stupid partners. Section 14 of the 1946 Flood Control Act provides authority for the Corps of Engineers to prevent erosion damages to public facilities, such as bridges, roads, public buildings, sewage treatment plants, water wells, schools, and the like. The maximum Federal cost for project development and construction of any one project is $1,000,000 and each project must be economically justified, environmentally sound, and technically feasible. Cost savings was often used as the principle benefit category for Section 14 studies. The without condition scenario would go something like this. Locals are spending $200,000 a year to protect a public facility from erosion and will incur these expenses annually for the foreseeable future. A Corps project can fix the problem once and for all with a $1 million expenditure thus saving the local partner well over $1 million in expenditures.

The problem with a scenario like this is that it assumes the local partners are not smart enough to implement the one time fix. The poor ignorant partner will continue to spend $200,000 in perpetuity. Such an assumption is not credible. Be sure the without condition is not based on unreasonable assumptions about future conditions or behaviors.

3.6.8 Rigging the Game

Benefits are needed to justify Corps participation in a Federal project and without condition scenarios can be constructed so as to maximize potential benefits. One can forecast continuing decline in environmental conditions, rising costs of waterborne transportation, rising operation and maintenance costs, rising probabilities of equipment and infrastructure failure and so on. When the future is uncertain there is an option to make assumptions that resolve uncertainty in favor of a project. This is at best naïve and at worst dishonest. Experienced planners know what kinds of without conditions will prejudice an analysis in favor of a project. Intentionally exploiting that knowledge is wrong. It is simply wrong and unacceptable to take advantage of uncertainty by making assumptions favorable to the justification of a project. The without condition scenario should be based on an honest assessment of the future without regard to the effect of the scenario on the viability of an eventual project.

3.6.9 Confusing Policy and The Future

There are a number of policy directives, constraints, and restrictions that have been imposed on the Corps' planning process. Policy and reality should not be confused. A without condition scenario should reflect reality. If reality conflicts with policy this can be addressed in the analysis that is done to quantify the effects of interest. Scenarios should not bend reality to accommodate policy. Analysis can be modified to accommodate policy under a realistic scenario description.

3.7 Summary and Look Forward

Scenarios are the stories we tell to describe the basic look and structure of an uncertain future. Scenarios are important to the professional literature of planning and a rich language has been developed to describe a wide variety of scenarios and their uses. There is a wide variety of types of scenarios that have been used in planning.

The Corps has developed its own specific language of scenarios. Some of these, like the existing, baseline or historical scenarios are inventoried, which is to say they are largely described. Others of these, like the future scenarios, are forecast or otherwise constructed based on evidence and informed speculation. The single most important scenario used by Corps planners is the most likely without condition scenario. The without condition scenario describes the basic framework of the study area's future if the planning partnership takes no intentional action to alter the future. This scenario has, in the past, been called the without project condition. When a single without project condition scenario can be used, the same scenario is used as the baseline condition for the purpose of estimating a plan's impacts on the study area for every plan consider. Of virtually equal importance to the without condition scenario, therefore, are the with condition scenarios that are constructed separately for each formulated plan that will be evaluated.

Scenario construction should not be confused with technical analysis. Planners first construct a without or with condition scenario, then they use the structure of that scenario to guide the assumptions and inputs to their technical analyses. Scenarios frame the technical analysis. Scenarios are not to be constructed from technical analysis, they must precede it.

There is a wide variety of fairly commonly repeated mistakes planners make when constructing a without condition scenario. Confusing the without condition to a no action scenario, making assumptions that cannot be supported by reason and trying to rig the game are three of the more pernicious kinds of errors that are made.

The next section takes a look at the sequence of steps required to construct a good most likely without condition scenario. It briefly addresses the need to do technical analysis consistent with the scenario view of the future and concludes by considering when it is appropriate to consider a single without condition scenario.

Section 4: Building a Without Condition Scenario

4.1 Introduction

In best practice planning, planners construct a basic without condition scenario and then completed their analysis of problems and opportunities and other effects of interest within that scenario. In less than best practice the without condition often just seems to emerge. There is no coherent or unifying notion of a without condition scenario analysis of the future. Engineers do their best guess analysis of future conditions and economists, environmentalists and others do the same. They are bundled together and called the most likely without condition. One would hope these groups coordinated their assumptions and methodologies about the uncertainty they faced but it is not always clear that is so.

The primary purposes of this section are to prescribe a method for developing a single most likely without condition scenario and to describe the scenario planning process. It begins with the consideration of the background information against which the scenario building process begins. It then considers a few practical questions like who makes the forecast and over what area and time frame before proceeding to offer a specific set of tasks required to complete a good scenario narrative. This description describes a methodology suitable for constructing one without condition scenario or the multiple without condition scenarios of a scenario planning process. The section concludes with short discussions of how the scenario is quantified and when it is appropriate to use one without condition scenario.

4.2 Preparing for a Without Condition Scenario

Scenarios depend on information and ideas. The first step in the planning process establishes the decision context for your planning study. In it you identify the problems to be solved, the opportunities to be attained, the objectives to pursue, and the constraints to avoid. In best practice planning you will have your first notion of the most important decision criteria as well. This is where the without condition scenario building begins.

Step Two of the planning process begins by preparing to develop the without condition scenario. This is done by an inventory of existing conditions, i.e., gathering the readily available data, information, knowledge and perspectives about the problems and opportunities, objectives and constraints, and decision criteria. It is important to understand that gathering the available evidence early in this task is not analytical work. While you will need some analysis to verify the problems and opportunities identified, most of the analysis is not done until after the without condition scenario is complete.

The sequence of events at this stage of the second step (assuming problems and opportunities have been verified) of the planning process is to:

1. Gather the available evidence
2. Build the without condition scenario
3. Quantify the without condition scenario.

This first task is the inventory spoken of in the P&G description of Step Two; the next two steps comprise the forecast the P&G speak of. Introducing the language of scenarios to the planning process reflects the next evolutionary step in both planning theory and the language of planning.

Inventorying the available evidence for a planning study that addresses flood risk management, ecosystem restoration, navigation or any other familiar project purpose is a straightforward matter for Corps analysts. They have many years of experience and many of the Nation's experts in these fields. In general, gathering the available evidence is a task planners do quite well.

Before beginning to develop a specific methodology for building a without condition scenario, it is useful to consider what a without condition scenario is not. That may be best done with an example. It may be unfair to call any actual without condition description representative of the Corps' wide body of work, and so we will not. Nonetheless, it is instructive to consider what might be called typical practice. Below, you will find the chapter outline of the without project condition description from a 2004 feasibility report for a flood damage reduction[3] and ecosystem restoration planning investigation. The chapter begins with this sentence: "This chapter describes the existing or without-project conditions in the study area." What follows is the chapter outline based on the bold headings and subheadings in the chapter.

Chapter Four: Affected Environment
4.1 RESOURCES NOT EVALUATED IN DETAIL
- 4.1.1 Physical Environment
  - Topography, Geology, and Soils
  - Climate
  - Hydrology
  - Wild and Scenic Rivers

4.2 SIGNIFICANT RESOURCES
- 4.2.1 Physical Environment
  - Geomorphology
  - River Hydraulics
  - Water Quality
  - Air Quality
- 4.2.2 Biological Environment
  - Vegetation
  - Wildlife
  - Fisheries and Aquatic Resources
  - Essential Fisheries Habitat
  - Special-Status Species
- 4.2.3 Socioeconomic Conditions
- 4.2.4 Agriculture/Prime and Unique Farmlands/Land Use
  - Agriculture/Prime and Unique Farmlands
  - Urban Land Use

[3] This report preceded the change to a Flood Risk Management program.

4.2.5 Transportation
4.2.6 Recreation
4.2.7 Aesthetics
4.2.8 Noise
4.2.9 Hazardous, Toxic, and Radiological Waste
4.2.10 Cultural Resources
Prehistory
Ethnography
Records and Literature Search
4.3 FUTURE WITHOUT-PROJECT ASSUMPTIONS
4.3.1 Geomorphology
4.3.2 River Hydraulics
4.3.3 Flood Management
4.3.4 Water Quality
4.3.5 Air Quality
4.3.6 Biological Conditions
Vegetation and Wildlife
Fisheries and Aquatic Resources
4.3.7 Socioeconomic Conditions
4.3.8 Land Use
Agriculture/Prime and Unique Farmlands
Urban Land Use
4.3.9 Transportation
4.3.10 Recreation
4.3.11 Noise
4.3.12 Hazardous, Toxic, and Radioactive Waste
4.3.13 Cultural Environment

This is not a scenario. There is no framework here. There is no plotline evident. It does not tell a cause and effect story of the future, and it does not address uncertainty systematically. What it does is assemble a number of disparate facts, assumptions, and opinions and dumps them in a series of more or less unrelated paragraphs in a single section of a larger report. It reads more like a NEPA[4] checklist than a vision of the future. It also confuses the notion of existing conditions and future conditions without action by the planning partnership. More than likely this section outline follows the template of a previous report from the District that successfully navigated the Corps' review process.

Scenarios are not analyses, predictions, or an assembly of facts. No one is seriously concerned about the future geology or air quality of the area. Land use and river hydraulics are not the independent topics they appear to be in this outline. Where do we go to learn about the future flood risk and ecosystem conditions in such an outline?

What we want to know is what are the problems and opportunities in the study area going to look like in the future? How are community's values going to be affected by and affect those developments? What is it we do not know about the future that we need to know in order to make a good decision in the present? What is driving all of this uncertainty about the future?

A good without condition needs to meet two sets of criteria. First, it must meet the needs of the planning investigation. That means it has to provide useful information about the decision context of the planning study. It must inform decision makers and the interested public about problems and opportunities,

[4] National Environmental Policy Act

objectives and constraints, and decision criteria. Second, it must be a good scenario. To do that it must address the future and its inherent uncertainty. Saritas et al. (2010) suggest that means considering trends, drivers, wild cards, discontinuities, and weak signals (These are addressed in detail in Appendix A.) These two ways of approaching the without condition scenario are conceptually illustrated in Figure 4.1.

	Trends	**Drivers**	**Wild cards**	**Discontinuities**	**Weak Signals**
Problems					
Opportunities					
Objectives					
Constraints					
Criteria					

Figure 4.1: Cross Impact Matrix of the Decision Context and A Scenario Construction 'Big Picture'

A good without condition scenario will describe in broad terms what each problem looks like in the future without any planning alternatives implemented. If it is a flood risk management issue, is the problem getting better, worse or staying the same? Why? Forget the analytical details for the moment and tell the flood risk story. Next, address the opportunities. What has happened to them over time? Have they disappeared, diminished, remained, or multiplied? Opportunities for ecosystem restoration might disappear or diminish if land is developed or water resources are depleted. These are some of the broad aspects of the plotline your without condition scenario should address.

Second, turn your attention to the planning objectives. These objectives reflect community values and significant resources that are important to the planning team and stakeholders. Are these values enhanced or reduced in the future if no planning action is taken? Why or why not? Focus on the story and its logic. Do the same for constraints. Will important social or resource constraints be violated in the without condition scenario?

Third, your without condition scenario should consider the decision criteria. These are likely to involve very specific analytical results that are not really part of the scenario forecast narrative. Remember, the scenario is the framework for the future within which you do your analysis. First, you develop the scenario then you do your analysis inside that scenario to quantify it. Decision criteria are usually part of that quantification. For flood risk management it will include expected annual damages and lives at risk, for example. An ecosystem restoration study may include estimates of habitat loss. Both of these will require detailed hydraulic and hydrologic analyses.

The without condition scenario sets the assumptions and lays out the story line, identifying the key uncertainties while doing so. Thus, the scenario must be broad enough to anticipate and accommodate the subsequent analysis of decision criteria. So, for example, if you know that the social vulnerability of a flood prone community is going to be important the without condition must be broad enough and complete enough to support that subsequent analysis.

Integration of these details into a coherent scenario is a critical step. In essence the output of this task is a newspaper article length and style story describing your future scenario. Initially integrating the details means telling a good story well. Every good story you have ever heard has a motivating beginning, an engaging middle and a satisfying ending. Tell your story of the future in the same way.

It helps to have a theme, i.e., something important the story is telling us. Let the theme grow out of the scenario, do not preach it. The plotline is about the struggle or conflict in which the main characters are involved. The problems and opportunities will hand you your plotline.

The main characters (e.g., stakeholders, natural resources, ecosystems, human communities and the like) usually win or lose something in an engaging story. Your objectives and constraints will help you identify the treasures there. Know your characters well before you start writing. Tell the story in a time and place and in a style and tone that will appeal to your audience, which is usually the community, but it also includes decision makers. Write to inform not to impress, it rarely hurts to use simple words and simple sentences.

Good stories often involve a mystery. The planner's mystery is that there are things that we do not know about our problems our objectives and our decision criteria. This is an essential element of your scenario. Do not ignore the most important uncertainties.

Story telling will get you to the initial and most important level of integration. In subsequent iterations of your scenarios, when you begin to analyze the problems and opportunities and to measure progress toward objectives and constraints, when you describe and quantify decision criteria integration moves to a new level. This is the quantification of your scenario.

4.3 A Few Details

Who prepares the scenario? For what area is it prepared? How long is the future? A few practical generic considerations are covered before we develop a specific approach for building a scenario.

4.3.1 Who Prepares the Scenario?

Ordinarily we expect the planning team or some subset of it to build the without condition scenario. Generally, the scenario building team should not be much more than a dozen or so people. In a large planning study this will be a subset of the team. The group should at least be multidisciplinary. An interdisciplinary team is the goal and a transdisciplinary team is the gold standard. Every once in a while the scenario will be influenced by decisions made outside the planning team. Law and authority must be respected. However, neither law nor authority exempt a planner form the responsibility to tell the truth about what is known and unknown about the future. In those rare instances where people outside the planning team will construct the scenario, they are going to need guidance, objective information and good advice. In other words, the planning team is always going to have a critical role in the development of a without condition scenario.

4.3.2 Where is the Future?

The natural answer here is that you are concerned about your study area, a watershed, the tributary area to a port, a community, or some such identifiable region. That is most often going to be the right answer. However, the drivers of your uncertainty may be regional, national, global, planetary or even larger in scope. Climate change has sensitized all good planners to the possibility of factors outside the study area having a significant impact on the future. Your scenario should focus clearly on your study area, but constructing the scenario may require a much larger point of reference.

4.3.3 How Long is the Future?

It is common Corps practice to use a 50 or even a 100-year planning horizon. When you build a scenario you are describing the future. But what future should you describe? How far down the time horizon should you be looking to construct your without condition 3, 10, 20, 50, 100 years? The answer is your scenario should describe a time that is just beyond where you can see to comfortably. It is not necessary to describe the future 50 years from now or 100 years from now. It may be sufficient to choose a number of years into the future where the uncertainty becomes a significant concern[5]. So, for example, if climate change and sea level rise are your greatest concerns you are looking at a more distant future than you would be if the mottled ducks are dying as we speak. Sometimes your without condition scenario is five years off, sometimes it is fifty years off.

No doubt you are disappointed with that guidance, having hoped for something simpler like the last year of the planning horizon or half way to the end of your planning horizon. One of the major purposes of a scenario is to avoid getting the future wrong in fundamental ways. In a dynamic planning environment that can happen well before the end of a planning horizon. If the future is uncertain ten years out then a ten-year scenario may be sufficient.

4.4 A Practical Approach

There is no one best way to build a scenario. The scenario planning and futurist literature is littered with approaches and you may take your pick. An academic literature search on the terms *scenario building*, *scenario forecasts*, and *scenarios* will quickly fill your larder. The approach presented here is an adaptation of Ralston and Wilson (2006) to better suit the Corps more traditional single most likely future condition style of planning. Presuming a completed first step in the planning process and the gathering of available evidence, the basic steps of this approach to developing a without condition scenario are:

1. Develop the decision context.
2. Identify key decision factors.
3. Assess key decision factors.
4. Identify the forces and drivers that will determine key decision factor outcomes.
5. Fill data gaps where possible.
6. Assess the forces and drivers.
7. Identify the axes of uncertainty.
8. Decide how many scenarios you need and integrate the details into a scenario logic.
9. Write the scenario.
10. Conduct analyses from within the scenario.

It is suggested that these steps be formally addressed in meetings devoted specifically to each task.

4.4.1 Develop the Decision Context

Step One in the planning process establishes the decision context. After the initial iteration of this step you should have a clear statement of the problems to be solved and the opportunities to be attained. Your planning objectives should identify the things that are important to people. Planning constraints will identify those things it is important to avoid doing. Best practice planning will also preliminarily identify the decision criteria. These are the criteria upon which the choice of a plan will be based and they may include such things as net NED benefits, costs, and specific environmental impacts. The

[5] Benefit analysis of Corps navigation studies has been limited to a 20-year projection for quite some time, precisely because it is impossible to see 50 years into the future.

decision toward which the planning team is working is what, if anything, to do about the problems and opportunities identified in the planning process.

These outputs of the planning process identify the focus of the without condition scenario. They will identify those things that are to be included in the scenario as well as the spatial and temporal scope of the scenario. The purpose of the without condition scenario is to describe the future course of the problems, opportunities, objectives and constraints if the planning partnership takes no steps to alter the course of the future.

The logic chain for the planning process is if the without condition scenario reveals a future that is not desirable, plans can be formulated to alter that future and better achieve the objectives of the community while avoiding the constraints. When the objectives are achieved and the constraints are avoided the identified problems will be solved and the opportunities attained. Decision criteria will be used to determine if progress toward the objectives is sufficient to justify taking positive action. There are to be no default assumptions for describing this future. Planners are not to be conservative or liberal in their assumptions. They are to be objective and objective about their uncertainty as well. If there is an unconstructed but authorized project in the study area, for example, do not automatically assume it will be constructed because it is authorized.

The output of this task is a clear list of problems, opportunities, objectives, constraints and decision criteria to be addressed by the without condition scenario and the analysis done within it.

KDF's for Flood Risk Management

Imagine you could brainstorm questions for an oracle to answer about your planning study; some clusters of questions might look like those below.

Cluster: Flows

What will be the largest flood in the next century?

How many floods will get far enough out of bank to cause damage?

How much of the watershed will be developed in the future?

Cluster: Property Damage

Will the town's floodplain economy thrive or deteriorate?

Will the factory close?

Will the slum areas gentrify?

Cluster: Social Vulnerability

What will the median age look like?

Will per capita income increase or decrease?

Will the minority population grow or decline?

4.4.2 Identify Key Decision Factors

Decision factors are events or outcomes in the future that we would like to know more about in order to improve the quality, relevance and efficacy of our decisions. Key Decision Factors (KDFs) are the most important factors that are outside the control of the decision makers that will affect their decisions. They are not the decision criteria themselves as much as factors that affect the problems, opportunities, objectives and constraints. One of the distinguishing characteristics of the KDFs is that they are external to the planning study and essentially uncontrollable. This does not mean that internal and controllable factors are unimportant. In fact, these controllable factors are expected to become essential elements of the plans that will be formulated to avoid undesirable futures without action by the study team.

How does the team identify these KDFs? The most effective way is to brainstorm them in a workshop scheduled specifically for this purpose. Assuming everyone is well aware of the decision context, you might begin by asking everyone a seed question.

What external issues (i.e., factors beyond your control) concern you the most? If there was an all-seeing oracle what question about the future would you like to ask?

You can ask these or other questions for each of the problems, opportunities, etc. At this point, your goal is to identify as many KDFs (external issues, questions, and so on) as possible. Have participants write their KDFs on an index card, putting any necessary details on the back of the card. Once the idea generation stage of your brainstorming session is completed examine the answers to your seed questions and begin to cluster them by topic or focus. Give each cluster of ideas a descriptive title.

The output of this step is a list of KDFs organized into clusters.

4.4.3 Assess Key Decision Factors

Table 4. 1: Generic Examples of Forces and Drivers

Social	Stakeholder values, needs, wants, beliefs and preferences Psychographic profiles of various publics NGOs, public interest groups, affinity groups Social vulnerability of affected publics Social issues of concern
Technological	Technology infrastructure Emerging consumer technologies Emerging water resource and engineering technologies Maritime technologies Digital divide Nanotechnology and genetic modification Basic research needs
Economic	Macroeconomic performance-GDP, inflation, balance of trade, unemployment National economy Regional economic performance-key sectors, markets, competition, economic base Infrastructure conditions Tax base and tax policy Income base and distribution Labor force structure and trends
Political	Political attitudes and issues Political parties Quality of government Fiscal responsibility Community activism
Demographic	Population growth Age, family size and structure, ethnicity Education levels Migration patterns Immigration and illegal aliens
Ecosystems	Environmental policy Sustainability and biodiversity Threatened and endangered species Water quantity and quality HTRW status and trends Pollution
International consideration	War and terrorism Globalization International trade patterns Strength and role of dollar Protectionism
Natural resources	Energy sources, prices and policies Resource reserves Resources prices Land use

Identifying KDFs is an exercise in divergent thinking. It is intended to get as many ideas out on the table as possible. It is not unusual to identify dozens of questions or KDFs in a brainstorming session. Assessing KDFs is a convergent thinking process. The process of clustering the KDFs and naming them is the first step toward identifying the most significant KDF clusters.

Once you have identified the clusters the team needs to identify those they believe will have the biggest impact on the success or failure of any decision (i.e., the performance of a plan) they make.

The output of this step is a clear identification of the most important KDF clusters. These clusters tell you where your scenario should focus. Think of them as section titles or headings in your scenario narrative. These clusters also help planners identify key areas of uncertainty that the scenarios will need to address. The significant KDF clusters are the external issues the without condition should address. Thus, the scenario for the flood risk management example of the textbox would include a description of flows, property damage and social vulnerability.

4.4.4 Identify the Forces and Drivers That Will Determine Key Decision Factor Outcomes

At this point you have identified a set of key decision factors that are essential to understanding your decision context. What the study team wants to know is what are the forces and drivers that will determine the outcomes for the KDF clusters you have identified. Think of forces as things beyond the control of stakeholders in the planning investigation and drivers as those things they can control or at least influence. Alternatively, think of this task as identifying the kind of information that would enable you to answer the questions asked of the oracle.

For our example, this means what forces/drivers will drive the flow considerations? This might include such things as climate change, sea level rise, zoning regulations and building codes for new development, jobs and income in the watershed that could influence future building and construction, channel constrictions and the like. Property damage may depend on the political party in power, the national economy, the success of new free trade zones, education levels in the watershed, and so on. Forces and drivers are identified for each KDF.

Once again, the task is to brainstorm the forces and drivers that will shape the future you are trying to describe. The forces and drivers we speak of are the trends and uncertainties that provide the foundation or underlying structure for the without condition. These forces and drivers include trends, conditions, factors, events, wildcards and shocks, discontinuities, weak signals and similar things that deserve consideration.

This step is akin to the external analysis of strategic planning and there are many methods for conducting such a scan of external environment forces. One method was suggested above, identify forces and drivers for the KDFs, and then group them into macro- and micro-environmental categories. An alternative and one of the more common schemes is SEPT, which categorizes forces by social, economic, political, and technological causes. This begins with some recurring macro-environment groups of forces and drivers and drills down to the micro-level. Ralston and Wilson have supplemented this scheme adding forces from demographic, natural resources, ecosystems, and international conditions. The preceding textbox provides examples of generic forces and drivers that might arise in water resource planning in the right column. The macro-environmental level includes broad national or global contexts in which these forces evolve. The micro-environmental level forces are more study area specific forces.

It is better to over-identify these forces and then to winnow them down to key areas of uncertainty than it is to underestimate these forces. A simple way to proceed is to simply ask, "What forces and drivers will influence H&H (i.e., force/driver number 1, 2, etc.)?" Ralston and Wilson have suggested that as a person identifies a force/driver they should complete an index card with the following information.

- The name of the force or driver
- One sentence describing it
- Possible future outcomes for the force or driver
- Identify what the force/driver will influence (tie it to a KDF cluster)
- Identify what influences the force/driver

Give the group 10 to15 minutes to identify forces/drivers in this way and then begin to ask each person to briefly describe their most significant force until all the unique forces have been identified. This is a divergent thinking task. As the forces are identified the team leader can begin, with the help of the group, to organize them. What you are trying to do in this step is to identify and map the major external forces that will affect the success or failure of your problem solutions and opportunity strategies (i.e., your plans). It is essential that the planning team spend face-to-face time to take advantage of the synergistic synthesis and creativity that is only possible when people spend time working together.

Once the team has identified the major forces and drivers that will determine how the KDF clusters will play. This task is complete.

Table 4.2 shows examples of the kinds of forces and drivers that might emerge in a flood risk management study like the Elliott City example of Section One. Many of these forces and drivers will be well known to the planning team. Others will be a mystery. Notice that the forces/drivers have been organized in clusters of related forces.

Table 4.2: Hypothetical Forces and Drivers in a Flood Risk Management Scenario

Land Use and Development	Property Values	Hydrology and Hydraulics
Growth projections (and associated land use conversions)	Depreciated structure values	Future stream conditions
Future land use	Square footage	Precipitation
Flooding potential	First floor elevations	Flooding potential
Urban development/encroachment	Structure values	Storm frequency events
Future growth rate	Content values	Future changes in H&H without project
Development activities	Land value	Hydrologic estimates of runoff (i.e. modeling)
Economic conditions	Agricultural crop patterns	n-values for floodplains
Community follows master plan	Crop yields/productivity	Cross-sectional changes to the channel geometry (changes in hydraulics)
Land use changes	Value of property in floodplain	Percentage impervious surface
Land use mix	Damage surveys	Rainfall
Zoning regulations	Expected annual damages	Runoff
Building codes	Real estate	Hydrographs
Political party in power	Jobs and income	Flow regimes
	National economy	Frequency curves
	Success of new free trade zones	Rating curves
	Education levels in the watershed	Climate change
		Storm frequencies
		Sea level rise
		Channel constrictions
		Erosion rates, land loss
		Vegetation

The outputs of this task are the cards describing the forces and the group's organizational scheme that has, in effect, separated them into like piles. This provides a basic map of the forces and driver's that will determine the study area's without condition scenario. Drivers and forces are an important enough subject to be taken up in more detail in Appendix A to this guide.

4.4.5 Fill Data Gaps Where Possible

At this point it is likely that team members will have an uneven understanding of the different forces and drivers. There will likely also be some critical new data gaps. This is the time to prepare simple focus papers[6] for those forces and drivers that are largely uncertain. This will require additional analysis by the planning team.

[6] The idea of a focus paper is a flexible one. Not every uncertain force/driver will require a focus paper. Some of the uncertainties may be resolved with a phone call. The idea is to resolve or reduce as much of the uncertainty as possible by any means possible, documenting the more important topics.

Ralston and Wilson have suggested these papers might address the following:

- The apparent trends in a cluster of forces
- Major uncertainties about how these trends might change in the future
- The impact the force clusters will have on the KDF clusters

This task simultaneously reduces and illuminates the uncertainty in your without condition scenario. The output of this task is a series of focus papers that explain forces that are not clear to all. In so doing, the papers provide not only a common understanding of a force but its attendant uncertainty as well.

4.4.6 Assess the Forces and Drivers

In this step planners rank and sort all of the forces/drivers. Discerning which of the forces/drivers is most important to determining the future is a fundamentally subjective process. It requires judgment and resolution of differences. This is important to understand. It is not an objective search for a knowable answer. That is one reason it is important to base the process on as much sound evidence, logic and transparency as possible.

To this point the process has focused on identifying environmental forces that must be considered in the without project condition scenario, judgment of these forces has been suspended. Done well, this brainstorming process could identify many dozens of forces and drivers and it is clearly impractical, if not impossible, to consider them all in the without condition. It is equally clear these forces will vary in both the extent of their uncertainty as well as their importance to the future planners seek to characterize.

In order to move to the work of developing the without condition planners must assess the forces and drivers. This is a critical step that has been often missed in the past. A major purpose of the without condition scenario is to make uncertainty about the future explicit. Thus, the purpose of this assessment task is to eventually identify those uncertainties that will form the basis for the without condition scenario.

The impact and uncertainty matrix of Figure 4.2 is one tool that has been used to assess the importance of a force or driver to the decision context as well as the degree of uncertainty about the range of future outcomes. To successfully use the matrix it is critically important that everyone share a common understanding of the matrix's row and column dimensions. Importance or impact is related to the force/driver's influence on future outcomes of the key decision factors you identified earlier in the process. If stream flows, property damage and social vulnerability are among the key decision factors that will figure in your decision making then you want to identify those external forces and drivers that will have the greatest impact on these three factors. Table 4.2 above provides a partial example of these forces.

Level of impact or importance	Degree of uncertainty		
	High	Medium	Low
High			
Medium			
Low			

Figure 4.2: Impact and Uncertainty Matrix a tool for Assessing Forces and Drivers

Uncertainty is a difficult idea to be clear about. For the purpose of using this matrix, however, uncertainty means the extent to which future outcomes of the key decision factors are not predictable. If there is widespread agreement on the outcome of a force on a decision factor, that is low uncertainty. If the team disagrees on what the outcomes might be there is medium or high uncertainty depending on the extent or range of possible outcomes envisioned by the team. Consider sea level change as an example. Suppose the team's range of opinion is between no change and a 7 meter increase. This is high uncertainty. Bearing in mind that no effect (e.g., no change in sea level) is often a possible outcome, the mindset rating the uncertainty might be would you bet your house on any one particular outcome? If not, there is medium to high uncertainty.

The use of this matrix is quite simple in concept. The team, in another workshop, takes the list of forces and drivers from a list like that in Table 4.2 and sorts them into the cells of the matrix. Thus, climate change, sea level change, zoning regulations, building codes, jobs and income in the watershed, channel constrictions, the political party in power, the national economy, the success of new free trade zones, education levels in the watershed, and every other force/driver identified is pigeon-holed in a cell in the matrix. Next, planners take the elements in each cell and rank them. It is important to do good work on this task but it is just as important to bear in mind there is not a right answer for this task and the planning team's judgments can always be vetted by interested stakeholders.

It can be helpful to establish a threshold for the maximum number of high importance/high uncertainty forces identified in order to force the team to discriminate carefully in their assessment of the forces. Ralston and Wilson suggest a maximum of 25 percent. Only the high importance and high impacts forces will be used to develop the without condition framework. Some of these will form the basic storyline and its logic. The other forces are not ignored; they can be used to fill in the details of the scenarios or in the analysis done within them later on in the technical analyses of the planning process.

It is recommended that the impact/importance of the force be assessed first. If you assess uncertainty first and a force is judged to be very uncertain because the range of uncertainty is great and includes *no change* as a potential outcome, as was the case in the seal level change example above, some may think no change is the most likely outcome. Then when the team moves to consider the impact it may result in a downgraded assessment of the impact. For example, if most people believe the likelihood of sea level rise is very small, they may be influenced by this and consider the impact to be low. Whereas, if the team considered only the impact of sea level rise, it would surely be high. So, begin by assessing the impact and then the uncertainty.

One effective technique for proceeding is to ask each team member to identify no more than five high impact forces. Going around the room each planner identifies the forces they chose. Once all have been identified the team is invited to disagree with any of the nominations. If consensus can be reached on disagreements the list is adjusted accordingly by demoting forces no longer considered high impact. If not, more formal consensus building techniques like strength of belief voting schemes may be required. An alternative approach, when the number of forces is reasonable, is to rank each force and discuss them individually with the goal of reaching agreement on an importance and uncertainty rating for each.

The output of this task is a list of the five or so most important high impact/high uncertainty forces. These should be those forces that can lead to the most significant differences in the future, differences that could affect our decision factors and our decision. For one study it might include climate change and sea level rise for another study it might be a commodity forecast.

4.4.7 Identify the Axes of Uncertainty

This is the long awaited heart of the scenario building process. The first goal of this step is to determine the scenario logics. This is a term of art that defies easy definition. You have identified some forces that are high impact but reasonably certain (i.e., low uncertainty). You are looking for a logic that sums up the impact of the most important forces you have identified that have high uncertainty. An example might be a climate change logic vs. a no climate change logic, or a normalization of trade with Cuba vs. no normalization of trade with Cuba. In some studies with relatively low uncertainty the logic may come down to high commodity forecasts vs. low commodity forecasts. This is the essential task where you will learn if you can move forward with a single without condition scenario or if you need multiple scenarios and scenario planning.

Imagine that we have looked at all the high impact/high uncertainty drivers for Elliott City and come up with the regional economy (a combination of land use and development and property values) and the hydrologic regimes as the two axes of uncertainty as shown in Figure 4.3.

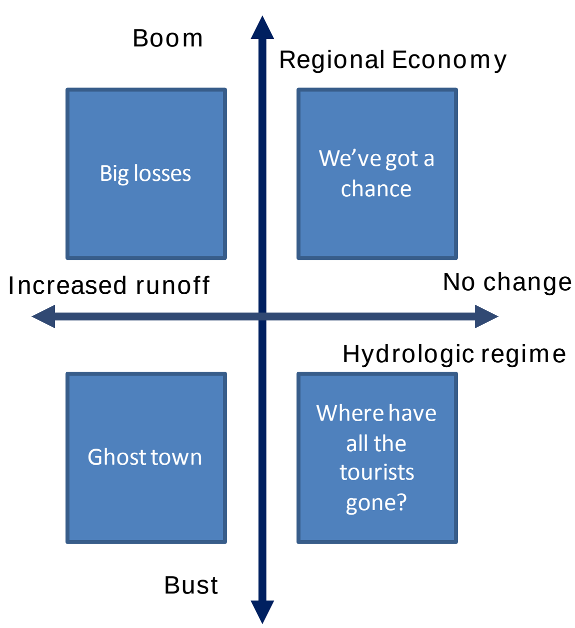


Figure 4.3: Scenario Planning Logics for Elliot City

It is common practice to look for the two most significant and different logics to frame your story about the future. Increased runoff and no change in the runoff define one logic. A booming (increased development and rising property values) and a declining (little upstream development and suffering property values) economy define the other logic. If each of these logics is considered an axis in an x-y grid they will define four quadrants as seen in Figure 4.3. The two logics form a simple map of the future broadly defining four different scenarios.

The goals of this step are four. First, identify one to four axes that encompass at least the majority of the high impact/high uncertainty forces. Second, the scenarios defined by these axes should be distinctly different from one another. If this exercise identifies variations of a central theme, that is when you know you can plan adequately with a single without condition scenario. For example, if you have four flood plain scenarios that are simply four variations on the extent of flooding in the future or, if you have four navigation scenarios that differ largely by the amount of commerce moved through the port; then you have variations on a theme.

Third, the axes need to be logical. That is, they stem transparently from the driving forces the team has identified. Fourth, although the probabilities of different scenarios are never estimated explicitly, they must be plausible. They can surprise and challenge people but they should not strain credulity. Thus, a logic that depends on Star Trek vintage transporting devices to move commerce may not be a reasonable logic. Likewise, destruction of the planet by a massive asteroid may be better left to Hollywood to consider.

If the pattern is not yet clear, this scenario construction method depends on alternating rounds of divergent thinking followed by convergent clustering of related ideas. This is done with KDFs, with forces, and then again with the uncertainty axes. Ralston and Wilson describe an exercise where all the key forces are displayed on post-it notes and team member are encouraged to move them around into logical groupings. Others react to what they see and rearrange the notes until a consensus begins to emerge. Remaining points of disagreement are resolved through discussion. The goal is to limit the groupings of forces to four or less. Each grouping is given a name to identify the theme that links all the ideas.

A logic is defined by Ralston and Wilson as a hypothesis about the future dynamics of the forces and drivers in the external environment that describes how the world will work in the future without condition. The logic is the central theme or dynamic that explains how the forces in a logic interrelate. This is plot development for story telling it is not analysis and hardcore forecasting. All the work done in the previous steps helps to shape realistic plausible logics. Plausible, as used here, should stretch the team’s imagination. The idea is to bound the uncertainty and planners are sometimes too conservative in their estimates of extremes.

If the team arrives at logics that are some version of high, medium, low variations on a theme this uncertainty can be handled in the analysis you do for a single scenario. The output of this task is a one paragraph description of each logic you identify. Thus, one paragraph describing the regional economy’s influence on the KFDs and one paragraph describing the hydrologic regime’s effects on the KDFs.

4.4.8 Decide How Many Scenarios You Need and Integrate the Details into a Scenario Logic

The goal is to develop a scenario or multiple scenarios that describe the future without condition. One of the more important decisions you will have to make is whether you can handle all of the relevant uncertainty adequately within the framework of a single scenario or if you need multiple scenarios to do so. The scenario or scenarios must describe the important trends and impacts of the forces and their associated uncertainty on KDFs. If the associated uncertainty can lead to markedly different outcomes (as opposed to variations on a theme) you are going to need multiple scenarios. Otherwise, a single scenario will do.

Most importantly, the scenario(s) must be useful in decision making. If the team uses one scenario it must adequately describe the key uncertainties or accommodate them when the scenario is quantified. If more than a single scenario is used, those experienced in scenario planning suggest a maximum of four scenarios be used. There must be enough scenarios to cover the range of relevant possible futures, one will often be sufficient in most planning contexts as long as the analysis within them is risk-based. In other words, the technical analysis done for a single most likely without condition scenario must adequately explore and address the relevant uncertainty that remains.

There need to be few enough scenarios that planners can understand and work with them all. If two or three scenarios will do the job use no more scenarios that you need. There could be a single axis of uncertainty, for example will climate change lead to significant sea level rise or not gives us a powerful basis for developing two scenarios for the without condition. Using four scenarios has helped planners avoid the good scenario/bad scenario trap and the low/medium/high trap. The number of scenarios is not based on the probability of their occurrence. We can save probabilities for calculations and forecasts made within the scenarios, scenarios are stories not forecasts.

The only time to focus on one most likely scenario is when you have one scenario. When working with multiple scenarios it is important to avoid the tendency to anoint one most probable. If one scenario provides you with good coverage of the envelope of uncertainty that characterizes the future use one, as seen in Figure 4.4 (adapted from Ralston and Wilson) on the left where the future is fairly regular and relatively easy to gage.

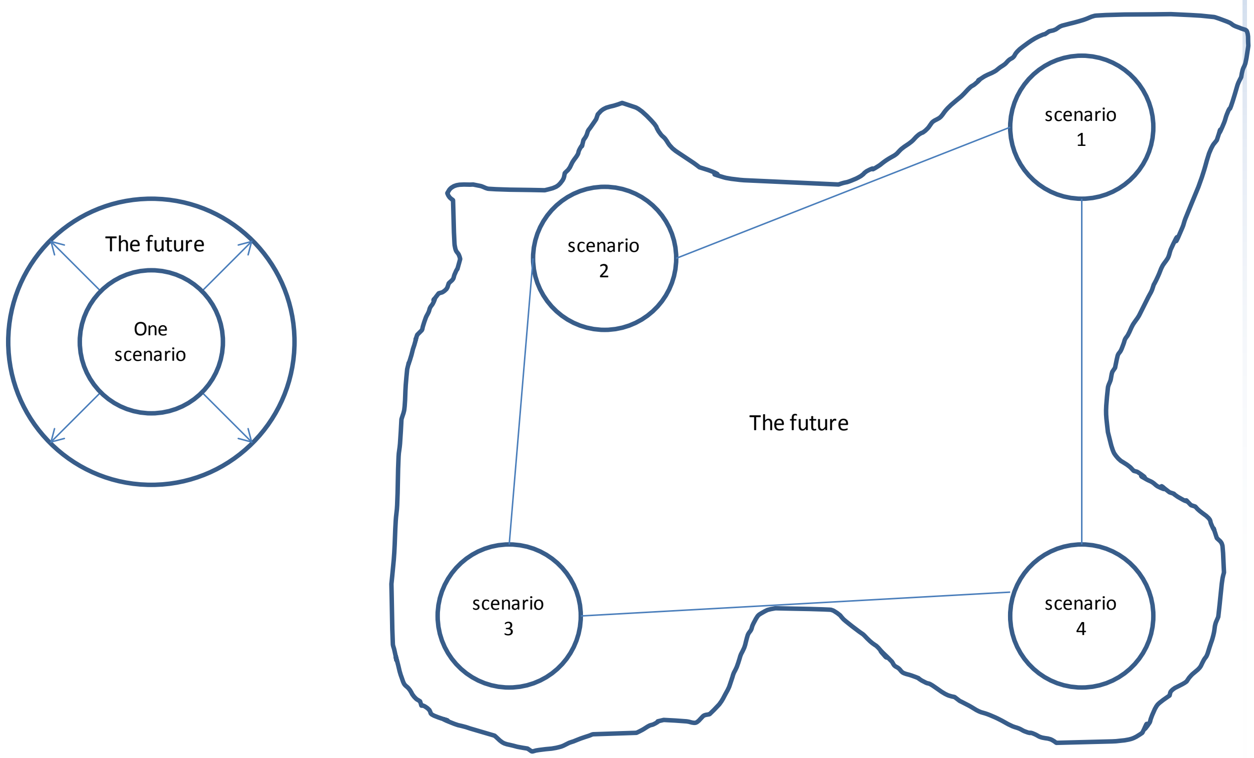


Figure 4.4: Scenarios Needed to Cover the Future's Envelope of Uncertainty

There will also be times when the map of the future and the envelope of uncertainty that covers it will be too complex for a single scenario. The irregular future on the right of Figure 4.4 represents a greater envelope of uncertainty. The scenarios chosen to represent it are selected to provide as much coverage of that future as possible. In essence, the planning team needs enough scenarios to capture all the discussions about significant forces, drivers and uncertainties that have taken place. In general, do not use any more scenarios than you need to do this well. In the Elliott City example the four scenarios, although different, are all variations on a theme of more or less flood damage. In that instance we would use a single without condition scenario.

In contrast, the Lake Okeechobee Watershed project in Florida began with a number of forces and drivers that could affect the nature and success of decisions made for the future. These included: runoff, sea level rise, the Lake Okeechobee regulation schedule, storm water treatment area dry outs, ecological response to measures taken, other CERP[1] projects, land availability, reservoir phosphorous reduction performance, and phosphorous loads. The axes of uncertainty (see Figure 4.5) identified from these drivers were runoff and phosphorous loads. Four scenarios were identified with the following logics: high runoff high phosphorous loadings, high runoff low phosphorous loadings, low runoff high phosphorous loadings, and low runoff low phosphorous loadings. This study would need to consider all four of these scenarios as they encompass different levels of flooding, phosphorous loadings in the water, water supply availability and significantly different futures for the area.

Figure 4.5: Axes of Uncertainty Forming Four Scenario Logics and Four Named Scenarios for Lake Okeechobee

The outputs from this task are two-fold. First, the team should decide on the number of without condition scenarios it will use. Second, all of the previous work on identifying the key uncertainties should be integrated into a clear scenario logic for each of your scenarios.

4.4.9 Write the Scenario

Writing the scenario is the critical integration step. This is where planners must weave the thread of the drivers and forces into distinctive patterns that describe their impact on your KDF clusters in the future without condition for the study area. Your scenario should have a plot and a storyline. Cause and effect relationships should be identified and spelled out. The scenario should see and describe the future as a whole rather than as a series of independent and seemingly unrelated trends and events. The scenario is a story that describes how the study area problems and opportunities will play out in the future. It is not an analysis.

The logics provide the outline for your story. Elliott City will face a future of more or less flood damages. It is a relatively simple problem. When there are more scenarios the stories become richer because of the differences among the scenarios.

You can, for example, start to tell the story of the Lake Okeechobee watershed if it has a run of dry years with low runoff and high phosphorous loadings to the Lake. There will be differences in floods, droughts and water quality. The story can be expanded quickly in scope and level of detail by relating some cause and effect events you have identified in the work you have done. Focusing on water quality, for example, suppose the State passes a law that requires best management practice on the farm to control phosphorous loads that reach waterways but farmers are unaware of the law or unable or unwilling to comply. With just a few cause and effect chains like this the story you tell becomes quite intricate and informative.

The scenario takes on greater meaning when specific developments are described, such as the loss of a super colony of birds because of water quality degradation. Add a dash of conflict between agricultural and environmental interests and you may not have a best seller on your hands but you will have a compelling scenario that will inform decision making.

A scenario is not a forecast. You are not saying this is what will happen. It is a simple statement that suggests given a future that unfolds like this; these are the sorts of things that can happen. A single scenario is sufficient in those planning situations where the forces and drivers are reasonably well defined and confined to variations on a theme rather than on disparate branching into alternative future.

Building on the work or Ralston and Wilson your scenario outputs should include the following:

- Scenario title
- Brief description
- Narrative
- Comparison of scenarios
- Analysis within the scenario

Generally, the team will develop the storyline and major details while one individual will do the actual writing, which the team then vets.

The title should be short, descriptive and, if possible, catchy, so it helps people to understand and remember the storyline (see Figure 4.5). The brief description is a one paragraph essence of the story. The narrative is the story, the history of the future. The scenario needs to be complete enough to support the necessary analysis and forecasting that will follow. It also has to have enough detail to support the evaluation and decision making of the subsequent steps in the planning process. The scenarios should be no more than a few pages (3 to 5) in length. Descriptions of the analyses conducted within a scenario can run much longer.

The scenarios are, as mentioned, not forecasts and you can expect their details to change as the team begins to get a better feel for the story you tell. When you use multiple scenarios, it is helpful to include a comparison table to help people understand the significant differences among the scenarios, well before analysis within the scenarios begins.

4.4.10 Conduct Analyses from Within the Scenario

With a scenario in hand, the planning team is ready to make its forecasts and to do its analysis. The scenario provides the foundation for assumptions about the hydrology and hydraulics work needed, it indicates the direction of the expected annual damage calculations and the habitat unit estimates as well as descriptions of water quality and transportation cost savings for navigation studies. It frames the team's view of the future in a coherent and unified way that supports technical analysis of an uncertainty future.

The analyses needed to forecast the problems into the uncertain future and to characterize the likely outcomes of opportunities are all conducted within the framework and confines of the without condition scenario. Planners place themselves in each scenario and do the analysis needed to describe what the problems and opportunities will look like. They do the analysis needed to characterize the state of the objectives and constraints and decision criteria that reflect the values that matter to people in each scenario.

When planners use only a single without condition scenario uncertainties are addressed through risk and uncertainty analysis of key relationships within the scenario. This means things like expected annual damages for Elliott City can be estimated using the risk-based features of HEC FDA to show the uncertain range of results. In a navigation study benefits may be estimated for high, medium and low commodity projections to explore the project's sensitivity to uncertain levels of commerce. Uncertainty in costs is characterized as are any other key uncertainties identified during the construction of the without condition scenario.

4.5 A Few Words about Forecasting Methods

In the past, planners spoke about forecasting the without condition rather than constructing a without condition scenario. Now, once the scenario is constructed, forecasts can be made within it. So let us take a few moments to consider the kinds of forecasts that might be done within the framework of a scenario. This is the part of the planning process that should be the most scientific. The scenario needs to be fleshed out and described in valid, consistent and reliable terms and that requires scientific evidence. Best practice planning demands evidence to support its scenarios. This is the major part of the initial analytical work. The methodologies and techniques required will vary from discipline-to-discipline and planning draws on many different disciplines.

Research is frequently an important part of the planning process. It is not always the laboratory experiment published research of the peer reviewed journals but the primary research of field work that ground truths what others claim. The quantitation of a scenario goes well beyond forecasting future problems and opportunities. It includes gathering, organizing, analyzing, presenting and explaining data that will be used to measure planning objectives and constraints as well as any other decision criteria that may be used throughout the planning process.

During this analytical step, analysts will identify their underlying conceptual model(s) of the future. This step is essential because it identifies the information we need to collect and analyze. All disciplines use models to organize their pursuit of information. Good analysis varies from analyses that simply extrapolate the future from past observations. It asks what is more likely than what and a planner's life becomes much more complex for doing so.

As the analysis moves from inventories to forecasting within a scenario, planners must specify the precise nature of their model(s) by identifying the variables required for their forecasts. They need to be honest about what is known and what is assumed about the relationships among these variables. Good forecasts must recognize the nature of the key variables and then apply the appropriate analytical techniques. There are four types of variables (other than the standard dependent and independent classifications) that are useful for planners to consider in this step (Wilson, 1983). Identifying the most important variables from each category is a crucial task in any given forecast?

Tangible variables can be verified physically. They usually have a high degree of predetermination and, in principle, are relatively less uncertain. Examples include topography, land use, ground cover, stream flow, distances, sizes of things and such. Some of these variables are dynamic (population data for example) others are static (size and weight of physical quantities).

Technological variables describe how technologies work. How much fuel does a ship or barge of a given size use in an hour? How much water can be released from a structure with various sized openings? How much hydroelectric energy can be generated from a turbine and so on?

Behavioral variables describe the ways people behave. They tend to be highly uncertain. Will people move into or out of a flood plain? How will they react to an energy price hike? Will they ship more or less by water? Will people be attracted to a restored ecosystem? Will farmers adopt the best available technology for phosphorous reduction just because we pass a law?

Wild card variables are sudden departures from the norm. Hurricanes, undersea oil spills, revolutions, terrorist attacks and such are examples. These are the most uncertain of all variables and they include the unknown unknowns.

The analysis done in the quantitation of the without condition scenario is the first major analytical step. It is not the only one. In Step Four of the planning process planners evaluate alternative solutions. This is the second major analytical step. There scenarios are forecast for conditions with alternative plan solutions in place.

Corps planners are, in general, very familiar with the models, methodologies and tools required to quantify a scenario. To this point, forecasting language has been largely avoided in this guide. Traditional forecasting techniques are often an important part of quantifying the without condition scenario. Changes in future runoff, in land use, in population growth, in vulnerability, in loss of habitat, changes in commerce and many other variables may need to be forecast.

Walonick (1993) provides an overview of forecasting methodologies that includes: genius forecasting, trend extrapolation, consensus methods, simulation method, cross-impact matrix method, and decision trees. When a single individual offers a view of the future based on intuition, insight, and luck, this is called a genius forecast. It covers everything from fortune tellers to true visionaries. Nostradamus is the author of many genius forecasts. The problem with them is it is impossible to tell a good forecast from a crackpot forecast until the forecast has come to pass. Planners are well advised to avoid the genius forecast.

Many forecasting methods examine trends and cycles in historical data and use mathematical techniques to extrapolate these trends to the future. These trend extrapolation techniques all assume the forces responsible for creating the past will continue to operate in the future. This is often more valid for short term forecasts than for medium and long term forecasts. The stability of the environment over time is a key factor in determining the appropriateness of this technique.

Consensus methods for forecasting are often used in the absence of better data. They involve seeking expert opinions, preferably from more than one person. A common method for arriving at a consensus forecast is to put all the experts in a room and let them *argue it out*. The Delphi method is usually considered an improvement over this more pedestrian approach to reaching consensus. It relies on well-known protocols.

Simulation methods use analogs to model complex systems. These analogs include mechanical analogs (e.g., a wave tank), mathematical and statistical analogs (e.g., an S-curve or regression analysis), metaphorical analogs (e.g., using the growth of a bacteria colony to describe human population growth), and game analogs (e.g., role playing).

The cross-impact matrix method takes into account the effect an event can have on the likelihoods of other events. It is sometimes considered an extension of the Delphi method. A matrix is constructed to show the interdependencies of different events. The set of events or trends that may occur constitute the rows and the events or trends that could be affected by them comprise the columns. Experts are tasked with assessing how the occurrence in each of the rows affects the probability of the event in the corresponding column.

Decision trees began as graphics to help illustrate structural relationships among alternative choices. Sophisticated commercial software has made it possible to create complex decision trees comprising many subsystems and feedback loops that assign probabilities to the likelihood of any particular path. Uncertainties can be explored through probabilistic methods and the use of utility theory and risk analysis.

4.6 When Is It Appropriate to Use a Single Most Likely Without Condition Scenario?

Historically, virtually all Corps planning studies have relied on the use of a single without condition description. A number of these have not been scenarios in the sense described here. Of those that were a good number were likely the only future scenario considered, hence it is difficult to know if they were truly the most likely alternative future as planning guidance has directed. No doubt a great many of these single without condition futures have been most likely scenarios. The single without condition scenario has served planning well in the past and is expected to do so in the present and future as well.

In the last quarter century or so the growing emphasis on risk-based planning, i.e., planning that intentionally addresses significant uncertainties in an explicit manner, has reoriented the planning process. At the macro-level of uncertainty increasing complexity, a rapidly increasing pace of change, and a growing emphasis on global events the fundamental direction of the future is often in doubt or hotly contested by experts on many sides. Climate change, geopolitical balances, fragile economies and financial systems, growing numbers of anthropogenic disasters, global terrorism, global pandemics, technological innovations and advancements are but some of the factors that render some future conditions impossible to discern. As a consequence, there are planning instances where it is simply not possible to adequately represent the range of potential futures with a single scenario. The futures are just too different. When the macro-level uncertainties are great, multiple scenarios may be required.

At the micro-level of uncertainty where knowledge and data are limited, models are uncertain and specific scenarios, e.g., how a levee or dam might fail, how an ecosystem function might be restored, or how an invasive species will find a pathway to a new waterbody, are uncertain it is still often possible to address all of these in a single scenario. In these circumstances the basic direction and shape of the future are relatively settled but the details of that future might vary significantly.

Section 4.4 provides a description of how to develop one or multiple scenarios. Even so, many will find the judgment call of when to use scenario planning and its multiple without conditions difficult to make.

It is reasonable to start off presuming you will use a single most likely without condition scenario for planning. The most common uncertainties encountered in the planning process are micro-level uncertainties. These can often be handled within a single without condition scenario using sensitivity analysis, simulations, probabilistic scenario analysis and other risk-based analysis tools and techniques to address the uncertain details. Let the single most likely without condition scenario be your default choice, think of it as a null hypothesis[7]. Then carefully examine your study's circumstances to try to build the best case against this choice that you can, i.e., gather evidence to try to reject the idea of a single scenario as adequate.

The evidence for multiple scenarios will be largely developed during a process like that described in Section 4.4. The case for multiple scenarios is strongest when the following circumstances hold:

- Macro-level uncertainty dominates
- The direction of the future is unknown
- A wide range of future possibilities are already recognized
- There is widespread disagreement about what the future will be like each with its merits
- Costly surprises have occurred in the past
- Failure to anticipate the truer future could render a project ineffective
- Stakeholders want to use scenario planning

Conversely, of course, when micro-level uncertainty dominates such that the direction of the future is relatively known but the details of that future are not, a single scenario will be adequate. Let the circumstances of your study convince you a single scenario is not the best way to proceed. But be sure to seriously challenge that assumption by considering multiple alternative future scenarios.

4.7 Summary and Look Forward

The without condition scenario(s) is generally prepared by the planning team for the study area. The scenario is flexibly *set* in an unspecified year far enough into the future that uncertainty has grown too great to say with confidence what the future or its details are going to look like. This is often less than the end of the planning horizon, which is usually 50 years.

A ten-step process for constructing a without condition scenario is offered in this section. It is suitable for defining a single most likely without condition scenario or for defining the multiple scenarios of a scenario planning process. It relies principally on well-defined decision context (Step One of the planning process) and the development of key decision factors and the most important and uncertain forces and drivers that will influence them.

Generally, planners will use a single most likely without condition scenario that is selected from among a number of considered alternatives. When that is not possible the multiple scenarios of scenario planning will be used. Once one or more without condition scenarios are developed planners conduct their technical analyses within the scenario(s) to adequately describe problems, opportunities, objectives, constraints, decision criteria and other effects of interest to the planning effort.

[7] The analogy of a hypothesis test is just that, a useful analogy. An actual hypothesis test is not suggested.

The next section describes in general terms how scenarios are used to evaluate alternative plans. This is done principally by distinguishing scenario analysis from scenario comparisons.

Section 5: Scenario Analysis and Comparison

5.1 Introduction

Analyzing scenarios is the source of decision critical information in the planning process. A great deal of analysis has to be done to describe a scenario. Once the scenario and its attendant analysis are complete it is time to use it for planning and decision making. When analysts begin to quantify a scenario they are quite likely to use one or more of the scenario analysis tools described here. There are three kinds of scenario analysis: monolithic, deterministic and probabilistic scenario analysis. Each is described in this section.

Once the analysis within a scenario is completed, decision critical information is obtained by comparing the various scenarios. The second topic of this section, scenario comparison, describes three forms of comparison that are used by the planning community.

5.2 Scenario Analysis

Language can be messy and confusing. Scenario is word with many contextual meanings. Thus, far we have used it to describe a narrative-like description of a possible future in considerable detail, the term is also used to describe alternative stories within this grand story. Thus, there are scenarios within scenarios. Scenario analysis as used in this section refers to the kinds of analysis used to address the key remaining uncertainty within the scenario framework, i.e., scenario analysis is applied to the scenarios within the grand scenario.

Monolithic scenario analysis is representative of decision making before uncertainty was explicitly recognized. Monolithic scenario analysis uses only one scenario for decision making. It describes what the future will look like. A single scenario is developed and presented as if it is a fait accompli. In rare instances of relative certainty a single path into the future may make sense, but this will be rare indeed.

For the last several decades the without conditions used in Corps planning studies have largely relied on monolithic scenarios. It has been common practice for planners to develop and present a single scenario as if it was fact rather than simply one of many possible story lines about the future of a study area.

The forces and drivers analysis provides a good point of reference for identifying the uncertainty in a planning investigation. Forces that have a low impact may often be fairly treated as monolithic scenarios.

Deterministic scenario analysis (DSA) defines and examines a limited number of specific scenarios. It describes what the future could look like. This can be a useful way to organize and simplify an avalanche of data into a small number of possible future states of the system being modeled. The scenarios so identified are usually chosen for specific reasons. They may be exploratory, such as with the worst case, most likely, best case scenarios; or they could be chosen for strategic or tactical reasons. For example, we might look at the effects of three different rates of funding on the construction schedule for a project. A common example of DSA is when a navigation study uses a discrete number of different commodity forecasts to estimate benefits.

There are some serious limitations to deterministic scenario analysis. Only a limited number of scenarios can be considered and likelihoods of these scenarios cannot be estimated with much confidence. The approach is, generally, inadequate for describing the full range of potential outcomes.

Probabilistic scenario analysis (PSA), on the other hand, overcomes these limitations by combining probabilistic methods, for example the Monte Carlo process, with a scenario generation method like event tree models to produce a PSA. PSA combines scenario structuring tools and probabilistic methods to produce a powerful bundle of tools. HEC FDA, IWR Plan, Beach FX and several other Corps tools are examples of PSA's. Monte Carlo simulations are another example of a PSA.

5.3 Scenario Comparisons

Candidate plans are evaluated by examining the differences in decision criteria that can be attributed to the plan. These differences are produced through scenario comparisons. Consider the example in Table 5.1. If no plan is undertaken the most likely without condition shows 1,000 habitat units but there will be no costs associated with maintaining them, as no effort will be made to do so.

Table 5.1: Simple Scenario Comparisons

	Habitat Units	Cost
Without Condition Scenario	1,000	$0
With Condition Scenario Plan A	2,500	$1,000,000
Change Due to Plan A	+1,500	+$1,000,000
With Condition Scenario Plan B	5,000	$10,000,000
Change Due to Plan B	+4,000	+$10,000,000

If Plan A is implemented habitat units increase by 1,500 to 2,500 at a cost increase of $1 million. If we compare the without and with condition scenarios we get the changes noted in the table. Plan evaluation requires planners to examine these and other differences and to judge whether these differences represent acceptable progress toward attaining planning objectives and avoiding constraints, thereby solving problems and realizing opportunities.

When a number of plans have been evaluated and found be acceptable (Step Four of the planning process) planning moves to the comparison of plans (Step Five). Plan B increases habitat units to 5,000 but at a much greater cost. Is the additional cost of Plan B justified by the increase in habitat units? Decision makers would be expected to choose the best plan based on differences revealed by scenario comparisons.

To be useful for decision makers, scenario comparisons must identify differences in scenarios that make a difference, i.e., show things that are important and that matter to decision makers. Scenario comparisons must begin by comparing things that matter, and that will usually include some comparison of decision criteria like net benefits, environmental improvements, project costs, reduced risk to life, and the like.

The complexity of some problems combined with lack of data and other uncertainties makes scenario comparison a rigorous and often difficult undertaking. There are three basic comparison methods: before and after, without and with condition, and gap analysis. Each will be considered in turn. For simplicity the example uses a point estimate for a single decision metric. A best practice scenario comparison would involve multiple decision criteria and quite likely distributions for each of them.

Outside the Corps, the most common scenario comparison may be a before and after comparison. Figure 5.1 provides an example. This takes an estimate of the decision criterion before any additional planning measures are implemented (the baseline scenario) and compares it to the decision criterion estimate that would occur under the improved conditions with the plan in place and functioning (the improvement scenario). The difference between these two estimates is calculated in a before and after comparison.

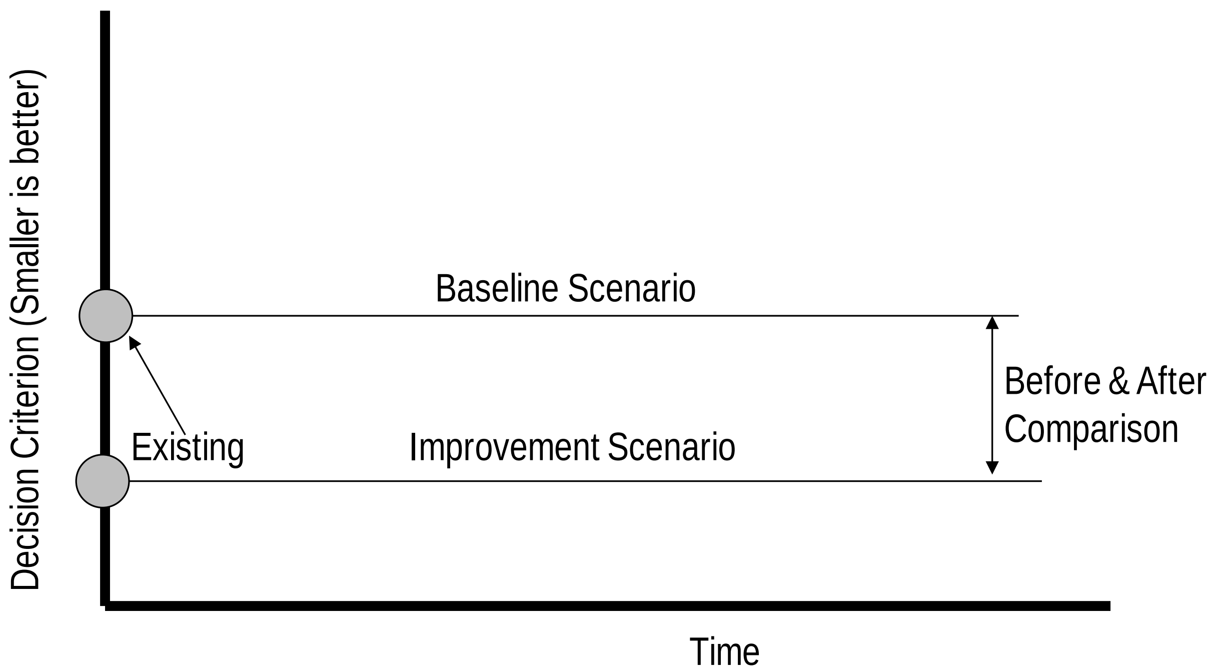


Figure 5.1: Before and After Scenario Comparison

The use of this comparison method is widespread. NEPA processes tend to favor before and after comparisons, for example. Its greatest weakness is that it does not take into account changes in the criterion over time. In dynamic systems criteria values may increase or decrease with environmental or other factors. Plan effectiveness may also vary depending on the phase-in period for the plan.

To account for these kinds of changes a without and with comparison, seen in Figure 5.2, is preferred. This example shows if no additional action is taken, the decision criterion worsens (increases) steadily over time. This represents the *without condition* for that criterion, i.e., its most likely future condition without a plan in place. For simplicity we assume the future can be represented by a single path. The concept holds for uncertain futures with multiple paths but the explanation grows more complex without adding much to understanding the basic nature of the comparison.

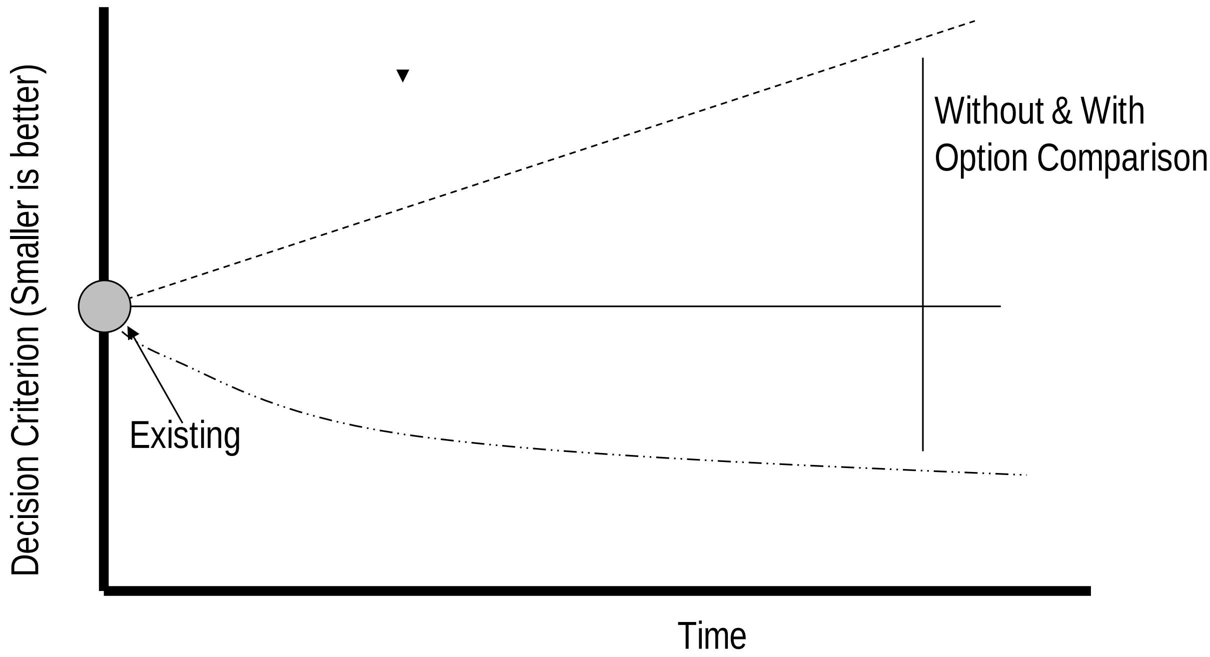


Figure 5.2: Without and With Condition Comparison

The figure shows a condition that grows worse without a plan. The path of the decision criterion's value with Plan A in place, the *with condition*, shows a future in which it takes some time to realize maximum reductions in this adverse effect. That could be because measures that comprise the plan are phased in over time or it could reflect the fact that people required to implement the plan comply at different times.

Under the without and with condition scenarios comparison a proper analysis would have to estimate the changes in the criterion over time. The original baseline estimate is still shown (the unlabeled line) to provide a reference point. If, for the convenience of this argument, we consider the baseline the before condition and the lowest position of the with condition as the after condition it is easy to see that the previously presented before and after view of the plan's performance provides a dramatically different picture than the without and with conditions comparison. In general, the without and with conditions comparison is more accurate and is preferred.

A third kind of comparison is predicated on some higher authority establishing a target or desirable level of an impact. Once a target, as seen in Figure 5.3, is established, planners try to hit the target. When the target is ambitious some plans may fall short of the target, establishing a gap between the desired level of performance and actual performance. Gap analysis is a comparison technique that focuses on the distance between the desired target and the actual performance.

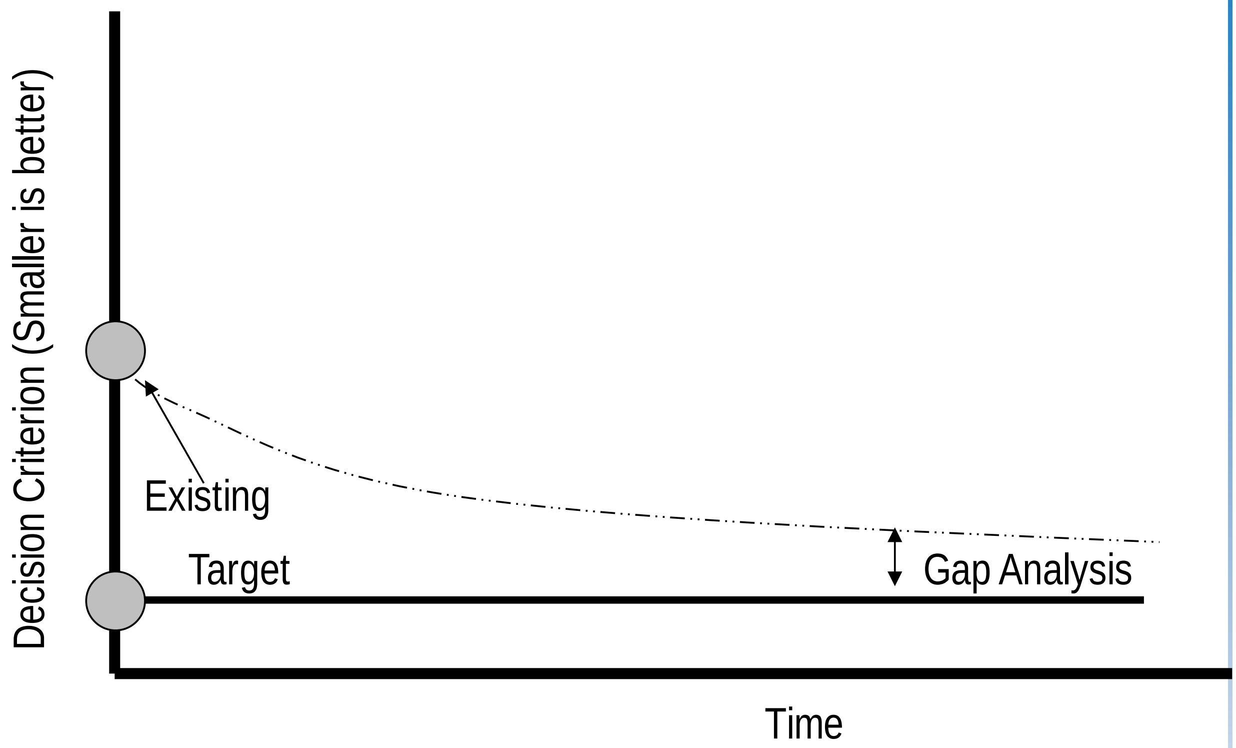


Figure 5.3: Gap Analysis

Frequently, when an option falls short of the target additional measures will be considered to mitigate this short fall. Water quality targets have often been set administratively or by legislation. Targets are not uncommon for environmental issues; they are also common organizational performance measures. Gap analysis has frequently been used in conjunction with mitigation banking for environmental issues. Note that a plan's performance could conceptually also exceed the targets.

Section 6: Addressing Uncertainity in the Without Condition

6.1 Introduction

"All our knowledge is about the past and all our decisions are about the future.[8]" What if the future is not like the past? The traditional planning approach is based on describing a single most likely without project condition and comparing it to a single most likely with project condition. In recent planning practice, experience suggests most future conditions are constructed from individual forecasts and analyses rather than constructed as coherent scenarios. It is common for planners to bundle their best efforts and endow them as *most likely*. That is a distinctly different approach than has been suggested in this guide, which is to identify reasonable future scenarios and do your analyses within them.

When it is reasonable to choose one of the constructed scenarios as representative of the future, and it often will be, then the model proposed in this guide does not differ a great deal from the common practice of using one without condition for all plans and one with condition scenario for each plan. The major difference in without condition analysis in a risk-based planning framework is to intentionally explore the significance of the remaining uncertainty in the quantitation of the scenario's problems, objectives, decision criteria and other important effects.

The single biggest methodological change in planning since the P&G were promulgated in 1983 has been the growing emphasis on being honest brokers of information. This means addressing the uncertainty that has always been part of the planning process in a more intentional manner. The evolution of the without condition from a series of forecasts to a scenario inside of which relevant analyses are conducted is primary evidence of this change.

When the future uncertainty is reasonably manageable, i.e., when the most important scenarios produce variations on a theme rather than distinctly different futures, a single without condition scenario is adequate. The remaining uncertainty, i.e., the details of that single future, can be explored using qualitative and quantitative methods in the analysis done within the framework of the scenario. Risk assessment techniques, designed to evaluate the effects of uncertainty on decision critical analytical outputs, will be useful for this purpose.

When the uncertainty driving the future is such that it can produce significantly different futures, a single without condition scenario is insufficient. In these instances scenario planning should be used. Risk assessment techniques may still be suitable for the analyses done within these multiple scenario frameworks. These two basic approaches to addressing the uncertainty in the without condition scenario(s) are the subjects of this section.

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[8] Ian Wilson January 31, 1975.

6.2 Uncertainty in a Single Scenario

If you follow the approach described in Section Four you will have already identified the most important uncertainties. These are the high impact/high uncertainty forces and drivers. Simply publishing the results of your impact and uncertainty matrix (see Figure 4.2 above) will inform stakeholders and decision makers alike about the key uncertainties in your without condition scenario. A similar approach can be taken for the with condition scenarios as well.

Identifying the key sources of uncertainty is the critical first step. This step will be of limited value, however, unless planners quantify or otherwise characterize the significance of these uncertainties for decision making. To make this discussion more concrete, let us focus on the expected annual damages from the hypothetical Elliott City example used in this guide. It is but one of many analytical results that would be important to quantify under the scenario.

A risk-informed approach should be taken when quantifying values in this uncertain future. Figure 6.1 provides an example of a risk informed approach to characterizing the flood problem via expected annual damages. Although a single scenario is used four different estimates of EAD are shown, reflecting the uncertainty revealed in the scenario development process.

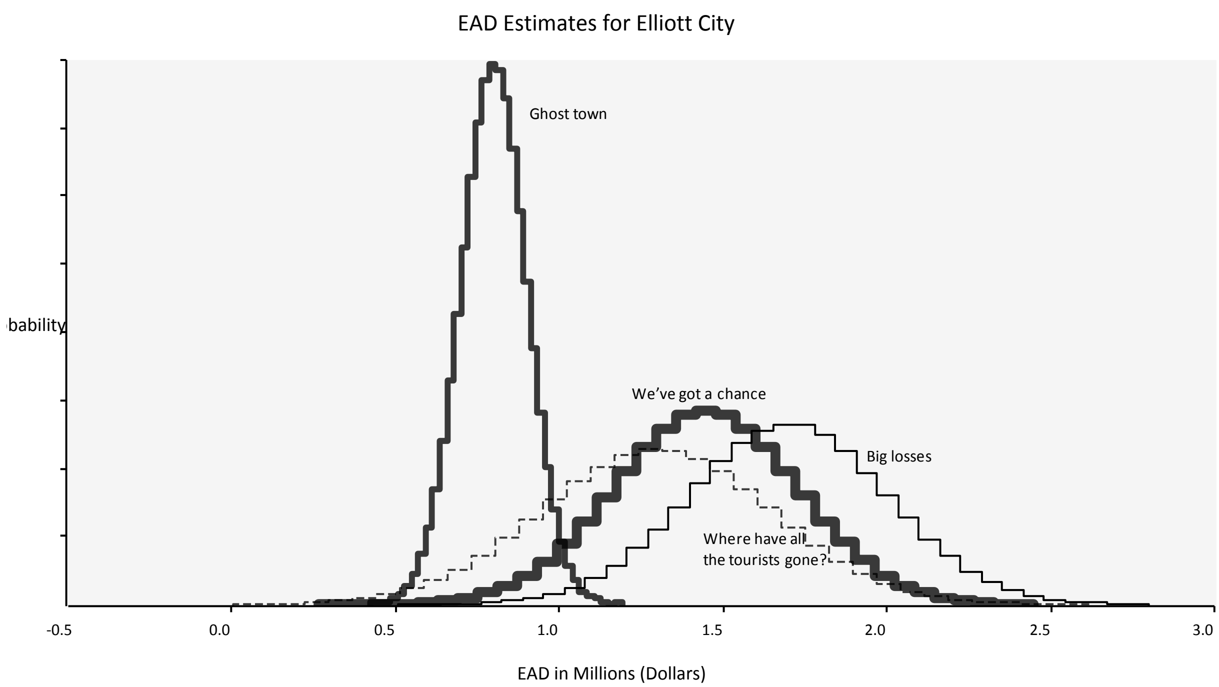


Figure 6.1: Range of Expected Annual Damage Estimates Reflecting Uncertainty in Elliott City Without Condition Scenario

Any one distribution in the figure demonstrates the uncertainty (i.e., knowledge uncertainty and natural variability) in an estimate of expected annual damages. The existence of four such distributions represents the knowledge uncertainty about how the future watershed and flood plain development and hydrology will unfold as well as the natural variability in flows and damages. A numerical summary of expected annual damages is provided in Table 6.1.

Table 6.1: Expected Annual Damages for Elliott City

	Ghost Town	Tourists	Chance	Big Losses
Minimum	$ 420,490	$ 2,792	$ 266,527	$ 507,033
1st quartile	$ 732,522	$ 1,063,894	$ 1,261,015	$ 1,497,519
Median	$ 799,957	$ 1,299,876	$ 1,449,864	$ 1,699,942
3rd quartile	$ 867,441	$ 1,535,998	$ 1,638,706	$ 1,902,313
Maximum	$ 1,190,149	$ 2,624,839	$ 2,449,759	$ 2,796,883

Such a table clearly conveys the fact that planners really are not sure what the future flood problem is going to be like without a plan in place, as characterized by expected annual damages. This is the sort of analysis that can be done to characterize all the uncertain quantities used to describe problems, opportunities, objectives, constraints and decision criteria under the without condition scenario.

6.3 Scenario Planning

History of Scenario Planning

Herman Kahn introduced the word 'scenario' to its planning context at the RAND Corporation in the 1950s. The first applications of scenarios in a planning context are thought to have been in the military strategy studies they did for the U.S. Government.

By the 1960s the Wharton School's H. Ozbekahn had used scenarios in an urban planning project for Paris, France. The theoretical foundations of scenario forecasting, an important component of scenario planning, were principally developed in the 1970s. Royal Dutch Shell is regularly credited with popularizing and modernizing the use of scenario planning for strategic planning in the early 1970s (Wack, 1985a, 1985b). In fact, Wack asserts it was Royal Dutch Shell that came up with the idea of scenario planning. French (Godet, 1987) and German (Brauers and Weber, 1988) planners have also made early use of these methods. The use of scenario-driven planning spread in the 1970s and by the 1980s it seems to have emerged as a distinct field of study with an extensive literature.

Source: Yoe (2004)

What is to be done when it is not possible to identify any one of the possible without condition scenarios as most representative of the future? How do planners proceed then? One answer is to use scenario planning.

If we are brutally frank we all know any single forecast of the future will be wrong. Thus, *traditional* planning is based on what could be, not necessarily what will be. What could be is wide open to debate and we cannot ignore it because the consequences of being wrong may be serious.

Scenario planning was developed in the second half of the 20th century primarily in Europe. It grew in popularity largely as a result of the failure of traditional planning, when its deterministic view of the future failed time and time again to capture what really happened.

Scenarios are narratives that describe alternative plausible futures that are significantly different views of the future. Scenarios are not predictions or variations around a theme. Neither are they alternative forecasts of a key variable. Scenario planning is described in a rich literature, so it is simply summarized here (see textbox). More details can be found in the works of Godet (2001), Ringland (2002), Lindgren and Bandhold (2003) or Ralston and Winston (2006). The latter of these is used as the primary reference for the steps described below.

Scenario planning is to be used when a single without condition scenario cannot adequately characterize the potential shape of a very uncertain future. The prospect of scenario planning with its multiple without condition scenarios is likely to be both intimidating and frightening to planners who have no experience with it. That is understandable. Consequently, it is critically important that the planning team make a concerted effort early in the planning process to honestly ascertain whether scenario planning is warranted in the present case.

There will be some instances where the planning team knows from the outset that they are going to be dealing with multiple without condition scenarios. Coastal studies that are extremely sensitive to assumptions about sea level change provide an example. In studies where an anticipated future event could change the future from black to white, such as normalizing trade with Cuba could do for some ports, scenario planning is warranted.

In other instances it may be unclear whether scenario planning is needed or not. Section Four provides a practical approach for developing a single scenario. When that approach reaches the axes of uncertainty step (Step Seven of ten) it is time to decide whether a single scenario will do or not. If the axes of uncertainty are variations on a theme (high, medium, low versions of the same force or future) or if the axes of uncertainty turn out to be variables or single dimensioned forces, it is likely that a single scenario will be sufficient. If the alternative scenarios are genuinely different but the differences are of little consequence for decision making, a single scenario will do. It is anticipated that most Corps planning investigations will be best served by a single without condition scenario.

When they are not, however, the same practical approach described in Section Four can be used to identify the alternative strategies. Ralston and Wilson, the source of that practical approach, describe the scenario planning process in 18 steps arranged in four major tasks as follows:

I. Getting Started

1. Develop case for scenarios
2. Get executive support and participation
3. Define decision focus
4. Design process
5. Select facilitator
6. Form scenario team

II. Laying Environmental-Analysis Foundation

7. Gather data & view
8. ID key decision factors
9. ID critical forces & drivers
10. Conduct focused research on key issues, forces, & drivers

III. Creating the Scenarios

11. Assess importance & predictability/uncertainty of forces/drivers
12. ID key axes of uncertainty
13. Select scenario logics to cover uncertainties
14. Write stories for scenarios

IV. Moving from Scenarios to Decisions

15. Rehearse future with scenarios
16. Decision recommendations
17. Identify signposts to monitor
18. Communicate results

This scenario planning approach will typically result in the identification of four different scenarios. Narratives are written for each one. In the traditional practice of scenario planning, each of the four scenarios would be quantified in much the way as suggested in the preceding section.

6.3.1 Formulation, Assessment and Choice in Scenario Planning

Once you have multiple without condition scenarios, what do you do with them? The planning process proceeds as usual, although it is a bit more complex when we are honest about the things we do not know. The next step in the planning process is to formulate solutions to the undesirable conditions found in the without condition scenario.

6.3.1.1 Formulation

Formulation can, like quantitation, take place within the scenarios. Planners can *move into* an individual scenario and formulate plans based on the specifics of the scenario. This approach leads to four sets of plans. The ideal formulation process would then seek ways to merge plans from the different scenarios into robust plans, i.e., plans that will yield desirable outcomes no matter how the future unfolds. An alternative approach is to formulate across scenarios. With this strategy planners seek to formulate robust plans from the outset.

When the uncertainty clouding the future is significant and does not lend itself to resolution through robust plans, adaptive management strategies will be useful. Plans are formulated for robustness and flexible in such a strategy.

Consider Table 6.2. Let Plan One be the best plan for one scenario, Plan Two the best for the second scenario, and so on. Robust elements of a plan would form the initial phase of a plan; they would perform well regardless of the manner in which future uncertainty resolves itself. In this case measure A would be implemented first. It is part of each best plan and will perform well regardless of the manner in which the future evolves. It is a robust measure.

Table 6.2: Robust and Flexible Plan Elements for an Uncertain Future

Plan	Measures Comprising Plan				
	A	B	C	D	E
One	X	X			
Two	X		X		
Three	X			X	
Four	X				X

Flexibility follows in subsequent phases. Research, experiments and monitoring can be incorporated into a plan in order to reduce the remaining uncertainty. As this uncertainty is resolved and it becomes more clear which of the multiple scenarios the future is most likely to reflect, planners will know which phase two option is best. If, for example, the future looks like it will follow the path described in scenario three, then measure D would be the second phase of the plan.

6.3.1.2 Assessment

Assessing plans includes the evaluation and comparison steps. Assume the with condition scenarios have been completed in a similar manner to the without conditions. The assessment is conceptually simple. Planners can evaluate plans formulated separately for each scenario, separately. That means evaluation and comparison is completed for the first scenario plans, then repeated for the second, etc. The best plan for each scenario is, thus identified.

This is generally inferior to a formulation process that is guided by robustness and flexibility. In this case you evaluate each plan against every one of the four scenarios to narrow the subset of plans. Then you compare each of the surviving plans against each of the scenarios to examine the decision criteria estimates the choice decision will be based upon.

6.3.1.3 Choice

There are many conceptual approaches for selecting a plan. Four are offered here. The first looks across all four scenarios to choose the most robust plan, regardless of how they were formulated. Which plan will perform best regardless of the future that is realized? That is the best plan. This approach is based on the implicit assumption that all the described futures are equally likely.

A second approach is to designate one of the alternative scenarios as the most likely without condition and then proceed as usual through the selection process. Once a best plan is chosen you would then evaluate the recommended plan against the other three remaining scenarios. If this leads to unacceptable results in any scenario the selected plan could be reformulated to eliminate or render the undesirable effects tolerable. Alternatively, adaptive management features could be added to monitor conditions that would lead to undesirable effects and flexible adaptations to the plan could be triggered at that future point. If the selected plan cannot be fixed, another plan would be selected. The value of this approach is to anticipate the things that could go wrong so contingent risk management measures can be formulated in advance.

A third option would base the choice on the regret criterion. Here regret refers to the situation where we would choose a formulated plan that turned out to be a suboptimal choice for the future that evolves. Consequently, we would regret having made that choice.

This approach requires planners to identify the maximum regret associated with the choice of each candidate plan, then choosing the plan that minimizes this maximum regret. This decision criterion is sometimes called the minimax criterion. Suppose we have four different possible states of the world (scenarios) and four different plans. To simplify the example imagine the primary decision criterion is net benefits. Let Table 6.3 summarize the payoff for each plan and state of the world.

Table 6.3: Payoff Matrix in Millions of Dollars of Net Benefits for Four Plans and Four States of the World

Plan	State of the World (Scenario Realized) $Millions of Net Benefits			
	Scenario A	Scenario B	Scenario C	Scenario D
One	10	15	1	-12
Two	5	8	7	4
Three	-1	0	6	20
Four	-5	6	12	2

From the payoff matrix a regret matrix is constructed as shown in Table 6.4. Here is how this is derived. Look at Table 6.3. If we choose plan one and state A is realized what is the most regret we would experience? One/A yields $10 million in net benefits. No other plan yields as much, so there would be no regret. If state B is realized plan one yields $15 million, again the maximum payoff, so there is no regret. If C is realized, we get $1 million and this is less than the $12 million of plan four. So we lose and regret the $11 million loss. If state D is obtained we lose $12 million instead of gaining $20 million with plan three. This is a regret of $32 million.

Table 6.4: Regret Matrix in Millions of Dollars of Net Benefits for Four Plans and Four States of the World

Plan	Regret Matrix $Millions of Net Benefits				
	Scenario A	Scenario B	Scenario C	Scenario D	Maximum Regret
One	0	0	11	32	32
Two	5	7	5	16	16
Three	11	15	6	0	15
Four	15	9	0	18	18

The maximum regret associated with each plan is shown in the last column. Plan three minimizes our regret. If we choose plan three the worst outcome would be scenario B and we would regret the loss of $15 million in additional net benefits.

A fourth approach uses premise sets. These are sets of beliefs or assumptions (premises) about how the key uncertainties will resolve themselves These sets of premises are laid out for decision makers to enable them to choose the set of conditions they believe will prevail. The chosen premise set will then point to the best plan. In a sense this approach asks decision makers to choose the most likely scenario but it does it by narrowing the cumulative uncertainty to a few key elements, which will likely be a subset of all the uncertainty.

This approach begins like the first approach above. Plans are formulated individually for each scenario. Imagine that we have identified the best plan for each scenario (Plans R, S, T and V) and they differ substantially from one another. Choices are presented to decision makers, conditioned on a set of premises. Consider a hypothetical example like that for Lake Okeechobee.

Table 6.5: Presenting Choices to Decision Makers Premised on Beliefs About Uncertainty and Planning Objectives

If you believe…..	..and want to…	…then choose…
*State will pass water quality law *Farmers will implement it *It is a wet period	*maximize net economic benefits *maximize water quality standards	Plan R
*Phosphorous runoff will stay the same or increase *It is a wet period	*maximize net economic benefits *exceed minimum water quality standards	Plan S
*State will pass water quality law *Farmers will implement it *It is a dry period	*maximize net economic benefits *maximize water quality standards	Plan T
*Phosphorous runoff will stay the same or increase *It is a dry period	* produce positive net economic benefits *exceed minimum water quality standards	Plan V

The decision maker assumes responsibility for resolving the uncertainty when premise sets are used.

6.4 Summary and Look Forward

Risk-informed planning requires planners to honestly, intentionally and explicitly address the significant uncertainty encountered in the planning process. Uncertainty includes knowledge uncertainty and natural variability. The without condition scenario can reflect uncertainty in one of two ways. First, when the general framework of the future is relatively easy to describe a single without condition scenario is used. Section Four describes a method for developing this scenario. Section 6.2 above provides an example of how risk-based analysis can be used to reflect uncertainty in the analyses doen within a single scenario.

The second way to reflect uncertainty in the without condition scenario is to use multiple scenarios in a scenario planning framework. This is most appropriate when macro-level or other significant forces and drivers are capable of producing futures that differ by more than their details. When the fundamental framework of the future is uncertain, multiple scenarios are appropriate.

Scenario planning has not yet been applied by the Corps in many instances. Consequently, the methods that would be most useful for completing the planning steps in a scenario planning framework have not been corporately established. Several alternative methods for formulating, evaluating, comparing and choosing a plan are described in this section. The last section provides a brief look forward in the use of the without condition in the planning process.

Section 7: Where to From Here?

7.1 Looking Forward

Following Hurricanes Rita and Katrina the Corps took steps to become more conscious of risk management in all of its functions and business lines. One aspect of these changes has been to move toward risk-informed planning, i.e., planning that is intentionally oriented toward decision making under uncertainty. The approach presented in this guide is consistent with a risk-informed planning approach. As the Corps continues to define, develop, gain experience with and refine its risk-informed planning process in the years ahead, methods for addressing uncertainty in planning will become more firmly established.

At the present time there are several adequate methods for addressing uncertainty in the planning process. The exact methods preferred by the Corps for formulation, evaluation, comparison and selection in a scenario planning framework, for example, are likely to become established in the future. This is a period of experimentation for scenario planning and planners are encouraged to surface and discuss their intentions for addressing uncertainty in the without condition scenario during the planning coordination and review processes.

As this guide is written the P&G are being revised and will be replaced by the Principles and Requirements (P&R). Each Federal agency will be tasked with developing specific procedures for implementing the P&R. It is anticipated that without condition scenarios will remain an integral part of the planning process.

A draft of the P&R, expected to be close to the final version indicates that risk and uncertainty will be designated one of the general planning requirements. The draft says in part:

"…Risk and uncertainty inherent in the analyses performed as well as risk and uncertainty associated with the future conditions and potential effects of each alternative should be identified. Decisions should be made with knowledge of the degree of reliability and the limits of available information, recognizing that even with the best available engineering and science, risk and uncertainty will always remain.

Risks and uncertainties should be identified and described in a manner that is clear and understandable to the public and decision makers. This includes quantifying and describing the nature, likelihood, and magnitude of risks, as well as the uncertainties associated with key supporting data, projections, and evaluations for competing alternatives. This should also include a concise discussion of what must occur, including the related probability or likelihood, in order to realize any projections. When there are considerable uncertainties concerning an alternative's ability to function as desired and produce desired outputs, its capacity to produce potential undesired outputs, and/or the general acceptability of the alternative, then improved data, models, and analyses should be pursued…"

The methods described in this guide are entirely consistent with this thinking.

References

Aristotle. (1991*). On rhetoric: A theory of public discourse*. (G. A. Kennedy, Trans. & Ed.). Oxford, UK: Oxford University Press. (Original work published 5th century B.C.)

Börjeson, L., Höjer, M., Dreborg, K.-H., Ekvall, T., & Finnveden, G. (2006). Scenario types and techniques: Towards a user's guide. *Futures*, *38*(7), 723-739.

Fahey, L., & Randall, R. M. (1998). *Learning from the future: Competitive foresight scenarios*. New York: John Wiley.

Godet, M. (2001). *Creating Futures: Scenario Planning as a Strategic Management Tool.* London: Economics.

Lewis, H. W. (1990). *Technological Risk.* New York: Norton & Company.

Lindgren, M. & Bandhold, H. (2003), *Scenario Planning the Link Between Future and Strategy*. New York: Palgrave Macmillan.

Meadows, D., Randers, J., & Meadows, D. (2005). *Limits to growth.* London: Earthscan.

Morgan, M.Granger, & Henrion, M (1990), *Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis.* Cambridge: Cambridge University.

Ralston, Bill, & Wilson, I (2006), *The Scenario Planning Handbook.* Mason, Ohio: Thompson South-Western.

Ringland, Gill. (2002), *Scenarios in Public Policy.* New York, John Wiley and Sons.

Saritas, Ozcan, & Smith, J.E. (2010). The Big Picture – Trends, Drivers, Wild Cards, Discontinuities and Weak Signals. *Futures,* article in press available online November 19, 2010.

Schwartz, P. (1991). *The art of the long view: Planning for the Future in an Uncertain World.* New York: Doubleday.

Smith, J. K., & Deemer, D. K. (2003). The problem of criteria in the age of relativism. In N. K. Denzin & Y. S Lincoln (Eds.), *Collecting and interpreting qualitative materials* (2nd ed., pp. 427-457). London: Sage.

Tainter, Joseph A. (1996). *Getting Down to Earth: Practical Applications of Ecological Economics.* Washington, DC: Island Press.

Throgmorton, James A. (1992). Planning as persuasive storytelling about the future. *Journal of Planning Education and Research* 12(1): 17-31.

U.S. Water Resources Council. (March 10, 1983). *Economic and environmental principles and Guidelines for water and related land resources implementation studies.* Washington, DC: U.S. Government Printing Office.

Walton, John S. (2008). Scanning beyond the horizon: Exploring the ontological and epistemological basis for scenario planning. *Advances in Developing Human Resources* 10(147).

Walonick, David S. (1993). An Overview of Forecasting Methodology. Retrieved January 20, 2011 from http://www.statpac.com/research-papers/forecasting.htm

Wilson, I. (1983). The benefits of environmental analysis. In K. J. Albert (Ed.), *The Strategic Management Handbook* (pp. 9.1-9.19). New York:McGraw-Hill.

Wilson, I. (1998). Mental maps of the future: An intuitive logics approach to scenarios. In L. Fahey & R. M. Randall (Eds.), *Learning from the future: Competitive foresight scenarios* (pp. 81-108). New York: John Wiley.

Yoe, Charles. (2004). Scenario Planning Literature Review. Unpublished. Institute for Water Resources.

Appendix A: More on Drivers and Forces[1]

Drivers are those things that provide impulse or motivation for change. A driver is a force that gives motion to other forces. They can be accessible to stakeholders and this often makes them more immediate than some forces, like longer term trends. Drivers can have strong effects on stakeholders. Stakeholders usually adapt to the effects of the drivers or they may adapt the drivers themselves. Climate change is an example of a force, while energy policies are an example of a driver. The drivers for one set of decision factors (stream flows) may differ from the drivers for another set of decision factors (social vulnerability of a community). Drivers that have a lot of uncertain and high potential impact on your key decision factors are important to consider in the creation of scenarios. When these drivers or forces could lead to futures that diverge in details that are important to your decision making in a planning study, then you should resort to scenario planning.

Some examples of drivers may include such things as:

- Budget priorities
- OMB policies
- Land use policies
- Water resource policies
- Business cycles
- Climate policies and resource practices
- Renewable energy requirements
- Trade with Cuba
- Enforcement of water quality standards
- Carbon credits or efforts to reduce greenhouse gases

Drivers tend to be relatively changeable. They involve factors and forces that can change more often or more quickly than the long term trends do, for example. Stakeholder action and public decision making may influence drivers. Trends are not so easily or readily influenced. Trends once discerned may be uncertain in their details but they tend not to lead to divergent futures. The future path of a driver may be very uncertain and capable of having divergent effects on patterns of change and adaptive choices in the future. If climate change is a trend, sea level rise may be a force; climate change policy might be a driver.

Some forces are sudden and others are more gradual and persistent. Trends are more gradual forces that cause change in the environment or society. Stakeholders in a planning investigation, by themselves, are likely to have little to no power or ability to affect the direction or intensity of the impact of a trend. Trends are often discerned by detectable patterns in behaviors and variables of interest to planners.

Some examples of trends include such things as:

- Population growth or decline
- Aging population
- Gentrification of property
- Increasing incidence of terrorism
- China's growing economic influence
- Climate change
- Globalization and changing trade patterns
- Increasing interest in sustainability
- The rise of digital technology including more mobile personal computing and communications
- Increasing political polarization of views on issues.

A very different kind of force is the high consequence low probability event that is sometimes called a wild card or shock. These events are usually more plausible than likely. But they can have impacts severe enough that even if their likelihood is remote we need to account for this contingency. We have all experienced situations in our personal lives that we did not foresee. The death of a loved one, a catastrophic fire or flood, loss of health, an unexpected job opportunity, or an inheritance are but a few examples. These are powerful forces that can alter our expectations if not the directions of our lives. So the idea of wildcards and shocks is familiar to everyone.

In some without condition scenarios it may be important to include wild cards that could reshape the trajectories of KDFs. Previously unanticipated problems and opportunities, for which we are totally unprepared, may emerge. What happens if future terrorist attacks result in a decision to offload all cargo into the US at offshore facilities? What happens to Port Everglades if we normalize trade with Cuba? What happens to US ports if the northern sea passage is opened? What are the impacts of a successful cyber attack on our power grid for Corps infrastructure?

It is often useful to link shocks and trends. What could happen in an emerging trend that would inject a shock into the system? Globalization is a trend and global conflict is a shock that could seriously affect the trend, for example. Some examples of wildcards include:

- Dirty nukes found in containerized cargo
- Nuclear bomb
- War
- Cyber collapse

- A large oil spill
- A devastating natural disaster
- Significant leap in human longevity
- A visit by alien intelligence
- Proof of God's existence

The real issue is how to handle them in your scenario. This is an important part of the art of scenario forecasting. When are these wildcards plausible enough to warrant scenario planning, when do we handle them as a significant uncertainty within a single scenario, and when do we ignore them? Scenario planning is warranted when the likelihood or the consequences of such an event are unacceptable.

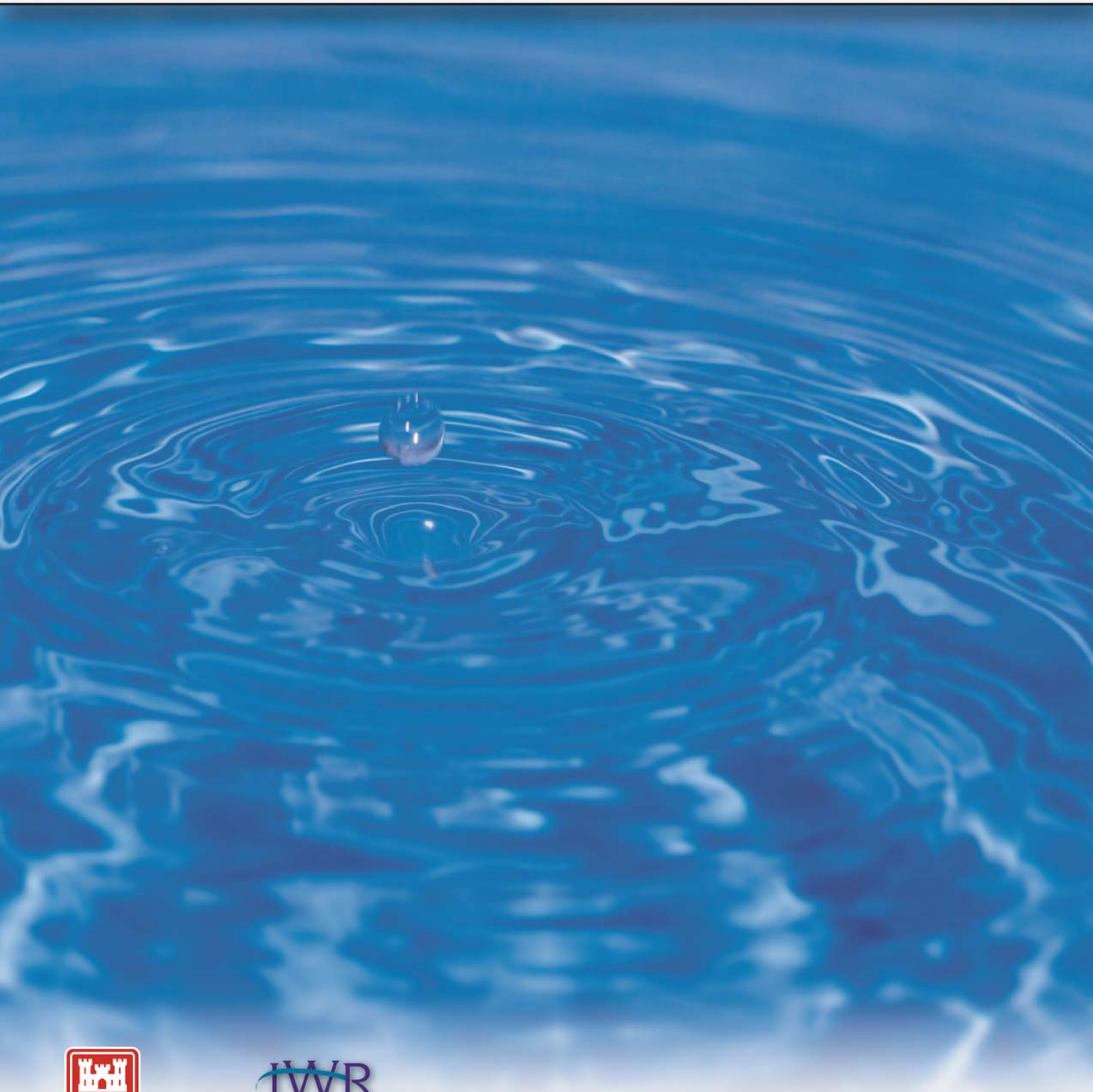
A third category of forces to consider is discontinuities. They are similar to shocks in that they can occur rapidly and can lead to shifts in future trajectories that were largely unanticipated. The major difference is that wild cards and shocks can be imagined and anticipated. Discontinuities themselves are unanticipated sudden sharp breaks that strike with disruptive force. These include the unknown unknowns. Containerized cargo, the electronic calculator, spreadsheet software, and the Internet are easy examples. The printing press changed the world and digital technology changed it again as physical printing is no longer necessary. Technological discontinuity has rendered many products and services obsolete. While districts jockey for channel deepening fund at ports, portside technology that loads and unloads containers may soon be far more important than channel depth.

Examples of discontinuities include such things as:

- Wiki environments for collaborative working
- The human genome project
- Bioengineering
- Nanotechnology
- Social networking
- Quantum computing
- Telecommuting

A fourth kind of force is the weak signal. Weak signals are the first, often subtle, indications of a change. They usually occur in areas of major uncertainty. You can think of them as the first reductions in uncertainty. They are raw information that serves the purpose of an advanced indication of change. Because the information is incomplete it is easy to miss, easy to misinterpret and difficult to read accurately. When we are intentionally looking to reduce uncertainty, however, we may be more inclined to pick up on these weak signals. They rarely exist in isolation and need to be evaluated in the context of their emergence and other available information.

Saritas and Smith (2010) cite James Hanson's presentation to the US Congress in 1988 about possible global warming on the horizon, and the speed of take up of *Mosaic* (precursor to Netscape) as the first internet browser in 1993 as examples of weak signals. The impacts of these events were hard to estimate at the time, but they can now clearly be seen as indicative of things to come. Many weak signals are easier to spot in retrospect once the change is evident. Saritas and Smith go on to describe weak signals as messages and signs usually associated with early developments in technologies, societal innovations, conflicts, origins of conflicts, and the like that are not easily verifiable from a present day perspective. The 911 Commission Report, for example, found numerous weak signals concerning the attack on the Twin Towers that were missed at the time. It is always easier to see when a neighborhood changed from good to bad when looking backward. Look for the weak signals of change in the use of a port or flood plain, the health of an ecosystem, or the decline in infrastructure performance. Learn to challenge popular explanations by looking behind the surficial reasoning. Incrementally reasonable ideas may be weak signals of something larger on the horizon. Is more invasive airport security and increasing usage of camera surveillance of citizens a weak signal in America? Is the sentiment to move away from NED-oriented planning a weak signal? Weak signals may provide you with alternative future scenarios as well as drivers.



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