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# Vegetation structure and species diversity in Dhadardihi 1 and Dhadardihi 2 wasteland of Kajora mining area West Bengal, India

**TRINANKUR BHATTACHARJEE*[1] AND DEBNATH PALIT[2]**

**[1*]Research Scholar, Department of Conservation Biology, Durgapur Government College, Durgapur, Paschim Bardhaman, 713214**

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**ABSTRACT**

*Dhadardihi 1 and Dhadardihi 2 are known as open-cast mining areas that are located in the Andal block under the Kajora mining area in West Bengal, India. Surface mining operations play significant roles in lands that result in impacted or imbalanced vegetation structure and species diversity. The study made clear that the vegetation evaluation that was produced could be a useful tool for determining which species would be best suited to revegetate the areas that had been mined. 58 plant species belonging to 26 families were recorded in Dhadardihi 1 and 55 plant species belonging to 23 families were recorded in Dhadardihi 2 wasteland. Streblus asper Lour. Was the most dominant plant species that had the highest IVI value of 141 and Otherwise, Melochia corchorifolia L. had the lowest IVI value of 1.96 in Dhadardihi 1 wasteland. Parthenium alpinum (Nutt.) Torr. & A.Gray was the most dominant plant species and had the highest IVI value of 92.03 Otherwise, Celosia argentea L., Cassia sophera L. and Paederia foetida L. had the lowest IVI values 2 in Dhadardihi 2 wasteland. The study revealed that the vegetation evaluation of which species would be best suitable to revegetate the wastelands.*

**Keywords:** *Open-cast mining, Surface mining, vegetation structure, species diversity, revegetate, wastelands*

## INTRODUCTION

Coal mining is important for the economic boost of our country but coal mining badly affects our environment and overall ecosystem. The main effects of excessive mining include pollution, deforestation, and social ecology collapse (Rai *et al.,* 2010, Singh *et al.,* 2011). Following the nationalization of the coal mines, excavation began in this area, one of India's major coal-producing zones under the Raniganj Coal Fields (1973 onwards) (Mondal *et al.,* 2020). Due to the extraction of minerals from the environment, mining has day by day increased dramatically in the present time, causing environmental degradation as well as negative effects on biological systems and ecosystems (Mondal *et al.,* 2020). Unscientific and informal mining is the biggest threat to biodiversity because it causes the reduction of soil, reduces the forest cover and also affects overall biodiversity (Kumar *et al.,* 2015). However, in this situation, it might take several years for these ecosystems to completely recover in terms of their biodiversity (Cooke, 1999). Decreasing harmful impacts and recovering degraded habitats to take necessary steps, may demonstrate the mining industry's major contribution to the appropriate and sustainable development of the impacted region (Hoadley *et al.,* 2002). Large areas of degraded land or it is also known as wasteland, are created by open coal excavations. These areas have developed primary succession characteristics but there has been very little colonization of the area, most likely as a result of unfavourable conditions or a lack of pioneer plants that are appropriate for the region (Jochimsen *et al.,* 1995). Dhadardihi 1 and Dhadardihi 2 are known as open-cast mining areas that are located in the Andal block under the Kajora mining area in West Bengal, India. Huge-scale open-cast mining in this area resulted in vast barren land and unproductive land. This open-cast mining destroys the overall vegetation in these areas and also impacts the environment. Therefore, the mine areas' goals should be effective reclamation and a basic understanding of them to fight ecological dangers and restore ecological balance (Mondal *et al.,* 2019). However, soil quality is important for the vegetation growth

[2]*Principal, Durgapur Government College, Durgapur, Paschim Bardhaman, 713214,*
*Corresponding author – bhattacharjeetrinankur@gmail.com*

(Barik *et al.,* 2017; Bhattacharya *et al.,* 2020). A thorough understanding of the native vegetation and the process that regulates its natural recovery is crucial for a more efficient and successful reclamation and restoration activity (Mondal *et al.,* 2019). The present study was conducted in Dhadardihi 1 and Dhadardihi 2 which are open-cast mining regions wastelands. This present study's main objective is to compare the two selected wasteland's vegetation structure and also species diversity.

## MATERIALS AND METHODS

**Study area:** Dhadardihi 1 and Dhadardihi 2 open-cast mining regions wastelands were selected as the study location under the Andal block and Kajora mining area and Durgapur division, West Bengal, India. Dhadardihi 1 wasteland longitude is 23º37′36″N and latitude is 87º9′38.7″E. Dhadardihi 2 wasteland longitude is 23º37′57.1″N and latitude is 87º9′51.3″E.

**Vegetation Analysis:** During the peak growth season, a vegetation survey was conducted using standard quadrat methods at both study sites (Srivastava, 2001). This study selected two wastelands and each wasteland using quadrat methods to know the vegetation structure. For each site, 100 quadrates (10m x 10m for trees), (5m x 5m for shrubs and climbers) and (1m x 1m quadrates for herbs) were placed to measure different vegetation layers. Quantitative community parameters were calculated using the A/F value (Whiteford, 1949) and (Misra, 1968) for each plant species, including frequency, density, abundance, and importance value index (IVI). Following (Raunkiaer's 1934) frequency class analysis, the resulting frequency values were classified into the following frequency classes: class A (1%–20%), class B (21%–40%), class C (41%–60%), class D (61%–80%), and class E (81%–100%) (Hewit and Kellman, 2002).

**Diversity indices analysis:** Species diversity (Shannon- Weaver, 1963), the Simpson index was determined (Simpson, 1949), Species richness (Margalef, 1958) and Evenness index (Pielou, 1966) were calculated for the selected study sites data.

## RESULTS AND DISCUSSIONS

The present study revealed that 14 trees, 31 herbs, 6 shrubs and 7 climbers' species in Dhadardihi 1 wasteland (Table 1) and Otherwise, 10 trees, 28 herbs, 9 shrubs and 8 climbers' species in Dhadardihi 2 wasteland (Table 2). In Dhadardihi 1, 8 families for trees, 17 families for herbs, 5 families for shrubs and 6 families for climbers were recorded (Table 3). Otherwise, In Dhadardihi 2, 7 families for trees, 20 families for herbs, 7 families for shrubs and 7 families for climbers were recorded (Table 3). (Kar and Palit, 2016) reveals the total 57 species that belonged to 22 families in open cast mining wasteland under the Raniganj coal field area. *Streblus asper* Lour. was the most dominant tree species and had the highest IVI value (141) in Dhadardihi 1 wasteland (Table 1). Otherwise, *Acacia nilotica* (L.) Del was the most dominant tree species and had the highest IVI value (19.05) in Dhadardihi 2 wasteland (Table 2). *Cynodon dactylon* (L.) Pers. was the most dominant herb species and had the highest IVI value (25.1) in Dhadardihi 1 wasteland (Table 1). Otherwise, *Parthenium alpinum* (Nutt.) Torr. & A.Gray was the most dominant herb species and had the highest IVI value (92.03) in Dhadardihi 2 wasteland (Table 2). *Ziziphus abyssinica* Hochst. ex A.Ric was the most dominant shrub species and had the highest IVI value (74.5) in Dhadardihi 1

Table 1: Species diversity of Dhadardihi 1 wasteland

| Sl. No. | Plants Names | Family | Life form | (A) | (B) | D | A | F | FC | A/F | IVI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tree | | | | | | | | |
| 1 | *Acacia auriculiformis* Benth. | Leguminosae | Ph | 2 | 2 | 0.02 | 1 | 2 | A | 0.5 | 8.35 |
| 2 | *Acacia nilotica* (L.) Del | Leguminosae | Ph | 10 | 10 | 0.1 | 1 | 10 | A | 0.1 | 17.2 |
| 3 | *Alstonia scholaris* (L.) R. Br. | Apocynaceae | Ph | 6 | 6 | 0.06 | 1 | 6 | A | 0.17 | 12.8 |
| 4 | *Azadirachta indica* A.Juss. | Meliaceae | Ph | 7 | 7 | 0.07 | 1 | 7 | A | 0.14 | 13.9 |
| 5 | *Borassus flabellifer* L. | Arecaceae | Ph | 2 | 1 | 0.02 | 2 | 1 | A | 2 | 13.8 |
| 6 | *Dalbergia sissoo* DC. | Leguminosae | Ph | 7 | 7 | 0.07 | 1 | 7 | A | 0.14 | 13.9 |
| 7 | *Ficus benghalensis* L. | Moraceae | Ph | 4 | 4 | 0.04 | 1 | 4 | A | 0.25 | 10.6 |
| 8 | *Ficus religiosa* L. | Moraceae | Ph | 2 | 2 | 0.02 | 1 | 2 | A | 0.5 | 8.35 |
| 9 | *Lagerstroemia speciosa* (L.) Pers. | Lythraceae | Ph | 1 | 1 | 0.01 | 1 | 1 | A | 1 | 7.24 |
| 10 | *Phoenix dactylifera* L. | Arecaceae | Ph | 5 | 5 | 0.05 | 1 | 5 | A | 0.2 | 11.7 |
| 11 | *Senna siamea* (Lam.) | Leguminosae | Ph | 19 | 19 | 0.19 | 1 | 19 | A | 0.05 | 27.1 |
| 12 | *Streblus asper* Lour. | Moraceae | Ph | 178 | 78 | 1.78 | 2.28 | 78 | D | 0.03 | 141 |
| 13 | *Terminalia arjuna* (Roxb.) | Combretaceae | Ph | 1 | 1 | 0.01 | 1 | 1 | A | 1 | 7.24 |
| 14 | *Trema orientalis* (L.) Blume | Cannabaceae | Ph | 1 | 1 | 0.01 | 1 | 1 | A | 1 | 7.24 |
| | | | Herbs | | | | | | | | |
| 1 | *Acalypha indica* L. | Euphorbiaceae | Th | 16 | 8 | 0.16 | 2 | 8 | A | 0.25 | 3.39 |
| 2 | *Achyranthus aspera* L. | Euphorbiaceae | Th | 170 | 79 | 1.7 | 2.15 | 79 | D | 0.03 | 12 |
| 3 | *Aerva lanata* Juss. | Amaranthaceae | Th | 189 | 80 | 1.89 | 2.36 | 80 | D | 0.03 | 12.8 |
| 4 | *Ageratum conyzoides* L. | Asteraceae | Th | 7 | 4 | 0.07 | 1.75 | 4 | A | 0.44 | 2.59 |
| 5 | *Alternanthera sessilis* L. | Amaranthaceae | Hc | 290 | 88 | 2.9 | 3.3 | 88 | E | 0.04 | 17 |
| 6 | *Amaranthus spinosus* L. | Amaranthaceae | Th | 5 | 5 | 0.05 | 1 | 5 | A | 0.2 | 1.68 |
| 7 | *Boerhaavia repens* L. | Nyctaginaceae | Ch | 206 | 78 | 2.06 | 2.64 | 78 | D | 0.03 | 13.5 |
| 8 | *Cleome viscosa* L. | Cleomaceae | Th | 18 | 9 | 0.18 | 2 | 9 | A | 0.22 | 3.5 |
| 9 | *Croton bonplandianus* Baill | Euphorbiaceae | Th | 78 | 78 | 0.78 | 1 | 78 | D | 0.01 | 8.28 |
| 10 | *Cynodon dactylon* (L.) Pers. | Poaceae | Hc | 500 | 100 | 5 | 5 | 100 | E | 0.05 | 25.1 |
| 11 | *Desmodium gangeticum* (L.) DC | Leguminosae | Hc | 59 | 8 | 0.59 | 7.38 | 8 | A | 0.92 | 11.1 |
| 12 | *Desmodium triflorum* (L.) DC. | Leguminosae | Hc | 228 | 78 | 2.28 | 2.92 | 78 | D | 0.04 | 14.4 |
| 13 | *Eclipta alba* (L.) Hassk. | Asteraceae | Th | 180 | 58 | 1.8 | 3.1 | 58 | C | 0.05 | 12.1 |
| 14 | *Eupatorium odoratum* L. | Asteraceae | Ch | 220 | 88 | 2.2 | 2.5 | 88 | E | 0.03 | 14.3 |
| 15 | *Euphorbia hirta* L | Euphorbiaceae | Th | 38 | 38 | 0.38 | 1 | 38 | B | 0.03 | 4.67 |
| 16 | *Evolvulus nummularis* L. | Convolvulaceae | Hc | 287 | 88 | 2.87 | 3.26 | 88 | E | 0.04 | 16.9 |
| 17 | *Gomphrena serrata* L. | Amaranthaceae | Th | 288 | 88 | 2.88 | 3.27 | 88 | E | 0.04 | 16.9 |
| 18 | *Heliotropium indicum* L. | Boraginaceae | Th | 57 | 25 | 0.57 | 2.28 | 25 | B | 0.09 | 5.86 |
| 19 | *Melochia corchorifolia* L. | Malvaceae | Hc | 8 | 8 | 0.08 | 1 | 8 | A | 0.13 | 1.96 |
| 20 | *Mimosa pudica* L. | Leguminosae | Hc | 56 | 56 | 0.56 | 1 | 56 | C | 0.02 | 6.29 |
| 21 | *Oxalis corniculata* L. | Oxalidaceae | Hc | 97 | 67 | 0.97 | 1.45 | 67 | D | 0.02 | 8.58 |
| 22 | *Panicum repens* L. | Poaceae | Th | 109 | 68 | 1.09 | 1.6 | 68 | D | 0.02 | 9.14 |
| 23 | *Parthenium histerophorus* L. | Asteraceae | Th | 300 | 100 | 3 | 3 | 100 | E | 0.03 | 17.7 |
| 24 | *Phyllanthus* L. | Euphorbiaceae | Th | 106 | 66 | 1.06 | 1.61 | 66 | D | 0.02 | 8.93 |
| 25 | *Polygonum hydropiper* L. | Polygonaceae | Hc | 56 | 10 | 0.56 | 5.6 | 10 | A | 0.56 | 8.95 |
| 26 | *Ruellia tuberosa* Lamk. | Acanthaceae | Th | 28 | 22 | 0.28 | 1.27 | 22 | B | 0.06 | 3.71 |
| 27 | *Rungia pectinata* (L.) Nees | Acanthaceae | Th | 199 | 56 | 1.99 | 3.55 | 56 | C | 0.06 | 13 |
| 28 | *Scoparia dulcis* L. | Scrophulariaceae | Th | 23 | 23 | 0.23 | 1 | 23 | B | 0.04 | 3.31 |
| 29 | *Sida acuta* Burman f. | Malvaceae | Th | 44 | 12 | 0.44 | 3.67 | 12 | A | 0.31 | 6.4 |
| 30 | *Sida cordata* L. | Malvaceae | Th | 158 | 29 | 1.58 | 5.45 | 29 | B | 0.19 | 12.5 |
| 31 | *Spermacoce ocymoides* Burm.f. | Rubiaceae | Th | 16 | 8 | 0.16 | 2 | 8 | A | 0.25 | 3.39 |
| | | | Shrubs | | | | | | | | |
| 1 | *Calotropis gigantea* (L.) Dryand. | Apocynaceae | Ch | 58 | 58 | 0.58 | 1 | 58 | C | 0.02 | 32.3 |
| 2 | *Calotropis procera* (Aiton) W.T.Aiton | Apocynaceae | Ch | 3 | 2 | 0.03 | 1.5 | 2 | A | 0.75 | 15.2 |
| 3 | *Clerodendrum infortunatum* L. | Lamiaceae | Ch | 180 | 89 | 1.8 | 2.02 | 89 | E | 0.02 | 66.7 |
| 4 | *Ricinus communis* L. | Euphorbiaceae | Ch | 76 | 76 | 0.76 | 1 | 76 | D | 0.01 | 39.4 |
| 5 | *Urena lobata* L.. | Malvaceae | Ch | 201 | 81 | 2.01 | 2.48 | 81 | E | 0.03 | 71.9 |
| 6 | *Ziziphus abyssinica* Hochst. ex A.Rich. | Rhamnaceae | Ch | 212 | 85 | 2.12 | 2.49 | 85 | E | 0.03 | 74.5 |
| | | | Climbers | | | | | | | | |
| 1 | *Cocculus hirsutus* (L.) W.Theob. | Menispermaceae | Ph | 19 | 5 | 0.19 | 3.8 | 5 | A | 0.76 | 31 |
| 2 | *Ipomoea obscura* (L.) Ker Gawl. | Convolvulaceae | Ph | 48 | 18 | 0.48 | 2.67 | 18 | A | 0.15 | 37.5 |
| 3 | *Luffa aegyptiaca* Mill | Cucurbitaceae | Ph | 66 | 43 | 0.66 | 1.53 | 43 | C | 0.04 | 47.4 |
| 4 | *Mikania scandens*B.L.Rob | Asteraceae | Ph | 199 | 67 | 1.99 | 2.97 | 67 | D | 0.04 | 101 |
| 5 | *Paederia foetida* L. | Rubiaceae | Ph | 56 | 56 | 0.56 | 1 | 56 | C | 0.02 | 48.1 |
| 6 | *Pergularia daemia* (Forssk.) Chiov. | Apocynaceae | Ph | 5 | 5 | 0.05 | 1 | 5 | A | 0.2 | 10 |
| 7 | *Tinospora cordifolia* (Willd.) Miers | Menispermaceae | Ph | 15 | 5 | 0.15 | 3 | 5 | A | 0.6 | 25 |

wasteland (Table 1). Otherwise, *Clerodendrum infortunatum* L. was the most dominant shrub species and had the highest IVI value (77.04) in Dhadardihi 2 wasteland (Table 2). *Paederia foetida* L. was the most dominant climber species and had the highest IVI value (48.1) in Dhadardihi 1 wasteland (Table 1). Otherwise, *Cayratia trifolia* (L.) Domin was the most dominant climber species and had the highest IVI value (19.11) in Dhadardihi 2 wasteland (Table 2).

Table 2: Species diversity of Dhadardihi 2 wasteland

| Sl. No. | Plants Names | Family | Life form | (A) | (B) | D | A | F | FC | A/F | IVI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TREE | | | | | | | | | |
| 1 | *Acacia auriculiformis* L | Leguminosae | *Ph* | *3* | *2* | 0.03 | 1.5 | *2* | A | 0.75 | 2.75 |
| 2 | *Acacia nilotica* (L.) Del | Leguminosae | *Ph* | *19* | *19* | 0.19 | 1 | *19* | A | 0.05 | 19.05 |
| 3 | *Ailanthus excelsa* Roxb.- | Simaroubaceae | *Ph* | *2* | *2* | 0.02 | 1 | *2* | A | 0.5 | 2.5 |
| 4 | *Albizzia lebbek* Benth. | Leguminosae | *Ph* | *6* | *6* | 0.06 | 1 | *6* | A | 0.17 | 6.167 |
| 5 | *Alstonia scholaris* (L.) R. Br. | Apocynaceae | *Ph* | *2* | *2* | 0.02 | 1 | *2* | A | 0.5 | 2.5 |
| 6 | *Azadirachta indica* A.Juss. | Meliaceae | *Ph* | *12* | *12* | 0.12 | 1 | *12* | A | 0.08 | 12.08 |
| 7 | *Borassus flabellifer* L. | Arecaceae | *Ph* | *30* | *15* | 0.3 | 2 | *15* | A | 0.13 | 15.13 |
| 8 | *Dalbergia sissoo* DC. | Leguminosae | *Ph* | *8* | *6* | 0.08 | 1.33 | *6* | A | 0.22 | 6.222 |
| 9 | *Melia azedarach* L. | Meliaceae | *Ph* | *3* | *3* | 0.03 | 1 | *3* | A | 0.33 | 3.333 |
| 10 | *Tectona grandis* L.f. | Lamiaceae | *Ph* | *2* | *1* | 0.02 | 2 | *1* | A | 2 | 3 |
| | | Herbs | | | | | | | | | |
| 1 | *Aerva lanata* (L.) Juss. | Amaranthaceae | *Th* | *30* | *6* | 0.3 | 5 | *6* | A | 0.83 | 6.833 |
| 2 | *Alternanthera sessilis* (L.) R.Br. ex DC. | Amaranthaceae | *Hc* | *92* | *45* | 0.92 | 2.04 | *45* | C | 0.05 | 45.05 |
| 3 | *Bacopa monnieri* (L.) Wettst. | Plantaginaceae | *Ch* | *39* | *18* | 0.39 | 2.17 | *18* | A | 0.12 | 18.12 |
| 4 | *Blumea lacera* (Burm. f.) DC. | Asteraceae | *Th* | *42* | *19* | 0.42 | 2.21 | *19* | A | 0.12 | 19.12 |
| 5 | *Celosia argentea* L. | Amaranthaceae | *Th* | *1* | *1* | 0.01 | 1 | *1* | A | 1 | 2 |
| 6 | *Centella asiatica* (L.) Urb. | Apiaceae | *Hc* | *54* | *4* | 0.54 | 13.5 | *4* | A | 3.38 | 7.375 |
| 7 | *Cleome viscosa* L. | Cleomaceae | *Th* | *57* | *18* | 0.57 | 3.17 | *18* | A | 0.18 | 18.18 |
| 8 | *Crotalaria juncea* L | Leguminosae | *Th* | *13* | *13* | 0.13 | 1 | *13* | A | 0.08 | 13.08 |
| 9 | *Croton bonplandianus* Baill | Euphorbiaceae | *Th* | *99* | *39* | 0.99 | 2.54 | *39* | B | 0.07 | 39.07 |
| 10 | *Cynodon dactylon* (L.) Pers. | Poaceae | *Hc* | *386* | *68* | 3.86 | 5.68 | *68* | E | 0.08 | 68.08 |
| 11 | *Cyperus rotundus* L. | Poaceae | *Cry* | *89* | *56* | 0.89 | 1.59 | *56* | C | 0.03 | 56.03 |
| 12 | *Dactyloctenium aegyptium* (L.) Willd. | Poaceae | *Th* | *185* | *76* | 1.85 | 2.43 | *76* | D | 0.03 | 76.03 |
| 13 | *Eclipta alba* (L.) Hassk. | Asteraceae | *Th* | *28* | *10* | 0.28 | 2.8 | *10* | A | 0.28 | 10.28 |
| 14 | *Eragrostis cilianensis* (All.) Janch. | Poaceae | *Hc* | *179* | *77* | 1.79 | 2.32 | *77* | D | 0.03 | 77.03 |
| 15 | *Euphorbia hirta* L | Euphorbiaceae | *Th* | *8* | *4* | 0.08 | 2 | *4* | A | 0.5 | 4.5 |
| 16 | *Evolvulus alopecuroides* Mart. | Convolvulaceae | *Hc* | *198* | *80* | 1.98 | 2.48 | *80* | D | 0.03 | 80.03 |
| 17 | *Gamochaeta coarctata* (Willd.) | Asteraceae | *Th* | *78* | *45* | 0.78 | 1.73 | *45* | C | 0.04 | 45.04 |
| 18 | *Kyllinga brevifolia* Rottb. | Poaceae | *Th* | *126* | *65* | 1.26 | 1.94 | *65* | D | 0.03 | 65.03 |
| 19 | *Mimosa pudica* L. | Leguminosae | *Hc* | *7* | *3* | 0.07 | 2.33 | *3* | A | 0.78 | 3.778 |
| 20 | *Ocimum basilicum* L. | Lamiaceae | *Th* | *16* | *3* | 0.16 | 5.33 | *3* | A | 1.78 | 4.778 |
| 21 | *Oldenlandia corymbosa* L. | Rubiaceae | *Hc* | *36* | *9* | 0.36 | 4 | *9* | A | 0.44 | 9.444 |
| 22 | *Oplismenus compositus* (L.) P.Beauv. | Poaceae | *Th* | *139* | *67* | 1.39 | 2.07 | *67* | D | 0.03 | 67.03 |
| 23 | *Oxalis corniculata* L. | Oxalidaceae | *Hc* | 23 | 23 | 0.23 | 1 | 23 | B | 0.04 | 23.04 |
| 24 | *Parthenium alpinum* (Nutt.) Torr. & A.Gray | Asteraceae | *Th* | *289* | *92* | 2.89 | 3.14 | *92* | E | 0.03 | 92.03 |
| 25 | *Rungia pectinata* (L.) Nees | Acanthaceae | *Th* | *65* | *29* | 0.65 | 2.24 | *29* | B | 0.08 | 29.08 |
| 26 | *Solanum sisymbriifolium* Lam. | Solanaceae | *Th* | *60* | *25* | 0.6 | 2.4 | *25* | B | 0.1 | 25.1 |
| 27 | *Tridax procumbens* L. | Asteraceae | *Th* | *79* | *23* | 0.79 | 3.43 | *23* | B | 0.15 | 23.15 |
| 28 | *Triumfetta rhomboidea* Jacq | Malvaceae | *Th* | *24* | *17* | 0.24 | 1.41 | *17* | A | 0.08 | 17.08 |
| | | Shrubs | | | | | | | | | |
| 1 | *Calotropis gigantea* (L.) Dryand. | Apocynaceae | *Ch* | *4* | *4* | 0.04 | 1 | *4* | A | 0.25 | 4.25 |
| 2 | *Calotropis procera* (Aiton) | Apocynaceae | *Ch* | *8* | *3* | 0.08 | 2.67 | *3* | A | 0.89 | 3.889 |
| 3 | *Cassia sophera* L. | Leguminosae | *Ch* | *1* | *1* | 0.01 | 1 | *1* | A | 1 | 2 |
| 4 | *Clerodendrum infortunatum* L. | Lamiaceae | *Ch* | *210* | *77* | 2.1 | 2.73 | *77* | D | 0.04 | 77.04 |
| 5 | *Jatropha aceroides* (Pax & K.Hoffm.) Hutch. | Euphorbiaceae | *Ch* | *75* | *67* | 0.75 | 1.12 | *67* | D | 0.02 | 67.02 |
| 6 | *Opuntia stricta* (Haw.) Haw. | Cactaceae | *Ch* | *6* | *6* | 0.06 | 1 | *6* | A | 0.17 | 6.167 |
| 7 | *Ricinus communis* L. | Euphorbiaceae | *Ch* | *39* | *16* | 0.39 | 2.44 | *16* | A | 0.15 | 16.15 |
| 8 | *Tephrosia abbottiae* C.E.Wood | Leguminosae | *Ch* | *97* | *65* | 0.97 | 1.49 | *65* | D | 0.02 | 65.02 |
| 9 | *Urena lobata* L. | Malvaceae | *Ch* | *8* | *8* | 0.08 | 1 | *8* | A | 0.13 | 8.125 |
| | | Climbers | | | | | | | | | |
| 1 | *Cardiospermum halicacabum* L. | Sapindaceae | *Ph* | *5* | *2* | 0.05 | 2.5 | *2* | A | 1.25 | 3.25 |
| 2 | *Cayratia trifolia* (L.) Domin | Vitaceae | *Ph* | *39* | *19* | 0.39 | 2.05 | *19* | A | 0.11 | 19.11 |
| 3 | *Ipomoea obscura* (L.) Ker Gawl. | Convolvulaceae | *Ph* | *5* | *3* | 0.05 | 1.67 | *3* | A | 0.56 | 3.556 |
| 4 | *Luffa aegyptiaca* Mill. | Cucurbitaceae | *Ph* | *2* | *2* | 0.02 | 1 | *2* | A | 0.5 | 2.5 |
| 5 | *Mikania acuminata* DC. | Asteraceae | *Ph* | *19* | *6* | 0.19 | 3.17 | *6* | A | 0.53 | 6.528 |
| 6 | *Paederia foetida* L. | Rubiaceae | *Ph* | *1* | *1* | 0.01 | 1 | *1* | A | 1 | 2 |
| 7 | *Pergularia daemia* (Forssk.) Chiov | Apocynaceae | *Ph* | *4* | *3* | 0.04 | 1.33 | *3* | A | 0.44 | 3.444 |
| 8 | *Trichosanthes cucumerina* L. | Cucurbitaceae | *Ph* | *8* | *8* | 0.08 | 1 | *8* | A | 0.13 | 8.125 |

*(A):Total no of plants present in 100 quadrats, (B):Present in how many quadrates, D:Density, A: Abundance, F:Frequency, FC: Frequency Class, A/F: Abundance/Frequency, IVI: Important Value Index, Ph:Phanerophytes, Ch:Chamaephyte, Th:Therophyte, Hc: Hemicryptophytes*

The highest IVI value of the plant species means those plants were the most dominant or frequent occurrence in this study area. Otherwise, some plant species had the lowest IVI values and those plants were not dominant in the study area. Tree species [*Lagerstroemia speciosa* (L.) Pers. (7.24), *Terminalia arjuna* (Roxb.) (7.24) and *Trema orientalis* (L.) Blume (7.24) and harb species *Amaranthus spinosus* L. (1.68) and shrub species *Calotropis procera* (Aiton) W.T.Aiton (15.2) and climber species *Pergularia daemia* (Forssk.) Chiov. (10)] all the plant species had the lowest IVI values and they are not dominant in the Dhadardihi 1 wasteland study area. Otherwise, Tree species [*Ailanthus excelsa* Roxb. (2.5) and *Alstonia scholaris* (L.) R. Br. (2.5) and shrub species *Celosia argentea* L. (2) and shrub species *Cassia sophera* L. (2) and climber species *Paederia foetida* L. (2)] all the plant species had the lowest IVI values and they are not dominant in the Dhadardihi 2 wasteland study area. However, In the past similar type of vegetation analysis was conducted by (Kar and Palit, 2016), (Mondal *et al.,* 2020) and (Mondal *et al.,* 2019). Dhadardihi 1 wasteland represented a total of 26 families and Dhadardihi 2 wasteland represented a total of 23 families. Leguminosae family was the most dominant family in both selected wastelands. The next dominant families in both wastelands were Euphorbiaceae, Asteraceae and Poaceae. In Dhadardihi 2 wasteland, the Poaceae family increased their dominant nature and I hope that in the future Poaceae family will be the dominant. Some researchers all most similar types worked in past (Helm, 1995) and (Skeel and Gibson, 1996). In Dhadardihi 1, Average of species richness of trees (143.325), herbs (1053.586), shrubs (237.561) and climbers (131.668) were high compared to Dhadardihi 2. That indicates that Dhadardihi 1 is rich in plant diversity as compared to Dhadardihi 2. The highest value index indicated the sites are rich in plant diversity and also stable communities. The plant species diversity indices (Table 4) showed a considerable degree of variance both between the two wastelands and between the various vegetation layers.

Table 3: Species, family compositions of Dhadardihi 1 and Dhadardihi 2 wasteland

| Species composition | Dhanderdihi 1 | Dhanderdihi 2 |
|---|---|---|
| | Tree | |
| No. of species | 13 | 9 |
| No. of genus | 14 | 10 |
| No. of family | 8 | 7 |
| | Herb | |
| No. of species | 28 | 28 |
| No. of genus | 31 | 28 |
| No. of family | 17 | 20 |
| | Shurbs | |
| No. of species | 5 | 9 |
| No. of genus | 6 | 9 |
| No. of family | 5 | 7 |
| | Climber | |
| No. of species | 7 | 8 |
| No. of genus | 7 | 8 |
| No. of family | 6 | 7 |

Table 4: Species diversity in the Dhadardihi 1 and Dhadardihi 2 wasteland

| PARAMETER | HABITAT | DHANDERDIHI 1 | DHANDERDIHI 2 |
|---|---|---|---|
| Average of Species Richness | Tree | 143.325 | 70.723 |
| | Herb | 1053.586 | 629.57 |
| | Shrub | 237.561 | 156.521 |
| | Climber | 131.668 | 46.126 |
| Evenness | Tree | 0.215 | 0.418 |
| | Herb | 0.365 | 0.371 |
| | Shrub | 0.23 | 0.238 |
| | Climber | 0.247 | 0.349 |
| Shannon-Wiener index (H') | Tree | 1.186 | 1.868 |
| | Herb | 3.037 | 2.898 |
| | Shrub | 1.518 | 1.455 |
| | Climber | 1.487 | 1.545 |
| Simpson's index | Tree | 0.538 | 0.202 |
| | Herb | 0.058 | 0.072 |
| | Shrub | 0.238 | 0.303 |
| | Climber | 0.3 | 0.292 |

Table 5: Raunkiaer categorized different species in Dhadardihi 1 wasteland into 5 frequency classes

| | Frequency Class | % of the total no. of species | Ranunkiaeurs normal frequency |
|---|---|---|---|
| CLASS-A=(27/100*100)=27 | A | 27 | 53 |
| CLASS-B=(5/100*100)=5 | B | 5 | 14 |
| CLASS-C=(6/100*100)=6 | C | 6 | 9 |
| CLASS-D=(11/100*100)=11 | D | 11 | 8 |
| CLASS-E=(9/100*100)=9 | E | 9 | 16 |

In Dhadardihi 1, Evenness was trees (0.215), herbs (0.365), shrubs (0.23) and climbers (0.247) and in Dhadardihi 2, Evenness was trees (0.418), herbs (0.371), shrubs (0.238) and climbers (0.349). In Dhadardihi 1 Shannon-Wiener index (H') was 1.186 for trees, 3.037 for herbs, 1.518 for shrubs and 1.487 for climbers respectively. Otherwise, trees, herbs, shrubs and climbers were 1.868, 2.898, 1.455, and 1.545 in Dhadardihi 2. Simpson's index in Dhadardihi 1 was Trees (0.538), herbs (0.058), shrubs (0.238) and climbers (0.3). Otherwise, 0.202 for trees, 0.072 for herbs, 0.303 for shrubs and 0.292 for climbers in Dhadardihi 2. Raunkiaer categorized different species in Dhadardihi 1 and Dhadardihi 2 wasteland into 5 frequency classes shown in (Table 5 and Table 6).

Table 6: Raunkiaer distributed various species into 5 Frequency Classes in Dhadardihi 2 wasteland

| | Frequency Class | % of the total no. of species | Ranunkiaeurs normal frequency |
|---|---|---|---|
| CLASS-A=(37/100*100)=37 | A | 37 | 53 |
| CLASS-B=(5/100*100)=5 | B | 5 | 14 |
| CLASS-C=(3/100*100)=3 | C | 3 | 9 |
| CLASS-D=(8/100*100)=8 | D | 8 | 8 |
| CLASS-E=(2/100*100)=2 | E | 2 | 16 |

Different life forms from the wasteland of Dhadardihi 1 and Dhadardihi 2 are represented and the derived biological spectrum is compared to Raunkiaer's standard spectrum in (Table 7). However, the variation in the vegetation structure and also plant diversity seen in this case were consistent with previous results in various coal mining sites (Maiti and Ghose, 2005) (Nath, 2009) (Rai *et al.,* 2010) (Hazarika, 2006) (Borpujari, 2008) and (Singh, 2012). However, if the wastelands were recovered we would see stable vegetation and also stable plant diversity. The current study indicates tolerant species, but to restore biological succession and guarantee favourable habitat conditions for plant colonization, rigorous plant selection and evaluation are essential.

Table 7: Different life forms from the wasteland of Dhadardihi 1 and Dhadardihi 2 are represented and the derived biological spectrum is compared to Raunkiaer's standard spectrum

| Life-forms | No. of species | | Raunkiaer’s standard | Obtained biological spectrum | |
|---|---|---|---|---|---|
| | Dhanderdihi 1 | Dhanderdihi 2 | | Dhanderdihi 1 | Dhanderdihi 2 |
| Phanerophytes | 21 | 18 | 46 | 36.2 | 32.72 |
| Therophyte | 20 | 18 | 13 | 34.48 | 32.72 |
| Hemicryptophytes | 9 | 8 | 26 | 15.51 | 14.54 |
| Chamaephyte | 8 | 10 | 9 | 13.79 | 18.18 |
| Cryptophyte | 0 | 1 | 6 | 0 | 1.81 |

## CONCLUSION

The current study was done kajora mining area in two coal mine-generated wastelands. In these areas, surface coal mining plays a significant role on the land. As a result, vegetation structure and species diversity are imbalanced. It also made it easier for the increased deposition of mine spoil to modify the condition of the soil. The current study revealed a total of 26 families in Dhadardihi 1 and 23 families in Dhadardihi 2. Leguminosae family was the most dominant family in both selected wastelands but Otherwise, Boraginaceae, Cucurbitaceae, Cannabaceae, Combretaceae, Cleomaceae, Lamiaceae, Lythraceae, Meliaceae, Nyctaginaceae, Oxalidaceae, Rhamnaceae, Scrophulariaceae, Vitaceae, Plantaginaceae, Sapindaceae, Solanaceae, Simaroubaceae, Cactaceae, Acanthaceae, Aceraceae and Apiaceae all these families dominant natuture was very low. In future, if the wastelands will not recover or improve the soil quality then these families will be extinct. Improving the efficiency of the wastelands is an essential and also vital requirement for managing mined wastelands.

## REFERENCES

A. Singh (2012) Natural colonization of woody species on revegetated coal mine spoils in a dry tropical environment," *Indian Journal of Plant Sciences*, vol. **1** no. 1, pp. 57-60.

A.K. Rai, B. Paul and G. Singh (2010) A Study on the Bulk Density and its Effect on the Growth of selected Grasses in Coal Mine Overburden Dumps, Jharkhand, India." *International Journal of Environmental Sciences*, vol. **1**, no. 4, pp. 677-684.

Barik, R., Saren, S., Mishra, A., & Acharya, B. P. (2017) Soil fertility status of some villages in Astaranga bock of Puri District of East and South Eastern Coastal Plain Agro Climatic Zone of Odisha. *Annals of Plant and Soil Research*, **19**(4), 408-412.

Bhattacharya, S., Pachauri, S., and Srivastava, P. (2020) Status of macro-and micronutrients in soils of Chamoli district of Uttarakhand. *Annals of Plant and Soil Research*, **22**(4), 361-366.

Cooke, J.A. (1999) Mining, Ecosystems of the World 16-Ecosystems of Disturbed Ground, ed. L.R. Walker, Elsevier, Amsterdam, the Netherlands, p.365-384.

D. Borpujari (2008) Studies on the occurrence and distribution of some tolerant plant species in different spoil dumps of Tikak opencast mine," *The Ecoscan*, vol. **2**, no. 2, pp. 255-260.

D.J. Helm (1995) Native grass cultivars for multiple revegetation goals on a proposed mine site in Southcentral Alaska," *Restoration Ecology*, vol. **3**, pp. 111-122.

Hewit, N. and Kellman, M. (2002) True seed dispersal among forest fragments: Dispersal ability and biogeographical controls. *Journal of Biogeography* (**3**): 351-363.

Hoadley M, Limpitlaw D. and Weaver, A. (2002) Mining, Minerals and Sustainable Development in Southern Africa, the report of the regional MMSD process, 1, 2 and 3.

Jochimsen, M., Hartung, J. and Fischer, I. (1995) Spontane und kunstliche Begrunung der Abraumhalden des Stein- und Braunkohlenbergbaus. Ber. d. *Reinhold Tuxen-Ges*.; **7**: 69–88.

Kar, D., & Palit, D. (2016) Assessment of plant species assemblages with their distribution in an open cast mining area of Raniganj coalfield, West Bengal, India. *Int J Sci Eng Res*, **7**(7), 443-52.

Kumar A, Jhariya MK and Yadav DK (2015) Community characters of herbaceous species in plantation sites of coal mine. *Journal of Plant Development Science* (**11**): 809-814.

Marglef D.R. (1958) Information theory in ecology. *General Systems Yearbook*: 36-71.

Misra R. (1968) Ecology Work Book. Oxford & IBH Publication, New Delhi.

Mondal, S., Palit, D., & Chattopadhyay, P. (2019) Species diversity and vegetation structure of coal mine generated wasteland of Raniganj Coal Field, West Bengal, India. *Int J Cur Res Rev*| Vol, **11**(13), 13.

P. Hazarika, N.C. Talukdar and Y.P. Singh (2006) Natural colonization of plant species on coal mine spoils at Tikak Colliery, Assam," *Tropical Ecology*, vol. **47**, no. 1, pp. 37-46.

Pielou EC (1966) Species diversity and pattern diversity in the study of ecological succession. : 370- *Journal of Theoretical Biology* 10 383.

Rai, A.K., Paul B. and Singh G. (2010) A study on the bulk density and its effect on the growth of selected grasses in coal mine overburden dumps, Jharkhand, India. *International Journal of Environmental Sciences* (**4**): 677-684.

Raunkiaer, C. (1934) The Life Form of Plants and Statistical Plant Geography. Claredon Press, Oxford.

S. Nath (2009) Ecosystem approach for mined land rehabilitation and present rehabilitation scenario in Jharkhand coal mines," Sustainable Rehabilitation of Degraded Ecosystems, O.P. Chaubey, V. Bahadu and P.K. Shukla, eds., Aavishkar publishers, distributors Jaipur, Raj. 302 003 India, pp. 46-66.

S.K. Maiti and M.K. Ghose (2005) Ecological restoration of acidic coal mine overburden dumps-an Indian case study," *Land Contamination and Reclamation*, vol. **13**, no. 4, pp. 361-369.

Saikat, M., Debnath, P., & Pinaki, C. (2020) Vegetation analysis in Chora and Joyalbhanga forest area of Raniganj coal field, West Bengal, India. *Indian Journal of Ecology*, **47**(3), 831-841.

Shannon, C.E. and Weaver, W. (1963) The mathematical theory of communication (323). Urbana: University of Illinois Press.

Simpson, E.H. (1949) Measurement of diversity, 688.

Singh A.K., Mahato MK, Neogi B, Mondal GC and Singh, T.B. (2011) Hydrogeochemistry, elemental flux and quality assessment of mine water in the Pootkee-Balihari mining area, *Jharia coalfield, India*. (**3**): 197-207.

Srivastva, H.N. (2001) Practical Botany. Pradeep Publications, Jalandhar.

V.A. Skeel, and D.J. Gibson (1996) "Physiological performance of Andropogon gerardii, Panicum virgatum, and Sorghastrum nutans on reclaimed mine spoil*," Restoration Ecology*, vol. **4**, no. 4, pp. 355-367.

Whiteford, P.B. (1949) Distribution of woodland plants in relation to succession and colonial growth. : 199-200.