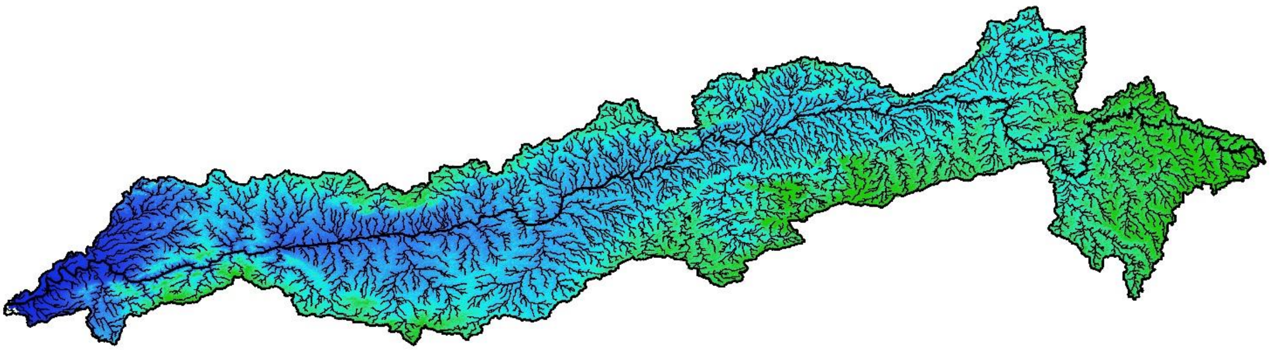
National River Conservation Directorate
Ministry of Jal Shakti,
Department of Water Resources,
River Development & Ganga Rejuvenation
Government of India

Topographic Maps of Narmada River Basin



March 2025

National River Conservation Directorate (NRCD)

The National River Conservation Directorate, functioning under the Department of Water Resources, River Development & Ganga Rejuvenation, and Ministry of Jal Shakti providing financial assistance to the State Government for conservation of rivers under the Centrally Sponsored Schemes of 'National River Conservation Plan (NRCP)'. National River Conservation Plan to the State Governments/ local bodies to set up infrastructure for pollution abatement of rivers in identified polluted river stretches based on proposals received from the State Governments/ local bodies.

www.nrcd.nic.in

Centres for Narmada River Basin Management Studies (cNarmada)

The Center for Narmada River Basin Management Studies (cNarmada) is a Brain Trust dedicated to River Science and River Basin Management. Established in 2024 by IIT Gandhinagar and IIT Indore, under the supervision of cGanga at IIT Kanpur, the center serves as a knowledge wing of the National River Conservation Directorate (NRCD). cNarmada is committed to restoring and conserving the Narmada River and its resources through the collation of information and knowledge, research and development, planning, monitoring, education, advocacy, and stakeholder engagement.

www.cnarmada.org

Centre for Ganga River Basin Management and Studies (cGanga)

cGanga is a think tank formed under the aegis of NMCG, and one of its stated objectives is to make India a world leader in river and water science. The Centre is headquartered at IIT Kanpur and has representation from most leading science and technological institutes of the country. cGanga's mandate is to serve as think-tank in implementation and dynamic evolution of Ganga River Basin Management Plan (GRBMP) prepared by the Consortium of 7 IITs. In addition to this, it is also responsible for introducing new technologies, innovations, and solutions into India.

www.cganga.org

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Acknowledgment

This report is a comprehensive outcome of the project jointly executed by IIT Gandhinagar (Lead Institute) and IIT Indore (Fellow Institute) under the supervision of cGanga at IIT Kanpur. It was submitted to the National River Conservation Directorate (NRCD) in 2024. We gratefully acknowledge the individuals who provided information and photographs for this report.

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Preface

The Narmada River, often referred to as the lifeline of central and western India, holds unparalleled significance for the region's water resources, ecosystems, and communities. Its hydrological complexity, combined with its ecological and cultural heritage, underscores the critical need for its preservation and sustainable management. In the face of mounting challenges such as climatic variability, groundwater depletion, and increasing anthropogenic pressures, a comprehensive understanding of the Narmada River Basin's hydrology is more important than ever.

This report, cantered on the hydrological characteristics of the Narmada River Basin, is an effort to provide an in-depth analysis of key parameters such as streamflow, water levels, groundwater trends, and climatic variations. Drawing on extensive data collection and advanced methodologies, it presents a spatial and temporal perspective on the basin's water resources and their interdependencies. From rainfall patterns to groundwater recharge dynamics, this report aims to uncover critical insights into the factors shaping the basin's hydrological profile.

The findings and recommendations presented in this report are intended to serve as a guiding framework for policymakers, researchers, and practitioners committed to sustainable water management in the Narmada Basin. By identifying trends and challenges, it aspires to inform climate-resilient strategies, enhance water resource planning, and support the development of policies that balance ecological preservation with socioeconomic progress.

We are deeply grateful to all individuals, organizations, and institutions that contributed to the preparation of this report. Their dedication, expertise, and support have been instrumental in shaping this study. It is our hope that this report will inspire collaborative efforts and meaningful action toward the long-term health and sustainability of the Narmada River and its basin.

cNarmada and cGanga

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Abbreviations and Acronyms

cGanga	Centre for Ganga River Basin Management and Studies
cNarmada	Centre for Narmada River Basin Management and Studies
DEM	Digital Elevation Model
ALOS PALSAR	Advanced Land Observing Satellite Phased Array type L-band Synthetic Aperture Radar
ASF DAAC	Alaska Satellite Facility Distributed Active Archive Centre
NRSC	National Remote Sensing Centre
SRTM	Shuttle Radar Topography Mission
GRBMP	Ganga River Basin Management Plan
NRCP	National River Conservation Plan
NRCD	National River Conservation Directorate
WRIS	Water Resources Information System

1. Introduction

India's vibrant and diverse landscapes are intricately linked to its remarkable river systems, which span from the towering Himalayas to the coastal ranges of the Western and Eastern Ghats. These rivers are vital, providing life-sustaining water for agriculture, drinking, and energy production while shaping the country's terrain and supporting its ecosystems. They also hold immense cultural and spiritual importance, making them central to India's traditions and economy.

Among these, the Narmada River stands out as a westward-flowing marvel and the fifth-longest river in the country. Flowing primarily through Madhya Pradesh and Gujarat, it is often referred to as the "Lifeline" of these states for its crucial contributions to irrigation, drinking water, and hydropower. The river is revered in Hindu mythology, with numerous temples and sacred sites along its banks, underscoring its spiritual significance.

Originating from the Amarkantak Plateau in Madhya Pradesh, the Narmada River flows westward for 1,312 km before emptying into the Arabian Sea through the Gulf of Khambhat. Its basin extends from 21° 40' 12'' to 23° 41' 24'' N latitudes and 72° 48' 36'' to 81° 45' 36'' E longitudes, covering 95,959.70 sq. km approximately 3% of India's total geographical area. The basin's elongated shape spans 915.65 km from east to west and 236 km from north to south.

The river's physiography is defined by three distinct zones: the upper, middle, and lower reaches. The upper Narmada flows through rugged and forested terrain, characterized by steep slopes and narrow valleys. Notable topographical features include the Kapildhara Falls near the river's origin and the Marble Rocks gorge at Bhedaghat near Jabalpur. The middle Narmada is marked by wider valleys and fertile plains, with prominent basaltic formations from ancient volcanic activity. This region is ideal for agriculture and supports several large irrigation projects. The lower Narmada basin transitions into the Gujarat plains, featuring alluvial deposits and a gentler gradient as it approaches the Arabian Sea.

The Narmada Rift Valley, a tectonic feature, significantly influences the river's course. Flanked by the Vindhya Range to the north and the Satpura Range to the south, this valley provides a unique geological setting. The river's flow is further augmented by its 41 tributaries like the Tawa, Hiran, and Shakkar Rivers, which contribute to the hydraulics, hydrological and ecological diversity of the basin.

The Narmada River basin is divided into three sub-basins based on geomorphology, hydrology, and hydraulics, each with unique characteristics and challenges. Upper Narmada Sub-Basin extending from Amarkantak to Hoshangabad (~720 km), this region encompasses the river's origin at the Amarkantak Plateau and its flow through rugged, forested terrain. The area is characterized by steep gradients and narrow valleys, making it ideal for hydropower projects such as the Bargi Dam. However, these steep slopes and high rainfall levels also make the sub-basin prone to soil erosion and sedimentation issues, affecting downstream water quality and reservoir capacity.

Spanning from Hoshangabad to Navagam (~485 km), the middle sub-basin is marked by wider valleys, fertile plains, and basaltic rock formations. This region supports extensive agricultural activity, thanks to irrigation systems fed by major projects like the Indira Sagar and Omkareshwar Dams. Despite its agricultural productivity, the middle Narmada faces challenges such as deforestation in the surrounding uplands, leading to increased siltation, and pollution from untreated urban and industrial effluents.

Covering the area from Navagam to the Gulf of Khambhat (~145 km), the lower sub-basin transitions into the flat alluvial plains of Gujarat. Here, the river slows down, creating rich floodplains that support diverse ecosystems and fertile agricultural lands. This region includes the Sardar Sarovar Dam, a critical infrastructure for irrigation, water supply, and power generation. However, the lower Narmada is heavily impacted by industrial discharges, sand mining, and changes in sediment flow due to upstream damming, leading to coastal erosion near the river's mouth.

The Narmada River Basin, one of the most significant fluvial systems in India, exhibits complex topographic and geomorphic characteristics that influence its hydrological and ecological dynamics. Understanding the terrain-driven controls on river morphology, flow behavior, and watershed characteristics is essential for effective river basin management. Topographic analysis provides critical insights into these aspects by examining key physical parameters such as elevation, slope, aspect, and drainage network configuration.

This study employs high-resolution topographic data from the ALOS PALSAR Digital Elevation Model (12.5 m resolution) and utilizes advanced Geographic Information System (GIS) techniques to systematically map and interpret topographic variability across the Narmada River Basin. By analyzing the spatial distribution of terrain features, this study aims to enhance the understanding of geomorphic controls on hydrological processes and sediment transport mechanisms.

The findings from this analysis have broad applications in watershed management, including drainage delineation, erosion risk assessment, floodplain mapping, and site selection for hydrological interventions. The insights derived from this study will serve as a foundational reference for researchers, engineers, and policymakers involved in sustainable river basin management, infrastructure development, and environmental conservation efforts within the Narmada Basin.

2. Data Acquisition and Methodology

2.1 Data Source

This study primarily utilizes two major sources for topographic data: the ALOS PALSAR Digital Elevation Model (DEM) and Survey of India (SoI) topographic sheets. These sources were chosen for their reliability, extensive spatial coverage, and suitability for regional-scale topographic and hydrological analysis. Although freely available DEMs such as the SRTM DEM and ASTER DEM were accessible, the ALOS PALSAR DEM was selected due to its higher resolution and superior data acquisition quality.

2.2 Importance of High-Resolution DEM

High-resolution DEMs play a crucial role in hydrological studies by providing detailed topographic information that is essential for understanding water flow patterns, drainage networks, and watershed characteristics. The accuracy and resolution of a DEM significantly influence the accuracy of hydrological models and simulations. High-resolution DEMs, such as the ALOS PALSAR 12.5m DEM, enable more precise delineation of watersheds, identification of drainage patterns, and modelling of hydrological processes, leading to improved water resource management and flood risk assessment.

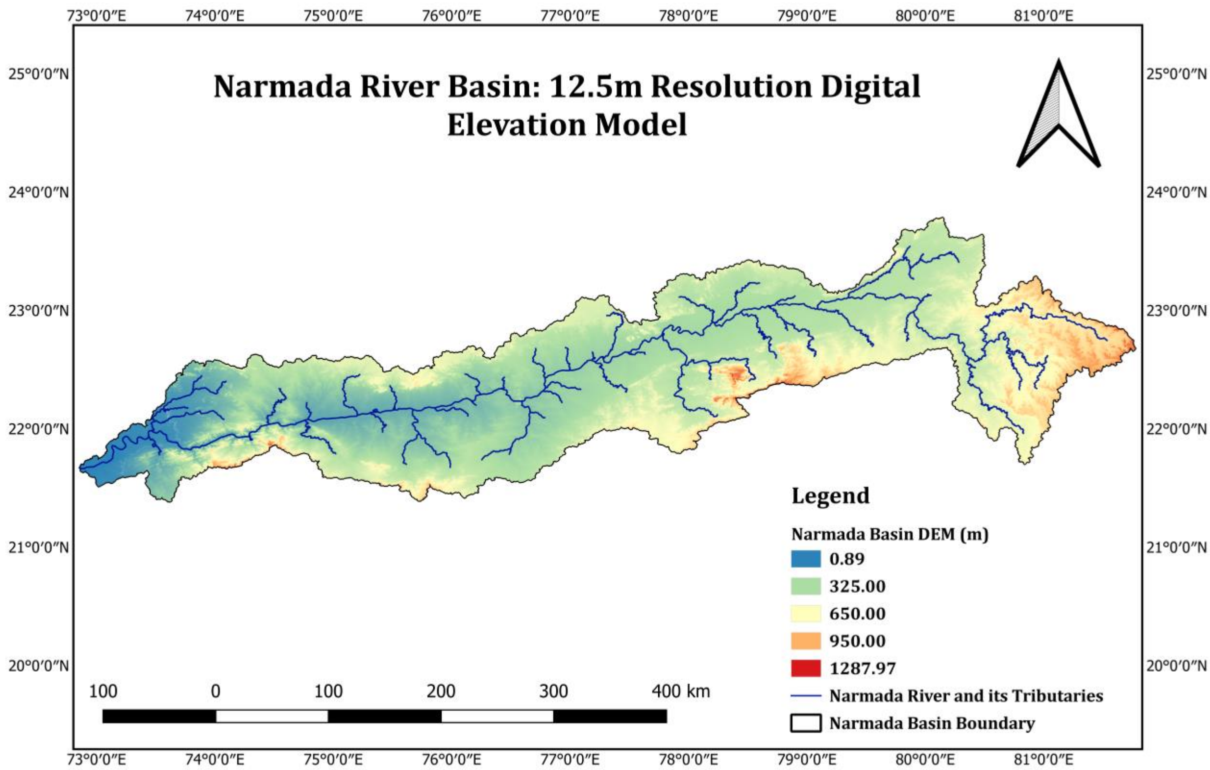

Fig. 01: ALOS PALSAR 12.5m DEM of the Narmada River Basin

2.3 Characteristics of the Dem Used (Resolution, Accuracy, Source)

The DEM used in this study is the ALOS PALSAR 12.5m DEM. The ALOS PALSAR (Advanced Land Observing Satellite – Phased Array type L-band Synthetic Aperture Radar) DEM is a high-resolution, freely available global elevation dataset provided by the Japan Aerospace Exploration Agency (JAXA). It has a spatial resolution of 12.5 meters, making it well-suited for detailed terrain analysis in large river basins like the Narmada. Moreover, this dataset has been widely used in river basin studies, watershed delineation, slope stability assessment, and flood risk mapping due to its balance between resolution and accessibility.

The accuracy of the ALOS PALSAR DEM is generally considered to be high, making it suitable for hydrological applications. The data was accessed from the Alaska Satellite Facility (ASF) Distributed Active Archive Center (DAAC). Fig. 01 shows the ALOS PALSAR 12.5m DEM of the Narmada River Basin, which provides detailed elevation information for hydrological analysis.

In addition to satellite-derived elevation data, Survey of India (SoI) topographic sheets were used as reference maps for validating elevation patterns and cross-verifying drainage structures. A total of 183 toposheets were downloaded and utilized for further verification and validation of topographic information, these toposheets, produced at a scale of 1:50,000, provide reliable cartographic information on elevation contours, spot heights, rivers, streams, watershed boundaries, and other physiographic features. Despite being produced through conventional ground-based surveys, SoI toposheets remain a gold standard for baseline topographic mapping in India. They are particularly useful for capturing terrain features not always resolved in satellite-based datasets and for historical terrain comparisons. Thus, together, the ALOS PALSAR DEM and SoI toposheets provide a solid foundation for topographic assessment in the Narmada River Basin, ensuring both spatial detail and historical accuracy.

3. Topography of the Basin

3.1 Elevation and Slope Characteristics

The elevation analysis of the Narmada River Basin reveals distinct spatial variability. A significant portion of the basin, approximately 27.26%, lies within the 200–300 m elevation range, making it the most dominant elevation zone. This is followed by the 300–400 m range, which covers 20.30% of the basin area. In contrast, the smallest proportion i.e., 0.14% is located in the highest elevation zone of 1000 - 1287 m, found primarily in the upper catchment near the river's origin. Overall, while the Narmada River Basin exhibits noticeable variation in elevation, the majority of the terrain consists of moderately sloping to gently undulating landforms, especially across the central and lower sections of the basin. PLEASE ADD THE MEAN ELEVATION OF THE BASIN AS OBATINED FROM ALOS PALSAR DEM.

Table 1: Areal Distribution of Elevation in the Narmada River Basin

Sl. No	Elevation (m)	Area (sq. km)	% of Total Area
1	< 5	2325.72	2.42
2	5 - 10	145.22	0.15
3	10 – 50	1077.61	1.12
4	50 – 100	2325.01	2.42
5	100 -200	11208.4	11.68
6	200 – 300	26154.6	27.26
7	300 – 400	19481.9	20.30
8	400 – 500	12335.7	12.86
9	500 -750	17654.3	18.40
10	750 – 1000	3114.34	3.25
11	1000 - 1287	136.4	0.14

To further analyse the terrain characteristics, a slope map of the Narmada River Basin was derived using the Surface Analysis tools in ArcGIS, specifically the Slope function under the Spatial Analyst toolbox. This process allowed for the extraction of slope values in degrees from the high-resolution ALOS PALSAR Digital Elevation Model (Fig. 01). The slope map of the Narmada River basin is presented in Fig. 02.

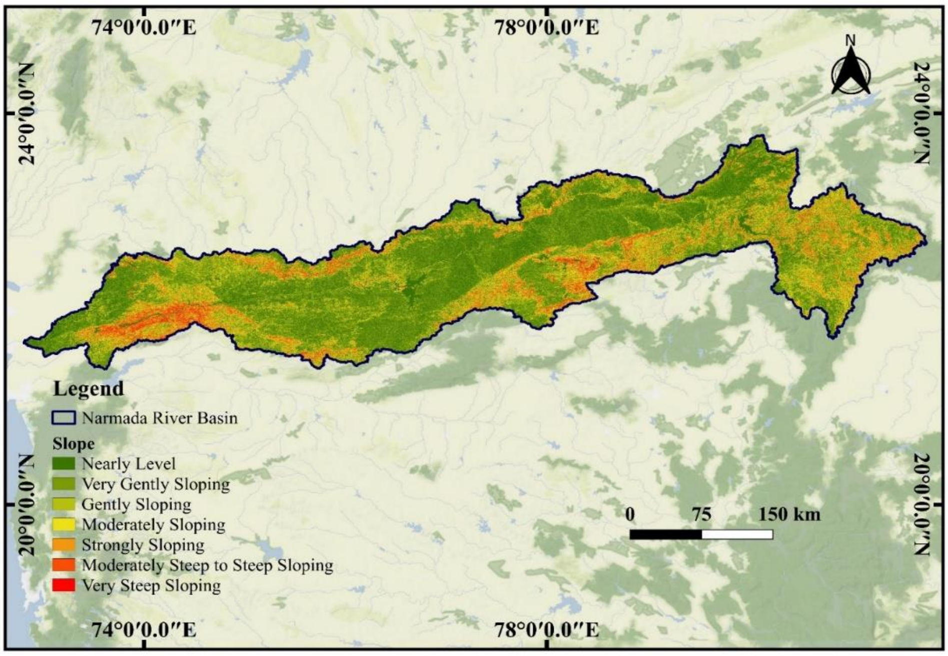

Fig. 02: Spatial distribution of slope across the Narmada River basin

The entire Narmada River Basin was classified into slope categories based on the guidelines provided by the National Remote Sensing Centre (NRSC). The slope classes include Nearly level (0°–1°), Very gently sloping (1°–3°), Gently sloping (3°–5°), Moderately sloping (5°–10°), Strongly sloping (10°–15°), Moderately steep to steep (15°–30°), and Very steep (>35°). As shown in Figure 7, very steep slopes are predominantly concentrated in the upper reaches near Amarkantak and the lower reaches near the Sardar Sarovar Dam, where the terrain is more rugged and dissected. In contrast, the middle section of the Narmada Basin largely features nearly level to very gently sloping landforms, reflecting a more stable and low-gradient terrain.

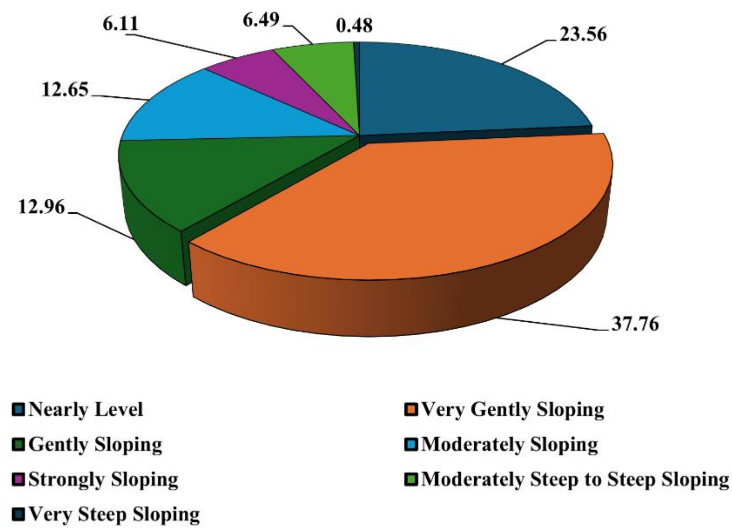

Fig. 03: Areal coverage of slope categories across the Narmada River basin

Based on the slope analysis illustrated in Fig. 03, approximately 37.76% of the Narmada River Basin consists of very gently sloping surfaces, indicating widespread low-gradient terrain suitable for agriculture, settlement expansion, and minimal surface runoff generation. In contrast, only about 0.48% of the basin area falls under the very steep slope category, signifying the presence of sharply inclined terrain that is generally restricted to the uppermost reaches near Amarkantak and the lowermost downstream zones, particularly near the escarpment-dominated regions adjacent to the Sardar Sarovar Dam. These steep zones are structurally controlled and represent geologically uplifted and dissected landforms.

3.2 Terrain and Flow Characteristics Evaluation

Following the slope classification, a detailed hydrological terrain assessment was carried out using the Surface toolbox under the Spatial Analyst Tool in ArcMap, wherein flow direction and flow accumulation rasters were derived from the high-resolution ALOS PALSAR Digital Elevation Model. The flow direction layer (Figure 9) illustrates the directional path of overland water movement from each raster cell based on the steepest descent algorithm. It reveals a predominant east-to-west flow trajectory, aligning with the geomorphological setting of the Narmada Rift Valley. The drainage pattern exhibits a strong dendritic to sub-dendritic configuration, indicative of a homogenous lithological base and minimal structural interference across large portions of the basin.

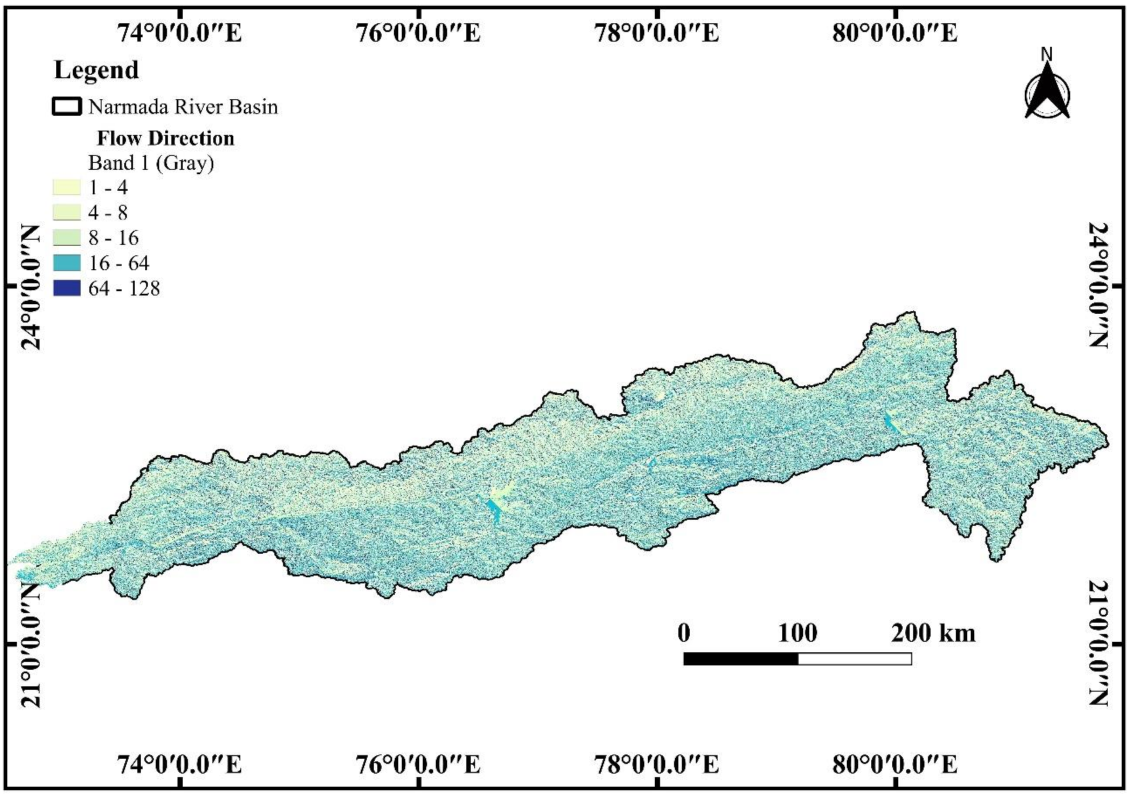

Fig. 04: Flow Direction map of Narmada River basin

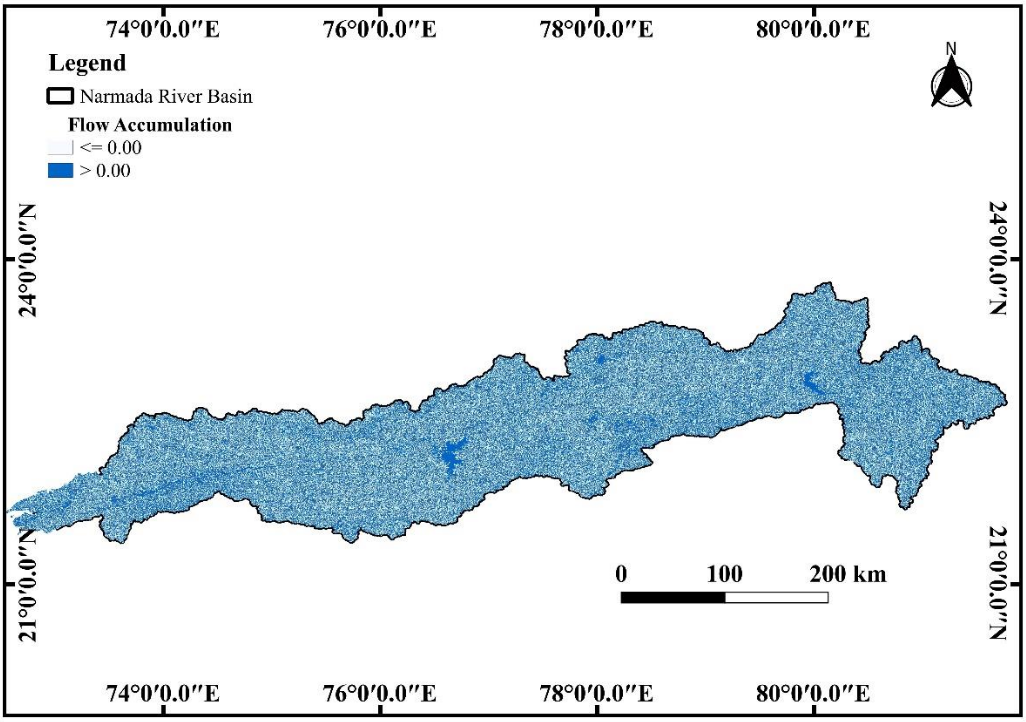

Fig. 05: Flow accumulation map of Narmada River

Complementing the flow direction, the flow accumulation map (Fig. 05) provides insight into the convergence of surface runoff within the basin. High accumulation zones, represented in darker shades of blue, correspond to the main stem of the Narmada River and its major tributaries, such as the Tawa and Hiran Rivers. These areas represent the primary drainage axes with significant runoff contribution, while the light-toned, low-accumulation regions represent the upland divides and headwater catchments. This delineation is critical for identifying potential stream channels, flood-prone zones, and for calibrating hydrological models.

Furthermore, to enhance the three-dimensional visualization and interpret the directional orientation of the terrain, aspect and hillshade maps were generated. The aspect map (Fig. 06) classifies the surface orientation of slopes across the basin. The distribution of aspect directions is varied, with east-, west-, and southwest-facing slopes being dominant in the central and lower basin, suggesting differential solar exposure, which influences microclimatic conditions, soil moisture retention, and vegetation patterns. On the other hand, hillshade analysis (Fig. 07) offers a simulated illumination of the terrain surface, revealing topographic relief and visually emphasizing landform features such as ridgelines, valleys, plateaus, and escarpments. The upper and lower segments of the basin exhibit sharper contrasts in illumination, reaffirming the presence of steeper and more dissected terrain in those regions. Thus, together, the flow direction, flow accumulation, aspect, and hillshade layers provide a comprehensive topographic framework for the Narmada River Basin. These outputs are invaluable for hydrological modelling, erosion risk assessment, catchment prioritization, and terrain-sensitive infrastructure planning.

The integration of slope-driven hydrological layers and surface orientation enhances our understanding of the basin's functional landscape and contributes to more accurate prediction of water movement, sediment dynamics, and ecological zoning.

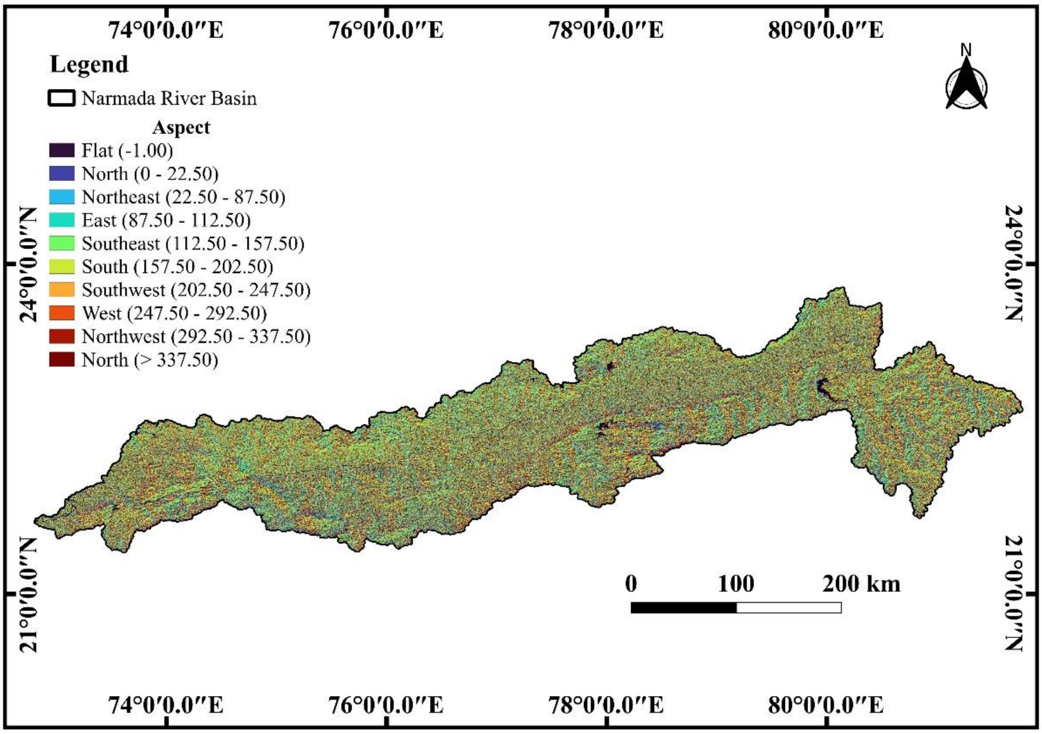

Fig. 06: Aspect Map of Narmada River Basin

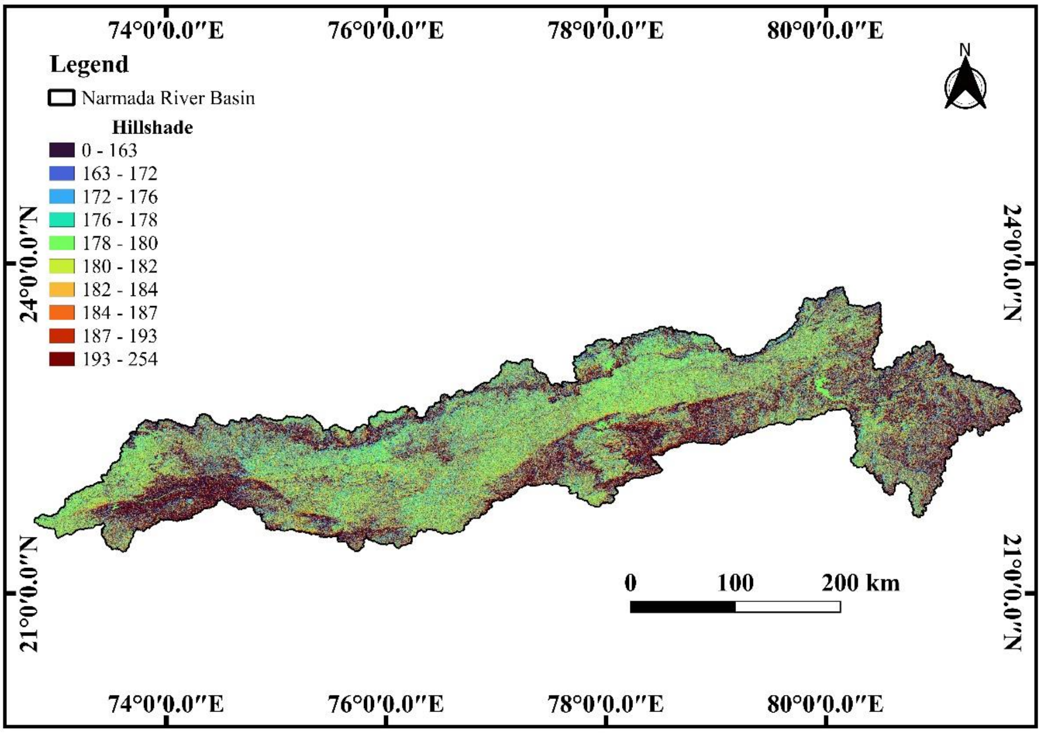

Fig. 07: Hillshade Map of Narmada River Basin

3.3 Contour Generation

In continuation of the topographic analysis, contour lines were generated to visualize elevation changes and terrain morphology across the Narmada River Basin. Contours represent lines of equal elevation and are essential for interpreting slope gradients, identifying ridges and valleys, and delineating watershed boundaries with high precision. For this study, two sets of contour maps were produced using the ALOS PALSAR Digital Elevation Model within the ArcGIS environment.

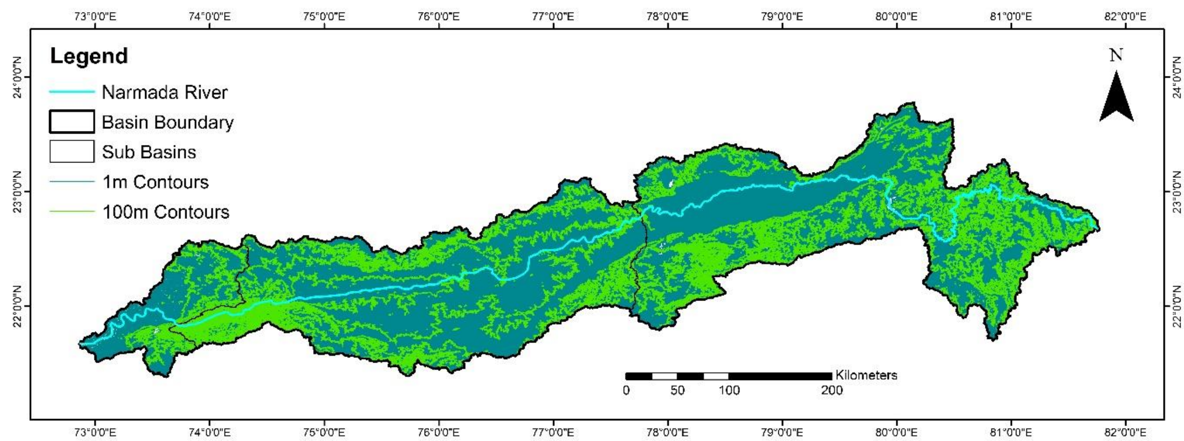

Fig. 08: Contour Map of Narmada River basin with contour intervals of 1m and 100 m respectively

Contours at 100-meter intervals were generated to provide a regional perspective of elevation variation across the basin. These contours clearly highlight major physiographic features such as the elevated plateaus of the upper basin, the deeply incised rift valley in the central stretch, and the undulating terrain of the lower basin near the river's mouth. This scale of representation is useful for understanding overall basin structure, river profiles, and sub-basin classification. Moreover, to complement this, high-resolution contours at 1-meter intervals were generated for selected regions to support fine-scale topographic assessments, particularly in zones of engineering relevance such as dam sites, riverbank stabilization zones, and flood-prone areas. These contours provide detailed elevation information that facilitate precise planning for hydraulic structures, sediment control, and land use regulation.

As shown in Fig. 08, the contour map of the Narmada River Basin presents both 100 m (green lines) and 1 m (blue lines) intervals, enabling analysis at multiple spatial scales. The 100 m contours capture the broader elevation gradient, extending from the highlands near Amarkantak in the east—where the river originates—to the low-lying western regions draining into the Arabian Sea. These lines trace significant terrain features such as ridges and escarpments, enhancing understanding of the basin's physiographic framework. In contrast, the 1 m contours appear densely concentrated along the main river channel and surrounding floodplains, particularly in the middle and lower stretches of the basin. Their close spacing indicates areas of gentle slope and subtle elevation transitions, typical of depositional zones and agriculturally productive land. These contours are especially valuable for localized studies where minor elevation changes can significantly influence hydrological behaviour.

The overall contour distribution reflects the east-to-west slope direction governed by the structural control of the Narmada Rift Valley. The map also outlines sub-basin boundaries, many of which exhibit distinct elevation-driven flow patterns feeding into the main river (Sub-basin-wise contour maps are presented in Figures 9 to 11). Thus, the combined use of 100 m and 1 m contour intervals provides a robust multi-resolution view of the basin's terrain, supporting both regional physiographic understanding and detailed site-specific analyses. When integrated with other terrain layers such as slope, aspect, and flow accumulation, these contours significantly enhance the spatial understanding of the Narmada River Basin and support terrain-sensitive planning and decision-making.

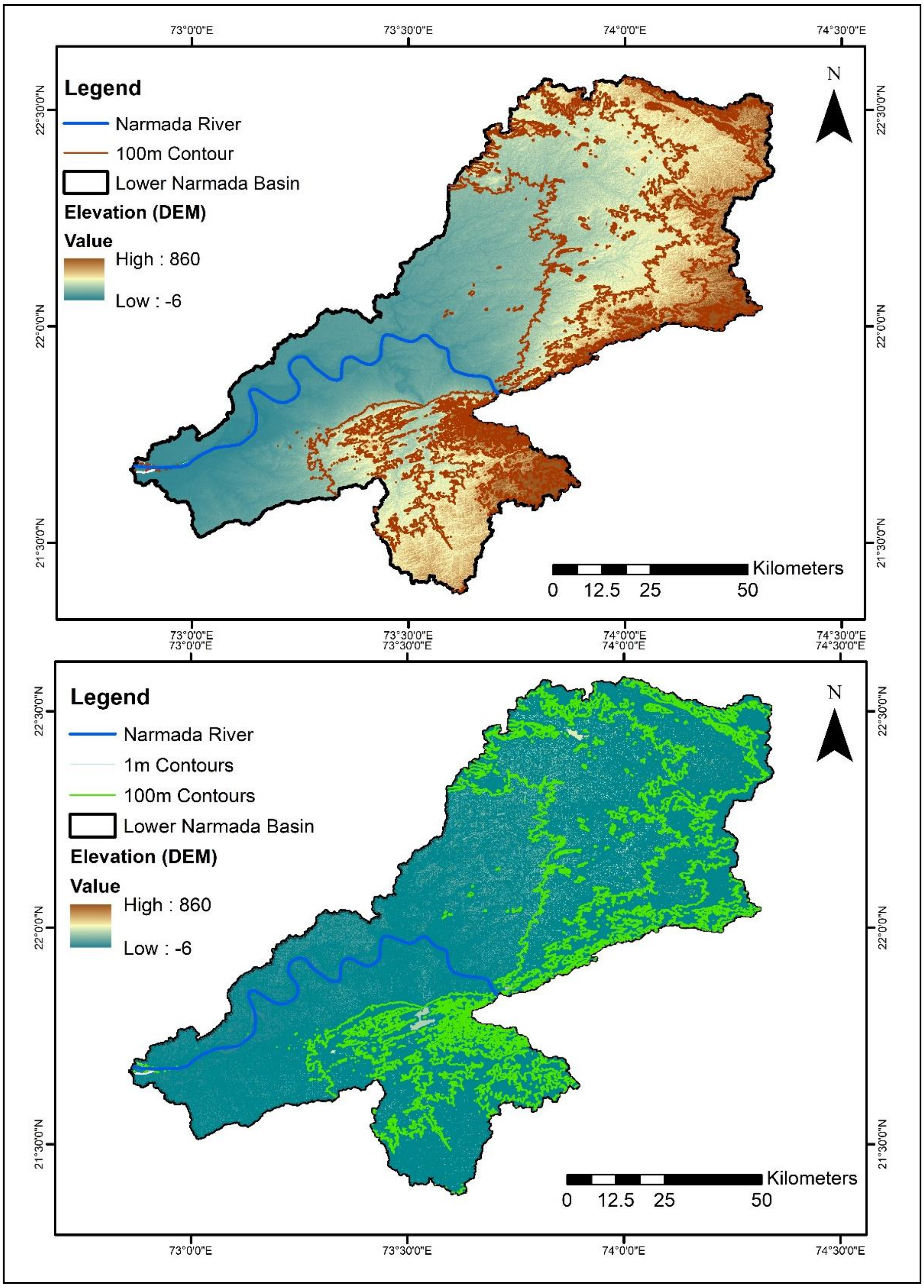

Fig. 09: Contour Map of Lower Narmada River basin with contour intervals of 100 m and 1m respectively

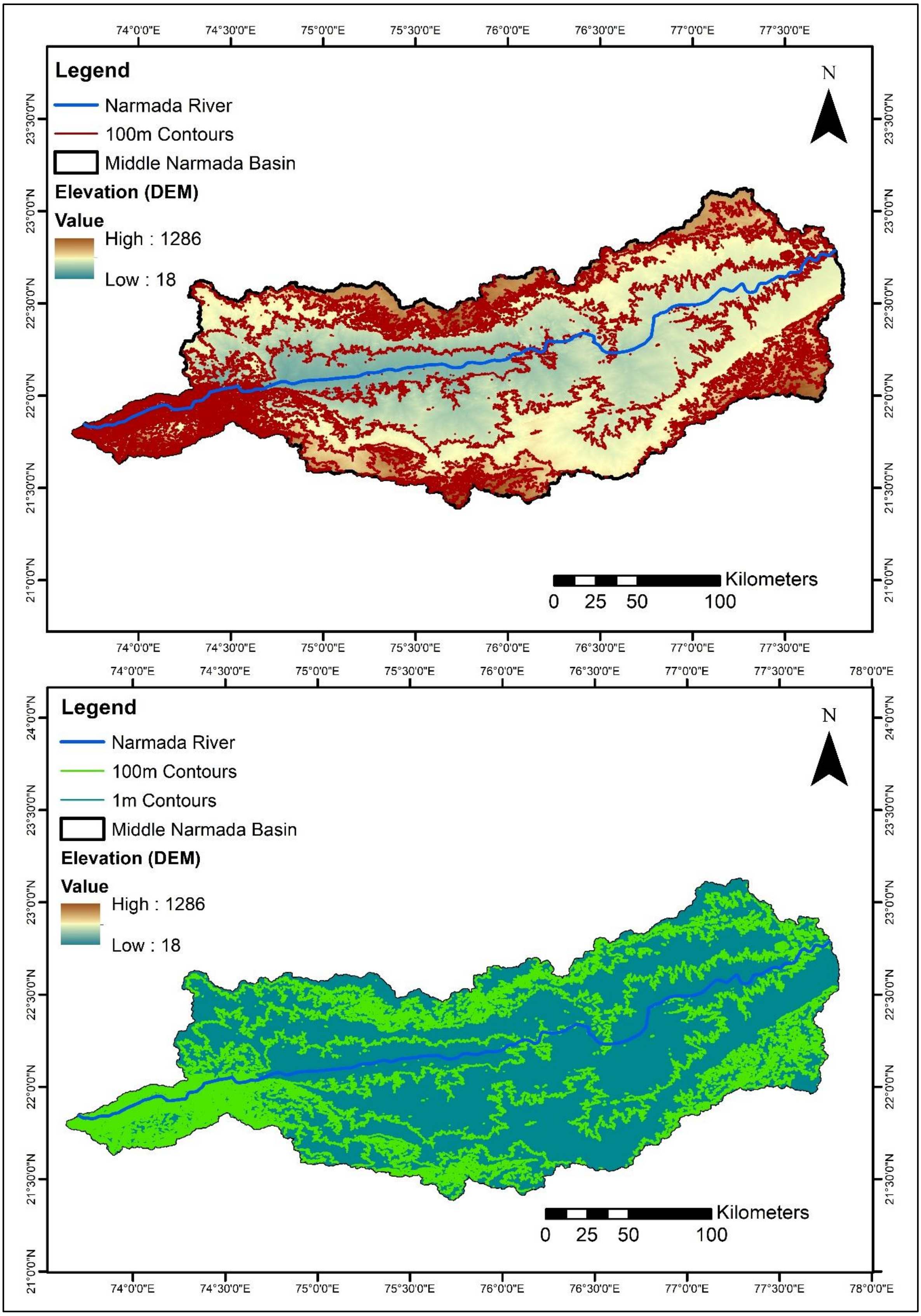

Fig. 10: Contour Map of Middle Narmada River basin with contour intervals of 100 m and 1m respectively

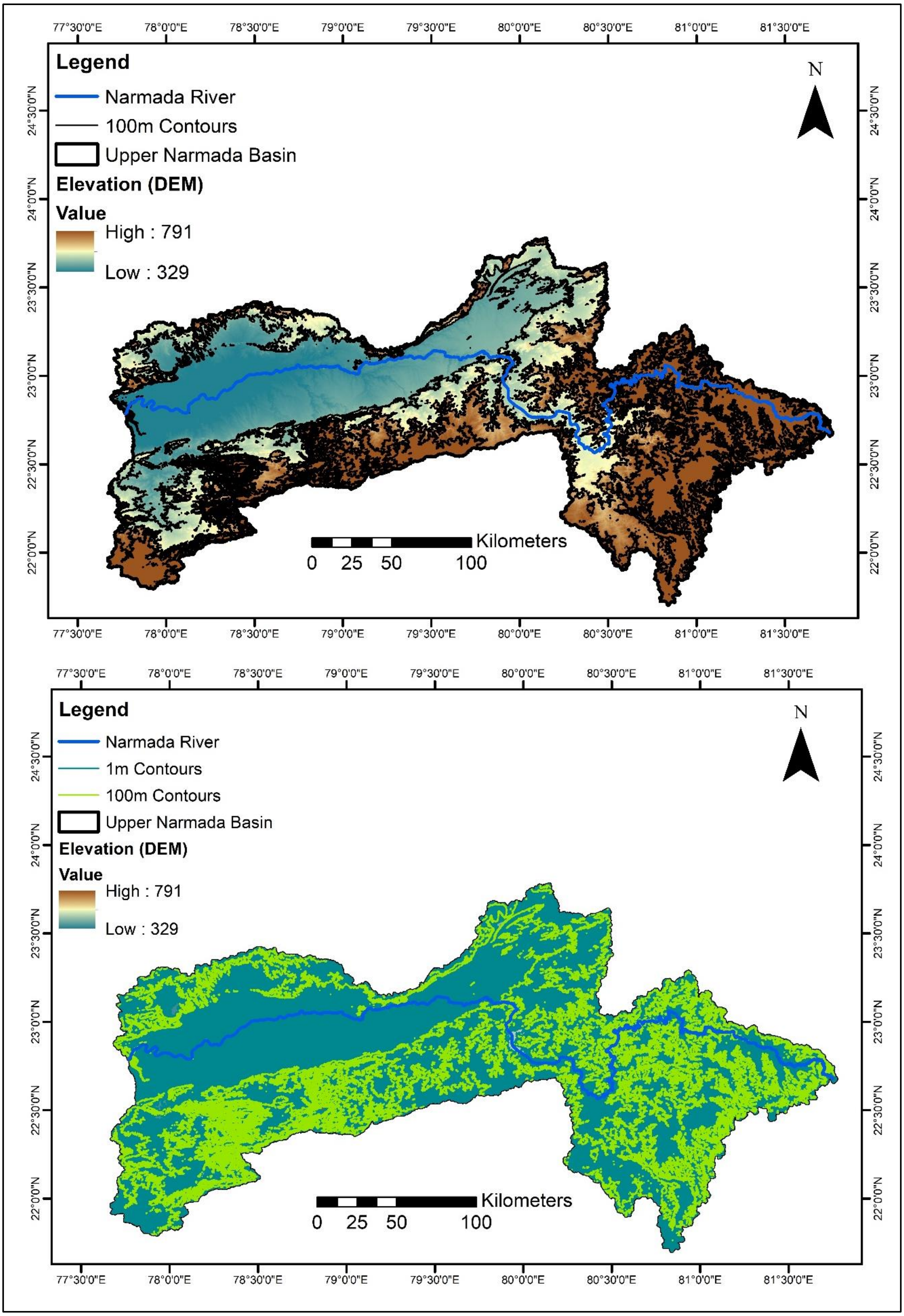

Fig. 11: Contour Map of Upper Narmada River basin with contour intervals of 100 m and 1m respectively

3.4 Terrain Feature Distribution of Narmada River Basin

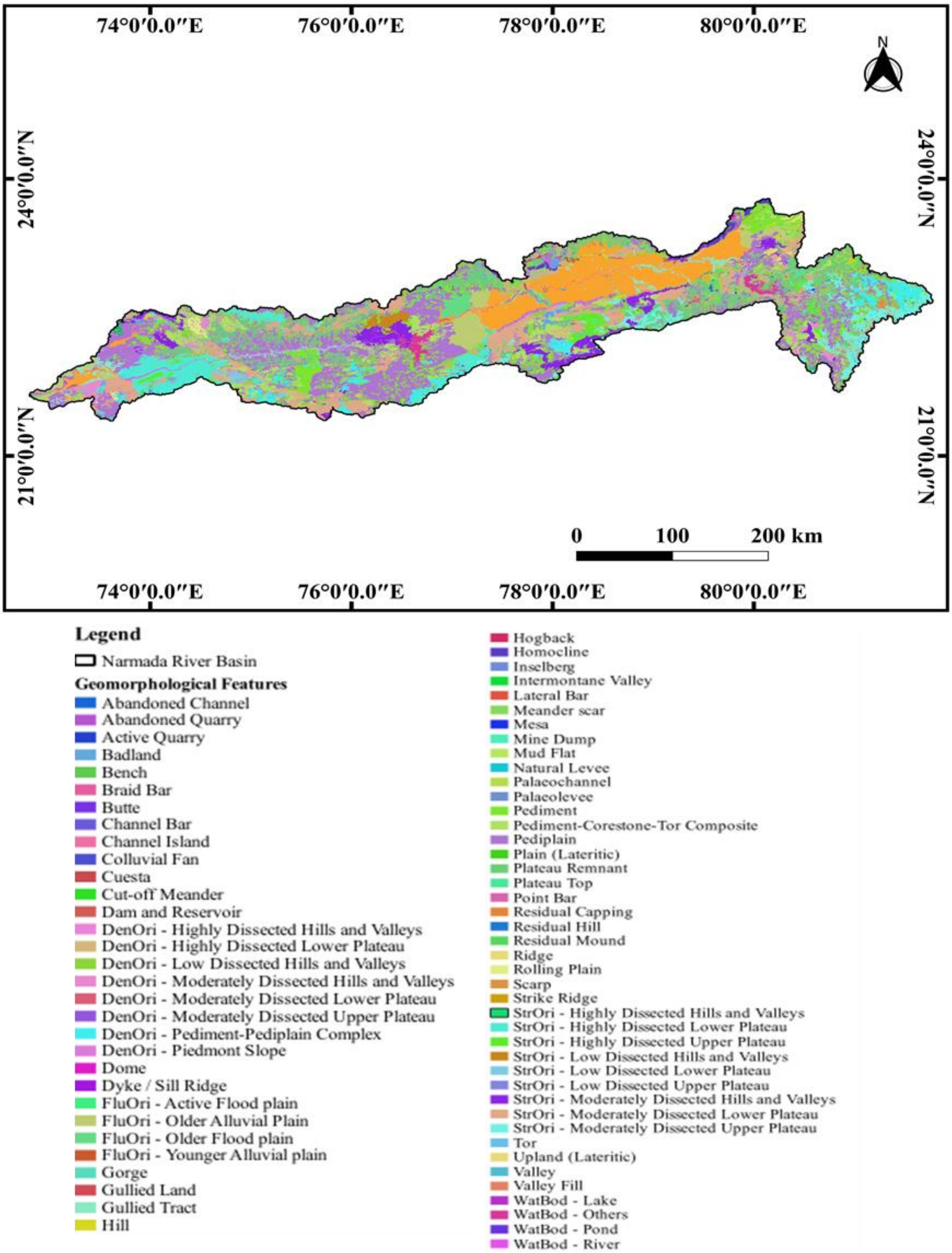

Fig. 12: Spatial distribution of geomorphological features across the Narmada River basin

To further enrich the topographic characterization of the Narmada River Basin, a geomorphological layer was integrated into the analysis, obtained from the BhuKosh portal developed by the Geological Survey of India (GSI). This layer provides detailed spatial information on landform types and terrain-forming processes, derived from remote sensing interpretation and field surveys. It includes a wide array of geomorphic features such as dissected hills, floodplains, pediments, ridges, valleys, and fluvial terraces, offering insight into both structural and fluvial controls that have shaped the basin's landscape over time. Thus, as shown in Figure 12, the geomorphological map reveals a highly diverse terrain composition across the basin. In the upper reaches, particularly near Amarkantak, the landscape is dominated by features such as residual hills, plateau remnants, and dissected upper plateaus, reflecting intense structural control and long-term erosional processes. These areas are associated with rugged terrain and steeper slopes, which correlate well with the elevation and slope maps discussed earlier.

The middle stretch of the basin, which lies within the structurally controlled Narmada Rift Valley, exhibits a mix of moderately dissected lower plateaus, floodplains, pediplains, and palaeochannels. This region is also marked by younger alluvial plains and valley fills, indicative of sustained fluvial activity and sediment deposition. The presence of features such as natural levees, point bars, and abandoned channels points to historical meandering and shifting of the river channel, consistent with the low-gradient terrain observed in slope and contour maps.

Further, in the lower reaches, near the Sardar Sarovar region and towards the mouth of the river, the terrain includes cuestas, dissected hills and valleys, and uplifted alluvial terraces, shaped by both fluvial erosion and tectonic uplift. The frequent occurrence of gullied lands, meander scars, and floodplain remnants in this region suggest episodes of channel instability, flash floods, and erosion-driven landform modification. Across the basin, several denudational features such as buttes, mesas, benches, and badlands are scattered, reflecting localized erosional resistance and variations in lithology. The distribution of structural features like strike ridges, domes, scarps, and hogbacks further supports the interpretation that the basin’s landscape is a result of complex interactions between tectonics, climate, and fluvial processes.

4. Applications

The datasets and methodologies employed in this report form the backbone of its findings, offering wide-ranging applications across policy, planning, infrastructure, and environmental management. The integration of high-resolution elevation data, hydrological modeling outputs, and geomorphological classifications provides a reliable and scalable framework for terrain-sensitive decision-making in the Narmada River Basin. The practical uses of these datasets are outlined below:

1. Policy Formulation: Policymakers can utilize the spatial insights derived from topographic and geomorphological layers to identify erosion-prone zones, flood-vulnerable areas, and stable regions suitable for development. This supports evidence-based policies in watershed management, soil conservation, and regional planning.

2. Infrastructure Planning and Design: The detailed slope, aspect, and contour datasets enable engineers and planners to select optimal locations for roads, canals, bridges, reservoirs, and flood-control structures. Contour and elevation data also guide structural design by accounting for terrain-induced challenges.

3. Watershed and Floodplain Management: Accurate delineation of watersheds and identification of drainage patterns using flow direction and flow accumulation layers are essential for micro-watershed planning, runoff management, and floodplain zoning. These layers assist in prioritizing sub-basins for conservation or intervention.

4. Land Use Suitability and Zoning: Topographic parameters are vital for assessing land capability and determining suitability for agriculture, forestry, or urban expansion. Areas with gentle slopes and favorable aspects can be designated for cultivation or settlement, while steep, dissected terrains can be conserved or afforested.

5. Environmental Monitoring and Conservation: The geomorphological diversity mapped from BhuKosh data provides insights into landform-driven ecological niches. These can guide habitat restoration, biodiversity conservation, and identification of geomorphologically sensitive zones that require protection.

6. Academic Research and Capacity Building: The datasets used—such as ALOS PALSAR DEM, Survey of India toposheets, and GSI's geomorphology maps—are valuable educational resources. They support research in geomorphology, hydrology, and GIS applications, and can be used in capacity-building programs for local authorities and communities.

Thus, by leveraging topographic data from different open sources, this report delivers actionable insights that form the foundation for informed planning, disaster preparedness, and sustainable development of the Narmada River Basin.

5. Conclusion

This report has presented a comprehensive topographic assessment of the Narmada River Basin using high-resolution ALOS PALSAR DEM, Survey of India toposheets, and geomorphological data from BhuKosh. The analysis focused on deriving and interpreting key terrain parameters—elevation, slope, aspect, flow direction, flow accumulation, contour intervals, and geomorphological units—to understand the physical landscape of the basin and its implications for planning and management.

The elevation analysis revealed that the majority of the basin lies within moderate elevation zones, with the most dominant area between 200–300 meters above mean sea level. Slope classification showed that 37.76% of the basin consists of very gently sloping surfaces, mainly in the middle section, supporting agriculture and settlement. Steeper slopes are found in the upper and lower reaches of the basin, where structural controls, escarpments, and dissected terrains dominate. Flow direction and flow accumulation maps confirmed the east-to-west drainage trend controlled by the Narmada Rift Valley structure, while also helping identify potential drainage pathways and convergence zones. The generation of contour maps at 100 m and 1 m intervals provided both basin-wide and micro-scale elevation detail, enhancing the interpretation of ridges, valleys, and floodplain boundaries. The geomorphological map further revealed a diverse terrain comprising of plateaus, pediplains, palaeochannels, floodplains, and residual hills, shaped by tectonic, fluvial, and erosional processes.

These insights form a robust foundation for terrain-sensitive decision-making. Based on the results of the analysis, the following recommendations are proposed:

1. Use in Watershed Planning: The delineated drainage network, slope categories, and flow accumulation patterns should be used to prioritize sub-watersheds for conservation, rainwater harvesting, and soil erosion control interventions.

2. Floodplain and Land Use Zoning: The gently sloping and low-elevation zones identified along the river channel are suitable for floodplain delineation and should be carefully zoned to prevent flood damage and regulate land use expansion.

3. Infrastructure Alignment: Contour, slope, and aspect data should guide the alignment and placement of roads, embankments, and check dams, ensuring compatibility with the natural terrain and minimizing construction risk.

4. Erosion Risk Reduction: Steep slope zones, particularly in the upper and lower basin, should be treated as high erosion-risk areas and prioritized for reforestation, gully plugging, and stabilization measures.

5. Site Suitability Analysis: The integration of 1 m contours with geomorphological mapping is useful for selecting suitable sites for small-scale interventions like farm ponds, recharge structures, and community reservoirs.

In conclusion, this topographic assessment provides essential spatial insights into the physical structure of the Narmada River Basin. The integration of terrain parameters with geomorphological interpretation enhances the understanding of natural processes shaping the basin and supports more informed, location-specific, and sustainable planning practices across sectors.

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