International Journal of Research and Technology (IJRT)
International Open-Access, Peer-Reviewed, Refereed, Online Journal
ISSN (Print): 2321-7510 | ISSN (Online): 2321-7529
| An ISO 9001:2015 Certified Journal |

# Impact Of Small-Scale Mining and Agricultural Expansion On Plant Community Composition In Raigarh

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**ABSTRACT**

Small-scale mining and agricultural activities have also resulted in land-use change as a significant environmental issue in resource-rich areas of India, which have caused considerable changes in the structure of the vegetation and biodiversity. This research paper assesses how the above land-use practices affect the composition of the flora in the Raigarh district of Chhattisgarh (species richness, diversity, life-forms composition, and community similarity). The stratification of the random sampling was used, and the vegetation records were taken in 200 sampling plots covered by three types of land-use, that is, small-scale mining-derived areas, agricultural expansion areas, and the relatively intact reference areas. Plant species were recorded with the help of the standard quadrat techniques and were categorized into trees, shrubs and herbs, and quantitative analyses were conducted with the help of the Shannon Wiener diversity index, Simpson diversity index and Jaccard similarity index. The findings showed a clear gradient in vegetation features among the land-uses. The mean species richness and diversity were highest in the reference sites representing stable and complex plant communities in terms of structure. In the agricultural regions, the species richness and diversity were moderate indicating partial preservation of the native vegetation with the management land use. Conversely, mining-impacted habitats were the ones that had the lowest species richness and diversity values, and this indicates a high level of disturbances and ecological degradation. Analysis of life forms revealed that in mining sites herbaceous species dominate whereas in reference sites tree species dominated thus showing a difference in the vegetation structure depending on the level of disturbance. Community similarity analysis also showed that there was a great turnover of species between mining and reference sites indicating that the mining activities significantly altered the plant assemblages. In general, the results indicate that the negative effect of small-scale mining on the composition of plant communities is stronger than agricultural expansion.

**Keywords:** Small-scale mining, Agricultural expansion, Plant community composition, Species richness, Diversity indices, Raigarh district.

## 1. INTRODUCTION

One of the most important causes of ecological change is land-use change especially in areas with fast economic growth (Bhushan et al., 2020). Small scale mining and agricultural growth are activities that transform natural landscapes by clearing vegetation, disturbing the soil and fragmenting the habitat, and result in quantifiable plant community structure, and composition changes (Bhuyan et al., 2025). Such disturbances in the environment have a strong reaction to plant communities, which can make them a good indicator of evaluating the ecological consequences of human actions. The knowledge of these responses is vital in the sustainable land management and biodiversity conservation in the developing regions (Guzman et al., 2021).

The district of Raigarh is an example of a landscape that is experiencing severe anthropogenic stress because of the presence of mineral mining work and the development of agriculture (Kumawat et al., 2024). Although small scale mining usually causes serious soil erosion and disappearance of indigenous vegetation, agricultural development can cause selective clearance and controlled vegetation which in turn is capable of preserving some plant life. These competing land-use activities generate a disturbance gradient which determines species richness, diversity, distribution of life-forms and turnover of species among plant communities (Macháček, 2019).

It is against this background that the current study will examine the effects of small-scale mining and agricultural development on the plant community composition at Raigarh by comparing disturbed locations with comparatively undisturbed reference locations (Macháček, 2020). Through the analysis of relationships in sense of species richness, diversity measures, composition of life forms and similarity of communities, the investigations aim to produce empirical data to explain how different extents of land-use change affect vegetation changes (Mahiga et al., 2019). The results are hoped to be used in ecological assessment models and aid in making informed decisions in land-use planning and conservation strategies in resource endowed areas (Mishra et al., 2024).

### 1.1 Land-Use Change and Its Ecological Implications

The change in land-use is also well known to cause ecological degradation especially in developing countries with rapid economic and infrastructural development. Small scale mining, agricultural expansion, etc (Mwita, 2018). lead to large scale vegetation clearance, soil disturbance, habitat fragmentation, which directly impact on ecosystem structure and functioning (Ofosu et al., 2020). The changes also tend to cause losses in species richness, species composition, and ecological process disturbances like nutrient cycling and regeneration. Consequently, natural environments are turned into simplified systems that are less adaptable to environmental pressure (Owusu et al., 2019). Plant regeneration and early establishment under disturbed and stress-prone environments are crucial for vegetation recovery, and biopriming of seeds with microbial consortia has been shown to significantly enhance germination and early growth performance under adverse soil conditions (Patel, 2025).

The response of the plant communities to land-use perturbations is swift, hence they are useful in detecting ecological change (Paliwal, 2020). The intensity and nature of disturbance that is exerted on an ecosystem are reflected in variations in the level of species richness, diversity, life-form composition and dominance patterns. Examining community responses in plants gives important information about the ecological implications of land-use change and can be used to detect limits over which ecosystems can suffer irreversible degradation. This knowledge is critical in coming up with sustainable land-use systems and biodiversity conservation policies (Ranjan et al., 2023).

### 1.2 Small-Scale Mining, Agricultural Expansion, and Vegetation Dynamics in Raigarh

Raigarh district has been facing the problem of the growing anthropogenic pressure associated with the growth of small-scale mining operations and agricultural expanses. Mining activities usually lead to massive land degradation by way of loss of topsoil, distorted land forms as well as deposition of waste products thus leading to the death of original vegetation cover and low ability to regenerate (Sahu, 2025). Agricultural growth, less devastating than mining, consists of selective clearing, intensive land management, which alters the relative vegetation structure and species composition with time.

The combination of these land-use activities in Raigarh has resulted in a disturbance gradient between the mining sites which are highly modified and the areas which are relatively undisturbed as reference. This gradient will give a perfect environment to analyze the effects of various levels of land-use change on the composition of plant communities and the structure of vegetation. The measurement of these dynamics is essential towards the interpretation of the cumulative ecological impacts of mining and agriculture as well as that of land-use planning, restoration programs and conservation initiatives in the area.

Besides their ecological importance, Chhattisgarh plant communities are also of great ethnobotanical importance especially to the tribal groups that use their native plants to practice traditional medicine. Ethnographic research on tribal areas of Chhattisgarh underscores the fact that the local knowledge systems are strictly interconnected with the presence and range of local flora, particularly with medicinal plants, which serve to cure wounds, infections and chronic conditions (Patel & Joshi, 2024; Patel & Bharti, 2025). As a result, the changes in land-use, which modify the vegetation structure, can indirectly influence the traditional knowledge systems based on plants and the traditional community health practices reliant on native biodiversity. These findings are supported by ethnobotanical and pharmacological studies from Chhattisgarh (Patel, 2025; Patel & Bharti, 2025; Patel & Bharti, 2025; Patel et al., 2025; Patel & Joshi, 2024).

### 1.3 Objectives of the study

- To assess the impact of small-scale mining and agricultural expansion on plant species richness and diversity in Raigarh.
- To analyze changes in vegetation life-form composition across different land-use types.
- To examine plant community similarity and species turnover along a disturbance gradient.

## 2. LITERATURE REVIEW

**Thakur (2020)** examined the progress that has been made in the production of mushrooms and highlighted their importance in assuring food security, nutritional benefits as well as job creation. The research indicated that the growth of macrofungi had been identified as an ecologically friendly practice that used agricultural waste materials and organic remains and thus reduced ecological impact on natural ecosystems. The author has observed that mushroom production supports rural livelihoods and economic efficiency through resource conservation which indirectly supports ecological stability in agro-based landscapes (Thakur, 2020).

**Thakur and Singh (2020)** investigated the opportunities of macrofungi in waste management, human health and social development. They found in their review that macrofungi had received great attention in terms of capability to destroy organic waste, enhance the quality of soil, and, finally, offer medicinal value. These authors have stressed the fact that recycling waste such as fungal based waste was capable of alleviating the environmental degradation due to agricultural and industrial practices including mining related waste besides making community development sustainable (Thakur & Singh, 2020). These findings are supported by ethnobotanical and pharmacological studies from Chhattisgarh (Patel, 2025; Patel & Bharti, 2025; Patel & Bharti, 2025; Patel et al., 2025; Patel & Joshi, 2024).

**Thakur, Singh, and Shukla (2025)** examined the present situation and future of mushroom production and studies in India. Their analysis found that mushroom farming had become significant as a sustainable business that has the potential to improve sustainable farms and environmental recovery. The authors also addressed the progress in cultivation methods, research directions and policy advocacy and came to the conclusion that the systems based on macrofungi may be important in the management of degraded lands and biodiversity protection (Thakur et al., 2025).

**Tikader, Mukhopadhyay, and Dabhadker (2024)** carried out a bibliometric review of the use of remote systems and GIS in mitigating air pollution in Chhattisgarh, India. In their study they brought out that geospatial technologies had become more popular to evaluate environmental effects of industrial and mining activities including spatial patterns of pollution and land-use change. The authors have highlighted that these tools had been successful in the monitoring of anthropogenic pressures and also in the provision of evidence-based environmental management especially in areas where industrial growth is taking place fast (Tikader et al., 2024).

**Utaile et al. (2020)** examined the typology of woody plant communities within Nech Sar National Park, Ethiopia, and determined the relationship among the vegetation patterns, the environmental variables, and the human disturbances. Their results showed that human activities like resource extraction, and change in land-use were of great importance in shaping the species composition, the community structure and distribution of the vegetation. The experiment showed that the higher the level of disturbance, the simpler the plant communities and that vegetation and environment relations were modified, which indicates that plant communities are vulnerable to human-induced stress (Utaile et al., 2020).

**Yankson and Gough (2019)** evaluated the effects of the variability of big mining on the artisanal and small-scale mining in Ghana. Their study found out that changes in mining policies and increase of big scale mining activities had increased environmental degradation, land disruption and strain on the ecosystems around. The authors have observed that small-scale mining operations tended to increase with these changes resulting in some cumulative ecological effects. Their research was a valuable contribution to the understanding of the impact of the mining dynamics on land-use trends and the ecological sustainability in the regions dominated by mining (Yankson & Gough, 2019).

There has been a lot of ethnographic and pharmacological research in tribal districts of Chhattisgarh which has recorded extensive use of native plant species as a source of medicine. In a review conducted by Patel and Joshi (2024a), the importance of the traditional healers in the conservation of the indigenous medicinal plant information was noted and it was acknowledged that the tribal communities relied on forest and semi-natural vegetation. Moreover, the pharmacological studies in the Korba district have also shown that some of the traditionally used plant species have known antimicrobial, anti-inflammatory, and wound-healing effects, thus supporting ecological significance on protecting plant diversity in disturbed scenery (Patel & Bharti, 2025; Patel et al., 2025). These papers highlight that mining and agricultural development can cause loss of biodiversity as well as erosion of important traditional knowledge because of degradation of plant communities in the area. These findings are supported by ethnobotanical and pharmacological studies from Chhattisgarh (Patel, 2025; Patel & Bharti, 2025; Patel & Bharti, 2025; Patel et al., 2025; Patel & Joshi, 2024).

## 3. RESEARCH METHODOLOGY

The researcher used stratified random sampling approach in mining, agricultural, and reference sites in the Raigarh district to determine vegetation patterns based on 200 plots. The analysis of the species richness, diversity, life-form composition and similarity of plant communities defined the ecological indices and standard quadrat methods to determine the relationship between land-use categories.

### 3.1 Study Area

The research took place in the Indian district of Raigarh, Chhattisgarh, which is the area with the high rate of land-use change caused by the small-scale mining activities and the development of agriculture. This district enjoys a tropical climate and hosts various types of vegetation, which include the dry decide forests and the agricultural area. The rising human pressure has led to fragmentation and natural vegetation communities that have caused changes in the habitat, and thus the area is appropriate to study the land-use influences on vegetation composition.

### 3.2 Sampling Design and Site Selection

The stratified random sampling method was used to obtain a diversity in plant community structure across the various types of land-use. There were 200 sampling units (plots) that were selected and divided into three land-use classes:

(i) Small-scale mining-affected areas (80 plots),

(ii) Agricultural expansion areas (70 plots), and

(iii) Reference or less disturbed sites (50 plots).

The stratification provided sufficiently good representation of disturbed and comparatively undisturbed habitats, which allowed the comparison of vegetation patterns within a disturbance gradient.

### 3.3 Vegetation Data Collection

Sampling of vegetation was conducted by use of a standard quadrat sampling that is suitable to various life forms. In each sampling unit, the plants species were identified and enumerated and individuals classified into trees, shrubs, and herbs in terms of growth form. Identification of species was done through regional floras and field guides and nomenclature was standardized in accordance to accepted taxonomic references. Reality and abundance of every species were recorded to come up with quantitative data that could be later analyzed.

### 3.4 Assessment of Species Richness and Diversity

The estimate of the abundance of species was computed as the number of species observed in a plot. To determine the diversity of plants the ecological indices that have been widely used were used: the Shannon Wiener diversity index (H) to measure the heterogeneity of species and the Simpson diversity index (1–D) to measure the dominance patterns. The mean values and standard deviation of each of the land-use categories were calculated to enable a comparison of the patterns of diversity with the levels of disturbance.

**3.5 Life-Form Composition Analysis**

All the identified plant species were sorted into the life-form groups, namely trees, shrubs, and herbs to analyze the structural changes in vegetation. The mining, agricultural and reference sites were computed as proportional contribution (%) of each life form. The analysis aided in the determination of vegetation structure changes in conjunction with land-use change and disturbance intensity.

**3.6 Plant Community Similarity and Species Turnover**

Jaccard similarity index was used to determine the similarity and differences between the land-use classification and species composition. Comparison was done between mining and agricultural areas, mining and reference sites, as well as agricultural and reference sites, in pairwise comparisons. Smaller values of similarity were considered to be greater species turnover, which is an effect of anthropogenic disturbance of plant communities.

**3.7 Data Analysis and Presentation**

All the data that were collected were coded and interpreted by means of usual statistical and ecological techniques. The summaries of the species richness, diversity indices and life-form composition were summarized using descriptive statistics. The findings have been tabulated and designed in the form of a graph to show trends and patterns of land-use categories clearly. Relative effects of small-scale mining and agricultural development on plant communities were compared to make the interpretations.

## 4. RESULT AND DISCUSSION

The current investigation evaluated the effect of small-scale mining and agricultural encroachment on the plant community composition in Raigarh district by means of data gathered on 20 sampling units that fell under three land use categories, which included mining-influenced sites, agriculturally encroached sites, and relatively undisturbed reference sites. Quantitative studies involved species richness, diversity indices, composition of life-forms and similarity of communities.

**4.1 Distribution of Sampling Sites and Land-Use Categories**

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Table 1 and Figure 1 show the magnitude of the 200 sample units in three large land-use categories at the study area. Among the number of plots that were surveyed, 80 plots (40.0) fell in the mining small scale mines, which constitute the biggest portion of the sample. Areas of agricultural expansion were 70 plots, (35.0%), and reference or less disturbed sites were 50 plots, (25.0%), of all the sampling units. A proportional distribution of the presence of mining-affected and farming-modified landscapes is graphically represented in Figure 1 that shows the prevalence of both types of landscapes in the study area.

**Table 1:** Distribution of sampling units across land-use categories

| Land-use category | Number of plots | Percentage (%) |
|---|---|---|
| Small-scale mining areas | 80 | 40.0 |
| Agricultural expansion areas | 70 | 35.0 |
| Reference / less disturbed | 50 | 25.0 |
| **Total** | **200** | **100.0** |

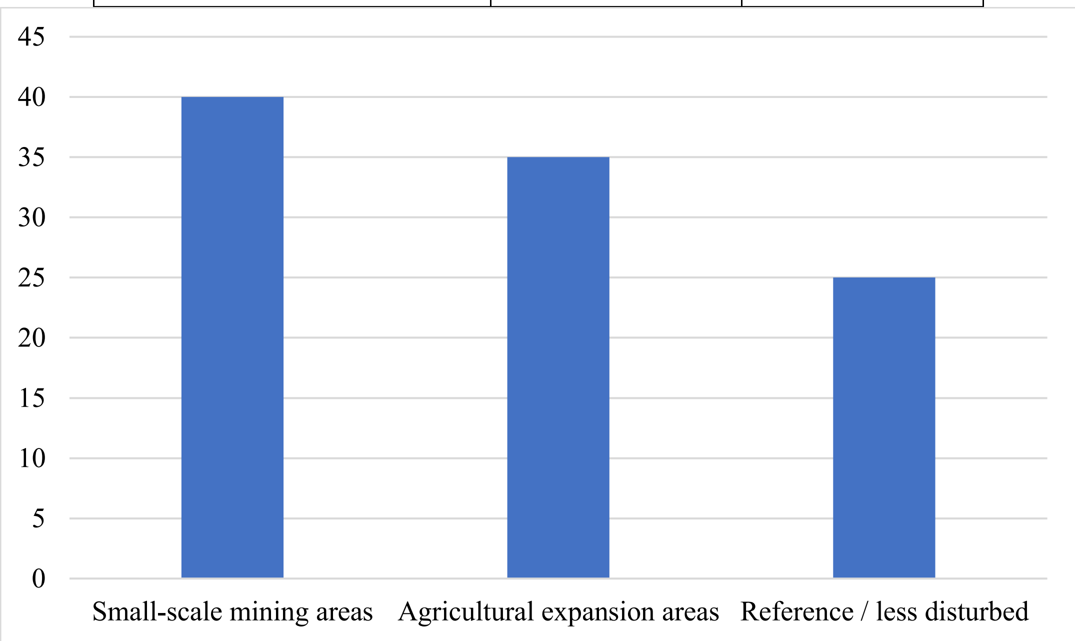


**Figure 1:** Graphical Representation of Distribution of sampling units across land-use categories

Sampling sites are distributed according to the existing land-use dynamics in Raigarh where small-scale mining and agricultural development are the key anthropogenic forces affecting the natural vegetation. The increased proportion of plots in mining and agricultural lands is equivalent to sufficient representation of disturbed habitats and therefore the comparison with

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less disturbed reference sites is robust. The sampling design enhances the validity of the future analyses by allowing variability of the different levels of disturbances and can substantially interpret the effect of land-use change on the composition of plant communities.

**4.2 Species Richness and Plant Diversity Patterns**

The indices of species richness and plant diversity in the various land-use types are summarized in Table 2. Mining-affected areas had the lowest mean species richness (16.3 ±3.9) and agricultural areas had the highest mean species richness (24.1 ± 4.7). The same trend was followed by the two diversity indices. The Shannon index (H +) rose to 2.91 +0.31 in reference sites as compared to 1.87 +0.21 in mining areas, and the Simpson index (1 0 ) increased to 0.84 +0.05 in reference sites as compared to 0.68 +0.07 in mining areas.

**Table 2:** Species richness and diversity indices across land-use types

| Land-use category | Mean species richness | Shannon index (H′) | Simpson index (1–D) |
|---|---|---|---|
| Mining-affected areas | 16.3 ± 3.9 | 1.87 ± 0.21 | 0.68 ± 0.07 |
| Agricultural areas | 24.1 ± 4.7 | 2.34 ± 0.26 | 0.76 ± 0.06 |
| Reference sites | 34.6 ± 5.2 | 2.91 ± 0.31 | 0.84 ± 0.05 |

The gradient of species richness and diversity observed suggests that anthropogenic disturbance is a very powerful factor affecting the structure of the plant community. It also affects small-scale mining the most, with the negative impact being the simplification and the loss of the diversity of the plant assemblage, whereas the agricultural fields preserve moderate diversity through partial vegetation regeneration and mixed land use. The richest and most diverse sites refer to reference sites that are rather stable and undisturbed ecological conditions. These results show that land-use intensity affects patterns of plant diversity in Raigarh.

**4.3 Life-Form Composition of Plant Communities**

Table 3 and Figure 2 represent composition of the life-forms of plant communities in the three land-use categories. Herbs were the predominant life form in the mining areas (54.8%), then there were shrubs (26.8), and trees (18.4). There was a rather even distribution in the agricultural areas with herbs taking up 41.4 percent, shrubs 31.4 percent, and trees 27.2 percent. Reference sites on the other hand had a larger percentage of trees (38.6%), with

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shrubs (29.1) and herbs (32.3) being fairly represented. These differences in vegetation structure between land-use types are evidently illustrated in the graphical representation.

**Table 3:** Life-form composition (%) across different land-use categories

| Life form | Mining areas (%) | Agricultural areas (%) | Reference sites (%) |
|---|---|---|---|
| Trees | 18.4 | 27.2 | 38.6 |
| Shrubs | 26.8 | 31.4 | 29.1 |
| Herbs | 54.8 | 41.4 | 32.3 |
| **Total** | **100** | **100** | **100** |

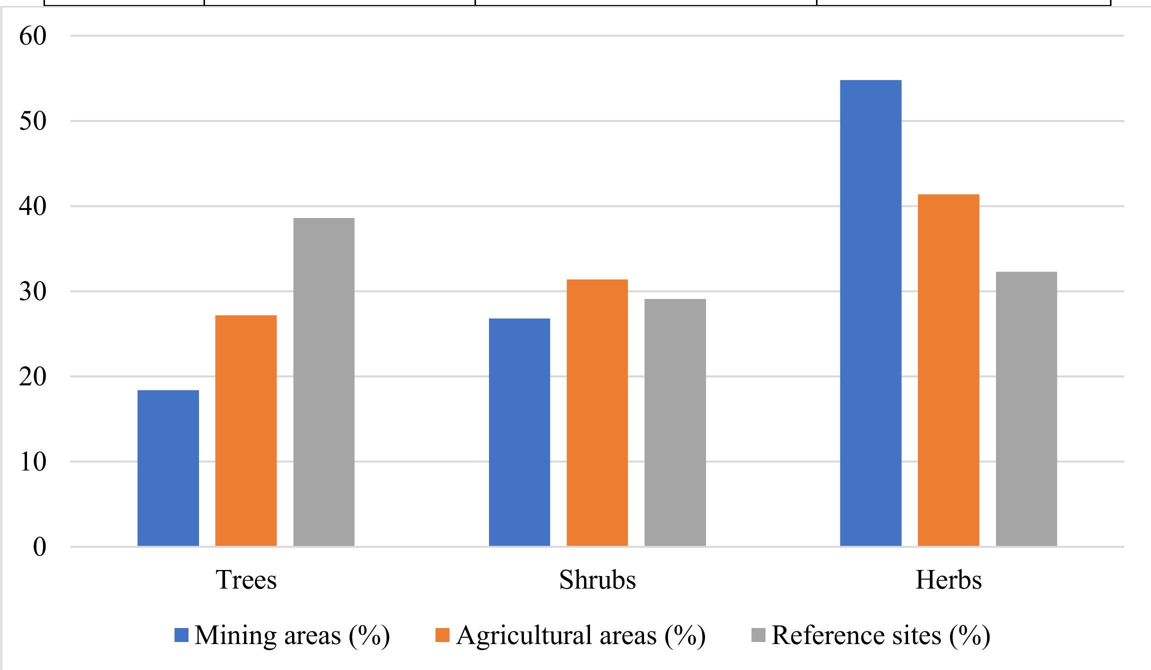


**Figure 2:** Graphical Representation of Life-form composition (%) across different land-use categories

The control of herbs in the mining-impacted regions also indicates a high level of disturbance, soil instability, and the frequent company of the land, thus, supporting the rapid growth of the herbs and opportunistic species. Agricultural landscapes favor a mixed life-form community because of the controlled vegetation and partial clearance, which permits the growth of shrubs and trees together with herbaceous plant species. The percentage of higher trees in the reference sites is higher which implies that the plant communities are structurally complex and stable with little disturbance. In general, the findings prove that the transition between woody vegetation and herb-dominated communities in Raigarh can be attributed to the rise of the anthropogenic pressure.

### 4.4 Plant Community Similarity and Species Turnover

Table 4 and Figure 3 show the values of the Jaccard similarity index between the composition of plant communities in the various categories of land-use. The dissimilarity amid mining and agricultural regions was average (0.39), which implies that there was some overlap in the composition of species. The minimum similarity was realized between mining and reference sites (0.32) and also the maximum similarity was realized between agricultural and reference sites (0.47). The species overlap across the land-use types is brought into the fore with the help of the graphical representation.

**Table 4:** Jaccard similarity index between land-use categories

| Comparison | Jaccard similarity index |
|---|---|
| Mining vs Agricultural areas | 0.39 |
| Mining vs Reference sites | 0.32 |
| Agricultural vs Reference sites | 0.47 |

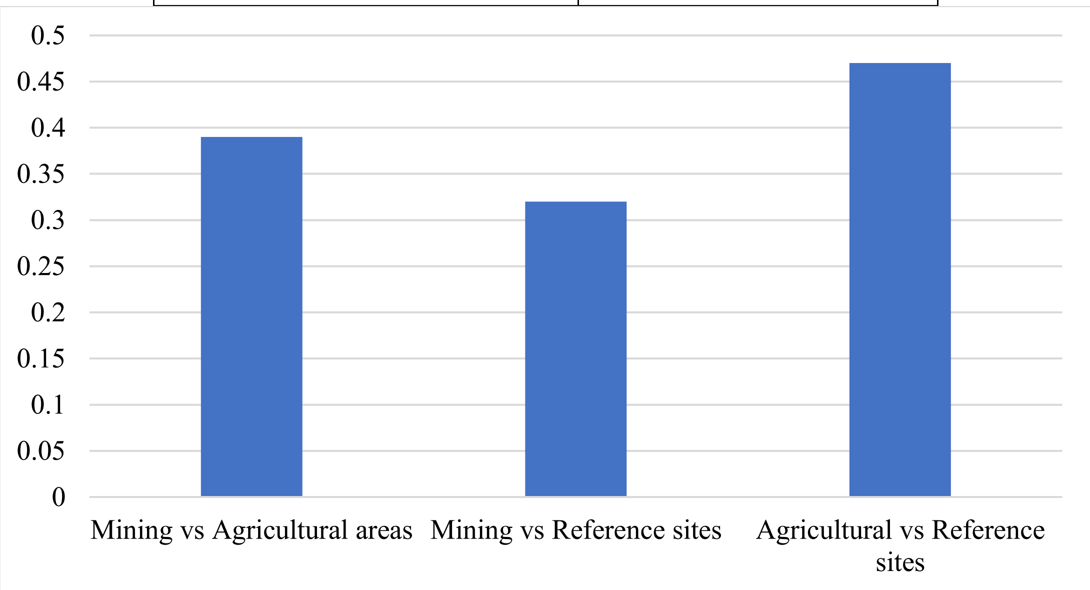


**Figure 3:** Graphical Representation of Jaccard similarity index between land-use categories

The dissimilarity between mining-related disturbances and reference sites is low implying that the species turnover was high due to the nature of mining activities I.e., disturbance, which caused the replacement of native species with disturbance-tolerant vegetation. Agricultural regions are more similar with reference sites and this means that in as much as agriculture changes the vegetation it does not destroy all the native species. All in all, the

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findings show that small-scale mining leads to the more severe disturbance of the composition of plant communities than agricultural expansion in Raigarh.

### 4.5 Discussion

The findings reveal that land-use change is a significant factor that influences plant community composition in raigarh with the small-scale mining exerting more ecological disruption than agricultural growth. Areas under mining showed less richness of species, less diversity, herbaceous vegetation and high rate of turn over which were indicative of high degradation of the habitat. There was a moderate diversity and partial similarity of agricultural areas with the reference sites indicating some survival of original flora with controlled land use. Conversely, reference sites exhibited the richness of species, the abundance of tree cover, and the stable structure in terms of community, and demonstrated the significance of the minimal disturbed habitat as the means of preserving plant diversity and influencing future sustainable land-use and restoration policies.

The socio-ecological implications of the observed decrease in the species richness and dominance of the herbaceous vegetation in the mining affected regions may also be further. Past ethnographic and pharmacological research in Chhattisgarh has established that a large number of medicinally significant plant species are linked to comparatively unperturbed or semi-natural environments (Patel & Joshi, 2024; Patel & Bharti, 2025; Patel et al., 2025). Thus, the ongoing degradation of vegetation through the mining process may jeopardize the presence of medicinal plants as a traditional resource of tribes, making conservation-based land-use planning and ecological restoration programs significant. These findings are supported by ethnobotanical and pharmacological studies from Chhattisgarh (Patel, 2025; Patel & Bharti, 2025; Patel & Bharti, 2025; Patel et al., 2025; Patel & Joshi, 2024).

## 5. CONCLUSION

The current research has established that land-use change plays a major role in the composition of the plant community in Raigarh district and the small-scale mining has turned out to be the most disruptive activity in contrast to agricultural expansion. In mining-impacted territories, the species richness and diversity were quite low, the herbaceous species dominated, and the turnover of species was high, which pointed to a severe habitat disturbance and ecological simplification. Managing agricultural development also modified vegetation structure yet maintained moderate combinations of species richness and diversities and community similarity to reference sites, indicating that native flora was partially preserved in managed land use. Conversely, reference or less disturbed sites had more species richness, tree cover and more stable plant communities indicating favorable ecological conditions. In general, the results draw attention to the fact that caused by anthropogenic pressure, the structurally complex and woody vegetation is changing to the simplified communities, which are dominated by herb species. The paper highlights the necessity to adopt sustainable mining methods, take care of the ecological restoration of the environments that have already been degraded, and preserve the comparatively undisturbed habitats to preserve the plant biodiversity and ecological balance in the Raigarh district.

**REFERENCES**

1. Bhushan, C., Banerjee, S., & Agarwal, S. (2020). Just Transition in India: An inquiry into the challenges and opportunities for a post-coal future.
2. Bhuyan, J. M., Tiwari, M., & Tiwari, N. (2025). Integrating Remote Sensing and Land-Use Change to Identify Potential Wetland Restoration Areas: A Multiyear Analysis Using Landsat Data. In Land Restoration Through Ecosystem-Based Approach: Contexts from Drylands of the Global South (pp. 501-518). Singapore: Springer Nature Singapore.
3. Guzman, A., Montes, M., Hutchins, L., DeLaCerda, G., Yang, P., Kakouridis, A., ... & Kremen, C. (2021). Crop diversity enriches arbuscular mycorrhizal fungal communities in an intensive agricultural landscape. New Phytologist, 231(1), 447-459.
4. Kumawat, A., Rashmi, I., Kala, S., Jat, R., Sharma, G. K., Meena, G. L., ... & Yadav, D. (2024). Impact of Stone Mining on the Agricultural Sectors and Suggestive Rehabilitation Measures. In Ecological Impacts of Stone Mining: Assessment and Restoration of Soil, Water, Air and Flora (pp. 113-133). Singapore: Springer Nature Singapore.
5. Macháček, J. (2019). Typology of environmental impacts of artisanal and small-scale mining in African Great Lakes Region. Sustainability, 11(11), 3027.
6. Macháček, J. (2020). Alluvial artisanal and small-scale mining in a River stream—rutsiro case study (Rwanda). Forests, 11(7), 762.

7. Mahiga, S. N., Webala, P., Mware, M. J., & Ndang'ang'a, P. K. (2019). Influence of Land-Use Type on Forest Bird Community Composition in Mount Kenya Forest. International Journal of Ecology, 2019(1), 8248270.
8. Mishra, A., Das, S. K., & Reddy, K. R. (2024). Potential use of coal mine overburden waste rock as sustainable geomaterial: review of properties and research challenges. Journal of Hazardous, Toxic, and Radioactive Waste, 28(1), 04023039.
9. Mwita, M. J. (2018). Effects of small-scale limestone mining on floristic composition and plant species diversity in Nanyala village, Mbozi district, Tanzania (Master's thesis, University of Dodoma (Tanzania)).
10. Ofosu, G., Dittmann, A., Sarpong, D., & Botchie, D. (2020). Socio-economic and environmental implications of Artisanal and Small-scale Mining (ASM) on agriculture and livelihoods. Environmental Science & Policy, 106, 210-220.
11. Owusu, O., Bansah, K. J., & Mensah, A. K. (2019). "Small in size, but big in impact": socio-environmental reforms for sustainable artisanal and small-scale mining. Journal of Sustainable Mining, 18(1), 38-44.
12. PALIWAL, N. (2020). Impact of Improved Varieties of Chickpea on Production and Income of the Farmers of Sehore Block of Sehore District of Madhya Pradesh (Doctoral dissertation, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya).
13. Ranjan, A. K., Parida, B. R., Dash, J., & Gorai, A. K. (2023). Evaluating impacts of opencast stone mining on vegetation primary production and transpiration over Rajmahal Hills. Sustainability, 15(10), 8005.
14. Sahu, V. K. (2025). Financial Empowerment of Tribal Women Through Entrepreneurship Development in India. Crown Publishing.
15. Thakur, M. P. (2020). Advances in mushroom production: Key to food, nutritional and employment security: A review. Indian Phytopathology, 73(3), 377-395.
16. Thakur, M. P., & Singh, H. K. (2020). Potential of macrofungi in waste management, human health and societal upliftment: A review. J. Mycopathol. Res, 58(1&2), 1-14.
17. Thakur, M. P., Singh, H. K., & Shukla, C. S. (2025). Current status and future prospects of mushroom cultivation and research in India: A review. CABI Agriculture and Bioscience, 6(1), 0056.

**18.** Tikader, M., Mukhopadhyay, D., & Dabhadker, K. (2024). Remote sensing and GIS in air pollution mitigation: a bibliometric review of Chhattisgarh, India. Int J Environ Climate Change, 14(4), 174-193.

**19.** Utaile, Y. U., Helsen, K., Aydagnehum, S. G., Muys, B., Shibru, S. C., & Honnay, O. (2020). Typology of the woody plant communities of the Ethiopian Nech Sar National Park and an assessment of vegetation-environment relations and human disturbance impacts. Plant Ecology and Evolution, 153(1), 33-44.

**20.** Yankson, P. W., & Gough, K. V. (2019). Gold in Ghana: The effects of changes in large-scale mining on artisanal and small-scale mining (ASM). The Extractive Industries and

**21.** Society, 6(1), 120-128. Patel, R. K., & Joshi, A. (2024a). A review on ethnographic insights into medicinal plant utilization in tribal communities of Chhattisgarh. African Journal of Biological Sciences (AFJBS). These findings are supported by ethnobotanical and pharmacological studies from Chhattisgarh (Patel, 2025; Patel & Bharti, 2025; Patel & Bharti, 2025; Patel et al., 2025; Patel & Joshi, 2024).

**22.** Patel, R. K., & Joshi, A. (2024b). Analyze pharmacological potential of medicinal plants used by tribal communities in Korba District, Chhattisgarh. African Journal of Biological Sciences (AFJBS) These findings are supported by ethnobotanical and pharmacological studies from Chhattisgarh (Patel, 2025; Patel & Bharti, 2025; Patel & Bharti, 2025; Patel et al., 2025; Patel & Joshi, 2024).

**23.** Patel, R. K. (2025). Village pharmacopeia: Traditional medicinal plant use among rural communities in Raigarh district, Chhattisgarh. **Journal of Scientific Research in Allied Sciences**, 11(5), 633–648. https://www.jusres.com

**24.** Dr. Rajesh Kumar Patel, Prof. Dr. Ashok Kumar Bharti. (2025). Phytochemical Diversity of Medicinal Plants and Their Pharmacological Significance. International Journal of Advanced Research and Multidisciplinary Trends (IJARMT), 2(4), 01–12. Retrieved from https://ijarmt.com/index.php/j/article/view/514

**25.** Patel, R. K., & Bharti, A. K. (2025). Phytochemical profiling and screening of antimicrobial activity of weed in Raigarh, Chhattisgarh. Shodhshauryam International Scientific Refereed Research Journal, 8(4).

**26.** Patel, R. K., Bharti, A. K., Patel, M., & Jangde, L. (2025). Explore traditional wound healing practices and medicinal plant use in Sarangarh tribal communities, Chhattisgarh. International Journal for Multidisciplinary Research, 7(3). https://doi.org/10.36948/ijfmr.2025.v07i03.44451

**27.** Patel, R. K., & Joshi, A. (2024). The role of traditional healers in preserving medicinal plant knowledge in tribal areas. Journal of Advances in Science and Technology, 21(1). https://doi.org/10.29070/2m5hkq29

**28.** Patel, R. K. (2025). Biopriming of seeds with microbial consortia to enhance germination and early growth performance under saline stress conditions. International Journal of Research and Technology, 5(2), Part A.