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Highlights: Understanding Climate Projections, Compounding Impacts, and Implications for Adaptive Management

A summary of a briefing paper to help inform symposia discussions

Delta Independent Science Board

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The Delta Independent Science Board (Delta ISB) has identified a critical need to understand the evolving science of climate change and its implications for the Sacramento-San Joaquin Delta region, which is essential for informing adaptive management strategies. To facilitate this understanding, the Delta ISB is organizing two symposia in 2025, with the first focusing on current climate projections, associated uncertainties, and compounded effects, and the second on how Delta organizations are integrating climate change into their decision-making. A briefing paper was prepared to synthesize the latest science and research, drawing on 50 key references summarized using NoteBookLM. This document summarizes the briefing paper. The full briefing paper and references used can be found here.

Key climate drivers for planning include **temperature increases, shifts in precipitation patterns, sea level rise, and extreme events like atmospheric rivers, droughts, and wildfires**. Observed changes already include increased average temperatures, altered temperature extremes, reduced snowpack, and rising sea levels, with recent years showing record-breaking extreme weather. Future projections indicate that these trends will intensify, with significant temperature increases, hotter and drier conditions, reduced winter snow, increased winter rains, more extreme precipitation variability, and rising sea levels expected. More frequent and larger floods and deeper droughts are anticipated, threatening the Delta water conveyance system and increasing coastal groundwater salinity.

State-of-the-science projections for the Delta region indicate significant changes with associated uncertainties. By 2050, sea levels in the San Francisco Bay-Delta Estuary are likely to rise between 0.6 to 1.1 feet, and by 2100, between 1.2 to 3.4 feet, with upper-range projections being significantly higher. Precipitation patterns are expected to become more variable, with longer dry spells and intense rainfall, and a greater proportion falling as rain, reducing snowpack. Temperature increases are projected to be substantial by 2050 and 2100, impacting water quality and

ecological processes. The frequency and intensity of extreme events like droughts, heat waves, and wildfires are also expected to increase. Changes in water quality, particularly eutrophication, are a concern, especially during droughts.

Compounding impacts and sequential events pose significant challenges, where the combination or succession of climate-related hazards can have effects greater than the sum of individual events. Examples include concurrent heatwaves and droughts increasing wildfire risk, and the combination of sea-level rise and coastal storms exacerbating flooding. Warming temperatures can intensify precipitation events and reduce snowpack, compounding drought impacts. Sequential events, such as earthquakes followed by heavy rain, can lead to cascading impacts like landslides.

The reliability of current downscaled climate products for regional application in the Delta region is complex. While downscaling techniques like LOCA help provide finer-scale projections from Global Climate Models (GCMs), uncertainties remain due to modeling and analysis assumptions. Precipitation projections are particularly uncertain at regional levels. Downscaled data also has limitations in representing the dynamic interactions within the Delta. Therefore, these products are most effective when used with caution and in conjunction with methods like decision scaling and sensitivity analyses.

Several gaps exist in current climate models and their application to decision-support. These include inadequate representation of processes like clouds, ocean circulation, ice sheets, and land surface processes. Feedbacks and interactions, such as eddy feedback and coupled processes, are also not fully captured. Uncertainties persist regarding climate sensitivity and downscaling to local levels. Data gaps include a lack of long-term groundwater monitoring and information on post-fire vegetation changes. Addressing these gaps requires improving model complexity and resolution, integrating feedbacks, representing compounding events, collecting more data, and enhancing interdisciplinary collaboration and communication. Prioritization strategies include vulnerability assessments, decision scaling, and addressing key data gaps.

Organizations in the Delta region are integrating climate projections into planning through initiatives like **Delta Adapts**, a comprehensive regional effort involving

vulnerability assessments and adaptation plans. State agencies like the Department of Water Resources (DWR) provide climate data and tools and incorporate climate extremes into their planning for flood and water management. Sector-specific integration is evident in flood management, water management, ecosystem restoration, and even transportation. Cross-cutting strategies include adaptive management, collaborative partnerships, and a focus on equity.

Useful and critical uncertainties and projections for decision-support include regional downscaled projections, probabilistic projections, scenario planning, decision scaling, near-term projections, extreme water level probabilities, projections incorporating deep uncertainty, and visualization tools. Understanding evolving impacts and risks helps build resilience by identifying vulnerabilities, developing adaptation strategies, prioritizing actions, implementing flexible approaches, integrating climate considerations into planning, enhancing community resilience, learning and improving, considering compounding events, and addressing equity.

While significant efforts are underway to address climate change in the Bay Delta region, current and previous efforts are likely **not yet fully adequate for enhancing the resilience of the system**. Ongoing vulnerabilities persist despite planning initiatives like Delta Adapts and the Central Valley Flood Protection Plan. Efforts span flood risk reduction, ecosystem restoration, agriculture, and water supply reliability. However, limitations exist in funding, the scale and pace of implementation, uncertainty in projections, coordination among agencies, equity considerations, and the consistent implementation of adaptive management. Therefore, accelerated implementation, increased funding, enhanced coordination, a stronger focus on equity, and a commitment to adaptive management are crucial for building a more resilient Bay Delta system.