SYMPOSIUM OP'24

ADVANCING OCEAN PREDICTION SCIENCE FOR SOCIETAL BENEFITS

Coastal resilience and long-term prediction

CLIMATE MODEL UNCERTAINTY AND ITS INFLUENCE ON COASTAL FLOOD RISK ASSESSMENT

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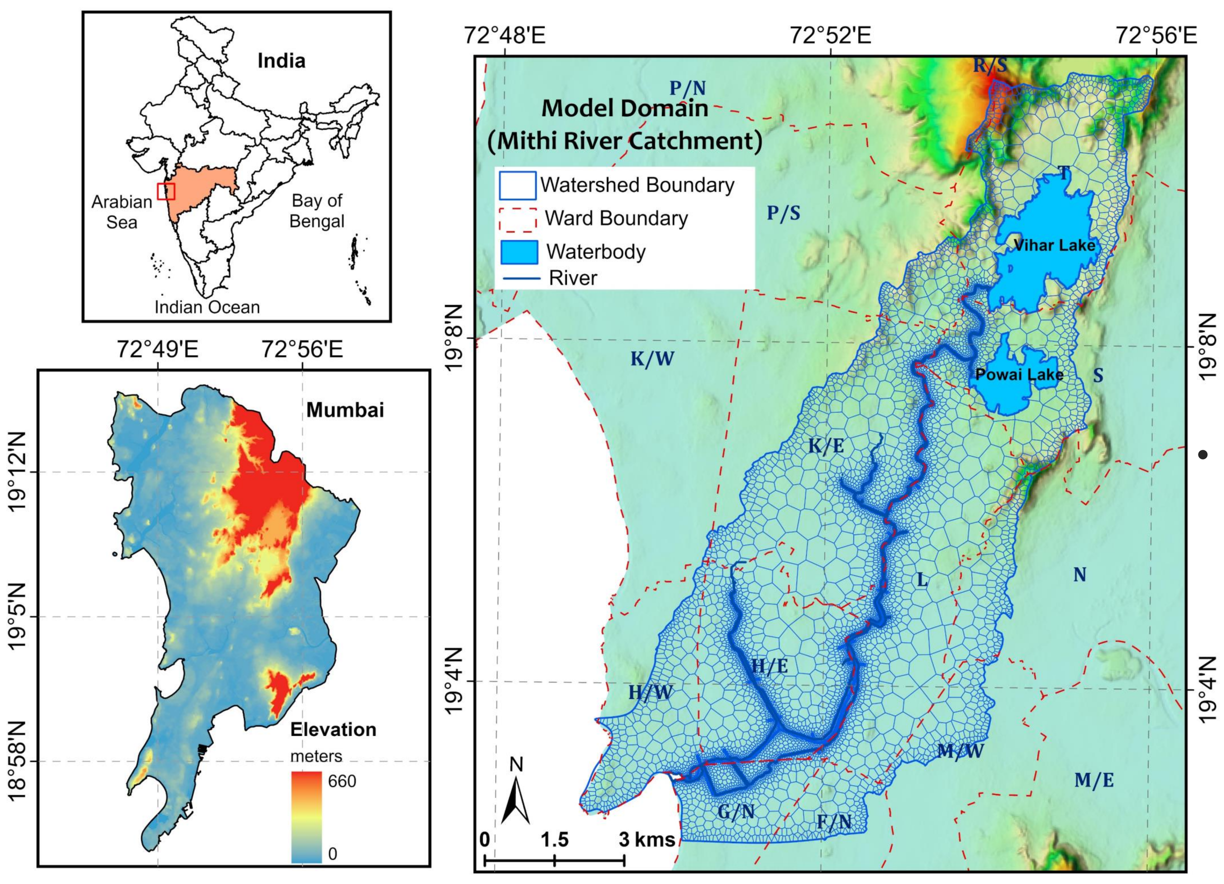
1. Introduction

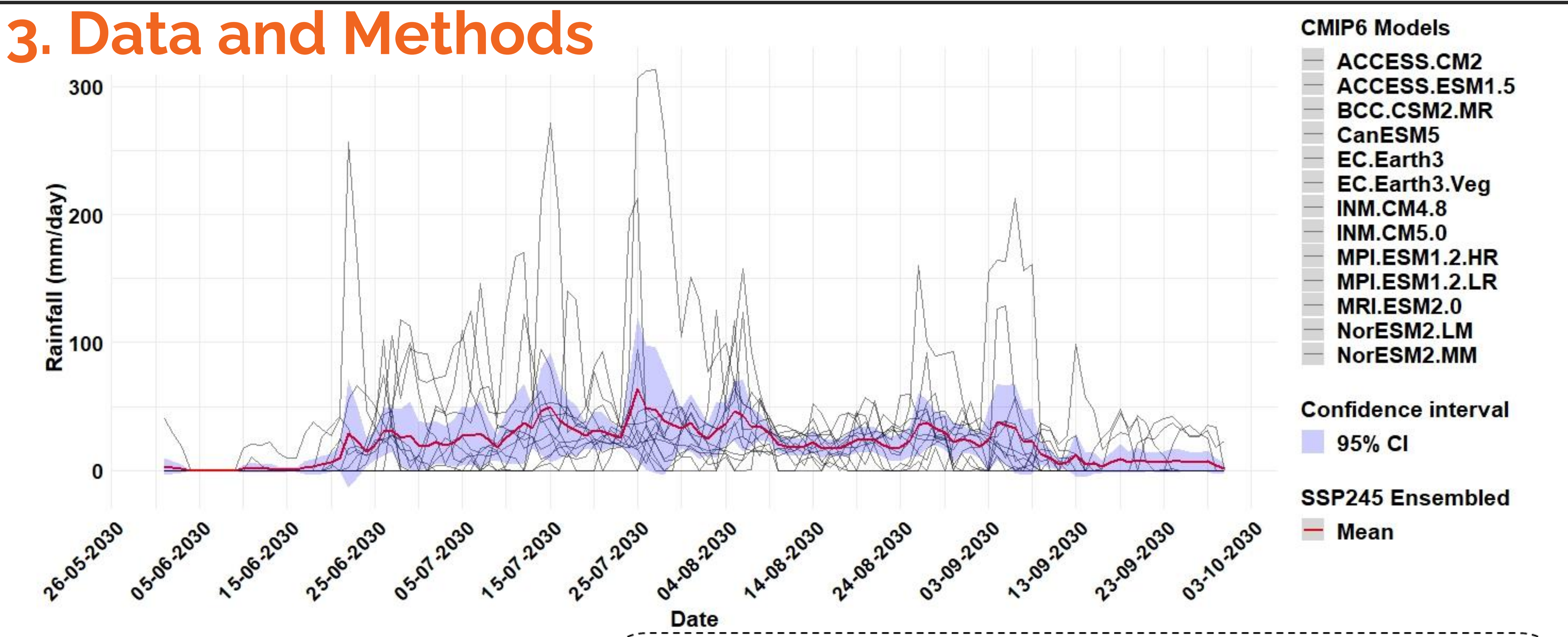
- The impact of climate change on the regional hydrological cycle has become a significant global scientific concern in recent decades, primarily due to its profound effects on droughts and floods.
- Therefore, it is crucial to study the changes in regional hydrological characteristics in the context of global warming to develop strategies for mitigating floods and optimizing water use in the future. Selecting an appropriate Global Climate Model (GCM) is an essential component of this process.
- To understand and quantify this, we assessed the performance of bias-corrected daily precipitation data from 13 Global Climate Models (GCMs) in the Coupled Model Intercomparison Project Phase 6 (CMIP6).

2. Study Area

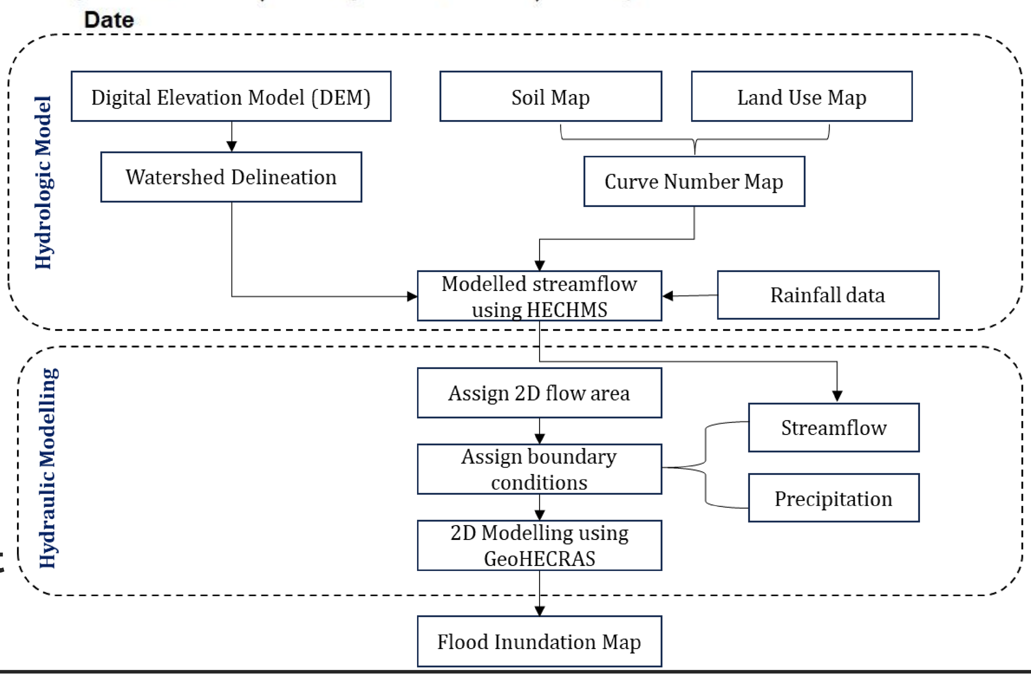


- Mumbai, with an estimated population of 21.6 million lies within the south-west monsoon belt and experiences flood disasters almost annually.
- This study focuses on the Mithi river watershed, a vital component of Mumbai's drainage network, which significantly influences flooding in the city.
- Watershed area spans of 73 km2, with the river's width varying from 5 m in the upper reaches to 70 m in the lower reaches with an average depth of 5.5 m.
- Vulnerable during high flooding events, disproportionately affecting slum dwellers residing along the riverbanks.

3. Data and Methods

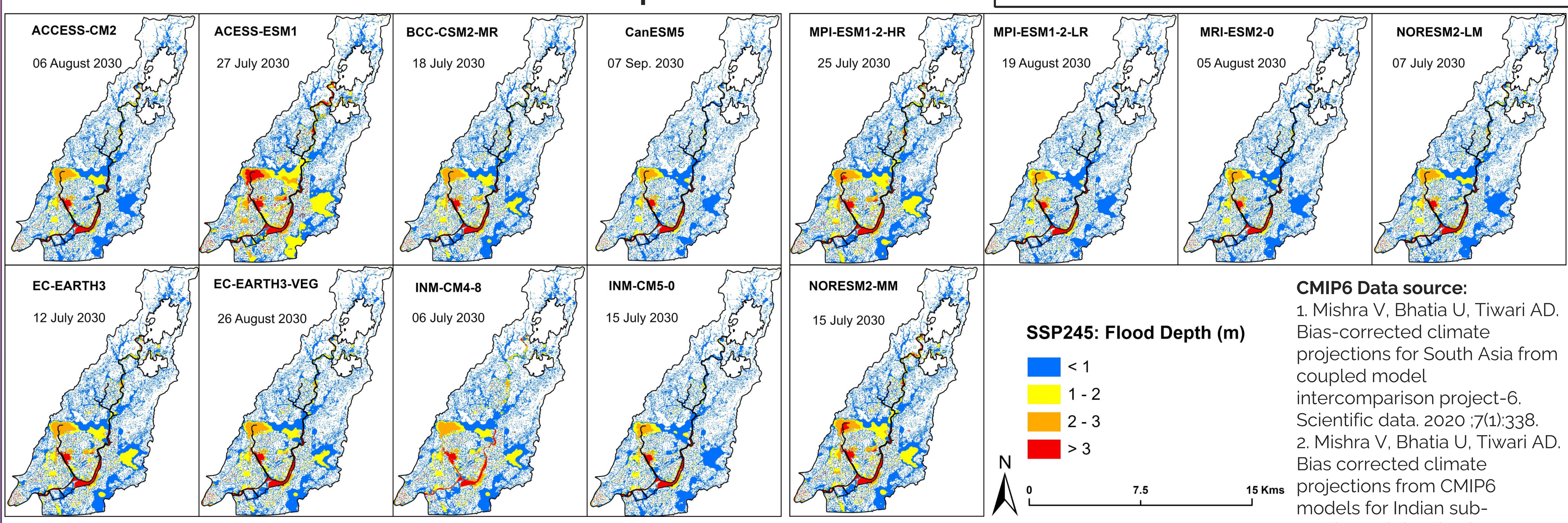


- The monsoon season in Mumbai typically spans from June to September, making these four months the focus for the near-future (2030) analysis.
- A day with extreme precipitation (Table 1) was selected from each of the CMIP6 models and used as input for the hydrodynamic modeling.



4. Results

Model outputs



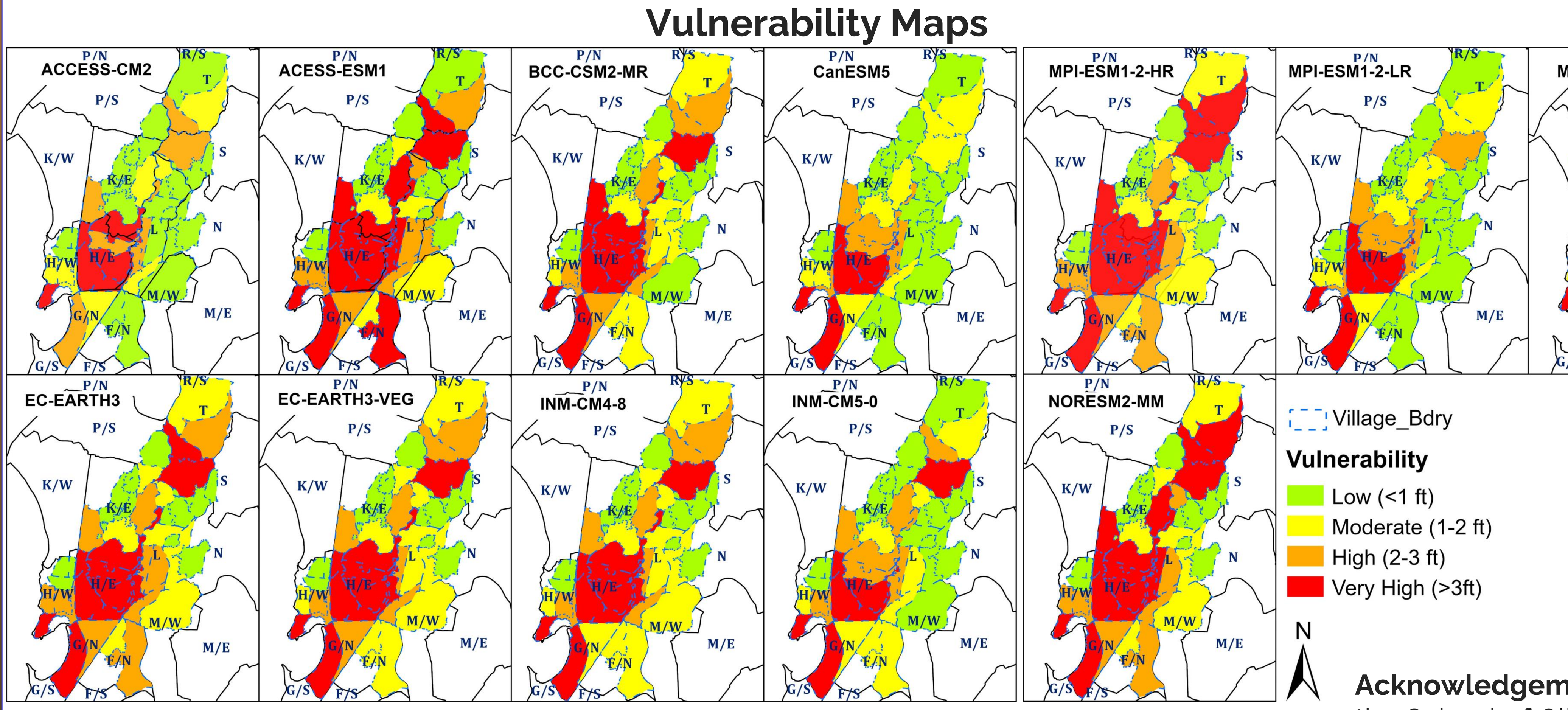
CMIP6 Data source:

1. Mishra V, Bhatia U, Tiwari AD. Bias-corrected climate projections for South Asia from coupled model intercomparison project-6. Scientific data. 2020 ;7(1):338.
2. Mishra V, Bhatia U, Tiwari AD. Bias corrected climate projections from CMIP6 models for Indian sub-continental river basins. 2020.

Table 1: Extreme precipitation events in each climate model

Model	Date	Rainfall (mm/day)
ACCESS-CM2	06 August 2030	157
ACCESS-ESM1	27 July 2030	313
BCC-CSM2-MR	18 July 2030	139
CanESM5	07 September 2030	58
EC-Earth3	12 July 2030	170
EC-Earth3-Veg	26 August 2030	160
INM-CM4-8	06 July 2030	124
INM-CM5-0	15 July 2030	53
MPI-ESM1-2-HR	25 July 2030	212
MPI-ESM1-2-LR	19 August 2030	48
MRI-ESM2-0	05 August 2030	61
NorESM2-LM	07 July 2030	146
NorESM2-MM	15 July 2030	271

Vulnerability Maps



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Projected population to be affected

Feedback/ suggestions

- Analysis using 13 CMIP6 models showed varying flood depths and inundation extents, with each model identifying different vulnerable areas.
- The variability in projections highlights the uncertainty in climate models, emphasizing the need for ensemble approaches to capture a wide range of possible flood scenarios.
- Future work will explore AI-based methods, such as machine learning algorithms, to reduce model uncertainty and improve the accuracy of flood risk projections.

Acknowledgements: We thank Azim Premji University for funding this research through the School of Climate Change and Sustainability.

SSP 245 Inundation Area (sqkm)

L: Low M: Moderate H: High VH: Very High

Ward	ACCESS-CM2				ACCESS-ESM1				BCC-CSM2-MR				CanESM5				EC-Earth3				EC-Earth-Veg				INM-CM4-8			
	L	M	H	VH	L	M	H	VH	L	M	H	VH	L	M	H	VH	L	M	H	VH	L	M	H	VH	L	M	H	VH
F/N	1.05	0.1	0.01	0.02	0.34	0.1	0.32	0.7	0.79	0.4	0.12	0.03	0.94	0.01	0.01	0.02	0.68	0.45	0.22	0.04	0.77	0.4	0.12	0.03	0.76	0.42	0.13	0.03
G/N	1.23	0.29	0.09	0.17	0.84	0.25	0.35	0.7	1.12	0.28	0.21	0.3	1.23	0.15	0.08	0.13	1.1	0.25	0.19	0.4	1.11	0.24	0.21	0.3	1.11	0.23	0.2	0.32
H/E	2.54	1.14	1.07	4.41	1.72	0.67	0.76	7.05	2.26	1.02	1.1	5.1	3.08	1.05	0.68	3.74	2.23	0.96	1.14	5.26	2.38	1.05	1.07	4.83	2.47	1.08	1.06	4.69
H/W	1.06	0.15	0.1	0.27	1.05	0.16	0.21	0.58	1.06	0.17	0.12	0.38	0.97	0.12	0.08	0.21	1.09	0.18	0.13	0.41	1.04	0.16	0.11	0.4	1.07	0.18	0.11	0.37
K/E	3.17	0.28	0.18	0.67	3.52	0.35	0.32	1.15	3.31	0.34	0.2	0.72	2.73	0.24	0.14	0.45	3.43	0.34	0.2	0.8	3.21	0.29	0.18	0.73	3.28	0.3	0.18	0.7
L	3.47	0.54	0.23	0.47	3.11	0.71	0.54	1.86	3.29	0.5	0.73	0.55	3.29	0.2	0.12	0.27	3.33	0.57	0.54	0.88	3.2	0.5	0.72	0.55	3.27	0.51	0.69	0.57
M/W	1.26	0.07	0	0	1.09	0.29	0.25	0.38	1.2	0.15	0.15	0	1.08	0	0	0	1.19	0.16	0.15	0.07	1.15	0.15	0.15	0	1.17	0.15	0.16	0.01
N	1.01	0.07	0	0	0.85	0.11	0.12	0.41	0.87	0.18	0.18	0	0.87	0	0	0	0.87	0.16	0.21	0.07	0.82	0.18	0.18	0	0.84	0.17	0.2	0
P/S	0.33	0.01	0	0	0.38	0.01	0.01	0	0.35	0.01	0	0	0.29	0.01	0	0	0.36	0.01	0	0	0.34	0.01	0	0	0.35	0.01	0	0
S	1.06	0.22	0.15	1.55	0.99	0.15	0.1	2.39	0.96	0.16	0.16	1.97	2.26	0.09	0.03	0.05	0.98	0.15	0.13	2.12	0.93	0.15	0.15	2.01	0.95	0.16	0.17	1.94
T	1.2	4.2	0.09	0.1	1.46	0.11	4.1	0.29	1.27	4.15	0.13	0.1	5.08	0.07	0.04	0.06	1.36	0.18	4.12	0.13	1.22	4.2	0.09	0.09	1.26	4.2	0.09	0.09

Ward	INM-CM5-0				MPI-ESM1-2-HR				MPI-ESM1-2-LR				MRI-ESM2-0				NorESM2-LM				NorESM2-MM			
	L	M	H	VH	L	M	H	VH	L	M	H	VH	L	M	H	VH	L	M	H	VH	L	M	H	VH
F/N	1.05	0.11	0.01	0.02	0.61	0.46	0.27	0.06	0.99	0.04	0.01	0.02	1.05	0.12	0.01	0.02	1.03	0.19	0.01	0.02	0.67	0.45	0.23	0.05
G/N	1.17	0.25	0.09	0.17	1.02	0.31	0.21	0.44	1.21	0.19	0.07	0.16	1.16	0.26	0.1	0.17	1.16	0.27	0.16	0.18	0.99	0.36	0.23	0.42
H/E	2.94	1.18	0.81	3.75	2.12	0.88	1.05	5.7	3.2	1.05	0.66	3.51	2.87	1.17	0.89	3.8	2.65	1.23	1.06	4.07	2.02	0.8	0.98	5.98
H/W	1	0.16	0.11	0.26	1.07	0.2	0.14	0.43	1	0.15	0.09	0.24	1	0.16	0.11	0.27	1.03	0.15	0.13	0.28	1.1	0.18	0.14	0.44
K/E	2.92	0.21	0.17	0.55	3.51	0.37	0.24	0.82	2.81	0.22	0.16	0.47	2.94	0.2	0.18	0.55	3.15	0.22	0.18	0.65	3.46	0.37	0.26	0.89
L	3.28	0.57	0.16	0.36	3.41	0.55	0.47	1.09	3.44	0.24	0.13	0.31	3.27	0.59	0.16	0.37	3.27	0.8	0.18	0.48	3.4	0.59	0.51	1.08
M/W	1.16	0.08	0	0	1.22	0.17	0.14	0.11	1.17	0	0	0	1.16	0.1	0	0	1.2	0.16	0	0	1.22	0.16	0.15	0.09
N	0.94	0.08	0	0	0.9	0.15	0.2	0.12	0.96	0	0	0	0.94	0.09	0	0	0.92	0.18	0	0	0.9	0.16	0.21	0.08
P/S	0.31	0.01	0	0	0.37	0.01	-	-	0.31	0.01	0	0	0.31	0.01	0	0	0.33	0.01	0	0	0.37	0.01	0	0
S	1.09	0.26	0.12	1.32	1	0.15	0.14	2.14	1.13	1.39	0.05	0.07	1.03	0.29	0.15	1.34	0.91	0.16	0.18	1.85	0.96	0.13	0.11	2.29
T	5.08	0.22	0.04	0.06	1.39	0.13	4.16	0.17	5.14	0.1	0.03	0.06	1.3	4.0	0.04	0.06	1.19	4.21	0.07	0.1	1.4	0.11	4.17	0.19