IMPACT OF SPATIO-TEMPORAL DISAGGREGATION OF RAINFALL ON HYDROLOGICAL MODELLING

Vemuri Harini[1] , Abhinav Wadhwa[2] and Pradeep P. Mujumdar[1,2]
[1]Department of Civil Engineering, Indian Institute of Science, Bengaluru, India (vemuriharini@iisc.ac.in)
[2]Interdisciplinary Centre for Water Research (ICWaR), Indian Institute of Science, Bengaluru, India

1. Introduction

- Short-duration high-intensity rainfalls are increasing due to urbanization and climate change leading to flash floods.
- The spatial variation of rainfall and landscape heterogeneity make urban areas particularly vulnerable to flooding.
- Erratic rainfall intensities hinder the accuracy of hydrological models, posing challenges to accurate prediction and management of flood events in urban areas.
- **Research Objectives: Obtain consistent and finer-time scale data from the observed data, develop Intensity-Duration-Frequency (IDF) curves and observe the variation in flood depths for different return periods using flood inundation maps.**

2. Study Area

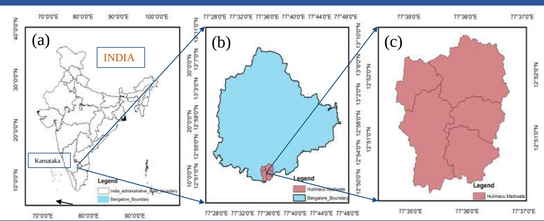
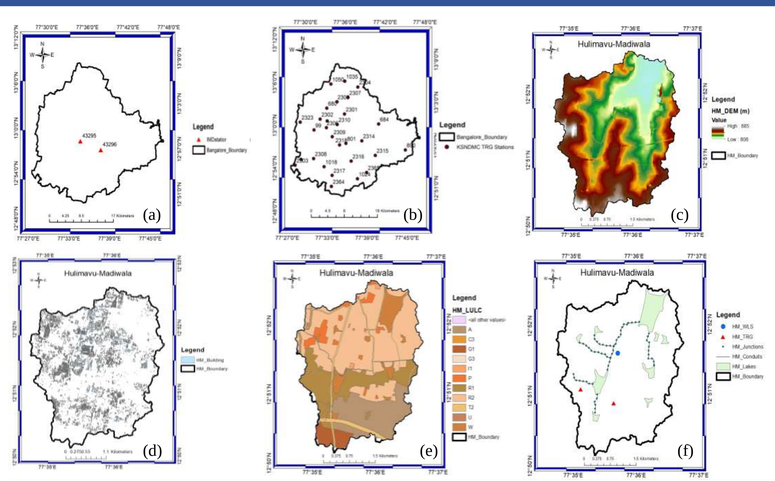


Fig 1. (a) Location of Bengaluru city in Karnataka, India. (b) Location of Hulimavu Madiwala sub – catchment in Bengaluru city. (c) Hulimavu Madiwala sub- catchment.

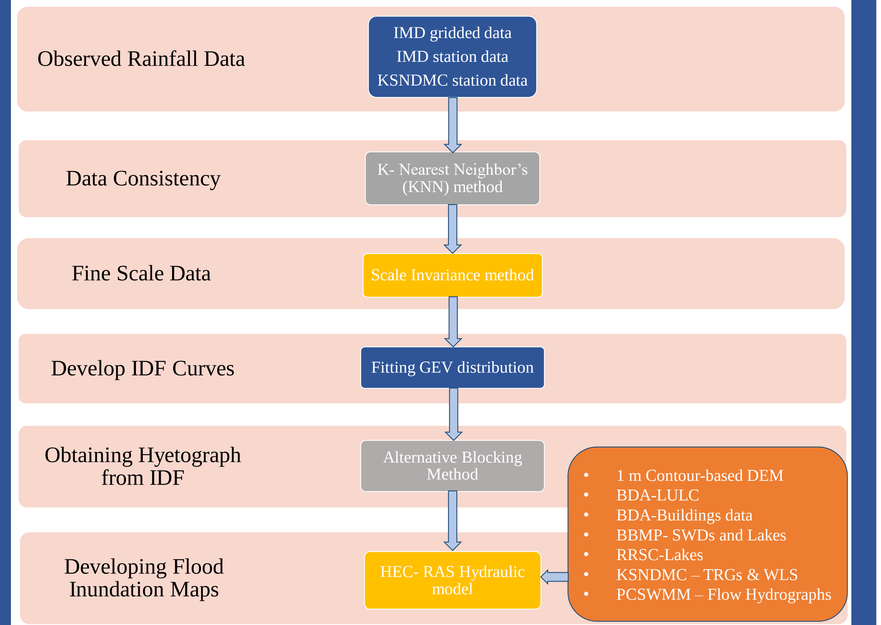
3. Data Used



A- Agricultural land, C3– Commercial, G1– State forest, G3– Parks and Green Spaces, I1- Industrial, P– Public and Semi- Public, R1– Residential (mixed), R2– Residential (main), T2– Major Roads, U– Public Utilities, W– Water bodies.

Fig. 2 (a) and (b) show location of IMD and KSNDMC rain gauge stations in Bengaluru city; (c), (d) and (e) show the Digital Elevation Model, Buildings data and Land Use Land Cover of Hulimavu Madiwala sub-catchment respectively; (f) shows lakes, conduits, Telemetric Rain Gauge (TRG) and Water Level Sensor (WLS).

4. Methodology



5. Rainfall Analysis

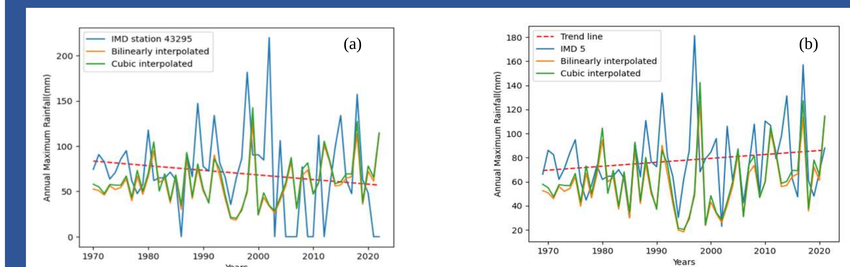


Fig. 3 (a) Annual Maximum Time Series of original IMD station 43295 (b) Annual Maximum Time Series of IMD station 43295 filled using KNN method

6. IDF Curves and Simulation Results

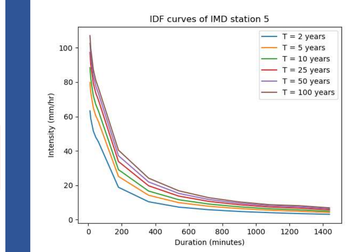


Fig. 4 IDF curve obtained for IMD station 43295 using Scale Invariance Method for 10 min to 24 hour duration.

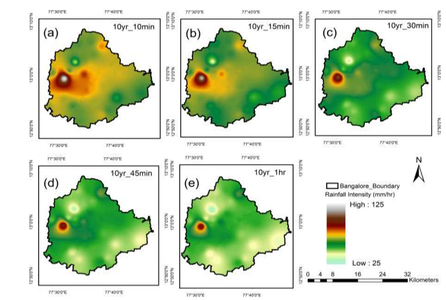


Fig. 5 Spatial plots of return levels corresponding to 10-year return period and duration of (a) 10 min (b) 15 min (c) 30 min (d) 45 min (e) 1 hour of Bengaluru city using Scale – Invariance.

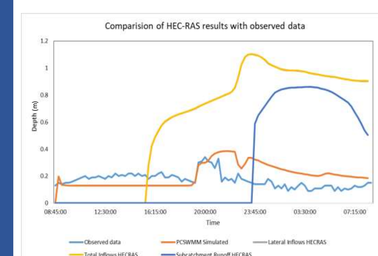


Fig. 6 Validation of 2D HEC-RAS model using the depth time series of PCWMM and observed data at Water Level Sensor for 08-09 September 2020.

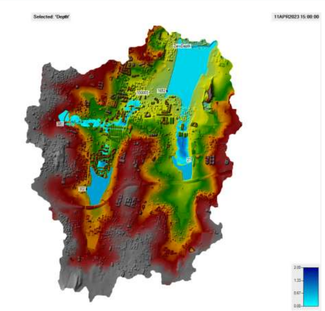


Fig. 7 Inundation map of Hulimavu Madiwala sub – catchment of Bengaluru city using HEC- RAS 2D for 10 year return period and 10 minutes duration.

7. Conclusions

- The decrease in error values (RMSE) and agreement of trends in the time series indicate the suitability of the KNN method for data filling
- Maximum rainfall intensity is observed in the western and central parts of Bengaluru city for all the durations.
- Relatively less rainfall intensity is observed in the south and south-east parts of Bengaluru city.
- The low-lying areas and the areas near lakes are easily susceptible to flooding, even for a 10-year return level.

8. Acknowledgments

- The first author express her gratitude for the financial support received from the Apra Labs- Travel Grant for Women Students through the Office of Development and Alumni Affairs, which enabled her participation in EGU2023.
- The authors also express their gratitude for the financial support received from the National Supercomputing Mission (NSM) project "Urban Modelling: Development of Multi-sectorial Simulation Lab and Science-Based Decision Support Framework to Address Urban Environmental Issues **(Project Sanction Number: MeitY/R&D/HPC/2(1)/2014))**" through the Department of Science and Technology (DST) and the Ministry of Electronics and Information Technology (MeitY), which enabled their participation in EGU2023. The authors also acknowledge the support from DST and MeitY.
- Additionally, the authors acknowledge the Ministry of Education for providing a stipend during the first author's M.Tech. program at IISc and express their gratitude for the support.