Title: Health Assessment of Agriculture-Dominated Watersheds in Data-Scarce Regions

Abstract:

Watershed health assessment is essential for getting a clear understanding of the present condition of watershed systems, which enables the effective allocation of resources and prioritization of management actions in a river basin. This study used an innovative framework for evaluating watershed health in data-scarce regions by considering the complex interrelations among geophysical, environmental, climatic, and anthropogenic factors. The framework brings together the Analytical Network Process (ANP) and Fuzzy Logic, addressing the challenges of managing interdependent variables.

The methodology is applied to 32 sub-watersheds of the Budhabalanga River Basin, located along the east coast of India. The ANP is used to analyse the intricate interplay among climate variables, topographic factors, non-point pollution sources, and human activities. Further, the Fuzzy Logic is employed to classify sub-watersheds based on their health status. Results show variations in watershed health, with upstream sub-watersheds being healthier compared to those in the middle and downstream regions of the river basin.

The proposed Fuzzy-ANP framework proved to be an effective tool for assessing watershed health in data-scarce regions. It provides a practical approach to sustainable resource management and can be easily adapted to other river basins. Thus, providing valuable insights for enhancing watershed resilience and supporting better decision-making.

Keywords: Watershed Health, Analytical Network Process (ANP), Fuzzy Logic

- It is located between 21°18′27″ N and 22°21′22″ N latitude, 86°17′14″ E and 87°05′3″E longitude.
- The main tributaries of the river are **Katara, Sono and Kalo** and all of them originate from Shimilipal hill range.
- Area: about 4693 km^2
- Elevation range: 0 to 1169 m above MSL
- Average annual rainfall of the study area is about 1451mm.
- Paddy is the major crop
- Green gram, black gram, mustard, groundnut and vegetables are also grown.

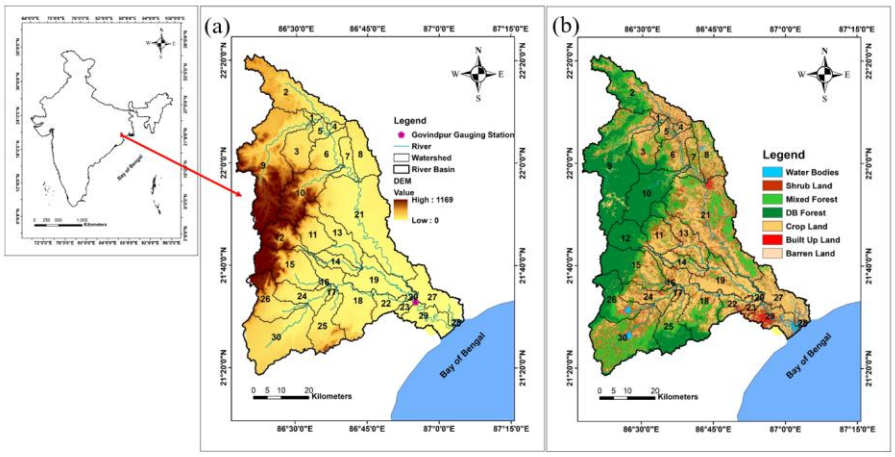


Figure 1. (a) Map of the study area, (b) LULC Map of the study area for the year 2020.

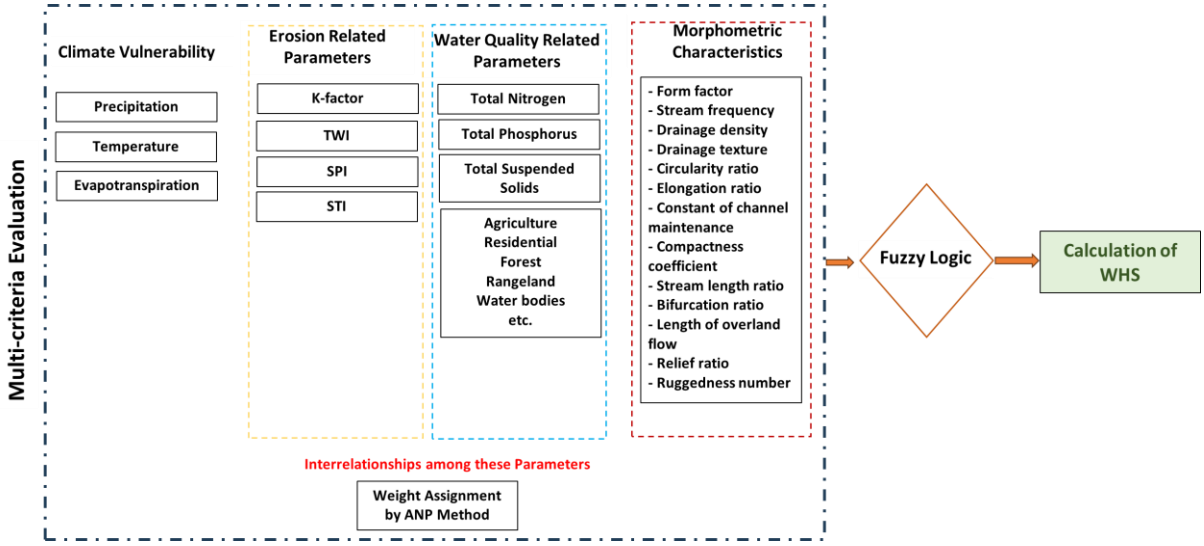


Figure 2. Methodology of the study.

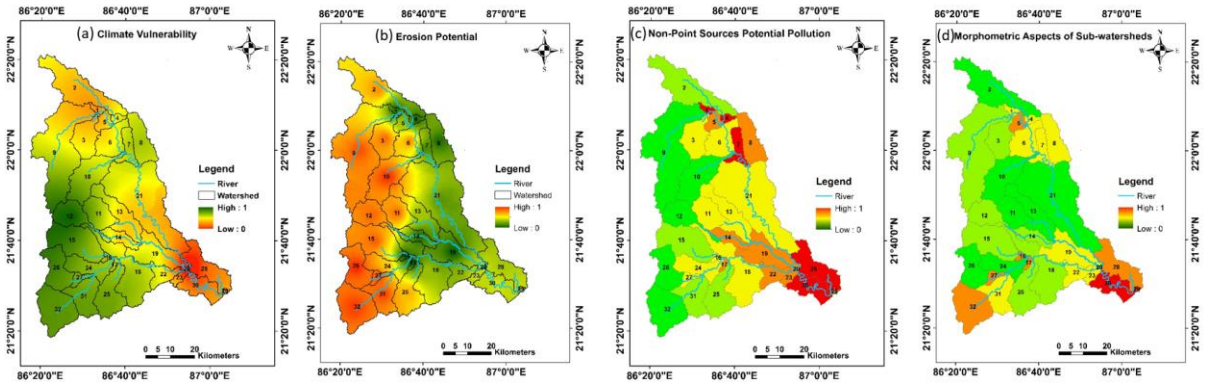
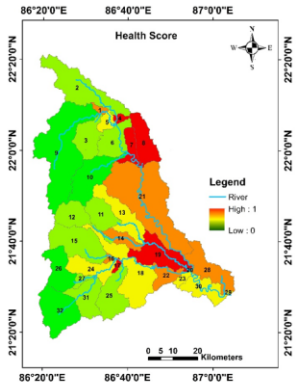
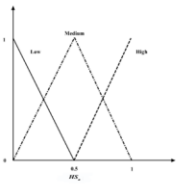


Figure 3. Distribution of vulnerability across sub-watersheds based on four criteria (a) Climate Vulnerability, (b) Erosion potential, (c) Non-point Sources Potential Pollution, and (d) Morphometric Aspects of Sub-watersheds.

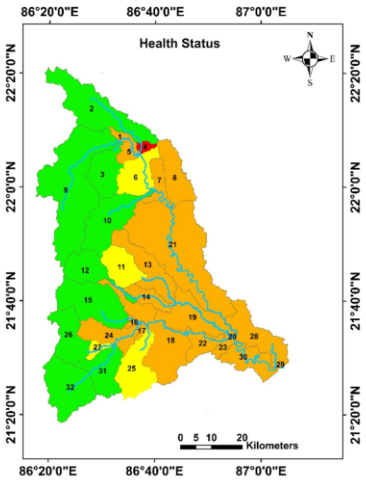


Weights of Criteria using the ANP Method

Criteria	Weight
Climate Vulnerability	0.23
Erosion	0.34
Morphometric Characteristics	0.12
Water Quality	0.31



Fuzzy membership functions



Very Poor | Poor | Average | Good | Very Good

Figure 4. Health status of sub-watershed of the Budhabalanga River Basin.