

# Analyzing Spatio – Temporal Patterns of GreenAreas– A Case Study of Pipalantri Village, Rajasmand, Rajasthan, India

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## ABSTRACT

Land use and land cover mapping plays an increasingly crucial role in monitoring changes in land utilization. This study specifically examines shifts in forested and mined areas within Pipalantri village. Data from 2012 and 2023 were analyzed to track these changes. Thematic maps depicting forest and mining extents were created using QGIS software, enabling comparative analysis. The findings indicate that forest cover in Pipalantri village expanded significantly from 6.72% in 2012 to 15.11% in 2023. Conversely, mining areas occupied 0.17% of the village in 2012, increasing to 1.77% by 2023. Over the study period, the forest area increased by 8.39%, attributed in part to the community tradition of planting 111 trees upon the birth of a girl child in Pipalantri village since 2006. These results highlight notable changes in land use dynamics. They underscore the proactive approach of stakeholders in recognizing environmental risks that impact human well-being, particularly in greenfield areas where such changes have already been observed.

**Key words:** QGIS, Land use change, Green area

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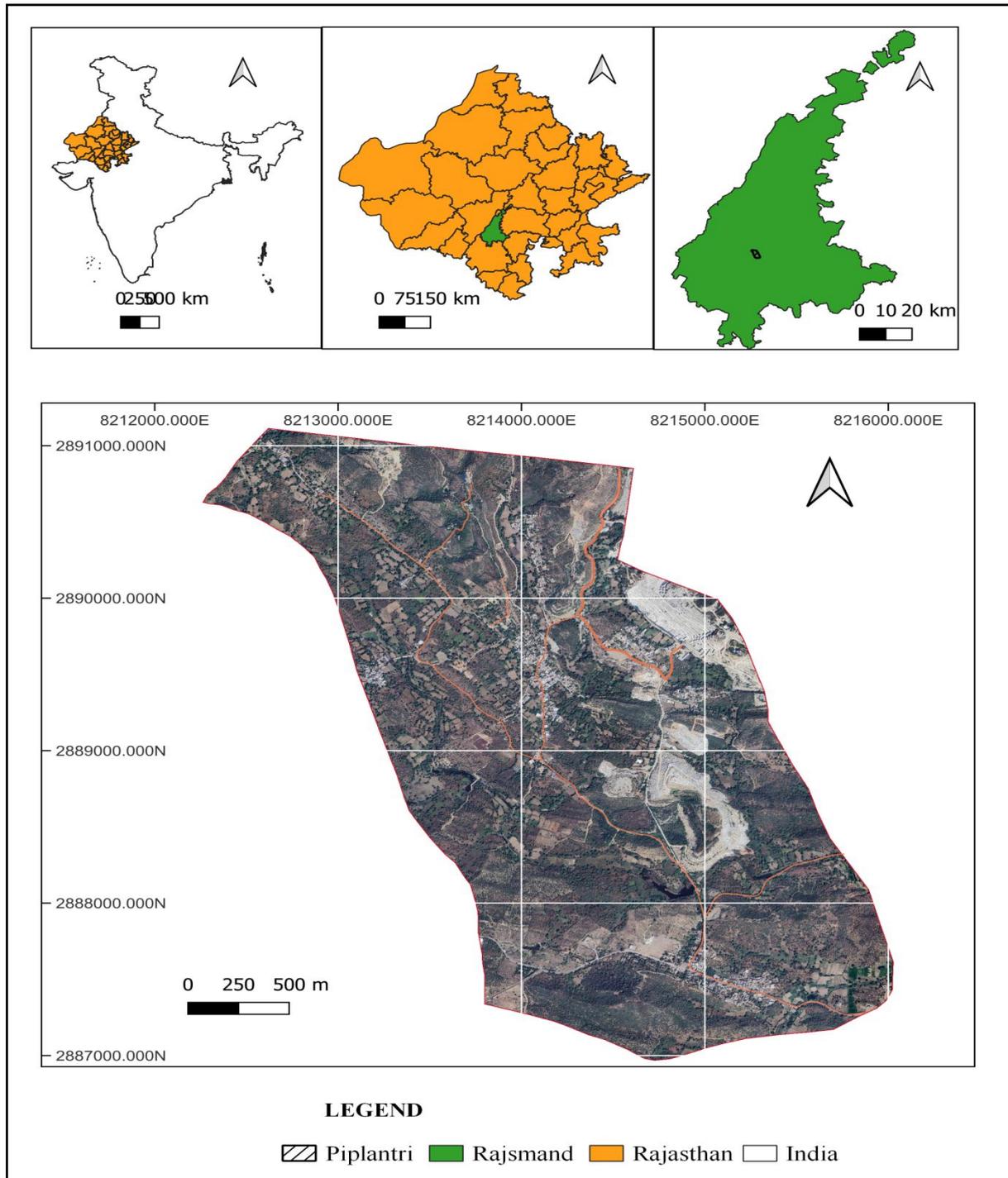
## INTRODUCTION

Since the onset of the Industrial Revolution and the subsequent advancements in technology, human activities have profoundly reshaped the Earth's landscapes. Over the past three centuries, there have been substantial shifts in land use patterns, catalyzed by theories such as Malthus's (1798), which continue to provoke scholarly debate. Malthus's predictions, notably relevant in the 20th century (Roy et al.), underscore the consequences of increased human exploitation of land resources (Benidick, 1999). The concept of land cover encompasses the physical and biological attributes of the Earth's surface, encompassing vegetation, soil, and human-made structures like mining and agriculture (Ellis, 2007). Concurrently, the study of land use serves the objectives of social science management and socio-economic planning (Lembin et al., 2001). Recent advancements in remote sensing technology have revolutionized the ability to monitor land dynamics continuously, facilitating the detection of subtle ecosystem changes and long-term trends in vegetation productivity (Woodcock et al., 2020). The presence and accessibility of rural green spaces are widely regarded as critical indicators of quality of life and environmental sustainability in rural areas. In contexts increasingly impacted by mining and environmental crises, tree plantations play a significant role in biodiversity conservation and the well-being of local populations (Farahani and Mellor, 2018). According to Gushue et al. (2020), both physical and institutional factors shape the preference for and utilization of green spaces within local communities. Green spaces offer promising solutions to challenges associated with climate change (Farahani and Mellor, 2018; Guenat et al., 2021), providing diverse benefits at the ecosystem level, including reduced air pollution, enhanced biodiversity, increased rainfall, mitigated soil erosion, and moderated air temperatures (Lo et al., 2017; Hoyle et al., 2019; Jahan et al., 2019; Wtodarczyk-Marciniak et al., 2020). This study investigates changes in forested and mined areas, illustrating how environmental conservation can align with economic development objectives. Remote sensing technologies are pivotal in accurately identifying and monitoring these transformations, reflecting significant advancements in the field in recent decades (NAP, 2008). Viewing green spaces through an ecological lens underscores their essential role in maintaining balanced ecosystems and environmental health.

## STUDY AREA

Piplantri, a village located 15 kilometers from Rajsamand district, occupies an area of 6.214 square kilometers at coordinates 25.06709°N and 73.883291°E. As of the 2011 census, the population stood at 1,519, since then which has grown to 5500 residents. In 2006, during a severe water crisis necessitating rail and tanker transport, Shyam Sunder Paliwal was elected as the sarpanch (village head). The village is renowned for its marble mining industry, initially

causing environmental harm by depositing waste on grazing lands, rendering them infertile. Upon assuming office, Paliwal spearheaded the construction of rainwater harvesting structures like earthen check dams and anicuts to address water scarcity. In 2006, in memory of his late daughter Kiran, Paliwal launched a movement to plant 111 trees for every girl child born in the village. This initiative gained international recognition, earning Paliwal the Padma Shri from the Government of India. Villagers collectively contribute Rs 21,000 towards this cause, with an additional Rs 10,000 deposited into a fixed account for each girl child's future. Today, Piplantri has flourished into a lush green haven with over 300,000 trees planted, including Neem, Sheesham, Mango, and Amla. Rakshabandhan is celebrated in Piplantri as an environmental festival, where girls tie rakhis to trees planted on their birthdays and pledge to safeguard them. Two nurseries within the village propagate a variety of species such as Neem, Amla, Banyan, Mango, Sheesham, Peepal, Arjun, and Bamboo. Aloe vera plants are strategically grown around these trees to protect them from pests and environmental challenges. Beyond his environmental initiatives, Paliwal has been a strong advocate for women's empowerment, promoting education and reducing gender inequality throughout the village.



**Figure 1. Location Map of Study Area**

## DATA AND METHODOLOGY

### DATA:

**Primary Data Collection:** In this study, the village boundary of Pipalantri was digitally mapped using QGIS, and land cover features were delineated using Google Earth Pro to analyze forested and mining areas within the village. Pipalantri served as the primary research site, where primary data collection involved a combination of observational methods and interviews. Key stakeholders, including the Sarpanch Secretary and community members, were interviewed to gather demographic insights, explore the history of tree planting initiatives, and map their distribution across Pipalantri.

Detailed field observations were conducted to document Pipalantri's ecological landscape, emphasizing conservation strategies for various tree species. Structured interviews with local leaders, such as Sarpanch Paliwal, provided valuable socio-economic perspectives. These discussions highlighted significant advancements supported by governmental funding, including initiatives like rainwater harvesting and programs promoting women's empowerment and gender equality within the community.

**Secondary Data Collection:** Complementary to primary data, secondary sources such as census data, government reports and news articles were utilized to provide contextual background information relevant to the research field.

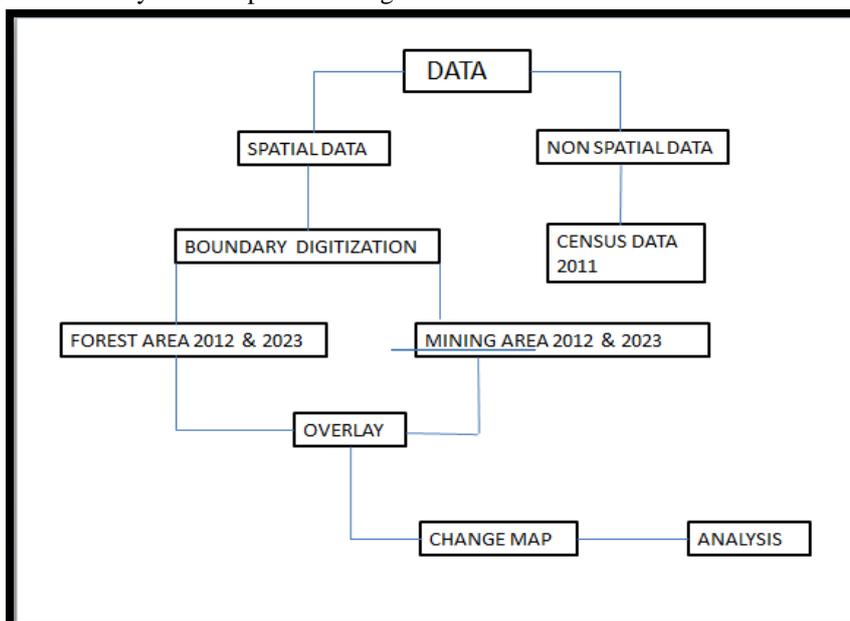
**Table 1. Data collection**

PRIMARY DATA	SECONDARY DATA
Pipalantri village Boundary	Census data
Interview Information	Forest data: Report, Articals
Observation	Base map: QGIS

### Methodology:

**Data Pre-processing:** The boundary of Pipalantri Village was initially acquired from Groundwater Rajdhara Rajasthan and subsequently georeferenced using QGIS software. Changes in forest and mining areas from 2012 to 2023 in Pipalantri village were assessed using Google Earth Pro software, and a shapefile was generated through manual digitization. Utilizing these vector files, the green area and mining extent of Pipalantri village were mapped and visualized in QGIS software. This methodology provides a structured approach for conducting comprehensive land use and land cover analysis using QGIS and Google Earth Pro, enabling researchers to effectively study spatial and temporal dynamics of landscapes and their implications for environmental management and planning.

**Estimation of Forest Change:** Land use map depicting mining and forest areas for 2012 and 2023 were generated using GIS software. A quantitative analysis was performed to calculate changes in square meters, visualized through bar diagram for enhanced clarity and comparative insights.



**Figure 2. Flow Chart of Methodology**

### RESULT

Analyzing the Change in Forest area and Mining Analysis of the maps from 2012 and 2023 reveals significant changes in the landscape of Pipalantri village. In 2012, the mining area covered 10.10 square meters in the northeast, with surrounding natural vegetation diminished. The total forest area for the village was 403.483 square meters. By 2023, the mining area expanded notably, encompassing not only the northeast but also extending into the eastern and central parts of the village, totaling 106.51 square meters. Concurrently, there was a remarkable increase in forest cover, particularly in the northeast and south-central regions of Pipalantri village. The forest area surrounding the mining sites also showed expansion. This growth can be attributed to local community efforts and collaboration with the village Sarpanch. Notably, the tradition of planting trees upon the birth of a girl child has significantly contributed to this expansion of forest cover through deliberate human intervention. Comparing the 2012 and 2023 maps underscores how Pipalantri village has achieved substantial environmental gains alongside economic development. This highlights a successful model of environmental protection and sustainable development through community engagement and local initiatives.

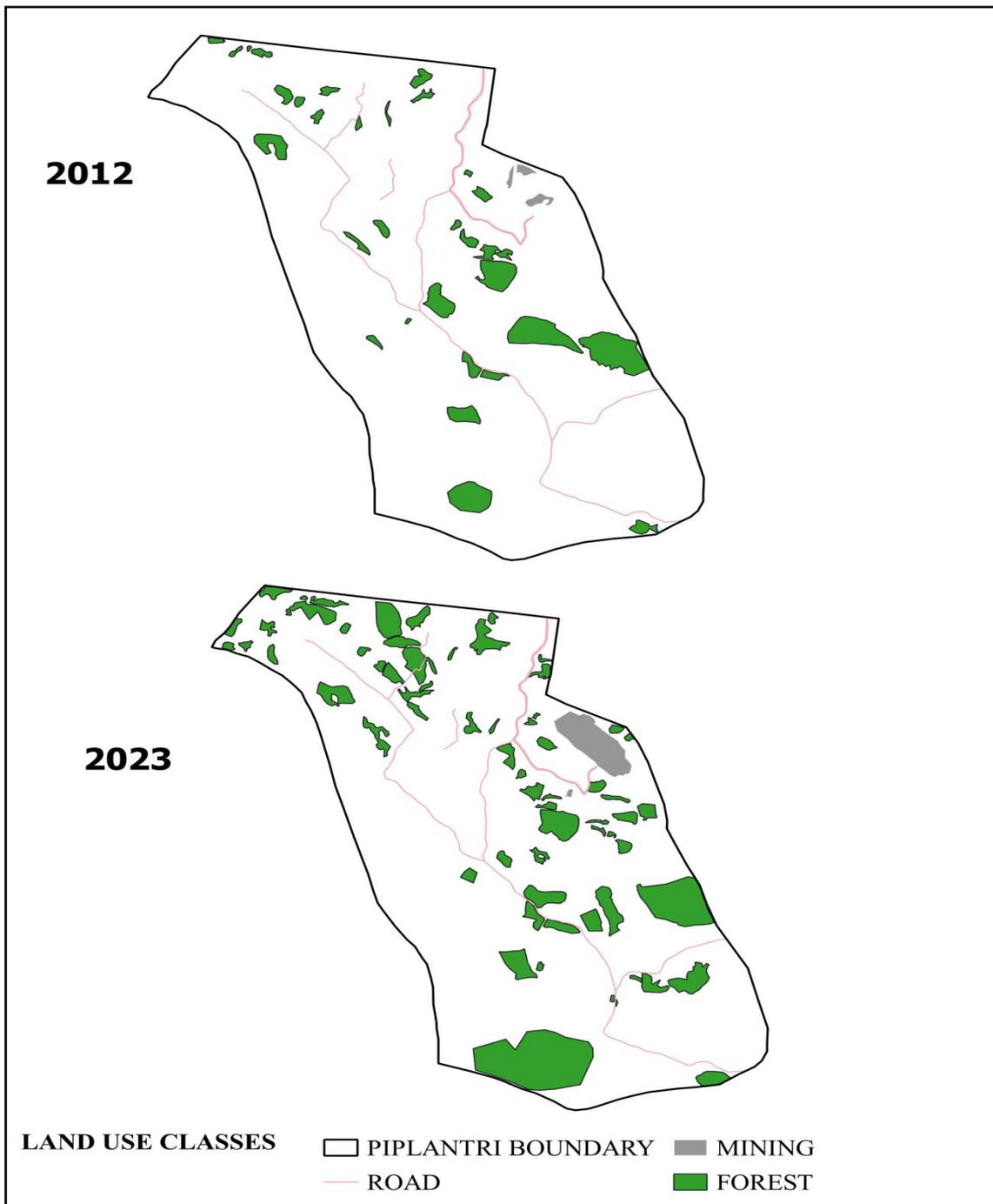


Figure 3. Forest and Mining classes of Pipalantri Village

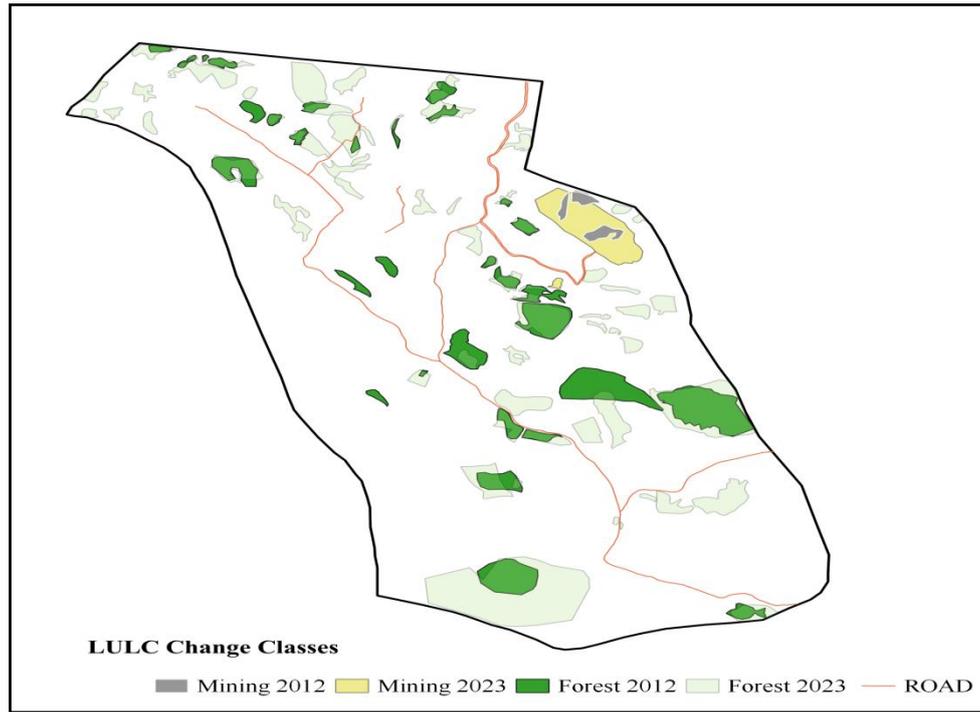


Figure 4 . Land use change Map of Pipalantri Village

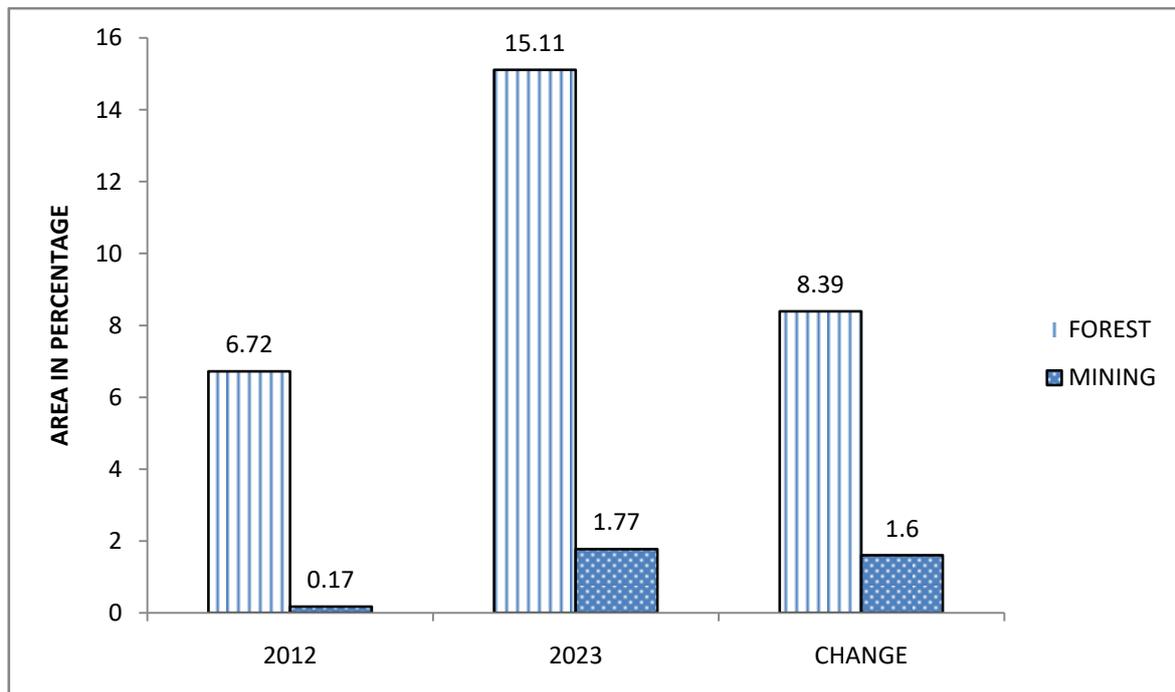


Figure 5. Comparative Analysis of Land Use Change in Pipalantri Village

Table 2. percentage of Forest and Mining in Piplanti Village

YEAR	Forest area in (%)	Mining area in (%)
2012	6.72	0.17
2023	15.11	1.77
CHANGE	8.39	1.6

Analysis of the change map in Figure 4 makes it clear that there has been a significant increase in forest area in the north, centre, east and south of Pipalantri village. The area where mining waste was previously dumped has now been planted with trees. In this way, with local cooperation, the land wasted due to mining waste was also put to good use. And work was done in the interest of the environment. Similarly, in 2012, the mining area in the north-east of Pipalantri village was less but in 2023, the mining area increased.

Figure 5 shows the forest and mining areas of Pipalantri village in 2012 and 2023 and the changes in forest and mining areas from 2012 to 2023. Analysis of Figure 5 shows that an increase of 1.6% has been recorded in the mining sector and an increase of 8.39 percent has been recorded in the forest area.

## CONCLUSION

In conclusion, this study has elucidated the dynamic interplay of forest and mining area changes influenced by human activities over the analyzed period. The notable expansion of forested areas, driven by community-led tree planting initiatives in Pipalantri village, underscores the positive impact of local involvement in environmental conservation. This growth not only enriches biodiversity but also enhances ecosystem resilience and provides essential services vital for community well-being. Conversely, the observed increase in mining areas highlights the inherent challenges of resource extraction, including habitat loss, soil degradation, and water contamination. Effective environmental management and regulatory measures are imperative to mitigate these adverse effects and address potential land use conflicts. The findings emphasize the importance of integrated land use planning that harmonizes environmental conservation with sustainable development objectives. Community-driven initiatives in Pipalantri village serve as a model for empowering local communities to combat environmental degradation and foster sustainable practices. Looking forward, fostering collaborative partnerships among communities, governmental entities, and stakeholders will be pivotal in implementing robust policies and practices that preserve natural resources while promoting socio-economic growth.

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