J. Himalayan Ecol. Sustain. Dev. Vol 20 *(2025)* ISSN 0973-7502

Assessment of Land Acquisition for the Srinagar Ring Road Project

Aadil Hussain Bhat[1]; Mohammad Muslim[2]

Department of Environmental Science, School of Earth and Environmental Sciences,

University of Kashmir Hazratbal -190006 Srinagar J&K

Corresponding author: mmuslim@uok.edu.in

ABSTRACT

Rapid infrastructure expansion is reshaping landscapes, often at the cost of fertile farmland and ecosystem services. In Kashmir Valley, the 62-km Srinagar Ring Road aims to ease congestion and improve connectivity but involves extensive land acquisition, raising concerns over livelihoods, food security, and environmental sustainability. This study evaluates the spatial extent and land use–land cover (LULC) characteristics of land acquired for the Srinagar Ring Road project. The proposed road alignment, obtained from the Srinagar Development Authority (SDA), was integrated with Sentinel-2 satellite imagery (2016) to delineate the study area. LULC classification was performed using the National Natural Resources Management System (NNRMS) classification scheme, with visual image interpretation preferred over digital classification to ensure greater accuracy in identifying heterogeneous land-use patterns. The mapping showed the extent of land acquisition and land use conversion due to project. A total of 690 hectares of land was acquired for road construction, with agricultural land accounting for the largest share at 418 hectares (60.58%), followed by orchards at 188 hectares (27.55%). Plantations contributed 38 hectares (5.51%), roads 30 hectares (4.35%), fallow land 12 hectares (1.74%), while both water bodies and built-up areas accounted for 2 hectares each (0.29%). The predominance of agricultural and orchard land loss underscores the vulnerability of agrarian landscapes to infrastructure expansion.The findings reveal a critical trade-off between infrastructure development and agricultural sustainability in the Kashmir Valley. By offering spatial evidence, the study informs policy decisions, supports land-use planning, and highlights broader implications for integrating farmland and ecosystem protection into sustainable infrastructure development.

Keywords: *Srinagar Ring Road, Land use land cover, Land acquisition, Infrastructure development.*

INTRODUCTION

Land cover of the earth's land surface has been changing since time immemorial and is likely to continue to change in the future (Ramankutty & Foley, 1998). Land use refers to the human purposes the land serves, such as agriculture or urbanization, while land cover refers to the physical material present on the surface, like vegetation or water bodies. These changes are occurring at a range of spatial scales from local to global and at temporal frequencies of days to millennia (Townshend *et al*., 1991). The land use modifications are dynamic in nature and are caused by multiple factors operating on local, regional and global scales (Hassan *et al*., 2016; Rahman *et al*., 2012). The rapid and uncontrolled population growth, coupled with industrial development and economic growth has been continuously transforming the land use pattern (Dutta *et al*., 2019). Several potential causes of land use land cover (LULC) changes have been identified such as industrial growth and urban agglomeration (Walker, 2001), climate change and population growth (Hassan *et al*., 2016), urban expansion (Dutta & Das, 2019; Voogta & Okeb, 2003) and policy provisions (Thiha *et al*., 2007). The urban areas expand outwards as a consequence conversion of agricultural and other natural land cover types into built-up area (Dutta *et al.*, 2020).

Evaluating LULC is essential for addressing regional environmental challenges, such as uncontrolled development, loss of agricultural land, and the degradation of wetlands and wildlife habitats (Anderson *et al*., 1976). Furthermore, LULC changes warrant significant attention in land management due to their adverse effects on ecosystem functioning and integrity (Quintas-Soriano *et al*., 2016). Studies on land use and land cover (LULC) change primarily focus on understanding five interrelated dimensions: identifying where changes occur, determining which land cover types are affected, examining the nature of the transformations, quantifying the rate and extent of these changes, and analysing the underlying drivers and proximate causes responsible for them (Loveland & Acevedo, 2006). The drivers of land use change, frequently human-induced, are complex and influence various policies governing land management (Adger & Brown, 1994; Krummer & Turner, 1994). In the Himalayan region, GIS and remote sensing techniques have been extensively employed to study LULC dynamics, providing critical insights for long-term planning, management, and policy making processes (Mishra *et al*., 2019; Sari *et al*., 2023).

Geospatial technologies, particularly Geographic Information Systems (GIS) and remote sensing, play a crucial role in examining land use and land cover (LULC) dynamics by enabling the systematic mapping, monitoring, and analysis of landscape transformations over space and time. LULC data are essential for understanding ecological processes and environmental challenges that influence human well-being and living standards (Anderson *et al*., 1976). Advances in high-resolution satellite imagery have further strengthened the capacity to generate detailed spatial information, allowing precise identification and monitoring of environmental changes in urban and peri-urban regions at appropriate spatial and temporal scales (Miller & Small, 2003). These tools are especially valuable in fragile mountain ecosystems such as the Himalayas, where recent development has often been rapid, poorly planned, and largely undertaken at the expense of fertile and arable agricultural lands. In the Kashmir Valley, urbanization has intensified in recent decades, driven by a combination of population growth, rural-to-urban migration, and economic diversification. The region, once predominantly agrarian, has witnessed rapid spatial and demographic transformations due to the expansion of educational facilities, healthcare infrastructure, and tourism-related activities (Naqshbandi *et al*., 2016). These changes mirror the broader patterns of urban expansion in India, where the urban population rose from 27.7% in 2001 to 31.1% in 2011, with projections estimating nearly 600 million urban residents by 2031 (Tali *et al*., 2011). In Kashmir region, urban traffic congestion has emerged as a critical challenge, imposing substantial economic and social costs and severely affecting the quality of urban life. In Srinagar, escalating vehicle numbers have far exceeded the capacity of existing road infrastructure, resulting in severe congestion and economic losses estimated at nearly ₹70 million per day in travel delays, amounting to over ₹800 million annually for commuters (Ahad *et al*., 2025). The Srinagar Ring Road project was conceived as an urgent intervention to address these challenges by decongesting the city, improving inter-district connectivity, and stimulating economic activity across Budgam, Ganderbal, Pulwama, and Baramulla districts.

However, this 62-km infrastructure project designed to bypass Srinagar has required the acquisition of extensive fertile agricultural land, raising concerns over agrarian livelihoods, food security, and environmental sustainability. Integrating spatial vulnerability analysis would establish a robust framework, advancing the study into a decision-support tool for sustainable infrastructure planning. Although LULC change studies are abundant, most emphasize regional or catchment-scale trends and lack project-specific assessments of infrastructure-induced land acquisition and its implications for agricultural sustainability. In the Kashmir Valley, previous studies have documented agricultural decline, horticultural expansion, urban growth, and hydrological impacts using geospatial data (Alam et al., 2019; Romshoo et al., 2021; Rasool et al., 2024; Dar et al., 2023). Others have focused on classification accuracy, spatial resolution, or urban–thermal dynamics (Zahoor et al., 2020; Sajad et al., 2002; Murtaza, 2014, 2023). However, these studies generally do not incorporate statutory infrastructure alignments within high-resolution spatial analyses, which constrains their applicability for informing infrastructure planning and policy formulation. This paper addresses this gap by providing a corridor-level LULC assessment of the Srinagar Ring Road, generating policy-relevant spatial evidence to support sustainable infrastructure planning and land-use regulation. In this context, the present study was conducted to examine the land acquisition across different land use and land cover categories and to assess the extent of impacts on productive agricultural landscapes. The findings provide spatially explicit evidence to support informed policymaking, equitable compensation, and environmentally sustainable, socially inclusive infrastructure planning in the Kashmir Valley.

STUDY AREA

The Srinagar ring road will traverse through 52 villages and 6 districts of Pulwama, Srinagar, Budgam, Baramulla, Bandipora, and Ganderbal. The Construction of the ring road is being carried out in two different phases. Phase 1 covers a length of 42 km from Galander (Pulwama) to Narbal (Budgam). Phase 2 covers 18.84 km from Narbal to Ganderbal via Sumbal road (Fig.1). The strategic importance of the Srinagar ring road lies in its potential to decongest the city centre by diverting a substantial volume of traffic away from the core urban areas, especially commercial vehicles and transit traffic that do not have Srinagar as their final destination.

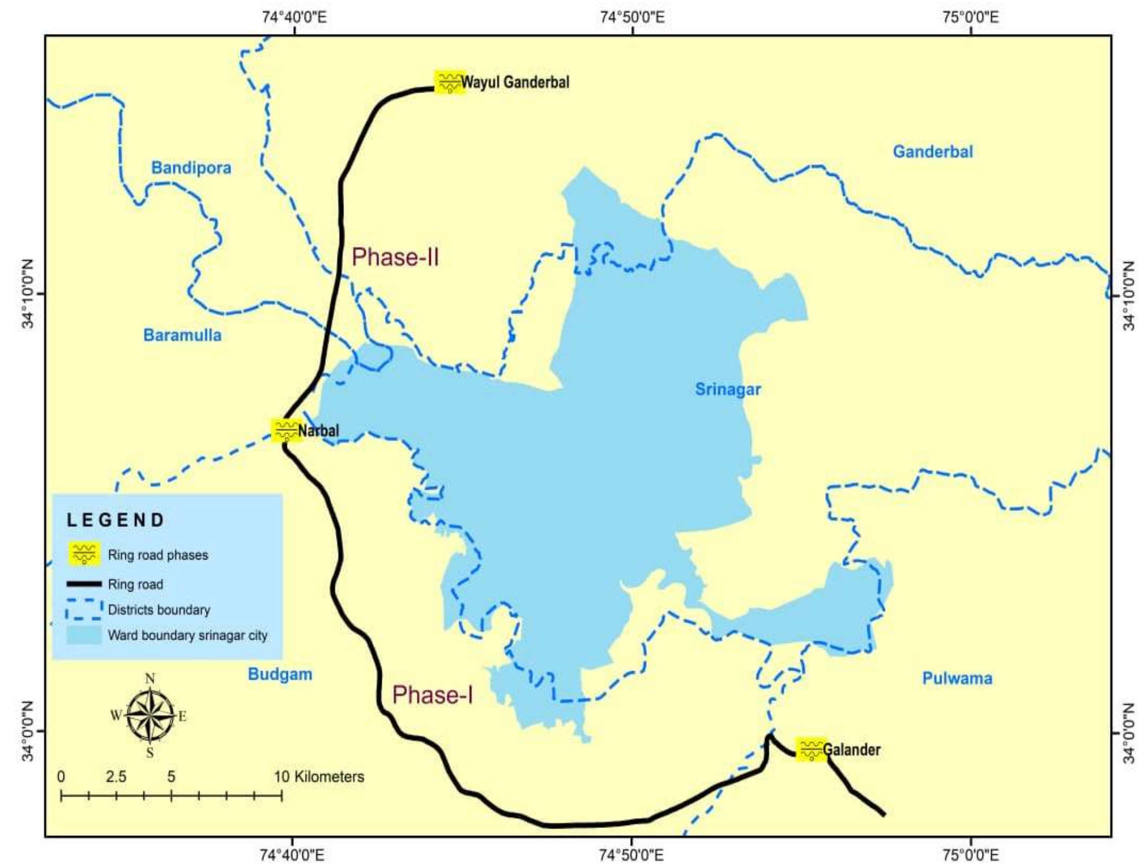

Fig. 1 Study site map of the Srinagar ring road alignment, illustrating Phase I (*Galander to Narbal Junction, ~42 km*) and Phase II (*Narbal to Ganderbal, ~18.8 km*).

MATERIALS AND METHODS

The general approach for studying the spatiotemporal extent and characteristics of land acquisition for the construction of the Srinagar ring road involved use of a base map obtained from the Srinagar Development Authority (SDA), as provided in the Srinagar Master Plan (2035).

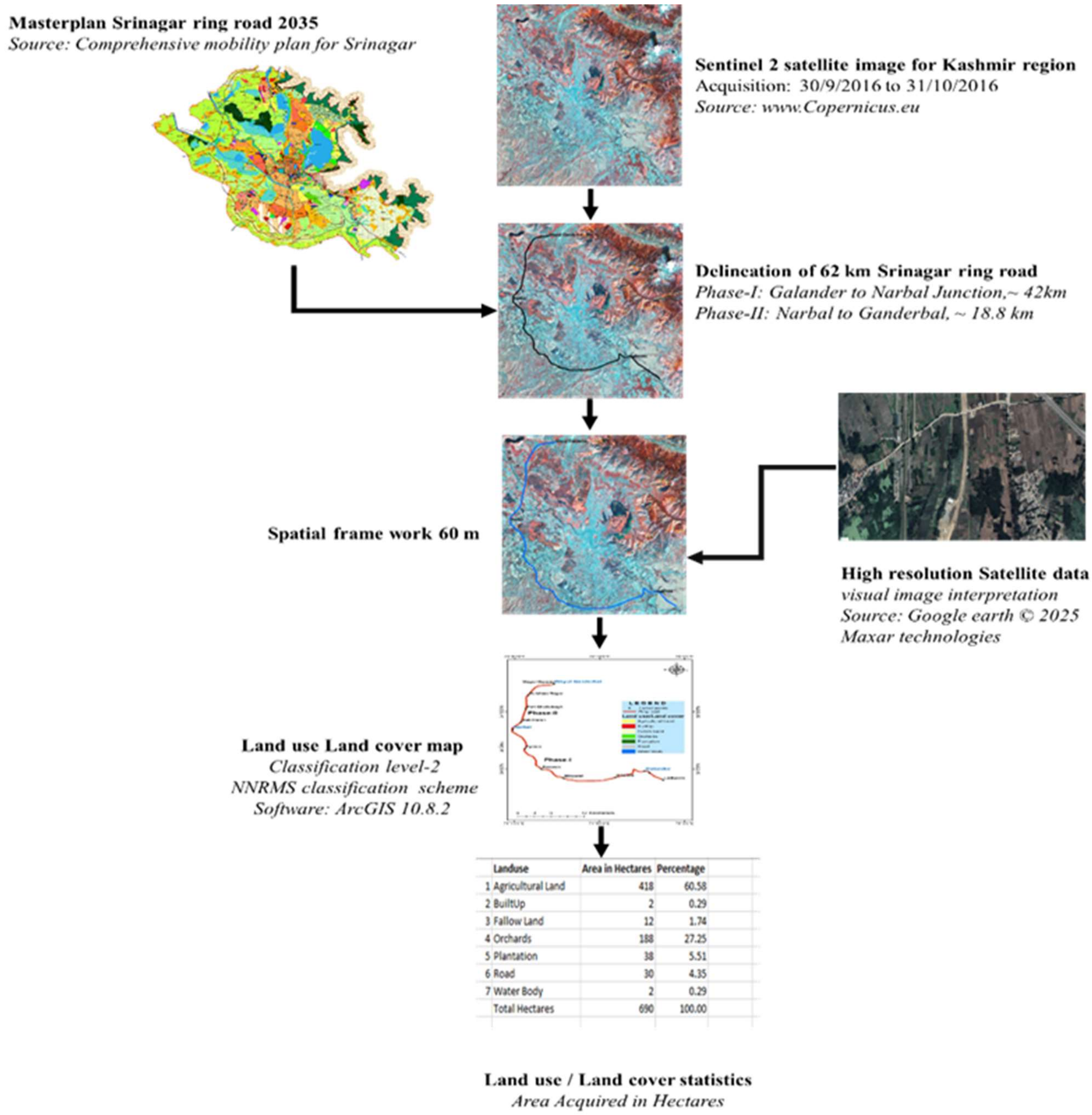

Fig. 2 Flow chart showing the methodology adopted

The acquired base map was georeferenced with the help of satellite data. Furthermore, the alignment of the Srinagar Ring Road was vectorized to delineate the road and establish a spatial framework, and then acquired land was delineated using visual image interpretation using high-resolution Google Earth and Sentinel -2 Imagery, with acquisition dates ranging from 30-09-2016 to 31-10-2016. These statistics were used to quantify the overall land use acquisition associated with the Srinagar ring road project. The conceptual framework of the methodology is presented in Fig. 2 and the detailed steps are described below.

Data source: The data used for the present study includes

- **Base map collection:** sourced from Srinagar Development Authority (SDA), as part of Srinagar Master Plan (2035). This base map includes the proposed layout of the 62 km Srinagar ring road.
- **Satellite Data:** Sentinel-2 imagery data obtained from the Copernicus Open Acess Hub was used for land use land cover analysis. Additionally, Google Earth was used for better land use land cover interpretation within the study area.

Georeferencing: The base map procured from the Srinagar Development Authority, was georeferenced using ArcGIS software version 10.8.2. The base map was projected to UTM zone 43N coordinate system with the WGS-84 datum. This ensured that the base map aligned accurately with real world coordinates for spatial analysis.

Vectorization: The proposed alignment of the Srinagar ring road was digitized using the georeferenced base map. This vector representation served as central axis for further spatial analyses, including the delineation of road, creation of buffer zones, and overlay of thematic layers.

Thematic Data Analysis: Thematic layers representing the proposed Srinagar ring road was developed from the georeferenced base map. Additionally, the Comprehensive Mobility Plan (CMP) for Srinagar (Final Report, January 2020) was consulted to delineate a buffer zone of 60 meters width along the 62 km length of the proposed ring road. This buffer zone served as a spatial reference framework for extracting and analysing LULC patterns.

Classification: Land use/ Land cover classification was carried out using visual image interpretation approach wherein satellite imagery was analysed based on key visual elements such as tone, texture, shape, size, pattern, and association to accurately delineate different land use/ land cover classes. The classification was performed following the level-2 NNRMS (National Natural Resources Management System) classification scheme which provides a standardized framework for categorizing land cover into detailed classes.

Accuracy assessment: A formal accuracy assessment was not performed because LULC mapping relied on manual visual interpretation using high-resolution Google Earth imagery. These images enabled clear feature identification and temporal cross-checking. Classification reliability was ensured through expert interpretation and multi-temporal visual consistency, a widely accepted approach in visual LULC studies (Lillesand et al., 2015; Jensen, 2016; Congalton & Green, 2019).

Land use Land cover Statistics: Zonal statistics were computed to quantify the extent and distribution of land-use classes, identifying areas affected by development, particularly agricultural lands subject to acquisition. Using the NNRMS standardized LULC classification, detailed maps were generated to represent land-use categories within the proposed ring road's buffer zone. Derived from multi-temporal satellite data, these maps provide insights into land distribution and usage patterns. The conceptual framework of this methodology is presented in Fig. 2.

RESULTS AND DISCUSSION

The development of the Srinagar Ring Road has brought about substantial changes in the land use and land cover (LULC) dynamics of the Kashmir Valley, significantly affecting agricultural land, horticultural landscapes, plantations, water bodies, fallow land, and built-up areas. These land categories are central to the Valley's socio-economic structure, ecological balance, and cultural identity. The large-scale transformations triggered by the ring road raise serious concerns regarding sustainability, resilience, and the long-term viability of Kashmir's fragile land systems. Table 1 summarizes the (LULC) distribution of the study area, showing the area (in hectares) and percentage share of each category relative to the total area. Spatial variations in LULC across different sections of the study area are illustrated in Fig. 3 (a–e).

Table 1. Land use land cover acquisition under the Srinagar ring road.

S. No.	Land Use Type	Area in hectares	Percentage (%)
1	Agricultural Land	418	60.58
2	Built-up	2	0.29
3	Fallow Land	12	1.74
4	Orchards	188	27.55
5	Plantation	38	5.51
6	Road	30	4.35
7	Water Bodies	02	0.29
Total Land		**690**	**100.00**

Of the total 690 hectares acquired for the project, agricultural land accounts for the largest share, with 418 hectares (60.58%) primarily comprising fertile paddy fields. This loss mirrors broader regional trends. Rafiqi *et al*., (2023) reported a 20% decline in agricultural land due to road widening along NH-44 in Anantnag between 2019 and 2022, while Alam *et al*., (2020) documented widespread conversion of arable land driven by urban expansion and infrastructure development across the Kashmir Valley. In central Kashmir alone, agricultural land declined by 28.85% during recent decades (Alam *et al*., 2020). Such losses contribute to a persistent regional contraction of cultivated land. Official data indicate that the net sown area in Jammu and Kashmir has remained largely stagnant at around 30–31% of total land over the past four years, while fallow land has increased steadily, reflecting a gradual withdrawal from active cultivation (Anonymous, 2025). Concurrently, land under non-agricultural uses has expanded, signalling a slow but continuous erosion of farmland (Anonymous, 2022). The conversion of productive agricultural land for infrastructure development threatens food security, undermines rural livelihoods, and weakens the agrarian foundation of the Valley.

Horticultural land constitutes the second-largest category affected by the ring road, with 188 hectares (27.55%) acquired. The project traverses 52 villages across Pulwama, Budgam, Baramulla, Srinagar, Bandipora, and Ganderbal districts (Ministry of Road Transport and Highways). Orchards particularly apple orchards form the backbone of Kashmir's rural economy and support the livelihoods of nearly 35 lakh people (Jammu and Kashmir Economic Survey 2023–24). The uprooting of mature trees, which take decades to

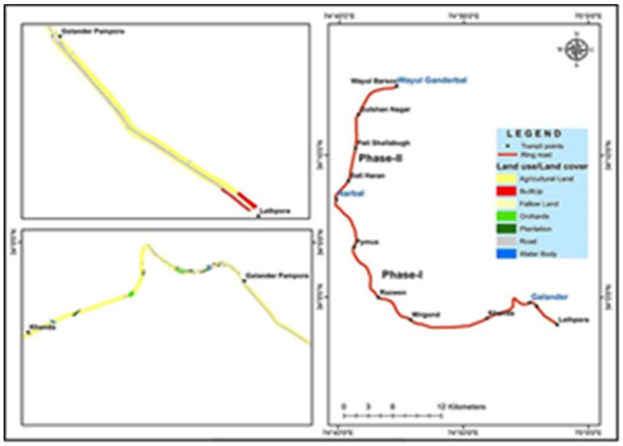

Fig. 3(a)

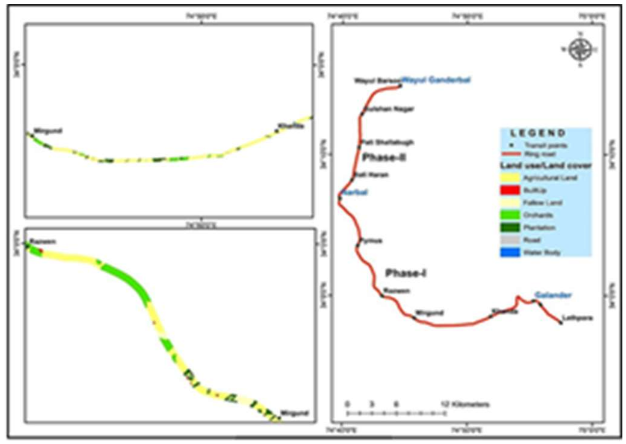

Fig. 3(b)

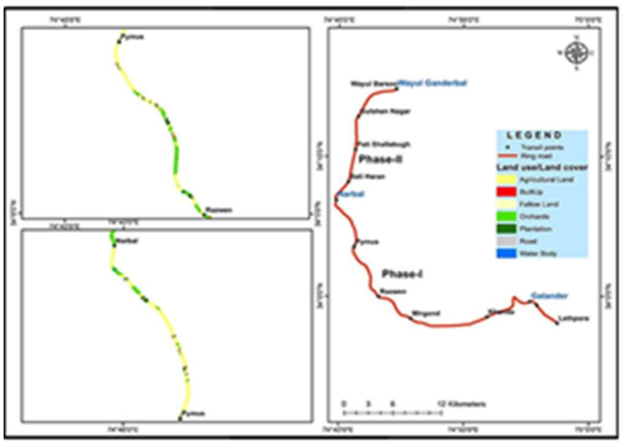

Fig. 3(c)

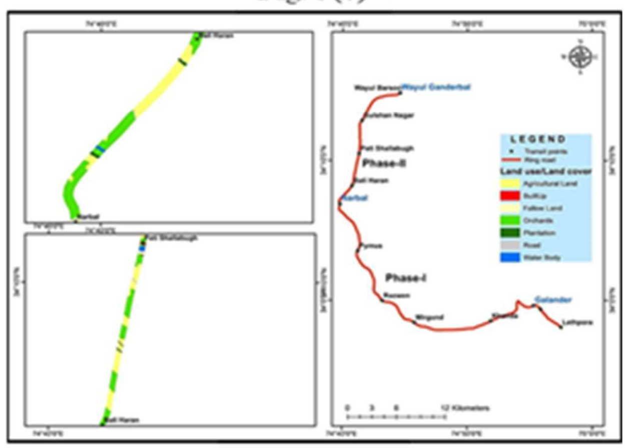

Fig. 3(d)

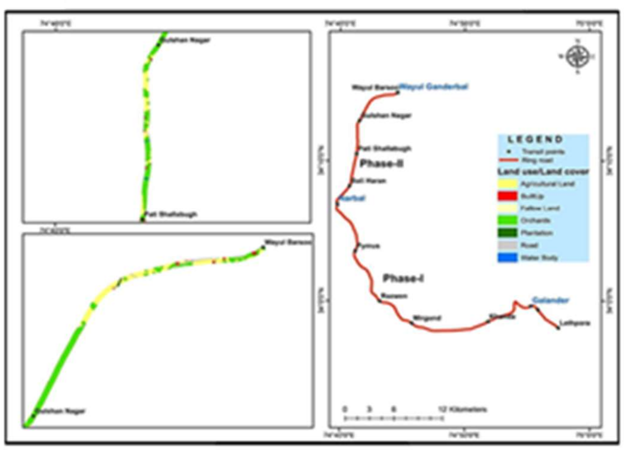

Fig. 3(f)

Fig. 3 (a-e) Land use Land cover changes of different sections of Srinagar ring road reach peak productivity, has resulted in direct income losses for farming households and reduced long-term economic stability. Fragmentation of orchard holdings along the road corridor further diminishes productivity, while dust deposition and vehicular emissions adversely affect fruit quality and market competitiveness. Given that horticulture contributes approximately 9% to the state's Gross Domestic Product (Department of Horticulture, J&K Government), continued loss of orchard land has far-reaching implications for regional economic resilience and national fruit supply chains. Beyond economic impacts, orchards provide critical ecosystem services, including carbon sequestration, soil conservation, and groundwater recharge. Their removal exacerbates soil erosion, land degradation, and ecological vulnerability, particularly on sloping terrain, thereby undermining both environmental stability and the cultural identity of the Valley.

Plantation land, accounting for 38 hectares (5.5%) of the acquired area, has also been notably affected. Poplar, willow, and walnut plantations serve as vital economic resources by supplying timber for packaging, plywood, and cottage industries, while also providing supplementary income to smallholder farmers. Ecologically, these plantations function as windbreaks, riparian buffers, and habitats for birds and pollinators. Their removal disrupts ecological linkages, reduces biodiversity, and weakens ecosystem services such as soil stabilization, carbon storage, and microclimate regulation. Similar impacts of infrastructure-induced deforestation and habitat fragmentation have been reported across the Valley (Ganaie et al., 2020). The loss of plantation cover thus not only diminishes rural economic resilience but also amplifies environmental stress in an already fragile Himalayan ecosystem.

Although limited in extent, the acquisition of water bodies—2 hectares (0.29%)—carries disproportionately large ecological and social consequences. Wetlands and small water bodies in the Kashmir Valley play a crucial role in sustaining biodiversity, regulating hydrological processes, and supporting livelihoods through irrigation and fishing. Their conversion into road infrastructure reduces groundwater recharge capacity, weakens flood mitigation functions, and heightens the risk of seasonal flooding and water scarcity in surrounding agricultural areas. In a region already experiencing wetland decline due to urbanization and climate change, even small losses represent a significant erosion of natural capital and ecosystem services.

Fallow land accounts for 12 hectares (1.74%) of the acquired area. These lands, largely located along peri-urban zones, are not true agricultural fallows but vacant spaces with potential for regulated urban expansion and community use. Unlike traditional fallows that support soil regeneration (Lambin & Meyfroidt, 2011), their conversion into transport infrastructure encourages ribbon development, unplanned sprawl, and loss of ecological buffers, reducing future flexibility for sustainable peri-urban planning.

The acquisition of built-up areas (2 hectares; 0.29%) and existing roads (30 hectares; 4.35%) has resulted in displacement, disruption of livelihoods, and erosion of social networks. Residential houses and small commercial establishments are integral to local socio-economic systems, and their removal has disproportionately affected economically weaker and marginalized groups. Delays in compensation and inadequate rehabilitation measures have further intensified vulnerabilities, highlighting the social costs embedded in large infrastructure projects.

Overall, the findings align with broader regional research documenting the steady conversion of agricultural land, forests, and wetlands into built-up areas across the Kashmir Valley (Alam *et al*., 2020; Fayaz *et al*., 2020; Rasool *et al*., 2021; Padder *et al*., 2022). While improved connectivity through the Srinagar ring road offers economic and mobility benefits, the cumulative loss of fertile land, orchards, plantations, and wetlands underscores a critical development paradox. Without robust land-use planning, environmental safeguards, and inclusive compensation mechanisms, infrastructure expansion risks undermining the very ecological resilience and food security upon which long-term regional sustainability depends.

CONCLUSION

This study highlights the broader implications of land acquisition for the Srinagar Ring Road project and its transformative impact on the Kashmir Valley's physical, ecological, and socio-economic landscape. While roads and infrastructure are vital for regional connectivity and economic growth, large-scale land conversion carries significant risks. Fertile agricultural and horticultural lands, which underpin local livelihoods and regional food security, are particularly vulnerable. The diversion of paddy fields and orchards threatens agrarian income systems, increases rural household vulnerability, and disrupts traditional land-use patterns. Additionally, the conversion of plantations and alteration of natural water bodies can undermine ecological balance by affecting biodiversity, microclimates, and hydrological processes. Expansion of road networks and built-up development may also accelerate unplanned urban sprawl, exposing gaps in existing land-use planning and regulatory frameworks, especially in the ecologically sensitive Himalayan environment. The study emphasizes that infrastructure development must be carefully planned to be sustainable. Strategic route alignment, protection of prime agricultural and environmentally sensitive lands, and use of alternative design solutions—such as non-arable lands, optimization of existing corridors, or elevated structures are crucial. Strengthened land-use governance, fair compensation, and environmentally informed planning are essential to balance development needs with ecological resilience, social equity, and long-term sustainability in the Kashmir Valley.

REFERENCES

Adger, W. N., & Brown, K. (1994). *Land use and the causes of global warming*. John Wiley.

Ahad, F., Rashid, H., Shah, S. A., Bhat, M. S., & Jeelani, P. (2025). A micro-level study of the economic losses of traffic congestion delays in Srinagar city of Kashmir Valley. *Discover Cities, 2*(1), 33.

Alam, A., Bhat, M. S., & Ahmad, B. (2019). Using Landsat satellite data to assess land use–land cover change in the central Kashmir Valley, India. *Journal of the Indian Society of Remote Sensing*, 47(1), 123–136.

Alam, A., Bhat, M. S., & Maheen, M. (2020). Using Landsat satellite data for assessing land use and land cover change in Kashmir Valley. *GeoJournal, 85*(6), 1529–1543.

Anderson, J. R., Hardy, E. E., Roach, J. T., & Witmer, R. E. (1976). *A land-use and land-cover classification system for use with remote* *sensor data* (U.S. Geological Survey Professional Paper No. 964). U.S. Government Printing Office.

Anonymous. (2022). Agriculture land in Kashmir shrinking fast. *Kashmir Dawn*.

Anonymous. (2025). Srinagar ring road creates mud, dust mess. *Daily Excelsior*.

Congalton, R. G., & Green, K. (2019). Assessing the Accuracy of Remotely Sensed Data. CRC Press.

Dar, M. U. D., Romshoo, S. A., Rashid, I., & Ali, N. (2023). Spatio-temporal analysis of land use/land cover change in central Kashmir Himalaya using geospatial techniques. Environmental Monitoring and Assessment, 195, 1–18.

Dutta, D., Rahman, A., Paul, S. K., & Kundu, A. (2020). Estimating urban growth in peri-urban areas and its interrelationships with built-up density using earth observation datasets. *The Annals of Regional Science*.

Dutta, I., & Das, A. (2019). Application of geo-spatial indices for detection of growth dynamics and forms of expansion in English Bazar urban agglomeration, West Bengal. *Journal of Urban Management, 8*(2), 288–302.

Fayaz, A., ul Shafiq, M., Singh, H., & Ahmed, P. (2020). Assessment of spatiotemporal changes in land use/land cover of North Kashmir Himalayas from 1992 to 2018. *Modeling Earth Systems and Environment*.

Ganaie, T. A., Jamal, S., & Ahmad, W. S. (2020). Changing land use/land cover patterns and growing human population in Wular catchment of Kashmir Valley, India. *GeoJournal*.

Government of Jammu & Kashmir, Planning/Finance Department. (2024). *Economic survey 2023–24 (provisional data)*. https://www.jkplanning.gov.in/pdf/Economic%20Survey%202024-25.pdf

Hassan, Z., Shabbir, R., Ahmad, S. S., Malik, A. H., Aziz, N., & Butt, A. (2016). Dynamics of land use and land cover change using geospatial techniques: A case study of Islamabad, Pakistan. *SpringerPlus, 5*(1), 812.

Horticulture Planning & Marketing Department, Government of Jammu and Kashmir. (2025). *Horticulture sector overview: Contribution to economy*. https://jkdhpm.in/

Jensen, J. R. (2016). Introductory Digital Image Processing. Pearson.

Krummer, D., & Turner, B. L., II. (1994). The human causes of deforestation in Southeast Asia. *BioScience, 44*(5), 323–330.

Lambin, E. F., & Meyfroidt, P. (2011). Global land use change, economic globalization, and the looming land scarcity. *Proceedings of the National Academy of Sciences, 108*(9), 3465–3472.

Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2015). Remote Sensing and Image Interpretation. Wiley.

Loveland, T. R., & Acevedo, W. (2006). *Land cover change in the eastern United States*. U.S. Geological Survey.

Miller, R. B., & Small, C. (2003). Cities from space: Potential applications of remote sensing in urban environmental research and policy. *Environmental Science & Policy, 6*(2), 129–137.

Mishra, V. N., Rai, P. K., & Mohan, K. (2019). Prediction of spatio-temporal land use/land cover dynamics using remote sensing, GIS and CA–Markov model. *Environmental Monitoring and Assessment, 191*(10), Article 618.

Murtaza, K. O., & Romshoo, S. A. (2014). Assessing the impact of spatial resolution on the accuracy of land cover classification. *Journal of Himalayan Ecology and Sustainable Development,* 9, 1–12.

Murtaza, K. O., Shafai, S., Shahid, P., & Romshoo, S. A. (2023). Understanding the linkages between spatio-temporal urban land system changes and land surface temperature in Srinagar City, India, using image archives from Google Earth Engine. *Environmental Science and Pollution Research*, 30(49), 107281–107295.

Naqshbandi, Z., Fayaz, S., & Bhat, M. S. (2016). Urban growth and its impact on land transformation in medium-sized urban centres of Kashmir Valley. *IOSR Journal of Humanities and Social Science, 21*(2), 46–51.

Padder, A. H., & Mathavan, B. (2022). Dynamics of land use and land cover change in Jammu & Kashmir. *Journal of Agriculture and Horticulture Research, 5*(2), 104–112.

Quintas-Soriano, C., Castro, A. J., Castro, H., & García-Llorente, M. (2016). Impacts of land use change on ecosystem services and implications for human well-being in Spanish drylands. *Land Use Policy, 54*, 534–548.

Rafiqi, S., & Singh, E. B. (2023). Road widening and land use land cover change detection at Anantnag, Kashmir.

Rahman, A., Kumar, S., Fazal, S., & Siddiqui, M. A. (2012). Assessment of land use/land cover change in the north-west district of Delhi using remote sensing and GIS techniques. *Journal of the Indian Society of Remote Sensing, 40*(4), 689–697.

Ramankutty, N., & Foley, J. A. (1998). Characterizing patterns of global land use: An analysis of global croplands data. *Global Biogeochemical Cycles, 12*, 667–685.

Rasool, A., Bhat, M. S., & Sheikh, A. H. (2024). Spatiotemporal dynamics of land use/land cover change in South Kashmir Himalaya using remote sensing and GIS. *Arabian Journal of Geosciences,* 17, 1–15.

Rasool, R., Fayaz, A., ul Shafiq, M., Singh, H., & Ahmed, P. (2021). Land use land cover change in Kashmir Himalaya: Linking remote sensing with an indicator-based DPSIR approach. *Ecological Indicators, 125*, Article 107447.

Romshoo, S. A., Rashid, I., Altaf, S., & Dar, R. A. (2021). Land use/land cover change and its impact on hydrology of the Sindh River basin, Kashmir Himalaya. *Journal of Mountain Science*, 18(3), 1–14.

Sajad, H., Hassan, M., & Khan, A. A. (2002). Dynamics of land use/land cover changes in the Upper Jhelum catchment of Kashmir Himalaya. *Geographical Review of India*, 64(4), 1–15.

Sari, D., Bhatta, B., & Kandel, P. (2023). Monitoring land use/land cover dynamics and its implications in the Himalayan region using remote sensing and GIS. *Environmental Challenges, 11*, Article 100765.

Tali, J. A., & Murthy, K. (2011). Impact of demographic and areal changes on urban growth: A case study of Mysore City. *International Journal on Technical and Physical Problems of Engineering, 4*(1), 74–79.

Thiha, T., Edward, L., Webb, E. L., & Kiyoshi, H. (2007). Biophysical and policy drivers of landscape change in a central Vietnamese district. *Environmental Conservation, 34*(2), 164–172.

Townshend, J. R. G., Justice, C. O., Li, W., Gurney, C., & McManus, J. (1991). Global land cover classification by remote sensing: Present capabilities and future possibilities. *Remote Sensing of Environment, 35*, 243–255.

Voogt, J. A., & Oke, T. R. (2003). Thermal remote sensing of urban climates. *Remote Sensing of Environment, 86*(3), 370–384. Walker, R. (2001). Industry builds the city: The suburbanization of manufacturing in the San Francisco Bay Area, 1850–1940. *Journal of Historical Geography, 27*(1), 36–57.

Zahoor, S., Romshoo, S. A., & Rashid, I. (2020). Accuracy assessment of land use/land cover classification using high-resolution satellite data in the Kashmir Valley. *Journal of the Indian Society of Remote Sensing*, 48(3), 1–12.