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Vegetation and Its Phenology of Degraded Land Area of Lodna Coal Mines of Jharia, Jharkhand

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Abstract: *Lodna area is one of the twelve operational areas of BCCL (Bharat Coking Coal Limited) situated in Dhanbad Sadar subdivision of Dhanbad district in the state of Jharkhand, India. Vegetation of Lodna is is subjected to disturbance due to the presence of coal mines. This results in a slowing of the rate of biomass growth, which is caused by fading of vegetation.*
In the present investigation the vegetation of degraded land area of Lodna and its phonological trend was studied. The results revealed the presence of 49 species of flowering plants that included under 40 genera and 22 families. Caesalpiniaceae was dominant family in Lodna coal mine area. the plant species collected from degraded land area of Lodna Coal Mines exhibited different biological clocks in different seasons. There are several driving variables such as photoperiods, soil water, soil temperature, atmospheric temperature which determines the phonological development of different plant species around the Lodna coal mines area.
Key Words: *Lodna Coal Mines, Vegetation, Phenology, Degraded land*

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I. Introduction

Lodna area is one of the twelve operational areas of BCCL (Bharat Coking Coal Limited) situated in Dhanbad Sadar subdivision of Dhanbad district in the state of Jharkhand, India. Geographically this area is located at 23.72011^{0}N 86.41059^{0}E and is situated in the central area of Jharia coalfield. Geographical location of Jharia is represented by a Google Map.

Collieries in the Lodna and Eastern Jharia Areas of BCCL
U: Undergroud colliery, O: Open Cast colliery, M: Mixed colliery, W: Washery, F: Facility, A: Administrative headquarters
Owing to space constraints in the small map, the actual locations in a larger map may vary slightly

Google Map of Jharia (Jharkhand)

Vegetation is an important part of the environment and is subjected to disturbance in areas close to coal mines. This results in a slowing of the rate of biomass growth, which is caused by fading of vegetation. Simultaneously, carbon stored in vegetation is constantly released, weakening vegetation ability to act as a carbon sink. The factors that severely affect vegetation can be divided into: natural factors; human surface activities; and coal mining,with each of these directly reflected in the spatial and temporal variation of the Normalized Difference

Vegetation Index (NDVI) (Yi Huang *et al*., (2015) [1].

Mining activity exerts a long lasting impact on landscape, eco-system and socio-cultural-economic considerations. The actual land mass available to mankind is about 30% of total global surface area. India's land area is about 2-3% of the global land area, where as it supports more than 16% of the global population. This important statistics reveals that the poor per capita land holding stands at 0.32 hectares, which calls for due attention to restoration/reclamation of land after mining in order to utilize the land for useful purpose. Mining and its subsequent activities have been found to degrade the land to a significant extent. Overburden removal from the mine area results in a very significant loss of rain forest and the rich top soil. Overburden removal is normally done by the process of blasting or using excavators, which results in generation of large volume of waste (soil, debris and other material). This is useless for the industry and is normally just stored in big piles within the mine lease area, and sometimes, on public land. The bigger the scale of the mine, greater is the quantum of waste generated. Opencast mines are therefore more pollution intensive as they generate much higher quantities of waste compared to the underground mines. Open-pit mines produce 8 to 10 times as much waste as underground mines (Anon, 2006) [2].

Coal mining seriously jeopardizes the ecological environment of the mining area, with the potential to cause a variety of impacts including surface subsidence, land desertification, soil degradation, surface and groundwater pollution, vegetation destruction, ecosystem degradation, undermined biodiversity, landscape damage and crop failures (Fan *et al*., 2003) [3]. These impacts may directly or indirectly affect and harm growth of the mining vegetation. This can lead to damaged vegetation releasing substantial carbon to the atmosphere, which further weakens the overall carbon sink effect of the vegetation and increases the environmental impact of coal mining. Many quantitative studies on carbon emissions, the global carbon cycle or the low-carbon economy focus on the carbon release mechanism during the use of carbon resources. However, there have been fewer studies focused on the environmental damage from the process of coal mining which also releases considerable carbon to the atmosphere and is a key component of anthropogenic greenhouse gases. A large amount of carbon is fixed in the vegetation in the mine area. Vegetation is therefore not only one of the key factors to consider during the analysis and evaluation of the ecological environment in the mining area, but also crucial to maintaining the environmental stability and carbon sequestration ability of the mining area.

In recent years 3S (GIS, GPS, RS) technology has been applied as studies that analyze the impact on vegetation in mining areas owing to mining activities have evolved, as the following paragraph details. The Normalized Difference Vegetation Index (NDVI) and unary linear regression were applied to analyze the dynamic variation of vegetation cover and land desertification (Wu *et al*., 2009) [4]. The cumulative effect on the ecological environment in mining areas was analyzed by clarifying interactions between mining area development and ecosystems, such as vegetation (Wang *et al*., 2010) [5].

The ratio of overburden excavated to the amount of mineral removed is called the stripping ratio. For example a stripping ratio of 4:1 means that 4 tons of waste rock are removed to extract one ton of ore. Lower the ratio, the more productive the mine. Stripping ratio varies with the area under mining.

The coal mines of Coal India Limited (CIL) removed about 500 million cubic meters (Mcum) of overburden (OB) to produce 260 MT of coal in 2003-04 at an average stripping ratio of 1.92 m^3 of OB against per ton of coal production (Sanyal, 2006) [6]. As demand for coal increases to meet the country's energy requirement, the coal companies are digging deeper and deeper and even opting for lower grades of coal. The country is even planning for production from 300 m depths at stripping ratio of 1:15 for D and F grade quality of coal. If these mines were operational, it would mean that even if 1 million tons of coal were extracted, it would generate 15 million tons of waste material. This is huge quantity and in a country like India where land is at premium, it would be very difficult to find enough land to store this waste.

The coal mining can influence the carbon sink effect of vegetation directly and indirectly. This complicates the process of calculating the biomass and carbon loss of vegetation owing to coal mining and quantifying the change in carbon sequestration of vegetation in the mining area. Several workers studied the variation of net primary productivity (NPP) of vegetation in mining areas and employed the remote sensing Carnegie–Ames–Stanford approach (CASA) model and eco-environmental parameters to analyze the eco-environment conditions (Xu *et al*., 2012; Hou *et al*., 2012) [7, 8].

The Vegetation cover in Lodna coalfield area (Jharkhand) comprises following five classes: Dense Forest, Open Forest, Scrubs, Plantation on Over Burden (OB) Dumps / Backfilled area, and Social Forestry.

Dense forest: Forest having crown density of above 40% comes in this class. Dense forest over the area is same as in year 2013.. A total dense forest is estimated to be 0.29sq km, i.e. 0.07% of the coalfield area. The area of the dense forest within the coalfield has remained same since 2013.

Open Forest: Forest having crown density between 10% to 40% comes under this class. Open forest cover over Jharia coalfield which was estimated to be 8.51 sq km (2,16%) in 2013 has marginally decreased to 6.27 sq km, i.e. 1.60 % of the coalfield area. Thus the area reduced is 2.24 sq km which is 0.56 % of the total coalfield area. This reduction is due to deforestation by local inhabitants.

Scrubs: Scrubs are vegetation with crown density less than 10%. Scrubs in the coalfield are seen to be scattered signature all over the area mixed with wastelands. There is 105.87 sq km, of scrubs, ie 26.95% of the coalfield area. In year 2013 the scrubs covered 122.50 sq km which were 31.20% of the coalfield area. There is a decrease of 16.63 sq km which is 4.25% of the coalfield area .The decrease is due to increase in mining areas and conversion of underground mine into open cast ones & also increase in agricultural land and waste land.

Social Forestry: Plantation which has been carried out on wastelands, along the roadsides and colonies on green belt come under this category. Analysis of data reveals Social Forestry covers 19.52 sq km, which is 4.97% of the coalfield area. In 2013 the area covered under social forestry was 19.41 sq km (4.94%). there is an increase of 0.11 sq km (0.03%). This increase is due to creation of some ecological restoration sites.

Plantation over OB Dump and backfilled area: Analysis of the data reveals that BCCL has carried out significant plantation on OB dumps as well as backfilled areas during the period for maintaining the ecological balance of the area. The plantation on the OB dumps and backfilled areas are estimated to be 8.59 sq km, i.e. 2.19% of the coalfield area. In year 2013 the plantation on OB Dumps were estimated to cover an area of 11.94 sq km which was 3.04% of the coalfield area. There is a decrease of 3.35 sq km (0.85%) in plantation over OB dumps. This is due to increase in mining activity & conversion of UG mines into OC mines.

Agricultural Land:

Land primarily used for farming and production of food, fiber and other commercial and horticultural crops falls under this category. It includes crop land (irrigated and unirrigated) and fallow land (land used for cultivation, but temporarily allowed to rest). Total agricultural land is 44.39 sq km in year 2016, which is 11.31 % of the coalfield area in year 2013 the total agricultural area was estimated to be 39.79 sq km which was 10.12% of the coalfield area. There is an increase on 4.60 sq km which is 1.19% of the coalfield area.

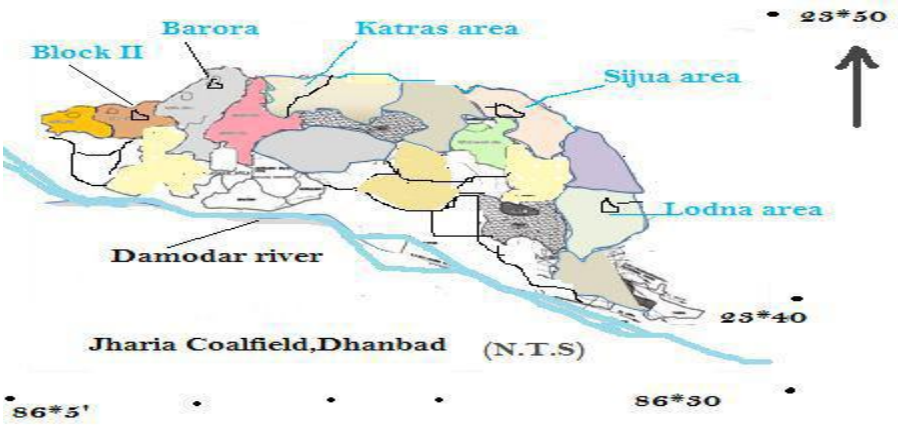
Surface mining not only destroys the existing land use pattern, air quality, water quality and vegetation but there is also a loss of topsoil in pedagogical or a biological sense. In addition, flora and fauna along with its hydrological relations are also drastically disturbed due to open-cast mining operations.

The aim of the present work is to study the vegetation and phenology in the degraded land areas of Lodna coal mines, Jharia (Jharkhand).

II. Materials and Methods

Study area

The Jharia Coalfields (JCF) is one of the Lower Gondwana coalfields of India, covering an area of about 72 km^2. It is one of the most important coalfields in India, located in Dhanbad district, between latitude 23° 39' to 23° 48' N and longitude 86° 11' to 86° 27' E. This sickle shaped coalfields is about 40 km in length and approximately 12 km in width stretches from West to East and finally turns southward covering an area of about 450 sq.km. Jharia coalfield (Jharkhand) is the single source of coking coal for prime quality in India. The coalfield has been a centre of coal mining activity for more than a century. The average maximum temperature recorded during April and May is about 37^0C - 41^0C. The average minimum temperature is about 7^0C-10^0C recorded usually during the months of December and January.



Map of study area (Jharia Coal field)

The present study was conducted at Lodna coal mines of Jharkhand from January to December 2018. Harvest method was employed for the determination of frequency, density, abundance and biomass of plant species. Plants were harvested 1 cm above the ground surface, packed in polythene bags separately and brought to laboratory for determination of density, frequency and abundance of plant species. Phenology of each plant species was recorded at bimonthly intervals from January 2018 to December 2018 by visiting the study sites at periodic intervals.

The phenology of the constituent species encountered at the study sites were marked by using different notations for different phenological stages of the life-cycle as follows:

Phenological stage	**Symbol used**
Germination	Ger
Vegetative	Veg
Flowering	Flr
Fruiting	Frt
Mature seeds	Msd
Death	Dth

The plants collected near the Lodna Coal Mines (Jharia), the family to which they belong and uses have been presented in Table-1. The phenology of different plant species recorded is illustrated in Table-2.

Table-1: Plants surveyed in the Lodna Coal Mines area

Scientific name	Local name	Family	Uses
Anacardium occidentale	Caju	Anacardiaceae	The kidney-shaped nut is the commercial cashew nut " kaju" which is edible and much prized all over the world. The fleshy-orange red „apple" is juice, rich in vitamin C and alcoholic, and makes a beverage called „feni"
Moringa olerifera	Munga	Moringanaceae	The leaves, flowers and young fruits are eaten as a vegetable. The seeds yield an oil similar to ben oil, the product of an African species of *Moringa*. The wood is spongy, perishable and useless. Root are used in medicine.
Butea monosperma	Palas	Fabaceae	Dyes prepared from dried petals. The tree is ornamental only when in flower. It is valuable host for the lac insect. Leaves are harvested for fodder for elephants and also used as wrappers for bidis. It is useful for afforestation of saline region.
Dalbergia sissoo	Shisham	Fabaceae	It is timber valuable timber tree after teak. It is hard, heavy, brown in colour with darker streaks. It is also used for spokes of wheels, carts, boats. Prevent skin diseases.
Dalbergia latiffolia	Satsar	Fabaceae	It is very much valued as timber plant.
Cassia fistula	Amaltas	Caesalpiniaceae	It is ornamental tree. The timber is hard and durable. The bark is used for tanning. The timber is used for house posts, agricultural implements and tool handles. The pulp is an ingredient of spiced Indian tobacco.

Saraca asoka	Ashoka	Caesalpiniaceae	The seeds are chewed as a substitute for betel nut. Timber is used for house building and ploughs. Buddha was born under an Ashoka tree, hence it is secred to Budhists. Flowers used in dysentery. Decoction of bark is used in uterine infection.
Tamarindus indica	Imli	Caesalpiniaceae	The pulp from the pods is used for seasonal curries, chutneys and ice –cream.Pulp is pressed, preserved and sold by weight in markets. Leaves and flowers are also edible. It is valuable timber and fuel; it was major fuel for producer- gas {gasogen} units that powered Indian trucks during Word War 2.
Delonix regia	Gulmohar	Caesalpiniaceae	It is an ornamental trees, throughout the warmer parts of India and in all tropical countries. One of the most beautiful trees when in full bloom.
Peltophorum pterocarpum	Copperpod	Caesalpiniaceae	It is an ornamental trees. Planted in road- side trees and also in gardens. The timber is used for making cabinets.
Poinciana pulcherima L.	Krishna chura	Caesalpiniaceae	It is ornamental trees. The flower is used as remedy in cases of intestinal worms. The leaves have a purgative action and also abortifacient.
Poinciana pulcherima L.	Radhachura	Caesalpiniaceae	It is ornamental trees. The flower is used as remedy in cases of intestinal worms. The leaves have a purgative action and also abortifacient.
Pithecellobium dulce	Jungle jilebi	Mimosaceae	Often cultivated as a hedge plant. An escape from in waste places, road- sides. Fruit edible.
Samanea saman	Rain tree	Mimosaceae	The fruit is fleshy pod and sweet to taste. It help in restant from wind. The sweet pulp of pods is readily eaten by cattle and horses. Seeds are generally undigestible. The pods fed to cows are believed to increases the quantity of milk.
Terminalia arjuna	Arjun	Combretaceae	An excellent shade tree and often planted on road sides. The bark is used in native medicine as a tonic and astringent. It is also used for tanning for which purpose the outer bark is best. It is carefully removed no injury is done to the tree. Leaves are fed to silkworms. The wood is used in building and in boats.
Terminalia tomentosa	Asan	Combretaceae	The timber is very useful and has been largely cut for sleepers.
Syzygium cumini	Jamun	Myrtaceae	It is used for shade- tree in parks. The wood is hard and durable and used as fuel and for making agricultural implements. The bark is astringent and is used in the form of decoction for mouth wash and gargle. Fresh bark juice mixed with goat"s milk is used to cure the diarrhoea of children. Leaves are used as fodder. Its fruit is also used in the preparation of wine and vinegar.
Callistemon lenceolata	Bottle brush	Myrtaceae	It is ornamental tree.
Lagerstromia speciosa	Jarul	Lythraceae	It is an ornamental tree. It used for boat building and furniture.
Punica granatum	Anar	Punicaceae	It is edible juicy seeds. Peels from the fruits used in diarrhoea and dysentery. The juice of its fruit help to reduce the risk of strokes heart diseases and heart attacks.
Anthocephalus cheninsis	Kadam	Rubiaceae	Its pseudocarp is eaten. The acidic but pleasantly flavoured fruit is relished by monkeys., bats and birds which also help in disseminating its minute seeds. The tree is associated with Lord Krishna and is sacred to the Hindus. The flowers are offered in temples. It is valued for matchwood and ply wood
Mimusops eleng L.	Bakul	Sapotaceae	The fruit is edible. The oil from the flowers is used in perfumery, from the seed in cooking . The wood being very strong is used in bridges and house construction.
Diospyros embryopteris	Gab (Makarkendu])	Ebenaceae	Fruits edible but poor in quality. Viscid pulp of the fruit is used for making fishing nets durable. Bark & rind of the fruits are used in diarrhoea & haemorrhage of internal organs.
Plumeria rubra	Gulanchi	Apocynaceae	Wood used for making drums and other musical instruments. It is ornamental tree.
Plumeria acutifolia	Gulanchi	Apocynaceae	Wood used for making drums and other musical instruments. It is ornamental tree.
Plumeria alba	Gulanchi	Apocynaceae	Wood used for making drums and other musical instruments. It is ornamental tree.

Thevitia peruviana	Pilikaner	Apocynaceae	It is used in cardiac diseases. It is offered to the Lord. Children eat the pulp of ripe fruit.
Alstonia scholaris	Chhatim	Apocynaceae	The soft white wood is used for tea chests, packing cases and match splints. It is very beautiful ornamental tree. The bark of this tree is source of a remedy against malaria, toothache and snake bite. The bark is also used in fever and in skin disease.
Jaccaranda mimosifolia	Jacaranda	Bignoniaceae	It is an ornamental plant. It is a timber tree.
Spathode acampanulata	Fountain tree	Bignoniaceae	It is an ornamental trees. The buds are often used by children who play with its ability to squirt the water.
Tectona grandis	Sagwan	Verbenaceae	The timber uses are well known. The hard knots which develop on trunk and prized for making tobacco pipes. It is widely used for making decks of ships and rightly called ship tree.
Baugainvellia glabra	Kagajphool	Nyctaginaceae	It is used as ornamental purpose.
Ficus bengalensis	Bargad	Moraceae	The leaves are fodder for elephants and camels. The figs provide food for a variety of animal life, including man in times of adversity. The leaves are made into plates. The leaves are used as fodder for goats, buffaloes, camels and elephants The banyan is sacred to the Hindus. It is used for shade.
Ficus religiosa	Pipal	Moraceae	The papal is used almost entirely as a shade tree. Being sacred to Hindus. In the forest it is lopped for feeding goats, buffaloes, elephants and camels.
Ficus virens	Pakar	Moraceae	The young shoots are eaten in curries and as pickles. The tree is much lopped to supply fodder for cattle.
Ficus heterophylla	Bhuidumar	Moraceae	Its fruits are eaten by even by local people.
Ficus hispida	Kat-gular	Moraceae	The young receptacles are used as vegetables. Its fruit are eaten and bark yields fiber.
Ficus racemosa L.	Gular	Moraceae	Its fruits are eaten by even by local people. Leaves are eaten by barking deer.
Artocarpus integrifolia	Kathal	Moraceae	Fruits aromatic sweet and fleshy and is eaten raw. The pulp and the seeds are also cooked. The fruit is relished by elephants.

Table-2: Phenology of constituent species of the study site

Scientific name	Months					
	Jan-Feb	March-April	May-June	July-Aug	Sep-Oct	Nov-Dec
Anacardium occidentale	*G*	*Veg*	*Flr*	*Frt*	*Msd*	*Msd*
Moringa olerifera	*Flr*	*Frt*	*Frt*	*Frt*	*Msd*	*Veg*
Butea monosperma	*Flr*	*Frt*	*Frt*	*Frt*	*Veg*	*Veg*
Dalbergia sissoo	*G*	*Veg*	*Flr*	*Frt*	*Veg*	*Veg*
Dalbergia latiffolia	*G*	*Veg*	*Flr*	*Frt*	*Frt*	*Veg*
Cassia fistula	*veg*	*Veg*	*Flr*	*Flr*	*Frt*	*Msd*
Saraca asoka	*Veg*	*Veg*	*Flr*	*Flr*	*Frt*	*Msd*
Tamarindus indica	*Veg*	*Veg*	*Flr*	*Frt*	*Frt*	*Msd*
Delonix regia	*Veg*	*Veg*	*Flr*	*Frt*	*Frt*	*Msd*
Peltophorum pterocarpum	*Veg*	*Flr*	*Flr*	*Frt*	*Msd*	*Msd*
Poinciana pulcherima L.	*Veg*	*Flr*	*Frt*	*Frt*	*Msd*	*Msd*
Poinciana pulcherima L.	*Veg*	*Flr*	*Flr*	*Frt*	*Frt*	*Msd*
Pithecellobium dulce	*Veg*	*Flr*	*Flr*	*Frt*	*Msd*	*Msd*
Samanea saman	*Veg*	*Flr*	*Flr*	*Frt*	*Msd*	*Msd*

Terminalia arjuna	*Veg*	*Flr*	*Frt*	*Frt*	*Frt*	*Msd*
Terminalia tomentosa	*Veg*	*Flr*	*Frt*	*Frt*	*Frt*	*Msd*
Syzygium cumini	*Veg*	*Veg*	*Flr*	*Frt*	*Frt*	*Msd*
Callistemon lenceolata	*Veg*	*Veg*	*Flr*	*Frt*	*Frt*	*Msd*
Lagerstromia speciosa	*G*	*Veg*	*Veg*	*Flr*	*Frt*	*Msd*
Punica granatum	*G*	*Veg*	*Flr*	*Frt*	*Frt*	*Msd*
Anthocephalus cheninsis	*G*	*Veg*	*Flr*	*Frt*	*Frt*	*Msd*
Mimusops eleng L.	*Veg*	*Flr*	*Flr, Frt*	*Frt*	*Msd*	*G*
Diospyros embryopteris	*Veg*	*Flr*	*Flr*	*Frt*	*Msd*	*G*
Plumeria rubra	*G*	*Flr*	*Flr, Frt*	*Frt*	*Msd*	*Veg*
Plumeria acutifolia	*G*	*Flr*	*Frt*	*Frt*	*Msd*	*Veg*
Plumeria alba	*G*	*Flr*	*Frt*	*Frt*	*Msd*	*Veg*
Thevitia peruviana	*Veg*	*Flr*	*Flr, Frt*	*Frt*	*Msd*	*Msd*
Alstonia scholaris	*Veg*	*Flr*	*Flr, Frt*	*Frt*	*Msd*	*G*
Jaccaranda mimosifolia	*Veg*	*Flr*	*Flr, Frt*	*Frt*	*Msd*	*G*
Spathode acampanulata	*G*	*Veg*	*Flr*	*Flr, Frt*	*Msd*	*Veg*
Tectona grandis	*Veg*	*Flr*	*Flr, Frt*	*Msd*	*Msd*	*Veg*
Baugainvellia glabra	*G*	*Veg*	*Flr, Frt*	*Flr, Frt*	*Msd*	*Veg*
Ficus bengalensis	*Veg*	*Veg*	*Flr*	*Flr, Frt*	*Msd*	*Msd*
Ficus religiosa	*Veg*	*Veg*	*Flr*	*Flr, Frt*	*Msd*	*Msd*
Ficus virens	*Veg*	*Flr*	*Flr, Frt*	*Frt*	*Msd*	*Veg*
Ficus heterophylla	*Veg*	*Flr*	*Flr, Frt*	*Frt*	*Msd*	*Veg*
Ficus hispida	*Veg*	*Flr*	*Flr, Frt*	*Frt*	*Msd*	*Veg*
Ficus racemosa L.	*Veg*	*Flr*	*Frt*	*Frt*	*Msd*	*Msd*
Artocarpus integrifolia	*Veg*	*Flr*	*Frt*	*Frt*	*Msd*	*Msd*

III. Results

Lodna coal mines are one of the most important coal fields of Jharia (Jharkhand) in India. In this degraded land area and 49 species of flowering plants that included under 40 genera and 22 families and were recorded in which Caesalpiniaceae was dominant family in Lodna coal mine area. *Shorea robusta* Garetn.f (Sal, Sakhua) being the state tree of Jharkhand and is a dominant species. A more or less similar flora has also been recorded by Siddique and Sarita Kumar (2016) [9] in Bokaro (Jharkhand).

The phenology of different plant species occurred at degraded land in the Lodna Coal Mines, Jharia at bimonthal intervals from January 2018 to December 2018 has been presented in Table-2. The various phonological events of the plants occurring during life cycle of plants have been represented by the following symbols:

Phenological stage	**Symbols used**
Germination	G
Vegetative growth	V
Flowering growth	F
Fruiting stage	Fr

Mature seeds	S
Death	D

During the month of January-February *Anacardium occidentale, Dalbergia sissoo, D. latifolia, Lagerstromia speciosa, Punica granatum, Anthocephalus cheninsis, Plumaria rubra, Plumaria acutifolia, Plumaria alba, Soathode acampanula and Bougainvillia glabra* exhibited germination and vegetative growth in the month of January-February, and March-April. The flowering started in the month of May-June. Flowering, fruit formation and maturation of seeds occurred from July-December. All the other plant species showed similar phonological order from January-December. Thus, from the result (Table-2) it is evident that the plant species collected from degraded land area of Lodna Coal Mines exhibited different biological clocks in different seasons. There are several driving variables such as photoperiods, soil water, soil temperature, atmospheric temperature which determines the phonological development of different plant species around the Lodna coal mines area.

IV. Discussion

The degree of environmental damage in coal mining areas is high, resulting in significant ecological disturbance. The underground coal resources, vegetation and soil systems are all important carbon sinks. Unlike carbon emissions during the use of coal resources, carbon emissions at the site of resource exploitation has not yet attracted enough attention. During disturbance from the exploitation, the vegetation suffers a reduction in both the amount of carbon it can absorb from the atmosphere and the amount it stores as biomass. The impact of coal mining on vegetation is divided into a direct loss that is represented by dead branches and leaves and an indirect loss represented by decreased capacity to absorb atmospheric carbon. The direct carbon loss is smaller. For woody plants, the carbon stored in dead trunks and branches will remain out of the atmosphere for a long time and less woody species will decay, undergo mineral and humification processes and have their embodied carbon sequestered by the soil. Therefore, the reduction in absorption of atmospheric carbon by vegetation is responsible for the larger portion of the carbon released owing to coal mining.

Coal mining activities are known to mainly affect the local vegetation from the following perspectives: mining activities cause surface subsidence and changes to cracks in the ground and surface micro topography that alter the growth environment of vegetation's roots (He, 2003) [10]; burning of gangue hill and underground coal fire causes large areas of vegetation to fade or die (Zhang *et al*., 2007) [11]; soil physical and chemical properties change which hinders nutrient absorption by vegetation (Hu *et al*., 2012; Sun *et al*., 2008) [12, 13] and pollution and declining levels of groundwater hinder water absorption by vegetation (Wang *et al*., 2008) [14].

Reducing the impact of mining on local environment factors, such as the physical structure and chemical composition of the soil and the level and quality of ground water, is the foremost method to reducing vegetation disturbance. Green mining technologies and recycling techniques, including water-preserved-mining, strip mining and coal and gas simultaneous mining, can reduce the disturbance to underground and surface environmental factors and should become the new direction of coal mining (Qian *et al*., 2003) [15].

V. Conclusions:

From the present results following highlighted points can be concluded:

* The continuous coal mining has had a negative effect on the vegetation in the mining area.
* Fluctuations in the vegetation Normalized Difference Vegetation Index (NDVI) as a response to changes in the local climate were positively correlated with the average NDVI value.
* The vegetation showed a relationship of mutual restraint with other environmental factors such as soil.
* The disturbance of vegetation owing to coal mining inevitably affected other ecological processes such as the storage of humus and soil respiration.

The mechanisms of carbon loss, however, require further study at scientific level.

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References

[1]. Yi Huang , Feng Tian, Yunjia Wang, Meng Wang, Zhaoling Hu (2015): Effect of coal mining on vegetation disturbance and associated carbon loss, *Environ Earth Sci*, **73:**2329–2342 DOI 10.1007/s12665-014-3584-z

[2]. Anon (2006): "Dirty Metal, Mining Communities and Environment, Earthworks", Oxfam America, Washington, p. 4.

[3]. Fan YH, Lu ZH, Cheng JL et al (2003) Major ecological and environmental problems and the ecological reconstruction technologies of the coal mining areas in China. *Acta Ecol Sinica* **23(10):**2144–2152 (In Chinese)

[4]. Wu LX, Ma BD, Liu SJ (2009) Analysis to vegetation coverage change in Shendong mining area with SPOT NDVI data. *J China Coal Soc* **34(9):**1217–1222 (in Chinese)
[5]. Wang YJ, Zhang DC, Lian DJ, Li YF, Wang XF (2010) Cumulative effects of coal mine development on resources and environment. *Sci Technol Rev* **28(10):**61–67 (in Chinese)
[6]. Sanyal, B (2006): Coal to stay key source for nation's energy needs, Business Line, November 22, 2006.
[7]. Xu ZJ, Hou HP, Zhang SL et al (2012) Effects of mining activity and climatic change on ecological losses in coal mining areas. *Trans Chin Soc Agric Eng (Trans CSAE)* **28(5):**232–240 (in Chinese)
[8]. Hou HP, Zhang SL, Ding ZY (2012) Study on the measurement of ecological loss based on the net primary productivity in coal mines. *J China Coal Soc* **37(10):**445–451 (in Chinese)
[9]. Siddique E. N. and Sarita kumara (2016): Flora of Bokaro, Jharkhand, India, *Bioscience Discovery*, 7(2):147-151
[10]. He WL (2003) Mining subsidence and damage in mountainous region. China Science and Technology, Beijing (in Chinese)
[11]. Zhang CX, Xu L, Zhou XC (2007) Land suitability assessment of vegetation restoration of the coal Gangue pile of Fuxin mine area. *Res Soil Water Conserv* **14(3):**246–248 (in Chinese)
[12]. Hu ZQ, Wang PJ, Li J (2012) Ecological restoration of abandoned mine land in China. *J Resour Ecol* **3(4):**289–296
[13]. Sun HY, Li XJ, Hu ZQ, Liu XR, Zhong WJ (2008) Variance of reclamation soil quality in Majiata opencast mine region. *Trans Chin Soc Agric Eng (Trans CSAE)* **24(12):**205–209 (in Chinese)
[14]. Wang L, Wei SP, Wang QJ (2008) Effect of coal exploitation on groundwater and vegetation in the Yushenfu Coal Mine. *J China Coal Soc* **33(12):**1408–1414 (in Chinese)
[15]. Qian MG, Xu JL, Miao XX et al (2003) Green mining technology of coal mine. *J China Univ Min Technol* **32(4):**343–348 (in Chinese)

Dr. Baidyanath Kumar, et. al. "Vegetation and Its Phenology of Degraded Land Area of Lodna Coal Mines of Jharia, Jharkhand." *IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB),* 6(5), (2020): pp. 43-51.