Urban Floods under Changing Climate – A Case Study of Greater Hyderabad, India

Need for Study

Climate change may cause intense, unpredictable and changing rainfall patterns. Like any other Engineering infrastructure, storm water network is also designed to handle a design flood in future, but future is uncertain. The storm water network at times may not captive for future precipitation extremes in the changing climate. This may cause overflow of nodes in turn causing overland flow and inundating areas in the city. Therefore, urban floods under changing climate needs to be addressed to circumvent the loss of life and property.

Physical Description of Catchment

Greater Hyderabad city- 625 sq. km, altitude- 536 m. Annual rainfall - 750mm on average. Greater Hyderabad Municipal Corporation (GHMC) divided the City into sixteen storm water zones based on topography (Figure 1). Major urban floods in the years 2000, 2008, 2016.

Methodology

•GFDL-CM3 datasets for simulating future daily precipitation. National Centers for Environmental Prediction (NCEP) and India Meteorological Department (IMD) datasets for historic precipitation data. Statistical downscaling–global to regional scale

•Precipitation depends on several other atmospheric variables i.e. predictands (Figure 1)

Non-linear Quadratic Regression best establishes the dependency among predictor and predictands, with least Root-Mean Square Error (RMSE).

Simulating future daily precipitation values for the time period 2020-2100 for RCPs 2.6, 4.5, 6.0 and 8.5

•Testing the efficacy of existing storm water network for historic and future precipitation extremes for all RCP scenarios using Storm Water Management Model (SWMM) Developing Inundation maps

Predictor Variables	Notation	Units
Eastward wind@500hpa	Ua-500	metres/second
Eastward wind@850hpa	Ua-850	metres/second
Northward wind@500hpa	Va-500	metres/second
Northward wind@850hpa	Va-850	metres/second
Geopotential height @500hpa	Zg-500	metres
Geopotential height @850hpa	Zg-850	metres
Mean sea level pressure	Psl	pascals
Near surface relative humidity	Rhs	%
Near surface specific humidity	Huss	Kilogram of vapour / kilogram of air
Precipitation	Pr	mm

Figure 1. Predictor variables for downscaling Precipitation

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- historic precipitation.
- increase in flooded nodes compared to historic precipitation.
- historic precipitation.
- Flood Management in India: Technology Driven Solutions



Conclusions

• RCP 6.0 is found to be suitable emission scenario for the study area.

• RCP 2.6 predicted 76% increase in precipitation, increasing runoff volume by 75% resulting in flooding of 31% more nodes compared to

RCP 8.5 simulated 71% increase in future precipitation with 66% increase in runoff volume and number of flooded nodes were increased by 29% compared to historic precipitation. RCP 4.5 simulated 62% increase in future precipitation with 55% increase in runoff volume and 24%

RCP 6 projected 41% increase in future precipitation, increasing runoff volume by 11% and 9% increase in flooded nodes compared to

• The daily maximum precipitation predicted by RCPs 2.6, 4.5, 6.0 and 8.5 are 693mm (in 2040's), 431mm (in 2090's), 282mm (in 2060's) and 563mm (in 2080's) respectively. Acknowledgement- ITRA-Water grant ITRA/15(68)/Water/IUFM/01 dated Sep 20, 2013, Integrated Urban



daily Figure 2: Annual maximum precipitation trend for all RCP's from 2006-2100 along with historic rainfall from 1975-2005

For RCP 2.6, the highest daily precipitation is expected to occur in the years 2020 and 2040 with magnitude of 578.38 and 693.25 mm respectively. For RCP 4.5, the highest precipitation is expected to be around the end of the 21st century [late 2090's] with 431 mm followed by medium rainfall events in 2040's and early 2090's. Whereas the RCP 6 predicts relatively less annual maximum precipitation values in 2060's as 282mm. RCP 8.5 projects an increasing annual maximum precipitation towards the end of the 21st century i.e. 2080 with precipitation of 563 mm.

Figure 3: Runoff volumes simulated by SWMM for RCP's and

As future precipitation increases, the runoff volume is increasing compared to historic precipitation. RCP 6 generated precipitation generates slightly higher runoff compared to historic precipitation.

Figure 4: Flood inundation for panjaguta for scenarios (a) Historic, (b) RCP 6.0, (c) RCP 4.5, (d) RCP 8.5, (e) RCP 2.6

As rainfall increases, the extent of area inundating is also increasing linearly. Historic precipitation i.e. 162 mm inundates less area, maximum area is inundated for a precipitation of 693 mm simulated