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Spatio-Temporal Analysis of Flood Disaster Impacts on Agriculture in Western Maharashtra Rivers

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Abstract:

*Recent climate variability and extreme hydrometeorological events have significantly increased the frequency and severity of floods across India, posing serious challenges to environmental sustainability and disaster management. Flooding remains one of the most damaging natural hazards, adversely affecting human life, infrastructure, agriculture, and regional economies. The present study aims to develop an **integrated flood rescue, relief, and management framework** using geospatial technologies, with Satara District of Maharashtra selected as the study area.*

*A long-term flood disaster management approach has been adopted through the integration of **Remote Sensing (RS), Geographic Information System (GIS), and Global Positioning System (GPS)** techniques. Multi-temporal satellite data and spatial datasets were processed and analyzed to evaluate flood hazard intensity, land use–land cover changes, topographic variation, hydrological imbalance, and spatial patterns of vulnerability. GIS-based spatial modeling was employed to identify flood-prone zones and assess their impact on natural and built environments.*

The results demonstrate that geospatial technology–based analysis provides an effective and reliable decision-support system for flood rescue, relief, and mitigation planning. The developed integrated flood management plan supports sustainable land-use planning and enhances preparedness, response, and risk reduction strategies. This study highlights the potential of RS and GIS as essential tools for informed flood disaster management and regional planning in flood-prone areas.

Keywords: Remote Sensing; Geographic Information System; Global Positioning System; Integrated Flood Management; Flood Hazard Analysis; Disaster Risk Reduction; Satellite Data.

Introduction:

The western part of Maharashtra has experienced significant flood impacts in several villages located within the Krishna and Koyna river basins. This study focuses on soil analysis in flood affected regions using scientifically structured, real-time data collection techniques. Various soil analysis methods were employed and the collected data were processed and systematically arranged using different geoinformatics software and methodological approaches.

From a geographical perspective, the study proposes predictive measures to assess and mitigate flood induced soil degradation. Remote Sensing (RS), Geographic Information Systems (GIS), and Global Positioning System (GPS) technologies were integrated to analyze soil conditions in floodwater affected areas. GPS technology provided highly accurate spatial locations of the study sites, enabling precise cartographic representation and spatial analysis.

The research emphasizes the identification of vulnerable locations, measurement of soil parameters and assessment of soil degradation patterns resulting from flooding. The integration of RS, GIS, and GPS environments offers an effective framework for monitoring flood impacts and supports sustainable land and soil management strategies in river basin regions.

Study Area:

South Maharashtra has been selected for the present study to analyze the dynamics of flood-induced changes in soil types. The study area represents a distinct geographical region with unique physical and environmental characteristics. It primarily encompasses the southern part of Maharashtra state. The Krishna and Koyna river basins extend between latitudes **15°44′ N and 18°35′ N** and longitudes **73°33′ E and 76°25′ E**. The total geographical area covered under the study is approximately **42,264 square kilometers**. This region is frequently affected by seasonal flooding, making it suitable for assessing soil dynamics and flood-related soil degradation using geospatial techniques.

Objectives:

The main objective of the present study is to develop a sustainable and comprehensive assessment of flood-affected regions in the Krishna and Koyna river basins using a GIS-based approach. The specific objectives of the study are as follows:

1. To identify villages affected by soil degradation within the Krishna and Koyna river basins.
2. To analyze flood-affected regions using integrated Remote Sensing (RS), Geographic Information Systems (GIS) and Global Positioning System (GPS) techniques.
3. To suggest suitable preventive and management measures for minimizing soil degradation in the flood-prone areas.

Method And Analysis:

The present study adopts an integrated methodological framework combining Remote Sensing (RS), Geographic Information Systems (GIS) and Global Positioning System (GPS) techniques to assess flood impacts and soil degradation in the Krishna and Koyna river basins of South Maharashtra.

1. Data Collection:

Both primary and secondary data were used in the study.

- **Remote Sensing Data:** Multi-temporal satellite imagery (pre-flood and post-flood periods of 2018 and 2019) was obtained to analyze flood extent, land-use/land-cover changes, and soil condition variations.
- **Secondary Data:** Topographic maps, soil maps, rainfall data, river discharge records, and census data were collected from government and authorized agencies.
- **Primary Data:** Field surveys were conducted in flood-affected villages, and soil samples were collected from selected sites. GPS was used to record precise geographical coordinates of sampling locations.

2. Data Processing and GIS Analysis:

Satellite images were geometrically corrected, georeferenced and processed using standard GIS and image processing software. The following analyses were carried out:

- Delineation of flood affected areas using spectral indices and change detection techniques.

- Preparation of thematic layers such as soil type, land use/land cover, drainage, slope and flood inundation maps.
- Overlay analysis was performed to identify villages and agricultural areas vulnerable to soil degradation.

3. Soil Degradation Analysis:

Soil samples collected from flood affected regions were analysed for key physical and chemical parameters such as texture, pH, electrical conductivity, organic matter and nutrient status. Comparative analysis between pre-flood and post-flood conditions was carried out to assess the extent of soil degradation.

4. Flood Impact Assessment:

Flood impact assessment was conducted by integrating flood inundation maps with socio economic data in the GIS environment. The analysis focused on impacts on agriculture, settlements, infrastructure, and natural resources. Vulnerability zones were classified into low, moderate, and high-risk categories.

5. Interpretation and Validation:

The results obtained from RS–GIS analysis were validated through field observations and GPS based ground truthing. The interpreted results were used to understand spatial patterns of flood-induced soil degradation and to propose suitable mitigation and management measures.

6. Land Use–Land Cover Outline:

Land use and land cover (LULC) patterns play a significant role in influencing flood occurrence and surface runoff characteristics. In the western part of the Krishna and Koyna river basins, improper land-use management has considerably affected surface runoff and flood behavior.

In western Satara district, the Krishna and Koyna rivers are the principal drainage systems. This region was traditionally dominated by evergreen forest cover, particularly in the Western Ghats zone. However, large tracts of forest land have been cleared to expand agricultural activities.

The area supports intensive agriculture with crops such as sugarcane, rice, wheat, maize, gram, tur, onion, groundnut, soybean, and jowar. In addition, extensive horticultural and orchard plantations are found in the central and western parts of the district, including mango, strawberry, banana, and grape cultivation.

The conversion of forest land into agricultural and plantation areas has altered the natural land cover, leading to increased soil erosion and reduced infiltration capacity. These changes have enhanced surface runoff during heavy rainfall events, thereby contributing to flood situations in the study region.

Conclusion:

The conclusion is based on field surveys, observations, mock interviews, and a review of relevant literature conducted during 2012–2013, along with an assessment of flood events in 2018 and 2019. The findings indicate that flood impacts were primarily concentrated in villages located along the banks of the Krishna and Koyna rivers.

The study identified two major tehsils Patan and Karad comprising approximately 20 villages that were significantly affected by flooding. During the flood events of 2018 and 2019, Patan and Karad tehsils experienced severe inundation. Patan town and Karad, including Wai city, were among the most affected settlements due to flooding from the Koyna and Krishna rivers, respectively. A large number of affected villages are characterized by settlements established close to riverbanks, often by migrant populations.

In Patan tehsil, the affected villages include Patan, Chopdarwadi, Maundrul Haveli, Sonaichiwadi, Sajur, and surrounding settlements. In Karad tehsil, flood-affected villages include

Karad, Mhopre, Old Sakurdi, Tambave, Yerwale, Belvade Haveli, Old Gote, Karad city, Kapil, Kodoli, Gondi, Atake, Rethare Budruk–Khurd, Khubi, and Malkhed, among others.

The villages affected by flooding are predominantly located at low elevations, with settlement altitudes nearly parallel to river levels in terms of mean sea level (MSL). The flood events of 2018 and 2019 caused extensive damage across these villages, as reflected by the high damage ratios presented in Table 1. The study highlights the strong relationship between settlement location, elevation, and flood vulnerability in the Krishna–Koyna river basin.

GIS-Based Observations:

- Loss prone areas are spatially aligned with low relative relief zones.
- The Krishna River shows a broader floodplain influence compared to Koyna.
- Confluence zones exhibit maximum spatial intensity of loss.
- Elevation difference between village center and river ranges from 3–15 meters, increasing vulnerability during high discharge events.

Planning and Management Implications:

- Villages with high loss area should be prioritized for:
    - Flood mitigation measures
    - River training works
    - Land-use zoning regulations
- GIS outputs can be directly integrated into:
    - District Disaster Management Plans
    - Watershed and floodplain zoning maps
    - Infrastructure planning studies

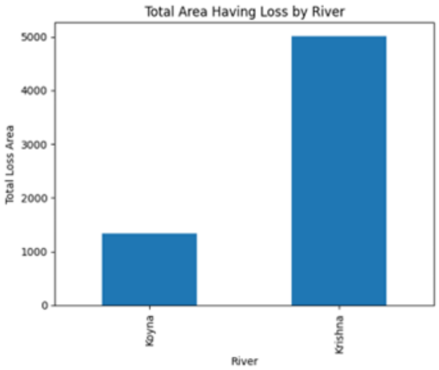
Table 1: The Satara District - Loss of Agricultural Land Due to Severe Flood

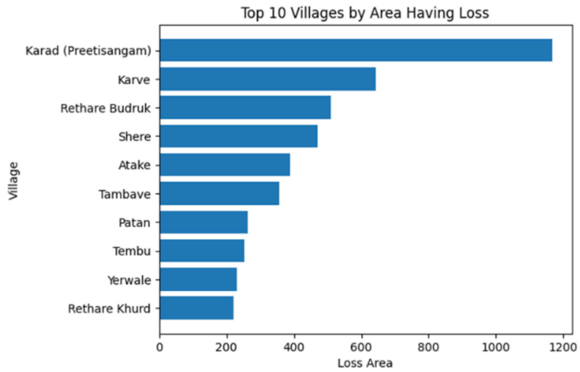
Sr. No.	River Name	Tehsil Name	Village Name	Village Altitude (Center)*	River Altitude in village*	Total area having loss**
1	Koyna	Patan	Patan	580	572	262.938
			Tripudi	581	572	179.564
			Chopdarwadi	580	572	61.123
			Maundrul Haveli	578	571	104.845
			Nisare	575	571	35.52
			Navadi	575	571	97.645
			Khilarwadi	581	571	59.597
			Sajur	573	567	142.795
			Mhopre	575	567	195.742
			Old Sakurdi	575	566	189.506
2	Krishna	Karad	Tambave	575	566	355.682
			Old Supane	576	565	112.718
			Yerwale	576	566	231.651
			Karad (Preetisangam)	575	560	1166.933
			Tembu	571	559	252.642
			Karve	571	558	643.557
			Kapil	568	557	147.459
			Kodoli	569	557	210.570
			Atake	568	556	389.759
			Dushere	569	556	134.338
			Shere	569	556	469.36

			Gondi	567	555	98.084
			Rethare Budruk	569	555	509.304
			Rethare Khurd	567	555	220.186
			Khubi	563	554	62.243
		Wai	Wai city	704	700	6.254

Source: Agricultural Department of Satara District, Report of Flood affected Area

*NB:, Unit: Metres. **NB:. Unit: hectares.





References:

1. Sakamoto T, Yokozawa M, Toritani H, Shibayama M, Ishitsuka N, Ohno H. A crop phenology detection method using time-series MODIS data. *Remote Sensing of Environment*. 2005;96:366–374.
2. Singh S. *Environmental geography*. Allahabad: Prayag Pustak Bhavan; 2000.
3. Smakhtin VU, Hughes DA. *Review, automated estimation and analyses of drought indices in South Asia*. Colombo: International Water Management Institute; 2004.
4. Tadesse T, Wilhite DA, Harms SK, Hayes MJ, Goddard S. Drought monitoring using data mining techniques: A case study for Nebraska, USA. *Natural Hazards*. 2004;33:137–159.
5. Tso B, Olsen R. A contextual classification scheme based on MRF model with improved parameter estimation and multiscale fuzzy line process. *Remote Sensing of Environment*. 2005;97(1):127–136.
6. Alam M, Rabbani MDG. Vulnerabilities and responses to climate change for Dhaka. *Environment and Urbanization*. 2007;19:81–97.
7. Alexander LV, et al. Global observed changes in daily climate extremes of temperature and precipitation. *Journal of Geophysical Research*. 2006;111:D05109.
8. Arora M, Goel NK, Singh P. Evaluation of temperature trends over India. *Hydrological Sciences Journal*. 2005;50:81–93.
9. Kadam A, Karnewar K. Analysis of monthly and seasonal temperature trends of Nanded. *Indian Streams Research Journal*. 2016;6(6):1–10.
10. Balling RC Jr, Idso SB. Historical temperature trends in the United States and the effect of urban population. *Journal of Geophysical Research*. 1989;94:3359–3363.