PIMPRI CHINCHWAD COLLEGE OF ENGINEERING & RESEARCH, RAVET, PUNE

(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

FINAL YEAR PROJECT REPORT

On

"GEOSPATIAL APPROACHES FOR DROUGHT VULNERABILITY ASSESSMENT IN THE MAUSAM RIVER BASIN"

Sponsored by:

Submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

In

CIVIL ENGINEERING

Submitted by:

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ACADEMIC YEAR: 2024–2025

CERTIFICATE

This is to certify that the work embodied in this Project Proposal Report entitled: **Geospatial Approaches For Drought Vulnerability Assessment In The Mausam River Basin.** The project work is submitted in partial fulfillment of the requirements for the award of the degree of Bachelor of Engineering in Civil Engineering of Pimpri Chinchwad College Of Engineering And Research, Pune. The content of this report is deemed satisfactory for the Phase I submission standard.

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ACKNOWLEDGEMENT

We express our sincere and heartfelt gratitude to our esteemed Project Guide, **Dr. Sahil S. Salvi**, for his invaluable guidance, technical expertise, unwavering support, and continuous encouragement throughout the initial phase of this project. His constructive criticism and vision were instrumental in shaping the direction of our research.

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Finally, we would like to thank our families and friends for their moral support, understanding, and encouragement, which were essential to the successful completion of this proposal.

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DECLARATION

We, the undersigned students of the Department of Civil Engineering, Pimpri Chinchwad College Of Engineering And Research, Pune, hereby declare that this Project Proposal Report entitled:"Geospatial Approaches For Drought Vulnerability Assessment In The Mausam River Basin "is an original work carried out by us in partial fulfillment of the requirements for the award of the degree of Bachelor of Engineering.

The work reported herein has not been submitted by us for the award of any other degree or diploma. The methodologies and preliminary findings presented are true and have been developed under the dedicated supervision of Dr. Sahil S. Salvi.

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Chapter 1

INTRODUCTION

1.1. BACKGROUND

The Mausam River Basin, located in Nashik district of Maharashtra, is one of the sub-basins of the Godavari River system. The basin has been facing increasing drought frequency and water scarcity over the past decade due to highly variable monsoon rainfall, rapid agricultural expansion, and unplanned land use changes. The semi-arid climatic conditions combined with over-extraction of groundwater have further worsened the situation.

Agriculture is the dominant occupation in the region, and irrigation demand heavily depends on seasonal rainfall and river flow. During prolonged dry spells, reduced river discharge and poor soil moisture conditions directly affect crop yield and livelihood stability. Moreover, deforestation and conversion of natural land to agricultural or built-up areas have significantly altered the hydrological response of the watershed — increasing surface runoff and reducing infiltration and groundwater recharge.

To manage this recurring drought situation efficiently, geospatial techniques such as Remote Sensing (RS) and Geographic Information System (GIS) offer valuable tools for understanding watershed characteristics, mapping vegetation health, monitoring surface water availability, and identifying the most vulnerable sub-basins. By integrating morphometric analysis with vegetation and water indices, the study can help in prioritizing areas for conservation and water management interventions in the Mausam River Basin.

1.2. PROBLEM STATEMENT

The Mausam River Basin frequently experiences seasonal droughts due to irregular rainfall patterns, increased agricultural pressure, and unsustainable land-use practices. Although the region's vulnerability is widely recognized, there has been no comprehensive geospatial assessment integrating morphometric, hydrological, and environmental parameters.

This lack of integration limits the ability to accurately identify drought-prone zones and to plan targeted watershed management interventions. Without such analysis, water resource planning remains fragmented and ineffective, leading to continued agricultural losses, groundwater depletion, and ecosystem degradation

1.3. AIM OF PROJECT

To maximize the benefit of water used based on watershed management by morphometric parameters and prioritization of sub basins for present land use of Mausam River basin using RS and GIS

1.4. OBJECTIVES OF PROJECT

1. To analyze the arrangement of streams and rivers within the watershed to understand the flow paths and drainage network.
2. To understand how the watershed morphology influences the hydrological response to precipitation events, including runoff generation and flow pathways.
3. To analyze the IRS-LISS-III image and produce a map of Mausam River watershed land-use, land cover (LULC), Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI) .
4. Using morphometric data to predict areas within the watershed that are prone to flooding and drought.

1.5. SCOPE AND LIMITATIONS

A. Scope

The project scope is defined by the following boundaries:

1. Geospatial Focus: The analysis will be strictly confined to the boundary of the Mausam River Basin in the Nashik district, Maharashtra.
2. Integrated Analysis: The project focuses on the integrated use of geospatial data (DEM, Satellite Imagery) and two major analytical methods: Morphometric Analysis and Drought Vulnerability Indexing (using LULC and NDVI).
3. Deliverable: The final outcome will be a priority map offering actionable recommendations for water conservation measures.

B. Limitations

The study is subject to the following constraints:

1. Data Resolution Dependency: The accuracy of the morphometric results is constrained by the 30-meter spatial resolution of the Digital Elevation Model (DEM) data used.
2. Model Accuracy: The results will be dependent on the performance of the Supervised Classification technique used for LULC mapping and the robustness of the Weighted Overlay Model.
3. No Primary Data: The study is based on secondary geospatial data and will not involve extensive field surveys or the collection of primary hydrological data

Chapter 2

LITERATURE REVIEW

Following are the literature reviews of the project:

1. ***Komal G. Rokade, Reshma B. Kadlag, Omkar D. Rajmane, Virendra N. Barai, and Ravindra D. Bansod , "Morphometric analysis of watershed using remote sensing and GIS: A case study of Darna River Basin in Maharashtra, India."***
   (Source: International Journal of Advanced Biochemistry Research,2025)
   A GIS-based morphometric analysis of the Darna River Basin (1,308 km^2) in Maharashtra was carried out using ArcGIS, QGIS, and Cartosat DEM to assess drainage characteristics and erosion potential. The study found moderate drainage density (1.35 km^{-1}) and structurally controlled drainage patterns, indicating balanced infiltration and runoff. High relief ratio (3.77) and semi-circular basin shape revealed zones prone to soil erosion. The research demonstrated that geospatial morphometric analysis effectively supports watershed prioritization and conservation planning, which is directly applicable to the present Mausam River Basin study.

2. ***Niharika Tiwari , Pratik Kumar Mishra and Vinod Kumar Tripathi , "Assessment of spatio-temporal variation in seasonal land surface temperature and its relationship with spectral land use indices in Varanasi "***
   (Source : Discover Cities, 2025)
   A study on Varanasi, India (1993–2023) used Landsat data to analyze the relationship between Land Surface Temperature (LST) and land-use indices (NDVI, NDBI, NDWI). Results showed that LST increased with urbanization and had a positive correlation with NDBI but a negative correlation with NDVI and NDWI, indicating that vegetation and water bodies reduce surface heat. The study highlights the role of land-cover changes in thermal variation and supports the use of remote sensing indices for assessing environmental and drought conditions, relevant to the present Mausam River Basin analysis.

3. ***Hassan Taib, Riheb Hadji, Younes Hamed, "Erosion patterns, drainage dynamics, and their environmental implications: a case study of the hammamet basin using advanced geospatial and morphometric analysis"***
   (Source: Journal of Umm Al-Qura University for Applied Sciences,2025)
   A morphometric study using Aster DEM (30 m) and ArcGIS analyzed eight sub-watersheds through a weighted sum approach to assess erosion risk and watershed prioritization. Compound factor values (−0.128 – 9.28) indicated varying erosion susceptibility, with Basins 4, 7, and 1 most prone to soil erosion. The study proved that DEM-based morphometric and weighted analysis effectively identifies vulnerable sub-basins for soil and water conservation, supporting the present Mausam River Basin research approach.

4. ***Subhash Anand, Harish Kumar, Pankaj Kumar, and Manish Kumar, "Analyzing landscape changes and their relationship with land surface temperature and vegetation indices using remote sensing and AI techniques"***
(Source: Geoscience Letters,2025)
A study on Baghpat District, Uttar Pradesh (1991–2021) used multitemporal Landsat imagery and geospatial techniques in ENVI and ArcGIS to analyze LULC changes and their relationship with NDVI, LST, and SAVI. Results showed a rise in agricultural land (from 58.94% to 84.79%) and a sharp decline in vegetation cover (from 29.53% to 1.14%), with strong negative correlations between NDVI/SAVI and LST. The findings highlighted that vegetation loss and land conversion significantly impact surface temperature and soil health, demonstrating the usefulness of remote sensing indices in assessing drought and land degradation—an approach aligned with the present Mausam River Basin study.

5. ***Weynshet Tesfaye, Eyasu Elias, Bikila Warkineh, Meron Tekalign, and Gebeyehu Abebe, "Modeling of land use and land cover changes using google earth engine and machine learning approach: implications for landscape management"***
(Source: Environmental Systems Research,2024)
A study on the Robit Watershed (Ethiopia) examined 30 years (1993–2023) of Land Use Land Cover (LULC) dynamics using Landsat imagery and machine learning algorithms (Random Forest, SVM, CART) in the Google Earth Engine (GEE) platform. The Random Forest classifier achieved the highest accuracy (OA = 95.6%, K = 0.94) when spectral indices and topographic variables were integrated. Results showed a decline in agricultural and forest areas and a progressive rise in built-up and bare lands, mainly driven by population growth and urban expansion. The study proved that GEE-based machine learning enables highly accurate LULC mapping and supports sustainable watershed management — aligning with the present Mausam River Basin project's use of GEE for NDVI, NDWI, and drought-vulnerability mapping.

6. ***Jemal Ali Mohammed, Temesgen Gashaw, , Zinet Alye Yimam , "Erosion-Prone Watershed Identification using Morphometric Analysis and GIS"***
(Source :Natural Hazards (Journal Article),2024)
A study on the Jemma Sub-Basin (Abbay Basin, Ethiopia) used morphometric parameter analysis and GIS with a 12.5 m DEM to prioritize seven sub-watersheds based on their soil erosion susceptibility. Sub-watersheds SW-5, SW-2, and SW-1 were found most vulnerable, requiring urgent soil and water conservation. The integration of remote sensing and GIS improved watershed characterization and erosion-risk mapping, highlighting the role of morphometric parameters in sustainable watershed management. The study emphasized that upstream erosion control and prioritization are vital for resource allocation and long-term watershed stability — an approach consistent with the present Mausam River Basin drought and watershed assessment.

7. ***Chaitanya B. Pande, Kanak N. Moharir, S. F. R. Khadri, "Assessment of land-use and land-cover changes in Pangari watershed area (MS), India, based on the remote sensing and GIS techniques"***
(Source: Applied Water Science,2021)
A study using Landsat and LISS-III satellite data (2008–2017) applied supervised classification (MLC) and NDVI analysis to map Land Use and Land Cover (LULC) changes in a semi-arid watershed. Results showed a 95% classification accuracy, with a notable increase in built-up and wasteland areas and a decline in agricultural and vegetative cover due to human activities and environmental stress. NDVI values (ranging from −0.53 to 0.11) reflected a steady decrease in vegetation health. The study confirmed that remote sensing and GIS techniques are efficient tools for monitoring land-use dynamics and guiding watershed management and agricultural planning, aligning with the present Mausam River Basin assessment.

8. ***Ashish Mani, Maya Kumari, and Ruchi Badola, "Morphometric Analysis of Suswa River Basin Using Geospatial Techniques."***
(Source :Engineering Proceedings, MDPI, Vol. 27, Paper 65,2022)
A study on the Suswa River Basin utilized SRTM DEM (30 m resolution) and ArcGIS Spatial Analysis Tools to perform a comprehensive morphometric analysis of the drainage basin. The results showed a sub-dendritic to dendritic drainage pattern with an average drainage density of 2.84 km/km² and an elongation ratio of 0.46, indicating a moderately elongated basin with moderate relief. The study emphasized that GIS-based morphometric analysis effectively reveals hydrological and geomorphological characteristics, which are crucial for watershed management and natural resource planning. It also highlighted that such analyses help identify infiltration zones, runoff behavior, and erosion-prone areas, enabling planners to design efficient surface water and groundwater management strategies.

9. ***Dr. Jaykumar S. Patel, Dr. Gaurang R. Chaudhari, "Identification of critical watershed using hydrological model and drought indices: a case study of upper Girna, Maharashtra, India"***
(Source : International Journal of Research in Engineering and Technology (IJRET), Vol. 03, Issue 09,2014)
A study conducted on the Upper Girna Sub-basin, Nashik, utilized the SWAT (Soil and Water Assessment Tool) model along with Reconnaissance Drought Index (RDI) and Streamflow Drought Index (SDI) to assess meteorological and hydrological drought conditions in a semi-arid ungauged catchment. The model was calibrated for the period 1981–2000 and validated for 2001–2010 using observed inflow data from the Girna Dam. The results highlighted specific sub-watersheds (8, 11, 12, 14, 16, 18, 3, 7, 20, 23, 24, 25) as being most prone to drought and runoff variability. The study demonstrated that integrating SWAT modeling with drought indices is highly effective in identifying critical and vulnerable watersheds for implementing water conservation, recharge, and drought mitigation measures. It emphasized that such modeling can guide local water resource management and policy-making in semi-arid regions like Nashik.

10. ***Amee K. Thakkar and S.D. Dhiman, "Morphometric Analysis and Prioritization of Miniwatersheds in Mohr Watershed, Gujarat Using Remote Sensing and GIS Techniques"***
(Source :Photonirvachak: Journal of the Indian Society of Remote Sensing, Vol. 35, No. 4 ,2007)
A study conducted on the Mohr watershed in Gujarat performed morphometric analysis and prioritization of eight mini-watersheds using Remote Sensing and GIS techniques. Key morphometric parameters such as stream length, bifurcation ratio, drainage density, stream frequency, texture ratio, form factor, circularity ratio, elongation ratio, and compactness ratio were analyzed. The watershed exhibited a dendritic drainage pattern, indicating natural stream development influenced by geological structure. The study found that the bifurcation ratio reached up to 9.5, suggesting strong structural control on drainage. Using a compound parameter approach, the 5F2B5b2 mini-watershed was identified as the most erosion-prone and was given highest conservation priority.
The research demonstrated the usefulness of GIS-based morphometric analysis for watershed prioritization, aiding in effective soil and water conservation planning. This approach provides a scientific framework for identifying erosion-susceptible areas and guiding sustainable watershed management practices.

Literature Review Summary

Various studies highlight the effectiveness of GIS and remote sensing in watershed management and morphometric analysis. Research on the Darna River Basin and Mohr watershed demonstrated how morphometric parameters help identify erosion-prone areas for conservation planning. Studies in Ethiopia's Jemma and Robit basins and Baghpat District (U.P.) emphasized the importance of LULC mapping, DEM-based analysis, and vegetation indices (NDVI, NDBI, NDWI) for monitoring environmental and hydrological changes. Work on the Girna River Basin used SWAT modeling and drought indices to identify critical sub-watersheds and assess runoff behavior.

Overall, the reviewed literature confirms that integrating GIS, remote sensing, and morphometric analysis provides a powerful approach for understanding drainage behavior, soil erosion, and land-use dynamics, supporting sustainable watershed and resource management — forming the scientific foundation for the Mausam River Basin study.

Chapter 3

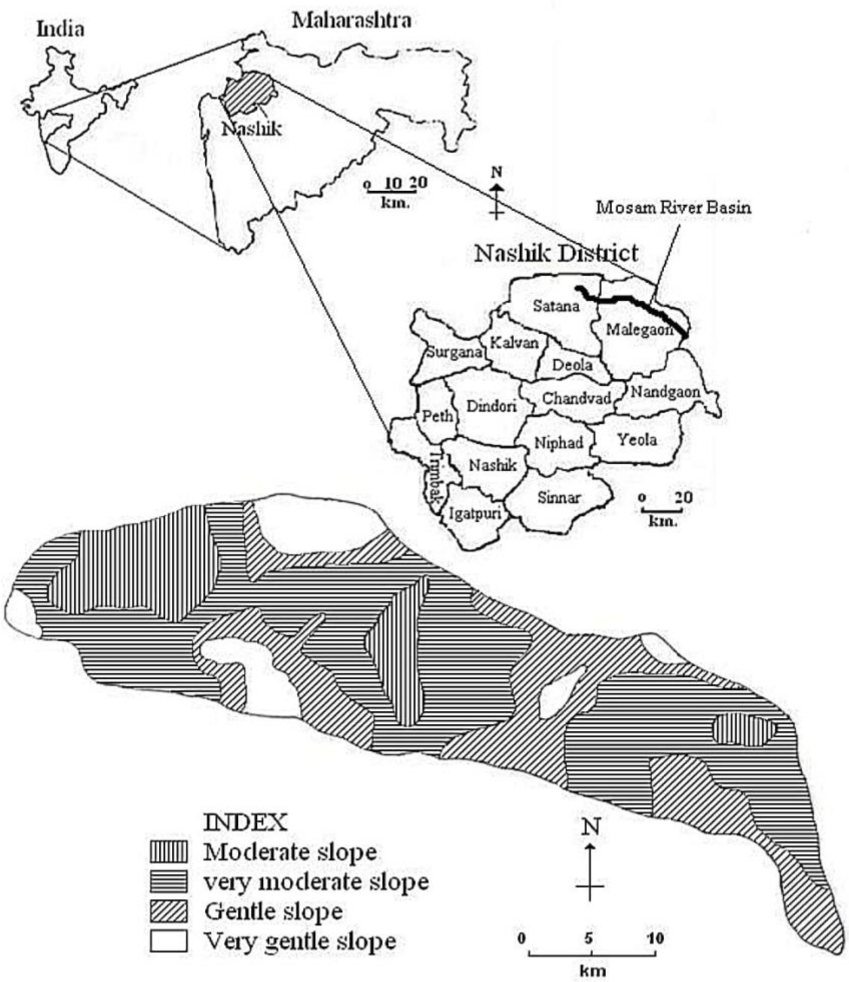
STUDY AREA

3.1. INTRODUCTION

The study area which is a sub basin of Girna River Basin is located in the north part of Nashik district in Maharashtra. Mosam River lies in the Tapi drainage system. Mosam is the tributary of river Girna and Girna is the tributary of River Tapi. Northern divide of the basin is the district boundary between Nasik and Dhulia, Nandurbar district. Western divide is the boundary between Nasik and Dang district (Gujarat State). From the hill fort (Salher) of western divide overlooking the Konkan. There are five branches of the Sahyadri tending eastwards along the Mosam river basin i.e. Satmala ranges. Small streams of Mosam descend from the hills, most of them containing water.

Narrow belts of level land bearing good soil are found on both the banks of Mosam and its tributaries. It is extend from 20˚ 32’ to 20˚ 52’ North latitude and 73˚ 56’ to 74˚ 32’ 20” East longitude .It covers an area of 501 sq. km. and its total length is 85 km. The average annual rainfall of the basin various between 899 mm. to 508 mm.

Location Map and Average Slope Map of Mosam River Basin



Mosam basin entirely lies on the Deccan Trap. The existing rock of trap is basalt. With regards to soil, little needs to be said from geological point of view. The valley is filled disintegrated basalt of various sheds from gray to black, washed by rain. It is an argillaceous nature and its color depends greatly upon the organic matter and length of time, it has been exposed to the air.

3.2. AREA DETAILS

River Name	Mausam River
Tributary of	Girna River
Taluka	Baglan
District	Nashik
State	Maharashtra
Latitude Range	20°31' N to 20°43' N
Longitude Range	74°0' E to 74°32' E

Chapter 4

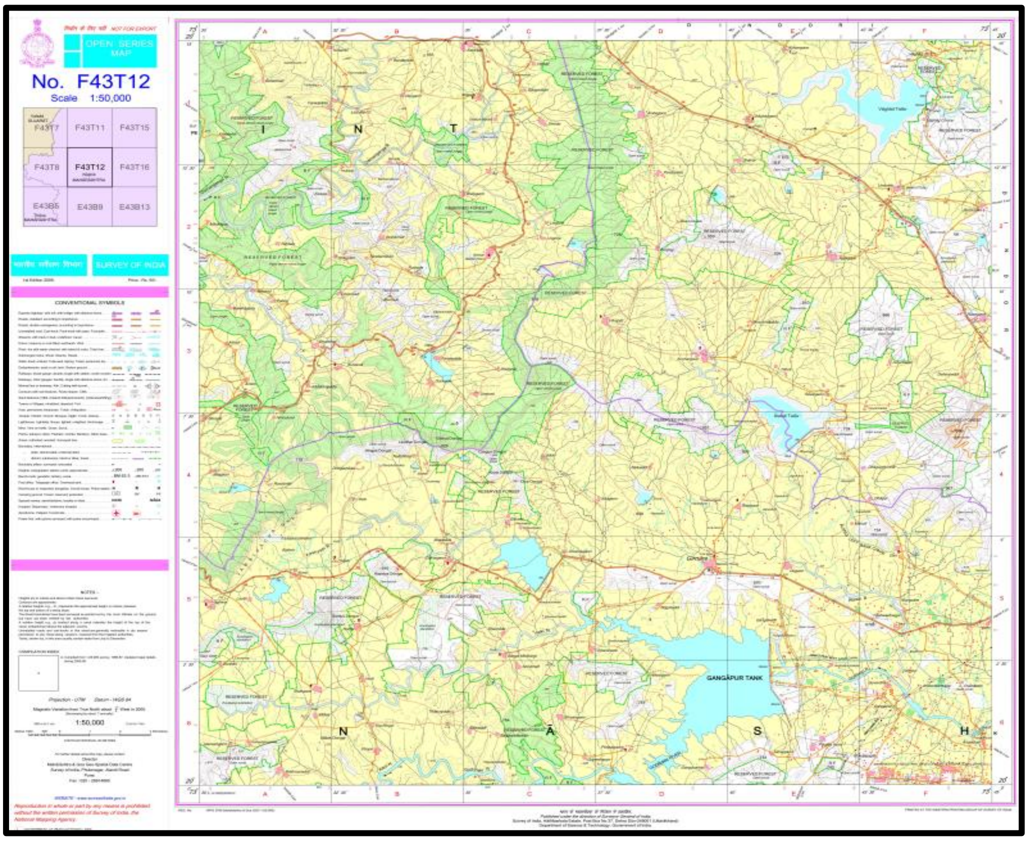
DATA COLLECTION

4.1. DATA SET REQUIRED

1. Toposheet
2. Digital Elevation Model
3. Satellite Images
4. Rainfall Data
5. Geology/ Soil
6. LULC Map

4.1.1. Toposheet

Survey of India toposheets at 1:50,000 scale covering the Baglan, Satana, and Malegaon talukas were used as the base map for the Mausam River Basin. The sheets provide detailed information on contours, drainage, settlements, transport networks, and elevation points. These sheets form the foundation for the delineation of the basin boundary and validation of the stream network derived from the DEM. The accurate representation of natural and man-made features supports the spatial alignment of all subsequent datasets and ensures the precision of hydrological mapping in the basin.



Toposheet No.	46H/12
Scale	1:50,000
OSM No.	F43T12
Area	Nashik
State	Maharashtra
Country	India

4.1.2. Digital Elevation Model (DEM)

The Cartosat-1 Digital Elevation Model (30 m) provided by NRSC-Bhuvan was used to generate topographic parameters such as slope, aspect, flow direction, and flow accumulation. The DEM represents the elevation surface of the Mausam Basin, which ranges from about 1,200 m in the western highlands near the Saptashrungi region to about 500 m in the eastern plains. It was further processed to delineate the watershed boundary, identify sub-basins, and derive morphometric parameters including drainage density, bifurcation ratio, and relief ratio. These features play a crucial role in understanding surface runoff patterns and identifying drought-prone regions within the basin.

4.1.3. Satellite Image

For drought and vegetation analysis, Sentinel-2 MSI (10 m) and Landsat-8 OLI (30 m) satellite imagery were used.

Sentinel-2 (ESA): Provides high-resolution multispectral data for vegetation and water-body mapping.

Landsat-8 (USGS): Offers long-term historical records for trend comparison.

Indices calculated:

NDVI = (NIR − RED)/(NIR + RED) → Vegetation health

NDWI = (GREEN − NIR)/(GREEN + NIR) → Surface-water presence

4.1.4. Rainfall Data

Rainfall data for the Mausam River Basin was obtained from the India Meteorological Department (IMD), Pune. The basin mainly falls under Baglan, Satana, and Malegaon talukas of Nashik District.

Average annual rainfall ranges from 620 mm – 950 mm, showing clear west–east decline due to orographic influence of the Western Ghats. The year 2024 recorded above-normal rainfall (+18 %), while 2022 was a moderately dry year.

Rainfall Distribution- Mausam River Basin (in mm)
(source: IMD District Rainfall Statistics, 2020-2024)

Year	Avg. Basin Rainfall (in mm)	Conditions
2020	793	Normal
2021	818	Normal
2022	689	Deficient
2023	906	Above Normal
2024	972	Excess

4.1.5. Geology/ Soil

Geological mapping for the Mausam Basin was derived from the Geological Survey of India (GSI, 2023). The basin is almost entirely underlain by Deccan Trap Basalt, comprising layered compact and vesicular flows. Limited alluvium occurs along major river courses and the Haranbari reservoir. Soils are predominantly black cotton (vertisols) in plains and red / lateritic soils in the uplands.

Geological and Soil Composition — Mausam River Basin
Source: Geological Survey of India (GSI 2023), CGWB District Groundwater Brochure (Nashik 2023).

Soil type	Area(km^2)	% of basin	Hydro- geological behaviour
Compact Basalt	243.8	41.6	Low permeability High runoff
Vesicular/ Amygdaloial Basalt	215.4	36.8	Moderate Secondary porosity Good Recharge

Alluvium/ Valley Fill	47.3	8.1	High Infiltration along rivers
Lateritic/ Red Soil	36.1	6.2	Well drained uplands
Black cotton Soil	43.7	7.3	High water holding Poor drainage

4.1.6. Land Use Land Cover

Land-use data was obtained from the NRSC Annual LULC Atlas of India (2022-23) and validated using Sentinel-2 imagery (2023). The Mausam Basin is dominated by agriculture, with notable forest cover on the western uplands and scattered built-up growth near Satana and Malegaon.

LULC Distribution — Mausam River Basin

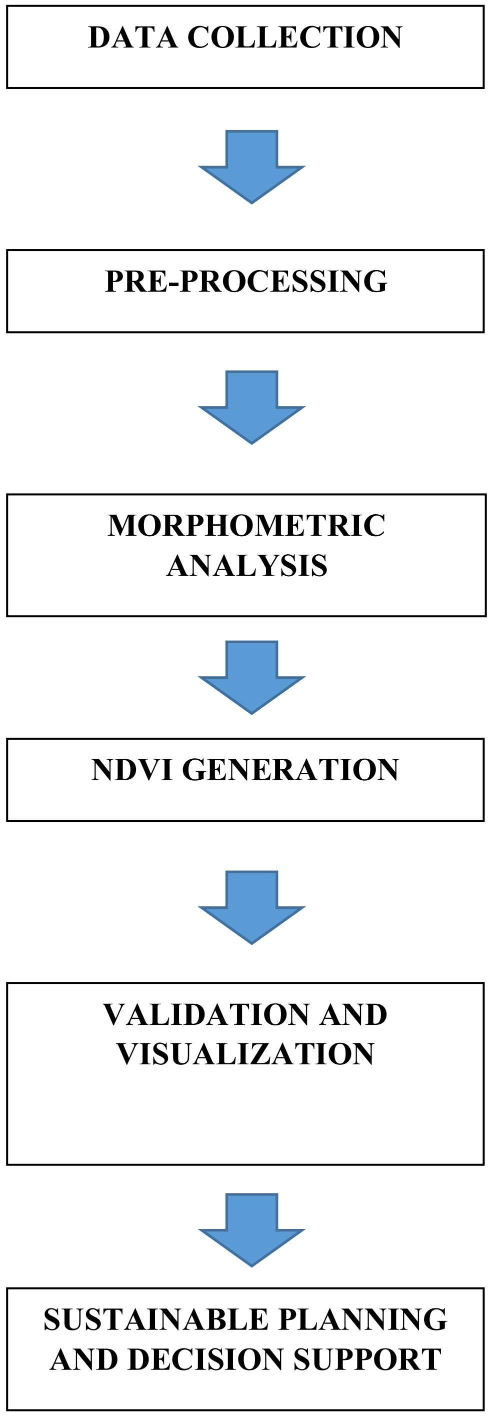
(Source: NRSC LULC Atlas 2022-23 (56 m resolution), validated with Sentinel-2 2023)

LULC Category	Area(km²)	%of basin
Agriculture	368.4	62.7
Forest	87.6	14.9
Barren land	55.1	9.4
Built-up area	49.3	8.4
Water Bodies	26.2	4.6

Chapter 5

METHODOLOGY

5.1. FLOWCHART



5.2. STEPS

5.2.1. DATA COLLECTION

In the first stage, all necessary spatial and non-spatial datasets were collected from authentic sources. The following datasets were used:

1. Toposheet
2. DEM
3. Satellite Image
4. Rainfall data
5. LULC data
6. Geology &Soil Data

5.2.2. PRE-PROCESSING

The Digital Elevation Model (DEM) was processed to extract topographic and hydrological features of the Mausam River Basin.

- The DEM was projected and clipped to the basin boundary.
- Fill Sink operation was applied to remove surface depressions.
- Flow Direction and Flow Accumulation layers were derived using ArcGIS Hydrology Tools.
- The Stream Network was extracted automatically using a threshold flow-accumulation value.
- The Basin Boundary was delineated based on the outlet point near Malegaon.
- These derived datasets formed the foundation for further morphometric analysis.

5.2.3. MORPHOMETRIC ANALYSIS (USING ARCGIS / RS TOOLS)

Morphometric analysis quantifies the basin's geometric, linear, areal, and relief aspects to evaluate its hydrological behavior.

Aspect	Parameter	Purpose
Linear	Stream order, Stream number, Stream length, Bifurcation ratio	Indicates drainage maturity and runoff potential
Areal	Basin area, Perimeter, Drainage density, Stream frequency, Elongation ratio, Form factor	Determines infiltration vs. runoff relationship
Relief	Basin relief, Relief ratio, Ruggedness number	Indicates erosion susceptibility and slope characteristics

5.2.4. NDVI GENERATION

The Normalized Difference Vegetation Index (NDVI) was derived from Sentinel-2 imagery (bands 4 and 8):

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)}$$

- NDVI was classified into five vegetation density zones: Very Low, Low, Moderate, High, and Very High.
- NDVI values were compared with rainfall data (2020–2024) to analyze vegetation stress patterns during drought years.
- A significant NDVI reduction was observed in 2022 (a deficient rainfall year).

5.2.5. VALIDATION AND VISUALIZATION

- Validation of derived data was performed through:
- Comparison of NDVI and rainfall trends (correlation analysis).
- Visual inspection using Google Earth Pro and Bhuvan Thematic Services.
- Overlay of LULC, slope, and drainage layers to verify spatial relationships.
- Final thematic maps (LULC, slope, NDVI, drainage density) were prepared using QGIS Layout Manager with proper legends, scale, and north arrow.

5.2.6. SUSTAINABLE PLANNING AND DECISION SUPPORT

Based on morphometric and NDVI outcomes, zones of high drought vulnerability were identified. Recommendations were made for sustainable watershed management, including:

- Construction of check dams and percolation tanks in high-runoff zones.
- Promotion of afforestation and agroforestry in degraded lands.
- Implementation of efficient irrigation practices in moderate-vulnerability zones.
- Rainwater harvesting structures near settlements for groundwater recharge.

5.3. SOFTWARE EXPOSURE

In the present study, two major geospatial software platforms — ArcGIS Pro and Google Earth Engine (GEE) — were used for data analysis, spatial processing, and visualization. These platforms together enabled efficient handling of remote-sensing and terrain data for assessing drought vulnerability within the Mausam River Basin.

5.3.1. ARC GIS PRO

ArcGIS Pro, developed by ESRI, served as the primary GIS environment for carrying out Digital Elevation Model (DEM) processing and hydrological modeling. The software was used to delineate the watershed and drainage network, generate slope and flow-accumulation maps, and compute various morphometric parameters under linear, areal, and relief aspects. Using the Cartosat-1 DEM, ArcGIS Pro facilitated detailed analysis of terrain characteristics such as drainage density, bifurcation ratio, elongation ratio, and relief ratio, which are essential for understanding the hydrological behavior of the basin.

5.3.2. GOOGLE EARTH ENGINE

Google Earth Engine (GEE), a cloud-based remote-sensing and data-processing platform developed by Google LLC, was employed for analyzing multispectral Sentinel-2 satellite imagery. The platform was used to generate Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI) layers to identify vegetation stress and surface-water availability conditions. The temporal NDVI and NDWI datasets derived from GEE were further utilized to map vegetation health and to classify drought-prone areas across the basin.

Chapter 6

EXPECTED RESULTS AND OUTCOMES

The present study aims to assess drought vulnerability in the Mausam River Basin, Nashik district, using integrated Remote Sensing (RS) and Geographic Information System (GIS) techniques. Based on the adopted methodology, the expected results and outcomes of the project are outlined below.

6.1 Watershed and Sub-Basin Delineation

Using the Cartosat-1 Digital Elevation Model (DEM), the entire Mausam River Basin will be delineated and divided into smaller sub-basins. This delineation will help in understanding the topographical variation and hydrological behavior of the basin. The expected outcome is the generation of:

- A Watershed Boundary Map showing the spatial extent of the Mausam Basin.
- Sub-basin maps indicating individual drainage divisions.
- These maps form the foundation for all subsequent morphometric and hydrological analyses.

6.2 Slope and Drainage Analysis

Slope maps and drainage density maps will be generated from the DEM using ArcGIS Pro.

- Slope Map: Shows the variation in terrain steepness, which affects surface runoff, infiltration, and erosion potential.
- Drainage Density Map: Highlights the distribution and intensity of stream networks, providing insight into the infiltration capacity of the basin.

Together, these maps will aid in identifying areas prone to high runoff and low infiltration, which are critical indicators for drought vulnerability.

6.3 Morphometric Analysis Results

Morphometric parameters, including bifurcation ratio, elongation ratio, relief ratio, and form factor, will be computed for each sub-basin.

These parameters will provide quantitative measures of:

- Basin shape and drainage pattern
- Runoff behavior
- Potential for groundwater recharge

The expected outcome is a Morphometric Characterization Table summarizing linear, areal, and relief aspects, which will be used for sub-basin prioritization.

6.4 NDVI and NDWI Mapping

Using Sentinel-2 imagery processed through Google Earth Engine (GEE), vegetation and water indices will be derived.

- NDVI (Normalized Difference Vegetation Index): Indicates the greenness and health of vegetation cover.
- NDWI (Normalized Difference Water Index): Represents surface water presence and moisture availability.

The expected outcome includes NDVI and NDWI maps showing zones of vegetation stress and water scarcity, which are direct indicators of drought-prone regions.

6.5 Composite Drought Vulnerability Mapping

A composite drought vulnerability map will be prepared by integrating morphometric, LULC, rainfall, and NDVI parameters using weighted overlay analysis in ArcGIS.The map will classify the Mausam River Basin into Low, Moderate, and High Vulnerability Zones.This map will serve as a crucial tool for identifying the most drought-affected areas and prioritizing regions for water conservation measures.

Chapter 7

PROPOSED WORKFLOW & PROJECT TIMELINE

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