

References

- Abhilash, S., Krishnakumar, E. K., Vijaykumar, P., Sahai, A. K., Chakrapani, B., & Gopinath, G. (2019). "Changing Characteristics of Droughts over Kerala, India: Inter-Annual Variability and Trend". *Asia-Pacific Journal of Atmospheric Sciences*, 55(1), 1–17.
- Abramowitz, M., & Stegun, I. A. (1965). Handbook of Mathematical Functions with formulas, graphs, and mathematical tables. *National Bureau of Standards Applied Mathematics Series. e*, 55, 953.
- AghaKouchak, A., Farahmand, A., Melton, F. S., Teixeira, J., Anderson, M. C., Wardlow, B. D., & Hain, C. R. (2015). Remote sensing of drought: Progress, challenges and opportunities. *Reviews of Geophysics*, 53(2), 452–480.
- Alam, N. M., Sharma, G. C., Moreira, E., Jana, C., Mishra, P. K., Sharma, N. K., & Mandal, D. (2017). Evaluation of drought using SPEI drought class transitions and log-linear models for different agro-ecological regions of India. *Physics and Chemistry of the Earth, Parts A/B/C*, 100, 31–43.
- Alexander, L V, Zhang, X., Peterson, T. C., Caesar, J., Gleason, B., Klein Tank, A. M. G., Haylock, M., Collins, D., Trewin, B., Rahimzadeh, F., Tagipour, A., Rupa Kumar, K., Revadekar, J., Griffiths, G., Vincent, L., Stephenson, D. B., Burn, J., Aguilar, E., Brunet, M., ... Vazquez-Aguirre, J. L. (2006). Global observed changes in daily climate extremes of temperature and precipitation. *Journal of Geophysical Research: Atmospheres*, 111(D5)

- Alexander, Lisa V. (2016). Global observed long-term changes in temperature and precipitation extremes: A review of progress and limitations in IPCC assessments and beyond. *Weather and Climate Extremes*, *11*, 4–16.
- Ali, H., Modi, P., & Mishra, V. (2019). Increased flood risk in Indian sub-continent under the warming climate. *Weather and Climate Extremes*, *25*, 100212.
- Allen, C. D., Macalady, A. K., Chenchouni, H., Bachelet, D., McDowell, N., Vennetier, M., Kitzberger, T., Rigling, A., Breshears, D. D., Hogg, E. H. (Ted), Gonzalez, P., Fensham, R., Zhang, Z., Castro, J., Demidova, N., Lim, J.-H., Allard, G., Running, S. W., Semerci, A., & Cobb, N. (2010). A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests. *Forest Ecology and Management*, *259*(4), 660–684.
- Allen, M. R., & Ingram, W. J. (2002). Constraints on future changes in climate and the hydrologic cycle. *Nature*, *419*(6903), 228–232.
- Alley, W. M. (1984). The Palmer Drought Severity Index: Limitations and Assumptions. *Journal of Applied Meteorology and Climatology*, *23*(7), 1100–1109.
- Alsafadi, K., Mohammed, S. A., Ayugi, B., Sharaf, M., & Harsányi, E. (2020). Spatial–Temporal Evolution of Drought Characteristics Over Hungary Between 1961 and 2010. *Pure and Applied Geophysics*, *177*(8), 3961–3978.
- Angelidis, P., Maris, F., Kotsovinos, N., & Hrissanthou, V. (2012). Computation of Drought Index SPI with Alternative Distribution Functions. *Water Resources Management*, *26*(9), 2453–2473.

- Ansari, R., & Grossi, G. (2022). Spatio-temporal evolution of wet-dry event features and their transition across the Upper Jhelum Basin (UJB) in South Asia. *Natural Hazards and Earth System Sciences*, 22(2), 287–302.
- Arias, P., Bellouin, N., Coppola, E., Jones, R., Krinner, G., Marotzke, J., ... & Zickfeld, K. (2022). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change; Technical Summary.
- Arnell, N. W. (1999). Climate change and global water resources. *Global Environmental Change*, 9, S31–S49.
- Arora, M., Goel, N. K., & Singh, P. (2005). Evaluation of temperature trends over India. *Hydrological Sciences Journal*, 50(1), 81–93.
- Bachner, S., Kapala, A., & Simmer, C. (2008). Evaluation of daily precipitation characteristics in the CLM and their sensitivity to parameterizations. *Meteorologische Zeitschrift*, 17(4), 407–419.
- Bayazit, M. (2015). Nonstationarity of Hydrological Records and Recent Trends in Trend Analysis: A State-of-the-art Review. *Environmental Processes*, 2(3), 527–542.
- Beguiría, S., Vicente-Serrano, S. M., Reig, F., & Latorre, B. (2014). Standardized precipitation evapotranspiration index (SPEI) revisited: parameter fitting, evapotranspiration models, tools, datasets and drought monitoring. *International Journal of Climatology*, 34(10), 3001–3023.

- Beguiría, S., Vicente-Serrano, S. M., & Angulo-Martínez, M. (2010). A multiscalar global drought dataset: The SPEI base: A new gridded product for the analysis of drought variability and impacts. *Bulletin of the American Meteorological Society*, *91*(10), 1351–1356.
- Bhat, G. S. (2006). The Indian drought of 2002 - A sub-seasonal phenomenon? *Quarterly Journal of the Royal Meteorological Society*, *132*(621), 2583–2602.
- Bhatt, D., Sonkar, G., & Mall, R. K. (2019). Impact of Climate Variability on the Rice Yield in Uttar Pradesh: an Agro-Climatic Zone Based Study. *Environmental Processes*, *6*(1), 135–153.
- de Amorim, P. B. (2015). Development of regional climate change projections for hydrological impact assessments in distrito federal, Brazil. Ph.D. Thesis, Tharandt, Technische Universität Dresden, Germany.
- Brown, J. F., Wardlow, B. D., Tadesse, T., Hayes, M. J., & Reed, B. C. (2008). The Vegetation Drought Response Index (VegDRI): A new integrated approach for monitoring drought stress in vegetation. *GIScience & Remote Sensing*, *45*(1), 16-46.
- Bürger, G. (1996). Expanded downscaling for generating local weather scenarios. *Climate Research*, *7*(2), 111–128.
- Burke, E. J., Brown, S. J., & Christidis, N. (2006). Modeling the Recent Evolution of Global Drought and Projections for the Twenty-First Century with the Hadley Centre Climate Model. *Journal of Hydrometeorology*, *7*(5), 1113–1125.

- Byakatonda, J., Parida, B. P., Moalafhi, D. B., & Kenabatho, P. K. (2018). Analysis of long term drought severity characteristics and trends across semiarid Botswana using two drought indices. *Atmospheric research*, 213, 492-508.
- Cai, G., Du, M., & Liu, Y. (2010, October). Regional drought monitoring and analyzing using MODIS data—A case study in Yunnan Province. In *International conference on computer and computing technologies in agriculture* (pp. 243-251). Springer, Berlin, Heidelberg.
- Chanda, K., & Maity, R. (2015). Meteorological drought quantification with standardized precipitation anomaly index for the regions with strongly seasonal and periodic precipitation. *Journal of Hydrologic Engineering*, 20(12), 06015007.
- Chaurasia, P. R., & Chandra, S. (2021). Bundelkhand Water Woes: Paradigm Shift is Needed in the Strategy. *Journal of The Institution of Engineers (India): Series A*, 102(1), 335-345.
- Chen, C.-T., & Knutson, T. (2008). On the Verification and Comparison of Extreme Rainfall Indices from Climate Models. *Journal of Climate*, 21(7), 1605–1621.
- Chen, J., Brissette, F. P., & Leconte, R. (2012). Downscaling of weather generator parameters to quantify hydrological impacts of climate change. *Climate Research*, 51(3), 185–200.
- Chou, C., Chiang, J. C. H., Lan, C.-W., Chung, C.-H., Liao, Y.-C., & Lee, C.-J. (2013). Increase in the range between wet and dry season precipitation. *Nature Geoscience*, 6(4), 263–267.

- Choux, M. (2005). Development of new predictor climate variables for statistical downscaling of daily precipitation process. Ph.D. Thesis, McGill University, Quebec, Canada
- Christensen, J. H., Boberg, F., Christensen, O. B., & Lucas-Picher, P. (2008). On the need for bias correction of regional climate change projections of temperature and precipitation. *Geophysical Research Letters*, *35*(20).
- Chu, J. T., Xia, J., Xu, C.-Y., & Singh, V. P. (2010). Statistical downscaling of daily mean temperature, pan evaporation and precipitation for climate change scenarios in Haihe River, China. *Theoretical and Applied Climatology*, *99*(1), 149–161
- Clausen, B., & Pearson, C. P. (1995). Regional frequency analysis of annual maximum streamflow drought. *Journal of Hydrology*, *173*(1), 111–130.
- Cook, B. I., Seager, R., & Smerdon, J. E. (2014). The worst North American drought year of the last millennium: 1934. *Geophysical Research Letters*, *41*(20), 7298–7305.
- Cook, B. I., Shukla, S. P., Puma, M. J., & Nazarenko, L. S. (2015). Irrigation as an historical climate forcing. *Climate Dynamics*, *44*(5), 1715–1730.
- Dahmen, E. R., & Hall, M. J. (1989). Screening of Hydrological Data: Tests for Stationarity and Relative Consistency. *International Institute for Land Reclamation and Improvement/ILRI*, 58.
- Dai, A. (2011). Drought under global warming: A review. *Wiley Interdisciplinary Reviews: Climate Change*, *2*(1), 45–65.

- Dai, A. (2013). Increasing drought under global warming in observations and models. *Nature Climate Change*, 3(1), 52–58.
- Dai, A., Trenberth, K. E., & Qian, T. (2004). A Global Dataset of Palmer Drought Severity Index for 1870–2002: Relationship with Soil Moisture and Effects of Surface Warming. *Journal of Hydrometeorology*, 5(6), 1117–1130.
- Danandeh Mehr, A., & Vaheddoost, B. (2020). Identification of the trends associated with the SPI and SPEI indices across Ankara, Turkey. *Theoretical and Applied Climatology*, 139(3–4), 1531–1542.
- Das, P. K., Dutta, D., Sharma, J. R., & Dadhwal, V. K. (2016). Trends and behaviour of meteorological drought (1901–2008) over Indian region using standardized precipitation–evapotranspiration index. *International Journal of Climatology*, 36(2), 909–916.
- Dash, S. K., Kulkarni, M. A., Mohanty, U. C., & Prasad, K. (2009). Changes in the characteristics of rain events in India. *Journal of Geophysical Research: Atmospheres*, 114(D10).
- Datta, P., & Das, S. (2019). Analysis of long-term precipitation changes in West Bengal, India: An approach to detect monotonic trends influenced by autocorrelations. *Dynamics of Atmospheres and Oceans*, 88, 101118.
- David, V., & Davidová, T. (2017). Relating Hydrological and Meteorological Drought Indices in Order to Identify Causes of low Flows in the Catchment of Blanice River. *Environmental Processes*, 4(1), 149–161.

- De Luca, P., Messori, G., Wilby, R. L., Mazzoleni, M., & Di Baldassarre, G. (2020). Concurrent wet and dry hydrological extremes at the global scale. *Earth System Dynamics, 11*(1), 251–266.
- Dehghan, S., Salehnia, N., Sayari, N., & Bakhtiari, B. (2020). Prediction of meteorological drought in arid and semi-arid regions using PDSI and SDSM: a case study in Fars Province, Iran. *Journal of Arid Land, 12*(2), 318–330.
- Deng, F., & Chen, J. M. (2011). Recent global CO₂ flux inferred from atmospheric CO₂ observations and its regional analyses. *Biogeosciences, 8*(11), 3263–3281.
- Déry, S. J., Hernández-Henríquez, M. A., Burford, J. E., & Wood, E. F. (2009). Observational evidence of an intensifying hydrological cycle in northern Canada. *Geophysical Research Letters, 36*(13).
- Diaz, H. F. (1983). Drought in the United States. *Journal of Applied Meteorology and Climatology, 22*(1), 3–16.
- Dikici, M. (2020). Drought analysis with different indices for the Asi Basin (Turkey). *Scientific Reports, 10*(1), 1–12.
- Ding, Y., Wang, Z., & Sun, Y. (2008). Inter-decadal variation of the summer precipitation in East China and its association with decreasing Asian summer monsoon. Part I: Observed evidences. *International Journal of Climatology, 28*(9), 1139–1161.
- Dore, M. H. (2005). Climate change and changes in global precipitation patterns: what do we know?. *Environment international, 31*(8), 1167-1181.

- Dracup, J. A., Lee, K. S., & Paulson Jr., E. G. (1980). On the definition of droughts. *Water Resources Research*, *16*(2), 297–302.
- Durman, C. F., Gregory, J. M., Hassell, D. C., Jones, R. G., & Murphy, J. M. (2001). A comparison of extreme European daily precipitation simulated by a global and a regional climate model for present and future climates. *Quarterly Journal of the Royal Meteorological Society*, *127*(573), 1005–1015.
- Edwards, D. C. (1997). Characteristics of 20th Century drought in the United States at multiple timescales.
- Edwards, D.C. and McKee, T.B. (1997) Characteristics of 20th Century Drought in the United States at Multiple Times Scales. *Atmospheric Science Paper*, 634, 1-30.
- Farhangi, M., Kholghi, M., & Chavoshian, S. A. (2016). Rainfall trend analysis of hydrological subbasins in Western Iran. *Journal of Irrigation and Drainage Engineering*, *142*(10), 05016004.
- Feng, G., Cobb, S., Abdo, Z., Fisher, D. K., Ouyang, Y., Adeli, A., & Jenkins, J. N. (2016). Trend Analysis and Forecast of Precipitation, Reference Evapotranspiration, and Rainfall Deficit in the Blackland Prairie of Eastern Mississippi. *Journal of Applied Meteorology and Climatology*, *55*(7), 1425–1439.
- Fleig, A. K., Tallaksen, L. M., Hisdal, H., & Demuth, S. (2006). A global evaluation of streamflow drought characteristics. *Hydrology and Earth System Sciences*, *10*(4), 535–552.

- Flato, G., Marotzke, J., Abiodun, B., Braconnot, P., Chou, S. C., Collins, W., ... & Rummukainen, M. (2014). Evaluation of climate models. In *Climate change 2013: the physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 741-866). Cambridge University Press.
- Fowler, H. J., Blenkinsop, S., & Tebaldi, C. (2007). Linking climate change modelling to impacts studies: recent advances in downscaling techniques for hydrological modelling. *International Journal of Climatology*, 27(12), 1547–1578.
- Fowler, H. J., Kilsby, C. G., & O'Connell, P. E. (2000). A stochastic rainfall model for the assessment of regional water resource systems under changed climatic condition. *Hydrology and Earth System Sciences*, 4(2), 263-281.
- Frei, C., Schöll, R., Fukutome, S., Schmidli, J., & Vidale, P. L. (2006). Future change of precipitation extremes in Europe: Intercomparison of scenarios from regional climate models. *Journal of Geophysical Research: Atmospheres*, 111(D6).
- Gautam, R. C., & Bana, R. S. (2014). Drought in India: Its impact and mitigation strategies - A review. *Indian Journal of Agronomy*, 59(2), 179–190.
- Ge, Y., Cai, X., Zhu, T., & Ringler, C. (2016). Drought frequency change: An assessment in northern India plains. *Agricultural Water Management*, 176, 111–121.
- Ghosh, K. G. (2019). Spatial and temporal appraisal of drought jeopardy over the Gangetic West Bengal, eastern India. *Geoenvironmental Disasters*, 6(1), 1-21.

- Ghosh, S., & Mujumdar, P. P. (2008). Statistical downscaling of GCM simulations to streamflow using relevance vector machine. *Advances in Water Resources*, 31(1), 132–146.
- Giorgi, F., & Mearns, L. O. (1991). Approaches to the simulation of regional climate change: A review. *Reviews of Geophysics*, 29(2), 191–216.
- Glantz, M. H., & Katz, R. W. (1977). When is a drought a drought? *Nature*, 267(5608), 192–193.
- Gond, S., Gupta, N., & Gupta, S. (2019). Evaluation of Drought Severity Indices and their Trend for Mirzapur (Uttar Pradesh). *24th International Conference on Hydraulics, Water Resources and Coastal Engineering Vol- II*, 2275-2283.
- Gosain, A. K., Rao, S., & Basuray, D. (2006). Climate change impact assessment on hydrology of Indian river basins. *Current science*, 346-353.
- Goswami, B. N., Venugopal, V., Sengupta, D., Madhusoodanan, M. S., & Xavier, P. K. (2006). Increasing trend of extreme rain events over India in a warming environment. *Science*, 314(5804), 1442-1445.
- Goyal, M. K., & Ojha, C. S. P. (2012). Downscaling of surface temperature for lake catchment in an arid region in India using linear multiple regression and neural networks. *International Journal of Climatology*, 32(4), 552–566.
- Guhathakurta, P., Menon, P., Inkane, P. M., Krishnan, U., & Sable, S. T. (2017). Trends and variability of meteorological drought over the districts of India using standardized precipitation index. *Journal of Earth System Science*, 126(8), 120.

- Guhathakurta, P., Rajeevan, M., Sikka, D. R., & Tyagi, A. (2015). Observed changes in southwest monsoon rainfall over India during 1901–2011. *International Journal of Climatology*, 35(8), 1881–1898.
- Gulacha, M. M., & Mulungu, D. M. M. (2017). Generation of climate change scenarios for precipitation and temperature at local scales using SDSM in Wami-Ruvu River Basin Tanzania. *Physics and Chemistry of the Earth, Parts A/B/C*, 100, 62–72.
- Gupta, N., Banerjee, A., & Gupta, S. K. (2021). Spatio-temporal Trend Analysis of Climatic Variables over Jharkhand, India. *Earth Systems and Environment*, 5(1), 71–86.
- Gupta, N., Gond, S., & Gupta, S. K. (2022). Spatiotemporal trend characteristics of rainfall and drought jeopardy over Bundelkhand Region, India. *Arabian Journal of Geosciences*, 15(12), 1155.
- Gupta, S. K., Gupta, N., & Singh, V. P. (2021). Variable-sized cluster analysis for 3D pattern characterization of trends in precipitation and change-point detection. *Journal of Hydrologic Engineering*, 26(1), 04020056.
- Gupta, V., Kumar Jain, M., & Singh, V. P. (2020). Multivariate Modeling of Projected Drought Frequency and Hazard over India. *Journal of Hydrologic Engineering*, 25(4), 04020003.
- Guttman, N. B. (1998). Comparing the palmer drought index and the standardized precipitation index 1. *JAWRA Journal of the American Water Resources Association*, 34(1), 113-121.

- Hadi, S. J., & Tombul, M. (2018). Long-term spatiotemporal trend analysis of precipitation and temperature over Turkey. *Meteorological Applications*, 25(3), 445–455.
- Hao, Z., & AghaKouchak, A. (2013). Multivariate Standardized Drought Index: A parametric multi-index model. *Advances in Water Resources*, 57, 12–18.
- Hao, Z., & Singh, V. P. (2015). Drought characterization from a multivariate perspective: A review. *Journal of Hydrology*, 527(May), 668–678.
- Hashmi, M. Z., Shamseldin, A. Y., & Melville, B. W. (2011). Comparison of SDSM and LARS-WG for simulation and downscaling of extreme precipitation events in a watershed. *Stochastic Environmental Research and Risk Assessment*, 25(4), 475–484.
- Hassan, Z., Shamsudin, S., & Harun, S. (2014). Application of SDSM and LARS-WG for simulating and downscaling of rainfall and temperature. *Theoretical and Applied Climatology*, 116(1), 243–257.
- Hayes, M. J., Alvord, C., & Lowrey, J. (2002). *Drought indices*. National drought mitigation center, University of Nebraska.
- Hayes, M. J., Alvord, C., & Lowrey, J. (2007). Drought indices. *Intermountain west climate summary*, 3(6), 2-6.
- Hayes, M. J., Svoboda, M. D., Wihite, D. A., & Vanyarkho, O. V. (1999). Monitoring the 1996 Drought Using the Standardized Precipitation Index. *Bulletin of the American Meteorological Society*, 80(3), 429–438.

- He, X., Estes, L., Konar, M., Tian, D., Anghileri, D., Baylis, K., Evans, T. P., & Sheffield, J. (2019). Integrated approaches to understanding and reducing drought impact on food security across scales. *Current Opinion in Environmental Sustainability*, *40*, 43–54.
- He, X., & Sheffield, J. (2020). Lagged Compound Occurrence of Droughts and Pluvials Globally Over the Past Seven Decades. *Geophysical Research Letters*, *47*(14).
- Heim, R. R. (2002). A Review of Twentieth-Century Drought Indices Used in the United States. *Bulletin of the American Meteorological Society*, *83*(8), 1149–1166.
- Hernandez, E. A., & Uddameri, V. (2014). Standardized precipitation evaporation index (SPEI)-based drought assessment in semi-arid south Texas. *Environmental Earth Sciences*, *71*(6), 2491–2501.
- Hessami, M., Gachon, P., Ouarda, T. B. M. J., & St-Hilaire, A. (2008). Automated regression-based statistical downscaling tool. *Environmental Modelling and Software*, *23*(6), 813–834.
- Hewitson, B. C., & Crane, R. G. (2002). Self-organizing maps: Applications to synoptic climatology. *Climate Research*, *22*(1), 13–26.
- Hewitson, Bruce C, & Crane, R. G. (1992). Large-scale atmospheric controls on local precipitation in tropical Mexico. *Geophysical Research Letters*, *19*(18), 1835–1838.
- Hosking, J. R. M., & Wallis, J. R. (1986). The value of historical data in flood frequency analysis. *Water resources research*, *22*(11), 1606-1612.

- Huang, C., Zhang, Q., Singh, V. P., Gu, X., & Shi, P. (2017). Spatio-temporal variation of dryness/wetness across the Pearl River basin, China, and relation to climate indices. *International Journal of Climatology*, 37(February), 318–332.
- Huang, J., Zhang, J., Zhang, Z., Xu, C., Wang, B., & Yao, J. (2011). Estimation of future precipitation change in the Yangtze River basin by using statistical downscaling method. *Stochastic Environmental Research and Risk Assessment*, 25(6), 781–792.
- Huntington, T. G. (2006). Evidence for intensification of the global water cycle: Review and synthesis. *Journal of Hydrology*, 319(1), 83–95.
- Huth, R., & Pokorná, L. (2005). Simultaneous analysis of climatic trends in multiple variables: an example of application of multivariate statistical methods. *International Journal of Climatology*, 25(4), 469–484.
- Hosking, J. R. M. (1990). L-Moments: Analysis and Estimation of Distributions Using Linear Combinations of Order Statistics. *Journal of the Royal Statistical Society. Series B (Methodological)*, 52(1), 105–124.
- IPCC (2001). Third Assessment Report of the Intergovernmental Panel on Climate Change IPCC (WG I & II). Cambridge Univ. Press, Cambridge.
- IPCC (2007). Climate Change 2007: Synthesis report. Contribution of working group I, II and III to the fourth assessment report of the Intergovernmental Panel on Climate Change.
- IPCC (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel

- on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC (2014). IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change., Intergovernmental Panel on Climate Change.
- Jain, S. K., & Kumar, V. (2012). Trend analysis of rainfall and temperature data for India. *Current Science*, 37-49.
- Jones, R. G., Murphy, J. M., Noguer, M., & Keen, A. B. (1997). Simulation of climate change over Europe using a nested regional-climate model. II: Comparison of driving and regional model responses to a doubling of carbon dioxide. *Quarterly Journal of the Royal Meteorological Society*, 123(538), 265–292.
- Karl, T. R. (1986). The Sensitivity of the Palmer Drought Severity Index and Palmer's Z-Index to their Calibration Coefficients Including Potential Evapotranspiration. *Journal of Climate and Applied Meteorology*, 25(1), 77–86.
- Karl, T. R., & Koscielny, A. J. (1982). Drought in the United States: 1895–1981. *Journal of Climatology*, 2(4), 313–329.
- Karl, T. R., & Young, P. J. (1987). The 1986 Southeast Drought in Historical Perspective. *Bulletin of the American Meteorological Society*, 68(7), 773–778.

- Kchouk, S., Melsen, L., Walker, D., & van Oel, P. (2021). A review of drought indices: predominance of drivers over impacts and the importance of local context. *Natural Hazards and Earth System Sciences Discussions*, June, 1–28.
- Kendall, M. G. (1975). Rank correlation methods. London: Griffin.
- Keyantash, J. (2002). An Evaluation of a Drought. *American Meteorological Society*, August, 1167–1180.
- Kidson, J. W., & Thompson, C. S. (1998). A Comparison of Statistical and Model-Based Downscaling Techniques for Estimating Local Climate Variations. *Journal of Climate*, 11(4), 735–753.
- Kironmala, C., & Rajib, M. (2015). Meteorological Drought Quantification with Standardized Precipitation Anomaly Index for the Regions with Strongly Seasonal and Periodic Precipitation. *Journal of Hydrologic Engineering*, 20(12), 6015007.
- Kishore, P., Jyothi, S., Basha, G., Rao, S. V. B., Rajeevan, M., Velicogna, I., & Sutterley, T. C. (2016). Precipitation climatology over India: validation with observations and reanalysis datasets and spatial trends. *Climate Dynamics*, 46(1), 541–556.
- Kothawale, D. R., Revadekar, J. V., & Rupa Kumar, K. (2010). Recent trends in pre-monsoon daily temperature extremes over India. *Journal of Earth System Science*, 119(1), 51–65.
- Kothyari, U. C., & Jain, S. K. (1997). Sediment yield estimation using GIS. *Hydrological Sciences Journal*, 42(6), 833–843.

- Kothyari, U. C., & Singh, V. P. (1996). Rainfall and temperature trends in India. *Hydrological Processes*, *10*(3), 357–372.
- Kripalani, R. H., Kulkarni, A., Sabade, S. S., & Khandekar, M. L. (2003). Indian Monsoon Variability in a Global Warming Scenario. *Natural Hazards*, *29*(2), 189–206.
- Kucharski, F., Molteni, F., & Bracco, A. (2006). Decadal interactions between the western tropical Pacific and the North Atlantic Oscillation. *Climate Dynamics*, *26*(1), 79–91.
- Kumar, K. R., Kumar, K. K., & Pant, G. B. (1994). Diurnal asymmetry of surface temperature trends over India. *Geophysical Research Letters*, *21*(8), 677–680.
- Kumar, N., Singh, S. K., & Pandey, H. K. (2018). Drainage morphometric analysis using open access earth observation datasets in a drought-affected part of Bundelkhand, India. *Applied Geomatics*, *10*(3), 173–189. <https://doi.org/10.1007/s12518-018-0218-2>
- Kumar, R., & Mishra, V. (2020). Increase in Population Exposure Due to Dry and Wet Extremes in India Under a Warming Climate. *Earth's Future*, *8*(12), e2020EF001731.
- Kumar, V., Shanu, & Jahangeer. (2017). Statistical distribution of rainfall in Uttarakhand, India. *Applied Water Science*, *7*(8), 4765–4776.
- Kusangaya, S., Warburton, M. L., Archer van Garderen, E., & Jewitt, G. P. W. (2014). Impacts of climate change on water resources in southern Africa: A review. *Physics and Chemistry of the Earth, Parts A/B/C*, *67–69*, 47–54.

- Łabędzki, L. (2007). Estimation of local drought frequency in central Poland using the standardized precipitation index SPI. *Irrigation and Drainage*, 56(1), 67–77.
- Labudová, L., Labuda, M., & Takáč, J. (2017). Comparison of SPI and SPEI applicability for drought impact assessment on crop production in the Danubian Lowland and the East Slovakian Lowland. *Theoretical and Applied Climatology*, 128(1), 491–506.
- Lenderink, G., & van Meijgaard, E. (2008). Increase in hourly precipitation extremes beyond expectations from temperature changes. *Nature Geoscience*, 1(8), 511–514.
- Li, Y. J., Zheng, X. D., Lu, F., & Ma, J. (2012). Analysis of drought evolvement characteristics based on standardized precipitation index in the Huaihe River Basin. *Procedia Engineering*, 28(2011), 434–437.
- Lin, H., Wang, J., Li, F., Xie, Y., Jiang, C., & Sun, L. (2020). Drought trends and the extreme drought frequency and characteristics under climate change based on SPI and HI in the upper and middle reaches of the Huai River Basin, China. *Water*, 12(4).
- Liu, C., Yang, C., Yang, Q., & Wang, J. (2021). Spatiotemporal drought analysis by the standardized precipitation index (SPI) and standardized precipitation evapotranspiration index (SPEI) in Sichuan Province, China. *Scientific Reports*, 11(1), 1–14.
- Lloyd-Hughes, B., & Saunders, M. A. (2002). A drought climatology for Europe. *International Journal of Climatology*, 22(13), 1571–1592.

- Loaiciga, H. A., & Leipnik, R. B. (1996). Stochastic renewal model of low-flow streamflow sequences. *Stochastic Hydrology and Hydraulics*, *10*(1), 65–85.
- Vicente-Serrano, S. M., Gouveia, C., Camarero, J. J., Beguería, S., Trigo, R., López-Moreno, J. I., ... & Sanchez-Lorenzo, A. (2013). Response of vegetation to drought time-scales across global land biomes. *Proceedings of the National Academy of Sciences*, *110*(1), 52-57.
- Madsen, H., Lawrence, D., Lang, M., Martinkova, M., & Kjeldsen, T. R. (2014). Review of trend analysis and climate change projections of extreme precipitation and floods in Europe. *Journal of Hydrology*, *519*(PD), 3634–3650.
- Mahajan, D. R., & Dodamani, B. M. (2015). Trend Analysis of Drought Events Over Upper Krishna Basin in Maharashtra. *Aquatic Procedia*, *4*, 1250–1257.
- Mahmood, R., & Babel, M. S. (2013). Evaluation of SDSM developed by annual and monthly sub-models for downscaling temperature and precipitation in the Jhelum basin, Pakistan and India. *Theoretical and Applied Climatology*, *113*(1), 27–44.
- Mahmood, R., & Babel, M. S. (2014). Future changes in extreme temperature events using the statistical downscaling model (SDSM) in the trans-boundary region of the Jhelum river basin. *Weather and Climate Extremes*, *5*, 56-66.
- Mahmood, R., & Jia, S. (2017). Spatial and temporal hydro-climatic trends in the transboundary Jhelum River basin. *Journal of Water and Climate Change*, *8*(3), 423–440.

- Mahmood, R., Jia, S., & Zhu, W. (2019). Analysis of climate variability, trends, and prediction in the most active parts of the Lake Chad basin, Africa. *Scientific Reports*, 9(1), 1–18.
- Mahsa, F., Majid, K., & Ali, C. S. (2016). Rainfall Trend Analysis of Hydrological Subbasins in Western Iran. *Journal of Irrigation and Drainage Engineering*, 142(10), 5016004.
- Mahto, S. S., & Mishra, V. (2020). Dominance of summer monsoon flash droughts in India. *Environmental Research Letters*, 15(10), 104061.
- Malik, A., & Kumar, A. (2020). Spatio-temporal trend analysis of rainfall using parametric and non-parametric tests: case study in Uttarakhand, India. *Theoretical and Applied Climatology*, 140(1–2), 183–207.
- Malik, A., Kumar, A., Kisi, O., Khan, N., Salih, S. Q., & Yaseen, Z. M. (2020). Analysis of dry and wet climate characteristics at Uttarakhand (India) using effective drought index. *Natural Hazards*, October.
- Mallya, G., Mishra, V., Niyogi, D., Tripathi, S., & Govindaraju, R. S. (2016). Trends and variability of droughts over the Indian monsoon region. *Weather and Climate Extremes*, 12, 43-68.
- Mann, H. B. (1945). Nonparametric tests against trend. *Econometrica: Journal of the econometric society*, 245-259
- Maraun, D., Wetterhall, F., Ireson, A. M., Chandler, R. E., Kendon, E. J., Widmann, M., Brienen, S., Rust, H. W., Sauter, T., Themeßl, M., Venema, V. K. C., Chun, K. P., Goodess, C. M., Jones, R. G., Onof, C., Vrac, M., & Thiele-Eich, I. (2010). Precipitation downscaling under climate change: Recent developments

- to bridge the gap between dynamical models and the end user. *Reviews of Geophysics*, 48(3).
- Marty, C. (2008). Regime shift of snow days in Switzerland. *Geophysical Research Letters*, 35(12).
- Maurer, E. P. (2007). Uncertainty in hydrologic impacts of climate change in the Sierra Nevada, California, under two emissions scenarios. *Climatic Change*, 82(3), 309–325.
- McKee, T. B. (1995). Drought monitoring with multiple timescales. In *Proceedings of 9th Conference on Applied Climatology, Boston, 1995*.
- McKee, T. B., Doesken, N. J., & Kleist, J. (1993). The relationship of drought frequency and duration to timescales. In *Proceedings of the 8th Conference on Applied Climatology*, 17(22), 179-183.
- McMichael, A. J. (2004). Environmental and social influences on emerging infectious diseases: past, present and future. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, 359(1447), 1049-1058.
- Meher, J. K., & Das, L. (2020). Selection of suitable predictors and predictor domain for statistical downscaling over the Western Himalayan region of India. *Theoretical and Applied Climatology*, 139(1), 431–446.
- Mekonen, A. A., Berlie, A. B., & Ferede, M. B. (2020). Spatial and temporal drought incidence analysis in the northeastern highlands of Ethiopia. *Geoenvironmental Disasters*, 7(1).

- Meenu, R., Rehana, S., & Mujumdar, P. P. (2013). Assessment of hydrologic impacts of climate change in Tunga–Bhadra river basin, India with HEC-HMS and SDSM. *Hydrological processes*, 27(11), 1572-1589.
- Mesbahzadeh, T., Mirakbari, M., Mohseni Saravi, M., Soleimani Sardoo, F., & Miglietta, M. M. (2020). Meteorological drought analysis using copula theory and drought indicators under climate change scenarios (RCP). *Meteorological Applications*, 27(1), 1–20.
- Mishra, A. K., Desai, V. R., Singh, V. P. (2007). Drought Forecasting Using a Hybrid Stochastic and Neural Network Model. *Journal of Hydrologic Engineering*, 12(6), 626–638.
- Mishra, A. K., Singh, V. P., & Desai, V. R. (2009). Drought characterization: A probabilistic approach. *Stochastic Environmental Research and Risk Assessment*, 23(1), 41–55.
- Mishra, A., & Liu, S. C. (2014). Changes in precipitation pattern and risk of drought over India in the context of global warming. *Journal of Geophysical Research: Atmospheres*, 119(13), 7833–7841.
- Mishra, Ashok K., & Singh, V. P. (2010). A review of drought concepts. *Journal of Hydrology*, 391(1), 202–216.
- Mishra, V., Aadhar, S., Asoka, A., Pai, S., & Kumar, R. (2016). On the frequency of the 2015 monsoon season drought in the Indo-Gangetic Plain. *Geophysical Research Letters*, 43(23), 12,102-12,112.

- Mishra, V., Aadhar, S., & Mahto, S. S. (2021). Anthropogenic warming and intraseasonal summer monsoon variability amplify the risk of future flash droughts in India. *Npj Climate and Atmospheric Science*, 4(1), 1-10.
- Mishra, V., Shah, R., & Thrasher, B. (2014). Soil Moisture Droughts under the Retrospective and Projected Climate in India. *Journal of Hydrometeorology*, 15(6), 2267–2292.
- Mishra, V., Smoliak, B. V, Lettenmaier, D. P., & Wallace, J. M. (2012). A prominent pattern of year-to-year variability in Indian Summer Monsoon Rainfall. *Proceedings of the National Academy of Sciences*, 109(19), 7213–7217.
- Mishra, V., Tiwari, A. D., Aadhar, S., Shah, R., Xiao, M., Pai, D. S., & Lettenmaier, D. (2019). Drought and Famine in India, 1870–2016. *Geophysical Research Letters*, 46(4), 2075–2083.
- Sharma, C., Ojha, C. S. P., Shukla, A. K., Pham, Q. B., Linh, N. T. T., Fai, C. M., ... & Dung, T. D. (2019). Modified approach to reduce GCM bias in downscaled precipitation: a study in Ganga River Basin. *Water*, 11(10), 2097.
- Mohammad, K., Kabir, R., & Sara, N. (2009). Development of a Hybrid Index for Drought Prediction: Case Study. *Journal of Hydrologic Engineering*, 14(6), 617–627.
- Mohan, S., & Rangacharya, N. C. V. (1991). A modified method for drought identification. *Hydrological Sciences Journal*, 36(1), 11–21.

- Moktan, S., Pandey, R. P., Mishra, S. K., & Pokharel, R. B. (2021). Study of Drought Characteristics in Ken River Basin in Bundelkhand Region in India. In *Hydrological Extremes* (pp. 87-109). Springer, Cham.
- Morid, S., Smakhtin, V., & Bagherzadeh, K. (2007). Drought forecasting using artificial neural networks and time series of drought indices. *International Journal of Climatology*, 27(15), 2103–2111.
- Mosley, L. M. (2015). Drought impacts on the water quality of freshwater systems; review and integration. *Earth-Science Reviews*, 140, 203–214.
- Mudryk, L. R., Kushner, P. J., Derksen, C., & Thackeray, C. (2017). Snow cover response to temperature in observational and climate model ensembles. *Geophysical Research Letters*, 44(2), 919–926.
- Narasimhan, B., & Srinivasan, R. (2005). Development and evaluation of Soil Moisture Deficit Index (SMDI) and Evapotranspiration Deficit Index (ETDI) for agricultural drought monitoring. *Agricultural and Forest Meteorology*, 133(1–4), 69–88.
- Naresh Kumar, M., Murthy, C. S., Sessa Sai, M. V. R., & Roy, P. S. (2012). Spatiotemporal analysis of meteorological drought variability in the Indian region using standardized precipitation index. *Meteorological Applications*, 19(2), 256–264.
- Nath, R., Cui, X., Nath, D., Graf, H. F., Chen, W., Wang, L., Gong, H., & Li, Q. (2017). CMIP5 multimodel projections of extreme weather events in the humid subtropical Gangetic Plain region of India. *Earth's Future*, 5(2), 224–239.

- Nath, R., Nath, D., Li, Q., Chen, W., & Cui, X. (2017). Impact of drought on agriculture in the Indo-Gangetic Plain, India. *Advances in Atmospheric Sciences*, 34(3), 335–346.
- Neugebauer, M. (1988). Reviews of Geophysics. *Eos, Transactions American Geophysical Union*, 69(37), 849.
- Niemeyer, S. (2008). New drought indices. *Options Méditerranéennes. Série A: Séminaires Méditerranéens*, 80, 267-274.
- Niranjan Kumar, K., Rajeevan, M., Pai, D. S., Srivastava, A. K., & Preethi, B. (2013). On the observed variability of monsoon droughts over India. *Weather and Climate Extremes*, 1, 42–50.
- Noguera, I., Vicente-Serrano, S. M., & Domínguez-Castro, F. (2022). The rise of atmospheric evaporative demand is increasing flash droughts in Spain during the warm season. *Geophysical Research Letters*, 49(11), e2021GL097703.
- Ojha, R., Nagesh Kumar, D., Sharma, A., & Mehrotra, R. (2013). Assessing Severe Drought and Wet Events over India in a Future Climate Using a Nested Bias-Correction Approach. *Journal of Hydrologic Engineering*, 18(7), 760–772.
- Omar, P. J., Gaur, S., Dwivedi, S. B., & Dikshit, P. K. S. (2019). Groundwater modelling using an analytic element method and finite difference method: an insight into lower ganga river basin. *Journal of Earth System Science*, 128, 1-10.
- Omar, P. J., Gaur, S., Dwivedi, S. B., & Dikshit, P. K. S. (2020). A Modular Three-Dimensional Scenario-Based Numerical Modelling of Groundwater Flow. *Water Resources Management*, 34(6), 1913–1932.

- Omonijo, T. O., & Okogbue, E. C. (2014). Trend Analysis of Drought in the Guinea and Sudano-Sahelian Climatic Zones of Northern Nigeria (1907-2006). *Atmospheric and Climate Sciences*, 04(04), 483–507.
- Otkin, J. A., Svoboda, M., Hunt, E. D., Ford, T. W., Anderson, M. C., Hain, C., & Basara, J. B. (2018). Flash droughts: A review and assessment of the challenges imposed by rapid-onset droughts in the United States. *Bulletin of the American Meteorological Society*, 99(5), 911–919.
- Pachauri, R. K., & Meyer, L. A. (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.
- Pai, D. S., Sridhar, L., Guhathakurta, P., & Hatwar, H. R. (2011). District-wide drought climatology of the southwest monsoon season over India based on standardized precipitation index (SPI). *Natural hazards*, 59(3), 1797-1813.
- Palmer, W. C. (1965). Meteorological Drought. In *U.S. Weather Bureau, Res. Pap. No. 45* (p. 58).
- Pallant, J. (2007). SPSS survival manual: A step by step guide to data analysis using SPSS for Windows (Version 15).
- Pandey, B. K., & Khare, D. (2018). Identification of trend in long term precipitation and reference evapotranspiration over Narmada river basin (India). *Global and Planetary Change*, 161, 172–182.
- Pandey, V., Srivastava, P. K., Singh, S. K., Petropoulos, G. P., & Mall, R. K. (2021). Drought identification and trend analysis using long-term chirps satellite precipitation product in Bundelkhand, India. *Sustainability*, 13(3), 1–20.

- Pant, G. B., & Kumar, K. R. (1997). *Climates of South Asia*. Wiley; *Belhaven Studies in Climatology*.
- Parida, Y., Saini, S., & Chowdhury, J. R. (2021). Economic growth in the aftermath of floods in Indian states. *Environment, Development and Sustainability*, 23(1), 535–561.
- Parthasarathy, B., Munot, A. A., & Kothawale, D. R. (1994). All-India monthly and seasonal rainfall series: 1871–1993. *Theoretical and Applied Climatology*, 49(4), 217–224.
- Patel, N. R., Chopra, P., & Dadhwal, V. K. (2007). Analyzing spatial patterns of meteorological drought using standardized precipitation index. *Meteorological Applications*, 14(4), 329–336.
- Pathak, A. A., & Dodamani, B. M. (2020). Trend analysis of rainfall, rainy days and drought: a case study of Ghataprabha River Basin, India. *Modeling Earth Systems and Environment*, 6(3), 1357–1372.
- Paul, S., Ghosh, S., Oglesby, R., Pathak, A., Chandrasekharan, A., & Ramsankaran, R. (2016). Weakening of Indian Summer Monsoon Rainfall due to Changes in Land Use Land Cover. *Scientific Reports*, 6(1), 32177.
- Paulo, A., Martins, D., & Pereira, L. S. (2016). Influence of Precipitation Changes on the SPI and Related Drought Severity. An Analysis Using Long-Term Data Series. *Water Resources Management*, 30(15), 5737–5757.
- Pervez, M. S., & Henebry, G. M. (2015). Assessing the impacts of climate and land use and land cover change on the freshwater availability in the Brahmaputra River basin. *Journal of Hydrology: Regional Studies*, 3, 285–311.

- Pharasi, S. (2006). Development of statistical downscaling methods for the daily precipitation process at a local site. M.E. Thesis, McGill University, Quebec, Canada
- Polong, F., Chen, H., Sun, S., & Ongoma, V. (2019). Temporal and spatial evolution of the standard precipitation evapotranspiration index (SPEI) in the Tana River Basin, Kenya. *Theoretical and Applied Climatology*, *138*(1–2), 777–792.
- Potop, V. (2011). Evolution of drought severity and its impact on corn in the Republic of Moldova. *Theoretical and Applied Climatology*, *105*(3), 469–483.
- Potopová, V., Štěpánek, P., Možný, M., Türkott, L., & Soukup, J. (2015). Performance of the standardised precipitation evapotranspiration index at various lags for agricultural drought risk assessment in the Czech Republic. *Agricultural and Forest Meteorology*, *202*, 26–38.
- Raje, D., & Mujumdar, P. P. (2010). Reservoir performance under uncertainty in hydrologic impacts of climate change. *Advances in Water Resources*, *33*(3), 312–326.
- Rajeevan, M., Bhate, J., & Jaswal, A. K. (2008). Analysis of variability and trends of extreme rainfall events over India using 104 years of gridded daily rainfall data. *Geophysical Research Letters*, *35*(18).
- Ramesh, K. V., & Goswami, P. (2007). Reduction in temporal and spatial extent of the Indian summer monsoon. *Geophysical Research Letters*, *34*(23), 1–6.
- Reichstein, M., Bahn, M., Ciais, P., Frank, D., Mahecha, M. D., Seneviratne, S. I., Zscheischler, J., Beer, C., Buchmann, N., Frank, D. C., Papale, D., Rammig, A.,

References

- Smith, P., Thonicke, K., van der Velde, M., Vicca, S., Walz, A., & Wattenbach, M. (2013). Climate extremes and the carbon cycle. *Nature*, *500*(7462), 287–295.
- Revadekar, J. V., Kothawale, D. R., Patwardhan, S. K., Pant, G. B., & Rupa Kumar, K. (2012). About the observed and future changes in temperature extremes over India. *Natural Hazards*, *60*(3), 1133–1155.
- Rhee, J., Im, J., & Carbone, G. J. (2010). Monitoring agricultural drought for arid and humid regions using multi-sensor remote sensing data. *Remote Sensing of Environment*, *114*(12), 2875–2887.
- Roxy, M. K., Ritika, K., Terray, P., Murtugudde, R., Ashok, K., & Goswami, B. N. (2015). Drying of Indian subcontinent by rapid Indian Ocean warming and a weakening land-sea thermal gradient. *Nature Communications*, *6*(1), 7423.
- Roy, A. K., & Hirway, I. (2007). Multiple Impacts of Droughts and Assessment of Drought Policy in Major Drought Prone States in India. *Centre for Development Alternatives*, 14.
- Sah, S., Singh, R., Chaturvedi, G., & Das, B. (2021). Trends, variability, and teleconnections of long-term rainfall in the Terai region of India. *Theoretical and Applied Climatology*, *143*(1–2), 291–307.
- Sahana, V., & Mondal, A. (2022). Evolution of multivariate drought hazard, vulnerability and risk in India under climate change. *Natural Hazards and Earth System Sciences Discussions*, February, 1–19.

- Saharwardi, M. S., Mahadeo, A. S., & Kumar, P. (2021). Understanding drought dynamics and variability over Bundelkhand region. *Journal of Earth System Science, 130*(3), 122.
- Saraf, V. R., & Regulwar, D. G. (2016). Assessment of Climate Change for Precipitation and Temperature Using Statistical Downscaling Methods in Upper Godavari River Basin, India. *Journal of Water Resource and Protection, 08*(01), 31–45.
- Sathyanathan, R., Deeptha, T., Reddy, Y. S. R., Revanth, V., Nishanth, T., & Bhagyaraja, M. (2018). Detecting Changes in Annual and Seasonal Rainfall Patterns for Chennai, India. *Journal of Hydrologic Engineering, 23*(4), 5018001.
- Shahid, S., & Khairulmaini, O. S. (2009). Spatio-temporal variability of rainfall over Bangladesh during the time period 1969-2003. *Asia-Pacific Journal of Atmospheric Sciences, 43*(5), 375–389.
- Sharma, C., Ojha, C. S. P., Shukla, A. K., Pham, Q. B., Linh, N. T. T., Fai, C. M., ... & Dung, T. D. (2019). Modified approach to reduce GCM bias in downscaled precipitation: a study in Ganga River Basin. *Water, 11*(10), 2097.
- Sharma, P. J., Loliyana, V. D., Resmi, S. R., Timbadiya, P. V., & Patel, P. L. (2018). Spatiotemporal trends in extreme rainfall and temperature indices over Upper Tapi Basin, India. *Theoretical and Applied Climatology, 134*(3–4), 1329–1354.
- Sheffield, J., Wood, E. F., & Roderick, M. L. (2012). Little change in global drought over the past 60 years. *Nature, 491*(7424), 435–438.

- Sillmann, J., & Roeckner, E. (2008). Indices for extreme events in projections of anthropogenic climate change. *Climatic Change*, *86*(1), 83–104.
- Singh, Deepti, Tsiang, M., Rajaratnam, B., & Diffenbaugh, N. S. (2014). Observed changes in extreme wet and dry spells during the South Asian summer monsoon season. *Nature Climate Change*, *4*(6), 456–461.
- Singh, Dharmaveer., Jain, S. K., & Gupta, R. D. (2015). Statistical downscaling and projection of future temperature and precipitation change in middle catchment of Sutlej River Basin, India. *Journal of Earth System Science*, *124*(4), 843–860.
- Singh, N., & Sontakke, N. A. (2002). On Climatic Fluctuations and Environmental Changes of the Indo-Gangetic Plains, India. *Climatic Change*, *52*(3), 287–313.
- Smakhtin, V. U., & Hughes, D. A. (2004). Review, automated estimation and analyses of drought indices in South Asia. In *Water Management*.
- Sohn, B. J., Yeh, S.-W., Schmetz, J., & Song, H.-J. (2013). Observational evidences of Walker circulation change over the last 30 years contrasting with GCM results. *Climate Dynamics*, *40*(7), 1721–1732.
- Sonali, P., & Nagesh Kumar, D. (2013). Review of trend detection methods and their application to detect temperature changes in India. *Journal of Hydrology*, *476*, 212–227.
- Soulé, P. T. (1992). Spatial patterns of drought frequency and duration in the contiguous USA based on multiple drought event definitions. *International Journal of Climatology*, *12*(1), 11–24.

- Spinoni, J., Antofie, T., Barbosa, P., Bihari, Z., Lakatos, M., Szalai, S., Szentimrey, T., & Vogt, J. (2013). An overview of drought events in the Carpathian Region in 1961–2010. *Advances in Science and Research*, *10*(1), 21–32.
- Sreeparvathy, V., & Srinivas, V. V. (2022). Global assessment of spatiotemporal variability of wet, normal and dry conditions using multiscale entropy-based approach. *Scientific Reports*, *12*(1), 9767.
- Srivastava, H. N., Dewan, B. N., Dikshit, S. K., Rao, G. S. P., Singh, S. S., & Rao, K. R. (1992). Decadal trends in climate over India. *Mausam*, *43*(1), 7–20.
- Suroso, Nadhilah, D., Ardiansyah, & Aldrian, E. (2021). Drought detection in java island based on standardized precipitation and evapotranspiration index (SPEI). *Journal of Water and Climate Change*, *12*(6), 2734–2752.
- Suryavanshi, S., Pandey, A., Chaube, U. C., & Joshi, N. (2014). Long-term historic changes in climatic variables of Betwa Basin, India. *Theoretical and Applied Climatology*, *117*(3), 403–418.
- Svoboda, M. D., Fuchs, B. A., Poulsen, C. C., & Nothwehr, J. R. (2015). The drought risk atlas: Enhancing decision support for drought risk management in the United States. *Journal of Hydrology*, *526*, 274–286.
- Svoboda, M. D., & Fuchs, B. A. (2016). *Handbook of drought indicators and indices* (pp. 1-44). Geneva, Switzerland: World Meteorological Organization.
- Svoboda, M., & Fuchs, B. (2016). Handbook of drought indicators and indices. Integrated drought management programme (IDMP), integrated drought

- management tools and guidelines series 2. *World meteorological organization and global water partnership, Geneva, Switzerland, 52.*
- Svoboda, M., LeComte, D., Hayes, M., Heim, R., Gleason, K., Angel, J., Rippey, B., Tinker, R., Palecki, M., Stooksbury, D., Miskus, D., & Stephens, S. (2002). The Drought Monitor. *Bulletin of the American Meteorological Society*, 83(8), 1181–1190. 0477-83.8.1181
- Swain, M., Sinha, P., Pattanayak, S., Guhathakurta, P., & Mohanty, U. C. (2020). Characteristics of observed rainfall over Odisha: An extreme vulnerable zone in the east coast of India. *Theoretical and Applied Climatology*, 139(1–2), 517–531.
- Tannehill, I. (1947). Drought, Its Causes and Effects. *Soil Science*, 64(1).
- Taylor, K. E., Stouffer, R. J., & Meehl, G. A. (2012). An Overview of CMIP5 and the Experiment Design. *Bulletin of the American Meteorological Society*, 93(4), 485–498.
- Sharma, C., Ojha, C.S.P., Shukla, A.K., Pham, Q.B., Linh, N.T.T., Fai, C.M., Loc, H.H., Dung, T.D. (2019). Modified Approach to Reduce GCM Bias in Downscaled Precipitation: A Study in Ganga River Basin. *Water*, 11, 2097.
- Thom, H. C. (1958). A note on the gamma distribution. *Monthly weather review*, 86(4), 117-122.
- Thomas, T., Gunthe, S. S., Sudheer, K. P., & Ghosh, N. C. (2015). Analysis of monsoon rainfall variability over Narmada basin in central India: Implication of climate change. *Journal of Water and Climate Change*, 6(3), 615–627.

- Thomas, T., Jaiswal, R. K., Galkate, R. V, & Nayak, T. R. (2016). Reconnaissance Drought Index Based Evaluation of Meteorological Drought Characteristics in Bundelkhand. *Procedia Technology*, 24, 23–30.
- Thomas, T., Nayak, P. C., & Ghosh, N. C. (2015). Spatiotemporal Analysis of Drought Characteristics in the Bundelkhand Region of Central India using the Standardized Precipitation Index. *Journal of Hydrologic Engineering*, 20(11), 05015004.
- Thornthwaite, C. W. (1948). An Approach toward a Rational Classification of Climate. *Geographical Review*, 38(1), 55.
- Tian, L., & Quiring, S. M. (2019). Spatial and temporal patterns of drought in Oklahoma (1901–2014). *International Journal of Climatology*, 39(7), 3365–3378.
- Timbal, B., Dufour, A., & McAvaney, B. (2003). An estimate of future climate change for western France using a statistical downscaling technique. *Climate Dynamics*, 20(7), 807–823.
- Tirivarombo, S., Osupile, D., & Eliasson, P. (2018). Drought monitoring and analysis: Standardised Precipitation Evapotranspiration Index (SPEI) and Standardised Precipitation Index (SPI). *Physics and Chemistry of the Earth*, 106, 1–10.
- Tomas-Burguera, M., Vicente-Serrano, S. M., Peña-Angulo, D., Domínguez-Castro, F., Noguera, I., & El Kenawy, A. (2020). Global characterization of the varying responses of the standardized precipitation evapotranspiration index to

- atmospheric evaporative demand. *Journal of Geophysical Research: Atmospheres*, 125(17), e2020JD033017.
- Tripathi, S., Srinivas, V. V., & Nanjundiah, R. S. (2006). Downscaling of precipitation for climate change scenarios: A support vector machine approach. *Journal of Hydrology*, 330(3), 621–640.
- Trzaska, S., & Schnarr, E. (2014). A review of downscaling methods for climate change projections. *United States Agency for International Development by Tetra Tech ARD, September*, 1–42.
- Tsakiris, G., Pangalou, D., & Vangelis, H. (2007). Regional Drought Assessment Based on the Reconnaissance Drought Index (RDI). *Water Resources Management*, 21(5), 821–833.
- Tsakiris, G., & Vangelis, H. (2005). Establishing a drought index incorporating evapotranspiration. *European Water*, 9(10), 3–11.
- van Belle, G., & Hughes, J. P. (1984). Nonparametric Tests for Trend in Water Quality. *Water Resources Research*, 20(1), 127–136.
- van Vuuren, D. P., Edmonds, J., Kainuma, M., Riahi, K., Thomson, A., Hibbard, K., Hurtt, G. C., Kram, T., Krey, V., Lamarque, J. F., Masui, T., Meinshausen, M., Nakicenovic, N., Smith, S. J., & Rose, S. K. (2011). The representative concentration pathways: An overview. *Climatic Change*, 109(1), 5–31.
- Vasiliades, L., Loukas, A., & Liberis, N. (2011). A Water Balance Derived Drought Index for Pinios River Basin, Greece. *Water Resources Management*, 25(4), 1087–1101.

- Vicente-Serrano, S. M., Beguería, S., & López-Moreno, J. I. (2010). A multiscalar drought index sensitive to global warming: The standardized precipitation evapotranspiration index. *Journal of Climate*, *23*(7), 1696–1718.
- Vicente-Serrano, S. M., Beguería, S., Lorenzo-Lacruz, J., Camarero, J. J., López-Moreno, J. I., Azorin-Molina, C., Revuelto, J., Morán-Tejeda, E., & Sanchez-Lorenzo, A. (2012). Performance of drought indices for ecological, agricultural, and hydrological applications. *Earth Interactions*, *16*(10).
- Vicente-Serrano, S. M., López-Moreno, J. I., Drumond, A., Gimeno, L., Nieto, R., Morán-Tejeda, E., Lorenzo-Lacruz, J., Beguería, S., & Zabalza, J. (2011). Effects of warming processes on droughts and water resources in the NW Iberian Peninsula (1930–2006). *Climate Research*, *48*(2/3), 203–212.
- Von Storch, H., Zorita, E., & Cubasch, U. (1993). Downscaling of global climate change estimates to regional scales: an application to Iberian rainfall in wintertime. *Journal of Climate*, *6*(6), 1161–1171.
- Vörösmarty, C. J., Green, P., Salisbury, J., & Lammers, R. B. (2000). Global water resources: Vulnerability from climate change and population growth. *Science*, *289*(5477), 284–288.
- Wang, B., Xiang, B., Li, J., Webster, P. J., Rajeevan, M. N., Liu, J., & Ha, K.-J. (2015). Rethinking Indian monsoon rainfall prediction in the context of recent global warming. *Nature Communications*, *6*(1), 7154.
- Wang, H., Pan, Y., & Chen, Y. (2017). Comparison of three drought indices and their evolutionary characteristics in the arid region of northwestern China. *Atmospheric Science Letters*, *18*(3), 132–139.

- Wang, Q., Wu, J., Lei, T., He, B., Wu, Z., Liu, M., Mo, X., Geng, G., Li, X., Zhou, H., & Liu, D. (2014). Temporal-spatial characteristics of severe drought events and their impact on agriculture on a global scale. *Quaternary International*, *349*, 10–21.
- Wang, W., Guo, B., Zhang, Y., Zhang, L., Ji, M., Xu, Y., Zhang, X., & Zhang, Y. (2021). The sensitivity of the SPEI to potential evapotranspiration and precipitation at multiple timescales on the Huang-Huai-Hai Plain, China. *Theoretical and Applied Climatology*, *143*(1), 87–99.
- Webster, P. J., Magaña, V. O., Palmer, T. N., Shukla, J., Tomas, R. A., Yanai, M., & Yasunari, T. (1998). Monsoons: Processes, predictability, and the prospects for prediction. *Journal of Geophysical Research: Oceans*, *103*(C7), 14451–14510.
- Wells, N., Goddard, S., & Hayes, M. J. (2004). A self-calibrating Palmer Drought Severity Index. *Journal of Climate*, *17*(12), 2335–2351.
- Whan, K., Alexander, L. V, Imielska, A., McGree, S., Jones, D., Ene, E., Finaulahi, S., Inape, K., Jacklick, L., Kumar, R., Laurent, V., Malala, H., Malsale, P., Pulehetoa-Mitiepo, R., Ngemaes, M., Peltier, A., Porteous, A., Seuseu, S., Skilling, E., ... Vaiimene, M. (2014). Trends and variability of temperature extremes in the tropical Western Pacific. *International Journal of Climatology*, *34*(8), 2585–2603.
- Wilby, R. L., Charles, S. P., Zorita, E., Timbal, B., Whetton, P., & Mearns, L. O. (2004). Guidelines for Use of Climate Scenarios Developed from Statistical Downscaling Methods. *Analysis*, *27*(August), 1–27.

- Wilby, R. L., & Dawson, C. W. (2007). SDSM 4.2— A decision support tool for the assessment of regional climate change impacts, User Manual. *Department of Geography, Lancaster University, UK, August*, 1–94.
- Wilby, R. L., Dawson, C. W., & Barrow, E. M. (2002). sdsim — a decision support tool for the assessment of regional climate change impacts. *Environmental Modelling & Software*, *17*(2), 145–157.
- Wilby, R. L., Wigley, T. M. L., Conway, D., Jones, P. D., Hewitson, B. C., Main, J., & Wilks, D. S. (1998). Statistical downscaling of general circulation model output: A comparison of methods. *Water Resources Research*, *34*(11), 2995–3008.
- Wilhite, D. A. (1997). State actions to mitigate drought: Lessons learned. *Journal of the American Water Resources Association*, *33*(5), 961–968.
- Wilhite, D. A. (2000). Drought As a Natural Hazard. *Droughts*, 33–33.
- Wilhite, D. A., & Glantz, M. H. (1985). Understanding: the Drought Phenomenon: The Role of Definitions. *Water International*, *10*(3), 111–120.
- Wilhite, D. A., & Glantz, M. H. (2019). Understanding the drought phenomenon: The role of definitions. *Planning for Drought: Toward A Reduction of Societal Vulnerability*, 11–27.
- Wilhite, D., & Vanyarkho, O. (2000). Chapter 18 Drought: Pervasive Impacts of a Creeping Phenomenon. *Drought Mitigation Center Faculty Publications*, 71.
- Wu, R., Zhang, J., Bao, Y., & Guo, E. (2019). Run theory and copula-based drought risk analysis for songnen grassland in Northeastern China. *Sustainability (Switzerland)*, *11*(21).

- Yevjevich, V. (1967). An objective approach to definitions and investigations of continental hydrologic droughts. *Journal of Hydrology*, 7(3), 353.
- Zargar, A., Sadiq, R., Naser, B., & Khan, F. I. (2011). A review of drought indices. *Environmental Reviews*, 19(1), 333–349.
- Zaifoğlu, H., Akıntuğ, B., & Yanmaz, A.M. (2017). Quality Control, Homogeneity Analysis, and Trends of Extreme Precipitation Indices in Northern Cyprus. *Journal of Hydrologic Engineering*, 22(12), 5017024.
- Zekai, S. (1980). Statistical Analysis of Hydrologic Critical Droughts. *Journal of the Hydraulics Division*, 106(1), 99–115.
- Zhang, X., Obringer, R., Wei, C., Chen, N., & Niyogi, D. (2017). Droughts in India from 1981 to 2013 and Implications to Wheat Production. *Scientific Reports*, 7(March), 1–12.
- Zhao, H., Gao, G., An, W., Zou, X., Li, H., & Hou, M. (2017). Timescale differences between SC-PDSI and SPEI for drought monitoring in China. *Physics and Chemistry of the Earth, Parts a/b/c*, 102, 48-58.
- Zhao, Y., Weng, Z., Chen, H., & Yang, J. (2020). Analysis of the evolution of drought, flood, and drought-flood abrupt alternation events under climate change using the daily SWAP index. *Water*, 12(7), 1969.

List of Publication

- Gupta, N., **Gond, S.**, & Gupta, S. K. (2022). Spatiotemporal trend characteristics of rainfall and drought jeopardy over Bundelkhand Region, India. *Arabian Journal of Geosciences*, 15(12), 1155. <https://doi.org/10.1007/s12517-022-10389-8>
- **Gond, S.**, Gupta, N., Patel, J., & Dikshit, P. K. S. (2023). Spatiotemporal evaluation of drought characteristics based on standard drought indices at various timescales over Uttar Pradesh, India. *Environmental Monitoring and Assessment*, 195(3), 439. <https://doi.org/10.1007/s10661-023-10988-2>
- **Gond, S.**, Gupta, N., Dikshit, P.K.S., & Dwivedi, S. B. (2022). Pattern Characterization of Meteorological Drought using Multivariate Drought Index over Mirzapur in Middle Gangetic Plains of India. *Nat. Environ. Pol. Tech.* 22(1). <https://doi.org/10.46488/NEPT.2023.v22i01.002>
- **Gond, S.**, Gupta, N., Dikshit, P. K. S., & Patel, J. (2023). Assessment of Drought Variability using SPEI under observed and Projected Climate Scenario over Uttar Pradesh, India' *Physics and Chemistry of the Earth, Parts A/B/C* (under review).
- Regional assessment of spatiotemporal dry-wet event characteristics and their transition over northern India from 1971 to 2018 (Under Preparation)