ISSN 2278-8808 SJIF 2015: 5.403
An International Peer Reviewed & Referred
SCHOLARLY RESEARCH JOURNAL
FOR INTERDISCIPLINARY STUDIES

GEOSPATIAL ANALYSIS OF WATER EROSION AT DISTRICT LEVEL IN INDIA

Neerja Asthana

Associate Professor, Department of Military Studies, Bareilly College, Bareilly. India.

Abstract

The general objective of this paper was to study the hot spots of water erosion problem at district level in India. Water erosion data was collected from NRSC/ISRO Open data and product archive facilitates. This layer consists of fraction of water erosion within a grid cell of 5000meters x 5000meters. The product was derived from Land degradation map on 1:50,000 scale generated using multi-temporal LISS III data aboard Resourcesat-1 / 2 of 2005-6. The data is provided as long integer format. To convert the data to fraction area of grid cell, the number has to be divided with 10000. Information on district boundaries was collected from official website of Indian Geo Platform of IISRO, National Remote Sensing Center, Government of India. The spatial variation in water erosion was analysed with the help of hot spot analysis tool of the ArcGIS platform. The hot spots of high water erosion problem were found as 187, 20 & 07 respectively at the confidence level of 99%, 95% & 90%. The findings of the work will help the policy makers to develop the programmes to minimise the problem of the water erosion in the problem prone districts.

Keywords: *Water erosion, Geostatistical analysis, Hot Spot Analysis.*

1. Introduction

Land degradation is a great threat for the future and it requires great effort and resources to ameliorate (Taddese, 2001). Land degradation cannot be judged independently of its spatial, temporal, economic, environmental and cultural context. Evaluations are therefore almost infinitely variable and very dynamic (Warren, 2002). Land degradation is always with us but its causes, extent and severity are contested. We define land degradation as a long-term decline in ecosystem function and productivity, which may be assessed using long-term, remotely sensed normalized difference vegetation (Bai et.al, 2002). Land degradation will remain an important global issue for the 21st century because of its adverse impact on

agronomic productivity, the environment, and its effect on food security and the quality of life (Eswaran et.al, 2008).

Land degradation is occurring in almost all terrestrial biomes and agro-ecologies, in both low and high income countries. However its impact is especially severe on the livelihoods of the poor who heavily depend on natural resources. Despite the severe impact of land degradation on the poor and the crucial role that land plays in human welfare and development, investments in sustainable land management (SLM) are low, especially in developing countries (Mythili & Goedecke 2016).

In several regions of India, especially the arid and semi-arid regions, environmental degradation is nearing irreversible levels even as replacement costs continue to rise. Land degradation occurs mainly in the form of water-induced soil erosion, though agrochemical and wind erosion have also made an impact (Reddy et.al, 2003).

Soil erosion by water has a debilitating effect on crop productivity. Though limited and scattered data is available on loss of production due to water erosion in India, no systematic effort has been made to compute the losses in crop production based upon experimental data, major soil groups, and prevailing erosion rates (Sharda, Dogra, & Prakash, 2010).

In this work trend analysis was performed using Excel, hot spot and spatial relationship was analysed using ArcGIS.

It was significant to study because, the same topic has not been studied widely by geospatial experts using space time cube analysis. The findings of the work will help the policy makers to develop the programmes to minimise the water erosion problem.

2. Materials and methods

2.1 Study Area

India is one of the oldest civilizations in the world with a kaleidoscopic variety and rich cultural heritage. It has achieved all-round socio-economic progress since its Independence. It covers an area of 32,87,263 sq. km (1,269,346 sq mi), extending from the snow-covered Himalayan heights to the tropical rain forests of the south. As the 7th largest country in the world, India stands apart from the rest of Asia, marked off as it is by mountains and the sea, which give the country a distinct geographical entity. Bounded by the Great Himalayas in the north, it stretches southwards and at the Tropic of Cancer, tapers off into the Indian Ocean between the Bay of Bengal on the east and the Arabian Sea on the west.

Lying entirely in the northern hemisphere, the mainland extends between latitudes 8° 4' and 37° 6' north, longitudes 68° 7' and 97° 25' east and measures about 3,214 km from north to south between the extreme latitudes and about 2,933 km from east to west between the extreme longitudes. It has a land frontier of about 15,200 km. The total length of the coastline of the mainland, Lakshadweep Islands and Andaman & Nicobar Islands is 7,516.6 km ("Profile | National Portal of India," 2011).

2.2 Data used

2.2.1 District Boundaries

Information on district boundaries was collected from official website of Indian Geo Plateform of IISRO, National Remote Sensing Center, Government of India (https://bhuvan.nrsc.gov.in/bhuvan_links.php#) ("ISRO," 2016).

2.2.2 Water Erosion Data

Satellite data

Three seasons' Ortho-rectified Resourcesat-2 LISS III satellite data viz. Kharif, Rabi & Zaid for the years 2005-2006 were used as base data for visual analysis. Approximately 300 LISS-III scenes were used for each season mentioned above. The initial mapping was carried out with Lambert Conical Conformal (LCC) projection. The final outputs were later converted Albers equal area with parameters. Projection: Albers Conical Equal Area projection Spheroid: WGS84 Datum: WGS84 Standard Parallel 1: 28:00:00 N Standard Parallel 2: 12:00:00 N Central Meridian: 78:00:00 E Origin of Latitude: 20:00:00 N. (NRSC, 2007).

Legacy/ancillary data

For mapping land degradation on 1 : 50,000 scale, available land use/land cover, wetland and wastelands thematic information from similar scale was used. Besides, forest cover map generated by FSI were also referred to. The 1:250000 scale salt-affected map generated under national mission was also used as reference information while mapping. Apart from this district boundaries from India WRIS and Survey of India topographical maps, meteorological data, soil maps and DEM information were used as inputs Universal Soil Loss Equation to assess the soil loss especially while mapping water erosion categories. The process-wise land degradation maps at their original scale were collected as thematic service from Bhuvan at following URL.

http://bhuvan.nrsc.gov.in/gis/thematic/index.php

2.2.3 Work Flow Chart

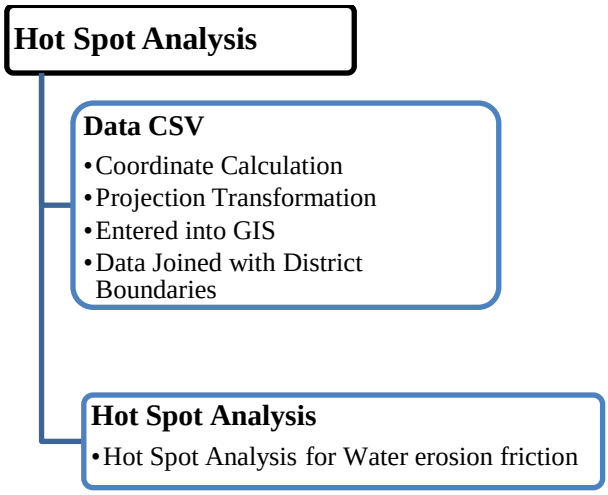

Fig. 2 the flowchart of the used methodology in the study area

2.3 Data Analysis

2.3.1 Hotspot analysis

Getis-Ord Gi* statistic was used to identify hot spots.

The Getis-Ord local statistics is given as follows:

$$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j}x_j - \bar{X}\sum_{j=1}^{n} w_{i,j}}{S\sqrt{\frac{\left[n\sum_{j=1}^{n} w_{ij}^2 - \left(\sum_{j=1}^{n} w_{i,j}\right)^2\right]}{n-1}}} \qquad (1)$$

Where x_j is the attribute value for feature j. w_{ij} is the spatial weight between feature i and j. n is equal to the total number of features and:

$$\bar{X} = \frac{\sum_{j=1}^{n} x_j}{n} \qquad (2)$$

$$z_I = \sqrt{\frac{\sum_{j=1}^{n} x_j^2}{n}} - (\bar{X})^2 \qquad (3)$$

Getis-Ord statistic is a z-score so no further calculations are required.

3. Results

3.1. Hot Spot area of water erosion in India

Table 1 shows the number of District under Hot/Cold Spots of the water erosion.

Table 1 Number of District Hot/Cold Spots of the water erosion

Hot/Cold Spots	Number of District
Cold Spot - 99% Confidence	241
Cold Spot - 99% Confidence	21
Cold Spot - 99% Confidence	10
Not Significant	100
Hot Spot - 90% Confidence	7
Hot Spot - 90% Confidence	20
Hot Spot - 90% Confidence	187

Figure 3 shows the map of districts under Hot/Cold Spots of the water erosion.

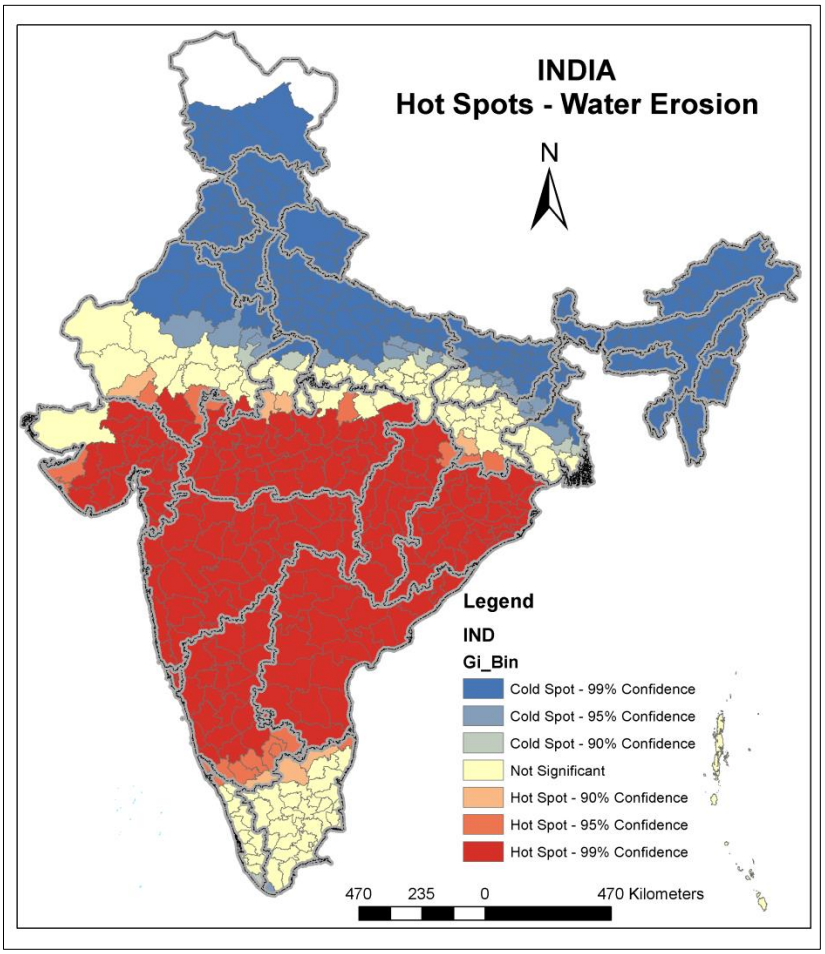

Fig. 1 Water Erosion

4. Discussion

The major findings of this study are first there is more water erosion problem in the states of Maharashtra, Andhra Pradesh, Karnataka, Chhattisgarh and Madhya Pradesh. Secondly the states lying in the Indo-Gangetic plain area have no much significant water erosion problem because land surface is relatively flat.

The major research question answered in the present work was to find the spatial and temporal variability in term of water erosion at district level. The research explored the potential use of hot spot analysis provided by ArcGIS platform for geospatial analysis. The findings will be helpful for all stockholders working to minimise the water erosion problem.

Acknowledgement

We thank the government of India initiative to provide up to date information on the web portal #.

Conflict of interest

The authors declare no competing financial interests.

References

Reddy, V. R. (2003). Land degradation in India: Extent, costs and determinants. Economic and Political Weekly, 4700-4713.

Bai, Z. G., Dent, D. L., Olsson, L., & Schaepman, M. E. (2008). Proxy global assessment of land degradation. Soil use and management, 24(3), 223-234.

Eswaran, H., Lal, R., & Reich, P. F. (2016). Land degradation: an overview. Response to land degradation, 20-35.

ISRO. (2016). Retrieved June 9, 2021, from Nrsc.gov.in website: https://bhuvan.nrsc.gov.in/bhuvan_links.php#

Mythili, G., & Goedecke, J. (2016). Economics of land degradation in India. In Economics of land degradation and improvement–a global assessment for sustainable development (pp. 431-469). Springer, Cham.

NRSC (2007). Nationwide mapping of Land degradation using multi-temporal satellite data. Project Manual. Soil and Land Resources Assessment Division, Earth Resources Group, RS &GIS application area, Department of Space, Govt. of India, Balanagar, Hyderabad, India.

Profile | National Portal of India. (2011). Retrieved September 15, 2021, from India.gov.in website: https://www.india.gov.in/india-glance/profile

Sharda, V. N., Dogra, P., & Prakash, C. (2010). Assessment of production losses due to water erosion in rainfed areas of India. Journal of Soil and Water Conservation, 65(2), 79–91. https://doi.org/10.2489/jswc.65.2.79

Taddese, G. (2001). Land degradation: a challenge to Ethiopia. Environmental management, 27(6), 815-824.

Warren, A. (2002). Land degradation is contextual. Land Degradation & Development, 13(6), 449-459.