THE VULNERABILITY OF CRITICAL ENERGY INFRASTRUCTURES TO CLIMATE CHANGE INDUCED FLOODING: A CASE STUDY FOR THE CONASAUGA RIVER BASIN

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INTRODUCTION

The U.S. energy infrastructure is considered as uniquely critical because it fuels the economy by providing required sources of energy to all infrastructure sectors that are essential to the growth and production (Energy-SSP 2015). However, the electric infrastructures are becoming more and more vulnerable due to frequent extreme weather conditions, cyberterrorism, infrastructure aging, man-made accidents, and other natural disasters (Energy-SSP 2015; Gilstrap et al. 2015; Zamuda et al. 2015; Forzieri et al. 2016). Extreme weather events have shown increase in frequency, intensity, spatial extent, and duration due to climate change and variability (Khedun and Singh 2014; Chandramowli and Felder 2014; Vale et al. 2014). Energy infrastructures that lie in areas vulnerable to flooding can be affected through changes in their energy production and consumption or through damages from floodwater (Chernin 2013; Morgan 2013; Tan 2013; Chandramowli and Felder 2014; Bollinger and Dijkema 2016). The effects of flooding on the critical electrical infrastructures are mainly attributed to the damages on electrical components due to the floodwater, which can rust metals, destroy insulation, and damage interruption capabilities (Farber-DeAnda et al. 2010; Vale et al. 2014; Bollinger and Dijkema 2016). Because the most common cause of damage to substation is flooding, some states recommend water-sensitive elements to be set above the Base Flood Elevation (BFE). Critical electric infrastructures can also be mitigated from extreme weather damages by changing the infrastructures physically to make them less vulnerable, which is also known as hardening (Farber-DeAnda et al. 2010; Gilstrap et al. 2015). However, due to the high cost of hardening and inadequate flood protection measures electric infrastructures are becoming more and more vulnerable. As Magill (2014) indicated, *"It does not take rising seas for electric power plants and other energy infrastructure in the U.S. to flood. Major 100-year floods can do that without the help of climate change.*" Therefore, the objective of this study is to assess the impact of

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climate change induced flooding on critical electric infrastructures inside the Conasauga river basin using a GPU+MPI-accelerated 2D flood model (Flood2D-GPU).

APPROACH

Taking the Conasauga river basin as a test bed, hydrologic simulation is conducted using a 90m resolution DHSVM hydrologic model driven by observed precipitation and simulated meteorology from Weather Research Forecasting (WRF) model. The DHSVM hydrograph along with a 30m resolution digital elevation model and estimated bed roughness are then used to conduct high resolution flood simulation using an accelerated Flood2D-GPU model. To perform the flood simulation, the largest flood events were identified from the three sets of hydrologic simulations (Control, Baseline and Future). The control case was driven be the 1981-2012 observed meteorology while the baseline was driven by the 1966-2005 bias-corrected input climate data. The future case is the same as the baseline but driven by the 2011-2050 downscaled meteorological data. The flow hydrographs for the baseline and future scenarios were prepared using 11-climate models. Selecting one flood event (the largest flood event from three consecutive days) per-scenario and per-climate model, a total of 23-flood simulations were performed for this case study. Because the flood simulations were not calibrated, model verification was done at three selected river segments. Finally, the vulnerability of critical electric infrastructure will be conducted by extracting the maximum flood depths at each substations and power plants.

RESULTS AND DISCUSSION

Preliminary results indicated that, the model verifications for the Flood2D-GPU show satisfactory agreement with NSE above 0.8. Moreover, the future simulations overall indicate wetter trend than the baseline simulations. This result is supported by the comparison of flood inundation extents between baseline and future simulations. The comparison revealed that seven of the eleven climate models show larger inundation extent in the future. Future efforts will focus on identifying some of the most vulnerable energy infrastructure locations in the Conasauga river basin and illustrate how they might be affected by climate change induced flooding.

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