Integrated Watershed Management: An Alternative Approach for Sustainable Development in Nagaland

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Abstract

The Indian State of Nagaland is characterized by a great degree of inaccessibility, fragility, marginality, diversity, specific niche opportunities and a unique human ecology. These biophysical characteristics also give rise to interlinkages that create objective circumstances influencing the use and patterns of natural resources and ultimately affecting the mountain environment. Degradation of watershed resources threatens the livelihood of tribal people of Nagaland. This distress migration from the Naga hills of active population affecting development potential in terms of resources and talents. The environmental degradation and development experience over the last fifty years indicates that the existing development planning is urgently to be modified to ensure the wise use of natural resources and their conservation, environment and development. Environmental degradation is often associated with shifting cultivation (Jhum) which is a traditional farming system of more than 80 per cent of the Naga people who are subsistence farmers. Actions urgently need to be taken by the political leaders, policy and decision makers at the highest level of government to implement the alternative approach of integrated watershed management for sustainable development of Nagaland. This holistic approach provides an ecologically sound economic base for the watersheds and its people which is now widely recognized as an important tool for vitalizing rural economies through simultaneously rehabilitating degraded ecosystems. The aim of this paper is to highlight the urgent need of the implementation of massive watershed management activities in Nagaland where environment and development are not yet in a satisfactory level after spending huge grants and a big span of time.

Keywords: Watershed management, Environment, Resource management, Sustainable development

Introduction

In recent years, Integrated Watershed Management (IWM) has been identified as a key for planning and management of natural resources in mountain ecosystems. It provides an ecologically sound economic base for the watersheds and its people. In any developmental activity, the watershed approach is more scientific because the inherent potential of soil, water and forest recourses in a particular area is controlled by various factors such as physiography, geological base, soil characteristic, climate, present land use, socio-economic aspects etc. (Rawat 1997) A watershed may be defined as an area which contribute rainwater falling on it and allows the water to flow in one or more water courses with a single out let at the end. The Watershed approach is increasingly being employed in various resource management and development programs like soil and water conservation, environmental management, water resources management and development, forest, man and livestock resources management and development etc (Sharma et. al 1998). Integrated watershed management is a new concept as a proper approach for managing and developing watersheds. Therefore, it is obvious that integrated watershed management is a technology for area planning of watershed resources to sub serve the socio-economic needs of community concerned (Bartarya, 1991).

Environmental degradation in the north-east hill region is often associated with shifting cultivation which has been and still continues to be, the mainstay of traditional farming systems over vast areas of the tropics. Slash and burn or shifting agriculture have received a great deal of attention due to their observed or hypothesized role in deforestation, biodiversity loss, accelerated soil erosion, increasing flood and landslide hazards, downstream sedimentation, decreased runoff and soil fertility and diminishing water resources and global warming.

During monsoon rains, this is disrupting the hydrological cycle, producing much heavier runoff and sediment transport, leading to devastating floods as well as reduced dry season flow. These consequences have far reaching implications for sustainable development of this region. Natural resources degradation is acute in most of the shifting cultivated areas of the north-eastern hills of India. There are nearly 600000 families of shifting cultivators in India, and more than 90 per cent are in the north-eastern states. In fact, the whole of north-east can be appropriately termed as "land of shifting cultivators" in the Agro-Kingdom. Shifting cultivation also remains to be dominant form of land use practices in Nagaland. Shifting cultivation is the traditional farming system of more than 80 per cent of the Naga people who are subsistence farmers. The Naga way of life revolves around this system of cultivation which governs most of their life, culture and tradition. Over 40 per cent of the geographical area of Nagaland is subject to jhum cultivation.

The livelihood of the tribal people living in these jhum cultivated watersheds is being threatened. Policies and strategies must urgently be developed to reverse present trends of watershed degradation. To do so will require scientific planning and implementation that must be based on technical knowledge of watershed management practices and their effects on sustainability of the resources (Rawat, 2000). Integrated watershed management may become an alternative of jhum cultivation. According to the proceedings of the National Seminar on Watershed Management, Govt. of India (1980) "Integrated watershed management is an integration of technologies within the material boundaries of drainage area for optimum use and development of land, water and forest resources to meet the basic minimum needs of the people in a sustained manner. Projectisation of the scattered programs of soil conservation, afforestation, water resources development and management, minor irrigation, animal husbandry and other rural development activities into well prepared micro watershed projects based on a study of climate, land, water and forest resources on the one hand and man and animal resources on the other offers hope for bringing about sustained natural resources development based on principles of ecology, environment, economics, employment generation and energy conservation". As an integral part of sustainable development, resource management programs are taken up on watershed basis for successful implementation of agriculture, forest and other eco-restoration programme (Rawat & Haigh,1998). Watershed management aims at optimizing the use of land, water, vegetation, man, animal and environment to prevent, soil erosion, moderate floods, improve water availability, increase food, fuel, fodder, fiber and timber production on a sustained basis (Bhardwaj and Dhyani, 1994).

Brief Geographical Overview of Nagaland

India's northeast region with 98 per cent of international border with China in the north, Myanmar in the east, Bhutan in the north-west and Bangladesh in the south- west covers a landmass of 2,62,500 sq. km. which is merely 8 percent of the total geographical area of the country comprising a total of eight states namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. Nagaland is the 16th State of Union of India and one of the extreme northeastern States which lies between 25° 06' N to 27° 04' N latitudes and 93° 20' E to 95° 15' E Longitudes with Myanmar in the east, Manipur in the south, Assam in the north and west and Arunachal Pradesh in the north (Fig. 1). Nagaland has a total geographic area of 16579 Sq.km which is divided into 11 administrative districts namely Dimapur, Peren, Kohima, Pughoboto, Phek, Mokokchung, Zunheboto, Wokha, Mon, Longleng, Tuensang and Kiphire. The districts are further divided into Blocks and Circles for administrative convenience. About 98 percent of its total area is mountainous. The altitude varies between 194 m to 3048 m above msl. Physiographically, Nagaland can be divided into three NE-SW trending segments. 1. High hill ranges in the east 2. medium high hill ranges in intermidates zone and 3. Western low range (Fig. 2). The high range, the highest mountain range in the state attaining a height of 3840 m at Saramati traverses the extreme eastern high hill ranges. It takes a north south course separating Nagaland from Myanmar. The Barail range is another mountain range in the south western part of the state. Japfu is the highest peak (3014 m). These two ranges spread out many ridges, spurs and small branches which are the spiral backbones of the physiography dissected by a number of seasonal and perennial rivers and rivulets with 'V' shaped valleys with sloppy spurs. Medium high hill ranges in the intermediate zone which is characterised by a continuous hilly range with altitude between 600 m and 1200 m. These ranges run through the middle of state-from northeast to southwest like a spiral column. The Western low ranges rise from the state having a altitude between 110m and 160m above msl. The most important plain is Dimapur. The hilly nature rugged terrain and lofty ranges have a great bearing on the environment and development including the human landscape of Nagaland (Rawat, 2008).

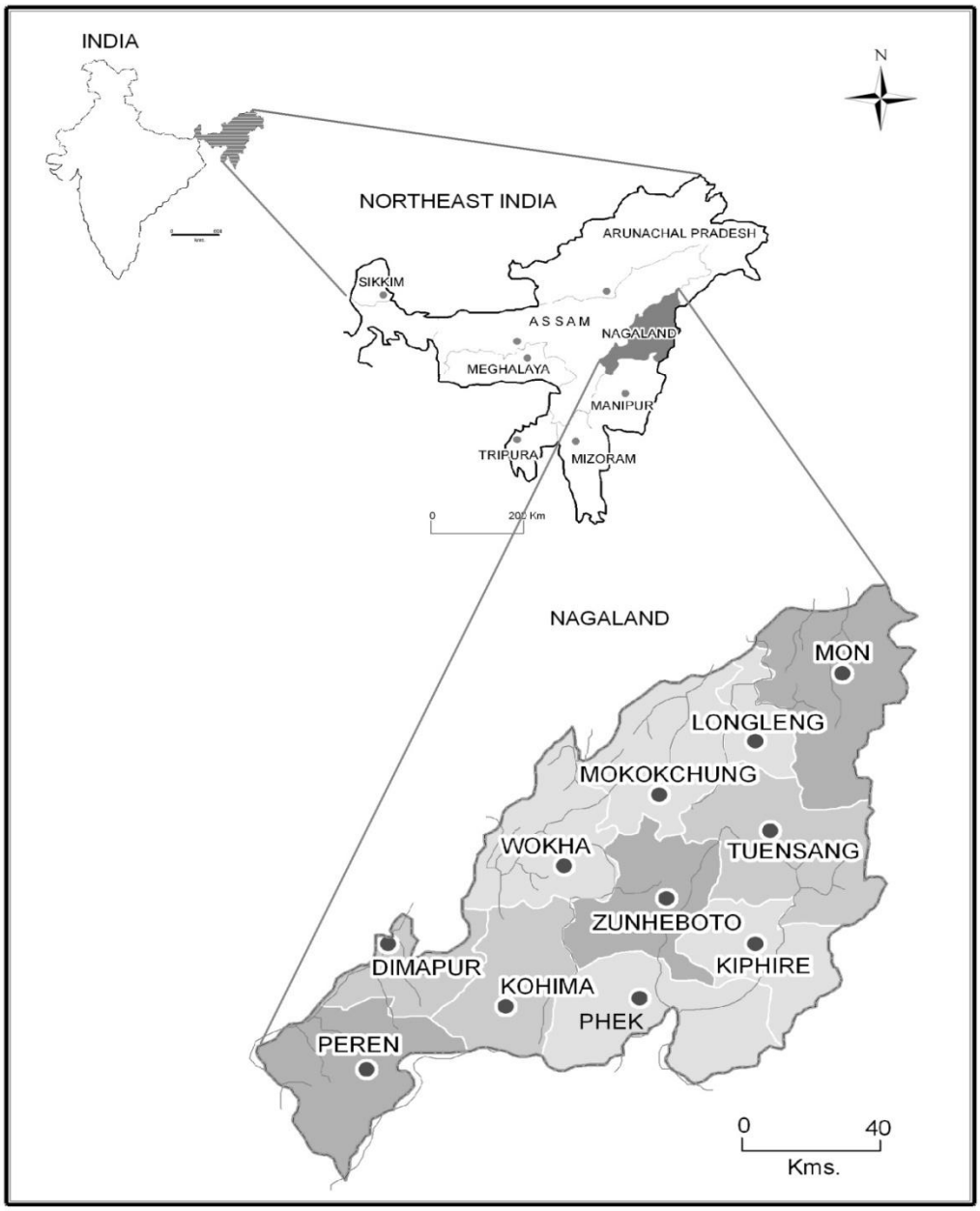

Fig. -1 : Location map of Nagaland, India.

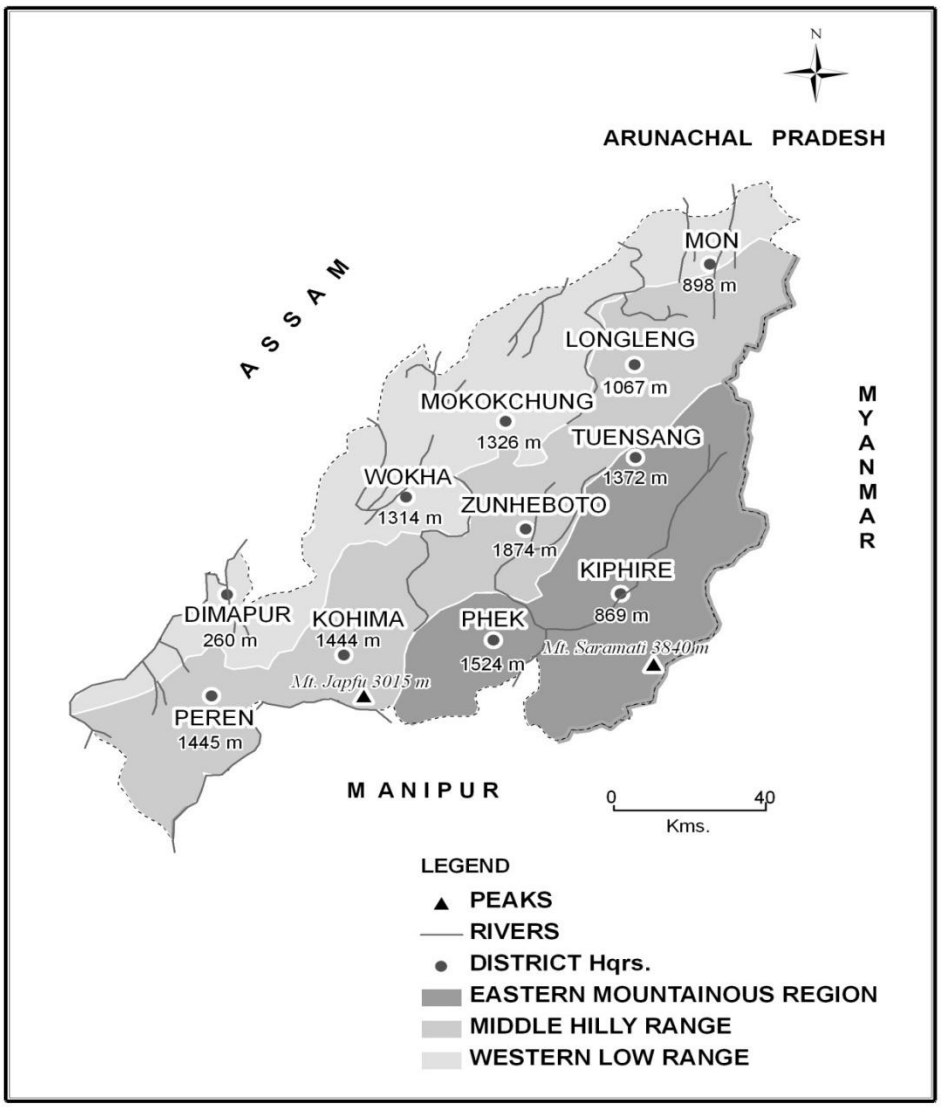

Fig.- 2 : Physiographic Map of Nagaland, India.

Environment and Development in Nagaland

Nagaland enjoys diverse climate ranging from sub-tropical to sub-montane temperate and even micro climate conditions within a short distance. The Summer and Winter temperature over the hills vary from 4° C to 28° C and those over the foothills have a range between 12° C to 34° C. The average annual rainfall is between 1200mm to 2500mm occurring over a period of six months from May to October with the maximum concentration in the months of July and August. January is the coldest month of the year (Table 1 to 7 at the last). Winter winds are generally weak and variable. The weather and climate conditions are vital part of our physical environment.

For the study of the characteristics of weather, daily meteorological data (Maxi-Mini Temperature, Rainfall and Humidity) have been collected from the most central part of Nagaland where Meteorological station is being operated at Zunheboto town at the altitude of 1780 m by the Department of Soil and Water Conservation, Govt. of Nagaland. These data are representative data for whole the Nagaland in the present study. The summary of mean monthly meteorological data for the years 2002 to 2007 have been presented in tables 1 to 6 at the last. The summary of the six years of daily rainfall data total annual rainfall and total numbers of rainy days has been presented in table 7. During the last six years (2002-2007) the annual average of temperature varied between 14ºc and 21ºc, the extreme maximum and minimum were recorded as 25.5ºc and 3.8ºc, respectively. The average humidity ranges between 96.5% to 49.4%. The average annual rainfall of these six years was recorded as 1965 mm. The total rainfall days varies between 128 days in the year 2007 and 176 days in 2005. Rainfall is one of the most important climatic factors. The potential of agricultural productivity is basically related to the periods when water needs of the crops are met to the optimum in various stages of their growth. Therefore, daily meteorological data are very helpful for the users to assess the length of the farming season in a rational manner. These data also play a vital role in selection of crops, adjusting cropping pattern, soil classification etc. in optimizing crops production and study of response of meteorological behavior to natural resources degradation.

Forest provides a wide range of tangible and intangible services to the mankind. For sound environmental health of the nation, the National Forest Policy aims to bring 33 percent of the total geographical area under forest cover. However the forested land occupies 862930 ha of land that constituted about 52 percent of geographical area of the state. The extent of dense and open forest has been assessed as 51375 sq.kms and 9027 sq.kms respectively. About 80 percent of the rural population of Nagaland directly depend on forest resources for their survival. The forest types found in the state are Tropical Wet Evergreen, Tropical Moist Deciduous Montane, Wet Temperate and Sub-Tropical Pine forest. There are three wildlife Sanctuaries and one National Park in the state. Bamboo often known as "Green Gold" is a plant that yielding renewable natural resource which is found extensively in Nagaland. The soil of Nagaland are generally acidic, very rich in organic carbon but poor in phosphate and potash content. Except in the gradient, the soil layer is thin because of torrential rain, rapid erosion of top soil layers occurs in the hillslopes. A properly manage soil is an asset, but when it is misused it creates environmental problems.

Nagaland is situated almost at tri-junction of the three major river basins of the region Viz. Brahmaputra watershed on the west and north, Meghna watershed on the south west and Chindwin watershed on the east (Table- 8). Dhansiri, Doyang, Melak, Dikhu and Disang are the sub watersheds of Brahmaputra River that covers the districts of Dimapur, Wokha, Mokokchung, Longleng, Mon and parts of Tuensang and Zunheboto. Barak Sub watershed of Meghna River. Covers the district of Peren, part of Kohima, Zunheboto Tizu / Zungki Laniye in South East of Chindwin East (Myanmar) watershed covers the district of Tuensang, Kiphire and parts of Zunheboto and Phek. The Doyang is the biggest and longest river in the state originating from Manipur. The Tizu River forms an important watershed system in the eastern part of Nagaland and finally leaves Nagaland and drain itself into the Chindwin River in Myanmar (Table 8). The watershed areas in Nagaland that drain into Brahmaputra and the watershed area of rivers that drains into chindwin are roughly equal, but one of the interesting differences between the two watersheds is that in the case of Brahmaputra watershed a couple of rivers drain the area and they join the Brahmaputra in Assam separately where as in the case of chindwin watershed all the tributaries join together and finally run into the Chindwin. Briefly, the river systems of Nagaland can be describe as follows – A. Rivers of the Brahmaputra Watershed in Nagaland - Dhansiri, Doyang, Tsurong, Milak, Dikhu, Tiru and Tizit rivers. B. Rivers of the Chindwin Watershed in Nagaland - Tizu, Zungki, Likimro and Hanye.

Humans occupy the core of cultural or socio-economic environment of any region. Being producers, creators influence and at times alter the physical environment. Therefore, a general study and analysis is required to know more of the interaction between man and nature in Nagaland where population is growing at an exponential rate and are yet to be tapped and used fully. The general geographical statistics of Nagaland have been presented in Table 9 as follows -

Table-8: Drainage Systems, Major Watersheds and their sub-Watersheds in Nagaland (Source: Ground Water Board of Nagaland, GWB, 2004)

Sl. No.	Drainage Systems	Major Watersheds/ River Basins	Sub-Watersheds	District covered
1	Brahmaputra Drainage System	Brahmaputra (W &SW)	Dhansiri, Doyang, Melak, Dikhu, Disang and their micro watersheds	Dimapur, Wokha, Mokokchung, Longleng, Mon, parts of Tuensang & parts of Zunheboto.
		Meghna (South)	Barak & its Micro Watersheds	Peren, parts of Kohima, Zunheboto & Phek
2	Chindwin Drainage System	Tizu	Zungki, Lanuye & their micro watersheds	Tuensang, Kiphire & parts of Zunheboto and Phek

Table 9: The General Geographical Statistics of Nagaland (Source: Census of India 2001)

Sl. No	Geographic Elements	Statistics
1	Total District	11
2	Total No of Villages	1317
3	Total No. of Inhabited Villages	1278
4	Total No. of Un-inhabited Villages	39
5	Total No. of main Towns	12
6	Density of population (Persons per sq.km)	120
7	Population Growth Rate (%)	64.5
8	Average House hold size	6.1
9	Urban Population (%)	17.2
10	Rural Population (%)	82.8

The Population of Nagaland is 1988636 as per the Census of 2001. Out of this 82.8 percent of the population is rural and 98.5 percent tribal. The average density of population is 120 persons per sq.km. Workers constitute 42.7 per cent of the total population of the state. 67.11 per cent of the population is literate. There has been an alarming growth of population at 64.4 per cent which is the highest in the country. Among the district, Kiphire has recorded the highest growth rate of 107.3 per cent followed by Wokha district while the lowest is recorded in Pughoboto as 38.79 per cent (Table. 10). Development of human resource is also an essential input in order to achieve a faster rate of economic growth and development.

Table-10: District wise Population Growth rate from 1971 to 2001 in Nagaland. (Source: Census of India (Nagaland) 2001

Name of District	1971	1981		1991		2001	
	Population	Population	Growth Rate	Population	Growth Rate	Population	Growth Rate
Dimapur	41488	111073	167.72%	177952	60.21%	309024	73.66%
Peren	17374	30826	77.43%	56505	83.30%	90766	60.63%
Kohima	62891	96848	53.99%	153124	58.11%	219318	43.23%
Zunheboto	55950	72519	29.87%	96218	28.30%	153955	64.81%
Phek	44594	70618	58.36%	102156	44.66%	148195	45.07%
Mokokchung	82852	104193	25.76%	158376	52.00%	232085	46.54%
Wokha	38297	57583	50.36%	82612	43.47%	161223	95.16%
Mon	71055	88887	25.10%	149699	68.41%	260652	74.12%
Longleng	19423	25704	32.34%	67703	163.39%	121581	79.58%
Tuensang	64127	87748	36.83%	117022	33.36%	193360	65.23%
Kiphire	18398	28931	57.25%	48181	66.54%	99877	107.30%
Total	**516449**	**774930**	**50.05%**	**1209548**	**56.08%**	**1990036**	**64.53%**

The most important occupation is agriculture which occupies 68.03 per cent of working force. Agriculture although dominates the primary sector, it has still not developed to a desired level, where more than 76 per cent of the total cropped area is under shifting cultivation, using mostly traditional technology, slow adoption of modern technology associated with low productivity and environmental degradation. The annual cultivated area under jhum is 131.349 ha and this alone accounts for 58.95 percent of the total net cultivated area. This extent of area under shifting cultivation is also maximum in Nagaland (0.39 million ha) compared to other states of north eastern hills. Due to time factor and the system responsiveness to changing requirements of high population pressure, Jhum cultivation has caused drastic decline in crop yield, loss of forest wealth, soil fertility, biodiversity and environmental degradation. The Geographical statistics of Agriculture in Nagaland is given in Table 11.

Table-11: Geographical Statistics of Agricultural Characteristics of Nagaland. (After Bhatt, 2005)

Sl. No.	Classification	Area (000'ha)
1.	Total Geographical Area	1657.90
2.	Cultivated Land	627.00
3.	% Cultivable Land of Geographical Area	37.76
4.	Total Crop Area (000'ha)	363.42
5.	Net Sown Area (000'ha)	312.77
6.	% Net Sown Area of Cultivable Area Used	49.89
7.	Area Sown More Than Once	50.65
8.	Net Irrigated Area	64.49
9.	Gross Irrigated Area	74.29
10.	% Gross Irrigated Area of Gross Cropped Area	31.58
11.	Non arable Land	67.34
12.	Cultivable Land	58.37
13.	Fallow Land	157.21
14.	Current Fallow	72.71
15.	Forest Land	862.93
16.	% Area Under Forest	52.05
17.	Annual Area Under Shifting Cultivation	19.00
18.	Cropping Intensity	116.00
19	National Cropping Intensity	140.00

Nagaland still remains an underdeveloped part of our country. Development is a political activity which is a cumulative outcome of several processes operate continuously embracing political, social cultural and economic activities in a particular region or state. Economic development is a process where by the people of a region or state come to utilize the resources available to bring about a sustained increase in per capita production goods and services (Rawat, 2002). The environmental degradation and development experience over the last forty five years indicate that the existing development planning is needed to be modified to ensure that the resources meet the needs of the local people. Our development planning has failed to move in right direction and the place of development has been slow. There has been an alarming growth of population and the number of educated unemployed Nagas have been rising at the rate of 9.32 per cent per annum. This distress migration drains the hills of its active manpower affecting development potential in terms of resources and skills. After four and half decades of economic development era, primary sector still continues to dominate the economy with low productivity, environmental degradation with population explosion. Despite abundant natural resources and potential and huge capital inflow from Centre, Nagaland could not attain the level of economic development as was expected.

According to the findings of a socio-economic study, the GDP of the state as estimated during 2002-03 is Rs. 2,64,148 lakhs with an average annual growth rate of 8.18% (10yrs) and 14.88% (5yrs) giving a per capita income of Rs. 12292 with average annual growth rate of 2.8% (10yrs) and 9.29% (5yrs). At present the primary sector contributes 37.39% and average annual growth rate of 13.82% (10yrs) and 22.19% (5yrs), secondary sector contributes 10.74% and average annual growth rate of 4.4% (10yrs) and 7.23% (5yrs) and the tertiary sector occupies the major chunk of 51.86% with average annual growth rate of 6.16% (10yrs) and 12.35% (5yrs).

Looking at the sector-wise development, agriculture with an average share of 91.79% contributes 34.33% to NSDP under primary sector followed by forestry and logging fishing, mining and quarrying. Under secondary sector, construction has been the major contributor with more than 90% share and contributing 10.10% to NSDP followed by manufacturing sector with 0.65%. Under tertiary sector transport and communication contributes maximum share of 34.41% (Sema, 2005). After 4-5 decades of economic development, primary sector (agriculture) still continues to dominate the economy with low productivity, environmental degradation and population explosion. During the same period, indiscriminate and reckless exploitation of forest cover, rapid expansion of jhum activities have caused irreparable damaged to the natural environment and ecology of this geo-dynamically sensitive and vulnerable mountain ecosystem,

The Environmental Consequences of Human Activities in Nagaland

The increasing population and the need to provide a better quality of life to hill people, the pressure on land, water and forest resources is tremendous in the Himalayan region (Rawat, 2011). The environmental consequences of development processes and human activities to the northeastern hill ecosystems have increasingly become the focus of scientific interest in recent years and many voices have been raised in warning against dramatic environmental and ecological consequences. For the last four-five decades in Nagaland, indiscriminate and reckless exploitation of forest cover, repaid expansion of jhum activities have irreparably damaged the natural environment and ecology of this geo-dynamically sensitive and vulnerable mountain ecosystem. As a result, the environmental consequences are-accelerated soil erosion, increasing flood hazard and landslide activity causing downstream sedimentation, increased nutrient runoff promoting poorer water quality, decreased runoff and soil fertility, diminishing discharge in springs and rivers. During the monsoon months this, in turn, disrupts the hydrologic cycle, producing much heavier rainy season runoff and sediment transport, leading to devastating floods as well as dry season flow. These consequences have far reaching implications for both the natural environment and for the sustainable development.

The Naga hills are characterized by a great degree of inaccessibility, fragility, marginality, diversity, specific niche opportunities and a unique human ecology. These biophysical characteristics also give rise to interlink ages that create objective circumstances influencing the use and patterns of natural resources and ultimately affecting the mountain environment. Increasing population is precipitating a move towards more intensive jhum cultivation including the rapid expansion around the hill tops. So far environment has not been taken as seriously as the social, economic and other components in development planning. Actions at all levels are required to develop and promote programs, policies and approaches that integrate environmental, economic and social components of sustainable development in Nagaland.

Integrated Watershed Management Approach for Sustainable Development in Nagaland

The evolutionary process of integrated watershed management in India began with the first generation project during the 1980s. They were conceived primarily to target forest productivity and conserve soil but they had limited success. The second generation of project adopted a more integrated management approach to all watersheds, taking into consideration better conservation and use of all natural resources at watershed and community levels. This also involved the active participation of local communities resulting in meaningful and successful long-term sustainable development (ICIMOD, 2006). Currently, watershed management approach is being taken up with high priority by most of the hill states in our country. In Nagaland many watershed management project are under implementation by the different departments of Government of Nagaland which are working in different places with different aims/objectives and approaches. But effective watershed management is rarely found in Nagaland due to the lack of research, sound demonstration areas and pilot watershed management projects which are essential steps before launching large scale projects. Guidelines needs to be established by one nodal agency which can promote the systematic and comprehensive development of programs avoiding conflicting sets of objectives and administrative formats. There is a great need to establish this type of very carefully conceived pioneer efforts in Nagaland where there is no awareness of the benefits of watershed management and sustainable development. A good watershed management approach has to be technically feasible and socially acceptable, accommodating the bare minimum needs of the people.

Recently, the Department of Land Resources, Govt. of Nagaland has released the GIS maps consisting of various micro watershed maps layers for the implementation of the integrated watershed management projects in Kohima district where altogether, 14 micro watersheds are selected in the initial phase of the watershed conservation and development plans of the state government. Seven different layers of GIS based maps viz. aspect map, contour map, drainage map, slope map, relief map, land use map, drainage map and soil map have been generated for every single watershed and in addition consisted of an action plan map as a target for the different activities to be taken up with a focus, fully aimed at the development and uplift of rural people. The GIS based watershed conservation and development projects implementation help to select the right crop for a particular area with the exact treatment required by that particular type of land and thus generating higher yield and also application of the proper soil management practices. The GIS based development planning system also helps in creating an environmental friendly system of development by integrating all the components of watershed in the development process. Efforts also should be made to develop watersheds. This has been a barrier for developing our watersheds in the watershed management activities.

Discussion and Conclusions

An attempt has been made to describe the environment, development and prospects of integrated watershed management for sustainable development in Nagaland, India. At present with its vast natural resources and its underdeveloped status, this State is at a cross road. It is high time to decide whether it would be wise to pursue the development processes that has resulted elsewhere in widening chasm between the poor and the rich and in accelerating environmental degradation. Actions urgently need to be taken by the political leaders, policy and decision makers of this State at the highest level of government to implement integrated watershed management as an alternative approach for sustainable development. River basins are ideal natural units which integrate the physiographic attributes of landscape with natural resources and human activities. The sustainability of socio-economic development and decision-making processes are primarily based on technological advancement and maximization of economic benefits. The consequences are many and varied. The infused technological forces and resultantly, the imposed-activity clusters of development may create imbalances in environment and ecosystem of the river basins. To maintain quality environment it is very important to have proper planning exercises, largely dependent upon the information inputs in a scientific manner that can ultimately provide an analytical objective basis for decision both at plan formulation, implementation and monitoring levels. There is a lack of data and scientific understanding especially of the spatial and temporal dynamics of land use and geo-hydrological processes in Nagaland. River basin management also calls for a better understanding of people and resource dynamics. In spite of the tremendous potential, development in this State is far from the expectations. Physical inaccessibility and socio-political marginality often mean that mountain people of Nagaland are left out of overall socio-economic development. Natural hazards, such as landslides and flash floods, have further caused hindrances in development activities and the environment. It will not be out of context to mention here that the basin falls under the highly seismic prone zone. Thus, there is strong need for proper planning to ensure sustainable development, and this necessitates scientific inputs from all states, central government departments and other organizations. The variability of major geo-hydrological events in time and space, the present data base is completely inadequate for determination of actual rates of activity of the various processes affecting the environment, development and ecology of the State. Degradation of natural resources is a major concern of livelihood, poverty alleviation and environmental services. Environmental and natural resources sustainability are relatively more important in this area. It is necessary not only to halt further exploitation and degradation but also to actively restore and rehabilitate the degraded ecosystems. There is a strong rationale for the integrated management of the river basins of Nagaland and the north-east region as a whole. This will offer the opportunity to improve water quality, sustain biodiversity, maintain river flow characteristics, sediment management, increase fisheries and reduce industrial pollution in the rivers. It is a fact that combating the degradation of natural resources especially soil, water and vegetation and investing in their conservation as well as in river basin management for future generation will be a major practical task promoting sustainable development and environmental protection. The immediate task therefore, before us is to make strategies using the scientific know-how available with us to preserve, protect, conserve and efficiently utilize precious natural resources to boost the economy of the State with sustainability of the resources and the environment.

There is a need of sharing of hydro-meteorological data between the States and region for improved flood, drought and other environmental hazards forecasting and warning and especially in the face of climate change. The IWM will be fruitful in the development of hydropower to meet the huge energy need, creation of improvement of navigation facilitating water transport and socio-economic upliftment of the region. Agro-horticultural system of land use with subsidiary source of income through livestock rearing provides most favorable indication in favor of adopting mixed land use system as an alternative to shifting cultivation on steep hillside within the river basins management activities Such a system will certainly be technologically feasible, sociologically acceptable, ecologically sound and economically viable. Integrated and coordinated management of the State is one of the best tools to achieve IWM objectives, i.e., economic growth, environmental sustainability, social development and Millennium Development goals. On the basis of the above description and review of the environment and development problems, this paper concludes as follows-

- The State's strategic location at the confluence of north-east India, southeast and east Asia made it an important gateway between the people of the region. Integrated river basin management offers prospects for environment and development of the entire north-east India and southeast Asian region.
- The river basins of Nagaland are in urgent need of conservation of natural resources and environment to check the eco-degradation and to remove poverty from the region. It will reduce migration of people in search of livelihood and develop a sustainable economy.
- Presently, the State is having inadequate basic developmental infrastructure, geographical isolation and difficult terrain, high rainfall and recurring environmental hazards, lack of capital formation and proper enterprise-climate, slow technology spread, absence of a supporting market and adequate institutional finance structures and very low level of private sector investment.
- In this State, nearly 80% population is depend on subsistence agriculture and economy is predominantly agrarian and rural where nearly 87% people live a deprived life in nearly 6000 villages, per capita consumption of power is lowest. Nearly 30% households have to have access to potable water.
- Geo-hydrological regimes of the basins are characterized by an extremely large and variable flow, enormous rates of sediment discharge, rapid cannel aggradations and accelerated rates of denudation. The area is experiencing regular hazards in the forms of floods, landslides and accelerated soil erosion etc.
- The socio-cultural and institutionally-based knowledge capital needs to analyzed and understand so that appropriate management practices that build on both scientific and traditional knowledge may be developed for effective integrated watershed management of the State.
- Critical gaps are existing between planning for economic development and environmental management in Nagaland. There is an urgency to integrate environment and economics in decision making and planning in the North East Hill region in general and Nagaland in particular.
- The present paper will advance the knowledge base on Nagaland and facilitate effectiveness of planning and implementation of integrated watershed management strategy in near future for sustainable development.
- It is finally concluded that integrated watershed management projects are viable on economic grounds and desirable on points of regional, national and global importance of environmental conservation which will have long-term beneficial impacts in time and space. It improves the local and regional environment and transforms the local economy from subsistence to a healthy sustainable level. Therefore it is clear that integrated watershed management is the holistic development seeking sustainable livelihood security system for all life forms in river basin ecosystems.
- India must need to come forward to support this extremely north-eastern State for integrated watershed management for sustainable development. The IWM is a powerful driver for regional integration and development.

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Table 1: Summary of meteorological data collected at the Meteorological Observatory at Zunheboto, Nagaland during the year 2002. (Source: Soil and Water Conservation Department, Govt of Nagaland)

Months (2002)	Temperature (^{0}C)			Total Rainfall (mm)	Average Humidity (%)
	Maxi	Mini	Average		
January	15.5	6.4	10.9	39.9	90.8
February	17.5	8.6	13.0	17.6	80.9
March	10.0	11.3	15.1	46.0	89.2
April	19.8	11.4	15.6	219.2	88.3
May	20.9	13.0	16.6	273.0	90.0
June	23.0	16.0	19.5	377.3	85.7
July	23.2	17.5	20.3	429.1	93.8
August	23.6	17.3	20.4	264.3	91.8
September	24.1	16.7	20.4	246.8	95.9
October	22.3	15.3	18.8	70.0	94.1
November	19.1	10.7	14.9	67.8	91.6
December	15.7	6.4	11.0	4.2	86.1
Year	**20.3**	**12.6**	**16.4**	**2155.2**	**89.8**

Table 2: Summary of meteorological data collected at the Meteorological Observatory at Zunheboto, Nagaland during the year 2003. (Source: Soil and Water Conservation Department, Govt of Nagaland.)

Months (2003)	Temperature (^{0}C)			Total Rainfall (mm)	Average Humidity (%)
	Maxi	Mini	Average		
January	14.8	6.2	10.5	30.4	88.4
February	16.4	6.6	11.5	36.4	89.7
March	16.5	6.6	11.5	80.6	87.2
April	20.6	9.6	15.1	183.6	87.9
May	21.7	11.7	16.7	173.9	90.9
June	21.5	13.7	17.6	349.6	95.2
July	21.5	14.2	17.8	403.5	94.1
August	22.6	14.6	17.8	537.4	94.7
September	21.6	14.1	17.8	295.8	95.7
October	19.0	12.0	17.8	214.8	96.5
November	16.3	7.2	17.8	37.6	96.6
December	16.7	5.1	17.8	0.0	88.8
Year	**19.1**	**10.1**	**15.8**	**2343.6**	**92.2**

Table 3: Summary of meteorological data collected at the Meteorological Observatory at Zunheboto, Nagaland during the year 2004. (Source: Soil and Water Conservation Department, Govt of Nagaland.) : NA = Not Available

Months (2004)	Temperature (^{0}C)			Total Rainfall (mm)	Average Humidity (%)
	Maxi	Mini	Average		
January	11.7	3.8	7.8	30.4	85.6
February	14.4	5.6	10.0	0.0	84.7
March	18.2	9.2	13.7	11.5	88.3
April	15.7	8.4	12.1	436.2	81.4
May	15.8	8.4	12.1	448.0	82.2
June	21.5	13.6	17.6	228.1	N.A.
July	N.A.	N.A.	N.A.	N.A.	N.A.
August	23.2	15.6	19.4	428.0	93.3
September	20.4	13.9	17.2	356.6	95.5
October	20.5	14.1	17.3	116.2	80.8
November	18.4	11.4	14.9	18.5	79.2
December	16.5	8.2	12.4	0.0	66.4
Year	**17.8**	**10.2**	**14.0**	**2073.5**	**83.7**

Table 4: Summary of meteorological data collected at the Meteorological Observatory at Zunheboto, Nagaland during the year 2005. (Source: Soil and Water Conservation Department, Govt of Nagaland.)

Months (2005)	Temperature (^{0}C)			Total Rainfall (mm)	Average Humidity (%)
	Maxi	Mini	Average		
January	15.5	6.4	10.6	39.9	90.6
February	15.7	6.2	10.6	6.0	72.1
March	18.4	11.2	14.8	0.0	71.5
April	20.3	10.2	15.3	42.0	80.3
May	19.4	11.0	15.2	497.2	87.7
June	22.0	14.4	18.2	365.5	90.4
July	22.3	15.8	19.0	494.5	93.9
August	23.1	15.8	19.4	480.2	93.3
September	22.6	14.9	18.7	484.9	95.7
October	20.6	13.8	17.2	105.7	90.5
November	17.9	9.7	13.8	14.2	89.1
December	16.3	6.6	11.4	0.0	80.4
Year	**19.5**	**11.3**	**15.3**	**2530.1**	**86.3**

Table 5: Summary of meteorological data collected at the Meteorological Observatory at Zunheboto, Nagaland during the year 2006. (Source: Soil and Water Conservation Department, Govt of Nagaland.)

Months (2006)	Temperature (^{0}C)			Total Rainfall (mm)	Average Humidity (%)
	Maxi	Mini	Average		
January	14.2	8.9	11.5	0.0	75.2
February	18.4	11.1	14.7	3.3	79.7
March	22.1	12.4	17.3	0.0	67.9
April	21.9	12.3	17.1	84.0	68.6
May	23.4	14.2	18.8	141.7	70.8
June	23.9	15.8	19.8	365.8	83.2
July	25.1	16.7	20.9	338.8	85.5
August	25.3	17.5	21.4	160.2	82.6
September	23.2	16.6	19.9	243.5	79.5
October	22.3	14.3	18.3	55.8	81.0
November	19.2	9.2	14.2	0.0	91.2
December	15.7	6.9	11.3	0.0	71.6
Year	**21.2**	**12.9**	**17.1**	**1393.1**	**78.1**

Table 6: Summary of meteorological data collected at the Meteorological Observatory at Zunheboto, Nagaland during the year 2007. (Source: Soil and Water Conservation Department, Govt of Nagaland.)

Months (2007)	Temperature (^{0}C)			Total Rainfall (mm)	Average Humidity (%)
	Maxi	Mini	Average		
January	16.0	7.2	11.6	0.0	79.4
February	14.2	5.5	9.8	11.2	72.3
March	23.3	14.4	18.8	10.1	63.6
April	25.5	15.4	20.4	51.2	49.4
May	23.8	14.7	19.2	141.8	68.5
June	24.8	17.0	20.9	268.0	80.3
July	22.9	16.3	19.6	354.3	86.8
August	23.5	17.1	20.3	198.4	79.5
September	24.5	16.9	20.7	240.8	86.7
October	21.0	15.2	18.1	0.0	89.3
November	18.6	8.3	13.4	17.4	87.9
December	16.5	5.9	11.2	0.0	68.5
Year	**21.2**	**12.8**	**17.0**	**1293.2**	**76.0**

Table-7: Summary of meteorological data (Mean Annual) collected at the most central place of Nagaland i.e., Zunheboto during the years 2002 to 2010 (Source: Department of Soil and water Conservation, Govt. of Nagaland)

Years	Average Temperature (ºC)			Total Rainfall (mm)	Average Humidity (%)
	Maxi	Mini	Average		
2002	20.3	12.6	16.4	2155.2	89.8
2003	19.1	10.1	15.8	2343.6	92.2
2004	17.8	10.2	14.0	2073.5	83.7
2005	19.5	11.3	15.3	2530.1	86.3
2006	21.2	12.9	17.1	1393.1	78.1
2007	21.2	12.8	17.0	1293.2	76.0
2008	20.53	12.87	16.12	1133.1	73.17
2009	21.52	13.64	17.58	1108.7	69.6
2010	21.8	13.0	17.36	1662.9	76.1
Average	**20.32**	**12.15**	**16.29**	**1743.71**	**80.55**