**GOVERNMENT OF TELANGANA**
**FOREST DEPARTMENT**

From
**Sri R.M.Dorbiyal, IFS,**
Principal Chief Conservator of Forests (Head of Forest Force)(FAC),
Telangana State, "Aranya Bhavan",
Saifabad, **Hyderabad.**

To
**The Spl. Chief Secretary to Government,**
Forests Department,
Telangana State,
**Hyderabad.**

**Ref.No. FC4/FC29/6/2022 , Dated:07/03/2023.**

**Madam**,

**Sub:** TSFD - F(C) Act, 1980 -Diversion of 649.3014 ha forest land in Ramavaram RF of Ramavaram Range of Kothagudem forest division for grant of mining lease for proposed VenkateshKhani OCP from Underground rights to Surface rights in Kothagudem Area in Bhadradri Kothagudem District in favour of M/s.SCCL - **Additional Information Sought by GoI, MoEF& CC, New Delhi- Information Furnished -** Regarding.

**Ref:**
1. CCF/CF, Kothagudem Rc.No.117/2020/M3,Dt:01.12.2020.
2. PCCF Rc.No. 10066/2019/FCA-4,Dt:16.01.2021.
3. GoI, MoEF & CC, New Delhi F.No. 8-05/2021-FC Dt. 08.03.2021.
4. PCCF Rc.No. 10066/2019/FCA-4,Dt:15.03.2021.
5. General Manager, Kothagudem Area, SCCL, Bhadradri Kothagudem district Ref.No.KGM/EST/F/33/265,Dt:10.06.2020.
6. FDO, Kothagudem Rc.No.631/2019/A5 Dt: 08.06.2021 addressed to DFO, BhadradriKothagudem
7. FDO, WLM kinnerasani Rc.No.213/2020/K3 Dt. 17.04.2021 addressed to DFO, Bhadradri Kothagudem.
8. PCCF Rc.No.10066/2019/FCA-4,Dt:29.06.2021.
9. General Manager, Environment, SCCL, Bhadradri Kothagudem district Ref.No.CRP/ENV/A/408A/617 dt:11.10.2021.
10. PCCF Rc.No.10066/2019/FCA-4 Dt:17.11.2021.
11. Director(Planning&Projects), SCCL, Kothagudem District Ref No.CRP/EST/C/005/1201 dt:21.12.2021.
12. PCCF Rc.No.10088/2021/FCA-4 Dt:10.01.2022.
13. State govt Lr.No.232/For.I(1)/2021 Dt. 28.01.2022.
14. Director(Operations), SCCL, Kothagudem District Ref No.CRP/EST/C/005/257 dt:04.02.2022.
15. PCCF Rc.No.10088/2021/FCA-4 Dt:21.02.2022.
16. GoI, MoEF & CC, New Delhi F.No. 8-05/2021-FC Dt. 25.02.2022.
17. CF, Karimnagar Rc.No.167/2022/M2, Dated:-06-05-2022.
18. PCCF Rc.No.FC4/FC29/6/2022 , Dated: 16-05-2022.
19. State govt Lr.No.232/For.I(1)/2021 Dt. 24.05.2022.
20. CF, Kothagudem Rc.No.40/2020/M3 dated 18.06.2022.
21. GoI, MoEF & CC, New Delhi F.No. 8-05/2021-FC Dt. 20.06.2022.
22. Director(Planning&Projects), SCCL, Kothagudem District Ref No.CRP/EST/F/117/724 dt:21.06.2022.
23. CF, Karimnagar Rc.No.167/2022/M2 dated 28.06.2022.
24. PCCF Rc.No.FC4/FC29/6/2022 , Dated:05.07.2022
25. GoI, MoEF & CC, New Delhi F.No.8-05/2021-FC Dt.26.10.2022.
26. PCCF Rc.No.FC4/FC29/6/2022 , Dated:12.11.2022.
27. DFO, Bhadradri Rc.No.241/2020/D1 Dt. 28.02.2023 addressed to CF,

Bhadradri
28.Director(Planning&Projects), SCCL, Kothagudem District
Ref No.CRP/DPP/VK/OC/20/51 dt:04.03.2023.

Vide ref 25th cited, the GoI, MoEF & CC, New Delhi has sought additional information on the subject proposal for further consideration of the proposal.

Accordingly, vide references 27th and 28th cited, the District Forest Officer, Bhadradri Kothagudem and the Director(Planning&Projects), SCCL, Kothagudem District has furnished information as desired by the GoI, MoEF & CC, New Delhi which are furnished as follows, with remarks:

**Point No.1:-A study to be carried out by IIFM Bhopal on the Cost-Benefit analysis on conversion of underground mines to open cast mines and the cost of the study will be borne by User Agency. The Cost Benefit Analysis shall account for the ecological/ecosystem services provisions from the proposed mining area/landscape.**

**Reply:-** M/s.SCCL has informed that, the work of getting the Cost Benefit analysis was entrusted to the IIFM-Bhopal. Accordingly, the Director, IIFM-Bhopal, has sent the report and the report has been prepared after field visits and taking all the essential components like ecological/ecosystem services into accounts. The revised Cost Benefit ratio has been arrived as 1:12.53 against the previous of 1:20.10. In the report emphasis has been laid on water conservation, sedimentation regulation etc. The SCCL is willing to work with this cost: benefit ratio and it is favorable to them. The report is enclosed.

**Point No.2:-The details/ KML files of the DFL identified for carrying out one half times CA w.r.t the safety zone may be provided.**

**Reply:-** The District Forest Officer, Bhadradri Kothagudem has informed that the one and half times the safety zone area is identified to an extent of 11.00 Ha in compartment No. 29 of Penagadapa RF, Ramavaram Range of Kothagudem Division. The Safety zone area map and KML file is enclosed.

M/s. SCCL will deposit the money with the Forest department as and when asked for raising afforestation in this area.

**Point No.3:-The State Government may comment on the dumping of the material in Goutham Khani Open Cast Mining and its impact on the approved Mining closure plan/ R&R plan based activities.**

**Reply:-**

1. M/s.SCCL has informed that the GouthamKhani OC Mine was started during the year, 1993-94 by converting 4 underground mines viz., 8 Incline, 9 Incline, 10 Incline and 11 Incline mines into OC. From this mine, 71.55 Mt of Coal has been extracted by generating 335.49 Mm3 of OB. Out of 902 Ha of GK OC Mine area, the forest land is 540.27 Ha and non-forest land is 361.73 Ha. The permission under F (C) Act for 540.27 Ha of forest land was obtained in 3 parcels viz., (i) 261.31 Ha of FL granted vide F.No.8-117/2002-FC, dt.01.02.2010, (ii) 124 Ha of FL granted vide F.No.8-17/98-FC, dated 08.02.1999 and (iii) 154.96 Ha granted vide F.No.8-62/2005-FC, dated 09.07.2008.
2. As per the approved Mining Plan (MP) of GK OC Mine, overburden dump was proposed in an area of **503.60 Ha up to a height of +80 Meters.** The void is supposed to be with standing water in an area of 221.64 Ha up to a depth of 240 Meters. The safety barrier all along the boundary is supposed to be in an area of 75.98 Ha and infrastructure area is in an area of 56.28 Ha.
3. At the time of submission of Mining Plan of GK OC Mine, there was no proposal of conversion of VK-7 and PVK-5 Incline UG coal mines into Open Cast. Subsequently, as the coal was exhausted in GK OC, without further scope of extraction of coal by UG method in VK No.7 Incline, these 2 mines were closed in 2022 and 2021 respectively. PVK No.5 Incline is an adjoining operating UG mine and will be day lighted after 11 years (from 2019-20) of underground mining. Except, 9.93 MT of balance reserves to be extracted underground mining during the next 11 years (from 2019-20), no further reserves could be extracted from these 2 mines by UG method due to adverse geo-mining conditions and safety issues prevailing in the mines. In case, these 2 mines are not converted to opencast, about 180.18 MT cannot be extracted and lost forever. Keeping in view of this, VK Coal Mine (Amalgamation of VenkateshKhani No.7 Incline, PadmavathiKhani No.5 Incline &GouthamKhani OC Mine) was formulated.
4. Accordingly, SCCL had obtained approval of Mining Plan (Including Mine Closure Plan) from MoC, GoI, vide 38011/12/2017-PCA, Dt.27.01.2020 for VK Coal Mine which involves 787.14 Ha of GK OC area. As per this proposal, VK No.7 UG will be converted into OC immediately and PVK No. 5 Incline will be converted into OC after 11 years (from 2019-20) of UG mining. In this context, it is to mention that 100 Ha of rehabilitated OB dumping area (FL) (out of 361.34 Ha of reclaimed external dump area of GK OC Mine), was surrendered to the Forest Department and the revised forest land diversion for 161.34 Ha of forest land was obtained vide F.No.8-117/2002-FC, dated 01.02.2010. Further, it is proposed to utilize 403.60 Ha of dumping area, 221.64 Ha void area, 75.98 Ha of safety zone all along the boundary & 56.28 Ha of infrastructure area of GK OC in the instant proposal as part of sequential mining.
5. It is further submitted that by utilising 403.60 Ha of GK OC OB dumping area, 221.64 Ha of GK OC voids & 75.98 Ha of safety zone all along the boundary and 56.28 Ha of infrastructure area, the following benefits will be accrued:

a. No new area is required for breaking for OB dumping, thus reducing the soil loss and soil flow into the adjoining area, if any.
b. In the instant proposal, rehabilitation of OB dump area will be in 1307.356 Ha (403.60 Ha of GK OC dumping area + 903.756 Ha of new OB dumping area) as

against rehabilitation in OB dumping area of 503.60 Ha in GK OC Mine. Thus, there is an increase of 803.756 Ha of OB dumping area. Hence, SCCL will do rehabilitation in more areas including regrassing which will be available for grazing purpose, carbon sequestration and other social benefits etc. The increased area after rehabilitation will also be helpful for wildlife in the adjoining area.

c. The void area will be in 386.334Ha with standing water upto 300 meters depth as against 221.64 Ha area of GKOC mine upto 240 meters. This will help in recharging the ground water in more area in the project as well as adjoining areas. This will be also helpful to wildlife and general improvement in landscape for wildlife.
d. The existing safety zone all along GKOC in 75.98Ha will be maintained and increased up to 160.80 Ha area in VKOC, thus reducing the impact, if any on the nearby wild life.
e. The existing manpower of GKOC including outsourcing manpower employed from the adjoining villages will be continued in the VKOC and hence, the employment will be continued.
f. By starting this mine, 180.18Mt of coal from VK OC will be produced during its life (40 years from 2019-20). Hence, the sustenance of coal supplies will be continued to the adjoining thermal power stations (Kothagudem Thermal Power Station (KTPS) of TS GENCO (1800 MW), Nava Bharat Ventures (264 MW), etc) situated at a distance of around 20 km.
g. Thus, by converting VK No.7 Incline & PVK No.5 Incline UG mines into OC by utilising GKOC Mine area, it will be beneficial to the SCCL, the State Government.

**Table 1**. Summary of impacts of dumping of the material in Goutham Khani Opencast Mining

| Sl. No | Parameter | GK OC | VK OC | Benefits of VK OC |
|---|---|---|---|---|
| 1 | Rehabilitation of OB dumping area (Ha) | 503.60 | 1307.356 | 1. Rehabilitation in more areas including regrassing which will be available for grazing purpose, carbon sequestration and other social benefits etc.<br>2. Helpful for wildlife in the adjoining area. |
| 2 | Void Area (Ha) for recharging the ground water | 221.64 | 386.334 | 1. Help in recharging the ground water in more area in the project as well as adjoining areas.<br>2. Helpful to wildlife and general improvement in landscape for wildlife. |
| 3 | Safety Zone all along the oc mine boundary (Ha) for reducing the impact on nearby wild life | 75.98 | 160.80 | 1. Increased area under safety zone will help in reducing the impact, if any on the nearby wild life. |

**Point No.4:-Considering the area to be diverted is very large a biodiversity impact assessment study may also be carried out by reputed institution. The cost for the study will be borne by the User Agency and the study report shall be submitted to this Ministry as early as possible.**

**Reply:- M/s.SCCL has** submitted the biodiversity report carried out by the EPTRI (Environment Protection Research & Training Institute, Hyderabad) (Copy enclosed). In the report it has been recommended to engage one wildlife expert at least for 10 years to monitor the impact of mining in adjoining forest area in the buffer, besides taking suitable Soil Moisture Conservation works in the adjoining areas and the same has also been reflected vide para 5 (Wildlife) in the Site Inspection report of the IRO, Hyderabad. A Wildlife Conservation/Mitigation plan was prepared was approved by the Chief Wildlife Warden, TS, vide reference 5694/2021/WL-I Dt.12.10.2021 for Rs.4.78 Crores.

Further , it is submitted that the GK OC Mine has been closed and nearest KTPS thermal power plant is having linkage with the proposed VK OC mines.

In view of the above, the State Government are requested to forward the information to GoI, MoEF& CC, New Delhi for consideration of this proposal for placing this proposal before FAC for grant of Stage-I approval as the proposal is very crucial for coal supply to the nearby thermal power plants.

**Encl: As above.**

Yours faithfully,

Signed by Rakesh Mohan Dobriyal
Date: 07-03-2023 12:04:39
Reason: Approved

Prl. Chief Conservator of Forests
Head of Forest Force(HoFF)

Advance Copy submitted to the Director General of Forests & Special Secretary to the Govt, MoEF& CC, GoI, Indira Paryawarana Bhawan, Jorbagh Road, New Delhi – 110003 for information and necessary action.

**Copy to**

The Conservator of Forests, Bhadradri Circle and the District Forest Officer, Kothagudem.

Sri Surendra pandey, IFS (Retd.), Advisor (Forestry), The SCCL, Singareni Bhavan, Red Hills, PB.No.18, Khairatabad(Post), Hyderabad – 500004 for information .

The General Manager, M/s Singareni Collieries Corporation Limited, Kothagudem Area, Bhadradri Kothagudem District, PO: Venkatesh Khani – 507103

// True Copy //

9/3/23

for Principal Chief Conservator of Forests

9/3/23

**G.VENKATESWARA REDDY**
Director (Planning & Projects)

**The Singareni Collieries Co. Ltd.**
(A Government Company)
KOTHAGUDEM - 507 101,
Bhadradri Kothagudem Dist.,T.S,. India.

CIN : U10102TG1920SGC000571

Ref.No.CRP/DPP/VK OC/20151 Date: 04.03.2023

To
The Principal Chief Conservator of Forests
& Head of Forest Force,
Govt. of Telangana,
Aranya Bhavan, Hyderabad.

Sir,

Sub:- F (C ) - Diversion of 649.3014 Ha of RF for Venktesh Khani OCP in Kothagudem Forest Division, submission of additional information as sought in the EDS raised by MOEF&CC, GOI, request to furnish this information to the MOEF &CC, GOI, and uploading it in Parivesh portal - Reg.

Ref:- 1. MoEF&CC, GoILr.No. 8-05/2021-FC, dated 26.10.2022.
2. GM KGM Ref.No-KGM/EST/F/33/594 Dt.15.12.2022
3-Director IIFM Ref.No-IIFM/SPS/Aca 01/2023 /28 Dt.20.02.2023

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Kind attention is invited to the references 1st cited wherein EDS has been raised and certain additional information was sought by the MOEF &CC, GOI. All the details are furnished herewith for favor of information and submission to the MOEF &CC, GOI through the State Government.

1. *A study to be carried out by IIFM Bhopal on the Cost-Benefit analysis on conversion of underground Mines to open cast mines and the cost of the study will be borne by User Agency. The Cost-Benefit Analysis shall account for the ecological/ecosystem services provisions from the proposed mining area/landscape.*

As advised by the MOEF &CC, GOI, the work of getting the C : B analysis was entrusted to the IIFM-Bhopal. Accordingly, vide reference 3rd cited, the Director, IIFM-Bhopal, has sent the report. This report has been prepared after field visits and taking all the essential components like ecological/ecosystem services into accounts. The revised C:B ratio has been arrived as 1:12.53 against the previous of 1:20.10. In the report emphasis has been laid on water conservation,



OFFICE : +91-8744-242602, Fax : +91-8744-242724, E-mail : dpp@scclmines.com

sedimentation regulation etc. The SCCL is willing to work with this cost : benefit ratio and it is favorable to them. The report is enclosed as **Annexure-I**

2. *The details/KML files of the DFL identified for carrying out one half times CA w.r.t the safety zone may be provided.*

The KML file of the DFL identified for carrying out one and half times CA w.r.t the safety zone is enclosed as **Annexure-II**. This area comes to 11 Ha.

The SCCL will deposit the money with the Forest department as and when asked for raising afforestation in this area. An undertaking to this effect is also enclosed.

3. *The State Govt. may comment on the dumping of the material in Goutham Khani Open Cast Mining and its impact on the approved Mining closure plan/R&R plan based activities.*

1. It is brought to the kind notice that Goutham Khani OC Mine was started during the year, 1993-94 by converting 4 underground mines viz., 8 Incline, 9 Incline, 10 Incline and 11 Incline mines into OC. From this mine, 71.55 Mt of Coal has been extracted by generating 335.49 Mm3 of OB. Out of 902 Ha of GK OC Mine area, the forest land is 540.27 Ha and non-forest land is 361.73 Ha. The permission under F (C) Act for 540.27 Ha of forest land was obtained in 3 parcels viz., (i) 261.31 Ha of FL granted vide F.No.8-117/2002-FC, dt.01.02.2010, (ii) 124 Ha of FL granted vide F.No.8-17/98-FC, dated 08.02.1999 and (iii) 154.96 Ha granted vide F.No.8-62/2005-FC, dated 09.07.2008.

2. As per the approved Mining Plan (MP) of GK OC Mine, overburden dump was proposed in an area of **503.60 Ha up to a height of +80 Meters**. The void is supposed to be with standing water in an area of 221.64 Ha up to a depth of 240 Meters. The safety barrier all along the boundary is supposed to be in an area of 75.98 Ha and infrastructure area is in an area of 56.28 Ha.

3. At the time of submission of Mining Plan of GK OC Mine, there was no proposal of conversion of VK-7 and PVK-5 Incline UG coal mines into Open Cast. Subsequently, as the coal was exhausted in GK OC, without further scope of extraction of coal by UG method in VK No.7 Incline, these 2 mines were closed in 2022 and 2021 respectively. PVK No.5 Incline is an adjoining operating UG mine and will be day lighted after 11 years (from 2019-20) of underground mining. Except, 9.93 MT of balance reserves to be extracted underground mining during the next 11 years (from 2019-20), no further reserves could be extracted from these 2 mines by UG method due to adverse geo-mining conditions and safety issues prevailing in the mines. In case, these 2 mines are not converted to opencast, about 180.18 MT cannot be extracted and lost forever. Keeping in view of this, VK Coal Mine (Amalgamation of Venkatesh Khani No.7 Incline, Padmavathi Khani No.5 Incline & Goutham Khani OC Mine) was formulated.

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a) No new area is required for breaking for OB dumping, thus reducing the soil loss and soil flow into the adjoining area, if any.

b) In the instant proposal, rehabilitation of OB dump area will be in 1307.356 Ha (403.60 Ha of GK OC dumping area + 903.756 Ha of new OB dumping area) as against rehabilitation in OB dumping area of 503.60 Ha in GK OC Mine. Thus, there is an increase of 803.756 Ha of OB dumping area. Hence, SCCL will do rehabilitation in more areas including regrassing which will be available for grazing purpose, carbon sequestration and other social benefits etc. The increased area after rehabilitation will also be helpful for wildlife in the adjoining area.

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d) The existing safety zone all along GKOC in 75.98Ha will be maintained and increased up to 160.80 Ha area in VKOC, thus reducing the impact, if any on the nearby wild life.

e) The existing manpower of GKOC including outsourcing manpower employed from the adjoining villages will be continued in the VKOC and hence, the employment will be continued.

f) By starting this mine, 180.18Mt of coal from VK OC will be produced during its life (40 years from 2019-20). Hence, the sustenance of coal supplies will be continued to the adjoining thermal power stations (Kothagudem Thermal

Power Station (KTPS) of TS GENCO (1800 MW), Nava Bharat Ventures (264 MW), etc) situated at a distance of around 20 km.

**g)** Thus, by converting VK No.7 Incline & PVK No.5 Incline UG mines into OC by utilizing GKOC Mine area, it will be beneficial to the SCCL, the State Government.

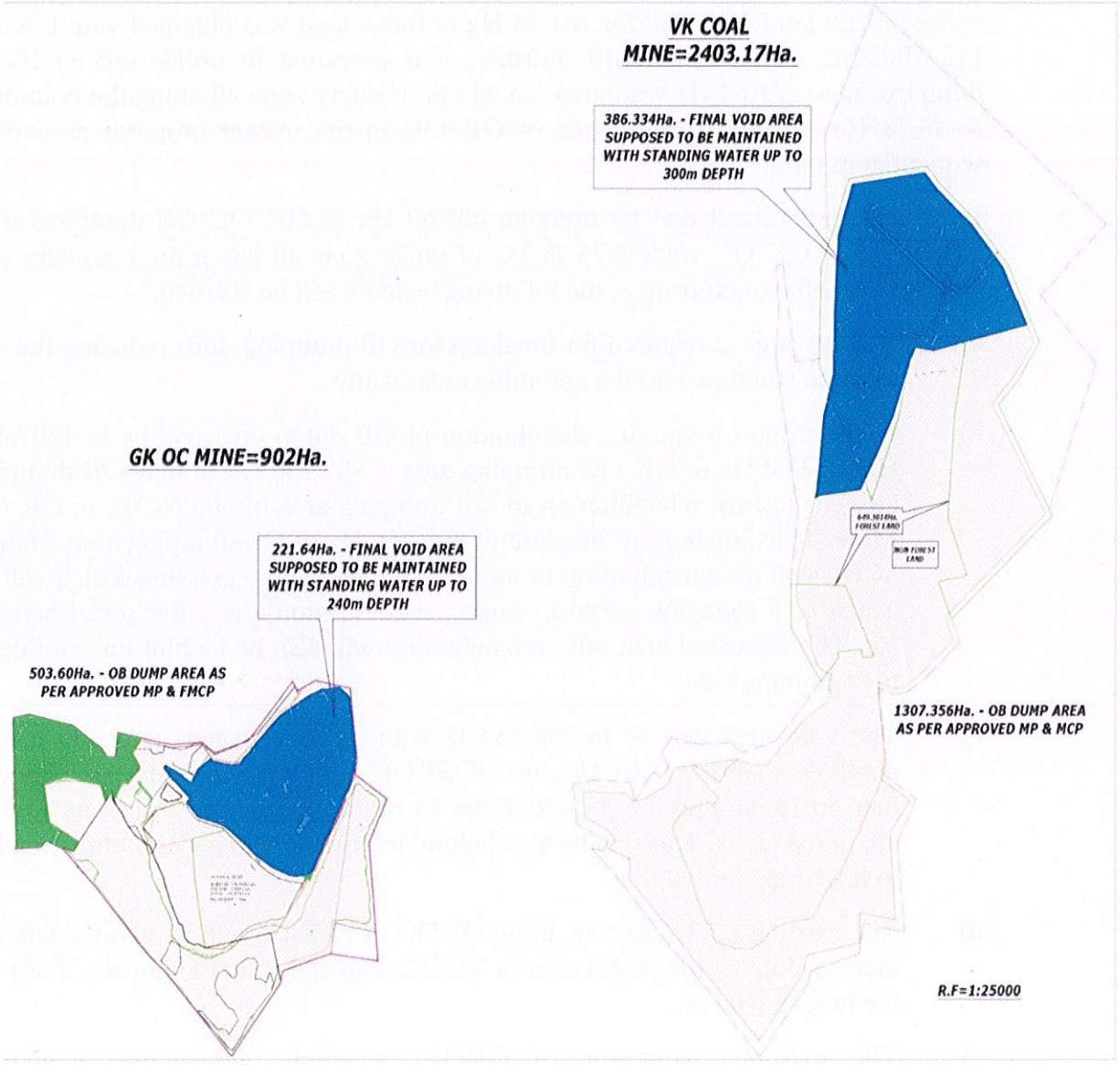

**Table 1.** Summary of impacts of dumping of the material in Goutham Khani Opencast Mining

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| 3 | Safety Zone all along the oc mine boundary (Ha) for reducing the impact on nearby wild life | 75.98 | 160.80 | 1. Increased area under safety zone will help in reducing the impact, if any on the nearby wild life. |

*iv-* *Considering the area to be diverted is very large a biodiversity impact assessment study may also be carried out by reputed institution. The cost for the study will be borne by the User Agency and the study report shall be submitted to this Ministry as early as possible.*

The Singareni Collieries (SCCL) vide reference 2nd cited, has submitted biodiversity report carried out by the EPTRI (Environment Protection Research & Training Institute, Hyderabad) to the O/o Principal Chief Conservator of Forest & HOFF, Hyderabad. (Copy enclosed as Annexure-III). In the report it has been recommended to engage one wildlife expert at least for 10 years to monitor the impact of mining in adjoining forest area in the buffer, besides taking suitable Soil Moisture Conservation works in the adjoining areas. The same has also been reflected vide para 5 (Wildlife) in the Site Inspection report of the IRO, Hyderabad. A Wildlife Conservation/Mitigation plan was prepared was

approved by the Chief Wildlife Warden, TS, vide reference 5694/2021/WL-I Dt.12.10.2021 for Rs.4.78 Crores.

It is submitted that as GKOC mine has been closed and nearest KTPS Thermal power plant is having linkage with this proposed VKOC Mines, early starting of the mining in this area is crucial.

Hence, it is humbly requested to kindly furnish this EDS replies to the MOEF &CC, GOI, through the State Government with a request to consider this proposal for placing this proposal before FAC during this month ie. March'2023 for grant of Stage-I as this proposal is very crucial for coal supply to the nearbythermal power plants.

Yours faithfully

Director (Planning & Projects)

Encl: as above

Copy submitted to :

The Inspector General of Forests (FC), Ministry of Environment and Forests & Climate Change, Government of India. Indira Paryavaran Bhavan, Jorbagh Road, Aliganj, New Delhi- 110 003 for favor of information with a request to consider our request.

The Regional Officer, Integrated Regional Office, MOEF & CC, GOI, 3rd Floor, Aranya Bhavan, Hyderabad, for favor of information.

The Chief Conservator of Forests, Bhadradri Circle, Warangal, for favor of information with a request to submit this report to the Nodal Officer & the Principal Chief Conservator of Forests, TS.

The District Forest officer, Bhadradri Kothagudem for favor of information with a request to submit this report to the Nodal Officer & the Principal Chief Conservator of Forests, TS.

Yours faithfully

Director ( Planning&Projects)

G. VENKATESWARA REDDY
Director (Planning & Projects)
The Singareni Collieries Co. Ltd.
KOTHAGUDEM

# Cost Benefit Analysis studies for Conversion of Underground Mine to Open Cast Mine of Venkatesh Khani Coal Mines of SCCL

Submitted by:

**Indian Institute of Forest Management**
**Bhopal**

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# 1 Introduction

Singareni Collieries Company Limited (also known as SCCL) is jointly owned by the Government of Telangana (51%) and the Government of India (49%). It comes under the Department of Energy of Telangana Government. The Union Government's administration of the company is held by the Ministry of Coal.

The Singareni Collieries Company Ltd. (SCCL) currently operates 24 underground mines and 18 open cast mines. These 42 mines are spread over six districts of Telangana which are Komaram, Bheem Asifabad, Mancherial, Peddapalli, Jayashankar Bhupalpalli, Bhadradri Kothagudem and Khammam. In the Godavari valley coalfield – There is a gap of 19.5 MT between demand and supply. To bridge this gap, SCCL is undertaking expansion of existing opencast mines, conversion of underground mines to opencast and opening new mines in the lease hold area. SCCL is also to open a new coal mine (Naini Coal Block) in Odisha State.

*Figure i: Study Area*

The study area of 650 Ha is located at Ramavaram RF, Kothagudem Forest Division in Bhadradri Kothagudem district of Telangana. Its geographical coordinates are Latitude 170 27'18" N to 170 28'04" N and Longitude 800 37'30" E to 800 39'45" E. The maximum temperature varies between 22.5 to 40.6°C with wind speed of 5.6m/s for south to south-west direction. The relative humidity ranges between 42.6 percent and 99.9 percent. The annual rainfall is 1150.7mm. There is presence of red soil.

The present assignment deals with calculating a revised benefit cost ratio taking into account the costs related to Ecosystem Services. These costs have not been accounted for in the original NPV calculations. The result is a revised Benefit-Cost ratio after considering the costs of ecosystem services that have not been taken into account in the original ratio.

# 2 Ecosystem Services

***Ecosystem Services***

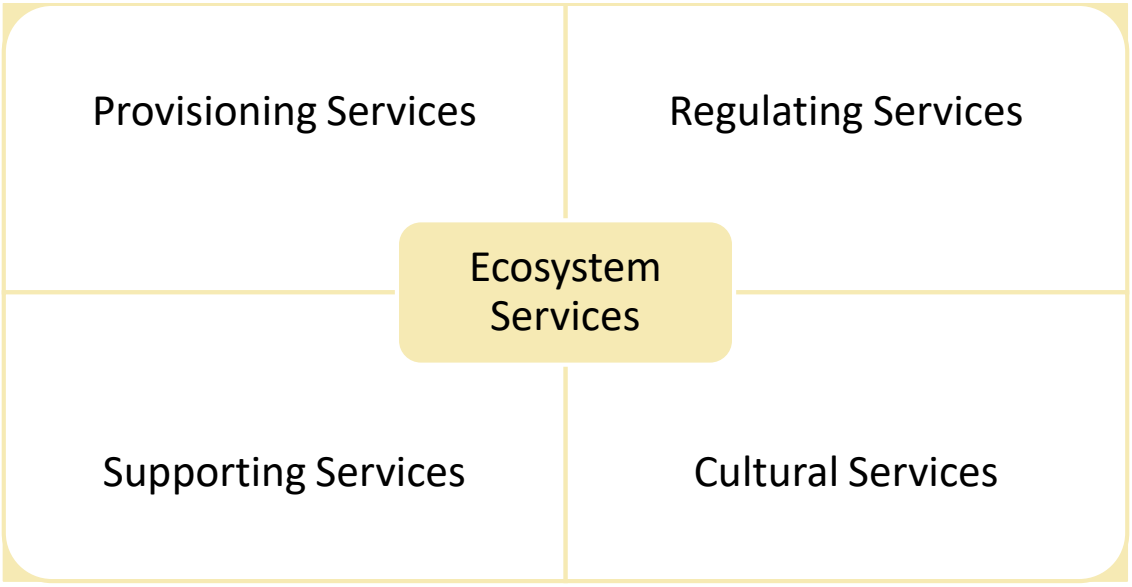
*Benefits (in terms of goods or services) provided by nature that are of fundamental importance to human well-being, health, livelihoods, and survival and include provisioning services, regulating services, cultural services, and supporting services*

The first study on the concept of the ecosystem was done by Daily et al. (1997). According to the study, ecosystem services are "a wide range of conditions and processes through which natural ecosystems, and the species that are a part of them, help sustain and fulfil human life. They maintain biodiversity and the production of ecosystem goods, such as food, forage timber, biomass, fuel, natural fibre, and many pharmaceuticals, industrial products, and their precursors".

Some common examples of ecosystem services are carbon sequestration and storage, air and water purification, flood mitigation, soil fertility, generation, renewal and preservation of soils, wastes decomposition, pollination, seeds dispersal, nutrients cycling, protection from the sun's harmful ultraviolet rays, partial stabilization of climate, moderation of weather events, aesthetic beauty, etc.

The flow of ecosystem goods and services in a region is determined primarily by its spatial dimensions. It also depends on the extent, the type, layout, and the associated ecosystem which are supplying the resources. For instance, the value of water quality service offered by a waterbody can critically be affected by the amount of nutrients cycled, sediments retention, waste detoxification etc. It may also be dependent on the location and soil type.

The Millennium Ecosystem Assessment (MEA) report of 2005, defines ecosystem services as the benefits people obtain from ecosystems. It categorizes ecosystem services under the following four categories.



There are few other studies where ecosystem services classification is based on the functional groups (de Groot et al., 2002, MA, 2005) such as habitat, production, regulation, carrier, and information services. The other classification (Norberg, 1999) is through organizational groupings. It includes services associated with certain species, that regulate some exogenous input, or that are related to the organization of biotic entities.

Another classification is through descriptive groupings, such as renewable non-renewable, resource goods, physical structure services, biotic services, biogeochemical services, information services, and social and cultural services (Moberg and Folke, 1999).

However, Boyd and Banzhaf, 2007 and MA, 2005 consider ecosystem services as only those goods and services that are directly enjoyed, consumed or used by humans as Final Ecosystem Goods and Services (FEGS). It identifies the following four types of ecosystem goods and services.

| | |
|---|---|
| **Directly usable final ecosystem goods and services** | Used directly by the human population (e.g., recreational or protective services, foodstuffs and feed production, timber yield, contribution to renewable energy) |
| **Input factors for market goods** | Not directly consumed (e.g., pollination as an agricultural input) |
| **Natural/healthy living environment** | Qualities of health-related environmental media are summarized (e.g., air quality) |
| **Intermediate ecosystem goods and services** | Offer humans no direct benefit |

According to Staub et al. (2011) ecosystem services "concentrates on those aspects of ecosystems that have a recognizable connection to (human) welfare, and is used or valued in some form or other by the human population".

# 3 Sediment Delivery Ratio (SDR)

## 3.1 Introduction

Sediment generation and transport is a natural ecosystem process. At landscape scales, erosion generates sediments and is mainly transported by water. The sediment is transported to and deposited in floodplains and the sea. It enriches the floodplains and coastal areas, and has led to the formation of deltaic regions. Natural vegetation cover is a vital element in this process, it slows down the process of erosion and traps substantial part of the sediment within the catchment. Without adequate natural vegetation, soil erosion and transport processes are much accelerated. These lead to poor soil quality, excessive siltation in river and streams, leading to increased flooding and shortening of lifespan of reservoirs due to siltation. An imbalance in sediment erosion and transport has far reaching consequences from local to regional scales. Thus, forests provide an important Ecosystem service by regulation of sediment dynamics.

## 3.2 Data acquisition

### *3.2.1 Land Use Land Cover (LULC)*

The LULC raster was sourced from the European Space Agency (ESA) initiated - WorldCover project. The land cover product is at 10 m resolution for the year 2020 and is based on both Sentinel-1 and Sentinel-2 data, containing 11 land cover classes out of which 7 land cover classes were witnessed in our study area.

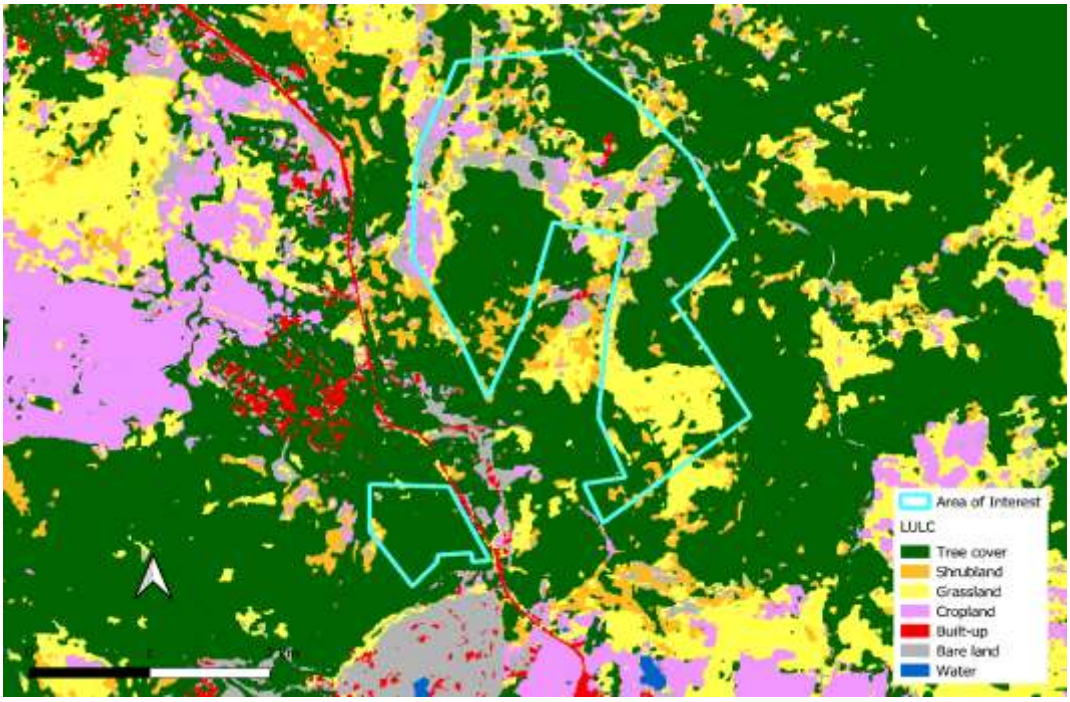



*Figure ii: LULC of the study area*

### *3.2.2 Watersheds*

InVEST tool DelineateIT is used to delineate watersheds. Watershed creation tools provided with GIS software, as well as some hydrology models, recommends to use the DEM that is being used in the InVEST modeling, such that the watershed boundary corresponds correctly to the topography.

### 3.2.3 Digital Elevation Model

A digital elevation model (DEM) is a raster map of elevation, where each pixel's value is its elevation above sea level (usually in meters). The Bhuvan website hosted by the National remote sensing center was used for the same. The satellite referred is Cartosat-1: CartoDEM Version-3 R.

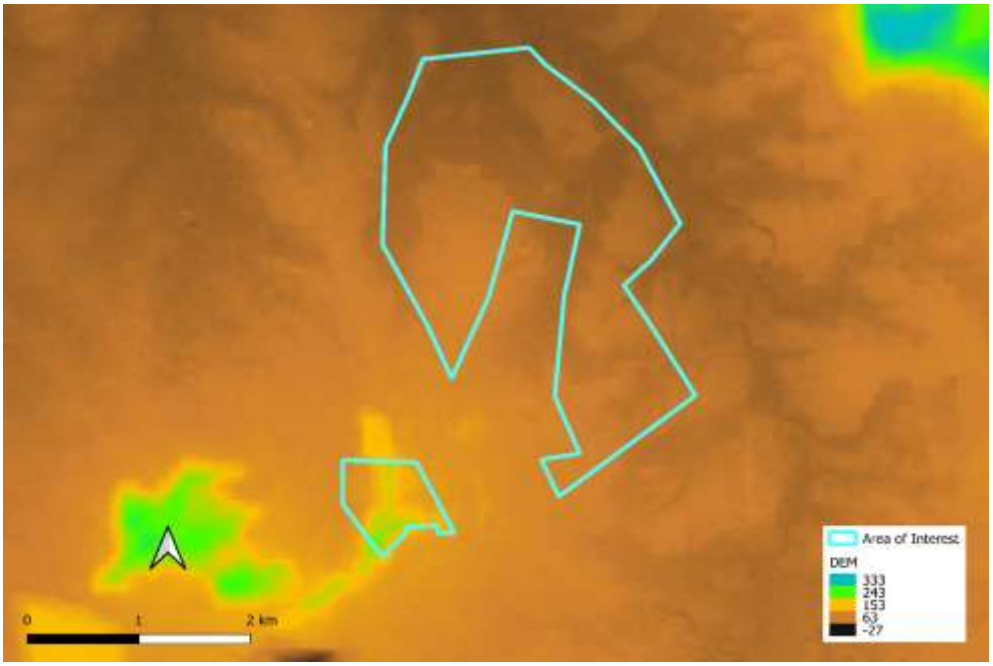



*Figure iii: DEM of the study area*

### 3.2.4 Erosivity

Rainfall Erosivity Index (R) is obtained from the country specific equations derived based on extensive literature search. The raster file of rainfall erosivity is obtained by using the formula: **R = 81.5 + 0.38P,** where R is the rainfall erosivity and P is the mean annual precipitation (Babu, B. L., & Kumar, 2004; Jain & Das, 2010; Benavidez, Rubianca, Jackson, & Max, 2018).

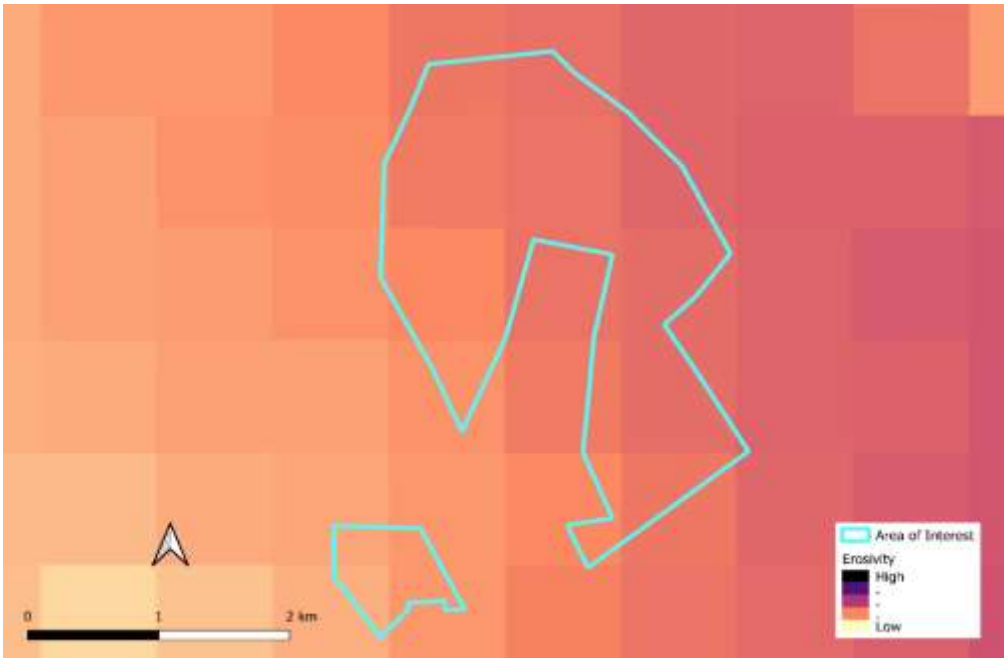
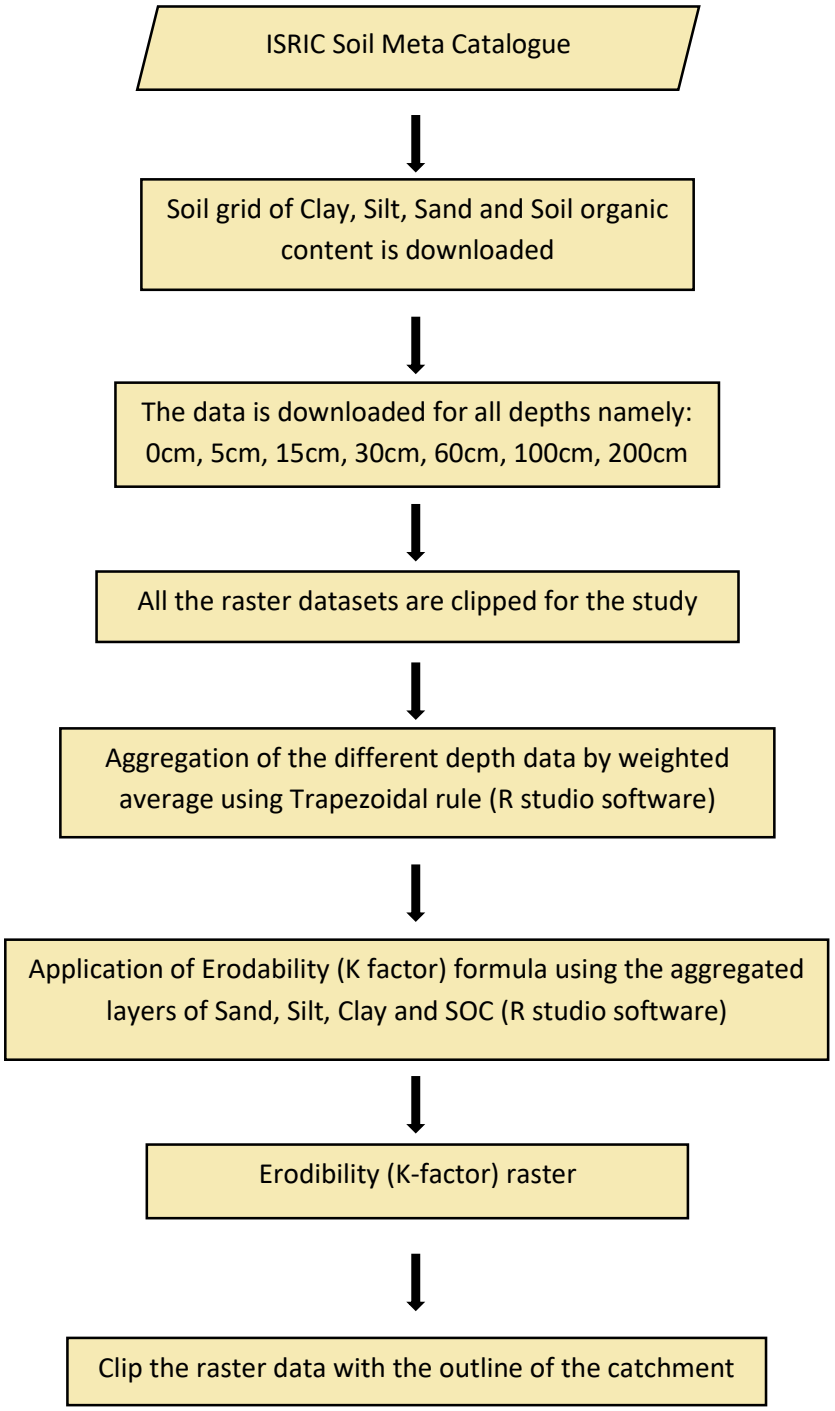



*Figure iv: Erosivity map of the study area*

### 3.2.5 *Soil Erodibility (K Factor)*

Soil erodibility factor gives the susceptibility of soil particles to detach and transport by rain fall or runoff. The raster data gives the erodibility factor for each pixel value. The ISRIC Soil metadata has been used to obtain layers of percentage sand, percentage clay, percentage silt and percentage soil organic carbon at various depths of soil. These raster layers are further processed as shown in the following flowchart by keeping (Tomislav, et al., 2017) and (Yang, et al., 2018) as reference.

Steps followed:



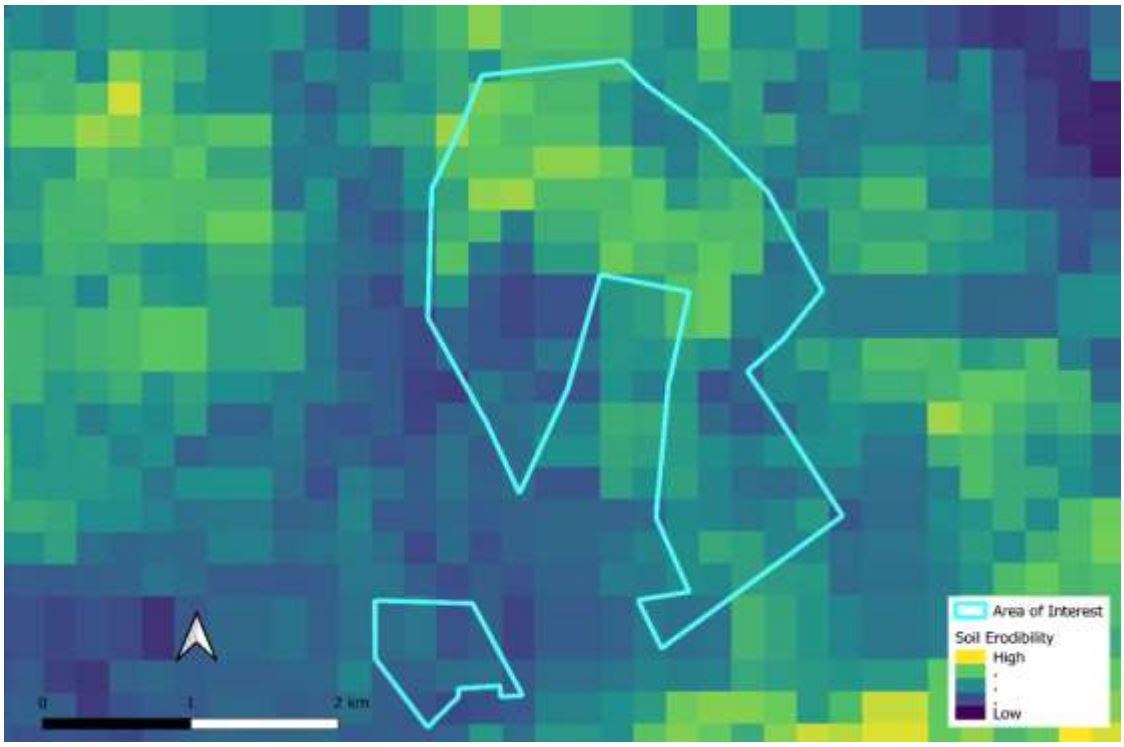



*Figure v: Erodibility map of the study area*

### 3.2.6 Biophysical Table

*Table 1: Biophysical table used for SDR modelling*

| Description | lucode | usle_c | usle_p |
|---|---|---|---|
| Cropland | 40 | 0.9 | 1 |
| Water | 80 | 0 | 1 |
| Bare land | 60 | 0.9 | 1 |
| Shrubland | 20 | 0.01 | 1 |
| Grassland | 30 | 0.01 | 1 |
| Built-up | 50 | 1 | 1 |
| Tree cover | 10 | 0.001 | 1 |

usle_c: It is the cover management factor. It accounts for the specified crop management relative to tilled continuous fallow.

usle_p: It is the support practice factor. It accounts for the effects of contour ploughing, strip-cropping or terracing relative to straight-row farming up and down the slope.

Both of these values are obtained by referring to the UN-FAO documentation provided in the appendix of the InVEST – SDR documentation (FAO, 2006).

### 3.2.7 Other Model Parameters

#### 3.2.7.1 Threshold Flow Accumulation

A threshold flow accumulation of value of 5000 is taken by referring to the InVEST, Sediment Delivery Ratio (SDR) specific documentation.

#### 3.2.7.2 Borselli K Parameter

A default value of 2 was used by referring to the InVEST, Sediment Delivery Ratio (SDR) specific documentation.

#### *3.2.7.3 Borselli IC0 Parameter*

A default value of 0.5 was used by referring to the InVEST, Sediment Delivery Ratio (SDR) specific documentation.

#### *3.2.7.4 Maximum SDR Value*

A default value of 0.8 was used by referring to the InVEST, Sediment Delivery Ratio (SDR) specific documentation.

#### *3.2.7.5 Maximum L Value*

A default value of 122 was used by referring to the InVEST, Sediment Delivery Ratio (SDR) specific documentation.

## 3.3 Method

The Land use pattern of the current scenario of the study area was used to run the SDR model in InVEST. Another land use raster was created with the change in the land use type of the study area from forest. Shrub-land and grassland to bare land as the area would be converted into an open cast. This was new land use raster was used as an input file in the SDR model with other parameters remaining same. The difference in the results of both the models was obtained to know the sediment deposition in the streams or lower elevation area due to the loss of vegetation in the study area.

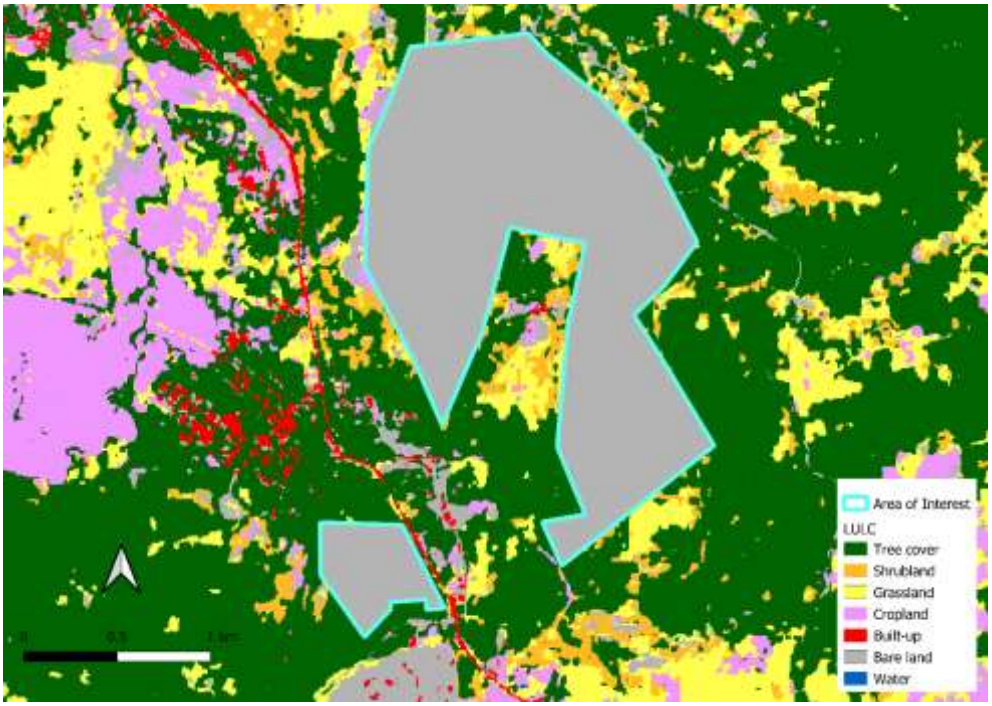



*Figure vi: Modified LULC of the study area*

## 3.4 Results

*Table 2: Results of SDR*

| Description | Result |
|---|---|
| Total Sediment deposited per year | 9203 tonnes |
| Soil erosion per hectare | 13.94 tonnes |

# 4 Ecosystem Services from Forests

In this study, the Millennium Ecosystem Assessment (MEA) framework has been used to assess the economic valuation of the various ecosystem services. These ecosystem services are valued using direct methods or the benefits-transfer method. The following section provides information regarding the ecosystem services, the methodology used for physical quantification and economic valuation, and the results. Overall, 16 services are being evaluated. Out of these, two services i.e., water provisioning, and Sediment retention are evaluated for the study area, using InVEST modeling software. For the remaining ecosystem services, suitable methods are used for evaluation.

## 4.1 Provisioning Services

Provisioning services are manifested in the goods people obtain from ecosystems such as food and fiber, fuel in the form of wood or non-woody biomass, and water from rivers, lakes, and aquifers. The above-mentioned list of provisioning services has been already taken into account in the calculation of the NPV in the original benefit-cost ratio.

## 4.2 Regulating Services

Regulating services provided by ecosystems are diverse and include the impacts of pollination and pest and disease regulation on the provision of ecosystem goods such as food, fuel, and fiber. Currently, the economic values of nine services from this category (gene-pool, gas regulation, pollination, biological control, water purification, water provisioning, sediment retention, carbon storage and, carbon sequestration) have been evaluated. Information is provided in the tables listed below. The values are estimates and further information would yield an appropriate estimate for accounting purposes.

### *4.2.1 Genepool protection*

The economic value of biodiversity in this study is envisioned in terms of the value of information and insurance.

a. **Biological Information Value:** Biodiversity, as we know, is a result of the continuous evolutionary process that has taken place over thousands of years. Thus, a stock of information is representedby various life forms. All the evolutionary process has taken place in various environmental contexts, thus enabling organisms to become more resilient to natural changes. Unique and endemic species throughout the various ecosystems have evolved various forms of defense mechanisms such as chemical compounds for survival. These compounds have an immense potential to cure human illnesses. For example, leukemia is today treated with compounds derived from the rosy periwinkle of Madagascar, and the bark of the Pacific yew tree is the sourceof treatment for ovarian cancer. Such chemicals are of potential value to the pharmaceutical industry. Additionally, wild cultivars and wild crop varieties are vital genetic repositories that play an essential role to ensure food security.

b. **Insurance Value:** Another way of product's approach to the value of biodiversity is the economicvalue of products derived from the value of the information contained in it.

Therefore, biodiversity is a precondition for all the other values derived from the forests. On this basis, the economic value of biodiversity as insurance is the insurance premium the consumers have to pay for the preservation of these services. The diversity contains millions of years of information and this brings resilience to the environmental change where it protects other functions of forests. Therefore, the economic value of a patch of forest must be equal to its informational value plus its insurance value.

Due to the lack of site-specific data for estimating the value of gene-pool protection, the benefit transfer method has been used. The economic value derived from a meta-analysis study by Costanza et al. (2014) was used for calculation purposes. All analyses have made the assumption that the conversion rate from US Dollars to Indian Rupees is Rs.81.78. Table 3 provides the summary of the methodology used for estimating the flow value of gene pool protection services.

*Table 3: Summary of methodology used for flow value for gene pool protection*

| Ecosystem Service Method | Gene pool Protection | |
|---|---|---|
| | Benefits transfer | |
| | Data used | Data sources |
| **Benefits transfer value** | Rs. 111079.35/ha/year | Costanza et al. (2014) |
| **Total physical area** | Total forest area – 650 ha | |
| **Economic value** | Rs. 7.22 crore / year | |

### *4.2.2 Biological control*

Forests and other natural ecosystems are known to control the populations of disease-inflicting organisms (Viruses, bacteria, parasites, etc.), their hosts, and intermediate vectors (rodents, insects, etc.). Deforestation reduces the diversity of the interactions between organisms and this results in the unbalanced population distribution of species, thereby, increasing the possibility of the spread of disease-infected organisms. Due to inadequate site-specific studies and data for estimating the economic value of biological control, the method of benefits transfer has been used.

Based on unit area values of biological control (@ Rs. 715/ha/year) for different types of ecosystems from a recent meta-analysis study (Costanza et al., 2014), the economic value of the ecosystem service has been derived at the division level. Table 4 provides the summary of the methodology used for estimating the flow value of biological control services.

*Table 4: Summary of the methodology used for economic value of biological control*

| Ecosystem Service Method | Biological Control | |
|---|---|---|
| | Benefits transfer | |
| | Data used | Data sources |
| **Benefits transfer value** | Rs. 715/ha/year | Costanza et al. (2014) |
| **Total physical area** | Total forest area – 650 (ha) | |
| **Economic value** | Rs. 0.05 crore / year | |

### 4.2.3 Pollination

Pollination is fundamental for agricultural production, and plant reproduction. It also maintains terrestrial biodiversity. Most of the world's major crops are consumed by humans and the majority of the wild flowering plants depend on animal pollination. Forests with their diversity of species depend on pollination and also provide a valuable service function for the surrounding areas. Due to a lack of data for pollination values in the state, the benefit transfer method has been used to estimatethe economic value.

Based on unit area values of pollination for different types of ecosystems from a recent meta-analysis study (Costanza et al., 2014), the economic value of the ecosystem service has been derived(@ Rs. 1950/ha/year) as shown in table 5.

*Table 5: Summary of the methodology used for flow value of pollination*

| Ecosystem Service Method | Pollination | |
|---|---|---|
| | Benefits transfer | |
| | Data used | Data sources |
| **Benefits transfer value** | Rs.1950/ha/year for tropical forests | Costanza et al. (2014) |
| **Total physical area** | Total forest cover – 650(ha) | |
| **Economic value** | Rs. 0.13 crore / year | |

### 4.2.4 Gas regulation

Forests are also known to regulate the local climate and improve air quality. Trees provide shade but they have a significant influence on rainfall and water availability. Forests also remove toxic airpollutants from the atmosphere. Site-specific studies related to the economic value of air quality improvement by forests are not available; hence, the benefit transfer method has been used.

Based on the unit area values of gas regulation for different types of ecosystems from a recent meta-analysis study (Costanza et al., 2014), the economic value of the ecosystem service has been derived(@ Rs. 780/ha/year). Table 6 provides the summary of the methodology used for estimating the flow value of gas regulation services.

*Table 6: Summary of the methodology used for economic value of gas regulation services in the study area*

| Ecosystem Service Method | Gas Regulation | |
|---|---|---|
| | Benefits transfer | |
| | Data used | Data sources |
| **Benefits transfer value** | Rs.780/ha/year for tropical forests | Costanza et al. (2014) |
| **Total physical area** | Total forest cover 650 (ha) | |
| **Economic value** | Rs. 0.05 crore / year | |

### 4.2.5 Carbon storage (Stock value)

1. **As per the ASFR-2021 Report,**
   a. The carbon stock value of the entire Indian forests is 7204 Million tonnes and the total area of forests present in the country is 7,13,789 sq.km. Hence carbon stock per hectare can be calculated by dividing the total carbon stock by total area (7204 x 1000000/713789 x 100). This gives a carbon stock of 101 tonnes per hectare.
   b. The value of carbon Stock per hectare will be = 101 * 86 *81.78 = Rs. 7,10,341/ Ha
   c. The value of Carbon Stock for 650 Ha will be = 7,10,341*650= 46.17 Crores.

2. **As per the Indian State Of Forest Report -2017**
   a. As per the report (table 8.6) the carbon stock for the Tropical Dry deciduous Forests per hectare is 95.54 tonnes. Accordingly, the Carbon stock for 650 Ha. will be = 650*95.54 = 62,101 tonnes.
   b. The value of carbon Stock for 650 Ha in rupees will be = 62,101*86*81.78 = 43.67 crores.

The carbon stock value of **43.67 crores** is chosen as this value of carbon stock resembles more with the forests present in the study area.

### 4.2.6 Water provisioning

Forests play an essential role in extending water supply to the landscape. Forests have a significantlydominant effect on the hydrological processes at the watershed level. The forest canopy cover intercepts precipitation and reduce their intensity of impact on the forest floor. Part of the water evaporates back into the atmosphere, part contributes to surface run-off and part of the precipitation is absorbed by the roots and later enters the atmosphere through transpiration. Once the soil moisture reaches its field or saturation capacity, the remaining water recharges thegroundwater table. Table 7 provides the summary of the methodology used for estimating the flow value of water provisioning services.

*Table 7: Economic value and methods used for the estimation of water provisioning services*

| Ecosystem Service Method | Water provisioning | |
|---|---|---|
| | Benefits transfer | |
| | Data used | Data sources |
| **Physical estimation** | Average water recharge value of forest – 73 $m^3$/ha/year | GIST Monograph 7 (2006) |
| **Per Unit Value** | Rs. 18.43 /$m^3$ is considered as the economic value of differential water recharge happening because of forests | World Bank (2013) |
| **Total physical volume** | 47450 $m^3$/year | |
| **Economic value** | Rs.0.09 crores / year | |

### 4.2.7 Sediment regulation

Forests with varying levels of canopy cover and soil properties play a vital role in holding the soil physical structure and thus ensuring its stabilization. In this study, the economic value has been estimated using the avoided offsite costs from sedimentation. Information from

secondary literature has been used to estimate the contribution of forests in preventing soil erosion compared to managed ecosystems. Sediment retention values provided by running the Sediment Delivery ratio models of InVEST was used for the physical quantification; the study recorded that 13.94 tons of sediment retention capacity is provided by each hectare of forests in the study area each year. Table 8 provides the summary of the methodology used for estimating the flow value of sediment regulation.

*Table 8: Economic value and methodology for sediment regulation*

| Ecosystem Service Method | Sediment Regulation | |
|---|---|---|
| | InVEST modelling | |
| | Data used | Data sources |
| | Total sediment lost in the watershed – 9203 tonnes | InVEST Result |
| **Cost of Substitute** | Dredging cost @ Rs 285 per 1.2 c.m. | Dredging Corporation of India |
| **Economic value** | Rs. 0.25 crores/year | |

### *4.2.8 Water purification*

Forests not only regulate the flow of water but also help in maintaining its quality. In evaluating the water purification service of the forests, the number of beneficiaries dependent around the study area has been assumed. Further, the per capita per day domestic water requirement is calculated to derive total domestic water requirement. This quantity is then multiplied with the average cost of treating water to obtain the cost of water purification.

*Table 9: Economic value and methods used for the estimation of water purification services*

| Ecosystem Service Method | Water purification | |
|---|---|---|
| | Benefits transfer | |
| | Data used | Data sources |
| **Physical estimation** | Average number of population surrounding the forest area - 2000 | |
| **Per capita per day consumption** | 200 liters per capita per day | Assumption |
| **Nominal cost of water treatment** | Rs.10 per $m^3$ | Nominal price |
| **Economic value** | Rs.0.15 crores / year | |

### *4.2.9 Climate regulation*

Climate regulation refers to the maintenance of a favorable climate, both at local and global scales, which has important implications for health, crop productivity, and other human activities. Forest ecosystems help in climate regulation by trapping moisture and cooling the earth's surface, thus regulating rainfall and temperature.

Due to the lack of site-specific studies for estimating the economic value of climate regulation, the method of benefits transfer has been used. Based on the unit area value of climate regulation for differenttypes of ecosystems from a meta-analysis study (Costanza et al., 2014), the economic value of this ecosystem service has been derived (@134904Rs. /ha/year). Table

10 provides the summary of the methodology used for estimating the flow value of climate regulation services.

*Table 10: Summary and methodology used for the flow value of climate regulation services*

| Ecosystem Service Method | Climate regulation | |
|---|---|---|
| | Benefits transfer | |
| | Data used | Data sources |
| **Benefits transfer value** | Rs. 134904 /ha/year for tropicalforests | Costanza et al. (2014) |
| **Total physical area** | Total forest area - 650 Ha | |
| **Economic value** | Rs. 8.77 crore / year | |

### *4.2.10 Waste assimilation*

Due to the lack of site-specific studies for estimating the economic value of climate regulation, the method of benefits transfer has been used. Using the estimate of economic value of waste assimilation for tropical forest (Rs. 7920 /ha/year) from a global meta-analysis study Costanza et al., 2014), the economic value of this ecosystem service has been derived (4389.97 crores/year). Table 11 provides the summary of the methodology used for estimating the flow value of waste assimilation services.

*Table 11: Summary and methodology used for the flow value of waste assimilation services*

| Ecosystem Service Method | Waste assimilation | |
|---|---|---|
| | Benefits transfer | |
| | Data used | Data sources |
| **Benefits transfer value** | Rs. 7920 /ha/year for tropical forests | Costanza et al. (2014) |
| **Total physical area** | Total forest area - 650 (ha) | |
| **Economic value** | Rs. 0.51 crore/ year | |

## 4.3 Supporting Services

Supporting services provide the basic infrastructure of life such as providing mechanisms to harnessthe sun's energy, forming and maintaining the fertility of the soils, and cycling of water and nutrients in the ecosystems. Supporting services lay the basic foundation for the production of all other ecosystem services and are strongly interrelated to the physical, chemical and biological interactions.

### *5.3.1 Habitat for species*

The forests provide habitats for some of the major species in India such as the tiger, and sloth bear, caracal, etc. In fact, forests are also genetic repositories for living organisms and, hence contribute to species preservation in case of species loss outside forest areas.

Due to the lack of site-specific studies for estimating the economic value of habitat provisioning, the method of benefits transfer has been used. Based on the unit area value of habitat/refugia for different types of ecosystems from a meta-analysis study, the economic value of this ecosystem service has been derived (@ Rs. 2535/ha/year). Table 12 provides the summary of the methodology used for estimating the flow value of habitat for species.

*Table 12: Summary for flow value of habitat for species*

| Ecosystem Service Method | Habitat for species | |
|---|---|---|
| | Benefits transfer | |
| | Data used | Data sources |
| **Benefits transfer value** | Rs. 2535/ha/year for tropicalforests | Costanza et al. (2014) |
| **Total physical area** | Total forest area - 650 (ha) | |
| **Economic value** | Rs. 0.16 crores / year | |

### *5.3.2 Nutrient cycling*

Forests with complex ecological structure avoid erosion of soil through runoff in streams. An indirect benefit of avoided soil erosion is the retention of nutrients and regulated discharge duringrainfall. According to the literature survey, nutrient cycling is estimated using the replacement cost of fertilizers and thus, a similar approach is used here in the valuation.

Physical quantification of nutrient cycling has been estimated using estimates of **soil erosion avoided**and the **concentration of NPK** (nitrogen, phosphorus, potassium) is derived from the GIST study conducted in 2006. According to the study, each kg of avoided erosion contains 2.32 g of nitrogen, 0.044 g of phosphorus, and 8.25 g of potassium. This physical estimate is then used along with the price of NPK fertilizers in India to obtain the economic value of nutrient cycling from forest areas as shown. Table 13 provides the summary of the methodology used for estimating the flow value of nutrient cycling/retention.

*Table 13: Summary and methodology used for the flow value of nutrient cycling services*

| Ecosystem Service Method | Nutrient cycling (InVEST) | |
|---|---|---|
| | Substitution cost and Benefits transfer method | |
| | Data used | Data sources |
| | Total sediment lost in the watershed – 9203 tonnes | InVEST Result |
| | Each kg of avoided erosion contains 2.32 g of nitrogen, 0.044 g of phosphorus and 8.25 g of potassium | GIST Monograph 7 (2006) |
| **Cost of substitute** | Price of NPK – Rs.178 | Indian Fertilizer Scenario 2017 |
| **Economic value** | Rs. 0.16 crores /year | |

# 5 Summary of Ecosystem Services Valuation

The economic valuation process has revealed that the forests of the study area provide ecosystem services worth about Rs. 175 crores as stock, and an annual flow of about Rs. 10.5 crores. Table: 17 and Table: 18 shows the summary of flow values of 11 ecosystem services that are mapped. **The valuation of genepool services of Rs 7.33 crores per year has not been taken into account in the calculation of the ecosystem services in Table 14, because the surrounding forest contains the same species as the study area, and the future benefits of this genepool are available for human well-being even if the study area is converted to open cast mining**.

*Table 14: Summary of ecosystem flow values per annum*

| Ecosystem Services | Economic Value (crores) |
|---|---|
| Water Provisioning | 0.09 |
| Water Purification | 0.15 |
| Sediment Regulation | 0.25 |
| Nutrient Cycling | 0.16 |
| Biological Control | 0.05 |
| Pollination | 0.13 |
| Habitat for Species | 0.16 |
| Gas Regulation | 0.05 |
| Climate Regulation | 8.77 |
| Waste Assimilation | 0.51 |
| **Total (Flows)** | **10.32** |

*Table 15: Summary of ecosystem stock values*

| Ecosystem Services | Economic Value (crores) |
|---|---|
| Carbon Stock | **43.80** |

# 6 Conclusion

The economic value of loss of eco-system services due to diversion of forests shall be the net present value (NPV) of the forest land being diverted as prescribed by the Ministry of Environment, Forests and Climate Change (MoEF&CC). In this study, in addition to the ecosystem services accounted in the calculation of NPV, certain additional services such as water provisioning, water purification, sediment regulation, nutrient cycling, biological control, pollination, habitat for species, gas regulation, climate regulation and waste assimilation services are also assessed and their respective flow values have been included in the calculation of a **revised NPV.** This is done by assuming a flow period of 25 years with a discount rate of 10% per year. A stock value of carbon from the existing forests has also been assessed and added to the cost of the project. Finally the **revised cost and benefit ratio** has been calculated which comes up to **1: 12.53**. The details of the cost benefit analysis is given in the table number 16, 17 and 18 of the annexures.

# 7 Appendix

## 7.1 Net Present Value (NPV) calculation of additional ecosystem services

In calculating the net present value (NPV), the stock value has been considered for only the $0^{th}$ year. The flow values of ecosystem services are considered for the next twenty five years. Hence, a sum of 10.32 crore has been considered starting from 'year 1' with a discount rate of 10 % for a period of 25 years.

*Table 16: Net Present Value calculation of flow values (in Rs crores)*

| Year | Cost | Present Value of Cost |
|---|---|---|
| 0 | 43.8 | 43.80 |
| 1 | 10.32 | 9.38 |
| 2 | 10.32 | 8.53 |
| 3 | 10.32 | 7.75 |
| 4 | 10.32 | 7.05 |
| 5 | 10.32 | 6.41 |
| 6 | 10.32 | 5.83 |
| 7 | 10.32 | 5.30 |
| 8 | 10.32 | 4.81 |
| 9 | 10.32 | 4.38 |
| 10 | 10.32 | 3.98 |
| 11 | 10.32 | 3.62 |
| 12 | 10.32 | 3.29 |
| 13 | 10.32 | 2.99 |
| 14 | 10.32 | 2.72 |
| 15 | 10.32 | 2.47 |
| 16 | 10.32 | 2.25 |
| 17 | 10.32 | 2.04 |
| 18 | 10.32 | 1.86 |
| 19 | 10.32 | 1.69 |
| 20 | 10.32 | 1.53 |
| 21 | 10.32 | 1.39 |
| 22 | 10.32 | 1.27 |
| 23 | 10.32 | 1.15 |
| 24 | 10.32 | 1.05 |
| 25 | 10.32 | 0.95 |
| | **Total** | **137.35** |
| | | **13734.51 (Rs. lakhs)** |

## 7.2 Estimation of Benefit – Cost ratio (with ecosystem services accounted as additional costs)

*Table 17: Estimation of costs (in Rs. Lakhs)*

| I. | ESTIMATION OF COSTS | | | | |
|---|---|---|---|---|---|
| **S. No.** | **Parameters** | **Unit** | **Rate Per Unit/Basis** | **Quantity** | **Value** |
| 1 | Ecosystem Services | Lakh/Ha | 8.03 | 649.30 | 5213.89 |
| 2 | Loss of Animal husbandry productivity | | 10% of NPV | | 521.39 |
| 3 | Cost of Human Resettlement | Lakh/PDF | 20 | 100 | 2000 |
| 4 | Loss of Public Facilities | Cr./Km | 4 | 5 | 2000 |
| 5 | Possession Value of Forest Land Diverted | | 30% of NPV | | 1564.17 |
| 6 | Cost of Suffering to Oustees | | 1.5 times of 2 years wage cost | | 362.7 |
| 7 | Habitat Fragmentation Cost | | 50% of NPV | | 2606.95 |
| 8 | Compensatory of Forestation | Lakh/Ha | 6.5 | 1298.60 | 8440.92 |
| | **Total Cost (A)** | | | | **22710.01** |
| | **Additional Costs** | | | | **13734.51** |
| | **Revised Total Cost (C)** | | | | **36444.51** |

*Table 18: Estimation of benefits (in Rs Lakhs)*

| II. | ESTIMATION OF BENEFITS | | |
|---|---|---|---|
| 1 | Increase in Productivity | As per detailed project report | 6729.28 |
| 2 | Benefit to Economy | | 334540.51 |
| 3 | No of population benefited | | |
| 4 | Economic benefits due to direct and indirect employment | | 114796.02 |
| 5 | Economic benefits due to compensatory afforestation | | 422.05 |
| | | **Total Benefits (B)** | **456487.86** |
| | | | |
| | | **Benefit Cost Ratio (B/A)** | **20.10** |
| | | | |
| | | **Revised Benefit Cost Ratio (B/C)(additional cost )** | **12.53** |

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# Report on the Biodiversity of area of Proposed Venkatesh Khani Coal Mine

of

The Singareni Collieries Company Ltd. (SCCL)

(A Government Company)

2022

**CONTENTS**



## Summary


Initially the mining by underground method started in Kothagudem Area during 1937. In the early 70s, underground mines in the name of 8, 9, 10, 11 incline in an area of 408 Hectares were operational in the proposed study area, which were subsequently closed in 1992. From these underground mines, 5.56 million tons of coal have already been extracted. Subsequently, one opencast mine by the name of Goutham Khani (GKOC) started in the year 1993 in a total area of 902 Hectares and which has been closed during March 2022. This opencast was the conversion of the four underground mines, where the 74.29 million tons leftover of earlier underground operation. In total, 76.91 million tons (underground – 5.56 + OC – 71.35) of coal has been removed from this area.

An average of manpower spent in these underground mines was around 6000 to 7000 and in the GK Opencast was of 1611 in total. Besides that, many coal loaded lorries/ vehicles move from mines to different places on daily basis (300 to 400 lorries per day).

Since, last 50 years of mine operations in this area, already movement of vehicles, people, constructions have started and as such hardly any area left undisturbed. The impact of the mining on the flora and fauna was also observed to be minimal, and records were also found that the fauna has moved away from this area to the nearby adjacent forest areas, plantation areas developed by SCCL and forest department in the 10 Kms radius from the proposed area. SCCL and Forest Department has taken many individual initiatives and joint actions in protecting, enhancing, and sustaining the biodiversity and its habitats in the adjoining forest areas in the buffer areas of mines to the 10 Kms radius. Hence the impact is very less.

Also, a National Highway (NH 30) connecting Kothagudem to Vijayawada passes through the forest and mine area, connected with many small public roads which is used by people actively. So, this also shows that there is not any fresh intrusion to the biodiversity/ wildlife by this proposed mine.

In this quarried area, SCCL has now proposed to dump the overburden material going to be excavated from the proposed VKOC to save fresh land.

# Background

As demand for energy increases, in absence of sufficient alternative energy source, Coal mining will remain an important part of global, national, and local economies in the foreseeable future. To meet the ever-increasing demand for Coal and to achieve the targets fixed by the Government of India from time to time, SCCL has embarked upon large-scale expansion of coal mining to increase coal production. Venkatesh Khani Coal Mine is one of the new Project identified in Ramavaram RF, Ramavaram Range of Kothagudem Forest Division.

At present there are two Underground mines viz., Venkatesh Khani No.7 Incline (384.40 Ha. R.F) and PVK No.5 Incline (789.78 Ha. R.F) for which forest permission was obtained for underground rights for 1174.18 Ha. vide MoEF, Government of India vide Lr.No.8-277/85-FC, dated 17.02.2009 with validity for 20 years i.e., till 16.02.2029.

| S. No. | Purpose of RF diverted | Extent (in Ha.) | MoEF&CC Letter No. | Validity till |
|---|---|---|---|---|
| 1. | Venkatesh Khani No.7 Inc. | 384.40 | Lr.No.8-277/85-FC, dated 17.02.2009 | 16.02.2029 |
| 2. | Padmavathi Khani(PVK) No.5 | 789.78 | -Do- | -Do- |
| 3. | Surface use for installation of Borewell in existing Padmavathi Khani No.5 Inc. | 2.85* | Stage-I clearance granted by MoEF&CC vide letter No.8-277/1985 – FC (VOI), Dated: 22-06-2018. | Pending with the MoEF&CC, GoI/Forest dept., for issue of final approval. |
| | **Total:** | **1174.18** | | ***2.85 Ha. is the surface area of UG Mine of PVK-5 Incline.** |
| 4 | Tella vagu (Stream) diversion to avoid seepage of water into UG Mine | 11.96 | MoEF&CC vide letter no. FCA/16.1/70/AP/MIN/07 dated.31.08.2005<br>Original course of stream was filled up with soil and planting done with local species as on today it is almost fully stocked. Further, there is no need to the re-divert/re-dig this stream. However, for the purpose of EC of total area of (1174.18+11.96) having mining lease. This is included in the total area of the Project. | |

Similarly, permission under F (C) Act-1980, was also obtained for doing Opencast Mining on the name of Goutham Khani Opencast project (GKOCP), details of which are as follows:

| S.No. | Purpose of RF diverted | Extent (in Ha.) | MoEF&CC Letter No. | Validity till |
|---|---|---|---|---|
| 1. | 1st Renewal of GK OCP (Phase-I) | 161.31 | MoEF&CC Letter No.8-117/2002 – FC, Dated: 01-02-2010. | 31.01.2030 |
| 2. | GK OCP (Phase-III) | 154.96 | MoEF&CC Letter No.8-62/2005 – FC, Dated: 09/15-07-2008. | 14.07.2028 |
| | **Total:** | **316.27** | | |

Similarly, an area of 124.965 Ha. was also diverted and it is under process with Forest department/ MoEF&CC, GoI, for renewal. Details of these diversions are as follows:

| S.No. | Purpose of RF diverted | Extent (in Ha.) | MoEF&CC Letter No. |
|---|---|---|---|
| 1. | 1st Renewal of GK OCP (Phase-II) (Extent increased as per DGPS Survey and Authentication by PCCF, Hyderabad). | 124.065 | MoEF&CC Letter No.8-17/98-FC, Dated: 08-02-1999 (for original diversion of 124.00 Ha.) |
| 2. | Surface use for installation of Borewell Padmavathi Khani No.5 Inc. | 0.90 | 1st renewal of File No.8-277/1985FC(vol. I) Dated: 15-10-2019(Stage-I Letter). |
| | **Total:** | **124.965** | |

In the present proposal, it is proposed to utilize parts of the existing forest area of the UG Mines of VK-7 incline and PVK-5 Incline by converting parts of underground mining into opencast **and continuing part UG Mining in 469.6336 Ha. This amalgamated mine will be called Venkatesh Khani coal mine.** The details of area proposed for utilization in the new project from underground mines is as follows:

| S.No. | Name of the UG Mine | Extent of RF land proposed for conversion (in Ha.) | RF Area proposed for continuation under UG | Total |
|---|---|---|---|---|
| 1. | Venkatesh Khani No.7 Inc. | 237.8569 | 146.5431 | 384.40 |
| 2. | Padmavathi Khani(PVK) No.5 | 411.4445 | 378.3355 | 789.78 |
| | | **649.3014** | 524.8786 | 1174.18 |

The balance extractable coal reserves of PVK No.5 & VK No.7 Inc is 190.11 million Tons of which about 64.18 million Tons is in Forest Land in Compartment Nos.2 (part), 3(part), 4(part), 5(part) & 11(part) of Ramavaram RF, and the balance of 125.93 million Tons is in non-Forest land. However, mining (OC) will simultaneously start both in forest and non-Forest land as per the approved Mining Plan.

The proposed fresh diversion of forest land for surface use from underground to opencast is 649.3014 Ha for which this permission is requested. However, this area will be mainly used for quarrying and excavated material will be taken into the left-over quarry as well over burden dumps of the GKOCP for which already permission is available and at appropriate time (before two years after expiry of permission) proposal will be submitted

for continuation of mining activities (dumping of excavated material of proposed Venkatesh Khani Coal Mine.

The total project area of **Venkatesh Khani Coal Mine** is 2403.17 Ha. This area is covered in 2 existing Mining Leases granted under MM (D&R) Act, 1957. The details of Mining Leases as per MMDR Act 1957 are as follows:

**Fig in Ha.**

| Name of Mining Lease | Lease Area | NFL | FL | |
|---|---|---|---|---|
| | | | Surface rights | UG rights |
| Kothagudem Mining Lease (2nd Renewal) | 5158.00 | 3692.00 | 291.82 | 1174.18 |
| GK OC Mining lease(1st renewal) | 261.31 | 0.00 | 261.31 | 0.00 |

The present proposed area is falling in Compartment Nos.2 (part), 3(part), 4(part), 5(part) & 11(part) of RF in Ramavaram R.F. of Kothagudem Division. The excavated material generated from the proposed OC mine will be transported through non-forest land for dumping into existing old mine of Goutham Khani Opencast. In the process the National Highway-30, passing through the non-forest land to the extent of 3.20 Kms will be diverted as per norms of the NHAI after obtaining suitable no objection certificate. Further, most of the forest area proposed for diversion either falls in to open forest, scrub forest or having grasses and degraded, wherever, better density is there it is because of plantations raised by the SCCL over the surface of the ongoing UG Mines.

Venkatesh Khani Coal Mine is planned to produce 6.3 (OC 5.3 + UG 1.0) million Tons of coal per annum (peak production) with a net capital out lay off about Rs.480.00 Crores and has a life of 40 years including pre-mining and post mining activities. The Mining plan including Mine closure plan has been approved by Ministry of Coal, Govt. of India vide Lr. No. 38011/12/2017-PCA, dated 27.01.2020. Further, the Nation will benefit by achieving increased coal production by exploiting coal reserves of the project and gets benefited financially by way of Royalty, excise Duty, Sales tax, and electricity supply continuously. Further, this project will also contribute benefit to the society by way of increased direct and indirect employment resources resultant improvement in standard of living and rise in per capital income of the population of surrounding villages of this area.

Generally, the activities of a mining could potentially pose some threats to biodiversity. A mining company must have a better understanding to appreciate the value of biodiversity in its long-term operations under its sustainable mining practice. It should consider all environmental impacts.

Habitat clearing during mining is generally unavoidable. However, impacts on fauna, including rare or threatened species, can be reduced through careful planning. Progressive clearing allows time for the animals to move into adjoining unmined/forest habitats. Despite the significant potential for negative impacts on biodiversity from mining operations, there are many opportunities for a mining company to enhance biodiversity conservation within their areas of operations. Being proactive in the assessment, monitoring, and management of biodiversity is important not only for new mine operations but also for those that have been operating for many years.

SCCL has been continuously adopting new and scientific approaches to managing biodiversity/wildlife as part of their commitments to establishing and maintaining the ecological balance. Prior to any mine expansion/operation in SCCL mines, the company reviews the biodiversity values and ensure that steps are taken to restore biodiversity wherever possible in scientific and sustainable manner. Removal of vegetation obviously has an immediate impact on local biodiversity, while ground disturbance may force biodiversity survival in rehabilitated areas.

***Need of a baseline study:***

A scientific intervention to assess the species diversity of an area which is selected for mining is necessary to understand the ecology, species composition and for enhancing the effectiveness of land management before and after mining.

Biodiversity is characteristically defined on three levels: genetic diversity, species diversity and ecosystem diversity. Biologists are aware of the importance of understanding diversity, at best with respect to the increasing loss of species due to the growing influence of human activities.

The term biodiversity describes the total number, variety, and variability of living organisms as well as the diversity of the ecosystem. Even though, there have been many different interpretations of diversity, the concept of biodiversity is the integration of biological variability across all scales, from genetic level, through species and ecosystems, to the landscapes that they form, or are part of, and the ecological processes that support them. The world's biodiversity includes all living organisms (animals, plants, fungi, and microbial groups inclusive of genetic diversity and ecosystem/landscape diversity) in their interactive state contributing to a multitude of services of relevance to sustain the ecological integrity for the benefit of the humankind. It defines biodiversity as the variability among living organisms from all sources including, inter alia (among other things), terrestrial and aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems". However, since the biodiversity of any ecosystem is far too complex to be comprehensively quantified, suitable indicators or surrogates of biodiversity are needed.

Conceptually, species richness appears as the most intuitive and straightforward parameter to measure biodiversity. In addition, measures of biodiversity have been developed; the Shannon index (H'), and Simpson index (D) was considered measures used to compare diversity among communities. In general, most studies have been carried out on specific selected taxa only. Scientific biodiversity interventions will reveal data on availability of endemic/range-restricted species, whereby policies could be formulated for their future preservation. Such knowledge of the presence/absence of important species also facilitates potential conservation of critical microhabitats in and around the operational area.

Hence, as per the standard ToR condition "A detailed biodiversity assessment study of the proposed area" (core zone and buffer zone, 10 Kms radius of the periphery of the mine lease) has been carried out. Details of flora and fauna have been documented and furnished here in this report. This report carries information related to wildlife populations, habitat, and information gaps (baseline data) of the proposed mine areas and its adjoining forests areas.

## Aim and Objectives

***Aim:***

There is an urgent need for interpreting this inventory before initiating mine operations and disseminating this information for sustainable management of this un-explored habitat and for encouraging further research and conservation in the adjoining forest areas, which will be the new home-range to the species getting disturbed/moving from this habitat.

***Objectives:***

For sustainable and eco-friendly mining project development, biological environment is studied. The objectives of the study are:

1. To register and validate existing information on biodiversity of the proposed area
2. To undertake field studies to study the impact of mines and record selected floral and faunal species including prominent invertebrates & soil surface arthropods
3. To recommend mitigation plans for species and habitat concern.
4. To assess any adverse impact on the local fauna because of the proposed mine.
5. Indicate the impacts and suggest suitable mitigation measures against the adverse impacts if any,

## Study Area

| | |
|---|---|
| **State** | : Telangana |
| **District** | : Bhadradri – Kothagudem |
| **Forest Division** | : Kothagudem |
| **Forest Range** | : Ramavaram |
| **Forest Section (s)** | : Ramavaram & Penagadapa |
| **Forest Beat (s)** | : Ramavaram, Penuballi and Gareebpeta (Ramavaram Section)<br>Musalivarre West (Penagadapa Section) |
| **Total study area** | : 649.3014 Ha (Part -A = 334.7372 Ha + Part -B = 258.6898 Ha + Part -C = 55.8744 Ha) |
| **Forest Type:** | Tropical Dry Deciduous Forest – Mainly Coppice growth |
| **Habitat Type** | : Mixed-dry-deciduous forest type with wide variety of microhabitats, ranging from open grasslands, water bodies and hillocks, plantations, and woodlands to scrub lands. |

It is proposed to open a new coal mining project under the name of Venkatesh Khani Coal Mine (VK Coal Mine) by amalgamating the three mines (***Gautham Khani OC***, ***Venkatesh Khani -7 Incline*** and **Padmavathi Khani-5 Incline)** with 6.3 (OC - 5.3& UG - 1.0) MTPA capacity in mine lease area of 2403.17 ha (1568.22 ha Forest Land and 834.95 ha Non-Forest Land) located in Venkatesh Khani Village, Kothagudem town, District Bhadradri Kothagudem (Telangana State).

### Physiographic Features of the study area:

To assess impacts of any set of activities, the environmental factors both within the core zone and buffer zone are to be analyzed. The core zone in this case covers project area while the buffer area covers the 10 Kms area around the core area.

***Core zone:*** VK Coal Mine project area is of flat topography, Bolligutta hill stands out as a prominent landmark of this area along the northern boundary. The general topographic elevation of the project area varies from 160m above MSL to 100m above MSL. The south part of the project is covered by the existing GKOC project area.

***Buffer zone:*** The buffer area is a plain terrain with relief of 160m in the south and 80m in the north and sloping towards north and northeast. A few hillocks located are Kanigiri gutta (432m) & an unnamed hillock (360m) in the northeast, Balusu gutta (328m) in the southeast, and Bolli gutta (340m) at the periphery of the project are existing in the buffer area.

## Drainage:

***Buffer zone:*** The buffer zone area drainage is drained by Murredu river. Edula vagu flowing in the western half and joins to Murredu river near Gollagudem village in the northern part of the buffer area. Tellavagu flows in the eastern part and joins Edulavagu near Penuballi village. The drainage of the area is dentritic to parallel type with a density of about 1.80 Kms/ sq.Kms. Singabhupalam Cheruvu a major irrigation tank is in the western part about 7 Kms away from the proposed VK Coal Mine project.

***Core zone:*** There is no effective drainage developed in this area, due to sandy soil cover. Tellavagu, an ephemeral stream Tellavagu which is a tributary of Edula vagu is flowing in the northern part of the project area. Drainage is moderately developed, and a few ephemeral streams are flowing and join the Tellavagu. The drainage density of the block area is about 1.65 Kms/ sq.Kms.

**Fig. 1. Google map showing VK Coal Mine along with study area**

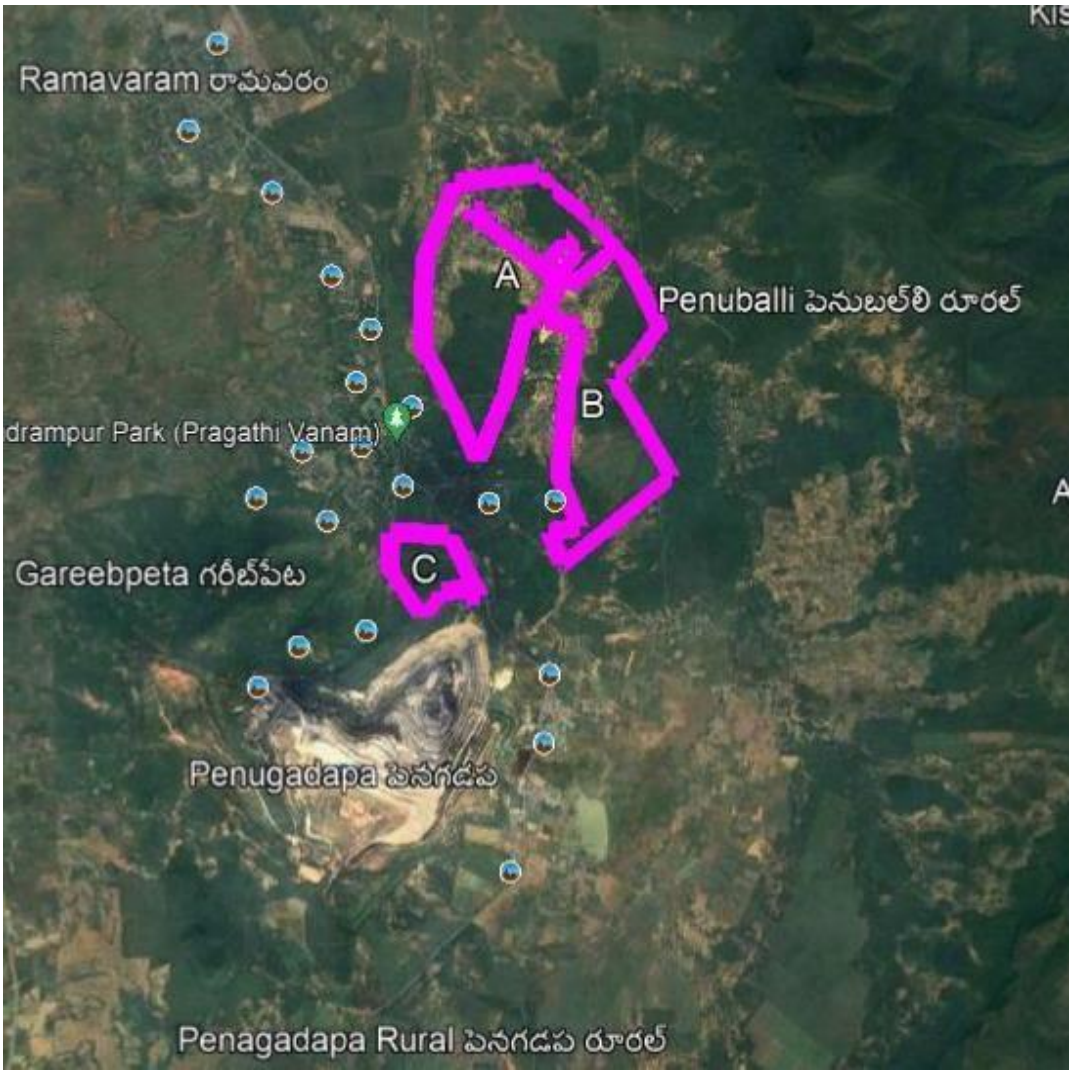


**Fig. 2. Google map showing Part - A of the study area with Nature Trails (Padmavathi Khani Mine)**

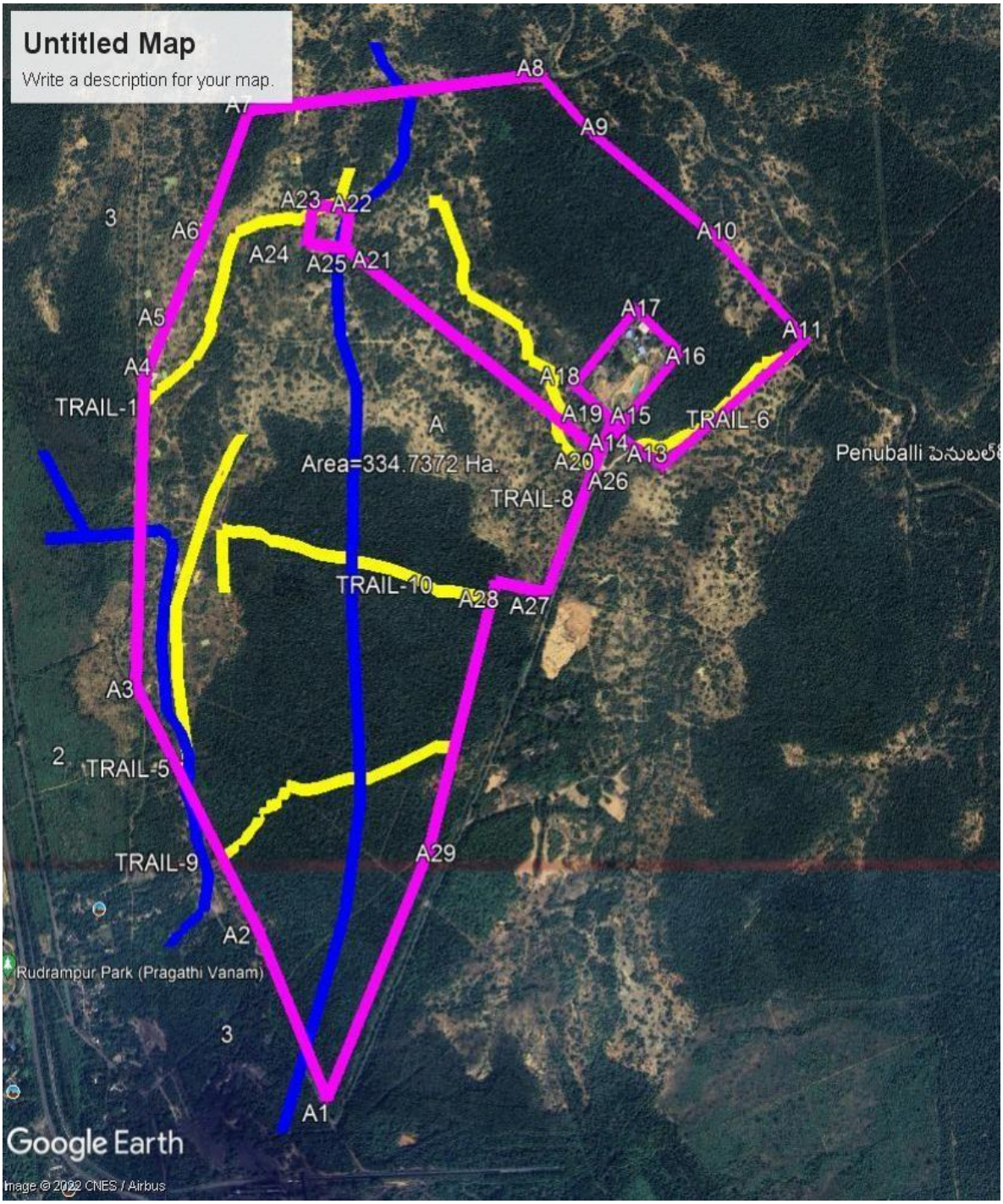


**Fig. 3. Google map showing Part - B of the study area with Nature Trails (Venkatesh Khani 7 incline Mine)**

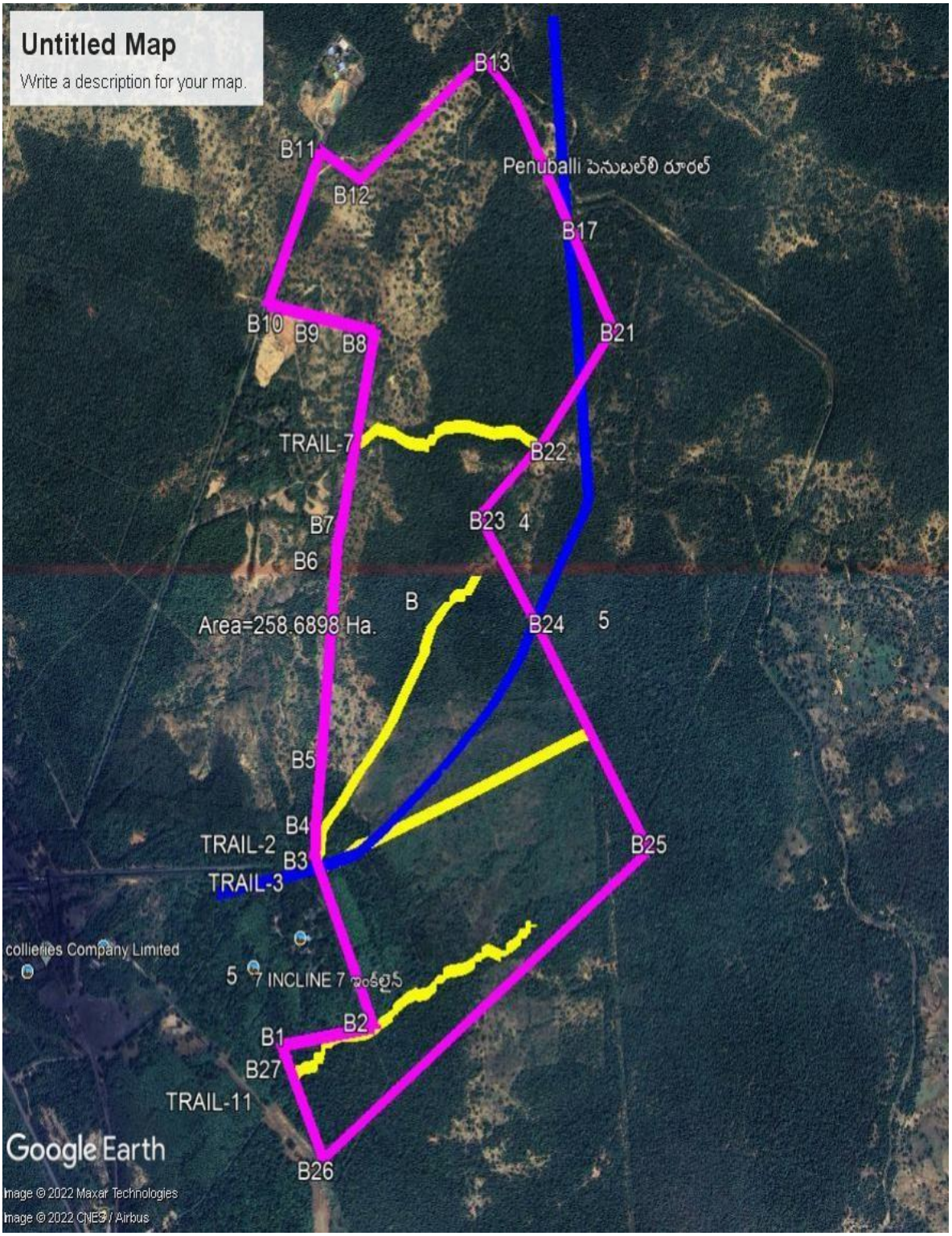


**Fig. 4. Google map showing Part - C of the study area with Nature Trails (Gautham Khani Mine)**

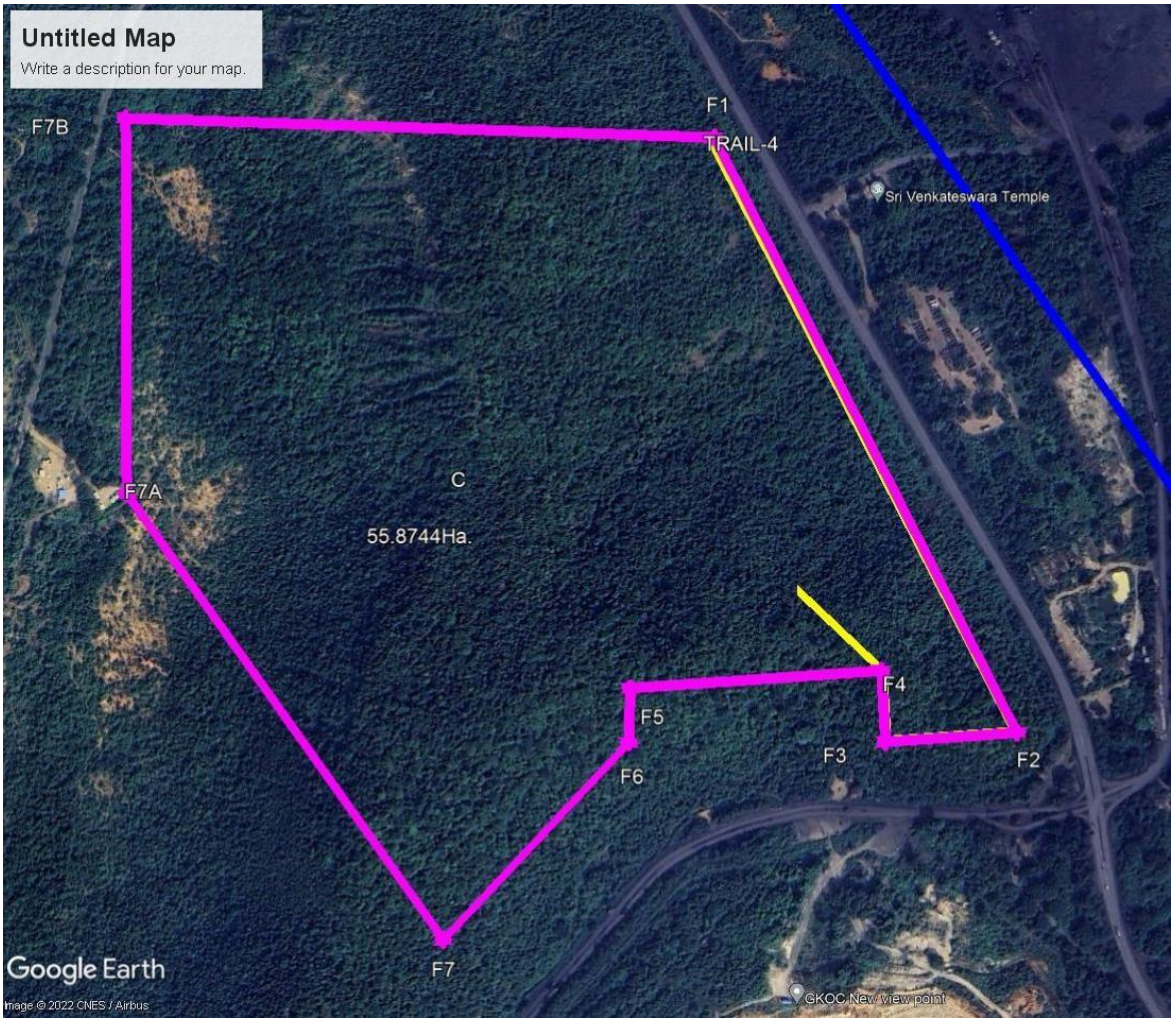
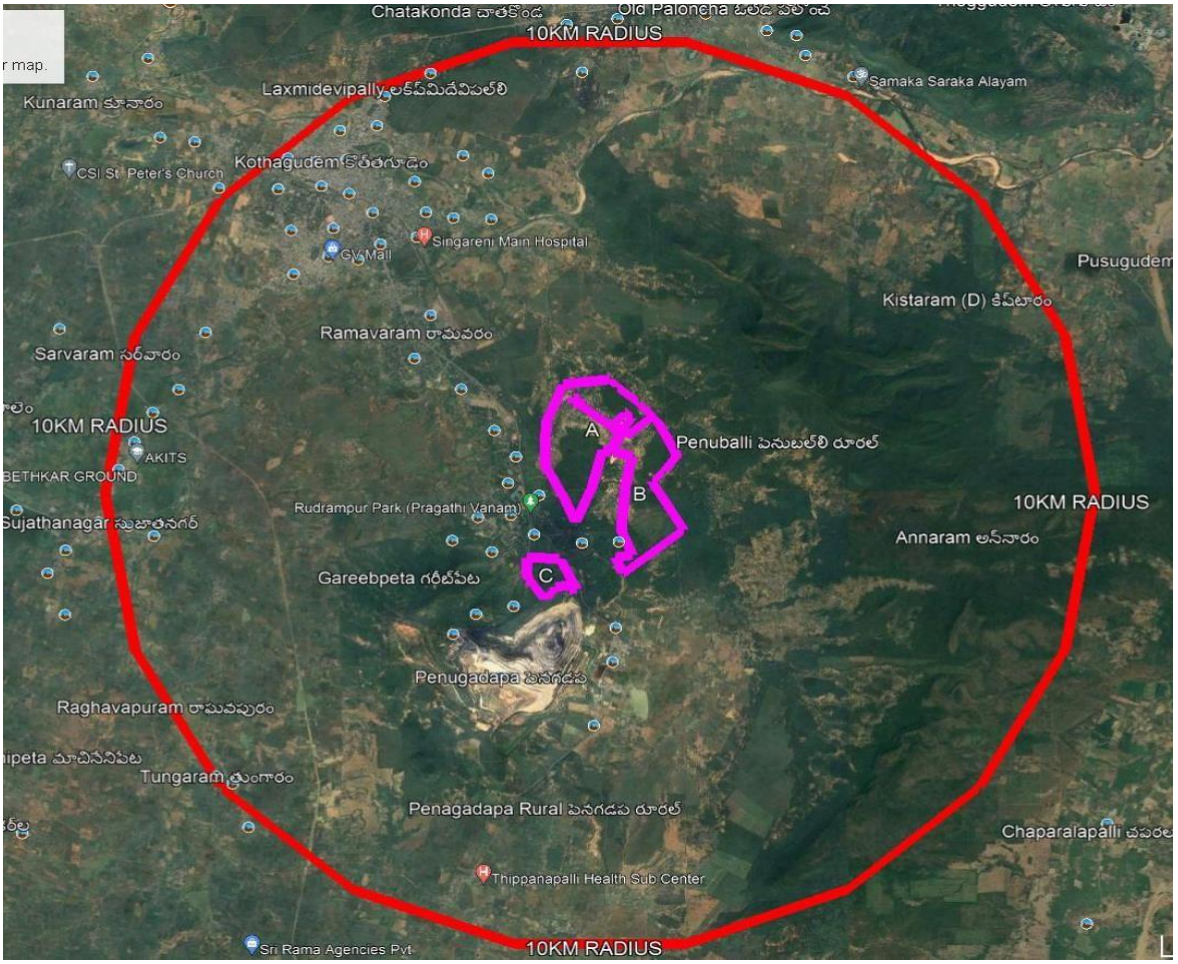


**Fig. 5. Google map showing Core and Buffer Zones of GK OC, VK-7 and PVK-5 in 10Kms of radius**




The study area does not form a part of any National Park or Sanctuary or Critical Wildlife habitat. No protected area is situated in the vicinity or within the Impact area of 10 Kms radius. The proposed study area is an existing mine. No important wild animals are noticed in the area. There is no endangered Flora and Fauna within study area. In the Impact area the important Schedule-I fauna found are Varanus and Python.

**List of Villages within the 10Kms of radius from the proposed study area**

1. Sitarampuram
2. Anandapuram
3. Gurulagudem
4. Chinthalapadu
5. Patta Cheruvu
6. Gudipadu
7. Bangarujalu
8. Patha Palvancha
9. Palvancha
10. Sitaramesth Banjara
11. Chathakonda
12. Kothagudem
13. Penuballi
14. Gollagudem
15. Laxmidevipalli
16. Hemachandrapuram
17. Sarvaram
18. Chunchupalli
19. Ramavaram
20. Kotha Anjanapuram
21. Narasimha Nagar
22. Garibpeta
23. Garimellapadu
24. Mangapeta
25. Anjanapuram
26. Sujathanagar
27. Siripuram
28. Nimmalagudem
29. Sithampeta
30. Raghavapuram
31. Thungaram
32. Repallevada
33. Arlapadu
34. Ganugapadu
35. Ravikampadu
36. Chandraguda
37. Ayyannapalem
38. Thippanapalli
39. Sitayegudem
40. Mohammad Nagar
41. Satyanarayanapuram
42. Rampuram
43. Penagadapa
44. Rudrampur
45. Laxmipuram Thanda
46. Dhanbad
47. 4 Incline
48. Mulkagudem
49. Chaparalapalli
50. Kommagudem

**Fig. 6. Map showing the forest compartments in the Core and Buffer Zones of GK OC, VK-7 and PVK-5 in 10Kms of radius**

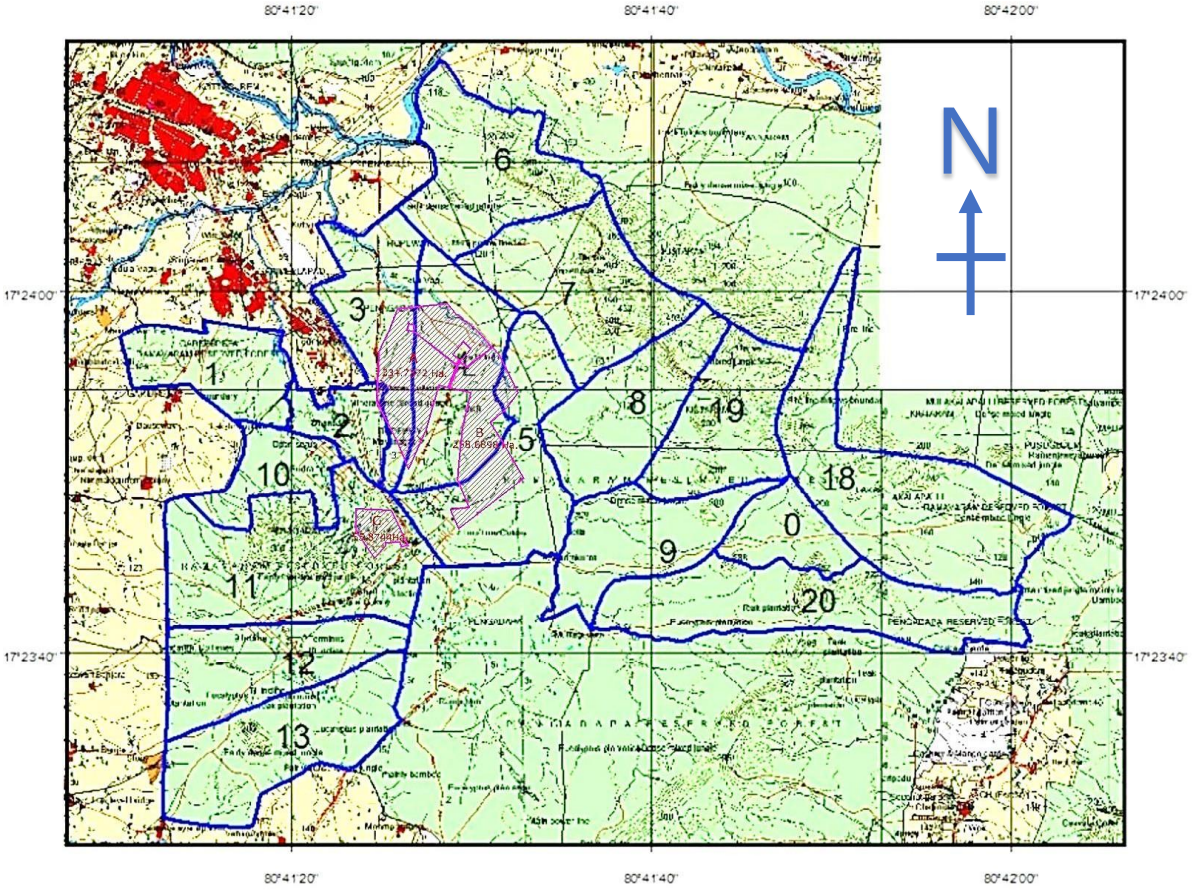
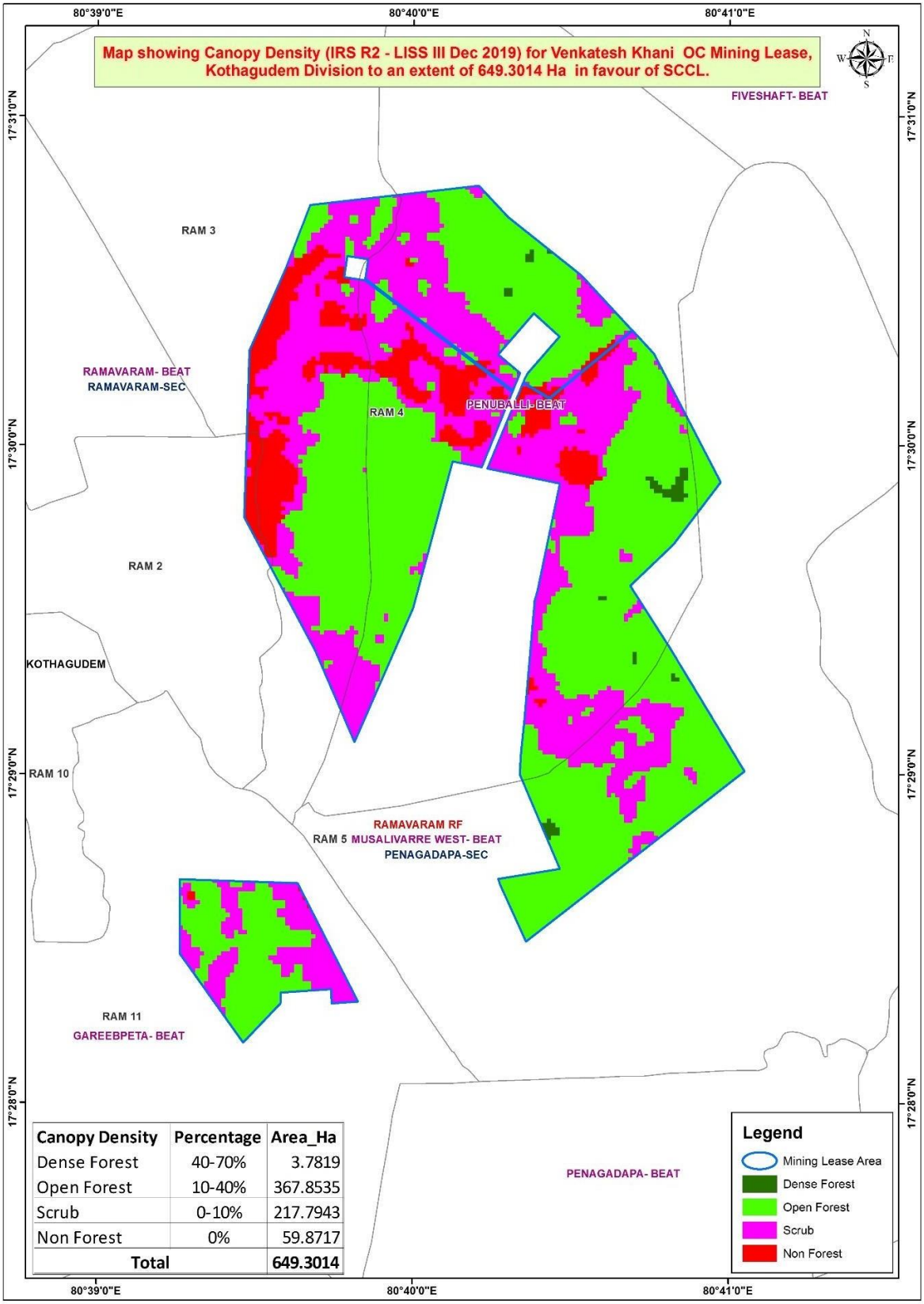


**Fig. 7. Map showing the Canopy Density in the study area (Part A, B&C)**




| Canopy Density | Percentage | Area_Ha |
|---|---|---|
| Dense Forest | 40-70% | 3.7819 |
| Open Forest | 10-40% | 367.8535 |
| Scrub | 0-10% | 217.7943 |
| Non Forest | 0% | 59.8717 |
| **Total** | | **649.3014** |

# Methodology

The study was conducted in all the three proposed parts (A, B & C) (Fig. 2, 3 & 4) for mining lease. The varying habitats in these three parts give rise to diverse ecosystems providing nesting and roosting site for birds, mammals, reptiles, amphibians, insects, and butterflies.

The present study is an assessment of biodiversity in the proposed area over a period of about one year and again re-visited the area during October- November 2022.

The procedure therefore involved field surveys of selected components of biodiversity such as plants butterflies, amphibians, reptiles, birds, and mammals. Intensive survey methods (including night trails in the proposed area) were used involving Forest Beat Officers. The team walked the pre-identified nature trails (Fig. 2, 3 & 4) in the study area extensively covering the entire proposed study area to enumerate different species as and when they were encountered or sighted.

Studies on faunal diversity were performed during both diurnal and nocturnal timings. Point counts on the nature trials were performed to document the bird species, Opportunistic surveys and listing encounters in random trails were also performed.

All observations were conducted on foot and were aided by 80x40 binoculars. Photo records were obtained withthe help of Nikon 24-3000 mm camera with 125x wide optical zoom lens.

Species were identified using

- "A pictorial guide to the mammals of the India". Avifauna species were identified using "A pictorial guideto the birds of the Indian Sub-Continent".

- Reptiles and amphibians were identified with the available identification keys include Fauna of British India.

- Filed guides and published literature were used for theidentification of Odonates, butterflies, arachnids, fishes, and other invertebrates.

### Meteorological data:

Basic field conditions were recorded by observing visually. The collected data was compared with the online data portals providing meteorological data.

### Floral sampling procedures:

Secondary data obtained from the Environment Management Plan already existing with the company was obtained and presented here in the report. (Fig. 7).

### Faunal sampling procedures:

1. **Pre-existing tracts and roads were marked as Nature Trails** in each Part of the study area covering microhabitats within it (Fig. 2, 3 & 4). These tracts were walked during morning and evening hours and sampling was done using line transect method.

A total of 11 nature trails with 1100 mts each were walked during the survey. (Table.1). Six trails in Part – A, four trails in Part – B, and one Trail in Part – C, covering all the vegetation and habitat type in the proposed study area. (Fig. 2, 3 & 4).

**Table 1. Geographic coordinates nature trails in the PART A, B & C study area**

| TRAILS | STARTING | | ENDING | | DISTANCE IN METERS |
|---|---|---|---|---|---|
| | LAT | LONG | LAT | LONG | |
| 1. | N17°30'14.598" | E80°39'29.022" | N17°30'38.128" | E80°39'51.403" | 1100 |
| 2. | N17°28'59.555" | E80°40'20.490" | N17°29'28.267" | E80°40'40.853" | 1100 |
| 3. | N17°28'58.613" | E80°40'20.907" | N17°29'12.146" | E80°40'55.242" | 1100 |
| 4. | N17°28'39.982" | E80°39'38.146" | N17°28'23.562" | E80°39'41.339" | 1100 |
| 5. | N17°29'38.4" | E80°39'32.526" | N17°30'11.703" | E80°39'39.723" | 1100 |
| 6. | N17°30'10.379" | E80°40'22.720" | N17°30'31.013" | E80°40'31.786" | 1100 |
| 7. | N17°29'41.580" | E80°40'25.348" | N17°29'41.328" | E80°40'48.795" | 1100 |
| 8. | N17°30'8.180" | E80°40'18.141" | N17°30'34.688" | E80°40'0.076" | 1100 |
| 9. | N17°29'29.789" | E80°39'37.310" | N17°29'47.372" | E80°40'4.776" | 1100 |
| 10. | N17°29'55.422" | E80°40'7.0173" | N17°29'55.960" | E80°39'37.669" | 1100 |
| 11. | N17°28'37.455" | E80°40'17.723" | N17°28'53.052" | E80°40'48.081" | 1100 |

*Line Transect Method*

*The line transect method of Gaston (1975) is adopted in most of the population estimation studies.*

*Procedure: At the start of the transect, the transect name, transect bearing, locality, date, starting time and other details were noted in proforma, especially designed for the purpose. Then the team walked along the transect carefully and silently looking for animals on both sides of the transect. On sighting an animal or group of animals, the number is counted, and their position is noted. Then, their angular distance i.e., the distance from the observer to the animal was measured visually. The sighting angle was derived from the compass bearing of the animal's location and the transect compass bearing. The perpendicular distance of the animal from the transect was estimated by multiplying the angular distance with Sin of the sighting angle. The data obtained from different nature trails were pooled and mean perpendicular distance was estimated.*

*Then, the density of the animal was calculated using the following formula,*

$$Density = n / 2l * r$$

*Where, n= number of animals sighted l= total length of the transect r= Angular distance*

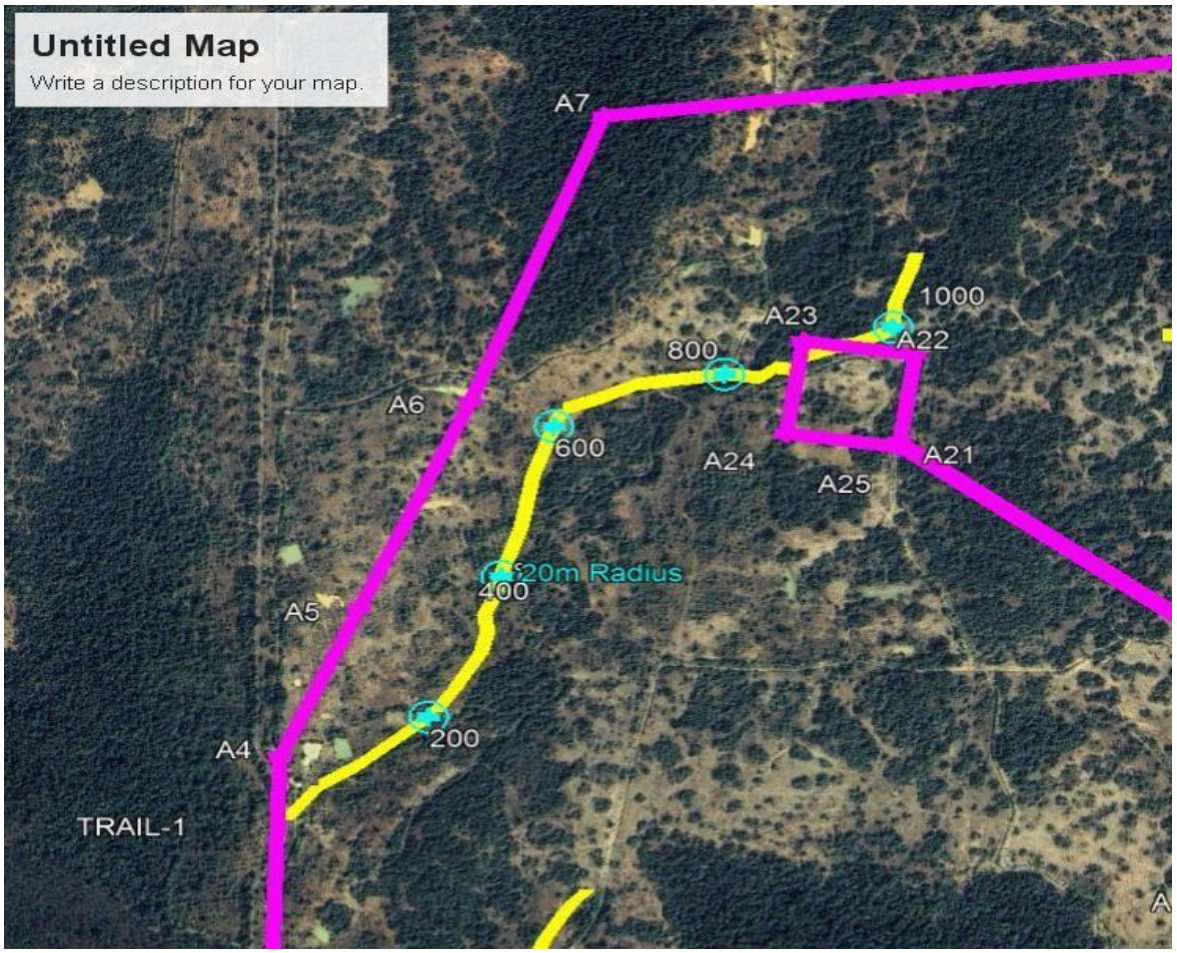
2. **Mammalian herbivore** presence was assessed through direct sighting only along the trails, and around watering points.

3. **Carnivore** presences were also studied through direct sighting only.

4. **Direct sighting and vocalizations** were recorded to study bird presence and validate existing data on birds of the all the Parts in the study area. Early morning and evening studies were carried out when bird activity is at its peak. The point-count method was used on the nature trails by marking each point at 200mts interval along each trail and the bird count was performed within a radius of 25mts at each point. (Fig. 8.). A total of 5 points were marked and used for the bird point-count at each trail in all the three parts of the study area (Table. 2). We collected

the data from 55 points established systematically and have been marked in all 11 nature trails of 1100mts each in the study area. (Table 2)

**Fig. 8. Google map showing Nature Trail with Bird Point-count locations**




*Bird Point Count Method*

*Procedure: A point count consists of standing in a specific location and counting birds. One counted the number of individual birds (of each species) within a circle of 20mts radius. When gathering data to compare one point count to the next, radius size was kept consistent. The radius of 20mts was as large as possible kept in the study area based on the vegetation type (mostly open forest) to maximize information gathering, and the birds could not be seen are heard and recorded throughout the nature trails in the study area. The 20mts radius point count at each point was performed to record all the birds seen or heard within a 5-minute period. We have recorded all birds that are seen or heard within the normal 20mts radius. At the same time, we have also recorded the birds that are heard or seen within a selected distance outside this 20mts radius. The birds counted within the 20mts radius were marked in the "Number of Birds" column of the data sheet and the birds seen or heard outside the 20mts radius (within a specified distance) are marked in the "Outside" column of the data sheet. Counting the same bird twice during the survey was avoided.*

*A bird that moves from the 0 - 20mts area was not counted twice. Counted the birds where it first appeared or sighted. The purpose of surveying birds in this manner is that it allows one to compare across sites.*

**Fig. 9. Diagrammatic representation of bird point-count design**

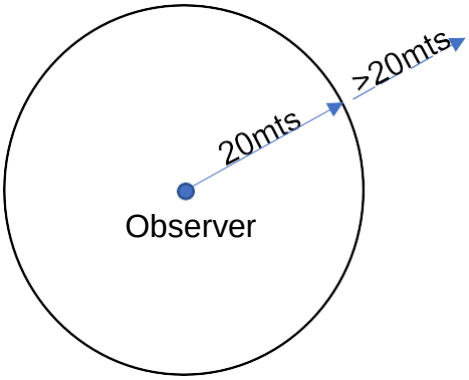



**Table 2. Geographic coordinates of bird point-count points marked in the nature trails in all the PARTs A, B & C of the study area**

| Point No. | Latitude | | | Longitude | | | Trail No. |
|---|---|---|---|---|---|---|---|
| | Deg. | Min. | Sec. | Deg. | Min. | Sec. | |
| 1 | 17 | 30 | 18.85598 | 80 | 39 | 34.08737 | **TRAIL-1** |
| 2 | 17 | 30 | 24.67052 | 80 | 39 | 36.66052 | |
| 3 | 17 | 30 | 30.91033 | 80 | 39 | 38.53268 | |
| 4 | 17 | 30 | 33.07393 | 80 | 39 | 44.58386 | |
| 5 | 17 | 30 | 35.00443 | 80 | 39 | 50.55766 | |
| 6 | 17 | 29 | 5.08251 | 80 | 40 | 23.53231 | **TRAIL-2** |
| 7 | 17 | 29 | 10.25375 | 80 | 40 | 27.62735 | |
| 8 | 17 | 29 | 15.67464 | 80 | 40 | 31.34328 | |
| 9 | 17 | 29 | 21.37146 | 80 | 40 | 34.45858 | |
| 10 | 17 | 29 | 26.24166 | 80 | 40 | 38.56585 | |
| 11 | 17 | 29 | 1.19389 | 80 | 40 | 27.01192 | **TRAIL-3** |
| 12 | 17 | 29 | 3.57506 | 80 | 40 | 33.31775 | |
| 13 | 17 | 29 | 6.04545 | 80 | 40 | 39.59193 | |
| 14 | 17 | 29 | 8.59187 | 80 | 40 | 45.83286 | |
| 15 | 17 | 29 | 11.1573 | 80 | 40 | 52.06552 | |
| 16 | 17 | 28 | 34.17069 | 80 | 39 | 41.11204 | **TRAIL-4** |
| 17 | 17 | 28 | 28.39292 | 80 | 39 | 44.23322 | |
| 18 | 17 | 28 | 22.61514 | 80 | 39 | 47.35436 | |
| 19 | 17 | 28 | 18.32158 | 80 | 39 | 47.712 | |
| 20 | 17 | 28 | 21.37383 | 80 | 39 | 43.75726 | |
| 21 | 17 | 29 | 44.00492 | 80 | 39 | 32.96772 | **TRAIL-5** |
| 22 | 17 | 29 | 50.47755 | 80 | 39 | 32.36692 | |
| 23 | 17 | 29 | 56.85014 | 80 | 39 | 33.10816 | |
| 24 | 17 | 30 | 3.02317 | 80 | 39 | 35.25616 | |
| 25 | 17 | 30 | 8.97316 | 80 | 39 | 37.93188 | |
| 26 | 17 | 30 | 11.83627 | 80 | 40 | 29.0699 | **TRAIL-6** |
| 27 | 17 | 30 | 16.12002 | 80 | 40 | 34.13094 | |
| 28 | 17 | 30 | 19.33687 | 80 | 40 | 39.49441 | |
| 29 | 17 | 30 | 23.89631 | 80 | 40 | 38.67032 | |
| 30 | 17 | 30 | 28.66663 | 80 | 40 | 34.05654 | |
| 31 | 17 | 29 | 42.04538 | 80 | 40 | 31.44358 | **TRAIL-7** |
| 32 | 17 | 29 | 43.25359 | 80 | 40 | 37.26235 | |
| 33 | 17 | 29 | 42.75506 | 80 | 40 | 43.93841 | |
| 34 | 17 | 29 | 42.3786 | 80 | 40 | 49.78611 | |
| 35 | 17 | 29 | 47.57437 | 80 | 40 | 53.87023 | |
| 36 | 17 | 30 | 12.89298 | 80 | 40 | 14.26144 | **TRAIL-8** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 37 | 17 | 30 | 18.38437 | 80 | 40 | 12.59121 | |
| 38 | 17 | 30 | 23.12239 | 80 | 40 | 8.92722 | |
| 39 | 17 | 30 | 26.85979 | 80 | 40 | 3.71859 | |
| 40 | 17 | 30 | 33.02159 | 80 | 40 | 2.18556 | |
| 41 | 17 | 29 | 34.25556 | 80 | 39 | 42.03252 | **TRAIL-9** |
| 42 | 17 | 29 | 36.4816 | 80 | 39 | 47.27233 | |
| 43 | 17 | 29 | 37.6769 | 80 | 39 | 53.8697 | |
| 44 | 17 | 29 | 40.31582 | 80 | 40 | 0.05682 | |
| 45 | 17 | 29 | 44.22869 | 80 | 40 | 3.9016 | |
| 46 | 17 | 29 | 56.47055 | 80 | 40 | 0.40638 | **TRAIL-10** |
| 47 | 17 | 29 | 58.69132 | 80 | 39 | 54.07332 | |
| 48 | 17 | 29 | 59.93205 | 80 | 39 | 47.43811 | |
| 49 | 17 | 30 | 1.8855 | 80 | 39 | 41.05976 | |
| 50 | 17 | 29 | 59.19858 | 80 | 39 | 37.43828 | |
| 51 | 17 | 28 | 41.15651 | 80 | 40 | 22.38711 | **TRAIL-11** |
| 52 | 17 | 28 | 42.92922 | 80 | 40 | 28.6734 | |
| 53 | 17 | 28 | 45.98556 | 80 | 40 | 34.26492 | |
| 54 | 17 | 28 | 48.81467 | 80 | 40 | 40.07795 | |
| 55 | 17 | 28 | 50.98344 | 80 | 40 | 45.74362 | |

***The following details provide the protocol adopted for bird count:***

a. **Selection of points:** *The study are satellite images were captured, and the bird points at 200mts distance each was fixed on the image having the pre-existing nature trails covering the vegetation sampling grids. The centre point of each point has been chosen based using GPS and systematic sampling was followed.*

b. **Duration and time of counts:** *Counts were done within three hours after sunrise. This is when birds are most active. Also done night-time surveys to count nocturnal species (done within three hours after sunset). During point counts, recorded all birds seen and heard within the survey area. The team initially stood for two minutes to allow some settling time for the birds that were disturbed. Observations were recorded for five minutes.*

c. **Recording method:** *For each sighting, the number of individuals, and the sighting distance was recorded. Flying birds and calls of the birds were recorded separately.*

d. **Counting FO (Flyovers):** *All higher-flying birds (above the tallest structure in the study area) were also noted if they are within the boundaries of the point count area.*

e. **Counting Birds Outside of Survey Area:** *Only birds seen or heard within the point count area were recorded .*

f. **Estimating Abundance:** *When multiple sightings of a species occurred within a point count, we have included only multiple entries for a species of sure that they are different individuals.*

g. **Avoided Artificial Densities:** *No sounds used that can attract birds to our trail or in the study are. No recorded calls, or any other methods that encourage birds to show themselves was used.*

h. **Set-up:** *Before conducting the point count, the boundaries of the area marked visually by using some identifiable object (e.g., a large tree). Also, marked the centre spot where we stood and observed the birds with GPS. The exact place was used each time for the survey.*

i. **Distance estimation:** *Ocular estimates of the distance were taken.*

j. **Weather:** *While conducting the point count, the general climatic conditions were recorded; Wind intensity (calm, slight, gusty, strong) and sky condition (clear, cloudy). This is important because climatic variables are known to affect bird activity. Bird point count studies were avoided on rainy days or extremely windy days because birds don't produce calls during that time, hence affecting the detectability.*

5. **Reptiles and amphibians** were recorded in through incidence rate along nature trails as well as occurrence and interception rates along water holes. Other than the day counts, sampling was also conducted during the early evening and night, when incidence rates are expected to be highest.

6. **Invertebrates** were estimated through incidence rates and direct sighting. Butterflies, ants, spiders, dragonflies, scorpions, bees, wasps, beetles, grasshoppers, and other prominent invertebrates were check-listed. Where identification is not possible in the field, photographs were taken for taxonomical purpose.

7. **Special habitats and eco-tones**, especially fields and grasslands were surveyed for estimating the presence of grassland birds, rodents, and small mammals.

**Source of secondary information on wildlife:**

- Secondary information on flora, fauna and their distribution were collected from Forest Department, Kothagudem (Working Plan/Management Plan of Kothagudem) Division, 2014-2024 of Bhadradri Kothagudem district. Also, data were collected on wildlife census conducted, incidents of forest fires, man-animal conflicts, compensation cases/details, water sources (natural and man-made structures), density enrichment plantations by Forest Department and SCCL, grassplots developed.

- Faunal availability was also verified from the local people and staff working in the forest department.

- Conservation status of the flora and fauna were cross checked under IUCN Red list through published literature and online as well as Indian Wildlife Protection Act (IWPA), 1972 and further Amendments.

**Source of secondary information on villages and livestock:**

The methodology adopted for the study mainly includes review of published secondary data and primary field survey (District Census Statistical Handbooks- 2011 and Primary Census Abstract of Census-2011) with respect to population, sex ratio, average household size, density of population, social stratification, literacy rate and occupational structure for 10 Kms radius study area. The villages falling within the study area were visited to have first-hand information on the socioeconomic conditions of the people living in these villages.

### Traffic Study:

The traffic study has been conducted to know the prevailing traffic volumes on the existing approach roads to the project area. Even though no coal transport is proposed through road mode in the project. It is essential to consider these details for assessing the anticipated future traffic volumes as a part of overall impacts assessment for the project.

### Methodology adopted for studying the Socio-economic Status within the 10Kms radius from the proposed study area:

The methodology adopted for the study mainly includes review of published secondary data and primary field survey (District Census Statistical Handbooks- 2011 and Primary Census Abstract of Census-2011) with respect to population, sex ratio, average household size, density of population, social stratification, literacy rate and occupational structure for 10 Kms radius study area. The villages falling within the study area were visited to have firsthand information on the socioeconomic conditions of the people living in these villages.

The information gathered during the interview and Participatory Rural Appraisal (PRA)/ Rapid Rural Appraisal (RRA) covered different aspects of socio-economic indicators to evaluate the present quality of life of the people living in the area and to know the people's perception on the proposed project.

# Results & Discussion

### Meteorological Data:

Kothagudem area experiences typical tropical climate of a distinct hot summer from March to May with occasional dust storms, a good monsoon between middle of June and September and a pleasant winter from December to February. The temperature varies between 9.10 C and 48.60 C.

**Fig. 10. Average Weather Data of the Study Duration (September 2022)**

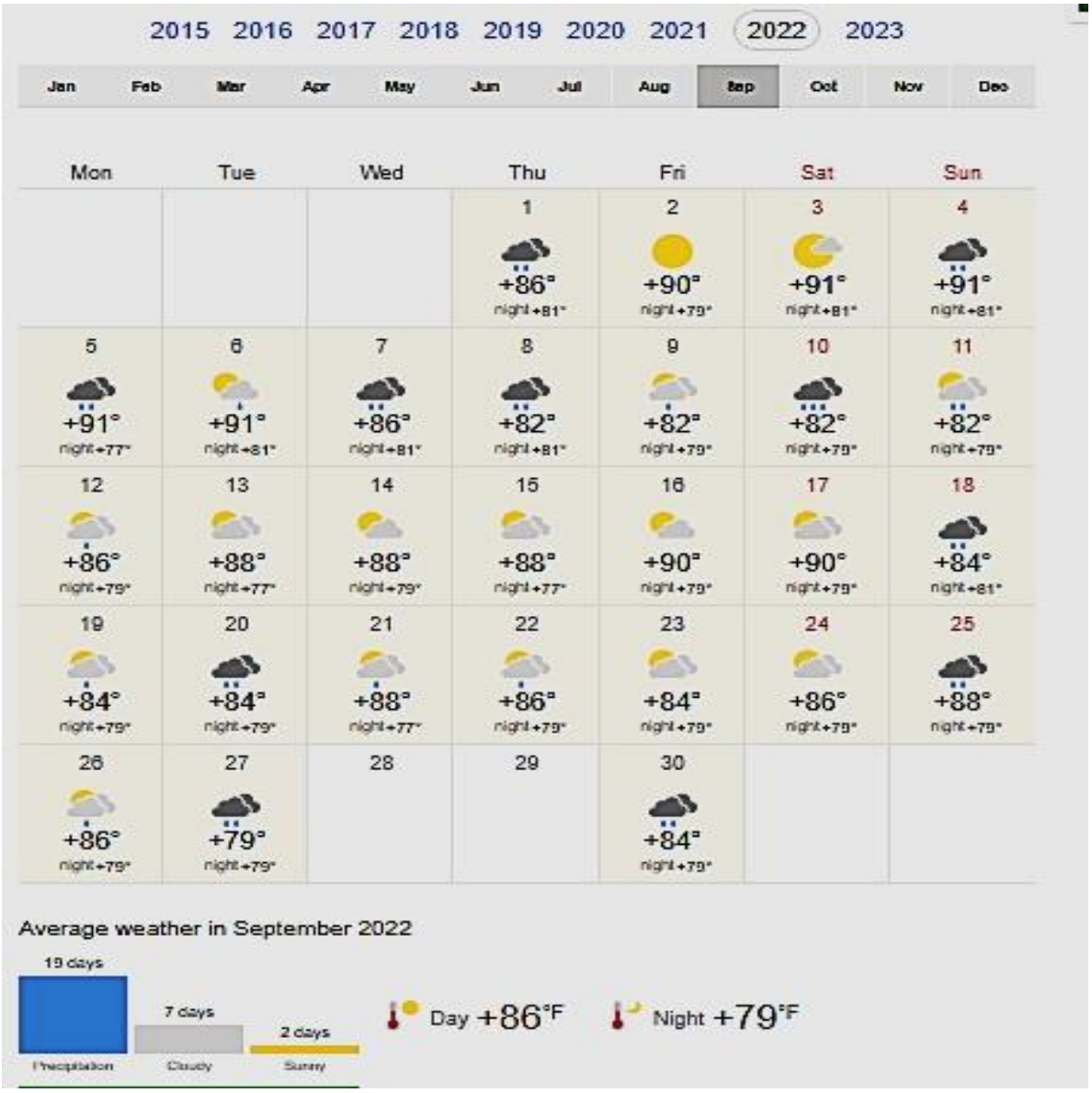
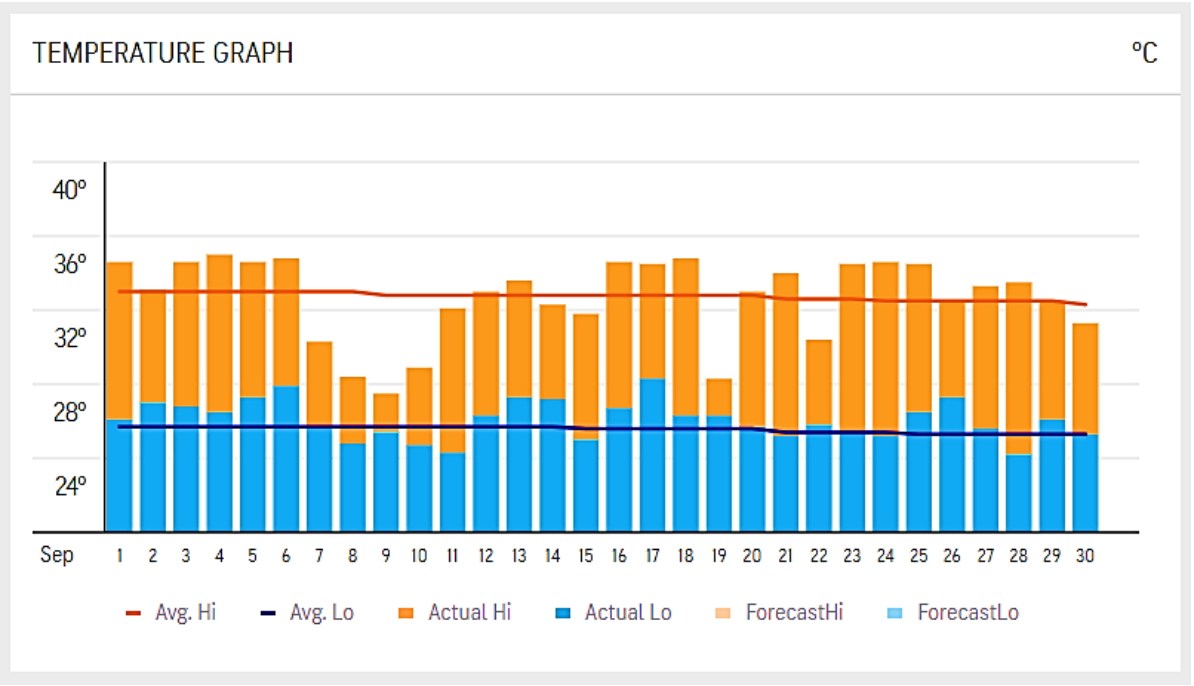


**Fig. 11. Temperature Graph of the Study Duration**




https://world-weather.info/forecast/india/kothagudem_7/september-2022/
https://www.accuweather.com/en/in/kothagudem/186810/september-weather/186810

Three seasons studies were carried out at the time of preparation of EMP. Again, study was carried out during October- November 2022. The season during the study period was post-monsoon season in the study area. Most of the days were sunny and had rains in the evening. The wind was also light during the study period. Sky was recorded always clear and cloudy during the rains. The weather conditions were favorable during the study period to record the existing species in the proposed study area.

**Floral Diversity:**

A total of 313 plant species belonging to 241 genera and 83 families were documented in the study area (Core and Buffer zone). Among 313 species listed: 89 species are trees, 41 shrubs, 14 lianas, 22 climbers, 117 herbs, 29 aquatic herbs and one is epiphyte.

As the vegetation analysis suggests there are more herbaceous species (117 species) in comparison to tree species or other life forms as shown in figure.

This infers to the study area of proposed project is medium density forests.

Among all 313 species, 23 species are recorded in core zone, 122 species in buffer zone and 168 are recorded in both core and buffer zone areas of the study area. The species listed in core zone includes 5 trees, 3 shrubs, 1 climber and 14 herbs; in buffer zone 19 trees, 14 shrubs, 4 lianas, 11 climbers, 48 herbs and 26 aquatic herbs; in core and buffer 65 trees,24 shrubs, 10 lianas, 10 climbers, 55 herbs, 3 aquatic herbs and one is epiphyte.

**Table 3. List of species of floral species documented**

| S. No. | Scientific Name | Family | Habit | Vernacular Name | Study Zone | IUCN Status |
|---|---|---|---|---|---|---|
| 1 | *Abildgaardia ovata* | Cyperaceae | H | - | B | LC |
| 2 | *Abrus precatorius* | Fabaceae | C | Guruginja | C&B | NA |
| 3 | *Abutilon hirtum* | Malvaceae | S | Palabenda | C&B | NA |
| 4 | *Abutilon indicum* | Malvaceae | S | Thuttutubenda | B | NA |
| 5 | *Acalypha capitata* | Euphorbiaceae | S | Chiru Kuppinta | C | NA |
| 6 | *Acalypha indica* | Euphorbiaceae | H | Muripinda | C&B | NA |
| 7 | *Achyranthes aspera* | Amaranthaceae | H | Uttareni | B | NA |
| 8 | *Acmella paniculata* | Asteraceae | H | Maratimoggalu | C&B | LC |
| 9 | *Actinoscirpus grossus* | Cyperaceae | AH | - | B | NA |
| 10 | *Adina cordifolia* | Rubiaceae | T | Rudraganapa, Patchabotruka | C&B | NA |
| 11 | *Aegle marmelos* | Rutaceae | T | Maredu, Bilvumu | C&B | NA |
| 12 | *Afrohybanthus enneaspermus* | Violaceae | H | Ratna purusha | C | NA |
| 13 | *Agave americana* | Asparagaceae | S | Kathaichettu | B | NA |
| 14 | *Ageratum conyzoides* | Asteraceae | H | Adavipudeena | C&B | NA |
| 15 | *Ailanthus excelsa* | Simaroubaceae | T | Pedda manu | C&B | NA |
| 16 | *Alangium salviifolium* | Cornaceae | T | Nallaoodaga | C&B | LC |
| 17 | *Albizia amara* | Leguminosae | T | Narlingi, Chigara | C&B | LC |
| 18 | *Albizia odoratissima* | Leguminosae | T | Chinduga | C&B | LC |
| 19 | *Albizia thompsonii* | Leguminosae | T | - | C&B | NT |
| 20 | *Alternanthera pungens* | Amaranthaceae | H | Mulla Ponnaganti | C&B | NA |
| 21 | *Alternanthera sessilis* | Amaranthaceae | H | Adavi Ponnaganti | C&B | LC |
| 22 | *Alysicarpus hamosus* | Leguminosae | H | - | C | NA |
| 23 | *Alysicarpus monilifer* | Leguminosae | H | Poosala mokka | B | NA |
| 24 | *Amaranthus spinosus* | Amaranthaceae | H | Mundla | C&B | NA |
| 25 | *Amaranthus viridis* | Amaranthaceae | H | Chilaka thotakura | B | NA |
| 26 | *Ammannia baccifera* | Lythraceae | AH | Nela Citramulam, Agnivendramu | B | LC |
| 27 | *Ammannia multiflora* | Lythraceae | AH | - | B | LC |
| 28 | *Andrographis echioides* | Acanthaceae | H | - | C&B | NA |
| 29 | *Andrographis paniculata* | Acanthaceae | H | Belavemu | C&B | NA |
| 30 | *Annona squamosa* | Annonaceae | T | Seetaphalam | C&B | LC |
| 31 | *Aponogeton crispus* | Aponogetonaceae | AH | Nammapuvvu | B | LC |
| 32 | *Aristida adscensionis* | Poaceae | H | Cheepuru | C&B | NA |
| 33 | *Aristida hystrix* | Poaceae | H | Chinnameesala gaddi | C&B | NA |
| 34 | *Aristida setacea* | Poaceae | H | Chipurugaddi | C&B | NA |
| 35 | *Aristolochia indica* | Aristolochiaceae | C | Iswaraveru | C&B | NA |
| 36 | *Asparagus racemosus* | Asparagaceae | C | Sathavari | C&B | NA |
| 37 | *Ayenia herbacea* | Malvaceae | H | Magasirigadda | C&B | NA |
| 38 | *Azadirachta indica* | Meliaceae | T | Vepa chettu | C&B | LC |

| | | | | | | |
|---|---|---|---|---|---|---|
| 39 | *Bacopa monnieri* | Plantaginaceae | AH | Brahmmi | B | LC |
| 40 | *Balanites aegyptiaca* | Zygophyllaceae | T | Ingudi, Garachettu | C | LC |
| 41 | *Bambusa bambos* | Poaceae | T | Veduru | C&B | NA |
| 42 | *Barleria prionitis* | Acanthaceae | H | Mullagorinta | B | NA |
| 43 | *Bauhinia racemosa* | Leguminosae | T | Arichettu | C&B | NA |
| 44 | *Bergia capensis* | Elatinaceae | AH | Neerupavila | B | LC |
| 45 | *Blepharis integrifolia* | Acanthaceae | H | Chatuspathri | C&B | NA |
| 46 | *Blepharis maderaspatensis* | Acanthaceae | H | Anthritapoolu | C&B | NA |
| 47 | *Blumea axillaris* | Compositae | H | Kukkapogaku | C | NA |
| 48 | *Blumea lacera* | Compositae | H | - | B | NA |
| 49 | *Boerhavia diffusa* | Nyctaginaceae | H | Punarnava, Atikimamidi | B | NA |
| 50 | *Boerhavia erecta* | Nyctaginaceae | H | Pandari punarnava | B | NA |
| 51 | *Bombax ceiba* | Malvaceae | T | Buruga | B | LC |
| 52 | *Bonnaya ciliata* | Linderniaceae | AH | - | B | LC |
| 53 | *Boswellia serrata* | Burseraceae | T | Anduga | B | NA |
| 54 | *Brachypterum scandens* | Leguminosae | L | Nallateega | C&B | NA |
| 55 | *Bridelia montana* | Phyllanthaceae | S | Adavi jama | C&B | NA |
| 56 | *Bridelia retusa* | Phyllanthaceae | T | Mullumaddi | C&B | LC |
| 57 | *Buchanania cochinchinensis* | Anacardiaceae | T | Chinna morli | C&B | NA |
| 58 | *Butea monosperma* | Leguminosae | T | Moduga | C&B | LC |
| 59 | *Butea superba* | Leguminosae | L | Teega modiga | C&B | NA |
| 60 | *Cajanus scarabaeoides* | Leguminosae | C | - | C&B | LC |
| 61 | *Calotropis gigantea* | Apocynaceae | S | Tella Jilledu | B | NA |
| 62 | *Calotropis procera* | Apocynaceae | S | Erra jilledu | B | NA |
| 63 | *Canavalia gladiata* | Leguminosae | L | Thammakaya | B | NA |
| 64 | *Canscora heteroclita* | Gentianaceae | AH | Thambakaya | B | NA |
| 65 | *Canthium coromandelicum* | Rubiaceae | S | Sinnabalusu, Balusu | C&B | NA |
| 66 | *Capparis sepiaria* | Capparaceae | S | Nallauppi | B | LC |
| 67 | *Capparis spinosa* | Capparaceae | L | - | C&B | LC |
| 68 | *Careya arborea* | Lecythidaceae | T | Budadarmi | C&B | NA |
| 69 | *Carissa carandas* | Apocynaceae | S | Kalivi | B | NA |
| 70 | *Cassia fistula* | Leguminosae | T | Rela chettu | C&B | LC |
| 71 | *Cassytha filiformis* | Lauraceae | C | Pasuputivva | C&B | NA |
| 72 | *Catunaregam spinosa* | Rubiaceae | S | Manga | C&B | NA |
| 73 | *Celastrus paniculatus* | Celastraceae | L | Jyothismathi, Teegapalleru | C&B | NA |
| 74 | *Ceratopteris thalictroides* | Pteridaceae | AH | - | B | LC |
| 75 | *Chara globularis* | Characeae | AH | Chara | B | LC |
| 76 | *Chloris barbata* | Poaceae | H | Jada kunchula gaddi | C&B | NA |
| 77 | *Chloroxylon swietenia* | Rutaceae | T | Billudu | C&B | VU |
| 78 | *Chromolaena odorata* | Compositae | S | Porangi | C&B | NA |
| 79 | *Chrozophora rottleri* | Euphorbiaceae | H | Lingamirapa | B | NA |
| 80 | *Chrysopogon fulvus* | Poaceae | H | - | C | NA |
| 81 | *Cleistanthus collinus* | Phyllanthaceae | T | Kodise | C&B | VU |
| 82 | *Cleome viscosa* | Cleomaceae | H | Kukka vominta | C&B | NA |
| 83 | *Clitoria ternatea* | Leguminosae | C | Dintena teega | B | NA |
| 84 | *Coccinia grandis* | Cucurbitaceae | C | Donda | B | NA |

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|---|---|---|---|---|---|---|
| 85 | *Cocculus hirsutus* | Menispermaceae | C | Chinnadusar teega | C&B | NA |
| 86 | *Coldenia procumbens* | Boraginaceae | H | Bukkinaaku | C&B | LC |
| 87 | *Colocasia esculenta* | Araceae | H | Chemadumpa | B | LC |
| 88 | *Combretum albidum* | Combretaceae | L | Yadateega | B | NA |
| 89 | *Commelina benghalensis* | Commelinaceae | AH | Vennadevikura | C&B | LC |
| 90 | *Commelina imberbis* | Commelinaceae | H | - | C&B | LC |
| 91 | *Cordia dichotoma* | Boraginaceae | T | Iriki | B | LC |
| 92 | *Crateva adansonii* | Capparaceae | T | Uskimanu, | B | LC |
| 93 | *Crotalaria hebecarpa* | Fabaceae | H | - | C&B | NA |
| 94 | *Croton bonplandianus* | Euphorbiaceae | H | Vanamokka | B | NA |
| 95 | *Cryptolepis buchananii* | Apocynaceae | C | Adavipalateega | C | NA |
| 96 | *Curculigo orchioides* | Hypoxidaceae | H | Nelathadi | C&B | NA |
| 97 | *Curcuma pseudomontana* | Zingiberaceae | H | Adavipasupu | C&B | VU |
| 98 | *Cyanotis axillaris* | Commelinaceae | AH | Neelavanthi | C&B | LC |
| 99 | *Cyanthillium albicans* | Compositae | H | Garitakamma | C&B | NA |
| 100 | *Cyanthillium cinereum* | Compositae | H | Sahadevi | B | NA |
| 101 | *Cycas rumphii* | Cycadaceae | T | Ranhaguvva | C | VU |
| 102 | *Cymbopogon coloratus* | Poaceae | H | Bodagaddi | C&B | NA |
| 103 | *Cymbopogon martini* | Poaceae | H | Kamaanchi kasuvu | C&B | NA |
| 104 | *Cynodon dactylon* | Poaceae | H | Garika | C&B | NA |
| 105 | *Cyperus corymbosus* | Cyperaceae | AH | - | B | NA |
| 106 | *Cyperus difformis* | Cyperaceae | AH | - | B | LC |
| 107 | *Cyperus exaltatus* | Cyperaceae | AH | - | B | LC |
| 108 | *Cyperus michelianus* | Cyperaceae | AH | - | B | LC |
| 109 | *Cyperus mindorensis* | Cyperaceae | AH | Gandala | C&B | NA |
| 110 | *Cyperus pangorei* | Cyperaceae | AH | - | B | LC |
| 111 | *Cyperus rotundus* | Cyperaceae | H | Thunga | B | LC |
| 112 | *Dalbergia lanceolaria* | Leguminosae | T | Patchari | C&B | NA |
| 113 | *Dendrocalamus strictus* | Poaceae | T | Sadanam | C&B | NA |
| 114 | *Dendrophthoe falcata* | Loranthaceae | S | Jiddu, Yolinga | C&B | NA |
| 115 | *Dentella repens* | Rubiaceae | H | Katakura | B | LC |
| 116 | *Dentella repens* var. *serpyllifolia* | Rubiaceae | H | - | B | NA |
| 117 | *Dichanthium annulatum* | Poaceae | H | Errasangali gaddi | B | NA |
| 118 | *Dichrostachys cinerea* | Leguminosae | S | Velthuruchettu | C&B | LC |
| 119 | *Dioscorea pentaphylla* | Dioscoreaceae | C | Adaviginasu teega | C&B | NA |
| 120 | *Diospyros chloroxylon* | Ebenaceae | T | Ullinda | C&B | NA |
| 121 | *Diospyros melanoxylon* | Ebenaceae | T | Beediakulu, Thuniki | C&B | NA |
| 122 | *Diospyros montana* | Ebenaceae | T | Muchha thuniki | B | NA |
| 123 | *Dodonaea viscosa* | Sapindaceae | S | Bandaru, Pullivavili | C&B | LC |
| 124 | *Drimia indica* | Asparagaceae | H | Adavi ulli | C | NA |
| 125 | *Drypetes sepiaria* | Putranjivaceae | S | Putrajivika, Kuduru | B | NA |
| 126 | *Eclipta prostrata* | Asteraceae | H | Guntagalagara | C&B | LC |
| 127 | *Ehretia aspera* | Boraginaceae | T | Paldattam | C&B | DD |
| 128 | *Eleocharis geniculata* | Cyperaceae | AH | - | B | LC |

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|---|---|---|---|---|---|---|
| 129 | *Elytraria acaulis* | Acanthaceae | H | Nela marri | B | NA |
| 130 | *Eragrostiella bifaria* | Poaceae | H | Noolugaddi | B | NA |
| 131 | *Eragrostis tenella* | Poaceae | H | Chinna garikagaddi | C&B | NA |
| 132 | *Eragrostis viscosa* | Poaceae | H | - | C&B | NA |
| 133 | *Eriocaulon quinquangulare* | Eriocaulaceae | H | - | C | NA |
| 134 | *Erythroxylum monogynum* | Erythroxylaceae | S | Gatiri, Adavi gongura | C&B | NA |
| 135 | *Euphorbia hirta* | Euphorbiaceae | H | Nanubalu | C&B | NA |
| 136 | *Euphorbia nivulia* | Euphorbiaceae | T | Aakujemudu, Bonthajemudu | B | NA |
| 137 | *Euphorbia thymifolia* | Euphorbiaceae | H | Reddivaari nanambralu | B | NA |
| 138 | *Evolvulus alsinoides* | Convolvulaceae | H | Vishnukrantha | B | NA |
| 139 | *Evolvulus nummularius* | Convolvulaceae | H | - | C&B | NA |
| 140 | *Ficus benghalensis* | Moraceae | T | Marri | C&B | NA |
| 141 | *Ficus hispida* | Moraceae | S | Bemmedu akulu | C&B | LC |
| 142 | *Ficus mollis* | Moraceae | T | Konda kalijuvvi | C&B | NA |
| 143 | *Ficus racemosa* | Moraceae | T | Medi | C&B | LC |
| 144 | *Ficus religiosa* | Moraceae | T | Ravi chettu | B | NA |
| 145 | *Fimbristylis aestivalis* | Cyperaceae | AH | - | B | NA |
| 146 | *Fimbristylis argentea* | Cyperaceae | AH | - | B | LC |
| 147 | *Fimbristylis quinquangularis* | Cyperaceae | AH | - | B | LC |
| 148 | *Flacourtia indica* | Salicaceae | S | Nakka neredu | C&B | LC |
| 149 | *Galactia striata* | Leguminosae | C | - | B | NA |
| 150 | *Gardenia gummifera* | Rubiaceae | T | Bikki | C&B | LC |
| 151 | *Gardenia latifolia* | Rubiaceae | T | Peddabikki | C&B | NA |
| 152 | *Garuga pinnata* | Burseraceae | T | Garuga, Kondavepa | B | NA |
| 153 | *Getonia floribunda* | Combretaceae | L | Pootangiteega | C&B | NA |
| 154 | *Gisekia pharnaceoides* | Gisekiaceae | H | Isukadantikura | B | NA |
| 155 | *Givotia moluccana* | Euphorbiaceae | T | Tella Poliki | C&B | NA |
| 156 | *Glinus lotoides* | Molluginaceae | H | Tellaporaku | B | LC |
| 157 | *Glinus oppositifolius* | Molluginaceae | H | Chayunta rashiaku | B | LC |
| 158 | *Gloriosa superba* | Colchicaceae | H | Naabhi, Adavinaabhi | C | LC |
| 159 | *Gmelina arborea* | Lamiaceae | T | Gummaditeku, Gambharee | C | LC |
| 160 | *Gmelina asiatica* | Lamiaceae | L | Chinna adavigummadi | B | LC |
| 161 | *Gomphrena serrata* | Amaranthaceae | H | Bendumalli | B | NA |
| 162 | *Grangea maderaspatana* | Compositae | H | Mastaru | C&B | LC |
| 163 | *Grewia flavescens* | Malvaceae | T | Bankajaana | C&B | LC |
| 164 | *Grewia hirsuta* | Malvaceae | S | Nalla Kattelu | C&B | NA |
| 165 | *Grewia tiliifolia* | Malvaceae | T | Budamara | C&B | NA |
| 166 | *Grewia villosa* | Malvaceae | S | Banta, Chenula | C&B | LC |
| 167 | *Gymnosporia emarginata* | Celastraceae | S | Danthi | C&B | NA |
| 168 | *Habenaria panigrahiana* | Orchidaceae | H | - | C | NA |
| 169 | *Hackelochloa granularis* | Poaceae | H | Naalipunuku | C | NA |

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|---|---|---|---|---|---|---|
| 170 | *Hardwickia binata* | Leguminosae | T | Naarepi | C&B | LC |
| 171 | *Helicteres isora* | Malvaceae | S | Gooba thada | C&B | NA |
| 172 | *Heliotropium indicum* | Boraginaceae | H | Nagadanti | B | NA |
| 173 | *Heliotropium marifolium* | Boraginaceae | H | - | C | NA |
| 174 | *Hemidesmus indicus* | Apocynaceae | C | Sugandhapala | C&B | NA |
| 175 | *Heteropogon contortus* | Poaceae | H | Yeddigaddi/ Kes aragaddi | C&B | NA |
| 176 | *Hibiscus micranthus* | Malvaceae | S | Nityamalle | B | NA |
| 177 | *Holarrhena pubescens* | Apocynaceae | S | Kolamukhi | C&B | LC |
| 178 | *Holoptelea integrifolia* | Ulmaceae | T | Nemalinaara | C&B | NA |
| 179 | *Huberantha cerasoides* | Annonaceae | T | Chilakadudduga | B | NA |
| 180 | *Hydrilla verticillata* | Hydrocharitacee | AH | Poonaachu | B | LC |
| 181 | *Hygrophila auriculata* | Acanthaceae | AH | Mulla gobbi | B | LC |
| 182 | *Indigofera linnaei* | Leguminosae | H | Yerrapalleru | C&B | NA |
| 183 | *Ipomoea aquatica* | Convolvulaceae | C | Thootiloora | B | LC |
| 184 | *Ipomoea carnea* | Convolvulaceae | C | Pandiri thooti | B | NA |
| 185 | *Ipomoea nil* | Convolvulaceae | C | Kolivitthulu | B | NA |
| 186 | *Ipomoea obscura* | Convolvulaceae | C | Nallateega | C&B | NA |
| 187 | *Ipomoea pes-tigridis* | Convolvulaceae | C | Mekamadugu | B | NA |
| 188 | *Ipomoea sagittifolia* | Convolvulaceae | C | Purititeega | B | NA |
| 189 | *Ixora pavetta* | Rubiaceae | S | Koravi | C&B | NA |
| 190 | *Jasminum auriculatum* | Oleaceae | L | Adavi teega malli | C&B | NA |
| 191 | *Jatropha gossypiifolia* | Euphorbiaceae | S | Nela amudam | B | LC |
| 192 | *Justicia glauca* | Acanthaceae | H | - | C&B | NA |
| 193 | *Justicia vahliana* | Acanthaceae | H | - | C&B | NA |
| 194 | *Knoxia sumatrensis* | Rubiaceae | H | Kampurodda | C&B | NA |
| 195 | *Lagerstroemia parviflora* | Lythraceae | T | Chennangi | C&B | NA |
| 196 | *Lannea coromandelica* | Anacardiaceae | T | Gumpena | C&B | LC |
| 197 | *Lantana camara* | Verbenaceae | S | Seesa kammari | C&B | NA |
| 198 | *Lepidagathis cristata* | Acanthaceae | H | Nakka pintuka | B | NA |
| 199 | *Leptopetalum biflorum* | Rubiaceae | H | - | C&B | NA |
| 200 | *Leucaena leucocephala* | Leguminosae | T | Subabulu | C&B | NA |
| 201 | *Limonia acidissima* | Rutaceae | T | Velaga | C&B | NA |
| 202 | *Madhuca longifolia* | Sapotaceae | T | Ippa | C&B | NA |
| 203 | *Maerua apetala* | Capparaceae | T | Pilli Adugu | B | NA |
| 204 | *Malvastrum coromandelianum* | Malvaceae | H | - | B | NA |
| 205 | *Mangifera indica* | Anacardiaceae | T | Mamidi | B | DD |
| 206 | *Manilkara hexandra* | Sapotaceae | T | Pala chettu | C&B | NA |
| 207 | *Marsilea quadrifolia* | Marsileaceae | AH | Chandamama kura | B | LC |
| 208 | *Memecylon umbellatum* | Melastomataceae | T | Alli, Peddalli | B | NA |
| 209 | *Merremia gangetica* | Convolvulaceae | H | Elukagemudu | B | LC |
| 210 | *Mesosphaerum suaveolens* | Lamiaceae | H | Danthitulasi | C&B | NA |
| 211 | *Miliusa tomentosa* | Annonaceae | T | Barredudduga | C&B | NA |
| 212 | *Mimosa pudica* | Leguminosae | H | Attipatti, Mudatha thaamara | B | LC |
| 213 | *Mitragyna parvifolia* | Rubiaceae | T | Kadamba | C&B | NA |
| 214 | *Morinda coreia* | Rubiaceae | T | Togaru | C&B | NA |
| 215 | *Naringi crenulata* | Rutaceae | T | Kukka velaga | B | NA |
| 216 | *Nelumbo nucifera* | Nelumbonaceae | AH | Kamalam | B | NA |

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|---|---|---|---|---|---|---|
| 217 | *Nyctanthes arbor-tristis* | Oleaceae | T | Parijatham | B | NA |
| 218 | *Nymphaea nouchali* | Nymphaeaceae | AH | Thamara | B | LC |
| 219 | *Ochna obtusata* | Ochnaceae | T | Raktha sirishamu | C&B | NA |
| 220 | *Ocimum basilicum* | Lamiaceae | H | Kammagaggiri aku | B | NA |
| 221 | *Ocimum tenuiflorum* | Lamiaceae | H | Thulasi | B | NA |
| 222 | *Olax scandens* | Olacaceae | L | Yelaka Nakkera | C&B | NA |
| 223 | *Oldenlandia umbellata* | Rubiaceae | H | Chiriveru | B | NA |
| 224 | *Opuntia stricta* | Cactaceae | S | Brahmma jemudu | C&B | LC |
| 225 | *Orthosiphon rubicundus* | Lamiaceae | H | Podathulasi | C&B | NA |
| 226 | *Osbeckia zeylanica* | Melastomataceae | H | Burada alli | C | NA |
| 227 | *Ouret lanata* | Amaranthaceae | H | Kondapindi | B | NA |
| 228 | *Parthenium hysterophorus* | Compositae | H | Vayyaribhama | C&B | NA |
| 229 | *Pavonia zeylanica* | Malvaceae | H | Karubenda | B | NA |
| 230 | *Pergularia daemia* | Apocynaceae | C | Dustapa teega | C&B | LC |
| 231 | *Persicaria glabra* | Polygonaceae | AH | Neetiganneru, Burada Gogu | B | LC |
| 232 | *Phoenix loureiroi* | Arecaceae | S | Konda itha | C&B | LC |
| 233 | *Phoenix sylvestris* | Arecaceae | T | Itha chettu | C&B | NA |
| 234 | *Phyllanthus amarus* | Phyllanthaceae | H | Nelausiri | B | NA |
| 235 | *Phyllanthus emblica* | Phyllanthaceae | T | Usirikaya | C&B | LC |
| 236 | *Phyllanthus maderaspatensis* | Phyllanthaceae | H | Pedda Nela Usiri | C&B | LC |
| 237 | *Phyllanthus reticulatus* | Phyllanthaceae | S | Purugudu | B | LC |
| 238 | *Phyllanthus virgatus* | Phyllanthaceae | H | Gadhausiri | C&B | NA |
| 239 | *Pleurolobus gangeticus* | Leguminosae | H | Kolakuponna | C&B | NA |
| 240 | *Pongamia pinnata* | Leguminosae | T | Kanuga | B | LC |
| 241 | *Portulaca oleracea* | Portulacaceae | H | Payalaku | B | LC |
| 242 | *Premna mollissima* | Lamiaceae | T | Kondamanga | C&B | NA |
| 243 | *Prosopis juliflora* | Leguminosae | T | Sarkar tumma | C&B | NA |
| 244 | *Pseudarthria viscida* | Fabaceae | C | Adavi chikkudu | B | NA |
| 245 | *Pteris argyraea* | Pteridaceae | AH | - | B | NA |
| 246 | *Pterolobium hexapetalum* | Leguminosae | L | Korintha | C&B | NA |
| 247 | *Pterospermum xylocarpum* | Malvaceae | T | Loluguchettu, Thada | C&B | NA |
| 248 | *Pulicaria wightiana* | Asteraceae | H | Adavipoddutir ugudu | C&B | NA |
| 249 | *Pupalia lappacea* | Amaranthaceae | H | Yerra utthareni | C&B | LC |
| 250 | *Rhynchosia rufescens* | Leguminosae | C | - | B | NA |
| 251 | *Rivea hypocrateriformis* | Convolvulaceae | L | Bodditeega | C&B | NA |
| 252 | *Ruellia tuberosa* | Acanthaceae | H | Chitapatakayal a mokka | C&B | NA |
| 253 | *Saccharum spontaneum* | Poaceae | H | Naagaswaram, Adavicheruku | B | LC |
| 254 | *Santalum album* | Santalaceae | T | Swethagandham | C | VU |
| 255 | *Sapindus emarginatus* | Sapindaceae | T | Kunkudu | B | NA |
| 256 | *Schleichera oleosa* | Sapindaceae | T | Poosuga | C&B | LC |
| 257 | *Schoenoplectiella articulata* | Cyperaceae | H | - | C&B | LC |
| 258 | *Schrebera swietenioides* | Oleaceae | T | Magalinga | C&B | NA |

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|---|---|---|---|---|---|---|
| 259 | *Scleria lithosperma* | Cyperaceae | H | - | C&B | NA |
| 260 | *Scoparia dulcis* | Plantaginaceae | H | Godathulasi | C&B | NA |
| 261 | *Senegalia chundra* | Leguminosae | T | Sandra | C&B | NA |
| 262 | *Senegalia torta* | Leguminosae | S | Korinta teega | B | NA |
| 263 | *Senna auriculata* | Leguminosae | S | Thangedi | B | NA |
| 264 | *Senna occidentalis* | Leguminosae | H | Kasinda | B | LC |
| 265 | *Senna tora* | Leguminosae | H | Thantepu mokka | B | NA |
| 266 | *Sida acuta* | Malvaceae | H | Katari kaanaaku | B | NA |
| 267 | *Sida cordifolia* | Malvaceae | H | Badiyalaku | B | NA |
| 268 | *Solanum virginianum* | Solanaceae | H | Nela vaakudu | B | NA |
| 269 | *Soymida febrifuga* | Meliaceae | T | Somi | B | NA |
| 270 | *Spermacoce articularis* | Rubiaceae | H | Madanaku | B | NA |
| 271 | *Spermacoce pusilla* | Rubiaceae | H | Chukkakaada | B | NA |
| 272 | *Sphaeranthus indicus* | Compositae | H | Bodasaramu | B | LC |
| 273 | *Stemodia viscosa* | Plantaginaceae | H | Bodasaramamu | C&B | NA |
| 274 | *Sterculia urens* | Malvaceae | T | Thapassi | C&B | NA |
| 275 | *Stereospermum tetragonum* | Bignoniaceae | T | Ummrttha | C | NA |
| 276 | *Streblus asper* | Moraceae | T | Barraniki | B | LC |
| 277 | *Striga angustifolia* | Orobanchaceae | H | Jonnamalle | C&B | NA |
| 278 | *Striga asiatica* | Orobanchaceae | H | Raathibadanika | C&B | NA |
| 279 | *Strobilanthes pavala* | Acanthaceae | H | - | C | NA |
| 280 | *Strychnos nux-vomica* | Loganiaceae | T | Mustichettu | C&B | NA |
| 281 | *Strychnos potatorum* | Loganiaceae | T | Chillanginja chettu | C&B | NA |
| 282 | *Tacca leontopetaloides* | Dioscoreaceae | H | Ritthakanda | C | LC |
| 283 | *Tamarindus indica* | Leguminosae | T | Chinta | C&B | LC |
| 284 | *Tarenna asiatica* | Rubiaceae | S | Konda Papidi | C&B | NA |
| 285 | *Tectona grandis* | Lamiaceae | T | Teku | C&B | NA |
| 286 | *Tephrosia purpurea* | Leguminosae | H | Vempali | C&B | NA |
| 287 | *Tephrosia villosa* | Leguminosae | H | Noogu vempalli | B | LC |
| 288 | *Terminalia anogeissiana* | Combretaceae | T | Sirimanu | C&B | NA |
| 289 | *Terminalia arjuna* | Combretaceae | T | Tellamaddhi | C&B | NA |
| 290 | *Terminalia bellirica* | Combretaceae | T | Thani | C&B | LC |
| 291 | *Terminalia elliptica* | Combretaceae | T | Nallamaddi | B | NA |
| 292 | *Trianthema portulacastrum* | Aizoaceae | H | Galijeru | C&B | NA |
| 293 | *Tridax procumbens* | Compositae | H | Gaddichamanthi | B | NA |
| 294 | *Trigastrotheca pentaphylla* | Molluginaceae | H | Pichichatraku | C | NA |
| 295 | *Triumfetta rotundifolia* | Malvaceae | S | - | C | NA |
| 296 | *Typha angustifolia* | Typhaceae | S | Jammu | B | LC |
| 297 | *Urochloa ramosa* | Poaceae | H | - | B | LC |
| 298 | *Vachellia leucophloea* | Leguminosae | T | Tella thumma | C&B | LC |
| 299 | *Vachellia nilotica* | Leguminosae | T | Nalla thumma | C&B | LC |
| 300 | *Vanda tessellata* | Orchidaceae | ES | Badanika | C&B | LC |
| 301 | *Ventilago denticulata* | Rhamnaceae | L | Erra sanguru | B | NA |
| 302 | *Viscum articulatum* | Santalaceae | S | Jilledu badanika | C | NA |
| 303 | *Vitex negundo* | Lamiaceae | S | Nalla vavilli | C&B | LC |
| 304 | *Waltheria indica* | Malvaceae | S | Nallabenda | C&B | LC |
| 305 | *Woodfordia fruticosa* | Lythraceae | S | Jargi seringi | C&B | LC |

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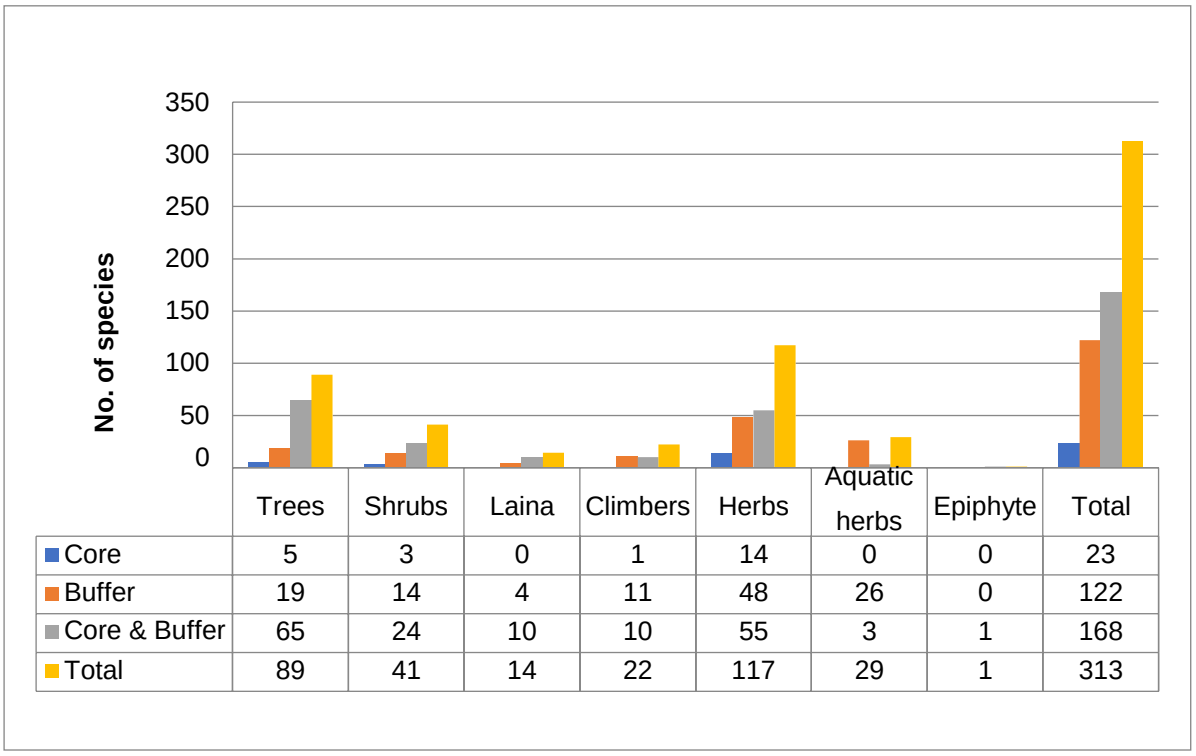
|---|---|---|---|---|---|---|
| 306 | *Wrightia tinctoria* | Apocynaceae | T | Palamaneru | C&B | NA |
| 307 | *Xanthium strumarium* | Compositae | S | Marulamathangi | B | NA |
| 308 | *Xenostegia tridentata* | Convolvulaceae | C | Mududantla | B | NA |
| 309 | *Xylia xylocarpa* | Leguminosae | T | Bojja | C&B | LC |
| 310 | *Ziziphus jujuba* | Rhamnaceae | T | Regu | C&B | LC |
| 311 | *Ziziphus oenopolia* | Rhamnaceae | L | Pariki kampa | C&B | LC |
| 312 | *Ziziphus xylopyrus* | Rhamnaceae | T | Gotti | C&B | NA |
| 313 | *Zornia gibbosa* | Fabaceae | H | Nelabariki | C&B | NA |

**Note: T-Trees; S-Shrubs; H-Herbs; C-Climbers; L-Lianas; AH-Aquatic herb; EP-Epiphyte; C-Core zone; B-Buffer zone; LC-Least Concern; NA-Not Assessed; VU-Vulnerable; NT-Near Threatened*

**Fig. 12. Vegetation Analysis**




| | Trees | Shrubs | Laina | Climbers | Herbs | Aquatic herbs | Epiphyte | Total |
|---|---|---|---|---|---|---|---|---|
| Core | 5 | 3 | 0 | 1 | 14 | 0 | 0 | 23 |
| Buffer | 19 | 14 | 4 | 11 | 48 | 26 | 0 | 122 |
| Core & Buffer | 65 | 24 | 10 | 10 | 55 | 3 | 1 | 168 |
| Total | 89 | 41 | 14 | 22 | 117 | 29 | 1 | 313 |

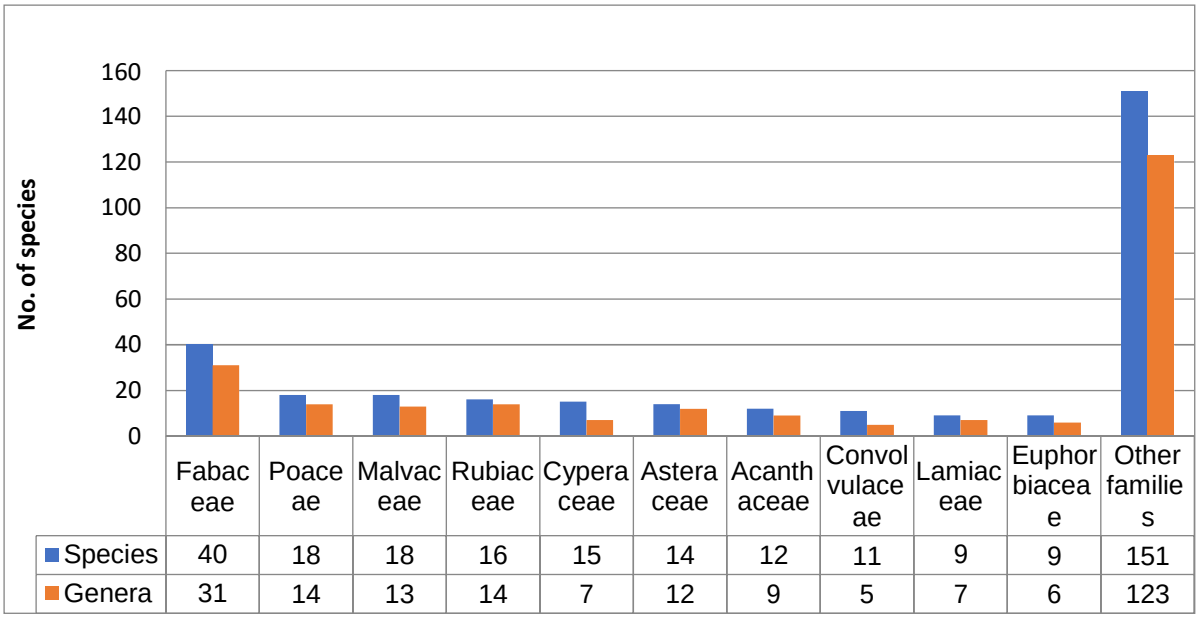
Twenty-nine Aquatic species observed in the study area of which, 19 are Angiospems (*Actinoscirpus grossus, Ammannia baccifera, A. multiflora, Aponogeton crispus, Bacopa monnieri, Bergia capensis, Bonnaya ciliate, Canscora heteroclite, Commelina benghalensis, Cyanotis axillaris, Cyperus corymbosus, C.difformis, C. exaltatus, C. mindorensis*subsp. *pygmaeus, C. mindorensis, C. pangorei, Eleocharis geniculate, Fimbristylis aestivalis, F. argentea, F. quinquangularis, Hydrilla verticillata, Hygrophila auriculata, Nelumbo nucifera, Nymphaea nouchali* and *Persicaria glabra*), three are Pteridophytes (*Ceratopteris thalictroides, Marsilea quadrifolia* and *Pteris argyraea*) and *Chara globularis* is Algae.

The most dominant families are Fabaceae represented by 40 species of 31 genera followed by Poaceae 18/14, Malvaceae 18/13, Rubiaceae 16/14, Cyperaceae 15/7, Asteraceae 14/12, Acanthaceae 12/9, Convolvulaceae 11/5, Lamiaceae 9/7, Euphorbiaceae 9/6, Apocyanaceae 8/7, Amaranthaceae 8/6, Phyllanthaceae 8/3, Combretaceae 6/3, Moraceae 6/2, Boraginaceae 5/4, Rutaceae 4/4, Capparaceae & Lythraceae each with 4/3, Rhamnaceae 4/2, Anacardiaceae, Annonaceae, Asparagaceae, Oleaceae, Plantaginaceae and Sapindaceae each with 3/3, Commelinaceae & Molluginaceae each

with 3/2, Ebenaceae 3/1, Burseraceae, Celastraceae, Dioscoreaceae, Melastomataceae, Meliaceae, Orchidaceae, Pteridaceae, Santalaceae & Sapotaceae each with 2/2, Arecaceae, Loganiaceae, Nyctaginaceae & Orobanchaceae each with 2 species in 1 generaand 41 families are represented each with one species of one genera.

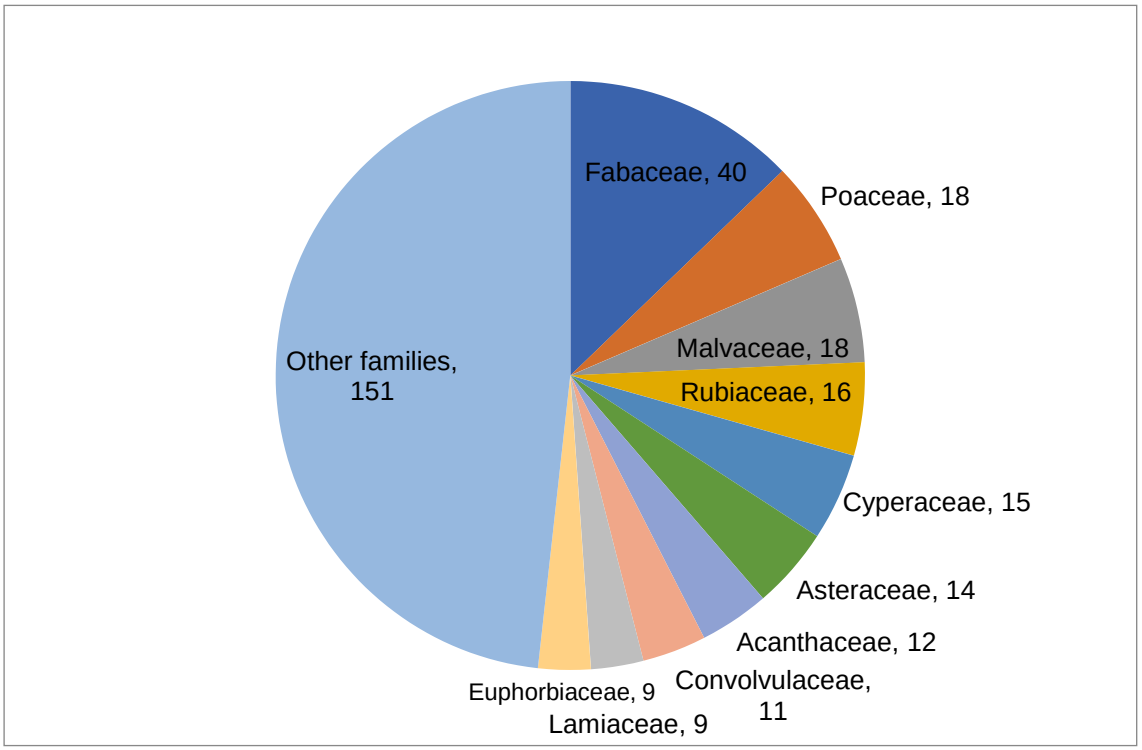
Top ten families are Fabaceae, Poaceae, Malvaceae, Rubiaceae, Cyperaceae, Asteraceae, Acanthaceae, Convolvulaceae, Lamiaceae and Euphorbiaceae are occupied 52% of the total vegetation structure.

**Fig. 13. Top Ten Dominated Families**




| | Fabaceae | Poaceae | Malvaceae | Rubiaceae | Cyperaceae | Asteraceae | Acanthaceae | Convolvulaceae | Lamiaceae | Euphorbiaceae | Other families |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | 40 | 18 | 18 | 16 | 15 | 14 | 12 | 11 | 9 | 9 | 151 |
| Genera | 31 | 14 | 13 | 14 | 7 | 12 | 9 | 5 | 7 | 6 | 123 |

**Fig. 14. Vegetation structure in the proposed project**



## Phyto-sociological features of trees, shrubs and herbs observed in core & buffer zones:

### Core Zone

**A.** Trees – From Importance Value Index (IVI), it is inferred that for trees the dominant species is *Tectona grandis* is with 34.71 of Importance Value Index followed by *Cleistanthus collinus* (22.97), *Xylia xylocarpa* (20.24) and *Boswellia serrata* (18.73). Simpson's Index value (0.07) and Shannon Wiener Index value (1.24) for trees shows that diversity is more in comparision to species dominance.

**B.** Shrubs – *Butea superb* is identified as the most dominant species with 51.6 of Importance Value Index followed by *Helicteres isora* (42.07), *Waltheria indica* (37.56), *Dioscorea pentaphylla* and *Derris scandens* each with 33.98. Simpson's Index value is 0.13 and the Shannon Wiener Index value is 0.93, which shows that diversity is more.

**C.** Herbs – *Drimia indica* is identified as the most dominant species with 43.85 of Importance Value Index followed by *Andrographis paniculata* and *Cyanthillium albicans* each with 39.21 and *Gloriosa superba* (37.89). Simpson's Index value is 0.13 and the Shannon Wiener Index value is 0.92, which shows that diversity is more.

**Table 4. Phyto-sociological features observed in core zone**

| Core zone | | | | |
|---|---|---|---|---|
| **31.62 x 31.62 m for Trees** | | | | |
| **S.No.** | **Name** | **IVI** | **Simpson** | **Shannon** |
| 1 | *Tectona grandis* | 34.71 | 0.028 | -0.13 |
| 2 | *Albizia odoratissima* | 8.53 | 0 | -0.04 |
| 3 | *Givotia moluccana* | 10.87 | 0.001 | -0.05 |
| 4 | *Cleistanthus collinus* | 22.97 | 0.009 | -0.1 |
| 5 | *Lannea coromandelica* | 3.74 | 0 | -0.01 |
| 6 | *Diospyros melanoxylon* | 17.88 | 0.004 | -0.08 |
| 7 | *Boswellia serrata* | 18.73 | 0.005 | -0.08 |
| 8 | *Dalbergia lanceolaria* subsp.*paniculata* | 13.42 | 0.002 | -0.06 |
| 9 | *Stereospermum tetragonum* | 8.53 | 0 | -0.04 |
| 10 | *Lagerstroemia parviflora* | 15.33 | 0.002 | -0.06 |
| 11 | *Hardwickia binata* | 9.7 | 0.001 | -0.04 |
| 12 | *Acacia leucophloea* | 11.51 | 0.001 | -0.05 |
| 13 | *Grewia flavescens* | 13.22 | 0.002 | -0.06 |
| 14 | *Hardwickia binata* | 10.87 | 0.001 | -0.05 |
| 15 | *Firmiana simplex* | 12.82 | 0.001 | -0.05 |
| 16 | *Acacia chundra* | 17.9 | 0.004 | -0.08 |
| 17 | *Aegle marmelos* | 13.22 | 0.002 | -0.06 |
| 18 | *Chloroxylon swietenia* | 15.56 | 0.003 | -0.07 |
| 19 | *Ficus mollis* | 3.74 | 0 | -0.01 |
| 20 | *Ochna obtusata* | 9.19 | 0 | -0.04 |
| 21 | *Xylia xylocarpa* | 20.24 | 0.005 | -0.08 |
| 22 | *Wrightia tinctoria* | 7.37 | 0 | -0.03 |
| | | | **0.07** | **-1.24** |

| | | | | |
|---|---|---|---|---|
| **5 x 5 m for Shrubs** | | | | |
| 1 | *Butea superba* | 51.6 | 0.047 | -0.14 |
| 2 | *Cajanus scarabaeoides* | 25.89 | 0.006 | -0.09 |
| 3 | *Waltheria indica* | 37.56 | 0.019 | -0.12 |
| 4 | *Phoenix loureiroi* | 21.5 | 0.003 | -0.07 |
| 5 | *Helicteres isora* | 42.07 | 0.025 | -0.13 |
| 6 | *Grewia hirsuta* | 10.99 | 0 | -0.03 |
| 7 | *Dioscorea pentaphylla* | 33.98 | 0.014 | -0.11 |
| 8 | *Derris scandens* | 33.98 | 0.014 | -0.11 |
| 9 | *Catunaregam spinosa* | 17.81 | 0.002 | -0.06 |
| 10 | *Tarenna asiatica* | 24.63 | 0.003 | -0.07 |
| | | | **0.13** | **-0.93** |
| **1 x 1 m for Herbs** | | | | |
| 1 | *Gloriosa superba* | 37.89 | 0.02 | -0.12 |
| 2 | *Evolvulus nummularius* | 26.09 | 0.006 | -0.09 |
| 3 | *Cyanthillium albicans* | 39.21 | 0.02 | -0.12 |
| 4 | *Orthosiphon rubicundus* | 41.51 | 0.026 | -0.13 |
| 5 | *Andrographis paniculata* | 39.21 | 0.02 | -0.12 |
| 6 | *Byttneria herbacea* | 29.55 | 0.006 | -0.09 |
| 7 | *Drimia indica* | 43.85 | 0.026 | -0.13 |
| 8 | *Scleria lithosperma* | 24.8 | 0.004 | -0.07 |
| 9 | *Phyllanthus virgatus* | 17.92 | 0.002 | -0.06 |
| | | | **0.13** | **-0.92** |

**Buffer Zone**

**A.** Trees – From Importance Value Index (IVI), it is inferred that, for trees *Xylia xylocarpa* is the most dominant species with 21.00 of Importance Value Index followed by *Tectona grandis* (16.27), *Lannea coromandelica* (15.85), *Anogeissus latifolia* (14.76), *Schleichera oleosa* and *Cleistanthus collinus* each with (10.3) and *Cleistanthus collinus* (10.36). Simpson's Index value is 0.042 and the Shannon Wiener Index value is 1.47, which shows that diversity is more.

**B.** Shrubs – *Woodfordia fruticosa* is identified as the most dominant species with 35.44 of Importance Value Index followed by *Canthium coromandelicum* (22.86), *Chromolaena odorata* (21.26), *Helicteres isora* (20.55) and *Getonia floribunda* (20.2). Simpson's Index value is 0.07and the Shannon Wiener Index value is 1.19, which shows that diversity is more.

**C.** Herbs – *Hybanthus enneaspermus* is identified as the most dominant species with 25.95 of Importance Value Index followed by *Orthosiphon rubicundus* (25.18), *Oldenlandia umbellate* and *Scleria terrestris* each with 23.84, *Byttneria herbacea* (22.88) and *Lepidagathis cristata* (21.02). Simpson's Index value is 0.07 and the Shannon Wiener Index value is 1.18, which shows that diversity is more.

This infers the buffer zone of woody species has more diversity when compared to other life forms of plants. Most of the natural growth recorded is of coppice in nature.

**Table 5. Phyto-sociological features observed in core zone**

| Buffer zone | | | | |
|---|---|---|---|---|
| **31.62 x 31.62 m for Trees** | | | | |
| 1 | *Xylia xylocarpa* | 21 | 0.01 | -0.1 |
| 2 | *Lannea coromandelica* | 15.85 | 0.005 | -0.08 |
| 3 | *Anogeissus latifolia* | 14.76 | 0.004 | -0.07 |
| 4 | *Madhuca longifolia* var. *latifolia* | 9.62 | 0.001 | -0.05 |
| 5 | *Mitragyna parvifolia* | 7 | 0 | -0.03 |
| 6 | *Schleichera oleosa* | 10.37 | 0.001 | -0.05 |
| 7 | *Terminalia alata* | 9.17 | 0.001 | -0.05 |
| 8 | *Miliusa tomentosa* | 10.08 | 0.001 | -0.05 |
| 9 | *Hardwickia binata* | 8.71 | 0.001 | -0.04 |
| 10 | *Cleistanthus collinus* | 10.36 | 0.001 | -0.05 |
| 11 | *Boswellia serrata* | 8.01 | 0.001 | -0.04 |
| 12 | *Buchanania cochinchinensis* | 8.26 | 0.001 | -0.04 |
| 13 | *Soymida febrifuga* | 7 | 0 | -0.03 |
| 14 | *Bombax ceiba* | 9.17 | 0.001 | -0.05 |
| 15 | *Albizia odoratissima* | 8.51 | 0.001 | -0.04 |
| 16 | *Givotia moluccana* | 8.09 | 0.001 | -0.04 |
| 17 | *Diospyros melanoxylon* | 7 | 0 | -0.03 |
| 18 | *Bridelia retusa* | 6.33 | 0 | -0.03 |
| 19 | *Dalbergia lanceolaria* subsp.*paniculata* | 9.02 | 0.001 | -0.05 |
| 20 | *Careya arborea* | 7.5 | 0.001 | -0.04 |
| 21 | *Lagerstroemia parviflora* | 9.02 | 0.001 | -0.05 |
| 22 | *Tectona grandis* | 16.27 | 0.005 | -0.08 |
| 23 | *Pterospermum xylocarpum* | 6.33 | 0 | -0.03 |
| 24 | *Terminalia bellirica* | 4.49 | 0 | -0.02 |
| 25 | *Grewia tiliifolia* | 6.92 | 0 | -0.03 |
| 26 | *Butea monosperma* | 4.49 | 0 | -0.02 |
| 27 | *Gardenia latifolia* | 6.33 | 0 | -0.03 |
| 28 | *Chloroxylon swietenia* | 4.49 | 0 | -0.02 |
| 29 | *Albizia amara* | 5.99 | 0 | -0.03 |
| 30 | *Bauhinia racemosa* | 5.99 | 0 | -0.03 |
| 31 | *Aegle marmelos* | 4.48 | 0 | -0.02 |
| 32 | *Wrightia tinctoria* | 9.75 | 0.001 | -0.04 |
| 33 | *Ochna obtusata* | 7.49 | 0 | -0.03 |
| 34 | *Acacia leucophloea* | 4.48 | 0 | -0.02 |
| 35 | *Euphorbia nivulia* | 4.48 | 0 | -0.02 |
| 36 | *Naringi crenulata* | 3.23 | 0 | -0.01 |
| | | | **0.042** | **-1.47** |
| **5 x 5 m for Shrubs** | | | | |
| 1 | *Woodfordia fruticosa* | 35.44 | 0.025 | -0.13 |
| 2 | *Tarenna asiatica* | 18.09 | 0.004 | -0.08 |
| 3 | *Ixora pavetta* | 15.97 | 0.003 | -0.07 |
| 4 | *Helicteres isora* | 20.55 | 0.005 | -0.08 |
| 5 | *Canthium coromandelicum* | 22.86 | 0.005 | -0.08 |
| 6 | *Getonia floribunda* | 20.2 | 0.006 | -0.09 |

| | | | | |
|---|---|---|---|---|
| 7 | *Chromolaena odorata* | 21.26 | 0.007 | -0.09 |
| 8 | *Catunaregam spinosa* | 19.14 | 0.005 | -0.08 |
| 9 | *Erythroxylum monogynum* | 18.09 | 0.004 | -0.08 |
| 10 | *Grewia hirsuta* | 12.3 | 0.001 | -0.05 |
| 11 | *Ziziphus oenopolia* | 15.72 | 0.003 | -0.07 |
| 12 | *Carissa carandas* | 12.3 | 0.001 | -0.05 |
| 13 | *Butea superba* | 12.3 | 0.001 | -0.05 |
| 14 | *Olax scandens* | 11.31 | 0.001 | -0.04 |
| 15 | *Acalypha alnifolia* | 6.46 | 0 | -0.02 |
| 16 | *Dichrostachys cinerea* | 8.89 | 0 | -0.03 |
| 17 | *Flacourtia indica* | 6.46 | 0 | -0.02 |
| 18 | *Phoenix loureiroi* | 6.46 | 0 | -0.02 |
| 19 | *Triumfetta rotundifolia* | 16.16 | 0.001 | -0.05 |
| | | | **0.07** | **-1.19** |
| **1 x 1 m for Herbs** | | | | |
| 1 | *Byttneria herbacea* | 22.88 | 0.008 | -0.09 |
| 2 | *Orthosiphon rubicundus* | 25.18 | 0.01 | -0.1 |
| 3 | *Andrographis paniculata* | 15.6 | 0.002 | -0.06 |
| 4 | *Spermacoce articularis* | 18.51 | 0.004 | -0.08 |
| 5 | *Sida cordifolia* | 17.06 | 0.003 | -0.07 |
| 6 | *Scleria lithosperma* | 23.84 | 0.008 | -0.09 |
| 7 | *Oldenlandia umbellata* | 23.84 | 0.008 | -0.09 |
| 8 | *Phyllanthus virgatus* | 17.74 | 0.004 | -0.08 |
| 9 | *Hybanthus enneaspermus* | 25.95 | 0.011 | -0.1 |
| 10 | *Lepidagathis cristata* | 21.02 | 0.006 | -0.09 |
| 11 | *Desmodium gangeticum* | 16.26 | 0.003 | -0.07 |
| 12 | *Fimbristylis ovata* | 20.91 | 0.003 | -0.07 |
| 13 | *Evolvulus nummularius* | 11.5 | 0.001 | -0.04 |
| 14 | *Eragrostis viscosa* | 8.36 | 0 | -0.03 |
| 15 | *Elytraria acaulis* | 11.5 | 0.001 | -0.04 |
| 16 | *Cyanthillium albicans* | 8.36 | 0 | -0.03 |
| 17 | *Alysicarpus monilifer* | 11.5 | 0.001 | -0.04 |
| | | | **0.07** | **-1.18** |

### IUCN Red list species

During primary data collection, identified *Chloroxylon swietenia, Cleistanthus collinus, Curcuma pseudomontana, Cycas rumphii* (Planted in core zone) and *Santalum album* which are falls under Vulnerable (Vu) category and *Albizia thompsonii* listed in Near Threatened category as per IUCN Red list.

Seed collection and rising of saplings may also be taken up by SCCL in their nurseries and planted in open areas to restore the ecosystem. *Cycas rumphii* was planted 30 years ago in Project Office of GK-OCP campus.

**Density enrichment plantations by Forest Department within the 10 Kms radius:**
The forest department has raised density enrichment plantations in a total of 234 Hectares, comprising 5 forest beats within the radius of 10 Kms, which is being home range for varied wildlife existing and moving in the adjoining forests outside the mine boundaries.

Also, the department has developed a 15 acres of grass plot in Tippanapalli forest beat as a fodder/ feeding ground for the ungulates present in the forest areas within the 10 Kms radius.

**Table 6. Total area of Beat wise plantations by forest department**

| S.No. | Beat | Plantation in Ha | | | Grass land | | |
|---|---|---|---|---|---|---|---|
| | | Ha | Latitude | Longitude | Ha | Latitude | Longitude |
| 1 | Tungaram | 30 | 17.44781 | 80.61903 | 0 | | |
| | | 20 | 17.4386 | 80.61918 | | | |
| | | 20 | 17.43909 | 80.62068 | | | |
| | | 10 | 17.4454 | 80.62151 | | | |
| | | 5 | 17.44800 | 80.61940 | | | |
| | | 14 | 17.43915 | 80.62355 | | | |
| | **Sub-Total:** | **99** | | | **0** | | |
| 2 | Tippanapalli | 20 | 17.4364 | 80.62889 | 15 | 17.43769 | 80.64544 |
| | | 25 | 17.4296 | 80.62501 | | | |
| | | 25 | 17.4287 | 80.61866 | | | |
| | | 20 | 17.42656 | 80.63245 | | | |
| | | 25 | 17.42041 | 80.62945 | | | |
| | **Sub-Total:** | **115** | | | **15** | | |
| 3 | Penagadapa | 20 | 17.42395 | 80.68048 | 0 | | |
| | **Sub-Total:** | **20** | | | **0** | | |
| 4 | Ramavaram | 0 | | | 0 | | |
| | **Sub-Total:** | **0** | | | **0** | | |
| 5 | Gareebpeta | 0 | | | 0 | | |
| | **Sub-Total:** | **0** | | | **0** | | |
| | **Grand Total:** | **234** | | | **15** | | |

The proposed core zone of the project is falls in Ramavaram reserve forest and Buffer zone is occupied by Five RFs namely falling in Ramavaram RF, Chatakonda RF, Penagadapa RF, Mulakalapalli RF and Paloncha East RF of Kothagudem and Paloncha divisions.

**There are no National Parks, Biosphere Reserve, Tiger Reserves and Elephant Reserve/Corridor in the study area.**

### Density enrichment plantations by SCCL within the 10 Kms radius:

A total of 1106 Hectares of (block, OB, and avenue) plantations have been raised by SCCL since 1984 in this area during ecological restoration processes. These restoration practices are highly upsurging in reversing the habitat degradation happened in and around the mine areas.

During the survey, it is observed that all the plantations are helping to restore organisms and their interactions with one another and with the physical environment. Observations of varied faunal groups shows the success of the ecological restoration practices of the mines, which focusses on the processes such as perseverance of species through natural recruitment and survival, functioning food webs, system-wide nutrient conservation via relationships among plants, and animals.

**Table 7. Kothagudem Block plantations from 1984-2020 by SCCL**

| Year of raising | Location | Name of the Species planted | Area in Ha | Lat & Long |
|---|---|---|---|---|
| 1984 | Cashew plantation | Cashew | 27 | N 17.5267 E 80.6424 |
| 1999 | Block pl' at CRP Camp | EC | 9 | N 17.5263 E 80.6311 |
| 1999 | Garemellapadu | EC | 11 | N 17.5267 E 80.6424 |
| 2000 | 7 Shaft dispensary | EC | 14 | N 17.4725 E 80.6656 |
| 2000 | Garemellapadu | EC | 5 | N 17.5191 E 80.6442 |
| 2001 | Garemellapadu | EC | 5 | |
| 2003 | 3 Incline | EC | 12 | N 17.5074 E 80.6479 |
| 2003 | Hemachandrapuram | EC | 10 | N 17.5535 E 80.5916 |
| 2003 | Garemellapadu | EC | 19 | N 17.5209 E 80.6467 |
| 2004 | Rly.siding | EC | 7 | N 17.5050 E 80.6518 |
| 2004 | St. Josephs | EC&M | 7 | N 17.4983 E 80.6510 |
| 2004 | VK Timberyard | EC | 5 | N 17.4692 E 80.6668 |
| 2004 | Coal Testing Lab | EC | 8 | N 17.5061 E 80.6528 |
| 2005 | GPF Nursery | EC | 25 | N 17.5345 E 80.6314 |
| 2005 | GKOCP | M | 10 | N 17.5345 E 80.6315 |
| 2005 | 5 & 7 Shaft | EC,M&B | 35 | N 17.4830 E 80.6647 |
| 2005 | VK compound wall | EC&M | 7 | N 17.4783 E 80.6729 |
| 2006 | Vanamanagar | EC&M | 5 | N 17.4702 E 80.6682 |
| 2006 | Goutampur | M | 4 | N 17.4815 E 80.6446 |
| 2006 | 5Shaft | M | 10 | N 17.4968 E 80.6692 |
| 2006 | Gadalamadugu | EC | 13 | N 17.5423 E 80.5562 |
| 2006 | GKOCP | M | 10 | N 17.5423 E 80.5563 |
| 2007 | Tilaknagar | EC | 5 | N 17.4802 E 80.6474 |
| 2007 | Goutampur | EC&M | 3 | N 17.4828 E 80.6463 |
| 2007 | Behind 3 Incline | EC | 5 | N 17.5100 E 80.6414 |
| 2007 | 7 Incline | EC&M | 5 | N 17.4748 E 80.6678 |
| 2007 | 7 Incline (S) | EC&M | 8 | N 17.4838 E 80.6719 |
| 2007 | 2 Incline | EC | 4 | N 17.5300 E 80.6382 |
| 2007 | Tellavagu | M | 6 | N 17.4931 E 80.6850 |
| 2008 | Subsidence panel 1 & 1A | M | 6 | N 17.4922 E 80.6625 |
| 2009 | Behind VK-7 Incline Mine-RF | EC | 9 | N17.5770 E 80.6379 |
| 2009 | Evacuated Colony of VK-7 Incline | EC | 7 | N 17.4761 E 80.6680 |

| | | | | |
|---|---|---|---|---|
| 2009 | Gaps in cashew pl' near Dhanbad and ITI | EC | 24 | N 17.5223 E 80.6411 |
| 2009 | Gaps in cashew pl' near Christian graveyards 2 incline | EC | 6 | N 17.4923 E 80.6584 |
| 2009 | Gaps in cashew pl' near B CF | EC | 8 | N 17.5147 E 80.6439 |
| 2009 | Behind Central Nursery, KGM | M | 9 | N 17.5770 E 80.6378 |
| 2010 | GKOCP-Block | EC&M | 8 | N 17.4466 E 80.6609 |
| 2011 | RF area in KGM near Deport. | M | 15 | N 17.5724 E80.6327 |
| 2012 | GKOCP Vacant patches | M | 4 | N 17.4622 E80.65163 |
| 2012 | VK-7 Incline Vacant patches | M | 4 | N 17.4816 E80.67233 |
| 2013 | Gaps in Cashew plantations at Garimellapadu | M | 33 | N 17.3130 E80.3835 |
| 2014 | VK-7 Incline | EU | 10 | N 17.2848 E80.4014 |
| 2016 | RF plantation near Gaddalamadugu | M | 22 | N 17.3301 E80.3830 |
| 2016 | RF plantation near 5B shaft | M | 42 | N 17.3012 E80.4018 |
| 2016 | Euc.clonal planatation near CRP camp, Ramavaram | EC | 2 | N 17.5283 E80.6309 |
| 2016 | Vacant patches in writer basthi. KGM/Corp | M | 2 | N 17.5283 E80.6310 |
| 2017 | RF plantation at Gaddalamadugu | EC & M | 50 | N 17.4947 E.80.657457 |
| | Gap plantation from writer basthi to main hospital area, Kothagudem | M | 10 | N 17.5500 E80.608049 |
| 2019 | Garimellapadu | M | 2 | N 17.5272 E.80.648357 |
| | **Total** | | **567.00** | |

(EC- Eucalyptus; B – Bamboo; M – Mixed/Miscellaneous )

**Table 8. Kothagudem Avenue plantations by SCCL**

| Year of raising | Location | Name of the Species planted | Area in Ha | Lat & Long |
|---|---|---|---|---|
| 2001 | Goutampur | M | 2 | N 17.4809 E 80.6478 |
| 2002 | Rudrampur | M | 5 | N 17.4984 E 80.6527 |
| 2003 | GKOCP, Writer basthi, Rudrampur colony | M | 13 | N 17.4555 E 80.6283 |
| 2004 | Rudrampur,5shaft | M | 5 | N 17.4984 E 80.6527 |
| 2005 | 5&7 shaft | M | 5 | N 17.4842 E 80.6679 |
| 2008 | Kothagudem area | M | 2 | N 17.4988 E 80.6530 |
| 2009 | Gaps in Writer basthi, KGM | M | 3 | N 17.5467 E 80.6156 |
| 2010 | GKOCP | M | 2 | N 17.4466 E 80.6591 |
| 2014 | PVK-Guest House | M | 1 | N 17.2911 E80.3929 |
| | **Total** | | **38.00** | |

**Table 9. GKOCP OB plantations by SCCL**

| Year of raising | Location | Name of the Species planted | Area in Ha | Lat & Long |
|---|---|---|---|---|
| 1999 | GKOCP, OB | M | 2 | N 17.4457 E 80.6456 |
| 2001 | GKOCP, OB | M | 10 | N 17.4495 E 80.6441 |
| 2002 | GKOCP, OB | M | 23 | N 17.4578 E 80.6285 |
| 2003 | GKOCP, OB | M | 52 | N 17.4558 E 80.6329 |
| 2004 | GKOCP, OB | M | 65 | N 17.4585 E 80.6294 |
| 2005 | GKOCP, OB | M | 48 | N 17.4640 E 80.6298 |
| 2006 | GKOCP, OB | M | 31 | N 17.4618 E 80.6328 |
| 2007 | GKOCP, OB | M | 7 | N 17.4600 E 80.6368 |
| 2008 | GKOCP, OB | M | 8 | N 17.2086 E 80.8122 |
| 2009 | GKOCP-West Dump-RF, OB | M | 44 | N 17.4618 E 80.6328 |
| 2010 | GKOCP-OB | M | 28 | N 17.4466 E 80.6591 |
| 2011 | GKOCP, OB | M | 19 | N17.44881 E80.65703 |
| 2012 | GKOCP OB dumps | M | 25 | N17.44663 E80.65681 |
| 2013 | GKOCP, OB | M | 33 | N17.2643 E80.3919 |
| 2014 | GKOCP, OB | M | 12 | N17.2871 E80.3949 |
| 2015 | GKOCP, OB | M | 12 | N17.2718 E80.3815 |
| 2016 | GKOCP, OB | M | 24 | N17.2871 E80.3949 |
| 2017 | GKOCP, OB | M | 12 | N17.4519 E80.6466 |
| 2018 | GKOCP, OB | EC & M | 46 | N17.4511 E80.6478 |
| | **Total for Kothagudem** | | **501.00** | |

Planting suitable vegetation can help to re-establish habitats relatively rapidly after mining disturbance. This may benefit varied biodiversity/wildlife of the area.

**List of mixed/miscellaneous species planted by SCCL:**

1. *Hardwikia binata*
2. *Dendrocalamus strictus*
3. *Ficus religiosa*
4. *Pterocarpus santalinus*
5. *Azadirachta indica*
6. *Limonia acidissima*
7. *Ficus bengalensis*
8. *Aegle marmelos*
9. *Mitragyna parvifolia*
10. *Dalbergia latifolia*
11. *Pterocarpus marsupium*
12. *Emblica officinalis*
13. *Syzygium cumini*
14. *Alstonia scholaris*
15. *Albizzia procera*
16. *Annona squamosa*
17. *Terminalia bellarica*
18. *Spathodea campanulata*
19. *Pongamia pinnata*
20. *Ficus mollis*
21. *Lagerstroemia parviflora*
22. *Bauhinia purpurea*
23. *Millingtonia harrtensis*
24. *Madhuka indica*
25. *Ficus carica*
26. *Tamarindus indica*
27. *Cassia fistula*
28. *Anthocephalus kadamba*
29. *Pithecelobium dulci*
30. *Sterculia urens*
31. *Tectonia grandis*
32. *Dalbergia sissoo*
33. *Cassia siamea*
34. *Adina cordifolia*
35. *Putranjeeva rasuburgi*
36. *Bombax ceiba*
37. *Mimusops elangii*
38. *Terminalia chebula*
39. *Peltophorum ferruginum*
40. *Albizzia lebbek*
41. *Couravpita guinensis*
42. *Holoptelea integrifolia*

## Fauna Diversity:

**Mammals:** In the study area, a total of **19 species** of mammals distributed in 16 Genera belonging to 6 orders and 13 families were recorded. The species include Wild Boar, Common Mongoose, Greater Indian fruit bat, Rhesus Macaque, Bonnet Macaque, Indian Palm Squirrel, Little Indian Field Mouse, Indian hare are common in their occurrence.

**Table 10. List of Mammals recorded from the proposed study area**

| S.No. | Common Name | Scientific Name | Family | Order | IUCN Status | IWPA Schedule |
|---|---|---|---|---|---|---|
| 1 | Nilgai | *Boselaphus tragocamelus* | Bovidae | Artiodactyla | LC | III |
| 2 | Indian Spotted Deer | *Axis axis* | Cervidae | Artiodactyla | LC | III |
| 3 | Indian Sambar | *Rusa unicolor* | Cervidae | Artiodactyla | VU | III |
| 4 | Jungle Cat | *Felis chaus* | Felidae | Artiodactyla | LC | II |
| 5 | Common Grey Mongoose | *Urva edwardsii* | Herpestidae | Artiodactyla | LC | IV |
| 6 | Wild Boar | *Sus scrofa* | Suidae | Artiodactyla | LC | III |
| 7 | Indian Spotted Chevrotain | *Moschiola indica* | Tragulidae | Artiodactyla | LC | NL |
| 8 | Indian Fox | *Vulpes bengalensis* | Canidae | Carnivora | LC | II |
| 9 | Indian Flying Fox | *Pteropus medius* | Pteropodidae | Chiroptera | LC | IV |
| 10 | Indian Hare | *Lupus nigricollis* | Leporidae | Lagomorpha | LC | IV |
| 11 | Rhesus Macaque | *Macaca mulatta* | Cercopithecidae | Primates | LC | II |
| 12 | Bonnet Macaque | *Macaca radiata* | Cercopithecidae | Primates | VU | II |
| 13 | Hanuman Langur | *Semnopithecus entellus* | Cercopithecidae | Primates | LC | II |
| 14 | Indian Crested Porcupine | *Hystrix indica* | Hystricidae | Rodentia | LC | IV |
| 15 | Lesser Bandicoot Rat | *Bandicota bengalensis* | Muridae | Rodentia | LC | IV |
| 16 | Greater Bandicoot Rat | *Bandicota indica* | Muridae | Rodentia | LC | IV |
| 17 | Little Indian Field Mouse | *Mus booduga* | Muridae | Rodentia | LC | IV |
| 18 | House Mouse | *Mus musculus* | Muridae | Rodentia | LC | IV |
| 19 | Indian Palm Squirrel | *Funambulus palmarum* | Sciuridae | Rodentia | LC | IV |

**Herpetofauna:** It is represented with **26 species** belonging to 23 genera, 3 orders and 13 families; it includes reptiles and amphibians consisting of two major classes namely Squamata and Anura, of which 20 species of reptiles belonging to orders Squamata and Testudines and 6 species of amphibians belonging to order Anura.

**Table 11. List of Herpetofauna recorded from the proposed study area**

| S.No. | Common Name | Scientific Name | Family | Order | Class | IUCN Status | IWPA Schedule |
|---|---|---|---|---|---|---|---|
| 1 | Asian Grass Frog | *Fejervarya limnocharis* | Dicroglossidae | Anura | Amphibia | LC | IV |
| 2 | Common Tree Frog | *Polypedates leucomystax* | Rhacophoridae | Anura | Amphibia | LC | IV |
| 3 | Asian Common Toad | *Duttaphrynus melanostictus* | Bufonidae | Anura | Amphibia | LC | IV |
| 4 | Indian Skipper Frog | *Euphlyctis cyanophlyctis* | Dicroglossidae | Anura | Amphibia | LC | IV |
| 5 | Green Pond Frog | *Euphlyctis hexadactylus* | Dicroglossidae | Anura | Amphibia | LC | IV |
| 6 | Indian Bullfrog | *Hoplobatrachus tigerinus* | Dicroglossidae | Anura | Amphibia | LC | IV |
| 7 | Common Garden Lizard | *Calotes versicolor* | Agamidae | Squamata | Reptilia | LC | IV |
| 8 | Forest Blood Sucker | *Monilesaurus rouxii* | Agamidae | Squamata | Reptilia | LC | NL |
| 9 | Pondichéry Fan-throated Lizard | *Sitana ponticeriana* | Agamidae | Squamata | Reptilia | LC | NL |
| 10 | Red sand boa | *Eryx johnii* | Boidae | Squamata | Reptilia | NT | IV |
| 11 | Rough-scaled Sand Boa | *Gongylophis conicus* | Boidae | Squamata | Reptilia | NT | IV |
| 12 | Indian Chameleon | *Chamaeleo zeylanicus* | Chamaeleonidae | Squamata | Reptilia | LC | II |
| 13 | Bronze-backed Tree Snake | *Dendrelaphis tristis* | Colubridae | Squamata | Reptilia | LC | IV |
| 14 | Checkered Keelback | *Fowlea piscator* | Colubridae | Squamata | Reptilia | LC | II |
| 15 | Indian Wolf Snake | *Lycodon aulicus* | Colubridae | Squamata | Reptilia | LC | IV |
| 16 | Common Kukri Snake | *Oligodon arnensis* | Colubridae | Squamata | Reptilia | LC | IV |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 17 | Green Vine Snake | *Oxybelis fulgidus* | Colubridae | Squamata | Reptilia | LC | IV |
| 18 | Indian Rat Snake | *Ptyas mucosa* | Colubridae | Squamata | Reptilia | LC | IV |
| 19 | Indian Cobra | *Naja naja* | Elapidae | Squamata | Reptilia | LC | II |
| 20 | Brooke's House Gecko | *Hemidactylus brookii* | Gekkonidae | Squamata | Reptilia | LC | NL |
| 21 | Common House Gecko | *Hemidactylus frenatus* | Gekkonidae | Squamata | Reptilia | LC | NL |
| 22 | Termite Hill Gecko | *Hemiductylus triedrus* | Gekkonidae | Squamata | Reptilia | LC | NL |
| 23 | Keeled Indian Mabuya | *Eutropis carinata* | Scincidae | Squamata | Reptilia | LC | NL |
| 24 | Common Indian Monitor | *Varanus bengalensis* | Varanidae | Squamata | Reptilia | NT | I |
| 25 | Russell's Viper | *Daboia russelii* | Viperidae | Squamata | Reptilia | LC | II |
| 26 | Indian Flapshell Turtle | *Lissemys punctata* | Trionychidae | Testudines | Reptilia | VU | IV |

**Avifauna:** A total of **86 bird species** belongs to 70 genera, 18 orders and 42 families were recorded in core and buffer zone areas. Among them, order Passeriformes represented with high number of species (37 species distributed in 28 genera of 19 families), followed by Pelecaniformes (8/7/3), Columbiformes & Gruiformes each with 5/4/1, Accipitriformes (4/4/1), Coraciiformes (4/3/3), Galliformes (4/3/1), Apodiformes (3/2/1), Bucerotiformes & Charadriiformes each with 2/2/2, Anseriformes, Ciconiiformes & Cuculiformes each with 2/2/1, Psittaciformes (2/1/1), Falconiformes, Piciformes, Podicipediformes and Strigiformes are represented with 1 species belong to 1 genera of 1 family respectively

**Table 12. List of Avifauna recorded from the proposed study area**

| S.No. | Common Name | Scientific Name | Family | Order | IUCN Status | IWPA Schedule |
|---|---|---|---|---|---|---|
| 1 | Shikra | *Accipiter badius* | Accipitridae | Accipitriformes | LC | IV |
| 2 | White-eyed Buzzard | *Butastur teesa* | Accipitridae | Accipitriformes | LC | IV |
| 3 | Black-winged Kite | *Elanus caeruleus* | Accipitridae | Accipitriformes | LC | IV |
| 4 | Black Kite | *Milvus migrans* | Accipitridae | Accipitriformes | LC | IV |
| 5 | Lesser Whistling Duck | *Dendrocygna javanica* | Anatidae | Anseriformes | LC | IV |
| 6 | Cotton Teal | *Nettapus coromandelianus* | Anatidae | Anseriformes | LC | IV |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | Common Swift | *Apus apus* | Apodidae | Apodiformes | LC | IV |
| 8 | House Swift | *Apus nipalesis* | Apodidae | Apodiformes | LC | IV |
| 9 | Asian Palm Swift | *Cypsiurus balasiensis* | Apodidae | Apodiformes | LC | IV |
| 10 | Indian Grey Hornbill | *Ocyceros birostris* | Bucerotidae | Bucerotiformes | LC | IV |
| 11 | Eurasian Hoopoe | *Upupa epops* | Upupidae | Bucerotiformes | LC | IV |
| 12 | Red-wattled Lapwing | *Vanellus indicus* | Charadriidae | Charadriiformes | LC | IV |
| 13 | Bronze-winged Jacana | *Metopidius indicus* | Jacanidae | Charadriiformes | LC | IV |
| 14 | Asian Openbill | *Anastomus oscitans* | Ciconiidae | Ciconiiformes | LC | IV |
| 15 | Painted Stork | *Mycteria leucocephala* | Ciconiidae | Ciconiiformes | NT | IV |
| 16 | Rock Pigeon | *Columba livia* | Columbidae | Columbiformes | LC | IV |
| 17 | Spotted Dove | *Spilopelia chinensis* | Columbidae | Columbiformes | LC | IV |
| 18 | Laughing Dove | *Spilopelia senegalensis* | Columbidae | Columbiformes | LC | IV |
| 19 | Oriental Turtle Dove | *Streptopelia orientalis* | Columbidae | Columbiformes | LC | IV |
| 20 | Yellow-footed Green Pigeon | *Treron phoenicoptera* | Columbidae | Columbiformes | LC | IV |
| 21 | White-throated Kingfisher | *Halcyon smyrnensis* | Alcedinidae | Coraciiformes | LC | IV |
| 22 | Little Green Bee- eater | *Merops orientalis* | Meropidae | Coraciiformes | LC | IV |
| 23 | Blue-tailed Bee- eater | *Merops philippinus* | Meropidae | Coraciiformes | LC | IV |
| 24 | Indian Roller | *Coracias benghalensis* | Coraciidae | Coraciiformes | LC | IV |
| 25 | Pied Crested Cuckoo | *Clamator jacobinus* | Cuculidae | Cuculiformes | LC | IV |
| 26 | Asian Koel | *Eudynamys scolopaceus* | Cuculidae | Cuculiformes | LC | IV |
| 27 | Common Kestrel | *Falco tinnunculus* | Falconidae | Falconiformes | LC | IV |
| 28 | Rain Quail | *Coturnix coromandelica* | Phasianidae | Galliformes | LC | IV |
| 29 | Common Quail | *Coturnix coturnix* | Phasianidae | Galliformes | LC | IV |
| 30 | Grey Francolin | *Ortygornis pondicerianus* | Phasianidae | Galliformes | LC | IV |
| 31 | Indian Peafowl | *Pavo cristatus* | Phasianidae | Galliformes | LC | I |
| 32 | White-breasted Waterhen | *Amaurornis phoenicurus* | Rallidae | Gruiformes | LC | IV |

| | | | | | | |
|---|---|---|---|---|---|---|
| 33 | Common Coot | *Fulica atra* | Rallidae | Gruiformes | LC | IV |
| 34 | Watercock | *Gallicrex cinerea* | Rallidae | Gruiformes | LC | IV |
| 35 | Common Moorhen | *Gallinula chloropus* | Rallidae | Gruiformes | LC | IV |
| 36 | Purple Swamphen | *Porphyrio porphyrio* | Rallidae | Gruiformes | LC | IV |
| 37 | Paddyfield Warbler | *Acrocephalus agricola* | Acrocephalidae | Passeriformes | LC | IV |
| 38 | Booted Warbler | *Iduna caligata* | Acrocephalidae | Passeriformes | LC | IV |
| 39 | Common Iora | *Aegithina tiphia* | Aegithinidae | Passeriformes | LC | IV |
| 40 | Ashy-crowned Sparrow Lark | *Eremopterix griseus* | Alaudidae | Passeriformes | LC | IV |
| 41 | Ashy Woodswallow | *Artamus fuscus* | Artamidae | Passeriformes | LC | IV |
| 42 | Small Minivet | *Pericrocotus cinnamomeus* | Campephagidae | Passeriformes | LC | IV |
| 43 | Common Tailorbird | *Orthotomus sutorius* | Cisticolidae | Passeriformes | LC | IV |
| 44 | Plain Prinia | *Prinia inornata* | Cisticolidae | Passeriformes | LC | IV |
| 45 | Ashy Prinia | *Prinia socialis* | Cisticolidae | Passeriformes | LC | IV |
| 46 | Jungle Prinia | *Prinia sylvatica* | Cisticolidae | Passeriformes | LC | IV |
| 47 | Large-billed Crow | *Corvus macrorhynchos* | Corvidae | Passeriformes | LC | IV |
| 48 | House Crow | *Corvus splendens* | Corvidae | Passeriformes | LC | V |
| 49 | Rufous Treepie | *Dendrocitta vagabunda* | Corvidae | Passeriformes | LC | IV |
| 50 | Tickell's Flowerpecker | *Dicaeum erythrorhynchos* | Dicaeidae | Passeriformes | LC | IV |
| 51 | White-bellied Drongo | *Dicrurus caerulescens* | Dicruridae | Passeriformes | LC | IV |
| 52 | Black Drongo | *Dicrurus macrocercus* | Dicruridae | Passeriformes | LC | IV |
| 53 | Indian Silverbill | *Euodice malabarica* | Estrildidae | Passeriformes | LC | IV |
| 54 | Scaly-breasted Munia | *Lonchura punctulata* | Estrildidae | Passeriformes | LC | IV |
| 55 | Red-rumped Swallow | *Cecropis daurica* | Hirundinidae | Passeriformes | LC | IV |
| 56 | Barn Swallow | *Hirundo rustica* | Hirundinidae | Passeriformes | LC | IV |
| 57 | Wire-tailed Swallow | *Hirundo smithii* | Hirundinidae | Passeriformes | LC | IV |
| 58 | Long-tailed Shrike | *Lanius schach* | Laniidae | Passeriformes | LC | IV |
| 59 | Common Babbler | *Argya caudata* | Leiothrichidae | Passeriformes | LC | IV |
| 60 | Large Grey Babbler | *Argya malcolmi* | Leiothrichidae | Passeriformes | LC | IV |
| 61 | Indian Paradise flycatcher | *Terpsiphone paradisi* | Monarchidae | Passeriformes | LC | IV |

| | | | | | | |
|---|---|---|---|---|---|---|
| 62 | Paddyfield Pipit | *Anthus rufulus* | Motacillidae | Passeriformes | LC | IV |
| 63 | White Wagtail | *Motacilla alba* | Motacillidae | Passeriformes | LC | IV |
| 64 | White-browed Wagtail | *Motacilla maderaspatensis* | Motacillidae | Passeriformes | LC | IV |
| 65 | Purple Sunbird | *Cinnyris asiaticus* | Nectariniidae | Passeriformes | LC | IV |
| 66 | Purple-rumped Sunbird | *Leptocoma zeylonica* | Nectariniidae | Passeriformes | LC | IV |
| 67 | Yellow-throated Sparrow | *Gymnoris xanthocollis* | Passeridae | Passeriformes | LC | IV |
| 68 | House Sparrow | *Passer domesticus* | Passeridae | Passeriformes | LC | IV |
| 69 | Red-vented Bulbul | *Pycnonotus cafer* | Pycnonotidae | Passeriformes | LC | IV |
| 70 | Red-whiskered Bulbul | *Pycnonotus jocosus* | Pycnonotidae | Passeriformes | LC | IV |
| 71 | White-browed Bulbul | *Pycnonotus luteolus* | Pycnonotidae | Passeriformes | LC | IV |
| 72 | Common Myna | *Acridotheres tristis* | Sturnidae | Passeriformes | LC | IV |
| 73 | Brahminy Myna | *Sturnia pagodarum* | Sturnidae | Passeriformes | LC | IV |
| 74 | Grey Heron | *Ardea cinerea* | Ardeidae | Pelecaniformes | LC | IV |
| 75 | Purple Heron | *Ardea purpurea* | Ardeidae | Pelecaniformes | LC | IV |
| 76 | Indian Pond Heron | *Ardeola grayii* | Ardeidae | Pelecaniformes | LC | IV |
| 77 | Cattle Egret | *Bubulcus ibis* | Ardeidae | Pelecaniformes | LC | IV |
| 78 | Little Egret | *Egretta garzetta* | Ardeidae | Pelecaniformes | LC | IV |
| 79 | Little Cormorant | *Microcarbo niger* | Phalacrocoracidae | Pelecaniformes | LC | IV |
| 80 | Indian Cormorant | *Phalacrocorax fuscicollis* | Phalacrocoracidae | Pelecaniformes | LC | IV |
| 81 | Red-naped Ibis | *Pseudibis papillosa* | Threskiornithidae | Pelecaniformes | LC | IV |
| 82 | Coppersmith Barbet | *Psilopogon haemacephalus* | Megalaimidae | Piciformes | LC | IV |
| 83 | Little Grebe | *Tachybaptus ruficollis* | Podicipedidae | Podicipediformes | LC | IV |
| 84 | Plum-headed Parakeet | *Psittacula cyanocephala* | Psittacidae | Psittaciformes | LC | IV |
| 85 | Rose-ringed Parakeet | *Psittacula krameri* | Psittacidae | Psittaciformes | LC | IV |
| 86 | Spotted Owlet | *Athene brama* | Strigidae | Strigiformes | LC | IV |

**Table 13. Bird species richness in the all the three parts of the study area**

| PART | MIN | MAX | MEAN (n=2) | SD | Cum Richness |
|---|---|---|---|---|---|
| A | 6 | 8 | 7.00 | 0.63 | 25 |
| B | 4 | 10 | 7.17 | 2.56 | 25 |
| C | 3 | 7 | 4.50 | 1.38 | 14 |

The total numbers of individuals recorded in all the points are analysed and tabulated.

From the table 12, it is found that the highest number of (20max & 5 min) individuals wasrecorded in the Part - B (Table 12). The overall density of birds in this point is 49.2 hac.

**Table 14. Bird densities in the all the three parts of the study area**

| PART | MIN | MAX | MEAN (n=2) | SD | DENSITY in hectare |
|---|---|---|---|---|---|
| A | 6 | 12 | 8 | 2.2 | 40.7 |
| B | 5 | 20 | 9.7 | 5.5 | 49.2 |
| C | 3 | 8 | 5.7 | 1.9 | 28.8 |

The reason behind the highest record of the individuals in the Part - B is due to the habitat type. The Part has shrub jungle with thick canopies, water sources and less anthropogenic and cattle movements. Hence it shows a high number of species and as well as the highest record of individuals in this part. The minimum number of birds recorded was in Part - C. This is due to rocky terrain and located roadside.

In most of the cases the birds prefer a good habitat for the survival, fulfil their food requirements. So here, on seeing the density of the species we can conclude that the reason for the abundant density in this part is due to their characteristic feature of the habitats.

**Bees, Dragonflies, Spiders and Butterflies (Invertebrates):** A total of **46 species of Invertebrates**, of which Butterflies under the order Lepidoptera represented with 31 species belong to 26 genera of 5 families. Dragonflies under the order Odonata (9 species belong to 7 genera of 4 families). Hymenoptera is with 4 species belongs to 2 genera of one family. Spiders under the order Araneae represented with 1 species belong to 1 genus of Lycosidae family.

**Table 15. List of Invertebrates recorded from the proposed study area**

| S. No. | Common Name | Scientific Name | Family | Order | Class | IUCN Status | IWPA Schedule |
|---|---|---|---|---|---|---|---|
| 1 | Common Funnel Web Spider | *Hippasa agelenoides* | Lycosidae | Araneae | Arachnida | NA | NL |
| 2 | Indian Honeybee | *Apis cerana* subsp.*indica* | Apidae | Hymenoptera | Insecta | NA | NL |
| 3 | Honeybee | *Apis mellifera* | Apidae | Hymenoptera | Insecta | NA | NL |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | Violet Carpenter Bee | *Xylocopa violacea* | Apidae | Hymenoptera | Insecta | NA | NL |
| 5 | Carpenter Bee | *Xylocopa tenuiscapa* | Apidae | Hymenoptera | Insecta | NA | NL |
| 6 | Paper Wasp | *Ropalidia marginata* | Vespidae | Hymenoptera | Insecta | NA | NL |
| 7 | Common Bush Hopper | *Ampittia dioscorides* | Hesperiidae | Lepidoptera | Insecta | NA | NL |
| 8 | Common Awl | *Hasora badra* | Hesperiidae | Lepidoptera | Insecta | NA | NL |
| 9 | Indian Grizzled Skipper | *Spialia galba* | Hesperiidae | Lepidoptera | Insecta | NA | NL |
| 10 | Dark Palm Dart | *Telicota ancilla* | Hesperiidae | Lepidoptera | Insecta | NA | NL |
| 11 | Angled Pierrot | *Caleta decidia* | Lycaenidae | Lepidoptera | Insecta | NA | NL |
| 12 | Common Pierrot | *Castalius rosimon* | Lycaenidae | Lepidoptera | Insecta | NA | NL |
| 13 | Lime Blue | *Chilades lajus* | Lycaenidae | Lepidoptera | Insecta | NA | NL |
| 14 | Grass Jewel | *Freyeria trochylus* | Lycaenidae | Lepidoptera | Insecta | NA | NL |
| 15 | Pale Grass Blue | *Pseudozizeeria maha* | Lycaenidae | Lepidoptera | Insecta | NA | NL |
| 16 | Dark Grass Blue | *Zizeeria karsandra* | Lycaenidae | Lepidoptera | Insecta | NA | NL |
| 17 | Blue Grass | *Zizina labradus* | Lycaenidae | Lepidoptera | Insecta | NA | NL |
| 18 | Tiny Grass Blue | *Zizula hylax* | Lycaenidae | Lepidoptera | Insecta | NA | NL |
| 19 | Tawny Coster | *Acraea terpsicore* | Nymphalidae | Lepidoptera | Insecta | NA | NL |
| 20 | Common Castor | *Ariadne merione* | Nymphalidae | Lepidoptera | Insecta | NA | NL |
| 21 | Plain Tiger | *Danaus chrysippus* | Nymphalidae | Lepidoptera | Insecta | NA | NL |
| 22 | Common Tiger | *Danaus genutia* | Nymphalidae | Lepidoptera | Insecta | NA | NL |
| 23 | Common crow | *Euploea core* | Nymphalidae | Lepidoptera | Insecta | LC | NL |
| 24 | Danaid Eggfly | *Hypolimnas misippus* | Nymphalidae | Lepidoptera | Insecta | NA | NL |
| 25 | Peacock Pansy | *Junonia almana* | Nymphalidae | Lepidoptera | Insecta | NA | NL |
| 26 | Yellow Pansy | *Junonia hierta* | Nymphalidae | Lepidoptera | Insecta | NA | NL |
| 27 | Lemon Pansy | *Junonia lemonias* | Nymphalidae | Lepidoptera | Insecta | NA | NL |
| 28 | Blue Pancy | *Junonia orithya* | Nymphalidae | Lepidoptera | Insecta | NA | NL |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 29 | Common Bushbrown | *Mycalesis perseus* | Nymphalidae | Lepidoptera | Insecta | NA | NL |
| 30 | Dark Tiger | *Tirumala hamata* | Nymphalidae | Lepidoptera | Insecta | NA | NL |
| 31 | Common Banded Peacock | *Papilio crino* | Papilionidae | Lepidoptera | Insecta | NA | NL |
| 32 | Common Mormon | *Papilio polytes* | Papilionidae | Lepidoptera | Insecta | NA | NL |
| 33 | Mottled Emigrant | *Catopsilia pyranthe* | Pieridae | Lepidoptera | Insecta | NA | NL |
| 34 | Plain Orange Tip | *Colotis aurora* | Pieridae | Lepidoptera | Insecta | NA | NL |
| 35 | Common Jezebel | *Delias eucharis* | Pieridae | Lepidoptera | Insecta | NA | NL |
| 36 | Common Grass Yellow | *Eurema hecabe* | Pieridae | Lepidoptera | Insecta | NA | NL |
| 37 | Yellow Orange Tip | *Ixias pyrene* | Pieridae | Lepidoptera | Insecta | NA | NL |
| 38 | Pale-spotted Emperor | *Anax guttatus* | Aeshnidae | Odonata | Insecta | LC | NL |
| 39 | Golden Dartlet | *Ischnura aurora* | Coenagrionidae | Odonata | Insecta | NA | NL |
| 40 | Indian Common Clubtail | *Ictinogomphus rapax* | Gomphidae | Odonata | Insecta | LC | NL |
| 41 | Common scarlet-darter | *Crocothemis erythraea* | Libellulidae | Odonata | Insecta | LC | NL |
| 42 | Ground Skimmer | *Diplacodes trivialis* | Libellulidae | Odonata | Insecta | NA | NL |
| 43 | Blue Marsh Hawk | *Orthetrum glaucum* | Libellulidae | Odonata | Insecta | NA | NL |
| 44 | Green Marsh Hawk | *Orthetrum sabina* | Libellulidae | Odonata | Insecta | NA | NL |
| 45 | Wandering Glider | *Pantala flavescens* | Libellulidae | Odonata | Insecta | NA | NL |
| 46 | Crimson Marsh Glider | *Trithemis aurora* | Libellulidae | Odonata | Insecta | NA | NL |

**Pisces: 14 species** of fish belong to 5 orders and 5 families. The order Cypriniformes and Siluriformes each with 5 species in 3 genera of 1 family followed Synbranchiformes (2/1/1), Anabantiformes & Mugiliformes are represented with one species in one genus.

**Table 16. List of Pisces recorded from the proposed study area**

| S.No. | Common/Local Name | Scientific Name | Family | Order | IUCN Status | IWPA Schedule |
|---|---|---|---|---|---|---|
| 1 | Climbing Perch/Goraka | *Anabas testudineus* | Anabantidae | Anabantiformes | LC | NL |
| 2 | Catla | *Labeo catla* | Cyprinidae | Cypriniformes | LC | NL |
| 3 | Rohu/Seelavathi | *Labeo rohita* | Cyprinidae | Cypriniformes | LC | NL |
| 4 | Buradamatta | *Channa punctata* | Cyprinidae | Cypriniformes | LC | NL |
| 5 | Korrameenu | *Channa striata* | Cyprinidae | Cypriniformes | LC | NL |
| 6 | Chittrai | *Cirrhinus reba* | Cyprinidae | Cypriniformes | LC | NL |
| 7 | Corsula | *Rhinomugil corsula* | Mugilidae | Mugiliformes | LC | NL |
| 8 | Long Whiskers Catfish/Jella | *Mystus gulio* | Bagridae | Siluriformes | LC | NL |
| 9 | Errajella | *Mystus vittatus* | Bagridae | Siluriformes | LC | NL |
| 10 | Golden Barb/Perka | *Puntius gelius* | Bagridae | Siluriformes | LC | NL |
| 11 | Buddajella | *Rita chrysea* | Bagridae | Siluriformes | LC | NL |
| 12 | Bondu | *Rita kuturnee* | Bagridae | Siluriformes | LC | NL |
| 13 | Bommidai | *Macrognathus guentheri* | Mastacembelidae | Synbranchiformes | NA | NL |
| 14 | Indian Spiny Eel/Kontemukku | *Macrognathus pacalus* | Mastacembelidae | Synbranchiformes | LC | NL |

**Faunal composition in the study area:**

| Component | Mammals | Herpetofauna | Birds | Invertebrates | Fishes | Total |
|---|---|---|---|---|---|---|
| Orders | 6 | 3 | 18 | 4 | 5 | **36** |
| Family | 13 | 13 | 42 | 12 | 5 | **85** |
| Genera | 16 | 23 | 70 | 38 | 9 | **156** |
| **No. of species** | **19** | **26** | **86** | **46** | **14** | **191** |

**Scheduled species:**

- Common Indian Monitor and Indian Peafowl falls under Schedule-I category as per Indian Wildlife Protection Act (IWPA)-1972, Common Indian Monitor also falls under Near Threatened category as per IUCN red list.

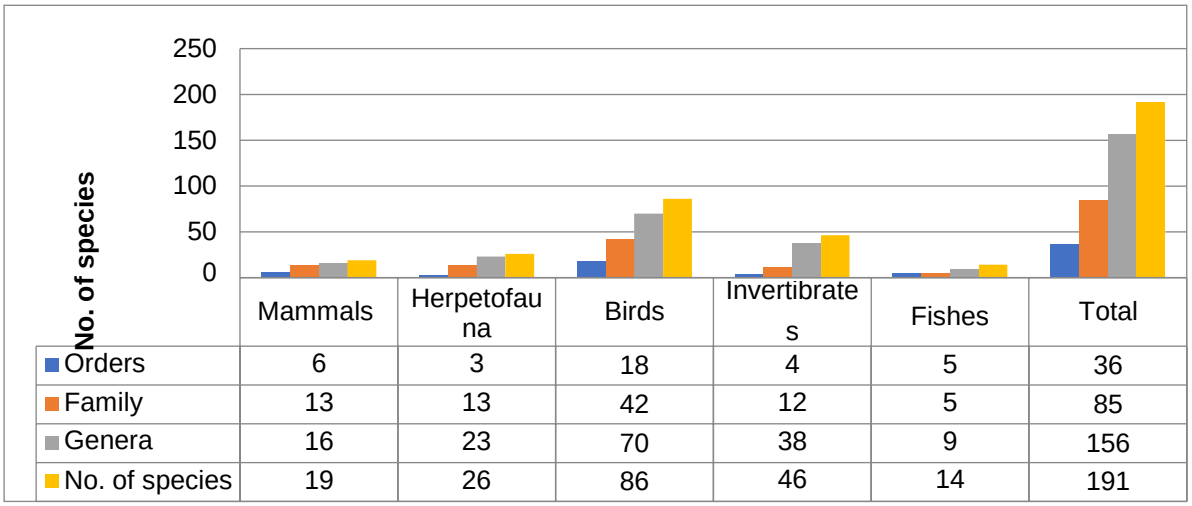
- Jungle Cat, Common Fox, Rhesus Macaque, Bonnet Macaque, Hanuman Langur, Indian Chameleon, Checkered Keelback, Indian Cobra, Russell's viper, are the common species that falls under Schedule-II category as per IWPA-1972.

- Nilgai, Indian Spotted Deer, Indian Sambar and Wild Boar falls under Schedule-III category as per IWPA-1972.

- A total of 108 faunal species (Mammals-9, Herpatofauna-15and birds-84) fall under Schedule-IV and Common Crow Schedule-V category according to IWPA- 1972.

**Species richness:**
Species richness: was high in Avifauna (86 species) followed by Spiders and Butterflies (46 species), Herpetofauna (26 species), Mammals (19 species) and Fishes (14 species), are depicted in Figure 15.

**Fig.15. Species richness**




| | Mammals | Herpetofauna | Birds | Invertibrates | Fishes | Total |
|---|---|---|---|---|---|---|
| Orders | 6 | 3 | 18 | 4 | 5 | 36 |
| Family | 13 | 13 | 42 | 12 | 5 | 85 |
| Genera | 16 | 23 | 70 | 38 | 9 | 156 |
| No. of species | 19 | 26 | 86 | 46 | 14 | 191 |

The diversity values recorded high for birds (0.108) followed by Invertebrates (0.031), herpetofauna (0.009) Mammals (0.005) and fishes (0.002).

Threatened Fauna Recorded in the Study Area as per IUCN:

| Species | IUCN Status |
|---|---|
| Indian Sambar *Rusa unicolor* | Vulnerable |
| Bonnet Macaque *Macaca radiata* | Vulnerable |
| Indian Flapshell Turtle *Lissemys punctata* | Vulnerable |
| Red sand boa *Eryx johnii* | Near Threatened |
| Rough-scaled Sand Boa *Gongylophis conicus* | Near Threatened |
| Common Indian Monitor *Varanus bengalensis* | Near Threatened |
| Painted Stork Mycteria *leucocephala* | Near Threatened |

**Wildlife Conservation Plan:**
A Wildlife conservation plan was prepared for conservation of the schedule-I species i.e., Indian Monitor Lizard and Indian Peafowl with an amount of Rs. 478.6 lakhs and was approved by the PCCF (HoFF) & CWLW, Telangana State Forest Department, vide reference No. 5694/2021/Wl-1 dated: 12.10.2021.

**Natural streams available in the adjoining forests in 10 Kms radius from the proposed study area:**

**Table 17. List of natural streams in the forest beats providing water to the wildlife in the 10 Kms radius**

| S.No | Beat Name | Streams | |
|---|---|---|---|
| | | Nos | Names |
| 1 | Tungaram | 1 | Isuka Vagu |
| | **Sub-Total:** | **1** | |
| 2 | Tippanapalli | 1 | Edumelikala Vagu |
| | **Sub-Total:** | **1** | |
| 3 | Penagadapa | 1 | Tella Vagu |
| | | 1 | Edumelikala Vagu |
| | **Sub-Total:** | **2** | |
| 4 | Ramavaram | 1 | Tella Vagu |
| | **Sub-Total:** | **1** | |
| 5 | Gareebpeta | 3 | Marri Vagu |
| | | | Dargaiah Vagu |
| | | | Uppenala Vagu |
| | **Sub-Total:** | **3** | |
| | **Grand Total:** | **8** | |

Habitat improvement infrastructures & Water Management Initiatives of the Forest Department to sustain and enhance the wildlife population in the 10 Kms radius:

**Table 18. No. of fire-line points developed by the Forest Department to avoid/control forest fires within 10 Kms radius**

| S.No. | Beat Name | Forest Fire Points |
|---|---|---|
| 1 | Tungaram | 0 |
| | **Sub-Total:** | **0** |
| 2 | Tippanapalli | 2 |
| | **Sub-Total:** | **2** |
| 3 | Penagadapa | 1 |
| | **Sub-Total:** | **1** |
| 4 | Ramavaram | 0 |
| | **Sub-Total:** | **0** |
| 5 | Gareebpeta | 5 |
| | **Sub-Total:** | **5** |
| | **Grand Total:** | **8** |

**Table 19. No. of PTs developed by the Forest Department**

| S.No | Beat Name | Percolation Tank (PTs) | | |
|---|---|---|---|---|
| | | Nos | Latitude | Longitude |
| 1 | Tungaram | 1 | 17.44470 | 80.62874 |
| | **Sub-Total:** | **1** | | |
| 2 | Tippanapalli | 1 | 17.43644 | 80.64424 |
| | | 1 | 17.43769 | 80.64544 |
| | **Sub-Total:** | **2** | | |
| | **Grand Total:** | **3** | | |

**Table 20. List of forest fringe villages within the 10 Kms radius with people depending on the forest for livelihoods and livestock rearing – biotic pressure to existing forest areas:**

| S.No. | Beat Name | No of Villages | | Population | No. of Cattles |
|---|---|---|---|---|---|
| | | Nos. | Names | | |
| 1 | Tungaram | 6 | Tungaram | 3900 | 2000 |
| | | | Sunkara Banjara | | |
| | | | Tekula Banjara | | |
| | | | Jarpula Thanda | | |
| | | | Seemla Thanda | | |
| | | | Mala Banjara | | |
| | **Sub-Total:** | **6** | | **3900** | **2000** |
| 2 | Tippanapalli | 5 | Tippanapalli | 4400 | 3200 |
| | | | Ahmednagar | | |
| | | | Venkata Puram | | |
| | | | Satyanarayana Puram | | |
| | | | Repallewada | | |
| | **Sub-Total:** | **5** | | **4400** | **3200** |
| 3 | Penagadapa | 3 | Penagadapa | 3000 | 1500 |
| | | | Rampuram | | |
| | | | Ambedkarnagar | | |
| | **Sub-Total:** | **3** | | **3000** | **1500** |
| 4 | Ramavaram | 8 | Garimellapadu | 4300 | 280 |
| | | | Ramavaram | | |
| | | | 3 Incline | | |
| | | | 2 Incline | | |
| | | | 4 Incline | | |
| | | | 5 Incline | | |
| | | | Dhanbad | | |
| | | | Barium Thanda | | |
| | **Sub-Total:** | **8** | | **4300** | **280** |
| 5 | Gareebpeta | 15 | Gareebpeta | 9375 | 560 |
| | | | Laxmipuram Thanda | | |
| | | | Rudrampur | | |

| | | | | | |
|---|---|---|---|---|---|
| | | | Laxmidevipalli | | |
| | | | Nimmalagudem | | |
| | | | Nimmalagudem Colony | | |
| | | | Marrithanda | | |
| | | | Chintal Thanda | | |
| | | | Komatpalli | | |
| | | | Seethampeta | | |
| | | | Seethampeta Banjara | | |
| | | | Reddipalem | | |
| | | | Ramji Thanda | | |
| | | | Sujathanagar | | |
| | | | Mangapeta | | |
| | **Sub-Total:** | **15** | | **9375** | **560** |
| | **Grand Total:** | **37** | | **24975** | **7540** |

### Socio-economic status within the 10 Kms radius from the proposed study area:

Based on the 2011 Census data, in the study area the Schedule caste (SC) population is 16.44%, and the Schedule Tribe (ST) population is 22.08%. Literacy rate in the project area is 66%.

Educational status has improved from generation to generation in this region. Schooling and collages are available up to engineering education. The working population is 41.91% and the non-working population is 58.09%. Infrastructure facilities such as the Road network, Banks, Post office, public distribution system and transport facility and communication facilities are good.

A sample survey of 440 households was surveyed in 15 villages of the study area. The number of females per 1000 males is 1016, showing healthy ratio of female population. Among the surveyed total population, 66% people were literate and 34% were illiterate. This shows that the educational facilities have improved in the sample area.

### Distribution of population

As per 2011 census the study area consisted of 2,89,491 persons inhabited in the study area. The distribution of Population in the study area is shown in Table 21.

**Table 21. Distribution of population**

| Particulars | 0-2 km | 2-5 km | 5-10 km | 0-10 km |
|---|---|---|---|---|
| No. of households | 4308 | 4398 | 66146 | 74852 |
| Male Population | 8623 | 8394 | 126544 | 143561 |
| Female Population | 8497 | 8441 | 128992 | 145930 |
| Total Population | 17120 | 16835 | 255536 | 289491 |
| Average household size | 3.97 | 3.83 | 3.86 | 3.87 |
| Sex ratio | 985 | 1006 | 1019 | 1017 |

*Source: Census 2011

**Table 22. Distribution of population by social structure**

| Particulars | 0-2 km | 2-5 km | 5-10 km | 0-10 km |
|---|---|---|---|---|
| Schedule caste | 4589 | 1724 | 41267 | 47580 |
| % of SC | 26.80 | 10.24 | 16.15 | 16.44 |
| Schedule Tribes | 1256 | 6783 | 55878 | 63917 |
| % of ST | 7.34 | 40.29 | 21.87 | 22.08 |
| Total SC & ST | 5845 | 8507 | 97145 | 111497 |
| % of total SC & ST | 34.14 | 50.53 | 38.02 | 38.51 |
| **Total Population** | **17120** | **16835** | **255536** | **289491** |

*Source: Census 2011

## Household Energy Sources

About 91% of the sample households were using LPG connection, 3% are using both gas and firewood while firewood are used occasionally or in absence of gas. 6% households were using firewood for cooking purpose as they are not having gas connection or immigrants. None of the House Holds are using Kerosene/coal as cooking fuel in the sample households. The LPG connection usage is very high as they are utilising the government subsidy scheme for the LPG connection.

| Type of Fuel | No's | % |
|---|---|---|
| Gas | 401 | 91 |
| Wood + gas (Dependency on forest) | 14 | 3 |
| Wood (Dependency on forest) | 25 | 6 |
| **Total** | **440** | **100** |

## Agricultural Scenario

The study area is not agrarian area and there are only a few farmers cultivating Paddy, Mirchi, vegetables and few are growing fodder for their own cattle. 20% of the sample population involved in the other occupation such as services, business, and daily labour works. Sample household survey reveals that only 38% farmers have their own agricultural lands. They were classified as marginal (below 1.00 ha) 37%, small holdings (1-2 ha) 1%, semi-medium no one family found (2 – 4 ha) holdings, medium (4 to 10 ha) and large holdings (10 ha & above) are nil. The remaining 62% doesn't possess any land, as shown in below Table. The major crops cultivated in the study area include Paddy, Mirchi and secondary crop is Maize and millets. The contributions of the agricultural sector to household income are relatively less in 31% of the families are, forming households.

**Table 23. Agriculture Hodings**

| Agriculture land Size Group | Farmers | % |
|---|---|---|
| Marginal | 162 | 37 |
| Small | 6 | 1 |
| Small-Medium | 0 | 0 |
| Medium | 0 | 0 |
| Large | 0 | 0 |
| Not having agricultural land | 272 | 62 |
| **Total** | **440** | **100** |

Besides land, both in absolute acreage and quality, the ownership of plough bullocks, tractors, and other farm equipment significantly affects the agricultural income. In the study area only 2% possess agricultural related items like tractor and plough. Even though most of them do not possess agricultural related items but they have access to these services through payment/rental basis.

### Livestock Farming

Livestock ownership details obtained in the study area during the socio-economic survey for 440 households. A total of 82 households has cattle as secondary source of income. 108 households have Poultry, and 13 families have the Goat/Sheep.

**Table 24. Livestock ownership in the 10 Kms around the study area**

| Herd Size | Cow/Buffalo | Goat/Sheep | Poultry |
|---|---|---|---|
| Not having | 358 | 427 | 332 |
| 1 to 3 | 68 | 0 | 86 |
| 4 to 7 | 14 | 0 | 19 |
| 8 & above | 0 | 13 | 3 |
| **Total** | **440** | **440** | **440** |

### Infrastructure

Transport facility, mobile communication and postal services are good in the study area. Banks and agricultural societies need to be improved. Women self-help groups are very active and public distribution system is good for ration supply. The details of the facilities are provided below.

**Table 25. Infrastructure and Educational facilities in the Study area**

| Infra structure Facility | % Coverage () 2011 | | | | 2020 (coverage %) | | | |
|---|---|---|---|---|---|---|---|---|
| | 0-2 km | 2-5 km | 5-10 km | 0-10 km | 0-2 km | 2-5 km | 5-10 km | 0-10 km |
| Post Office | 50 | 25 | 43 | 39 | 100 | 63 | 74 | 73 |
| Mobile Phone Coverage | 100 | 100 | 97 | 97 | 100 | 100 | 100 | 100 |
| Public Bus Service | 50 | 75 | 87 | 82 | 100 | 100 | 100 | 100 |
| Black Topped (pucca) Road | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Banks | 50 | 12.5 | 22 | 22 | 100 | 63 | 70 | 70 |
| Self - Help Group | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Public Distribution System | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

**Table 26. List of floral species documented by the forest department in the adjacent forest areas within the 10 Kms of radius from the proposed study area**

| Trees | | |
|---|---|---|
| **Sl. No** | **Species** | ***Common Name*** |
| 1 | *Acacia chundra* | *Sundra* |
| 2 | *Acacia leucophloea* | *Tella Thumma* |
| 3 | *Aegle marmelos* | *Maredu* |
| 4 | *Alangium salvifolium* | Uduga |
| 5 | *Albizia amara* | Nalla regu |
| 6 | *Albizia lebbeck* | Dirishanam |
| 7 | *Albizia odoratissima* | Chinduga |
| 8 | *Andina cordifolia* | Bandaru |
| 9 | *Anogeissus latifolia* | Chirumanu Yelama |
| 10 | *Azadirachta indica* | Vepa |
| 11 | *Bauhinia racemosa* | Ari |
| 12 | *Bombax ceiba* | Buruga |
| 13 | *Boswellia serrata* | Andugu |
| 14 | *Buchanania lanzan* | Sarapapu, Mori |
| 15 | *Cassia fistula* | Rela |
| 16 | *Cassine glauca* | Bhutangi |
| 17 | *Chloroxylon swietenia* | Billudu |
| 18 | *Cleistanthus collinus* | Bankanakkiri, Kodisa |
| 19 | *Cochlospermum religiosum* | Kondagogu |
| 20 | *Cordia dichotoma* | Iriki/BankaNakkera |
| 21 | *Dalbergia latifolia* | Jetregi |
| 22 | *Dalbergia paniculata* | Soppera/Pachari |
| 23 | *Dichrostachys cinerea* | |
| 24 | *Diospyros chloroxylon* | Illintha |
| 25 | *Diospyros melanoxylon* | Tuniki |
| 26 | *Erythroxylum monogynum* | Devadaru |
| 27 | *Eucalyptus tereticornis* | Nilagiri |
| 28 | *Feronia elephantum* | Velaga |
| 29 | *Ficus mollis* | Juvvi |
| 30 | *Ficus racemosa* | Medi |
| 31 | *Gardenia lucida* | Yerra bikki, Karinga |
| 32 | *Garuga pinnata* | Garga - Garugu |
| 33 | *Givotia rottleriformis* | Tella poliki |
| 34 | *Gmelina arborea* | Gummadi Teak |
| 35 | *Grewia tiliaefolia* | Jana/Thada |
| 36 | *Hardwickia binata* | Yepa |
| 37 | *Holarrhena pubescens* | Kodisepala |
| 38 | *Holoptelea integrifolia* | Nauli |
| 39 | *Ixora pavetta* | Koravi |
| 40 | *Lagerstroemia parviflora* | Chennangi |
| 41 | *Lannea coromandeliana* | Gumpena |
| 42 | *Madhuca longifolia* | Ippa |

| | | |
|---|---|---|
| 43 | *Mangifera indica* | Mango |
| 44 | *Manilkara hexandra* | Pala/Pedda pala |
| 45 | *Miliusa tomentosa* | Nuluva/ Barre duddi |
| 46 | *Mitragyna parviflora* | Batta ganapa |
| 47 | *Morinda pubescens* | Thogarmogali |
| 48 | *Naringi crenulata* | Torrivelaga |
| 49 | *Nyctanthes arbor-tristis* | Parijatham |
| 50 | *Paasi* | |
| 51 | *Phyllanthus emblica* | Usiri |
| 52 | *Polyalthia cerasoides* | Chilakaduddi |
| 53 | *Pongamia pinnata* | Kanuga |
| 54 | *Premna tomentosa* | Nagur |
| 55 | *Pterocarpus marsupium* | Yegisa |
| 56 | *Pterospermum xylocarpum* | Loluga |
| 57 | *Schleichera oleosa* | Rakot/Pusugu |
| 58 | *Schrebera swietenioides* | Mokkep, Makkam |
| 59 | *Semecarpus anacardium* | Jeedi |
| 60 | *Soymida febrifuga* | Somi |
| 61 | *Sterculia urens* | Thapsi chettu |
| 62 | *Strychnos nux-vomica* | Visha Mushti |
| 63 | *Strychnos potatorum* | Chilla |
| 64 | *Tamarindus indica* | Chintha |
| 65 | *Tectona grandis* | Teak |
| 66 | *Terminalia alata* | Nalla maddi |
| 67 | *Terminalia arjuna* | Tella/Veru maddi |
| 68 | *Terminalia bellirica* | Thani - Thandra |
| 69 | *Terminalia chebula* | Karaka |
| 70 | *Viscum heyneanum* | Karisha |
| 71 | *Ximenia americana* | Udutanakkera |
| 72 | *Xylia xylocarpa* | Bojja/Konda tangedu |
| 73 | *Ziziphus xylopyrus* | Gotti - Gotiki |
| | | |
| **Shrubs** | | |
| 1 | *Canthium parviflorum* | Balusu |
| 2 | *Cissus vitiginea* | Gummadi Podha |
| 3 | *Dodonaea viscosa* | Bandaru |
| 4 | *Grewia hirsuta* | Bontha |
| 5 | *Helicteres isora* | Nulithada |
| 6 | *Jasminum arborescens* | Adavi malli |
| 7 | *Lawsonia inermis* | Kommi |
| 8 | *Maytenus emarginata* | Danthi |
| 9 | *Phyllanthus reticulatus* | Sunnambatti |
| 10 | *Randia spinosa* | Manga chettu |
| 11 | *Woodfordia fruticosa* | Jaji |
| 12 | *Ziziphus oenoplia* | Parikatheega |
| | | |

| Climbers | | |
|---|---|---|
| 1 | *Acacia pinnata* | Chenchu campa |
| 2 | *Aganasoma caryophyllata* | Gudapala |
| 3 | *Asparagus racemosus* | Pilli bitiri |
| 4 | *Cocculus hirsutus* | Dusari teega |
| 5 | *Mucuna pruriens* | Adavi ulava |
| 6 | *Tylophora indica* | Teega Gaddi |
| | | |
| **Herbs** | | |
| 1 | *Acalypha indica* | Muripindi teega |
| 2 | *Achyranthes aspera* | Uttareni/Antisa |
| 3 | *Aerva lanata* | Konda pindi |
| 4 | *Ageratum conyzoides* | Goat weed |
| 5 | *Andrographis paniculata* | Nelavemu |
| 6 | *Atylosia scarabaeoides* | Showy pigeonpea |
| 7 | *Combretum decandrum* | Yedagaddi |
| 8 | *Curculigo orchioides* | Eethakula Gaddi |
| 9 | *Hemidesmus indicus* | Sugandipala |
| 10 | *Hybanthus enneaspermus* | Ratnapurusa |
| 11 | *Hyptis suaveolens* | Sima tulasi/ Mahaveera |
| 12 | *Ocimum americanum* | Kukka tulasi |
| 13 | *Ocimum sanctum* | Adavi tulasi |
| 14 | *Phyllanthus niruri* | Nela usiri |
| 15 | *Sida acuta* | Chittemu |
| **Grasses** | | |
| 1 | *Aristida setacea* | Cheepuru gaddi |
| 2 | *Cymbopogon martinii* | Kasha gaddi |
| 3 | *Cynodon dactylon* | Garika gaddi |
| 4 | *Cyperus pertenius* | Nalla Tunga |
| 5 | *Cyperus rotundus* | Tunga |
| 6 | *Dioscorea bulbifera* | Adavi gaddu |
| 7 | *Echinochloa colona* | Kaproda gaddi |
| 8 | *Eclipta alba* | Gutta gaddi |
| 9 | *Eragistielia bifarice* | |
| 10 | *Eragrostis tenella* | Chinna Garika Gaddi |

| **B A M B O O S** | | |
|---|---|---|
| **S. No.** | **Scientific Name** | **Common Name** |
| 1 | *Bambusa arundinacea* | Mullam Bongu |
| 2 | *Dendrocalamus strictus* | Sadanam |
| | | |

**Table 26. List of faunal species documented by the forest department in the adjacent forest areas within the 10 Kms of radius from the proposed study area**

| S.No. | Scientific Name | Common Name |
|---|---|---|
| 1 | *Boselaphus tragocamelus* | Nilgai |
| 2 | *Tetracerus qudricornis* | Four horned antelope |
| 3 | *Antilope cervicarpa* | Black buck |
| 4 | *Cervus unicolor* | Sambar |
| 5 | *Axis axis* | Spotted deer |
| 6 | *Sus scrofa* | Wild boar |
| 7 | *Bos gaurus* | Indian bison |
| 8 | *Melurus ursinus* | Sloth bear |
| 9 | *Herpestes edw ardej* | Common mongoose |
| 10 | *Canis aureus* | Jackal |
| 11 | *Vulpes bengalensis* | Indian fox |
| 12 | *Macaca mulatt* | Rhesus monkey |
| 13 | *Presbytis entellus* | Common langur |
| 14 | *Penthera tigris* | Tiger |
| 15 | *Panthera pardus* | Leopard |
| 16 | *Felis chaus* | Jungle cat |
| 17 | *Cuon alpinus* | Wild dog |

## Conclusion

The 313 species of plants and 191 animals that were identified during the brief preliminary survey have highlighted the maximum potential magnitude of biodiversity of the study area. The groups of organisms such as spiders, scorpions, millipedes, insects including butterflies are apparently diverse.

The fauna study reveals the presence of schedule-I faunal species i.e., Indian Monitor lizard, Indian Rock Python and Indian Peafowl falls in the study area of the project. Further, the field survey team have not sighted their presence and did not find any indirect evidence i.e., pug marks, squats, feathers, or dead remains etc. of any wild animals in the study area of the project during field survey. Since, no migratory route / corridors found in the core area. Hence, there is no effect on wildlife migration due to mining.

## Recommendations

Restoration and reclamation process during and after mining in the proposed study area and compensatory measures of SCCL with the forest department in the adjoining forests will provide alternate habitats for these species without much competition in resource partition with other existing species around the study area.

These processes should be monitored by a wildlife expert from the beginning of the mining operations, in a long-term period continuously without fail. The long-term monitoring will provide inputs and advisories to maintain and sustain the ecological balance of the study area. One wildlife expert at least for 10 years to monitor the impact of mining in adjoining forest area in the buffer may be engaged.

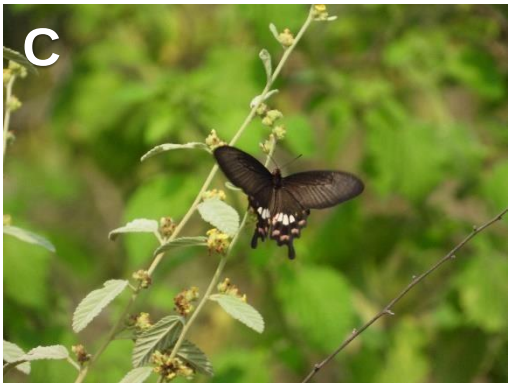
Also, the monitoring will help in creating a database by conducting the research throughout the mining project covering all seasons as these may also lead to the management of the proposed study area and the adjoining forest areas. Such studies may also raise questions on urban wildlife conservation and its importance in and around the mine operational areas.

A wildlife Conservation/ Mitigation plan was prepared was approved by the Chief Wildlife Warden, TS, vide reference 5694/2021/WL-I Dt.12.10.2021 for Rs.4.78 Crores. This plan shall be implemented within 3 years from the start of mining.

## Photo Plates

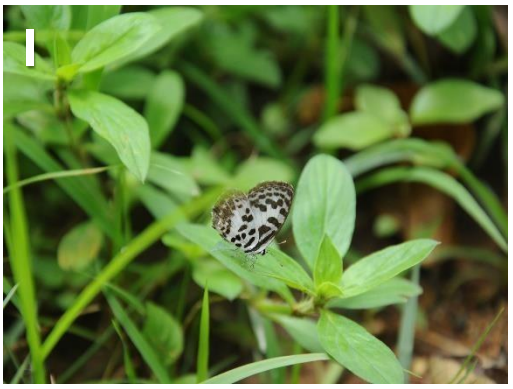
**Butterflies**















| No. | Common Name | Scientific Name |
|---|---|---|
| A. | Tawny Coster | *Acraea violae* |
| B. | Chocolate Pansy | *Junonia iphita* |
| C. | Common Rose | *Pachliopta aristolochiae* |
| D. | Lime | *Papilio demoleus* |
| E. | Plain Tiger | *Danaus chrysippus* |
| F. | Lemon Pansy | *Junonia lemonias* |
| G. | Yellow Orange Tip | *Ixias pyrene* |
| H. | Common Grass Yellow | *Eurema hecabe* |
| I. | Common Pierrot | *Castalius rosimon* |
| J. | Common Indian Crow | *Euploea core* |
| K. | Common Banded Awl | *Hasora chromu* |
| L. | Indian Cupid | *Everes lacturnus* |
| M. | Common Jezebel | *Delias eucharis* |
| N. | Common Evening Brown | *Melanitis leda* |

## Odonates







| No. | Common Name | Scientific Name |
|---|---|---|
| A. | Green Marsh Hawk | *Orthetrum sabina* |
| B. | Ground Skimmer | *Diplacodes trivialis* |
| C. | Golden Dartlet | *Ischnura aurora* |
| D. | Ditch Jewel | *Brachythemis contaminata* |
| E. | Common Picture Wing | *Rhyothemis variegata* |
| F. | Blue-tailed Green Darner | *Anax guttatus* |

## Other Invertebrates

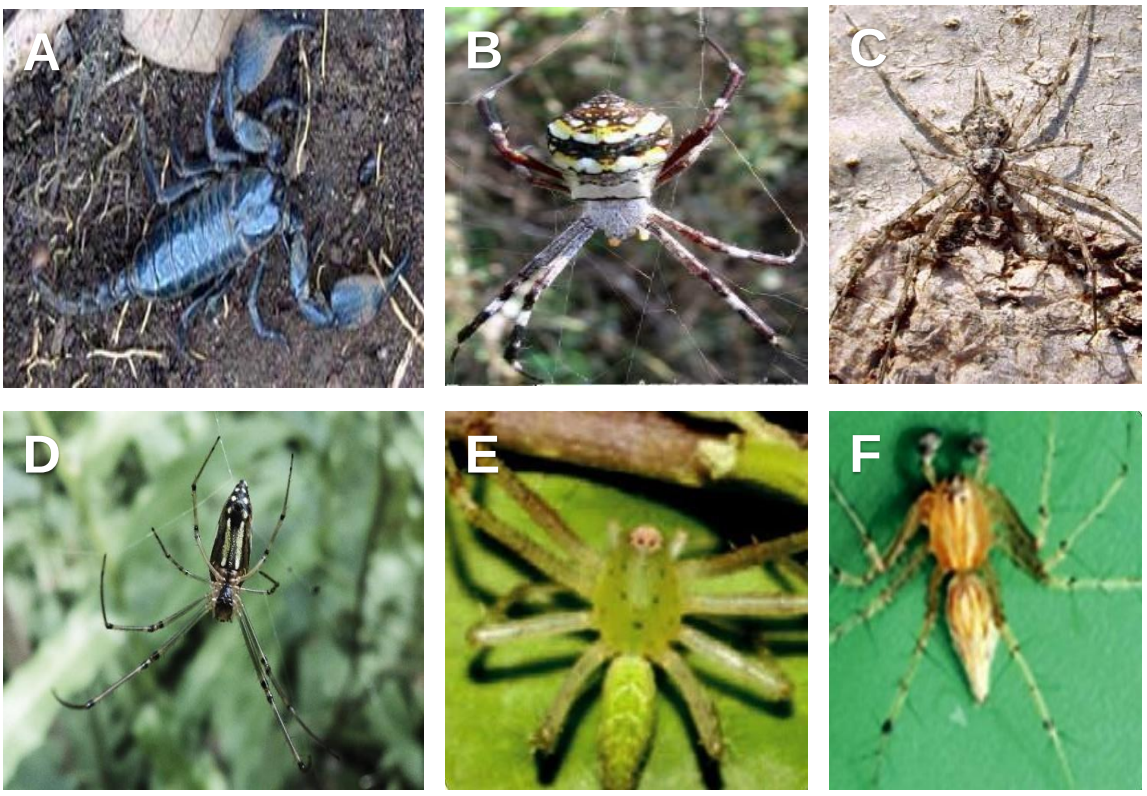






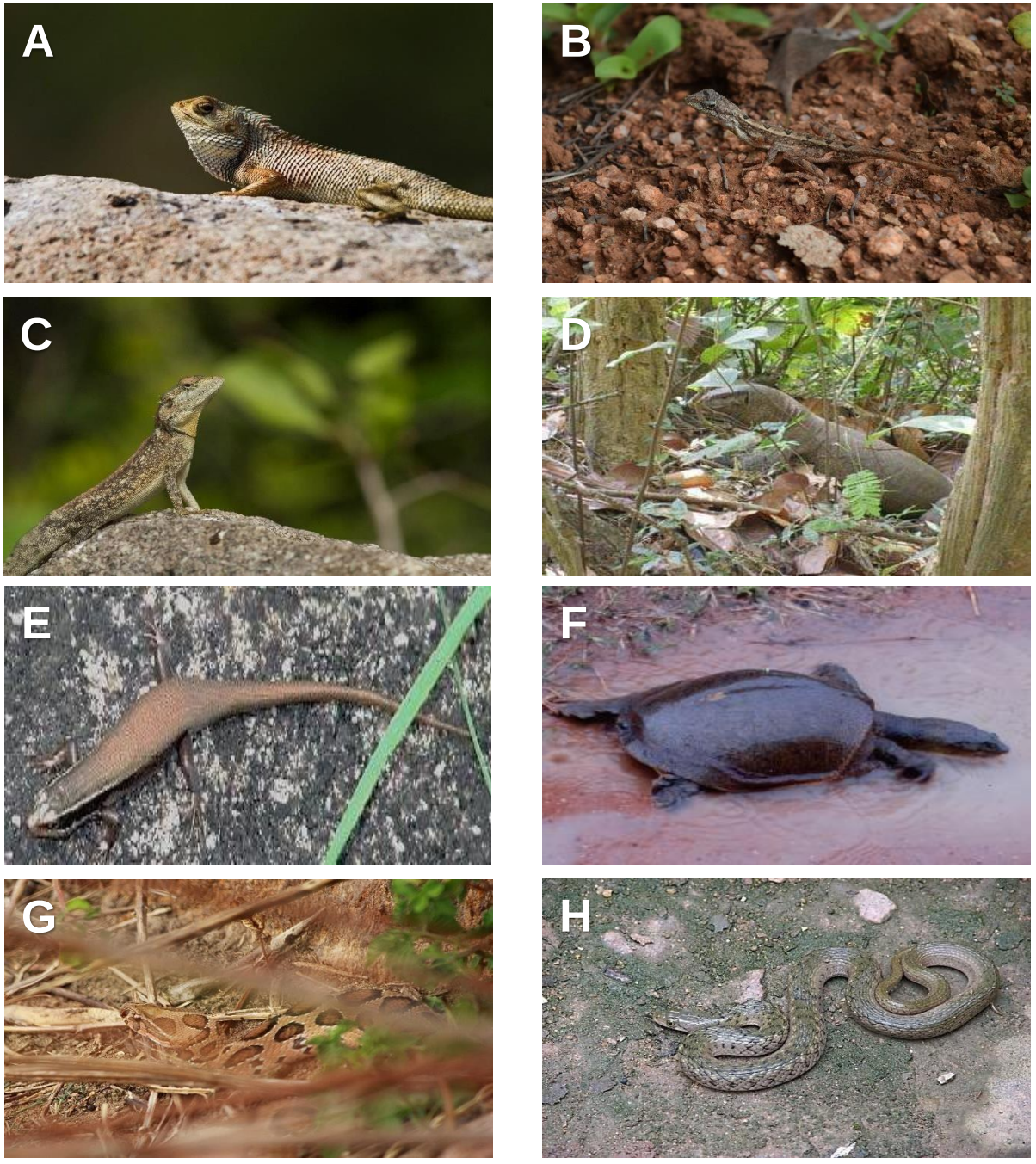
| No. | Common Name | Scientific Name |
|---|---|---|
| A. | Six-spot Ground Beetle | *Anthia sexguttata* |
| B. | Brown Grasshopper | *Melanoplus sanguinipes* |
| C. | Painted Grasshopper | *Poekilocerus pictus* |
| D. | Palm Rhinoceros Beetle | *Oryctes nasicornis* |
| E. | Common Godzilla ant | *Componatus compressus* |
| F. | Procession Ant | *Leptogenys processionalis* |

## Arachnids




| No. | Common Name | Scientific Name |
|---|---|---|
| A. | Giant Forest Scorpion | *Heterometrus swammerdami* |
| B. | Signature Spider | *Argiope anasuja* |
| C. | Common Two Tail | *Hersilia savignyi* |
| D. | Decorated Spider | *Leucauge decorata* |
| E. | Yogesh's Green Lynx Spider | *Peucetia yogesh* |
| F. | Pawan's Green Lynx Spider | *Oxyopes pawani* |

## Reptiles

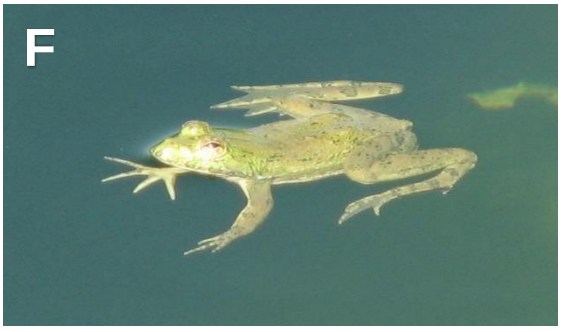



| No. | Common Name | Scientific Name |
|---|---|---|
| A. | Indian Garden Lizard | *Calotes versicolor* |
| B. | Fan-throated lizard | *Sitana ponticeriana* |
| C. | South Indian Rock Agama | *Psammophilus dorsalis* |
| D. | Keeled Grass Skink | *Eutropis carinata* |
| E. | Bengal Monitor | *Varanus bengalensis* |
| F. | Indian Flap-shelled Turtle | *Lissemys punctata* |
| G. | Checkered Keelback | *Xenochrophis piscator* |
| H. | Russell's Viper | *Daboia russelii* |

## Amphibians



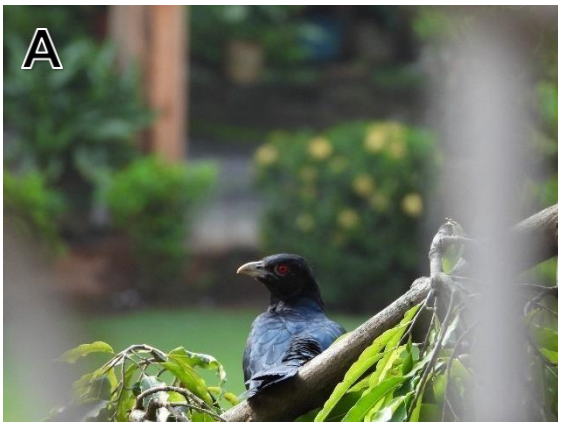





| No. | Common Name | Scientific Name |
|---|---|---|
| A. | Skittering Frog | *Euphlyctis cyanophlyctis* |
| B. | Common Indian Toad | *Duttaphrynus melanostictus* |
| C. | Indian Cricket Frog | *Fejervarya limnocharis* |
| D. | Indian Bull Frog | *Hoplobatrachus tigerinus* |
| E. | Common Tree Frog | *Polypedates maculates* |
| F. | Indian Pond Frog | *Euphlyctis hexadactylus* |
| G. | Marbled narrow-mouthed frog | *Uperdon variegates* |
| H. | Marbled Balloon Frog | *Uperodon systoma* |

**Aves**











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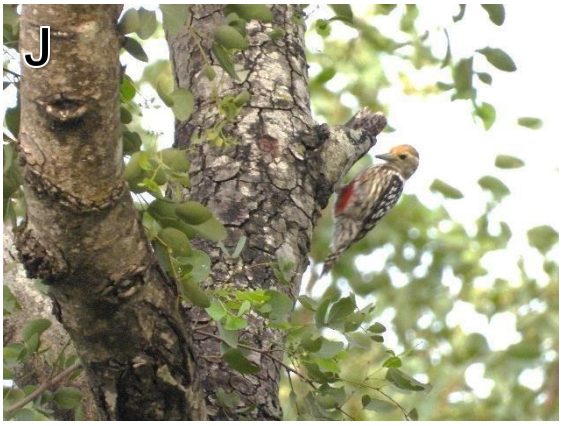
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| No. | Common Name | Scientific Name |
|---|---|---|
| A. | Asian Koel | *Eudynamys scolopacea* |
| B. | Black Drongo | *Dicrurus macrocercus* |
| C. | Red-vented Bulbul | *Pycnonotus cafer* |
| D. | Bay-backed Shrike | *Lanius vittatus* |
| E. | Spotted Dove | *Streptopelia chinensis* |
| F. | Eurasian Golden Oriole | *Oriolus oriolus* |
| G. | Cattle Egret | *Bubulcus ibis* |
| H. | Green Bee-eater | *Merops orientalis* |
| I. | Purple-rumped Sunbird | *Nectarinia zeylonica* |
| J. | Brown-capped pygmy woodpecker | *Yungipicus nanus* |
| K. | Red-rumped Swallow | *Hirundo daurica* |
| L. | Coppersmith Barbet | *Psilopogon haemacephalus* |
| M. | White-throated Kingfisher | *Halcyon smyrnensis* |
| N. | Common Babbler | *Turdoides caudatus* |
| O. | Shikra | *Accipiter badius* |
| P. | Scaly-breasted Munia | *Lonchura punctulata* |
| Q. | Gray Francolin | *Francolinus pondicerianus* |
| R. | Indian Gray Hornbill | *Ocyceros birostris* |
| S. | Spotted Owlet | *Athene brama* |
| T. | Pied Bushchat | *Saxicola caprata* |
| U. | Rose-ringed Parakeet | *Psittacula krameri* |
| V. | Alexandrine Parakeet | *Psittacula eupatria* |
| W. | Indian Nightjar | *Caprimulgus asiaticus* |
| X. | Common Iora | *Aegithina tiphia* |

## Mammals






| No. | Common Name | Scientific Name |
|---|---|---|
| A. | Rhesus Macaque | *Macaca mulatta* |
| B. | Bonnet Macaque | *Macaca radiata* |
| C. | Hanuman Langur | *Semnopithecus entellus* |
| D. | Common Grey Mongoose | *Herpestes edwardsii* |
| E. | Three-striped Palm Squirrel | *Funambulus palmarum* |

**Fieldwork Glimpses in the Nature Trails along with the Forest Beat Officers**









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***

**GOVERNMENT OF TELANGANA**
**FOREST DEPARTMENT**

From
Sri Laxman Ranjeet Nayak, IFS.,
District Forest Officer,
Bhadradri Kothagudem District.

To
The Conservator of Forests,
Bhadradri Circle,
Kothagudem.

**Rc. No. 241/2020/D1, dt: 28.02.2023**

Sir,

Sub: - TSFD – F (C) Act, 1980 – Diversion of 649.3014 Ha of forest land in Ramavaram RF of Ramavaram Range of Kothagudem Forest Division for grant of mining lease for proposed Venkateshkhani OCP from Underground rights to Surface rights – Kothagudem area of Bhadradri Kothagudem District in favour of M/s Singareni Collieries Company Limited – Additional information Sought by Got, MoEF& CC, New Delhi– Submitted - Reg.

Ref: 1. Prl. CCF, T.S., Hyderabad, Rc. No. FC4/FC29/6/2022, Dt: 12.11.2022.
3. FDO, Kothagudem Rc. No. 631/2019/A5, dt: 04.12.2022 (Received on 28.02.2023).

◇◇◇

With reference to the subject and references cited above, it is submitted that, as per the instructions of the Principal Chief Conservator of Forests (HoFF), T.S. Hyderabad vide reference 1st cited, regarding the information called for, i.e., the "details / KML files of the DFL identified for carrying out one half time CA with reference to the safety zone" for the proposals for Diversion of 649.3014 Ha of forest land in Ramavaram RF of Ramavaram Range of Kothagudem Forest Division for grant of mining lease for proposed Venkateshkhani OCP from Underground rights to Surface rights, Kothagudem area of Bhadradri Kothagudem District in favour of M/s Singareni Collieries Company Limited, the Forest Divisional Officer, Kothagudem vide reference 2nd cited has submitted the KML File for the safety zone area of 11.00 Ha identified in Compartment No. 29 of Penagadapa RF,Ramavaram Range of Kothagudem Division. The same is submitted herewith for favour of kind further necessary action.

This is submitted for favour of kind information and necessary action.

Encl: As above(KML File).

Yours faithfully,

District Forest Officer,
Bhadradri Kothagudem District.

28/2/23

28/2/2023

Copy submitted to the Principal Chief Conservator of Forests (HoFF), T.S. Hyderabad along with KML File for favour of kind information.

Copy to the General Manager, the Singareni Collieries Company Limited, Kothagudem area for information.

Copy to the Forest Divisional Officer, Kothagudem for information.

District Forest Officer,
Bhadradri Kothagudem District.

28/2/23

28/2/2023

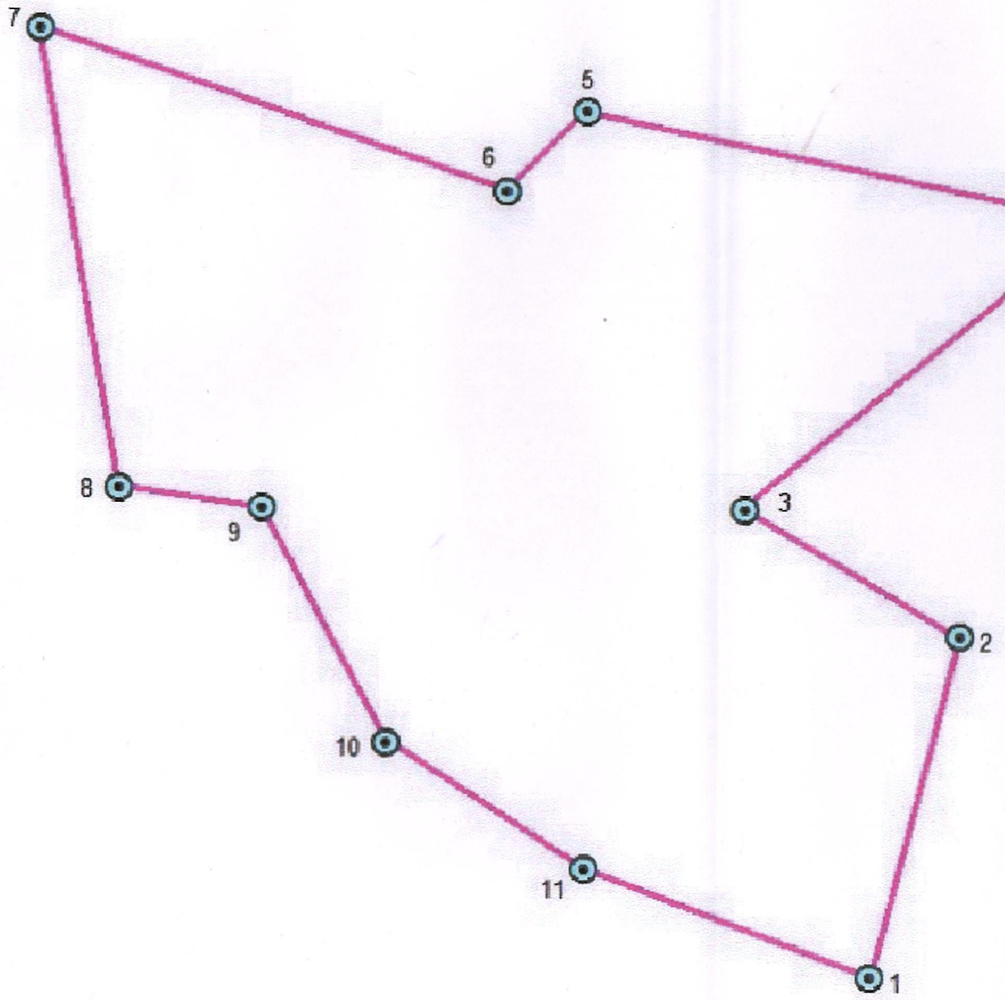
# Location map of Diversion of 649.3014 Ha of Forest land for Venkatesh Khani Coal mine from underground rights to Surface rights in Ramavaram RF of Kothagudem Division in favour of M/s Singareni Collieries Company Limited, Kothagudem

N

1:3500

Compt.No.29
Beat: Penagadapa
Section: Penagadapa
Range: Ramavaram

Gross Area: 12.776 Ha
Net Area: 11 Ha

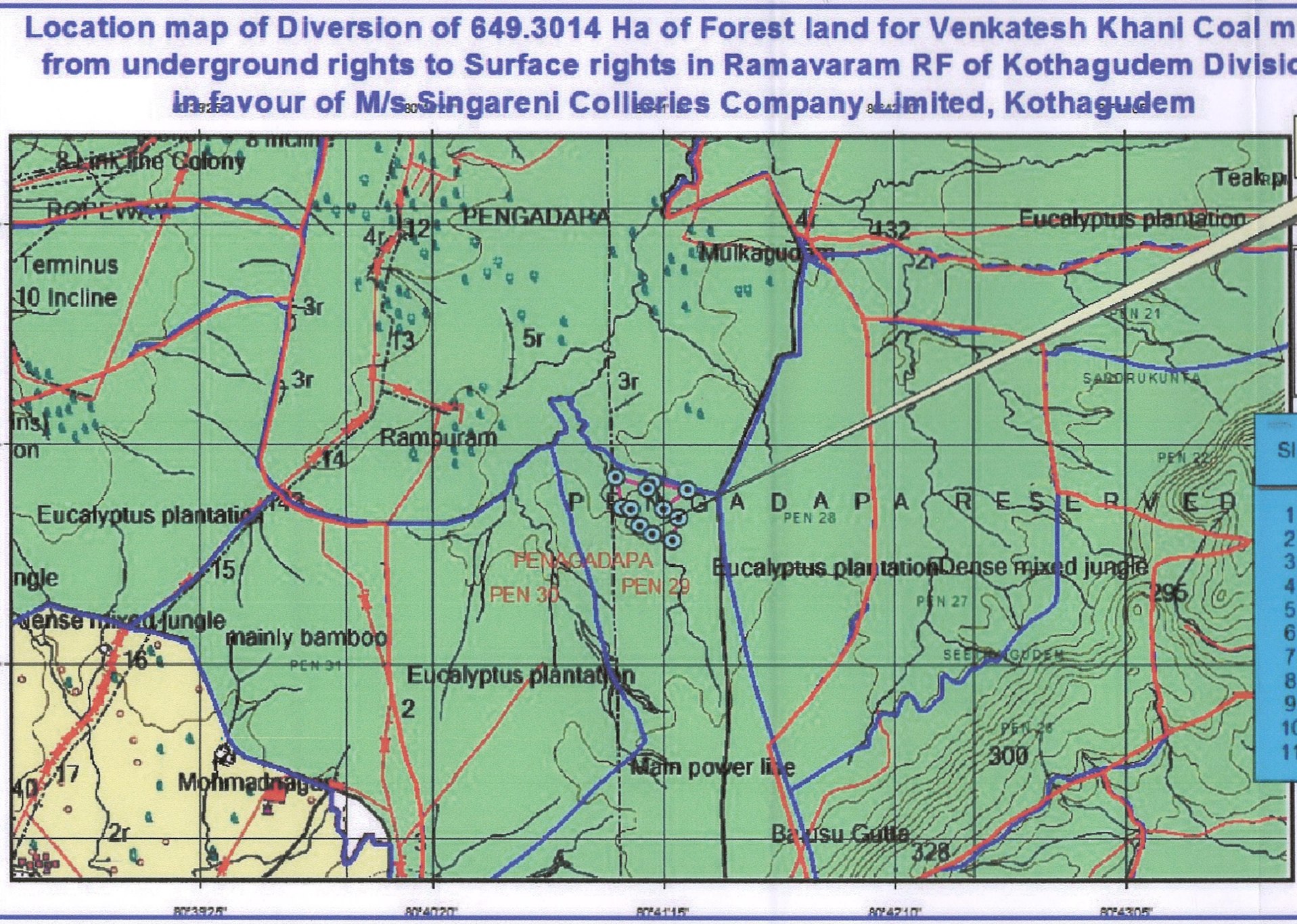



| Sl.No | Latitude | Longitude |
|---|---|---|
| 1 | 17.43648 | 80.68816 |
| 2 | 17.43800 | 80.68856 |
| 3 | 17.43856 | 80.68760 |
| 4 | 17.43984 | 80.68916 |
| 5 | 17.44032 | 80.68688 |
| 6 | 17.43996 | 80.68652 |
| 7 | 17.44068 | 80.68444 |
| 8 | 17.43864 | 80.68480 |
| 9 | 17.43856 | 80.68544 |
| 10 | 17.43752 | 80.68600 |
| 11 | 17.43696 | 80.68688 |

Area

FOREST DIVISIONAL OFFICER
Kothagudem.

# Location map of Diversion of 649.3014 Ha of Forest land for Venkatesh Khani Coal mine from underground rights to Surface rights in Ramavaram RF of Kothagudem Division in favour of M/s Singareni Collieries Company Limited, Kothagudem




FOREST DIVISIONAL OFFICER
Kothagudem.