Published by: National Cave Research and Protection Organization, India

**ambient
SCIENCE**
Vol. 01(1):16-24
Year 2015

RESEARCH ARTICLE

Challenges and Remedies to Biodiversity in Singhason Landscape

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Study Area: Karbi Anglong district of Assam, India

Coordinates: : 25°3' to 26°36' N and 92°90' to 93°54' E

Key words: Singhason hills, Biodiversity, Jhum,
Monoculture, Overexploitation, Mining, Agroforestry

Abstract

The Singhason hill range in Assam is a cultural landscape with rich biodiversity and implications for conservation of biodiversity. In recent years, the hill range has been under pressure particularly from human interference that poses considerable threats to biodiversity and the landscape. There is no previous study on environment of Singhason hills due to which biodiversity status, agricultural practices and other related aspects of the hill are unknown. In the present paper, drivers of environmental deterioration in Singhason landscape and opportunities for its conservation are discussed. Data collection included interview and participant observations; informant responses on drivers of environmental deterioration have been presented as Relative Frequency. Over-harvesting is the most potent driver with RF score of 91.7% followed by mining of lime stone and coal (83.3%), monoculture with rubber and teak (35.4%) and shifting cultivation (12.5%). Overexploitation is the major cause of degradation of agar-wood, cinnamon, black dammar, rattans and bamboo resources. Agroforestry with local plants such as black dammar, cinnamon, broom grass, orange, pineapple and pear hold promises for food production, food security, nutrition, health and socio-cultural benefits.

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Introduction

Healthy environment is key for sustained production and human well-being. Natural environment, sans human interference, is self-regulating. An ecosystem, a subunit of biosphere has a carrying capacity and if its exploitation is stretched beyond its carrying capacity, the system collapse. Anthropogenic activities have been largely blamed for environmental degradation. The degradation occur due to overexploitation of the natural resources and deforestation, these factors inflict significant impact on biodiversity and ecosystems (Sharma & Mishra, 2011). Agricultural practices like shifting cultivation (Jhum) has been viewed as wasteful and destructive technique which destroy thousands of hectares of forest cover every year (DeJong, 1997; Brady, 1996; Tinker *et al.*, 1996). In India, *Jhum*, main subsistence practice of smallholder farmers, is more prevalent in tribal areas of Northeast and Central India. However, it has in the recent past, due to short jhum cycles, has led to forest degradation, spread of weeds and loss in regeneration (Ramakrishnan, 1992). The National Biodiversity Strategy and Action Plan consider conversion of natural mixed forests into monoculture stands or plantations as one of the drivers of degradation and qualitative changes in environment. Forest fires (both natural and human-induced) have also been responsible for considerable changes in the natural forest communities and their species composition, often damaging valuable ecosystems beyond redemption and rendering the constituent species highly vulnerable (Sastry, 2002). The exploitation or removal of natural resources from their origins has led to the extinction of many species of plants and animals thereby resulting in loss of biodiversity and changes in the ecosystem (Sata *et al.*, 2008; Veravatnanond, 1998).

The Singhason hills in Karbi Anglong district, Assam is acclaimed for rich biodiversity and mineral resources. The region presents diverse topography and characterized by aquatic, terrestrial and arboreal ecosystems. These ecosystems further produce diverse microhabitats for different group of plants such as lichens, saprophytes, parasites, lithophytes, epiphytes, grassland, bogs, alpine, etc. Being contiguous with the famed Kaziranga National park it serves as important corridor for wildlife. Ecosystem services provided by the forest are indispensable for sustenance and livelihoods of local residents and the adjacent areas. The hills form watershed for all perennial rivers and their tributaries that flow to the plains (Fig. 1). The landscape forms the main production system for agricultural products, the chief subsistence practice of the people. Non-timber forest products (NTFPs) is common resources for local people who use the products mainly for household requirements; major NTFPs currently extracted by local people includes bamboos, rattans, *Rauvolfia* sp., Agarwood (*Aquilaria malaccensis* Lamk.), *Cinnamomum zeylanicum* Blume, Dammar (*Canarium* spp.), *Garcinia* spp., *Citrus* spp., *Aristolochia* spp. and many more. Among water resources, fishes constitute source of food and livelihoods. Many poor families are engaged in trading of NTFPs as a strategy for diversification of livelihoods. *Alom-Bilom*, the sacred tree of the Karbis is considered to be distributed in the Singhason hills for which the hill is regarded as cultural heritage of the district. Many plants, particularly wild and underutilized crops, in the region have horticultural potentials; the region thus, has scope for domestication and production of

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organic foods. In recent years, the hill range is under pressure particularly from human interference that poses considerable threats to biodiversity and the landscape. There is no previous study on environment of Singhason hills due to which biodiversity status, agricultural practices and other related aspects are yet not known. In the present communication, we discussed drivers of environmental deterioration in Singhason landscape and proposed opportunities for its conservation. This study will help in documentation of biodiversity status and drivers of environmental deterioration in the area. It will highlight agricultural practices of local people, agrobiodiversity and plant resources in Singhason hills. The study will also help in identification of challenges for biodiversity conservation and opportunities for the same. Result of the present study will serve as baseline information for future research in the area.

Materials and Methods:

Study area: The Singhason hills in Karbi Anglong district of Assam state comprises of the Singhason peak (1360m above MSL) and the adjacent hills including some protected areas such as Mikir Hills RF, Kalyani RF and Nambor RF. The hill range is located in the eastern part of the district surrounded by the Rengma hills. The region abruptly rises through successive ranges to the north of the Jamuna River. On the east and west, it gradually slopes down to the neighbouring plains of Golaghat and Nagaon respectively while to the north it reaches the Brahmaputra River through a low plateau surface. The hill range represents vegetation of semi-deciduous to semi-evergreen type (Champion & Seth, 2005). The semi-deciduous vegetation shows distinct three-storied formation. *Adina cordifolia* (Roxb.) Hook. f., *Terminalia bellirica* (Gaertn.) Roxb., *Bombax ceiba* L., *Schima wallichii* Choisy, *Dillenia* spp., *Sterculia alata* Roxb. and *Albizia* sp. are major species in the top storey; *Careya arborea* Roxb., *Callicarpa arborea* Roxb., *Trewia nudiflora* L., *Premna multiflora* Zipp. ex Span. and *Albizia lucida* Benth. are the important components of the middle storey whereas the lower storey consists of *Alstonia scholaris* (L.) R. Br., *Bauhinia* spp., *Vitex trifolia* L., *Holarrhena antidysenterica* (Roth) Wall. Ex A. DC. and *Syzygium* sp. The ground vegetation includes *Lantana* sp. and many other bushy species. The semi-evergreen vegetation occur in patches in high rainfall zone and show typical three storied zonation. Important species are *Michelia champaca* L., *Phoebe* sp., *Terminalia* spp., *Mangifera sylvatica* Roxb., *Tetrameles nudiflora* R. Br., *Cinnamomum camphora* (L.) J. Presl, *Gmelina arborea* Roxb., *Albizia* sp., *Chukrasia tabularis* A. Juss., (Upper storey); *Syzygium* spp. *Amoora wallichii* King., *Dillenia pentagyna* Roxb., *Cephalanthus occidentalis* L., etc., interspersed with bamboo forest (Middle storey); *Hydnocarpus kurzii* (King.) Warb., *Holarrhena antidysenterica* (Roth) Wall. Ex A. DC., *Polyalthia* sp., *Albizia lucida* Benth., etc., (Lower storey). The ground vegetation is dominated by ferns, *Alpinia allughas* (Retz.) Roscoe, *Phrynium pubinerve* Blume, etc.

The region presents diverse topography characterized by three major ecosystems-aquatic, terrestrial and arboreal. These ecosystems further produce diverse microhabitats for different group of plants such as lichens, saprophytes, parasites, lithophytes, epiphytes, grassland, bogs, alpinas, etc. However, biodiversity status of the study area has not been

evaluated so far. Further, the region is also home to different ethnic groups like Karbi, Kuki, Rengma, Naga, Shyam, Hmar, Garo, Chakma and Tea-Tribes who have altered the habitat through agricultural and other practices developing the hill range into a cultural landscape.

Data collection and analysis: Field study was conducted among ethnic communities of 12 villages during September 2012 to April 2014 in Singhason hills. Permission for collecting data was obtained from the village chiefs and informants were apprised of the objectives of the research before obtaining their consents. Snowball method (Goodman, 1961) was used to identify respondents. Household elders were interviewed on issues of agricultural practices, land use pattern and utilization of biodiversity, land and water resources. During the study period, participant observation was recorded on swidden fields, monoculture, and extraction of plant and mineral resources. Focus group interview of 48 community elders was conducted in order to reconstruct ecological history and drivers or factors of environmental deterioration in the region. Relative Frequency (RF) was calculated for over-harvesting (overexploitation) of resources, mining, monoculture and shifting cultivation to assess relative importance of these drivers. Authors have also recorded farmers' perception on the sustainability of traditional agricultural practices and suggestions for conserving the landscape.

Results and Discussion:

Drivers and trends of environmental deterioration in Singhason hills: Shifting cultivation or slash and burn (Fig. 1) is the main mode of agricultural practice of the people. It is a type of traditional farming system adopted historically in tropical forestry ecosystems, where people do the cutting of the forest and burn the vegetal residues as land preparation for subsistence farming (Jeus *et al.*, 2012). In Singhason hills, the cultivation generally begins from the middle of February to the beginning of March by clearing vegetation and burning the debris to create cultivating fields. The soil is tilled with the help of spades. Farmers grow multiple crops of which paddy is the major one besides maize, cucurbits, beans, cassava, yams, aroids, sesame and other minor crops. When the soil fertility gets exhausted, the plot is abandoned and a new site is cleared for cultivation. Earlier the fallow period was long about 20 to 30 years, however, probably with increase in human population and government restrictions there has been pressure on land and Jhum cycle was drastically reduced, in some case only 2-3 years. With loss of forest cover biodiversity also disappears and as soil remains barren for many months before growth of crops, soil fertility is degraded as a result of erosion. Further, as the fallow is devoid of fertility it takes years to recuperate. This change progressively led to land degradation in Singhason hills, a threat that can have wide implications in downstream regions. Sometimes soil erosion creates problem of siltation

Figure. 2. Jhum operation in Singhason hills (drying of slash)

downstream.

Overexploitation particularly for economic benefits has been a bane for the rich natural wealth of Singhason hills. The region is acclaimed for bamboo and rattan resources but overexploitation has degraded these resources (Fig. 2a & 2b). During recent years, youths are increasingly being drawn to the lucrative trade of supplying bamboo or canes to paper mills and industries which has accelerated the pace of forest degradation. The fate of rattans is no different from bamboo; collection pressure has exceeded biological potential of the plant. Earlier, Agarwood (*Aquilaria malaccensis* Lamk.), highly valued for its resin embedded heartwood and distinctive fragrance and used for

Figure. 3. Resin of black dammar (*Canarium resiniferum*)

incense and perfumes, was found to be plenty in the

forests of Singhason. But the present study found the plant is almost on the verge of extinction due to over collection. As parent trees were felled for extraction of resin, seed production was prevented. This finding was supported by local people engaged in trading agarwood. Broad (1995) also reported the high price of agarwood as the main factor for the depletion of this plant resource. Unscientific extraction of black dammar (*Canarium resiniferum* Bruce ex King) (Fig. 3) for its aromatic medicinal resin has resulted in the loss of many mature trees from Singhason

Figure. 2a Bamboo being loaded on truck for supply to paper mill

Figure. 2b Rattan resource in Singhason hills

Figure. 4a. A view of Coal mining in Singhason hills

Figure. 4b. Limestone mining in Singhason hills

Figure. 5. Rubber plantation in the foothills of Singhason hills Figure. 6. Ginger cultivation in Singhason hills

hills. Likewise, the once abundant cinnamon trees (*Cinnamomum zeylanicum* Blume.) are also under pressure due to extensive felling for its medicinal bark.

Extraction of coal and limestone (Fig. 4a & 4b) pose serious threats to Singhason landscape through destruction of forest cover, fragmentation and pollution. As biodiversity of the region has not been characterized many species may have been displaced or lost and the present trend of change will only accelerate biodiversity loss. Local residents from the mining areas of Singhason hills have reported increase in respiratory problems though this claim needs further study to underpin the actual cause of the problem. Nevertheless, their economic activities, such as agriculture, hunting and gathering food and medicinal plants were interrupted due to pollution of production systems (i.e., land and water).

Large scale clearing of vegetation for monoculture of a few selected economic plants is another major driver of forest degradation in Karbi Anglong district including the Singhason hills. Massive teak plantations have already fragmented the local ecosystems. In recent years, rubber is emerging as one of the important cash crops cultivated in the district and as a result more and more forest and fallow lands have been converted into rubber plantations. Rubber plantation (Fig. 5) in and around Singhason hills has risen alarmingly at the cost of environmental sustenance; local residents have reported decline of water availability in comparison to the other areas where there are no rubber plantations. Ginger cultivation (Fig. 6) is another trend of monoculture that has led to destruction of large tract of Singhason forests. The crop has provided livelihoods to many families in Karbi Anglong district but as mature forest patches are cleared for the cultivation, it has resulted in undesirable change in the landscape of the hill region and loss or displacement of valuable biodiversity. Monoculture has also created openings for establishment of weeds and exotic plants like *Lantana* and *Mikania*.

Relative Frequency (RF) (Fig. 7) calculated on the basis of informant's responses (Table 1) on drivers of environmental deterioration (over-harvesting or overexploitation, shifting cultivation, monoculture and mining) in Singhason hills revealed maximum

Figure. 8: Relative Frequency analysis on drivers of environmental changes in Singhason hills

positive response lies on the issue of over-harvesting (91.7%) while shifting cultivation (12.5%) is considered least potent issue which is suggestive of sustainable agricultural practice adopted by farmers. There is, however, no available data on the extent of degraded forest in the study area. Monoculture (35.4%) with teak and rubber plantations and mining of lime stone and coal (83.3%) have been graded by informants as being medium drivers whose value lies between that of overexploitation and shifting cultivation. A section of informants were ignorant about the cause of environmental deterioration in Singhasan hills with RF score of 64.6% (shifting cultivation), 47.9% (monoculture), 20.8% (mining) and 8.33% (over-harvesting). But all farmers interviewed are unanimous for continuation of jhum for subsistence and livelihoods; imposing strict restriction on this traditional agriculture will inconvenience the people but they suggested value addition on jhum can contribute to food production, livelihoods and biodiversity conservation.

Challenges and Opportunities for conservation: Conservation initiative in Singhasan landscape pose great challenge and success of the initiative presents a long drawn exercise. As of now, control of overexploitation of forest resources, which has been unabated since many years, presents the most potent hurdle for conservation. The effects are apparent as many commercial species once abundant in the region have declined. At the receiving ends of this trend are agar-wood, cinnamon, black dammar, rattans and bamboo. Though local residents do not consider jhum as destructive, yet it leads to vegetation loss of considerable magnitude. Unscientific extraction of coal and lime stone is another serious challenge. Pollution from these activities has potentials to degrade both land and water systems and also produce adverse downstream impacts. Monoculture with rubber and teak plantations has triggered clearing of natural forest in the periphery of Singhasan hills. This has deteriorated the landscape through forest fragmentation and alteration of microhabitats. Forest fragmentation can act as gateway for establishment of weeds and invasive species leading to undesirable change in floristic composition.

The present trend of environmental changes in Singhasan hills demands urgent conservation initiatives. The forces or drivers of destruction need to be mitigated for maintaining ecological balance in the region. Application of agroforestry practices by growing locally important plants among dominant crops could be one option for enhanced food production and management of soil fertility and control erosion. The farmers of Singhasan hills are less aware of the potentials of agroforestry in rural development though some elements of sustainability exist in their farming system. Intercropping with trees like Areca nut (*Areca catechu* L.), Banana (*Musa sp.*), Papaya (*Carica papaya* L.), Pineapple (*Ananas comosus* (L.) Merr.), Pigeon pea (*Cajanus cajan* (L.) Millsp.), Tree bean (*Parkia roxburghii* G. Don) and neem (*Azadirachta indica* A. Juss.) among major crop (i.e. paddy) can bring good dividends in terms of food production, livelihood and socio-cultural benefits. Black dammar (*Canarium resiniferum* Bruce ex. King) and cinnamon (*Cinnamomum zeylanicum* Blume.) are other potential candidates for economy-based agroforestry as these plants grow well in wild habitat. Management of fallow swidden with broom grass (*Thysanolaena maxima* Roxb.) is a

common practice in some parts of Karbi Anglong district and the same can be applied in Singhason hills. This practice has dual benefits of restoring ecosystem through economic returns and checking soil erosion. The hills also have potentials for organic fruit production like orange (*Citrus sinensis* (L.) Osbeck), pear (*Pyrus pyrifolia* Burm.f. Nakai), pineapple (*Ananas comosus* (L.) Merr.) and jackfruit (*Artocarpus heterophyllus* Lamk.); some farmers have been cultivating orange (*Citrus sinensis* (L.) Osbeck) since many years.

Rejuvenation of traditional agricultural practices among local farmers can supplement to management and conservation of soil and agrobiodiversity in Singhason hills. Jhum represents the original method of farming that was developed through the interaction of social and environmental systems. It involves the extensive use of local knowledge and natural resources supporting biological diversity by means of crop rotation and crop diversification. Smallholder farmers usually grow folk varieties of crops that are well adapted to local environment and culture and presents a source of genetic repository for improvement of crops. Modern agriculture homogenizes cultivating fields to suite the growth of a few so called high yielding varieties and displaces traditional farming systems and folk crop varieties. Besides, cultivating high yielding varieties gives economic burden to smallholder farmers as it requires huge investment of irrigation, fertilizers and pesticides.

Table 1: Informant responses on drivers of environmental changes in Singhason hills

Sl. No	Drivers of environmental change	Yes	No	Others	RF Positive %	RF Negative %	RF Ignorant %
1	Shifting Cultivation	06	11	31	12.5	22.9	64.6
2	Mining	40	05	10	83.3	10.42	20.8
3	Over-harvesting	44	14	04	91.7	29.17	8.33
4	Monoculture	17	10	23	35.4	20.8	47.9

Conclusion:

From being resource pool of food, crops, medicinal plants, nutritious edible wild roots and tubers, livelihoods and cultural heritage, Singhason hills is gradually being converted into commodity for economic benefits. The hills with its rich biodiversity have potential for horticultural development but the current trend of environmental deterioration poses threat to this prospect. Economic value of biodiversity has influenced overexploitation in Singhason hills and has been recognized as the most potent threat to biodiversity. The latter is inherently associated with subsistence practices and livelihoods of its residents, hence any initiative to address environmental deterioration needs holistic approach that will address local demand for resources and recognize traditional practices and values of stakeholders (ethnic communities). As of now, farmers of Singhason hills has no alternative to multicropping jhum system. Nevertheless, modern farming may be introduced as a supplement to the traditional system but not as a replacement to the latter. Agroforestry with local plants like black dammar,

cinnamon, broom grass, orange, pineapple and pear hold promises for food production, food security, nutrition, health and socio-cultural benefits. In summary, maintenance of environmental health and proper management of resources are crucial for sustainable development vis-à-vis conservation of biodiversity of Singhasan cultural landscape.

Acknowledgements:

Authors are thankful to the people of Singhasan hills for their cooperation during field study and valuable suggestions for improvement of the report. Authors would also like to thank the Institutional Biotech Hub, funded by Department of Biotechnology, Govt. of India, for infrastructure and kind assistance.

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