The Garo Hills of Meghalaya consist of three districts – East Garo Hills, West Garo Hills and South Garo Hill. The districts are bordered in the north and west by Assam state, south by Bangladesh and east by West Khasi Hill district of the state. The landscape is highly dissected with irregular terrain. The highest point of Garo hills is the Nokrek peak with an altitude of 1,412m above.

The total area of Garo Hills landscape is 8,167 sq km, which is 36.4 percent of the total area of the state. Garo Hills has the richest reservoir of plant diversity of India and is part of one of the biodiversity hotspots of the world.

During the last few decades there has been a phenomenal increase in urbanization and population pressure, causing large-scale destruction and deterioration in the environment. Activities like shifting cultivation, urbanization, forest fire, mining of minerals, extraction of timber and plantation (cash crops) are responsible for environmental intimidation in the Garo Hills.

Being relatively under-developed compared to other regions of the country, opportunities for alternative livelihoods are limited. Local communities of this region are pre-dominantly agrarian; they are dependent on forest products and meat for their livelihoods. This is apparently more so after a ban was imposed on the felling of trees and hunting, curtailing any further opportunities to earn livelihoods. The Government manages only 15% of the total land in protected areas and reserved forests. The remaining land belongs to the local Garo communities, who use it widely for Jhumming and as source of non-timber forest resource.

Slash-and-Burn Agriculture

Slash-and-burn agriculture, commonly known as shifting cultivation and jhum, in Northeast India is regarded as one of the traditional methods of cultivation in the hilly area of the tropics. Shifting cultivation has a rich customary ecological

Since policies related to shifting cultivation and land management in the Garo Hills will affect the livelihoods of thousands of marginal farmers, strengthening rather than replacement of shifting cultivation is recommended.
knowledgebase and remains an important component of forested landscape in many parts of the Asian tropics.

The Garo tribe uses the forest land for shifting cultivation. In this forest vegetation is cut and burnt on site and site is cultivated for crops. When final crop harvests are made, the site becomes fallow allowing for natural regeneration. After a few years these plots are again used for cultivation. Due to population pressure and demand on land, the gap (jhum cycle) of years has reduced to just 2-3 years in the Garo hills, which was 12-15 years in the past decades.

Paddy in jhum cultivation in Garo Hills (left) and a jhum in Nokrek Biosphere Reserve (right)

The time frame for slash-and-burn agriculture is strict especially keeping in mind the heavy rainfall of the area, requiring the land to be cleared and seed sowed in time for the monsoons. Generally, the village community chooses where the fields for the coming season will be established – slashing and subsequent burning are preconditions of this traditional farming system.

The slashing operation is usually done in the last week of November by simply slashing the vegetation to dry in the Sun for about 3-4 weeks and then burnt during the last week of December.

Burning of forest land for jhum leading to emission of greenhouse gases

Impact on Forest Ecosystem

Multiple land use practices in forests lead to loss of carbon stocks and emissions of carbon dioxide. Moreover, if the biomass is burned during the clearing process, additional greenhouse gases are emitted. Therefore, clearing of vegetation by burning, which is an aspect of shifting cultivation, results in more emission of carbon dioxide and other GHGs.

The current distribution of vegetation cover in Garo Hills is the result of gradients in physical condition like elevation, slope-aspect, climate substrate and past human disturbances. These environmental characteristics of landscape are also responsible for forest fire and vegetation flammability. In the

Burning is a noisy operation, causing huge flames on the hills, reducing the visibility and polluting the atmosphere. Following the burning and cleaning of the newly burnt sites, sowing and broadcasting of millets and other vegetable crops is started from January. Each jhum area is generally cultivated for two cropping cycles. Crops totally depend on the monsoon due to lack of irrigation facilities.

Land use land cover map of Garo Hills, Year-2010 (Source: Yadav and Sarma 2014)

Garo Hills

Slope and elevation are important factors that affect soil erosion. Garo Hills has very variable slope and elevation characteristics.

Abandoned jhum land after slash-and-burn agriculture
The environmental characteristics of landscape are also responsible for forest fire and vegetation flammability. In the last few years, forest fire was recorded as one of the major causes with large impact on canopy growth and regeneration in the Garo Hills. The repeated intensity of uncontrolled fire in jhum fields and other forest floors is responsible of forest degradation.

Due to increasing agricultural population pressure in the Garo Hills regions significant deforestation has been experienced, which brings new land cover under cultivation. Thus, population pressure first exerts its impact on the expansion of marginal lands under cultivation, to some extent shortening the fallow period, which in turn increases the gross agriculture production as well as exploitation for fodder, fuel wood and timber.

Yadav et al. (2012) working on the impact of slash-and-burn agriculture on the forest ecosystem in the Garo Hills concluded that the prominent pressure to native forest biodiversity in the Garo Hills is the increasing anthropogenic conversion of mature and primary forest to jhum land. The decreasing fallow period has a deep impact on the life sustainability in Garo Hills and has reduced the quality of soil thereby reducing the possibility of vegetative restoration of the locality.

There was tremendous increase in slash-and-burn land, i.e. 5.15% in the year 2010 when compared to only 0.83% in the year 1991 (Table 1). The overall reduction in the forest, mainly due to jhumming can severely affect a viable forest habitat of endangered fauna like the Asian elephant and Hoolock gibbon. The need to understand the effect of slash-and-burn cycle and to differentiate between ecologically sound traditional methods of jhum from the current unsustainable form is most important.

### Soil Erosion and Runoff

Slash-and-burn land clearing on sloping land leads to increased soil run-off following disappearance of the protective vegetation cover. Soil erosion is an irreversible phenomenon causing land degradation and deterioration of surface

### Table 1:

<table>
<thead>
<tr>
<th>Land use/cover (Classes)</th>
<th>Year 1991</th>
<th>Year 2001</th>
<th>Year 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area in km²</td>
<td>Area in %</td>
<td>Area in km²</td>
</tr>
<tr>
<td>Dense Forest</td>
<td>836</td>
<td>10.24</td>
<td>375</td>
</tr>
<tr>
<td>Open Forest</td>
<td>6649</td>
<td>81.41</td>
<td>6365</td>
</tr>
<tr>
<td>Slash-and-burn Land</td>
<td>68</td>
<td>0.83</td>
<td>172</td>
</tr>
<tr>
<td>Non Forest</td>
<td>614</td>
<td>7.52</td>
<td>1255</td>
</tr>
<tr>
<td>Total</td>
<td>8167</td>
<td>100</td>
<td>8167</td>
</tr>
</tbody>
</table>
water quality. Soil run-off is enhanced by disappearance of vegetative cover and surface litter following the burned vegetation. Heavy rainfall in the area may lead to sedimentation run-off from higher elevation and steep slopes.

Slope and elevation are important factors that affect soil erosion. Garo Hills has very variable slope and elevation characteristics. Vegetation reduces water-caused erosion by intercepting rainfall, increasing water infiltration on associated “soil fertility” island, intercepting run-off at surface level and stabilizing the soil with root. Heavy rainfall in the area leads to sedimentation run-off from higher elevations and steep slopes.

Today, it is becoming clear that jhum cultivation is playing a very big role in degradation of soil, forests.

What Can Be Done?

Policies related to shifting cultivation and land management in the Garo Hills will affect the livelihoods of thousands of marginal farmers. Therefore, strengthening rather than replacement of shifting cultivation is recommended, especially considering the benefits shifting cultivation has to offer. The following recommendations may be quite useful in developing an ideal cropping system as a modified shifting cultivation system:

1. The Garo Hills have witnessed the conversion of forests to other non-forest areas during the last decade. This alteration needs to be checked immediately. The short cycle not only effects soil fertility but also exposes the top soil to erosion. Further, the conversion of forest areas into other land use should be properly planned.

2. Threats of soil degradation and soil erosion due to jhumming can affect the vitality of native vegetation due to loss of necessary nutrients and soil features needed for their natural survival. To achieve balanced nutrients in traditional shifting cultivation system, a long fallow period is required.

3. Wide spectrum of fallow management strategies should be improved in shifting cultivation to accommodate the needs of the growing population.

4. More multipurpose (usually nitrogen-fixing) tree species should be protected during the clearance (slash-and-burn) phase, especially economic trees.

5. There should be innovative technologies, institutions and policies that can address two fundamental challenges like poverty alleviation and biodiversity conservation.

6. In response to the shortening fallow period and increasing pressure on land resources, farmers should go in for innovations that allow them to produce more and stay longer on the same plot, under the same soil fertility conditions. They can thus postpone the clearing of a new plot, and allow the forest on that plot to grow a few years longer, which in the long run saves labour.

7. Plantations should be promoted by governments and extension agencies in a bid to find alternatives to shifting cultivation that provide farmers with a livelihood, while at the same time maintaining forest cover. Species may include several timbers, rubber, tea, cashew and areca nut.

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