



Original Article

# Integrated Geospatial Analysis for Land Suitability Assessment for Agriculture in Amravati Basin

Dr. Satish Patil

S V Ss Dadasaheb Rawal College Dondaicha

Manuscript ID:

IBMIIRJ -2025-020804

Submitted: 05 July 2025

Revised: 10 July 2025

Accepted: 05 Aug 2025

Published: 31 Aug 2025

ISSN: 3065-7857

Volume-2

Issue-8

Pp. 14-18

Aug 2025

Correspondence Address:

Dr. Satish Patil, S V Ss Dadasaheb

Rawal College Dondaicha

Email: [satishgeography@gmail.com](mailto:satishgeography@gmail.com)



Quick Response Code:



Web: <https://ibrj.us>



DOI: 10.5281/zenodo.17120532

DOI Link:

<https://doi.org/10.5281/zenodo.17120532>



Creative Commons

## Abstract

The assessment of agricultural land suitability is vital for promoting sustainable land use and optimizing agricultural productivity, particularly in semi-arid regions like the Amravati River Basin in Maharashtra, India. This study aims to evaluate land suitability using integrated geospatial techniques and multi-criteria decision analysis (MCDA) through the Analytical Hierarchy Process (AHP). Various thematic layers such as soil, slope, land use/land cover (LULC), rainfall, lithology, and hydrology were collected and analyzed using satellite imagery and secondary data sources. These layers were weighted and integrated using ArcGIS Pro to develop a land suitability map categorized into four classes: Highly Suitable (S1), Moderately Suitable (S2), Marginally Suitable (S3), and Not Suitable (N).

The results indicate that 31.42% of the area is highly suitable, 38.96% moderately suitable, 21.07% marginally suitable, and 8.55% not suitable for agriculture. The S1 zones are mainly located near the river and in flat alluvial regions with good soil and water availability, while unsuitable areas are mostly rugged, hilly, and erosion-prone zones. This spatial distribution reveals how physiographic and environmental factors influence land potential. The study highlights the importance of geospatial tools for accurate land evaluation and supports evidence-based agricultural planning. The findings serve as a decision-support tool for land managers, planners, and policymakers aiming to enhance food security and sustainable rural development.

**Keywords:** Land Suitability, Geospatial Analysis, Agricultural Planning, AHP, GIS, Remote Sensing, Sustainable Land Use

## Introduction

Land suitability refers to the assessment of a land's capability to support specific land uses or agricultural practices based on its physical, chemical, and biological characteristics (Sengupta et al., 2022). This evaluation takes into account various factors, including soil quality, climate conditions, topography, and water availability, to determine how well a particular parcel of land can sustain agricultural activities or other uses (Halder, 2013). In semi-arid regions like the Amravati River Basin, land suitability assessment is critically important for several reasons. First, it aids in resource management by identifying the most productive areas for agriculture, which is essential in regions facing limited water resources and variable rainfall patterns (Bandyopadhyay et al., 2009). Second, it plays a vital role in food security; by pinpointing suitable land for cultivation, stakeholders can enhance crop yields and food production, addressing the pressing challenges of food scarcity in such environments (Singha & Swain, 2016). Moreover, proper land use planning based on suitability assessments can stimulate economic development, allowing farmers to achieve higher productivity and profitability, thereby contributing to the region's overall economic growth (Zolekar, 2018).

Additionally, land suitability assessment helps minimize land degradation and environmental impact by avoiding the cultivation of crops on unsuitable lands, thus preserving natural ecosystems and maintaining biodiversity (Mandal et al., 2021). Finally, understanding land suitability enables better adaptation strategies to climate change, allowing farmers to select appropriate crops resilient to changing conditions (Parihari et al., 2021). Thus, land suitability assessment is a crucial tool for promoting sustainable agricultural development, resource management, and environmental conservation in semi-arid regions like the Amravati River Basin.

## Creative Commons (CC BY-NC-SA 4.0)

This is an open access journal, and articles are distributed under the terms of the [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International](https://creativecommons.org/licenses/by-nc-sa/4.0/) Public License, which allows others to remix, tweak, and build upon the work noncommercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

## How to cite this article:

Patil, S. (2025). Integrated Geospatial Analysis for Land Suitability Assessment for Agriculture in Amravati Basin. *InSight Bulletin: A Multidisciplinary Interlink International Research Journal*, 2(8), 14–18. <https://doi.org/10.5281/zenodo.17120532>

In this context, utilizing integrated geospatial techniques can significantly enhance the accuracy of land suitability assessments, ultimately fostering sustainable agricultural practices in the Amravati Basin (Agone & Bhamare, 2012). The application of multi-criteria decision-making approaches, such as Analytical Hierarchy Process (AHP), can further refine land suitability evaluations, ensuring optimal agricultural productivity in the Amravati Basin (Anusah et al., 2022) (Choudhary et al., 2023).

Land suitability assessment is crucial for effective agricultural planning and resource management, particularly in semi-arid regions like the Amravati River Basin. It evaluates a land's ability to support specific agricultural practices based on its physical, chemical, and biological characteristics (Anusah et al., 2022). By identifying the most productive areas for agriculture, land suitability assessments help optimize resource use, which is essential in regions with limited water resources and variable rainfall patterns. This process not only aids in enhancing food security by pinpointing suitable land for cultivation, thereby increasing crop yields and food production, but it also stimulates economic development (Pan, 2022). Higher agricultural productivity can lead to increased profitability for farmers, contributing to the overall economic growth of the region. Furthermore, these assessments play a vital role in minimizing land degradation and environmental impact by preventing the cultivation of crops on unsuitable lands, thus preserving natural ecosystems and biodiversity. Additionally, understanding land suitability enables the development of better adaptation strategies to climate change, allowing farmers to select crops that are resilient to changing conditions. Overall, land suitability assessment is an essential tool for promoting sustainable agricultural practices, resource management, and environmental conservation.

### **Study area**

Amravati River is an important tributary of Tapi River system, flowing through Maharashtra States. It originates from fringes of Sahyadri range, 650 m above mean sea level west of Deccan plateau in Dhule District, Maharashtra. It flows 57.73 kms eastwards and joins Tapi River at Shendvade in Dhule District, Maharashtra. The study basin extends between Latitudes 21° 09' 44" to 21° 24' 42" N and Longitudes 74° 12' 55" to 74° 44' 06" E. spanning an area of 795 sq. km.

### **Aim and Objectives**

#### **Aim**

To assess the agricultural land suitability of the Amravati River Basin using integrated geospatial techniques and multi-criteria decision analysis for promoting sustainable agricultural development and effective land use planning.

#### **Objectives**

- To collect and analyze various biophysical and climatic data layers such as soil, slope, land use/land cover, rainfall, lithology, and hydrology relevant to agricultural suitability.
- To integrate thematic layers using GIS-based spatial analysis to classify the land into different suitability zones.
- To apply the Analytical Hierarchy Process (AHP) as a multi-criteria decision-making tool for assigning weights and ranking suitability factors for agricultural land use.
- To develop a comprehensive land suitability map for agriculture using weighted overlay modeling in ArcGIS Pro.

### **Methodology and Database**

The present study integrates multiple thematic layers derived from satellite imagery, existing maps, and secondary sources to assess agricultural land suitability in the Amravati Basin using geospatial techniques. The data used includes lithology, landform, lineament, land use/land cover (LULC), rainfall, soil, and stream networks. Lithological data was obtained from the Geological Survey of India, providing information on the underlying rock types that influence soil development and groundwater conditions (Agone, 2014). Landform and slope data were extracted from the Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM), which helped in delineating topographic variations relevant to erosion risk and mechanization. Lineaments were identified using remote sensing techniques from Sentinel-2 imagery and supplemented by published geological maps to account for structural controls on drainage and subsurface water movement. LULC data was derived through supervised classification of recent satellite imagery, enabling identification of current land use patterns such as croplands, forests, and fallow areas.

Rainfall data was collected from the Indian Meteorological Department (IMD) and interpolated to generate spatial distribution maps, which are critical for evaluating water availability for crops. Soil data, including texture, depth, and drainage properties, was sourced from the National Bureau of Soil Survey and Land Use Planning (NBSS&LUP). The stream network was extracted from the DEM using hydrological tools in GIS to determine proximity to water sources, drainage density, and potential irrigation support.

Each thematic layer was processed and standardized in a GIS environment using ArcGIS Pro platforms. Layers were reclassified based on their suitability for agriculture into categories such as highly suitable, moderately suitable, marginally suitable, and not suitable. To integrate these layers, a Multi-Criteria Decision Analysis (MCDA) approach was employed using the Analytic Hierarchy Process (AHP). Expert opinion and literature review guided the development of a pairwise comparison matrix, and weights were assigned to each criterion based on their relative influence on agricultural productivity. A consistency ratio was calculated to ensure logical coherence in the weight assignment. The weighted layers were then overlaid using raster-based weighted overlay analysis, resulting in a composite land suitability index. This final map was further classified into four suitability zones. Where possible, the results were validated using existing agricultural yield data and field-level observations. The resulting spatial analysis provides a scientifically grounded, visually interpretable assessment of suitable agricultural zones in the Amravati Basin, supporting evidence-based land management and planning.

**Results****Table 1 Spatial analysis of agricultural land suitability of the Amravati River Basin**

| Land Suitability         | Area (sq.km) | Area (%) |
|--------------------------|--------------|----------|
| Not Suitable (N)         | 67.955       | 8.55     |
| Marginally Suitable (S3) | 167.468      | 21.07    |
| Moderately Suitable (S2) | 309.758      | 38.96    |
| Highly Suitable (S1)     | 249.819      | 31.42    |

(Source: Computed by research using ArcGIS Pro Spatial Overlay Modeling)

The Land Suitability Map of the Amravati River Basin developed through ArcGIS Pro Spatial Overlay Modeling offers a detailed spatial assessment of the agricultural potential of the region. The analysis shows significant differences in the suitability of land, which are classified into four classes as follows: Highly Suitable (S1), Moderately Suitable (S2), Marginally Suitable (S3), Not Suitable (N).

The Moderately Suitable (S2) category prevails in the basin occupying about 309.76 sq.km, which is 38.96% of the total area. This class is generally spread over the central, western and southern parts of the basin, which is an indication of areas with reasonably favorable topography, soil texture, and water availability, but not optimal. These regions are probably limited by moderate slopes, seasonal waterlogging or lack of nutrients.

The Highly Suitable (S1) areas, which constitute 31.42% (249.82 sq.km) are mostly located in the northern and northeastern parts of the basin. Such zones are the best agricultural potential, probably because of flatter terrain, fertile alluvial soils, good drainage, and proximity to water resources. Their spatial clustering around the river and flatter alluvial zones confirm this inference, and they are excellent areas for intensive cultivation.

The Marginally Suitable (S3) land which accounts for 21.07% (167.47 sq.km) is mainly distributed in fragmented patches within the central and western parts. These areas are probably characterized by moderate constraints such as rocky substrata, low organic content, or a poor irrigation infrastructure. Cultivation is possible but may need a lot of inputs to sustain productivity. Finally, Not Suitable (N) zones cover the smallest area, about 8.55% (67.96 sq.km) and are predominantly found in rugged terrain, steep slopes or erosion-prone areas – likely in the extreme west and scattered highland zones. These are not suitable for agriculture because of extreme restrictions such as shallow soil depth, stoniness or environmental sensitivity.

**Discussion**

The spatial distribution shows the ways in which physiographic factors like elevation, slope, soil quality and drainage affect land suitability. The fact of the river's existence seems to be of a key importance in defining higher levels of suitability, particularly in downstream and flatter areas where sediment deposition makes the soil richer. Upland and hilly areas on the other hand have reduced suitability because of erosion risk and rough terrain.

In the aggregate, the map highlights the need for targeted land-use planning. Areas that are highly and moderately suitable should be given priority for agricultural development and the marginal and unsuitable zones may be appropriate for afforestation, grazing or conservation. The results provide useful advice for sustainable land management in the Amravati River Basin. In addition, a closer look shows localized clusters of high suitability even in otherwise less suitable upland areas. These exceptions are often associated with more gentle slopes or areas which receive colluvial deposition, thus indicating the need for micro level assessment in the larger picture of land use planning strategies. On the other hand, some low-lying areas, even though they are very close to the river, may have low suitability because of waterlogging or poor drainage thus emphasizing the need for a thorough soil and hydrological survey.

The interaction between physiographic factors and human activity should also be taken into account. Erosion in upland areas, for example, can be made worse by deforestation thus reducing land suitability. Likewise, unsustainable agricultural activities in currently viable areas can cause soil erosion and its subsequent fall in productivity after some years. It is, therefore, important, for the management practices of the soils / land to be integrated taking into consideration not only the biophysical environment but also the human factors influencing the environment so as to ensure the maintenance and improvement of the suitability of the land and soil.

Finally, this spatial analysis of land suitability in the Amravati River Basin offers a strong basis for informed decision making. Through incorporating this information into socio-economic concerns and stakeholder engagement, optimal land-use planning can be achieved to advance a sustainable development that optimizes agricultural productivity, environmental conservation and long-term welfare of communities inhabiting the region in the future. A forward thinking and adaptive strategy that continually monitors and changes management strategies due to the observed changes and emerging challenges, will be invaluable in ensuring the future generations will be able to continue the suitability of the land.

**Conclusion and Suggestions**

The integrated geospatial analysis of the Amravati River Basin was able to identify and classify the land into four suitability classes; Highly Suitable (S1), Moderately Suitable (S2), Marginally Suitable (S3) and Not Suitable (N) for agricultural use. The results show that a large percentage of the basin (more than 70%) is highly and moderately suitable, which indicates high agricultural potential in the region. These are predominantly areas characterized by favorable topography, fertile soils and better water accessibility especially in the northern and central parts of the basin.

On the other hand, marginally suitable and non-suitable areas are largely found in the western and upland areas where steep slopes, shallow soils, and poor drainage make agricultural productivity very low. The spatial distribution clearly shows the significant impact of physiographic and environmental variables on land suitability. The application of remote sensing data, GIS-

based modeling, and the Analytical Hierarchy Process (AHP) was successful in obtaining a reliable and objective suitability assessment.

This research offers a useful decision-support tool for planners of land use, policymakers, and stakeholders in agriculture seeking sustainable resource management, food security, and climate-resilient farming strategies.

To improve sustainable land use in the Amravati River Basin, agricultural activities should be given priority in the highly and moderately suitable (S1 and S2) zones by enhancing irrigation, better crop practices, and farmer support. Marginally suitable (S3) areas can be developed using soil conservation measures and water management techniques. Cultivation in non-suitable (N) areas should be avoided to avoid degradation; rather, these zones can be used for afforestation or conservation. Future assessments should contain socio-economic data and should be updated regularly with the help of geospatial tools to respond to environmental and land use changes.

#### **Acknowledgment**

The author expresses sincere gratitude to S. V. S's Dadasaheb Rawal College, Dondaicha, for providing the necessary academic support and research environment that facilitated the successful completion of this study. Special thanks are extended to the Department of Geography for encouragement, constructive feedback, and access to essential resources.

The author is also deeply thankful to the Geological Survey of India (GSI), the National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), and the Indian Meteorological Department (IMD) for providing valuable datasets that formed the basis of this analysis.

Heartfelt appreciation is extended to colleagues and peers for their thoughtful discussions and suggestions, which helped refine the methodology and interpretations. The assistance received from various scholars, whose works have been cited in this paper, is gratefully acknowledged.

Finally, the author acknowledges with gratitude the constant moral support and encouragement from family and friends, which provided motivation throughout the research journey.

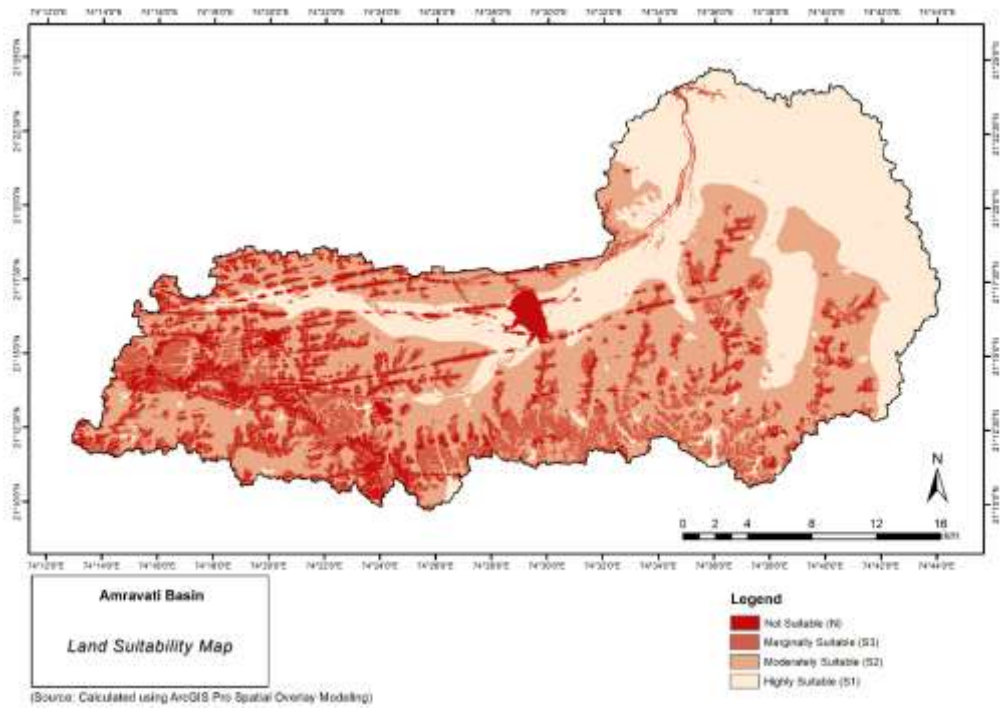
#### **Financial support and sponsorship: Nil**

#### **Conflicts of interest**

The authors declare that there are no conflicts of interest regarding the publication of this paper.

#### **References**

1. Anusah, B. N., Babu, K. R., Kumar, B., Sree, P. P., Veeraswamy, G., Priya, C. H. S., & Rajasekhar, M. (2022). Integrated studies for land suitability analysis towards sustainable agricultural development in semi-arid regions of AP, India. *Geosystems and Geoenvironment*. <https://doi.org/10.1016/j.geogeo.2022.100131>
2. Agone, V. (2014). Hydrogeomorphic analysis of Tittur drainage basin. LAP LAMBERT Academic Publishing.
3. Agone, V., & Bhamare, S. M. (2012). Change detection of vegetation cover using remote sensing and GIS. *Journal of research and development*, 2(4).
4. Bandyopadhyay, S., Jaiswal, R. K., Hegde, V. S., & Jayaraman, V. (2009). Assessment of land suitability potentials for agriculture using a remote sensing and GIS based approach. *Journal of Remote Sensing*. <https://doi.org/10.1080/01431160802395235>
5. Choudhary, K., Boori, M. S., Shi, W., Valiev, A., & Kupriyanov, A. (2023). Agricultural land suitability assessment for sustainable development using remote sensing techniques with analytic hierarchy process. *Remote Sensing Applications: Society and Environment*. <https://doi.org/10.1016/j.rsase.2023.101051>
6. Halder, J. C. (2013). Land Suitability Assessment for Crop Cultivation by Using Remote Sensing and GIS. *Journal of Geography and Geology*. <https://doi.org/10.5539/JGG.V5N3P65>
7. Mandal, P., Mandal, S., Halder, S., & Paul, S. (2021). Assessing and mapping cropland suitability applying geospatial and MIF techniques in the semiarid region with an integrated approach. *Arabian Journal of Geosciences*. <https://doi.org/10.1007/S12517-021-08171-3>
8. Pan, Y. (2022). Land-use Suitability is Not an Intrinsic Property of a Land Parcel. *Environmental Management*. <https://doi.org/10.1007/s00267-022-01764-y>
9. Parihari, S., Das, K., & Das Chatterjee, N. (2021). Land suitability assessment for effective agricultural practices in Paschim Medinipur and Jhargram districts, West Bengal, India. <https://doi.org/10.1016/B978-0-12-823895-0.00034-8>
10. Sengupta, S., Mohinuddin, S. K., Arif, M., Sengupta, B., & Zhang, W. (2022). Assessment of agricultural land suitability using GIS and fuzzy analytical hierarchy process approach in Ranchi District, India. *Geocarto International*. <https://doi.org/10.1080/10106049.2022.2076925>
11. Singha, C., & Swain, K. C. (2016). Land suitability evaluation criteria for agricultural crop selection: A review. *Agricultural Reviews*. <https://doi.org/10.18805/AR.V37I2.10737>
12. Zolekar, R. B. (2018). Integrative approach of RS and GIS in characterization of land suitability for agriculture: a case study of Darna catchment. *Arabian Journal of Geosciences*. <https://doi.org/10.1007/S12517-018-4148-4>



*Figure 1 Agricultural land suitability Map of Amravati River Basin.*