CHAPTER 3

STUDY AREA

3.1 Location

Orissa’s Koraput district, as diverse in its topography as in its demography and culture, is truly a blessed land. Nestling in the Eastern Ghats, Koraput is endowed with wealth of mineral deposits with verdant meadows, thick forests, cascading waterfalls, rolling hills, terraced valleys and languid plateaus. The name Koraput is derived from ‘Koraputti’ or the hamlet of Strychnos nux-vomica. Another school of thought believes that one Khora Naiko, a loyal servant of Nandpur dynasty, laid the foundation of a village, then known as ‘Khora Puttu’ which later changed to ‘Koraput’ (India, 2005b).

Panchpatmali bauxite deposit of Koraput District, Orissa falls partly in the Survey of India toposheet 65 J/13 and partly in 65 N/1. The deposit is bound by latitudes 18° 45’ N to 18° 55’ N and longitudes 82° 55’ E to 83° 05’ E, and can be accessed from southern side via Vizag – Vizianagaram – Sunki NH 43 or through Rayagada – Roopkona – Lakshmipur – Kakriguma from northern side. The nearest railway line passing close to the deposit is to the west of deposit on Koraput-Rayagada line of South Eastern Railway.

The deposit is part of the East Coast Bauxite deposits which came to light in mid-seventies of the last century by the publication of Geological Survey of India report. Here bauxite occurs on plateau top as a blanket deposit. The plateau is elongated, about 21 km long trending NNE-SSW with width varying from 1.8 km to as low as 100 m. The plateau is generally flat on top with elevation varying from 1200 m to 1350 m above mean sea level, rising by about 150 m to 300 m above the adjoining plains and valleys.

3.2 Drainage pattern

Panchpatmali plateau is the catchment’s dividing line; hence, rain water and streams on either side of the Panchpatmali hill flow in opposite directions to join
different rivers. The eastern side of Panchpatmali is catchment of Nagavalli and the western side is the catchment of river Muran, a tributary of river Indravati.

Fig. 3.1: Map of Koraput district, Orissa (Source: www.mapsofindia.com).

### 3.3 Climate

The study area is characterized by tropical to sub-tropical climate. Though the area is located near the East Coast region, general climate is more of Deccan type but not as strong as that of main Deccan plateau. This is mainly because of the elevation and location/situation with hilly terrain. Four distinct seasons are generally experienced here. The hot summer season is from March to May. The monsoon season is little longer extending from June to September. Maximum relative humidity is experienced during this period. The autumn season is October-November and the winter months extend from December to February.
3.3.1 Temperature

The plateau area of the Koraput district generally has cooler climate compared to other parts of the district. Thick blanket of fog is a common phenomenon particularly on the plateau area.

The area experiences high temperature during March- May months. Since the area is at a higher altitude, temperature rise as much as plains. South- west monsoon sets in the area by mid June and intensifies during July- August. The monsoon lasts till mid September, and this area receives about 80 % of the total rainfall during this period. Average annual rainfall is of the order of 1300 mm- 2100 mm. Panchpatmali plateau receives higher rainfall than the surrounding plains.

3.3.2 Rainfall

The distribution of rainfall is largely influenced by the ghat terrain of the Koraput district. The high hills forming the Eastern Ghats stand like a boundary wall forcing the monsoon current to rise up resulting in heavy precipitation in the plateau. By the time current crosses over to the eastern edge, it loses most of its water content and thus receives comparatively less rainfall. Koraput plateau receives maximum rainfall.

The study area receives pre-monsoon showers in late May. By June, the monsoon almost gets established. Months of July, August and September are the peak rainy months with maximum rainfall during this period. It is quite common to receive a few showers in October which gradually becomes less in the month of November.

The region is also influenced by cyclonic storms due to depressions in the Bay of Bengal that causes high velocity winds and widespread rains. The effect of cyclones, lasting 3-4 days, normally occurs sometime during September to November. Humidity is high during monsoon and winter. Fog during monsoon is sometimes quite dense on hill top causing poor visibility.
Table 3.1 Month-wise Maximum and Minimum Mean Temperatures data of the Study Area (°C)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>JAN</th>
<th>FEB</th>
<th>MAR</th>
<th>APR</th>
<th>MAY</th>
<th>JUN</th>
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<th>AUG</th>
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(Source: NALCO)

Table 3.2 Month-wise total Rainfall data of Panchpatmali plateau (mm)

<table>
<thead>
<tr>
<th>YEAR</th>
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<th>FEB</th>
<th>MAR</th>
<th>APR</th>
<th>MAY</th>
<th>JUNE</th>
<th>JUL</th>
<th>JULY</th>
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</table>

(Source: NALCO)
3.3.3 Humidity

High relative humidity and other forms of precipitation, e.g., mist and dew, are helpful in prolonging humid conditions in the locality. These conditions are favourable for development of natural vegetation and other growth like orchids and epiphytes. Relative humidity is generally high during the monsoon and post-monsoon months, particularly below the plateau (Popli, 2006).

3.4.1 Geology of the area

Bauxite is not a distinct mineral species but rather a generic term for a number of aluminous hydroxides often in a colloidal condition (Kundu and Chakravarty, 1996). It is an essential ore of aluminium metal and essential input for refractory and chemical industries. A naturally occurring heterogeneous ore, it contains hydrated aluminium oxides as the main constituent, and iron oxide, silica and titania in varying proportions as impurities.

Geologists have put forth several theories to explain the origin of bauxite deposits, however, the prevalent view is that bauxite is formed by the weathering of aluminous rocks under conditions favourable for the retention of alumina and the leaching of other constituents present in the parent rocks.

Bauxite deposits have been formed from all types of rocks which contain alumina. However, the parent material is not as important as the intensity and duration of weathering under the requisite favourable conditions (India, 1977).

The East Coast Bauxite deposits crown the east-central part of the Eastern Ghat hill ranges that are mainly made up of the Archaean khondalite and charnockite groups of rocks. Morphologically, the area exhibits conical hills, gently sloping plateaus and broad and confined valleys. The bauxite deposit occurs mostly on the gentle to moderately sloping plateaus (Rao and Raman, 1979). For bauxite reserves of Western Australia also, Gardner and Bell (2007) reported that deep weathering, predominantly during the Cretaceous, and subsequent surface laterization have formed the duricrusts and deep lateritic profiles of alumina, quartz, and iron oxides.
In the Orissa sector, the individual cappings have large areal extent and are widely scattered in an area of 4,000 sq. km. Most of the duricrusts are referred to by the name of the hills on which they occur, such as Panchpatmali deposit, Baphlimali deposit, etc. Here bauxite occurs as cappings of varying thickness (2-54 m) over the khondalite and charnockitic rocks. Some cappings have vast areal spreads of up to 10-15 sq. km, e.g., in case of Baphlimali and Panchpatmali deposits. The area comprising the bauxitic duricrust is generally devoid of thick vegetation whereas the slopes support thick vegetation.

The Panchpatmali bauxite deposit is low in silica (<4%) and titania (<2%), and high in iron (8-28%) content. The alumina content generally varies between 42-56% (Rao and Raman, 1979).

According to Choudhury (2007), major bauxite deposits of Orissa occur as a very gently undulating blanket, capping the parent rocks on plateau tops constituting integral part of lateritic profiles at elevations of 900 m to 1400 m above M.S.L. Bauxitization is more pronounced in the case of khondalites. A generalized profile of East Coast Bauxite deposits is as follows:

- Soil
- Laterite
- Aluminium laterite / bauxite
- Lithomarge / kaolinite
- Unaltered khondalite

The Directorate of Mines, Government of Orissa had been investigating for bauxite on the Panchpatmali plateau in Koraput district, Orissa since 1966 but its real economic potential came to light only after 1972.

**3.4.2 Bauxite profile at Panchpatmali**

The Panchpatmali deposit is composed of a thick layer of khondalite. The dominant rock assemblage in the region comprises of khondalite (quartz-garnet-potash-feldspar-sillimanite-gneisses) and its variants. The other group includes charnockite
(hypersthene-diopside-granite) and its equivalents of Archaean age. Khondalites in general have the strike NNE-SSW with dip towards ESE. The amount of dip varies from 400 to 800.

At Panchpatmali, bauxite occurs as a gently sloping or nearly horizontal blanket, capping the partially lateritised or weathered khondalite (PLK). The full profile can be observed in some of the scraps faces. Generalized profile is as follows:

i) **Overburden** – consisting of soil, clay and laterite, varies in thickness from 0.0 to 12.0 m and covers almost the entire plateau, the average thickness of overburden being 5.5 m.

ii) **Bauxite** – at a cut-off of >40 % Al₂O₃ and <5.0 % SiO₂, is varying in thickness from 0.0 to 25.0 m and the average thickness is 10 m. The top layer of bauxite is more gibbsitic. The overburden-bauxite contact is gradational, but that of bauxite-bottom is sharply defined.

iii) **Transition zone** - Bauxite is underlain by partially lateritised kondalite (PLK) and kaolinised khondalite (KK), the parent rock. Further down at more than 100 m, the khondalite rock in unweathered condition is likely to be encountered.

A generalized profile of Panchpatmali hill indicates that the floor is highly undulating, and thus, it needs a special mining technique to avoid dilution of bauxite by bottom PLK or KK and also to avoid loss of bauxite at the floor (India, 2004b).

The deposits are highly heterogeneous with wide variations in chemical grades and thicknesses. The transition zones between laterite and bauxite at the top and again between bauxite and PLK at the floor are highly undulated due to irregular leaching process. The deposit contains 40-44 % total alumina (Al₂O₃), total silica (SiO₂) in the range of 2-4 %, and iron (Fe₂O₃) in the range of 25-30 %, approximately (Ibid, 2004b).

### 3.5 Soil of the area

Soils of the Koraput district are developed from two main rock types, viz., charnockite and khondalite, though the underlying parent rock is invariably granite and
gneiss except for localized alluvial soils. This also explains for the majority of soil being red, yellow or brown in colour. Broadly, three types of soils are met with in the district. They are (i) yellow to brown soils, (ii) red sandy to loamy soils, and (iii) alluvial soils.

Light yellowish to brown soil mixed with laterised mass is found mainly in the hills and hill slopes whereas red sandy to loamy soils are occurring in the foothills and uplands. Most of the soils of the district fall under these two categories. Alluvial soils are found in a limited scale along the valleys and river banks.

Soil depth varies from shallow (25-50 cm) to moderately deep (75-100 cm). The soil particles are from clayey to loamy and the soil temperature regime is mostly hyperthermic (22-28 °C). Due to rampant ‘podu’ (shifting cultivation) coupled with surface run-off, the water holding capacity is usually low. Moreover there is no structural development in the soil and as such, they are massive and porous (Popli, 2006).

3.6 Forest cover

The entire stretch of Panchpatmali plateau is almost devoid of major tree species except stemless wild date palms (*Phoenix acaulis*). Old stumps of *Phyllanthus emblica* with 30-40 cm long 2-3 shoots and *Terminalia chebula* along with a few grasses and herbaceous species are also present. However, *Phyllanthus emblica* and *T. chebula* do not get established as trees due to fire and other anthropogenic factors and keep on sending up annual shoots for their root stocks.

3.6.1 Composition and condition of the forests

Several locality factors, including well-drained soils, good rainfall, prolonged period of monsoon, wide variation in temperature and reasonably high relative humidity are good enough to give rise to a rich and varied flora in the region. However, with passage of time, degradation has set in and many forest blocks, which once boasted of luxuriant growth, have almost become scrub forest and/or barren.
Biotic interference has continued to be so severe that nature of the forests of the area has even undergone drastic changes. The main biotic factors contributing to this change in forest types and degradation are excessive and arbitrary removal of timber, heavy grazing, shifting cultivation and frequent forest fires. Many forests are devoid of regeneration and ground flora.

3.6.2 Forest types

Forests of this area are mainly tropical deciduous type and can be broadly classified into two major groups: Moist Tropical Forests and Dry Tropical Forests. There is no clear dividing line between these forest groups; one gradually merging with another, though Bamboo Forests are generally found in association with the second type. However, according to revised classification of Forest Types of India by Champion and Seth, these forests have been further classified into different types and sub-types depending upon physiognomy, moisture conditions, floral composition and other variables (Ibid., 2006).

A. Moist Peninsular Sal Forest

<table>
<thead>
<tr>
<th>Group-3</th>
<th>Tropical moist deciduous forests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-group-3C</td>
<td>North Indian tropical moist deciduous forests</td>
</tr>
<tr>
<td>Type-3C/C2</td>
<td>Moist sal bearing forests</td>
</tr>
<tr>
<td>Sub-Type-3C/C2e</td>
<td>Moist peninsular Sal Forest.</td>
</tr>
</tbody>
</table>

This sub-type of forest has ‘dominants’ which are mainly deciduous but ‘sub-dominants’ and lower storey are largely evergreen. This category of forests is confined to a very few pockets and is characterized by the presence of sal as principal species.

B. Southern Dry Mixed Deciduous Forest

<table>
<thead>
<tr>
<th>Group-5</th>
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</thead>
<tbody>
<tr>
<td>Sub-group-5A</td>
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<tr>
<td>Type-5A/C3</td>
<td>Southern dry mixed deciduous forest.</td>
</tr>
</tbody>
</table>
The most characteristic tree of this type is *Anogeissus latifolia* while *Terminalia tomentosa* is a very typical associate. *Diospyros tomentosa* is also common (Ibid., 2006).

**C. Dry Peninsular Sal Forest**

<table>
<thead>
<tr>
<th>Group-5</th>
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</thead>
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</tr>
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<td>Type-5-B/ C1</td>
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</tr>
<tr>
<td>Sub-type-5B/C10</td>
<td>Dry peninsular sal forest.</td>
</tr>
</tbody>
</table>

This sub-type occurs, where, although rainfall is not low but moisture conditions are yet not favourable for the development of moist sal forests (Ibid., 2006).

**D. Northern Dry Mixed Deciduous Forest**

<table>
<thead>
<tr>
<th>Group-5</th>
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</tr>
</thead>
<tbody>
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<td>Sub-group-5B</td>
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</tr>
<tr>
<td>Type-5-B/ C2</td>
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</tr>
</tbody>
</table>

The upper canopy is light and the trees have relatively short bole and poor form. In this type of forest *Anogeissus latifolia* is very widely spread (Ibid., 2006).

**E. Dry Deciduous Scrub Forest**

<table>
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</thead>
<tbody>
<tr>
<td>Type 5/DS</td>
<td>Dry deciduous scrub forest (Biotic climax type).</td>
</tr>
</tbody>
</table>

This is the degraded type of dry deciduous forests. Since such forests are the result of continued biotic interference, these are also known as biotic climax type. A typical characteristic of this forest type is a low broken cover of shrubby growth including some tree species reduced to similar conditions, usually many stemmed from the base. Some bamboo is often present. Many good forest areas of the past now stand reduced to this type of forests.
Most of these degraded forests under this type are the result of long continued maltreatment, grazing and lopping being the chief factors, though other reasons like illicit felling and frequent fires are equally influential. Sal has almost vanished from these forests (Ibid., 2006).

**F. Dry Deciduous Savannah Forest**

<table>
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<tbody>
<tr>
<td>Type 5/DS₂</td>
<td>Dry deciduous savannah forest (Biotic climax type).</td>
</tr>
</tbody>
</table>

The second degradation stage of dry deciduous forest is this type of forest. It is an open forest but typical formation of original forests is lost and the trees stand apart singly or in small groups in more or less heavy grass in which certain fire resistant plants persist. These fire resistant plants gradually and slowly establish themselves as trees. However, in most of the cases, such plants do not get established as trees because of fire and other biotic factors and instead, keep sending up annual shoots from woody rootstock. Stemless phoenix is a particular characteristic of this forest, as is found in bauxite bearing plateau areas. Presence of *Phoenix* sp. implies poor shallow soil. Moreover, large presence of a number of weeds, like *Chromolaena* sp. indicates the degraded condition of the site (Ibid., 2006). Forest type of the present study area at Panchpatmali is represented by this type of forest.

All the above described climatic types are susceptible to be reduced to open savannah type; the intensive biotic interference in such forest areas causes conspicuous presence of grass which is otherwise a secondary feature in those forests (Climatic type). Some of the grass species encountered in these forests are *Oryza rufipogon, Eragrostis unioloides, Heteropogon contortus, Arundinella setosa* and *Saccharum spontaneum*. In fact, the conditions leading to the formation of this forest make them more xerophytic when compared with their corresponding climatic types.

Though the preponderance of the grasses is the characteristic feature in these forests, tree species found occurring here are *Phyllanthus emblica, Bauhinia retusa, Dillenia sp., Careya sp.*, etc. These trees have very short boles and are mostly crooked.
and unsound. Most of these degraded forest blocks are the result of long continued over exploitation, heavy grazing and other maltreatments including repeated short rotational ‘podu’ cultivation. The resultant effect has been the drastic reduction in natural regeneration of many tree species leading to complete wiping out of established seedlings of important species like sal, ‘dhaura’, etc. from such forest areas (Ibid., 2006).

G. Dry Bamboo Brakes

<table>
<thead>
<tr>
<th>Group-5</th>
<th>Tropical dry deciduous forests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 5/E₀</td>
<td>Dry bamboo brakes (edaphic climax type).</td>
</tr>
</tbody>
</table>

Many species of deciduous forests like Anogeissus, Butea monosperma, bamboo, and Boswellia serrata, etc. are capable of forming more or less pure stands. This is mostly the result of harsher environmental conditions including edaphic and biotic factors. The forests subjected to these factors lead to the formation of edaphic climax types and the ‘Dry Bamboo Brakes’ is one such type of forests. Only Dendrocalamus strictus occurs in pure from in this forest type making relatively low but dense brakes. However, with increased grazing pressure and frequent ground fire, bamboo has grown into dense and congested form with grass and thorny shrubs in between.

3.6.3 Degradation of the forests

Present condition of these forests is distressing. Unending pressure on the forest area has led to the regular removal of the matured trees of economic importance resulting in the dominance of bushes and scrubs.

Progression of many forest types into climatic climax has been arrested. Rather retrogression has set in which may ultimately lead to preponderance of dry scrub and savannah forests if corrective measures are not taken up forth with.
Fig. 3.2: Sequence of Changes in Forest Types (Source: Popli, 2006)

The main factors contributing to such degradation are many, among which the more prevalent are rampant ‘podu’ cultivation and selective illicit removal of commercially important trees. Forest fire, though mostly confined to the ground, has also been one of the factors responsible for degradation of crop density. To add to further damage to the forest, the cattle pressure has been alarming. There is no protected area in Koraput district. Common wild life species found around these areas are barking deer, spotted deer, hare, jackal, hyena, langur, sloth bear, wild boar, various species of reptiles and birds, and very occasionally leopard at the apex of the food chain (Ibid., 2006).

3.7 People and their habitation

Koraput district is predominantly a highlanders’ society with more than 49% schedule tribes and about 13% schedule castes as per 2001 census figures. Major tribes
around Panchpatmali plateau are ‘Paraja’, ‘Kandha’ and ‘Gadaba’ (Mohanti et al., 2006).

The ‘Parajas’ are one of the well known tribes of Orissa. They are primarily cultivators but poorer sections are mainly landless labourers. They adopt both shifting and wet cultivation. They grow paddy and minor millets. They are fond of cattle wealth and rear cows, bullocks, buffalos, goats, pigs and fowls.

‘Kandhas’ are plain land dwellers exhibiting greater adaptability to the forest environment. However, due to development interventions in education, medical facilities, irrigation, plantation and so on and so forth, they have started adapting to the great tradition or modern civilization standards in many ways. Their traditional life style, customary traits of economy, political organization, norms and values have been drastically changed over a long period of time.

The ‘Gadabas’ practice both shifting and wet cultivation. Localized podu is done in the plains and the land holding of each family is divided into two parts. These parts are cultivated in alternate years. However, hill Gadabas solely depend on shifting cultivation. They grow crops like paddy, ragi, maize and several types of grams but their staple food is ragi.

Tribal communities exhibit socio-economically backward life with mixed economies, their main occupation being collection of non-timber forest produce (NTFP), hunting, fishing, shifting cultivation (‘Podu’), settled agriculture, manufacturing of household art and craft, and wage earning in private/public and organized/ non-organised sectors (Ibid., 2006). Marriage by negotiation, capture, service and elopement are common among tribals. Divorce, re-marriage and widow marriage have social sanctions. There is no dowry menace; rather payment of ‘bride price’ is an established practice. Women enjoy higher status and respect in the family. Religious beliefs, alcoholism and superstitions take away major part of their income.

The tribals of the area observe a string of festivals. Some are closed affairs, relating to a birth or death within the family or daughter attaining puberty. Others relate to sowing or harvest time and these involve the entire community. Mostly, a festival is
an occasion for ‘mahua’ liquor or ‘handia liquor’, a game roasted on the spirit and a night of song and dance. There is an animal sacrifice too for the deities and spirits must be appeased first (Ibid., 2006).

Koraput district is rich in diversity of flora and fauna, and thus there is large dependence of the population on forests for health care based on traditional systems of medicine. In fact, varieties of medicinal plants are in use in the district by the traditional healers. Moreover, number of such plants and their derivatives are even harvested for use by drugs and pharmaceutical industries. This use has increased manifold in the recent past (Ibid., 2006).

Tribal economy mostly revolves round forest and it cannot be separated economically, ecologically and socio-culturally from tribal life. Tribals’ dependence on forest for food, fodder, fuel wood, housing materials, medicines and employment is well known without a blemish of doubt. Inadequate availability of suitable cultivable lands in the hands of tribals, low productivity of their lands due to undulating landscape, scarce water resources for irrigation, traditional agricultural practices, and above all poverty of these tribal people make their agricultural production insufficient to support their livelihood. Hence, tribals generally supplement their livelihood through collection of various items from forests. Many survive on edible roots, tubers, corns, fruits, mushrooms and even insects. They preserve ‘mahua’ (Madhuca indica) flowers, sal (Shorea robusta) seeds and ‘kusum’ (Schleichera oleosa) seeds and mango kernel for rainy days. ‘Siali’ (Bauhinia vahlii) leaves, hill broom (Thysanolaena maxima), tamarind (Tamarindus indica), myrobalans, various roots (‘kanda’), honey, resin, lac, ‘beedi’ leaves (Diospyrus melanoxylon), wax, ‘sabai’ (Eulaliopsis binata) grass, fuelwoods, etc. are important sources of their direct income. They also collect bamboo and other woods for house making, ‘shikakai’ (Acacia concinna), ‘char’ (Buchanania lanzan) seeds, soap nut (Sapindus mukorossi), marking nut (Semecarpus anacardium), ‘patalgarud’ (Rauwolfia serpentina), ‘kamalgundi’ (Mallotus philippensis), ‘bhuin neem’ (Andrographis paniculata) and various other herbs and plant parts for medicinal purposes (Mohanti et al., 2006; Popli, 2006).
Weekly market (‘haat’) plays a significant role in their socio-economic life. Selling their products and buying their requirements are done there, and even barting does take place sometimes (India, 2005b). The main markets for forest products of the area are Sunabeda, Semiliguda, Damanjodi, Kakariguma, etc. Prior to the year 2000, the NTFP items were leased out to the co-operative bodies like Orissa Forest Development Corporation and private agencies. These organizations used to collect NTFP items through local people providing them seasonal employment. However, in March 2000, Government of Orissa announced new NTFP policy. The orientation was changed from revenue earning to livelihood approach. The ownership of 68 NTFP items has been vested with Panchayats. Anyone who is interested in doing trade in NTFP has to get registered in Panchayats. Subsequently in November 2002, Government of Orissa, has framed MFP rules called ‘The Orissa Grama Pachayats (Minor Forest Produce Administration) Rules 2002’. As per these rules, Panchayat Samiti fixes the minimum procurement price for MFP items. The penal provisions for violation of any conditions are also spelt out in these rules (Popli, 2006).

There is no village or any habitation on the plateau top and on the slopes of Panchpatmali hill. However, a few villages / settlements are found in the adjacent valleys and plains, few kilometers away from the plateau. Eastern slope of the plateau is very thinly populated, whereas western slope has a few villages / habitations. Mostly maize, mustard, millets and paddy are cultivated by the local people on the lateritic soil. Koraput is very rich in indigenous varieties of paddy, which is generally grown along ‘nullahs’. Cashew nut and coffee are also grown in the region, but by the outsiders only.

### 3.7.1 Shifting cultivation

Though, with the passage of time, some tribals have settled for permanent cultivation, however, shifting cultivation or ‘Podu’ is still being practiced in Koraput district by the majority of the highlanders. This destruction of forest area by practicing ‘Podu’ finds mention in very old governmental records also. In 1877, the then Conservator of Forests, Govt. of Madras observed that the part of the forest tract in this region should be kept reserved against the ruinous system of felling and to prohibit extension of ‘Podu’ cultivation on hills. In 1918, Mr. Harriss, the then Agency
Commissioner enumerated ill-effects of ‘Podu’ in the area, eg., drying up of streams below the hills, washing of soil from the ‘Podu’ land, loss of valuable timber in lieu of less valuable crops, heavy floods in the rivers, siltation down below, etc. In 1950, Mr. H.F. Money, the then Conservator of Forests, Sambalpur addressing the then Food Commissioner, Cuttack had elaborately explained the effects of ‘Podu’ in the region. He observed that “So badly devastated are parts of Upper Koraput that it is difficult to imagine the hills otherwise than barren to their summits. But there is adequate evidence to prove that they were once well covered with forest growth upto 4500 ft at least; and even now shrubs and stunted trees can be seen clinging to their precarious footholds in sheltered gullies upto 5500 ft on the highest mountains. It is reasonable to infer that the disappearance of trees and shrubs growth on these hills is directly due to impact of shifting cultivation….. The current portion of this hill plateau between Koraput, Padwa and Pottangi, an area of some 300 sq. miles, presents a scene of desolation and acute denudation which can't be equated anywhere in Bihar, Orissa or the eastern Madhya Pradesh……This particular area presents a major land utilization problem. The hills must be saved from further denudation and cultivation on slopes exceeding 30 degrees forthwith be stopped...” (Ibid., 2006).

Sowing of seeds by spraying is taken up at pre-monsoon time. ‘Kandlan’ (a variety of ‘arhar dal’), ‘suan’ (a variety of rice), ‘kangu’ (a variety of maize) and ginger are generally cultivated. Turmeric is also sown with ‘kangu’ and ‘suan’. Generally, after three years the land is abandoned, where natural regeneration starts from the available root stock and seed dispersal. Bamboo comes up naturally, and ‘kendu’ (D. melanoxylon), Terminalia, ‘mahua’ (Madhuca indica) along with some climbers also regenerate. Generally, the land is not cultivated for the next ten years. During this period, tribals collect root suckers and other eatables from this area. 'Salpa' and 'mahua' are used for the preparation of local liquor for their own consumption. Imperata arundinacea is collected for thatching.

The problem of shifting cultivation in the region continues to be the matter of concern for the authorities. Repeated short-cycle shifting cultivation has created forest canopy gaps, which are evident from the barren hills around. Local disappearance of
native species and invasion of exotic weeds (*Lantana* spp., *Eupatorium* spp., etc.) and other plants are some of the other ecological consequences of shifting cultivation observed in the Koraput district (*Ibid*, 2006).

### 3.8 Mine planning and design

Bauxite mining is a surface operation, removing on average 4 m of the profile including the duricrust and mottled zone immediately below. This truncates the soil profile with the sandy gravel topsoil and overburden being replaced on top of deeper mottled and pallid clays during the restoration operation (Koch, 2007a).

The total mining lease area of NALCO is 7204 ha. including 1700 ha. of bauxite bearing area (Mohanty, 2001). Being heterogeneous thin blanket type deposits with high undulations at contact zones, conventional mining methods do not ensure better quality control and 100% mineral recovery. Hence, ‘Trench method of mining’ widely practiced by the technical collaborator M/s Aluminium Pechiney, France, has been adopted. The mining process at Panchpatmali may be summarized as below (India, 2004b):

**A. Trench Mining:** A pilot trench is driven through the mid of the deposit and several other trenches are opened on both sides of it in a staggered pattern exposing and creating more numbers of working fronts. The staggering of trenches facilitates in preventing concentration of mining machineries at one place and thereby preventing accidents, excess noise and high dust generations, etc.

**B. Rock breaking:** The fertile top soil is dozed aside and preserved exposing hard laterite of 3-4 m thickness which needs drilling and blasting. The top slice of bauxite of 8-10 m thickness is loosened by drilling and blasting and by ripping in few places of soft strata. The bottom bauxite of 3-4 m thickness is soft and removed by using backhoe shovels as selective mining to prevent dilution of silica in bauxite.

**C. Land Reclamation:** Overburden removed is dumped in fully mined out area to approximately a height of 4-5 m and capped with soil removed from the first layer of
overburden. Plantation is carried out on this with onset of monsoon. This process of excavation and reclamation goes on simultaneously during the life cycle of the mine.

D. Peripheral barrier: The hill has sharp escarpments mostly on the eastern side and steep gradient slopes on western side. In order to prevent rolling down of mining equipment to the slopes, prevent spreading of dust and noise to the surrounding and prevent flow of surface run off from mining areas to the valleys, a 15 m width of bauxite is left on both sides of the hill to act as peripheral barrier. Plantation is carried out ahead of mining on this barrier to act as a green belt.

3.9 Reclamation at Panchpatmali Bauxite Mine

After drilling, blasting or ripping-dozing, bauxite is separated and the top bauxite is transported by loader- dumper combination or by front shovel- dumper combination to crusher/stockpile. The mined-out trenches are filled by overburden material and are designed to convenient benches and are leveled. Provisions for proper drainage are engineered. Now the benches/terraces are capped with approximately 0.3- 0.5 m of topsoil and plantation with suitable species is done during the next monsoon. Pits of 45 cm cube and 30 cm cube are dug as per requirement of the species. The density of plantation was maintained at 1600/ha till 1994-95 (2.5 m X 2.5 m), which has been increased to 2500/ha (2.0 m X 2.0 m) from 1995-96 onwards. Fungicides and pesticides are used before planting (Pattnaik and Roul, 2003).
Fig. 3.3: Map of Panchpatmali Bauxite Mine Area (Source: NALCO)
Photo 1: Virgin Area (VA) of the plateau top before mining

Photo 2: Drilling for blasting the overburden

PLATE- 1
Photo 3: Excavation and loading of bauxite

Photo 4: Bauxite profile

PLATE- 2
Photo 5: Top soil brought for spreading over filled up area

Photo 6: Spreading of top soil

PLATE- 3
Photo 7: Leveled area ready for plantation

Photo 8: One year old plantation

PLATE- 4