



Floral Diversity Assessment of India's Largest Chromite Mine and Adjacent Polluted Areas with the Special Reference of Native and Alien Invasive Species

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Abstract

The number and dominance of alien invasive species in India's floral diversity continues to grow. One of the main reasons for this continuous increase is anthropogenic human activity and environmental pollution. We have studied the floral diversity of India's largest chromium Mine Valley and the surrounding area, where anthropogenic activity and environmental pollution are very high. In our study, we have documented a total of 292 plant species, of which 107 are alien invasive species belong to 34 different families, and the remaining 185 are native species, which belong to 57 families. Most of the alien invasive species here came from Tropical America (35 species), Central America (25 species) and the African continent (20 species). Some invasive species *Chromolaena odorata* (L.) R.M.King & H. Rob., *Croton bonplandianus* Baill., *Cuscuta reflexa* Roxb., *Lantana camara* L., *Parthenium hysterophorus* L., *Pennisetum pedicellatum* Trin., *Mikania micrantha* Kunth., *Tridax procumbens* L. these invasive species are spreading the habitat of this mining valley and surrounding area quite faster than the native species, and they have put intense pressure on the diversity of native species as well as the ecosystem. Our study will help to recover diversity of native species by the management of alien invasive species in the future.

Keywords: Alien invasive species; Floral diversity; Chromium mine; Environmental pollution; Native species.

Introduction

In general floral diversity refers to the variety of naturally occurring indigenous or native plants. Every individual native plant species plays a role in maintaining a productive ecosystem through the synthesis of energy, maintaining the carbon cycle, acquiring water and nutrients. When there are many native plant species in an ecosystem, it is very productive, and that eventually leads to growing rich biodiversity (Oldfield. *et al.*, 2019). But the spread and establishment of alien invasive species are severe threats to native plant species, and this is likely to get worse as more species are introduced into the new habitat. (Hobbs. *et al.*, 1995; Balaguru. *et al.*, 2016). These alien invasive plant species possess a set of remarkable traits that allow

them to colonize huge areas upon invasion. Studies of alien invasive species revealed that the effects of their invasions are complex and can permanently change the structure and function of the ecosystem, that leading to extinction of native species. (Gurevitch and Padilla 2004). Extinction of native species and continues competition from alien invasive species gradually leads to loss of biodiversity (Bauer. 2012). For some of the special biological characters of the invasive species, they can easily spread anywhere. Those characters are: fitness homeostasis, large number of seed production, low weight of seed, alternative mode of reproduction, competitive ability, allelopathy and phenotypic plasticity. For all these characters,

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invasive species can be easily invaded in a polluted or more impacted area. Where native species only try to adapt to pollution, cannot compete with more competitive alien invasive species (Maron. *et al.*, 2004). Environmental alterations may suddenly put even previously well-adapted native species to a competitive disadvantage with non-native species. Once invasive species spreads over an area, it is very difficult to manage those invasive species and rescue native species (Crooks. *et al.*, 2011).

Due to rapid economic development and gradual acceleration of trade, travel and transportation, developing countries are being attacked by invasive species, and those countries are becoming a source of invasive species for other countries. The launch of a massive development project in India is detrimental to the natural habitat of the native plant. It has opened up disturbance corridors, providing habitat to the establishment and spread for alien invasive species (Sharma. *et al.*, 2005). India is one of the 12 mega biodiversity countries in the world, over 49,003 species of plants belonging to various groups have been documented (Singh. 2020). But currently, 1,599 are invasive species belonging to 842 genera in 161 families and constitutes 8.5% of the total Indian vascular flora. Asteraceae (134 spp.), Papilionaceae (114 spp.) and Poaceae (106 spp.) are families that have the most invasive species (Khuroo. *et al.*, 2012).

The situation is worrying because already more than 13,000 plant species (conventional global vascular 4 to 4%) have become naturalized anywhere in the world as a result of human activity, and many of them represent a threat to biodiversity. Odisha ranks 7th among all Indian states in terms of invasive species number, with 199 invasive species found so far (Pergl. *et al.*, 2018). There is much mining, and industrial activity is continuously increasing; gradually, pollution is also growing. Thus, the number of alien invasive species is predicted to increase significantly in the future. Inventory and documentation of invasive species is an

urgent priority because it represents a critical beginning for the scientific understanding and systematic management of biological invasions on local, regional and global scales. Such inventory and documentation are compiled at the regional level, they provide the basic information needed to management of invasive species. A few numbers of research studies that inventories the invasive species of some regions in India have been carried out (Khuroo. *et al.*, 2012). Thus, our research has conducted and focused on the identification and documentation of plant diversity concerning alien invasive species and native species, which requires immediate management and conservation. Here, we address the situation by conducting field trips to the mining and surrounding regions of Sukinda chromite mine valley, Odisha. This mining valley fourth most polluted area in the world (BSI 2007). Throughout the year in different seasons and make a comprehensive idea about the floral diversity with the help of native and alien invasive species. Native and alien invasive plant species that should be taken care of to maintain the ecological balance in the environment.

Materials and Methods

Study area

Sukinda chromite valley is the largest chromite mine in India, almost 98% of country's chromium are produce from this valley. The valley situated in Jajpur district of Odisha state, which covers an area of two hundred kilometre (Fig. 1). The study area consists of an extensive plateau in the interior with a foreground of wide coastal plain and underlain by Precambrian rock. The region is located between 21 ° 00 ' N to 21 ° 05 ' N latitude and 85 ° 44 ' E to 85 ° 53 ' E, which is a tropical climate zone (F. There are three main session- winter from December to February, summer from March to May and rainy session from June to September. The months of October and November are autumn session. The mean maximum temperature of the place is 38° C in April and day, the mean minimum temperature is 15°C in December and January. Normal annual rainfall in the valley is 1480 mm, the average number of rainy days in a

year is 72, most of which are from middle June to middle September. These area mostly confined to the lower permanently moist valley, characterised by mostly deciduous species and some are evergreen. The primary contaminant here is hexavalent chromium (Cr VI), for this contaminant these area's air, water and soil are highly polluted, due to opencast mining activities like drilling, blasting, transportation of raw Chromite. Other major pollutants in the valley are Particulate matters ((PM10, PM2.5), Sulfur dioxide (SO₂), Nitrogen dioxide (NO₂) and Carbon monoxide (CO) (Mishra. *et al.*, 2016). Deforestation is highly privilege in this area, for the extraction of chromium.

Specimen Collection and Preservation

Extensive floristic survey was conducted during the period of October 2018 to December 2019. At the time of field survey, every plant species from the valley and the adjoining forest area were collected for identification. The standard procedure followed for plant specimen collection. Every field trip we would carry collection kit; consisting of secateurs, tags, field notebook, pencils, hand lens, digital camera, field plant press, blotting paper, GPS for collection of plant specimen. For small herbaceous plants, the entire aboveground part of the plant and for large shrub or tree plants, small part including leaves, flowers, or fruits were collected. During each species collection all information was recorded in field-notebook including collection date, location (using GPS), habitat type, habit, flower and bark color, distinctive odor, local name, population size, collector's names. A unique identification number was given during each collection of single species. Immediately after collection, the specimen kept in blotting paper, then specimens, along with blotting papers, were placed in the field plant press. Specimens are brought from the field to the laboratory and dried in an air dryer. Dried specimens mounted on the acid-free mounting paper and standard size label were labelled along with all necessary data from the field notebook. After given accession number, specimens were placed in herbarium

of Regional Research Laboratory, Bhubaneswar (RRL-B) for future reference. After carrying out all morphological characters, proper identification of each species was made with the help of available flora books; Flora of Orisha (Saxena and Braham 1994-1996) and Flora of British India (Hooker 1890). After identifying all the plants, two separate lists of alien invasive and native species were made based on some available literature, and also collect information about the nativity and origin of alien invasive species. (Hiremath and Sundaram 2013; Panda. *et al.*, 2018; Saxena. 1991; Srivastava. *et al.*, 2014; Panda. *et al.*, 2020).

Results and Discussion

Total 294 species have been documented from this valley, out of 107 species are alien invasive belonging 35 family and 87 genera (**Table 1**) and rest of 187 species are native belonging in 52 family and 145 genera (**Table 2**). In the case of alien invasive species Asteraceae contributes the highest number of species (17 spp.) followed by leguminosae (12 spp), Poaceae (10 spp.) Euphorbiaceae (8 spp.) Convolvulaceae, Malvaceae (6 sp. Each) (**Figure 2**). Eighteen families are represented by single species. In the case of generic richness *Euphorbia*, *Senna*, *Ludwigia*, *Ipomoea* and *Solanum* (3 spp. each) ranked highest. It is demonstrated that most of the alien invasive species of this valley were American (60 species) followed by African (20 species), Australian (6 species) and South East Asian (2 species), European (3 species), one species from each places Mediterranean, Brazil, Madagascar, Mexico and West Indies. Habit wise distribution analysis showed that the herb represented a high proportion 53 species, shrubs 36 species, climbers 12 species and trees 6 species viz., *Annona reticulata* L., *Borassus flabellifer* L., *Delonix regia* (Hook.) Raf., *Kigelia africana* (Lam.) Benth., *Simarouba amara* Aubl. and *Ziziphus mauritiana* Lam. In the case of native species; Leguminosae contribute highest number of species (21 species), followed by Acanthaceae (16 species), Rubiaceae (15 species), Malvaceae (14 species), Lamiaceae (9 species) and Poaceae (8 species). Twenty six

family represent by single species. In terms of generic richness *Ficus* ranked with five species followed by *Sida* (4 species), *Justicia* and *Terminalia* (3 species each). Habit wise distribution analysis showed that tree species

were represented a higher proportion with 73 species, Herbs 59 species, shrubs 34 species and climbers 19 species. 27% of all invasive species are dominant, and only 2.7% of native species are dominant.

Table1: Alien invasive plant species of Sukinda chromite mine and adjacent area

Sl. No.	Botanical name	Family	Habit	Abundance	Locality	Accession no.	Origin area
1	<i>Abrus precatorius</i> L.	Leguminosae	Climber	Common	Tomka	9703	Australia
2	<i>Acalypha indica</i> L.	Euphorbiaceae	Herb	Common	Chingudi pal	9688	Africa
3	<i>Acanthospermum hispidum</i> DC.	Asteraceae	Herb	Dominant	Dumtang ar	9630	Central and South America
4	<i>Acmella oleracea</i> (L.) R.K.Jansen	Asteraceae	Herb	Common	Kaliapani	9628	Trop. South America
5	<i>Acmella paniculata</i> (Wall. ex DC.) R.K.Jansen	Asteraceae	Herb	Common	kathapal	9636	Trop. South America
6	<i>Agave americana</i> L.	Agavaceae	Shrub	Frequent	Tomka	9649	Tropical America
7	<i>Ageratum conyzoides</i> L.	Asteraceae	Herb	Dominant	Sukurungi	9635	Central America
8	<i>Alternanthera sessilis</i> (L.) DC.	Amaranthaceae	Herb	Dominant	South Kaliapani	9640	Central America
9	<i>Alysicarpus vaginalis</i> (L.) DC.	Leguminosae	Herb	Common	Saruababil	9704	Africa
10	<i>Amaranthus spinosus</i> L.	Amaranthaceae	Herb	Dominant	kathapal	9641	Central America
11	<i>Annona reticulata</i> L.	Annonaceae	Tree	Rare	Chingudi pal	9644	Central America
12	<i>Antigonon leptopus</i> Hook. & Arn.	Polygonaceae	Climber	Dominant	Dumtang ar	9683	Trop. America
13	<i>Argemone mexicana</i> L.	Papaveraceae	Herb	Dominant	Kanasa	9722	South America
14	<i>Blumea lacera</i> (Burm. F.) DC.	Asteraceae	Herb	Common	Dumtang ar	9628	Central America
15	<i>Borassus flabellifer</i> L.	Arecaceae	Tree	Rare	Fecor	9648	Tropical Africa
16	<i>Calotropis gigantea</i> (L.) R. Br.	Apocynaceae	Shrub	Common	Kanasa	9645	Tropical Africa
17	<i>Calotropis procera</i> (Ait.) R. Br.	Apocynaceae	Shrub	Common	Kumurada	9646	Tropical Africa
18	<i>Capparis zeylanica</i> L.	Capparaceae	Shrub	Common	Chingudi pal	9663	South East Asia

19	<i>Cardiospermum halicacabum</i> L.	Sapindaceae	Climber	Dominant	Kanasa	9686	Australia
20	<i>Catharanthus roseus</i> L.	Apocynaceae	Herb	Frequent	Ostapal	9647	Central America
21	<i>Chenopodium album</i> L.	Amaranthaceae	Shrub	Common	kolarangi	9642	Europe
22	<i>Chloris barbata</i> (L.) Sw.	Poaceae	Herb	Dominant	South Kaliapani	9674	Central America
23	<i>Chromolaena odorata</i> (L.) R.M.King & H.Rob.	Asteraceae	Shrub	Dominant	Dumtangar	9634	Tropical America
24	<i>Chrozophora rottleri</i> (Geiseler) A.Juss. ex Spreng.	Euphorbiaceae	Shrub	Common	Kaliapani	9689	Tropical Africa
25	<i>Cissampelos pareira</i> L.	Menispermaceae	Climber	Dominant	Kaliapani	9717	Africa
26	<i>Cleome rutidosperma</i> DC.	Cleomaceae	Herb	Common	kolarangi	9660	Tropical America
27	<i>Cleome viscosa</i> L.	Cleomaceae	Herb	Common	Saruababil	9662	Central America
28	<i>Corchorus tridens</i> L.	Malvaceae	Herb	Frequent	Fecor	9716	Trop. Africa
29	<i>Crotalaria pallida</i> Aiton	Leguminosae	Herb	Common	Chingudi pal	9705	Trop. America
30	<i>Croton bonplandianus</i> Bail.	Euphorbiaceae	Herb	Dominant	Chingudi pal	9690	Temperate South America
31	<i>Cuscuta reflexa</i> Roxb.	Convolvulaceae	Climber	Dominant	Kaliapani	9659	Mediterranean
32	<i>Cyperus iria</i> L.	Cyperaceae	Herb	Common	Chingudi pal	9653	Trop. America
33	<i>Datura metel</i> L.	Solanaceae	Shrub	Frequent	kolarangi	9673	Central America
34	<i>Delonix regia</i> (Hook.) Raf.	Leguminosae	Tree	Frequent	kolarangi	9710	Madagascar
35	<i>Dicliptera paniculata</i> (Forssk.) I.Darbysh.	Acanthaceae	Herb	Common	Sukurungi	9637	Trop. America
36	<i>Echinochloa colona</i> (L.) Link	Poaceae	Herb	Common	Dumtangar	9675	Tropical South America
37	<i>Eclipta prostrata</i> (L.)	Asteraceae	Herb	Common	kathapal	9650	Tropical America
38	<i>Emilia sonchifolia</i> (L.) DC. ex DC.	Asteraceae	Herb	Common	Sukurungi	9633	Tropical America
39	<i>Eragrostis amabilis</i> (L.) Wight & Arn.	Poaceae	Herb	Common	Kanasa	9676	Africa
40	<i>Eragrostis ciliata</i> (Roxb.) Nees	Poaceae	Herb	Common	South Kaliapani	9677	South America
41	<i>Euphorbia heterophylla</i> L.	Euphorbiaceae	Shrub	Common	Sukurungi	9691	Central America
42	<i>Euphorbia thymifolia</i> L.	Euphorbiaceae	Shrub	Common	Kumura	9692	Tropical

		ae		n	da		America
43	<i>Euphorbia hirta</i> L.	Euphorbiaceae	Shrub	Common	Sukurungi	9693	Tropical America
44	<i>Evolvulus nummularius</i> (L.) L.	Convolvulaceae	Climber	Common	kathapal	9658	Central America
45	<i>Fimbristylis dichotoma</i> (L.) Vahl	Cyperaceae	Herb	Common	Sukurungi	9652	Tropical America
46	<i>Gnaphalium pensylvanicum</i> Willd.	Asteraceae	Herb	Common	South Kaliapani	9621	Trop. America
47	<i>Gomphrena serrata</i> L.	Amaranthaceae	Herb	Dominant	Dumtangar	9643	Tropical America
48	<i>Grangea maderaspatana</i> (L.) Poir.	Asteraceae	Herb	Common	Sukurungi	9627	Trop. South America
49	<i>Hyptis suaveolens</i> (L.) Poit.	Lamiaceae	Shrub	Common	Dumtangar	9699	Central America
50	<i>Imperata cylindrica</i> (L.) Raeusch.	Poaceae	Herb	Common	Fecor	9678	Trop. America
51	<i>Indigofera trita</i> L.f.	Leguminosae	Herb	Common	Fecor	9709	Trop. Africa
52	<i>Ipomoea obscura</i> (L.) Ker.-Gawal.	Convolvulaceae	Climber	Dominant	kathapal	9657	Tropical Africa
53	<i>Ipomoea hederifolia</i> L.	Convolvulaceae	Herb	Common	Sukurungi	9656	Trop. America
54	<i>Ipomoea pes-tigridis</i> L.	Convolvulaceae	Climber	Dominant	kathapal	9655	Tropical America
55	<i>Jatropha gossypifolia</i> L.	Euphorbiaceae	Shrub	Common	Kumurada	9694	Brazil
56	<i>Kigelia africana</i> (Lam.) Benth.	Bignoniaceae	Tree	Rare	Saruababil	9651	Tropical Africa
57	<i>Lantana camara</i> L.	Verbenaceae	Shrub	Dominant	Kanasa	9668	Central America
58	<i>Leonotis nepetifolia</i> (L.) R.Br.	Lamiaceae	Shrub	Frequent	South Kaliapani	9700	Trop. Africa
59	<i>Leucas aspera</i> (Willd.) Link	Lamiaceae	Herb	Frequent	Ostapal	9701	Africa
60	<i>Lippia alba</i> (Mill.) N.E.Br. ex Britton & P.Wilson	Verbenaceae	Shrub	Common	Kanasa	9667	Tropical America
61	<i>Ludwigia parviflora</i> Roxb.	Onagraceae	Herb	Common	Ostapal	9720	Tropical Africa
62	<i>Ludwigia perennis</i> L.	Onagraceae	Herb	Common	South Kaliapani	9718	Tropical Africa
63	<i>Ludwigia adscendens</i> (L.) H.Hara	Onagraceae	Herb	Frequent	kolarangi	9719	Tropical Africa
64	<i>Malachra capitata</i> (L.) L.	Malvaceae	Shrub	Frequent	Ostapal	9711	Central America
65	<i>Malvastrum coromandelianum</i> (L.) Garcke	Malvaceae	Herb	Common	Kumurada	9712	Trop. America
66	<i>Martynia annua</i> L.	Pedaliaceae	Herb	Frequent	Kanasa	9725	Trop. America

67	<i>Merremia aegyptia</i> (L.) Urb.	Convolvulaceae	Herb	Frequent	South Kaliapani	9654	Trop. America
68	<i>Mikania micrantha</i> Kunth.	Asteraceae	Climber	Dominant	Kaliapani	9626	Central America
67	<i>Mimosa pudica</i> L.	Leguminosae	Herb	Dominant	Tomka	9698	South America
70	<i>Ocimum americanum</i> L.	Lamiaceae	Shrub	Common	Tomka	9702	Tropical America
71	<i>Oplismenus hirtellus</i> (L.) P.Beauv.	Poaceae	Herb	Dominant	Kaliapani	9679	Australia
72	<i>Opuntia stricta</i> (Haw.) Haw.	Cactaceae	Shrub	Frequent	kolarangi	9664	Central America
73	<i>Oxalis corniculata</i> L.	Oxalidaceae	Climber	Dominant	South Kaliapani	9721	Europe
74	<i>Panicum repens</i> L.	Poaceae	Herb	Common	Kumura da	9680	Africa
75	<i>Parthenium hysterophorus</i> L.	Asteraceae	Shrub	Dominant	South Kaliapani	9625	North America
76	<i>Passiflora foetida</i> L.	Passifloraceae	Climber	Dominant	kolarangi	9723	South America
77	<i>Pavonia zeylanica</i> (L.) Cav.	Malvaceae	Shrub	Frequent	Fecor	9713	Australia
78	<i>Pedaliium murex</i> L.	Pedaliaceae	Shrub	Common	Dumtang ar	9724	Central America
79	<i>Pennisetum pedicellatum</i> Trin.	Poaceae	Shrub	Dominant	kolarangi	9681	Africa
80	<i>Peristrophe paniculata</i> (Forsk.) Brummitt	Acanthaceae	Herb	Dominant	Kaliapani	9639	Tropical America
81	<i>Phyla nodiflora</i> (L.) Greene	Verbenaceae	Herb	Common	kolarangi	9666	Tropical America
82	<i>Physalis angulata</i> L.	Solanaceae	Herb	Common	Dumtang ar	9669	Trop. America
83	<i>Plumbago zeylanica</i> L.	Plumbaginaceae	Shrub	Common	Kanasa	9727	Africa
84	<i>Portulaca quadrifida</i> L.	Portulacaceae	Herb	Common	Saruababil	9684	Mexico
85	<i>Rhynchosia rufescens</i> (Willd.) DC.	Leguminosae	Climber	Common	Kaliapani	9706	South East Asia
86	<i>Ricinus communis</i> L.	Euphorbiaceae	Shrub	Common	Kumura da	9728	Africa
87	<i>Ruellia tuberosa</i> L.	Acanthaceae	Herb	Common	Saruababil	9638	Trop. America
88	<i>Scoparia dulcis</i> L.	Plantaginaceae	Herb	Common	kolarangi	9726	Central America
89	<i>Senna alata</i> (L.) Roxb.	Leguminosae	Shrub	Common	Kumura da	9695	South America
90	<i>Senna occidentalis</i> L.	Leguminosae	Shrub	Common	Ostapal	9696	South America
91	<i>Senna tora</i> L.	Leguminosae	Shrub	Common	Saruababil	9697	South America

92	<i>Sesbania bispinosa</i> (Jacq.) W.Wight	Leguminosae	Shrub	Frequent	kolarangi	9707	Tropical America
93	<i>Setaria pumila</i> (Poir.) Roem. & Schult.	Poaceae	Herb	Common	Kanasa	9682	Europe
94	<i>Simarouba amara</i> Aubl.	Simaroubaceae	Tree	Common	Kumurada	9687	Tropical America
95	<i>Solanum nigrum</i> L.	Solanaceae	Shrub	Common	Kumurada	9672	Central America
96	<i>Solanum torvum</i> Sw.	Solanaceae	Shrub	Common	Kaliapani	9671	Central America
97	<i>Solanum viarum</i> Dunal.	Solanaceae	Shrub	Common	kolarangi	9670	Central America
98	<i>Synedrella nodiflora</i> (L.) Gaertn.	Asteraceae	Herb	Common	Chingudipal	9624	Central America
99	<i>Synedrella nodiflora</i> (L.) Gaertn.	Asteraceae	Herb	Dominant	kathapal	9632	West Indies
101	<i>Tephrosia purpurea</i> (L.) Pers.	Leguminosae	Shrub	Dominant	Dumtangar	9708	Australia
101	<i>Tribulus terrestris</i> L.	Zygophyllaceae	Herb	Dominant	Saruababil	9665	Central America
102	<i>Tridax procumbens</i> L.	Asteraceae	Herb	Dominant	Sukurungi	9623	Central America
103	<i>Urena lobata</i> L.	Malvaceae	Shrub	Common	Ostapal	9714	South America
104	<i>Urena sinuata</i> L.	Malvaceae	Shrub	Common	Saruababil	9715	South America
105	<i>Vernonia cinerea</i> (L.) Less	Asteraceae	Herb	Dominant	kathapal	9631	Tropical America
106	<i>Xanthium indicum</i> Koenig.	Asteraceae	Shrub	Common	Chingudipal	9622	Central America
107	<i>Ziziphus mauritiana</i> Lam.	Rhamnaceae	Tree	Frequent	Kanasa	9685	Australia

Table 2: Native plant species of Sukinda chromite mine and adjacent area

Sl. No.	Botanical name	Family	Habit	Abundance	Locality	Accession no.
1	<i>Abutilon indicum</i> (L.) Sweet	Malvaceae	Shrub	Frequent	kathapal	9436
2	<i>Acacia catechu</i> (L.f.) Willd.	Leguminosae	Tree	Rare	Chingudipal	9491
3	<i>Acacia leucophloea</i> (Roxb.) Willd.	Leguminosae	Tree	Frequent	Kumurada	9492
4	<i>Aegle marmelos</i> (L.) Correa	Rutaceae	Tree	Frequent	Kanasa	9552
5	<i>Aerva lanata</i> (L.) Juss.	Amaranthaceae	Herb	Common	Sukurungi	9580
6	<i>Ailanthus excelsa</i> Roxb.	Simaroubaceae	Tree	Common	Dumtangar	9558
7	<i>Alangium salviifolium</i> (L.f.) Wangerin	Cornaceae	Tree	Frequent		9613
8	<i>Albizia lebbek</i> (L.) Benth.	Leguminosae	Tree	Frequent	Kaliapani	9510

9	<i>Alstonia scholaris</i> (L.) R.Br.	Apocynaceae	Tree	Rare	Chingudipal	9585
10	<i>Ammannia baccifera</i> L.	Lythraceae	Herb	Common	Kumurada	9513
11	<i>Anacardium occidentale</i> L.	Anacardiaceae	Tree	Frequent	Chingudipal	9582
12	<i>Andrographis paniculata</i> (Burm. f.) Nees	Acanthaceae	Herb	Common	Sukurungi	9565
13	<i>Andrographis echinoides</i> (L.) Nees	Acanthaceae	Herb	Rare	Saruababil	9566
14	<i>Anisomeles indica</i> (L.) Kuntze	Lamiaceae	Herb	Common	Kaliapani	9480
15	<i>Anisomeles indica</i> (L.) Kuntze	Lamiaceae	Shrub	Common	Dumtanga	9487
16	<i>Antidesma acidum</i> Retz.	Phyllanthaceae	Shrub	Rare	Kumurada	9543
17	<i>Argyrea nervosa</i> (Burm. f.) Bojer	Convolvulaceae	Climber	Common	Tomka	9515
18	<i>Asparagus racemosus</i> Willd.	Asparagaceae	Climber	Frequent	Tomka	9595
19	<i>Azadirachta indica</i> A.Juss.	Malvaceae	Tree	Common	kathapal	9446
20	<i>Bambusa tuldoidea</i> Munro	Poaceae	Tree	Frequent		9448
21	<i>Barleria cristata</i> L.	Acanthaceae	Herb	Common	Kaliapani	9567
22	<i>Barleria prionitis</i> L.	Acanthaceae	Herb	Common	South Kaliapani	9568
23	<i>Barringtonia acutangula</i> (L.) Gaertn.	Barringtoniaceae	Tree	Rare	Fecor	9598
24	<i>Bauhinia acuminata</i> L.	Leguminosae	Shrub	Frequent	South Kaliapani	9504
25	<i>Biophytum reinwardtii</i> (Zucc.) Klotzsch	Oxalidaceae	Herb	Dominant	Chingudipal	9619
26	<i>Bischofia javanica</i> Blume	Phyllanthaceae	Tree	Rare	Sukurungi	9544
27	<i>Blepharis maderaspatensis</i> (L.) B. Heyne ex Roth	Acanthaceae	Herb	Common	kathapal	9569
28	<i>Boerhavia diffusa</i> L.	Nyctaginaceae	Herb	Common	Fecor	9538
29	<i>Bombax ceiba</i> L.	Malvaceae	Tree	Frequent	Fecor	9730
30	<i>Breynia vitis-idaea</i> (Burm.f.) C.E.C.Fisch.	Phyllanthaceae	Shrub	Common	Kaliapani	9540
31	<i>Bridelia retusa</i> (L.) A.Juss.	Phyllanthaceae	Tree	Rare	Sukurungi	9542
32	<i>Butea monosperma</i> (Lam.) Taub.	Leguminosae	Tree	Common	Fecor	9494
33	<i>Caesalpinia bonduc</i> (L.) Roxb.	Leguminosae	Climber	Common	Fecor	9505
34	<i>Callicarpa tomentosa</i> (L.) L.	Lamiaceae	Tree	Rare	South Kaliapani	9485
35	<i>Canscora diffusa</i> (Vahl) R.Br. ex Roem. &Schult.	Gentianaceae	Herb	Common		9479
36	<i>Canthium coromandelicum</i> (Burm.f.) Alston	Rubiaceae	Shrub	Rare	Tomka	9465
37	<i>Cassia fistula</i> L.	Leguminosae	Tree	Common	kathapal	9506
38	<i>Cassytha filiformis</i> L.	Lauraceae	Climber	Rare	Tomka	9488

39	<i>Catunaregam spinosa</i> (Thunb.) Tirveng.	Rubiaceae	Shrub	Rare	Chingudipal	9456
40	<i>Cleistanthus collinus</i> (Roxb.) Benth. ex Hook.f.	Phyllanthaceae	Shrub	Common	Tomka	9541
41	<i>Clerodendrum infortunatum</i> L.	Lamiaceae	Shrub	Common	kolarangi	9562
42	<i>Combretum album</i> Pers.	Combretaceae	Climber	Dominant	Chingudipal	9610
43	<i>Commelina benghalensis</i> L.	Commelinaceae	Herb	Common	Ostapal	9611
44	<i>Cordia dichotoma</i> G.Forst.	Boraginaceae	Tree	Rare	South Kaliapani	9602
45	<i>Costus speciosus</i> (J. Konig) Sm.	Costaceae	Shrub	Frequent	Ostapal	9614
46	<i>Crotalaria albida</i> Roth	Leguminosae	Herb	Frequent	Fecor	9495
47	<i>Crotalaria juncea</i> L.	Leguminosae	Herb	Common	Dumtanga	9496
48	<i>Cryptolepis dubia</i> (Burm.f.) M.R.Almeida	Apocynaceae	Climber	Rare	kolarangi	9592
49	<i>Cyanotis cristata</i> (L.) D. Don	Commelinaceae	Herb	Frequent	Kaliapani	9612
50	<i>Cynodon dactylon</i> (L.) Pers.	Poaceae	Herb	Common	kathapal	9449
51	<i>Cyperus iria</i> L.	Cyperaceae	Herb	Common	Saruababil	9524
52	<i>Cyperus rotundus</i> L.	Cyperaceae	Herb	Common	Ostapal	9522
53	<i>Dalbergia sissoo</i> DC.	Leguminosae	Tree	Frequent	Kaliapani	9497
54	<i>Dendrophthoe falcata</i> (L.f.) Ettingsh.	Loranthaceae	Shrub	Common	Tomka	9511
55	<i>Desmodium gangeticum</i> (L.) DC.	Leguminosae	Shrub	Common	kathapal	9490
56	<i>Desmodium triflorum</i> (L.) DC.	Leguminosae	Herb	Common	Dumtanga	9508
57	<i>Digitaria longiflora</i> (Retz.) Pers.	Poaceae	Herb	Common	Kanasa	9450
58	<i>Dioscorea bulbifera</i> L.	Dioscoreaceae	Climber	Frequent	Tomka	9528
59	<i>Diospyros montana</i> Roxb.	Ebenaceae	Tree	Rare	Kumurada	9526
60	<i>Diospyros melanoxylon</i> Roxb.	Ebenaceae	Tree	Frequent	kathapal	9615
61	<i>Duranta erecta</i> L.	Lamiaceae	Shrub	Common	Sukurungi	9484
62	<i>Echinochloa colona</i> (L.) Link	Poaceae	Herb	Common	Kumurada	9451
63	<i>Elephantopus scaber</i> L.	Asteraceae	Herb	Frequent	Sukurungi	9597
64	<i>Eragrostis nutans</i> (Retz.) Nees ex Steud.	Poaceae	Herb	Common	Kumurada	9452
65	<i>Erythrina stricta</i> Roxb.	Leguminosae	Tree	Rare	Dumtanga	9498
66	<i>Eugenia roxburghii</i> DC.	Myrtaceae	Tree	Rare		9473
67	<i>Falconeria insignis</i> Royle	Euphorbiaceae	Tree	Rare	Chingudipal	9546
68	<i>Ficus benghalensis</i> L.	Moraceae	Tree	Common	Kumurada	9532
67	<i>Ficus hispida</i> L.f.	Moraceae	Tree	Rare	Sukurungi	9536
70	<i>Ficus racemosa</i> L.	Moraceae	Tree	Frequent	Tomka	9534

71	<i>Ficus religiosa</i> L.	Moraceae	Tree	Common	Sukurungi	9533
72	<i>Ficus rumphii</i> Blume	Moraceae	Tree	Rare	Chingudipal	9620
73	<i>Fimbristylis ovata</i> (Burm.f.) J.Kern	Cyperaceae	Herb	Common	Dumtanga	9523
74	<i>Firmiana simplex</i> (L.) W.Wight	Malvaceae	Tree	Rare	Dumtanga	9443
75	<i>Flacourtia indica</i> (Burm.f.) Merr.	Salicaceae	Shrub	Rare	kolarangi	9548
76	<i>Flemingia chappar</i> Benth.	Leguminosae	Shrub	Frequent	Sukurungi	9499
77	<i>Flemingia strobilifera</i> (L.) W.T.Aiton	Leguminosae	Herb	Common	Kumurada	9500
78	<i>Gardenia latifolia</i> Aiton	Rubiaceae	Tree	Rare	Saruababil	9463
79	<i>Glinus oppositifolius</i> (L.) Aug.DC.	Molluginaceae	Herb	Common	kathapal	9471
80	<i>Glochidion zeylanicum</i> (Gaertn.) A.Juss.	Phyllanthaceae	Tree	Rare	Kanasa	9563
81	<i>Gloriosa superba</i> L.	Colchicaceae	Climber	Rare	Ostapal	9605
82	<i>Gmelina arborea</i> Roxb.	Lamiaceae	Tree	Rare	Fecor	9483
83	<i>Grewia hirsuta</i> Vahl	Malvaceae	Shrub	Rare	Kumurada	9444
84	<i>Haldina cordifolia</i> (Roxb.) Ridsdale	Rubiaceae	Tree	Frequent	Kumurada	9457
85	<i>Helicteres isora</i> L.	Malvaceae	Shrub	Frequent	Dumtanga	9440
86	<i>Heliotropium indicum</i> L.	Boraginaceae	Herb	Common	South Kaliapani	9603
87	<i>Hemidesmus indicus</i> (L.) R. Br. ex Schult.	Apocynaceae	Climber	Common	Chingudipal	9588
88	<i>Hemigraphis latebrosa</i> (Roth.) Nees.	Acanthaceae	Herb	Common	kolarangi	9570
89	<i>Holarrhena pubescens</i> Wall. ex G.Don	Apocynaceae	Tree	Rare	Fecor	9586
90	<i>Holoptelea integrifolia</i> (Roxb) Planch	Ulmaceae	Tree	Frequent	Kanasa	9561
91	<i>Hygrophila auriculata</i> (Schumach) Heine	Acanthaceae	Herb	Frequent	Dumtanga	9571
92	<i>Ichnocarpus frutescens</i> (L.) W.T.Aiton	Apocynaceae	Shrub	Frequent	Chingudipal	9593
93	<i>Ipomoea hederifolia</i> L.	Convolvulaceae	Climber	Common	Fecor	9517
94	<i>Jasminum sambac</i> (L.) Sol	Oleaceae	Climber	Frequent	Chingudipal	9617
95	<i>Justicia adhatoda</i> L.	Acanthaceae	Shrub	Frequent	Chingudipal	9572
96	<i>Justicia japonica</i> Thunb.	Acanthaceae	Herb	Common	Kanasa	9572
97	<i>Justicia diffusa</i> Willd.	Acanthaceae	Herb	Common	Tomka	9576
98	<i>Knoxia sumatrensis</i> (Retz.) DC.	Rubiaceae	Herb	Common	Dumtanga	9468

99	<i>Lagerstroemia indica</i> L.	Lythraceae	Tree	Frequent	Chingudipal	9512
100	<i>Leea indica</i> (Burm. f.) Merr.	Leeaceae	Tree	Common	Kaliapani	9489
101	<i>Lindenbergia indica</i> Vatke	Scrophulariaceae	Herb	Common	kolarangi	9557
102	<i>Lygodium flexuosum</i> (L.) Sw.	Lygodiaceae	Herb	Frequent	kolarangi	9564
103	<i>Macaranga peltata</i> (Roxb.) Müll.Arg.	Euphorbiaceae	Tree	Common	Saruababil	9474
104	<i>Madhuca longifolia</i> (J.Koenig ex L.) J.F.Macbr.	Sapotaceae	Tree	Rare	Dumtanga	9556
105	<i>Mallotus philippensis</i> (Lam.) Mull. Arg.	Euphorbiaceae	Tree	Frequent		9525
106	<i>Mangifera indica</i> L.	Anacardiaceae	Tree	Frequent	Ostapal	9581
107	<i>Melia azedarach</i> L.	Malvaceae	Tree	Common	Fecor	9447
108	<i>Melochia corchorifolia</i> L.	Malvaceae	Herb	Frequent	Kaliapani	9441
109	<i>Merremia gangetica</i> (L.) Cufod.	Convolvulaceae	Climber	Common	Kumurada	9516
110	<i>Merremia umbellata</i> (L.) Hallier f.	Convolvulaceae	Climber	Common	Kanasa	9518
111	<i>Meyna spinosa</i> Roxb. ex Link	Rubiaceae	Tree	Frequent	kolarangi	9469
112	<i>Mimosa himalayana</i> Gamble	Leguminosae	Shrub	Rare	Dumtanga	9493
113	<i>Mitracarpus hirtus</i> (L.) DC.	Rubiaceae	Herb	Common	Chingudipal	9467
114	<i>Mollugo disticha</i> Ser.	Molluginaceae	Herb	Frequent		9531
115	<i>Mollugo pentaphylla</i> L.	Molluginaceae	Herb	Frequent	Tomka	9530
116	<i>Morinda citrifolia</i> L.	Rubiaceae	Tree	Rare	Sukurungi	9458
117	<i>Mukia maderaspatana</i> (L.) M.Roem.	Cucurbitaceae	Climber	Rare	Fecor	9519
118	<i>Murdannia japonica</i> (Thunb.) Faden	Commelinaceae	Herb	Rare	South Kaliapani	9514
119	<i>Murraya koenigii</i> (L.) Spreng.	Rutaceae	Tree	Common	kolarangi	9553
120	<i>Nelsonia canescens</i> (Lam.) Spreng.	Acanthaceae	Herb	Common	South Kaliapani	9579
121	<i>Neolamarckia cadamba</i> (Roxb.) Bosser	Rubiaceae	Tree	Frequent	Kumurada	9459
122	<i>Ochna obtusata</i> DC.	Ochnaceae	Tree	Rare		9616
123	<i>Oldenlandia auricularia</i> (L.)	Rubiaceae	Herb	Common	Saruababil	9470

3	K.Schum.					
12	<i>Oldenlandia pinifolia</i> (Wall. ex G.Don) Kuntze	Rubiaceae	Herb	Frequent	Saruababil	9466
4						
12	<i>Oplismenus burmannii</i> (Retz.) P.Beauv.	Poaceae	Herb	Common	Tomka	9453
5						
12	<i>Oroxylum indicum</i> (L.) Kurz	Bignoniaceae	Tree	Rare	Ostapal	9599
6						
12	<i>Pavetta tomentosa</i> Roxb. ex Sm.	Rubiaceae	Shrub	Rare	Sukurungi	9464
7						
12	<i>Pentatropis capensis</i> (L. f.) Bullock	Apocynaceae	Climber	Frequent	Kanasa	9591
8						
12	<i>Pergularia daemia</i> (Forsk) Chiov	Apocynaceae	Climber	Rare	Ostapal	9589
9						
13	<i>Phoenix sylvestris</i> (L.) Roxb.	Arecaceae	Tree	Rare	Chingudipal	9594
0						
13	<i>Phyla nodiflora</i> (L.) Greene	Lamiaceae	Herb	Common	Kumurada	9486
1						
13	<i>Phyllanthus emblica</i> L.	Phyllanthaceae	Tree	Rare	kathapal	9539
2						
13	<i>Pogostemon benghalensis</i> (Bur m.f.) Kuntze	Lamiaceae	Shrub	Dominant	kathapal	9481
3						
13	<i>Polygala arvensis</i> Willd.	Polygalaceae	Herb	Frequent	kathapal	9547
4						
13	<i>Pongamia pinnata</i> (L.) Pierre	Leguminosae	Tree	Frequent	Dumtanga	9501
5						
13	<i>Portulaca oleracea</i> L.	Portulacaceae	Herb	Common	Sukurungi	9729
6						
13	<i>Pteris vittata</i> L.	Pteridaceae	Herb	Frequent	Sukurungi	9549
7						
13	<i>Pterocarpus marsupium</i> Roxb.	Leguminosae	Tree	Rare	Kumurada	9502
8						
13	<i>Putranjiva roxburghii</i> Wall.	Euphorbiaceae	Tree	Frequent	Dumtanga	9478
9						
14	<i>Rauvolfia tetraphylla</i> L.	Apocynaceae	Shrub	Rare	kolarangi	9587
0						
14	<i>Rhinacanthus nasutus</i> (L.) Kurz	Acanthaceae	Shrub	Frequent	kathapal	9578
1						
14	<i>Rubia cordifolia</i> L.	Rubiaceae	Shrub	Rare	Tomka	9461
2						
14	<i>Ruellia tuberosa</i> L.	Acanthaceae	Herb	Rare	Kumurada	9573
3						
14	<i>Rungia pectinata</i> (L.) Nees	Acanthaceae	Herb	Common	Fecor	9575
4						
14	<i>Saccharum spontaneum</i> L.	Poaceae	Herb	Dominant		9455
5						
14	Sapindus trifoliatus L.	Sapindaceae	Tree	Rare	Dumtanga	9555
6						
14	<i>Saraca asoca</i> (Roxb.) Willd.	Leguminosae	Tree	Rare	Kaliapani	9509
7						
14	<i>Schleichera oleosa</i> (Lour.)	Sapindaceae	Tree	Rare	Saruababil	9554

8	Merr.					
149	<i>Semecarpus anacardium</i> L.	Anacardiaceae	Tree	Rare	Sukurungi	9583
150	<i>Setaria glauca</i> (L.) Beauv.	Poaceae	Herb	Common	kolarangi	9454
151	<i>Shirakiopsis indica</i> (Willd.) Esser	Euphorbiaceae	Tree	Rare	Sukurungi	9477
152	<i>Shorea robusta</i> Gaertn.	Dipterocarpaceae	Tree	Dominant	South Kaliapani	9527
153	<i>Sida acuta</i> Burm.f.	Malvaceae	Herb	Common	South Kaliapani	9437
154	<i>Sida cordata</i> (Burm.f.) Borss.Waalk.	Malvaceae	Herb	Common	Dumtanga r	9438
155	<i>Sida rhombifolia</i> L.	Malvaceae	Herb	Common	South Kaliapani	9439
156	<i>Sida schimperiana</i> Hochst. ex A. Rich.	Malvaceae	Shrub	Rare	Fecor	9435
157	<i>Smilax ovalifolia</i> Roxb. ex D.Don	Smilacaceae	Climber	Common	kolarangi	9559
158	<i>Spathodea campanulata</i> Beauv.	Bignoniaceae	Tree	Rare	Kanasa	9600
159	<i>Spermacoce articularis</i> L.f.	Rubiaceae	Herb	Common	kathapal	9460
160	<i>Spondias mombin</i> L.	Anacardiaceae	Tree	Rare	Sukurungi	9584
161	<i>Sterculia foetida</i> L.	Malvaceae	Tree	Rare	Tomka	9442
162	<i>Streblus asper</i> Lour.	Moraceae	Tree	Common	Kaliapani	9535
163	<i>Strobilanthes auriculata</i> Nees	Acanthaceae	Shrub	Frequent	South Kaliapani	9577
164	<i>Syzygium cumini</i> (L.) Skeels	Myrtaceae	Tree	Frequent	Sukurungi	9537
165	<i>Tamarindus indica</i> L.	Leguminosae	Tree	Frequent	Sukurungi	9507
166	<i>Tarenna asiatica</i> (L.) Kuntze ex K.Schum.	Rubiaceae	Shrub	Rare	Dumtanga r	9462
167	<i>Tectona grandis</i> L.	Lamiaceae	Tree	Common	Sukurungi	9482
168	<i>Terminalia arjuna</i> (Roxb) W. & A.	Combretaceae	Tree	Frequent	Tomka	9606
169	<i>Terminalia bellirica</i> (Gaertn) Roxb.	Combretaceae	Tree	Rare	Kumurada	9607
170	<i>Terminalia catappa</i> L.	Combretaceae	Tree	Rare	Chingudipal	9608
171	<i>Terminalia chebula</i> Retz.	Combretaceae	Tree	Rare	Kanasa	9609
172	<i>Thespesia lampas</i> (Cav.) Dalzell	Malvaceae	Shrub	Frequent	Kaliapani	9521
173	<i>Thunbergia grandiflora</i> (Roxb.	Acanthaceae	Climber	Common	Ostapal	9574

3	ex Rottl.) Roxb.		r			
17	<i>Tinospora cordifolia</i> (Willd.) Miers.	Menispermaceae	Climber	Common	Fecor	9529
4						
17	<i>Tragia involucrata</i> L.	Euphorbiaceae	Herb	Common	Sukurungi	9545
5						
17	<i>Trema orientalis</i> (L.) Blume	Cannabaceae	Shrub	Common	Kanasa	9604
6						
17	<i>Trichodesma indicum</i> (L.) Lehm.	Boraginaceae	Herb	Rare	South Kaliapani	9601
7						
17	<i>Triumfetta rhomboidea</i> Jacq.	Malvaceae	Shrub	Common	Chingudipal	9445
8						
17	<i>Uraria rufescens</i> (DC.) Schindl.	Leguminosae	Shrub	Frequent	Fecor	9503
9						
18	<i>Vanda tessellata</i> (Roxb.) Hook. ex G. Don	Orchidaceae	Herb	Frequent	Kumurada	9618
0						
18	<i>Ventilago denticulata</i> Willd.	Rhamnaceae	Shrub	Common	Kumurada	9550
1						
18	<i>Withania somnifera</i> (L.) Dunal	Solanaceae	Herb	Rare	Dumtanga	9560
2						
18	<i>Woodfordia fruticosa</i> (L.) Kurz	Lythraceae	Shrub	Common	kolarangi	9472
3						
18	<i>Wrightia tinctoria</i> R.Br.	Apocynaceae	Tree	Rare	Ostapal	9590
4						
18	<i>Ziziphus oenopolia</i> (L.) Mill.	Rhamnaceae	Tree	Frequent	Kanasa	9551
5						

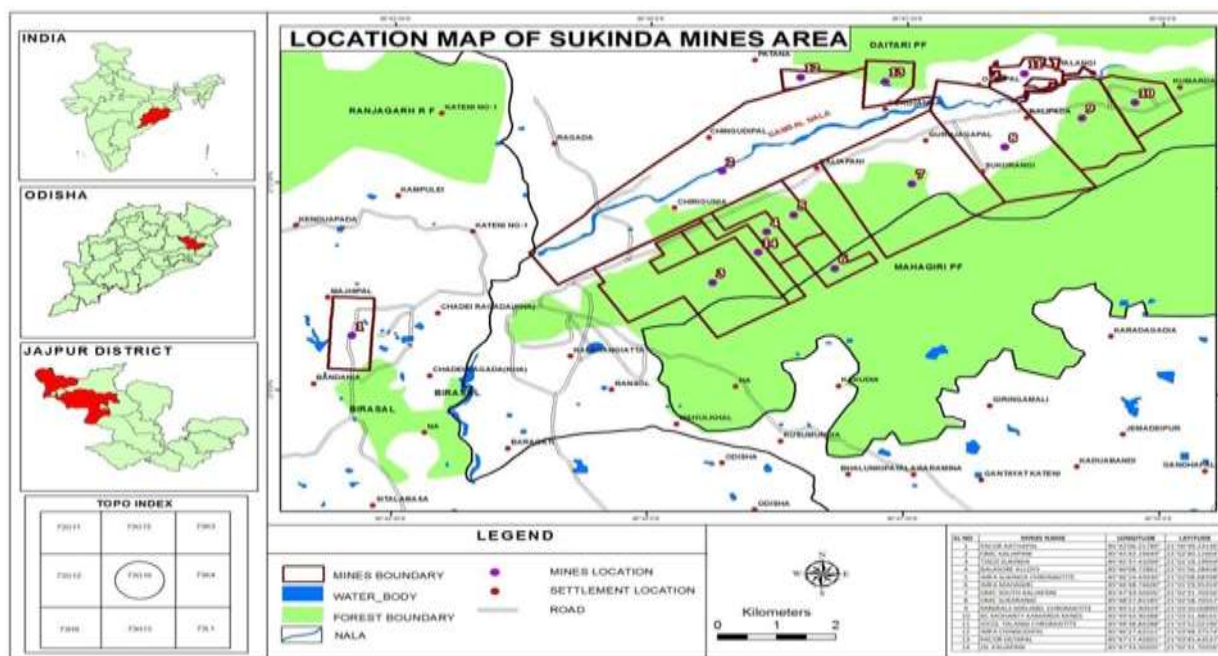


Figure 1: Location map of sukinda chromite mine area



Figure 2: Partial view of Sukinda chromite mine valley

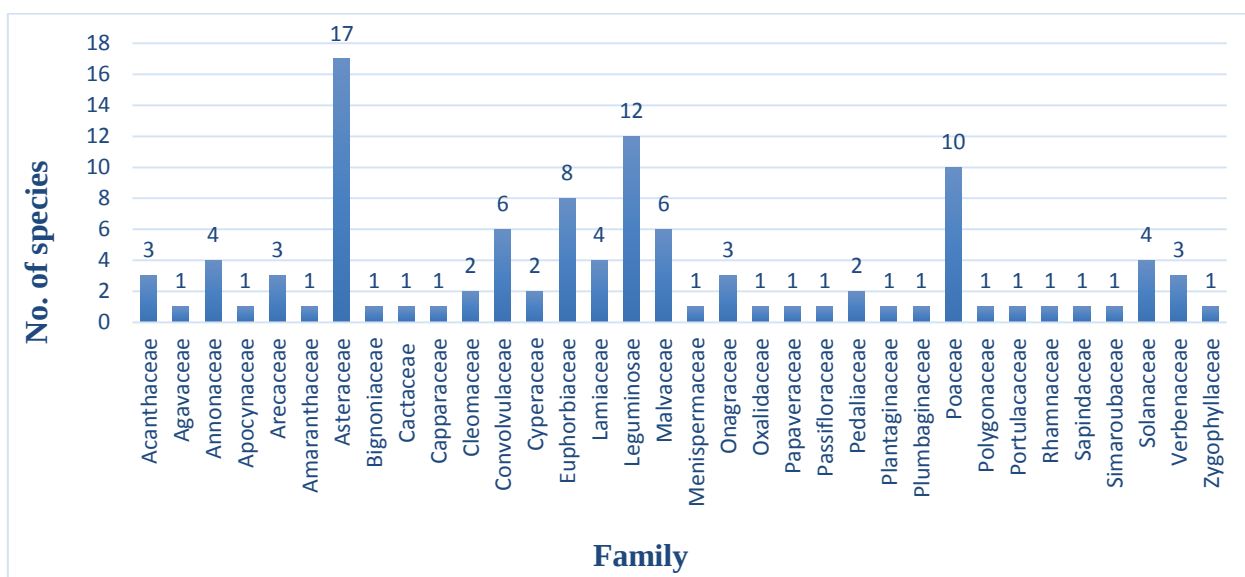


Figure 3: Alien invasive species number of different family

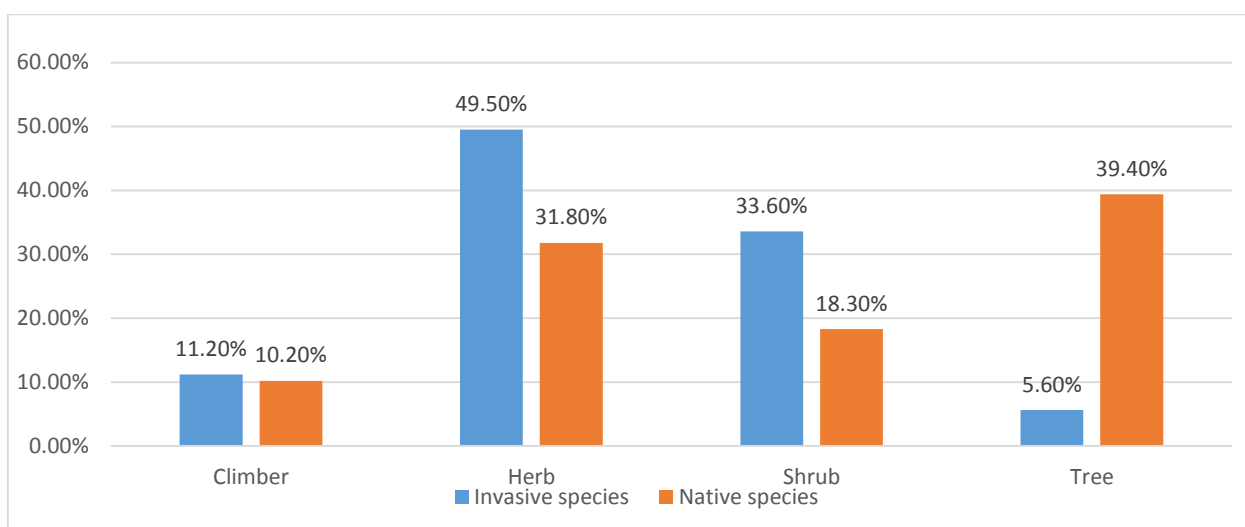


Figure 4: Habit wise distribution analysis

Alien invasive plant species are exotic plant species that move beyond their natural habitat and adapt. India has been the hardest hit by this species, with the emergence of exotic plants dating back to historical trade relations, most of which are tropical American invasive weeds and some plants that have economic value. Most of the species that came to India for various purposes are expansive everywhere in India (Pergl, J. et al., 2018). All the alien invasive species listed in our study have also been reported as weeds in other countries and are included in the Global Compendium weeds (Srivastava, S. 2014). In those families more native species have been found are Leguminosae(21), Acanthaceae(16), Rubiaceae(15), Malvaceae(14), Lamiaceae(9). Because these families are the most species-related families, which play an important role in shaping the floral diversity of the region. We found the highest number of alien invasive species belongs to Asteraceae (17), Leguminosae (12), Poaceae (10), Euphorbiaceae (8), because of their reproductive success and can adapt any kind of climatic condition. We also found alien invasive species mostly consist of herb (49.5%), shrub (33.6%) and low percentage of tree species (5.6%). Because herbs and shrubs have short generation times, and are therefore more likely to establish and spread rapidly. Some alien species in this valley, such as *Kigelia africana* (Lam.) Benth., *Pennisetum pedicellatum* Trin., *Ricinus communis* L., *Senna alata* (L.) Roxb., and *Simarouba amara* Aubl. were planted for soil pollution removal, i.e., phytoremediation purposes, but now those species are beginning to spread to the surrounding forest areas. Individually, the invasion by *Chromolaena odorata* (L.) R.M.King & H.Rob., *Croton bonplandianus* Baill., *Cuscuta reflexa* Roxb., *Ageratum conyzoides* L., *Lantana camara* L., *Mikania micrantha* Kunth. and *Parthenium hysterophorus* L. are causing great concern in this valley. Four of the world's worst 100 invasive alien species are found in this valley viz. *Chromolaena odorata* (L.) R.M.King & H.Rob., *Opuntia stricta* (Haw.) Haw., *Lantana camara* L., and *Mikania micrantha* Kunth.

Conclusion

The abundance of invasive species shows that many species have adapted well despite the environmental pollution of the region. On the other hand, very few native species are able to adapt to this region. Our study points out that pollution, invasion of alien species and deforestation are posing a serious threat to the native floral diversity of the areas. Different methods could be used to control alien invasive species; those are Chemical control using herbicides, pesticides Mechanical control, physically removing the invasive species, Implement management plans, and conduct monitoring.

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References

1. Balaguru, B., S. Soosairaj., N. Nagamurugan., R. Ravindran. and Khaleel, A. A. "Native vegetation pattern and the spread of three invasive species in Palani Hill National Park, Western Ghats of India." *Acta Ecologica Sinica* 36.5 (2016): 367-376.
2. Bauer, J. T. "Invasive species: "back-seat drivers" of ecosystem change?." *Biological invasions* 14.7 (2012): 1295-1304.
3. BSI. "The world's worst polluted places: the top ten (of the dirty thirty)." New York: Blacksmith Institute (2007): 16-17.
4. Byers, J. E., Sarah, R., John, M. R., Ingrid, M. P., Carey, S. S., Lonsdale, W. M., Atkinson, I. A. E., Seastedt, T. R., M. Williamson., E. Chornesky. and D. Hayes. "Directing research to reduce the impacts of nonindigenous species." *Conservation Biology* 16.3 (2002): 630-640.
5. Crooks, J. A., Andrew, L. C. and Gregory, M. R. "Aquatic pollution increases the relative success of invasive species." *Biological Invasions* 13.1 (2011): 165-176.
6. Gurevitch, J. and Dianna, K. P. "Are invasive species a major cause of extinctions?."

- Trends in ecology & evolution* 19.9 (2004): 470-474.
7. Hiremath, A. J. and Bharath, S. "Invasive plant species in Indian protected areas: conserving biodiversity in cultural landscapes." *Plant invasions in protected areas* (2013): 241-266.
 8. Hobbs, R. J. and Humphries, S. E. "An Integrated Approach to the Ecology and Management of Plant Invasions." *Conservation biology* 9.4 (1995): 761-770.
 9. Hooker, J. D. "The Flora of British India." *L. Reeve* (1890).
 10. Khuroo, A. A., Zafar, A. R., Akhtar, H. M., Ewald, W., Irfan, R. and Dar, G. H. "Alien flora of India: taxonomic composition, invasion status and biogeographic affiliations." *Biological Invasions* 14.1 (2012): 99-113.
 11. Maron, J. L., Montserrat, V., Riccardo, B., Sarah, E. and Paul, B. "Rapid evolution of an invasive plant." *Ecological Monographs* 74.2 (2004): 261-280.
 12. Mishra, S. R., Rudra, P. P., Prusty, B. A. K. and Sanjat, K. S. "Meteorology drives ambient air quality in a valley: a case of Sukinda chromite mine, one among the ten most polluted areas in the world." *Environmental monitoring and assessment* 188.7 (2016): 402.
 13. Oldfield, S. F., Peggy, O., Nancy, S. and Kayri, H. "The Importance of Native Plants and the Pressures They Face." *Seeds of Restoration Success* (2019): 7-24.
 14. Panda, T., Nirlipta, M., Bikram, K. P. and Raj, B. M. "Expansive alien flora of Odisha, India." *Journal of Agriculture and Environment for International Development (JAE-ID)* 112.1 (2018): 43-64.
 15. Panda, T., Nirlipta, M., Shaikh, R., Bikram, K. P. and Raj, B. M. "An annotated checklist of weed flora in Odisha, India." *Bangladesh Journal of Plant Taxonomy* 27.1 (2020): 85-101.
 16. Pergl, J., Mark, v. K., Martin, H., Cherukuri, R. B., Sudipto, M., Paramjit, S., Surendra, P. S., Sugali, S., Boyina, R. P. R. and Petr, P. "Naturalized alien flora of the Indian states: biogeographic patterns, taxonomic structure and drivers of species richness." *Biological Invasions* 20.6 (2018): 1625-1638.
 17. Saxena, H. O. and M. Braham. "The Flora of Orissa." *Orissa Forest Development Corporation Ltd, BBSR, Orissa* (1994-1996): 1-4.
 18. Saxena, K. G. "Biological invasions in the Indian subcontinent: review of invasion by plants." *Ecology of biological invasion in the tropics*. (1991): 53-73.
 19. Sharma, G. P., Singh, J. S. and Raghubanshi, A. S. "Plant invasions: emerging trends and future implications." *Current science* 88.5 (2005): 726-734.
 20. Singh, P. "Floristic diversity of India: an overview." *Biodiversity of the Himalaya: Jammu and Kashmir State* (2020): 41-69.
 21. Srivastava, S., Ashish, D. and Ravindra, P. S. "Invasive alien species of terrestrial vegetation of north-eastern Uttar Pradesh." *International Journal of Forestry Research* (2014).

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