ICFM Webinar No. 14

Workshop on the Development and Application of the Global Flood Model

Integrating Global Flood Models for Precise Regional Flood Risk Mapping

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Assessment of Flood-risk Across Different Scales - Global, Regional, and Local

- Flood risk assessment is an important non-structural flood management strategy that warrants global attention
- Flood risk (*R*) consists of two major components (Koks et al., 2015)
  - (i) Hazard (***H***) - Probability of occurrence of flood at a specific location in space and time
  - (ii) Vulnerability (***V***) - Susceptibility and degree to which various physical, social, economic and environmental conditions might be affected during floods(UNISDR, 2009; Boudou et al. 2016)
- It is expressed as the combination of *H* and *V*.

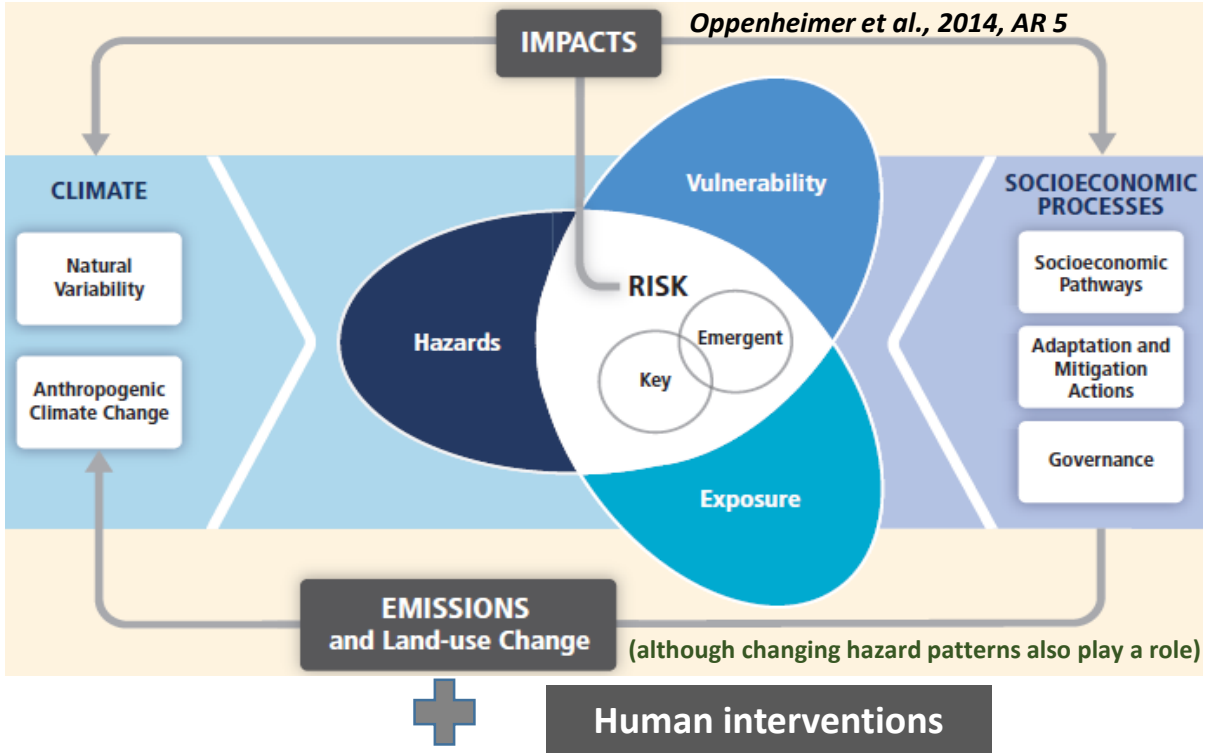
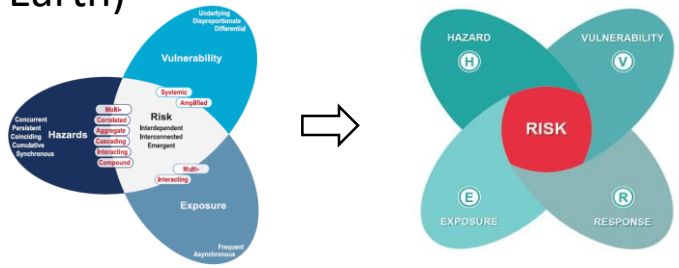


Figure: Schematic of the interaction among the physical climate system, exposure, and vulnerability producing risk

Risk function: Triplet → Quadruplet (derived from IPCC, 2022 and Simpson et al., 2021, One Earth)



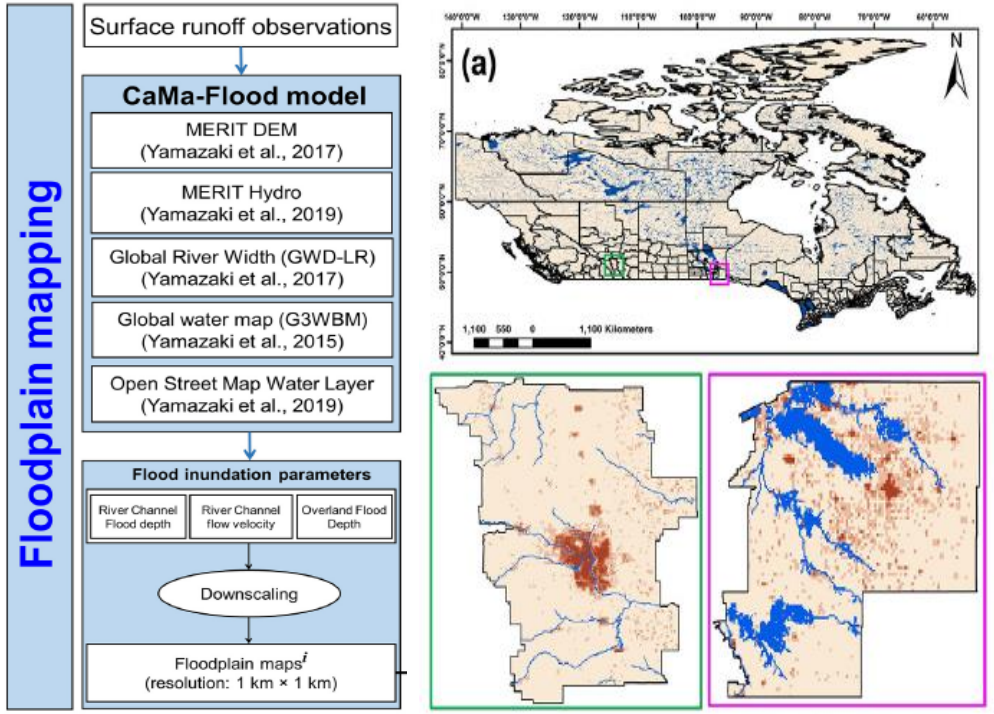
Conventional risk triplet of IPCC, AR5

New risk quadruplet integrating 'response' as a determinant of risk

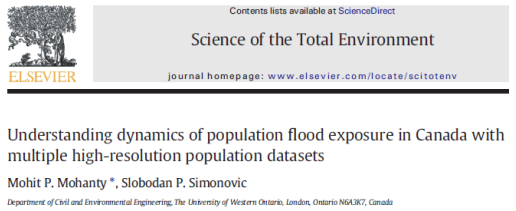
Please remember:
Global Flood Modeling for effective Flood Hazard and Risk Mapping, not intended for precise flood forecasting.

Flood Hazard Mapping: Global Scale

- Increasing demand for strategic global assessments of flood risks under current and future conditions.
- Large-scale hydrological models (Kundzewicz et al. 2019, Nat. Hazards Earth Syst. Sci.) i.e., Global hydrological models (GHMs) + Land surface models (LSMs) >> Global flood models >> Inundation & velocity
- Implementation of global flood hazard maps is vital across various sectors such as (re)insurance, large-scale flood preparedness, and climate change adaptation.
- Over the last two decades, numerous data sets and models have been developed for global flood risk assessment (Yamazaki et al. 2009, 2018)
- Recent advancements have led to the refinement of these models, making them informative at national scales.
- National utilization of these data sets could yield significant benefits, particularly in regions lacking comprehensive flood risk information.




water
MDPI
Article
A Comprehensive Approach for Floodplain Mapping through Identification of Hazard Using Publicly Available Data Sets over Canada
Mohit Prakash Mohanty [1,2,*] and Slobodan P. Simonovic [2]


Contents lists available at ScienceDirect
Science of the Total Environment
journal homepage: www.elsevier.com/locate/scitotenv
ELSEVIER
Understanding dynamics of population flood exposure in Canada with multiple high-resolution population datasets
Mohit P. Mohanty *, Slobodan P. Simonovic
Department of Civil and Environmental Engineering, The University of Western Ontario, London, Ontario N6A3K7, Canada

- **Inclusion of local acceleration term in the diffusive wave approximation,**
- **Upscaling of fine resolution flow maps to coarse resolution for correct representation of river network**

A flood depth map generated for the flood event on August 22, 2011, using the CaMa-Flood model

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Football Extra Newsletter

India floods situation worsens in UP, Bihar and Orissa

26 September 2011

http://reliefweb.int/node/442608

NEWS / INDIA NEWS / Floods Hit Thousands In Bihar, UP

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THIS STORY IS FROM AUGUST 26, 2011

Floods hit thousands in Bihar, UP

TNN / Updated: Aug 26, 2011, 04:30 IST

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The flood situation remained grim in most of north India with Uttar Pradesh and Bihar being the worst affected. More than a hundred people have died since the start of the monsoon and thousands of people rendered homeless.

TOI

LUCKNOW: The flood situation remained grim in most of north India with Uttar Pradesh and Bihar being the worst affected. More than a hundred people have died since the start of the monsoon and thousands of people rendered homeless. Standing crop has been damaged in several districts and livestock of

SITREP NO-83/2011
1700 hours

No.32-20/2011-NDM-I
Ministry of Home Affairs
(Disaster Management Division)

Dated, 22nd August, 2011

Subject: **SOUTHWEST MONSOON-2011: DAILY FLOOD SITUATION REPORT**

SUMMARY OF IMPORTANT EVENTS AS ON 22.08.2011

RAINFALL/FLOOD SITUATION IN THE COUNTRY

- Moderate to heavy rainfall with isolated very heavy falls have been reported in some parts of Sikkim, Andhra Pradesh, Gujarat and Assam.

Indian Meteorological Department (Major features of weather forecast)

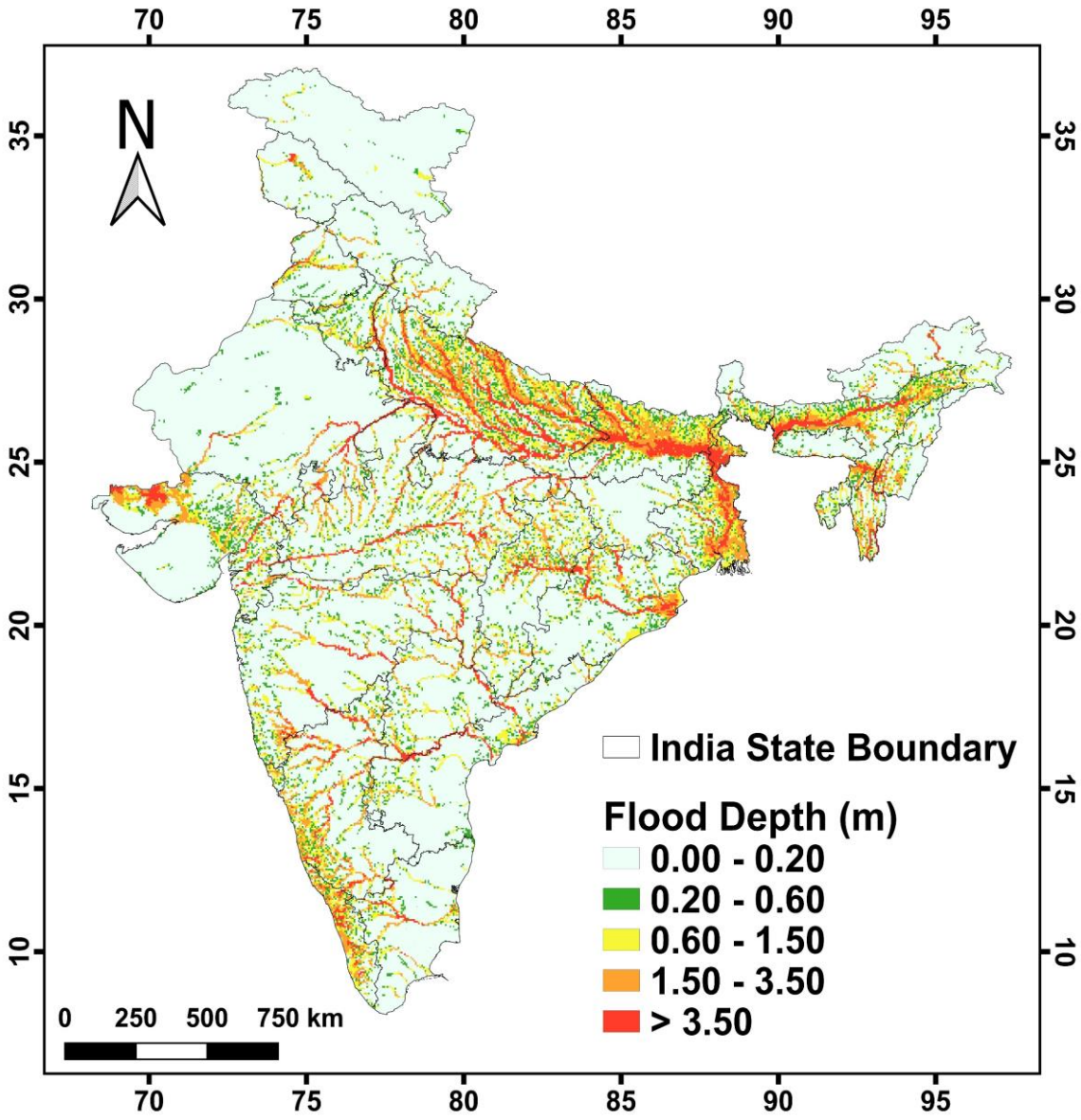
- Fairly widespread rain/thundershowers would occur over northeastern states, Lakshadweep, Andaman & Nicobar and along west coast.
- Fairly widespread rain/thundershowers would occur over Gujarat state, interior Maharashtra, Karnataka and Andhra Pradesh during next 24 hours and decrease thereafter.
- Scattered rain/thundershowers would occur over Rajasthan and central India. However, rainfall activity would decrease over Rajasthan from tomorrow.
- Isolated rain/thundershowers would occur over remaining parts of the country. However, rainfall activity would increase over Indo Gangetic plains from tomorrow onwards.

CENTRAL WATER COMMISSION (daily water levels and forecasts for level forecast sites)

- There are 02 High flood situation sites (Bihar-01) , (Uttar Pradesh-01) and 19 Moderate flood situation sites (Assam-01, Bihar-11,Uttar Pradesh-05, Jharkhand-01, West Bengal -01) in the country on 22.08.2011.

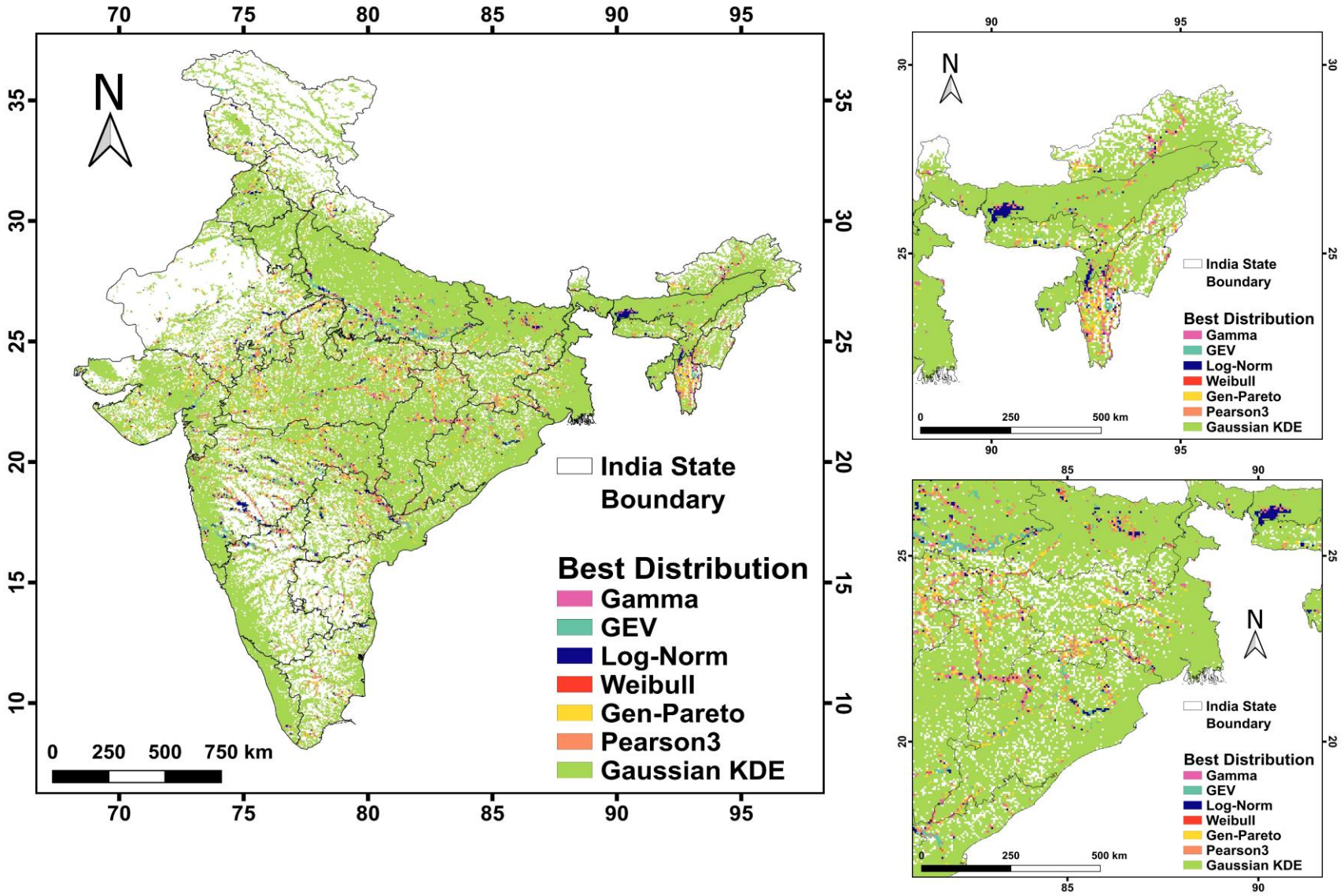
DEPLOYMENT OF NATIONAL DISASTER RESPONSE FORCE (NDRF) ON 22nd August , 2011

- In Assam, 06 teams consisting of 160 personnel in Kamrup(17), Dhubri (29), Lakhimpur (24), Sonitpur (32), Jorhat (28) and Dhemaji (30) alongwith equipment have been deployed for emergent response and rescue operations in case of any flood or any other disaster.
- In West Bengal , 02 Teams consisting of 68 personnel in Howarh have been deployed alongwith equipment to provide emergency response during flood situation.
- In Andhra Pradesh, 02 teams consisting of 66 personnel in Vijayawada have been deployed alongwith equipment to provide emergency response during flood situation.
- In Kerala, 01 team consisting of 38 personnel in Kozhikode deployed alongwith equipment to provide emergency response during flood situation.
- In New Delhi 01 team consisting of 12 personnel deployed at Parliament House, New Delhi for emergency response.
- In Bihar, 05 teams consisting of 152 personnel in Saharsa (29), Madhepura (22), Supaul (35), Khagaria (32) and Gopalganj (34) deployed alongwith equipment to provide emergency response during flood situation.
- In Uttar Pradesh, 03 team consisting of 103 personnel in Lucknow(44), Shahjahanpur (25) and Gorakpur (34) deployed alongwith equipment to provide emergency response during flood situation.



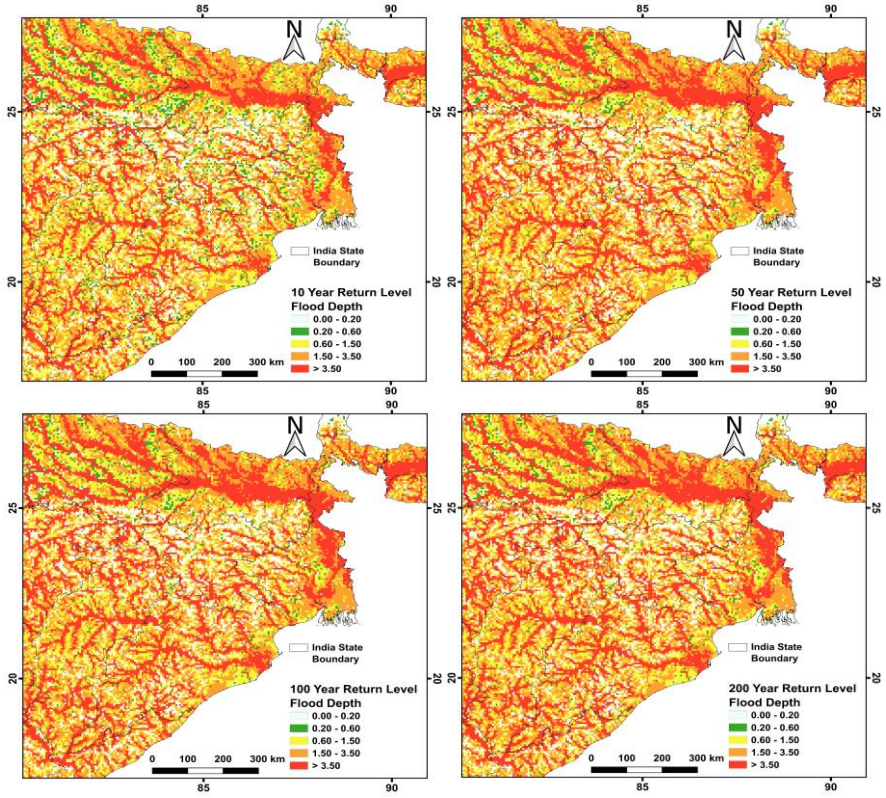
Frequency Analysis: Uncertainty Linked to Assumed Distributions

- Before performing frequency analysis, the best-fit distributions are determined at the grid scale
- Grids with flood depths below 0.2 m were excluded

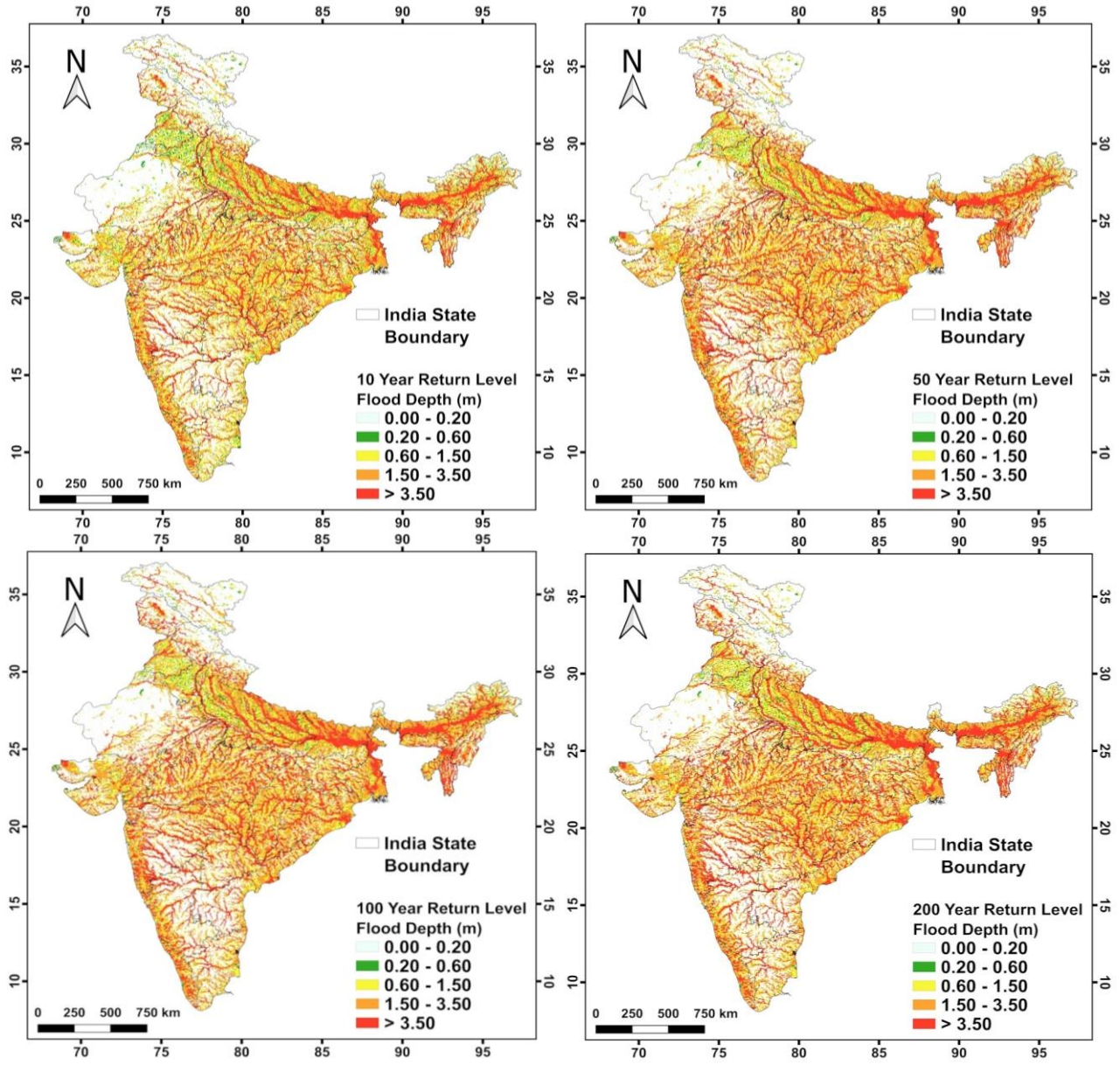


Zoomed-in maps of the northern region of India showcasing the best-fit distribution at a 0.05-degree resolution

Maps Illustrating Flood Hazards Across Different Return Periods

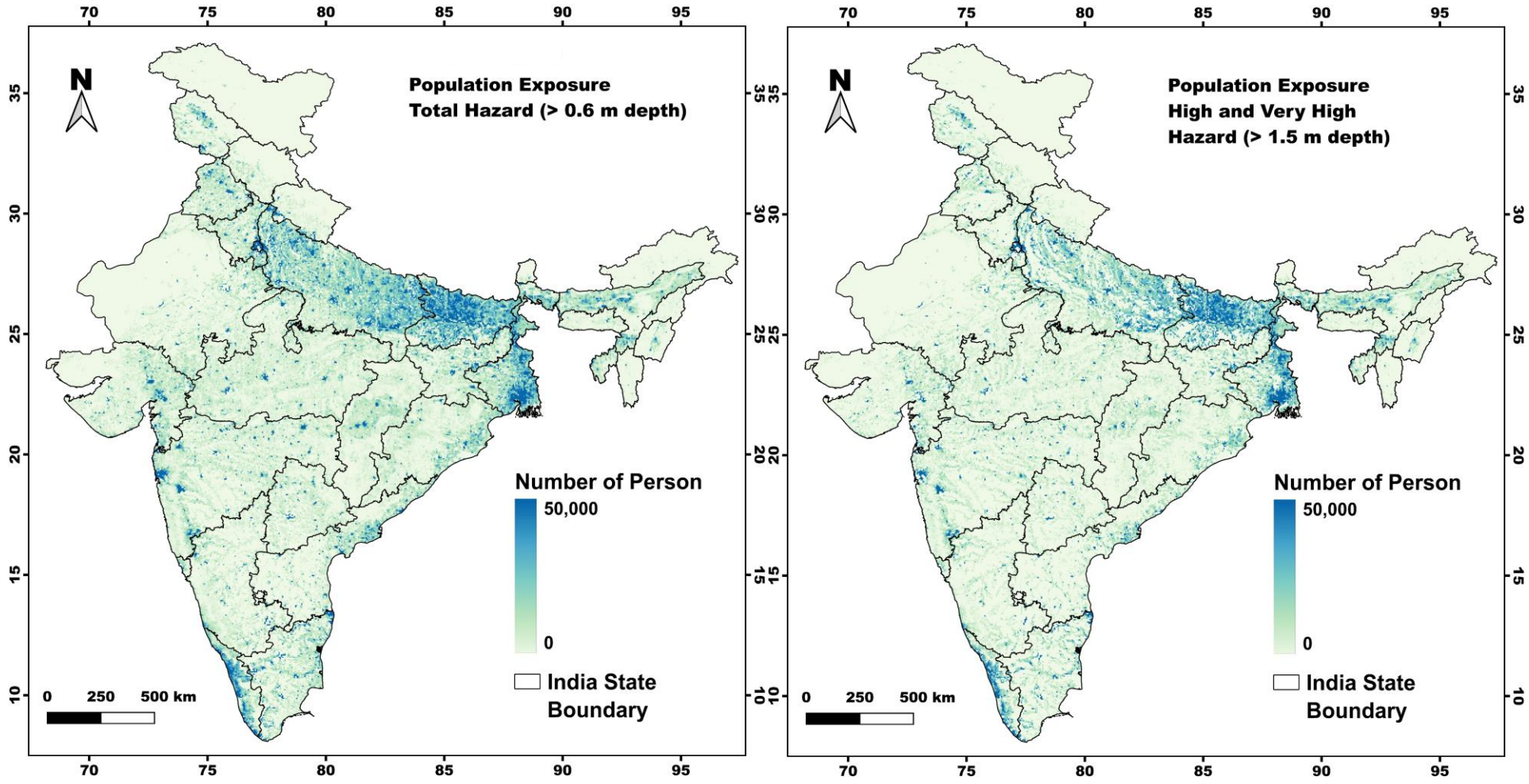


Various return levels flood depth maps are prepared for hazard classification



Maps illustrating the co-occurrence of flood hazard area and population

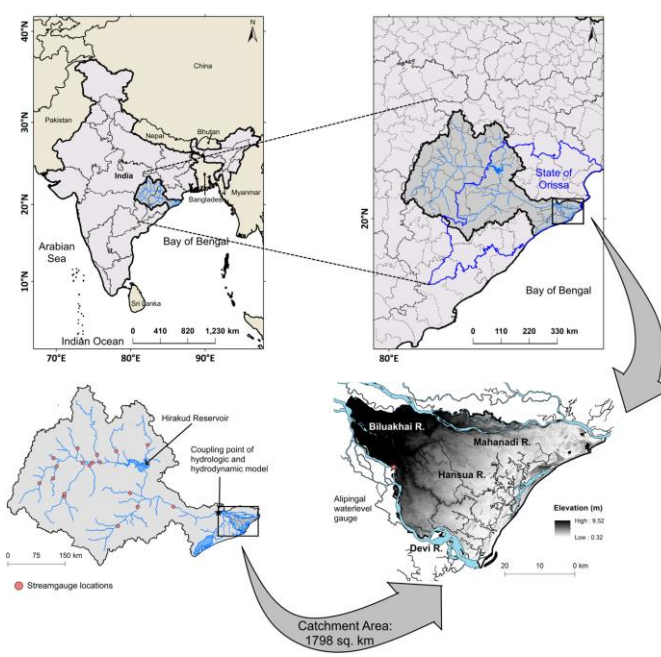
Population exposure could be determined which could significantly help the society and decision maker



Parmar and Karmakar, 2024 (under review)

Regional Flood Modeling for Flood Hazard Mapping

- Implemented at a regional geographic scale (one or multiple watersheds).
- Involves nested hydrological and hydraulic (hydrodynamic) modelling at a regional level.
- Limited data on bathymetry and structures (with hydrological approximations).
- Incorporate medium-resolution data inputs. Also, Leverages remote sensing and artificial intelligence (AI) methods.
- Used for preliminary land-use planning, hazard screening and prioritization, facilitating public awareness initiatives, Support emergency response planning, filling in gaps between detailed engineering flood hazard maps.

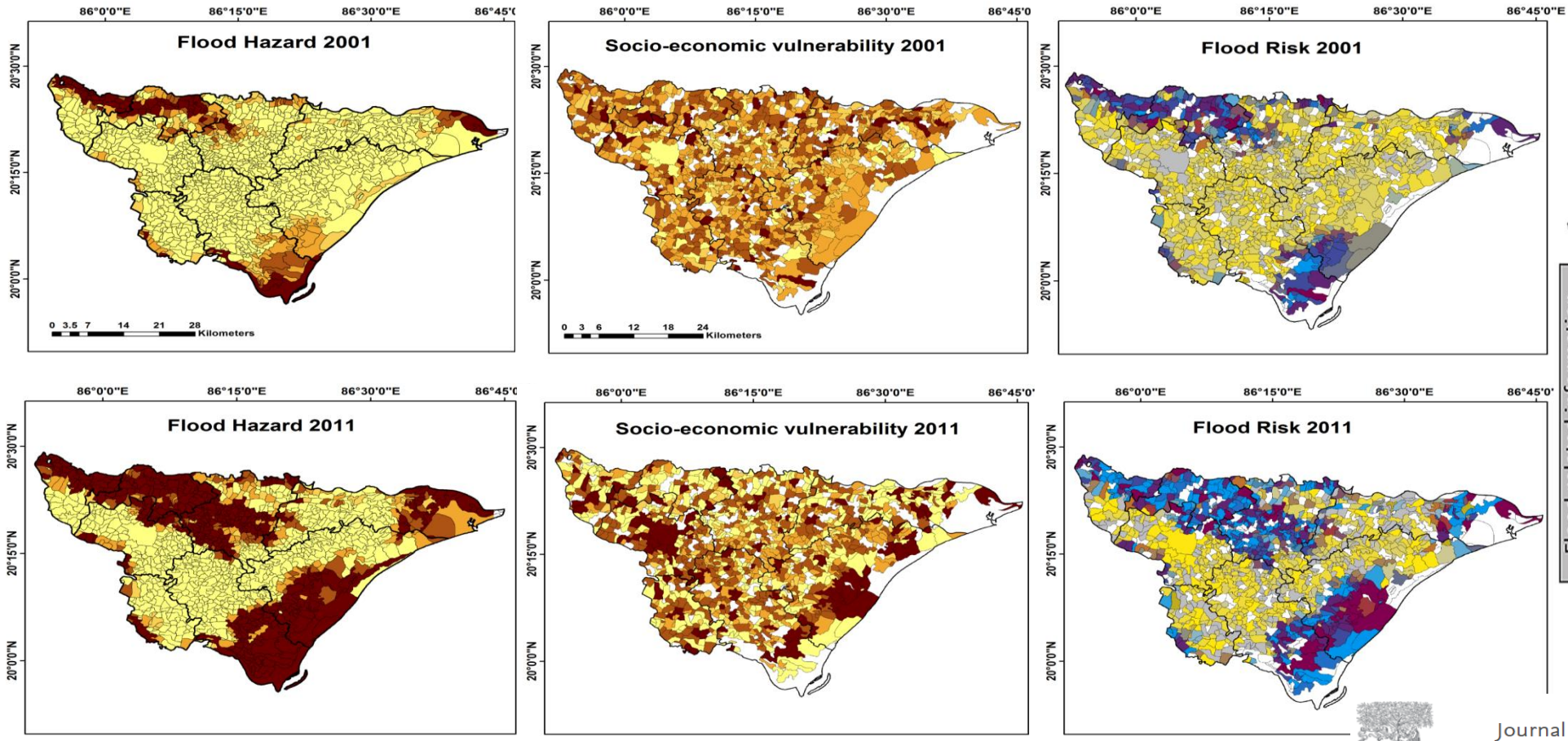


d

		Future Scenario (RCP 4.5)					
	Hazard Classes	Very Low	Low	Moderate	High	Very high	
Baseline Scenario	Very Low	75	49	26	25	15	Increase in hazard
	Low	45	101	92	26	22	
	Moderate	33	30	182	108	32	
	High	17	28	38	72	53	448
	Very high	29	20	43	35	89	
Decrease in hazard					318		519

Figure (d) represents a graphical table showing the transformation of FHCs from baseline to near-future.

Regional Flood Modeling for a Comprehensive Flood Risk Mapping



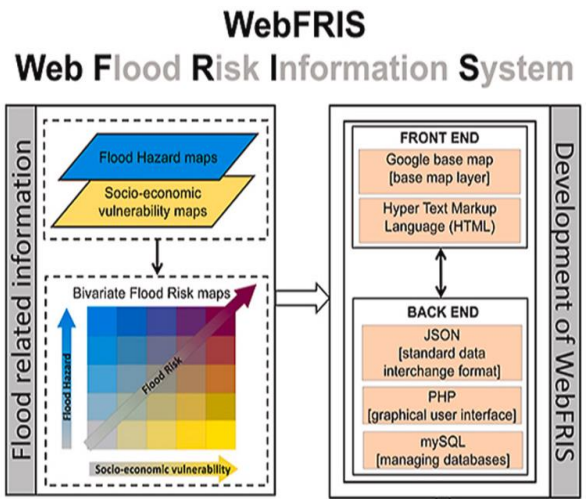


Fig. Flood hazard maps for the census years 2001 (a) and 2011 (d), Socio-economic vulnerability maps for the census years 2001 (b) and 2011 (e) and bivariate flood risk maps for census years 2001 (c) and 2011 (f) for Jagatsinghpur district, Odisha, India; The values inside choropleth cells show the percentage of area under a particular class of risk

(Mohanty et al. 2018, Mohanty et al. 2020 a, b; Mohanty and Karmakar 2021)

ELSEVIER

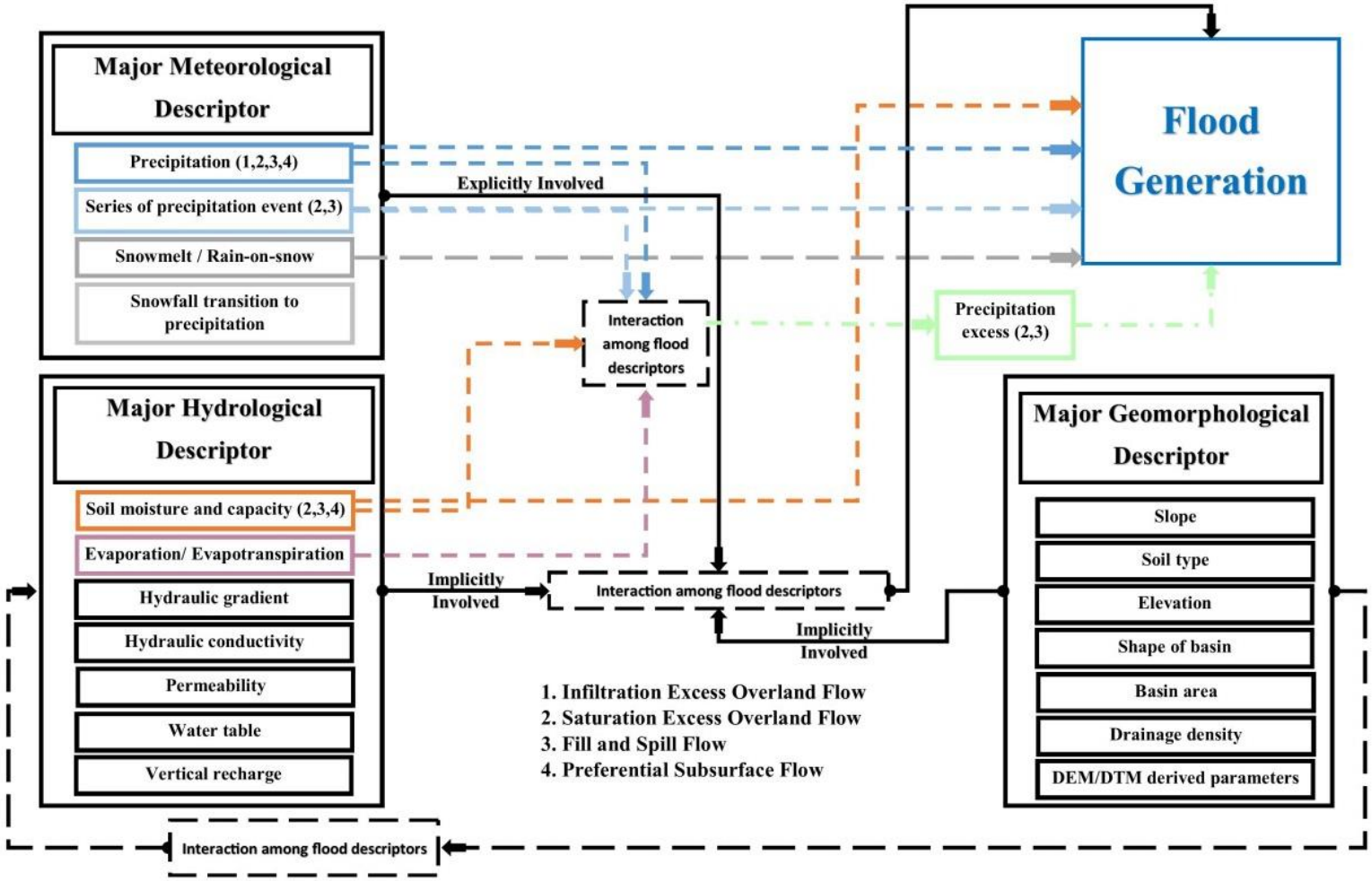
Journal of Environmental Management
Volume 288, 15 June 2021, 112456

Research article

WebFRIS: An efficient web-based decision support tool to disseminate end-to-end risk information for flood management

Mohit Prakash Mohanty [a], Subhankar Karmakar [a, b, c]

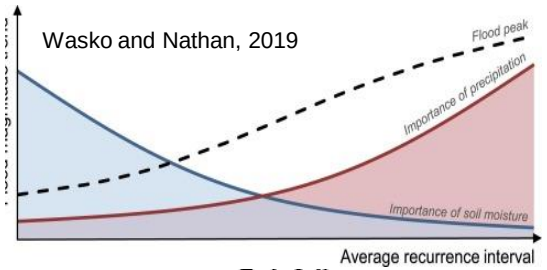
Regional Flood Modeling for Identification of Flood Drivers



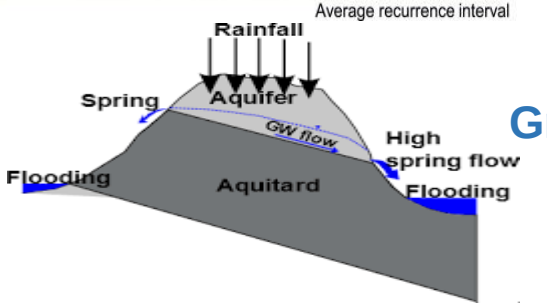
Multiple direct and indirect influencer of flood generation

Parmar and Karmakar, 2024 (under review)

Snowfall driven



Soil moisture
or
Rainfall driven

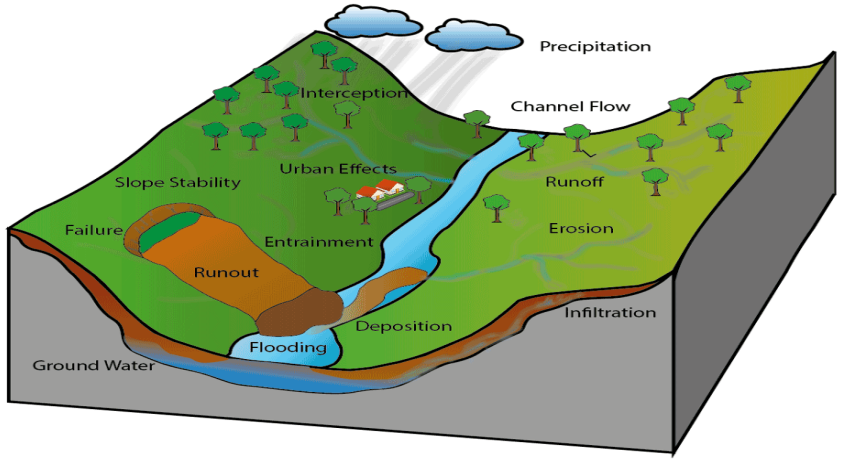


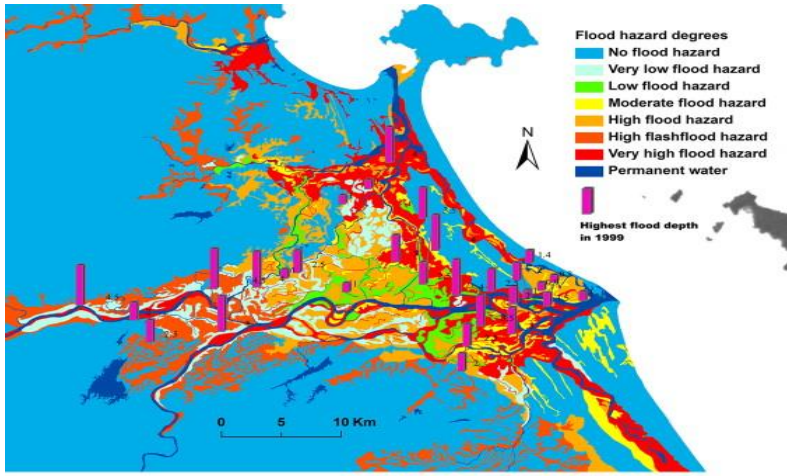
Groundwater driven

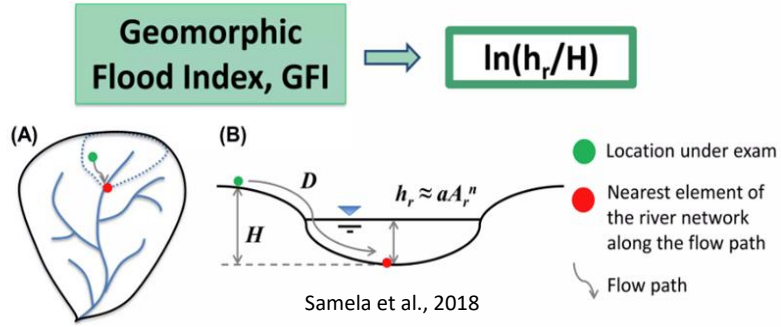
Regional Flood Modeling for Deriving Flood Susceptibility Maps

Geomorphology

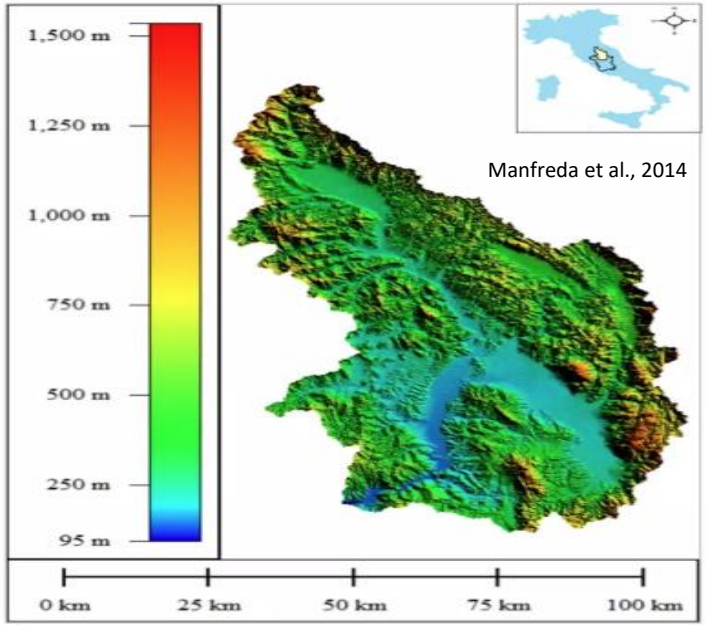
=> Contributing area, Flow path distance, Elevation difference to nearest channel, Profile curvature, slope and many more..



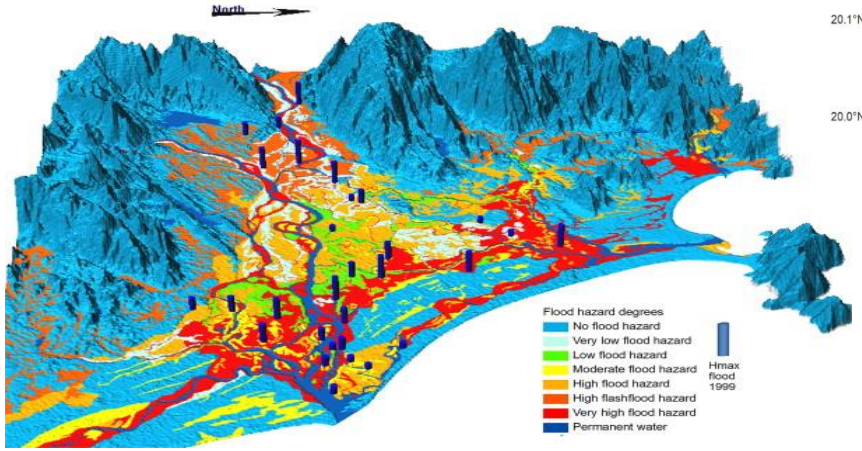


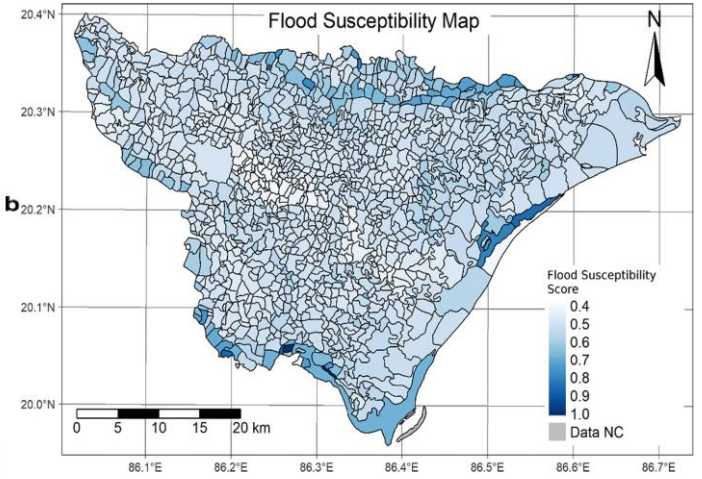


Samela et al., 2018



Manfreda et al., 2014





Flood susceptibility map

Deroliya et al., 2022

A novel flood risk mapping approach with machine learning considering geomorphic and socio-economic vulnerability dimensions

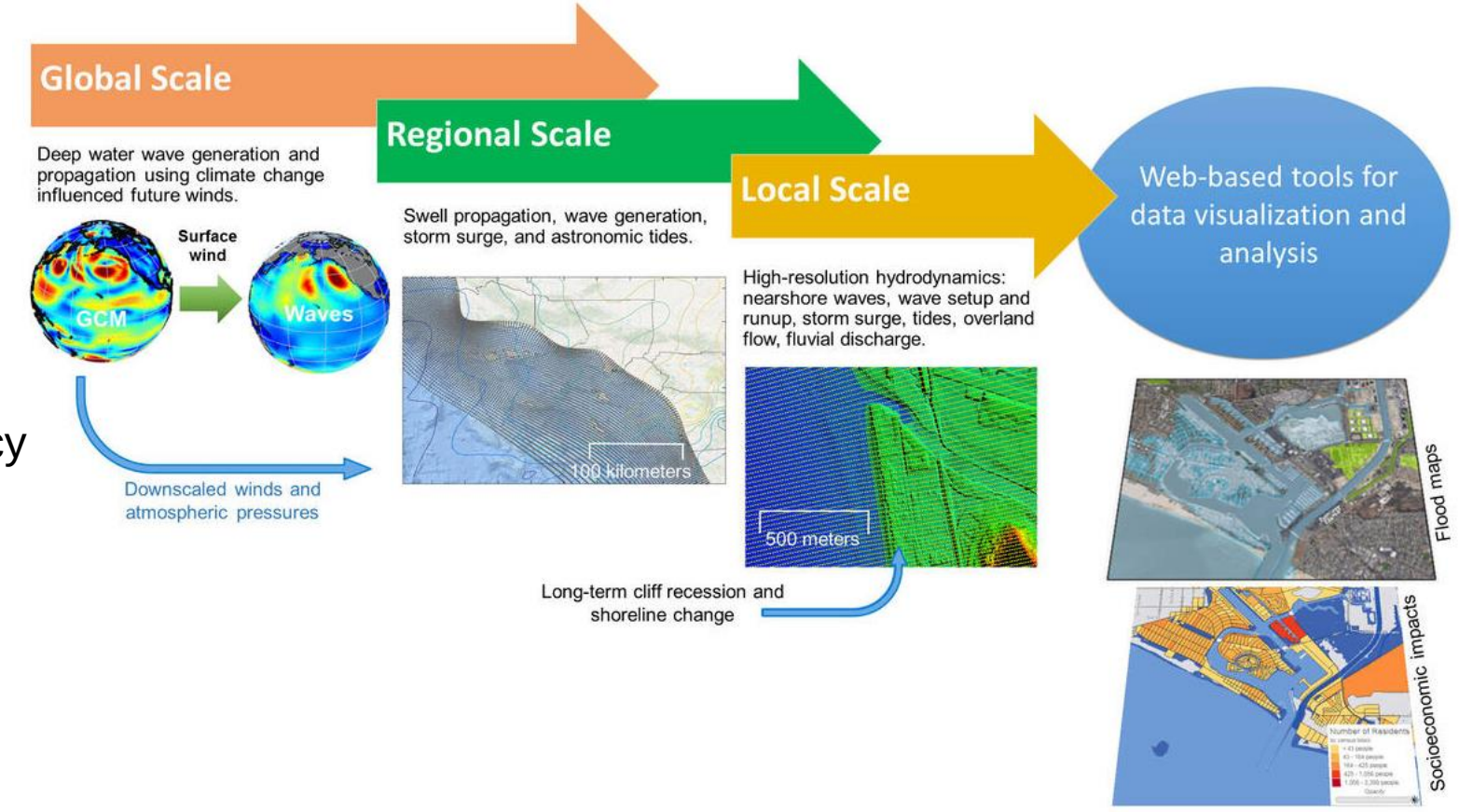
Prakhar Deroliya [a], Mousumi Ghosh [b], Mohit P. Mohanty [a,c], Subimal Ghosh [b,d], K.H.V. Durga Rao [f], Subhankar Karmakar [a,b,e,*]

Exploring the Community Modeling Concept

- Community models complement traditional flood modeling by integrating local knowledge and engagement, ultimately enhancing flood resilience at the community level.

Offers several advantages:

1. Collaborative Development
2. Resource Sharing
3. Transparency
4. Rapid Innovation and Updates
5. Standardization and Consistency
6. Wider Application and Testing
7. Capacity Building
8. Adaptability and Flexibility
9. Cost and Time Efficiency
10. Decision Support



<usgs.gov/media>

Acknowledgements

- China Institute of Water Resources and Hydropower Research (IWHR),
- International Conferences on Flood Management (ICFM）
- Environmental Science and Engineering Department || Centre for Climate Studies
- My Students at IIT Bombay
- Dept. of Science & Technology || Ministry of Earth Sciences || Office of the Principal Scientific Adviser to the Government of India || ISRO-IIT(B) Space Technology Cell || Ministry of Water Resources, River Development and Ganga Rejuvenation ||
- My Collaborators - especially Prof. S. P. Simonovic (UWO, Canada), Prof. Cheng Zhang (IWHR, China)
- All data sharing organizations: Mumbai Metropolitan Region Development Authority (MMRDA), Municipal Corporation of Greater Mumbai (MCGM, Previously Brihanmumbai Municipal Corporation, BMC), Thane Municipal Corporation (TMC), National Remote Sensing Centre (NRSC), India Meteorological Department (IMD), Department of Water Resources (DoWR), Govt. of Odisha; and Odisha Space Applications Centre (ORSAC), Odisha,

Thank you