Assessment of Forest Biomass Flow in the Upper Kosi Watershed of Kumaon Himalaya

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Ashutosh Singh
& S.B. Singh

Abstract

Forest are the primary resource of wood, fuel wood, decayed plant material, and food for the natives of the Himalayan area. Here, reliance of people on the woodlands biomass for operating their income is extremely great and it is a millennium old exercise. Increasing human beings in the wide grasslands – moderate and downhill as well as gathering decayed plant material through lopping decayed plant material plants from the moderate woodlands, consumes the major position in the profession and economic system of the area. Forest biomass intake differs from 11 kg/day/households (fuel wood) and 14 kg/day/household (fodder) in the reduced level (1200 m) to 14 kg/day/household (Fuel wood) and 18 kg/day/household (fodder) in the greater level (2000 m). This paper tries to explain the forest biomass-flow estimation in the Upper Kosi Watershed. With the help of case study it also tries to explain that fuelwood and fodder withdrawal is a very common method in the Upper Kosi area and is a main livelihood option.

Introduction

Personal relationship with biomass can be divided into four main categories. The first one is that biomass as a resource like food resource, timber, energy, looks for food for creatures and so on. The second one is as an environmental training part such as land and water conservator, wind security and the likes. The third one is that as an indicator of landscapes functions. It all one is also as a process for individual life being atmosphere for indigenous to the isle diseases like tsetse fly, resource of weeds of impact like wilderness locust, hurdle of accessibility and so on (ITC, 1994). The lifestyle of biomass is proportional with the lifestyle of individual life or other wildlife, while deterioration of biomass happens due to organic and anthropogenic aspects. Natural aspects here include famine, area moving, and relevant geological aspects. Anthropogenic aspects are those relevant individual actions like growth of harvested area, overgrazing, agreement, desertification, facilities growth etc. Such problems are common in the creating nations in common and sub-Saharan ones specifically (Muthoka, 1998). Because of such and similar factors, biomass degradation becomes core problem for loss of natural resources especially that of soil, decrease in its fertility, eradication of wildlife, increasing demand for fuel and the likes are becoming common problems.

Once the problem of biomass degradation happens, analyzing its level may take significant period. That is because realizing its effect is not simple issue to be identified easily. It can be recognized when some environmental change occurs or affects human life. The worst among

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Ashutosh Singh, SRF, Department of Geography, BHU, Varanasi- 221 005, Email:ashutosh4a@gmailcom
Prof. S. B. Singh, Ex. Head, Dept. of Geography, BHU, Varanasi- 05, Email: sbsinghbhu@gmail.com

Fig.1 Upper Kosi Watershed, Almora District

all is that people in the area cannot give attention may be due to lack of awareness or similar reasons. On top of all the above, biomass, habitats, way of living of the community and physiographic conditions of the area are interdependent. If there is failure in one of them, the whole system can be affected in one or other way. Biomass condition in general is a good indicator of the soil, water resource, farming system, ecological system, and the likes. Therefore, ones the biomass is exposed for degradation, their survival can be under question mark. The abundance, productivity, species composition and canopy structure of natural vegetation are good indicators of level of degradation. According to some studies in Kenya, soil acidity, salinity and alkalinity are directly related with degradation of biomass or substitution of the indigenous by exotic ones (GOK: 2005). Land use/ land cover conditions are interrelated with that of biomass condition. If interpretation of land use takes place, it is also interpreting the biomass condition. Through land use and cover analysis one can also generalize overall resource condition of natural and manmade resources (FAO: 1997). Changes in land use cover can be categorized into modification and conversion. Here modification

Table 1: Upper Kosi Watershed, Demographic and Occupational Indicators

	Demographic Indicators			*Occupational Indicators*		
	Total Population	*Sex Ratio*	*Literacy (in %)*	*Main Workers*	*Marginal Workers*	*Non Workers*
Baigniya	2690	1274	58.15	853	141	1696
Basauli	7490	1210	61.41	1503	1630	4357
Bhaisangaoun	3410	1282	59.70	631	895	1884
Chanauda	7024	1147	66.40	1839	1415	3770
Dhaungar	3844	1198	61.19	595	1385	1864
Someshwar	5835	1189	59.91	1713	928	3194
Takula	2922	1056	62.23	405	820	1697
Devsthal	3588	1140	61.61	1301	153	2134
Dhamas	8594	1099	57.58	1858	1881	4855
Guruna	1627	1266	88.23	354	455	818
Gwalakot	5004	1198	63.53	993	1541	2470
Kayala	1730	1181	64.26	671	217	842
Khatiyari	10943	984	70.37	2605	1162	7176
Patlibagar	2098	1271	64.40	331	662	1105
Phalsima	4915	1048	67.94	1283	481	3151
Ramna	2963	1138	61.63	881	376	1706
Salla-Rautela	3624	1152	62.84	759	851	2014
Total	78301	1167	63.75	18575	14993	44733

Source: Census of India, 2011

means a change of condition with a cover type. A good example can be changing of species of plants. On the other hand, conversion is a change from one cover type to another. Examples can be that of deforestation to create croplands. The crucial life-supporting environmental services provided by mountain forests and highland pastures in vulnerable fragile terrain such as the Himalayas are qualities too often taken for granted by mid-altitude village communities and populations of the lower valleys and plains. Through the ages, these mountain forests have been valued more for the direct subsistence and economic benefits – timber, fodder and fuelwood and as spiritual and recreational non-material enrichments to culture and wellbeing. Almost without exception too, the mountain communities whose security and wellbeing derive almost entirely from these mountain forest resources and services are the least involved in any management and decision making to ensure sustainable utilization and conservation practices. Moreover, the consequences of any devastation or devastation in these forests surroundings will provides threats to the success of their team elements and natural know-how and the stability and protection of these stakeholders. Activities for improved environmental strength in conventional socio-agricultural exercise absolutely include assisting the strength in govt., particularly the schedule and institutionalized exception to this rule of marginalized non-urban stakeholders (Bandyopadhyay, 1992).

Materials and Methods

The study is based on primary data collected through various methods and techniques such as village and household survey with the help of standard questionnaire. Focused group discussions had been organized for head member of the family. Nine village case studies of Upper Kosi watershed were carried out for generating data concerning to the parameters identified i.e., biomass withdrawn from the forests by women in the form of wood, lopped branches of trees and the grasses cut from the watershed.

The Study Area

Nestling in the Kumaoun Himalayas, lying between 29^0 33' 10"N to 29^0 52' 25" N and 79^0 30' 28"E to 79^0 44' 55" E, the Upper Kosi Watershed lies in the district Almora of Uttarakhand (Fig. 1). The entire region is drained by river Kosi that is the main tributary of Ram Ganga River. Rising from the mountainous region lying in the Bhatkote east reserved forest to the south –west of Baijnath. In its upper reaches the river is fed by the waters of numerous streams and rivulets, along the eastern slopes of a group of mountain ranges and to the east stands the ridge on which Kausani is situated, acts as the water divide between the drainage of Kosi and Gomati. In the upper courses, the river has a southeasterly course and it is a considerable stream near Someshwer, where it has a wide fertile valley. It is joined by two minor streams from east and west. About 16 kilometers downstream, it receives the water of Nana Kosi near Hawalbagh Block from western direction. Here the Kosi changes its direction and flows slightly south-west passing due west and so. The watershed encompasses two development blocks namely, Takula and Hawalbagh. The total population of the watershed is 78,301consisting 36,642 male and 41,659 female whereas the sex ratio is 1167 female/1000 males. Out of the total population, 55,205 people are literates and the male and female literacy is 29,097 and 25,808 respectively. As far as the occupational characteristics of the villages are concerned, the total worker and non workers is 34,027 and 41,625 respectively. In total worker, the main worker is 21,516 and marginal worker is 12,511. Out of total main workers, 14,502 are engaged in cultivation while 6,189 are engaged in other activities. Only 210 workers are engaged in household industries (Table 1).

Acute environmental stress like extreme climate, highly dissected terrain, poor infrastructure and government services, lack of modern technological interventions, lack of off farm activities, inaccessibility to markets and overall administrative ignorance are some of the important characteristics faced by the people living in the Upper Kosi Watershed. Forest, Slope and pasture land degradation area the main conspicuous trait of the study area augmented by faulty landuse has accelerated the rate of soil erosion and in totality has degraded the landuse of the area. The basic reason behind all this being the exponential rise of population. The geology, topography, slope length and steepness and climatic variability in time and space are also seemed equally responsible for the excessive soil erosion in the study area. Recently, numerous construction works in the name of infrastructure development have further intensified soil erosion due to the lack of ecological consideration in the planning of such development activities over the region.

Agricultural lands are located on slopes varying from 10 to 35 per cent with terracing. Major area is under single and occasional crops. These terraces need maintenance and protection from surface erosion. The per capita land holding of agricultural land is only 0.38 ha. The farmers

practice traditional agriculture and are hardly aware of new improved practices of scientific farming. Land is kept fallow without any valid reason. Local varieties are grown, which take long duration and yield poorly. Wherever water is taken for paddy from hill streams is conveyed to these fields through unlined channels, which are locally known as *guls*. Hence, conveyance losses are heavy and the channel is damaged very often and provides irrigation only for a short period after cessation of monsoon. In the hill region, storage of rainwater in soil profile is a problematic because of high porosity in soil.

Climate

The watershed lies in the temperate latitudes, remote from the marine influence, at a high elevation and diversified configuration, suffers from vagaries of sub-mountain to mountain cold climate with marked anomalies. As climate is regarded as a controlling factor for land use, the complexities of the landscape promote variations in micro climatic phenomena and influence the soil and vegetation. Notable amongst the climatic factors, which ultimately effect the growth and development of plants and crop production, are temperature and rainfall.

The cold weather season corresponds to a period of Rabi crops. By October, a high-pressure belt develops in the north western India and the prevailing winds blow eastward from this belt along the trend of the Himalayan ranges. By mid October, these dry continental winds pass over the basin that causes a sudden decrease in temperature. The month of November registers a further decrease in the mean monthly temperature by half (Table 2) while in December there is further decrease in the mean monthly temperature. By February and March, there is a successive rise in the temperature accompanied by a large diurnal range of temperature. Fair weather is rare during these months sky is often overcast due to depressions of pressure of the Mediterranean ocean, which pass through the watershed.

Table 2: Mean Monthly Temperature and Average Rainfall, Upper Kosi Watershed

Months	*Temperature (Mean of 10 years)*		*Average Rainfall of 10 years (mm)*
	Max.(^{0} C)	*Min.(^{0} C)*	
January	15.30	2.75	66.00
February	16.71	4.01	36.10
March	22.38	8.38	39.60
April	26.93	12.78	26.40
May	29.80	15.29	60.63
June	28.14	17.40	187.30
July	28.37	18.27	260.80
August	26.16	18.09	269.70
September	26.63	15.89	208.60
October	24.40	12.21	23.50
November	20.66	6.97	3.30
December	17.47	3.79	13.90

Source : Calculated by author

The hot weather season corresponds to the period of the Rabi crops on one hand and the early period of Kharif crops on the other. By the second half of March, temperature rises abruptly. The mean temperature reaches about 23^{0}C and registers continuous rise until the first half of June with the commencement of monsoons (Fig. 2). The advent of monsoons brings a complete change in weather. It immediately affects the fall in day temperature with rainfall. Occasional long breaks in rain and long sudden bursts are the main characteristics of the rainy season in the area. By October, there is huge decrease in the rainfall and the diurnal range of temperature is comparatively higher. Due to the good drainage of the watershed provided by the gradient of the land, between October to November is the most pleasant time of the year from the climatic point of view.

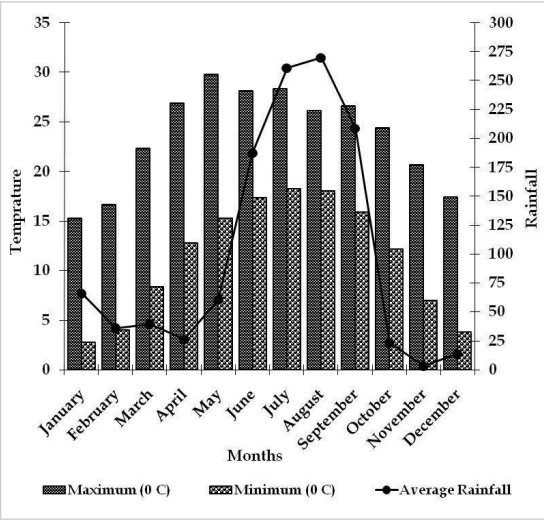

Fig: 2 Temperature and Rainfall

Since irrigational facilities in the watershed are far from adequate, the availability of rainfall acquires great importance in the agricultural life of the watershed. The ridges are lying in the south and southeast act as the outer barrier where the first force of the monsoon exhausts. The watershed experiences different amount of rainfall during the monsoons, usually each month has some share of annual rainfall (Table 2).

Natural Vegetation

A major part of the region is covered by forest, constituting a source of enormous wealth of the region. Due to variations in gradient, temperature and rainfall the watershed has varied altitudinal growth and variety of vegetation. However, agriculturally sub marginal and industrially almost untouched possesses rich vegetation that is essentially arboreal (Jhonson, 1993). The natural vegetation of the Upper Kosi watershed has been classified into two groups:

(I) Himalayan Sub Tropical Pine Forest

Pine (Chir) forests ordinarily extend on the southern aspects from 1100 to 2300 meters and on the northern aspects from 1100 to 2200 meters elevation and are well distributed in the watershed (Fig. 3). Chir is found on almost all geological formations, which occur in this zone on the hot exposed southern slopes with shallow soil. It is entirely replaced by low-level miscellaneous scrubs and other broad-leaved species tend to take its place along watercourses and in moist sheltered places, particularly in the northern aspects (Palo, 1999). Chir forests are seldom very dense. The ground is covered by grass, sometimes dense, whatever the aspect of covered canopy, and there is almost a discontinuous undergrowth of scrubs often so widely scattered noticeable. In the upper transitional limits of Chir and Oak, it is associated with Banj (Quarcus incae), Burans (Rhodendron arboretum), Kaphal (Myrica nagi), Mahal (Pyrus pashia) and Hinsalu (Rubus auilicus) etc in the lower limits.

(II) Temperate Moist Broad Leaved Forests

These forests are scattered in the southern, east and northern pockets of the watershed where the elevation is above 1820 meters. Further, temperate moist broad-leaved forests of the watershed are divided into the following categories:

(a) Temperate Moist Deciduous Forests : Appears to favour the deeper moist soils particularly on the northern aspects, is found commonly in the northeastern part of the watershed. The undergrowth is usually thin in the undistributed forest owing to the heavy shade of the trees but the canopy is often broken enough to permit the growth of small trees and shrubs also largely deciduous. Pangar (Aesculus indica), Maples (Wallichiana ap.), Saru (Tetula alnoides), Akhor (Jhglans regia) and Angu (Eraxinus micrantha) are the main species forming part of this forest type. This forest type very rarely forms an extensive forest of its own but is overlapped by Silver Fir and Oak forests.

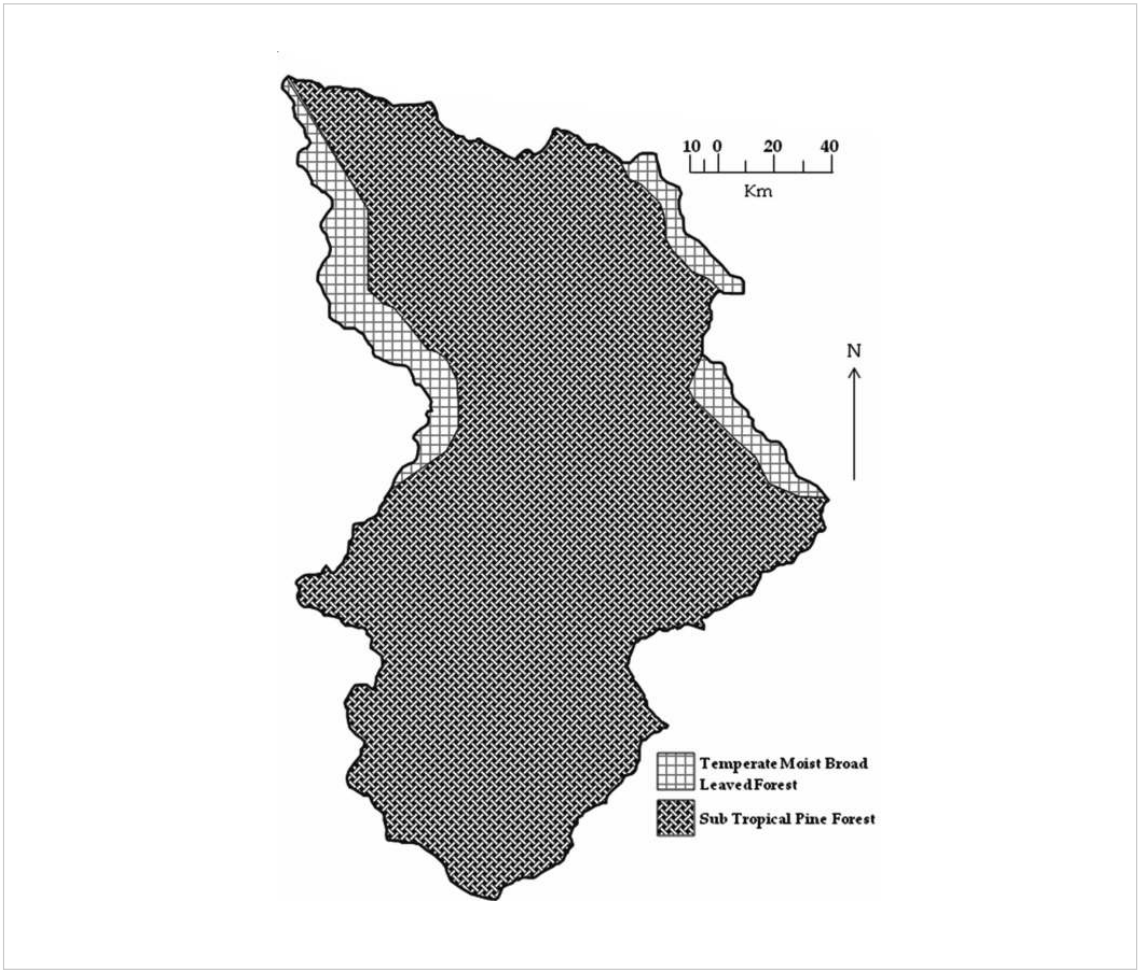

Fig.-3 Upper Kosi Watershed, Natural Vegetation

From the gentler slopes of the study area this type of forest has generally been cleared up to make way for agricultural practices.

(*b) Banj (Quercus incane) Forests:*

Banj (Oak) is the predominating species existing from the highest point in the basin to the Chir zone. The dividing line between Banj and Chir is vague, but towards its lower limits Oak follows ravines and watercourses particularly in the northern aspect down to 1800 meters. The soil of the oak zone is usually moist, though towards the southern aspect often forms a marked exception and there is a high degree of atmospheric humidity throughout the monsoons, irrespective of aspect. Rich xerophytes flora of mosses, ferns and linches drape on Oak trees indicate humidity.

Present Status of the Area

In the study area's biggest afforestation programme, several controversies have cropped up. Data from some evaluation studies indicate that large farmers, especially of the Someshwar

Table 3: Nyay Panchayat Wise Forest Distribution and Tree Species

Nyay-Panchayats	*No. of villages*	*Distribution of forest (%)*	*Tree Species*
Baigniya	11	0.4	Pine, Oak, Devadar, Apricot, Khirk, Beyul
Basauli	14	1.8	Pine, Oak, Khirk, Beyul ,plum, Apricot,
Bhaisangaoun	12	0.9	Pine, Oak, Khirk, Beyul ,peach, pear, Apple
Chanauda	14	0.6	Pine, Khirk, Beyul peach, pear, Kainth
Dhaungar	10	0.8	Oak ,Pine, Devadar, Apricot, Khirk, Beyul, Toon
Someshwar	20	0.7	Pine, Khirk, Beyul peach, pear, Walnut, Plum, Kafal
Takula	8	0.4	Oak ,Pine, Devadar, Apricot, Khirk, Beyul, Kail
Devsthal	13	0.9	Oak, Kaphal,Mahal,Hinsalu, Pear, Plum, Khirk, Beyul
Dhamas	30	2.5	Oak, Akhor, Pangar, Angu, Apple, Pear, Plum, Pine
Guruna	10	0.4	Oak, Akhor, Kaphal, Angu, Plum, Khair, Kainth, Walnut
Gwalakot	17	1.3	Oak, Pine, Khirk, Beyul, Pear, Kail, Deodar
Kayala	9	0.6	Pine, Khirk, Beyul, Walnut, Apple
Khatiyari	18	1.4	Oak, Deodar, Pine, Khirk, Beyul, Walnut, Aprikot
Patlibagar	8	0.5	Pine, Khirk, Beyul, Kaphal, Akhor, Hinsalu , sahtoot
Phalsima	13	0.7	Oak, Pine, Apple, Walnut, Akhor, Kail
Ramna	9	0.7	Oak, Pine, Beyul, Khirk, Peach, Sahtoot
Salla-Rautela	11	0.7	Maples, Akhor, Pangar, Angu, Pine ,Apple, Pear, Plum, Oak, Devdar,
Total	227	15.3	

Source: Field Survey and Patwari Records February 2013

valley are the main beneficiaries of the seedling distribution programme, and the achievement under community forestry have been modest. The reports from several *nyay panchayats* that large tracts of agricultural lands are being diverted from food corps to tree farming for commercial gains in the Someshwar *nyay panchayat* (Table 3). This means that critical biomass needs of the poor have not been met. Under farm forestry, it is alleged that some of the earlier farms which used to provide employment to the rural poor have been replaced and orchard farming has increased the income gaps between rich and poor formers. It is argued that this may also affect the study area's self-sufficiency in food grains. The other camp argues that the charges leveled against farm forestry and orchard farming is unsubstantiated.

Forest Biomass Withdrawn

Loss of forested area is one of the serious threats to the environment in the region. Since many decades, the process of ongoing deforestation has lead to the deterioration of local environment across the region. It is generally said that the over-exploitation of the forest products in the course of meeting their basic needs by the growing number of population and the failure of the government forest management policies are the fundamental causes for rapid deforestation.

Table 4: Average Fuel Wood Consumption, Upper Kosi Watershed, 2012

Village Name	Height (in meter)	Accessibility from road (In km.)	Total HH**	Fuel wood (in K.g.) withdrawn/day/HH			Total Biomass (In K.g.) withdrawn/year
				Pine	Oak	Total	
Barseela	1600	4	28	14	-	14	5110
Doba	2000	18	83	-	18	18	6570
Sutoli	1600	On road	35	14	-	14	5110
Lohana	1800	8	58	6	11	17	6205
Dotial Gaon	1850	On road	205	-	12	12	4380
Rikhi	1600	On road	60	10	4	14	5110
Bari	1200	.5	13	10	-	10	3650
Deoli Khan	1700	2	103	4	12	16	5840
Dal	1200	On road	112	11	-	11	4015
Total			697	9.85*	11.4*	14*	45990

*Source: Primery data collection, ** Census data 2001 , * Average of fuel wood consumption*

Primitive management of agricultural lands has yielded poorly, therefore it does not meet the food and fodder requirement of the people and their cattle in watershed. The needs of the people are so inextricably mixed with the forest in the region that the very life of the people would be almost impossible without forest. The biomass withdrawn from the forest includes the lopping of the trees for fuelwood (branches) and fodder (leafs) and the cutting of the grasses from sloppy precipitous surface as well as from the enclosed areas. A family of six needs at least 11 tones (9977 Kg.) of good fuel wood per year. One cattle unit (a cow) requires 7 kg of green leaf fodder and 11 kg of green forage grasses and legumes per day for optimum health and productivity.

The research has been created to evaluate the biomass removed for the forest from these two accounts. Enquires were created and actual timber consumed in different months was calculated on the basis of withdrawn biomass from the forest as fuel wood per households. The evaluation of the lopped biomass was created by actually with a weight of the lopped divisions of plants by the people, chosen as a example cases for seven times and then operating out a normal per homeowners per day. However, the examples were chosen arbitrarily. Based on the common, the evaluation of the complete biomass removed by loping was created possible for the area. Grasses withdrawn from August to October (92 days) are meant for stall-feeding to the cattle during the intense winters. Although, the requirement of stall feeding varies depending upon the number and type of animals kept by a household and yet everybody wants to store as much grass as possible because it finds readily available local market too. Thus, the storage of grass biomass is independent of requirement and assumes an almost uniform pattern. In such a situation, the assessment was made by surveying the green grass withdrawn by single households. While surveying, cattle was taken to assess as accurately as possible, the volume amount of grass stored. Thereafter an average for a household was worked out which when multiplied

Table 5: Biomass Withdrawn by Looping and Grass Cutting, 2012

Village name	Total HH**	Biomass (in kg) withdrawn/day/HH			Total Biomass (in KG) withdrawn/year
		By looping	by grass cutting	Total	
Barseela	28	-	13	13	4745
Doba	83	12	9	21	7665
Sutoli	35	-	15	15	5475
Lohana	58	11	5	16	5840
Dotial Gaon	205	14	8	22	8030
Rikhi	60	-	13	13	4745
Bari	13	-	10	10	3650
Deoli Khan	103	5	12	17	6205

*Source: Primery data collection, ** Census data 2001, * Average biomass withdrwan*

by total number of households would give us the total biomass withdrawn in the shape of grasses. On the basis of the above discussion, particularly with respects to climatic condition, a working schedule for biomass withdrawn was worked out (Sati and Song, 2012).

Forest is the major source of fuel wood collection in Upper Kosi watershed, as the area is undeveloped and far from national development mainstream. The main feature of the area is that female are the principal worker and they collect fuel and fodder. In the watershed, there is no proper supply of gas connection. Therefore, till this date the whole pressure put upon forest. The consumption of fuelwood is varying from month to month. Fuel wood consumption is very low from the month of April to September as fuel wood is not used for heating purposes. In the month of March and October, consumption of fuel wood is moderate and in the month of December and January, consumption of fuel wood is high due to drastic winter season. The consumption of fuel wood also varies due to location and slope. Fuel wood consumption is high in Doba, Lohana, Deoli Khan, Dotial Gaon because of high altitude (table 3). The main source for fuel wood collection is Oak forest. Villages located at lower altitude like Bari and Dal have less fuel wood consumption and get fuel wood from Pine forest. The main problem of the watershed area is deficit of fuel wood and fodder especially in drastic winter and summer.

Villages located in high altitude namely Doba, Lohana, Deoli Khan, Dotial Gaon fulfill their need in summer season by looping whereas the mid altitude located villages Barseela, Sutoli and Rikhi fulfill their need by looping and grass cutting both. The villages of low altitude fulfill their need by grass cutting only (Table 4, Fig.4). The community forest of the watershed in the present condition cannot provide 60 per cent of the requirement of fuel and fodder. The villagers depend on the reserved forest for fuel, fodder and timber both for building construction as well as tools and implements. As a result there is a severe erosion and high runoff on steep slopes aggravating the situation more considerable in the area.

Fig.4-Upper Kosi Wateshed: Case Study Villages

Concluding Remark

There is eminence potential in area by self-reliant development. For low altitude villages, there is good scope for biogas plant. For high altitude villages solar plant is good as they receive maximum solar radiation throughout the year. Protection of community forest is very necessary for the watershed and the income so generated benefits the communities. An important aspect is the transfer of biomass from the forest to the farmland especially, animal feed and bedding materials that is returned to the arable soils in the form of compost and manure to maintain fertility and soil productivity in the

absence of fertilizers, and to improve soil resistance to erosion. Further biodiversity is important to find solutions for tackling the impact of climate change on rural populations of the study area that depend on biomass for their livelihood.

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