Using the Budyko framework to evaluate the human imprint on long-term surface water partitioning across India

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Abstract

The Budyko curve, relating a catchment's water and energy balance, provides a useful tool to analyse how humans may impact long-term runoff. Often a parametric form of the curve, the Fu's equation, is used to represent the relationship between a catchment's long-term water partitioning behaviour and climate. Fu's parameter ω, typically derived from observed climate and runoff data, can further be related to catchments' physio-climatic characteristics for understanding the main drivers of its water balance. We employ this approach to quantify the impact of human interventions on surface water partitioning across India. We explore the relationship between ω and a curated database of 33 physio-climatic and socio-economic characteristics for 534 regional divisions of India using two related machine learning algorithms: classification and regression trees (CART) and random forest (RF). Both algorithms diagnose the hierarchy of representative vegetation, climate, soil, land use land cover, topography and anthropogenic controls. RF validates CART output while also providing a data-driven model to estimate ω in assumed data-scarce regions, enabling us to assess the value of this dataset for predictions in ungauged basins. The most relevant characteristics controlling ω based on CART and RF analysis were: long-term temperature, percentage of short rooted vegetation, population density, and long-term precipitation. RFs were able to correctly predict the classified ω for 63.9 % of assumed ungauged regions. We found that population density's influence on ω was comparable to that of climate and vegetation, highlighting the role of humans in controlling long-term surface water partitioning variability across India.

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Running Head: HUMAN INFLUENCES WATER PARTITIONING BUDYKO INDIA

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Keywords : Budyko; India; Fu's parameter; CART; random forest; human impact

Short Informative :

- Use machine learning algorithms to identify dominant factors governing Fu's parameter across landmasses of India
- Account for possible compensatory effects of factors and identify hierarchy of controls
- Show a considerable influence of population density on Fu's parameter
- Show regional variations in dominating factors with water availability dominating in regions with greater short rooted vegetation

Acknowledgement: The data sets used in the study are freely available for academic research in the public domain. The calibrated omega values and associated characteristics values for each regional division

along with the codes are provided at:*https://riddhisingh.weebly.com/codeanddata.html* . We acknowledge and thank Sai Veena and Ankit Deshmukh for their assistance with data extraction and assimilation.

Data Availability Statement: The calibrated omega values and associated characteristics values for each regional division along with the codes are provided at:*https://riddhisingh.weebly.com/codeanddata.html* . The data used to estimate various physio-climatic and socio-economic characteristics were derived from the following resources available in the public domain:

1. Temperature and precipitation daily data, India Meteorological Department: http://imdpune.gov.in/Clim_Pred_LRF_New/Grided_Data_Download.html#
2. NDVI, Global Inventory Monitoring and Modelling System's (GIMMS): https://ecocast.arc.nasa.gov/data/pub/gimms/3g.v0/
3. Settlements, Anthropogenic Biomes of the World, Version 2: 2000: https://doi.org/10.7927/H4D798B9
4. PESWC, Global plant extractable soil water capacity maps: https://doi.org/10.3334/ORNLDAAC/545
5. Topographical data (Aspect, Elevation, Slope, and SlopeTan): https://earthexplorer.usgs.gov/
6. Saturated hydraulic conductivity, GLobal HYdrogeology MaPS (GLHYMPS): https://doi.org/10.5683/SP2/DLGXYO
7. Soil composition data, SoilGrids1km: https://soilgrids.org/
8. Land cover data, Global Land Cover (GLC2000) maps for South Asia: https://forobs.jrc.ec.europa.eu/products/glc2000/products.php
9. Data on existing dams, Global Reservoir and Dam Database (v1.01): https://doi.org/10.7927/H4N877QK
10. Population data, Census India, 2011: https://censusindia.gov.in/2011census/population_enumeration.html

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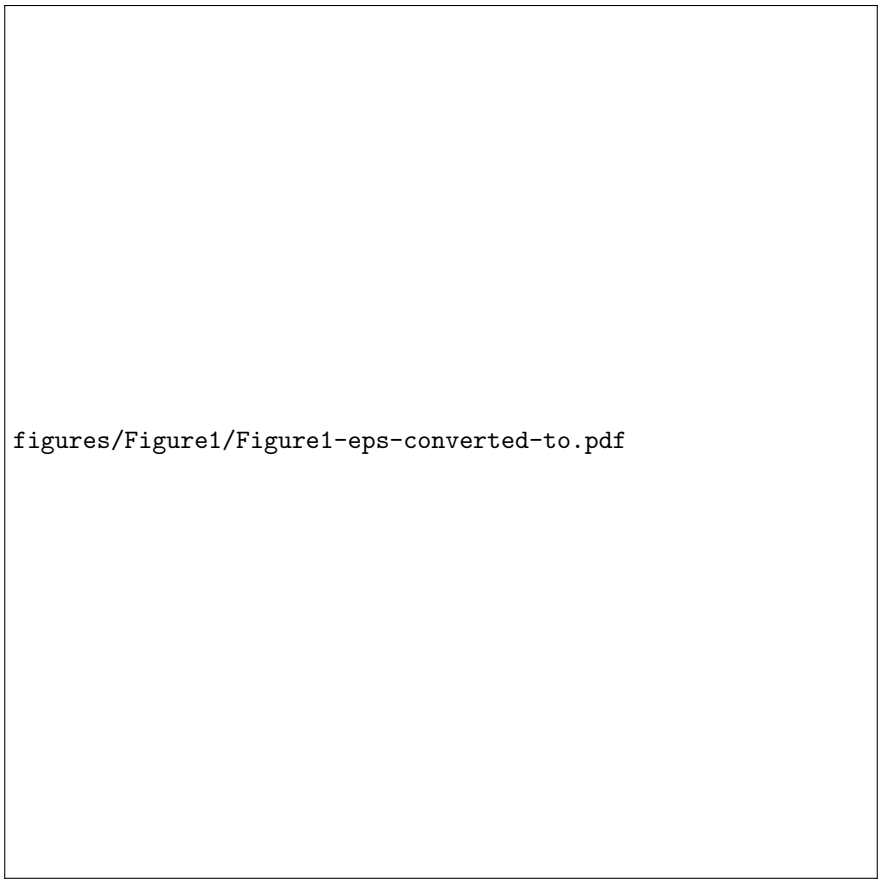

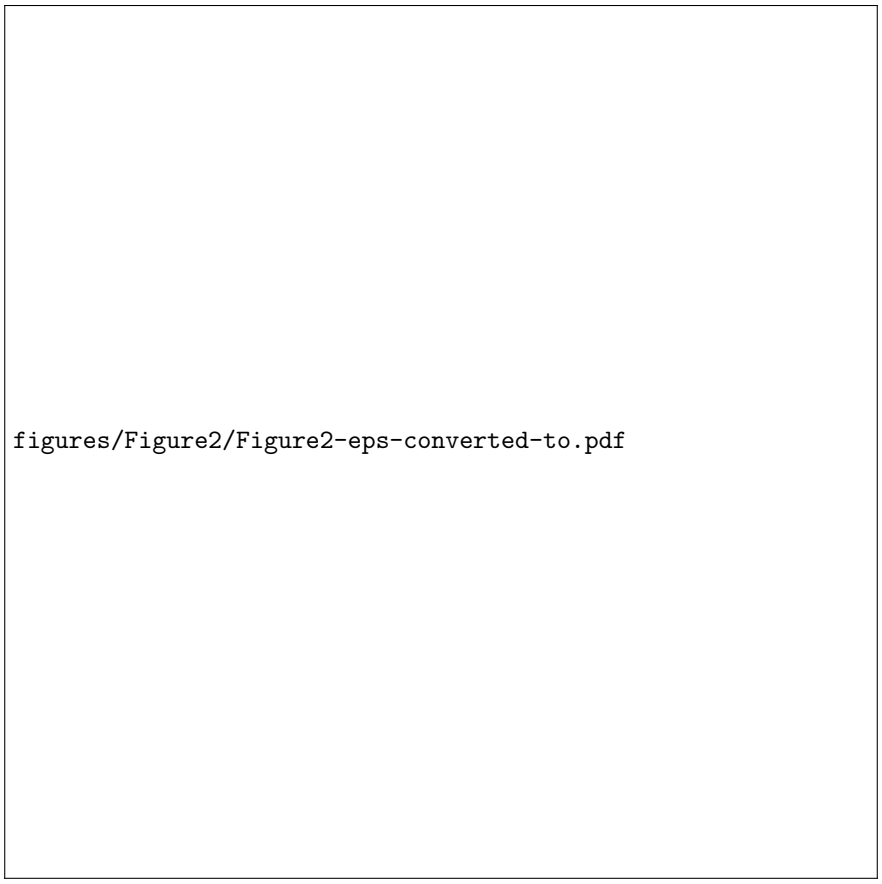

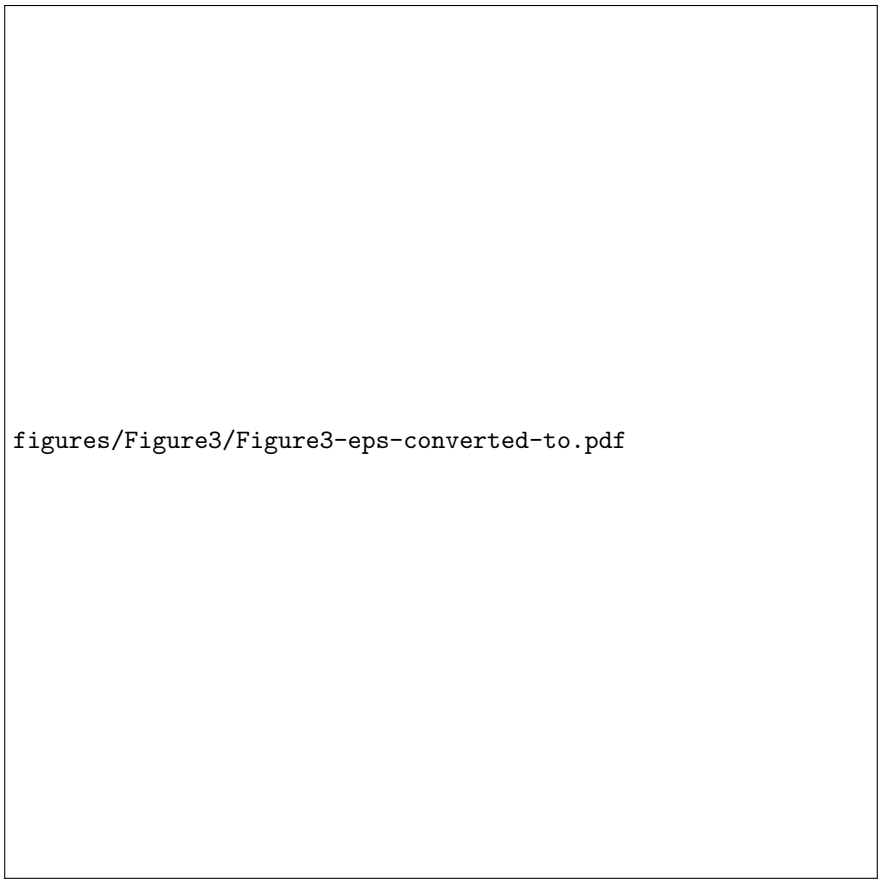

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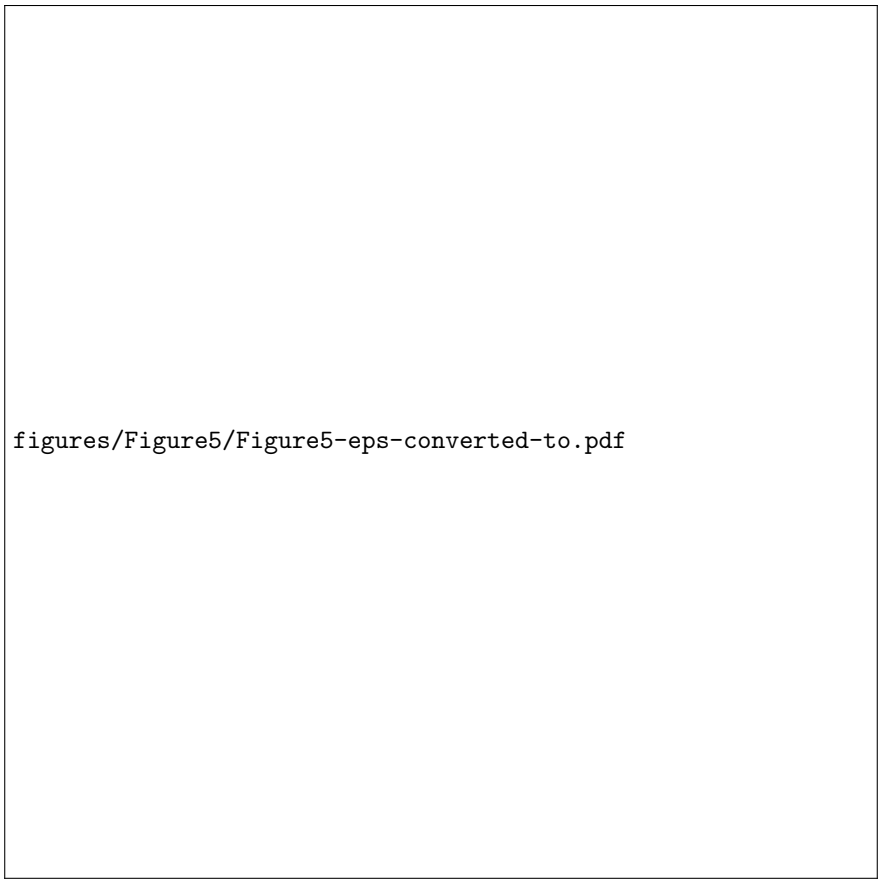

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