



Supplement of

Evolution of multivariate drought hazard, vulnerability and risk in India under climate change

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Figure S1. Standard deviation of the country-wide cumulated observed and rescaled datasets of precipitation (top panel) and soil moisture (bottom panel).



Figure S2. Country-wide average annual precipitation for baseline period and multi-model ensemble mean of average annual precipitation of projected period for different time-slices and RCP scenarios.



Figure S3. Country-wide average annual soil moisture for baseline period and multi-model ensemble mean of average annual soil moisture of projected period for different time-slices and RCP scenarios.



Figure S4. Observed and ISIMIP-model simulated climatology of country-wide average monthly precipitation and soil moisture for the period 1980-2005.



Figure S5. Difference between the observed and SSP2 pathway dataset at the year 2010 for a) Population density and b) GDP.



Figure S6. Time series of SPI, SSI and MSDI for Marathwada region for 1980 - 2015 (a). Time window for 1980-1984 is expanded in (b). MSDI effectively captures the drought initiation, propagation and termination by correctly characterising drought events whenever either SPI, or SSI, or both fall below a chosen threshold (green horizontal line).



Figure S7. Constant drought vulnerability indicators for drought vulnerability assessment. a) Slope, b) Soil texture.



Figure S8. Scatter of meteorological sub-division-wise DHI and DVI for the scenarios a) Baseline, b) RCP2.6-SSP2 Near future, c) RCP2.6-SSP2 Far future, d) RCP6.0-SSP2 Near future, e) RCP6.0-SSP2 Far future.

Vulnerability indicator	Classification	Weight	Normalized Weight
Land use	Water Body	0	0
	Barren	1	0.04
	Scrub	3	0.12
	Forest	4	0.15
	Agriculture	8	0.31
	Habitation	10	0.38
Soil	Silty Clay	2	0.032
	Clay	3	0.048
	Silty Clay Loam	4	0.063
	Clay Loam	5	0.079
	Silt Loam	7	0.111
	Loam	9	0.143
	Sandy Clay Loam	10	0.159
	Sandy Loam	11	0.175
	Loamy Sand	12	0.190
Slope (%)	0-1	1	0.048
	1-4	2	0.095
	4-6	4	0.190
	6-10	6	0.286
	>10	8	0.381

Table S1. Weightages for categorical vulnerability indicators used for vulnerability assessment (Thomas et al. 2016; Sahana et al. 2021)

MSDI	Class	Weight	Frequency of occurence	Rating
-0.99 to 0.99	Mild	1	0.71-0.82	6
			0.60-0.68	5
			0.49-0.57	4
			0.37-0.46	3
			0.26-0.348	2
			0.18-0.24	1
-1 to -1.49	Moderate	2	0.150-0.15	4
			0.13-0.13	3
			0.098-0.098	2
			0.07-0.07	1
-1.5 to -1.99	Severe	3	0.04-0.04	1
-2 or less	Extreme	4	0.016-0.016	1

Table S2. Weighting and rating scheme for DHI calculation for a randomly chosen grid (11° lat, 75° lon).

References:

Sahana, V., Mondal, A. and Sreekumar, P.: Drought vulnerability and risk assessment in India : Sensitivity analysis and comparison of aggregation techniques, J. Environ. Manage., 299, 113689, doi:10.1016/j.jenvman.2021.113689, 2021.

Thomas, T., Jaiswal, R. K., Galkate, R., Nayak, P. C. and Ghosh, N. C.: Drought indicators-based integrated assessment of drought vulnerability: a case study of Bundelkhand droughts in central India, Nat. Hazards, 81(3), 1627–1652, doi:10.1007/s11069-016-2149-8, 2016.