RS-GIS

Land-use mapping and change detection in Parsa East & Kanta Basan (PEKB) Coal Block in Chhattisgarh

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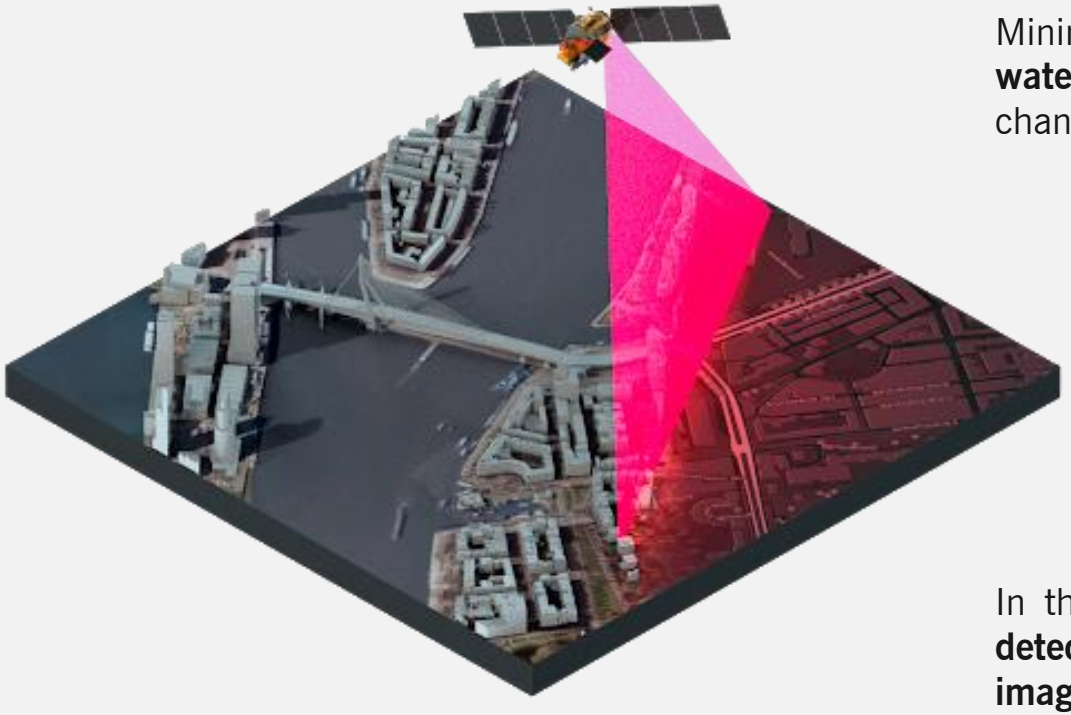
Natural Resources

Introduction



Mining industry is associated with significant **environmental challenges** related to **air, water** and **ground surface**. These include subsidence of ground, deformations, seismicity, changes in water relations, soil erosion, noise pollution and emissions of gases and dust.

It is important to monitor and assess such conflicts for managing land and policy making. In this regard the **remote sensing (RS)** and **Geographical Information System (GIS)** have immense potential in serving as useful tools.

In this background it was decided to carry out **Land Use Land Cover (LULC) change detection study** over the period **2011** (pre-mining) to **2016** through the help of **satellite imageries** for the **Parsa East and Kanta Basan (PEKB) coal block**.

Location

Parsa East and Kanta Basan

Coalfield: Hasdeo-Arand

District: Surguja

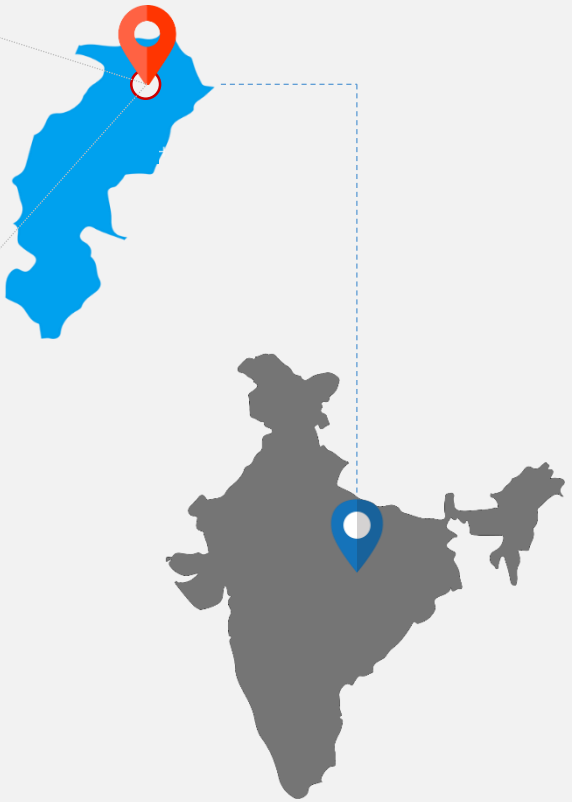
Latitude: 22°47'39" & 22°51'12"N

Longitude: 82°46'38" & 82°50'51"E

Area: 2711.034 Ha

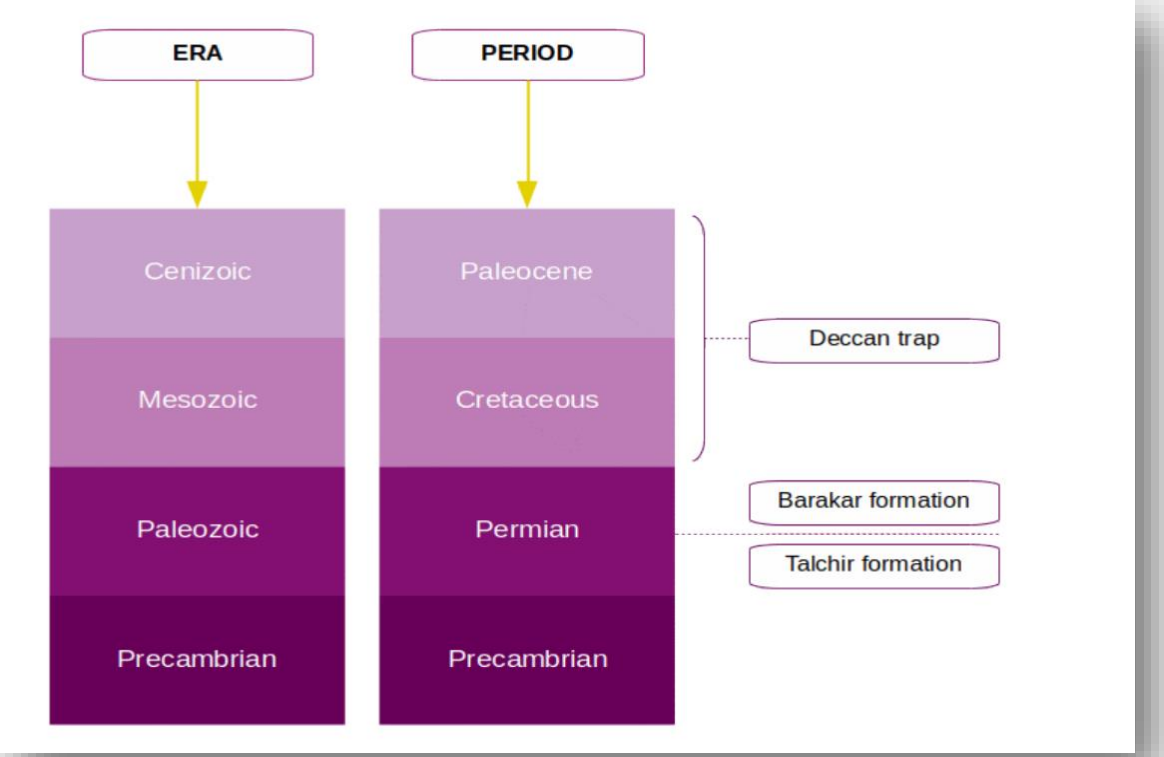
Stretch: 6 km along strike direction (NW-SE) and about 4.6 km along dip direction (SW)

PEKB Coal Block



Geology

- The coal formations within the **core zone** mainly belong to **Barakar formation** of **Gondwana Group**
- The coalfield is traversed by several generally **NW-SE** and **NE-SW** trending faults of varying magnitudes with a lateral extent of about **2 to 8-km**



Coal Reserves

S. No.	Parameters	Values
1.	Number of seams	Seam IV, Seam V, Seam VI
2.	Strike length	6.6 Km
3.	Total mineable reserve	452.46 MT
4.	Stripping ratio	5.16 m3/T

"**Seam IV** is the most potential both qualitatively and quantitatively and has least number of in-seam dirt bands followed by Seam-VI and V"

Topography

Core Zone

Topography: Highly undulating with several mounds as well as elevated and flat land.

50% (approx.) of the core zone is covered by **Matringa** and **Phatepur protected forest** area.

The mine pit is located in the northern part which is under **active mining** covered with dumps of **overburden material and coal**.

Buffer Zone

Topography: Mostly undulated terrain exhibiting hills, hill remnants, valley and plains.

About **70%** of the buffer zone is covered by **reserved and protected forests.**

Elevation of the buffer zone varies from **339m – 976m** above MSL.

Drainage

Drainage of the lease area is controlled by **Atem Nadi** which is **2 km** from Northern boundary of the block. A seasonal nala namely **Parsa nala** flows on the South eastern part of the block and discharge its water into Atem Nadi.

Methodology

Iterative Self Organizing Data Analysis Techniques (ISODATA) clustering method was used to perform unsupervised classification using **ERDAS** Software.

To better understand the **impact of mining** on various **environmental parameters** and **socio-economic transformation** brought about **by mining** in its immediate vicinity**, LULC change** was studied **at core and buffer zone**, where detailed studies were conducted using **high resolution satellite data** supported by **field surveys**.

Classification used for studies:

- Dense Green Forest
- Green Cover
- Agricultural Land
- Fallow Land
- Open Scrub
- Water Bodies
- Plantation
- Mining Area
- Build-up Area

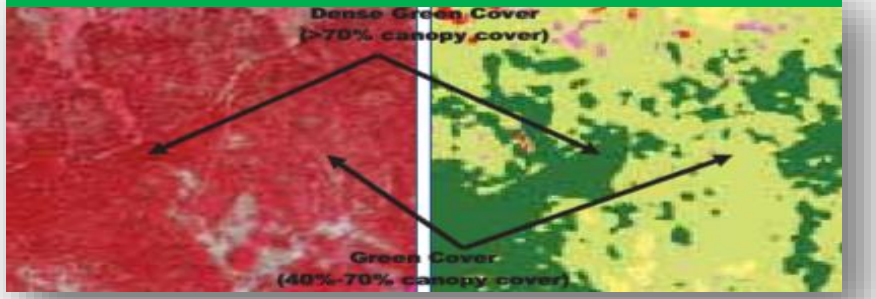
Dense Green Forest

- covers all lands with **tree cover** of canopy **density** of **70% and above.**
- are characterized on **FCC satellite imagery** by a **deep red color** and a **compact and coarse texture.**

Green Cover

- covers all lands with **tree cover** of canopy **density** between **70% and 40%.**
- are characterized on **FCC satellite imagery** by **irregularly spaced open areas in between the canopy.**

Dense Green Forest & Green Cover

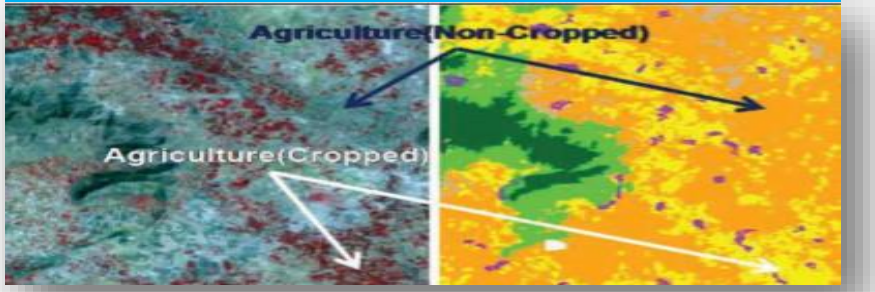


Satellite image Classified image

Agricultural Land

- covers land which has been **cropped at least once in a year – Rabi, Kharif or both**.
- are easily recognizable on **False Color Composite (FCC)** by **their light red or pinkish tone with a distinctive non-contiguous pattern** and **regular rectangular/polygonal outline shape.**

Agricultural Land

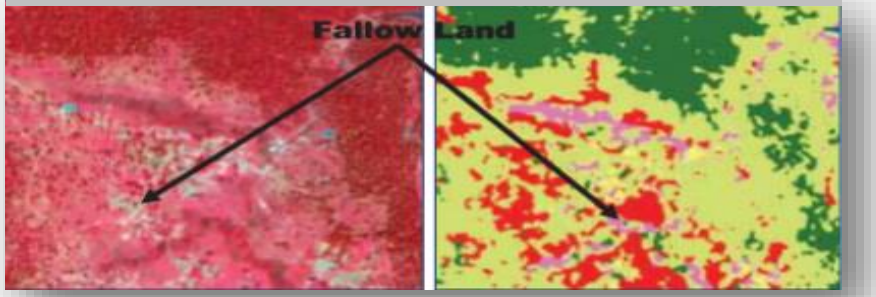


Satellite image Classified image

Fallow Land

- area where cropping is not observed in either Rabi or Kharif season
- are characterized on **FCC by light/dark greenish or grayish tone** with **non-contiguous pattern** and **regular rectangular** or **polygonal outline shape**

Fallow Land



Satellite image Classified image

Open Scrub

- comprises of both scrub land (areas with sparse vegetation) as well as open land (areas devoid of any vegetation
- are characterized by **very light red or pinkish tone on satellite imagery**

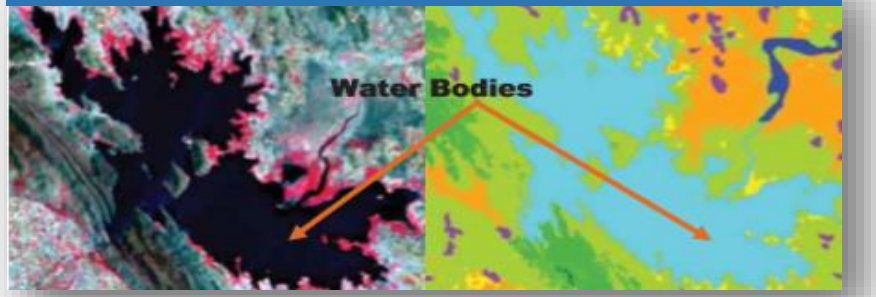
Open Scrub

Satellite image Classified image

Water Bodies

- comprised of **surface drainage** features such **as nala, rivers** as well as **water bodies such as lakes, ponds, reservoirs,** etc.
- can be interpreted **on FCC imagery by its black or dark blue/gray tone** and varied specific shapes

Water Bodies



Satellite image Classified image

Plantation

- On satellite images, these appear to have a pattern **similar to agriculture,** but have **a coarser texture**
- definite **row pattern, darker tone** and have a **bigger size** as **compared to croplands**.

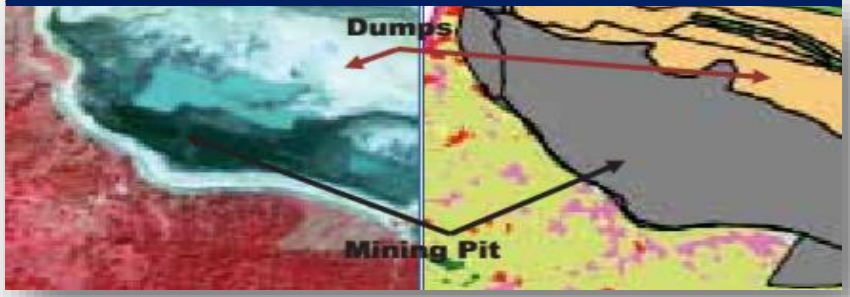
Plantation

Satellite image Classified image

Mining Area (Pits & Dumps)

- includes all **mining pits (opencast mining areas)** and **overburden dumps**
- are recognized on **FCC satellite imageries by bright (white /brownish yellow**) exposed areas, which appear as **excavated terraced depression.**

Mining Area (Pits & Dumps)

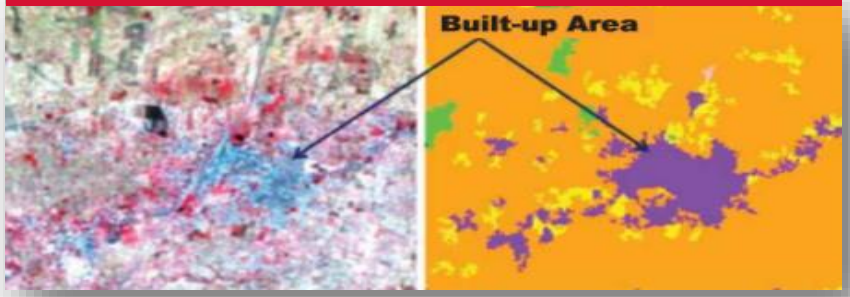


Satellite image Classified image

Build-up Area

- includes all the **man-made construction** features like **industrial** and **commercial buildings, offices, factories, houses, etc**.
- can be interpreted **on the FCC satellite imagery** by a **deep cyan/light cyan color, coarse to medium texture** and **varied shapes and sizes**

Build-up Area



Satellite image Classified image

Data Source

Primary Data

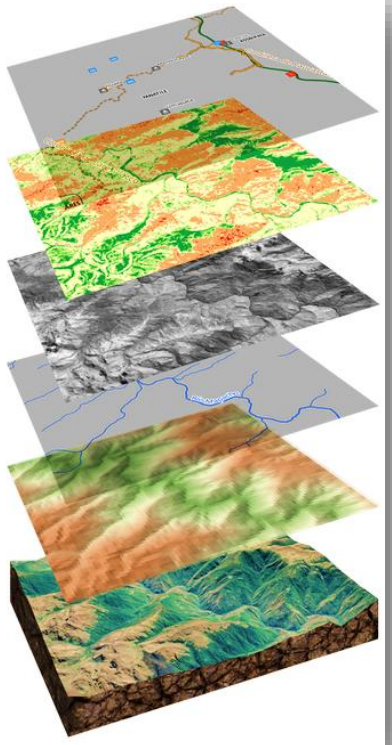
Raw satellite data, obtained from **National Remote Sensing Centre (NRSC)**, **Hyderabad**, was used as primary data source for the study.

Satellite	Sensor	Data of Pass	Path	Row	No. of Bands
CARTOSAT-1 (IRS-P5)	PAF	24-12-2016	0561	291	1
	PAF	03-04-2011	0561	291	1
	PAF	11-11-2011	0560	291	1
	PAF	24-11-2016	0560	291	1
IRS-P6-LISS-IV MX	L4FX	26-10-2011	102	056	3
	L4FX	23-10-2016	102	056	3
	L4FX	11-01-2012	103	056	3
	L4FX	10-12-2016	102	056	3

Secondary Data

> **Secondary (ancillary) and ground data** constitute important baseline information in remote sensing, as they improve the interpretation accuracy and reliability of remotely sensed data by enabling verification of the interpreted details and by supplementing it with the information that cannot be obtained directly from the remotely sensed data.

Different layers



Other layers

Thematic layers

Space & aerial imagery

Hydrography

Digital terrain model

Real World

1. Geometric correction, rectification and geo-referencing
2. Image enhancement
3. Training set selection
4. Signature generation and classification
5. Creation/overlay of vector database
6. Validation of classified image
7. Layer wise theme extraction using GIS
8. Final vegetation map preparation

Platform	Sensor	Spectral Bands (um)	Radiometric Resolution	Spatial Resolution	Temporal Resolution	Country
IRS-R2	L4FX	B2 0.52-0.59 Green B3 0.60-0.68 Red B4 0.77-0.86 NIR	16-bit (256- grey levels)	5.8m	24 days	India

Satellite used in this study

Land Use/ Land Cover Mapping

Core Zone	Study for 2011 (pre-mining status), 2016 and 2018 (present status)							
LULC Classes	**Area (Ha)**				**%age difference (2011-2016)**	**Area Ha**		**%age difference (2016-2018)**
	2011	**%**	**2016**	**%**		**2018**	**%**	
Dense Green Cover	692.10	25.1	659	23.9	-1.2	-	-	-
Green Cover	1464.91	53.2	1101.15	40	-13.2	451.97	16.28	-23.72
Agricultural Land	374.88	13.6	323.62	11.8	-1.8	106.57	3.84	-7.96
Fallow Land	74.15	2.7	0.0	0.0	-2.7	182.36	6.57	6.57
Open Scrub	118.88	4.3	83.63	3.0	-1.3	484.62	17.45	14.45
Plantation	0.0	0.0	28.38	1.0	+1.0	42.85	1.54	0.54
Mining Area	0.0	0.0	502.20	18.2	+18.2	650.35	23.43	5.23
Build-Up Area	0.0	0.0	49.12	1.8	+1.8	75.09	2.7	0.9
Water Bodies	27.89	1.0	5.7	0.2	-0.8	45.89	1.65	1.45
Total	**2752.81**		**2752.80**			**2039.7**		

About **42.82%** of the **core zone** is covered with **forest area** under various density categories and **10.41%** under **cultivation** and **24.96%** under **Mining area**.

2018

28.38 hectares of the mined-out area has been **reclaimed** and there of plantation has been carried out till October 2016

2016

Land Use/ Land Cover Mapping

Core and Buffer Zone	Study for 2011 (pre-mining status) and 2016					Buffer Zone (2018)	
LULC Classes	**Area (Ha)**				**Difference**	**Area (Ha)**	
	2011	**%**	**2016**	**%**	**(%)**	**2018**	**%**
Dense Green Cover	26726.93	47.84	26294.55	47.07	-0.77	-	-
Green Cover	19439.05	34.80	19334.41	34.61	-0.19	18299.37	33.19
Agricultural Land	5360.02	9.59	7704.58	13.79	+4.20	4492.49	8.15
Fallow Land	2465.48	4.41	0	0.0	-4.41	2796.44	5.07
Open Scrub	1255.54	2.25	1342.61	2.41	+0.16	4950.05	8.98
Plantation	0	0.0	28.56	0.05	+0.05	42.85	0.08
Mining Area	0	0.0	502.26	0.90	+0.90	667.17	1.21
Build-Up Area	0	0.0	76.64	0.14	+0.14	449.98	0.82
Water Bodies	615.87	1.10	579.3	1.04	-0.06	1466.16	2.66
Total	**55862.90**		**55862.90**			-	

73% of the **buffer zone** is covered with **Reserved and Protected Forest** area under various density categories, and **13%** under **agriculture**.

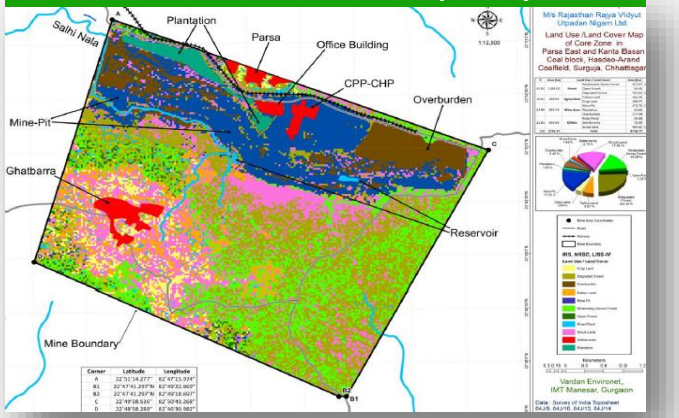
2018

Major changes in land use have occurred in **fallow land (4.41 %), agricultural land (+ 4.20%)**, **mining area (+ 0.90%)** and **dense green cover (0.77%).**

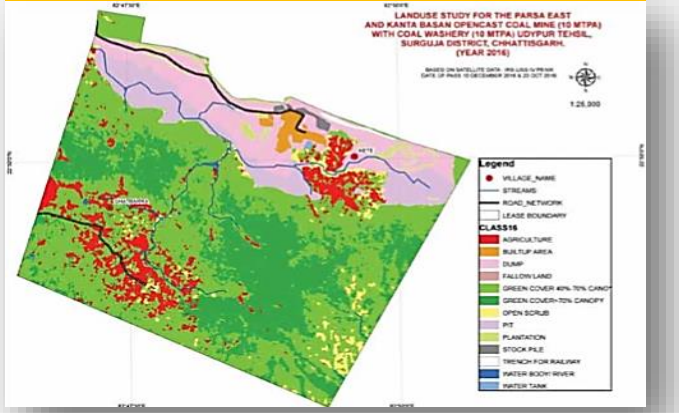
Compared to **2011** (pre-mining), **agriculture** in the study area in 2016 has **increased** significantly by **4.20%** (an increase of approx**. 2,344 ha**)

2011 -

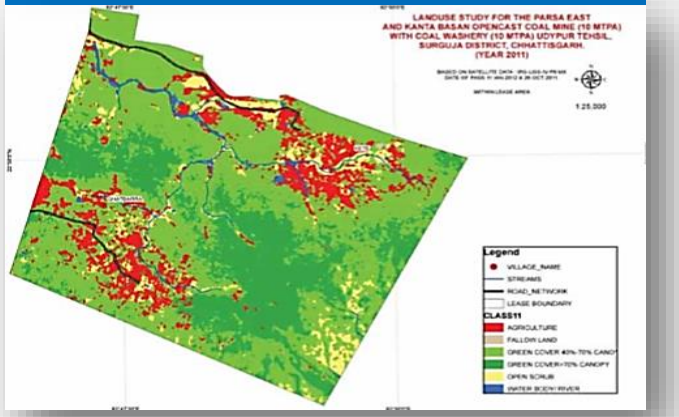
Land Use status of core zone (2018)



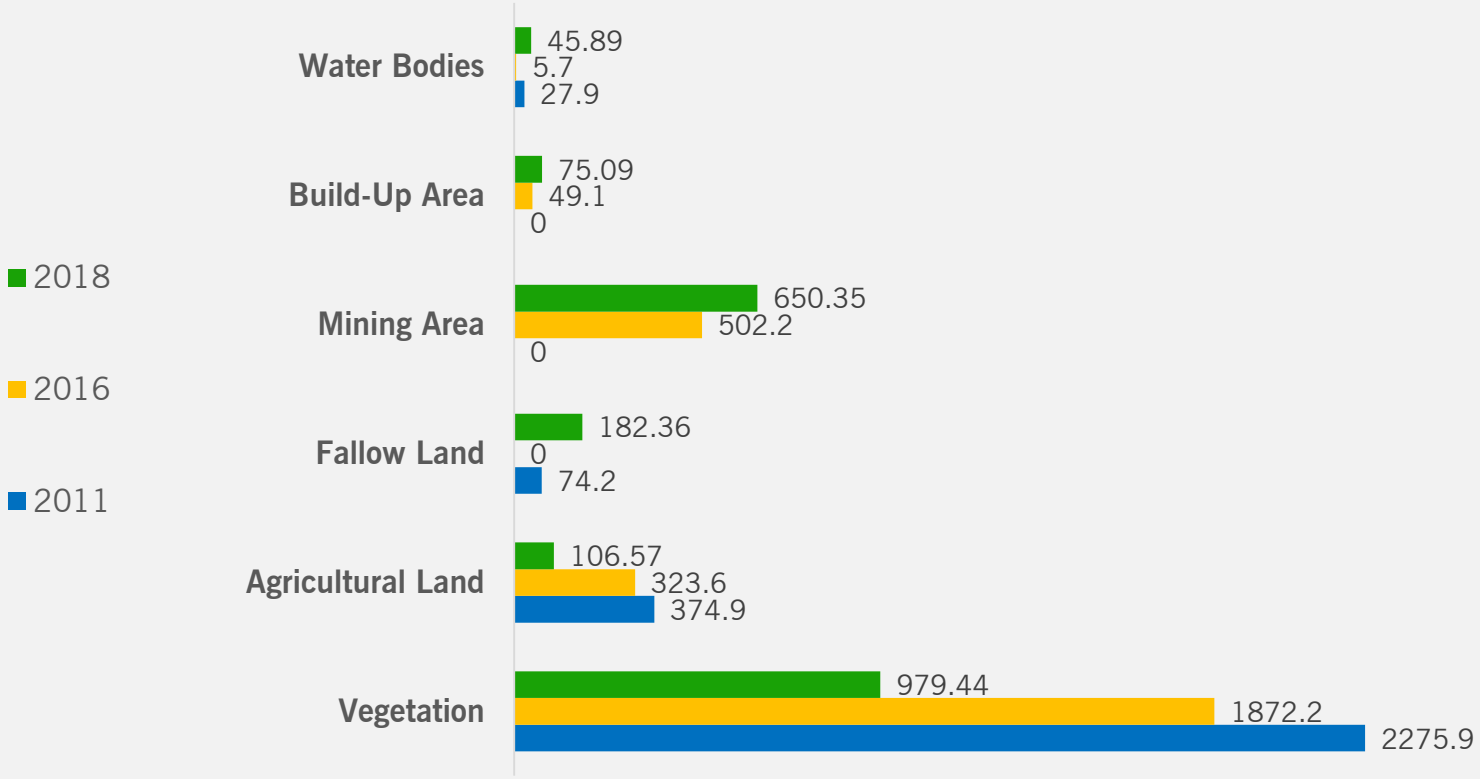
Land Use status of core zone (2016)



Land Use status of core zone (2011)



Land use cover distribution of **core zone** in **PEKB coal block** during **2018**, **2016** and **2011.**



Vegetation in the graph includes the **dense green cover**, **green cover, open scrub** and **plantation areas**.

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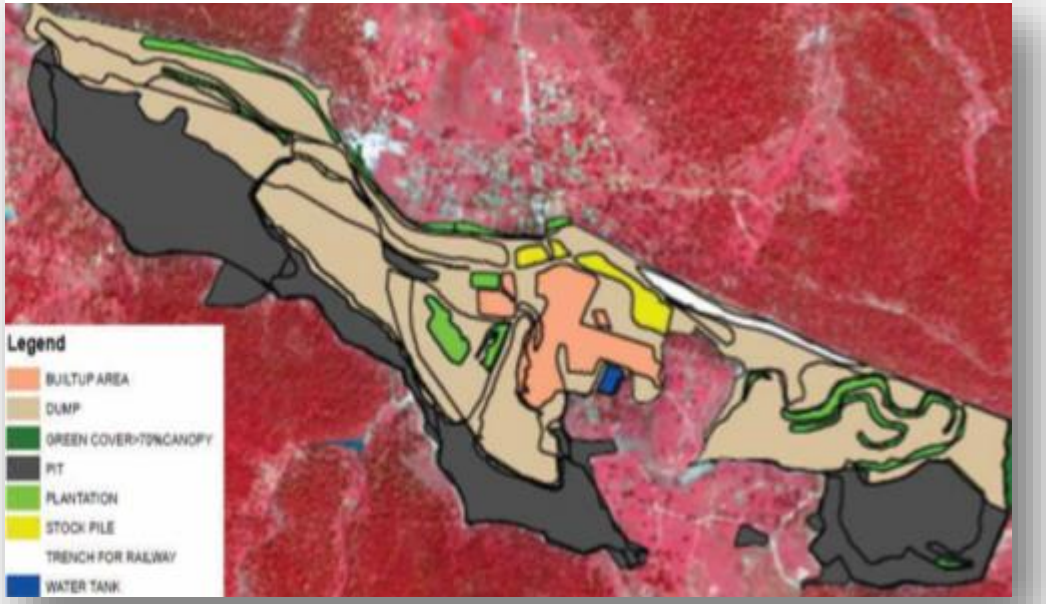
Encouraging to note that within a short span of **4 years** (since mining commenced in **February 2013**), **28.38 hectares** of the mined-out area has been **reclaimed**.

2011 -

Plantation in mine area highlighted in green



Tree transplanter at mine

Transplanted tree at mine

By the end of **FY 2019-20**, plantation in the mine has **increased to 206.71 Ha**.

During the period **2012-20**, the mine has **planted more than 4.93 Lakh saplings. E**stablishment of **nursery** has been done.

Tree-transplanter uses an unique **root-ball**, **frame** and **crane technique** to **uproot** a tree along-with its root and then moves it to the desired location and **plants the tree**.

As on **2020**, approximately **8,145 trees** (of **girth less than 60cm**) have been **transplanted** in the mined-out **reclaimed area and safety zone**.

Major Species Planted

It is a significant achievement in the sense that the mining area comprises of Sal forests and such efforts have helped greatly in afforestation of the native species.

Shorea robusta- **19,710**

Bambusa Vulgaris- **71,870**

Senegalia catechu- **23,613**

Tectona grandis- **25,498**

Dalbergia sissoo -**10,883**

Terminalia arjuna -**23,929**

Dalbergia sp- **1,38,773**

Pongamia pinnata -**17,185**

Syzygium cumini- **20,638**

Gmelina arborea- **20,876**

Terminalia Elliptica- **10,862**

Azadirachata Indica -**14,494**

Pterocarpus marsupium -**25,354**

Mangifera indica **9,461**

DRONE IMAGES SHOWING RECLAMATION IN PARSA EAST & KANTA BASAN OPENCAST COAL MINE PROJECT

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Conclusions:

1. Mining results in important alterations within land use/land cover (LU/LC) change mainly **due to its impact on the forests**.

2. About **42.82%** of the **core zone** is covered with **forest area** under various density categories and **10.41%** under **cultivation** and **24.96%** under **Mining area**.

3. About **73.04 %** of the **buffer zone** is covered by **reserved and protected forests** of various categories, about **13.22 %** of the area by **agriculture activities.**

4. **9 major classes** with **10 iterations** were selected: **Dense Green Cover, Green Cover , Agricultural Land, Fallow Land, Open Scrub, Water Bodies, Plantation, Mining Area** (pit and dumps) and **Built-up Area** (Infrastructure such as coal washery, office, railway trench, etc.).

5. Compared to **2011** (pre-mining), **agriculture** in the study area in **2018** has **increased significantly.**

6. As on **2020**, approximately **8,145 trees (of girth less than 60cm)** have been **transplanted** in the mined-out reclaimed area and safety zone.

7. As on **2020**, approximately **more than 4.93 Lakh saplings** have been **planted** in the mined-out reclaimed area and safety zone.