International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 15 Issue 5, May-2026

Integrated Assessment of Wasteland Resources for Sustainable Agricultural Land Management: A Geospatial Study of Western Haryana, India

Sara Beniwal[1], Dr. Sunil Kumar[2], Dr. Sandeep Kumar[3]

[1]Research scholar, Om Sterling Global University, Hisar
[2]Associate Professor Dept. of Geography, School of Humanities, Om Sterling Global University
[3]Assistant Professor of Geography, Government College, Adampur, Hisar

ABSTRACT

Land degradation and the expansion of wastelands pose significant challenges to sustainable agricultural development in the semi-arid regions of India, particularly in Western Haryana, where soil salinity, groundwater deterioration, waterlogging, and declining land productivity adversely affect agricultural sustainability. The present study aimed to develop an integrated geospatial framework for assessing wasteland resources and formulating site-specific land use recommendations to support sustainable agricultural land management. The study covered eight districts of Western Haryana (Bhiwani, Charkhi Dadri, Fatehabad, Hisar, Jind, Mahendragarh, Rewari, and Sirsa) covering a total geographical area of 21,717.98 km². Multi-source spatial datasets, including soil resource maps, groundwater quality, wasteland inventory, land use/land cover (LULC), and seasonal cropping patterns, were integrated within a Geographic Information System (GIS) environment. Standard spatial preprocessing techniques, including georeferencing, projection, clipping, resampling, and thematic database preparation, were followed prior to GIS-based overlay and multi-criteria spatial analysis. The integration of these datasets facilitated the delineation of Integrated Land Resource Mapping Units (ILRMUs), representing homogeneous land units characterized by similar resource conditions, agricultural potential, and management requirements. The integrated assessment revealed substantial spatial heterogeneity in land capability and degradation across the study area. Soil salinity, poor-quality groundwater, waterlogging, sandy soils, and declining soil fertility were identified as the principal constraints limiting agricultural productivity. Based on the integrated resource analysis, 26 site-specific land use recommendation classes were developed to optimize land utilization while minimizing environmental degradation. The results indicated that agri-horticulture integrated with salt-tolerant crops and improved irrigation management was the dominant recommendation, occupying 23.39% (5,080.07 km²) of the study area under crop diversification and intensive agriculture, followed by 14.31% (3,108.04 km²) requiring water conservation and residue management and 10.70% (2,324.62 km²) requiring drip irrigation, mulching, and moisture conservation. Agroforestry-based systems integrated with conjunctive use of canal and groundwater accounted for 10.53% (2,286.69 km²) of the region, highlighting their potential for improving productivity in salt-affected and groundwater-stressed landscapes. Double-cropping systems coupled with soil and water conservation measures were recommended for 10.03% (2,177.77 km²) of the area, emphasizing the importance of efficient resource management for enhancing cropping intensity. Severely degraded lands were identified as suitable for silvipasture, forestry plantations, biodrainage, and saline aquaculture, providing environmentally sustainable alternatives where conventional agriculture is no longer viable. The study demonstrates that the integration of Remote Sensing and GIS with multi-source land resource information provides a robust and scientifically reliable framework for spatially explicit land capability assessment and sustainable land use planning. The developed recommendation framework supports evidence-based decision-making by matching land management interventions with local resource conditions, thereby improving agricultural productivity, enhancing water-use efficiency, mitigating land degradation, and strengthening climate resilience. The proposed methodology is transferable to other semi-arid regions experiencing similar environmental constraints and offers a practical decision-support tool for policymakers, land resource managers, and agricultural planners working towards sustainable agricultural development.

Keywords: Wasteland assessment, Sustainable land management, Remote Sensing, Geographic Information System (GIS), Integrated Land Resource Mapping, Site-specific management, Agricultural planning.

INTRODUCTION

Land is one of the most valuable natural resources supporting agricultural production, ecosystem services, biodiversity conservation, and rural livelihoods. However, rapid population growth, urbanization, unsustainable agricultural practices, groundwater overexploitation, soil erosion, salinization, and climate variability have accelerated land degradation worldwide, threatening food security and environmental sustainability (FAO, 2024; Rawat et al., 2018). Sustainable land management has therefore become a global priority under the Sustainable Development Goals (SDGs), particularly SDG 15.3, which emphasizes achieving Land Degradation Neutrality (LDN) through scientific assessment, restoration, and sustainable utilization of land resources.

In India, land degradation is a major environmental concern, particularly in arid and semi-arid regions where soil salinity, waterlogging, wind erosion, nutrient depletion, and groundwater deterioration have significantly reduced agricultural productivity. Wastelands are defined as degraded lands that are presently underutilized because of natural or anthropogenic constraints but can be brought under productive use through appropriate reclamation and management practices (Choudhary, 2018). The National Remote Sensing Centre (NRSC) has undertaken nationwide wasteland mapping programmes using Remote Sensing and GIS to provide spatial information for reclamation planning and sustainable land resource management.

Haryana is one of India's most productive agricultural states; however, the western part of the state faces increasing challenges due to soil salinity, waterlogging, sandy desertification, groundwater quality deterioration, declining soil fertility, and climate variability. Districts such as Bhiwani, Charkhi Dadri, Fatehabad, Hisar, Jind, Mahendragarh, Rewari, and Sirsa contain extensive areas affected by degraded soils, coarse-textured sandy landscapes, and saline groundwater, which adversely influence agricultural productivity. Previous studies have shown that geospatial technologies are highly effective for identifying degraded lands, monitoring wasteland dynamics, and supporting land reclamation planning in Haryana (Rawat et al., 2018).

Remote Sensing (RS) and Geographic Information System (GIS) technologies have emerged as powerful tools for land resource assessment because they provide rapid, accurate, repetitive, and cost-effective information on land use/land cover, soil resources, vegetation, wastelands, and hydrological conditions. The integration of satellite imagery with thematic datasets such as soil characteristics, groundwater quality, topography, and existing land use enables comprehensive assessment of land capability and supports evidence-based decision-making. Compared with conventional field surveys, geospatial techniques facilitate efficient mapping, monitoring, and prioritization of degraded lands over large geographical areas (Choudhary, 2018; NRSC, 2024).

Several studies have demonstrated the usefulness of remote sensing and GIS for mapping wastelands, monitoring land degradation, assessing soil salinity, and analysing land use/land cover dynamics in India. However, most investigations have focused on individual components such as wasteland mapping, land use change, or soil degradation without integrating soil resources, groundwater quality, wasteland characteristics, cropping patterns, and land use/land cover into a comprehensive framework for sustainable agricultural planning. Consequently, there remains a need for an integrated geospatial approach capable of developing site-specific land management recommendations for degraded agricultural landscapes.

Integrated land resource assessment provides a scientific framework for evaluating the capability and limitations of land resources by combining multiple thematic layers. Such integration enables the delineation of homogeneous Integrated Land Resource Mapping Units (ILRMUs) and supports the development of location-specific management strategies, including agri-horticulture, agroforestry, silvipasture, crop diversification, salt-tolerant cropping systems, biodrainage, conjunctive use of canal and groundwater, drip irrigation, mulching, residue management, and conservation agriculture. These approaches contribute to improving agricultural productivity while conserving soil and water resources and enhancing resilience to climate variability.

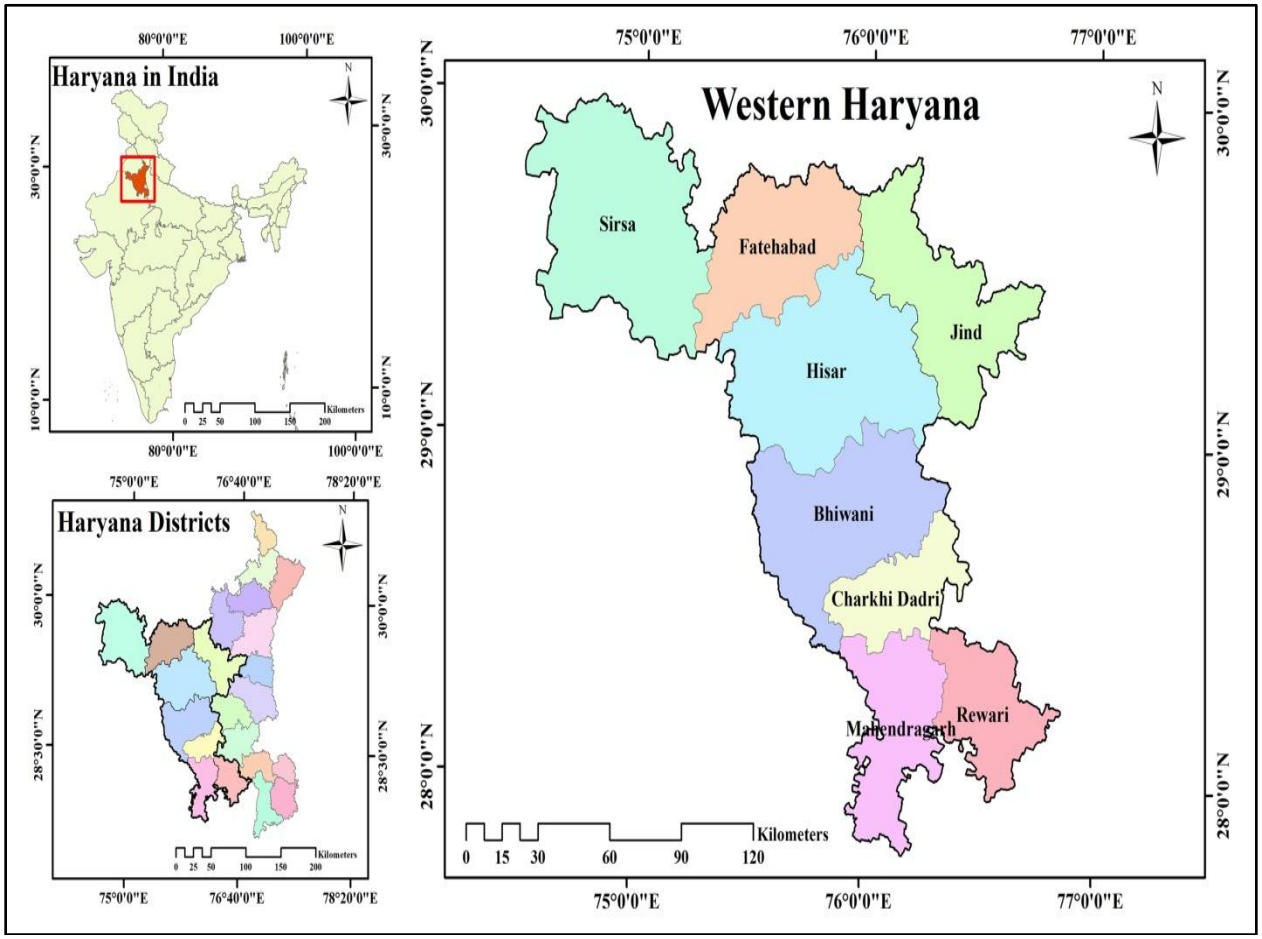
Western Haryana represents one of the most resource-sensitive agricultural regions of northwestern India because of the coexistence of fertile alluvial plains, sandy desertic landscapes, saline soils, waterlogged areas, and declining groundwater quality. Although several district-level studies have been conducted, a comprehensive integrated assessment of wasteland resources covering the entire Western Haryana region remains limited. Such an assessment is essential for developing scientifically sound land use strategies that balance agricultural productivity with environmental sustainability. Therefore, the present study aims to integrate Remote Sensing and GIS techniques for the assessment of wasteland resources and development of site-specific land management recommendations in Western Haryana. The specific objectives are to (i) map and characterize major wasteland categories, (ii) integrate soil resources, groundwater quality, land use/land cover, and

cropping pattern information to delineate Integrated Land Resource Mapping Units (ILRMUs), (iii) evaluate the constraints and agricultural potential of each mapping unit, and (iv) develop site-specific recommendations for sustainable agricultural land management. The findings are expected to provide a robust scientific decision-support framework for policymakers, planners, researchers, and farmers to reclaim degraded lands, improve agricultural productivity, enhance water-use efficiency, and promote sustainable land management in Western Haryana.

STUDY AREA

The present study was conducted in Western Haryana, located in the northwestern part of India. Haryana occupies a geographical area of 44,212 km², accounting for approximately 1.34% of the total geographical area of India. Geographically, the state extends between 27°39′ N to 30°35′ N latitude and 74°28′ E to 77°36′ E longitude, with an elevation ranging from 200 to 1,100 m above mean sea level. Haryana is administratively divided into 22 districts, namely Ambala, Bhiwani, Charkhi Dadri, Faridabad, Fatehabad, Gurugram, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Mahendragarh, Nuh, Palwal, Panchkula, Panipat, Rewari, Rohtak, Sirsa, Sonipat, and Yamunanagar. The state shares its boundaries with Punjab and Himachal Pradesh in the north, Rajasthan in the west and southwest, and Uttar Pradesh and Uttarakhand along the eastern boundary, where the Yamuna River forms the natural state boundary.

Map-1: ***Location map of the study area comprising eight districts of Western Haryana, India.***



Source:Prepared by the researcher using QGIS based on the Administrative Boundary dataset obtained from the Survey of India (SoI).

The study area comprises the eight districts of Western Haryana, namely Bhiwani, Charkhi Dadri, Fatehabad, Hisar, Jind, Mahendragarh, Rewari, and Sirsa, covering a total geographical area of approximately 21,718 km². These districts represent the semi-arid agro-ecological zone of Haryana and were selected because of the widespread occurrence of wastelands, soil salinity, sandy landscapes, groundwater quality deterioration, and land degradation. The location of the study area is presented in Map 1.

Physiographically, Western Haryana is dominated by extensive alluvial plains, interspersed with aeolian sandy plains, pediplains, interdunaldepressions, residual hills, and localized rocky outcrops. The southwestern districts, particularly Sirsa, Fatehabad, Bhiwani, Mahendragarh, and Rewari, are influenced by the northeastern extension of the Thar Desert, resulting in sandy soils and active aeolian processes. The region is characterized by a semi-arid climate, with hot summers, cool winters, and highly variable monsoonal rainfall. Annual precipitation generally ranges from 300 to 600 mm, most of which is received during the southwest monsoon season. The combination of low rainfall, high evapotranspiration, and uneven water availability makes the region vulnerable to drought and land degradation.

Agriculture is the principal land use and the dominant source of livelihood in Western Haryana. Major cropping systems include Cotton–Wheat, Rice–Wheat (in irrigated areas), Pearl Millet (Bajra)–Mustard, Pearl Millet–Gram, Guar–Mustard, Wheat–Fodder, and Cotton–Mustard, depending on soil characteristics and irrigation availability. Canal irrigation, primarily through the Bhakra Canal System and the Western Yamuna Canal network, together with groundwater extraction, supports agricultural production. However, excessive dependence on groundwater, coupled with poor-quality irrigation water in several areas, has accelerated secondary salinization, alkalinity, and waterlogging, adversely affecting agricultural productivity.

The soils of Western Haryana are predominantly alluvial in origin, varying from sandy, coarse loamy, fine loamy, to clay loam textures. Fine-textured alluvial soils possess relatively high fertility and moderate to high available water holding capacity, whereas sandy soils have poor moisture retention and are highly susceptible to wind erosion. In many parts of Sirsa, Fatehabad, Hisar, Jind, and Bhiwani, saline and sodic soils occur due to poor drainage, shallow saline groundwater, and prolonged use of marginal-quality irrigation water. Localized waterlogged areas, particularly in canal-irrigated tracts, further aggravate soil degradation and reduce crop productivity.

Land degradation is one of the major environmental challenges in the study area. The principal forms of degradation include soil salinity, alkalinity, waterlogging, wind erosion, sand deposition, nutrient depletion, and declining groundwater quality. These processes have resulted in the development of various wasteland categories, including salt-affected lands, sandy wastelands, dense and sparse scrublands, degraded grazing lands, waterlogged areas, and barren rocky terrain. Nevertheless, many of these degraded lands possess significant reclamation potential through scientific interventions such as agroforestry, agri-horticulture, silvipasture, cultivation of salt-tolerant crops, biodrainage, conjunctive use of canal and groundwater, drip irrigation, residue management, moisture conservation, and integrated soil and water conservation practices.

METHODOLOGY

The methodological framework adopted in this study integrates multi-source geospatial datasets, thematic resource information, and GIS-based spatial analysis to identify degraded land resources and formulate site-specific sustainable agricultural land use recommendations (Figure: 1). The workflow consists of eight sequential stages: data acquisition, thematic database preparation, spatial preprocessing, GIS integration, integrated resource analysis, delineation of Integrated Land Resource Mapping Units (ILRMUs), identification of major resource constraints, and development of sustainable land use recommendations.

The methodology adopted in this study integrates Remote Sensing (RS), Geographic Information System (GIS), and ancillary datasets to assess wasteland resources and develop sustainable agricultural land use recommendations for Western Haryana. Initially, satellite-derived spatial datasets, including soil maps, wasteland maps, land use/land cover (LULC), Kharif and Rabi cropping patterns, and crop rotation maps, were collected. In addition, ancillary datasets comprising soil physical and chemical properties, groundwater quality and water table information, land use data, and other thematic resource information were compiled to support the integrated analysis.

All datasets were standardized through georeferencing, projection, digitization, mosaicking, clipping, resampling, and attribute preparation to ensure spatial compatibility within the GIS environment. The processed thematic layers were subsequently integrated using overlay analysis, spatial analysis, layer stacking, reclassification, weighted overlay, and multi-criteria evaluation (MCE) techniques to evaluate land resources comprehensively.

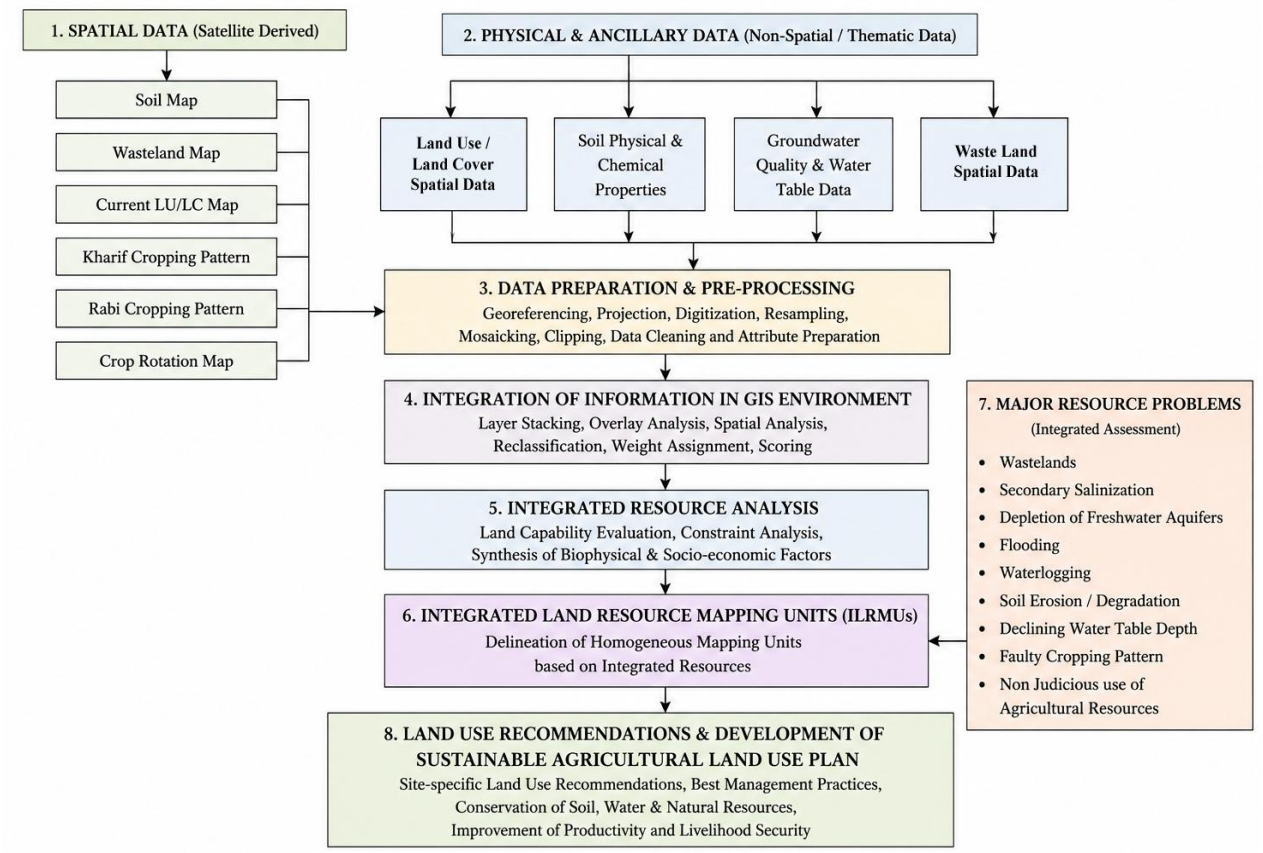


Figure-1: ***Methodological framework illustrating the integration of multi-source geospatial datasets and thematic resource information for Integrated Land Resource Mapping Units (ILRMUs) delineation and site-specific sustainable agricultural land use planning in Western Haryana.***

The integrated database was analysed to identify the major resource constraints affecting agricultural productivity, including wastelands, soil salinity, groundwater depletion, waterlogging, flooding, soil degradation, declining water table, and unsuitable cropping patterns. Based on the integrated assessment, Integrated Land Resource Mapping Units (ILRMUs) were delineated by combining homogeneous land resource characteristics. Finally, site-specific sustainable agricultural land use recommendations were developed for each ILRMU, including agroforestry, agri-horticulture, silvipasture, crop diversification, salt-tolerant cropping systems, water conservation measures, and integrated soil and water management practices. The developed framework provides a scientific decision-support system for sustainable land resource management and agricultural planning in Western Haryana.

RESULT AND DISCUSSION

The results of the integrated geospatial analysis provide a comprehensive assessment of wasteland resources and their suitability for sustainable agricultural land management in Western Haryana. By integrating thematic layers of soil characteristics, groundwater quality, wasteland distribution, land use/land cover, and cropping patternswithin a GIS environment, homogeneousIntegrated Land Resource Mapping Units (ILRMUs) were delineated and evaluated. The findings reveal considerable spatial variability in land capability and resource constraints across the study area, resulting in the development of site-specific land use recommendations.

Land Use Recommendations Based on Integrated Resource Assessment:

The integrated analysis of soil resources, groundwater quality, wasteland characteristics, land use/land cover, and cropping patterns resulted in the delineation of site-specific land use recommendations for the entire Western Haryana region (Table 1).

The recommendations were developed by integrating multiple biophysical resource constraints within the GIS environment to optimize agricultural productivity while ensuring long-term sustainability of soil and water resources.The analysis revealed that agri-horticulture combined with salt-tolerant crops and improved irrigation management represents the most

suitable land use option across the study area. The largest proportion of land (5,080.07 km²; 23.39%) was identified as highly suitable for crop diversification and intensive agriculture under this recommendation category.

These areas possess relatively favorable soil and groundwater conditions and therefore offer substantial potential for diversification into high-value horticultural crops with improved irrigation practices. In addition, 3,108.04 km² (14.31%) was recommended for agri-horticulture integrated with water conservation and residue management, while 2,324.62 km² (10.70%) requires supplementary drip irrigation, mulching, and soil moisture conservation to improve water-use efficiency under semi-arid climatic conditions. A comparatively smaller area (364.09 km²; 1.68%) exhibited high productivity potential under balanced nutrient management, whereas only 16.65 km² (0.08%) required no additional management beyond improved irrigation.

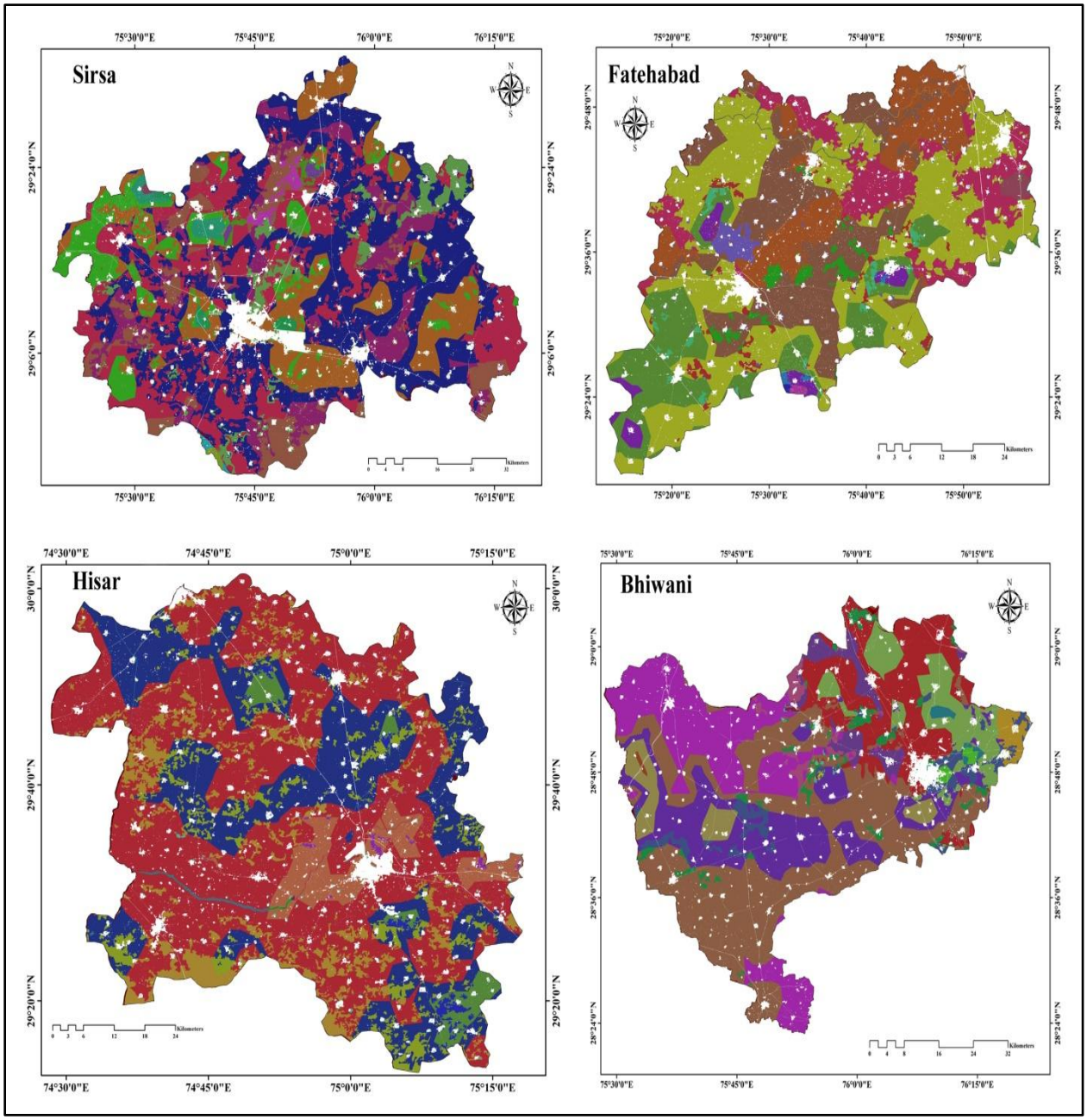
Table-1: Area under Site-Specific Land Use Recommendations in Western Haryana.

Code	Land Use Recommendation	Area (km²)	Area (%)
1	Agri-horticulture + STC + IIM	16.65	0.08
2	Agri-horticulture + STC + IIM + DIMMC	2324.62	10.7
3	Agri-horticulture + STC + IIM + BNM	364.09	1.68
4	Agri-horticulture + STC + IIM + CDIA	5080.07	23.39
5	Agri-horticulture + STC + IIM + WCRM	3108.04	14.31
6	Agroforestry + STS + Biodrainage + WCC + DIMMC	155.19	0.71
7	Agroforestry + STS + Biodrainage + WCC + BNM	0.98	0
8	Agroforestry + STS + Biodrainage + WCC + CDIA	194.55	0.9
9	Agroforestry + STS + Biodrainage + WCC + WCRM	130.47	0.6
10	Agroforestry + STC + Conjunctive Water Use	3.79	0.02
11	Agroforestry + STC + Conjunctive Water Use + DIMMC	840.27	3.87
12	Agroforestry + STC + Conjunctive Water Use + BNM	87.92	0.4
13	Agroforestry + STC + Conjunctive Water Use + CDIA	2286.69	10.53
14	Agroforestry + STC + Conjunctive Water Use + WCRM	1001.64	4.61
15	Double Cropping + CDSWC	34.74	0.16
16	Double Cropping + CDSWC + DIMMC	2177.77	10.03
17	Double Cropping + CDSWC + BNM	339.76	1.56
18	Double Cropping + CDSWC + CDIA	1816.86	8.37
19	Double Cropping + CDSWC + WCRM	1042.92	4.8
20	General Sustainable Agriculture + DIMMC	43.82	0.2
21	General Sustainable Agriculture + CDIA	32.86	0.15
22	General Sustainable Agriculture + WCRM	2.46	0.01
23	Settlement (No Agricultural Recommendation)	577.15	2.66
24	Silvipasture/Forestry + Biodrainage + Saline Aquaculture + DIMMC	3.22	0.01
25	Silvipasture/Forestry + Biodrainage + Saline Aquaculture + CDIA	3.93	0.02
26	Silvipasture/Forestry + Biodrainage + Saline Aquaculture + WCRM	3.5	0.02
Total		**21,717.98**	**100**

Table Footnote:**STC** = Salt-Tolerant Crops, **STS** = Salt-Tolerant Species,**IIM** = Improved Irrigation Management, **DIMMC** = Drip Irrigation, Mulching and Moisture Conservation, **BNM** = Balanced Nutrient Management, **CDIA** = Crop Diversification and Intensive Agriculture, **WCRM** = Water Conservation and Residue Management, **WCC** = Water-Conserving Crops, **CDSWC** = Crop Diversification, Soil and Water Conservation.

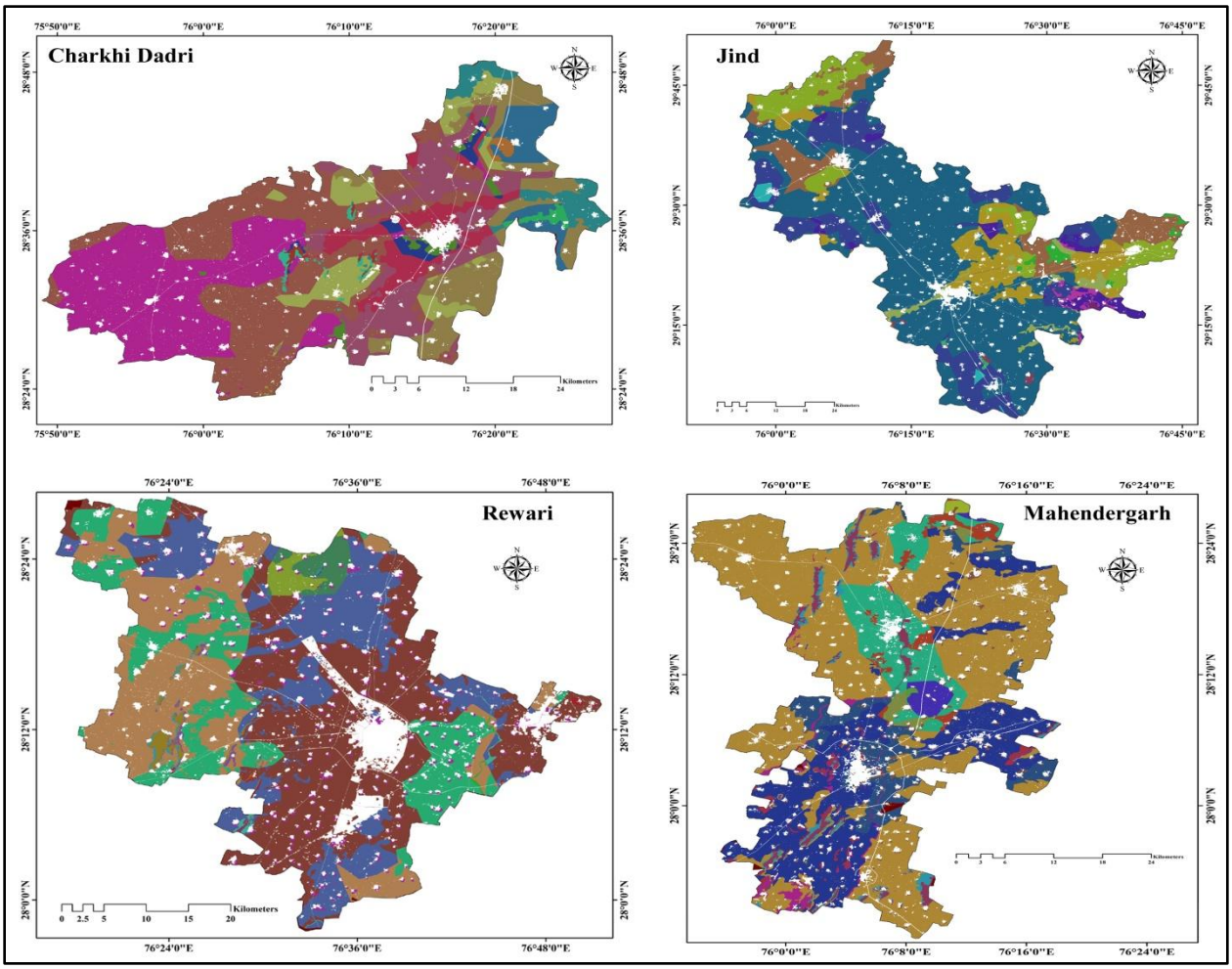
The second major recommendation category comprised agroforestry systems integrated with salt-tolerant crops and conjunctive use of canal and groundwater, reflecting the importance of diversified tree-based production systems in degraded landscapes. Approximately 2,286.69 km² (10.53%) was identified as suitable for crop diversification and intensive agriculture within agroforestry systems, while 1,001.64 km² (4.61%) requires water conservation and residue management to improve land productivity. Furthermore, 840.27 km² (3.87%) was recommended for agroforestry supported by drip irrigation and moisture conservation measures. These recommendations are particularly suitable for areas affected by groundwater salinity and declining water tables, where integrated tree-crop systems can enhance water-use efficiency, reduce evapotranspiration losses, and improve ecosystem resilience.

Map-2: ***Integrated Assessment of Wasteland Resources for Sustainable Agricultural Land Management for Sirsa, Fatehabad, Hisar and Bhiwani District.***



Source: Prepared by the researcher using QGIS based on the Administrative Boundary dataset obtained from the Survey of India (SoI).

Map-3: ***Integrated Assessment of Wasteland Resources for Sustainable Agricultural Land Management for Charkhi Dadri, Jind, Rewari, Mahendergarh District.***



Source:Prepared by the researcher using QGIS based on the Administrative Boundary dataset obtained from the Survey of India (SoI).

Agroforestry involving salt-tolerant tree species, biodrainage, and water-conserving crops was recommended for localized degraded landscapes affected by salinity and shallow groundwater. Although this category occupies a relatively small proportion of the study area (approximately 2.2%), it represents environmentally sensitive zones where conventional agriculture is less sustainable. Biodrainage through deep-rooted tree species offers an effective biological approach for

controlling waterlogging and reducing soil salinity while simultaneously improving carbon sequestration and biodiversity conservation.

The integrated assessment further identified double cropping combined with crop diversification and soil-water conservation practices as another important sustainable agricultural strategy. This recommendation covers nearly one-quarter of the agricultural landscape, with 2,177.77 km² (10.03%) requiring drip irrigation and moisture conservation, 1,816.86 km² (8.37%) suitable for intensive diversified agriculture, and 1,042.92 km² (4.80%) requiring water conservation and residue management. These areas generally possess moderate land capability but require improved resource management practices to sustain long-term agricultural productivity under increasing climatic variability.

Only a limited proportion of land was classified under general sustainable agricultural management, indicating that most agricultural landscapes in Western Haryana require specialized management interventions rather than generalized agronomic practices. Likewise, settlement areas occupied 577.15 km² (2.66%), where agricultural recommendations were not applicable because of urban and built-up land uses.

A very small proportion of highly degraded landscapes (less than 0.05%) was recommended for silvipasture, forestry plantations, biodrainage, and saline aquaculture. These areas represent severely salt-affected or environmentally fragile ecosystems where conventional crop cultivation is economically and environmentally unsuitable. Instead, integrated silvipastoral systems and saline aquaculture provide sustainable alternatives that enhance ecological restoration while generating livelihood opportunities.

CONCLUSION

The present study demonstrates the effectiveness of integrating Remote Sensing (RS) and Geographic Information System (GIS) techniques for the comprehensive assessment of wasteland resources and the development of site-specific land use recommendations in Western Haryana. The integration of multiple thematic datasets, including soil characteristics, groundwater quality, wasteland distribution, land use/land cover, and cropping patterns, enabled the delineation of Integrated Land Resource Mapping Units (ILRMUs) that accurately represent the spatial variability of land resources across the study area.

The results revealed that the agricultural landscapes of Western Haryana exhibit considerable heterogeneity in terms of soil properties, groundwater quality, salinity, waterlogging, and land degradation, highlighting the limitations of adopting uniform land management practices. The predominance of recommendations favouringagri-horticulture, agroforestry, crop diversification, improved irrigation management, water conservation, balanced nutrient management, and conservation agriculture indicates that sustainable agricultural development in the region largely depends on efficient management of existing land resources rather than expansion of cultivated land. Furthermore, highly degraded landscapes affected by salinity, waterlogging, and poor-quality groundwater were identified as suitable for alternative land use systems such as silvipasture, forestry plantations, biodrainage, and saline aquaculture, thereby providing environmentally sustainable options for land reclamation.

The GIS-based integrated assessment proved to be an effective decision-support framework for identifying resource constraints and matching appropriate land use interventions to local biophysical conditions. Such a spatially explicit approach facilitates the efficient allocation of land resources, enhances agricultural productivity, improves water-use efficiency, reduces land degradation, and strengthens climate resilience. The generated land use recommendation map provides valuable guidance for policymakers, planners, agricultural extension agencies, and farmers in implementing scientifically sound and location-specific land management strategies.

REFERENCES

1. Choudhary, B. K. (2018). *Applications of Remote Sensing and GIS in Wasteland Mapping*. e-PGPathshala, Ministry of Education, Government of India.
2. Food and Agriculture Organization. (2024). *Land assessment and monitoring*. FAO.
3. Food and Agriculture Organization. (2021). *Land Degradation Neutrality*. FAO.
4. National Remote Sensing Centre. (2024). *Soils: Technical overview*. ISRO, Hyderabad.
5. National Remote Sensing Centre. (2024). *Prioritization of wasteland areas suitable for greening using remote sensing*. ISRO, Hyderabad.

6. Rawat, K. S., Mishra, S. V., & Singh, S. K. (2018). Integration of Earth Observation Data and Spatial Approach to Delineate and Manage Aeolian Sand-Affected Wasteland in Highly Productive Lands of Haryana, India. *International Journal of Geophysics, 2018*, 2847504. https://doi.org/10.1155/2018/2847504
7. High Level Expert Committee (1998), Management of Waterlogging and Soil Salinity problems in Haryana.
8. High Level Expert Committee (1998), Management of Waterlogging and Soil Salinity problems in Haryana.
9. Kumar, S., Kumar, A., Kundu, B. S., & Singh, M. (2015). Trajectories of land use & land cover in Sirsa District, Haryana: Temporal composition, spatial configuration and probability of changes in GIS environment. *International Journal of Science, Engineering and Technology Research (IJSETR), 4*(1).
10. Kumar, S., Deen, S., &Sonu. (2020). Integrated resource management for sustainable agricultural land use plan in Hisar District using geo-informatics: A case study. *Indian Journal of Ecology, 47*(4), 1158–1163.
11. Kumar, S., &Siwach, P. (2012). Investigating statistical analysis of canal density & canal network analysis of Hisar District (Haryana) using remote sensing & GIS. *International Journal of Physical and Social Sciences, 2*(8), 341. http://www.ijmra.us