Executive Summary

Introduction to Scenarios

A scenario is a description of potential future conditions, which is developed to inform decision-making under uncertainty. Originally developed for study of military and security problems, scenarios are now widely used for strategic planning, analysis, and assessment by businesses and other organizations. Scenarios are also increasingly used in planning, analysis, and policy debate for environmental issues, including global climate change. Major decisions setting mitigation and adaptation strategies have the conditions – e.g., high stakes and deep or poorly characterized uncertainty – that make scenarios potentially useful. Although such decisions are being made in the near term, making them responsibly requires considering their potential consequences over the longer term, including the substantial associated uncertainties.

Scenarios are distinct from assessments, models, decision analyses, and other decision-support activities. Scenarios provide inputs to these activities when they need descriptions of potential future conditions. Scenarios can also be distinguished less sharply from other types of future statements to inform decisions, called projections, predictions, and forecasts. Compared to these, scenarios tend to be more multivariate, to be produced in groups to explore key uncertainties, and to presume lower predictive confidence, because they pertain to processes for which weaker causal understanding or longer time horizons make uncertainties deeper.

Scenarios vary on many dimensions, of which three are particularly prominent. First, scenario exercises vary in their proximity to specific decisions. Some may directly inform an identified decision, while others support decision-making indirectly, by helping to clarify an issue’s importance, frame a decision agenda, shake up habitual thinking, provoke insights, clarify points of agreement and disagreement, identify and engage needed participants, or provide a preliminary structure for analysis of potential future decisions. A related dimension of variation is the degree to which a set of scenarios are intended to be predictive, versus exploratory or heuristic. Scenarios can also differ in how much they explicitly incorporate normative elements, i.e., in the degree to which they include descriptions of future conditions included on the basis of their desirability or undesirability, as opposed to on the basis of their perceived plausibility or likelihood.

Table ES-1 Idealized Sequence of Major Choices in Scenario Development.

- Main focus, framing, users, question(s) to be addressed
- Process and participation
- Key uncertainties to explore: how many, over what range
- Narrative, quantitative, or both
- Level of complexity (number of quantitative variables, detail of narrative)
- Specific variables and factors to specify
- Time horizon and spatial extent
- Temporal and spatial resolution

The main dimensions of choice involved in constructing a scenario exercise are shown in highly simplified form in Table ES-1. Most fundamental is identifying the main focus of the exercise: what issues do the scenarios address, what decisions do they inform, and for whom? Deciding the process of a scenario exercise includes what range of expert knowledge and stakeholder perspectives to include, which can be decisive for the usefulness of the exercise. Deciding what few uncertainties to represent, usually by constructing multiple scenarios that embody alternative realizations of key uncertainties, is a crucial judgment that shapes much of what follows in a scenario exercise. The complexity of scenarios can vary greatly, from merely specifying time-paths of a few quantitative variables, to constructing rich, coherent, multivariate narratives. Complex scenarios may combine qualitative and quantitative elements.

Scenarios in Climate-Change Applications

Scenarios to inform climate change mitigation and adaptation decisions, directly or indirectly, come in five types according to where they fall along a simple linear causal chain representing the climate-change issue, from the socio-economic determinants of greenhouse-gas emissions through the impacts of climate change, as in Figure ES-1. (Note: this figure does not represent the actual causal structure of the climate issue, which has multiple feedbacks. This simple structure only illustrates the ways scenarios have been used to fit within the simplest and most prominent causal pathway of the issue.)

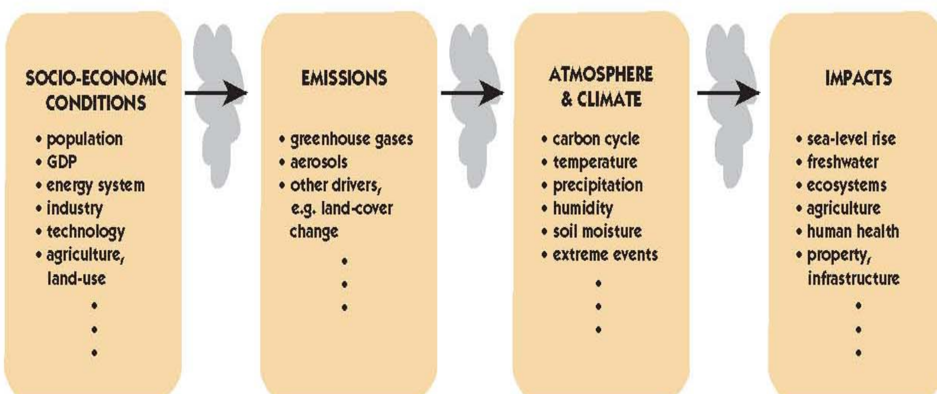

Figure ES-1: Anthropogenic climate change: Simple linear causal chain

The types of scenarios differ in what parts of the issue they specify, and what part of the issue is the focus of the subsequent analysis or use of the scenario.

Emissions Scenarios for Climate Simulations: Emissions scenarios stipulate future paths of greenhouse-gas emissions or other climate perturbations, to provide inputs to climate models. They can include simple arbitrary specifications of future emissions or concentrations (e.g., doubling atmospheric CO_2), or time-paths reflecting specified assumptions for evolution of socio-economic drivers such as population, economic growth, and technological change.

Emissions Scenarios for Exploring Alternative Energy/Technology Futures: Emission scenarios can also be used with the causal logic reversed, stipulating an environmental or emissions target and examining what patterns of socio-economic change, energy resource availability, or technology development are consistent with the target or what interventions might be needed to meet it. The target may be set based on normative criteria, political targets, or arbitrarily. While the most frequent use of this type of scenario has been to examine emissions trajectories that stabilize atmospheric CO_2 concentrations at specified levels, recent projects have instead adopted stabilization of radiative forcing as the target, in order to examine the role of non-CO2 greenhouse gases in stabilization regimes.

Climate-Change Scenarios: Climate scenarios describe potential future climate conditions, to inform assessments of impacts, vulnerabilities, and adaptation options, and inform decision-making related to either adaptation or mitigation. They can be produced by simple arbitrary perturbations to present climate conditions, by using climatic conditions from the past record or from some other location as an analog for potential future climate in a given location, or by climate-model simulations, which require some specified scenario of future emissions.

Scenarios of Direct Biophysical Impacts: Sea Level Rise: Scenarios can be constructed of important dimensions of climate impact that influence many other impacts. The primary example is sea level rise, the major pathway of climate impact in many coastal regions. Scenarios of sea level rise can be constructed by combining climate-change scenarios with information about coastal uplift or subsidence and other specific regional characteristics. In addition to its gradual impacts, sea level rise is subject to large uncertainties associated with potential loss of continental glaciers in Greenland and West Antarctica.

Multivariate Scenarios for Impact Assessment: Many potentially important impacts of climate change cannot be adequately assessed by considering only climate change. For these, scenarios are required that include not just climate and its impacts, but also other characteristics likely to influence impacts. These may include other dimensions of environmental change, and multiple socio-economic characteristics likely to influence specific vulnerabilities and capacity for adaptation. The factors that influence specific dimensions of vulnerability are likely to vary among specific types of impact, locations, and cultures, and many include many demographic, economic, technological, institutional, and cultural characteristics. Consequently, scenarios may have to be generated in an exploratory manner in the context of attempting to assess specific local and regional impacts.

Major Climate-Change Scenario Exercises:

We summarize and seek to draw insights from four major examples of experience generating or using scenarios for climate-change applications, plus eight brief descriptions of smaller-scale experiences that are particularly unusual or illuminating.

The IPCC has conducted three exercises to generate scenarios of 21st-century greenhouse-gas emissions, of which the largest, most ambitious, and most important was the Special Report on Emissions Scenarios (SRES), conducted form 1997 to 1999. Established in response to criticisms that the previous scenario exercise relied excessively on one model, treated important areas such as sulfur emissions and land-use change inadequately, and failed to represent income convergence between industrialized and developing countries, the project initially reviewed the prior scenarios literature and ran an open process by which any researcher was invited to submit scenarios. In addition, they developed a set of new scenarios, beginning with four qualitative storylines that were then quantified by six participating energy-economic modeling teams. The exercise published forty scenarios with supporting documentation, although the most prominent outputs of the exercise were six "marker" scenarios – one model quantification of each of the four initial storylines, plus two technological variants on one storyline that stressed fossil-intensive and low-carbon energy supply technologies respectively.

The marker scenarios have been the most prominent scenarios in subsequent climate modeling, impact assessment, and decision support. They highlighted several insights, including the ability of alternative paths with similar emissions in 2100 to follow widely differing interim pathways and so yield divergent atmospheric concentrations; the ability of alternative technological assumptions alone to generate as wide a range of emissions futures as substantially divergent socio-economic pathways; and the fact that similar emissions paths can come from widely different combinations of underlying socio-economic factors and so pose distinct mitigation problems. The most prominent controversy over these scenarios concerned alternative measures to compare incomes between industrial and developing countries, an issue of minor importance for emissions trajectories or challenges facing future scenarios exercises. Other challenges associated with these scenarios of greater significance for future scenario exercises included how to balance and integrate qualitative and quantitative scenarios; how to deploy and coordinate multiple models to generate the most useful insights; and whether, when, and how it is appropriate to assign explicit probability judgments to alternative scenarios or quantitative variable ranges.

The U.S. National Assessment was a comprehensive assessment of potential impacts of climate change and variability on the United States, conducted between 1997 and 2002 by analytic teams examining major US regions and sectors (agriculture, water, human health, coastal areas and marine resources, and forests) with some central coordination. The Assessment needed scenarios of 21^{st}-century US climate and socio-economic changes. For climate scenarios, it relied principally on runs of the UK Hadley Centre climate model and the Canadian climate model, each driven by a single emissions scenario, with statistical downscaling based on detailed local conditions and present patterns of fine-scale climate variation. Other proposed approaches to constructing climate scenarios, including historical scenarios and inverse methods to probe for key vulnerabilities, were used less. For socio-economic scenarios, a two-level approach was proposed, combining national specification of scenarios for a few key variables such as population and economic growth, and a common process to elaborate and document additional socio-economic assumptions needed for specific regional and sector analyses. The Assessment was criticized for relying on just two climate-model runs and one emissions scenario, although these choices were dictated by time limits and the availability of climate-model runs at the time. Limited use was made of the socio-economic approach, principally due to time limits and communication problems, so the validity of the proposed approach was not effectively tested.

The UK Climate Impacts Program supports research and analysis of impacts for particular regions, sectors, and activities in the UK, by university researchers and stakeholders. The program provides common datasets and tools, as well as ongoing assessment support to stakeholder groups. As part of this support the program has produced three sets of scenarios: climate scenarios in 1998 and 2002 based on the Hadley Centre climate model, and socio-economic scenarios in 2001. The program has followed a substantially different model from the US National Assessment, based on building a sustained assessment capability rather than a single project. In addition, the central program has less authority over the separate assessments, instead acting more as motivator, resource, and gentle coordinator.

The Millennium Ecosystem Assessment (MEA) examined the status, present trends, and longer-term challenges to the world's ecosystems, including climate change and other stresses. One of the assessment's four working groups constructed scenarios of global ecosystems to 2050 and beyond, largely independently of the group examining current status and trends. All components of the assessment used a common large-scale conceptual framework, which distinguished indirect drivers of ecosystem change (e.g., population and economic growth, technological change, policies and lifestyles), direct drivers (e.g., climate change, air pollution, and land-use and land-cover change), ecosystem indicators, ecosystem services, measures of human well-being, and response options. The Scenarios working group applied this framework to long-term ecosystem trends through 2050, with more limited projections to 2100. They constructed four scenarios, based on two dimensions of uncertainty, globalization and the degree of proactive vs. reactive response to ecosystem changes. The qualitative storylines comprising these scenarios were more richly developed than in other climate-change scenario exercises. Key issues and challenges with these scenarios concerned integration and consistency between qualitative and quantitative scenarios, concerns about breadth and potential circularity within scenarios, and unexplained similarity of projected effects between scenarios.

Other experience with climate-change and related scenarios are examined more briefly, highlighting several additional issues and potential insights. Climate-change scenarios can be used to inform concrete decisions related to impacts and adaptation, and there are increasing attempts to do so. Collaboration with users and decision-makers is important to the success of such exercises, and scenarios need to provide information in form and detail that decision-makers can use. Although interest in such uses is increasing, many applications that could clearly benefit from considering climate-change scenarios have not yet done so or are only starting to. Scenarios can contribute to broad perceptions of the character and seriousness of an issue, particularly when presented as part of large-scale, official assessments. They can then influence diverse decisions that respond to such aggregate perceptions of seriousness, including mitigation decisions by diverse actors. Extreme case scenarios can make useful contributions to risk assessment, but are vulnerable to misunderstanding and misinterpretation in policy debates.

Issues, Challenges, and Controversies in Climate-Change Scenarios

Scenarios and Decisions

Scenarios can inform climate-change mitigation and adaptation decisions, but most uses so far have had relatively indirect connections to such decisions. Although there is no single global climate-change decision-maker, scenarios can inform the many decision-makers with diverse responsibilities that will affect and be affected by climate change. To consider potential contributions of scenarios more specifically, real climate-change decision-makers can usefully be considered in three groups: national officials, impacts and adaptation managers, and energy resource and technology managers.

National officials make both adaptation and mitigation decisions. In their impacts and adaptation responsibilities, they need scenarios of potential future climate change under specified assumptions about global emissions trends, and resultant impacts on particular resources and communities within their nation, with particular focus on the areas of greatest vulnerability. In their mitigation responsibilities, they need information about aggregate climate-change impacts, and also projections of future emissions in the absence of additional mitigation efforts, the consequences of alternative policies, and information about the context in which these decisions are made, mainly mitigation strategies adopted and implemented by other major nations.

Impacts and adaptation managers have responsibility for particular assets, resources, or interests that might be sensitive to climate change. To assess the threats and opportunities they face and evaluate responses, they need scenarios of potential future climate change, its impacts in their areas of responsibility, and the factors that influence vulnerabilities. Particular decision-makers' needs will be highly specific in the variables they require, and their time and space scale and resolution.

Energy resource and technology managers include developers and operators of fossil or non-fossil energy resources, investors in long-lived energy-dependent capital stock such as electrical utilities, and researchers, innovators, and investors in new energy-related technologies, mostly but not entirely in the private sector. The consequences of their decisions will predominantly be influenced by the mitigation policies in effect, nationally and internationally, over the lifetime of the relevant investments. Consequently, these actors will most benefit from scenarios that explore alternative policy regimes and their consequences for the value of energy and technology assets.

For all these decision-makers, a key issue in scenarios is the reflexivity of decisions, i.e., how to represent decisions within scenarios. The appropriate treatment depends on the intended user of the scenario. Decisions by others outside their control should be represented like any uncertainty, based on estimates of their likely outcomes and importance for the user's decisions and concerns. Decisions by the user, however, must be explicitly examined relative to baseline conditions specified in scenarios. This difference is most pronounced for mitigation decisions: scenarios for impacts and adaptation should presume a likely range of mitigation efforts, while scenarios for mitigation decisions should allow explicit examination of the entire range of decisions being considered. Consequently, scenarios for impacts and adaptation will typically include a narrower range of potential emissions futures than scenarios for mitigation.

Scenarios in Assessments and Policy Debates

In large-scale assessments of climate change, scenarios can provide required inputs to other parts of the analysis, and can serve as devices to organize and coordinate multiple components of the assessment, particularly those that are forward-looking. Because of the prominence that scenarios used in assessments can gain, they may be used in planning or decision-support processes outside the original assessment. Scenarios can also contribute to the broad framing of public and policy debate on the issue, in part by serving as aggregate metrics for the issue's degree of seriousness or concern.

In these roles, scenarios become prominent in pluralistic policy debates where many contending views and interests are represented. They consequently become subject to politically motivated attempts to influence their development and content, and political reactions to them once developed, particularly because a scenario may be perceived as implying the desirability or undesirability of particular policy actions. The unavoidable judgments underlying construction of scenarios provide opportunity for partisan distortion and efforts to make scenarios policy-prescriptive, and for claims in policy debates that only certain scenarios are plausible (e.g., high or low-emissions scenarios, depending on the critic's motivation), or that a particular scenario is implausible.

Scenario Development Process: Expert-Stakeholder Interactions

Scenario exercises must decide how and how much scenario users and stakeholders are involved in scenario development. In other areas of scenario use where users are typically clearly identified, relatively small and homogeneous, close, intensive collaboration between scenario developers and users or their representatives is widely advocated. Although similar arguments for intensive user involvement have been widely advanced for climate change scenarios, the decision is more complex since some climate-change scenario exercises serve a large and highly heterogeneous set of potential users and stakeholders, who may not be identified or may have contending material interests in the scenarios' content or use. Under these conditions, the most useful nature and extent of stakeholder participation will vary from case to case. The more clearly identified the potential users and the more consistent their perspectives and needs, the stronger is the case for close collaboration in scenario development, e.g., when users are analysts or modelers producing other components of an assessment. But even in providing climate scenarios to impacts analysts, users' specific needs are likely to have substantial differences in addition to their commonalities. Involving a representative collection of users in scenario production is likely still productive, but potential users' numbers and diverse needs may require including only selected representatives. The larger and more diverse the potential users and stakeholders, the more difficult is the decision who to involve in what capacity in scenario production. With extreme user diversity, scenario exercises may serve only a subset of needs, or be limited to broad, exploratory purposes.

Communication of Scenarios

Climate change scenarios must be communicated to multiple audiences with diverse interests and information needs. In addition to the scenarios' content, sufficient information must be provided about the process and reasoning by which the scenarios were developed, to allow users to scrutinize the underlying data, models, and reasoning, judge their confidence in the scenarios, and have opportunities to critique the scenarios and suggest alternative approaches. Ideally, effective communication can engage a broad user community in updating and improving scenarios. Providing transparency rather than claiming authoritative status for scenarios is likely both to increase users' confidence that the scenarios have reasonably represented current knowledge and key uncertainties, and help them develop alternatives if they are unconvinced.

Consistency and Integration in Scenarios

Scenarios must strive for internal consistency. At one level, this means avoiding clear contradictions given well established knowledge, and not moving inadvertently far outside bounds of historical experience or presently recognized causal processes – although such sharp departures from experience may be useful if they are pursued intentionally to examine low-probability risks or broaden decision-makers' perceptions. Internal consistency can be interpreted as a claim that the multiple factors stipulated in a scenario are more likely than alternative combinations, but this claim usually rests on scenario developers' subjective judgments. Subjective judgments cannot be avoided, but raise well known risks of error and bias. These difficulties can be compounded when a scenario exercise pursues integration in addition to consistency. This can impose on scenarios the burden of describing most or all relevant components of the issue. Consistency problems grow when scenario exercises involve multiple models and attempts are made to harmonize model outputs. Using multiple models in parallel can aid exploration of causal relations and helps to characterize uncertainty, but when models use different variables as exogenous inputs it is particularly difficult to avoid inconsistency in values that are specified for some models and calculated for others. Attempting to avoid such inconsistency can pose even more serious problems, however, by requiring reverse-engineering of internal model relationships to match specified outputs, thereby obscuring interpretation of results and precluding use of model variation to illuminate uncertainty.

Attempts to connect qualitative and quantitative aspects of scenarios have been particularly challenging for pursuit of consistency. Narrative scenarios typically specify deep structural characteristics like social values and the nature of institutions, which are associated with behavioral characteristics represented in model structures, such as the determinants of fertility trends, labor-force participation, savings and investment decisions, and substitutability in the economy. Consequently, different narrative scenarios correspond more closely to different model structures than to variation of parameters, because they reflect different assumptions about how the world works. Better integrating the two approaches will require developing ways to connect narrative scenarios to model structures, rather than merely to target values for a few variables that models are then asked to reproduce.

Treatment of Uncertainty in Scenarios

Representing and communicating uncertainty is perhaps the most fundamental purpose of scenarios. In most scenario exercises, uncertainty is represented by variation between scenarios. The choices to be made in deciding how to represent uncertainty include what characteristics are varied; how much they are varied, how many scenarios are considered, and whether explicit characterizations of probability are assigned.

When scenarios are complex and multivariate and their use is costly – e.g., running a large costly model or spending much time and energy of busy senior people – only a few can be included in any scenario exercise. Consequently only one or two fundamental uncertainties can typically be considered. One must judge what uncertainties to consider, and how many outcomes of each: just high or low values? Are departures in both directions from the middle important enough to consider? For example, one might judge that scenarios of small climate change do not need explicit consideration in an impact assessment, since associated impacts are likely to be small. Extreme outcomes may need to be considered, if the gravity of their consequences or their effect on preferred decisions is extreme enough to offset their low probability. For example, in a coastal assessment the great difference between a half-meter and five-meter sea level rise, together with the known mechanism for such a rise, may suggest including a scenario with loss of one of the major continental ice masses. Because such scenarios carry the risk that their probability will be exaggerated, developers have special responsibilities to communicate clearly the special status of such scenarios.

Complex narrative scenarios pose special problems in representing and communicating uncertainty. In contrast to simple quantitative scenarios, these lie in a higher-dimension space and may lie in no clear ordinal relationship. Even greater selectivity is required to choose a few scenarios, typically by seeking underlying structural uncertainties – e.g., deep societal trends such as globalization or values shifts – that are judged to influence variation in many other factors including outcomes of concern. Although the likelihood of any scenario must decrease as the number of characteristics specified increases, such scenarios may still meet the condition of being likely enough to consider if the chosen structural uncertainties do in fact strongly condition outcomes on many other characteristics, or are regarded as drawn from a set of discrete possibilities.

A major debate in climate-change scenarios, engaged most prominently over the SRES scenarios, has concerned whether or not to explicitly assign probabilities to scenarios or associated ranges of quantitative outcome variables. The debate rests in part on different views of the typical contents of scenarios. At the simplest extreme, scenarios that specify time-paths of just one quantitative variable can readily assign subjective probabilities to the intervals so defined. Such explicit assignment would offer various advantages for assessing alternative decisions, and declining to provide them risks users assigning their own, perhaps less informed, probability judgments – as many subsequent users did with the distribution of emissions from the SRES scenarios. Opponents of explicit probability assignment raise practical objections even in simple cases, but focus primarily on the case of rich multivariate scenarios, often including narrative elements. They argue that probabilities cannot be sensibly estimated for such rich, multidimensional descriptions, that there is no clearly defined interval "between" such scenarios and their boundaries are not clearly defined, and that attempting to assign probabilities consumes scarce time and attention at little value to scenario users.

Conclusions and Recommendations

Use of Scenarios in Climate-Change Decisions

- Scenarios can make valuable contributions to climate-change decision-making, but there is a big gap between the use of scenarios in current practice and their potential contributions.

- Interest in considering and using climate-change scenarios is sharply increasing.
- Scenarios of global emissions and resultant climate change are required by many diverse climate-related decision-makers, but beyond these variables decision-makers' needs from climate-change scenarios are highly diverse.
- Impacts and Adaptation Managers are a major group of scenario users with distinct information needs.
- Meeting information needs for impacts and adaptation may require a cross-scale organizational structure.
- Scenarios for Impact and Adaptation Managers should be based on emissions assumptions that include a likely range of mitigation interventions.
- Mitigation Policy-Makers are also a major group of climate-change scenario users with distinct needs.
- Scenarios for mitigation decisions should include a wide range of baseline emissions assumptions and not pre-judge the likely level of mitigation effort.
- Mitigation Decision-Makers can use target-driven scenarios for backcasting.
- Mitigation decisions require scenario development capacity at the national level.
- Energy Resource and Technology Managers are a third major group of climate-change scenario users with distinct needs.

Use of Scenarios in Climate-Change Assessments

- Large-scale, official assessments are the major use for scenarios at present, and are likely to remain an important use.
- Within assessments, scenarios are principally used to support further analysis, modeling, and assessment.
- Presentation of scenarios in assessments leads to additional unforeseen uses.
- In assessments, scenarios can be an effective issue-framing device.
- Scenarios contain unavoidable elements of judgment in their production and use.

A Sustained Capacity for Scenarios

- CCSP should provide resources to support a new capacity for to produce, analyze, support, and update scenarios of global emissions and resultant climate change.
- Several institutional models would be feasible for this capacity – US-based or international; governmental, non-governmental, or a multi-party network; producing scenarios, convening activities to produce scenarios, or receiving and reviewing scenarios produced by others.
- Several criteria would have to be met, however, for this capacity to be effective:

- Adequate sustained resources.
- Connections with outside expertise, analysis, models.
- Insulation from political control.
- Maximum transparency.
- A mandate to support development of methods and models.
- Authority for effective coordination and quality control.

What should centrally provided emissions and climate scenarios look like?

- Scenarios should be global in scope and century-scale in time horizon.
- Several distinct logical types of emissions scenarios should be developed, e.g., alternative baselines, alternative degrees of explicitly represented mitigation effort, and alternative environmental targets.
- Emissions scenarios should be based on diverse socio-economic futures.
- Scenarios should reflect various explicit degrees of coordination.
- Global socio-economic and emissions scenarios should include and link qualitative and quantitative components.
- Emission scenarios should connect narratives to model structures, not parameters
- Centrally provided scenarios of global emissions and climate change cannot provide all information needed for either mitigation or adaptation decisions at national or smaller scale.

Scenario Process: Developer-User Interactions

- In general, there are benefits in collaboration between scenario developers and users, particularly at the beginning and ending stages of a scenario exercise.
- The value of such interactions, and the ease of achieving them, are likely to be greater when scenario users are few in number, clearly identified, and similar in their interests and perspectives.

Communication of Scenarios

- Effective communication of scenarios is essential, including the means to reach audiences of diverse interests and technical skills.
- Transparency of underlying reasoning and assumptions is crucial.

Consistency and Integration in Scenarios

- Each scenario needs internal consistency.

- In scenario exercises using multiple models to explore potential future conditions, model inputs should be controlled for consistency, rather than model outputs.
- An important exception to the advice not to control for consistency in model outputs is that such control can be valuable in exercises that specify common output targets for policy evaluation.
- Transparency in reporting model differences, assumptions, and reasoning can help to overcome the presence of some inconsistencies in scenario generation.

Treatment of Uncertainty in Scenarios

- More explicit characterization of probability judgments should be included in some future scenario exercises than has been practiced so far.
- Including explicit probability judgments is likely to be more useful when key variables are few, quantitative outcomes are needed, and potential users are numerous and diverse.
- Including explicit probability judgments is likely to be less useful when scenarios specify multiple characteristics, including prominent narrative or qualitative components; when the purpose of a scenario exercise is sensitivity analysis or heuristic exploration; and when potential users are few, similar, and known.
- The centralized capacity we propose should endeavor to provide probability estimates for global emissions and climate-change scenarios.
- Providing explicit probability and likelihood statements allows users to choose whether to use them or not.
- Scenario exercises should give more attention to extreme cases.