Modeling the Upper Little Missouri River 2010 Flash Flood Using a Coupled Distributed Hydrologic and Hydraulic Model

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Introduction

Flash floods are among the most devastating natural hazards, which cause loss of life and severe economic damages. Modeling flash floods to provide warnings to the public to prevent/mitigate the impacts of this type of disaster is still challenging.

A coupled model that consists of the currently used Hydrology Laboratory - Research Distributed Hydrologic Model (HL-RDHM) at NWS and a high resolution hydraulic model (BreZo) has been developed for flash flood modeling purposes. This research aims to use this system to simulate the Upper Little Missouri River 2010 flash flood .

Catastrophic flash flooding occurred in the early morning hours of June 11, 2010, in the Upper Little Missouri River and tributary streams in southwest Arkansas. The flooding resulted in **20 fatalities** and substantial property damage.

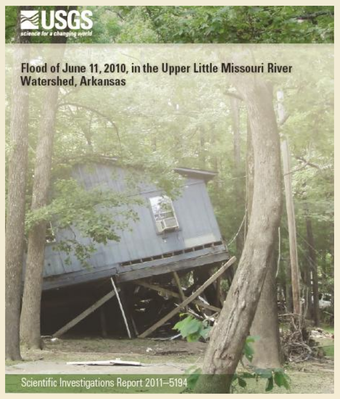

Figure 1: USGS Scientific report of the flash flood 2010 in Upper Little Missouri River Watershed, Arkansas

"…upon waking up and looking out the back door, I saw that the water level from the Little Missouri ***was just below our back deck****, by the time I made two quick phone calls including one to my father at* ***3:38 AM****….he owns the cabin….****the water had risen another several feet*** *and was* ***now over the deck****.* ***This could not have been more than 5 minutes*** *or so.* ***I have been coming to Albert Pike since I was a kid and have never seen anything like it****.* ***The speed of rise was unbelievable*** *going up* ***5 to 6 feet*** *in about* ***5 minutes****…."*

Sergeant Brady Gore *(quoted from USGS report 2011)*

Data

Little Missouri River

Area3: 328 km^2

Rainfall: Stage IV, hourly

Observations: discharge data from USGS

DEM 10m from NHD-USGS

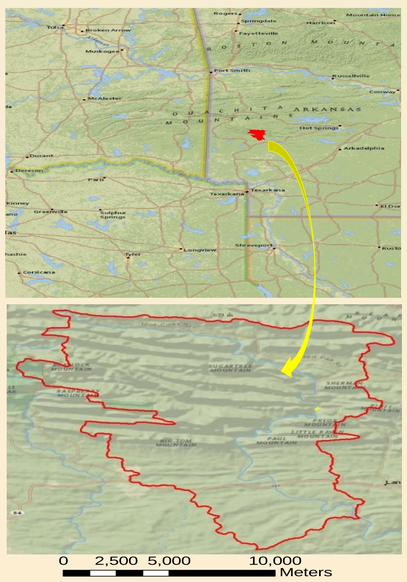

Figure 2: Research site: (a) Location, (b) Little Missouri River Watershed and (c) 3D Topography. Albert Pike Recreation Area (red spot) and Camp Albert Pike (blue spots)

Methodology

HL-RDHM

HL-RDHM is the current operational distributed hydrologic model at NWS –NOAA with the core component SAC rainfall-runoff generator.

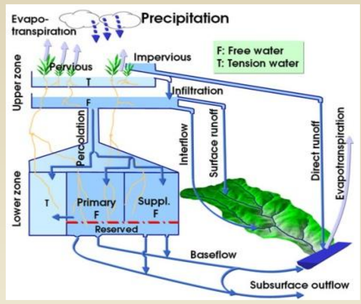

Figure 3: SAC component in HL-RDHM

BreZo

Hydraulic model solving the shallow-water equations using a Godunov-type finite volume algorithm and runs on an unstructured grid of triangular cells

Figure 4: Demo of BreZo simulation

Coupling HL-RDHM with BreZo

The model employs HL-RDHM as a rainfall-runoff generator in coarse resolution to produce surface runoff which will be zoned into point source hydrographs at the sub-catchment outlets. With point source input, BreZo simulates the spatial distributions of water depth and velocity of the flow in the river/channel and flood plain

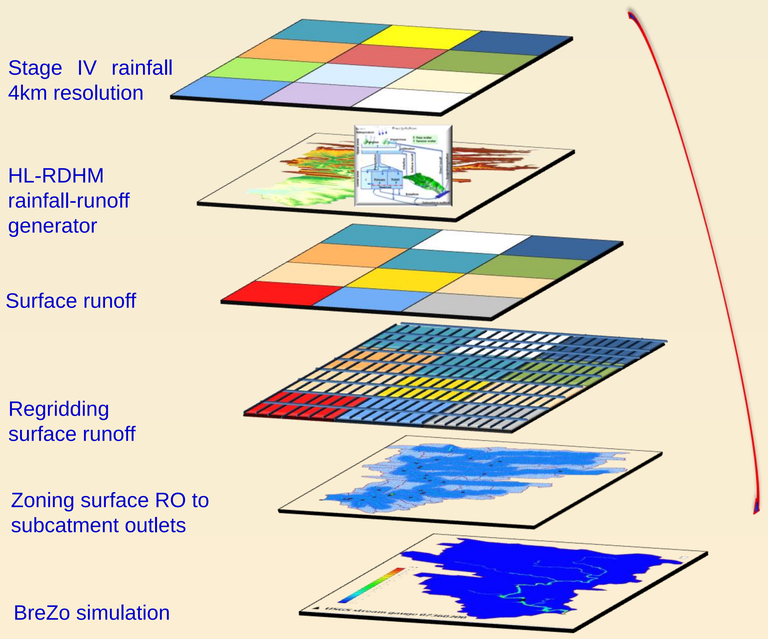

Figure 5: Steps in coupling HL-RDHM with BreZo

Results

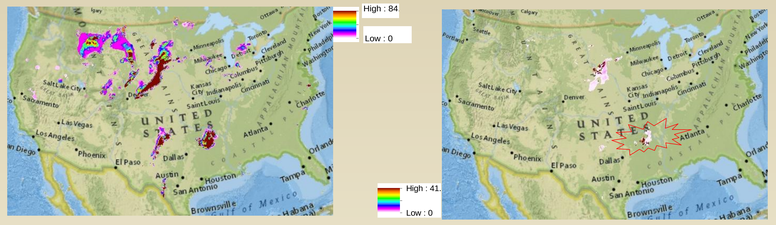

Figure 6: (left) Rainfall (mm/h) at 06-11-2010 00:00:00, (right) Surface runoff (mm/h) calculated by HL-RDHM at 06-11-2010 02:00:00 (CDT)

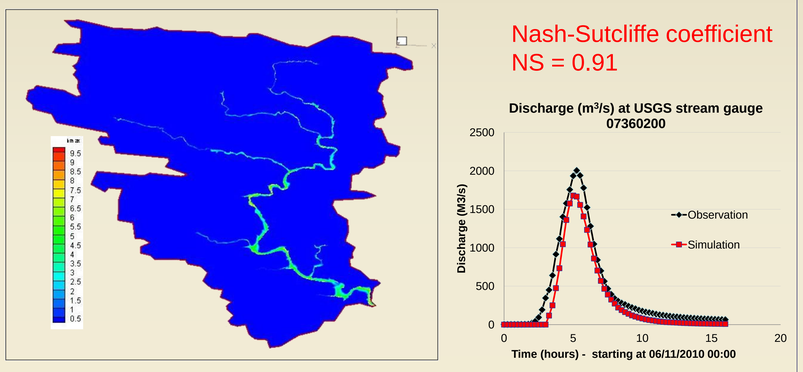

Figure 7: Simulation results: (left) Flooded map (m), (right) Discharge (m^3/s)

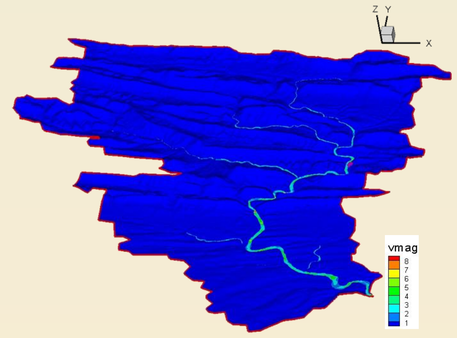

Figure 8: Flow velocity (m/s) at 06-11-2010 05:30

Conclusion

The simulation results show the system performed very well not only for the total discharge at the catchment outlet (Nash-Sutcliffe coefficient = 0.91) but also the spatial distribution of the flash floods.

Footprints, evidence and aerial images of this event are being collected to further evaluate the performance of the model.

Acknowledgement and References

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