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Tuesday, Nov. 10
3:30 PM – 5:00 PM
SESSION 32: Sea Level Concerns

A Pilot Assessment of Hydrologic and Water Quality Sensitivity to Climate and Land-Use Change in the Minnesota River - Thomas Johnson, U.S. Environmental Protection Agency, Washington, DC (co-authors: Andrew Parker, John Butcher)

Projected changes in climate during the next century could cause or contribute to increased flooding, drought, water quality degradation, and ecosystem impairment. The effects of climate change in different watersheds will vary due to regional differences in climate change, physiographic setting, and interaction with land-use, pollutant sources, and water management in different locations. To better understand the sensitivity of streamflow and water quality to climate change, EPA is conducting watershed modeling in 20 relatively large watersheds across the U.S. (approximately 10,000-15,000 square miles in size). This talk presents results from pilot modeling studies in 5 watersheds: the Appalachicola/Chattahoochie R., Minnesota R., Susquehanna R., Verde/Salt R., and Willamette R. In each watershed, the HSPF and SWAT watershed models were used to develop hydrologic and water quality change scenarios reflecting future climate change alone, future land-use change alone, and the combined effects of climate and land-use change. Future (2040-2070) climate change scenarios were developed using regional climate change simulations from the National Center for Atmospheric Research NARCCAP project. Land-use change scenarios reflecting future (2050) changes in housing density (i.e. developed land only) were based on projected demographic changes allocated spatially using the SERGoM model (Spatially Explicit Regional Growth Model). A range of hydrologic and water quality endpoints were determined for each simulation. Endpoints include mean monthly and mean annual stream flow, and mean monthly and mean annual nitrogen, phosphorus, and sediment loads. The resulting hydrologic and water quality change scenarios are intended to improve our general understanding of how hydrologic systems could respond to complex changes in climate and land-use drivers, and to present a plausible range of future changes that could occur in different regions of the country.

The Influence of Sea Level Rise on Storm Surge in Southern Louisiana - Mary Cialone, USAE-ERDC, Vicksburg, MS (co-authors: Alison S. Grzegorzewski, Tate O. McAlpin)

The design elevation of coastal Louisiana flood protection levees are based on many factors including an analysis of storm surge levels, waves, wave run up, tides, and anticipated sea level rise. Historically, sea level rise estimates were linearly added to design water levels, but this approach can over- or under-estimate the effect of sea level rise on total water level, thereby making the levee unnecessarily high or causing flooding, respectively. In order to evaluate the effect of sea level rise on total storm surge, numerical modeling of synthetic storms of varying intensity was employed to estimate the surge sensitivity to three water levels: the present condition and two estimated future sea level rise conditions. Sea level rise will strongly impact the type of viable wetland vegetation in this micro-tidal environment as submerged wetlands evolve from freshwater marsh to brackish marsh to open water with increasing water level. To account for changes in marsh type in the sea level rise model simulations, the roughness values were modified. The study is focused on storm surge response as a result of altered water level, vegetation type, and frictional resistance. Results indicate that peak water levels are generally higher for sea level rise simulations, but it is not a linear process. Some areas experience amplification in peak surge (particularly enclosed “pocket” areas) and other areas decrease slightly. Surge propagation over broad, shallow, wetland areas of moderate peak surge are highly sensitive to sea level rise, with surge levels increasing more than the sea level rise itself. The deeper water depths due to sea level rise and the degradation of the wetlands appear to increase the surge propagation speed and allow greater inundation. The loss of the cypress canopy as sea level rises also contributes to large local variations in surge levels.

Assessing the Future of the California Water Distribution System: The Sacramento-San Joaquin Delta - William Fleenor, UC Davis, Davis, CA (co-author: Jay Lund)

For the past several years a collaborative group at UC Davis has been examining the environmental and economic consequences of several water export options for the Sacramento-San Joaquin Delta. The delta is the hub of California's water distribution system and supplies drinking water to over 23 million residents and irrigation water to several hundred thousand acres of the central valley. Recently an initial assessment of the salinity implications of four broad strategies for managing Delta water exports was presented. The four strategies include: (1) continued pumping of exports through the Delta (the current policy), (2) diverting water upstream and conveying it around the Delta through a peripheral canal, (3) combining the current through-Delta pumping strategy with a peripheral canal (so-called "dual conveyance" or "dual facility"), and (4) ending exports altogether. Salinity implications of two main aspects of change in the Delta over this century: one to three feet of sea level rise and increased island flooding are considered. The focus is on salinity, the water quality characteristic of primary interest to water users and the one most easily represented in most models. Change will occur in the Delta, with outcomes of export possibilities depending on what conveyance strategy is chosen, how the system is operated, and how sea level and climate conditions evolve. With sea level rise predicted over the next century, initial model simulations suggest significant increases in salinity in the Delta, eventually pushing Delta salinity beyond reasonable levels for drinking water and irrigation unless large (and costly) increases in Delta outflows or reductions in upstream use and exports are made. Similarly, permanently flooded western islands significantly increase salinity intrusion into the Delta. The approach represents a first cut at predicting trends and magnitudes of likely changes with different export management strategies and changed natural conditions. The analysis also points to many areas that require more detailed modeling work to more thoroughly evaluate issues related to sea level rise, island flooding, and the effects of operational changes (notably varying the timing of exports and the operation of upstream reservoirs) both now and in the future.

Modeling the Impact of Sea Level Rise on Urban Stormwater Systems - Joseph Brascher, Clear Creek Solutions, Inc., Tumwater, WA

The impact of sea level rise on urban stormwater systems in coastal communities has the potential to increase stormwater flooding by reducing the ability of the existing stormwater systems to drain to adjacent coastal waters. This is the concern of the City of Olympia, Washington, located on Budd Inlet at the south end of Puget Sound. On December 15, 1977, Olympia's highest recorded tide occurred. It was reported that flooding occurred in downtown Olympia as a result of the extreme high tide. Further, this high tide coincided with an intense low pressure weather system. This storm may have influenced the flooding that occurred at high tide. Although this scenario is extremely rare, it is an example of how high tides combined with Pacific Northwest storms can contribute to potential flooding in downtown Olympia. The City of Olympia contracted with Clear Creek Solutions to examine the effects of sea level rise on the stormwater system in downtown Olympia. Specifically, the goal was to identify portions of the stormwater system that could potentially create flooding scenarios in conjunction with a heavy rainfall event, where a high tide could adversely affect the ability of the stormwater system to drain the stormwater to Puget Sound. The University of Washington Climate Impacts Group provided to the City of Olympia a set of sea level rise scenarios based on their research. Clear Creek Solutions then used these sea level rise scenarios to model the city's downtown stormwater system. Clear Creek Solutions used SWMM to model 12 different rainfall/high tide scenarios. The models revealed specific locations that are likely to flood in downtown Olympia when heavy storm runoff occurs during a low tide after a high tide. This happens because tidal water enters the stormwater system at high tide and does not drain out before stormwater runoff floods the system. The stormwater system does not have the capacity to drain both the existing tidal water in the stormwater pipe system and the stormwater runoff water entering the system.

Using GRACE to Investigate the Changes in Land Water Storage, Caspian Sea Basin in Iran as a Case Study - Seyed Hamed Alemohammad, MIT, Cambridge, MA (co-authors: Reza Ardakanian)

The increasing trend of Green House gases' emission, after the Industrial Revolution, has changed the balance of these gases in the atmosphere. Aggregation of these gases in the atmosphere has caused the temperature increase at the Earth's surface. This temperature increase has altered the stationary trend of climatic variables. This change has been entitled, Climate Change. One of the important impacts and challenges of Climate Change is Sea Level Fluctuation, which has so many factors. Due the last researches, changes in Land Water Storage are one of the probable factors that change the sea level. Land water storage consists of all of the waters in lakes, ponds, ground waters, snow and soil moisture. Before the last decade and as a result of not having a global monitoring system, direct observation and measurement of this volume of water was impossible. It was in 2002 that NASA launched the GRACE satellite and made it possible to monitor Land Water Storage directly. After that, many modeling of Land Water Storage have been done in different parts of the world. This research focuses on developing a model to estimate the impacts of changes in Land Water Storage on sea level fluctuations. A model based on an inverse linear method using the least square criterion is developed. The GRACE observations will be the inputs of this model. Furthermore the relation between these changes and the sea level fluctuations has been described. Moreover, the model has been used to estimate the Land Water Storage in Caspian Sea Basin in Iran. At the end, the change in the Caspian Sea Level due to the changes in Land Water Storage of the basin has been calculated. Results show that the changes in Land Water Storage in Caspian Sea basin is positive and can raise the Caspian Sea level about 10 mm per year in future.