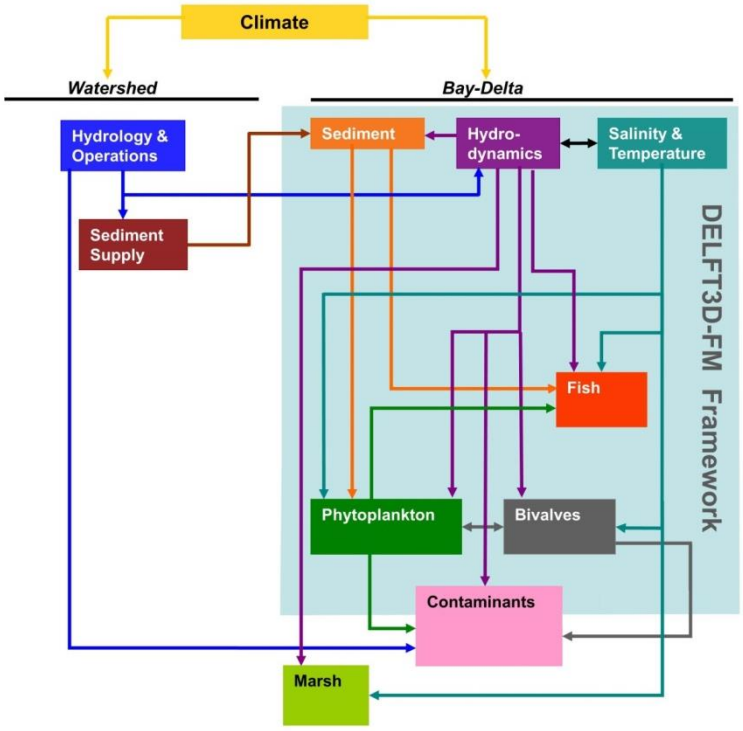
CASCaDE II: Computational Assessments of Scenarios of Change for the Delta Ecosystem

CASCaDE II builds upon a prior model-based effort to develop a holistic view of the Bay-Delta-River-Watershed system. In CASCaDE I, a set of linked models to assess Delta ecosystem response to climate change was developed. In CASCaDE II, we have refined and extended those modeling capabilities to assess Delta ecosystem response to changes in climate and physical configuration. With new state-of-the-art hydrodynamic and water quality models at its core, CASCaDE II links models of climate, hydrology, hydrodynamics, sediment, phytoplankton, bivalves, contaminants, marsh accretion, and fish (see Schematic).

Our goals are to apply these linked models to 1) better understand Delta ecosystem function, 2) assess possible futures of the Delta under scenarios of climate and structural change, and 3) provide science-based information to support the Delta Stewardship Council in its co-equal goals of ensuring water supply and ecosystem protection. The tools developed will provide an objective basis for anticipating and diagnosing Delta ecosystem responses to planned and unplanned changes. Experiments using the linked models are designed to address questions such as: How will a changing climate, together with new conveyance structures or increased flooded island habitat, alter water flow and drinking water quality? With projected changes in hydrodynamics, turbidity, temperature, and salinity, how might primary productivity, invasive bivalves, marsh processes, contaminant dynamics, and fish populations respond?



Schematic of CASCaDE 2 modeling tasks. Boxes represent modeling efforts. Arrows represent data flow between models. Task boxes overlaying the pale blue shaded area are either computed on the new Deltares flexible mesh "FM" grid, or coupled to it through Deltares linkage tools.

Most CASCaDE II modeling tasks either: 1) are entirely new initiatives in CASCaDE, (2) implement new modeling software, or (3) link to new models. A great deal of the project term has been devoted to model R&D. Not only have substantial time and effort been invested in the development of individual models and their tailoring to the San Francisco Bay-Delta ("SFBD"), but significant resources have also been devoted to the *linkages* between models. This complex web of interdependent, evolving, linked models is currently one in which individual tasks and linkages are in different stages of development.

Significant progress has been made: A 20-member subset of CMIP5 global climate model (GCM) simulations has been selected and downscaled for the period 1950-2100. Projected temperature and precipitation have been run through a hydrology model for California and through routing and operations models to obtain impaired flow estimates throughout the SFBD watershed. Sea level projections have been generated for 10 scenarios. A watershed sediment model has been developed, through which GCM outputs and managed flows will be routed to produce upstream sediment boundary conditions for the SFBD sediment model. Multiple historic datasets have been analyzed to understand recent decadal scale decreases in sediment concentrations in and supply to the Bay-Delta. A state-of-the-art 3D hydrodynamic model of the Bay-Delta (including a new seamless bathymetric/topographic DEM) has been developed in collaboration with the non-profit Deltares, and validation for hydrodynamics and salinity is nearly complete; coupling to a temperature model is underway. A 2D sediment model for the Delta has been calibrated and published, and a 3D SFBD sediment model is being developed. Simplified models of phytoplankton have been developed and published to guide expectations of restored Delta habitats; several components of a more complex 2D/3D SFBD phytoplankton model have been developed and are currently being merged. A one-dimensional marsh surface elevation model was adapted and applied to explore Delta marsh sustainability and sensitivity to sea level rise, sediment delivery, and organic matter accumulation. Datasets for bivalves and contaminants have been expanded and analyzed, and SFBD selenium analyses have been published. Habitat suitability indices have been developed for multiple fish and bivalve species and a selection of environmental parameters; habitat analysis tools have been developed and tested. We expect that model development, linkages, and planned scenarios will be completed over approximately the next year.

USGS science for a changing world
Deltares Enabling Delta Life
SDSC San Diego Supercomputer Center
SF State
SACRAMENTO STATE
UNESCO-IHE Institute for Water Education
Delta Science Program
Delta Stewardship Council
UCSD