वन्यप्राणी परियोजना पर प्रधान मुख्य वन संरक्षक (वन्यप्राणी) का अभिमत

(विशेषकर खनन प्रकरणों में)

बगदेवा भूमिगत परियोजना , जिला कोरबा साउथ इस्टन कोलफील्ड्स लिमिटेड बिलासपुर छ.ग. (भारत सरकार का सार्वजनिक उपक्रम) के अंतर्गत कोरबा ज़िले में सन् 1995 से संचालित है। यह परियोजना कोरबा शहर से लगभग 30 कि.मी की दूरी पर स्थित है।

इस परियोजना का मौजुदा खनन अधिकार प्राप्त क्षेत्रफल 1026.307 हे. है । वर्तमान में इस परियोजना के 502.60 हे0 भूमि के नीचे कोयला उत्खनन का कार्य चल रहा है । इस परियोजना की कोयला उत्पादन क्षमता 0.75 मिलियन टन (नोर्मेटिव) एवं 0.76 मिलियन टन (पीक) प्रति वर्ष है।

एसईसीएल बगदेवा भूमिगत परियोजना ने एक व्यापक वन्यप्राणी परियोजना TFRI Jabalpur द्वारा तैयार किया है, जिसकी प्रति पृष्ठ क्रं. 289... में संलग्न है।

साउथ इर्स्टन कोलफील्ड्स लिमिटेड, बगदेवा भूमिगत परियोजना जिला कोरबा (छ.ग.) का वन्यप्राणी परियोजना पर प्रधान मुख्य वन संरक्षक (वन्यप्राणी) का अभिमत लेने हेतु वचन पत्र संलग्न है।

29/8/23

खान प्रबंधक
बगदेवा भूमिगत खदान

30/8/23

उपक्षेत्रीय प्रबंधक
ढेलवाडीह–सिंघाली–बगदेवा उपक्षेत्र

Under jurisdiction of Bilaspur Court only

साउथ ईस्टर्न कोलफिल्ड्स लिमिटेड

SOUTH EASTERN COALFIELDS LIMITED

(कोल ईण्डिया का एक अंश/A Subsidiary of Coal IndiaLtd.)

कार्यालय महाप्रबंधक,कोरबा क्षेत्र

OFFICE OF THE GENERAL MANAGER

KORBA AREA

" A MINI RATNA COMPANY "

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संदर्भ कं:एसईसीएल / महाप्रबंधक / कोरबा / 2023 / 72

दिनांक: 30/08 / 2023

वचन पत्र

वन संरक्षण अधिनियम 1980 के अंर्तगत एसईसीएल बगदेवा भूमिगत परियोजना का वन्यप्राणी परियोजना पर प्रधान मुख्य वन संरक्षक (वन्यप्राणी) का अभिमत लेने हेतु

साउथ इर्स्टन कोलफील्ड्स लिमिटेड, बगदेवा भूमिगत परियोजना , जिला कोरबा (छ.ग.) लिखित रूप से वचन पत्र प्रस्तुत करता है कि बगदेवा भूमिगत परियोजना की अवेदितराजस्व वन भूमि के प्रत्यावर्तन प्रस्ताव के संबंध में भारत सरकार द्वारा वन संरक्षण अधिनियम 1980 के अंर्तगत वन्यप्राणी परियोजना पर प्रधान मुख्य वन संरक्षक (वन्यप्राणी) का अभिमत लिया जाएगा एवं वन्यप्राणी परियोजना के संबंध में प्रधान मुख्य वन संरक्षक (वन्यप्राणी) द्वारा जो भी शर्त रखी जाएगी उसको मान्य करने हेतु एसईसीएल कोरबा क्षेत्र बाध्य रहेगा।

30/8/23

उपक्षेत्रीय प्रबंधक
ढेलवाडीह–सिंघाली–बगदेवा उपक्षेत्र

30/8/23

क्षेत्रीय महाप्रबंधक
एसईसीएल कोरबा क्षेत्र

288-A

INTEGRATED WILDLIFE CONSERVATION PLAN

For endangered species found in and around the Dhelwadih UG, Bagdeva UG and Singhali UG mines of DSB Sub Area of SECL, Korba (Chhattisgarh)

March 2023

Report prepared by

ICFRE-Tropical Forest Research Institute, Jabalpur
(Indian Council of Forestry Research and Education)

Submitted to

South Eastern Coalfields Limited, Korba Area

Title of the report:

Wildlife Conservation Plan for endangered species found in and around the Dhelwadih UG, Bagdeva UG and Singhali UG mines of DSB Sub Area of SECL, Korba (Chhattisgarh)

Work Order:
No. SECL/GM/KRB/ENVT/20/143 Dt. 02.11.2020

Project Execution Team

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Dheeraj Gupta, Scientist D
Vishnu Marskole, Junior Research Fellow
Ashish Pandey, Junior Project Fellow

Citation:
TFRI (2023) Wildlife Conservation Plan for endangered species found in and around the Dhelwadih UG, Bagdeva UG and Singhali UG mines of DSB Sub Area of SECL, Korba (Chhattisgarh). ICFRE-Tropical Forest Research Institute, Jabalpur, India.

INTEGRATED WILDLIFE CONSERVATION PLAN FOR DHELWADIH UG, BAGDEVA UG AND SINGHALI UG MINES OF DSB SUB AREA OF SECL, KORBA AREA, CHHATTISGARH

Title as per work order:

Wildlife Conservation Plan for endangered species found in and around the Dhelwadih UG, Bagdeva UG and Singhali UG mines of DSB Sub Area of SECL, Korba Area

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Ashish Pandey, *Junior Project Fellow*

Suggested Citation: TFRI (2023) Conservation Plan for endangered species found in and around the Dhelwadih UG, Bagdeva UG and Singhali UG mines of DSB Sub Area of SECL, Korba (Chhattisgarh). ICFRE-Tropical Forest Research Institute, Jabalpur, India.

March 2023

Submitted to:

Office of the General Manager
South Eastern Coalfields Limited
Korba Area
Korea 495677
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Contents

Preface

Korba Coalfield is located between latitudes 22° 15' N and 22° 30' N and longitudes 82° 15' E and 82° 55' E. Korba Coalfield covers an area of about 530 square kilometres (200 sq m). Therefore, extraction is mainly amenable to underground mining except a few blocks in eastern part of these coalfields which have opencast potential.

Dhelwadih UG, Bagdeva UG and Singhali UG mines of DSB Sub Area of SECL, Korba underground mines falls under the administrative control of Korba Area of SECL. Total project area of Dhelwadih is 742.976 ha, of which 492.641 ha is forest land, 186.89 ha is government land. Whereas, the total project area of Bagdeva is 502.60 ha, of which 282.28 ha is forest land, 76.81 ha is government land and 143.51 is agricultural land. And the total project area of Singhali is 862.289 ha, of which 301.480 ha is forest land, 314.64 ha is government land.

The project area falls beyond a distance of 10 Km from the areas of high conservation value ie. Achanakmar Amarkantak Biosphere Reserve and Sanjay National Park. Southern Dry Mixed Deciduous Forest, Moist Peninsular High Level Sal Forest, Dry Peninsular Sal Forest and Northern Dry Mixed Deciduous Forest are the predominant forest types found in the region. A total of 118 species distributed in 68 genera and 27 families of higher plants were recorded from the proposed project area and its 10 km buffer. The plant community is dominated by *Shorea robusta*, with *Diospyros melanoxylon* and *Terminalia tomentosa* as codominants. *Lantana camara* dominates the shrub layer. Saplings of *Butea monosperma* and *Diospyros melanoxylon* were present in high densities. Within the sampled list, it was found that, there were 29 species of medicinal plants, 8 species of fodder plants, 13 species of food plants and 10 species of timber trees. Among the surveyed list of plants, there were two species which appears in the IUCN Red List of Threatened Species *Dalbergia latifolia* (Vulnerable) and *Pterocarpus marsupium* (Near Threatened).

Ministry of Environment, Forest and Climate Change (MoEF&CC) had accorded Environmental Clearance (EC) for accorded Environmental Clearance to Dhelwadih, Singhali and Bagdeva underground coal mines of SECL, Korba Area for production of coal under the provisions of EIA Notifications (1994) and subsequent amendments thereto subject to compliance of the terms and Special conditions of EC.

In case of Dhelwadih UG, Bagdeva UG and Singhali UG mines, one of conditions under EC requires preparation of a Conservation Plan for endangered species found in and around the project area in consultation with State Forest and Wildlife Departments.

Subesequently, General Manager, Korba Area awarded a work order to Tropical Forest Research Institute, Jabalpur entitled 'Conservation Plan for endangered species found in and around the Dhelwadih UG, Bagdeva UG and Singhali UG mines of DSB Sub Area of SECL, Korba (Chhattisgarh)'.

Acknowledgments

The team of experts for preparation of Conservation Plan is highly obliged to ICFRE Headquarters for providing the opportunity to prepare this plan for South Eastern Coalfields Limited (SECL), Korba Area. We thank Director, ICFRE-Tropical Forest Research Institute for provided the guidance and support.

We are very much thankful to GM, SECL, Korba Area and Nodal Officer (Environment) for providing all the support including secondary data and facilities during the field studies and suggestions on the Plan. We also thank the committee which read through the draft report and vetted it with observations.

We are extremely obliged to Foresters and Forest Guards of Katghora Forest Division, who provided us the field guidance for our field study and Survey Personnels from SECL who provided basic knowledge of the area.

We are thankful to all who has helped us in collection of information and compilation of this report.

List of Abbreviations

Abbreviation	Description
DFO	Divisional Forest Officer
EIA/EMP	Environment Impact Assessment/Environment Management Plan
FRO	Forest Range Officer
FSI	Forest Survey of India
GIS	Geographical Information System
IUCN	International Union for Conservation of Nature and Natural Resources
KM	Kilometre
KMPH	Kilometre per hour
M	Metre
mm	millimetre
MSL	Mean Sea Level
NTCA	National Tiger Conservation Authority
PLWC	Plantation Working Circle
PPR	*Peste-de-petits* Ruminant
SECL	South Eastern Coalfields Limited
SFR	State of Forest Report
Sp	Species
UG	Under Ground
VDF	Very Dense Forest
WPA	Wildlife Protection Act

Executive Summary

i. Dhelwadih UG, Bagdeva UG and Singhali UG mines of DSB Sub Area of SECL, Korba are underground coal mining projects of SECL, Korba Area.

ii. The project area falls beyond a distance of 10 Km from the areas of high conservation value ie. Achanakmar Amarkantak Biosphere Reserve and Sanjay National Park.

iii. Southern Dry Mixed Deciduous Forest, Moist Peninsular High Level Sal Forest, Dry Peninsular Sal Forest and Northern Dry Mixed Deciduous Forest are the predominant forest types found in the region.

iv. A total of 118 species distributed in 68 genera and 27 families of higher plants were recorded from the proposed project area and its 10 km buffer.

v. The plant community is dominated by *Shorea robusta*, with *Diospyros melanoxylon* and *Terminalia tomentosa* as codominants.

vi. *Lantana camara* dominates the shrub layer. Saplings of *Butea monosperma* and *Diospyros melanoxylon* were present in high densities.

vii. Within the sampled list, it was found that, there were 29 species of medicinal plants, 8 species of fodder plants, 13 species of food plants and 10 species of timber trees.

viii. Among the surveyed list of plants, there were two species which appears in the IUCN Red List of Threatened Species *Dalbergia latifolia* (Vulnerable) and *Pterocarpus marsupium* (Near Threatened).

ix. Sloth Bear (*Melursus ursinus*) and Monitor Lizard (*Varanus bengalensis*) are listed in Schedule I of the Indian Wildlife Protection Act which necessitates legal protection of the animals.

x. Except direct sightings of few groups of langurs, butterflies and birds, no other carnivores or herbivores could be recorded directly in the surveyed area. But the larger landscape of Katghora Forest Division has records of many fauna (carnivores and herbivores) such as

Leopard, Spotted deer, Sambar deer, Barking deer, Wild dogs, Common Jungle Cat, Jacka and Striped Hyaena.

xi. Potential Conservation Areas (PCA) around Hasdeo Bango Reservoir and adjacent Forest Areas are identified for the possibility of carrying out conservation and mitigation measures for wildlife.

xii. Creation of Green belt and Herbal garden are suggested.

xiii. An indicative budget for **Rs. 821.25 Lakhs** is proposed for various activities to be undertaken based on the proposed mitigative measures for 10 years. The DFO, Katghora will work out the actual costing and monitor the implementation of the prescriptions.

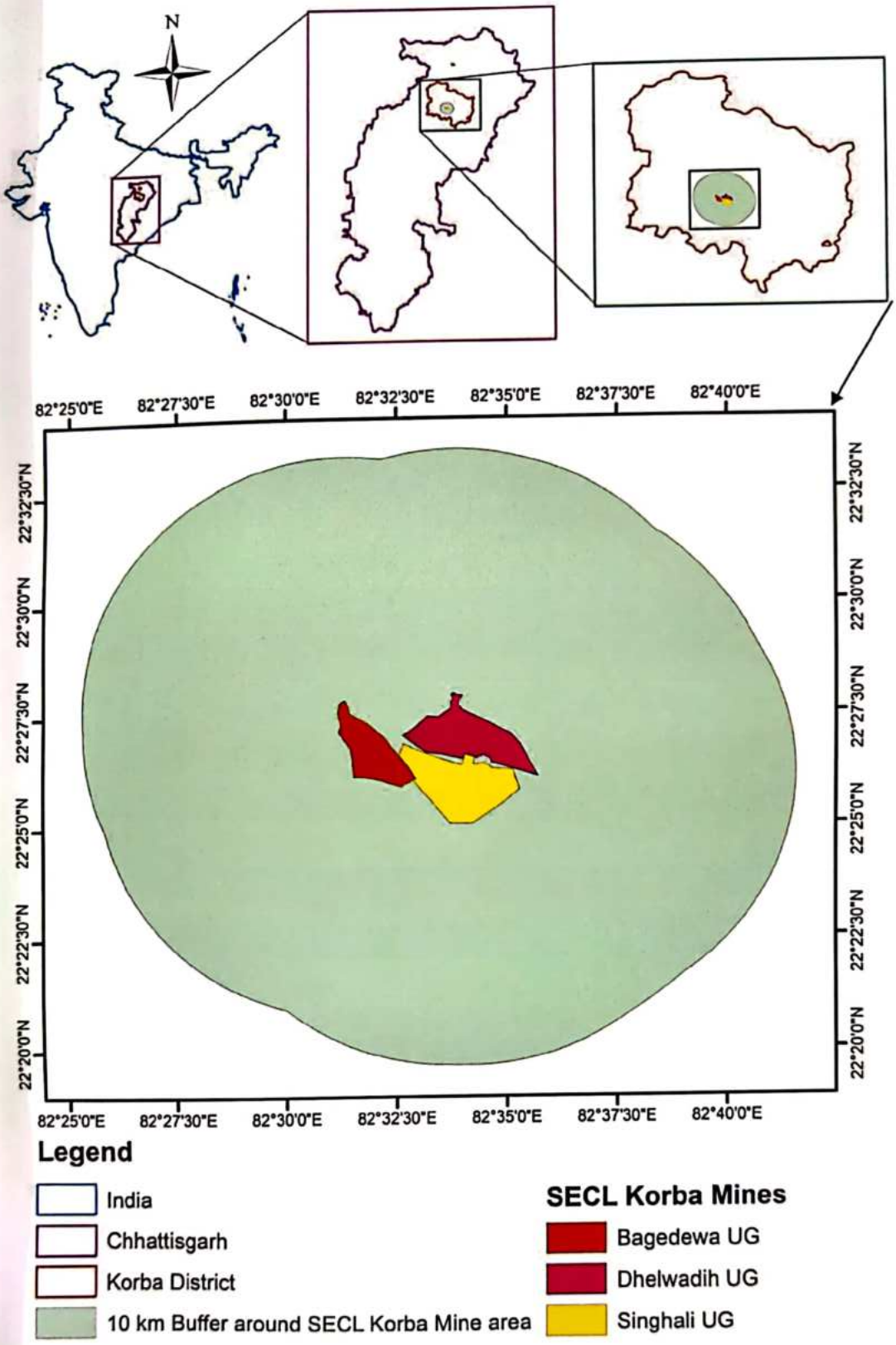
Background information

Ministry of Environment, Forest and Climate Change (MoEF&CC) had accorded Environmental Clearance (EC) for Dhelwadih UG, Singhali UG and Bagdeva UG mines of SECL, Korba Area for production of coal under the provisions of EIA Notifications (2006) and subsequent amendments thereto subject to compliance of the terms and Special conditions of EC.

In case of Dhelwadih UG, Singhali UG and Bagdeva UG, one of the conditions under EC requires preparation of a Wildlife Conservation Plan for Endangered species found in and around Dhelwadih UG, Singhali UG and Bagdeva UG mines of DSB Sub Area of SECL, Korba Area in consultation with State Forest and Wildlife Departments.

General Manager, SECL, Korba Area vide its letter No. SECL/GM/KRB/ENVT/20/143 Dt. 02.11.2020 referring the above mentioned facts, has approached Tropical Forest Research Institute, Jabalpur for preparation of wildlife conservation plan under the scope of article III of MoU signed between ICFRE and CIL on 01.09.2016.

The required Wildlife Conservation Plan is for Dhelwadih UG, Bagdeva UG and Singhali UG mines which are coal seams lying adjacent the same surface area in Korea District of Chhattisgarh. Total project area of Dhelwadih is 742.976 ha, of which 492.641 ha is forest land, 186.89 ha is government land. Whereas, the total project area of Bagdeva is 502.60 ha, of which 282.28 ha is forest land, 76.81 ha is government land and 143.51 is agricultural land. And the total project area of Singhali is 862.289 ha, of which 301.480 ha is forest land, 314.64 ha is government land. The current wildlife conservation plan is for for Dhelwadih UG, Bagdeva UG and Singhali UG mines which lies in Korba District of Chhattisgarh. (Map 1)



Map 1: Location map of the Dhelwadih UG, Bagdeva UG and Singhali UG mines of SECL Korba Area and its 10 km buffer (zone of influence)

Objectives

Scope of the study is to assess the possible impacts of mining activities due to underground coal mining on the plant communities, wildlife (especially mammals and birds) and wetlands within 10 km buffer area of the following mine:

Objectives of the plan are to:

- Assess the flora (trees, understorey and ground flora) and fauna (mammals and birds) within 10 km buffer of the proposed underground mines in order to take stock of the forest, plant species and habitat conditions for wildlife.
- Predict the probable impacts caused due to the operation of these mines and
- Suggest measures to mitigate the anticipated impacts.

Various aspects of the studies to be covered include the following:

Flora – vegetation status

- Characterization of forest types (as per Champion and Seth classification) in the study area.
- Inventory of plant communities including trees and ground flora.
- Phyto-sociology of plant communities with respect to dominance, density, frequency, abundance, diversity index, importance value index (IVI) of the study area based on sampling through Quadrat methods.
- Listing out economically important species like medicinal plants, timber, fuel wood, fodder, etc.
- Details of endemic and endangered/Schedule-I species found in the project area.
- Flora under RET categories as per IUCN and Botanical Survey of India's Red Data list.
- Determining the distance and existence of areas of high conservation priority such as National park, Sanctuary, Biosphere Reserve etc in the study area.

Terrestrial Fauna

- Conducting occupancy surveys for mammals by walking line transects.
- Documenting the "presence-absence" of important wildlife through existing secondary information.
- Status of avifauna and assessing their threat.
- Documentation of important pollinators (butterflies and bees) found in the area.
- Endemic and Endangered/Schedule-I species found/recorded from the study area.

- RET species as per different schedule of Indian Wildlife (Protection) Act, 1972 and IUCN Red Data list.
- Determining the existence of habitat and corridors for important wildlife.

Aquatic life (flora and fauna)

- Assessing the water quality for macro and micro elements including heavy metals from natural drainage/streams/water bodies through Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES)
- Documenting the aquatic plants and associated wildlife (eg. water birds) in the study area.
- Record of fish species found in the water bodies/streams under the study area from primary and secondary sources.

Preparation of maps using GIS and Remote Sensing

- Maps will be prepared using MapSource and iGIS Version 2.0
- Land Use Land Cover (LULC) data will be provided for the study area and it will be used to give inputs on the land use pattern.
- Maps for Forest Density and Vegetation Types will be prepared for ascertaining the different forest types and its density.
- Map for biological richness of the forest area within 10 km buffer will be prepared.
- Location of villages within 10 km buffer will be mapped.
- Streams/Channel/Natural drainage within the study area and its 10 km buffer will be mapped.
- Distance of the proposed project site to the nearest area of high conservation priority such as National Park, Tiger Reserves, Biosphere Reserves and Wildlife Sanctuaries will be noted in the map.
- LULC (Land Use Land Cover) map for the study area will be prepared to determine the various land use patterns such as forest land, agriculture area, built-up spaces or villages etc.

The Proposed Mine and its features

Korba Coalfield is located in Korba district in the Indian state of Chhattisgarh in the basin of the Hasdeo River, a tributary of the Mahanadi. Dhelwadih UG, Bagdeva UG and Singhali UG mines of DSB Sub Area of SECL, Korba underground mines falls under the administrative control of Korba Area of SECL.

Dhelwadih Underground Project is for expansion in production. The total project area is 742.976 ha of which 492.641 ha is forest land, and 186.89 ha is Government land. Forestry clearance has been obtained for 355.463 ha. There are no National Parks, Wildlife Sanctuary, Biosphere Reserves found in the 10 km buffer. Badripali Reserve Forest is situated within 2 km of the mine lease in the buffer. The project does not involve modification of the natural drainage nor construction of any structure. Mining will be underground by semi-mechanised method.

Bagdeva Underground Project is also for expanision in production capacity. There are no National Parks, Widlife Sanctuary, Biosphere Reserves found in the 10 km buffer. Of the total lease area of 502.60 ha, of which 143.51 ha is agricultural land, 282.28 ha is forest land and 76.81 ha is government land. Mining will be underground by semi-mechanised method. This also does not involve any modification of the natural drainage.

Singhali Underground Project is for expansion in production of the existing mine. The total project area is 862.289 ha of which 301.480 ha is forest land. There are no National Parks, Widlife Sanctuary, Biosphere Reserves found in the 10 km buffer. The project does not involve modification of the natural drainage. Mineral transportation of coal would be by road.

A view of forest patch overlying Dhelwadih UG, Bagdeva UG and Singhali UG mines

A view of researchers collecting soil and water samples near the waterbodies overlying Dhelwadih UG, Bagdeva UG and Singhali UG mines

Table 1: Break-up of land details involved in the *Dhelwadih UG, Bagdeva UG and Singhali UG mines* Project

Sl. No.	Name of the mine	Total Project Area (in Ha)	Forest Land (in Ha)	Government Land (in Ha)	Agriculture Land (in Ha)
1.	Dhelwadih UG	742.976	492.641	186.89	-
2.	Bagdeva UG	502.60	282.28	76.81	143.51
3.	Singhali UG	862.289	301.480	314.64	-
	Total	**2107.865**	**1076.401**	**578.34**	**143.51**

The integrated project area is of 2107.865 ha comprising of 1076.401 ha of forest land, details of which are mentioned in Table 1.

2.1. Approach and access

This mine is approached by an all-weather road from on the Raipur – Bilaspur – Pali – Katghora – Korba. The nearest railway station is Korba. From Raipur Junction to Korba train takes approx. 4 hrs. Train route is from Raipur (Jn.) – Bilaspur (Jn) – Champa (Jn) -Korba station.

2.2. Significance of the site

In case of an underground coal mine project, the forest area above the mine are not subjected to any felling or large scale physical disrturbance. While underground mining initially disturbs only a small portion of the surface above a mined area, long-term effects from ground subsidence can be more severe and widespread than the effects from modern opencast mining and reclamation.

Dhelwadih UG, Bagdeva UG and Singhali UG coal mining projects falls within Katghora Forest Division. The forests are predominantly of Sal trees. There are records of presence of animals like Sloth Bears, Jackals, Hyena, common langurs, various species of birds and butterflies within the core project area and in the zone of influence. The forest of the area is the catchment of the Hasdeo river. Hasdeo is a tributary of Mahanadi. There are no places of cultural or heritage importance in the zone of influence area.

Mining is always closely linked with forestry and environment issues. A significant part of the nation's known reserves of some important minerals are in forest areas. The National Mineral Policy of

Ministry of Mines, Govt. of India – 2008 has stressed the need to have standards for mining industries. The Mining activity is an intervention in the environment and has the potential to disturb the ecological balance of an area. However, the needs of economic development make the extraction of the nation's mineral resources an important priority.

Underground coal mining will cause large-scale surrounding rock movement, resulting in surface subsidence and irreversible deformation of surface morphology, which would lead to geological and ecological environment problems. Mining activity most often leads to land degradation, deforestation, atmospheric pollution, pollution of aquatic system, soil erosion due to disposal of solid wastes like overburden. All these affect the ecological balance of the area and often lead to desiccation. According to the National Mineral policy, *Prevention and mitigation of adverse environmental effects due to mining and repairing and re-vegetation of the affected forest area and land covered by trees in accordance with the latest internationally acceptable norms and modern afforestation practices shall form integral part of mine development strategy in every instance. All mining shall be undertaken within the parameters of a comprehensive Sustainable Development Framework which will be so devised as to take all these aspects into consideration. The guiding principle shall be that a miner shall leave the mining area in better ecological shape.*

2.3. High Conservation Value Forests (HCVFs)

A HCV area is simply the area (e.g. a forest, a grassland, a watershed, or a landscape-level ecosystem) where these values are found, or more precisely, the area that needs to be appropriately managed in order to maintain or enhance the identified values. Identifying the areas where these values occur is therefore the essential first step in developing appropriate management for them. HCV suggests those values of the forests which have global, national or regional significance and need added efforts to maintain and enhance such values. Such values may be endangered/ threatened/ endemic species of flora and fauna, large landscape level forests, threatened ecosystems, the forest providing critical services of nature like watershed, containing soil erosion, etc. and the forests providing livelihood, home and sustenance to the local communities and preserving their cultural values.

Ministry of Environment, Forests and Climate Change, GoI in its guidelines mandates identifying the nearest HCVF (National Park/ Wildlife Sanctuaries/ Tiger Reserves/ Elephant Reserves/ Biosphere Reserves/ Ramsar Site for Wetlands) is crucial and the first step for consideration of any developmental projects involving forest diversion.

In this case, HCVF nearest to Dhelwadih UG, Bagdeva UG and Singhali UG mines is Achanakmar-Amarkantak Biosphere Reserve (AABR). AABR is located at about 110 kms of aerial distance. Guru

Ghasidas National Park and Sanjay National Park are located at an aerial distance of 87 and 85 kms respectively.

2.4. Method of mining

The project authorities adopt Bord & Pillar method of mining for underground removal and Coal is carried out from face to Surface by Belt conveyor and collected in surface bunker, then transported from surface bunker to Surakachhar siding by contractual tippers.

2.5. Geology and Hydrogeology

Physiographically, the district is a part of Northern Hills and characterized by undulating topography with high hills, dissected plateaus, steep slopes and scarps. The Basaltic terrain is characterized by highly undulating topography with steep hills and plateau tops. The plateaus and ridges in the area are of 600 m amsl. The maximum elevation observed for hilly areas is 1025 m amsl and is at the central part of the district namely the Devgarh peak. The lowest elevation is 380 m amsl and is along the Banas river, which is on the northwestern part of the district.

Physiographically, the structural land forms of Katghora region is represented by plateau, hills and valleys. The northern part of this region is a combination of tropical moist peninsular forests and southern dry mixed deciduous forests with both hills and plain areas.

Seam V of the Dhelwadih UG, Bagdeva UG and Singhali UG mines has low cover and trends to contain water. Seam IV B is varying 1 to 1.5 meters, thickness the entire transport and travelling route is being either dinted or ripped for facilitating movement of men and machines which are constrain for achieving the desired level of production whereas Seam-V consists of immediate roof of mud and tiny clay.

2.6. Soil

The Katghora region is covered by various rock types viz Basaltic, Sedimentary and Grainitic terrains. Soil is also depending upon lithology of the area.

Soils of Laterite Terrain, which are commonly found in undulating land are slightly deep, well-drained loamy skeleton to loamy soils with moderate erosion. Soils of Basaltic Rocks, which are commonly found in hills and hill ranges, are very thin stony with moderate erosion, moderately well drained clayey soils on gently sloping plateau. Soils of Sedimentary Rocks (Gondwanas), which are commonly found

in the undulated plateau, are deep, moderately well drained clayey soils on foothills slopes with moderate erosion.

2.7. Drainage

The entire Katghora region is falling under Hasdeo sub-basin area of the Mahanadi basin, the main river of the district is the Hasdeo river. The river originates about 910.0 m above sea level, in a place about 10.0 km from Sonhat in Koriya district. Hasdeo River is the largest tributary of Mahanadi River. It joins Mahanadi River near Shiladehi (Birra). The total length of the river is 333.0 km, and drainage area is 9856 km^2. The major tributary of Hasdeo River is Gej River.

2.8. Climate

The Climate of this region is characterized by a hot summer and general dryness, except during southwest monsoon season. The year may be divided into four seasons. The cold season, December to February is followed by the hot season from March to about the middle of June. The period from the middle June to September is the southwest monsoon season. October and November are the post monsoon or transition period. The area experiences three seasons during the year. Summer is from March to June when the day's temperature varies from 34°C to 41°C and in the night it is 15.5°C to 26.5°C, June to September is the rainy season and from October onwards the winter sets in. In winter season the day's temperature is between 24°C to 29°C and night's temperature drops to 15°C - 17°C. Generally, May and June are the hottest months & January and December are coldest months of the season.

2.9. Rainfall

The average annual rainfall for the district is 1130 mm. The annual temperature varies from 10°C in winter to 40°C in summer. The relative humidity varies from 75% in rainy season to 30-40% during winter.

The maximum rainfall takes place during the south-west monsoon period i.e. from June to September. The August month is the wettest month of the year and about 30% of the annual rainfall takes place only during this month. During winter & summer season about 10% and 3% of respectively rainfall takes place. From October to May, only 13% of the annual rainfall takes place.

2.10. Hydrogeology

Geologically the district mainly covers formations ranging in age from Archaean to Cretaceous in age. Apart from these the Recent Alluvium and Pliestocene Laterites occur in isolated patches in non mapable form. The Chhota Nagpur Gneissic Complex of Archaean to Proterozoic age covers the southern part of the district. The Chhota Nagpur Gneissic Complex mainly consists of Quartzite, Mica Schist, Amphibolite, Schist, Granite gneiss, Biotite gneiss and Calc Silicate. Gondwana Supergroup of rocks including both upper and lower Gondwana sequence covers the northern part of the district. The Gondwana Supergroup includes Talchir, Barakar, Barren Measure, Upper and Middle Pali, Raniganj, Undifferentiated Coal measures, Panchet, Mahadeva/Supra Panchet/Parsora (Suprabarakar) Formations. The Gondwana Supergroup of rocks mainly consists of sandstone, shale, clay, siltstone and coal seams. The Deccan traps of Cretaceous to Palaeogene age occur on the northwestern part of the district. The Dolerite and Gabbro occurs as dykes trending E-W and NNE-SSW directions in Gondwana formations.

The ground water in these formations occurs under water table conditions in the porous media and under confined to semi-confined conditions in the fractured part of the rock. In Chhota Nagpur Gneissic Complex, the weathered thickness varies from negligible to 15m with average thickness around 10 to 12 m. The weathered and fractured part constitutes the aquifers. In Gondwana formations, the porous, permeable and fractured part constitutes the aquifers. The ground water movement is controlled by the intergranular pore spaces, joints and fractures. At places auto-flow conditions are also encountered in this formation. The depth range of the aquifer zones tapped in Gondwana formation was from 30 to 233 m and in a well the no. of zones encountered varies from 2 to 8 in number. In Deccan Traps, the weathered thickness varies from negligible to 25 m with an average around 12 to 15m. The weathered and the vesicular part of the formation constitute the aquifers.

UG coal mines also affect the groundwater of the mining area. Over exploitation of groundwater and dewatering within the UG mines affect the groundwater regime. Subsidence of land also damaged the aquifer. Thus, water contained within the aquifer may penetrate deep below as a result of subsidence. Sometimes, the water that discharged from UG mines has high hardness due to the presence of Sulphate and Chloride, which are not suitable for drinking or bathing. Thus, the quality of both surface and subsurface water gets degraded by wastewater discharged from the UG mines.

Flora – Vegetation Status

3.1 Forest cover

A forest cover analysis of Dhelwadih UG, Bagdeva UG and Singhali UG mines and its 10 km buffer with the help of satellite images from, Forest Survey of India is shown in **Map 3**. There is about 71.12 % of area which is Very dense forest in the project area. And additional Sparse Vegetation of about 16.31 %. It is notable that there is majority of the area which falls under the category of Forests which can potentially be enriched with plantations, Restoration activities and Assisted Natural Regeneration (ANR) activities. The target should ideally be towards making the sparse vegetation into moderately dense or very dense forest.

Table 2: LULC classification of Dhelwadih UG, Bagdeva UG and Singhali UG mines and its 10 km buffer (zone of influence)

Class Name	Area (ha)	Percentage (%)
Moist deciduous	247.00	0.43
Teak mixed moist deciduous	1239.70	2.17
Dry deciduous	49.90	0.09
Sal	646.10	1.13
Degraded forest	2534.00	4.43
Scrub	4448.10	7.77
Agriculture	40658.40	71.02
Barren land	5446.60	9.51
Water body	1228.20	2.15
Settlement	754.80	1.32
Total	**57252.80**	**100.02**

Table 3: Individual mine-wise details of LULC classification

LULC class	Dhelwadih UG	Singhali UG	Bagedewa UG
Degraded forest	213.20	154.70	81.60
Agriculture	399.70	666.70	429.40
Barren land	152.50	29.60	-
Water body	1.00	21.40	-
Settlement	-	20.80	-
Total	**766.40**	**893.20**	**511.00**

3.2 Forest types

The forest cover type prevailing in the project area and the zone of influence (10 km buffer) as per the Champion and Seth Classification (1968) is of the type of Moist Peninsular High Level Sal Forest (3C/2el), Southern Dry Mixed Deciduous Forest (5A/C3), Northern Dry Mixed Deciduous Forest (5B/C2), Dry Peninsular Sal Forest (5B/C1c), Dry Deciduous Scrub (5/DS1), Boswellia Forest (5/E2), Dry Bamboo Brake (5/E9), Dry Teak Forest (5A/C1b), Plantation (TOF) and Non Forest.

Table 4: Details of Forest types, Sub-types and its corresponding extent in hectares found within 10 km buffer (zone of influence) of Dhelwadih UG, Bagdeva UG and Singhali UG mines

Forest Type	Sub forest types	Area (ha)
Tropical Moist Deciduous Forest	3B/C2 Southern Moist Mixed Deciduous Forest	3512.30
Tropical Moist Deciduous Forest	3C/2e (ii) Moist Peninsular Low Level Sal Forests	498.10
Tropical Dry Deciduous Forest	5B/C1 c Dry Peninsular Sal Forest	37.70
Tropical Dry Deciduous Forest	5B/C2 Northern Dry Mixed Deciduous Forest	690.90
Tropical Dry Deciduous Forest	5/DS1 Dry Deciduous Scrub	101.00
Tropical Dry Deciduous Forest	5/E9 Dry Bamboo Brake	2042.80
Plantation/TOF	Plantation/TOF	301.00
Water	Water	1309.90
Non Forest	Non Forest	48761.10
Total		**57254.80**

3.3 Inventory of Plant Communities (Trees and Ground flora)

An inventory of plant species was carried out by a team of experts from Tropical Forest Research Institute, Jabalpur in the month of July 2021 and November 2022 for capturing biodiversity, water analysis, terrestrial fauna and other data collection as per the TOR in and around Dhelwadih UG, Bagdeva UG and Singhali UG mines. About Nine (08) locations or sites were identified for conducting the vegetation sampling in which a total of 24 quadrats of 10 m × 10 m were laid in order to study the biodiversity of trees, shrubs and herbs (Table 6).

Table 5: Individual mine-wise details of Forest types, Sub-types of Dhelwadih UG, Bagdeva UG and Singhali UG mines

Forest Type	Dhelwadih UG	Singhali UG	Bagedewa UG
Tropical Moist Deciduous Forest	244.50	158.20	55.80
Tropical Dry Deciduous Forest	18.30	-	-
Plantation/TOF	1.10	-	1.60

Water	-	8.20	5.90
Non Forest	502.10	726.30	448.70
Total Area (ha)	**766.00**	**892.70**	**512.00**

Table 6: Details of sites and its GPS locations selected for vegetation study in the zone of influence (10 km buffer) of Dhelwadih UG, Bagdeva UG and Singhali UG mines.

Site No.	Site name	Quadrat No.	Geo-coordinates	
1	Dhelwadih	Q-1	N- 22°23' 17.80"	E- 082°45' 14.04"
1	Dhelwadih	Q-2	N- 22°23' 19.09"	E- 082°45' 07.03"
1	Dhelwadih	Q-3	N- 22°23' 09.24"	E- 082°45' 25.71"
2	Singhali	Q-1	N- 22°23' 37.48"	E- 082°43' 52.93"
2	Singhali	Q-2	N- 22°23' 36.18"	E- 082°43' 49.92"
2	Singhali	Q-3	N- 22°23' 46.09"	E- 082°43' 38.28"
3	Bhagdeva	Q-1	N- 22°21' 49.89"	E- 082°39' 57.36"
3	Bhagdeva	Q-2	N- 22°21' 58.57"	E- 082°39' 53.44"
3	Bhagdeva	Q-3	N- 22°22' 03.68"	E- 082°40' 07.73"
3	Bhagdeva	Q-4	N- 22°22' 02.36"	E- 082°40' 30.51"
3	Bhagdeva	Q-5	N- 22°21' 59.48"	E- 082°40' 28.48"
3	Bhagdeva	Q-6	N- 22°21' 51.68"	E- 082°41' 00.09"
4	Hasdeo-Bango Reservoir	Q-1	N- 22°20' 40.10"	E- 082°42' 49.66"
4	Hasdeo-Bango Reservoir	Q-2	N- 22°20' 45.30"	E- 082°42' 47.36"
4	Hasdeo-Bango Reservoir	Q-3	N- 22°20' 55.59"	E- 082°42' 46.31"
5	Keramuda	Q-1	N- 22°20' 19.96"	E- 082°41' 24.40"
5	Keramuda	Q-2	N- 22°20' 22.55"	E- 082°41' 26.21"
6	Patpara	Q-1	N- 22°20' 19.28"	E- 082°41' 21.88"
6	Patpara	Q-2	N- 22°20' 18.96"	E- 082°41' 19.94"
7	Patpara	Q-1	N- 22°19' 27.88"	E- 082°42' 22.10"
7	Patpara	Q-2	N- 22°19' 27.04"	E- 082°42' 25.91"
7	Patpara	Q-3	N- 22°19' 23.58"	E- 082°42' 30.90"
8	Bagdara	Q-1	N- 22°21' 21.59"	E- 082°44' 28.05"
8	Bagdara	Q-2	N- 22°21' 20.53"	E- 082°44' 32.05"

Exploration and documentation of flora with established sampling methodology was carried out. The vegetation comprises of 39 species of trees, 15 shrubs, 37 herbs, including grasses (Table 7). A total

of 116 species distributed in 76 genera and 32 families of higher plants were recorded from the study area (Table 5).

Table 4: Habitat-wise number of species found in and around Dhelwadih UG, Bagdeva UG and Singhali UG mines

Habit	Number of Species
Tree	39
Shrub	15
Herb	37
Grass	5
Total	**96**

The importance of the plant species was determined by the Importance Value Index (IVI) of species **(Table 8a, 8b and 8c).** The value of IVI was computed by summation of the values of the relative frequency, relative density and relative dominance (Curtis and McIntosh, 1950, 1951; Mishra, 1968). Basal cover is considered as the portion of ground surface occupied by a species (Greig–Smith, 1964). Basal area was calculated by using following formula; basal area = πr^2, Where 'r' is the radius of the species.

Data for tree-saplings and tree-seedlings were compiled with the shrubs and herbs respectively. In case of trees categories viz. seedling (height < 20cm), sapling (20-150cm and DBH < 10cm), and tree (DBH > 10cm) were used following Muller-Dombis and Ellenberg (1974).

The plant, which is woody perennial, differing from a perennial herb in its persistent and woody stem, and less definite from a tree in its low stature and has habit of branching at ground level is considered as shrub. The plant whose stem is always green and tender and height is usually not more than one metre was considered as herb. According to the life span the herb may be annual, biennial or perennial.

3.4 Phytosociology

The phytosociological studies **(Table 8a)** were carried out to identify the species and communities of conservation importance. The plant community is dominated by *Shorea robusta*, with *Diospyros melanoxylon* and *Buchanania lanzan* as codominants. On the basis of dominance, *Shorea robusta – Diospyros melanoxylon – Buchanania lanzan* community was found in the study area. *Anogeissus*

latifolia, *Lagerstroemia parviflora* and *Bridelia retusa*, were the common trees in the community, while *Chloroxylon swietenia*, *Ougenia dalbergioides* and *Schleichera oleosa* were encountered occasionally. The forest community shows typical composition of Sal forest **(Table 8a)**.

The shrub layer was composed of 15 species. Saplings (having height 20-150 cm and DBH < 10 cm) of 13 tree species along with 2 shrub species were recorded from the shrub layer. *Lantana camara*, a forest invasive species dominates the shrub layer with highest IVI. Saplings of *Butea monosperma*, *Diospyros melanoxylon*, *Shorea robusta*, *Madhuca indica* and *Anogeissus latifolia* were frequently found in the study area **(Table 8b)**.

The herb layer in the community is composed of 37 species, out of which seedlings of 2 tree species and 17 herbaceous species were recorded from the forest floor. Among the tree regeneration, the highest IVI was recorded for *Shorea robusta* (12.06) indicating regeneration of the tree species. Seedlings of *Shorea robusta* were also recorded in the forest floor with IVI value of 4.05, **(Table 8c)**. Highest IVI was recorded for *Hyptis suaveolens* which is an invasive species.

Shorea robusta dominates the site and is the major canopy species. However, the species is poorly represented in shrub layer indicating poor regeneration. Saplings of *Butea monosperma* and *Diospyros melanoxylon* were present in high densities in the study area, which shows that these species are very hardy and are easily established in the new sites.

A dominance-diversity was used to depict the distribution and dominance of the species. *Shorea robusta* dominates the tree layer and have access to majority of the available resources. The other associates are sparsely distributed in the community. It can be said that the distribution of other species in the community is largely regulated by the density of dominant species. *Lantana camara* dominates the shrub layer. However, saplings of *Butea monosperma* and *Diospyros melanoxylon* are also found in the community. Both species are hardy and regenerate and establish successfully in the new areas. The herb layer shows log normal distribution, which is common in tropical forests. It indicates that the niche space occupied by the species is determined by the number of conditions such as food, space, microclimate and other variables that affect the success of one species in competition with another.

3.5 Species with medicinal, food, fodder and timber values

Within the enumerated list, we found that, there were 31 species of medicinal plants (**Table 9**), 6 species of fodder plants (**Table 10**), 15 species of food plants (**Table 11**), and 12 species of timber trees (**Table 12**) were present in and around the Dhelwadih UG, Bagdeva UG and Singhali UG mines.

3.6 RET species

Among the surveyed list of plants, there were two species which appears in the RET category according to IUCN Redlist (IUCN 2021. The IUCN Red List of Threatened Species. Version 2021-1. <https://www.iucnredlist.org>. Accessed on 21.03.2021). They are *Dalbergia latifolia* (Vulnerable) and *Pterocarpus marsupium* (Near Threatened)

3.7 Species Importance Value Index (IVI)

The formulae used to calculate importance value index are:

$$\text{Density} = \frac{\textit{Total number of individuals of a species}}{\textit{Total number of quadrats studied}}$$

$$\text{\% Frequency} = \frac{\textit{Total number of quadrat of occurence of species}}{\textit{Total number of qudrats studied}} X100$$

$$\text{Relative Frequency} = \frac{\textit{Frequency of a species}}{\textit{Frequency of all the species}} X100$$

$$\text{Relative Density} = \frac{\textit{Density of a species}}{\textit{Density of all the species}} X100$$

$$\text{Relative Dominance} = \frac{\textit{Basal area of a Species}}{\textit{Basal area of all species}} X100$$

Importance Value Index (IVI) = Relative Frequency + Relative Density + Relative Dominance

Shannon-Wiener diversity index (Shannon and Wiener, 1963) was calculated from the IVI values using the formula as given in Magurran (1988):

$$H' = -\sum_{i=1}^{s} pi \ln pi$$

Where, H′ is Shannon-Wiener index of species diversity, pi is the proportion of i^{th} species and s is the number of individuals of all the species.

Simpson index of dominance was calculated from IVI values using the formula suggested by Muller-Dombis and Ellenberg (1974).

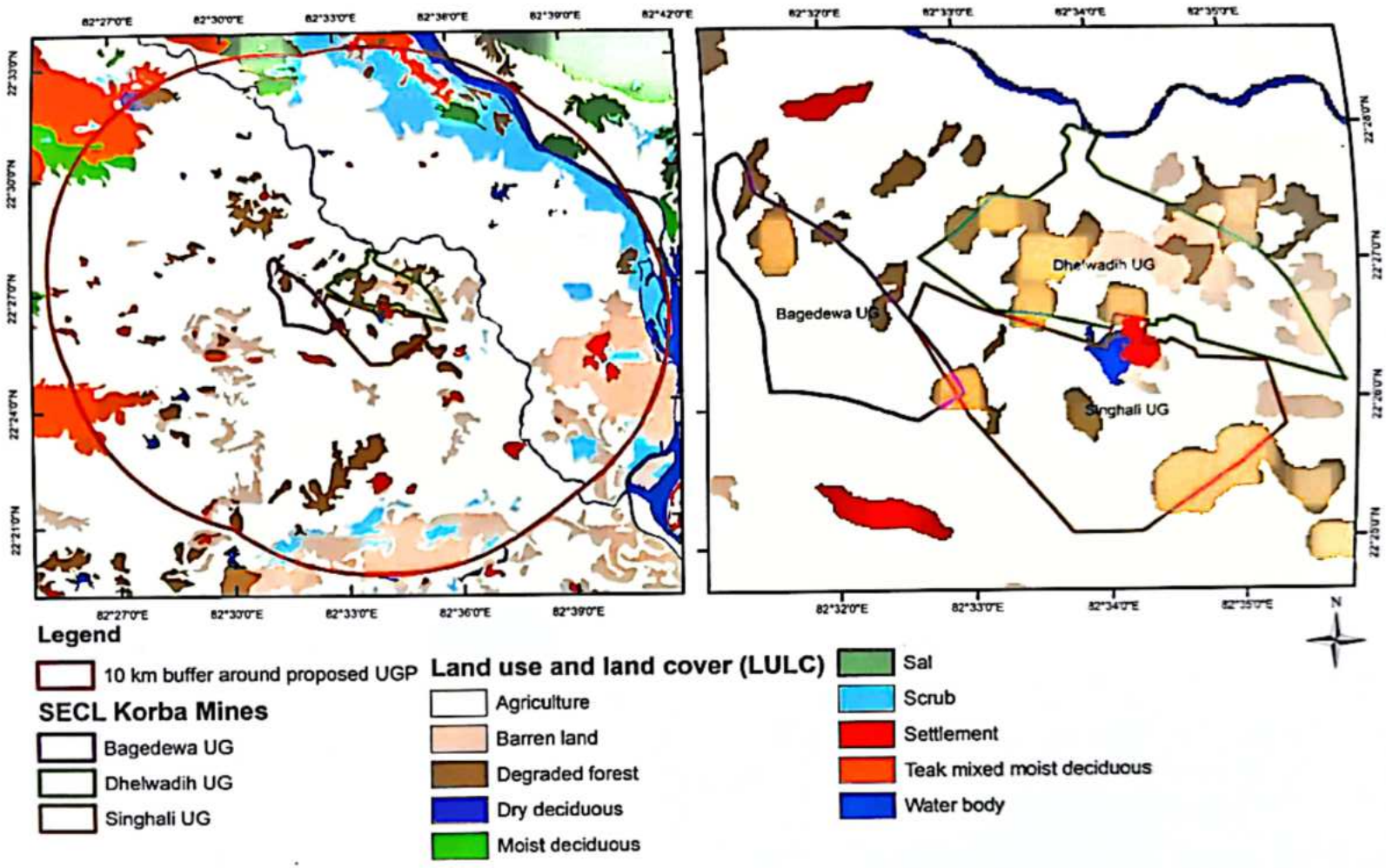
$$D' = \sum_{i=1}^{s} pi^2$$

Where, D′ is Simpson index of dominance, pi is the proportion of i^{th} species and s is the number of individuals of all the species.

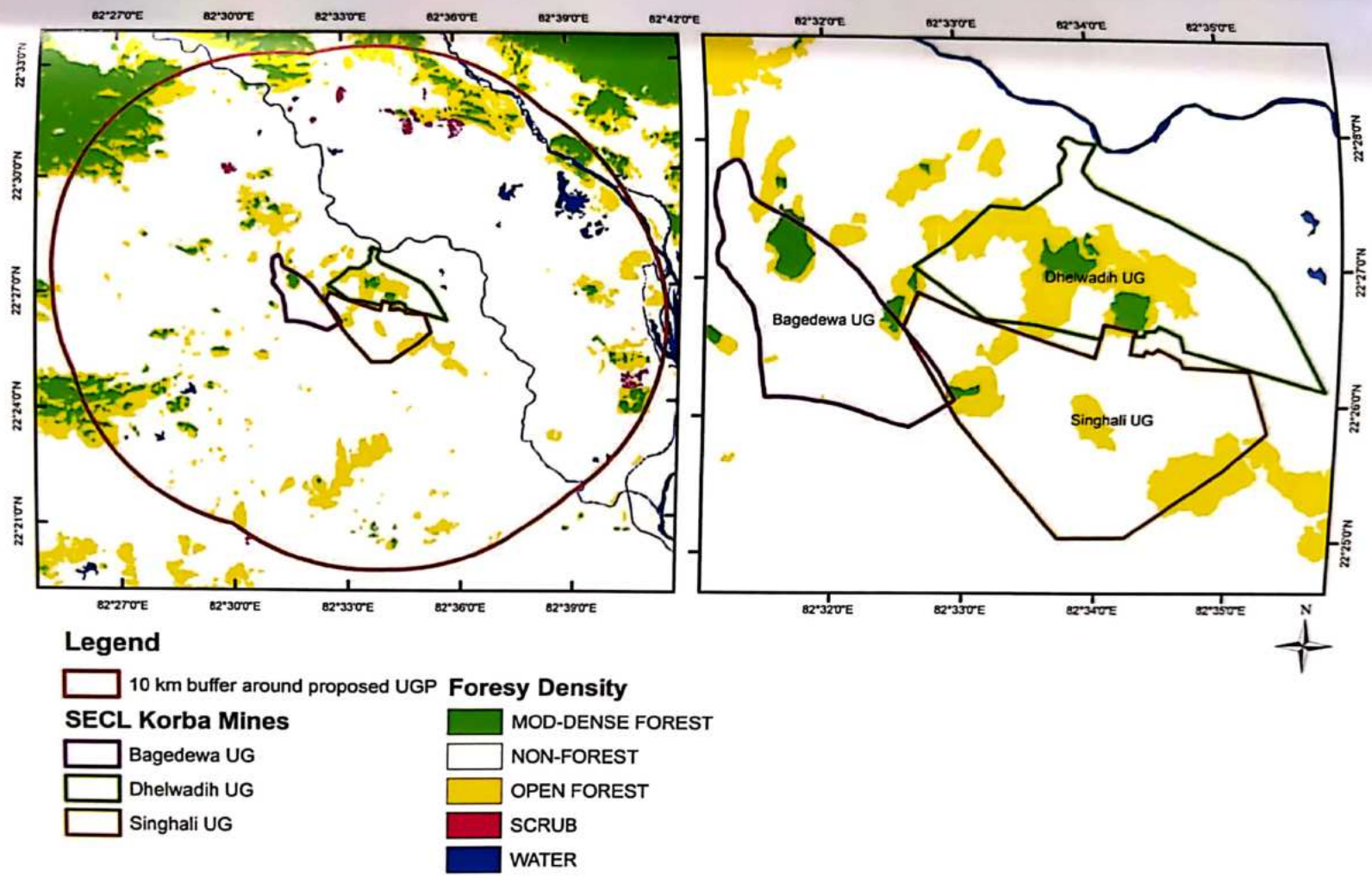
Evenness, for the community was determined by index of evenness Pielou's (1975).

$$J' = \frac{H'}{Ln(S)}$$

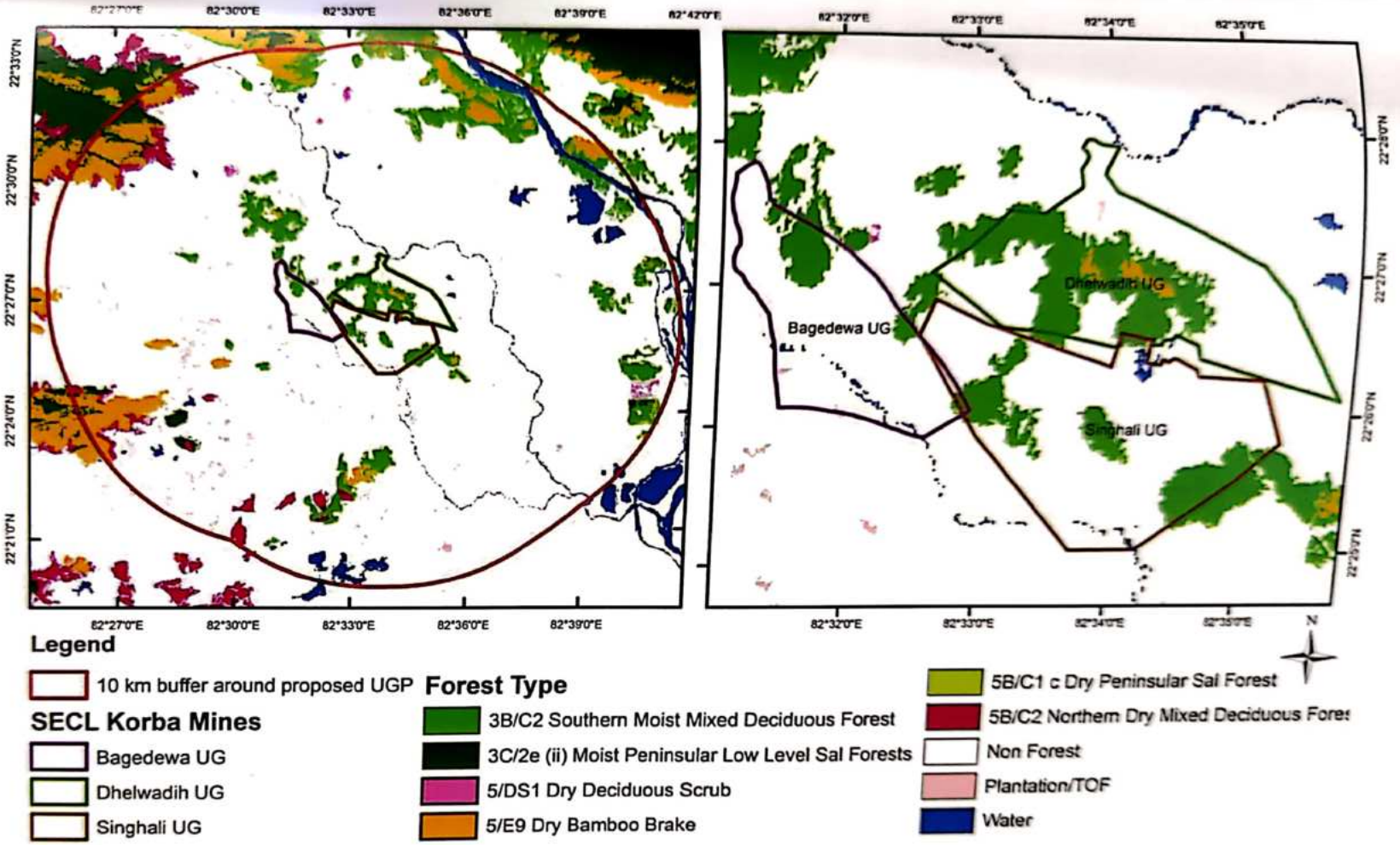
Where, J' is Pielou index of evenness, H' is Index of diversity for the community and S is the number of species in the community.



Map 3: LULC Classification of the Integrated mine boundaries of Dhelwadih UG, Bagdeva UG and Singhali UG mines and its 10 km buffer (zone of influence)



Map 4: Forest Density of Integrated mine boundaries of Dhelwadih UG, Bagdeva UG and Singhali UG mines and its 10 km buffer (zone of influence)



Map 4a: Forest types of Integrated mine boundaries of Dhelwadih UG, Bagdeva UG and Singhali UG mines and its 10 km buffer (zone of influence)

Table 7: List of plant species recorded during the field survey of the forest in the zone of influence (10 km buffer) of Dhelwadih UG, Bagdeva UG and Singhali UG mines

Sl. No.	Species Name	Family	Habit
1	*Acacia nilotica* (L.) Delile	Leguminosae	T
2	*Acacia nilotica* (L.) Delile	Leguminosae	T
3	*Achyranthes aspera* L.	Amaranthaceae	H
4	*Ageratum conyzoides* (L.) L.	Compositae	H
5	*Albizia procera* (Roxb.) Benth.	Leguminosae	T
6	*Alysicarpus vaginalis* (L.) DC.	Leguminosae	H
7	*Anogeissus latifolia* (Roxb. ex DC.) Wall. ex Guillem. & Perr.	Combretaceae	T
8	*Apluda mutica* L.	Poaceae	G
9	*Asparagus racemosus* Willd.	Asparagaceae	Cl
10	*Azadirachta indica* A.Juss.	Meliaceae	T
11	*Bauhinia vahlii* Wight & Arn.	Leguminosae	Cr
12	*Bauhinia variegata* L.	Leguminosae	T
13	*Bidens pilosa* L.	Compositae	H
14	*Biophytum sensitivum* (L.) DC.	Oxalidaceae	H
15	*Blepharis maderaspatensis* (L.) B.Heyne ex Roth	Acanthaceae	H
16	*Bombax ceiba* L.	Malvaceae	T
17	*Bridelia retusa* (L.) A.Juss.	Phyllanthaceae	T
18	*Buchanania cochinchinensis* (Lour.) M.R.Almeida	Anacardiaceae	T
19	*Butea monosperma* (Lam.) Taub.	Leguminosae	T
20	*Butea superba* Roxb.	Leguminosae	S
21	*Cajanus scarabaeoides* (L.) Thouars	Leguminosae	H
22	*Careya arborea* Roxb.	Lecythidaceae	T
23	*Carissa macrocarpa* (Eckl.) A.DC.	Apocynaceae	S
24	*Cassia fistula* L.	Leguminosae	T
25	*Cassine glauca* (Rottb.) Kuntze	Celastraceae	T
26	*Catunaregam spinosa* (Thunb.) Tirveng.	Rubiaceae	T
27	*Celosia argentea* L.	Amaranthaceae	H
28	*Chloroxylon swietenia* DC.	Rutaceae	T
29	*Colebrookea oppositifolia* Sm.	Lamiaceae	S
30	*Curculigo orchioides* Gaertn.	Hypoxidaceae	H
31	*Cyanthillium cinereum* (L.) H.Rob.	Compositae	H
32	*Cyperus iria* L.	Cyperaceae	G
33	*Cyperus rotundus* L.	Cyperaceae	G
34	*Desmodium gangeticum* (L.) DC.	Leguminosae	H
35	*Desmodium oojeinense* (Roxb.) H.Ohashi	Leguminosae	T
36	*Desmodium triflorum* (L.) DC.	Leguminosae	T
37	*Dioscorea bulbifera* L.	Dioscoreaceae	Cl
38	*Dioscorea oppositifolia* L.	Dioscoreaceae	Cl
39	*Diospyros melanoxylon* Roxb.	Ebenaceae	T
40	*Diospyros montana* Roxb.	Ebenaceae	T

	Elephantopus scaber L.		
41	*Emilia sonchifolia* (L.) DC. ex DC.	Compositae	H
42	*Eragrostis unioloides* (Retz.) Nees ex Steud.	Compositae	H
43	*Euphorbia hirta* L.	Poaceae	G
44	*Evolvulus alsinoides* (L.) L.	Euphorbiaceae	H
45	*Ficus racemosa* L.	Convolvulaceae	H
46	*Flacourtia indica* (Burm.f.) Merr.	Moraceae	T
47	*Flemingia macrophylla* (Willd.) Merr.	Saliaceae	S
48	*Haldina cordifolia* (Roxb.) Ridsdale	Leguminosae	S
49	*Haldina cordifolia* (Roxb.) Ridsdale	Rubiaceae	T
50	*Helicteres isora* L.	Rubiaceae	T
51	*Hemidesmus indicus* (L.) R. Br. ex Schult.	Malvaceae	T
52	*Hyptis suaveolens* (L.) Poit.	Apocynaceae	Cr
53	*Jatropha curcas* L.	Lamiaceae	H
54	*Justicia japonica* Thunb.	Euphorbiaceae	T
55	*Lagerstroemia parviflora* Roxb.	Acanthaceae	H
56	*Lannea coromandelica* (Houtt.) Merr.	Lytheraceae	T
57	*Lantana camara* L.	Anacardiaceae	T
58	*Leucaena leucocephala* (Lam.) de Wit	Verbenaceae	S
59	*Leucas aspera* (Willd.) Link	Leguminosae	T
60	*Ludwigia octovalvis* (Jacq.) P.H.Raven	Lamiaceae	H
61	*Madhuca longifolia* var. *latifolia* (Roxb.) A.Chev.	Onagraceae	H
62	*Miliusa tomentosa* (Roxb.) J.Sinclair	Sapotaceae	T
63	*Mitragyna parvifolia* (Roxb.) Korth.	Annonaceae	T
64	*Olax scandens* Roxb.	Rubiaceae	T
65	*Oplismenus burmanni* (Retz.) P.Beauv.	Olacaceae	T
66	*Oxalis corniculata* L.	Poaceae	G
67	*Parthenium hysterophorus* L.	Oxalidaceae	H
68	*Pentanema indicum* (L.) Ling	Compositae	S
69	*Phoenix acaulis* Roxb.	Compositae	H
70	*Phyllanthus emblica* L.	Arecaceae	S
71	*Phyllanthus niruri* L.	Phyllanthaceae	T
72	*Pogostemon benghalensis* (Burm.f.) Kuntze	Phyllanthaceae	H
73	*Rungia eriostachya* Hua	Lamiaceae	H
74	*Rungia pectinata* (L.) Nees	Acanthaceae	H
75	*Schleichera oleosa* (Lour.) Merr.	Acanthaceae	H
76	*Semecarpus anacardium* L.f.	Sapindaceae	T
77	*Senna tora* (L.) Roxb.	Anacardiaceae	T
78	*Shorea robusta* Gaertn.	Leguminosae	S
79	*Sida acuta* Burm.f.	Dipterocarpaceae	T
80	*Sida cordata* (Burm.f.) Borss.Waalk.	Malvaceae	H
81	*Smilax zeylanica* L.	Malvaceae	H
82	*Solanum virginianum* L.	Smilacaceae	Cl
83	*Spermacoce verticillata* L.	Solanaceae	H
84	*Stereospermum chelonoides* (L.f.) DC.	Rubiaceae	H
85	*Syzygium cumini* (L.) Skeels	Bignoniaceae	T
86		Myrtaceae	T

	Tectona grandis L.f.	Lamiaceae	T
87	*Tephrosia purpurea* (L.) Pers.	Leguminosae	H
88	*Terminalia alata* Wall.	Combretaceae	T
89	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae	T
90	*Terminalia chebula* Retz.	Combretaceae	T
91	*Tridax procumbens* (L.) L.	Compositae	S
92	*Triumfetta rhomboidea* Jacq.	Malvaceae	H
93	*Ventilago maderaspatana* Gaertn.	Rhamnaceae	Cl
94	*Vitex negundo* L.	Lamiaceae	S
95	*Wendlandia heynei* (Schult.) Santapau & Merchant	Rubiaceae	H
96	*Woodfordia fruticosa* (L.) Kurz	Lytheraceae	S
97	*Xanthium strumarium* L.	Compositae	H
98	*Ziziphus jujuba* Mill.	Rhamnaceae	S
99	*Ziziphus jujuba* Mill.	Rhamnaceae	S
100	*Ziziphus oenopolia* (L.) Mill.	Rhamnaceae	S
101	*Ziziphus xylopyrus* (Retz.) Willd.	Rhamnaceae	S
102	*Desmodium gangeticum* (L.) D.C.	Leguminosae	H
103	*Cajanus scarbaeoides* (L.) Thouars	Leguminosae	H
104	*Citrullus colocynthis* (L.) Schrad.	Cucurbitaceae	H
105	*Asparagus racemosus* Willd.	Asparagaceae	H
106	*Cryptolepis buchananii* Roem. & Schult.	Asclepiadaceae	H
107	*Adiantum spp*	Pteridaceae	H
108	*Phoenix acaulis* Roxb.	Arecaceae	H
109	*Desmodium gangeticum* (L.) D.C.	Leguminosae	H
110	*Cajanus scarbaeoides* (L.) Thouars	Leguminosae	H
111	*Corchorus aestuans* L.	Tiliaceae	H
112	*Rungia pectinata* (L.) Nees	Acanthaceae	H
113	*Alysicarpus vaginalis* (L.) DC.	Leguminosae	H
114	*Grewia hirsute* Vahl	Tiliacaeae	H
115	*Tridax procumbens* (L.) L.	Asteraceae	H
116			

Table 8 (a): Phyto-sociological attributes of top ten tree species in Dhelwadih UG, Bagdeva UG and Singhali UG mines and its adjacent areas

S.No.	Tree species	Density (Stems/ha)	Abundance	Frequency (%)	Basal cover (m^2/ha)	Relative Density	Relative Frequency	Relative Dominance	IVI
	Grand Total	**101.11**		**366.67**	**2.86**	**100.00**	**100.00**	**100.00**	**300.00**
1.	*Shorea robusta*	41.11	5.29	77.78	1.55	40.66	21.21	54.35	116.22
2.	*Diospyros melanoxylon*	21.11	3.80	55.56	0.32	20.88	15.15	11.04	47.08
3.	*Madhuca indica*	6.67	1.20	55.56	0.32	6.59	15.15	11.20	32.94
4.	*Lagerstroemia parviflora*	14.44	4.33	33.33	0.15	14.29	9.09	5.27	28.64
5.	*Boswellia serrata*	2.22	1.00	22.22	0.09	2.20	6.06	3.13	11.39
6.	*Buchanania lanzan*	3.33	1.50	22.22	0.02	3.30	6.06	0.75	10.10
7.	*Anogeissus pendula*	2.22	1.00	22.22	0.05	2.20	6.06	1.60	9.85
8.	*Terminalia tomentosa*	2.22	1.00	22.22	0.02	2.20	6.06	0.77	9.03
9.	*Gmelina arborea*	2.22	2.00	11.11	0.10	2.20	3.03	3.59	8.82
10.	*Lannea coromandelica*	2.22	2.00	11.11	0.09	2.20	3.03	3.19	8.42

Simpson Index of dominance =0.21
Shannon Weiner index of diversity=0.85
Plieou index of evenness= 0.33

Table 8 (b): Phyto-sociological attributes of tree saplings and shrubs in Dhelwadih UG, Bagdeva UG and Singhali UG mines and its adjacent areas

S.No	Tree species	Density (Stems/ha)	Abundance	Frequency (%)	Basal cover (m^2/ha)	Relative Density	Relative Frequency	Relative Dominance
	Saplings							
1.	*Anogeissus latifolia*	246.91	2.00	11.11	0.02	0.59	4.55	0.98
2.	*Azadirachta indica*	123.46	1.00	11.11	0.02	0.29	4.55	0.87
3.	*Buchanania lanzan*	123.46	1.00	11.11	0.03	0.29	4.55	1.11
4.	*Butea monosperma*	3580.25	14.50	22.22	0.77	8.53	9.09	32.08
5.	*Diospyros melanoxylon*	3209.88	13.00	22.22	0.42	7.65	9.09	17.40
6.	*Gardenia gummifera*	987.65	8.00	11.11	0.09	2.35	4.55	3.93
7.	*Haldiana cordifolia*	123.46	1.00	11.11	0.03	0.29	4.55	1.11
8.	*Lagerstroemia parviflora*	123.46	1.00	11.11	0.03	0.29	4.55	1.11
9.	*Madhuca indica*	246.91	2.00	11.11	0.05	0.59	4.55	2.21
10.	*Shorea robusta*	1481.48	6.00	22.22	0.14	3.53	9.09	5.90
	Shrubs							
11.	*Phoenix acaulis*	123.46	1.00	11.11	0.03	0.29	4.55	1.11
12.	*Lantana camara*	31358.02	36.29	77.78	0.75	74.71	31.82	31.22
13.	*Holarhena antidysentrica*	246.91	2.00	11.11	0.02	0.59	4.55	0.98
		41975.31		**244.44**	**2.40**	**100.00**	**100.00**	**100.00**

Simpson Index of dominance =0.24
Shannon Weiner index of diversity=0.74
Plieou index of evenness= 0.30

Table 8 (c): **Phyto-sociological attributes of seedlings (trees and shrubs) and herbs in Dhelwadih UG, Bagdeva UG and Singhali UG mines and its adjacent areas**

S.No	Tree species	Density (Stems/unit area)	Abundance	Frequency (%)	Basal cover (m^2/ha)	Relative Density	Relative Frequency	Relative Dominance	IVI
	Herbs								
1.	*Alternanthera sessilis*	0.89	4.00	22.22	0.001	1.67	3.64	1.40	6.70
2.	*Bothrichola ischaemum*	0.44	4.00	11.11	0.000	0.84	1.82	0.70	3.35
3.	*Atylosia scarabaeoides*	0.11	1.00	11.11	0.000	0.21	1.82	0.17	2.20
4.	*Cynadon dactylon*	0.44	4.00	11.11	0.000	0.84	1.82	0.70	3.35
5.	*Cyperus compressus*	3.44	15.50	22.22	0.004	6.47	3.64	5.41	15.52
6.	*Dactyloctenium aegyptium*	0.89	2.67	33.33	0.001	1.67	5.45	1.40	8.52
7.	*Desmodium trifolium*	2.11	4.75	44.44	0.002	3.97	7.27	3.32	14.56
8.	*Elephantopus scaber*	0.78	7.00	11.11	0.002	1.46	1.82	2.75	6.03
9.	*Eragrostis cilianensis*	0.11	1.00	11.11	0.000	0.21	1.82	0.39	2.42
10	*Evolvulus alsinoides*	2.78	25.00	11.11	0.003	5.22	1.82	4.36	11.40
11	*Setaria virdis*	0.56	2.50	22.22	0.001	1.04	3.64	0.87	5.55
12	*Sida acuta*	8.89	40.00	22.22	0.009	16.70	3.64	13.96	34.30
13	*Spermacoce hispida*	3.11	9.33	33.33	0.003	5.85	5.45	4.89	16.19
14	*Vernonia cinerea*	0.44	2.00	22.22	0.000	0.84	3.64	0.70	5.17
15	*Holarhena antidysentrica*	0.44	2.00	22.22	0.003	0.84	3.64	4.36	8.83
	Seedlings (shrubs/ trees)								
16	*Lantana camara*	0.22	2.00	11.11	0.001	0.42	1.82	2.18	4.42
17	*Diospyros melanoxylon*	0.11	1.00	11.11	0.001	0.21	1.82	1.09	3.12
18	*Lagerstroemia parviflora*	0.11	1.00	11.11	0.001	0.21	1.82	1.09	3.12
19	*Shorea robusta*	0.89	4.00	22.22	0.006	1.67	3.64	8.73	14.03
		53.22	**208.92**	**611.11**	**0.07**	**100.00**	**100.00**	**100.00**	**300.00**

Simpson Index of dominance =0.07
Plieou index of evenness= 0.36

Table 9: List of medicinal plants recorded from the sampled list of species in the influence zone of Dhelwadih UG, Bagdeva UG and Singhali UG mines.

S. No	Species name	Local name	Life form
1	*Aegle marmelos*	Bhel	*Tree*
2	*Bombax cieba*	Semal	*Tree*
3	*Cassia fistula*	Dhanbaher	*Tree*
4	*Chloroxylon swietiena*	Bhirra	*Tree*
5	*Elephantopus scaber*		*Herb*
6	*Embelia tsjeriam-cottam*	Baibiring	*Climber*
7	*Evolvulus alsinoides*	Neelkanthi	*Herb*
8	*Gmelina arborea*	Kharner	*Tree*
9	*Helictres isora*	Ainthe	*Shrub*
10	*Hemidesmus indicus*	Anantmul	*Herb*
11	*Holarrhena antidysenterica*	Kurchi	*Tree*
12	*Melia azadirachta*	Bakain	*Tree*
13	*Phyllanthus emblica*	Aonla	*Tree*
14	*Pongamia pinnata*	Karanj	*Tree*
15	*Pterocarpus marsupium*	Bija sal	*Tree*
16	*Schleichera oleosa*	Kusum	*Tree*
17	*Semecarpus anacardium*	Bhilwa	*Tree*
18	*Shorea robusta*	Sal	*Tree*
19	*Sida rhombifolia*	Bala	*Herb*
20	*Syzygium cumini*	Jamun	*Tree*
21	*Terminalia bellerica*	Bahera	*Tree*
22	*Cocculus hirsutus*	-	*Herb*
23	*Costus speciosus*	-	*Herb*
24	*Curculigo orchioides*	-	*Ginger*
25	*Cyperus rotundus*	-	*Grass*
26	*Datura metel*	-	*Herb*
27	*Desmodium gangeticum*	-	*Herb*
28	*Eclipta prostrata*	-	*Shrub*
29	*Elephantopas scaber*	-	*Herb*
30	*Embelia tsjeriam-cottam*	-	*Herb*
31	*Emilia sonchifolia*	-	*Herb*

Table 10: List of fodder plants recorded from the sampled list of species in the influence zone of Dhelwadih UG, Bagdeva UG and Singhali UG mines

S. No	Species name	Local name	Life form
1	*Cynadon dactylon*	Duba	*Grass*
2	*Apluda mutica*	-	*Grass*
3	*Dactyloctenium aegyptium*		*Grass*
4	*Dendrocalamus strictus*	Baans	*Grass*

5	*Brachiaria ramosa*	-	*Herb*
6	*Brachiaria reptans*	-	*Herb*

Table 11: List of food plants recorded from the sampled list of species in the influence zone of Dhelwadih UG, Bagdeva UG and Singhali UG mines

S. No	Species name	Local name	Life form
1	*Aegle marmelos*	Bhel	*Tree*
2	*Alangium salvifolium*	Ankol	*Shrub*
3	*Bauhinia vahlii*	Maloo	*Climber*
4	*Bombax cieba*	Semal	*Tree*
5	*Buchanania lanzan*	Chiraunji	Tree
6	*Dendrocalamus strictus*	Baans	*Grass*
7	*Diospyros melanoxylon*	Tendu	*Tree*
8	*Madhuca longifolia*	Mahua	*Tree*
9	*Mangifera indica*	Aam	*Tree*
10	*Phoenix acaulis*	Chinnd	*Shrub*
11	*Phyllanthus emblica*	Aonla	*Tree*
12	*Semecarpus anacardium*	Bhilwa	*Tree*
13	*Sterculia urens*	Kullu	*Tree*
14	*Syzygium cumini*	-	*Tree*
15	*Uvaria hamiltonii*	-	*Herb*

Table 12: List of timber trees recorded from the sampled list of species in the influence zone of Dhelwadih UG, Bagdeva UG and Singhali UG mines

S. No	Species name	Local name	Life form
1	*Anogeissus latifolia*	Dhawda	Tree
2	*Bridelia retusa*	-	*Tree*
3	*Cassia fistula*	Dhanbaher	*Tree*
4	*Chloroxylon swietiena*	Bhirra	*Tree*
5	*Dalbergia latifolia*	Sisuan	*Tree*
6	*Dalbergia sisso*	Sisso	*Tree*
7	*Gmelina arborea*	Khamer	*Tree*
8	*Haldiana cordifolia*	Haldu	*Tree*
9	*Lagerstroemia parviflora*	Lendia	*Tree*
10	*Lannea coromandelica*	Goonja	*Tree*
11	*Madhuca longifolia*	Mahua	*Tree*
12	*Mangifera indica*	Aam	*Tree*

Terrestrial Fauna

Faunal survey was conducted by a team of experts from Tropical Forest Research Institute, Jabalpur in the month of July 2021 and November 2022. Sampling was done in the forest area in and around the proposed site using line transects perpendicular to the forest road. One of the important sightings during the survey was of Sloth Bear (*Melursus ursinus*) which is listed in Schedule I of the Indian Wildlife Protection Act and Vulnerable under IUCN Red list which necessitates legal protection of the animal. The habitat requirements of Sloth Bear and prescriptions for its monitoring are given below.

4.1. Site specific prescriptions for Sloth Bear (*Melursus ursinus*)

Sloth Bear (*Bhalu* in Hindi) is listed in Schedule I of the Indian Wildlife Protection Act and Vulnerable under IUCN Red list which necessitates legal protection of the animal.

Behaviour and biology

Sloth Bear is a nocturnal insect eating mammal found throughout Indian Subcontinent. Sloth bears subsist primarily on termites, ants, and fruits. This is the only species of bear adapted specifically for ant and termite-eating.

In areas where forest cover is less, and where daytime temperatures are high, the bear is largely nocturnal and usually shelters in rock outcrops, thickets, and tree cavities during the heat of the day. Although sloth bears may be active during the day in protected areas, they tend to be almost exclusively nocturnal in disturbed and fragmented forests interspersed with human habitations (Akhtar *et al.* 2004).

Sloth bears typically breed during June-July, and females give birth, usually to one or two cubs, during November –January (Joshi *et al.* 1999, Chauhan *et al.* 2003).

Studies in Nepal and Sri Lanka suggest that sloth bears avoid areas where human disturbance is high, so crop depredation by sloth bears is typically rare (Joshi *et al.* 1995). On the contrary, in some parts of India, sloth bears routinely raid peanut, maize, and fruit crops (e.g., Changani 2002). Chauhan (2006)

suggests that such crop depredations may occur because these habitats are severely affected by human exploitation, including the extraction of several food sources for bears.

The most important threat for sloth bear is largely related to deteriorating habitat, which increases the chance of interaction between people and bears. Thus, habitat improvements would be helpful in alleviating such conflicts.

Manual monitoring

Date, time and place of direct sighting of the animals should be recorded by the field staff of SECL, Korba Area. Photographs if possible should be taken to make the sightings more prudent. The data gathered over time, will help in identifying the frequently visited sites and timings. This data would be significant in order to take appropriate course of action for the field staff and villagers to avoid such sites to minimize the bear-human conflicts.

Habitat improvement

Extensive reforestation programme should be carried out for fruiting trees such as, *Syzigium cumini* (Jamun), *Madhuca indica* (Mahua) and *Ficus glomerata* (Gular) in order to make more fruiting trees available for the bear. Termite mounds should not be disturbed and Extensive awareness programme should be initiated to make people of the area understand the importance of wildlife and linkage with the forest area. Any efforts on the part of the villagers to protect and conserve the sloth bear should be incentivized occasionally in the form of rewards as well.

4.2. Site specific prescriptions for Monitor Lizard (*Varanus bengalensis*)

Behaviour and biology

Monitor Lizard (*Goh* in Hindi) is listed in Schedule I of the Indian Wildlife Protection Act and Least Concern under IUCN Red list which necessitates legal protection of the animal.

Manual monitoring

Three survey techniques can be used in the terrestrial habitats for monitoring populations of herpetofauna. The drift fence technique revealed the presence of more species and individuals in every habitat and was the only one to detect species dissimilarity among habitats. Nonetheless, coverboards

contributed to measures of abundance and revealed species not detected by other techniques. It is suggested that a combination of census techniques be used when surveying and monitoring herpetofaunal communities in order to maximize the detection of species.

Following conservation actions for monitor lizards can be implemented:

- Protection of critical habitats for wild populations.
- Prevention of illegal hunting and trade.
- Awareness programmes to revive support for monitor lizard conservation and
- Establishment of sustainable use programmes for common species.

Habitat improvement

This species is found in a variety of habitats, from desert areas to floodplains, scrubland to forests, at moderate elevations (Auffenberg 1994, Pianka 2004). It can also inhabit agricultural areas (Auffenberg 1994).

This species is possibly threatened by habitat destruction, however, as it can utilize a wide range of habitat types this is not considered a major threat at this time. This species is indirectly affected by pesticides which reduce the food resource availability in agricultural areas. However, perhaps the greatest threat to this species is hunting as it is hunted commercially for its skin, and its meat is commonly eaten. The fat of this species is also used in traditional medicine. In Iran, it is killed by people who mistakenly consider it to be dangerous; it is not hunted for food or skins in that country.

4.3. Wildlife Census Data

The Katghora Forest Division wildlife census data for Kudargarh Range lists - Sambhar, Spotted Deer, Barking Deer, Langur, Peacock, Blue Bull, Jackal, Porcupine, Hare, Jungle Cat, Wild Boar & Hyena. During our survey except sightings of few groups of langurs and Sloth Bear no other carnivores or herbivores could be sighted in the surveyed area. Most of the small mammals in such landscapes are nocturnal. Indirect sign such as faecal droppings of Sloth bear, Jackal, Spotted Deer have been recorded in the surveyed area.

4.4. Impacts of mining on wildlife (flora and fauna):

The likely impacts of the Dhelwadih UG, Bagdeva UG and Singhali UG mines are described below:

(i) *Impact on the flora and fauna within of the project*

Dhelwadih UG, Bagdeva UG and Singhali UG mines are underground mines. Clearing of land for setting-up of infrastructure for the mines, air pollution from transport, etc may have some impacts on the local flora and fauna. However, since undeground mining does not require clearing of vast stretches of land for coal miining, the impacts on flora and fauna are much limited as compared to that in opencast mining.

(ii) *Impacts of the streams and river of the area*

The surface drainage pattern may change due to water logging in the depressions caused by the subsidence. Damage caused to the aquifers may reduce the availability of water in the surrounding areas.

(iii) *Forest fire*

Forest fire in India is most of the man-made. Human carelessness is a common cause of forest fires. Smoking near vegetation and disposing the cigarette into dry vegetation without putting out the burning butt is the most common cause of man-made forest fire. Mining activities, vehicular movement and rising human activities are increasingly known to cause fire in the adjacent vegetated area. Forest fire if occurs would affect the habitat adversely causing change in structure and composition of vegetation affecting animal communities.

(iv) *Forest degradation*

Depletion of Forests & Reduction in forest cover means that various habitats of wild animals are disappearing and hence animals that need those habitats often tend to displace. Increased human presence due to mine and proximity of villages to the forest area creates pressure on the forest for grazing and firewood. This would affect forest within and outside the mine boundary, the regeneration of the area and overall health of the forest.

(v) *The Limiting factors*

The availability of food and water could be one of the limiting factors for the animals found in proposed mine area. Overall dry conditions and natural features of the area could be attributed to this factor. During the height of summer, animals may go under stress due to limited water availability. Livestock present in the adjacent villages and agriculture may also be limiting factors for these animals.

4.5. Status of Avifauna

A total of 96 species of birds (Table 10) and 8 species of butterflies (Table 11) were spotted during field survey. Detailed lists of birds sighted at each location and their photographs are enumerated in the Annexure I.

Table 10: List of birds with its common name recorded during the avifaunal survey in the zone of influence of Dhelwadih UG, Bagdeva UG and Singhali UG mines

Sl. No.	Common name of birds	No. of individuals sighted
1	Ashy Drongo	1
2	Asian brown flycatcher	6
3	Asian Open bill Stork	1
4	Baya Weaver	110
5	Black drongo	5
6	Black Redstart	8
7	Black-headed Ibis	4
8	Black-naped monarch	1
9	Blck Winged kite	1
10	Blue Throat	2
11	Blyth's Reed Warbler	6
12	Brainfever bird	2
13	Bronze-winged Jacana	1
14	Bush Warbler	2
15	Cattle Egret	∞
16	Chest Nut Nuthatch	3
17	Common coot	12
18	Common iora	2
19	Common Kingfisher	2
20	Common Myna	∞
21	Common Sand piper	1
22	Common Tailorbird	11
23	Common woodshrike	4
24	Eurasian hoopoe	2
25	Eurasian Maarsh Harrier	1
26	Eurasian Wryneck	1
27	Falcons	1
28	Flycatcher	1
29	Golden-fronted Leaf bird	4
30	Great Tit	8
31	Green Bee-eater	6
32	Greenish Warbler	5
33	Grey Francolin	3
34	Grey-headed Canary-Flycatcher	3

35	Grey-headed woodpecker	2
36	House Sparrow	3
37	Indian Golden Oriole	4
38	Indian Grey hornbill	5
39	Indian Jungle Crow	7
40	Indian Pond-Heron	3
41	Indian pygmy woodpecker	7
42	Indian Robin	22
43	Indian Roller	5
44	Indian Silver bill	15
45	Indian Vulture	7
46	Indian Yellow Tit	8
47	Jungle Babbler	40
48	Jungle Myna	2
49	Jungle Owlet	1
50	Kite	1
51	Large billed Crow	3
52	Large Cuckooshrike	2
53	Laughing Dove	21
54	Lesser flame back woodpecker	2
55	Lesser Whistling-duck	6
56	Little Cormorant	18
57	Little Egret	6
58	Little Grebe	2
59	Long-tailed Shrike	6
60	Olive-backed pipit	1
61	Oriental Magpie-Robin	8
62	Oriental Turtle Dove	2
63	Oriental White-eye	18
64	Paddy field Pipit	9
65	Painted Stork	2
66	Pied Myna	1
67	Plain Martin	∞
68	Plain Prinia	5
69	Plum headed Parakeet	22
70	Purple Sunbird	15
71	Purple Swamphen	2
72	Purple-rumped sunbird	1
73	Red Avadavat	4
74	Red eyed Babbler	13
75	Red-crested pochard	25
76	Red-rumped Swallow	7
77	Red-vented Bulbul	107
78	Red-wattled Lapwing	25

79	Rock Pigeon	5
80	Rock Sparrow	1
81	Rose-ringed Parakeet	27
82	Rufous treepie	5
83	Scaly-Breasted Munia	∞
84	Scarlet minivet	9
85	Shank	1
86	Short-toed Snake-Eagle	1
87	Siberian Stonechat	1
88	Small minivet	10
89	Spotted Dove	23
90	Swallows	∞
91	Temminck Stint	1
92	Thick-billed Flowerpecker	1
93	Tickell's Blue Flycatcher	15
94	Verditer Flycatcher	1
95	Warbler	14
96	Western yellow wagtail	1

Table 11: List of butterflies recorded during the survey in the zone of influence of Dhelwadih UG, Bagdeva UG and Singhali UG mines:

Sl. No.	Common name of butterflies	No. of individuals sighted
1	*Junonia orithya*	3
2	*Catopsilia pomona*	8
3	*Pieris brassicae*	1
4	*Junonia almana*	9
5	*Melanitis leda*	12
6	*Eurema hecabe*	2
7	*Chilades trochylus*	14
8	*Polyommatus icarus*	5

4.6. Disturbance and biological richness in the zone of influence

Information of high disturbance and high biological richness areas are important to suggest future management strategies and formulating action plans. Different spectral indices like Disturbance index (DI), and Normalized Difference Vegetation Index (NDVI) were derived from remote sensing methods (satellite data from different sensors Landsat and Sentinel) as well as the Geographical Information System (GIS) were applied to the forest disturbance in Dhelwadih UG, Bagdeva UG and Singhali UG mines and its zone of influence. Disturbance index and Biological richness (As per IIRS's National

Biodiversity Characterization at Landscape Level) of the zone of influence area is shown in **Map 5 and Map 6.**

From the Map 5, it is clear that disturbance index of the vegetation of the zone of influence area is moderate to high. Most of the disturbed areas are located close to human habitation and agricultural land.

The anthropogenic influence on the landscape is a discrete event through time that modifies landscapes, ecosystems, community, and population structure, changing the substrata, the physical environment, and availability of resources (White and Picket, 1985). Disturbance and fragmentation are two related processes with strong relationships, and it is difficult to distinguish the role and rate of the interactions. Ecosystems are in a continuous state of change, either due to natural succession or degradation due to anthropogenic pressure. The latter phenomenon is more prevalent in the areas to be taken up in phase III of the project study. The spatial distribution of the anthropogenic/natural forces on the landscape was used to generate the spatial distribution of disturbance factors, viz., proximity to roads, villages, fire intensity, shifting cultivation, and mines using ground based sampling data as well as ancillary databases.

Biological richness of as a function of ecosystem uniqueness, species richness, biodiversity value, terrain complexity, and disturbance and depicts the potential for harboring the maximum number of ecologically unique and important species. This helps in assigning conservation priorities to threatened, rare, endemic, and taxonomically distinct species and to different types of habitats or landscape elements on the basis of the richness and significance of threatened species. As a part of this project, the biologically rich areas were spatially identified for the purpose of conservation and saving the existing gene pool from extinction. Since the disturbance index, which is a part of the ecosystem process, is also a function of the biological richness, so the level of stress on the biologically rich areas is also ascertained and adequate remedial measures can be taken while implementing conservation strategies.

Biodiversity Characterization at Landscape Level) of the zone of influence area is shown in **Map 5 and Map 6.**

From the Map 5, it is clear that disturbance index of the vegetation of the zone of influence area is moderate to high. Most of the disturbed areas are located close to human habitation and agricultural land.

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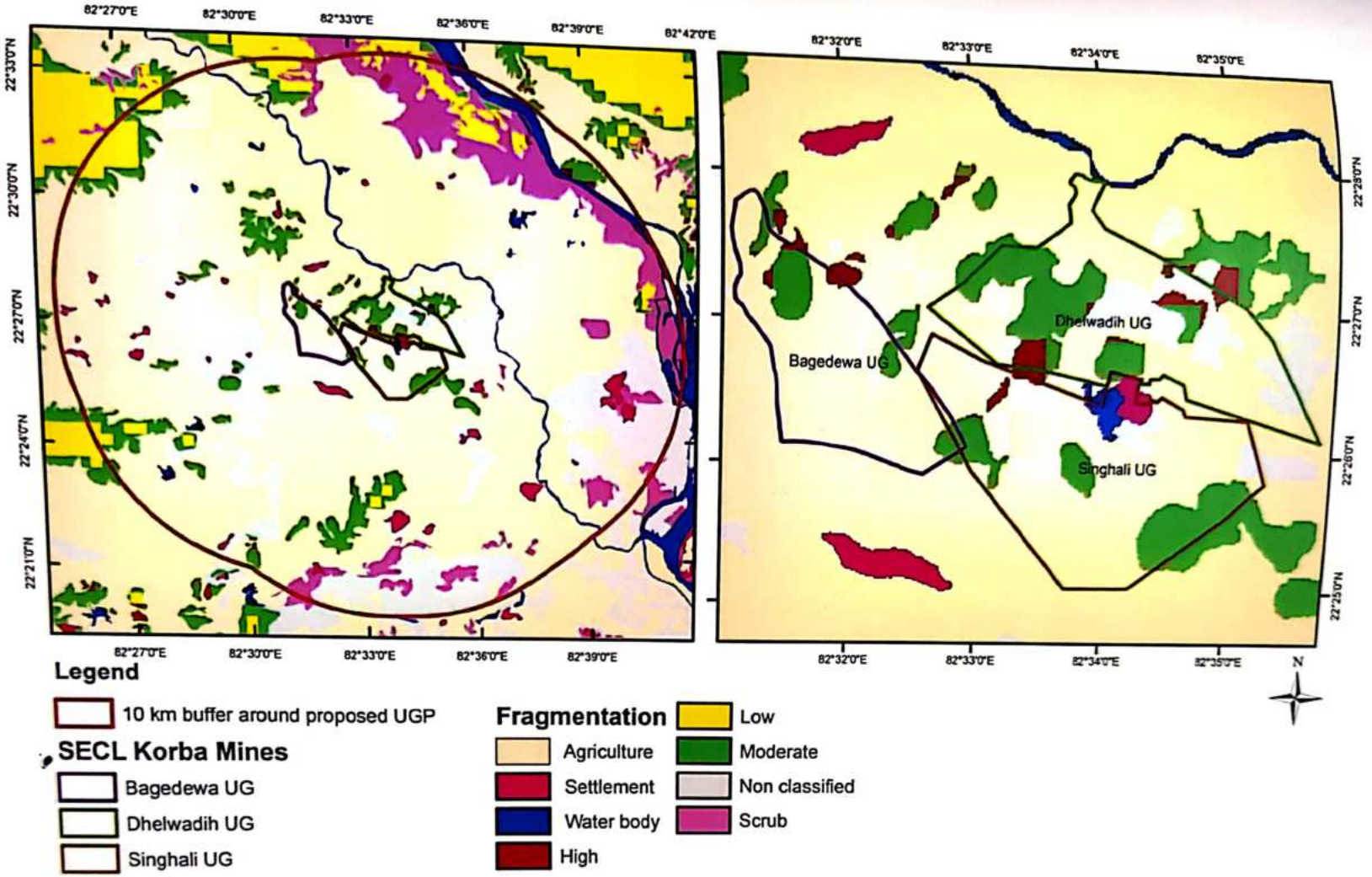
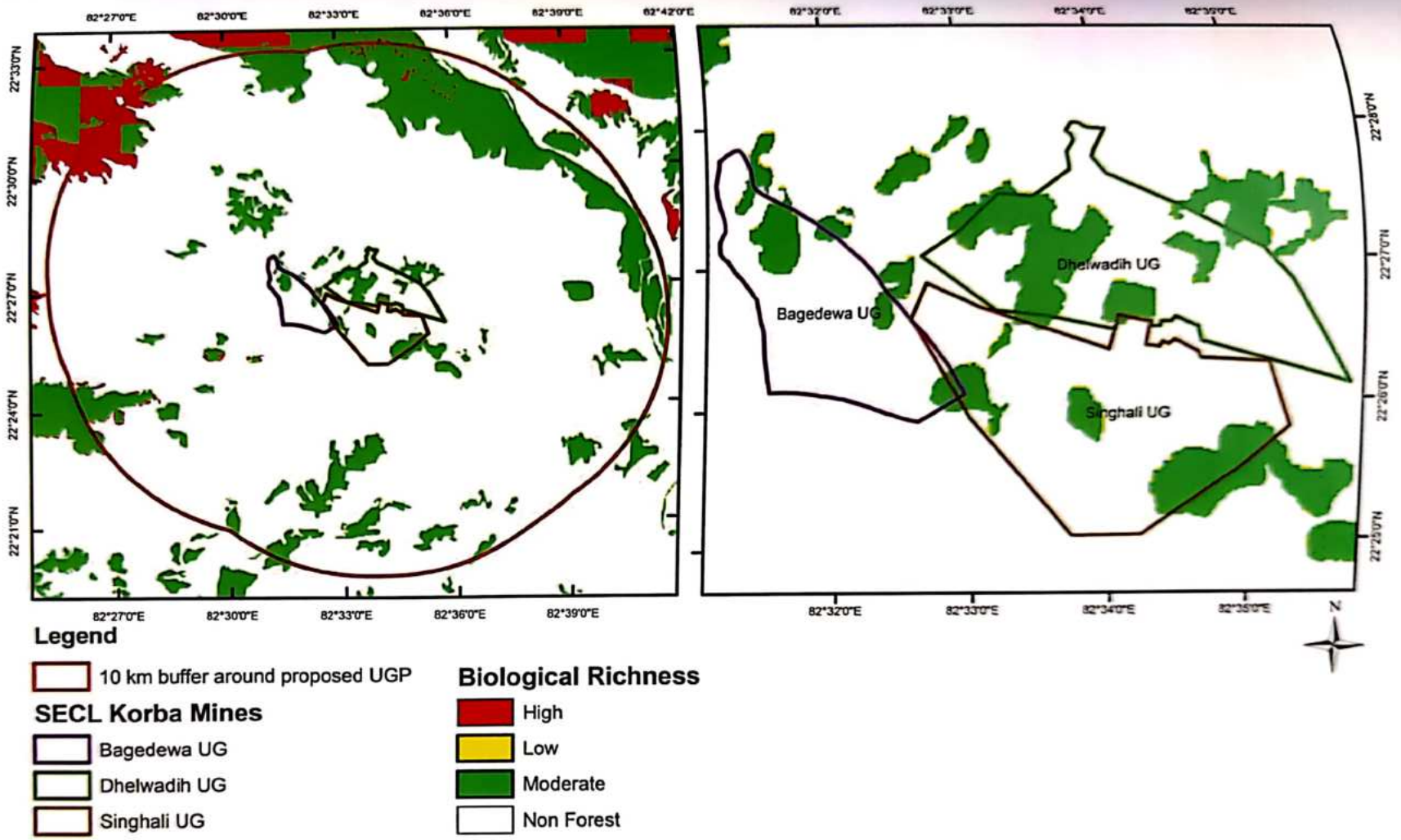


Map 5: Fragmentation index maps of Integrated mine boundaries of Dhelwadih UG, Bagdeva UG and Singhali UG mines and its 10 km buffer (zone of influence)



Map 6: Biological richness - Normalized difference vegetation index maps of Integrated mine boundaries of Dhelwadih UG, Bagdeva UG and Singhali UG mines and its 10 km buffer (zone of influence)

Water quality monitoring and assessment

Assessment of heavy metals and their effects on quality of water in water bodies in and around the project area is crucial for management. Continuous monitoring of drinking water quality is essential in terms of heavy metals and toxic substances.

Water samples were collected from a total of four locations which fall in the zone of influence. A portable sampling kit was used to collect water samples from the selected sites in Table 14. The samples were collected in September 2020.

Representative water samples were randomly collected from water bodies and bore wells near habitation (villages) located within 10 km buffer of Dhelwadih UG, Bagdeva UG and Singhali UG mines. Polypropylene bottles of 250 and 500 ml were used to collect and store water samples. The bottles were opened there only and firstly rinsed with sample water and then the samples were collected in bottles. pH and EC was measured using portable pH and EC meter at the time of collection of samples. 2-3 drops of Conc. HNO_3 was added in the water samples.

Visible features such as turbidity, colour and odour were noted down on the field records. The collected water samples were brought to Tropical Forest Research Institute Jabalpur for physico-chemical analysis using Inductively Coupled Plasma – Optical Emission Spectrometry (ICP-OES) in the laboratory. Micro and macro elements analysed from the water samples were found within permissible limits.

Table 14: Sampling locations located within 10 km buffer of Dhelwadih UG, Bagdeva UG and Singhali UG mines and its zone of influence

Sl. No.	Sampling locations	Geo-coordinates	Habitat / surrounding features
1.	Abhaypur Pond	N- 22° 26' 50.36" E- 082° 33' 06.26"	Vgetation mix of scattered trees and shrubs
2.	Budapura village Hand pump	N- 22° 28' 16.98" E- 082° 33' 53.41"	Village.
3.	Jawali Near Bagdeva	N- 22° 25' 33.32"	Scattered vegetation comprising

		E- 082° 32' 34.82"	herbs and grasses.
4.	Amarpura	N- 22° 27' 35.64" E- 082° 30' 55.47"	Village

Table 15: Macro and micro-elements in water samples collected during September, 2020 from water bodies in the zone of influence (10 km buffer) of Dhelwadih UG, Bagdeva UG and Singhali UG mines

Sl. No.	Site	Macro elements (%)				Micro elements (ppm)						
		Na	Mg	K	Ca	Cr	Mn	Fe	Co	Ni	Cu	Zn
.	Abhaypur Pond	1.752	1.186	1.754	15.234	-0.004	-0.004	-0.308	0.0004	-0.001	0.00142	-0.211
2.	Budapura village Hand pump	4.523	13.629	0.417	66.852	-0.003	0.004	-0.306	0.0004	-0.014	0.00011	-0.143
3.	Jawali Near Bagdeva	5.239	10.268	0.237	13.638	-0.004	-0.004	-0.309	0.0001	-0.018	0.00001	-0.228
4.	Amarpura	1.427	5.548	0.636	20.557	-0.004	-0.004	-0.309	0.0000	-0.013	0.00063	-0.217

Sl. No	Site	Micro elements (ppm)									
		Cd	Ba	B	Al	Hg	Pb	As	Se	Ec	pH
.	Abhaypur Pond	-0.00005	0.009	-0.014	-0.020	0.001	-0.005	0.0027	0.004	1446	6.8
2.	Budapura village Hand pump	0.00005	0.157	-0.015	-0.094	0.001	-0.004	0.0007	0.004	2391	7.11
3.	Jawali Near Bagdeva	-0.00010	0.002	-0.024	-0.102	0.001	-0.005	-0.0001	0.003	1867	7.41
4.	Amarpura	-0.00013	0.004	-0.027	-0.064	0.001	-0.005	0.0027	0.001	1534	7.32

Mitigative measures and restoration strategies to minimise adverse impacts

Keeping in view the extant Acts and Rules for conservation of forests, wildlife and overall bio-diversity and based on the analysis of the ground situation, following mitigative measures and restoration strategies are proposed to tackle the adverse impacts of the Dhelwadih UG, Bagdeva UG and Singhali UG mines.

Protection

Since, the whole of the core project area and its zone of influence area are inhabited by the human population and animals, it is important to ensure protection of the forest areas and its fauna from their deleterious effects. Hence, regular patrolling of the forest area should be ensured, especially in the fringe areas bordering human habitation to minimise exploitation of the forest, water source and its wildlife.

Catchment area and channel treatment

To ensure water availability to fauna during pinch period, channels most affected with the erosion and gullies formation would be treated as per the standard soil and moisture conservation measures (Boulder checkdams/ Anicuts etc) being practiced, under the supervision of the forest department.

The water of underground mine should not be allowed to mix with the adjoining channels of the area. Efforts should be taken to treat the mine water before it gets mixed with adjoining streams, river etc.

Habitat improvement through enrichment plantation

Since many species of fauna frequent the area, enrichment plantation is proposed in open forest of the zone of influence so that canopy cover is improved and enough food plants are available for birds and animals. The choice of species as food plants for Sloth bear may be Ficus, *Cordia myxa, Zizyphus jujuba, Mangifera indica, Syzygium cimini, Casia fistula* etc. (Schaller, 2004) and *Diospyros melanoxylon, Zizyphus mauritiana* (Yoganand *et al.*, 2005). The area-wise choice of species may be decided by the DFO, Katghora while preparing annual plan of operation every year.

Green belt

A green belt along the nearyby areas of the Dhelwadih UG, Bagdeva UG and Singhali UG mines would be beneficial in many ways leading to conservation of biodiversity, retention of soil moisture, recharge of ground water and maintaining pleasant micro climate of the region. In addition, vegetation cover can also absorb pollutants from the environment and helps in effective pollution control. Green belts in and around mining areas are important to the ecological health of any given region. Caution has to be ensured while selecting the species for green belt plantation. Plantation species should be indigenous and those that are already available in the landscape.

Raising of plantations in and around villages

Plantations proposed in the degraded land of the villages of zone of influence area so as to enrich biodiversity in consultation with the forest department. The preferred list of the species to be planted and the area may be decided through village level consultative meetings by the officials of Forest Department and villagers.

Managing invasive species

Lantana camara among the shrub species and *Hyptis suaveolens* among the herbs species have been found in the surveyed area as most important forest invasive species that need eradication through managemental interventions. Therefore, these weeds should be removed periodically from the forest area so that other forest species saplings are established.

6.1. Potential Conservation Areas (PCA)

Habitat conservation/ improvement is being suggested to carry out in some of the below identified areas in a phased manner. The list of areas mentioned here is an indicative list, there can be more areas which can be identified by the DFO, Katghora in due course to execute the works related to habitat improvement. The work needs to be started after getting final forest clearance and other clearances. Within the 10 km buffer of the Dhelwadih UG, Bagdeva UG and Singhali UG mines, there are many areas which are Reserved Forest. All such works are needed to be conducted within the prescriptions of Forest Working Plan and in consultation with DFO, Katghora.

Habitat improvement/development by *ex-situ* conservation through plantation, soil conservation, and development of water bodies is suggested in the following locations, which were surveyed to identify the possibility of carrying out conservation and mitigation measures for wildlife. Activities such as

compensatory plantation, plantation of fruiting trees and desilting of ponds may be carried out in the below mentioned locations and forest compartments.

Sl. No.	Potential conservation areas	Latitude/Longitude	Habitat Type
1.	Bharuhamuda	N- 22°24' 51.25", E- 082°25' 01.09"	Foot hill forests
2.	Pandripani	N- 22°30' 46.46", E- 082°27' 41.41"	Foot hill forests
3.	Manikpur	N- 22°24' 32.97", E- 082°26' 53.00"	Forest
4.	Mahora	N- 22°32' 14.75", E- 082°30' 57.06"	Rocky outcrops

The open forest areas within the 10 km buffer of the proposed Dhelwadih UG, Bagdeva UG and Singhali UG mines are found to have less than 10% canopy cover. Therefore, these are ideal places for undertaking plantation work. The choice of species for plantation has to be indigenous and should resemble the natural species composition of the area (which can also be referred from the species list given in this plan).

6.2. Conservation education

Training for the officials of SECL, Korba Area

Sensitization programme can be organised for the officials of SECL, Korba area regarding forest, wildlife and environmental conservation.

Training for the villagers and school children

For effective implementation of the conservation strategies, active co-operation of the all villagers of the zone of influence area and other stakeholders is required. Meetings and seminars will be organised in villages on regular basis to keep people actively involved. The training and awareness programme may include the forest and its utility, Forest and wildlife interaction, man-animal conflict, Forest and water regime of the area, Conservation and Development, habitat degradation etc.

Training for minimising the man-animal conflict

It is noteworthy to mention that maximum of human injury cases in the surrounding villages have been caused by Sloth bear alone. Usually, bear attacks take place when being suddenly surprised and not

knowing how to escape or when female bear with young ones are encountered. Therefore, it becomes imperative to train the villagers on the ways to avoid/minimise the interface with sloth bear.

Do's and don'ts for villagers must be widely circulated either formally or informally during the months of elephant transit in the neighbouring area, Mahua flowering months and December, January when bear cubs are born to minimise the conflict.

Immediate compensation to villagers for crop damage/ human injury

Immediate compensation to villagers should be given in case of injuries/death of human, crop raiding and damages to property caused by any wild animals as per the rates notified by the state forest department and after assessment of damage in consultation with the local forest officers.

Preventive vaccination of the livestocks in the villages of zone of influence

Vaccination programme should be conducted annually/bi-annually in all villages for prevention of diseases such as Black Quarter, Foot & Mouth Disease, Haemorrhagic Septicaemia, Brucellosis and Anthrax in large animals (cattle and buffaloes), PPR (*Peste-des-Petits* Ruminants) in goats and Swine Flu in Pigs in consultation with the animal husbandry department of the district. It will reduce the risk of disease transmission from livestock to wild animals.

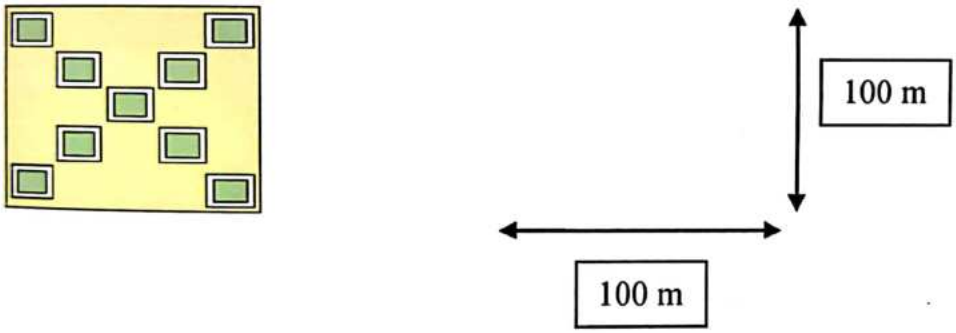
Research and Monitoring

Biodiversity monitoring

With a view to closely observe and analyse any changes in biodiversity, a baseline study needs to be carried out in the first year of the plan and re-survey will be done in 3rd, 5th, 7th and 9th years. The findings will be entered in the Biodiversity register of the Biodiversity Management Committee at Gram Panchayat level maintained under the provisions of the Biological Diversity Act, 2002.

Vegetation Monitoring

Habitat monitoring in woodland areas will be done using hectare plots (100m X 100m) in which 9 plots of 10m X 10m will be nested on diagonals. Further, 2m X 2m plots will be sub-nested in the centre of the 10m X 10m plot.



Recording within these plots will be done in the following manner:

Vegetation over 5 m height: In Hectare plot

Vegetation from 0.5m to 5m height: Nested plot

Vegetation less than 0.5m height: Sub-nested plot

Habitat use by different animals may be recorded through indirect signs within above nested plots.

Routine Ecological Monitoring

For ecological monitoring of the vegetation, following format will be used by the protection squad/frontline staffs of the range office and a register will be maintained:

Particulars of Patrolling			Phenology			
Date	Place & Compartment No.	Time	Flowering Trees/ Plants	Fruiting Trees/ Plants	Leaf Fall	New Leaves
1	2	3	4	5	6	7

Following indices will be prepared for each species of plants:

Frequency = Number of plots in which species Occur/Total number of plots surveyed x 100

Density = Total number of individuals of the species/Total number of plots surveyed x 100

Relative frequency = Frequency of a species /Sum of frequency of all the species x 100

Relative density = Density of a species / Sum of density of all species x 100

Species Richness Index d = S-1/log N

Where S = Number of species tallied over all Plots

N = Number of individuals tallied over all Plots

Shanon Index of general density:

$H = \Sigma (ni /N) \times \log (ni/N)$

Where ni = Importance value of each species

N = Total of importance values of all species

ni/N = Importance probability of each species

(Importance value is based on number of basal area)

The data collected during various phases for sampling for Vegetation, Human disturbance will be collated and put in GIS Domain. This can be correlated with animal base presence. Any change in the habitat can be monitored by time-series data analysis in GIS over the years.

Water quality monitoring

Quality testing of water in the water bodies to assess their content with regard to silt, heavy metals, toxins etc will be done from a certified laboratory and the report will be submitted to the DFO, Katghora every year.

Wildlife Monitoring of the Area

To maintain and preserve the wild animals for maintaining ecological processes of the area, periodic monitoring of major species has to be carried out based on standard protocols using line transect, road

transect for monitoring herbivores and carnivores, block count for elephant and point counts for monitoring birds during different seasons in different habitats.

All tree species being used by the birds for nesting must be retained as such and these species should be included in the plantation of the adjoining area. Snags should also be allowed to remain as such that are likely to be utilised by many birds species for nesting and perching.

Funding Structure and Responsibilities

Contingency Corpus Fund

A corpus fund with an initial corpus of Rs. 50.00 lakhs will be maintained with DFO, Katghora in a separate account to which contribution will be made by SECL, Korba Area to meet the requirement of immediate ex-gratia payment (for damages caused by wild animals) to the people of the zone of influence area.

Plan period

The plan is for a 10 year period from 2023-24 to 2032-2033. Intermediate revision may be undertaken if felt necessary by the forest department.

Monitoring Committee

A monitoring committee under the Chairmanship of the DFO Katghora will be formed with one representative from SECL Korba, village representatives and Range officer as members. The committee will oversee the smooth implementation of plan. The committee will assess the progress of implementation twice in a year based on the annual plan of operations and Budget. The committee will also ensure that the adherence to conditions imposed under statutory clearances is complied with in letter and spirit.

Funding

The plan will be fully funded by the South Eastern Coalfields Limited, Korba Area. A separate account shall be maintained for this purpose with DFO, Katghora who shall be implementing agency.

Budget

An estimated amount of **Rs. 821.25 Lakhs** is proposed under following categories to be undertaken based on the proposed mitigative measures for 10 years, with a provision for Chhattisgarh Forest Department (DFO, Katghora) to work out the exact costing in annual plan of operations and monitor the implementation of the prescriptions (Table 16).

Sl. No.	Category
1	Biodiversity monitoring

2	Habitat improvement
3	Catchment area and channel treatment
4	Training and awareness
5	Compensation
6	Contingency corpus fund

Table 16. Budget proposed for various activities and its breakup under the wildlife conservation plan for Dhelwadih UG, Bagdeva UG and Singhali UG mines

Sl. No.	Category	Items of work	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total amount in Rs.
													(in Lakhs)
1	Biodiversity monitoring	a. Habitat survey of the proposed site	8	8	3	0	0	0	0	0	0	0	19
		b. Ecological/Environmental monitoring	0	0	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	12.8
		c. Monitoring of physicochemical properties of water bodies near site	0	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	4
		d. Creation of biodiversity park / herbal garden	17	23	7	7	0	0	0	0	0	0	54
2	Habitat improvement	a. Enrichment plantation of suitable species	8	6	5	4	3	2	2	1	1	1	33
		b. Raising of plantations in and around villages	7	7	6	6	6	5	5	4	4	4	54
		c. Protection work (Fencing of boundaries, fields and villages)	8.5	3.5	3.5	2.7	2.7	1.6	1.6	1.6	1.6	1.6	28.9
		d. Weed/Invasive species eradication works	6.5	3.75	3.75	3.75	3.75	2.25	2.25	2.25	2.25	2.25	32.75
		e. Green belt	0	0	11.5	8.5	8	6	6	3	2	2	47
3	Catchment area and channel treatment	a. Soil and moisture conservation works	12	12	8	8	8	8	8	6	6	6	82
		b. Existing watershed development and reclamation of streams	16.5	11.5	11.5	11.5	7.5	7.5	5.2	5.2	3	3	82.4
4	Training and awareness	Empowering and sensitizing villagers for protection of wildlife	0	0	0	6.5	6.5	6.5	4.2	4.2	4.2	4.2	36.3
5	Compensation	Provision for compensation for loss/damage/injury to crop, property, human and livestock	8	8	6.5	6.5	6.5	5.7	5.7	5.7	4.3	4.3	61.2
6	Protection	a. Fire protection, watch towers	15	15	10	0	0	0	0	0	0	0	40
		b. CPT, Fencing of boundaries, fields and villages, wherever necessary	20	7	7	7	7	7	7	5	5	5	77
		c. Patrolling vehicles for wildlife monitoring	30	0	0	0	0	0	0	0	0	0	30
7	Contingency corpus fund	Corpus fund to remain with concerned DFO Katghora to meet any contingency and miscellaneous work as approved by concerned authorities	50	0	0	0	0	50	0	0	0	0	100
	Total		206.5	104.75	84.85	73.55	61.05	103.65	49.05	40.05	35.45	35.45	821.25

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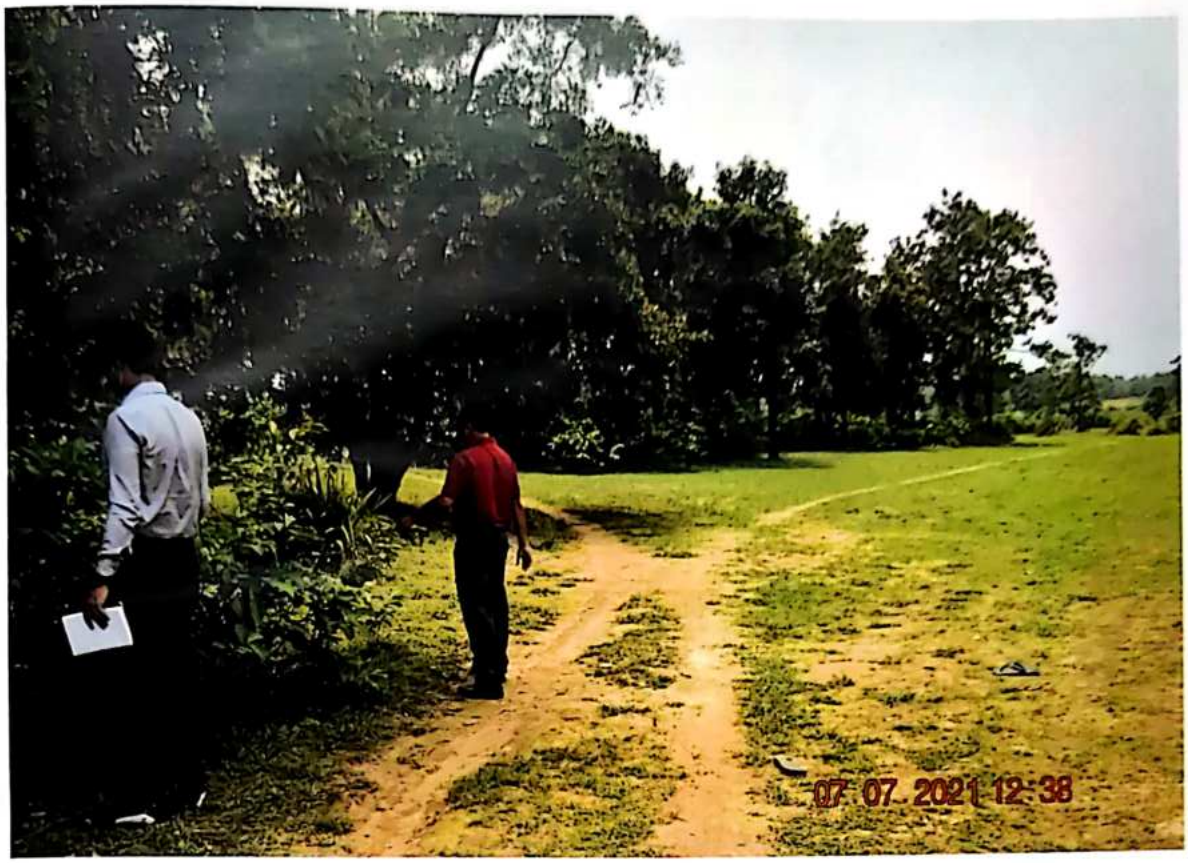
Photographs of the field visits:

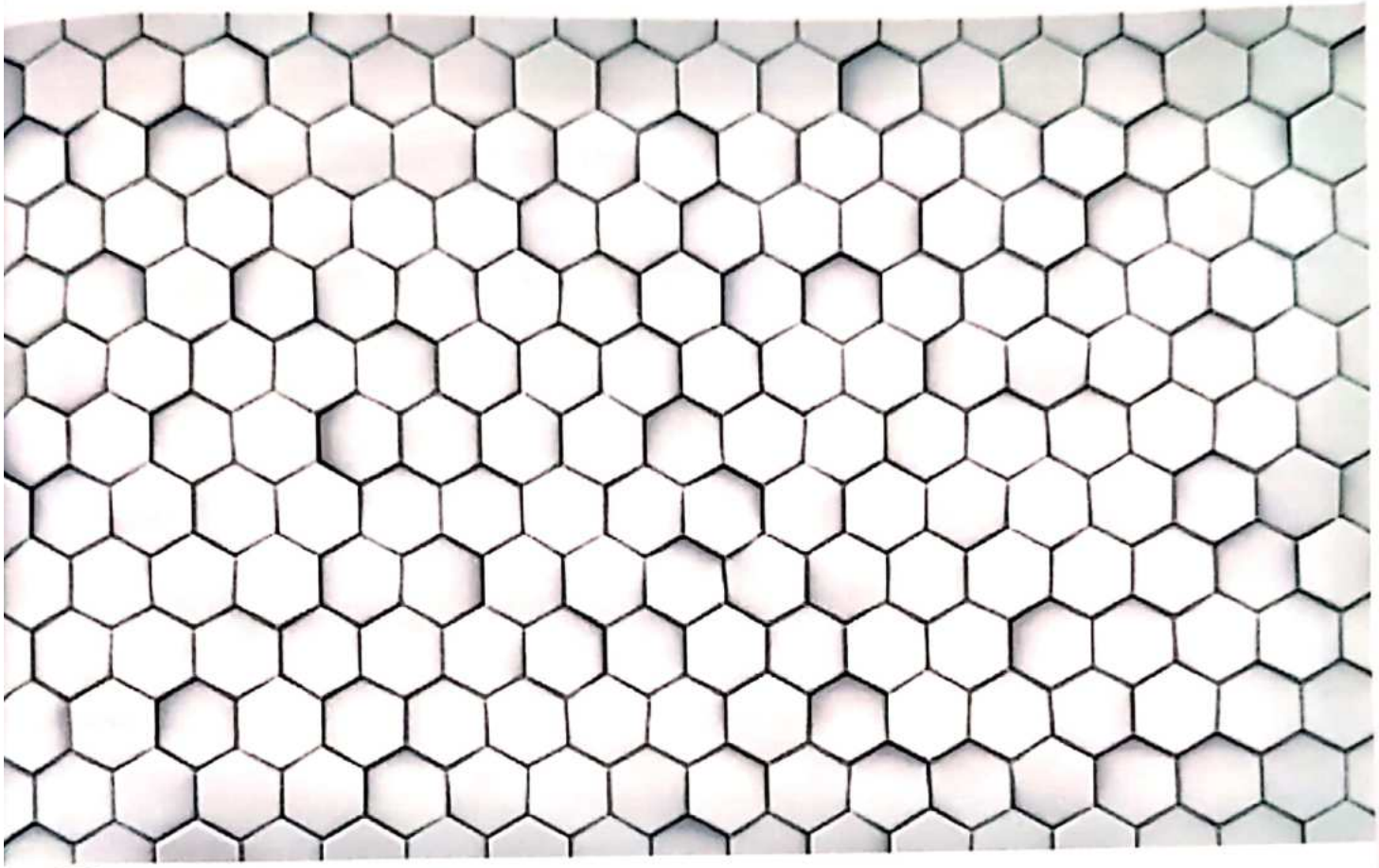
Team of Researchers having discussions with Officials of DSB mines

View of researchers collecting data in the forests surrounding DSB Mines



View of researchers collecting data in the forests surrounding DSB Mines

View of Potential Conservation Areas near Hasdeo-Bango reservoir



उष्ण कटिबंधीय वन अनुसंधान संस्थान

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