Analysis of Flood Statistics for Flood Risk Management in the Far South San Francisco Bay

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The ability to estimate flood stage frequency is a critical step in flood risk management. In many cases, such as the far south San Francisco Bay (SSFB), limited site specific data is available for use in this effort. However, the San Francisco tide station has over 100 years of tide data. To estimate flood frequency in SSFB a sensitivity analysis of various sampling criteria of predicted and residual tide were used to identify and sample significant flood events at the Golden Gate tide station. The probability distribution functions of the sampled predicted and residual tides and in-bay wind direction and speed were used to design hydrodynamic model simulations that covered the full range of these controlling parameters to transfer water elevation surface (WSE) to the SSFB. WSE was transferred in the form of a look-up table for existing (Yr-0) and future conditions (Yr-50 with NRC III sea level rise) project conditions for the establishment of WSE data base at the project site for use in statistical analysis.

Monte Carlo Simulation (MCS) model was used to estimate the flood stage frequency at the project site. The transferred WSE from the San Francisco tide station, static and dynamic levee failure mechanisms, local wind wave induced run-up and overtopping, and annual flood event occurrence were all implemented in the MCS model. The extreme probability analysis and Joint Probability Method were also employed to calculate the flood stage frequency curves for comparison. Reasonable flood stage frequency curves with uncertainty were using the MCS method under all the scenarios studied. The comparisons of flood stage frequency results among the different statistical approaches seem very reasonable. It’s concluded that the technical approaches developed, using hydrodynamic and Monte Carlo simulations, would provide a reasonable way for the establishment of coastal flood stage frequency at the project site.

Keywords: Flood Frequency Statistics, Flood Risk Management

Wednesday, October 17, 2012: Room 307, Flood and Levee Management– Order 1

Modeling the Establishment of Riparian Habitat Vegetation with Applications to *Populus fremonti* on the Sacramento River, California

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The existence of healthy riparian forests in the Sacramento, San Joaquin and other tributaries of the Bay-Delta is important for successfully managing the estuary for both human and ecosystem benefits. These riparian forests provide important ecological services including stream bank stabilization, shade, nutrient inputs, and physical habitat for terrestrial and aquatic species. The survival and renewal of riparian forests requires the periodic establishment of cottonwood and other riparian vegetation seedlings in near-river sediments in order to replace trees lost to natural mortality and other causes. Determining under what conditions riparian vegetation seedlings will survive is an important consideration in managing river flows for both human and ecological objectives.

To address this need, a hydro-biological conceptual model describing the growth and survival of riparian vegetation from germination through the first year of seedling growth was developed. This Riparian Habitat Establishment Model (RHEM) was developed by integrating the conceptual model into the well-known HYDRUS-2D numerical model. RHEM dynamically simulates seedling root and shoot growth and plant survival as the combined effects of sediment texture, meteorological conditions, and water table depth. Using the RHEM model, an analysis based on water table controlled cottonwood (*Populus Fremonti*) growth experiments revealed that the seedlings do not experience significant water stress until a critical water table depth is reached. This depth depends on sediment texture with finer textured sediments having greater critical depths. Additional analyses showed that, for the conditions simulated in this study, sediment texture has a larger effect on seedling survival than meteorological conditions. The RHEM model was also used to derive and evaluate a simple cottonwood seedling density and survival model which was applied to observed seedling growth and survival conditions on the Sacramento River, CA. The density model was able to successfully replicate the decline in seedling density observed as river stage declined.

Keywords: Riparian vegetation modeling

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Holland Tract Levee - Case History

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Delta Levees provide protection for the lands and habitat behind the levees. The highly altered waterways now depend on the levees to maintain water flows through the delta and to protect critical habitat. The levee on Holland Tract has a long history of concerns and the levee failed in 1980. The presentation will include a history of levee construction and engineering concerns with the Holland Tract levee. In the 30 plus years since levee failure, the Holland Tract levee has included several phases of construction to raise, widen and improve the levee. Recent funding though the DWR special studies program has provided additional funding for rehabilitation of the levee.

Rehabilitation of the delta levees is widely recognized as necessary to protect to protect the ecosystem and to protect the water supply of California. The presentation will provide a historical perspective of how the levee improvements are helping to achieve these goals. The Holland Tract levee improvements will allow for future improvement to counteract the effects of sea level rise and to provide a more robust levee to resist earthquake forces. The existing designs will be presented along with potential schemes for sea level rise and seismic improvements.

Keywords: Levee Case History

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Identifying High-Risk Islands and Modeling Levee Failure Scenarios Using the Adaptive Hydraulics Model (ADH)

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Flooding in the Sacramento – San Joaquin Delta presents significant risks to residents of the Delta, the ecosystem, and the state's economy. Areas of the Delta are at high risk for levee failures which would put hundreds of lives at risk and cause billions of dollars in damage. Army and Corps of Engineers guidance documents define risk as the "probability and severity of loss linked to hazards" and prescribe a composite risk assessment method to be used in Corps projects. Information regarding the relative probability of hazards and the severity of risk was taken from the Delta Risk Management Strategy (DRMS) Phase I and II documents and put into the Corps' Composite Risk Matrix (CRM). From these results, four areas were chosen to demonstrate levee failure scenarios using the ADH hydrodynamic model using criteria of; life loss risk index, economic loss risk index, tidal and shear stress impacts, and annual failure rate. The four islands chosen for analysis were Sargent Barnhart Tract, Smith Tract, SM-124 near Suisun City, and Brannan-Andrus Island. Detailed computational meshes, developed for each island based on LiDAR data, were connected to a calibrated ADH model of the entire Delta. ADH has been tested extensively for dam and levee failure scenarios and its computational scheme makes ADH accurate and efficient for these studies. Worst case failure scenarios were run for each of the four islands. Local flooding patterns and rates were evaluated as well as system-wide hydrodynamic and salinity effects. Study results can be used to inform and prioritize emergency response planning and provide insight for Delta management strategies to mitigate salinity intrusion and persistence which would affect the water supply and ecosystem.

Keywords: Levee failure, Flooding, Risk analysis, Modeling, ADH, Emergency management

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Economic Consequences of Levee Failure Associated with Subsidence and Accretion, Sacramento-San Joaquin Delta

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Subsidence of Delta organic soils and sea level rise results in increasing hydraulic forces on levees and seepage through and under levees. Conversion of Delta islands to managed impounded marshes can stop and reverse the effects of subsidence and reduce hydraulic forces and seepage. We used subsidence and wetland accretion models and economic analysis to assess the potential financial benefit of conversion of farmed islands to shallow flooded wetlands that sequester carbon. We conducted an analysis of the costs of levee failure over the next several decades on Twitchell Island under two land management scenarios. The first (baseline) assumes Twitchell Island continues to subside. The second scenario assumes the island has been converted to wetland and land and water levels increase over time

The economic effects of the two management alternatives were simulated using a Monte-Carlo modeling framework. We simulated hydraulic forces on island levees under the two scenarios and with sea level rise. Estimates of future hydraulic forces were applied to probabilities of levee failure, according to CA-DWR estimates based on sunny-day, seismic event and flooding risks.

We calculated a range of in-delta costs associated with levee failure for a single island (Twitchell). Preliminary results indicate substantial potential for avoided costs. During the next 100 years, we estimated a Net Present Value savings of 1to 3 billion in avoided levee-failure costs. We conclude that widespread conversion to wetlands could provide substantial economic benefit.

Keywords: subsidence, wetlands, levees, economics

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