CSULB Dual Drainage Flood Modeling

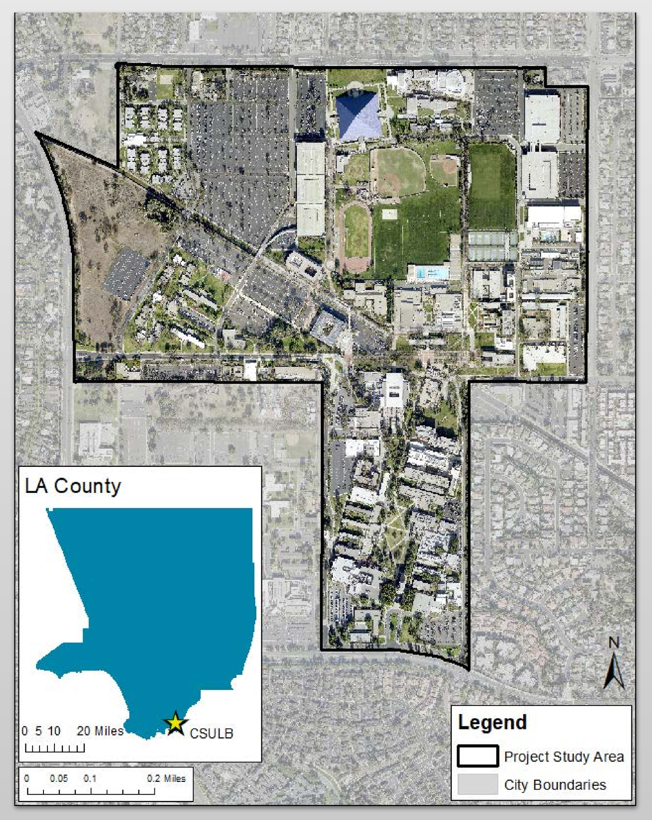
Kathy Eung, Yoko Rader, Julie Medina

Masters of Science in Geographic Information Science (MSGISci)

Department of Geography, California State University, Long Beach

Introduction

California State University of Long Beach (CSULB) has closed its campus due to severe rain and flooding (LA Times 2010). As urban flooding becomes more frequent and disastrous, the question arises of how to deal with this phenomenon, which is both global and local. There are many hydrologic flood models that try to simulate urban flooding for instance, Storm Water Management Model (SWMM), which simulates dynamic rainfall, storm water runoff, and other drainage systems. A specific type of urban flooding problem is campus flooding which lacks detailed flood maps and spatially-explicit hydrological and hydraulic data.



This research aims to determine the extent, magnitude, & inundation potential posed by flood risk by creating a hydro-logically accurate flood map & disseminating the simulation results in an interactive story map.

Figure 1. *CSULB Study Area*

Data and Data Sources

Data required to develop a dual drainage model consist of a Digital Elevation Model (DEM),obtained from United States National Elevation Dataset and precipitation data from the National Oceanic and Atmospheric Administration (NOAA). The drainage data and historical flood information was obtained from Physical Planning & Facilities Management (PPFM) at CSULB. Land use shapefile was acquired from CSULB Geography department, while soil data was obtained from USDA SSURGO. The data was formatted and organized for 1-D & 2-D models and stored in an enterprise geodatabase.

Datasets	Sources
DEM	US National Elevation Dataset 10m
Land-use shapefile	CSULB Geography Department
Soil shapefile	USDA Soil Survey Geographic Database (SSURGO)
Precipitation Data	National Oceanic and Atmospheric Administration
Drainage shapefile	CSULB PPFM
Historical flood areas	CSULB PPFM

Table 1. List of data and data sources used in the project

Methodology

This project followed a SWMM model methodology developed by Hall (2016) to recreate the storm of January 9, 2005 to identify potential inundation risks in a small scale urban area at CSULB. Land-use and soils data were used to calculate the curve number (CN). CN values are used to identify the imperviousness of the land. Runoff coefficient (C) was then calculated using the CN which calculates the depth of runoff from the precipitation. The watershed was then calculated using WMS (Watershed Modeling System) with the DEM to identify the flow of the water. Storm drains, pipes, channels, obstructions (buildings), outfalls, and junctions (manholes and inlets) data were processed to develop a dual drainage network which involves the connection of the overland flow and drainage networks. A Thiessen polygon was then created at each node to delineate subcatchments. Subcatchments determine where the surface water will flow into which node. These data sets were then inputted and run in PCSWMM which calculates the potential inundation risks. The inundated areas outputted by the model were compared with digitized historic flood maps created by PPFM. These were visualized in a story map created in ArcGIS Online.

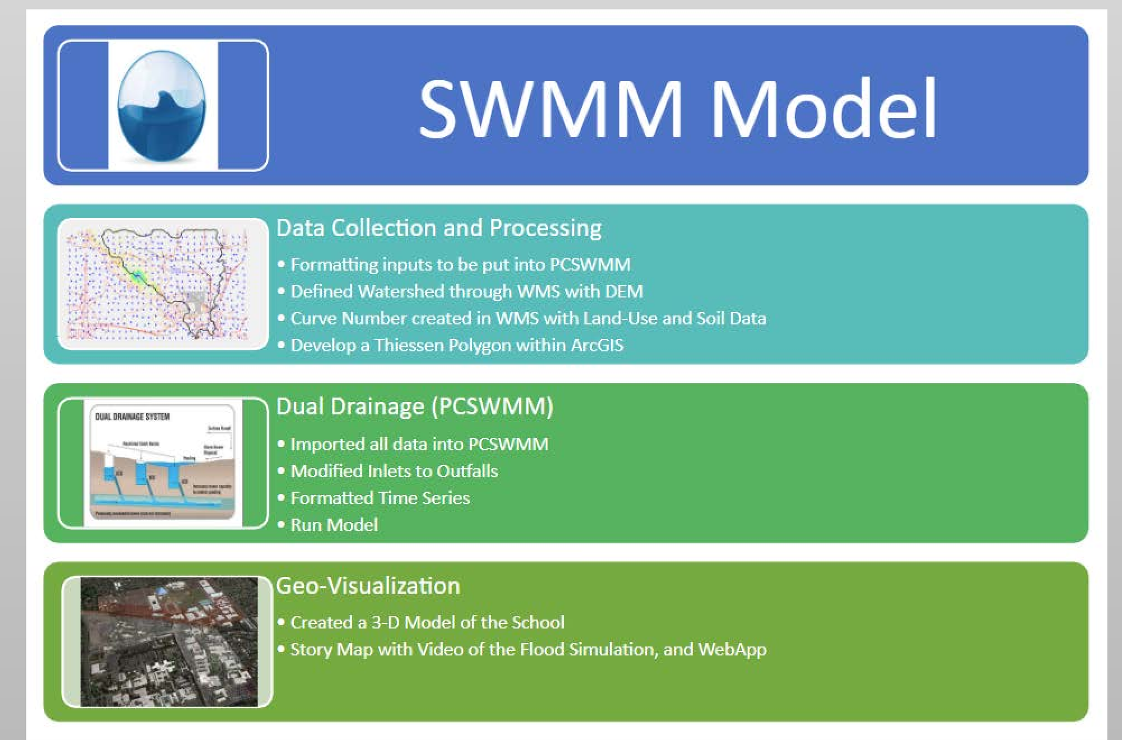


Figure 2. *SWMM model flow chart*

Timeline

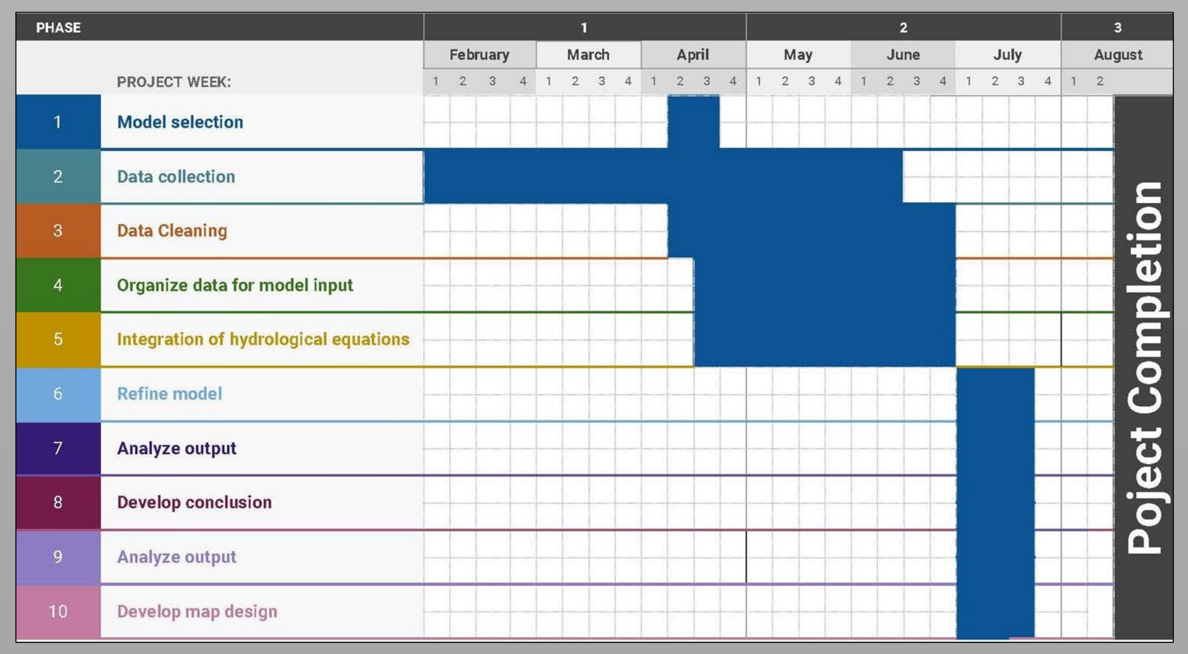


Table 2. *Timeline that was followed to complete this project.*

Results

CSULB campus has a sandy clay loam soil which is categorized as soil type C. Lower campus drainage pipes were significantly more flooded than upper campus based on the 1-D model. However, the dual drainage model resulted in higher flooding depths around the Bouton Creek channel which progresses to lower campus with time.

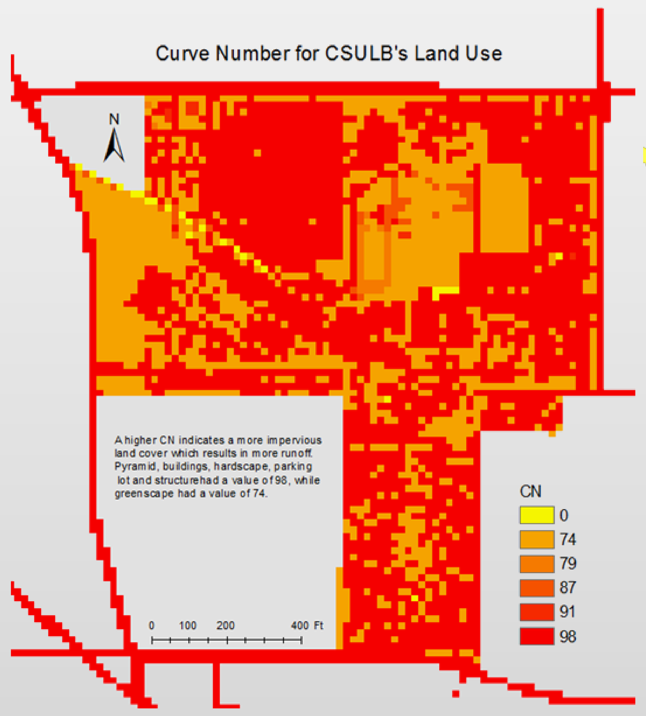


Figure 3 . *Calculated Curve Number*

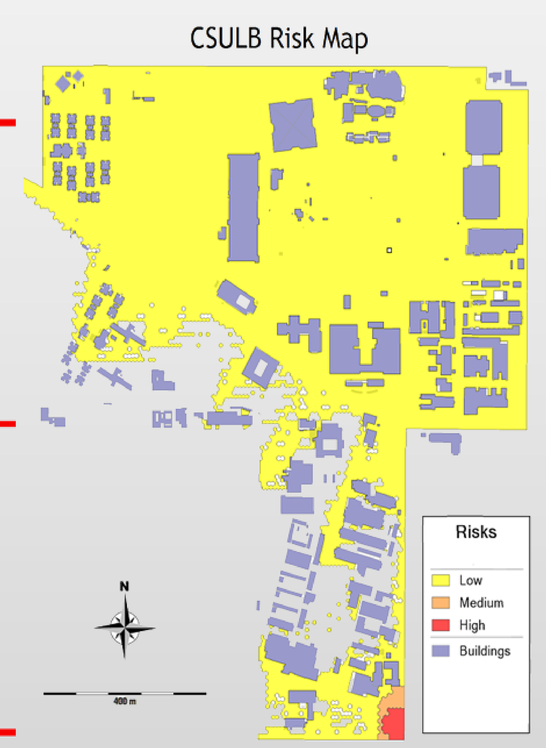


Figure 4. *Risk Map: Inundated areas divided into three categories of severity*

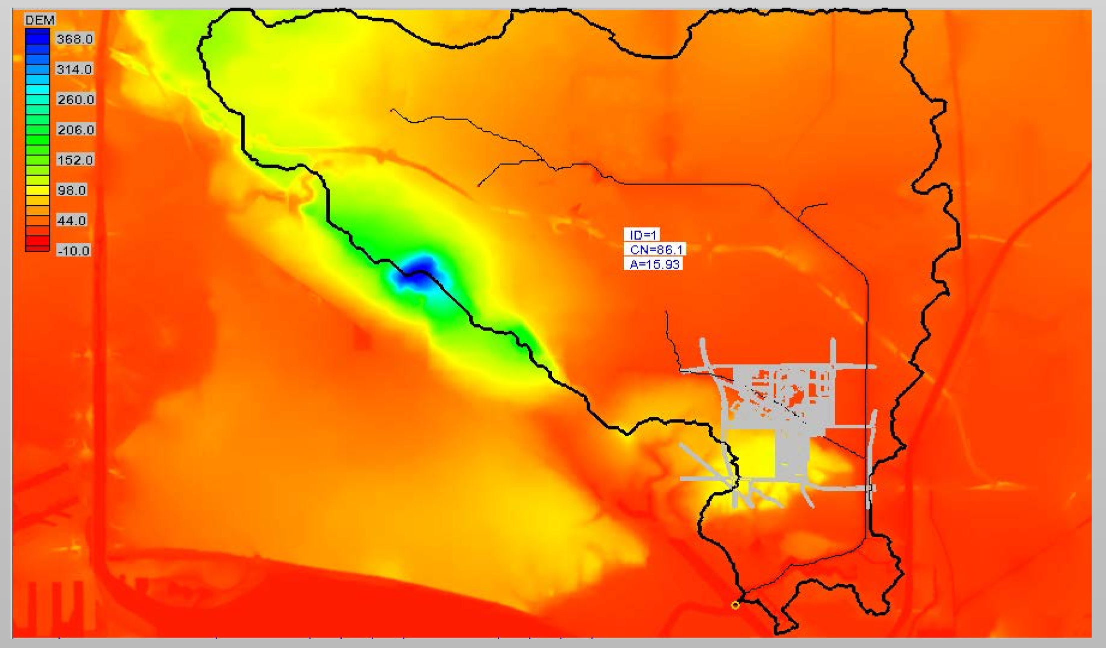


Figure 5. *Illustrates the watershed delineation from WMS and location of campus in it.*

Discussion

Methods and Results

Data acquired was easily converted to a useable format in WMS and PCSWMM for the creation of the 1-D/2-D model. The Dual Drainage model identified the areas that are more prone to flooding within the CSULB campus. These areas were mostly located on lower campus which were similar to that of the historic map (see Figure 3A and 3B). This was due to elevation which played a significant role as well as high impervious areas such as the areas near the channel on lower campus. The southeast corner of the campus floods significantly higher than the rest of campus which may be due to an error within the model. Small inaccuracies within the model can have significant outcomes therefore it is crucial to have reliable data.

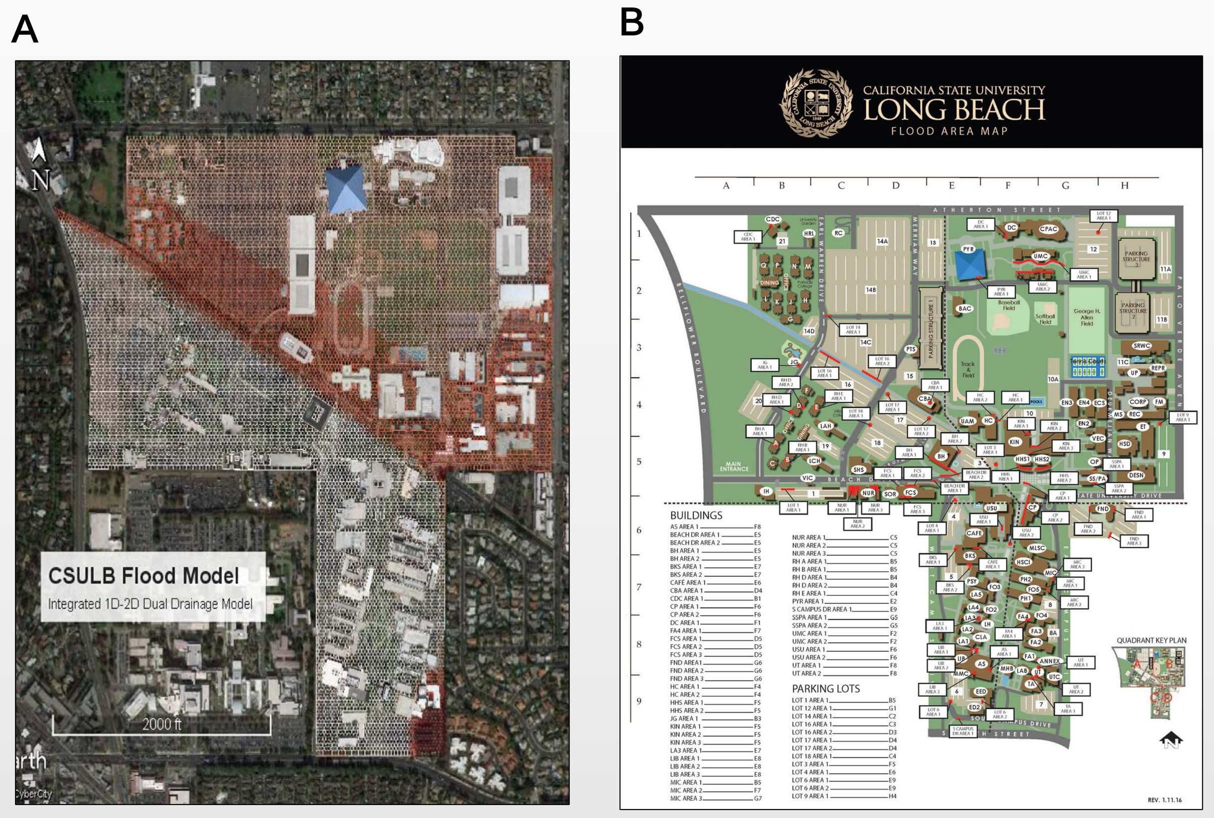


Figure 6. *PCSWMM (6A) identified areas of flooding v.s. (6B) the surveyed historic flood map provided by PPFM.*

Model Validation

Results for 1-D/2-D model were not validated as the historical maps do not identify the depth, magnitude and extent at which the area flooded. In addition to lack of historical data, there were no significant rainfall events during the study period to conduct validation surveys.

Ethics

Users should not rely heavily on this model as more improvements and validation are necessary. In addition, sewer and storm drain data must remain private as it is sensitive information and can cause security and public health issues. As such the 1-D model was not displayed due to this restriction.

Conclusion

Model calibration and validation are crucial determining factors for incorporating the flood simulation results in the campus emergency plan. Because this flood simulation could not be validated or calibrated, future work would need to ensure this step is considered. Physical experiments to analyze flood flow using time lapse photography, and calibrating model through trial and error should be implemented in future methodology.
Despite the limitations with the model, this study brings to light the importance of having a large scale hydrologically accurate flood map for the CSULB study area, as many universities lack a detailed up-to-date flood map. Preparing for extreme weather events can save thousands of dollars in mitigating damages to campus infrastructure. With global warming and the onset of more extreme weather patterns, this study represents a good starting point for further research.

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For additional information please contact: Kathy Eung: ekathy3@gmail.com, Julie Medina: julie.medina19@gmail.com ,Yoko Rader: rdryoko@msn.com

http://csulb.maps.arcgis.com/apps/Cascade/index.html?appid=cc02552f561a4f3bb5f039073c6241b9