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Vegetative Reclamation in the Rajrappa Coalmine Region

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ABSTRACT
Coal mining activities causes great change and disturbance in the landscape. The major changes brought by coal mining are surface subsidence, deforestation, soil erosion, landscape fragmentation, water table disturbance, interrupted flow of water channels, vegetation disruption and many more. Vegetative reclamation emerges as a promising strategy to restore these disturbed landscapes in coal mine regions. The effectiveness of vegetative reclamation has been demonstrated time to time for improving soil quality, increasing vegetation cover, and promoting biodiversity by case studies and field experiments. The present study highlights the importance of integrating ecological principles into reclamation practices to achieve a balance between economic development and environmental conservation in coal mine regions. This study investigates the efficacy of vegetative reclamation using satellite monitoring technology to assess and manage reclaimed areas.

Keyword: Landscape, Vegetative Reclamation, Coalmine, Satellite Monitoring

1. Introduction

Landscape is the part of ecosystem that is comprised of all sort of natural resources like soil, water, flora and fauna. Land portion in the Earth, i.e., non-submerged part by water resources like seas and oceans constitutes 29.2% of the Earth's surface (Allaby, 2013). Different types of landforms are available on the landscape, which consist of hills, mountains, valleys and shoreline (bays, capes and peninsulas)(Howard, 2017). These all are natural landforms, but with the evolution of human civilization; man-made landforms have been introduced in the ecosystem. The use of land is intensely entangled with human development (UNCCD, 2017b). About one-third of the land is being used for agriculture till date (FAO, 2022; UNCCD, 2017a). For agriculture, the land cover is chopped and native flora and fauna are replaced with newly introduced crops and livestock in the beginning of the human civilization (UNCCD, 2017c). But now urbanization and mining has even taken over few of that (UNCCD, 2017d).
Mining is also one of the oldest uses of the land; about 3000 BCE there has been evidence of mining activity in Ancient Egypt. Mining is performed to obtain mineral ore (iron ore); which is raw product of manufacturing industries, gemstones used as jewelry and currency (back then) and coal used as source of energy production (UNCCD, 2017c). All these uses of land (agriculture and urbanization), except mining has keep on pushing each other, but technological and innovative advancement has developed an alignment between these two land uses. Mining is a site-specific industry, thus cannot be lifted away to any other site. The surface destruction caused by mining are deforestation, landscape fragmentation, flow

of water channels, vegetation disruption and soil erosion. Mining even causes under surface destruction like surface subsidence, water table disturbance, sedimentation and others.

Coal mining significantly effects landscapes, leading to ecological disturbance in the various forms. First of all, there will be deforestation of vast areas to access coal deposits resulting into habitat loss for wildlife, loss of biodiversity and disturbance in the local ecosystem (Wu et al., 2019). Second, change of vegetation in the nearby region as pollution sensitive vegetation will subside(Wang et al., 2023). Third, soil erosion due to lack of vegetation and degradation of soil quality due to exposure of pollutants from the mining site and use of chemicals (explosives etc.) for loosing coal seams (Zhao et al., 2023). Fourth, mining operations causes fragmentation of landscapes that create isolated patches of habitat. If mining is operated for longer duration the movement of wildlife will be hindered, causing fall of genetic diversity and interrupted ecological processes (Wu et al., 2019). Fifth, when the mining is carried out under the surface, the most obvious chances are of surface subsidence causing topographical changes (Zhao et al., 2023).

In the present study, Rajrappa coalmine also faces more or less similar ecological disturbance due to hindered landscape as mentioned foresaid. Therefore, there is an urgent need to reclaim the mined-out landscape and restore the productive use of mining activity along sustainable development. This will help in mitigating environment degradation. As the climate of India is tropical monsoon type(IMD, 2020), which means optimum humidity can be observed throughout the year that supports natural restoration of the coal mined region by vegetation. Mostly grasses are visible over the overburden dumps in a year but natural recovery of vegetation loss takes prolonged time (Cui et al., 2019). Thus, Rajrappa coalmine which is a part of Coal India Ltd. (CIL) has been undergoing reclamation project; under assigned job of Central Mine Planning & Design Institute (CMPDI), a Government of India (GoI) enterprise. They monitor land reclamation and status of all coal mines of the Government undertaking by remote sensing satellite on regular basis annually for the development of mines sustainably. The reclamation of the mines has been initiated in the year of 2008 on annual basis and changes in the status of land reclamation have been assessed.

Since the Rajrappa Coalmine region is an active mine where production of coal and over burden (waste rocks) is more than 5 million m^3 per annum (CMPDI, 2022,2023,2024). Land reclamation of all coal mining projects and its monitoring has been observed as the legislative necessities of Ministry of Environment, Forest & Climate Change (MoEF&CC) formerly known as Ministry of Environment and Forests (Bureau, 2014) and Government of India (GoI). The technique of monitoring enables in taking mitigation measures on time and thus can play a great role in reversal of the environmental degradation. The method of reclamation and the technique used in monitoring benefit coal companies to utilize the reclaimed land for more socio-economic profits in a strategic system. The land reclamation is carried out by two methods adopted in coal companies: first, the area mined out are backfilled by overburden dumps; which are dumps of waste rocks mined out along coal during excavation (Mohanty & Patra, 2011) and second, the overburden dumps and the backfilled area are planted with vegetation.

In this study vegetative reclamation performed in the Rajrappa Coalmine region by the company is monitored by satellite data obtained via remote sensing. This helps in checking status of vegetation reclamation every year and take further remedial measure if required.

2. Methodology

Study area

Rajrappa Coalmine is an open cast project (OCP) of Central Coalfields Limited (CCL) in the Ramgarh

Coalfield. It lies in 23º35’ N- 23º38’N latitude and 85º39’ E- 85º42’E longitude (CMPDI, 2022,2023,2024).plate 9.10

Data collection

The present study is based on the satellite data fetched by National Remote Sensing Centre (NRSC) Hyderabad, India sourced from the official website of CMPDI. The NRSC serve as the nodal agency for the supply of data in digital form that is stored in database on Geographic Information System (GIS) platform. This GIS platform aids to identify the temporal changes in the study area (Venna et al., 2016).

Ground truthing

Although there is satellite imaging and mapping facility for monitoring; field visit of the study area provides primary/ basic information of the study area (Figure 1).

Figure 1. Different stages and views of vegetative reclamation

a. Saplings plantation

b. Growth of saplings into plants

c. Road side view in dry season

d. View from an active mine

e. Road side view in wet season

f. View in bright sunny day

Source: Source: Adopted and modified from (CMPDI, 2022,2023,2024)

3. Result and discussion

In the present study, land reclaimed by vegetation over backfilled area and overburden area has been observed in the Rajrappa coalmine region for four consecutive years; 2020-2023 (Table 1). In the year 2020, vegetation on backfilled area was 1.30 km^2, which get reduced to 1.27km^2 in the consecutive years from 2021 to 2023. On the other hand, vegetation on overburden dumps has been observed 3.02 km^2 throughout these consecutive years; 2020-2023. Since total excavated area was increasing with the increase in coal production; thus, area under active mining was also increasing. Post Covid (2020), the hike for the year 2020-2021 was same for active mine area and excavation area, 0.14 km^2. But for the year 2021-2022; and 2022-2023, there is steady difference of 0.02 km^2 for active mine area and excavation area.

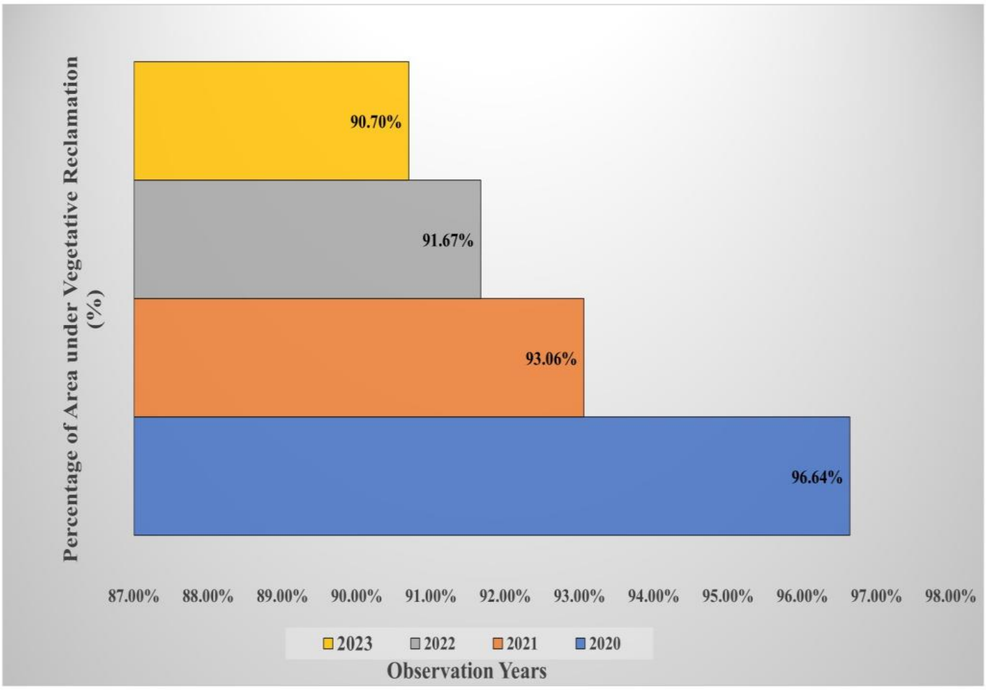
Table 1. Status of vegetative reclamation in the Rajrappa Coalmine region

Year	Vegetation on backfilled area (sq km.)	Vegetation on overburden dumps area (sq km.)	Area under active mining (sq km.)	Total excavated area (sq km.)	Total area under vegetative reclamation (sq km.)	Percentage of area under vegetative Reclamation (%)
2020	1.3	3.02	0.8	4.47	4.32	96.64
2021	1.27	3.02	0.94	4.61	4.29	93.06
2022	1.27	3.02	1.03	4.68	4.29	91.67
2023	1.27	3.02	1.1	4.73	4.29	90.70

Source: Adopted and modified from (CMPDI, 2022,2023,2024)

Although, there is uniformity in the vegetation on backfilled area and vegetation on overburden dumps area; there is difference in the percentage of area under vegetative reclamation (Figure 2). This difference may be because of increase in active mine area and total excavated area.

Figure 2. Status of vegetative reclamation in the Rajrappa Coalmine region



4. Conclusion

Coal mining operations have led to significant landscape disturbance, resulting in environmental degradation and loss of biodiversity. The present study aids the exploration of the impact of coal mining on the environment and the role of vegetative reclamation in mitigating the mentioned effects. By employing various plant species, including native grasses, shrubs, and trees, vegetative reclamation aims to stabilize soil, reduce erosion, enhance soil fertility, and re-establish habitat for wildlife. The process involves careful planning, selection of appropriate plant species, and ongoing management to ensure successful restoration. Furthermore, vegetative reclamation contributes to the long-term sustainability of mining regions by providing ecosystem services such as carbon sequestration and water purification. The findings demonstrate that satellite monitoring is an effective tool for tracking the progress of vegetative reclamation, ensuring timely and informed decision-making.

5. References

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