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Wednesday, Nov. 8
1:30 PM – 3:00 PM
SESSION 44: Reservoir Operations, Levees, and Hydraulic Modeling

A Practical Comparison of 1D and 2D Hydraulic Modeling in HEC-RAS - Christopher Goodell, WEST Consultants, Portland, OR, USA (co-author: K. Denn)

HEC-RAS is one of the most popular software programs in the world for computing flood risk, floodplain management, instream alternatives design, sediment transport, and water quality in rivers. It is commonly used in a wide variety of applications ranging from stream restoration, effects of climate change on riverine and estuary systems, river operations, to flood risk quantification. Recently a new feature was incorporated into HEC-RAS that allows for two-dimensional (2D) hydraulic computations and flood mapping in addition to the traditional one-dimensional (1D) computations. This has opened the door for a much wider application of HEC-RAS and in many cases provides a much more accurate method of analyzing velocity patterns and water surface elevation variances in riverine systems. However, it is not always clear as to which method (1D or 2D) is most appropriate in all applications and what should be the expected differences between the two. A number of tests that compare the two methods will be presented followed by a practical discussion for the selection of 1D or 2D as the computation method for a variety of different HEC-RAS applications.

Managing a California Reservoir During Dam Re-Construction, Flood, and Drought Using a GoldSim System Model - Rebecca Leonardson Pluche, San Francisco Water, Power and Sewer, San Francisco, CA, USA

Hydrological forecasts and systems operations are combined in a numerical model built on the GoldSim platform to manage water level on Calaveras Reservoir, a 100,000 acre-foot reservoir providing water to the city of San Francisco. Calaveras Dam is being re-built for seismic safety while Calaveras Reservoir is being actively operated for water supply and environmental purposes. Until 2019, the reservoir must be tightly managed at low water levels to accommodate construction activities and seismic safety limitations. Maintaining a low water level is difficult because the basin has flashy hydrology and the dam outletworks 1) have low capacity at low water levels, 2) are unavailable for extended periods, and 3) are regularly being physically re-configured. Failure to manage water levels can result in costly damage and delays in the construction project, as well as elevated risk of complete dam failure. An integrated water system model was built in GoldSim, a visually enhanced, dynamic simulation framework. The GoldSim model supports decision and risk analysis by simulating future performance while quantitatively representing the inherent uncertainty and risks. This model combines hydrologic inflow ensemble forecasts, hydraulic routing, systems logic, and operational choices to give operators a reservoir level forecast. Physical changes in infrastructure are incorporated by addition of new logic such as elevation-discharge capacity curves. The model can be run at varying time-scales for both flood-risk management and medium-term water supply planning. During the very wet winter of 2016-17, thirty-one forecasts were made, providing a vital decision support tool to help operators cap the maximum water level and meet the end-of-season water level target before the most recent construction shutdown.

Levee Breach Analysis in Everglades Protective Areas, Florida - Sheng Yue, SFWMD, West Palm Beach, FL, USA (co-author: M. Ansar)

The South Florida Water Management District's (SFWMD), Florida, operates and maintains a massive water management infrastructure (canals, levees, pumps, spillways, weirs, culverts...etc.) which includes about 760 mile of levees. This infrastructure is intended for flood protection, water supply, environmental restoration and water quality enhancement. Failure of any of these levees has a potential for significant economic damages, and possibly potential losses of human lives. To mitigate the damages caused by a levee breach, it is necessary to evaluate levee breach flooding risks. This entails prediction of the volume of water that is released from the breach with reasonable accuracy and proper simulation of flood wave propagation throughout the floodplain. This results in floodplain inundation maps that are typically used in support of development of FEMA emergency action plans. This study presents a levee breach analysis on the L-40 Levee, which is located in Palm Beach County, Florida, and is part of the East Coast Protective Levee System, authorized by the US Congress Flood Control Acts of 1948 and 1952. The L-40 Levee forms an eastern boundary of water conservation area No.1 (WCA-1) in the Everglades protective Areas. WCA-1 provides water conservation and flood protection to several communities in the vicinity of West Palm Beach, Boynton Beach, Boca Raton, and Fort Lauderdale, Florida. This presentation describes the levee breach analysis procedure, including selection of the numerical model, boundary conditions, validation and results. The L-40 Levee breach study results include the estimated breach geometry, the breach flow hydrograph and breach flood inundation maps.

Unlocking the Value of Data to Assess the Impact of Changing Conditions on Reservoirs - Lauren Patterson, Nicholas Institute, Duke University, Durham, NC, USA (co-author: M. Doyle)

The U.S. Army Corps of Engineers (USACE) operates reservoirs across the United States. Each reservoir is designed and constructed in accordance with Congressional authorizations. Over 89% of reservoirs were constructed prior to 1980 and since that time many reservoirs have experienced changes in environmental conditions (e.g. climate and sediment yield) and societal conditions (e.g. water/energy demand and ecological flows). The capacity for reservoirs to absorb these changes and consistently operate as they were originally intended may be impacted by these changes.Technological conditions have also changed since many of these reservoirs were constructed, with much of the data collected prior to the widespread adoption of personal computers in the 1970's, the internet in the 1990's, and the movement by the federal government towards a policy of open data since 2009. The open data revolution is particularly a challenges to the USACE because the data for each reservoir is stored in 38 different districts; each district developing their own methods of data collection and management since previously the data could not easily be shared between districts. Thus, the USACE provides a microcosm to highlight the potential value of sharing and integrating data to better understand how reservoir operations are being impacted by changing conditions.Here, we collected reservoir data from 20 districts. The data were formatted to increase interoperability between districts; combining historic daily reservoir data and operational targets for 349 reservoirs into a single database. We developed a series of metrics to gain a national picture of which reservoirs indicate systematic deviations from the operational target over the period of record. Based on our scoring, 69% of reservoirs operated consistently in line with targets; whereas 72 reservoirs indicated a systematic deviation based on the magnitude and frequency of departures. These metrics provide a broad overview of changes but are not able to determine the underlying cause(s) of systematic deviations. We then focus on one of these flagged reservoirs, Falls Lake in the Wilmington District, to demonstrate how the original conditions the reservoir was designed to meet have changed with regard to climate, sedimentation, water withdrawals, and minimum flows. This work highlights the potential value added in open data, as well as sharing and integrating data between districts. We created an interactive data visualization tool to allow the USACE to explore these metrics across different reservoirs.