DRAFT

Science Supporting Decision-making under Deep Uncertainty

Delta Independent Science Board

Draft Prospectus

March 16, 2023

Motivation

This effort aims to build understanding of scientific tools and concepts that can inform management and policy decision-making under rapid change and increasing uncertainty of future forecasts. The Sacramento-San Joaquin Delta is undergoing continual and often rapid change. Predicting and preparing for those changes is challenging, as the past is becoming an inadequate model of future variability. Therefore, managers will require new methods of anticipating the future to effectively manage Delta systems.

Scientific analysis can be applied to make reasonable predictions of some future conditions, and much scientific effort aims to improve the accuracy and the time and space scales of those predictions. However, many types of change have unknown or unknowable likelihoods of occurrence. Other changes may be ignored due to their perceived low probability of occurrence. Climate change and other drivers contribute to so-called *deep uncertainty*, which is system variability that cannot be well characterized with existing data, models, and understanding. Often, there is little or no agreement on how systems are likely to behave or the probabilities of occurrence of events, including the duration, sequence, and co-occurrence of events (Haasnoot et al. 2013; Hallegatte et al. 2012).

Ignoring uncertainty can lead to inefficient investments since the solution that is optimal under a “best guess” future is not necessarily the one that performs best under diverse plausible future conditions (Wainger et al. 2021, Groves et al. 2019). As recent events have helped us realize, preparing for low probability events with potential high consequences for water supplies, ecosystems, or human well-being is needed for effectively managing risks. Anticipating unlikely, but still plausible, future conditions has been demonstrated to speed up responses during crises, improve resilience, and can create new insights about effective preparation for change.

One tool commonly used to support such forward-looking, future-oriented thinking is scenario analysis. Scenarios of plausible futures are collaboratively developed and used with models to evaluate how well alternative policies, scientific capabilities, or projects perform under various conditions. The process of developing and analyzing alternative future scenarios reveals research gaps and management or policy needs. Further, if diverse stakeholders are involved throughout the process, it can increase capacity to prepare for, respond to and adapt to rapid change. Such scenario building can be supported by horizon scanning activities that seek to identify early signs of change in the behaviors of ecological and social systems.

Scenario analysis is uniquely valuable among decision support tools in that it can be used to probe deep uncertainties that reach beyond those that have been estimated using existing data and models (e.g., flood frequency). Formal techniques have been developed in the interdisciplinary social sciences (especially decision science) to generate scenarios that systematically account for deep uncertainty. These approaches are particularly valuable for stress-testing policies to understand the conditions under which a proposed approach will fail, rather than only representing the optimal approach for a single best guess future scenario (e.g., Lempert et al. 2004).

The proposed effort will draw on the interdisciplinary sciences that support decision making under deep uncertainty (DMDU) by evaluating current and potential uses of scenario planning in the Delta. This effort addresses anticipatory decision-making needs in the Delta by revealing opportunities to evaluate the potential benefits of alternative scenario development approaches. The ultimate goal is to support planning and management of events that are largely unpredictable or of greater magnitude in outcomes than are typically prepared for in current management practices (e.g., long-term average conditions).

Audience

The intended audiences for this work are those who manage resources or design projects using intermediate to long planning horizons, along with scientific and technical staff at government agencies. We expect the results will be of interest to a wide range of management applications such as salinity management, water supply, and ecosystem restoration goals.

Inputs to the review

Inputs will include information gathered through 1) public seminars; 2) an inventory and analysis of current scenario design and development processes in the Delta; and 3) interviews with Delta decision-makers.

Seminars

A public seminar series introducing concepts from the decision sciences, futurism, and other relevant scientific fields will engage stakeholders, rights holders, and other interested and affected parties. The seminar series will feature experts speaking on the science of DMDU, major sources of deep uncertainty in the Delta, and current efforts to address those deep uncertainties. The seminar series will be hosted by the Delta ISB with support from the Delta Science Program.

Inventory and analysis of scenarios

Current Delta scenarios will be identified and analyzed using social scientific methods. The analysis will empirically characterize current scenario design and development processes and systematically assess how they incorporate processes, tools, and techniques to address deep uncertainty.

Interviews

Semi-structured interviews are planned with Delta decision-makers to deepen understanding how scenarios are being developed and applied to address uncertainty in Delta analysis and decision-making.

Timeframe

Target Date	Benchmark
April 2023	Prospectus finalized
Ongoing (Throughout 2023)	Hold public seminar series to: a) Introduce concepts of DMDU b) Explore/identify deep uncertainties in the Delta as perceived from diverse individual and/or organizational perspectives c) Identify some signals of future change d) Provide other useful background information
Spring-Summer 2023	Survey and qualitative analysis to systematically characterize and critically evaluate existing Delta scenario design and development processes through an interdisciplinary decision science and futurism lens.

Target Date	Benchmark
Summer-Fall 2023	Interviews with Delta decision-makers to understand use of scenarios to address uncertainty in their decision-making processes.
Winter 2024	Release draft report summarizing information gained through seminar series, scenario inventory and analysis, and interviews, with recommendations to improve science of scenario analysis to inform decision-making under deep uncertainty in the Delta.
Spring 2024	Finalize summary report and findings

Related Reviews

We are not aware of any similar previous or current review efforts. This effort is responsive to multiple recommendations produced by the Delta Independent Science Board (Delta ISB) and the Delta Science Program (DSP) that have noted the need for anticipatory management (Delta Independent Science Board 2022; Norgaard et al. 2021; Delta Stewardship Council, Delta Science Program 2019).

Expected Products and Outcomes

Results and insights gained through the inputs described above will be summarized in a report and shared through public presentations and other methods. The outputs will include recommendations to help the Delta science and management community better characterize, prepare for, and adapt to uncertainty for a range of management needs such as salinity management, water supply, and ecosystem goals. Recommendations could inform new analyses, simulations, and strategic scientific planning and collaboration by agencies and other activities to anticipate and prepare for the future.

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