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Temporal Changes in River Morphology: A 6-Year Remote Sensing Analysis of the Tansa River, Palghar District, Maharashtra

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Abstract
River systems are dynamic geomorphic units that maintain ecological balance through sediment transport and channel stability. However, anthropogenic disturbances such as sand extraction can significantly alter these natural processes. The present study examines temporal changes in river morphology over a Six-year period in the Bhatane–Usgaon region of Palghar district, Maharashtra, using Google Earth satellite imagery. A qualitative assessment was carried out to evaluate variations in channel width, sediment deposition, bank stability, and adjacent land use. The observations indicate progressive channel widening, reduction in sand bar formation, and increasing bank irregularity over time. These changes suggest a shift in the natural sediment-flow balance of the river. The study highlights how multi-temporal satellite imagery can be effectively used to understand geomorphological transformations and their potential ecological implications in riverine environments.

Introduction

Sand is one of the most important natural resources used globally, particularly in construction and infrastructure development. It is a key component in the production of concrete, mortar, asphalt, and other building materials, and is extensively used in the construction of roads, bridges, buildings, and other civil structures. Among different types of sand, river sand is especially preferred due to its suitable grain size, smooth texture, and low impurity content, making it ideal for structural applications.

River systems naturally maintain a balance between erosion, transportation, and deposition of sediments. Sand plays a critical role in stabilizing river channels, supporting groundwater recharge, and maintaining aquatic and riparian habitats. The removal of this material, especially from active river channels, can disturb this balance and lead to noticeable geomorphological changes over time.

The Tansa River, like many alluvial river systems, exhibits dynamic channel behavior influenced by seasonal flow variations and sediment movement. Such rivers depend on a continuous supply and redistribution of sediments to maintain their form and function. Any sustained disturbance in sediment availability can alter channel geometry, bank stability, and flow characteristics.

Studies have shown that extraction of riverbed material can result in channel incision, lateral widening, and destabilization of riverbanks. In-channel removal of sand may increase flow velocity and reduce the natural resistance provided by sediment deposits, leading to enhanced erosion. Over time, these processes can modify the planform of the river and affect adjacent land areas. Similar observations have been reported in different river systems where sediment imbalance has led to changes in channel morphology and associated environmental impacts (Ashraf et al., 2011; Galay, 1983).

Remote sensing and GIS-based approaches have proven to be effective tools for analyzing such changes over time. Satellite imagery enables the comparison of river conditions across different years, allowing for the identification of gradual transformations in channel structure and surrounding landscapes. Previous studies have successfully used multi-temporal imagery to assess river morphology changes and sediment dynamics in large river systems (Hossain et al., 2013; Rozo et al., 2014).

In this context, the present study focuses on analyzing temporal changes in the morphology of a selected stretch of the Tansa River using satellite imagery over a Six-year period. The study aims to observe variations in channel width, sediment deposition patterns, bank conditions, and adjacent land use, in order to understand how the river system has evolved over time.

Study Area:

The present study was conducted along a selected stretch of the Tansa River in the Bhatane–Usgaon region of Palghar district, Maharashtra, India. The area lies within the northern part of the Konkan coastal belt and is characterized by a combination of agricultural land, rural settlements, and riverine landscapes.

The study was conducted in January 2026, during which the selected river stretch was identified and corresponding satellite imagery was analyzed. The study site is located approximately at 19.4796456° N latitude and 72.9214991° E longitude, representing a segment of the river that exhibits active geomorphological features suitable for temporal analysis.

The Tansa River is an important river system in the region, contributing to local hydrology and supporting agricultural activities. It shows seasonal variation in discharge, with higher flow during the monsoon season and reduced flow during drier months. These variations influence sediment transport and deposition patterns within the channel.

The river stretch selected for this study is predominantly composed of alluvial material, making it sensitive to changes in sediment balance and channel form. The surrounding land is largely used for agriculture, with cultivated fields located close to the riverbanks. Scattered vegetation patches and small settlements are also present in the vicinity.

Geomorphologically, the river exhibits features such as mild meandering, depositional zones, and variable channel width. These characteristics make it suitable for observing changes in channel morphology, sediment distribution, and bank conditions over time.

For consistency, the same river segment centered around the given coordinates was analyzed using multi-temporal Google Earth imagery over a Six-year period, ensuring comparability across different years.

Research Methodology:

The study is based on high-resolution satellite imagery obtained from Google Earth. Multi-temporal images of the selected stretch of the Tansa River were collected for a period of Six years from 2011 till 2016. Care was taken to select images from similar seasons to minimize seasonal variation in river flow and sediment distribution.

To maintain consistency in analysis:

The same river stretch centered around the coordinates (19.4796456° N, 72.9214991° E) was used for all years

- Images were viewed at a similar zoom level, maintaining a consistent eye altitude of approximately 4,396 m across all selected years.
- • The scale was standardized using a 700 m scale bar, ensuring uniform spatial reference during image comparison.
- • North orientation was kept constant to maintain consistency in spatial alignment across all temporal datasets.
- Visual clarity (minimal cloud cover and distortion) was considered while selecting images

A qualitative visual interpretation method was adopted. Each year's image was carefully examined and compared with the baseline year to identify changes over time. Observations were recorded systematically and later organized into a year-wise comparison table (Table.1) to track progressive changes in river morphology.

No advanced GIS-based quantitative measurements were used in this study; instead, emphasis was placed on consistent visual comparison across multiple years to identify patterns and trends.

Year	Channel Width	Sand Bars / Sediment Deposition	Riverbank Condition	Adjacent Land Use	General Observation
2011	Relatively narrow with defined channel edges	Prominent sediment deposition visible (marked area)	Banks appear stable and continuous	Agricultural fields close to river margins	Baseline condition with clear sediment accumulation zones
2012	Slight increase in width in lower stretch	Noticeable change in sediment deposition patterns	Initial irregularity along bank edges	No major land use change	Beginning of morphological variation with shifting sediments
2013	Moderate widening in central channel	Formation of mid-channel bars and redistributed sediments	Banks start showing uneven margins	Minor shifts near agricultural boundaries	Transition phase with active sediment movement
2014	Wider channel, especially in Area 1	Sediment concentration reduced in Area 1, localized in Area 2	Increased bank irregularity in certain sections	Agricultural fields slightly set back in some parts	Spatial shift in sediment zones indicating channel adjustment
2015	Further widening and expansion of active channel	Large sediment-depleted zones; accumulation seen upstream	Banks show signs of retreat and uneven edges	Slight encroachment into nearby land visible	Increased dominance of erosional processes
2016	Widest observed channel condition	Reduced sediment deposition; fragmented patches remain	Banks appear more unstable and irregular	Noticeable alteration in adjacent agricultural layout	Clear shift toward altered and dynamic river morphology

Table.1: Year-wise Observations of River Morphology (2011–2016)

Results and Discussion

The analysis of multi-temporal satellite imagery over the selected Six-year period reveals a gradual but consistent transformation in the morphology of the Tansa River within the Bhatane–Usgaon region. The observed changes are not abrupt; rather, they develop progressively across the study period, indicating a cumulative alteration in the river system.

a) Channel Width Variation

One of the most noticeable changes is the increase in channel width over time. In the baseline year, the river channel appears relatively narrow with well-defined and stable banks. As the years progress, certain stretches of the river show lateral expansion, resulting in a wider and more irregular channel form.

This widening is not uniform across the entire stretch, suggesting localized areas of higher disturbance. Such patterns are commonly associated with changes in sediment balance and flow dynamics, where reduced resistance from the riverbed can lead to increased erosive activity.

b) Changes in Sand Bars and Sediment Deposition

The earlier imagery shows clearly identifiable sand bars and depositional features, indicating active sediment accumulation within the channel. However, in subsequent years, these features appear to reduce in size, become fragmented, or shift in position.

By the final year of analysis, stable sand bar formations are less prominent, and sediment appears more dispersed. This suggests a disturbance in the natural processes of deposition and redistribution. Since sediment plays a key role in regulating flow and stabilizing the channel, its reduction can influence overall river morphology.

c) Riverbank Condition and Stability

Changes in riverbank condition are also evident across the study period. The banks in earlier images appear relatively smooth and continuous. Over time, they become increasingly irregular, with sharper edges and uneven margins.

Certain sections show signs that may indicate bank retreat or erosion, particularly where the channel has widened. This observation aligns with the idea that weakening of supporting sediment layers can make banks more vulnerable to erosion, especially during periods of higher discharge.

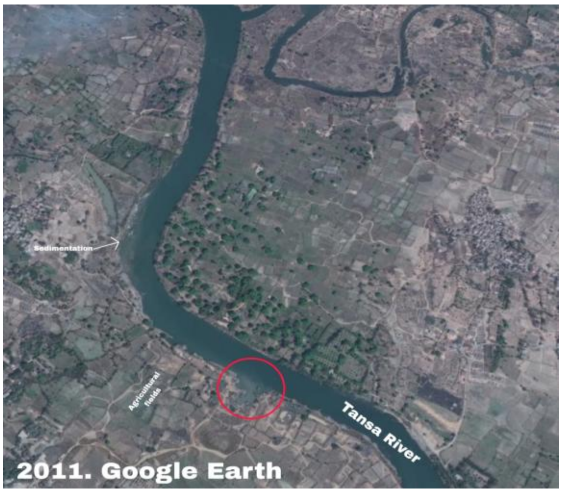
d) Changes in Adjacent Land Use

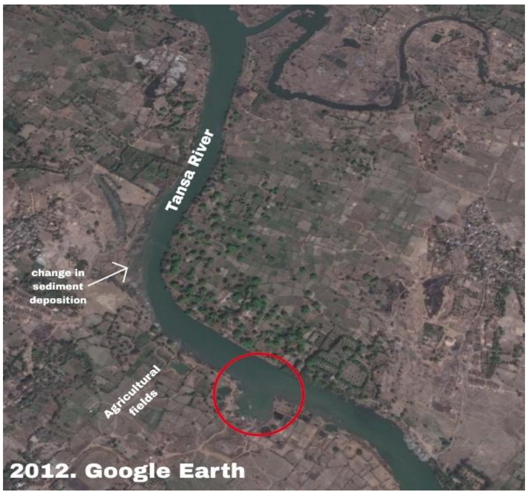
The impact of channel changes extends beyond the river itself and is visible in the adjacent land areas. Agricultural fields located near the river margins show slight but noticeable shifts in their boundaries over time.

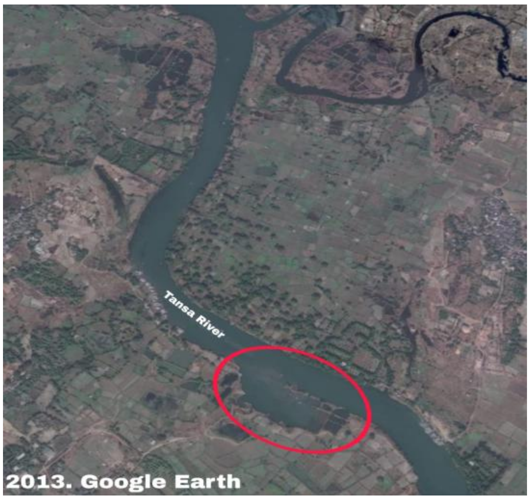
In some areas, the distance between cultivated land and the active channel appears to decrease, suggesting gradual encroachment of the river into nearby land. While seasonal variations may influence minor changes, the consistent pattern observed across multiple years indicates a more sustained process.

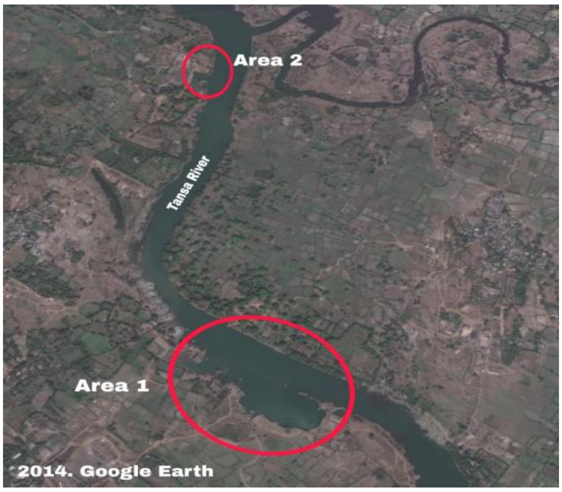
Overall, the observations indicate a transition from a relatively stable river system to a more dynamic and altered channel condition. The combination of channel widening, reduction in sediment deposition, and increasing bank irregularity suggests a shift in the natural equilibrium of the river.

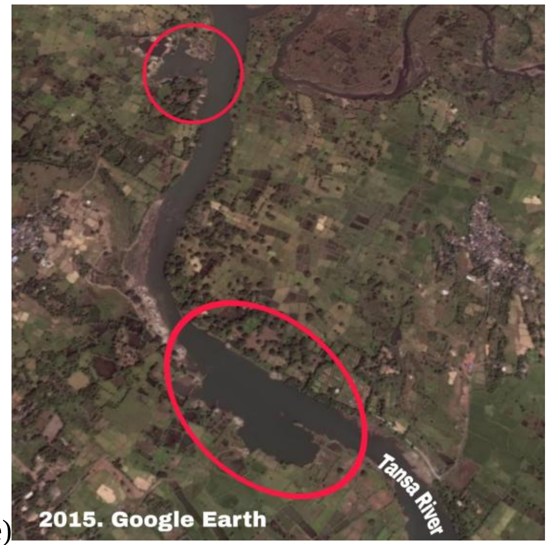
Similar patterns have been reported in studies where sediment removal affects channel form and flow behavior (Ashraf et al., 2011; Galay, 1983). The disturbance of sediment balance can lead to enhanced erosion, reduced depositional stability, and long-term geomorphic adjustments.

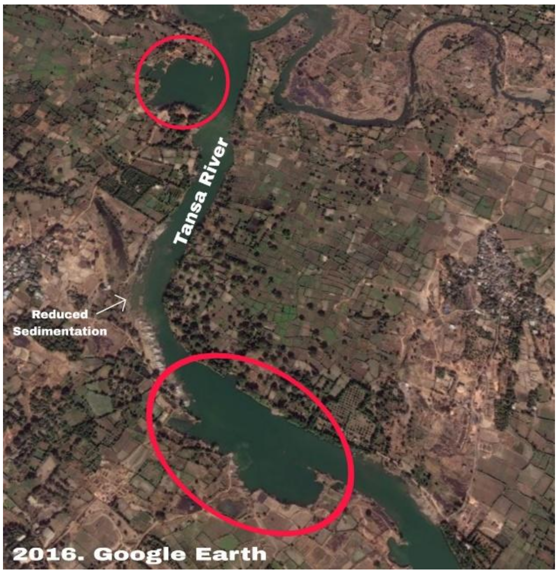
a) 

b) 

c) 

d) 

e) 

f) 

Conclusion:

This study analyzed changes in the morphology of the Tansa River in the Bhatane–Usgaon region over a six-year period (2011–2016) using satellite imagery. The results indicate a gradual transformation in the river system, marked by channel widening, reduction and redistribution of sediment deposits, and increasing bank irregularity.

Sediment accumulation observed in earlier years becomes fragmented in later images, suggesting a disturbance in natural sediment dynamics. Changes in riverbanks and slight shifts in adjacent agricultural land further indicate the expanding influence of channel adjustments.

Overall, the study highlights a transition from a relatively stable river condition to a more dynamic channel system. The use of multi-temporal Google Earth imagery proved effective in capturing these changes and provides a useful approach for monitoring river morphology over time.

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