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Repeated and Excessive Slash and Burn Agriculture and Adverse Effects on Environment: *A Case on Matamuhuri Catchments of South-Eastern Tertiary Hills of Bangladesh*

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Abstract: *Matamuhuri catchment is a part of Greater district of Chittagong and Chittagong Hill Tracts and it occupies about 2,05,628 hectares of hilly landmass. Once the hilly region represents green vegetated landscape and people satisfy their essential needs from nature. But at present, due to increasing population and extension of reserved forest traditional jhum cycle (interval between two subsistence slash and burn agriculture) of tribal people has been reduced from 15-25 years to 2-3 years or maximum 5 years only. In reserved forests and khash lands the forest department and different organizations have been introduced commercial monocultures (teak, acacia, eucalyptus, rubber etc.). Those monocultures are created after total slash and burn of natural vegetation. All slash and burn processes cause massive soil erosion, oversiltation in streambeds, loss of natural woody plant, bamboo, cane, medicinal plants, natural fruit and roots, fishes in streams, rise in temperature, increasing landslide and such other problems. To search out the actual problems-originated from slash and burn agriculture different PRA sessions (group and individual interviews of key informants) have been done in different locations of study area. Direct field observation has been introduced in different field of slash and burn (different jhum fallows and land of monocultures) to note down physical environment of soil, hillslope, status of natural flora and fauna, output from jhumfields, temperature, natural spring and stream flow etc. Soil samples have been collected from different lands of slash and burn and naturally vegetated lands to trace out actual scientific cause of soil degradation and associated problems. The study reveals that slash and burn agriculture causes decrease in hydrogen ion of soil (pH value) that indicates soil becomes toxic, significant decrease in organic matter that is the actual cause of soil disintegration and erosion and decrease in soil moisture. All these conditions cause creation of barren hill ridges in study area. Soil properties are much degradable in land of monocultures than those of different jhumlands. The striking result of this research is that soil properties are not degraded at all in long jhum fallows.*

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Introduction:

'Slash and Burn Agriculture' or Jhum cultivation (Shifting cultivation) is the primitive from of agriculture (started from Neolithic age which comprises cutting and burning of forest, making holes over the small hill beds and then sowing a variety of seeds (Hossain,1996) Shaheed, 2002) Shifting cultivation, which is at the fore-front of forest exploitation in South and South east Asia, accounts for about 49% of deforestation (FAO,1982).

In Bangladesh Jhum (shifting cultivation) is practiced only Chittagong Hill tracts and in some tribal areas of adjacent hill region of greater Chittagong. Shifting cultivation is also treated as rotational cultivation. The nomads or Jhumias use the land after a certain interval. After a slash and burn process a land can revive it's nutrient capacity after fifty years (Alexander,1977). In Chittagong Hill tracts formally the fallow period was 15-25 yerar. Later it has been decreasing with the increase of population and now the interval is only 2-3 years in maximum places (Gafur, *et.al.* 2000). Beside it yield from Jhum field become very and the Jhumias are taking alternative works for survive all over the year. In most cases they cut the timber wood and as for result no natural mature trees are seen in the region without some very remote places. The maximum Jhum fields are now totally devoid of trees or large vegetation. The ultimate result is that the ecosystem of the area becomes seriously endangered. From field survey, massive soil erosion and landslide, oversiltation in torrents and riverbes, loss of maximum hilly springs, decreases in water flow, intolerable temperature, disappear of forest rainfall (which was seen before 30-40 Years) decrease of crop and natural output (bamboo, cane, natural fruits and roots, fishes shrimps and others), crisis of pure drinking water, decrease in water level and such other problems have been identified. The total Jhum fields have been increased 3-4 times after peace treaty with tribal leaders(Shaheed, 2007).

In recent decades, some other forms of 'Slash and Burn Agriculture' have been running in study area. They are apparently more devastating to hilly environment than that of traditional shifting agriculture. Teak, acacia, eucalyptus, pine, gamar and such other monocultures are established after complete slash and burn of natural vegetation. Most of them are exotic origin and the mature gardens of teak, acacia and eucalyptus represents zero undergrowth.

The British colonial foresters introduced teak in 1872 at Sitapahar, Kaptai with seeds brought from Burma (Myanmar), the Pakistan and Bangladesh Government followed that colonial policy (Gain,1997) and now teak monoculture covers around 60 percent of total forestation program (Sources of Rangamati, Chittagong, Bandarban and Cox's Bazar forest divisions).The teak is not beneficial to environment. It is criticized for massive soil erosion. Undergrowth vegetation is totally absent in the teak plantation because of an acidic reaction with the soil (Marchak, 1998). Teak is not indigenous specie and perhaps not a proper replacement. The monoculture of teak, however desirable commercially, is a death knell to wildlife conservation (Schendel, *et.al,* 2000).

Pulpwood or industrial plantations with exotic species (pine, eucalyptus & acacia) have already contributed to massive deforestation with severe environmental degradation and replaced natural forests with alien species in Chittagong and Chittagong Hill Tracts. In some places such plantations have been established on the traditional jhum land and cause loss of biodiversity and soil erosion. Actually such plantations are monoculture and they typically have sparse canopies-do not protect the land. They cause rise in air temperature and deplete water table (Marchak,1998).

Objectives:

The aim of this study is to identify the nature of slash and burn agriculture and the environmental problems- originated from this malpractice. To reach the goal the following objectives have been adopted.

1. Observe different fields of slash and burn agriculture in some selected areas and find out the environment hazards- originated from them;

2. Find out the status of soil properties in different field of slash and burn agriculture.

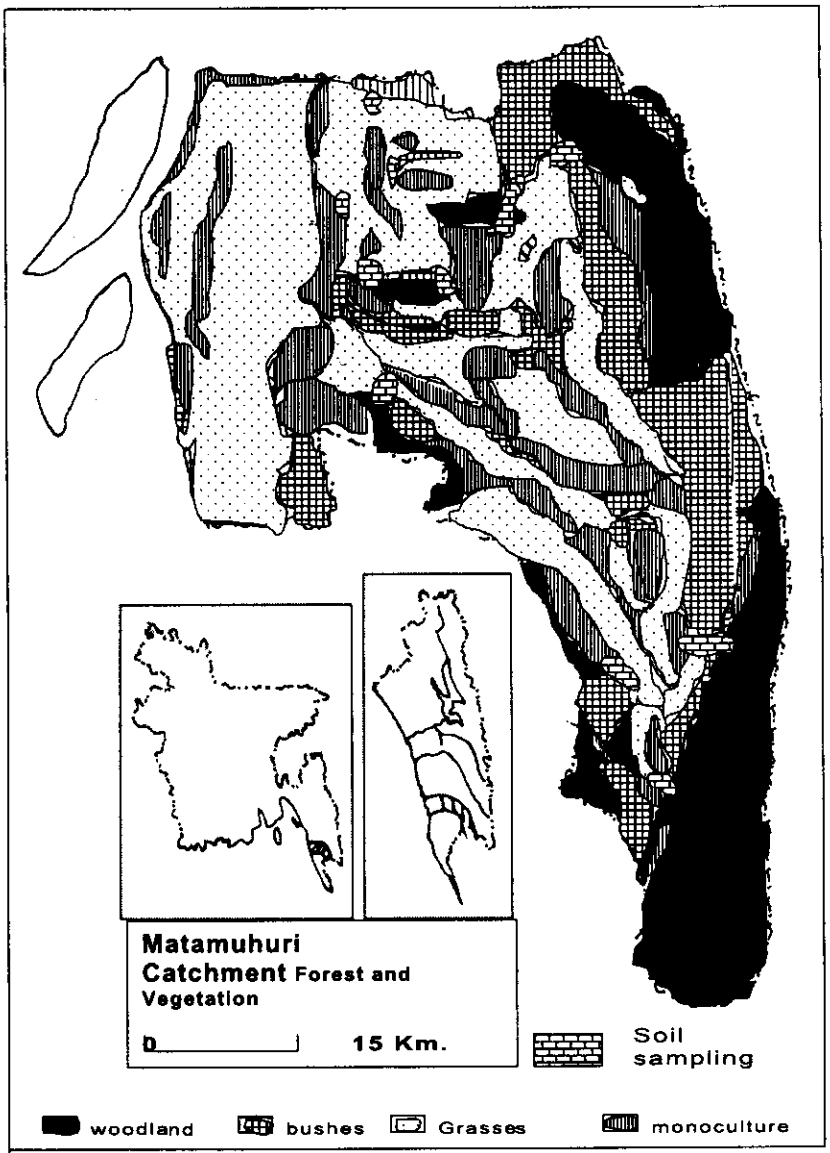

Fig.1: Forest and Vegetation Map of Matamuhuri Catchment
(*Source*: Shaheed, 2007)

Study Area:

The Matamuhuri Catchment of Greater districts of Chittagong and Chittagong Hill Tracts represents low hilly area. The hilly region

stretches latitudinally between 210 21/ - 21059/ north and longitudinally between 91075/-92034/ east. The area includes whole Alikadam upazila of Bandarban district and maximum portion of Lama (Bandarban) and Chokoria upazila of Cox' s Bazar. The catchment area stretches from Bandarban Sadar and Lohagora upazila in the north and Arakan of Myanmar in the south. The eastern border represents Ruma and Thanchi upazila of Bandarban while the western part comprises Cox's Bazar district and Bay of Bengal. Area of this hilly river catchment is about 1400 square kilometer in which maximum part represents very dense hilly forest or shrubs.

Methodology:

Primary and secondary- both types of data have been considered. Primary data have been collected from field visit (PRA Sessions in different locations). To determine the environmental hazards due to slash and burn agriculture several PRA sessions (individual and group interviews of key informants of the localities) have been done. In depth field observations have been adopted to find out the scientific cause and actual scientific effects on environment. This process has been done to note down physical environment of soil, hillslope, status of natural flora and fauna, output from jhumfields, temperature, natural spring and stream flow etc. To measure the soil degradation, sample from different places have been collected. Mainly soil organic matter, moisture content of soil and soil pH has been tested in laboratory to find out the cause of soil loss and abolish of undergrowth vegetation. Some data have been collected from secondary sources. Previous research works, reports, journals and books have also been considered.

Characteristics of existing lands of 'Slash and Burn Agriculture':The matamuhuri catchment represents different types of jhumland and monoculture-

i) Short fallow (repeated jhumfield): 2-3 years jhum cycle; In lama upazila, specially lama sadar and Aziznagar union, the jhum cycle has been reduced too much due to heavy population pressure and lack of secondary or tertiary occupation.

ii) Short to medium fallow: 4-6 years jhum cycle In north Alikadam and south lama upazila the tribal peoples become habituated in some alternative occupations. Tobacco plantation forest workers or N.G.O and private services give some opportunities of employment. The returns from jhum fields are not so satisfactory and population density

is not so thick like Aziznagar and lama sadar or other parts of hills like Bandarban sadar, Taracha, Kaptai, Rangamati, or Kahagrachari.

iii) Medium to long fallow (jhum cycle is 5-8 years): In Lemupalong of lama, some part of Matamuhuri reserved forest, Champra and Tainpa of Alikaloam, population density is very low and actually there are no administrative controls at all. In those places the tribal use land anywhere as they like. The jhum cycle is comparatively longer in those places and production satisfies the farmers

iv) Long fallow (11-20 years): Apparently these are not jhum fields. In some places of matamuhuri reserved forest, Champra, Lemupalong, Lulaing are filled with bushes and medium aged scattered tress. Local people reported that jhum cultivation had been occurred there long days ago (11-20 years).

Teak monoculture: Mature (more than 50 years), semi mature (20 years+) and tin aged teak gardens are seen elsewhere. They cover about 60% of plantation. But the great concern for this practice is that the hillslopes of teak monocultures are totally devoid of undergrowth vegetation. Due to long absence of micro flora, topsoil has been totally eroded for rainfall action. hillslopes have become very fragile and regular increasing landslides are observed in barren hills after collection of timber.

Acacia monoculture: This type of monoculture is also very dominant feature in study area. The land situation is almost same like teak garden.

Rubber monoculture: Very few lands of study area are used for this practice. Rubber monoculture is also created after complete slash and burn of natural forest and this landscape also shows ' total absence of natural flora'.

Eucalyptus monoculture: This practice is decreasing in study area. Very few gardens are remaining here and there and they cover poor area. But the lands covered by eucalyptus monoculture are also barren like teak and other monocultures.

Adverse effects on environment Due to Repeated and Excessive Slash and Burn Agriculture:

Excessive slash and burn of natural forest for commercial monoculture and repeated jhum practice are doing great harm to environment. The following table shows the situation:

Table-1: People's perception about environmental degradation-originated from slash and burn agriculture

Problem	Very high	High	Medium	Low	Rank
Soil erosion	500	-	-	-	1
Loss of soil fertility	500	-	-	-	1
Siltation	500				1
Landslide	500				1
Decrease in river depth	500				1
Decrease in water flow (dry season)	500				1
Loss of fauna	500				1
Crisis of fishes from natural sources	500				1
crisis of natural food	500				1
Crisis of medicinal plants	500				1
Loss of hilly spring	421	72	7		2
Decrease in water level	417	82	1		3
Rise in temperature	406	88	6		4
Loss of natural trees	403	87	0		5
Loss of bamboo	397	91	12		6
Loss of cane	381	103	16		7
Extension of Grassland	287	193	105	15	8
Extension of shrubby area	245	230	25	-	9
Extension of barren hill	23	252	104	121	10
Crisis of fishes from natural sources	21	240	201	38	11
crisis of natural food		191	171	18	12
Crisis of medicinal plants		181	179	75	13
Water logging	-	33	41	426	14
Crisis of drinking water (dry season)		24	219	257	15
decrease in rainfall		19	307	174	16
Sheet erosion and mudflow	-		232	268	17

NB: Five hundred people have been interviewed from different locations

Table1 shows the environmental problems - originated from slash and burn agriculture. These are the common results. In depth field observation and soil sample test can show the actual scientific cause of environmental degradation in different field of slash and burn agriculture.

Scientific Evidences of Soil Degradation and Loss of Production: The proportion of sand is increased after slash and burn of vegetation (SCWM,1998). For this reason, the overjhumming area is suffering from huge soil erosion. The rate of soil loss from active jhum land is 43 ton/hectare/ year, which is 4-5 times from normal land uses (SCWM,1998). The soil erosion from land of monoculture of exotic

species is highest reportedly but no authentic calculation has been done for soil loss from monocultures. Table2 can explain the scientific cause of excessive soil erosion from land of monoculture and repeated jhumland

Table-2: Average value of organic matter, pH and water aggregate in Study Area

Land category	average value		
	organic matter(%)	p^H	water aggregate(%)
Natural woodland forest	4.8	7.4	44.5
Natural bush and shrubs	4.3	6.5	31
Short *jhum* fallow	1.7	5.7	26.5
Short to medium *jhum* fallow	3.1	5.9	30
medium to long *jhum* fallow	4.6	6.2	31.5
Long *jhum* fallow	4.8	6.8	20
Teak monoculture	0.88	4.0	8
Acacia monoculture	1.5	4.2	12
Rubber monoculture	1.1	4.3	22
Eucalyptus monoculture	0.93	3.9	7.5

Table 2 represents the soil organic matter, pH, water holding capacity of natural forest soils of hill slope and soils of those degraded hillslope that are used for modern and indigenous land use.

The table shows that organic matter content of teak, acacia, eucalyptus and rubber monoculture is very poor. Long fallow after slash and burn and repeated jhum fallow are also harmful but not so like monoculture. Loss of organic matter causes disintegration of soil (Asthana, 2001). Water aggregate of monocultures (except rubber) is also very poor. Very low pH value indicates toxicity of soil (Biswas and Mukherjee,1991) - In this situation, no plant will grow and animal species will be disappeared due to destruction of food and shelter.

Table-3: Physical environment of different land category in Study Area

Land category	Physical environment			
	status of phytodiversity	density of hilly spring (per sq. km)	temperature	slope stability
Teak monoculture	no undergrowth, climber or another flora	0	highest 36° c variation 10°c -14°c	very fragile, top soil eroded from mature gardens
Acacia monoculture	no undergrowth, climber or another flora	0	highest 34° c variation 9°c -11°c	also fragile but not so dangerous like teak
Eucalyptus monoculture	no undergrowth, climber or another flora	0	highest 36° c variation 10°c -13°c	fragile
Rubber monoculture	no undergrowth, climber or another flora	0	highest 32° c variation 9°c -11°c	accelerated erosion due to lack of undergrowth
Traditional long jhum fallow	natural forest regrowths, bountiful phytodiversity	7	highest 28° c variation 4°c -7°c	stable
medium to long jhum fallow	natural forest regrowths,thin bushes	3	highest 30° c variation 6°c -8°c	fragile
short to medium jhum fallow		0	highest 36° c variation 10°c -14°c	fragile
Modern repeated short jhum fallow	thin shrub	0	highest 36° c variation 11°c -15°c	fragile
Natural bushes	bountiful phytodiversity	10	highest 28° c variation 5-9°c	stable
Natural woodland	bountiful phytodiversity	14	highest 28° c variation 4°c -5°c	stable

Source: Shaheed,2007

[*note: the variation of temperature ranges from 180-220C. The record of SCWM weather station, Bandarban shows the variation from 150-180C. The site of weather station is not totally barren. Beside it some big trees and mixed man make gardens are seen here and there. So temperature of totally barren land will be higher than that station.*]

The above table shows natural woodland and bushes represent bountiful phytodiversity, natural springs as source of water, low temperature and slope stability. Traditional jhumlands also represent same situation. But monocultures are totally devoid of phytodiversity and natural springs. They represent very high temperature and slope instability. The situation of modern jhumlands is almost same as monocultures.

Cause and effect relationship between depletion of forest land (originated from over jhumming) and environmental degradation: 'Slash and Burn' agriculture in hilly area is too much harmful to environment and ecosystem also. After jhum cultivation, natural flora can grow again and long interval jhum cultivation in limited area is almost eco-friendly but creation of monoculture of exotic species causes permanent damage of natural flora and significant change in environment and eco-system. The following model shows the relationship between permanent 'Slash and Burn' agriculture and environmental degradation.

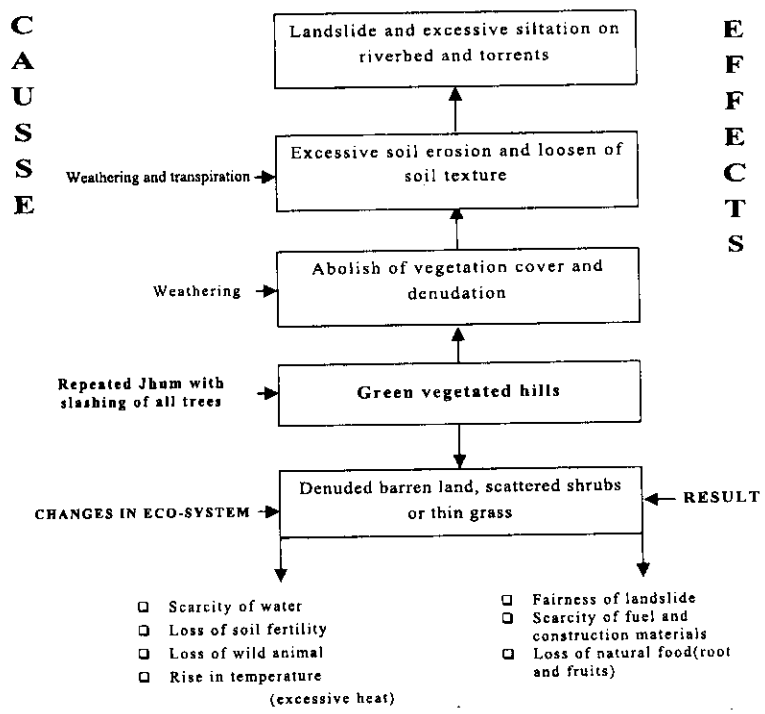

Figure-2 : Relationship between permanent 'Slash and Burn' agriculture and environmental degradation.

The postulated model shows that repeated slash and burn agriculture causes abolish of vegetation cover that starts destruction of hill slope and significant changes in ecosystem. Weathering on denudated landmass causes excessive soil erosion and loosen of soil texture. This process originates accelerated landslide and over sedimentation on riverbeds or torrents. Barren lands represent significant degradation in hill eco system. After destruction of green vegetation the hill area suffers from scarcity of water, rise in temperature, loss of soil fertility, fairness of landslide, scarcity of fuel wood and construction materials, loss of natural food (fish, fruit and roots) and such other problems. In a word, the hill ecosystem becomes unfavorable for mankind and animal species after destruction of natural forest adopting repeated and excessive jhum cultivation.

Conclusion:

Repeated and excessive jhum cultivation is originated from over-population and their unemployment problem. In most cases, jhum cultivators have no scope to get alternative job. But in future they will get no return from the barren denuded land. Then the problem will be multiplied. So govt. and others institutions should take attempt to provide jhumias in other sector for greater national interest. Moreover, monoculture should be banned very soon and local woody plants will be replaced for greater interest of the nation.

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