A talk on

On

Checking the performance of Regional Climate models in determining Flooding at Basin Scale using Global Hydrodynamic model

Hrishikesh Singh[1], Mohit Prakash Mohanty[2]

[1,2]Department of Water Resources Development and Management, Indian Institute of Technology, Roorkee
Email: hrishikesh_s@wr.iitr.ac.in , mohit.mohanty@wr.iitr.ac.in

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Presented by

Hrishikesh Singh

Research Scholar
Department of Water Resources
Development and Management

Indian Institute of Technology Roorkee

Introduction and Background

- A recent report by CRED (2020) highlights that **201 major flood events occurred worldwide in 2020** alone, surpassing the earlier **decadal average of 163 nos., which is roughly 23% more.**
- Rentschler (2022) report that **1.81 billion individuals (~23% global population)** are directly impacted by floods that have a frequency of occurrence of **1 in 100** years. Of these, **1.24 billion people, or roughly 70%, live in South and East Asia.**
- As per CRED (2022), India reported 2,035 flood mortalities, the highest for any country. Recent flood incidences such as the ***North India Floods in 2023 (at least 100 reported deaths, and economic loss of about 1.5-2 Billion USD***), is a solemn testimony to the fact.
- Under such situations, there is a dire need to understand and quantify the dynamics of flood risks at the finest administrative scale to confront the adverse impacts and ascertain optimum protection to the vulnerable communities.

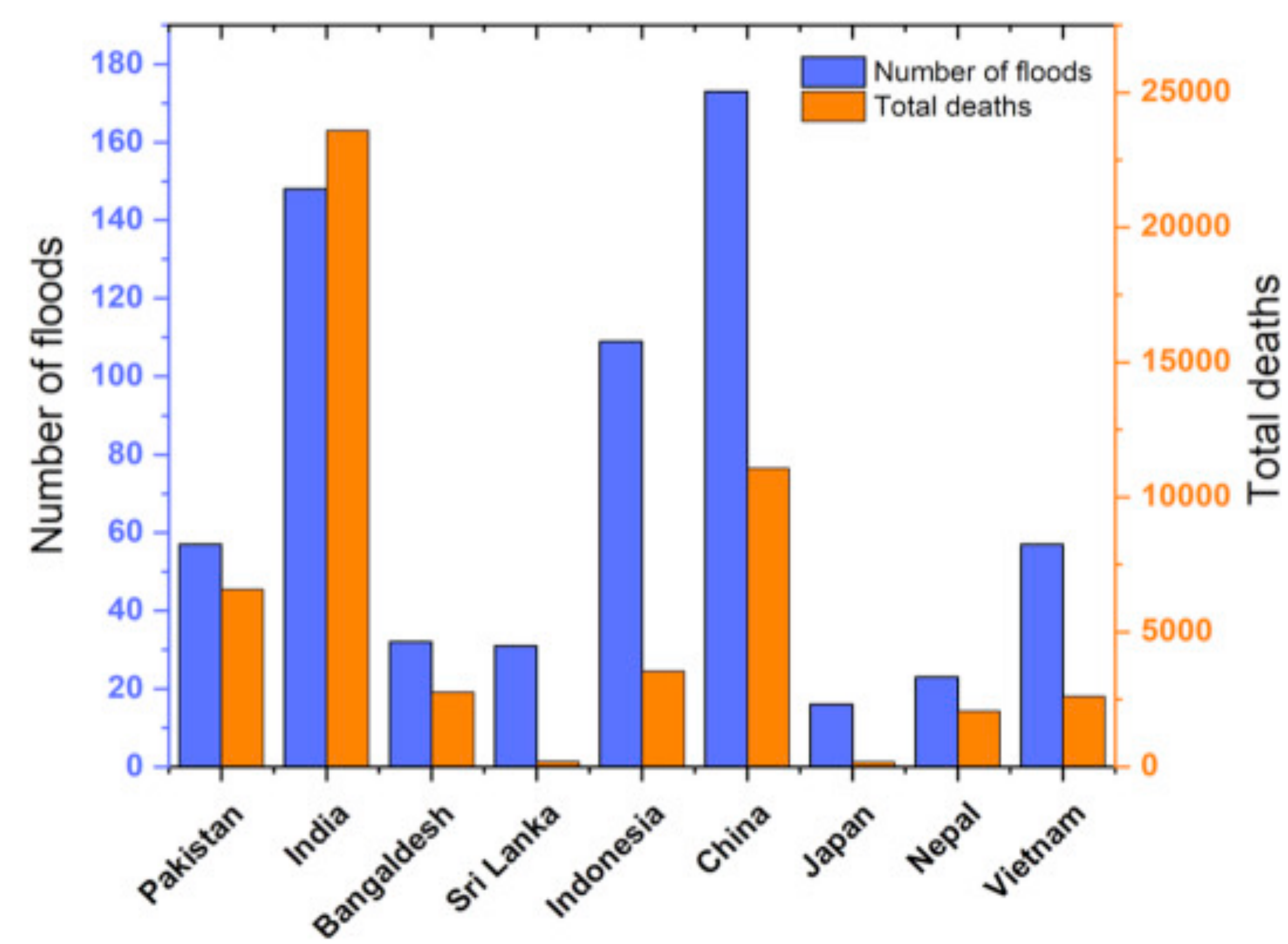

Figure 1. Number of flood events and total deaths in selected Asian countries between 2000 and 2010 (Mohanty et al. 2020)

Study Area

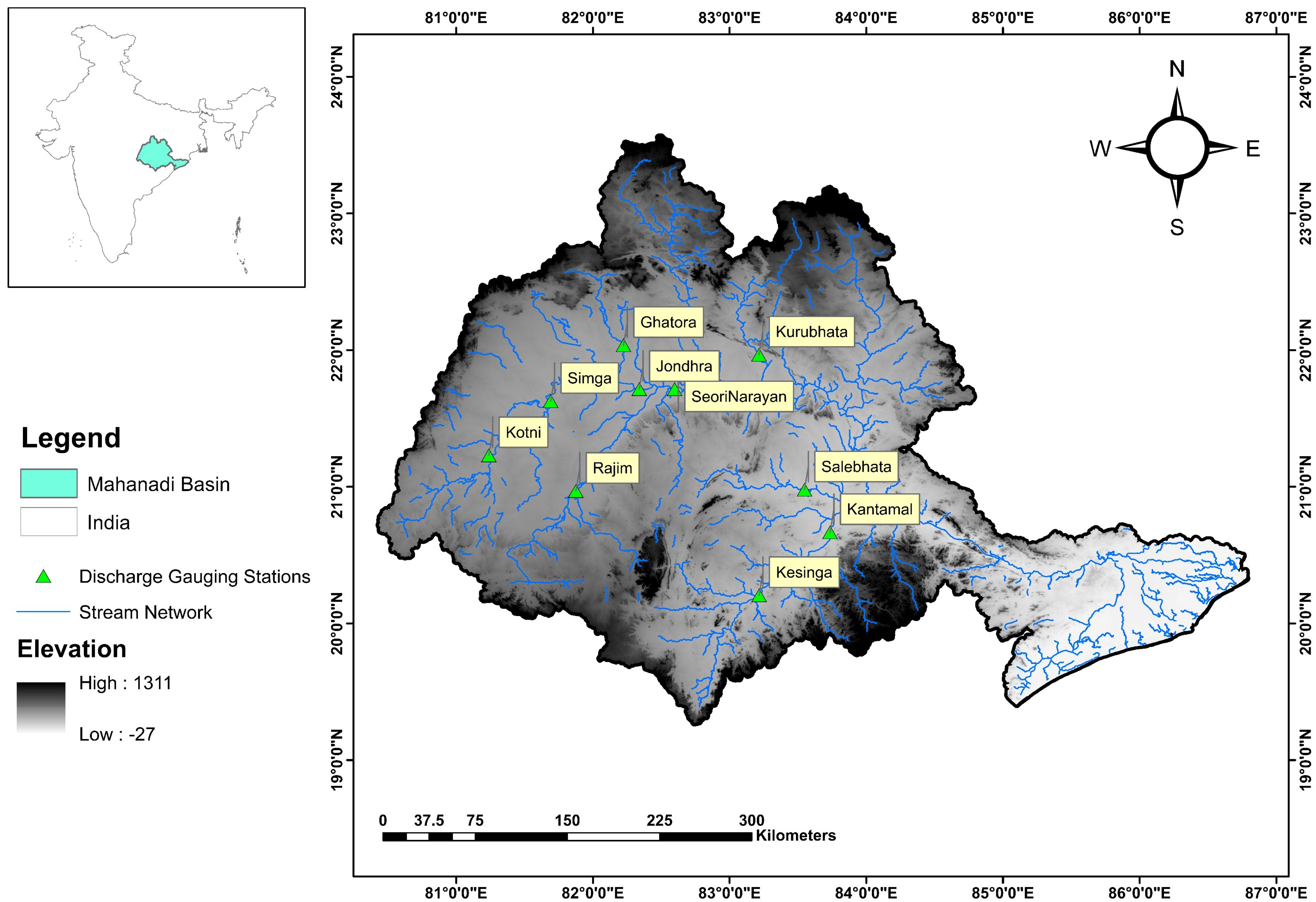

Figure 2. Mahanadi River Basin, which experienced 25 major flooding events from 1985 to 2016 (Ganguli et al. (2020). Despite higher likelihood and risks to flooding, the basin still lacks an optimal stock of ground-based observations both in terms of spatial and temporal resolution

- The region experiences a tropical monsoon climate from the South-West monsoon contributing abundant rainfall from June to September, resulting in high water-levels/streamflow in the river systems.
- Heavy precipitation, coupled with diverse topographic features exhibiting varying landscapes, including plains, plateaus, hills, and mountains contributes to significant variations in channel flow, and sediment transport; hence amplifying the vulnerability of the region to riverine flooding.
- There were 63 flood events between 1863 and 1946 (Odisha State Water Plan, 2004).

Datasets and Methodology

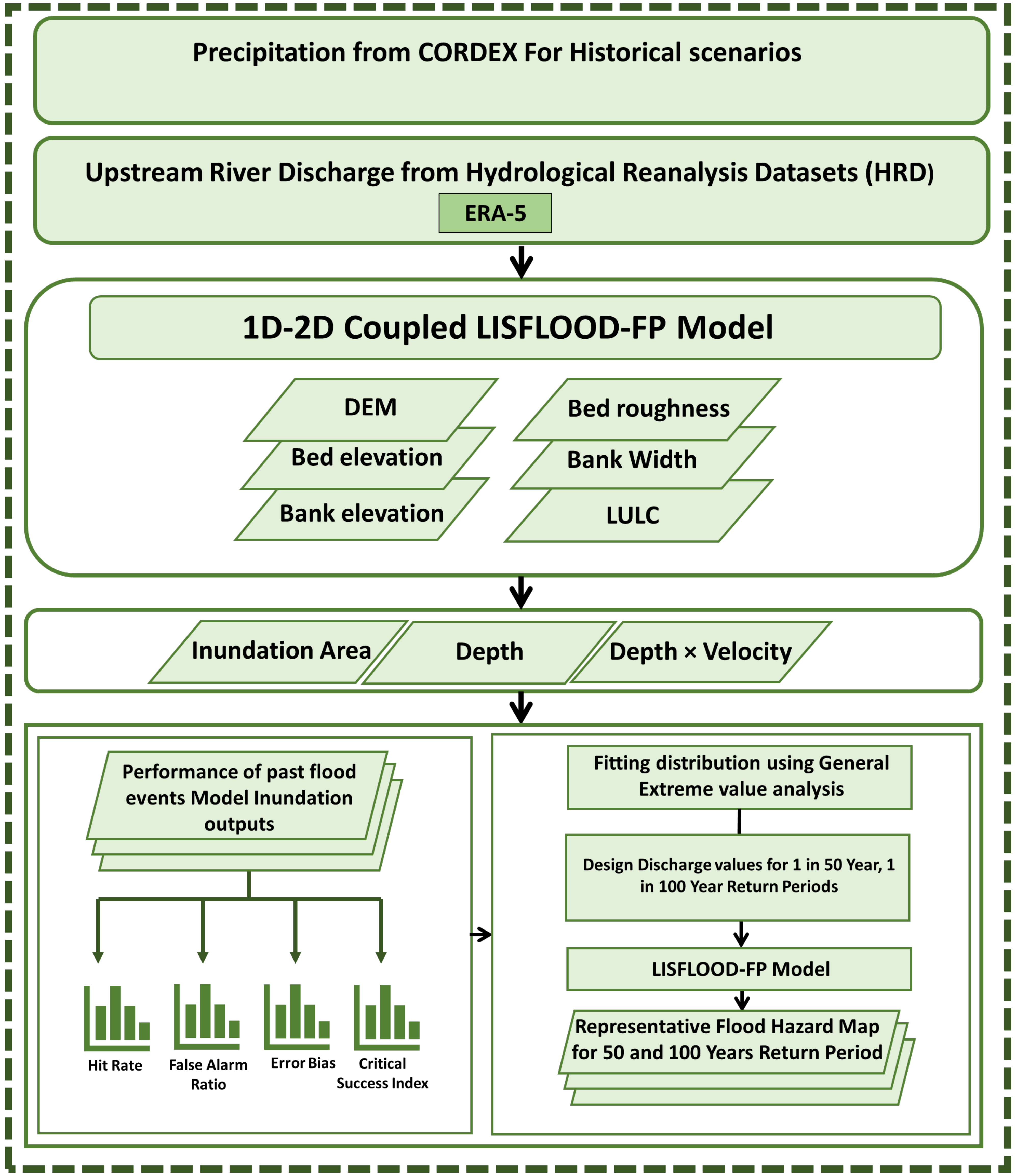

Figure 3. The framework of the adapted Methodology

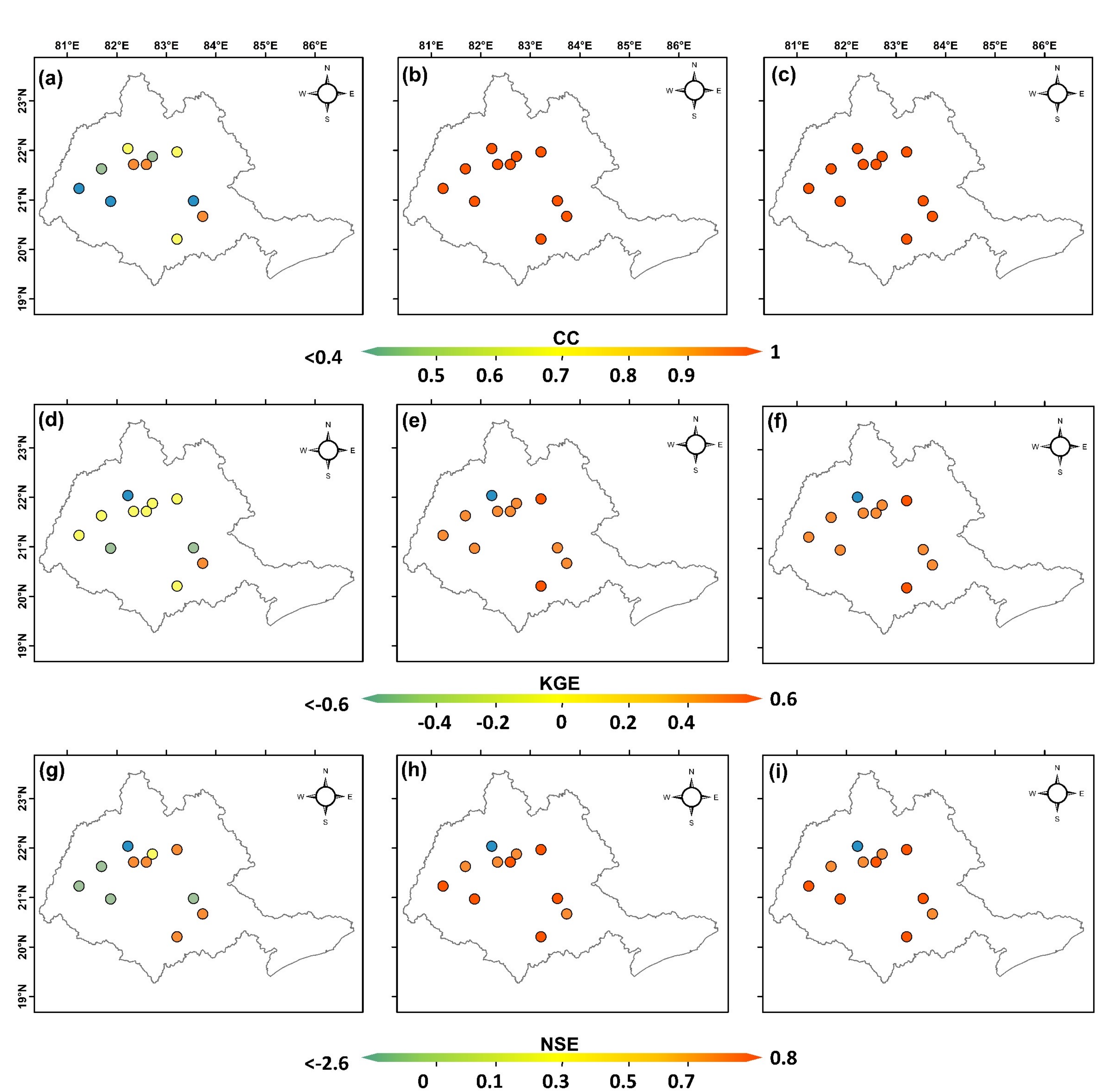

Figure 4. Comparison of ERA5 and station-level runoffs; **a**, **d**, and **g** provide the correlation coefficients, KGE and NSE values of raw runoffs; **b**, **e** and **h** provide the correlation coefficients, KGE and NSE values at the 95th percentile levels; **c**, **f** and **i** provide the correlation coefficients, KGE and NSE values at the 99th percentile levels.

Datasets and Methodology

The 2003 Mahanadi Flooding

- The flooding occurred mainly due to heavy rainfall in the upper and few parts of the Lower MRB, which resulted in high river discharge in the Mahanadi River from the tributaries.
- As a result of which, the Hirakud dam was at a Full Reservoir level leading to the release of huge volume towards downstream, which further aggravated the situation in the Lower parts of MRB, including the coastal areas
- The estimated return period of the August 2003 flood at Basantpur using the GEV distribution fitted on annual maxima is 132 years. (Pandey et al., 2022)
- A total of about 35 lakh people were affected in the nine coastal districts (Relief-Web, 2003). In this study, 5 September to 12 September 2003 i.e. 8-day event was considered to depict flood patterns.

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On the occurrence of the observed worst flood in Mahanadi River basin under the warming climate

Deeptija Pandey [a], Amar Deep Tiwari [a], Vimal Mishra [a b]

Show more

The severity of 2003 flooding. (Image source : Shutterstock)

Results

The 2003 Flooding Event simulation

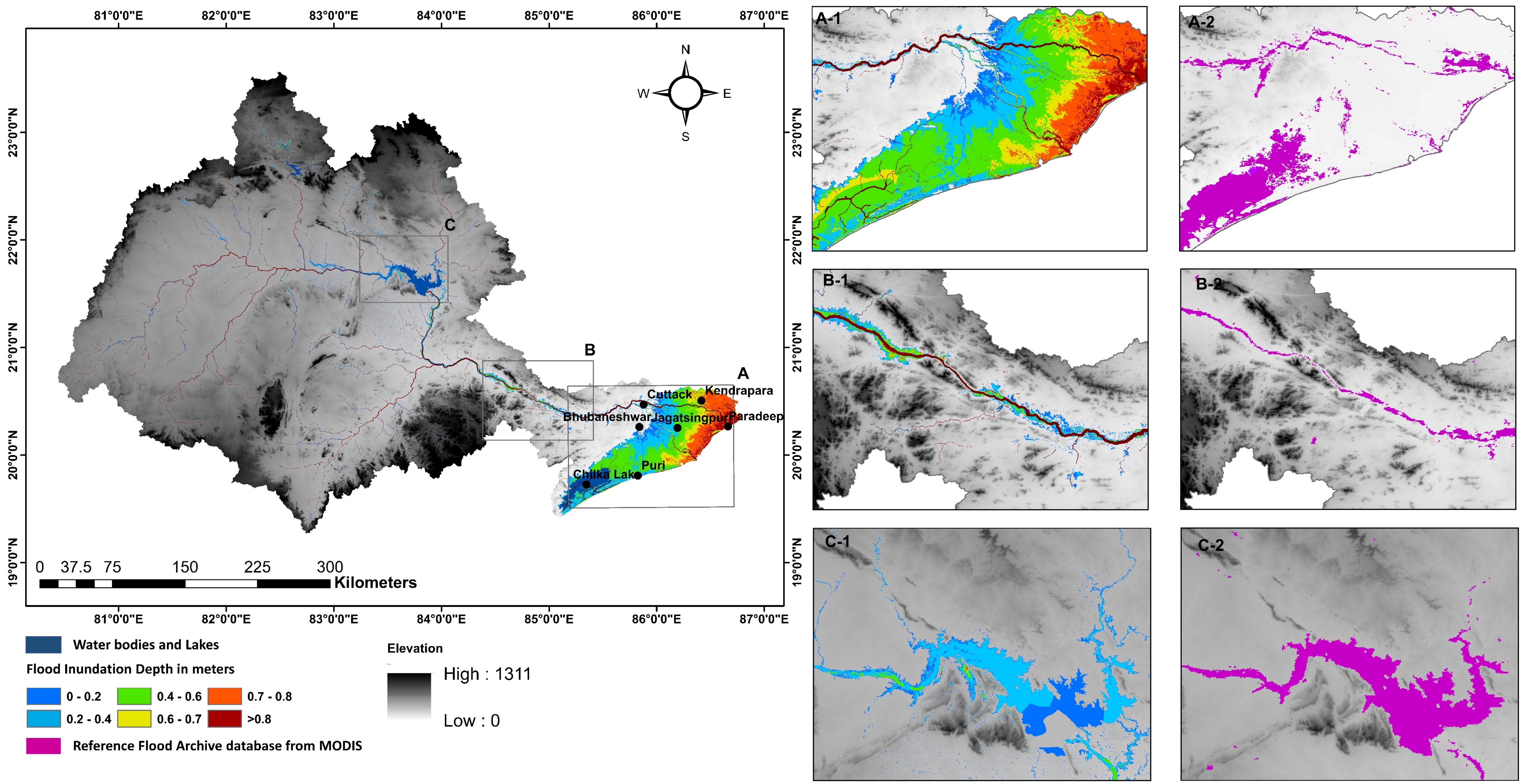

Figure 5. Simulated flood inundation map for the 2003 flooding event over MRB. The inset maps (A-1, B-1, C-1) illustrate zoomed pictures of the flooded locations and the inset maps (A-2, B-2, C-2) illustrate the reference flood map

Results

Validation of 2003 Flooding Event simulation

Table 1. Description of the Performance Statistics to establish comparison between simulated and reference flood map

Performance Statistic	Mathematical expression	Range
Hit rate (H)	$H = \frac{S \cap R}{R}$	0 to 1
False Alarm ratio (F)		0 to 1
Error Bias (EB)		1 to ∞
Accuracy		0 to 1
Kappa		-1 to 1

Table 2. Performance Metrics of simulated inundation maps

Flood Event	Hit Rate	False Alarm Ratio	Error BiasI	Accuracy	Kappa
2011	0.81	0.76		0.97	0.81

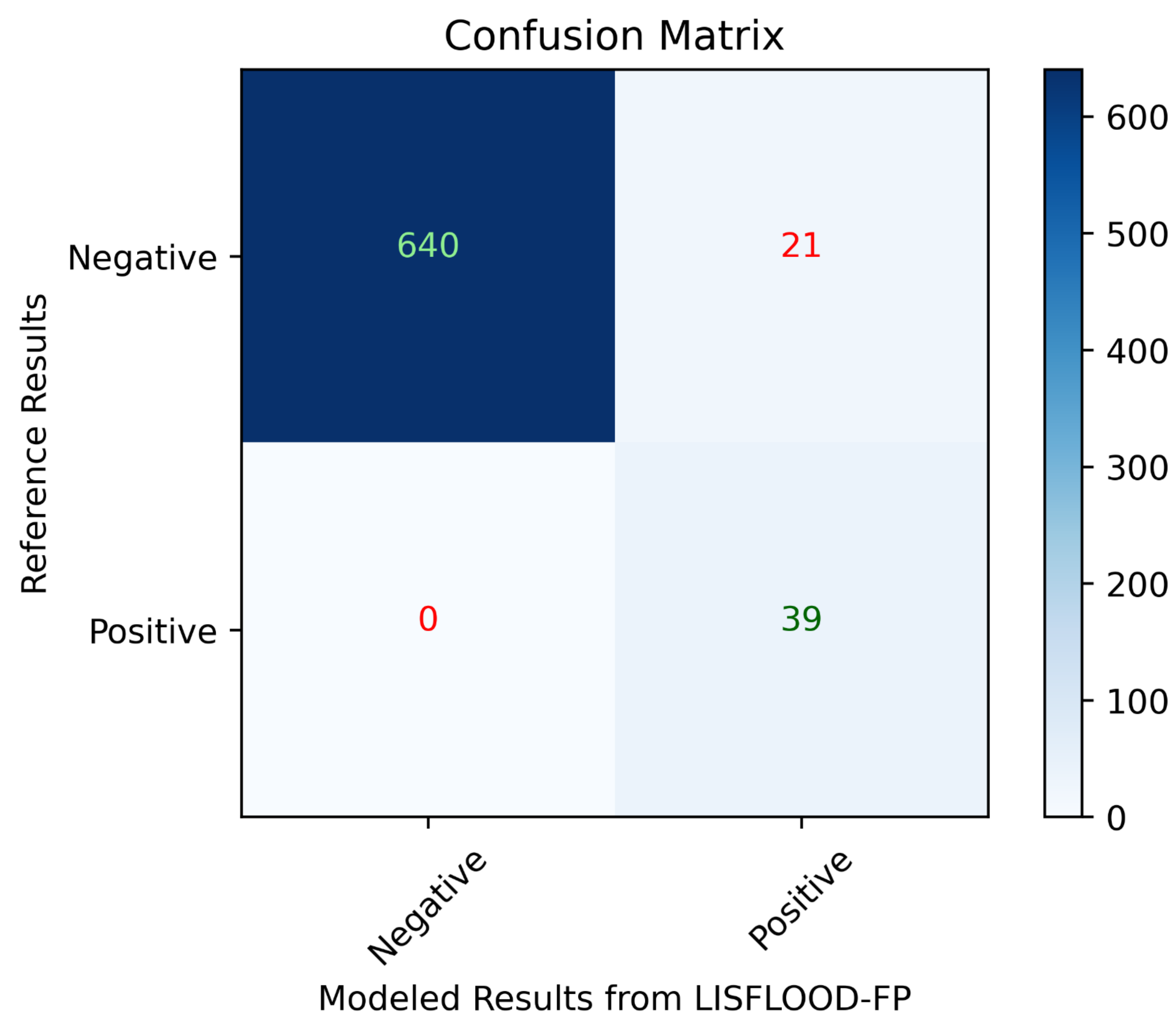

Figure 6. Confusion Matrix for Flooding event 2003

Results

The 50 Years Return Period Flood Hazard Map

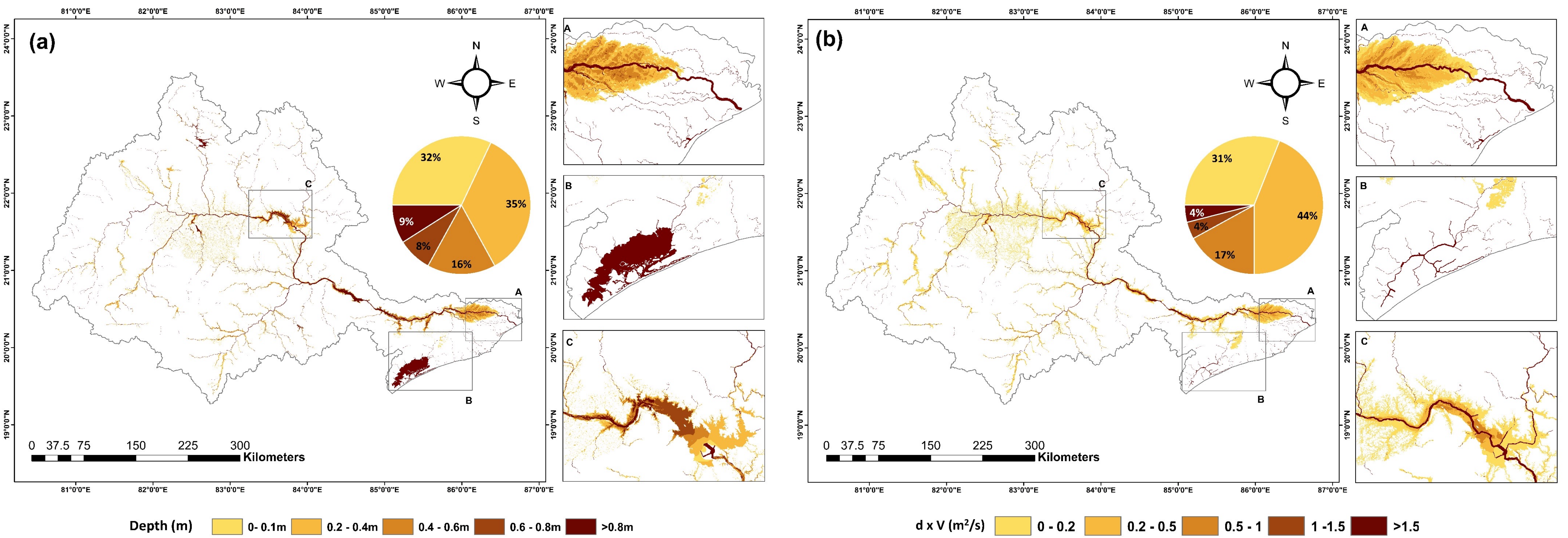

Figure 7. Simulated Flood Hazard Maps of MRB for a 50-years return period; (a) represents flood hazard in terms of depth, and (b) represents flood-hazard in terms of product of depth and velocity. Pie Chart shows Percentage of flooded grids falling in each class

Results

The 100 Years Return Period Flood Hazard Map

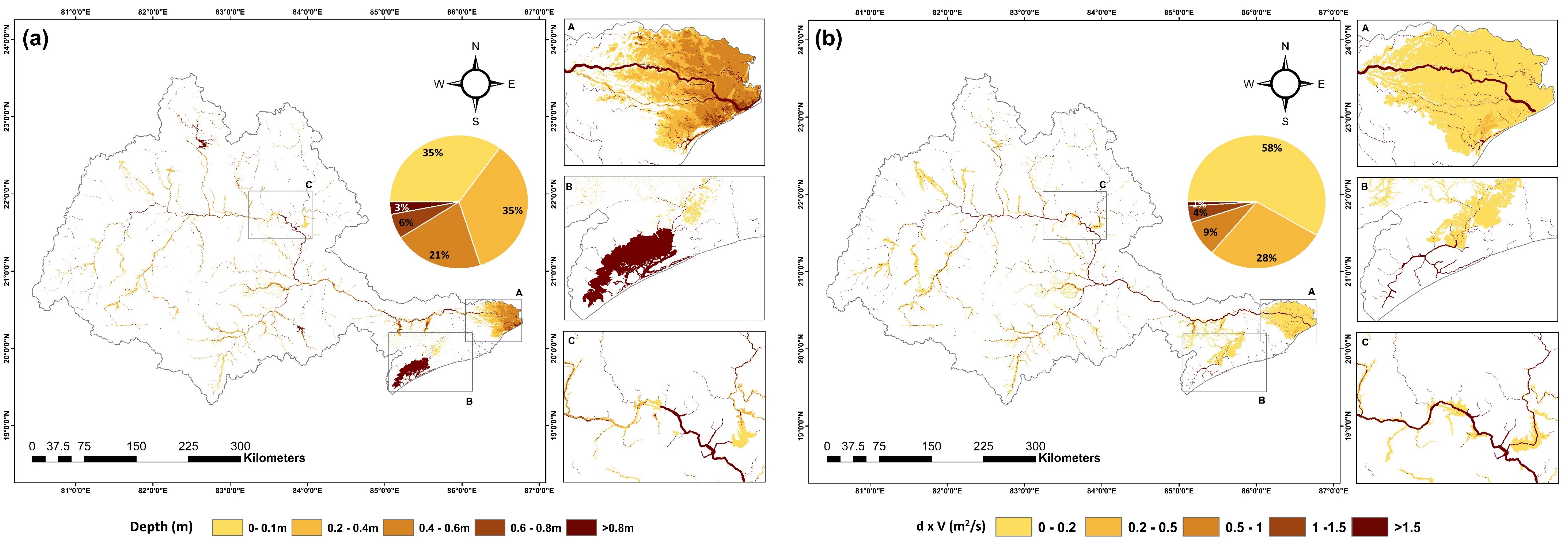

Figure 8. Simulated Flood Hazard Maps of MRB for a 100-years return period; (a) represents flood hazard in terms of depth, and (b) represents flood-hazard in terms of product of depth and velocity. Pie Chart shows Percentage of flooded grids falling in each class

Outcomes and Crux

- Understanding of the efficacy of RCMs output products on flood inundation mapping, especially over ungauged/partially gauged and data-scarce flood-affected regions
- High-resolution flood hazard maps, which will provide insights on the current status and alterations in flood susceptibility.
- Rational recommendation of a set of structural and non-structural measures, befitting to the context of flooding over a particular region
- The proposed research shall offer directives to the Government and urban local bodies, humanitarian and development organizations for a shared analysis of flood risk information to ensure their collective actions are better aligned to reduce and manage flood impacts at the regional and local scales.
- The information of changes in regional floodplain regimes impacted by climatic extremes may be added to the existing database of **Flood Hazard Zonation Atlas** (https://www.nrsc.gov.in/Atlas_FloodHazardZonation) developed by the National Remote Sensing Centre (NRSC), ISRO.

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