We are excited to announce a collaborative webinar hosted by the USGS and Alameda County Flood Control District. This event will highlight research and practical experiences related to the San Francisco Bay Community Model:

Date | Wednesday, 11 September 2024

Time | 09:00 - 12:00 PDT (UTC-7) or 12:00 - 15:00 EDT (UTC-4)

Duration | 20-minute presentations followed by a brief Q&A session

Target Audience | Academics, regulatory agencies, design, flood control agencies, local government officials

AGENDA

Moderator | Lauren Schambach, Deltares USA

Introduction to the Community Model | Kees Nederhoff, Deltares USA

A Collaborative Journey with CoSMoS and the Community Model | Li Erikson, USGS

Hindcasting of Extremes for Flood Control Purposes | Rohin Saleh, Aquaflows (formerly at Alameda County Flood Control District)

Predicting Extremes: Water Level Forecasting in the Bay with AQPI | Liv Herdman, USGS

Hybrid Statistical-Dynamical Modeling Approach | Zhenqiang Wang, Oregon State University

Sediment Transport and Morphology in the Bay | Mick van der Wegen, Deltares Netherlands

From the Bay to Delta | Stefan Talke, California Polytechnic State University

GET INVOLVED

We invite you to join us for this informative session. Your participation and feedback are crucial to the success of this webinar. Please register here to express your interest and provide your availability. We look forward to your participation and valuable insights.

For registration, please click here: https://www.d3d-baydelta.org/webinar

THE SAN FRANCISCO BAY COMMUNITY MODEL WEBINAR ABSTRACTS

Introduction to the San Francisco Bay-Delta Community Model

Presenter: Kees Nederhoff, Deltares USA

The San Francisco Bay-Delta is one of the most complex estuarine environments on the U.S. West Coast, where understanding and managing water levels and quality is crucial for addressing climate change impacts and enhancing flood resilience. Historically, models of the Bay-Delta have faced significant limitations: they were often inaccessible to the public, lacked consistent data across regions, or required substantial technical expertise to operate.

The San Francisco Bay-Delta Community Model provides a reliable, science-based tool that decision-makers can trust for effective planning and implementation of SLR strategies. The Delft3D platform, renowned for its global community of over 30,000 users ranging from academia to consultancy, serves as the foundation for this model. The platform's history in San Francisco Bay-Delta modeling dates back to 2006, with collaborations involving the USGS extending even further, to around 2000. The model's open-source nature ensures that it remains accessible and adaptable for various stakeholders.

This model is a product of collaboration between Deltares USA, Deltares Netherlands, the United States Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA), and the Alameda County Flood Control & Water Conservation District. It comes in two main flavors:

Three-Dimensional Hydrodynamic Model: Using the Delft3D Flexible Mesh suite, this model simulates salinity, temperature, and the impact of atmospheric forcing on the Bay-Delta ecosystem, as demonstrated in studies by Martyr-Koller et al. (2017) and Vroom et al. (2017).

1D-2D Still Water Level (SWL) Model: A hybrid model providing detailed analysis of hydrodynamics, including still water levels and tidal/surge interactions across the San Francisco Bay and Sacramento-San Joaquin Delta, as described by Nederhoff et al. (2021).

The community model concept fosters a standardized approach to modeling, offering free access to software and model setups. This platform not only supports scientific research and consultancy but also facilitates networking among stakeholders committed to the sustainable management of the Bay-Delta system.

A Collaborative Journey with CoSMoS and the Community Model

Presenter: Li Erikson, USGS

It can be said that the roots of the San Francisco Bay Model stem back more than a decade and is the result of strong collaborations between the USGS, Deltares (formerly Delft Hydraulics), and SF Bay authoritarians and academics. In this presentation we will highlight some of the milestones and offshoots that have led to the present open-source model. Highlights published in the 2013 Marine Geology Special Issue will be re-visited and an overview of the Coastal Storm Modeling System (CoSMoS) and impact assessment webtools will be given.

Hindcasting of Extremes for Flood Control Purposes

Presenter: Rohin Saleh, Aquaflows (formerly at Alameda County Flood Control District)

Sea-level rise poses a significant threat to coastal regions worldwide, with increasing coastal inundation jeopardizing homes, businesses, and critical infrastructure. Coastal communities face the urgent challenge of adapting to future flooding to safeguard their residents' lives and livelihoods.

The San Francisco Bay and Delta Community Model, focused on Still Water Levels (SFBD-SWL), is a regional Delft3D FM 1D-2D model developed by Deltares USA and the U.S. Geological Survey, with support from the Alameda County Flood Control District and the California Department of Water Resources. This model offers a consistent and reliable tool for evaluating various adaptation strategies, providing crucial insights into how tidal and storm dynamics will evolve in response to both regional and local interventions as sea-level rise (SLR) progresses.

In this presentation, we will share recent model results, highlighting the model's accuracy, efficiency, and effectiveness in hindcasting extreme water levels for flood control purposes. We will discuss the critical role of the Golden Gate as a natural restrictor of water level dynamics in the Bay and examine the impacts of shoreline hardening on tidal extremes. Additionally, we will demonstrate the effectiveness of local and subregional storm surge barriers in mitigating extreme water levels, providing valuable information for the development of robust adaptation strategies.

Predicting Extremes: Water Level Forecasting in the Bay with AQPI

Presenter: Liv Herdman, USGS

Advanced Quantitative Precipitation Information (AQPI) combines observations and models to improve monitoring and forecasts of precipitation, streamflow, and coastal flooding in the San Francisco Bay area. Now being run operationally by the Center for Western Weather water Extremes (CW3E), AQPI leverages more than a decade of research, innovation, and implementation of a statewide, state-of-the-art network of observations, and development of the next generation of weather and coastal forecast models. AQPI was developed as a prototype in response to requests from the water management community for improved information on precipitation, riverine, and coastal conditions to inform their decision-making processes. Observations of precipitation in the complex Bay Area landscape of California’s coastal mountain ranges is known to be a challenging problem. But, with new advanced radar network techniques, AQPI is helping fill an important observational gap for this highly populated and vulnerable metropolitan area. The prototype AQPI system consists of improved weather radar data for precipitation estimation; additional surface measurements of precipitation, streamflow and soil moisture; and a suite of integrated forecast modeling systems to improve situational awareness about current and future water conditions from sky to sea. Together these tools will help improve emergency preparedness and public response to prevent loss of life and destruction of property during extreme storms accompanied by heavy precipitation and high coastal water levels — especially high-moisture laden atmospheric rivers. The Bay area AQPI system could potentially be replicated in other urban regions in California, the United States, and world-wide.

Hybrid Statistical-Dynamical Modeling Approach

Presenter: Zhenqiang Wang, Oregon State University

Compound coastal flooding due to astronomic, atmospheric, oceanographic, and hydrologic forcings poses severe threats to coastal communities. While physics-driven approaches are able to dynamically simulate temporally and spatially varying compound flooding generated by multiple partially correlated drivers, computational burdens limit their capability to explore the full range of conditions that contribute to compound coastal hazards. Data-driven statistical approaches address some of these computational challenges, however they are also unable to explore all possible forcing combinations due to short observational records, and projections are typically limited to a few locations. This study proposes a hybrid statistical-dynamical approach for compound coastal flooding analysis that integrates a stochastic generator of compound flooding drivers, a hydrodynamic model, and a machine learning-based surrogate model. The framework is demonstrated in San Francisco (SF) Bay over a period of 500 years with high accuracy and computational efficiency. The stochastic generator of compound flooding drivers is developed by coupling a sea surface temperature (SST) reconstruction model with a climate emulator, weather generator, and hydrologic model. Using reconstructed SSTs as input, the generator of compound flooding drivers is employed to simulate time series of the forcing factors

contributing to compound flooding (e.g., surge, waves, river flow, etc.) in SF Bay. A process-based hydrodynamic model is built to predict total water levels (TWLs) varying in time and space throughout SF Bay based on the stochastically generated drivers. A machine learning-based surrogate model is then developed from a relatively small library of hydrodynamic model simulations to efficiently predict water levels (WLs) for compound flooding analysis under the full range of stochastic drivers. This study contributes a hybrid statistical-dynamical approach to better understand the spatial distribution and temporal evolution of compound coastal flooding, along with the relative contributions of the forcing drivers in complex nearshore, estuarine, and river environments for centennial timescales under past, present, and future climates.

Sediment Transport and Morphology in the Bay

Presenter: Mick van der Wegen, Deltares Netherlands

Sediments are abundant in the Bay-Delta system. While suspended they impact turbidity and water quality. While coming to rest they shape the bathymetry and morphology. Delft3D type of modeling will help to gain insight into sediment pathways throughout the Delta -Bay system as well as morphodynamic development as the result of human interventions and climate change.

This contribution highlights modeling efforts over the past decades. Focus will be on validated hindcasts and forecasts of the yearly Bay-Delta fine sediment budget, morphodynamic developments as the result of South Bay salt pond restoration efforts and climate change induced impact on San Pablo Bay morphodynamics.

Model results show skillful reproductions of observed sediment concentrations, sediment transports and morphodynamic developments. Together with sound measurement campaigns Delft3D modeling shows great potential to enhance understanding of Bay-Delta sediment dynamics, assess impact of human interventions and climate change and act as a tool to co-design adaptation measures for a sustainable future of the estuarine landscape.

From the Bay to the Delta

Presenter: Stefan Talke, California Polytechnic State University

The San Francisco Bay and Sacramento-San Joaquin Delta system is influenced by coastal forcing, wind, river flow, water extractions, and nonlinear interactions between these factors on short (< tidal) and long (seasonal) timescales. Over annual and decadal time scales, changes to coastal forcing, bathymetric change, locally variable vertical land motion, and sea level rise influence hydrodynamic response (e.g., tides and currents). In this presentation, we summarize some of the known hydrodynamic responses of the combined bay-delta system to meteorological, hydrological, and hydrodynamic forcing and climate change and explore the implications for model calibration, validation, and interpretation, particularly for extreme events. Additionally, we present the results of our data archaeology effort in the Sacramento Delta, which is adding more than 2000 station years of water level records between 1900-present to our knowledge of tides and extremes. In the future, these records will enable much more resolved modeling efforts that capture non-stationarity on multiple time scales.

Multiple approaches and tools are discussed that may help improve the calibration, validation, and interpretation of numerical model results. A physics-based statistical model (Baranes et al., 2023) is presented which captures the response of both daily mean and extreme water levels to river forcing, tides, wind, water extraction, and non-linear interaction between river flow and tides. The results are compared in a compact way with Delft 3-D model results from a model based on Nederhoff et al. (2021). Not unexpectedly, results are good in San Francisco Bay but improvements are needed in the more challenging bathymetry east of the Carquenez straits. Additionally, a running 32-day harmonic analysis incremented forward in 1-day increments is applied to ~100 gages over the 2017 and 2023 water years. Results in both the data and model show a large, correlated variation in the M2 constituent response to river flow; even in the South Bay, tidal amplitudes are reduced by ~10% during high river flow from the Delta, due to the reduction in forcing at the Golden Gate. At individual locations, the D3D model either overshoots or undershoots the nonlinear response; for example, in Alameda, the observed decrease in M2 of 12.5% in 2017 is about 25% larger than the 9.5% decrease observed in the model. Model sensitivity tests are also run with wind forcing and show that the south-wind during storm conditions can influence extreme water levels in the North Bay, and Delta water levels during the summer time. Longer term, vertical land motion in the system that varies between 0 and 10 mm/yr is producing large divergences in the amount of time left before chronic flooding becomes an issue. Moreover, variations in tidal properties throughout the system lead to fundamental differences in the duration of a high-tide flood, when it occurs. Going forward, these factors should be considered in model projections and planning guidance.