

DIVERSITY AND *EX SITU* CONSERVATION OF ORCHID SPECIES IN LEKHAPANI RESERVE FOREST UNDER MAKUM COAL FIELD, ASSAM

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Abstract

Orchids are fascinating group of angiosperms that have attracted the admiration of scientists, horticulturists, and industrialists because of their amazing ornamentation, brilliant color combinations, and extended blooming period. They are very sensitive and have high specificity towards pollution free environment of their niches and need much more care for protection of their habitat for their existence. The process of open-cast coal mining involves removal of top overlying soil layer with vegetation cover, leading to denudation and total elimination of the forest cover. Majority of the orchids are found as epiphytes and destruction of trees has created permanent elimination of these epiphytes. Assam is blessed with wide-range of eco-climatic suitability to fulfill the specific micro-climatic requirement for the growth of orchids. The present study deals with the natural diversity of orchids within Lekhapani Reserve Forest of Makum Coal Field in Digboi Forest Division under Dihing-Patkai Wildlife Sanctuary. The reserve forest covers an area of 1158.46 hectares. Lekhapani-Tipongpani Mining lease lies on the South West border with Arunachal Pradesh. Bio-geographically, the study site is situated in the Eastern Himalayan province where the major forest type is Assam Valley Tropical Wet Evergreen Forest dominated by *Canarium resiniferum* Brace ex King., *Dipterocarpus retusus* Blume., *Lagerstroemia speciosa* (L.) Pers., *Terminalia bellerica* (Gaertn.) Roxb., *T. myriocarpa* Van Heurck & Müll. Arg. etc. and is situated over a huge deposition of coal. Surveys and walked transects were conducted to enumerate the species and its population status. A total of 39 orchid species under 24 genera have been recorded from the study site, mostly of sub tropical and temperate environment. Amongst them, 36 species were epiphyte, 3 species were terrestrial and 6 species were found to be rare in rank. This study covered the distribution of the species, their host range, phenology, and ecological status. According to government policies, the total destruction of the forest for open cast coal mining has created a great threat for this plant resource especially the orchid flora of the Dihing-Patkai Region. With a view to conserve these species, Rain Forest Research Institute, jointly with Makum Coal fields planned the *ex situ* conservation and multiplication of orchids germplasm of Lekhapani Reserve Forest.

Introduction

ORCHIDS ARE highly evolved, fascinating group of angiosperms known for their aesthetic beauty and great floral architecture. With amazing ornamentation, brilliant color combinations, and extended blooming period, they acquire highest admiration from scientists, horticulturists, and industrialists. These plants are very sensitive and have high specificity about pollution free environment of their niches and need much care for protection of the habitat for their existence. Heavy shrinkage of forest areas has created increasing threat of endurance of entire orchid group. However, destruction of habitats and many other anthropogenic pressures, some species of orchids have vanished from the Indian localities (Bhandari *et al.*, 2018; Devi *et al.*, 2018; Kumar *et al.*, 2016; Kumar *et al.*, 2018; Sharma *et al.*, 2017; Vij, 2001; Yonzon and Rai, 2016). The process of open-cast coal mining involves removal of top overlying soil layer with vegetation cover which leads to denudation and total elimination of forest cover. Majority of the orchids are found as epiphytes and destruction of tree species has created permanent elimination of the epiphytes. In other words, orchids are the indicators of clean environment of a region.

Orchids are the inquisitive botanical wealth of Assam. Assam is blessed with wide-range of eco-climatic

suitability to fulfill the specific micro-climatic requirement for the growth of orchids. Orchid diversity of Assam has been explored by different workers from time to time (Barua, 2001; Bhattacharjee *et al.*, 2018; Dey *et al.*, 2007; Gogoi *et al.*, 2012). Presently, many spectacular and economically important orchid species of Assam are facing danger of extinction because of destruction of their natural habitats due to mining. Hence, it is a necessity to enumerate the orchid species from the mining areas and develop strategies for their multiplication and conservation. The present study deals with the natural diversity of orchids in Lekhapani Reserve Forest of Makum Coal Field under the Digboi Forest Division where orchids are the most important component of the vegetation.

Material and Methods

Study Site

Study was conducted in Lekhapani Reserve Forest of Makum Coal Field in Digboi Forest Division under Dihing-Patkai WLS lies between 27°16'30" N to 27°19'0" N and 95°48'30" E to 95°25'0" E, with altitudinal range from 156 m to 221 m amsl (Fig. 1). The reserve forest covers an area of 1158.46 hectares. Lekhapani-Tipongpani Mining lease lies on the South West border



Fig. 1. Study map of Lekhapani Reserve Forest.

with Arunachal Pradesh. The study site is situated in the Eastern Himalayan province at the junction of the Palaeartic, Indo-Chinese, and Indo-Malayan Biogeographic Regions where the major forest type is Assam Valley Tropical Wet Evergreen Forest (Champion and Seth, 1968). The forest occurred along foothills and river/steam bank dominated by *Altingia excelsa* Noron, *Schima wallichii* (DC) Kuntze, *Canarium resiniferum* Brace ex King., *Dipterocarpus retusus* Blume., *Lagerstroemia speciosa* (L.) Pers., *Terminalia bellerica* (Gaertn.) Roxb. *T. myriocarpa* Van Heurck & Müll. Arg. intermingled with various climbers and lianas and is situated over a huge deposition of coal. The understory vegetation was dominated by the species of *Amischotolype*, *Colocacia*, *Costus*, *Curculigo*, *Floscopa*, *Phrynium* and several species of grasses and ferns. This area falls under humid zone, which is characterized by high precipitation

and humidity. Highest rainfall occurs during the month of August (454.5 mm) whereas the lowest average rainfall was recorded during November (11.3 mm). The months of November to February are dry and cold, July to August are the wettest and hottest months, whereas December and January are the coldest months. The relative humidity is generally high in most part of the year. Soil is acidic with pH 3.99 and moisture content is 26.07% at 0-15 cm depth. Land cover in Lekhapani proposed Open Cast mining sites was represented in Fig. 2.

Methodology

Extensive field survey was carried out in Lekhapani Reserve Forest of Makum Coal Field area during the period of 2018-19. Surveys and walked transects were conducted seasonally in all parts of the forest to enumerate the species and their population status. All the necessary field documents were recorded in field book during the survey for further study. Identification of the species was done with the help of published literature such as local floras (Chowdhury, 2005; Gogoi, 2017; Sharma *et al.*, 2006) and consulting herbaria of Botanical survey of India, Shillong (Assam). Nomenclature of the species was confirmed with data bases like The Plant List and Tropicos.

Results and Discussion

The present study was conducted in Lekhapani Reserve Forest under Tinsukia District positioned in the Eastern part of Assam. It bears a unique ecosystem that favours luxuriant growth of orchids. A total of 39 orchid species under 24 genera had been recorded from the study site, mostly of sub tropical and temperate

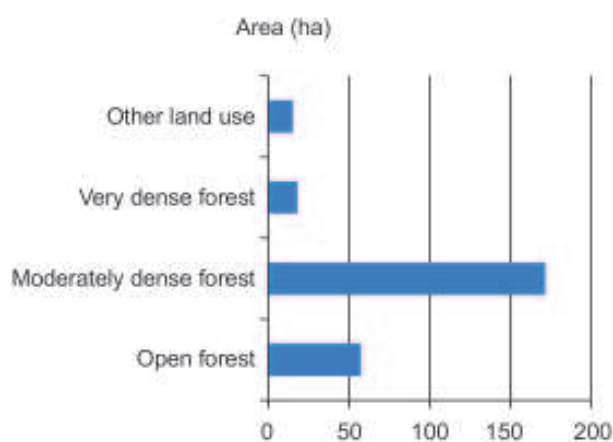


Fig. 2. Land cover in Lekhapani proposed Open Cast mining sites.

Table 1. Strength wise number of orchid genera found in Lekhapani Reserve Forest.

Species	India	Assam	Lekhapani Reserve Forest
<i>Acampe</i> Lindl.	5	4	2
<i>Aerides</i> Lour.	8	4	3
<i>Agrostophyllum</i> Bl.	5	2	1
<i>Bryobium</i> Lindl.	-	1	1
<i>Bulbophyllum</i> Thou.	97	35	2
<i>Calanthe</i> R.Br.	23	11	1
<i>Cleisocentron</i> Bruhl.	1	1	1
<i>Cleisostoma</i> Bl.	19	11	2
<i>Cymbidium</i> Sw.	22	15	1
<i>Dendrobium</i> Sw.	102	56	7
<i>Dienia</i> Lindl.	3	1	1
<i>Eria</i> Lindl.	53	15	2
<i>Gastrochilus</i> D.Don	15	4	1
<i>Luisia</i> Gaud.	16	5	1
<i>Micropera</i> Lindl.	4	4	1
<i>Oberonia</i> Lindl.	53	14	1
<i>Papilionanthe</i> Schltr.	5	2	1
<i>Peristylus</i> Bl.	29	3	1
<i>Phalaenopsis</i> Bl.	16	10	1
<i>Pholidota</i> Lindl.	7	6	3
<i>Pinalia</i> Lindl.	-	8	2
<i>Rhynchostylis</i> Bl.	2	1	1
<i>Robiquetia</i> Gaud.	4	2	1
<i>Vanda</i> Jones ex R.Br.	16	7	1

environment. Amongst them, 36 species were epiphytic in nature and only 3 were of terrestrial habit. Orchid genera distributed in Assam, India and the Lekhapani Reserve Forest was incorporated in Table 1. The species namely *Bulbophyllum careyanum* (W. J. Hook.) Spreng., *Eria tomentosa* (Koenig) J. D. Hook., *Gastrochilus dasypogon* (J. E. Sm.) Ktze., *Micropera pallida* (Roxb.) Lindl., *Peristylus goodyeroides* (D. Don.) Lindl., *Phalaenopsis mannii* Reichb. f., *Pinalia pumila* (Lindl.) Kuntze, and *Vanda tessellata* (Roxb.) W.J. Hook. ex Don were rare in their ecological status and very sparsely found in the site. *V. tessellata* was distributed globally in India, Myanmar, and Sri Lanka. In the present study, it was observed that the orchid

species very occasionally grow on *Canarium resiniferum*, *Dipterocarpus retusus*, and *Terminalia bellerica* trees. *Dendrobium nobile* Lindl. was the only species under Critically Endangered category and *Cleisostoma appendiculatum* (Lindl.) Benth. & J. D. Hook. ex Jackson was placed in Vulnerable category. *Peristylus goodyeroides*, a terrestrial species was found near the water bodies of the hill sides and badly affected by habitat disturbance. Other two terrestrial species namely *Calanthe masuca* and *Dienia ophrydis* were found in dense damp floor of the forest. *Dendrobium* is the second largest genus of the orchid family with 56 number of species distributed in Assam (Gogoi, 2018). According to grouping of *Dendrobium* by Seidenfaden (1985), *D. aphyllum*, *D. fimbriatum* var. *oculatum*, *D. lituiflorum*, *D. moschatum* *D. nobile*,

Table 2. Number of orchid species associated with the host plants in Lekhapani Reserve Forest.

Host plant	Number of orchids
<i>Ailanthus integrifolia</i> Lam.	2
<i>Altingia excelsa</i> Noronha	1
<i>Balakata baccata</i> (Roxb.) Esser.	7
<i>Bischofia javanica</i> Blume	15
<i>Canarium resiniferum</i> Bruce ex King	8
<i>Castanopsis indica</i> (Roxb. ex Lindl.) A. DC.	2
<i>Chukrasia tabularis</i> A. Juss.	8
<i>Dipterocarpus retusus</i> Blume	10
<i>Duabanga grandiflora</i> (Roxb. ex DC.) Wall.	1
<i>Gmelina arborea</i> Roxb.	1
<i>Lagerstroemia speciosa</i> (L.) Pers	31
<i>Macaranga denticulata</i> (Blume) Müll. Arg.	1
<i>Magnolia hodgsonii</i> (Hook. f. & Thomson) H. Keng	4
<i>Mangifera sylvatica</i> Roxb.	3
<i>Melia azadirach</i> L.	2
<i>Schima wallichii</i> (DC) Kuntze	2
<i>Stereospermum tetragonum</i> DC.	1
<i>Stereospermum chelonoides</i> (L.f.) DC	1
<i>Tectona grandis</i> L.f.	10
<i>Terminalia chebula</i> Retz.	2
<i>Terminalia bellerica</i> (Gaertn.) Roxb.	11
<i>Terminalia myriocarpa</i> Van Heurck & Müll. Arg.	3
<i>Vatica lanceifolia</i> (Roxb.) Blume	3

D. transparens were placed under the section *Dendrobium* and only *D. acinaciforme* was placed under section *Aporum*. Flowering period of dendrobiums are extended from March to May. *Aerides* is another most floristically important monopodial vandaceous orchid,

3 species were recorded in Assam and all three were blooming in Lekhapani Reserve Forest during the month of April to June. Present study recognizes 23 species as host plants where the epiphytic orchids take shelter and proliferate. Orchids are very specific for

Table 3. Orchid species of Lekhapani Reserve Forest and their host range.

Species	Habit	Status	Host plant
<i>Acampe praemorsa</i> (Roxb.) Blatt. & Mc Cann	Epiphyte	Abundant	<i>Tectona grandis</i> , <i>Lagerstroemia speciosa</i> , <i>Bischofia javanica</i> , <i>Terminalia myriocarpa</i>
<i>A. rigida</i> (Buch.-Ham.ex J.E. Sm.) P.F. Hunt	Epiphyte	Sparse	<i>Lagerstroemia speciosa</i> , <i>Tectona grandis</i>
<i>Aerides odorata</i> Lour.	Epiphyte	Abundant	<i>Magnolia hodgsonii</i> , <i>Balakata baccata</i> , <i>Stereospermum chelonoides</i> , <i>Castanopsis indica</i> , <i>Bischofia javanica</i> , <i>Chukrasia tabularis</i> , <i>Terminalia bellerica</i> , <i>Canarium resiniferum</i>
<i>A. multiflora</i> Roxb.	Epiphyte	Abundant	<i>Chukrasia tabularis</i> , <i>Lagerstroemia speciosa</i> , <i>Tectona grandis</i> , <i>Dipterocarpus retusus</i> , <i>Magnolia hodgsonii</i>
<i>A. rosea</i> Lodd. ex Lindl. & Paxt.	Epiphyte	Sparse	<i>Lagerstroemia speciosa</i>
<i>Agrostophyllum planicaule</i> (Wall. ex Lindl.) Reichb. f.	Epiphyte	Abundant	<i>Bischofia javanica</i> , <i>Lagerstroemia speciosa</i>
<i>Bryobium pudicum</i> (Ridl.) Y.P.Ng & Cribb.	Epiphyte	Abundant	<i>Lagerstroemia speciosa</i> , <i>Duabanga grandiflora</i>
<i>Bulbophyllum affine</i> Lindl.	Epiphyte	Abundant	<i>Balakata baccata</i> , <i>Lagerstroemia speciosa</i>
<i>B. careyanum</i> (W. J. Hook.) Spreng.	Epiphyte	Rare	<i>Balakata baccata</i> , <i>Lagerstroemia speciosa</i>
<i>Calanthe masuca</i> (D. Don) Lindl.	Terrestrial	Abundant	-
<i>Cleisocentron pallens</i> (Cathcart ex Lindl.) Pearce & Cribb	Epiphyte	Abundant	<i>Lagerstroemia speciosa</i>
<i>Cleisostoma appendiculatum</i> (Lindl.) Benth. & J. D. Hook. ex Jackson	Epiphyte	Vulnerable	<i>Lagerstroemia speciosa</i> , <i>Bischofia javanica</i> , <i>Terminalia bellerica</i> , <i>Schima wallichii</i>
<i>C. linearilobatum</i> (Seidenf. & Smitind.) Garay	Epiphyte	Abundant	<i>Bischofia javanica</i> , <i>Terminalia bellerica</i> , <i>Lagerstroemia speciosa</i>
<i>Cymbidium aloifolium</i> (L.) Sw.	Epiphyte	Abundant	<i>Stereospermum tetragonum</i> , <i>Vatica lanceifolia</i> , <i>Castanopsis indica</i> , <i>Schima wallichii</i> , <i>Mangifera sylvatica</i> , <i>Chukrasia tabularis</i> , <i>Dipterocarpus retusus</i> , <i>Lagerstroemia speciosa</i>
<i>Dendrobium acinaciforme</i> Roxb.	Epiphyte	Sparse	<i>Terminalia chebula</i> , <i>Lagerstroemia speciosa</i>
<i>D. aphyllum</i> (Roxb.) Fischer	Epiphyte	Abundant	<i>Balakata baccata</i> , <i>Lagerstroemia speciosa</i> , <i>Tectona grandis</i> , <i>Bischofia javanica</i> , <i>Canarium resiniferum</i> , <i>Terminalia bellirica</i>
<i>D. fimbriatum</i> W. J. Hook var. <i>oculatum</i> Hook.	Epiphyte	Abundant	<i>Lagerstroemia speciosa</i> , <i>Ailanthus integrifolia</i> , <i>Terminalia chebula</i>
<i>D. lituiflorum</i> Lindl.	Epiphyte	Abundant	<i>Ailanthus integrifolia</i> , <i>Bischofia javanica</i> , <i>Lagerstroemia speciosa</i>
<i>D. moschatum</i> (Buch.-Ham.) Sw.	Epiphyte	Abundant	<i>Altingia excels</i> , <i>Castanopsis indica</i> , <i>Lagerstroemia speciosa</i>
<i>D. nobile</i> Lindl.	Epiphyte	Critically Endangered	<i>Balakata baccata</i> , <i>Lagerstroemia speciosa</i> , <i>Tectona grandis</i> , <i>Bischofia javanica</i> , <i>Terminalia bellerica</i> , <i>Canarium resiniferum</i>

Table 3. Orchid species of Lekhapani Reserve Forest and their host range (contd.).

Species	Habit	Status	Host plant
<i>D. transparentis</i> Lindl.	Epiphyte	Abundant	<i>Gmelina arborea</i> , <i>Lagerstroemia speciosa</i> , <i>Vatica lanceifolia</i> , <i>Magnolia hodgsonii</i> , <i>Balakata baccata</i> , <i>Castanopsis indica</i> , <i>Dipterocarpus retusus</i> , <i>Melia azedarach</i> , <i>Tectona grandis</i>
<i>Eria lasiopetala</i> (Willd.) Ormerod	Epiphyte	Abundant	<i>Bischofia javanica</i> , <i>Chukrasia tabularis</i> , <i>Mangifera sylvatica</i>
<i>E. tomentosa</i> (Koenig) J. D. Hook.	Epiphyte	Rare	<i>Bischofia javanica</i> , <i>Chukrasia tabularis</i> , <i>Terminalia bellerica</i> ,
<i>Gastrochilus obliquus</i> (Lindl.) Ktze. var. <i>suavis</i> (Seidenf.) Z.H.Tsi	Epiphyte	Rare	<i>Bischofia javanica</i> , <i>Lagerstroemia speciosa</i> , <i>Terminalia myriocarpa</i>
<i>Luisia tristis</i> (G.Forst.) Hook.f.	Epiphyte	Abundant	<i>Lagerstroemia speciosa</i> , <i>Bischofia javanica</i> , <i>Terminalia bellerica</i> , <i>Canarium resiniferum</i>
<i>Dienia ophrydis</i> (J.Konig) Seidenf.	Terrestrial	Sparse	-
<i>Micropera pallida</i> (Roxb.) Lindl.	Epiphyte	Rare	<i>Terminalia bellerica</i> , <i>Lagerstroemia speciosa</i>
<i>Oberonia mucronata</i> (D.Don) Ormerod & Seidenf.	Epiphyte	Abundant	<i>Lagerstroemia speciosa</i> , <i>Bischofia javanica</i> , <i>Terminalia bellerica</i> , <i>Canarium resiniferum</i>
<i>Papilionanthe teres</i> (Roxb.) Schltr.	Epiphyte	Abundant	<i>Melia azedarach</i> , <i>Dipterocarpus retusus</i> , <i>Castanopsis indica</i> , <i>Chukrasia tabularis</i> , <i>Terminalia myriocarpa</i> , <i>Tectona grandis</i>
<i>Peristylus goodyeroides</i> (D.Don.) Lindl.	Terrestrial	Rare	-
<i>Phalaenopsis manni</i> Reichb. f.	Epiphyte	Rare	<i>Lagerstroemia speciosa</i>
<i>Pholidota articulata</i> Lindl.	Epiphyte	Abundant	<i>Dipterocarpus retusus</i> , <i>Macaranga denticulate</i> , <i>Balakata baccata</i> , <i>Vatica lanceifolia</i> , <i>Tectona grandis</i> , <i>Bischofia javanica</i> , <i>Chukrasia tabularis</i> , <i>Lagerstroemia speciosa</i>
<i>P. imbricata</i> W. J. Hook.	Epiphyte	Abundant	<i>Macaranga denticulate</i> , <i>Magnolia hodgsonii</i> , <i>Castanopsis indica</i> , <i>Chukrasia tabularis</i> , <i>Lagerstroemia speciosa</i> , <i>Canarium resiniferum</i> , <i>Dipterocarpus retusus</i>
<i>P. pallida</i> Lindl.	Epiphyte	Sparse	<i>Lagerstroemia speciosa</i> , <i>Canarium resiniferum</i>
<i>Pinalia amica</i> (Rchb.f.) Kuntze	Epiphyte	Abundant	<i>Lagerstroemia speciosa</i> , <i>Dipterocarpus retusus</i>
<i>P. pumila</i> (Lindl.) Kuntze	Epiphyte	Rare	<i>Lagerstroemia speciosa</i> , <i>Dipterocarpus retusus</i> , <i>Castanopsis indica</i> , <i>Tectona grandis</i>
<i>Rhynchostylis retusa</i> (L.) Bl.	Epiphyte	Abundant	<i>Canarium resiniferum</i> , <i>Lagerstroemia speciosa</i> , <i>Tectona grandis</i> , <i>Bischofia javanica</i> , <i>Mangifera sylvatica</i> , <i>Terminalia bellerica</i> , <i>Dipterocarpus retusus</i> , <i>Canarium resiniferum</i>
<i>Robiquetia spathulata</i> (Bl.) J.J.Sm.	Epiphyte	Abundant	<i>Lagerstroemia speciosa</i> , <i>Canarium resiniferum</i>
<i>Vanda tessellata</i> (Roxb.) W.J. Hook. ex Don	Epiphyte	Rare	<i>Canarium resiniferum</i> , <i>Terminalia bellerica</i> , <i>Dipterocarpus retusus</i>

choosing the host plant and trees with rough bark was the main characteristic feature for the orchids to survive. *Bischofia javanica*, *Castanopsis indica*, *C. resiniferum*, *Dipterocarpus retusus*, *Lagerstroemia speciosa*, *Tectona grandis*, *Terminalia bellerica*, and

T. myriocarpa were the most prominent host species supporting a large number of orchids in studied forest. Detailed list of the host species and number of orchid species associated with the host plants were given in Table 2, 3. It was observed that the host trees which

bear the epiphytic orchids naturally in the forest, deplete day by day. Restoration and protection of the forest is extremely important for conserving this precious wealth. Bhattacharjee and Dutta (2009) reported that the conservation of habitat is the only way to conserve the orchids.

A good number of wild orchids have been on the verge of disappearance and some more are at rare and endangered levels because of large scale conversion of the forest. Increasing vulnerability has demanded technology for *ex situ* conservation of such species. Depending on the habit, orchids can grow in a variety of media. Pot cultivation is the best for multiplication of orchids. Number of potting compost media were suggested by many workers (Hegde, 1981; Gupta and Saravanan, 2017; Jain, 1985; Patnaik *et al.*, 2017; Mukherjee, 1996). Barua *et al* (2014) reported the vegetative propagation of *Renanthera imschootiana* Rolfe, an endangered spectacular orchid through low cost potting media. During the present study, all the germplasm of Lekhapani Reserve Forest were successfully cultivated and multiplied in a mixed compost media of Brick: Charcoal: Sphagnum moss (1:1:1 ratio) and conserved in the botanical garden of Rain Forest Research Institute, Jorhat, Assam.

Conclusion

Proposed extension of coal mines in Lekhapani Reserve Forest and rapid destruction of the forest are leading the orchid family in high risk of threat and this will clearly have a negative impact on orchid diversity of the site. Shifting cultivation is prevailing in the southern part of the study area by few inhabitants of Naga Tribe, which has also become a serious environmental issue. There are some encroachments on the forest land by establishing tea garden within the forest that should be checked and further proper demarcation of the boundary is needed. Number of unauthorized mining activities and subsequent smuggling of coal is going on in the reserve forest, leading to the fragmentation of dense and moderately dense forest patches. Hence, Biodiversity Management Plan for the Makum Coal fields in Assam was prepared by Rain Forest Research Institute in 2017 and suggested "Green Belt Development Plan" with typical design for the mine lease area of the forest.

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