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Scenarios

Imagining the Possible

THIS CHAPTER LINKS SCIENCE WITH IMAGINATION IN THINKING about the future. It explores how, by navigating through time, we can uncover our biases about what we know and explore new ways to integrate uncertainty into decision-making. I suggest that we can learn from the future, and to demonstrate this, I ask how the imaginary futures presented in chapter 1 challenge the assumptions of urban design and planning paradigms. Using a hypothetical example of the planning process that a city might employ to adapt to climate change, the chapter draws a road map and highlights key elements of a creative process for strategic foresight.

The Power of Surprise

Surprises happen in the present and change the way we think about the future. It is when an unexpected event shifts the focus of our attention and rearranges our priorities that we typically become most creative in solving problems. When we encounter unexpected circumstances, both as individuals and as communities, we tend to engage in creative actions, see a greater range of opportunities, and gain the ability to rapidly determine the most effective response. Although this capacity is widely experienced on an individual level in the setting of extraordinary events, if we look closely, we see that everyday life events in cities are also extraordinary and that creative capacity is a crucial element in the way that humans operating in uncertain conditions make decisions. The key here is the unexpected. Under such circumstances, we release both our thinking and our capacity to act from the long-held expectations and inevitable biases that bind them—and that constrain our imaginations.

Key qualities that surprise brings to life include a sudden change of viewpoint and the realization that there may be many viewpoints and temporal scales that redefine our priorities and options for action. Other qualities include curiosity, perception, and intuition. Surprise leads people to access underutilized sensors and untapped resources and to try a new focus, to narrow down the problem and figure out possible solutions. When faced with unexpected circumstances, we tend to be more open to envisioning opportunities than we might otherwise be; we are more adept at identifying multiple solutions to novel problems.

In a recent study, Stahl and Feigenson (2015) found that surprise plays a critical role in infant learning. Infants selectively explore and learn from objects that violate their prior beliefs by engaging in hypothesis testing that specifically reflects the observed violations. Here I suggest that novelty is the fundamental element of surprise that allows for change: it prompts instability but is also a key ingredient of innovation and renewal. Faced with novel conditions, humans and other organisms learn, evolve, and adapt.

Learning from the Future

It may seem counterintuitive to suggest that surprise is a key ingredient of effective planning. Yet the best way to test a plan is to see how it helps communities deal with surprise. So why not incorporate surprise into planning from the outset? Why not intentionally harness the intuitive power elicited by confronting the unexpected? How to best introduce uncertainty and surprise into strategic planning and decision-making is our next challenge. I started this book with the suggestion that through imagining the future, we can transform the way we live in the present. What do the four hypothetical futures visited by Max, the subway rider in chapter 1, teach us about planning?

In Glacial City, we see that change may occur as a dramatic shift in what a city has experienced since its birth, but we also see that climatic regime shifts do not necessarily imply the end of life. Some species may adapt successfully, and novel species may emerge. This view suggests that human agency may play a more subtle role in the future of Earth than either of the two archetypical and opposing possibilities of resilience and collapse, which may oversimplify and fall short of what is possible and desirable for the planet and the human species. At one extreme, they reflect both our fears and our overconfidence that we have the capacity to control nature; at the other, they reflect a naïvely optimistic vision of what technology and science might achieve. They do speak clearly about the limits of our collective imagination. Glacial City proposes that humans have the opportunity to lead transformation toward a desirable co-evolutionary outcome.

Empty City is an important dominant archetype in the history of planning, one that is still present in the institutional frameworks of most planning agencies and the mental models of most practitioners. It is a future that relies on the illusion of control. Despite the incontestable evidence that the strength and rigidity of control structures are failing and are, perhaps, even driving the system to failure, control often reemerges in new forms. For planners and designers, it may be difficult to fully appreciate the concepts of emergence and self-organization and to reimagine their roles accordingly. The Empty City reminds us that old paradigms challenge the process of renewal and reorganization until a new paradigm emerges.

Dream City probes the limits of our imagination. In every epoch, architects, planners, and engineers, as well as historians and philosophers, have dreamed about the city of tomorrow, from the Ville Radieuse (Radiant City) of Le Corbusier (1935) to Ebenezer Howard's Garden Cities (1902) and Frank Lloyd Wright's Broadacre City (1932). More recent dream cities may float (e.g., the Lilypad, by Vincent Callebaut) or be submerged (e.g., the "Ocean City" concept, called Syph, by Arup Biomimetics). Some are guided by a conscious intent to establish a new relationship with nature (e.g., the green cities and biophilic cities movements) or to use the most advanced technologies (e.g., smart cities).

Yet people are rarely the protagonists in such dreams. Instead they are users and spectators. In Dream City, the fantasies of architects, city planners, and technocrats have become real, but what about the dreams of ordinary people? Dream City leads the protagonist of the story to realize that our cities and urban communities are much more complex, dynamic, and abundant with possibilities than any mere idea of them could be—not because imagination has any real limits, but because once we can represent the imaginary city, it becomes part of reality.

This complex reality and the possibilities that are inextricably linked to its uncertain future are what Hybrid City accepts. In Hybrid City, surprise is part of the normal distribution of events, and uncertainty and instability challenge all the city's living organisms to evolve and reinvent themselves in the face of change. They foster learning and innovation and provide opportunities for transformation.

The Challenge

In urbanizing regions, multiple steady and unstable states exist simultaneously (Alberti and Marzluff 2004). This has profound implications for decisions about how to best respond to environmental change. At first glance, human and natural functions in an urban ecosystem may seem to be operating independently, but in reality, they are highly coupled (Alberti 2008). Consider, for example, how the built infrastructure in an urban ecosystem modifies hydrological functions. As an area becomes urbanized, humans tend to replace natural hydrological functions with built infrastructure; doing so lets them control the water flow, extract and distribute water for human uses, and purify water before it returns to natural water bodies. In this process, urbanization decreases the number and quality of natural hydrological functions and replaces them with built infrastructure that supports human functions.

The infrastructure's ability to serve multiple uses depends on the size, availability, and recharge capacity of the clean water supply. But the decline of natural hydrological function may constrain that supply. As a result of human pressure, the coupled hydrological function (both human and natural) may decline as ecosystem functions, both local and global, are reduced. The functional form of the relationships among ecosystem function, human function, and urbanization depends on the specific ecosystem functions being considered; it may also depend on alternative future conditions caused by complex interactions among drivers of change (e.g., climate or technology).

There is another factor that makes it even more difficult to model interactions among drivers and to predict potential shifts in system behaviors: their effects are both cumulative and synergistic. In general, environmental disturbances have an important impact when the factors causing them are grouped so closely in space or time that they overwhelm the natural system's ability to remove or dissipate that impact (W. C. Clark 1986). In cities, human pressure on ecosystem functions may cross thresholds beyond which stresses may irrevocably damage important ecological functions. In most ecological systems, processes occur stepwise rather than progressing smoothly, and sharp shifts in behavior are natural (Holling 1973). These related properties of ecosystems require us to consider how functional interdependencies affect resilience in urban ecosystems under highly uncertain future scenarios.

Modeling the future of urban ecosystems is challenging not only because the systems are complex and the phenomenology and modeling approaches are diverse, but also because those who participate in developing strategic foresights conceptualize and treat uncertainty differently. Many factors can exacerbate uncertainty. For example, we may not sufficiently understand a given phenomenon, or we may make systematic and random errors or subjective judgments. Natural systems can change abruptly and in discontinuous ways, and characterizing the responses of the system function involves thresholds and multiple domains of stability (Carpenter 2002; Scheffer and Carpenter 2003). Because the knowledge of environmental systems is always incomplete and uncertain, surprise is inevitable (Brock, Carpenter, and Scheffer 2006; Holling 1996), which has significant implications for planning.

Strategic Planning and Foresight

Strategic planning has traditionally relied on projections and forecasts of future conditions to assess potential risks and alternative actions. But the increasing complexity and uncertainty of decision-making have challenged the effectiveness of such approaches. Coupled human-natural systems test our traditional assumptions and strategies for planning and managing natural resources and the environment (Liu et al. 2007a). The success or failure of many policies and management practices depends on their ability to account for the complexities and uncertainty of these systems. The emergence of strategic foresight and scenario planning to address rapid environmental change is a fundamental shift in thinking about the future: from a single probable future toward a range of plau-

FIGURE 9.1 Representations of future scenarios for Seattle. Imagine Seattle fifty years from now. How will interactions among alternative development patterns, economic trends, and climate change affect ecosystem function and human well-being? Photograph: Aerolist-photo.com.

sible ones. From a theoretical standpoint, this is a shift in both the science and the practice of decision-making.

The objective of strategic foresight is better decisions, not better predictions (Dearlove 2002). Better decisions are *robust* under a range of plausible scenarios (figure 9.1). Such decisions may not be *optimal* under all plausible futures, but they will perform well across the range of plausible scenarios that might emerge (Sutherland and Woodroof 2009). Thus strategic foresight reconfigures the decision-making process (Cook et al. 2014): instead of first defining a set of objectives, it starts by framing the problem and characterizing the uncertainty in key driving variables. Focusing on the problem and the uncertainty, this process informs planners as they develop a range of plausible scenarios, prompting identification of new risks and opportunities. Perhaps the most important outcome of strategic foresight implementation is that it enables planners and managers to respond to surprise events with potentially significant impacts (Taleb 2007).

Strategic foresight identifies alternative scenarios as plausible sets of conditions from which to identify and select the most robust responses.

In contrast to traditional planning and design processes, a strategic foresight process systematically considers a range of plausible divergent futures, the hidden assumptions that underlie these futures, their potential consequences for policies and decisions, and the actions that might promote more desirable futures (Inayatullah 2005). Strategic foresight builds on what we know and simultaneously expands our mindset by enhancing our ability to keep the inevitable bias of the past from dominating how we think about the future.

Unfolding the Steps

How can we ensure that a process of creative foresight will be effective? The few practical experiments that have been documented in the literature suggest a few key elements, although researchers do not agree on a single "best" approach or offer evidence to support one approach or tool as superior to all others. The application of strategic foresight in environmental planning and urban design has not yet generated sufficient data to provide general principles. However, strategic foresight has existed since the 1950s and has been applied in a variety of fields and sectors, ranging from the military to business organization and governmental institutions (D. A. King and Thomas 2007).

Strategic foresight may involve a variety of approaches and tools (Cook et al. 2014) and is performed through several activities: (1) set the scope; (2) collect inputs; (3) analyze signals; (4) interpret information; (5) determine how to act; and (6) implement outcomes. Various approaches have been applied in different contexts, ranging from horizon scanning to scenario planning and backcasting (Godet 1986; Hines 2006; Robinson 2003; Sutherland et al. 2014), and some of them emphasize, and are generally more effective in performing, a particular step.

Setting the scope means first defining a shared problem—the focal issue—which establishes the limits of the system of interest. Then one should identify key issues and the important actors that must be involved in the foresight process. The focal issue of any foresight process guides each of the steps as well as the design of the exercise. In practice, the steps may involve a variety of approaches and tools (Cook et al. 2014).

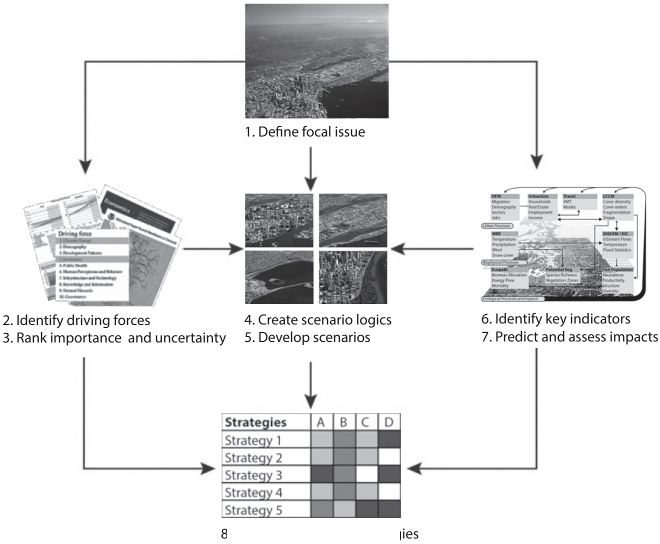

FIGURE 9.2 Scenario process and key elements. Participants develop a shared definition of the focal issue (e.g., ecosystem function) (1) based on both observations and expert knowledge to identify and rank key driving forces influencing future change (2) that are used to draw the scenario logics (3) and develop the scenario storylines (5). Indicators are selected to assess the impacts of scenarios (6) on the focal issue under predicted changes (7). Baseline scenarios and predictions are used to evaluate the efficacy and robustness of alternative strategies to address the focal issue (8).

Scenario planning is one of many approaches to strategic foresight. It involves eight steps: (1) set the focal issue; (2) identify key drivers; (3) rank the importance and uncertainties associated with the key drivers; (4) create scenario logics; (5) develop scenarios; (6) identify indicators; (7) assess implications; and (8) evaluate strategies (Alberti, Russo, and Tenneson 2013) (figure 9.2).

To demonstrate how scenarios can be used to assess alternative planning strategies, I provide an example of a hypothetical strategic foresight exercise designed to inform the development of a strategy for metropolitan adaptation to climate change (table 9.1). At the scale of a city or metropolitan area, such an exercise might involve a different scope, and thus a different set of variables and spatial and temporal scales, than would be appropriate for a regional plan for protecting biodiversity.

Table 9.1. Scenario planning elements, actions, and questions for a hypothetical city's plan for adapting to climate change

Scenario Element	**Rationale and Objectives**	**Action and Sources**	**Adaptation Plan Example**
Focal issue	Scenarios depend on the problem being addressed and the decision that needs to be made. *Develop a shared problem definition and conceptual framework to ensure that credible scenarios are developed.*	Based on a series of data, observations, historical documents, and expert knowledge, the scenario team identifies key drivers and processes and the relevant temporal and spatial scales at which they operate and interact.	• Which critical decisions face the city in the next 50 years? • Which key drivers of land use and climate change will affect the city ecosystem functions over the long term? • Who are the major agents of change and stakeholders? What are the objectives of the adaptation plan?
Driving forces	Driving forces are variables that influence the trajectory of the focal issues in significant ways. They might represent clusters of trends. For example, urbanization is a driving force that can affect both resource consumption and ecosystem change. *Identify key drivers of change affecting the focal issue.*	Based on the best available science, the team identifies the importance of different driving forces and characterizes their uncertainty.	• What are key drivers of change with respect to the focal issue? • What is the nature of the uncertainty (e.g., magnitude, variability, and/or direction of trend in a specific variable)?
Ranking importance and uncertainty	Interactions among the most important and uncertain driving forces determine the range of possible future outcomes. *Capture the most divergent yet plausible futures.*	Participants are asked to identify and rank driving forces based on their importance and uncertainty.	• Which key drivers of change are simultaneously the most important and uncertain with respect to the focal issue?

Scenario logics	Scenarios are hypotheses about plausible interactions that may take place given the uncertainty in key identified driving forces. *Define the organizing structure representing divergent yet plausible future conditions that can emerge from the interactions of uncertain driving forces.*	The team uses selected driving forces to create frames for developing scenario logics. Frames are created by crossing the plausible trajectories of selected dimensions and endpoints of key uncertain driving forces.	• Which major dimensions and endpoints best characterize the uncertainty? An example of a dimension for a climate variable such as precipitation is average rainfall, and endpoints may represent the magnitude.
Scenario development	Scenario development entails researching and writing the narratives of each scenario based on the driving forces and identified agents. *Characterize four distinct and internally consistent stories of how the future can unfold.*	Participants develop scenarios, story lines, and narratives. The process essentially follows the initial "what if" question emerging from a plausible hypothesis regarding the interactions of selected driving forces.	• Which plausible futures emerge from interactions between a major or minor climate change outcome and alternative development patterns and/or infrastructures?
Selected indicators	Indicators describe the implications of the scenarios for the focal issue (e.g., ecosystem function, resource availability, human health, etc.). *Select indicators that are (1) relevant, (2) sensitive to scenarios, (3) quantifiable, and (4) communicable.*	The team uses scenarios to select key indicators that can effectively describe the current status and future impact of land use and climate change for ecosystem function and human well-being.	• What are the best (most relevant, available, or sensitive) indicators of ecosystem functions that capture the effect of divergent futures? • Which warning signals can help us to anticipate critical transitions?

(continued)

Table 9.1. (continued)

Scenario Element	Rationale and Objectives	Action and Sources	Adaptation Plan Example
Impact assessment	Scenarios identify potential risks that driver interactions may generate and expand the boundary conditions of existing model predictions. *Assess future conditions under alternative scenarios.*	The team uses predictive models to assess future trajectories of selected indicators. Scenarios are applied to expand the boundary conditions assumed in the models to make predictions.	• How can we quantify scenario outcomes as alternative future baseline conditions of ecosystem function? • How can models help us test the sensitivity of alternative strategies to future conditions?
Evaluation of alternatives	Scenarios aim to identify the most robust strategy given the plausible future. *Identify the most robust and effective planning strategy.*	Using potential risks and opportunities of alternative scenarios, participants explore possible strategies. Based on selected indicators, participants evaluate the efficacy and robustness of alternative strategies across the alternative plausible futures.	• How do we evaluate adaptation strategies? • What are potential trade-offs across strategies? • Which strategies best incorporate uncertainty? • Which warning signals can help us to anticipate critical transitions?

Once the scope has been defined, the next step in developing strategic foresight is to collect inputs: to solicit and compile information, from a wide range of sources, on past trends and potential future trajectories of selected drivers (Amanatidou et al. 2012). The foresight team engages in various iterations of data collection, expert interviews, and conceptualization. The diversity of knowledge and expertise among the participants ensures a robust outcome in the foresight process (Bengston, Kubik, and Bishop 2012).

The team then analyzes key signals by integrating data sources, examining drivers' trajectories and interdependencies, and modeling potential impacts. In the fourth step, interpreting information, the team examines the influence of assumptions and uncertainty in the alternative scenarios. This information constitutes the basis for determining a diverse set of possible actions, assessing alternative strategies under different scenarios, and developing a monitoring strategy.

Scenario Planning

Scenario planning offers a systematic and creative approach for bringing the future into present decisions by challenging our assumptions and expanding old mindsets (Alberti, Russo, and Tenneson 2013). Scenarios are narratives about alternative environments in which participants can play out their decisions about planning and management strategies (Schwartz and Ogilvy 1998). They are plausible accounts, based on empirical data, expert knowledge, and participants' experience of how relevant forces might interact.

Scenarios are not predictions or visions. Rather, they are hypothetical alternative futures that highlight the risks and opportunities involved in specific strategic issues (Schwartz 2005). They help us to see how robust alternative strategies may be plausible—or not—under future conditions (Schoemaker 1995; Wack 1985). As we begin to develop shared hypotheses of alternative futures, we can envision both the challenges and opportunities to come.

Scenarios are written as plausible stories—not probable ones. Traditional approaches to planning and management rely on predictions that are based on probabilities and quantified uncertainties. Peterson, Cumming, and Carpenter (2003) described a prediction as the best possible estimate of future conditions. As compared to scenarios, predictions assume knowledge of the probability distributions of specified ecological variables at specified times in the future. However, the accuracy of such a prediction depends on current conditions, specified assumptions about drivers, the measured probability distributions used in model parameters, and the measured probability of the model itself being correct (J. S. Clark et al. 2001). Alternative scenarios expand the boundary conditions of predictive models by acknowledging irreducible uncertainties.

Planning through New Lenses

Scenarios synthesize observations through new lenses developed by exposing the assumptions within our professed knowledge; by challenging assumptions, scenarios allow scientists to capture pictures of how the world could look. A set of such pictures helps decision-makers to make long-term plans by generating discussions around desirable and conceivable futures, and it can serve to expand the time scale of decision-making.

Empirical studies of the practices of scenario planning that reflect on the challenges and opportunities of this approach for decision-making are just beginning to emerge. In a recent study, Oteros-Rozas et al. (2015) drew insights and experiences from twenty-three case studies on the opportunities and limitations of using scenario planning for place-based social-ecological research. The authors concluded that scenario planning did succeed in engaging stakeholders, increasing dialogue, and resolving conflicts by building a shared understanding of the problem and encouraging a complexity perspective on social-ecological systems. In the following paragraphs, I draw a few insights from both the literature (van Vliet et al. 2012; Carpenter et al. 2015a; Oteros-Rozas et al. 2015) and my direct experience of scenario planning in the Puget Sound region (Alberti, Russo, and Tenneson 2013).

Focus on Resilience

How can scenarios help decision-makers shift their attention toward resilience? Resilience, as noted earlier in the book, is the capacity of a system to tolerate disturbance without shifting into a qualitatively different state that is controlled by a different set of processes. Resilience theory relies on assumptions about four interdependent elements of coupled social-ecological systems: complexity, change, diversity, and uncertainty. At times, maintaining or enhancing the resilience of one subsystem is costly, as it means reducing the resilience of another. Planning decisions may involve important trade-offs that cannot be eliminated but can be explicitly addressed through negotiations among various stakeholders.

Expand the Decision Context

Using scenarios to plan for the future implies that we can define present problems and identify drivers of change, actors, and their behaviors and views. The diverse and heterogeneous composition of cities, in terms of values, backgrounds, and experiences, leads to both innovation and conflict. The scenario-building process expands the decision context and provides opportunities to shift power domains (actors), conceptualize problems (information), and pay attention to the politics (priorities) and innovations (substitutable actions) that divergent strategies may imply. An expanded decision context helps us to explore strategies that are generally more equitable, flexible, proactive, and anticipatory.

Challenge Our Assumptions

Scenarios challenge our assumptions about the future. They focus on irreducible uncertainty: future changes that diverge from past observations. Based on the interactions among variable trajectories of multiple drivers, scenarios explore hypothetical boundary conditions beyond the scope of predictive models' assumptions. Scenarios become powerful when combined with predictive modeling. They are not an alternative to models but a complement to them, expanding boundary conditions and linking multiple social and ecological models in an integrated framework. Using the expanded boundary conditions set by the divergent scenarios, integrated models can help us to accomplish three tasks: (1) test hypothesized trajectories and interactions; (2) refine potential relationships and feedback among variables; and (3) assess potential impacts that hypothesized futures will have on ecosystem services and human well-being. Scenario planning provides a systematic approach to dealing with uncertainties in assessing alternative strategic actions.

Highlight Risks and Opportunities

A fundamental objective of scenario planning is to explore the interactions between multiple critical uncertainties, thus entertaining potential future conditions that might otherwise be overlooked. Scenarios attempt to highlight risks and opportunities of plausible future conditions by looking at divergent trajectories. If planners and decision-makers consider multiple divergent scenarios, they can engage in a creative process for imagining solutions.

Provide Warning Signals

Scenarios also help decision-makers to anticipate potential regime shifts by helping to reveal warning signals that may allow them to change their strategies in a timely and effective way. Robust strategies are effective under divergent futures, but adaptive strategies support effective action under specific conditions. Critical sensitivities refer to potential thresholds or irreversible conditions with significant implications for multiple ecosystem services and diverse stakeholders.

Make Robust Decisions

Scenarios help decision-makers to identify robust decisions and then to adopt and act on those decisions, despite uncertainty, by providing a systematic way to assess the robustness of alternative strategies under a set of plausible future conditions. The divergent future conditions that could emerge from the interaction of uncertain trajectories might help us to see the different effects of a major climate change versus a minor one in terms of magnitude and variability. They could also help us to recognize diverse trajectories of change in social values that characterize relationships between society and nature.