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San Francisco Bay-Delta: Ground Zero for california water challenges - risks and water resources

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SAN FRANCISCO BAY-DELTA: GROUND ZERO FOR CALIFORNIA WATER CHALLENGES - RISKS AND WATER RESOURCES

BY JAY LUND

Coastal deltas are frequently changing and shifting landscapes subject to varying freshwater and sediment flows, sea level changes and tides, as well as many forms of human land and water management. California's Sacramento-San Joaquin Delta shares the inherent instability of delta landscapes, and also serves a central role in the water supply for one of the world's largest economies. It is a substantial agricultural area, and has the greatest potential for restored aquatic habitat of any region in California.

However, as summarized in Table 1, this California Delta, part of the largest estuary on the Americas' Pacific coast, is particularly unstable in serving these purposes due to California's highly variable hydrology, intense and changing human management of water and land, invasive species, climate change, and the threat of major earthquakes.

Many of these changes are inevitable, and threaten several current functions of California's Delta, with implications for management and for hydrologists and water managers in similar situations worldwide.

Risks to Landforms in the Delta

A fundamental risk to the Sacramento-San Joaquin Delta is to its current landforms. Land subsidence is a common problem for the stability of developed delta lands worldwide, from the Netherlands to Louisiana. Since having been largely diked and drained, starting in the 1860s, the California Delta's western and central peat lands have been exposed to air, oxidized, and subsided, often at the rate of several centimeters per year. Many of the most subsided islands are now 3-9 meters below sea level, as seen in Figure 1.

This raises flooding and drainage issues in the most subsided lands. This fundamental instability in the landscape from land subsidence is exacerbated with rising sea levels, threat of earthquakes, floods, climate change, and low agricultural land values for most deeply subsided lands. In the last 4 decades, 5 of 40 subsided Delta islands have been flooded, with four of these flooded islands having been abandoned.

Newly flooded islands and other drivers of change often have fundamental implications for California's water supply system, the region's native and recreational ecosystems, and the Delta's local society and economy.

Risks to Local Society and Economy

The flooding of Delta islands will affect human uses of the Delta. Up to about 31,000 hectares of subsided, mostly agricultural land are at risk of abandonment following levee failure. This would result in the loss of about 1,000 direct and indirect jobs, gross crop revenue losses of about $150 million annually, and lost economic value added of about $83 million/year. This economic harm would be partially mitigated by the expected expansion of some recreational fishing and boating activities. Internal seepage is another growing problem for some of the most subsided islands, as waterlogging slowly displaces productive agricultural acreage with subsided and disconnected wetlands.

Risks to water supplies from the Delta

The Delta directly or indirectly supplies water to most of California's population and much of its irrigated agriculture. Landform, water quality, water management, and ecological changes can affect both the ability to pump water directly from the Delta and the ability to divert water from upstream tributaries.

Major flooding of one or more Delta islands during California's long dry season, due to a major earthquake for example, could lead to severe sea water intrusions, and so jeopardize water quality for users of Delta. Lack of large freshwater inflows into the southern Delta, where most water export pumps are located, could prolong this salinity intrusion for many months.

However, permanent flooding of islands often tends to dampen local tidal ranges and mixing, which reduces seawater intrusion into the Delta at high tides. However, Delta island levee failures also would expose more Delta water to contaminants from peat soils, adding treatment costs for urban water users.

Continued tightening of drinking water quality standards is making treatment of Delta water more expensive, due to its high organic carbon content, along with salts and bromides from seawater and agricultural drainage. Rising salt concentrations in Delta water also affect local agriculture and larger agricultural areas depending on water exports pumped from the Delta.

Risks to Ecosystems

The Delta is the permanent or seasonal home to several endangered species of fish and other

Table 1 - Major drivers of change and their impacts for California's Sacramento-San Joaquin Delta

Change → / Driver	Landforms	Island flooding	Salinity intrusion	Water supplies	Native fish species	Recreational fishing	Local economy & society
Sea level rise	●	●	●	●		●	●
Land subsidence	●	●					●
Floods	●	●					●
Earthquakes	●	●	●	●			●
Upstream sediment & quality	●			●	●	●	
Tightening treatment standards				●			●
Water exports			●	●	●		●
Endangered & invasive species				●	●	●	●

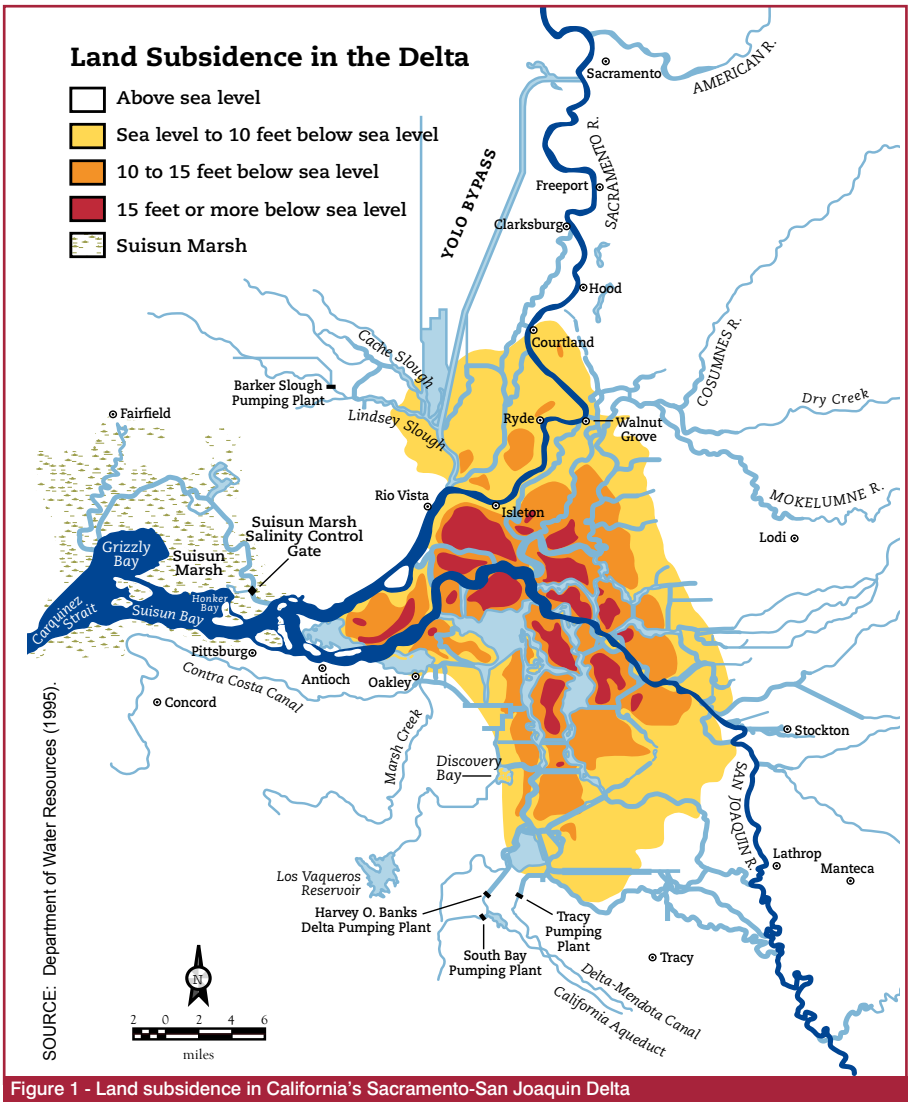

Figure 1 - Land subsidence in California's Sacramento-San Joaquin Delta

animals and has become home to an increasing number of invasive and introduced species. In much of the Delta, native fish species are only 10-20% of total fish biomass. Invasive clams, zooplankton, and plants have fundamentally altered most of the Delta's ecosystem. The Delta's landscape has changed from predominantly tidal freshwater wetlands to often-subsided agricultural land ringed by riprapped levees. Stream and channel flows have been greatly altered in their flow patterns and direction due to upstream water management and in-Delta pumping.

Flooding of Delta islands would return some areas to open water, enlarging aquatic habitat area, but at much greater depths, quite different from the vast freshwater tidal marshes of pre-development times.

Uncertain solutions

These changes, and tightening restrictions on water diversions due to endangered species concerns, have led to great, but highly controversial, interest in the construction of tunnels to divert fresh water from the Sacramento River under the Delta to the major water diversion locations for cities and farms south and west of the Delta.

For ecosystems, there is great interest in restoring the Delta's tidal wetlands, which are limited by the scarcity of suitable land elevations after subsidence, changing and reducing water diversions, and controlling the introduction of new invasive species. These actions would affect local and regional economic activity, displace some agriculture, and would usually reduce water diversions from the Delta. This reduction in Delta water exports would result in several hundred million dollars per year of lost economic value, especially during drier years.

Much of the Delta's local economy and society will be unaffected by these changes because it lies far from areas of the Delta likely to be most affected. However, these changes will fundamentally affect much of the western and central subsided areas of the Delta, and there is great interest in further strengthening Delta levees and increasing freshwater flushing flows from the Delta.

Several State and federal agencies and major Delta export water users are currently proposing a Bay Delta Conservation Plan that would restore extensive habitat areas, build tunnels to improve Delta water export quality and reliability, and provide a different long-term basis for managing water in the Delta. This plan is unsurprisingly controversial.

As with many deltas around the world, some changes are physically and economically inevitable for California's Sacramento-San Joaquin Delta. Changes are always difficult with so many diverse interests in the outcomes and management of change. California faces a strategic challenge in how to best manage the Delta, this central feature of local and statewide water supply and ecosystem importance. Time will tell how successful California will be in this effort, given the highly decentralized, and locally effective, system of water governance in California.

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