American Water Resources Association
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GIS & Water Resources VI
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Wednesday, March 31
8:30 AM – 10:00 AM
SESSION 27: Flood Inundation II

Understanding and Predicting Floods in Arid Environments - Tatiana H. Papakos and Kristi Root, Tetra Tech, Chicago, IL

Most of Yemen is located in an arid climate with convective storms that produce flash floods and cause significant damage. A tropical storm landed in the eastern part of Yemen between October 23 and 25 of 2008 causing severe destruction and leaving thousands without their homes or their livelihoods. A probabilistic risk assessment project was conducted for the Hadramout and Al Mahra governorates to determine the extent and depth of flood risks in these governorates, to develop recommendations for the recovery and reconstruction of these areas, and to reduce destruction from potential flood events. On October 31, 2008, it was reported that 4,600 homes and 2,000 huts in these two governorates sustained total or significant damage, leaving 25,000 people in need of shelter. Flooding from this tropical storm was reported to have claimed 73 lives, left 17 people missing and injured many others. The flooding not only damaged people's homes but also had a devastating effect on agricultural land. A flood hazard analysis was performed to recreate the tropical storm of 2008 and to determine the extent and depth of flooding for different flood frequency events. Hydrologic modeling analysis performed with HEC-HMS software was used to process precipitation data, identify basin characteristics and simulate the design flows produced by the Hadramout and Al Mahra river basins. HEC-GeoHMS was used to expedite this process. Hydraulic modeling performed with HEC-RAS software used the design flows and digital elevation data to model the stream conveyance and calculate flood depths. HEC-GeoRAS was used in the preprocessing and post processing efforts to expedite the parameter inputs and mapping process. Several challenges were overcame, including limited historical rainfall and flow data, discrepancies between satellite and gauge precipitation as a result of evaporation, infiltration losses due to agricultural use of land, and low resolution of digital elevation models available. Floodplains were mapped along the major waterways of the Hadramout and Al Mahra governorates. This information is being used to determine the areas prone to flooding and will be used to make recommendations in the rebuilding of roads, buildings in populated areas, agricultural lands, and flood control structures.

Distributed Flood Prediction for a High Hazard Urban Basin - Jean Vieux, Vieux & Associates, Norman, OK (co-author: Baxter E Vieux)

Hydrologic modeling and information systems can be configured to provide predictions that can save lives. This presentation will chronicle a rainfall event that occurred in the City of Austin, TX, and the performance of technology implemented for their Flood Early Warning System (FEWS). Observed rainfall and physics-based modeling in real-time resulted in an hour of lead-time for a 13-square-mile basin. On a recent weekend, a late afternoon thunderstorm occurred in Shoal Creek, which has a deadly flash flood history. The basin is an elongated basin that is fully developed and located in central Austin. Intense rainfall over the upper end of the basin was detected by a rainfall monitoring system that adjusts weather radar (NEXRAD) using rain gauges to produce accurate rainfall over watershed areas. Spatially variable rainfall is used by the physics-based model, VfloTM with updates every 15 minutes. The model is parameterized with GIS data, e.g. soils, land use/cover, and topography, and solves the kinematic wave equations in each grid cell representing overland and channel areas. The solution also accounts for reservoir or detention, and wetland areas. Cross-sections and rating curves and be input directly in the model. The grid resolution for this basin configuration is 60x60 meter with a total of 9,426 cells receiving rainfall from 60 rainfall grids at 1x1 km resolution. The resulting hydrologic predictions for this event provided an hour lead-time for a downstream location along the 11-mile long channel. The City operators of FEWS took action based on their prior experience with the hydrologic forecasting technology, providing advanced warning to occupants of pedestrian walkways along the creek.

Quantifying Uncertainty in Flood Inundation Mapping - Venkatesh Merwade, Purdue University, West Lafayette, IN (co-author: Younghun Jung)

The process of creating flood inundation maps is affected by uncertainties in data, modeling approaches, parameters, and geo-processing tools. Generalized likelihood uncertainty estimation (GLUE) is one of the popular techniques used to represent uncertainty in model predictions through Monte Carlo analysis coupled with Bayesian estimation. The overall of objective of this study is to quantitatively represent the uncertainties in flood inundation mapping by using the GLUE technique. Specifically, the effect of roughness coefficient is investigated on the output of one-dimensional HEC-RAS model, and the subsequent flood inundation map for an observed flood event on East Fork White River near Seymour, Indiana. Performance of GLUE is assessed by selecting three likelihood functions including the sum of absolute error (SAE) in water surface elevation and inundation width, sum of squared error (SSE) in water surface elevation and inundation width, and a statistic (F-statistic) based on the area of observed and simulated flood inundation map. Results show that the flood inundation maps produced by applying GLUE have different uncertainty bounds depending on the selection of the likelihood function. Overall, the likelihood function based on area based F-statistic produced the narrowest uncertainty bound in flood inundation map compared to the other two techniques.

Dam Breach Analysis and Inundation Mapping in Low Slope Coastal Plains - Ross Gordon, AECOM, Houston, TX (co-authors: Jacob M. Torres, Tyler Ray, Anthony Holder, Lonnie Anderson, Jason Afinowicz, Matthew Zeve)

Improved dam safety rules established by the Texas Commission on Environmental Quality (TCEQ) have emphasized the need for owners of state-regulated dams to re-evaluate existing dam conditions and their associated risks of failure. Moreover, understanding dam breach impacts is one of several aspects required as part of a comprehensive assessment to determine a dam's hazard classification, its need for emergency action plans, and necessary operational guidance. Focus has turned to dams located in areas of relatively flat topography, where flood waves can propagate in non-uniform directions, therefore exceeding the capabilities of traditional one-dimensional models. The application of dynamic two-dimensional modeling methods used in dam breach analysis has been shown to improve the accuracy of inundation mapping and risk communication. This discussion will present an overview on the applications of two-dimensional finite-element flow models for dam breach inundation mapping in low slope coastal plains, and will review the unique advantages of this approach for use in emergency planning.