Green Water Scarcity Index Mapping for India Using Geospatial Data Products

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Introduction

- Green water assessment is evolving as a significant aspect of hydrological science since its existence is critical for crop production in rain-fed areas.
- The green water scarcity index (GWSI), is based on evapotranspiration and effective rainfall.
- The GWSI can assist researchers in understanding the water requirements of agriculture and the current water stress condition.
- The GWSI is handy for deciding the spatial location for rain-fed crop cultivated areas.

Objectives

To generate a GWSI map of India from 2017 to 2019 at monthly and yearly scales.

Materials and Methodology

This study employed Indian Meteorological Department (IMD) gridded rainfall and TerraClimate-based actual evapotranspiration data products.

The Green Water Scarcity Index (GWSI) of Hoekstra measured as the ratio of green water consumption (GW) and effective rainfall (ER). It is calculated using following equations.

$$\text{GWSI} = \frac{GW}{\text{ER}} \quad (1)$$

$$\text{GW} = \text{ET}_{\text{green}} = \min(\text{AET}, \text{ER}) \quad (2)$$

$$ER = \frac{(P \times (125 - 0.2 \times \mathbf{3} \times P))}{125} \; for\; P \leq \frac{250}{\mathbf{3}}\; mm \quad (3)$$

$$ER = 125/\mathbf{3} + 0.1 \times P \quad for\; P > \frac{250}{\mathbf{3}}\; mm \quad (4)$$

Where, P= Rainfall in mm, AET = Actual Evapotranspiration in mm.

Results

- The results showed that India experienced low GWSI throughout the monsoon season, as was to be expected, but interestingly, there were no high GWSI values (> 0.9) during the summer months, as seen in the winter.
- India experienced average GWSI values of 0.87, 0.86, and 0.83 in 2017, 2018, and 2019, respectively.
- In comparison to other years, 2019 has a lower GWSI, and rest years have similar GWSI values in the July and December months.
- In contrast to how almost all months in all years have similar GWSI values, the substantial discrepancy is only seen in September 2019.
- Due to the high frequency of rainfall events in September 2019, the ER rate has increased, which has led to a decrease in the GWSI in India's month of September 2019.

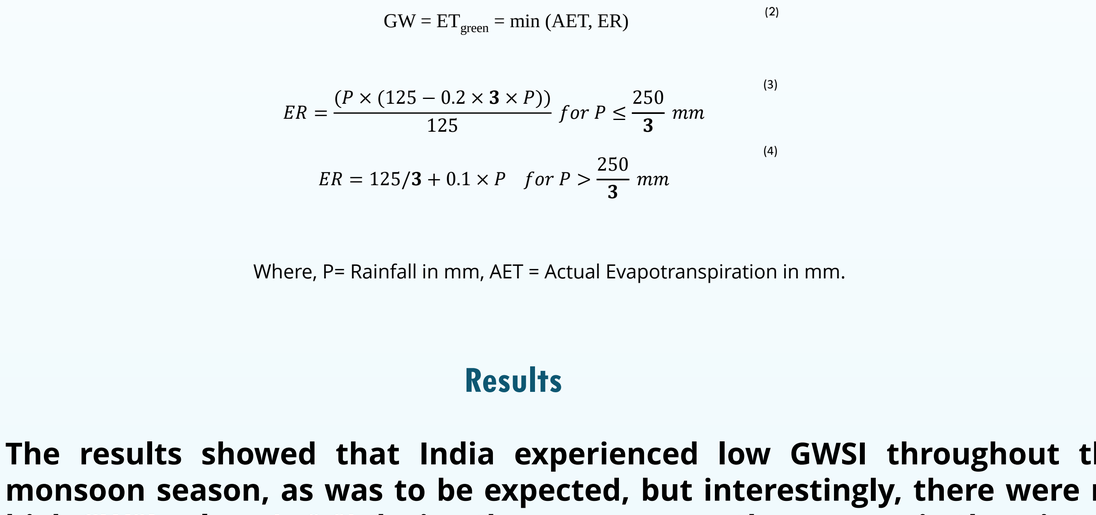

Fig 1: Effective Rainfall mapping for India during 2017-2019

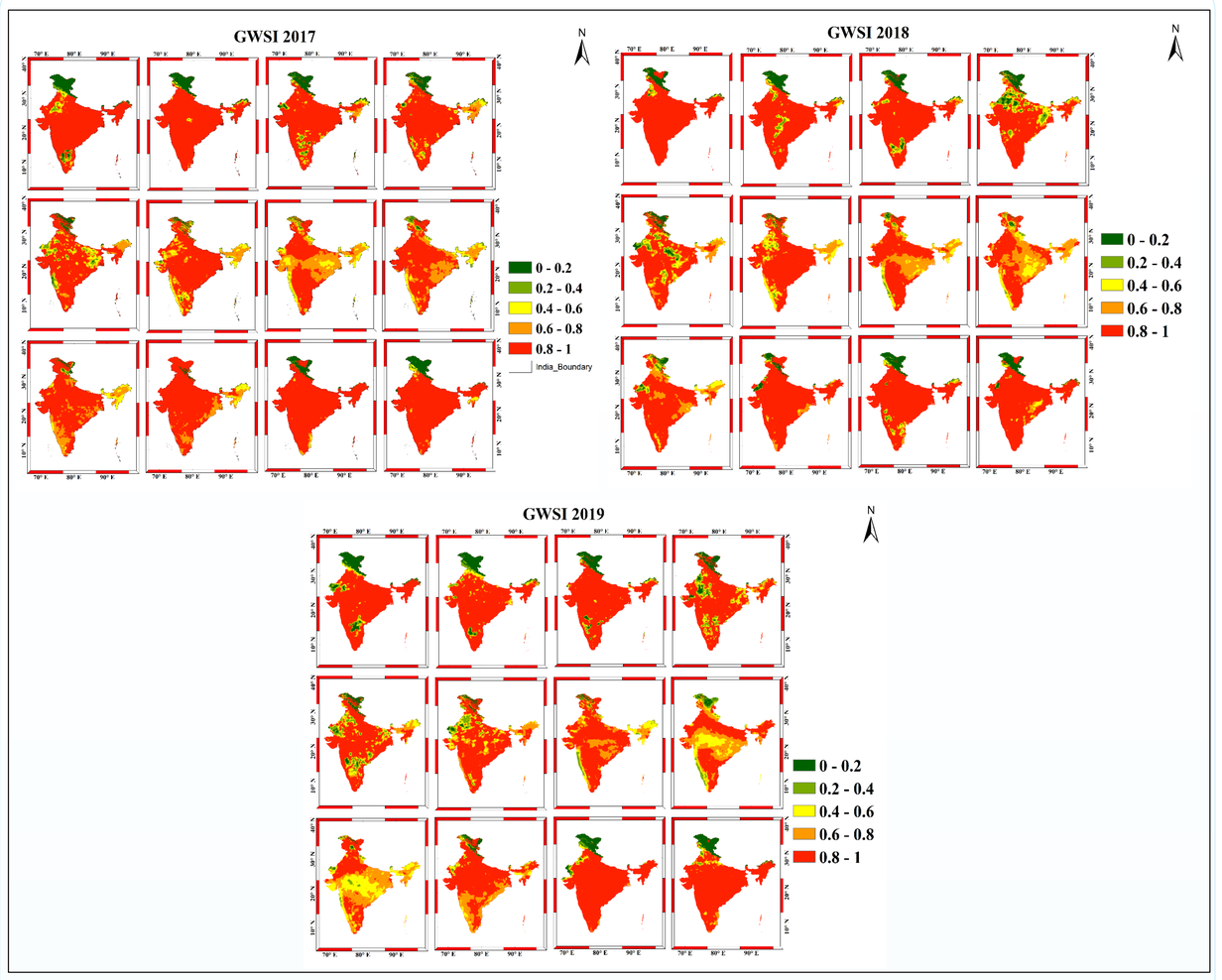

Fig 2: Spatial variation GWSI mapping for India during 2017-2019 (Monthly Scale)

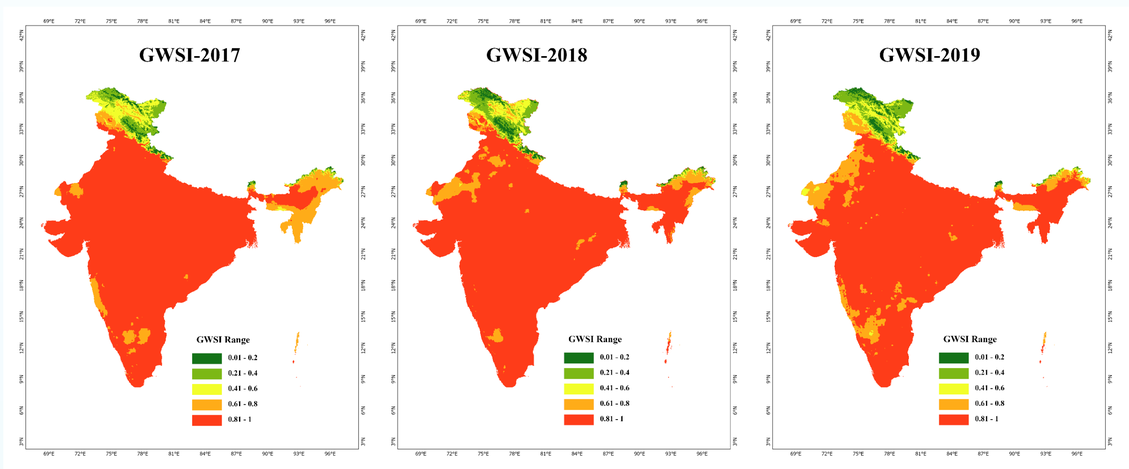

Fig 3: GWSI mapping for India during 2017-2019 (Annual Scale)

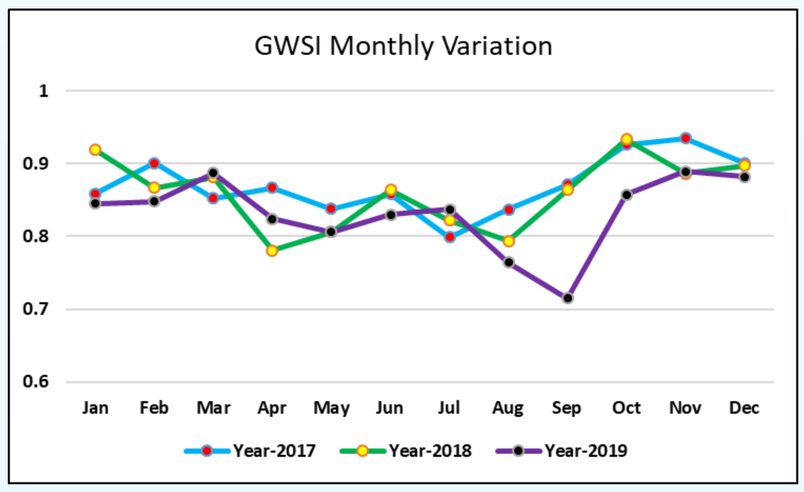

Fig 4: Temporal variation GWSI mapping for India during 2017-2019 (Monthly Scale)

Conclusions

- According to the findings of this study, the monsoon has less of an impact on GWSI.
- India experiences green water scarcity all year round, necessitating extensive irrigation for agriculture.
- The lack of green water resources enabled the transition away from rainfed agriculture cultivation.
- This research will aid in determining the precise condition of water stress in the targeted region, as well as the zoning of water-scarce regions, so that future irrigation planning can be done appropriately.

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