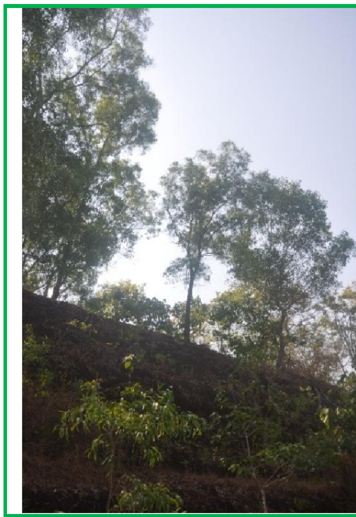
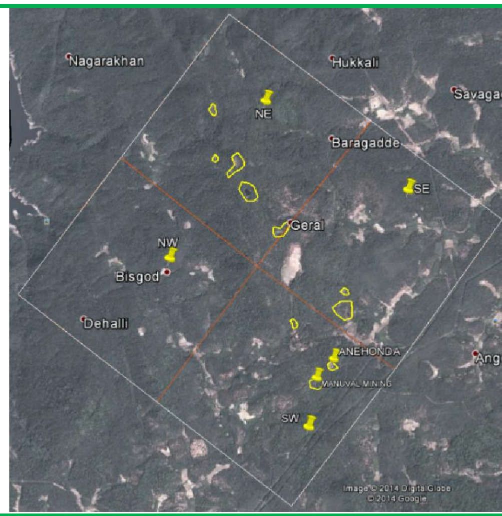
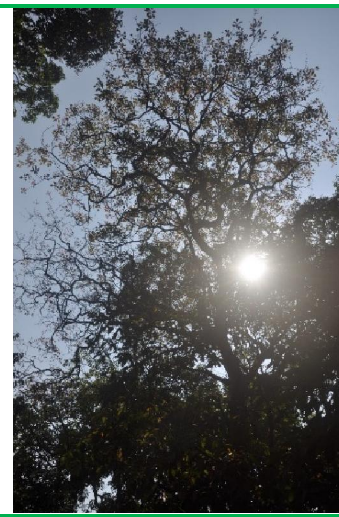
Sahyadri Conservation Series 43

Reclamation of Mine Regions at Bisgod: Approaches and Challenges







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Reclamation of Mine Regions at Bisgod: Approaches and Challenges

Executive Summary

Mine reclamation entails restoring landscape so as to regain its earlier ecological status. Although the process of mine reclamation occurs with the cessation of mining, planning of mine reclamation activities need to be done prior to mining in a region. This helps to provide protection and mitigate the adverse environmental impacts while improving the aesthetics of the area. Mine closure plan needs to focus on the beneficial post closure use to all stakeholders including proximate communities. Mining is a temporary use of a natural resources such as land and are disturbed by the operations that needs to be rehabilitated after completion of mining.

Mining activity has significant ecological, economic and social footprints much beyond the physical boundaries of mines. In-situ beneficiation and long distance transportation of minerals also significantly contribute to expand the mining footprint over a geographically large area. The environmental degradation is a manifestation of agents such as socio-economic, institutional, technological activities, population growth and rising energy use and transportation. However, preventative measures help in mitigating the effects of further degradation due to mining. Region specific land use planning would help in minimizing land degradation. These initiatives will help in controlling fragmentation considering issues such as deforestation, increase in population and infrastructure development. Mine site closure planning should occur within the initial mine planning and feasibility assessment phase prior to the commencement of mine site operations. Earlier practices of mine closure and rehabilitation have neglected the fundamental concepts of land use development and integrated mine closure planning. The planning always operates under legislative measures which prescribes recommendations and regulations. So, if the planning incorporates by using zoning measures addressing specific parcels rather than land use plans at general basis.

Environmental issues including reclamation, rehabilitation are under surveillance of Indian bureau of mining (IBM) by virtue of implementation of approved closure plans and further creating awareness among mining community through Mines Environment & Mineral Conservation (MEMC) during last three decades. Indian mineral policy amended in 1993, to include minimisation of adverse effects on forest, environment and ecology with due regards to safety and health of all concerned people and rehabilitation of mine closures and displaced

persons. But, in the case of Bisgod, reclamation process is weak despite some initiatives of afforestation by forest department and other agencies. Mine closure planning should recognise that rehabilitation provides an opportunity for post mine land use development, mitigate environmental damage, achieve a productive use of the land, or return the land to its original condition or an acceptable alternative and provide for sustainability or social and economic benefits, which were not effectively attained in Bisgod region.

Recommendations to mitigate impacts due to mining are:

- Regional mine development plan to be developed only after an assessment of carrying capacity of a region. This should include local infrastructure capacity, number and type of mining leases in an area; beneficiation requirements, prevalent mining methods; ore transportation alternatives, management of top soil, mine closure plan, etc.
- Regional strategic plan to include environmental, ecological and social impact issues and drive the internalization of their associated mitigation costs (eg., mine waste management; conservation, protection and development of water and ecological resources; regional social issues etc.). This includes focus on conservation of biodiversity, ecology and hydrology of a region.
- Assessment of cumulative impacts and setting threshold limits at local levels.
- Recovery of an ecosystem (that has been degraded or destroyed) through ecological restoration, involving restoration of the stability and productivity of land to enable regrowth of vegetation. Reshaping of the 2 to 5 m high pit walls to a maximum slope angle of 20º. In order to improve the stability of the area, a minimization of slope inclination to < 30% is required. Broad terraces (8-12 m width) and small terraces (1.2 m width) would help in addressing erosion hazards.
- Need to restore the land to its approximate original contour. In open-pit mining area, the mining steeps are to be flattened with the provision of drainage channels with retaining walls avoids the soil erosion.
- Topsoil of the study area is very poor in nutrients, with low content of clay and medium organic matter and very alkaline. Need to maintain over 25 cm in order to support effectively the established species. Also, the topsoil should be enriched with organic matter (2% at least) in order to improve soil fertility. The organic materials nourish degraded soil are to be enriched with nitrogen fixing bacteria (Rhizobium, Azotobacter) and endo-mycorrhizal fungi.

- Organic wastes aid as both fertilizers and soil amendments. The most practical way to increase the nitrogen content of ecosystems is to establish nitrogen fixing plants such as, legumes (Horse gram *Macrotyloma uniflorum* immediately after first showers) and use of these plants as mulch later.
- Top soil of the region need to be handled carefully during mining and use of top soil during the rehabilitation of mined regions will help in rejuvenation of the region.
- Plant the native species of early successional species of herbs and grasses- planting early succession species of native herbs and grasses would help in improving soil quality. The important grass species, namely, *Bothriochloa pertusa, Chrysopogon fulvus, Cymbopogon flexuosus, C. martinii, Cynodon dactylon, Dichanthium annulatum, Eleusine indica, Heteropogon contortus, Saccharum spontaneum,* etc., may be planted in the region including slips and root stocks.

Table 1: Grass species suggested for re-vegetating degraded landscapes

Sp	Inclusion	Remarks
Bothriochloa pertusa	Yes	It is able to grow in many types of soils. It withstands drought and disturbance, and it can sprout up in dry, degraded habitat, such as roadsides. It survives short-term water logging and fire
Chrysopogon fulvus	Yes	Considered a useful pasture grass and has been used to enrich degraded grasslands. Grazing is to be avoided during the establishment year. Palatable and fairly high-yielding
Cymbopogon flexuosus	Yes	also called Cochin Grass or Malabar Grass is a perennial grass native to India, Sri Lanka, Burma, and Thailand. It is placed in the genus Cymbopogon (lemon grasses**). Grown in moist, full sun to partial shade**
C. martinii	Yes	Similar to above
Cynodon dactylon	Yes	
Dichanthium annulatum	Yes	The grass can also be used to revegetate degraded grasslands. It is a very effective binding plant for erosion control. This is favored pasture grass species in India.
Eleusine indica	Yes (in moist areas)	It grows in **moist** as well as marshy areas, puddles, shallow ponds, fields, river and stream edges, ditches, canals etc. It is tolerant of heavy disturbance like trampling, organic pollution and can grow along sewage lines, gutters easily
Heteropogon contortus	Yes	Valuable pasture species. Favoured in most environments by frequent burning.
Saccharum spontaneum	Yes (needs initial moist conditions)	Occurs along river banks; usually in sheltered places. It grows as wasteland weed. It is considered as valuable medicinal herb in traditional systems of medicine in India. Planted to check soil-erosion

- Reclamation of mined out areas is a challenging task due to altered chemical and physical trait of the region. In the initial stages of reclamation quick growing grasses with short life cycle will improve the nutrient and organic matter content in soil. Plantation of mixed species of economic importance could be done after 2-3 years of growing grasses. Cover the area with a loose layer of hay mulch to provide the initial "jump start" of forage required for the livestock.
- Use of microbial activator or a mixture of microorganisms and organic matter will aid in increasing soil organic fertility and productivity.
- Mining activities are unsustainable not only because they exploit non-renewable resources, but also because they leave behind degraded landscapes to the society. Large scale mining should be banned in ecologically sensitive regions – Western Ghats.
- Address the needs of all stakeholders including miners and local community during pre and post mining periods.
- There is a need to strengthen grassroots administrative structures especially gram panchayaths to address the issues related to mining fitting into existing communities to cooperate with the local communities to improve the region for a meaningful contributor to sustainable development.
- Post project monitoring committee: Empowered multi-disciplinary committee comprising of mining engineer, civil engineer, hydrologist, ecologist, wildlife biologist, village forest committee members, local forest officers and representatives of the affected communities would help in administering the restoration of the region especially stabilization of slopes, re-establishment of vegetation, lowering of silt yield and transport, enrichment of habitats of endemic fauna, etc.
- The forestry as the future land use of the mining area as the previous land use was predominately forests (includes degraded forest land, used for animals grazing and firewood production)
- Monitoring of afforestation activities and submission of yearly reports regarding survival status of saplings in coordination with forest department.
- Afforestation practices help in restoring and enhancing the vegetation cover in mine areas in various ways. Reclamation through afforestation with native species requires inventories such as area to be planted, native species of the region, slope gradient, quality of soil, climate conditions and nature of biotic pressure in the mining sites,

overburden sites and abandoned sites. Those species have to be selected which have ecological supremacy in enhancing soil moisture, maximum canopy in short time as well as hard woody and ability to fix direct atmospheric nitrogen.

- Instead of dense *Acacia auriculiformis* planting in mine pit areas, mix of native forest species such as *Terminalia sp, Aporosa lindleyana, Lagerstroemia lanceolate, Diospyros montana, Syzygium cumini, Olea dioca, Buchnania lanzan, Venguria spinosa, Randia dumentorum, Careya arborea, Schleichera oleosa, Adina cordifolia* etc., is to be practiced to improve the soil quality and fertility. Introduction of nitrogen fixing trees such as *Albizia sp, Cassia fistula, Xylia xylocarpa* and addition of biofertilizers such as Azotobacter, Rhizobium, and endomycorrhizal fungi would enable the plant species to be stress tolerant through continuous supply of nutrients during early stages of growth.
- The species that survive in varied habitats such as *Sapindus emarginatus, Mangifera indica, Artocarpus heterophyllus, A. lakoocha, Garcinia indica, Ficus spp., Terminalia bellirica, Caryota urens, Madhuca indica, Pongamia pinnata, Corypha umbraculifera, Aegle marmelos, Bombax ceiba, Phyllanthus emblica* etc. will aid as shade trees, utility trees (fruits, medicine, fodder leaves etc.) and habitat for nectar species, with varied ecosystem services.
- The cattle-proof trench (CPT) is required to prevent cattle browsing and encroachments in forest regeneration areas.
- An alternative to improve soil quality of degraded lands in Bisgod region is the establishment of forest with the mix of native species, which improve ecosystem services such as: litter supply, nutrient cycling, water infiltration, control of erosion, and increasing of biodiversity. This process allows the soil exploration by abundant root system, the protection of the soil surface against erosion, and the reactivation of nutrient cycling via litter production and decomposition.
- Provision of LPG cylinders to all households and alternate energy devices such as biogas to minimize the dependence on forest wood for domestic cooking, water heating, etc.
- Post mine environmental monitoring and management groups' (of the affected communities) active involvement in rejuvenating the region by afforestation, development of native species nurseries, nurturing of sapling during initial stages, etc.

- Village Forest Committees of Bisgod and NGOs, self-help groups that are environmentally conscious to be involved in planning of recovery of native vegetation. The programme of raising seedling by the local women and unemployed youth would empower local population.
- Existing Acacia plantations are to be replaced with native vegetation in phased manner and the revenue generated be used for afforestation endeavours.
- Forest plantation establishment is broadly divided into three management phases such as, seed collection and handling; nursery practices and plantation establishment; and management. The forest department should make VFCs and local women as an active partner of plantation, management.
- Improved regulations and independent monitoring teams should be commissioned to provide moral as well as monetary support to local communities through VFCs.
- The abandoned mined sites (acting as a lakes) in the villages of Nagarakan, Hukkalli, Bale Kodlu to support rainwater recharge and aid as food and water resources for wild animals as well as local people.
- Some mined sites are already acting as a water bodies and has water throughout the year, which should be provided with stone pitching to reduce the degradation of surface water bodies in monsoon. Construction of diversion channels, protective earthen bunds and check dams at appropriate locations to minimize sedimentation in surface water bodies.
- The overburden needs to be managed separately and stockpiled nearby. Reuse of these as cover for the mine region will help in the direct return of fresh topsoil which enhances the possible return of viable seeds, nutrients, organic matter and beneficial soil micro-organisms.
- Forest fragments close to the degraded areas are important sources of seeds and these fragments needs to be preserved and monitored to sustain natural resources.There is an urgent need for creation of grassy patches in Garel, Bisgod region to reduce the grazing pressure on forests. The vacant staff quarters (Figure 14) of mining agencies should be handed over to the use of forest department, local schools or VFCs.
- Mining company are required to deposit with IBM at least 15% of annual revenue (or based on the spatial extent of mines or quantity mined very year). This money deposited with IBM, be used for restoration of the region during the post mining period. This has

distinct advantage over financial assurance concept, every year as the fund increases making it viable and substantial in the end of life.

- In this regard, State Government can conduct the survey of abandoned mines, prepare project report in consultation with IBM for assessment of fund for reclamation and rehabilitation activities for further monitoring and commission preparation of reclamation projects in consultation with local committees to be executed by District Mineral Foundation out of State Mineral Funds as per proposed MMDR2011.
- Provision of financial surety would guarantee the reclamation costs at the time of abandonment of mines. Therefore, the financial surety should come into active force if the mining agencies fail to meet the standard regulations of reclamation at the time of abandonment, technical and financial failure or in the event of premature closure. The recommendations and representation of VFC is provided in Annexure-1.

The Central Pollution Control Board (CPCB), Ministry of Environment and Forests, Government of India, has initiated a study entitled "Description of Clean Technology for Iron Ore Mines and Development of Environmental Standards " provides the following guidelines for reclamation.

- The mined land is to be cleared of rubbish, surplus materials, temporary structures and equipment and all parts of the land shall be left in a condition as close as possible to that prior to use.
- Topsoil should be replaced along the contour where possible. This will help in erosion control by reducing water flow down slope and increasing water storage. Wherever possible, the topsoil should be immediately replaced on an area where the land form reconstructions are complete.
- If topsoil is not available, the cost of transporting is prohibitive, or the topsoil contains such high levels of week seed or plant pathogens that it is unsuitable for rehabilitation, then subsoil, overburden, waste rock or similar materials must be used as a substrate for re-vegetation.

- The following are techniques which can be considered to improve the ability to support plant growth in the long term
- Application of organic matter such as animal manures, sewage sludge or other wastes; chemical amendments such as Gypsum to improve the structure and reduce the pH of highly alkaline substances. Lime to raise the pH of acid substrates and inorganic fertilizers.

- Soil conditioners such as growing green manure crops help in the faster reclamation.
- Mulches can be used to protect the soil from raindrop impact. Most suitable materials are brush matting, stubble mulch; lazy mulch, sawmill wastes, bitumen, and other chemical stabilizers. These materials may also aid, or in some cases inhibit, germination of seeds in the revegetation program.
- Native planting is the key to successful rehabilitation. Plant species can be established on rehabilitated areas from propagules (seeds, lignotubers, corns, bulbs, rhizomes and roots) stored in the topsoil or sowing seeds (seed retained on the plant in persistent woody capsules) onto areas being rehabilitated, planting nursery-raised seedlings; habitual transfer – the transfer of substantial amounts (around 1 m to 200m).
- Species which have similar growth forms to the original vegetation, and thrive in areas with comparable soil types, drainage status, aspect and climate of the rehabilitated area, are the most appropriate. Care must be taken to avoid introducing a species which could become an unacceptable fire hazard, invade surrounding areas of native vegetation or become a weed for the local agriculture.
- Tailing dams/ ponds should be redesigned with decant tunnels, channels to provide for storm water run-off.
- Re-vegetation of exposed surfaces shall be done as far as possible in mines. Techniques such as hydro-seedling shall be used on steep slopes and other difficult areas as a measure of soil erosion control and slope stabilization.
- The effects of reclamation operations themselves over the surrounding environment should also be not ignored. The continuous monitoring should focus to account the effects of runoff on quality and quantity of surface waters; the effects of seepage on aquifer quality & recharge in ground water; effects on aquatic and adjacent terrestrial habitats & migration routes on wildlife habitats; changes in climatic conditions; flora & fauna; changes in soil cover & land use for agriculture or forestry. For this, some sampling stations may probably have to be located outside the boundaries of the former mine site, so as to ensure that the surrounding conditions are satisfying the environmental criteria. This approach will provide the success of current management practice and helps in further for better planning.
- After the reclamation project, monitoring team should ensure that the objectives of land reclamation are achieved.

Part –I: **Land cover in Bisgod, Uttara Kannada: Impact of Mining and Rejuvenation**

Summary:

Mining activities in forested Western Ghats exerts pressure on environment at many stages i.e. exploration, extraction, processing, and post closer operations. Large scale opencast mining operations in the study area disturb the land by directly removing mine wastes during excavation and concurrently dumping it in adjacent areas. Impacts induced by abandoned mines are potentially harmful to surface or underground water flow modifications as well as surface instability developments capable of affecting people or infrastructure. During this course of action often lands under the cover of forest are diverted for mining caused impacts on the lands by changing in topography, drastic change in drainage pattern and triggering lands slides and rapid soil erosion. The mining was stopped in 1997 as a due to the sustained agitations from local people and NGOs. Vegetation cover aids as a regulatory factor towards the reconstruction of an ecosystem and mine soil, as it improves the physical and biological diversity of disturbed sites. The reforestation programs were initiated with local communities, NGOs (Vriksha Raksha Andolan and others) and VFCs (Village Forest Committee) helping the region to salvage its earlier status. The vegetation cover has improved in un-mechanised mining regions compared to mechanised regions. Recovery of an ecosystem (that has been degraded or destroyed) through ecological rejuvenation, involving restoration of the stability and productivity of land to enable regrowth of vegetation. Ecological restoration helps in the recovery of an ecosystem that has been degraded, damaged, or destroyed to return degraded biological communities to their original state and to re-establish self-regulatory natural processes. Reclamation reduces negative geomorphological processes, such as landslides and erosion, which are important factors in unstable localities such as high forested and mountainous regions

Introduction:

Quantitative analysis of land use land cover (LULC) changes is necessary for effective planning of a region. Land cover (LC) refers to the physical or biological material cover on the earth surface. Land cover configuration is stated as a unified reflection of the existing natural resources, dynamic natural processes. Land cover categories include forest, savannah, desert, water which are refined into more categories representing specific communities (e.g., plantations, scrublands, mangroves, perennial streams, grassland, etc...). Land use refers to the human induced changes in the land cover for agricultural, industrial, residential, recreational purposes. The drivers of land use changes include policies, mining of natural resources, agricultural production, urbanization, etc. Land use change alters the homogeneous landscape into heterogeneous mosaic of patches. LULC change is driven by the interaction of ecological, geographical, economic, and social factors (Zang and Huang, 2006) that determine the landscape development and the particular combination of factors operating in that area (Geist and Lambin, 2006). Understanding of LULC changes help in mitigating impacts due to deforestation, soil erosion by water and wind, salinisation etc. LULC study offers the appropriate solutions (also referred as alternatives) to the origins for land cover changes.

Mining refers to the process of extracting metals and minerals from the earth. Land use changes in terms of mining activities cover a diverse range of environmental challenges which were unique and specific to each mine site. Mining activities will invariably have direct or indirect impact on environment such as land degradation, degradation of forest and loss of biodiversity, soil contamination, air pollution, uncontrolled noise vibrations, surface and ground water pollution deterioration of natural drainage system (Dasgupta et al., 2012). Mining is a major economic activity, whether small or large-scale, are inherently cause deterioration in environment (Akabzaa, 2000), producing enormous quantities of waste that can have deleterious impacts for decades, as a result of inappropriate working practices and rehabilitation measures. Mining has a number of common stages or activities, each of which has potentially adverse impacts on the natural environment, society and cultural heritage, the health and safety of mine workers, and communities based in close proximity to operations (Noronha, 2001). Large scale operations of mining activities will contribute directly or indirectly to the depletion of the biological diversity in the region. Contiguous forests are being fragmented for excavation of minerals, development of mining infrastructure and dumping of overburdens.

The direct impacts of mining are extinction of plants and animals due to mining activities or contact with toxic wastes and mine drainages. Indirect impacts may include changes in habitat alteration, nutrient cycling and disruption of food chain (Gayatri et al., 2010). The mining activities can also produce contamination of water through tailing discharges or other direct or indirect contacts, mixing or use of water in the processing. Removal of vegetation cover often aggravates massive soil erosion, siltation of river and reservoirs that affect both the surface and ground water regime. The intensive mining activities considerably influence the hydrology and the severity of pollution depends on sources of liquid effluents in opencast mining, spent water from dust extraction and dust suppressing system and leachate run off from waste dumps.

Reclamation through revegetation of mine spoils in abandoned mine lands is the viable solution to protect the land scape and its environs from further degradation. Reclamation usually reduces negative geomorphological processes, such as landslides and erosion, which are important factors in unstable localities such as high forested and mountainous regions (Huttl and Gerwin, 2004). Tree plantation is supposed to be the best tool for reclamation of mine spoils (Singh et al., 2002), because the trees not only provide long-term ecosystem stabilisation and render potential enrichment in soil quality (Bradshaw, 1987), but also have potential commercial and aesthetic value (Torbert et al., 1993). The establishment of vegetation in abandoned mine areas involves the formation of the slopes, provision of necessary quantities of topsoil, the selection of the suitable native plant species able to survive in such extreme site conditions, the possible problems due to toxicity and environmental pollution (Gong and Yang, 2014). Successful reclamation requires knowledge of both biotic and abiotic factors, and also about ecological processes, it is necessary to analyze the properties of the reconstructed soils, because all physical and chemical soil characteristics are extremely important components of the impending ecosystem structure (Hendrychova, 2008).

Afforestation with native saplings is the commonly adopted management strategy in post mining landscapes, both from the ecological and economic point of view (Tajovsky and Vozenilkova, 2002; Bhattacharya, 2005). Reclamation with vegetation potentially reduces dangerous or toxic emissions or reduce discharges of potentially dangerous chemical substances into the environment (Wolkersdorfer, 2006). Vegetation exert a catalytic effect in the mine spoil restoration, by changing the understorey microclimatic conditions (viz. increased soil moisture, reduced temperature, etc.), increased vegetational-structural complexity, and development of litter and humus layers, which occur during the early years of plantation growth (Singh et al., 2002). Vegetation reverses the degradation occurred due to mining activities by stabilizing soils through development of extensive root systems (Sharma and Sunderraj, 2005) in disturbed habitats. In reclamation process species consideration should focus an array of agro-socioeconomically productive properties (Juwarkar et al., 2009) along with notably similar environmental outcomes such as promoters of nitrogen fixing interactions, relatively fast growers, well adapted to environmental conditions within more arid zones (i.e., intense heat, sunlight), and have root architectural adaptations for drought tolerance (Koul et al., 1990; Sharma et al., 2004; Scott et al., 2008). Soil properties of the mined sites will approximate to the natural soils of the area with the passage of time as the revegetation process will progress by the improvement in soil texture and nutrients (Hanief et al., 2007).

Natural recovery of the mine spoil also takes place, but it takes several years to reach the natural condition through colonization of plant and animal species. On the other hand, vegetation through afforestation, with several amendments, takes comparatively lesser time to reach the values of a native forest ecosystem (Jha and Singh, 1992, Evans et al., 2013). The systematic ecosystem approach is the feasible solution for reviving the abandoned mined sites. Ecological restoration is the process of assisting the recovery of a degraded ecosystem. These restoration strategies must address soil structure, microbe populations, and nutrient cycling in order to return the land as closely as possible to its pre-disturbance condition and continue as a self-sustaining ecosystem. A restoration programme not only helps in restoring the soil fertility, but also enhances the biological diversity (Dobson et al., 1997; Singh and Singh, 2006; Vermai et al., 2007). Spatial data acquired at regular intervals through space borne remote sensors has the ability to provide consistent measurements of landscape conditions, allowing detection of both abrupt changes and slow trends (Kennedy et al. 2009; Fraser et al., 2009; Bharath et al., 2013). LULC changes reflect the most significant impact on the environment due to human activities or natural forces revealed effectively by remote sensing for getting wide impression (Zhou et al., 2004). Remote sensing data along with GIS and GPS (Global positioning system) helps in effective measure of landscape dynamics (Ramachandra et al., 2014) in cost effective manner (Lillesand et al., 1987). Remote sensing data with GIS has been a useful tool for planning, and decision making to devise sustainable land use and environmental planning (Dewan and Yamaguchi 2009).

Objectives:

- To identify and assess the spatio temporal changes in the land scape of Bisgod pre and post mining activities.
- To examine local communities perceptions on how mining activities impacted the environment.
- To suggest interventions that can assist in mitigating the negative impacts of mining.

Indian Mining sector-a brief review: Mining sector has been in the news in recent times due to unlimited and unsustainable exploitation of mineral resources, pollution and destruction of natural resources including forests, large scale displacement of rural and tribal people, rapid depletion of mineral wealth of the region, royalty paid to the state is negligible. Small scale mines and artisanal mines form a major proportion though their geographical area of operation may be small. Forest land diversion for mining has been estimated as 1.64 lakh hectares in the country. Mining of major minerals generated about 1.84 billion tonne of waste (2006), which has been disposed-off without due considerations toward the environment. Out of the 9416 mines (excluding fuel, atomic and minor minerals) in the Country, there are about 5345 (56%) number of mining leases that have a lease area less than 10ha in size. However, their cumulative lease area is 21,000 ha which is 4% of total mine lease area in the country. There is no reliable information on the physical distribution pattern of mining leases in the minor mineral sector wherein small and medium scale mines and artisanal mines of less than 5 ha in size dominate. Mandated government agencies like Indian Bureau of Mining (IBM), State Pollution Control Boards (SPCB) also report significant lack of capacity to perform their regulatory functions to the levels required. Current capacity within IBM can cover only about 2500 leases, while there are approximately 7000 leases and 5000 operational mines in the country (HLC, 2006). Legal and regulatory loopholes and inadequate policing has allowed the illegal mining operations to flourish and grow in the country (TERI, 2001). The coincidence of rich biodiversity with mineral bearing areas, is understood but not adequately factored into the comprehensive assessment and mitigation of long term impacts, leading to inadequate response from the project proponents and the regulator.

Study area:

India's 78% vanadium ore, 73% iron ore (magnetite), 42% tungsten ore, 37% asbestos, 28% limestone, 22% gold, 20% granite, 17% dunite, and 14% corundum resources comes from

Karnataka State. Between 1980 and 2005, around 7,558 hectares of forest land in Karnataka was diverted for mining activities – this is about 8 per cent of the total forest land diverted for mining in India, while revenues from mining has remained a bare 0.7-0.8 per cent of the state's total revenues. The manganic-ferrous formation in Uttara Kannada district, Karnataka has marked discontinuously along the Anmod–Bisgod tract and continues northwards into Belgaum district. Lateritic weathering of the Late Archean meta sedimentary manganic-ferrous formation of the Shimoga Schist Belt and subsequent epeirogenic uplift and erosion of the Western Ghats terrain gave rise to the uniquely disposed supergene ore accumulations in the Anmod–Bisgod belt (Sethumadhav et al., 2010). In Bisgod region, ore occurs as conformable units within phyllite and chert and at times with dolomite. Mining in Bisgod region was mainly by opencast extraction method. Open cast mining involves the removal of overburden including the valuable topsoil and plus the natural vegetative cover to meet the expected mineral deposits. The most common surface mining method is opencast mining, which keeps exposure to the surface during the extraction period. Disruption of the surface significantly affects the soil, fauna, flora and surface water, thereby influencing all types of land use. Mining activities are carried out by Mysore Minerals Limited (MML) in stages: deposit prospecting and exploration, mine development and preparation, mine exploitation, and treatment of the minerals obtained at the respective installations with the aim of obtaining marketable products. The emerging environmental hazards associated with open cast mining practices are numerous.

Opencast mining excavates large land areas to extract the mineral ore and at the same time requires huge areas to dump the mine spoils. During this course of action nearby areas under the cover of forest or agriculture are diverted for mining. This exploitation impacted on the landscape resulting change in topography, drastic change in drainage pattern, triggering lands slides, rapid soil erosion, rapid siltation and degradation of surface water bodies. Opencast mining operation creates enormous quantity of dust of various sizes which passes into transportation and disperse significant amount of suspended particulate matters (SPM) and gaseous pollutants in to the atmosphere. These pollutants not only affect the mine workers but also affected the nearby populations, agricultural crops and livestock. It was also noted blanketing mine spoils in the nearby agricultural and grazing lands, which affected productivity of farming. In order to obtain the fine-grained metals and other minerals, large quantities of rock are mined, crushed, and processed to recover metal and other mineral values. Mining industry produces enormous quantities of waste, rock particles etc., these wastes are known as "tailings." In Bisgod region, major dumping was done in a large pond called Anekere -

'elephant's pond'- (where historically elephants used to drink water) has been totally filled up with mining refuse. According to Mines and Minerals Development and Regulation Act, 1957 every mine is required to submit mine closure plan, which are (i). Progressive Mine Closure Plan and (ii) Final Mine Closure Plan. This is to be submitted to concerned authorities by the project proponent (owner, agent, manager or mining engineer). Even in case of fresh grant or renewal of mining lease, submission of a Progressive Mine Closure Plan as a component of mining plan to the officer authorized by the State Government is mandatory. Submission of final mine closure plan to authorities at least one year prior to closure has not been for Bisgod. Manganese mines in the Bisgod and its neighboring regions has devastated the area during the last 30 years.

The present study aimed at identifying the impact of mining and restoration of forests in the region with temporal data. The Bisgod and its surrounding was divided in to four directions NE, SE, SW and NW covering an area of 2.5*2.5 km region (Figure 1 (a & b)). The NE, SE, SW regions are potential mined areas, where as NW region no mining activities were took place. As per Karnataka Forest department working plan, total area allotted for mining is about 7,558 Ha. The total land released for MML is done at periodically as 70 Ha, 40 Ha etc. at different places in Bisgod region. Figure 1 maps mined areas in each direction. Field analysis was carried out to understand the status of vegetation in the region with afforestation endeavor by local forest department and also regeneration prospects. Mining license was acquired in 1961 by MML with Goa based private mining industries. The major mining work was executed in post 70's. The license expired in 1989 but the company continued mining till 1997. During this period with mechanized extraction impact on forests is evident with degradation of the forest area. This affected more than 10,000 local people who were dependent on the forests for their livelihood. The mining activities were stopped with the sustained agitation from local people and NGOs (Vriksha Raksha Andolan, and other).

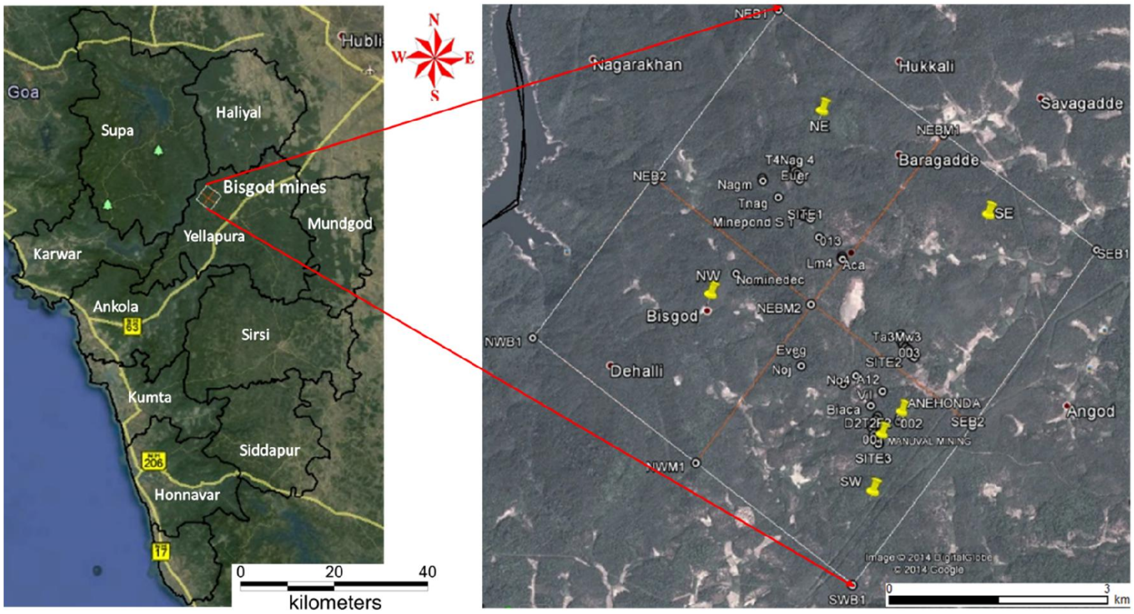

Figure 1 (a): Study area- Bisgod landscape (Uttara Kannada district, Karnataka)

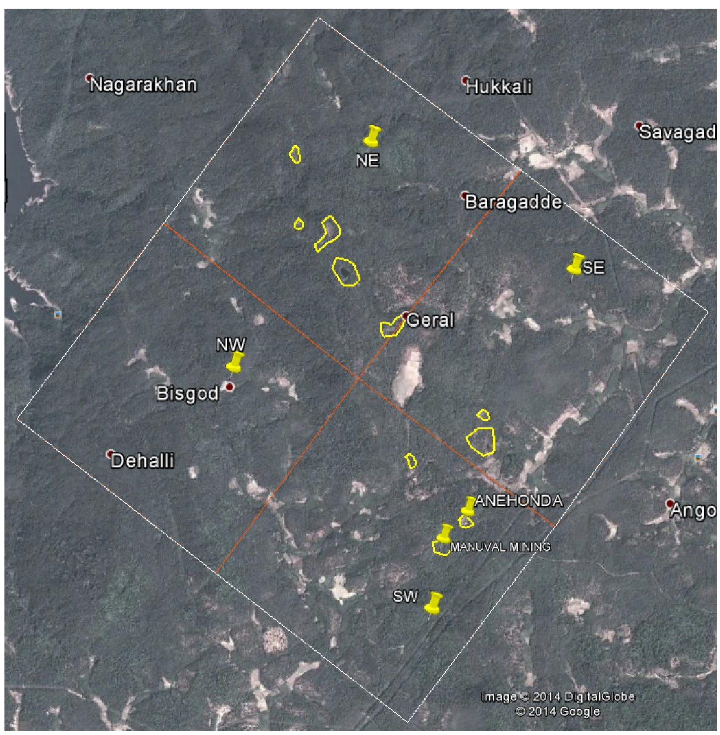

Figure 1 (b): Study area and mined sites visited for field investigation

Figure 2: Mining area in SW direction (near Anekere- no mechanised extraction)

Figure 3: Mining area in NE direction (Nagar Kan area-mechanised extraction)

Method:

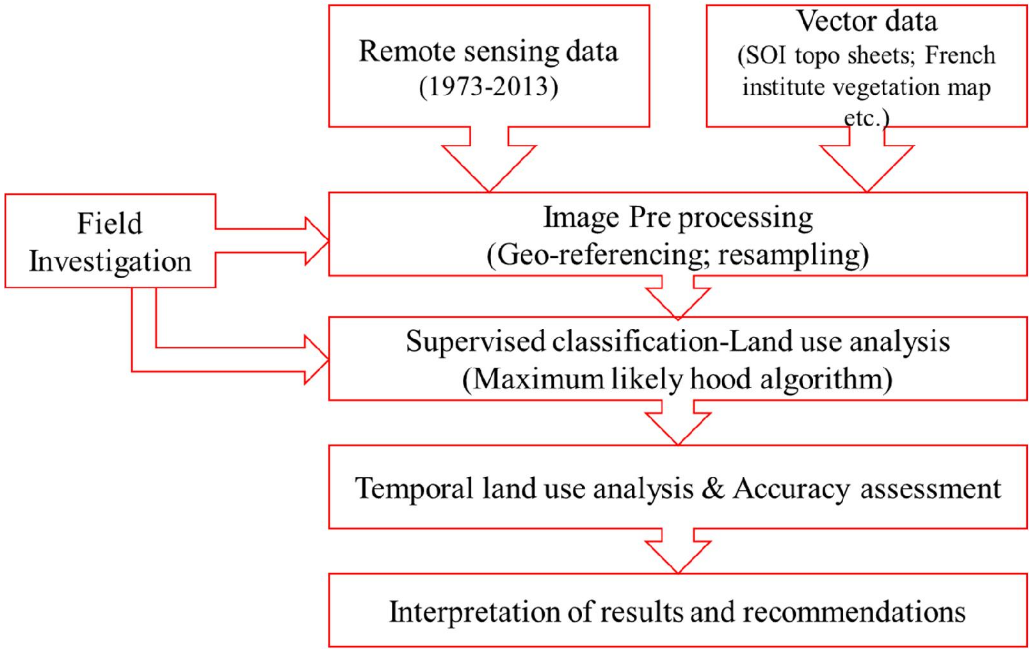

Figure 4: Method followed in the analysis

LULC changes in Bisgod region has been analysed with the help of temporal remote sensing data (RS), ancillary data (collateral data compiled from government agencies) and field investigations. Figure 4 outlines the method followed in the analysis. The RS data used in the study are Landsat MSS (1973), TM (1989, 1999), Landsat ETM^+ (2013) and online Google Earth (http://earth.google.com) data. The ancillary data is used to assist the interpretation of different land use types from remote sensing data. Topographic maps provided ground control points to rectify remotely sensed data and scanned paper maps (topographic maps). Survey of India (SOI) topo sheets (1:50000 and 1:250000 scales) and vegetation map of South India developed by French Institute (1986) of scale 1:250000 was digitized to identify various forest cover types and temporal analyses to find out the changes in vegetation. Other ancillary data includes land cover maps, administration boundary data, transportation data (road network) and pre-calibrated **GPS** (Global Positioning System - **Garmin GPS unit)** for field measurements. Ground control points are used to geometrically correct remote sensing data and verify the classified land use information.

The temporal remote sensing data of Landsat satellites were collected and enhancement of images (depending on the scene that required treatment) was done at image preprocessing stage. The RS data is geometrically corrected using ground control points collected from the field using pre calibrated GPS (Global Positioning System) and also from known points (such as road intersections, etc.) collected from geo-referenced the Survey of India topographic maps. Geometric correction is the process of referencing a map/image to a geographic location (real earth surface positions) using GCPs (ground control points). In the correction process numerous GCPs are located in terms of their two image coordinates; on the distorted image and in terms of their ground coordinates typically measured from a map or located in the field, in terms of UTM coordinates or latitude and longitude. The land use analysis was done using supervised classifier based on - Gaussian maximum likelihood algorithm with training data (data collected from field). Maximum Likelihood algorithm is a common, appropriate and efficient method in supervised classification techniques by using availability of multi-temporal “ground truth” information to obtain a suitable training set for classifier learning. This approach quantitatively evaluated both the variance and covariance of the category spectral response patterns when classifying an unknown pixel of remote sensing data, assuming the distribution of data points to be Gaussian. **GRASS GIS** ***(Geographical Resources Analysis Support System)*** software is used for the analysis, which is a free and open source software having the robust support for processing both vector and raster files accessible at http://wgbis.ces.iisc.ernet.in/grass/index.php. To classify earlier time data, training polygon along with attribute details were compiled from the historical published topographic maps, French institute vegetation maps, revenue maps, land records available from local regulatory authorities, etc. This information provided as a base for analysing earlier time data with more valid positioning. The 60% of training data has been used for classification, while the balance is used for remote sensing data validation or accuracy assessment. Accuracy assessments is a statistical assessment decide the quality of the information derived from remotely sensed data considering reference pixels. These test samples are then used to create error matrix (also referred as confusion matrix) kappa (κ) statistics and overall (producer's and user's) accuracies to assess the classification accuracies.

Results and discussion:

The land use analysis from 1973 to 2013 reveals the transition in the landscape of Bisgod region (Figure 5 and Table 1). The region had 89.99% of evergreen forest cover and 5% of crop lands in 1973. The evergreen forest declines to 61.13% by 1999 with the initiation of mining and associated developments. The forest loss and fragmentation highlights land conversion for non-forestry purposes. The land use conversions subsequent to mining include ancillary facilities and statutory buildings (workshops, stores, offices and canteen), residential colony and related welfare amenities like school, hospital, shopping center etc.. The major impact on the land use during the pre-mining phase was removal of vegetation and creation of facilities for executing mining operation. During mining and post-mining phases, changes in landscape were soil-erosion, loss of top soil, creation of waste dumps and voids, disposal of wastes, deforestation etc. The post mining, region has seen the transformation with afforestation endevour by the forest department. Transition in vegetation cover is observed due to pressure of anthropogenic activities. To reduce the impact of mining and soil erosion, the forest department has raised the Acacia plantations in mining sites and other vacated lands near mining area. The area under Acacia plantation cover is accounted to be 7.94% by 2013. The high rainfall in the mining areas also contributing to erosion which results in many of the waterways being silted and or becoming un-navigable.

The region is divided into four zones (NE, SE, SW and NW) to identify micro level changes, region wise how mining activity affected the local ecosystem and the regeneration of vegetation in abandoned mining sites. The top soil in this region was dumped into nearby forest area of Baragadde village (Figure 6) highlights mismanagement during mining era. Figure 7 and Table 2 shows the status of NE region, which covers Nagarakan, Hukkalli, Baragadde villages. The evergreen forest cover lost from 98.32 to 57.80%. Mining activities have severely affected the forests of this region and resulted in forest fragmentation. The region has **3.56%** of Acacia plantations in mining sites due course of afforestation. The mine regions which are not afforested are acting as a minor water bodies, which are catering the water requirement for wild animals. The weed infestation is noted as highest in the forest plantations, if not controlled they dry up and increases fire hazard. Soil compaction and higher run-off are associated with monocultures. The tailings were slided down the forested hill-slopes into a tributary of Kali river. Open-pit backfilling is also practiced in some places, where tailings are deposited into abandoned pits or portions of activepits.

Table 1: Landscape dynamics of Bisgod from 1973 to 2013

Year	1973		1989		1999		2013	
Category	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**
Built-up	3.48	0.11	9.30	0.30	10.11	0.33	26.46	0.86
Water	0.00	0.00	0.45	0.01	9.00	0.29	2.61	0.08
Crop land	154.06	5.00	91.90	2.98	173.92	5.65	176.93	5.75
Open fields	0.00	0.00	25.62	0.83	18.91	0.61	39.82	1.29
Moist deciduous forest	62.52	**2.03**	369.53	12.00	537.40	17.45	829.88	**26.95**
Evergreen to semi evergreen forest	2770.88	**89.99**	2245.33	72.92	1882.27	61.13	1457.9	**47.35**
Scrub/grass	73.76	2.40	100.80	3.27	71.98	2.34	158.78	5.16
Acacia/ Eucalyptus/ Hardwood plantations	13.69	0.44	112.49	3.65	169.05	**5.49**	244.38	**7.94**
Teak/ Softwood plantations	0.09	0.00	65.08	2.11	82.85	2.69	60.33	1.96
Coconut/ Areca nut/ Cashew nut plantations	0.00	0.00	56.80	1.84	123.62	4.01	79.75	2.59
Dry deciduous forest	0.72	0.02	1.89	0.06	0.09	0.00	2.34	0.08
TOTAL AREA	**3079.2**							

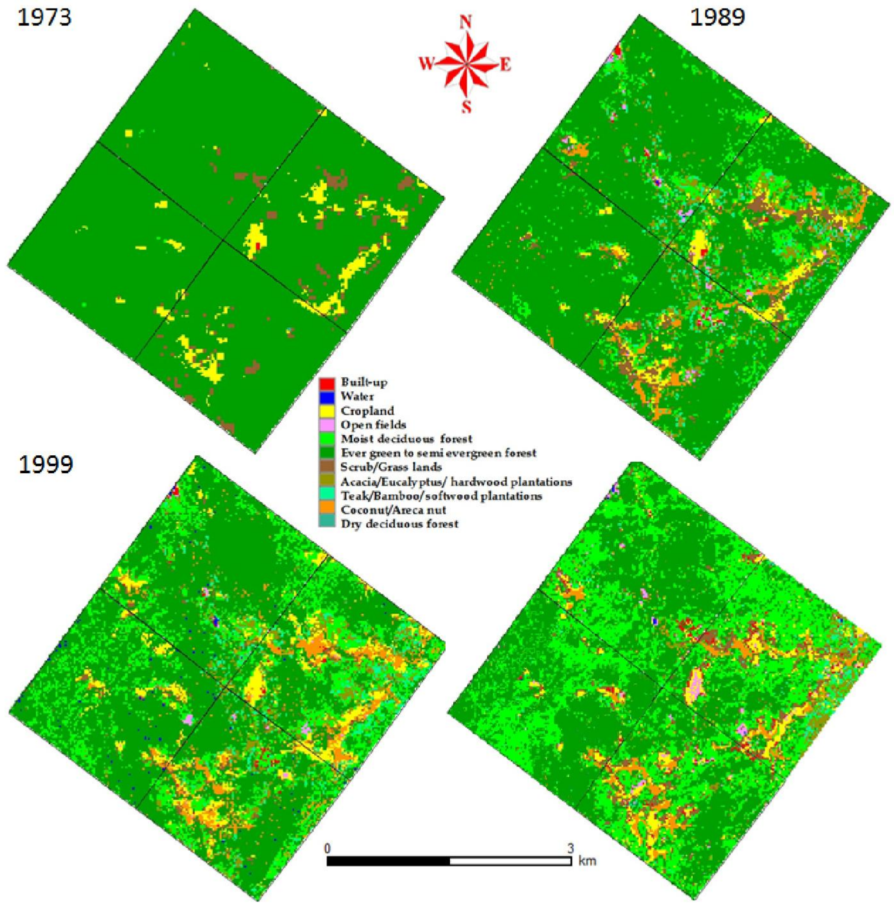

Figure 5: Land use analysis from 1973 to 2013

Figure 6: Top soil and mine waste dumped in forest area

Table 2: Land use changes in NE zone

NE Year	1973		1989		1999		2013	
Category	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**
Built-up	0.00	0.00	3.42	0.44	2.79	0.36	5.13	0.67
Water	0.00	0.00	0.45	0.06	3.15	0.41	0.90	0.12
Crop land	2.70	0.35	4.77	0.62	23.13	3.01	12.69	1.65
Open fields	0.00	0.00	9.09	1.18	2.16	0.28	6.39	0.83
Moist deciduous forest	0.45	0.06	68.32	8.88	131.5	17.08	240.7	**31.27**
Evergreen to semi evergreen forest	756.84	**98.32**	631.0	81.97	545.13	70.81	444.94	**57.80**
Scrub/grass	9.09	1.18	7.29	0.95	11.61	1.51	19.08	2.48
Acacia/ Eucalyptus/ Hardwood plantations	0.54	0.07	23.22	3.02	23.22	3.02	27.38	**3.56**
Teak/ Softwood plantations	0.00	0.00	15.12	1.96	14.85	1.93	3.78	0.49
Coconut/ Areca nut/ Cashew nut plantations	0.00	0.00	6.84	0.89	12.15	1.58	8.46	1.10
Dry deciduous forest	0.18	0.02	0.27	0.04	0.09	0.01	0.36	0.05
TOTAL AREA	769.80	100.00	769.80	100.00	769.80	100.00	769.80	100.00

The land use analysis in SE direction (Figure 8 and Table 3) represents the major loss in evergreen forest cover from 81.27% to 23.99%. The intensive mining activities in Gerel and its environs shows a major change in the forest cover. The major region of forests are turning to moist deciduous cover due to alteration of microclimate and from 1973 to 1989 major cover of 18.28% of area represents this change. The mined regions are afforested by Acacia plantations which covers 21.29% in this area. During mining, many agriculture areas in the region were piled up with eroded soil in monsoon and resulted as unproductive land for cultivation. A large portion of land in the heart of the evergreen forest has removed vegetation cover, leading to erosion of top soil, excessive silting and landslide (ex: in Hosmane village) as a result of manganese ore mining by a Mysore minerals limited and associated number of companies. Tailings were disposed unscientifically (based on convenience and minimal cost), often in flowing water or directly into drainages. As local concerns arose about sedimentation in downstream watercourses, water use and other issues, mining authority began impounding tailings often in other region away from Bisgod.

Table 3: Land use changes in SE direction (1973-2013)

SE Year	1973		1989		1999		2013	
Category	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**
Built-up	0.72	0.09	2.34	0.30	2.79	0.36	11.79	1.53
Water	0.00	0.00	0	0.00	0.45	0.06	0.27	0.04
Crop land	63.01	8.19	52.03	6.76	80.47	10.45	81.66	10.61
Open fields	0.00	0.00	8.28	1.08	13.33	1.73	14.04	1.82
Moist deciduous forest	37.81	4.91	140.69	18.28	159.41	20.71	183.27	**23.81**
Evergreen to semi evergreen forest	625.60	81.27	402.27	52.26	286.42	37.21	184.71	**23.99**
Scrub/grass	40.15	5.22	46.36	6.02	21.06	2.74	70.03	9.10
Acacia/ Eucalyptus/ Hardwood plantations	2.25	0.29	72.64	9.44	101.18	13.14	163.89	**21.29**
Teak plantations	0.09	0.01	28.53	3.71	45.37	5.89	27.00	3.51
Coconut/ Areca nut	0.00	0.00	15.57	2.02	59.32	7.71	31.86	4.14
Dry deciduous forest	0.18	0.02	1.08	0.14	0.00	0.00	1.26	0.16
TOTAL AREA	769.80	100.00	769.80	100.00	769.80	100.00	769.80	100.00

The SW region covers the un-mechanized mines at Bisgod and Anagod villages. MML provided contract to Goa based private company, for exploiting minerals. The mined regions were abandoned after the expiry of permit and in these regions natural regeneration are noticed. Figure 9 shows one of the trail pit created in mining era, with regeneration of moist deciduous species. Occurrence of *Olea dioica, Schleichera oleosa, Vitex altissima, Lagerstroemia microcarpa* etc. highlight the regeneration status. But at the same time, one can observe the intensified pressure from illegal logging (Figure 10), wood and litter collection. The land use analysis (Figure 11 and Table 4) reveals the region had 85.20% of evergreen cover reached to 41.88% and Acacia plantations of 6.33% (2013). The Acacia plantations are at Bisgod (near MML quarters, branch office, school area, etc.). This region requires fencing to allow regeneration, which helps in the return of primeval evergreen forest cover.

The NW region of Bisgod represents a region without any mining activities. The region (Figure 12 and Table 5) has good forest cover of 65.72% evergreen and 23.24% of moist deciduous. The region also has some natural springs, which provides continuous supply of water to agriculture activities. The region has a rich primeval forest cover and least disturbance from anthropogenic pressure as compare to other zones (Figure 13). The region has good native cover with greater basal area and least interference of agriculture activities. The reforestation and fencing the areas connected to betta lands can further improve the vegetation cover.

Table 4: Land use changes in SW direction (1973-2013)

SW Year	**1973**		**1989**		**1999**		**2013**	
Category	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**	**Ha**	**%**
Built-up	2.08	0.27	2.63	0.34	3.33	0.43	6.75	0.88
Water	0.00	0.00	0.00	0.00	1.35	0.18	1.35	0.18
Crop land	77.54	10.07	24.30	3.16	40.15	5.22	43.03	5.59
Open fields	0.00	0.00	7.98	1.04	1.44	0.19	15.94	2.07
Moist deciduous forest	0.00	0.00	90.76	11.79	117.5	15.26	227.1	**29.49**
Evergreen to semi evergreen forest	655.88	**85.20**	548.63	71.27	475.81	61.81	322.36	**41.88**
Scrub/grass	23.04	2.99	35.22	4.57	24.30	3.16	47.44	6.16
Acacia/ Eucalyptus/ Hardwood plantations	10.90	1.42	12.04	1.56	39.70	5.16	48.74	**6.33**
Teak/ Softwood plantations	0.00	0.00	19.80	2.57	21.10	2.74	22.97	2.98
Coconut/ Areca nut/ Cashew nut plantations	0.00	0.00	27.90	3.62	45.13	5.86	33.49	4.35
Dry deciduous forest	0.36	0.05	0.54	0.07	0.00	0.00	0.72	0.09
TOTAL AREA	769.80	100.00	769.80	100.00	769.80	100.00	769.80	100.00

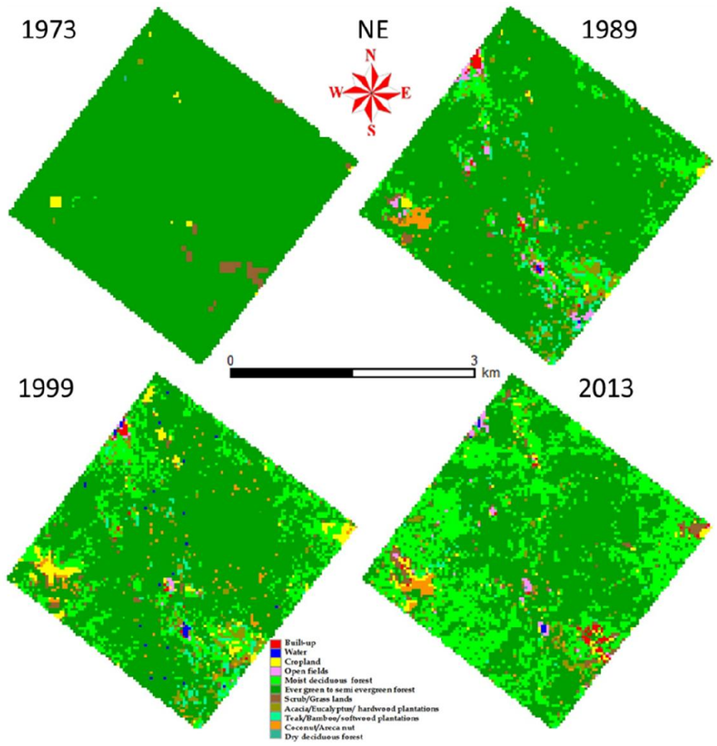

Figure 7: Land use dynamics in NE direction (Covers Nagarakan, Baragadde, Hukkalli villages)

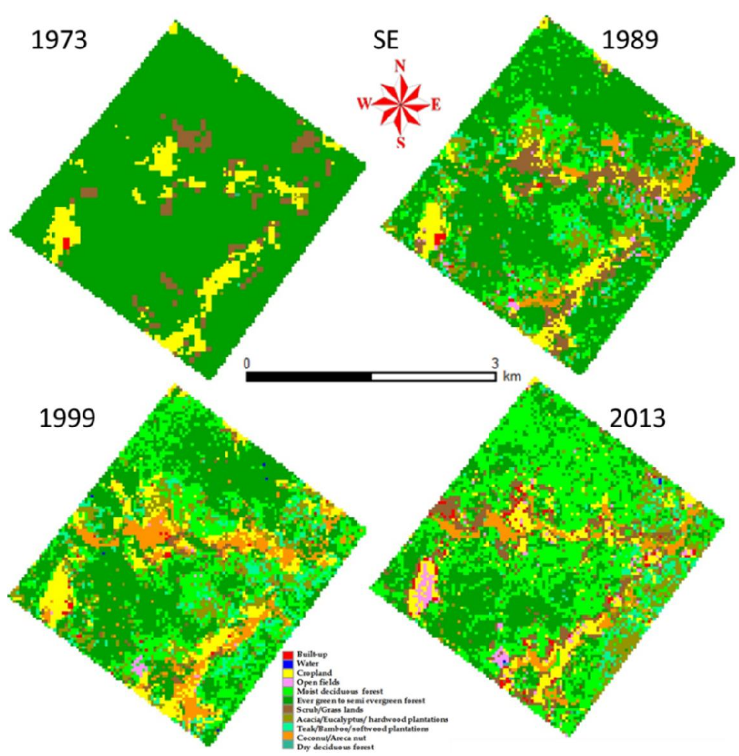

Figure 8: Land use changes in SE direction

Figure 9: Trail pit in mining area-natural regeneration

Figure 10: Illegal logging in forest area of earlier mined region and its environs

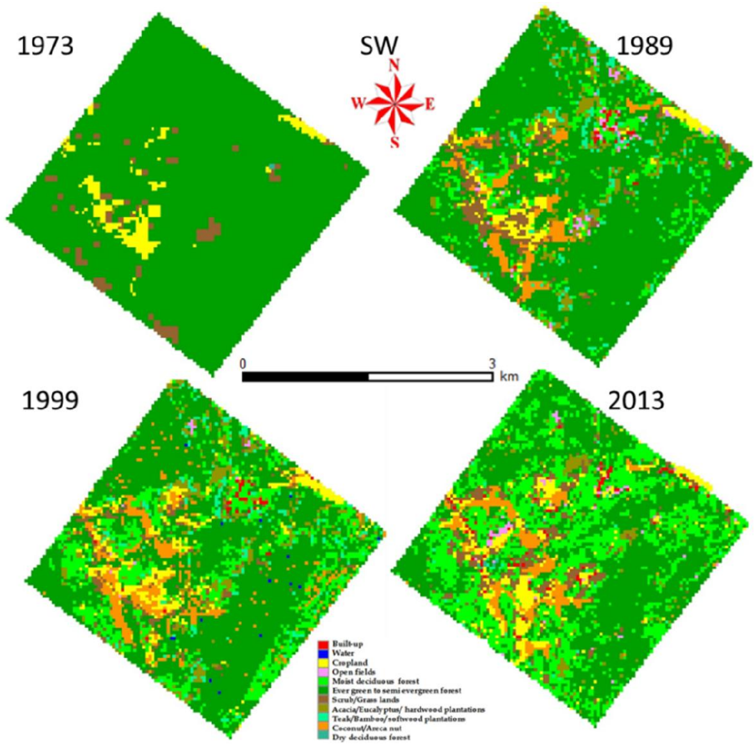

Figure 11: Land use changes in SE direction

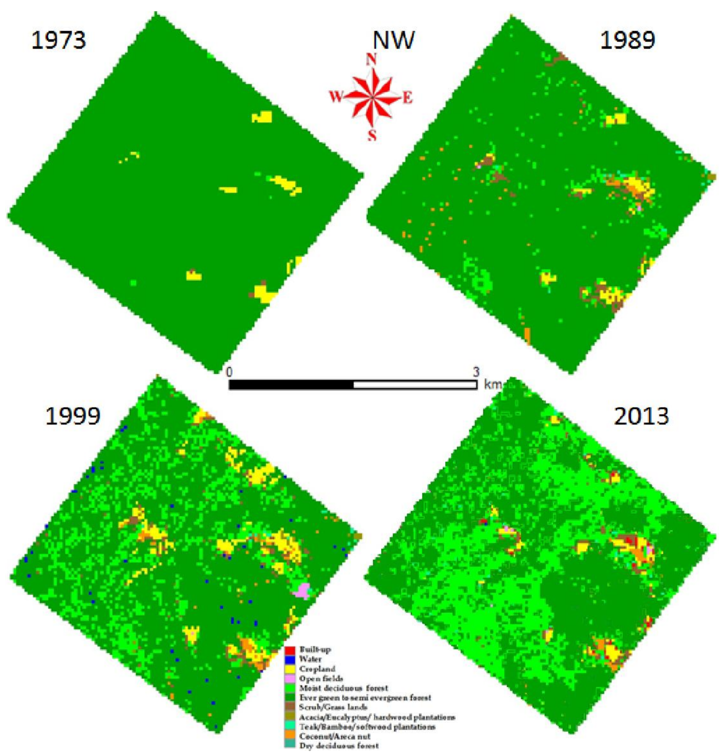

Figure 12: Land use changes in NW direction

Figure 13: Good native cover of forests in NW zone (Unmined area)

Figure 14: Vacant staff quarters of MML

Table 5: Land use changes in NW direction (1973-2013)

BNW Year	1973		1989		1999		2013	
Category	Ha	%	Ha	%	Ha	%	Ha	%
Built-up	0.69	0.09	0.91	0.12	1.20	0.16	2.79	0.36
Water	0.00	0.00	0.00	0.00	4.05	0.53	0.09	0.01
Crop land	10.80	1.40	10.80	1.40	30.16	3.92	39.55	5.14
Open fields	0.00	0.00	0.27	0.04	1.98	0.26	3.45	0.45
Moist deciduous forest	**24.26**	**3.15**	**69.76**	**9.06**	**128.99**	**16.76**	**178.90**	**23.24**
Evergreen to semi evergreen forest	**732.57**	**95.16**	**663.43**	**86.18**	**574.91**	**74.68**	**505.90**	**65.72**
Scrub/grass	1.48	0.19	11.93	1.55	15.00	1.95	22.23	2.89
Acacia/ Eucalyptus/ Hardwood plantations	0.00	0.00	4.59	0.60	4.95	0.64	4.37	0.57
Teak/ Softwood plantations	0.00	0.00	1.62	0.21	1.53	0.20	6.57	0.85
Coconut/ Areca nut/ Cashew nut plantations	0.00	0.00	6.48	0.84	7.02	0.91	5.94	0.77
Dry deciduous forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL AREA	769.80	100.00	769.80	100.00	769.80	100.00	769.80	100.00

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Part-II: **Vegetation status in Bisgod, Uttara Kannada during Post-mining**

Summary:

Assessment of vegetation status is essential to implement appropriate management strategies towards reclamation of degraded land. Vegetation analyses provide insights to the possibility of natural regeneration or restoration and impact of mining activities. Vegetation sampling has been carried out in mining area at Bisgod of Yellapur taluk, Uttara Kannada district, Karnataka of Central Western Ghats. Vegetation sampling carried out through transect based quadrats showed the signs of succession of forests in the region. Highly disturbed landscapes due to mechanised mining are with poor natural regeneration compared to un-mechanised regions. The survey records a total of 151 species belonging to 63 families and 131 genera in the region. Habit-wise, trees (83 species) are in higher number, followed by shrubs (36 species), climbers (22 species), and herbs (10 species). Family-wise analyses show that Rubiaceae had the highest species number (11), followed by Leguminosae (9), and Anacardiaceae, Apocynaceae, Euphorbiaceae with 7 species. Shrub layer has higher species number, evergreeness and endemism showing a healthier recruitment of post mining status. The study reveals that the region with developed undergrowth and herb layers highlight the scope for regeneration. Planting native saplings in the region with soil amendments accelerate the reclamation of forests and maintenance of biodiversity.

INTRODUCTION

Extraction of metal ores through opencast mining involves large scale destruction of natural forests, loss of productive top soil, siltation of water bodies. The natural recovery of forests in these regions takes long time (Sharma, and Wesley Sunderraj, 2005). Mining and quarrying have destroyed large tracts of forests land, evident from diversion of 1, 14, 304. 45 Ha in India between 1980 and 2008 (Mishra & Reddy. 2009, Department of Mines, GoI, 2008). Mining of mineral resources have severe environmental implications in the absence of planning and appropriate environment management strategies. Mining creates large amounts mine tailings, which are of concern due to the biotic and abiotic oxidation of minerals that release acidity and metals in the environment (Szczerski et al., 2013). Monitoring of such areas helps in the implementation of site specific remedial measures for environmental conservation.

Reforestation through planting and nurturing of native plants improves landscape's physic-chemical structure (Young et al., 2013) and has been effective in reclamation to mitigate the spread of tailings and emissions in the environment. Re-vegetation protects the ground surface against wind erosion, diminishes the threat of water erosion and also provides obvious environmental benefits such as providing habitat for animal species, carbon capture, etc. (Koszelnik-Leszek et al., 2013). Permitting regeneration and plantation of local species of vegetation allows islands of vegetation to persist, where species and populations typical of specific habitats concentrate, increasing the biodiversity of post mined areas (Shu et al., 2003; Sena, 2014).

Degradation of land due to mining disrupts the regional biogeochemical cycles. Land reclamation of these soils requires appropriate choice of plant species, based on their ability to adapt to extreme and restrictive soil conditions (Leon et al., 2013). A systematic approach to improve degraded soils in mined regions is through reactivation of biogeochemical nutrient cycles (via litter production and decomposition), the establishment of active restoration models using new forestry plantations, agroforestry systems (Juan et al., 2014). The nutrient recycling is critical as lower nutrient conditions are associated with the mismanagement of top soil while mining. The litter provides substrate for leaf litter fungal assemblages that include ecological guilds such as saprotrophs, endophytes, parasitic and pathogenic fungi and a few mycorrhizal fungi. The litter decomposition is mediated by both biotic and abiotic processes, leaf litter fungal decomposers play an important biotic role in recycling ecosystem nutrients (Schneider et al. 2012). The establishment of vegetation cover improves ecosystem services such as: litter supply, nutrient cycling, water infiltration, control of erosion, and increasing of biodiversity (Murgueitio, et al., 2011). This occurs due to (i) nutrients cycling through plant's root system, (ii) the protection of the soil surface against erosion, and (iii) maintenance of soil moisture and organic content via litter production, decomposition, etc. (Kumar, 2008).

The objective of the study is to understand the vegetation status in post mining period at Bisgod, Yellapur taluk, Karnataka. This involved an analysis of flora and structural characterization, diversity and regeneration. This provided insights to the secondary succession in degraded areas, which helps in evolving restoration strategies considering self-recovery potential.

METHOD

The vegetation status is assessed in Bisgod mining area, Yellapur taluk, Uttara Kannada district, Karnataka of Central Western Ghats. The region receives high rainfall of > 3500 mm annual). Vegetation in this region mainly comprises of tropical wet evergreen, semi-evergreen forest to moist deciduous as the rainfall is high. Scrub with savannas is found in more disturbed areas. The landscape elements also include a mosaic of natural forests with *Acacia* and teak plantations, rice fields and areca nut gardens.

Studies on forest vegetation were carried out using belt transects. Each transect with a length of 180m had alternating 5 quadrats with 20 m inter-distance (between quadrats). Trees (≥ 30 cm GBH) were studied in each quadrat of 20 x 20 m. Members of the shrub layer (GBH ≤30 cm and height more than 1 m) were enumerated in two shrub quadrats (5x5m) placed diagonally inside each tree quadrat. Inside each shrub quadrat two herb plots (height ≤ 1 m) were laid diagonally (1 x 1m). Total of 3 transects with 15 quadrats were laid in different regions of mining area. Associated features such as presence of epiphytes, climbers, parasites, human disturbances etc. were recorded. Opportunistic survey was also carried out to list species that are not encountered in the transect areas. The data from the transects were pooled into three classes locality wise with herb layer (<1m height), shrub layer (≥ 1m and < 30 cm GBH) and tree layer (≥ 30cm GBH) and analysed accordingly layer wise (mostly tree and shrub layer) to get the present status of vegetation and regeneration aspects.

Table 1(a): Study area details

SNO	Location	Taluk	Latitude	Longitude	Altitude
1	**Nagarkan-Angod**	Yellapur	15.03024	74.636	609
2	**Balekodlu-Keral-Dehalli**	Yellapur	15.00948	74.650	567
3	**Hosmane-Angod**	Yellapur	14.9993	74.646	545

RESULTS AND DISCUSSION

Composition and structure of Flora: A total of 151 species of 63 families and 131 genera were recorded in the study area (Table 1 (a)) and habit-wise trees dominate (83 species), followed by shrubs (36 species), climbers (22 species), and herbs (10 species) (Figure 1). Family-wise Rubiaceae had the highest species number (11), followed by Leguminosae (9), and Anacardiaceae, Apocynaceae, Euphorbiaceae with 7 species each (Figure 2).

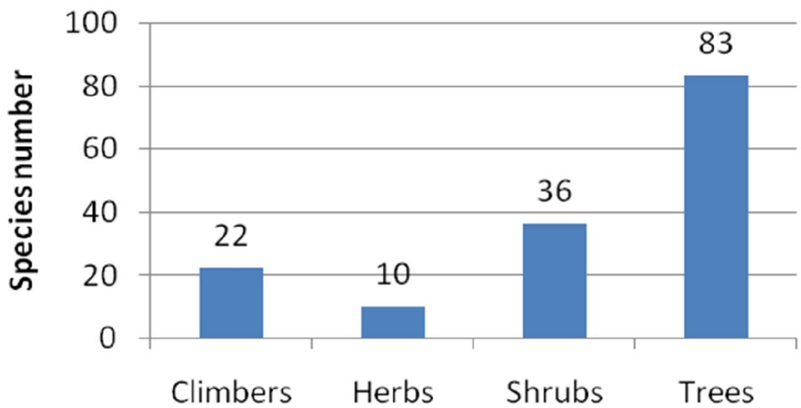

Figure 1: Habit wise species distribution in the mined area.

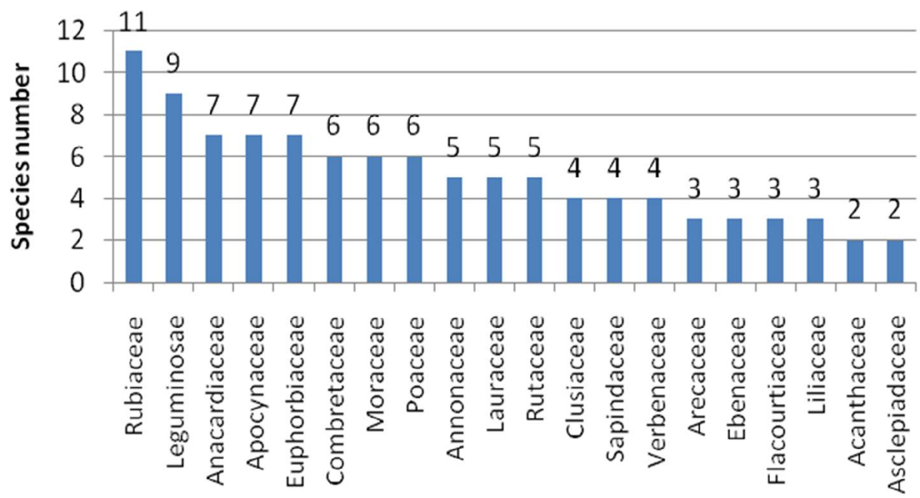

Figure 2: Family richness in the study area

Forest structure: Tree layer

Due to higher rainfall in these locations, forests type are predominantly evergreen to semi-evergreen forests. Disturbed patches due to anthropogenic activities consist of disturbed semi-evergreen to moist deciduous forests. Forests in Balekodlu-Keral-Dehalli transect (in mined regions) have attained their average biomass of 48.31 m^2/ha (per hectare basal area comparable natural forests in nearby regions). Nagerkhan-Angod area has lowest basal area (30.79 m^2/ha.) indicating higher disturbance or insufficient recovery (Table 1 (b)). Acacia plantations are with poor natural regeneration (Figure 3), and poor canopy opening (Figure 4). Planting mixed species varieties in these localities would enrich the ecosystem. The organic matter and nutrient return rate via litter depends on factors that influence decomposition process at the ecosystem level. Plant species selected for reclamation of mined regions should preferably have symbiotic associations with soil microorganisms (i.e., mycorrhizal fungi and N_2 fixing bacteria).

Table 1 (b): Total individuals, total species, average height, tree population per hectare and per hectare basal area in the tree layer of Bisgod transects.

Location	**Forest type**	**Total individuals/transect (2000 m^2)**	**Total species/transect**	**Average height(m)**	**Tree population/ha**	**Per hectare basal area (m^2/ha.)**
Nagarkan-Angod	Semievergreen to moist deciduous	75	21	15.55	375	30.79
Balekodlu-Keral-Dehalli	Semievergreen to moist deciduous	97	26	15.02	485	48.31
Hosmane-Angod	Semievergreen to moist deciduous	78	20	14.54	390	44.91

Figure 3: absence of regeneration in dense *Acacia auriculiformis* plantation

Figure 4: Very less regeneration in mined pit area

Forest diversity and endemism

Generally undisturbed forests are higher in evergreeness, endemism and diversity. However in the studied forest area owing to the past and present disturbance such as mining, forest extractions such as fuel wood collection, logging etc., forest is both less in endemism and evergreeness. Endemism percentage is as low as 13.33 in Nagarkhan-Angod area (Table2). Forest with low endemism is dominated by *Olea dioica, Schleichera oleosa, Aporosa lindleyana*,etc. However, in the absence any further human impacts such forests gradually pass through progressive succession stages towards higher biomass, diversity and endemism.

Table 2: Species richness, Shannon diversity, Simpson dominance, Simpson diversity, Pielou's evenness index, percentage Western Ghats endemics, and percentage evergreeness in the study area.

Location	Species richness	Shannon diversity	Simpson dominance	Simpson diversity	Pielou	% Western ghats endemics	% Evergreeness
Nagarkan-Angod	4.63	2.37	0.18	0.82	0.78	13.33	78.67
Balekodlu-Keral-Dehalli	5.46	2.77	0.10	0.90	0.85	24.74	75.26
Hosmane-Angod	4.36	2.43	0.14	0.86	0.81	16.67	85.90

Important value index

In these localities, important value index (IVI) was higher for midlevel succession evergreen species such as *Olea dioca* and *Aporosa lindleyana and* deciduous species such as *Schleichera oleosa Terminalia bellirica, Vitex altissima* etc. These species indicate progressive forest succession towards better forests from earlier impacts on mining activities. The presence of mid-succession evergreens and associated deciduous trees in higher IVI indicates the prospects of return of evergreen if the region is not subjected to further disturbance. The presence of evergreens in all the transects is an indication of absence of fire which otherwise hardly give chance to evergreen species such as *Olea dioica, Aporosa lindleyana, Cinnamomum malabatrum, Aglaia roxburghii, Ixora brachiata, Alseodaphne semecarpifolia* etc.

Table 3: Location wise tree species and their Important Value Index (IVI)

Nagarkan-Angod		Balekodlu-Keral-Dehalli		Hosmane-Angod	
Species	**IVI**	**Species**	**IVI**	**Species**	**IVI**
Olea dioica	91.72	*Syzygium cumini*	45.17	*Olea dioica*	65.83
Schleichera oleosa	27.14	*Olea dioica*	43.18	*Schleichera oleosa*	53.76
Terminalia bellerica	20.69	*Holigarna grahamii*	24.28	*Vitex altissima*	22.95
Aporosa lindleyana	17.64	*Diospyros montana*	17.16	*Lagerstroemia microcarpa*	18.41
Lepisanthus tetraphylla	15.36	*Lannea coramendellica*	15.86	*Xantolis tomentosa*	17.98
Cinnamomum malabatrum	14.79	*Terminalia paniculata*	15.74	*Cinnamomum malabatrum*	16.01
Alseodaphne semicarpifolia	12.51	*Ixora brachiata*	13.35	*Aglaia roxbhurgii*	12.86
Macaranga peltata	11.86	*Flacourtia montana*	13.20	*Flacourtia montana*	12.62
Vitex altissima	11.50	*Aporosa lindleyana*	12.94	*Alseodaphne semicarpifolia*	11.15
Ervatamia heyneana	10.30	*Terminalia bellerica*	12.16	*Stereospermum coleus*	8.79
Lagerstroemia micrcarpa	10.26	*Mammea suriga*	11.56	*Lannea coramendellica*	8.71
Ixora brachiata	7.80	*Randia dumatorum*	9.89	*Holigarna ferrugenia*	7.61
Syzygium cumini	6.68	*Beilsmedia fagifolia*	7.22	*Ixora brachiata*	7.17
Tectona grandis	6.65	*Artocarpus lacoocha*	5.97	*Mammea suriga*	7.03
Terminalia paniculata	6.47	*Mangifera indica*	5.52	*Ficus microcarpa*	5.68
Dalbergia latifolia	5.82	*Schleichera oleosa*	5.15	*Caryota urens*	5.59
Cassia fistula	5.28	*Terminalia tomentosa*	5.02	*Beilsmedia fagifolia*	5.03
Glochidion zeylanica	4.46	*Cinnamomum malabatrum*	4.72	*Ervatamia heyneana*	4.30
Randia dumatorum	4.43	*Vitex altissima*	4.66	*Cassina glauca*	4.27
Mitragyna parviflora	4.36	*Strycnos nux vomica*	4.54	*Diospyros montana*	4.25

Regeneration in Shrub layer

Compared to tree layer, shrub layer has higher species number, evergreeness and endemism which highlights a healthier recruitment (Table 4 and 5). Shannon diversity was highest in Hosmane-Angod area (3.2). Recruitment of endemic species is higher in Balekodlu-Keral-Dehalli (49.48) compared to tree layer (24.7). Hence regeneration in forests surrounding the non-mecanised pit is good. Compared to this, in machinery mined pit tree saplings are very less due to heavily compacted hard soil and absence of any leaf litter. These are sparsely covered by climbers such as *Calycopteris floribunda*, and tree saplings of *Terminalia* *paniculata, Diospyros montana, Syzygium cumini, Lea indica*, etc. However in more densely planted *Acacia auriculiformis* areas, there are no tree or climber saplings and seedlings. In manually mined areas without machinery, good regeneration of most forest tree species was observed including evergreen species as seen in Hosmane-Angod area.

This analysis highlights the return of evergreen forest with endemic species of Western Ghats in the non-mechanised mining area in Bisgod (Table 6). The growing stock needs protection from cattle grazing and illicit extraction of forest produce, especially timber, firewood, etc.

Table 4: Species number and individuals per transect and shrub population per hectare in studied localities

Location	**Total individuals/transect (250 m^2)**	**Total species**	**Shrub population/ha.**
Nagarkan-Angod	325	40	13000
Balekodlu-Keral-Dehalli	291	39	11640
Hosmane-Angod	296	45	11840

Table 5: Shrub layer Species richness, Shannon diversity, Simpson dominance, Simpson diversity, Pielou's eveness index, percentage Western Ghats endemics, and percentage evergreeness in the study area.

Location	**Species richness**	**Shannon diversity**	**Simpson dominance**	**Simpson diversity**	**Pielou's eveness index**	**% endemism**	**% evergreeness**
Nagarkan-Angod	6.743	2.998	0.077	0.923	0.813	27.69	83.077
Balekodlu-Keral-Dehalli	6.698	2.886	0.079	0.921	0.788	49.48	90.034
Hosmane-Angod	7.732	3.227	0.055	0.945	0.848	29.73	73.649

Table 6: Tree species with good regeneration in the study area

Sn	Tree species with good regeneration in forested mined areas
1	*Aporosa lindleyana*
2	*Flacourtia montana*
3	*Ixora brachiata*
4	*Cinnamomum malabatrum*
5	*Ervatamia heyneana*
6	*Olea dioca*
7	*Aglaia roxburghiana*
8	*Lepianthus tetraphylla*
9	*Murraya koengii*

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Annexure 1:

Checklist of plants in Bisgod mining study area

Sl	Family	Genera	Species	Habit	Distribution
1	Leguminosae	Acacia	sinuata	S	
2	Lauraceae	Actinodaphne	tadulingami	T	E
3	Apocynaceae	Aganosma	cymosa	S	India, Sri Lanka
4	Meliaceae	Aglaia	roxbhurgii	T	
5	Alangiaceae	Alangium	salvifolium	T	
6	Sapindaceae	Allophylus	cobbe	S	
7	Annonaceae	Alphonseo	zeylanica	T	
8	Lauraceae	Alseodaphne	semecarpifolia	T	India, Sri Lanka
9	Apocynaceae	Alstonia	scholaris	T	
10	Menispermaceae	Anamirta	cocculus	C	
11	Ancistrocladaceae	Ancistrocladus	heyneanus	C	E
12	Euphorbiaceae	Aporosa	lindleyana	T	India, Sri Lanka
13	Myrsinaceae	Ardisia	solanacea	S	
14	Arecaceae	Arenga	wightii	T	E
15	Aristolochiaceae	Aristalochia	indica	C	India, Sri Lanka
16	Annonaceae	Artabotrys	zeylanica	S	India, Sri Lanka
17	Moraceae	Artocarpus	heterophyllus	T	E
18	Moraceae	Artocarpus	hirsuta	T	E
19	Moraceae	Artocarpus	gomezianus	T	India, Sri Lanka
20	Liliaceae	Asparagus	racemosus	C	
21	Rutaceae	Atlantia	racemosa	T	India, Sri Lanka
22	Poaceae	Bambusa	arundinacea	S	India, Sri Lanka

23	Lauraceae	Beilschmiedia	fagifolia	T	E
24	Euphorbiaceae	Bridelia	stipularis	S	India
25	Anacardiaceae	Buchanania	lanzan	T	
26	Arecaceae	Calamus	thwaitesii	S	E
27	Verbenaceae	Callicarpa	tomentosa	T	India
28	Clusiaceae	Calophyllum	polyanthum	T	
29	Combretaceae	Calycopteris	floribunda	C	
30	Burseraceae	Canarium	strictum	T	E
31	Rubiaceae	Canthium	parviflorum	S	E
32	Capparidaceae	Capparis	grandis	T	
33	Lecythidaceae	Careya	arborea	T	
34	Apocynaceae	Carissa	carandas	S	India
35	Arecaceae	Caryota	urens	T	
36	Flacourtiaceae	Caseria	bourdillonii	T	E
37	Leguminosae	Cassia	fistula	T	
38	Celastraceae	Cassine	glauca	T	
39	Lauraceae	Cinnamomum	malabathrum	T	E
40	Vitaceae	Cissus	discolor	S	
41	Lamiaceae	Colebrookea	oppositifolia	S	
42	Combretaceae	Combratum	latifolium	C	
43	Liliaceae	Curculigo	orchioides	H	
44	Zingiberaceae	Curcuma	neilgherrensis	H	E
45	Menispermaceae	Cyclea	peltata	C	E
46	Cyperaceae	Cyperus	iria	H	
47	Poaceae	Cyrtococcum	oxyphyllum	H	
48	Leguminosae	Dalbergia	latifolia	T	
49	Leguminosae	Dalbergia	horrida	C	E
50	Dichapetalaceae	Dichapetalum	gelonioides	S	
51	Dilleniaceae	Dillenia	pentagyna	T	
52	Poaceae	Dimeria	ornithopoda	H	
53	Sapindaceae	Dimocarpus	longan	T	
54	Ebenaceae	Diospyros	montana	T	
55	Ebenaceae	Diospyros	buxifolia	T	
56	Ebenaceae	Diospyros	candolleana	T	E
57	Agavaceae	Dracaena	terniflora	S	
58	Elaeagnaceae	Elaeagnus	latifolia	S	
59	Elaeocarpaceae	Elaeocarpus	serratus	T	India, Sri Lanka
60	Asteraceae	Elephantopus	scaber	H	

61	Leguminosae	Entada	pursaetha	C	India, Sri Lanka
62	Poaceae	Eragrostis	uniloides	H	
63	Apocynaceae	Ervatamia	heyneana	T	E
64	Convolvulaceae	Erycibe	paniculata	C	India, Sri Lanka
65	Asteraceae	Eupatorium	odoratum	S	
66	Moraceae	Ficus	arnottiana	T	India, Sri Lanka
67	Moraceae	Ficus	microcarpa	T	
68	Flacourtiaceae	Flacourtia	montana	T	E
69	Leguminosae	Flemingia	strobilifera	S	
70	Clusiaceae	Garcinia	morella	T	
71	Clusiaceae	Garcinia	indica	T	E
72	Euphorbiaceae	Glochidion	zeylanica	T	E
73	Liliaceae	Gloriosa	superba	C	
74	Rutaceae	Glycosmis	pentaphylla	S	India, Sri Lanka
75	Tiliaceae	Grewia	microcos	S	
76	Asclepiadaceae	Gymnema	sylvestre	C	
77	Sterculiaceae	Helicteres	isora	S	
78	Asclepiadaceae	Hemidesmus	indicus	C	India, Sri Lanka
79	Apocynaceae	Holarrhena	antidysenterica	T	
80	Anacardiaceae	Holigarna	arnotiana	T	E
81	Anacardiaceae	Holigarna	ferruginea	T	E
82	Anacardiaceae	Holigarna	grahamii	T	E
83	Dipterocarpaceae	Hopea	ponga	T	E
84	Flacourtiaceae	Hydnocarpus	laurifolia	T	E
85	Apocynaceae	Ichnocarpus	frutescens	C	
86	Poaceae	Ischaemum	indicum	H	India
87	Rubiaceae	Ixora	coccinea	S	India, Sri Lanka
88	Rubiaceae	Ixora	parviflora	S	
89	Rubiaceae	Ixora	arborea	T	E
90	Rubiaceae	Ixora	brachiata	T	E
91	Olacaceae	Jasminum	malabaricum	C	E
92	Acanthaceae	Justica	simplex	H	
93	Myristicaceae	Knema	attenuata	T	E
94	Lythraceae	Lagerstroemia	microcarpa	T	E
95	Anacardiaceae	Lannea	coromandelica	T	
96	Verbenaceae	Lantana	camara	S	
97	Leeaceae	Leea	indica	S	
98	Sapindaceae	Lepisanthes	tetraphylla	T	

99	Lauraceae	Litsia	sp	T	
100	Euphorbiaceae	Macaranga	peltata	T	India, Sri Lanka
101	Euphorbiaceae	Mallotus	philippensis	T	
102	Clusiaceae	Mammea	suriga	T	E
103	Anacardiaceae	Mangifera	indica	T	E
104	Melastomaceae	Melastoma	malabathricum	S	
105	Sapotaceae	Mimusops	elengi	T	
106	Rubiaceae	Mitragyna	parviflora	T	
107	Caesalpiniaceae	Moullava	spicata	C	India
108	Leguminosae	Mucuna	monosperma	C	
109	Rutaceae	Murraya	paniculata	T	
110	Rutaceae	Murraya	koenigii	T	
111	Rubiaceae	Mussaenda	laxa	S	E
112	Myristicaceae	Myristica	dactyloides	T	India, Sri Lanka
113	Rananculaceae	Naravelia	zeylanica	C	
114	Anacardiaceae	Nothopegia	racemosa	T	E
115	Icacinaceae	Nothopodytes	nimmoniana	S	
116	Poaceae	Ochlandra	scriptoria	Reed	E
117	Ochnaceae	Ochna	obtusata	S	India, Sri Lanka
118	Oleaceae	Olea	dioica	T	India
119	Pandanaceae	Pandanus	fascicularis	S	
120	Euphorbiaceae	Phyllanthus	urinaria	H	
121	Euphorbiaceae	Phyllanthus	emblica	T	
122	Piperaceae	Piper	nigrum	C	India, Sri Lanka
123	Rubiaceae	Psychotria	dalzellii	S	E
124	Rubiaceae	Psychotria	flavida	S	E
125	Rubiaceae	Randia	dumetorum	T	
126	Apocynaceae	Rauvolfia	serpetina	S	
127	Annonaceae	Saccopetalum	tomentosum	T	
128	Annonaceae	Sageraea	laurifolia	T	E
129	Sapindaceae	Schleichera	oleosa	T	
130	Smilacaceae	Smilax	zeylanica	C	
131	Leguminosae	Spatholobus	parviflorus	C	
132	Bignoniaceae	Steriospermum	personatum	T	
133	Moraceae	Streblus	asper	T	
134	Acanthaceae	Strobilanthus	heyneanus	S	E
135	Loganiaceae	Strychnos	nux-vomica	T	
136	Myrtaceae	Syzygium	cumini	T	

137	Myrtaceae	Syzygium	caryophyllatum	T	India, Sri Lanka
138	Verbenaceae	Tectona	grandis	T	
139	Combretaceae	Terminalia	chebula	T	
140	Combretaceae	Terminalia	alata	T	India, Sri Lanka
141	Combretaceae	Terminalia	bellirica	T	
142	Combretaceae	Terminalia	paniculata	T	India
143	Ulmaceae	Trema	orientalis	T	
144	Annonaceae	Uvaria	narum	C	India, Sri Lanka
145	Rubiaceae	Vangueria	spinosa	T	
146	Verbenaceae	Vitex	altissima	T	
147	Sapotaceae	Xantolis	tomentosa	T	
148	Leguminosae	Xylia	xylocarpa	T	
149	Rutaceae	Zanthoxylum	rhetsa	T	
150	Rhamnaceae	Ziziphus	rugosa	S	India, Sri Lanka
151	Rhamnaceae	Ziziphus	oenoplia	S	

ಕರ್ನಾಟಕ ಅರಣ್ಯ ಇಲಾಖೆ

ಗ್ರಾಮ ಅರಣ್ಯ ಸಮಿತಿ ಕರ್ಕಿನಬೈಲ

ಪೋ|| ಬಿಸಗೋಡ ತಾ|| ಯಲ್ಲಾಪುರ (ಉ.ಕ.) 581 359

ನೋಂದಣಿ ಸಂಖ್ಯೆ : 29 ದಿನಾಂಕ : 24-09-1996

ಕ್ರಮ ಸಂಖ್ಯೆ :

ದಿನಾಂಕ : 29/11/2014

ವಿಜ್ಞಾನಿಗಳು.
ಭಾರತೀಯ ವಿಜ್ಞಾನ ಭವನ
ಬೆಂಗಳೂರ ಇವರಿಗೆ,

ಮಾನ್ಯರೇ,

ತಮ್ಮ ಭಾರತೀಯ ವಿಜ್ಞಾನ ಭವನದ
ಕುಮಾರ [illegible]
ಅಧಿಕಾರಿಗಳು ನಮ್ಮ ಗ್ರಾಮ ಅರಣ್ಯ ಸಮಿತಿಯ
ಬನಗಳ ಗಣಿಗಾರಿಕೆ ಪ್ರದೇಶದ ಸುತ್ತಮುತ್ತಲಿನ
ಪ್ರದೇಶಗಳ ನಿವಾಸಿಗಳ ಹಾಗೂ ಜೀವವೈವಿಧ್ಯತೆಗಳ
ಬಗ್ಗೆ ಅಧ್ಯಯನ ನಡೆಸಿ ವರದಿ ತಯಾರಿಸಿದ್ದೀರಿ
ನಿಮಗೆ ಹೃದಯ ಪೂರ್ವಕ ಅಭಿನಂದನೆಗಳು
ಹಾಗೆಯೇ ನಮ್ಮ ಸುತ್ತಲಿನ ಅರಣ್ಯ ಪ್ರದೇಶದ
ಹಾಗೂ ಗ್ರಾಮ ಅರಣ್ಯ ಸಮಿತಿ ಕರ್ಕಿನಬೈಲದ ಕೆಲಸ
ಚಟುವಟಿಕೆಗಳು ಈ ವರದಿಯಲ್ಲಿ ಸೇರಿಸಿ ಬರೆದ
ಮುಂದಿನದಲ್ಲಿ ಇನ್ನೂ ಹೆಚ್ಚಿನ ಅಧ್ಯಯನಗಳು ಆಗಿ
ಅರಣ್ಯ ಅಭಿವೃದ್ಧಿ ಆಗಲಿ ಎಂದು ಆಶಿಸುತ್ತೇವೆ
ಧನ್ಯವಾದಗಳೊಂದಿಗೆ

(signature)
ಅಧ್ಯಕ್ಷರು,
ಗ್ರಾಮ ಅರಣ್ಯ ಸಮಿತಿ, ಕರ್ಕಿನಬೈಲ.

ಸ್ಥಳ:- ಕರ್ಕಿನಬೈಲ

(ಚನ್ನಪ್ಪ ಎನ್. ಗೌಡ (m- 9480355963)

ಗ್ರಾಮ ಅರಣ್ಯ ಸಮಿತಿ - ಕಳಸನಕೊಪ್ಪ (ಬಾರೆ)

ಉ.ಕ. ಜಿಲ್ಲೆಯ ಯಲ್ಲಾಪುರ ತಾಲೂಕಿನ ಬಾರೆ ಗ್ರಾಮದ
ಅರಣ್ಯ ಪ್ರದೇಶದಲ್ಲಿ ಸನ 1960 [illegible] M.M.L
(~~ಮೈಸೂರ~~ Mysore Minerals Limited) ಕಂಪನಿ ಅವರು
[illegible] ಗಣಿಗಾರಿಕೆ ಪ್ರಾರಂಭಿಸಿ ಅರಣ್ಯದ ಪ್ರದೇಶ [illegible] ಕೆರೆಗಳು, ಹಾಗೂ [illegible]
ಅರಣ್ಯ ಪ್ರದೇಶಗಳು ಮತ್ತು [illegible] ಕಾಡು ಅರಣ್ಯ
ಭೂಮಿಗಳು ನಾಶವಾಗಿ ಇಲ್ಲಿನ ಕೃಷಿ ಜೀವನ [illegible]
ಅನ್ನ ನೀರಿನ ಮೇಲೆ ಕೆಟ್ಟ ಪರಿಣಾಮಗಳು ಆದವು
ಇದೆಲ್ಲವನ್ನು ಗಮನಿಸಿದ ಸ್ಥಳೀಯ ಜನರು [illegible] ಹೋರಾಟ
ಪ್ರಾರಂಭಿಸಿದರು ಸಂಘಟನೆಗಳಿಂದ [illegible]
ಹೋರಾಟವನ್ನು ಮಾಡಿ. ಜನಾಂದೋಲನ [illegible]
ಗಣಿಗಾರಿಕೆ [illegible] ಸಮಿತಿಯಿಂದ [illegible]
ಗಳು ಹೋರಾಟ ಮಾಡಲಾಯಿತು. [illegible]
ಈ ಹೋರಾಟದ ಫಲವಾಗಿ [illegible]
[illegible] ಗಣಿಗಾರಿಕೆ [illegible] ಗ್ರಾಮ ಅರಣ್ಯ
ಸಮಿತಿ ರಚನೆಯಾಯಿತು 15-10-1998
[illegible] ಕಳಸನಕೊಪ್ಪ 200 ಹೆಕ್ಟೇರ್ ಪ್ರದೇಶಗಳಲ್ಲಿ [illegible]
ಅನಂತರ [illegible]
ಮಾಡಲಾಯಿತು. [illegible] ಮಾಡಲಾಯಿತು.
[illegible]
[illegible] ಈ ಪ್ರದೇಶದಲ್ಲಿ [illegible]
ಅರಣ್ಯ [illegible]
[illegible]
[illegible] ಅಭಿವೃದ್ಧಿ [illegible]

ಇನ್ನು ಹೆಚ್ಚಿನ ಅರಣ್ಯೀಕರಣ ಮಾಡಲು ಹಾಗೂ
ನಮ್ಮ ಗ್ರಾಮ ಅರಣ್ಯ ಸಮಿತಿಯ ಚಟುವಟಿಕೆಗಳು
ಇತ್ತೀಚೆಗೆ ಬನಗಳೆಯನಲ್ಲಿ ನಡೆದ ಬೆಳವಣಿಗೆ
ಗಳ ಪ್ರಮಾಣದ ಮನಸ್ಥಿತಿನ ಅಧ್ಯಯನದ ರೀತಿಯಲ್ಲಿ ನಾವು
ಚಿತ್ರಿಸಿದಂತೆ ನಮಗೆಲ್ಲರಿಂದ ಇನ್ನೂ ಅರಣ್ಯ ಇಲಾಖೆ
ಯಿಂದ ಆದರೆ ಕೆಲವು ಕಾರ್ಯಗಳು ಆಗಬೇಕಾದ
ಅವಶ್ಯಕತೆ ಇದೆ!

(1) ಗ್ರಾಮ ಅರಣ್ಯ ಸಮಿತಿ ಬಲಪಡಿಸುವುದು - ಹಾಗೂ
ಬೇರೆ ಬೇರೆ ಜಾತಿಯ ಅರಣ್ಯ ಬೆಳೆಸುವುದು

(2) V.F.C ಯಲ್ಲಿ ಬರುವುದರಿಂದ ಬರುವ ಅರಣ್ಯ ಉತ್ಪನ್ನಗಳು ಸ್ಥಳೀಯ
ಜನರಿಗೆ ಸಿಗುವಂತೆ ಆಗಬೇಕು,

(3) ಕಿರು ಕಾಡುಉತ್ಪನ್ನಗಳು V.F.C ಮೂಲಕ ಸಂಗ್ರಹ ಹಾಗೂ ವ್ಯಾಪಾರ
ಮಾಡಬೇಕು.

(4) ಬನಗಳೆಯನಲ್ಲಿ ಪರಿಸರ ECO Tourism ಆಗಬೇಕು

(5) ಜೀವದ ವನ ನಿರ್ಮಾಣವಾಗಬೇಕು

(6) ಗೋಮಾಳದಿಂದ ಕೆರೆಗಳ ನಿರ್ಮಾಣವಾದ ಅವುಗಳ
ಅಭಿವೃದ್ಧಿ ಆಗಬೇಕು

(7) ಸ್ಥಳೀಯರಿಗೆ ಉದ್ಯೋಗ. ಕಸುಬಿಗೆ. ಬಡವರಿಗೆ ಗ್ಯಾಸ್ ಒಲೆ
ಘಟಕಗಳು, ಸೋಲಾರ್ ಲೈಟ್, ಅಸ್ತ್ರ ಒಲೆ, ಗೋಬರ್ ಗ್ಯಾಸ್
ನಿರ್ಮಾಣವಾಗಬೇಕು

(8) ಬನಗಳೆಯನಲ್ಲಿ M.M.L ಕಂಪೆನಿಯವರು ನಿರ್ಮಿಸಿದ
ಕಟ್ಟಡಗಳು ಹಾಗೆ ಇದ್ದು ಸ್ಥಳೀಯರಿಗೆ (V.F.C. ಸಮಿತಿಗೆ)
ಉಪಯೋಗಕ್ಕೆ ನೀಡಬೇಕು.

(9) ಬನಗಳೆ ಸಂರಕ್ಷಿತ ಪ್ರದೇಶ ಘೋಷಣೆ ಮಾಡಬೇಕು.

(10) ಚಕ್ರಸಾಲ ಕೆರೆ, ಬಾಳೆಗುಡ್ಡೆ ಕೆರೆ, ಅಭಿವೃದ್ಧಿಪಡಿಸಿ - ಬೋಟಿಂಗ್
ಹಾಗೂ ಮೀನು ಸಾಕಾಣಿಕೆ ಹಾಗೂ ಮಾಡುವುದು

(11) V.F.C ಸಮಿತಿಗೆ ಪ್ರೋತ್ಸಾಹಕ್ಕಾಗಿ ಒಂದು ಜೀಪು
ಯುವಕರ ಯಾನ




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