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Research Papers

FOOD SECURITY *VIS-A-VIS* NATURAL RESOURCES SUSTAINABILITY IN NORTH EASTERN REGION OF INDIA

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INTRODUCTION

The North Eastern Region of India is endowed with rich natural resources of soil, water and diverse flora and fauna. Gross misuse and indiscriminate exploitation of the resources has resulted in vast amounts of soil erosion, nutrient loss and environmental degradation in the hills and silting of river beds causing floods, loss of property and life in plain areas. The seven sister states of North Eastern Region of India, comprising of the states of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura lie between 21.75^0 to 29.28^0 N latitude and 89.40^0 to 97.255^0 E longitude. The state of Sikkim is recently included among the North Eastern states. It has a total geographical area of 2.25 lakh km^2 that is about 7.5% of the country's total geographical area. The region is characterized by difficult terrain, wide variation in slopes and altitude (75m to > 5000 m above msl), high rainfall and humidity, low solar radiation and extreme low to very high temperatures, private/community owned land tenure systems and primitive cultivation practices. The region falls under high rainfall zone and the climate ranges from sub tropical to alpine. The region is endowed with rich natural resources (flora, fauna, soil, water and mineral). The region has lagged much behind the other states of the country in overall development. The infrastructure facilities like roads, transport, communication, industries, health care and agriculture are in adequate. The supply of inputs, marketing, institutional credit and extension services are still inadequate resulting in the poor growth of agriculture sector despite good potential. Majority of the population is still dependent on agriculture and allied land based activities mainly due to lack of modern industries. Shifting cultivation, also known as slash and burn agriculture is the chief means of livelihood of tribal people in these areas who have evolved this mode of cultivation in response to the most difficult terrain and topography under most inhospitable environment.

The primitive system of shifting cultivation practiced widely in all the states of North East, except Sikkim, has led the region to the brink of collapse as far as the resources sustainability is concerned. The inaccessibility in deep afforested areas and rugged terrain provided the locals as well as businessman the best opportunities for exploiting the natural resources unabated; mainly forest resources. The resources sustainability too has reached to a highly vulnerable state, resulting from huge scale destruction of forests and degradation of steep hill slopes, extinction of a large species of vegetation and animals besides other related ills. Gross inappropriate use and indiscriminate exploitation of resources has resulted in excessive soil erosion, excessive to heavy nutrient loss through leaching and environmental degradation in the hills and silting of river beds in plain areas causing menacing floods, loss of property and life each year.

The natural resources are required to be conserved, developed and harnessed on sustainable basis for ensuring food security in the region, which is otherwise deficit in food grains. Before drawing any conclusion about the effect of different problems on the production gaps, one has to critically evaluate the potentials too, and then try to find out finer points where the interventions can be made in order to improve upon. The following paragraphs are dedicated to study the strengths of the region on which the food and nutritional security of the region is actually dependent.

NATURAL RESOURCES OF NORTH EAST INDIA

The North Eastern region, comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura, is endowed with rich natural resources of soil, water and vegetation. Management of resources of the region need scientific interventions in the form of judicious rain water harvesting, ground water extraction, creation of surface storages of water, and in situ water harvesting tanks, improving irrigation efficiency and reduction in evaporation loss. Since most of the area

is hilly, development of agriculture based on micro-watershed approach will be more useful. The resources of the region have been described in brief in the following paragraphs.

PHYSIOGRAPHY

The North Eastern region is characterized predominantly by hilly terrain, deep gorges and flat valleys. The climate varies from sub-tropical to extreme temperature and is bestowed with rich natural resources viz, water, petroleum, minerals, rare flora and fauna. The region is broadly divided into four major divisions (i) Assam valleys (ii) Assam Himalayas (iii) Meghalaya hills and (iv) Eastern high lands. Assam valley is 80-129 km wide and 725 km long. The river Brahmaputra passes through the middle of the valley. The Mishmi hills, Abor hills, Mikir hills, and Dafla hills are in Assam Himalayas in Arunachal Pradesh. The Meghalaya hills (Shillong Plateau) is in south of Assam valley. The Garo, Khasi and Jaintia hills, Mikir hills and North Cacher hills are in Shillong plateau. The Eastern high lands include the Patkai, Naga hills, Barail hills, high lands of Manipur and Mizo hills. Manipur lies on the east of the Barail range, whereas Tripura lies in the western flank of Mizo hills. Nagaland is situated between Manipur and Arunachal Pradesh .

CLIMATE

The altitudinal differences coupled with varied Physiography contributes to climatic variations in the North Eastern region of India. The climate in the region varies from sub-tropical to alpine. Despite diverse physiographic characteristics of the region, sub-regional variations in the average seasonal temperature are not striking. Bulk of the annual rainfall in the region (64%) is received during June – September period. The North Eastern states of the region, though have 7.75% of the geographical area of the country, receive about 12.7% of the total precipitation in the country. The area can be divided in to three climatic regions, viz, (i) the cold humid monsoon climate of the frontier hilly region (above 200 m), (ii) wet sub-tropical monsoon climate and (iii) humid mesothermal monsoon climate with heavy monsoon showers. Average annual rainfall in the region is about 2490 mm with highest rainfall of 12,500 mm in the world in the Cherrapunji Mawsynram state. The region, due to heavy rainfall, has very high humidity varying from 62% to 91% in rainy season and 42% to 65% in other seasons (Table 1).

Table 1 Agro-climatic zones of north eastern region.

Zones	Altitude range (m msl)	Areas covered
I. Alpine zone	3500 and above	Parts of Sikkim, Arunachal Pradesh & Darjeeling Dist
II. Temperature sub-Alpine zone	1500&3500	Tuenchang, Zunheboto & Mukokchung, Dist. of Nagaland, western Arunachal Pradesh, Khasi hills of Meghalaya, North East Manipur, parts of Sikkim and Mizoram (E&SE)
III. Sub-tropical hill zone	1000-1500	Tirap of AP, East Khasi hills, Jaintia hills and Garo hills of Meghalaya, parts of Sikkim, North East Mizoram, Kohima and Wokha of Nagaland
IV. Sub- tropical plain zone (valley areas)	400-1000	Imphal of Manipur, Bagti & Longnak of Nagaland, Jaintia hills of Meghalaya Buh-Changphai areas of Mizoram
V. Mild tropical hill zone	200-800	South Jaintia and North Khasi hills of Meghalaya, West Manipur, lower Sikkim, Dimapur and Ghaspani of Nagaland, Jamnpia hills of Tripura, North and West Mizoram
VI. Mild tropical plain zone	200 below	Lohit, Pasighat and Singhphos of A.P, West Garo hills of Meghalaya, major parts of Tripura, Dimapur plains of Nagaland.

Source: Samra *et al*., 1999.

LAND UTILIZATION PATTERN

The North Eastern region states have a total geographical area of 255,090 km^2 out of which 136785 km^2 or 54.4% is under forest cover. About 37220 km^2 or 14.5% of the total area is under cultivation in the region. Arunachal Pradesh, having 83749 km^2 area is the largest state while Tripura with 10490 km^2 area is the smallest state of the region. Assam has the maximum net sown area (927060 km^2) and Mizoram has the minimum (9650 km^2) net sown area. Total waste land estimated in the region is 29008 km^2 (Table 2). About 31.15% of the total geographical area has been classified as waste land. The overall terrain of the region is predominantly hilly and characterized by agro-climatic and geophysical situations. The region can broadly be divided into three physiographic zones, viz. (i) Hills and mountains of folded topography (ii) Peninsular plateau and (iii) The plains .

Table 2: Land use classification in north eastern states ('000 ha).

State	Geographical area	Forest area	Area not available for cultivation	Other uncultivable land	Net sown area
Arunachal Pradesh	8374	5154	77	44	149
Assam	7844	3071	2455	535	2706
Manipur	2233	1515	1445	24	140
Meghalaya	2243	851	226	646	202
Mizoram	2108	1593	211	81	65
Nagaland	1658	862	28	224	190
Tripura	1049	631	131	40	270
Total	25509	13677	4573	1594	3722

Source: NEC, 1995

Shifting cultivation, the predominant form of agriculture prevalent in the region, is practiced in about 3,869 km^2 of area annually, affecting 14,660 km^2 area at one time or the other. The system is uneconomical and has caused resource depletion, and land and environmental degradation (Table 3).

Table 3: Landuse/cover data of the region (in hectares).

State	Agril. land	Forest land	Waste land	Water bodies	Other total
Arunachal Pradesh	206380	6935087	114732	80330	1027859
Assam	4248638	1726387	NA	NA	NA
Manipur	169212	1414078	29010	10664	601902
Meghalaya	73162	1424983	2550	10153	730354
Mizoram	6600	1956467	0	63	137097
Nagaland	38951	1142184	0	0	473892
Tripura	154807	380652	0	6562	502642
Total	4897750	14979838	31560	27442	2445887

Source: N.R.S.A, 1995

SOILS OF NORTH EASTERN INDIA

Except Manipur, Barak valley and Brahmaputra valley of Assam (7,200 km^2), all other areas are hilly (1,83,090 km^2). Major soil groups in the region are entisols, alfisols, ultisols and inceptisols. Alpine zone soils are dark brown in colour and have developed on schist and granite type of parent material. The sub-tropical palin and valley zones soils are developed on alluvium derived from adjacent Himalayas by the rivers. Soils are moderate to highly acidic having the problem of P- fixation, iron and aluminium toxicity . More than 95% of the soils of the region are acidic. Management of hill soils requires soil and water conservation measures and amelioration of acidity for optimum crop production. Application of Farm Yard manure (FYM) or compost @ 10 to 15 t ha –1 improves the availability of P for better crop growth. The misuse of land resources has resulted into huge soil degradation (Table 4).

Table 4: Status of land degradation in North Eastern States – present assessment *vis-a-vis* earlier data (lakh ha).

	Earlier assessment			Present assessment	
State	Geo. Area	Area	% of Geo Area	Area	% of Geo Area
Arunachal Pradesh	83.74	26.54	31.7	11.95	14.3
Assam	78.44	29.99	38.2	19.63	25.0
Manipur	22.33	7.34	32.9	13.26	59.4
Meghalaya	22.43	11.02	49.2	11.02	49.1
Mizoram	21.08	6.20	29.4	10.02	47.5
Nagaland	16.58	10.38	62.6	8.21	49.5
Tripura	10.49	2.79	26.6	2.95	28.1
Total	255.09	94.26	33.83 (Av)	77.04	34.11 (Av)

Source: Sethi *et al.*, 1994

WATER RESOURCES

North East is endowed with bounty of water resources accounting for about 46% of the total water resources in the country. The tentative assessment of this dynamic resource in the North East India is about 60 million hectare meter (M ha m). Unfortunately, this vast potential has not been rationally exploited yet. The region experiences a paradoxical hydro-climatic environment and represents a typical hydrological entity in the world atlas. Endowed with huge water resources potential, it has also the worst water resource problems rendering untold sufferings to millions every year. The region experiences excessive rainfall and high floods during monsoon months and also suffers from acute shortage of drinking water in many areas due to lack of management. The basic issue under lying the water resources problems are: recurring floods, drainage congestion, soil erosion, human influence on environment and so on and calls for its integrated use for drinking, irrigation generation of hydropower, navigation, pisciculture, recreation, etc. Most of the area in the North East region is restricted area for military reasons; even the research scholars have limited access to elementary physiographic or geomorphological data to make proper inventory. Per capita fresh water availability in the Himalayan Region is evaluated to range from 1757 m^3/yr in Indus, 1473m^3/yr in Ganges, 18417 m^3/ yr in Brahmaputra with an all India average of 2214m^3/yr.

Rainfall Pattern

The North Eastern Region is the highest rainfall zone of the country and enjoys typical monsoon climates with variants ranging from tropical to temperate conditions. The rapid changes in topography result in climatic changes within short distances. The foothills plains, sheltered valleys and the mountain ranges are however marked with climatic contrasts and as such any generalization regarding the climate of the whole region will be hardly apt for its micro zone. The rains are of long duration and occur mostly between March and October. During March and April the rainfall is sporadic but it is steady and heavy or very heavy during May and October. Annual rainfall in north eastern portion of Arunachal Pradesh, north-west of Dihang and north-east of Bomdila is about 4000 mm, but gets reduced in southern western districts. The rainfall increases in Khasi, Jaintia and Garo hills (over 10,000 mm) but drops down in the north of Brahmaputra valley (about 2000 mm). The central parts of Meghalaya is famous for phenomenal high rainfall experienced there, average annual rainfall varying 2000 to 4000 mm. The Imphal, Lumding regions which lie partly in the rain shadow of the Mikir hill range records lowest rainfall of 1000 – 2000 mm (Table 5). The rainfall is mostly associated with storms and is generally heavy with average number of days having 25 mm or more. Daily rainfall with a ten year return period ranges from 150 to 225 mm over most of the region and that over 500 mm can be expected once in a year (Sharma, 1987). The pre monsoon rainfall (March–May) accounts for 25% of annual rainfall while bulk of the rainfall (67%) occurs during June–September which constitutes the monsoon season. The post monsoon rainfall (Oct–Dec) and winter monsoon rainfall are scanty limiting the scope for agricultural activities during the rabi season. The annual variation in rainfall is wide from one place to another and its duration is most uncertain. Delay in pre monsoon showers and delay in on set of monsoon not only leads to serious

dislocations but also causes great damage to the crops. On the other hand, the excessive precipitation causes rapid runoff on steep slopes resulting heavy soil loss as well as siltation of riverbed and catastrophic flood hazards in plains and also dangerous land slides. It also causes excessive leaching of losses resulting causing poor soil status and acidity.

RIVER BASINS

The region has two major river basins, *viz*., Brahmaputra and Barak. The Brahmaputra basin drains an area of 194,413 km^2 stretching from Arunachal Pradesh, greater parts of Assam to Meghalaya and Nagaland. The Barak and other basins, draining an area of 78.150 km^2, occupies northern and western parts of Manipur and southern parts of Assam. Both river basins cover approximately 86% of the total geographical area of the region. The Brahmaputra carries an annual flow of 61.65 M ha m and silt load of 3700 hectare meter (ha m). Not more than 10% of the annual of 61.65 million ha m is economically harnessable. Scarcity of storage structures or sites in hills, unstable dam foundation due to seismicity restrict judicious exploitation of Brahmaputra river. Per capita and per ha annual run-offs are 21060 m^3 and 44232 m^3 for Brahmaputra and 7475 and 53680 m^3 for Barak basin.

Table 5: Distribution of monthly rainfall (mm) in north eastern region

Month	Assam (Guwahati)	Arunachal Pradesh (Basar)	Manipur* (Imphal)	Meghalaya (Barapani)	Mizoram (Kolasib)	Nagaland (Jharnapani)	Tripura (Lembu cherra)
Jan	18.4	26.5	9.7	0.0	7.5	24.6	10.0
Feb	38.4	117.5	416.7	16.6	18.5	50.0	51.2
Mar	81.5	139.0	168.8	199.0	65.5	102.0	290.4
Apr	212.6	229.0	213.4	238.0	84.0	119.9	116.3
May	237.6	234.5	268.4	299.8	88.5	117.6	199.0
Jun	484.3	484.0	418.8	193.8	64.0	342.8	192.4
Jul	446.8	336.7	225.3	158.3	441.0	202.3	238.6
Aug	395.9	133.5	297.9	361.0	157.0	143.4	243.8
Sep	317.1	213.0	104.0	356.5	157.0	79.5	84.7
Oct	144.1	181.6	34.8	342.8	55.0	99.2	110.6
Nov	30.8	11.2	13.0	291.2	1.0	13.0	51.2
Des	8.9	18.5	0.0	0.0	0.0	0.0	0.0
Total	2416.4	2124.5	2170.1	2459.0	1762.0	1294.3	1588.2

Note: Based on the Annual Report, I.C.A.R. Research Complex for N.E.H. Region, Umiam.

* Data for 1993

(Source: Mishra *et. al.,* 2000)

Brahmaputra River Systems

The Brahmaputra originates in the Kailas range of Himalayas about 1000 km south of the lake Kanaggyn Tsha at an elevation of 5150 m. After flowing about 1625 km parallel to the main range of the Himalayas, it enters India. The river Brahmaputra drains 75% of the total geographical area of the region and flows for about 220 km in Arunachal Pradesh, about 720 km in the plains of Assam before entering Bangladesh. Out of its total catchment area of 580,000 km^2, 196,636 km^2 lies in India and the rest in China and Bangladesh. The river Brahmaputra has about 20 important tributaries on the north bank and about 13 on the south bank. The northern tributaries come from the high rainfall region, pass through fragile Himalayan reaches with the steep slope and carry heavier sediment. Its southern tributaries pass through a relatively stable reaches with flat slope and carry lower sediment. The river drains 51,000–70,000 m^3 of water annually. The average annual runoff of basin is estimated as 537,240 M ha m which is the highest in India. The specific yield of the river Brahmaputra is 3.03 cusec per km^2 is also the highest in the world.

Barak River Systems

The Barak river system, the second largest river in the region with its catchment area of 26,193 km^2 drains about 16% of the total area of the region. Barak, a tributary of the river Meghna originates in the upper hill reaches in Nagaland near Nagaland–Manipur border. On emerging from the hills, it traverses the valley in a westerly direction to Bhagnas below Badarpur where it bifurcates into two branches:- the Surma and the Kushiara. The Surma branch enters in to Bangladesh near Bhagna itself, while the Kushiara continues to flow.

Natural Reservoirs

There are four major natural lakes in the region with their catchment areas in Assam, Manipur, Meghalaya and Tripura of approximately 1420, 165, 2.13 and 5.0 km^2 respectively. However, there are innumerable number of small natural bodies, viz., swamp, beels and ponds. The area under natural water bodies were estimated and the in land water resources potential in different states has been assesses and presented in Table 6.

Table 6: Inland water resources potential of different types (lakh ha)

State	River length (km)	Reservoirs	Tanks/ Ponds	Lakes
Arunachal Pradesh	2000	-	0.01	0.03
Assam	4850	0.55	0.20	1.10
Manipur	3360	Negligible	0.03	0.29
Meghalaya	1000	0.01	0.02	Negligible
Mizoram	1748	-	0.50	-
Nagaland	1600	0.27	0.07	Negligible
Tripura	1200	0.06	-	0.06
Total	15728	0.8	0.83	1.48

GROUND WATER RESOURCE POTENTIAL

The Brahmaputra valley, underlain by unconsolidated alluvial sediments, (sand, gravel, pebbles, etc.) has immense ground water potential. The water table depth in the northern part of the valley (about 10 km wide along the foot hills of Himalayas) varies between 8 and 22 meter. In the synclinal valleys of Cachar and Karimganj districts, aquifers are found in the semi consolidated soft and stones of tertiary age where both shallow (within 50 meter with yield 20 to 30 m3/hr) and deep tube wells (150 to 200 meter deep with yield varying from 80-150 m3/hr) are feasible. Potential deep aquifers in the upper tertiary areas of Meghalaya have been identified in western and south western parts of the West Garo Hills district. In the intermontane valley of Nagaland and Manipur such surveys have revealed that the aquifers within 100m depth are moderately productive yielding 10-20m3/hr with heavy drawdown (Prasad, 1988). The latest estimate of ground water potential is 18.42 km3 (Anonymous, 1987) but its current utilisation is insignificant. Lack of road communication, non availability of flat areas in the hills, high iron content, lack of right type of the equipments for drilling bouldry foundation, huge thickness of clay bodies and over burden of weathered residuam are the dominant problems of ground water development in the area.

GEOMORPHIC UNITS OF THE REGION

Central Ground Water Board described the few geomorphic units of the region from ground water point of view as given below:-

(a) High Lands Plateau of Shillong and Mikir Hills: The yield prospects of wells in hard rock is generally 5 to 10 m^3/ ha. In Shillong area, water tapped within 100m depth yields 1016 m^3/hr. This limestone belt may prove to very potential aquifer.

(b) Promount Plains or Bhabhar Belt: This belt extends along the foot hills of the eastern Himalayas in Assam and Arunachal Pradesh. Ground water occurs at depth between 12-25 m. This potential aquifer is not so far, fully exploited.

(c) Alluvial Plains of the Brahmaputra Valley: This aquifer system is hydraulically connected with major perennial river Brahmaputra and its tributaries and the unconsolidated formations of the valley have been divided into three principal zones. In thick and regionally extensive confined and unconfined aquifer the shallow and deep tube wells can be made use of irrigation purpose. In moderate thick discontinuous confined and unconfined aquifers, the yield ranges from 100–150 m3/ ha for draw down up to 13m and in foot hills of Naga – Patkai range, the tube wells are feasible but yield may vary from 30 –50 m^3/hr for draw of 20 –30 m.

(d) Syclinal Valley of Tripura and Barak: The disposition of aquifers is though consistent but thickness decreases from east both in Tripura and Cachar. Artesian conditions exist with auto flow discharge of 0.1 –3.0 m^3 /hr mainly in central parts of the valley. The general range of discharge in 100-225 m deep tube wells is 75-150 m^3/hr.

(e) Intermountane Valley: Ground water occurs in the intermontane valleys under confined and unconfined conditions and yield 15-16m3/hr for draw of 15-30m at the depth of 120-150 m. Central Ground Water Board has estimated the ground water resource potential of the region is presented in Table 7.

Water Balance

The region has 46% of the country's valuable surface water resource. The surface water is distributed in important rivers, tributaries and natural reservoirs. The rivers of the region are fed by heavy precipitation and to a lesser extent by snow of Himalayan range. Most of the surface water is confined to the two important river systems– Brahmaputra and Barak. The state wise annual water budget based on the available data has been worked out and presented in Table 8.

Irrigation Potential and Development

The mountain ecosystem of North Eastern India, characterised by undulating hilly terrain, limits the scope for utilisation of water resources for irrigation; in the vast areas rainfed agricultural is mostly practiced following old traditional cultivation methods using primitive farm tools. The entire region has a peculiar climate with high rainfall and humidity, long cold period, limiting sunshine and maximum cloud coverage which restrict the photosynthesis, retard the plant growth and prolong the crop season. Permanent cultivation in the plains, valleys and terraces and shifting cultivation (practised by 4,43,336 families in an area of 386500 ha annually) in hills are the predominant patterns of prevailing land use. Irrigation is one of the weakest links in the region, only meagre 7.75% of the net cropped area is irrigated; consequently the extension of the new crop is slow. By the end of the VII Five Year plan, irrigation potential of only 2.53 lakh hectare under major and medium irrigation sector had been created in the seven states of this region, which constituted just 0.8% of the potential created in the country, against its share of 8% in the geographical area, and over 3% share in the gross cropped area in the country, which also indicates, the available irrigation is being utilised marginally. The existing irrigation schemes in the plains are mainly for utilising surface water fed by rains. The sources are generally rivers and rivulets, tanks, beals and wells. Most of these are not of permanent nature. The position of irrigation remained static for the last so many years; 3 to 5 incidences of floods every year in Assam valley creates serious problem for irrigated agriculture. Lack of tradition of irrigated agriculture, heavy rainfall during monsoon along with various agro-physical factors have contributed to the growth of largely mono-cropped subsistence farming system - a switch over to multi cropped system with the adoption of HYV seeds, fertilizers, insecticides and the like, would primarily depends on irrigation and a new approach to development of water resources. Due to hilly nature of the terrain, development of major and medium projects in the most parts of the region is more or less absent; small size minor irrigation projects are of immediate necessity to do away with the practice of jhuming in the hills. Assam has the highest ultimate irrigation potential of 2670 thousand ha from major and minor projects. Total irrigated area in the region is around 560,000 ha of which 69.8% area is in Assam. Manipur has 25.5% of the net sown area under

irrigation compared to 13.8% in Meghalaya, Manipur has also the highest ultimate irrigation potential of 171.4% of the net sown area.

Table 7. Ground water resource potential in North Eastern Region (in M ha m)

Sl. No.	State	Utilizable resource for irrigation	Net draft	Potential available for exploitation	Level of development (%)	Year of up date
1	Arunachal Pradesh	0.1223	Neg.	0.1223	Neg.	1990
2	Assam	1.8421	0.0797	0.7624	4.33	1991
3	Manipur	0.2681	Neg.	0.2681	Neg.	1990
4	Meghalaya	0.1041	0.001	0.1031		1990
5	Mizoram	Not estimated				
6	Nagaland	0.0615	Neg.	0.0615	Neg.	1990
7	Tripura	0.2135	0.0097	0.2038	4.54	1990

(Source: Ground Water Estimation Committee, 1992, Central Ground Water Board, New Delhi.)

Table 8. Water budget of North Eastern States

S. N.	Item		Aruna-chal	Assam	Mani-pur	Megha-laya	Mizo-ram	Naga-land	Tripura	Total	Remark
	Geographical area (km^2)		83740	78440	22330	22430	21080	16580	10490	255090	
A.	Annual Water Budget										
1	Avg. Rainfall	mm	2930	2336	1972	2253	2535	1986	2516	2493	Weight-ed Avg.
		MCM	245358	183236	44035	50535	53438	32928	26393	635923	
2	E.T.Loss es	MM	905 (31%)	873 (37%)	864 (43%)	807 (36%)	976 (39%)	872 (44%)	857 (34%)	883 35.5%)	Weight-ed Avg.
		MCM	75785	68478	18891	18101	20574	14458	8990	225267	
3	Recharge to ground water	MM	205 (7%)	234 (10%)	118 (6%)	113 (5%)	128 (5%)	99 (5%)	151 (6%)	183 7.3%)	Weight-ed Avg.
		MCM	17168	18355	2635	2535	2698	1641	1584	46716	
4	Surface water runoff	MM	1820 (62%)	1229 (53%)	1008 (51%)	1313 (59%)	1431 (56%)	1015 (51%)	1508 (60%)	1426 57.2%)	Weight-ed Avg.
	Total	MCM	152405	96403	22509	29751	30166	16829	15819	363581	

(Source: Thansanga *et. al.*, 2000)

Drainage

The soils developed on moderately steep to slopes of low to somewhat excessively drained and those on undulating uplands and gently sloping plain are well to imperfectly drained. The soils developed in recent and active flood plains are well to moderately well drained with moderate flooding hazards. About 43% area in the region comes under well-drained condition and 38% falls under excessively drained condition. In well-drained soils, excessive leaching of bases due to high rainfall results in poor base status and soil acidity leading to detrimental environment for nutrient availability of common

agricultural crops. Soils in inter hill valley are deep, poorly to imperfectly drained, fine in texture with more flooding hazards. Very poor and poor drainage accounts for about 7.5% of the total area mostly confined to various river valley zones of the region resulting into huge losses due to floods (Table 9a & 9b).

Table 9a: Drainage conditions in the North Eastern Region of India

Class	Attribute	Area (%)	Cummulative area	Area (km^2)
1	Very poor	2.71	2.71	6875
2	Poor	4.79	7.50	12163
3	Imperfect	4.02	11.52	10213
4	Well	43.68	55.21	110882
5	Excessive	38.49	93.69	97694
6	Rocky mountains	4.16	97.85	10553
7	Marshy lands	0.33	98.18	833
8	Rivers	1.82	100.00	4623
Total		100.00		253835

(Source: Velayutham, 1999.)

Table 9b: Extent of flooding in the North Eastern Region of India

Class	Attribute	Area (%)	Area (km^2)
1	None	73.98	187776
2	Occasional	8.81	22358
3	Moderate	5.09	12924
4	Severe	5.82	14770
5	Rocky mountains	4.16	10552
6	Marshy lands	0.33	832
7	Rivers	1.82	4624
Total		100.00	253836

(Source: Velayutham, 1999)

PRODUCTION AND PRODUCTIVITY OF IMPORTANT FOOD GRAINS IN THE REGION

Rice is the major crop of the region accounting for about 89% of the area and 92% of the total food grains production. The other major crops are maize, wheat, millets, oilseeds and pulses. The region is deficient in food grains and the gap between demand and supply is widening. During the years 1980-95, the annual Compound Growth Rate (CGR) of food grains production was a megre 2.11% as against 2.41% increase in the population (Table 10). The production in Meghalaya and Assam has lower annual CGR than population. Sustainable Yield Index (SYI), which gives an idea of the overall yield sustainability of major crops, is shown in Table 11. The average productivity in the region is very poor. The annual CGR of productivity indicates that productivity of various food crops is declining in Meghalaya, while it is very poor in Assam and Nagaland. This could be attributed to low use of fertilizer nutrients, traditional agricultural practices, mostly rainfed agriculture, lack of availability of good seed, suitable cropping patterns, etc. (Sharma, 1995).

The annual removal of major nutrients by various crops in the region is 294.08, 83.98 and 187.14 thousand tonnes of N, P2 O5 and K2 O, respectively, whereas, replenishment is only 36.42 (12.3%), 10.92 (13.0%) and 7.91 (4.2%) thousand tones, respectively. This is a cause of concern as we are mining the soil at a faster rate that would affect the sustainability of food production system. The overall fertilizer nutrient response potential (FNRP) achieved in the region is only 16%, with highest (34.4%) in Manipur and lowest (6.3%) in Arunachal Pradesh. There still exists a lot of scope for enhancing the productivity of food crops in the region with optimum use of nutrients (Sharma, 1992).

Table 10. Annual Compound Growth Rate (%) of food production and population in North Eastern States (1980-95).

Sate	CGR of food production	CGR of population
Arunachal Pradesh	3.91	3.11
Assam	2.01	2.15
Manipur	3.54	2.74
Meghalaya	1.29	2.85
Mizoram	9.35	3.72
Nagaland	5.51	3.45
Tripura	1.57	2.90
NE States	2.11	2.41
All India	2.54	2.19

Source: Sharma, 1996

Table 11. Sustainable Yield Index (SYI) of various crops in NE Region (1980-1990 -91)

State	Rice	Maize	Wheat	Pulses	Total
Arunachal Pradesh	0.895	0.898	0.308	-	0.573
Assam	0.779	0.947	0.943	0.887	0.782
Manipur	0.7171	0.584	-	-	0.713
Meghalaya	0.727	0.735	0.88	0.716	0.850
Mizoram	0.658	0.584	-	0.408	0.648
Nagaland	0.647	0.564	-	0.426	0.647
Tripura	0.709	-	-	0.709	0.731
NE State	0.793	0.774	0.679	0.439	0.797

Source: Sharma, 1996

MAJOR CONSTRAINTS AFFECTING FOOD PRODUCTION AND FOOD SECURITY IN NORTH EASTERN REGION

In previous paragraphs few constrains affecting the production and productivity of food grains have been indicated. However, we have to look to many other commodities for food security and nutritional availability. This portion tries to enlist the main factors responsible for lower production and productivity of these sectors directly responsible for food and nutritional security in North Eastern India.

A. LAND TENURIAL SYSTEM

The land tenurial system prevalent in the region is very peculiar. Three categories of land holding systems are generally found in the region *viz,* (i) land belonging to village chief (ii) community land and (iii) land belonging to individuals. In the first category, the farmers only have cultivation right over the land and, therefore, do not feel a sense of belongingness. This discourages the farmers to use inputs for getting the optimum yields. The right for distribution of land for cultivation is usually vested with the village chief or headman and the village council. However, the distribution of the land is done according to need and availability of family labour in the household. Shifting cultivation in its pure form is practiced on community land. Due to the imperatives of new emerging social systems, different land tenure systems are also emerging even under shifting cultivation.

B. PRODUCTION CONSTRAINTS IN FARMING

Apart From the basic constraints of land tenurial system and land holding patterns there are several other bottlenecks too, in successful farming. A few are listed below:

a. Agriculture

Shifting cultivation, land tenurial system, small land holdings, lack of proper marketing facilities, lack of appropriate communication systems, lack of finance, acid soils, non-availability of inputs at required time and inadequacy of amounts, high humidity resulting in more pests, insects and diseases problems, high rainfall, humidity and low solar radiation (photo periods) and other problems

related with it, inhospitable terrain, low scientific strength, lack of advanced trained staff, lack of medical facilities, lack of interest of farmers to grow more than one crops, and overall lack of interest in agriculture are the main constraints in agriculture in the region.

b. Horticulture

Lack of proper markets, lack of finance, lack of organized sector to encourage horticulture and dependence on only one cereal crops for subsistence, lack of proper planting material suited to different agro-climatic situations, no processing unit to process the surplus fruits and spices like pineapple, ginger, mandarin, and minor fruit plants, poor post harvest management, non-availability of desired expert advise to the farmers on the matters of right plantation and management practices for good orchards, citrus decline, continuation of old orchards beyond their normal productive life, poor management of orchards, high losses of soils due to erosion, leaching of nutrients and resultantly low productivity of soil are the main constraints in horticulture sector in the region.

c. Forestry/Agroforestry

Prevalence of shifting cultivation - a practice based on deforestation, free access of the individuals to forest for timber and fuel as source of income, prevalence of varied type of forest areas ownership in the region which does not allow the line department to function properly, lack of authority with state government to prevent deforestation and burning of forests, biotic interference of fire and free grazing, cutting of grasses from the forest area in the rainy season, lack of organized plantation, haphazard or unorganized plantation, lack of economically important plantations and non-availability of advanced disease free nurseries are the main constraints in forestry/agro-forestry sectors in the region.

d. Fisheries

Lack of availability of fingerlings, lack of finance for digging of ponds and procurement of fish feed, low temperature and sunshine prevent fish growth. Lack of proper facilities of disease control, lack of infrastructure for fish processing, lack of technical know-how with the farmers for fisheries are the other constraints in the development of fisheries in the region despite vast potentials .

e. Dairy and Livestock Production

Non-availability of feeds, shortage of labour for livestock management, no efforts on genetic improvement, low breeding efficiency in cattle, non-availability of vaccines, lack of trained manpower, lack of infrastructure facilities of processing, marketing and distribution, contamination of vaccinated animals with non-vaccinated due to porous borders and unchecked movement and intermixing are the main bottlenecks in growing dairy and livestock industry in the region.

f. Other agro-based ventures

Other agro-based ventures are practically non-existent due to the combination of factors mentioned as above except moderate sericulture (Muga culture) in some parts of Assam. This has resulted in to overall economic backwardness of the region. Simultaneously, the poor economic condition of the farmers has led to reduced purchasing power and thus affected the food security and nutritional availability.

FOOD SECURITY VIS-A-VIS SUSTAINABLE NATURAL RESOURCES MANAGEMENT

Despite being rich in natural resources, the region has not been able to provide for endured supplies of food on sustainable basis. The following measures are recommended:

1. The forests are dwindling at a rate of 0.7% annually in the region owing to shifting cultivation. The practice has caused enormous deforestation and land and environmental degradation in the region. Therefore, a general awareness needs to be created among the cultivators about the natural hazards associated with shifting cultivation. Improvement in faulty agricultural practices, that area no longer acceptable under the present situation like shifting cultivation is a must.

2. Integrated watershed management approach is the best solution for the problems related with sustainability of production systems and food and nutritional security of the people of the region.

3. Watershed/micro-watershed based farming systems with various land uses such as a combination of agriculture, horticulture, agri-horti-silvi pastoral, livestock based, etc., need to be popularized. Research conducted on various farming systems has shown that watershed based farming systems are more remunerative and help in conservation of soil and water.

4. Though the steep hill slopes are not suitable for bringing under agriculture yet the limitations with farmers can prevent them to till these slopes. If cultivation is absolute necessary which is evident from the conditions of North Eastern hill region, these hill slopes should be put under soil conservation measures, like bench terraces, contour bunding, half moon terraces, grassed water ways, etc., to prevent soil and nutrient loss due to erosion. These measures have been found to check the land degradation in the hilly tract with potential to terrain 80-100% of annual rainfall in situ, contributing towards grounds water development and recharge of streams.

5. The mountain eco-system of North Eastern region, characterized by undulating hilly terrain, limits the scope for utilization of water resources for irrigation. Rainfed agriculture is mostly practiced in the region following old traditional cultivation methods. The region is predominantly monoculture. There is need to cultivate more than one crop per year. If possible, the emphasis should be on growing cash crops which could fetch foreign exchange. The cereals and other food grains could then be imported from other countries or states. For this to happen, conservation of water in small water harvesting structures in watersheds to store run-off and intercepted base flow and utilizing the stored water for fish production or recycled back for irrigation .

6. Judicious utilization of land resources as per land capability classification would ensure higher productivity and resources sustainability.

7. Promotion of new farming systems and cropping patterns according to the local agro-climatic conditions for improving overall productivity of food crops.

8. Average consumption of the fertilizers, pesticides, insecticides and other chemicals are relatively lower as compared to other regions. In these days, it is a strength rather than weakness. However, in the North Eastern region adequate and judicious use for fertilizer/nutrients for getting optimum yields should be popularized to replenish the soil resources with nutrient that are washed away due to heavy rains and cultivation. It would be good to supplement nutrient with organic/biological resources.

9. Use of high yielding varieties, advance tools and farm machinery suitable for hilly terrains and improved post harvest techniques of various crops and better management practices.

10. Large scale afforestation programmes either of timber, horticultural plants, plantation crops or agro- forestry systems.

SUMMARY AND CONCLUSIONS

North Eastern region is lagging much behind as for as the requirements are concerned. Ironically the region has got ample resource potential not only to become self reliant but also a surplus region by proper utilization of its resources. It is however, the other side of the picture which has a darker side in the form of all ills in utilization, conservation and management of the precious natural resources which not only has so far deprived the region from becoming self sufficient but also put the resources in jeopardy. It can be concluded from the above discussion that if the region has to become a food self sufficient instead of a deficit one and the long term sustainability of the resources for utilization of the future generations are the goals, a strategic plan has to be implemented despite many a constraints by meticulously redesigning the whole process of agricultural production. In this connection it is also arguable that in order to safeguard the long term interest of the country as well as the region the total shift from sedentary

agriculture sector which in turn is very low productive to more remunerative high-tech commercial agriculture.

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PRESENT STATUS OF MAIZE CULTIVATION IN SIKKIM AND FUTURE STRATEGIES

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Maize (*Zea mays*), as the major cereal crop of Sikkim occupying nearly 40,000 ha of area (nearly 38 per cent of area under cultivation) has thus far been the mainstay of the farming community. The total production hovers around 60,000 tonnes with an average yield of 1,500 kg ha^{-1} (Anonymous, 2001). Such productivity under rainfed condition and nominal application of chemical fertilizers can be considered reasonable though in the USA and other advanced countries productivity of hybrid maize is at exceptionally high levels of 8 to 10 t ha^{-1}. In Sikkim, the maize yields generally decrease with increase in altitude, which can be attributed to absence of location specific varieties, low use of chemical fertilizers and unfavourable climatic conditions particularly during the pre-Kharif and post-Kharif seasons. Besides, there are no improved or high yielding varieties for the higher altitude.

Historical perspective *vis-à-vis* origin of maize

Historically, maize is considered to be of the New World origin as this plant was unknown in any part of the Old World before Columbus discovered America in 1492. In 1956 two Japanese scientists Suto and Yoshida referred to the statement recorded by the famous Chinese naturalist, Li Shih-Chen that a pod like corn was introduced to China from India via Tibet in 1368. Some investigators, who supposed the time could be mid 16th Century, questioned this date. This date cannot be ruled out altogether because long before the discovery of the New World by Columbus, Buddhist Missionaries, both Indians and Tibetans, communicated between India and Tibet across the Himalayas, and commodities travelled from India to Tibet. It is thus possible that the "pod like corn" was collected from one of the maize growing areas of the Himalayas rather than the plains in the South. The Tibetan word "*Ma-rmos-pai-lo-tog*" is invariably taken to mean maize particularly in Tibet, Bhutan and Sikkim (Thapa, 1966).

According to Thapa (1966) one of the most primitive maize races in the world was revealed to two foreign scientists (E. W. Sprague and N. L. Dhawn) in various parts of Sikkim in 1962. This living (or surviving) specimen bore the closest resemblance to the wild maize of which an actual specimen in fossil was uncovered in the lower levels of San Marcos Cave in Mexico in 1960 (Mangelsdorf *et al*., 1964). He also contemplates as to when and how maize was introduced to the hilly areas of the South East Asia, where people of the Tibeto-Burman stock were still practicing 'jhumming' is not known. It is a fact that in many of these areas maize ears are offered to the deity before harvesting the crop. This offering of maize ears is indeed an ancient tribal custom, a kind of 'thanksgiving' offering, in the Eastern Himalayas. Thus, the Lepcha ritual of offering the ears of corn holds the key to this problem of introduction of maize to the Old World. It is no mere accident that though Sikkim is the Valley of Rice, *Lepcha*(*s*), *Bhutia*(*s*), *Tsong*(*s*) and others place the highest premium on the ear of corn (maize) and not the ear of paddy (rice) in their tribal rituals inherited from the prehistoric times. Singh (1977) described that races of maize in India could be grouped for convenience in to four categories: primitive, advanced or derived, recent introductions and hybrid races. The primitive group comprised several races of popcorn, which had become differentiated at various altitudes and under diverse conditions. These were *Poorvi Botapa*, *Murli* sub-race of *Poorvi Botapa*, *Tirap Nag-Sahypung*, *Arun Tepi* and *Alok Sapa*. These were distributed throughout the eastern Himalayan region including Sikkim in the altitude range from 600 to more than 2000m, under conditions of traditional cultivation.

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Poorvi Botapa, the most primitive race was found in pure form in Sikkim and other parts of Eastern Himalayas and Murli sub-race of Poorvi Botapa was in Sikkim and Mikir and Cachar hills of Assam. In Sikkim the latter was grown as Sikkim Primitive-1 and 2 and also known as Murli maize. An interesting feature of Murli sub-race of Poorvi Botapa was that it showed marked resemblance in its general plant type to the reconstructed ancestral form of maize reported by Mangelsdorf and his collaborators (Mangelsdorf, 1958; Mangelsdorf *et al*., 1964). Such evidence revealed that maize was an important component of the cultivated crops from time immemorial in Sikkim.

Existing land use in Sikkim

The general land use pattern of the state comprises 33.94 per cent under dense and reserve forests, 11.79 per cent under forest blank, scrub in reserve forest and alpine scrub, 28.92 per cent under alpine barrens, high mountains, rocky cliffs and permanent snow-clad peaks and 14.73 per cent is cultivated land, having only 8.74 per cent as the net sown area (Table 1). During the last three decades the grossed-cropped area under agriculture has remained around 80,000 ha while the area available for cultivation has declined from nearly 1,10,000 ha to 1,04,500 ha. The decrease in the cultivated area has resulted with diversion of agricultural land to non-agricultural uses, including developmental interventions. This does not augur well for the future agriculture in Sikkim. Even the per capita land holdings have witnessed a decline *vis-à-vis* net cultivated area, operated area, pasture and also forest among others primarily following fragmentation of families. These again are disturbing signs (Table 2).

Table 1. Existing land use pattern in Sikkim

	Land use	Area (km^2)	% of total geographic area
1.	Total geographic area	7096.00	100.00
2.	Alpine barren/snow glacier*	2051.93	28.92
3.	Land under water bodies, dry river beds, landslide, rock outcrops and built up area*	149.93	2.11
4.	Alpine pasture*	433.00	6.10
5.	Permanent pastures and other grazing lands	43.71	0.62
6.	Dense forest cover	1901.29	26.79
7.	Reserve forest cover	507.08	7.15
8.	Forest blanks, alpine scrubs and scrubs in reserve*	836.59	11.79
9.	Land not available for cultivation		
a)	Other barren and unculturable land	98.87	1.39
b)	Land put to non-agricultural uses	26.08	0.37
10	Land available for cultivation		
a)	Net sown area	620.43	8.74
b)	Fallow lands	346.50	4.88
c)	Land under miscellaneous tree crops and groves not included in net sown area	56.72	0.80
d)	Culturable waste	23.87	0.34

Source: *Anonymous, 1994 and
Bhutia, Kunga Gyatso, 1996.

Area and seasonal suitability

Sikkim with a total geographic area of 7096 km^2 has wide variations in altitude that governs the climate. As one moves up from 300m to 8586 m amsl the climate changes from subtropical to alpine. This region receives copious rainfall being one of the wettest regions of the Himalayas given its most proximal position to the Bay of Bengal. The annual rainfall ranges from 2000 to 5000 mm and average humidity hovers around 70 per cent or higher at any given time of the year. The mean annual air temperature varies from 6.0^0C to 31.0^0C.

Table 2. Area under operational holdings and *per capita* availability of land

Type of land	Area in hectares 1976 – 77	1980 – 81	1990 – 91
1. Net sown area	64,927	78,321	63,254
2. Current fallow	501	4,428	3,906
3. Other cultivated land excluding fallow	4,925	4,560	10,830
4. Fallow other than current fallow	944	9,474	9,204
5. Culturable wasteland	1,153	681	9,807
6. Land not available for cultivation	6,613	11,604	14,300
Total operated area	79,062 (11.14)	109,068 (15.37)	111,301 (15.69)

	Per Capita land (ha) 1971	1981	1991
1. Net cultivated area	0.31	0.27	0.17
2. Operated area	0.38	0.36	0.28
3. For non-agricultural use	0.33	0.28	0.21
4. Pasture and culturable waste	0.40	0.24	0.18
5. Forest	1.26	0.83	0.65
6. Total no. of operational holdings	31,061 (1977)	56,000	52,697
7. Average size of holdings	2.55 (1977)	1.95	2.11

Source: Anonymous, 1996

In Sikkim, maize is extensively grown in the altitude ranging from 300 to 2,200 m above mean sea level with more than 80 per cent in the mid-hills. The acreage is higher in the drier belts of South and West Sikkim. It is also cultivated in paddy lands prior to Kharif season at the lower hills up to an altitude of 900 m. As of now, maize is not grown at lower altitudes perhaps due to lack of irrigation facility. Wherever some irrigation is available, farmers prefer growing winter season vegetables and potato. Maize is cultivated during S-W monsoon season (Kharif) in the non-paddy lands both as pure and mixed crops, and pre-Kharif season in the paddy lands at lower altitudes. It is also grown in the post-Kharif season at the lower and mid altitudes after the harvest of the main season maize crop. Such maize is cultivated with pulses, beans and pulse-type beans. Where irrigation possibilities exist, high yield potential of Rabi maize can be exploited at lower altitudes.

Since 1970 there has been an increase in the area under maize cultivation and its production (Table 3). The increase in area under maize was basically due to increased area of pre-Kharif maize in the paddy lands. In the main season, maize area under non-paddy lands there has in fact been significant reduction in area. The period 1981 to 1990 witnessed 27.6 per cent increase in the acreage with 174.3 and 111.1 per cent increase in total production and per unit yield. This was the period of introduction of the HYVs in to the State. But these increases both in total production and per unit yield could not be sustained during the next decade 1991 to 2001; during this period only 31.7 and 22.3 per cent increase, respectively was recorded. This was despite more choice of HYVs being available during the latter period.

Time of sowing

The time of maize sowing varies with altitude and growing season. Pre-Kharif sowing in the paddy lands at the lower altitudes is done in mid-February to second week of March. Main season maize is sown at different altitudes from mid-February to April. Normally sowing time is early at the lower

altitudes than the mid and higher hills, where it is delayed. Compared to the Plains of North India, the sowing time of the main season (Kharif) is much earlier. Post-Kharif maize is sown in July and first week of August along with pulses, beans and pulse-type beans. Rabi (winter) maize can be planted in the last week of September to October in the lower hills.

The traditional sowing time for main season maize though ideal from soil conservation point of view is perhaps too early as it normally encounters drought of variable durations effecting considerable reduction in its productivity. Importance is attached to growth of cover crops along with maize to reduce the ecological impact of heavy downpour events accompanied by hailstorms during March and April. By then the canopy cover of maize does not attain its maximal spread and the erosion losses can be considerable. Sowing of maize can be delayed by a month to ward off the climatic assaults that often result in partial or complete crop damage. Thus, timely sowing is not devoid of the element of risk.

Table 3. Temporal changes in the area under maize, varieties cultivated and production in Sikkim

	1970 – 1980	1981 – 1990	1991 – 2001
I. Area (hectares)	28500	36367 (27.6)	39924 (9.8)
II. Production			
1. Total (tons)	16500	45260 (174.3)	59612 (31.7)
2. Per unit (kg ha^{-1})	579	1222 (111.1)	1494 (22.3)
III. Varieties			
a. Local	Sethia, Khukurey, Garbarey, Pahenli, Lachung	Sethia, Garbarey, Pahenli,	Sethia, Garbarey, Pahenli,
b. Improved local	Sikkim White	Sikkim White	Sikkim White
c. Improved exotic	A de Cuba		
High Yielding Varieties (HYVs)			
i. Composite	Diara – 3 , Vijay	NLD White, Super 1	NLD White, Mansar, Prabha, Suwan
ii. Hybrids	Him 123, G 101	VL – I, GS – 2, Deccan – 103, Ganga – 5	Ganga–5, P–416, P–3485, P–316, Him–129, P–4640

Values in parenthesis are per cent decadal increase
Source: Bhutia, Kunga Gyatso, 2001 (Unpublished, *Pers. Commun.*)

Agronomic management

Seed rate ranges from 15-20 kg ha^{-1} depending upon the variety and the season. Sowing is done in furrows at a depth of 3-5 cm at a spacing of 15 cm between rows and 30 cm between plants or 60 cm between rows and 45 cm between plants. Spacing varies with variety and season; however, for post-replace with; Kharif, Rabi maize and dwarf varieties the spacing is reduced. Organic manure is evenly spread and incorporated into the soil during land preparation, while fertilizer mixtures are applied in furrows some 5 cm away from the rows and thoroughly mixed prior to sowing of seeds following which the soil is firmed up. Interculture operations begin once the seedlings are 10 days old with the help of hand-held fork. Top-dressing of fertilizer especially urea is done following the weeding. Earthing up process continue up to 15 to 20 days to flowering. Intercrops are grown when maize attains sufficient height while relay cropping with soybean, rice bean and the like crops are practised when the oldest leaves start yellowing.

Changing planting material

Commonly, traditional local varieties dominate the planting material that includes open-pollinated varieties and composites and recently the HYVs. Sikkim was once known for its prized possession of popcorn varieties- Sikkim Primitive-1 and 2 also known as Murli maize with the exceptional characteristic of multiple cobbing. Popular local cultivars such as Sethia, Khukurey, Garbarey, Pahenli, and Lachung are gradually getting replaced by improved varieties particularly composites like NLD White, Suwan, Prabha and some hybrids (Table 3). Hybrid maize is also grown and despite being encouraged by the Government, its acreage has not increased because the seeds have to be replaced every year. For higher altitudes no improved varieties are available and the farmers continue growing local cultivars like Kukharey, Pahenli and others. Similarly, farmers still persist with the cultivar (cv) Sethia in the pre-Kharif season. For post-Kharif and Rabi season also there are no specific local or improved seed material. Therefore, it is crucial to have the right kind of variety for every microclimate within Sikkim.

Table 4. Specific attributes required for ideal growth of maize in different seasons in Sikkim

Growing season/area	Varietal attributes	Crop duration	Preferred grain types	Preferred grain colour
Pre-Kharif	Tolerant to drought, complete husk cover, strong stalk, resistant to lodging	Short	Flint	White
Kharif (main season)	Tolerant to diseases and pests, medium height, strong stalk, lodging resistance, complete husk cover on the cobs	Medium to long	Flint	White, yellow or orange
Post–Kharif	Drought tolerant, strong stalk	Short	Flint	White or other colour
Rabi	Drought tolerant, frost tolerant	Medium	Flint	White or other colour
High hills	Frost tolerant, strong stalk, lodging resistance, complete husk cover and medium height	Short to medium	Flint	White or orange

Nutrient management

Proximity to the Bay of Bengal and direct exposure to the south-west monsoon make this region the most humid in the entire Himalayas. An amalgamation of conditions under the influence of heavy rains has generated soils that are moderately to strongly acid in reaction, low exchangeable bases and rich in organic matter (Avasthe and Avasthe, 1996), high in available zinc, copper, iron and manganese contents and deficient in available boron and molybdenum (Avasthe and Avasthe, 1995). Soils also reveal considerable fixation of applied phosphorus. Such conditions do not favour normal crop growth without the use of appropriate amendments to overcome soil acidity and obtain response from the applied nutrients. The local varieties of maize traditionally grown in Sikkim are characterized with thin and tall stalk, hence, susceptible to lodging even at minimum levels of fertilizer application. The farmers generally have the tendency of not following the recommended doses of fertilizers or the amendments and prefer to concentrate more, firstly, on farmyard manure and secondly, nitrogenous fertilizers. The main season for growing maize is normally faced with soil moisture deficit, and sowing under such conditions leads to low germination besides poor nutrient uptake.

Of the four districts of Sikkim, the frequency of soil having pH less than 5 are 50 per cent in North Sikkim while in the others it is about 12 per cent (Bhutia *et al*., 1985). Such soils reveal aluminum and manganese toxicities and liming is essential to provide an acceptable plant-root environment. Results from field experiments conducted in Sikkim revealed that the highest yields of maize were achieved when dolomitic limestone was applied at the rate of 1-2.5 equivalent of exchangeable Al to raise the pH around 5.5 (Patiram *et al*., 1991). This was sufficient for a period of two years in a maize sequence after which only half the amount of limestone was necessary for sustained levels of production (Patiram *et al*., 1990). Further field experiments suggested an economically affordable rate 250 kg limestone ha^{-1} for poor and

marginal farmer that could be furrow applied every year to achieve optimum productivity. The standard recommendation of fertilizer for the main season HYV maize is nitrogen 120 kg, phosphorus 80 kg and potassium 40 kg per hectare. These are reduced to a much lower level for the traditional varieties and rainfed condition for the post-Kharif and Rabi maize. The farmers are known to apply varying levels of organic manure before sowing and top dress with urea but the recommended dose of either fertilizer (N, P, or K) or the amendment is seldom adhered to. Top dressing is done at knee-high stage or at flowering. Maize is often grown as an intercrop with ginger, which is cultivated with enormous quantities of organic manure. Since both are exhaustive crops nutrient management is a crucial parameter, as it is not known nutrient requirement of which crop is achieved.

Many of the indigenous varieties have been on the verge of extinction and thus need to be conserved for future crop improvement programmes. The local and composite varieties popular earlier are gradually getting replaced with hybrids/HYVs. Yet, the recent maize productivity trend in Sikkim has been far from impressive. This could be attributed to factors such as timely non-availability of fertilizers and other inputs and low use of fertilizers, 6.9 kg N, P and K ha^{-1}, respectively (Pradhan, Yashoda, 2001). The latter is the more crucial reason for low production because the HYVs perform to their full potential only when supplemented with optimum nutrient levels under good crop management measures. Further enhancement in productivity can be achieved with suitable improved varieties for pre-Kharif maize in paddy lands and for high altitudes being made available and also promotion of Rabi maize under assured irrigation. Proper soil acidity management can also increase the productivity.

Maize-based cropping systems

Planting geometry of the crop has been traditionally exploited and/or manipulated to include crops like soybean, pulses, pulse-type beans, and millets as intercrops at different growth stages of maize. At lower and mid hills, ginger has also been cultivated as an intercrop and this is an important system for Sikkim, despite both the crops being exhaustive in character. Keeping this in mind the farmers over a period of time have applied large quantities of FYM that could range anywhere between 50 – 80 to 100 t ha^{-1}. Peas and potato are the intercrops in the high hills. Turmeric and Lady's finger are also grown in the lower and mid hills. Pigeon pea too can be cultivated on the terrace risers with success.

Perhaps because of insecurity, the small holdings farmers grow maize as an intercrop in their mandarin orchards. Here the cultural operations leading to the cultivation of maize damage the root systems of mandarin trees. However, cultivation of leguminous crops like beans, pulses, and pulse-type beans, peas; vegetables, ginger, turmeric as intercrops is perceived beneficial to maize. Besides fixing nitrogen legumes generate additional income.

Diseases and insect-pest management

Maize is generally seen as a hardy crop; thus, the incidence of insect-pests and diseases is not of major distress in Sikkim. A detail of only two diseases and one insect-pest (Gupta *et al*., 1994) incidence in this state is presented below.

Diseases of maize				
	Causal organism	Spread	Appearance of disease at 1350 m amsl	Approx. loss (%)
Leaf blight	*Helminthosporium* sp.	Endemic all over Sikkim	May	20
Rust	*Puccinia sorghi*	Endemic all over Sikkim	April	10
Insect-pests of maize				
Stem borer	*Chilo* sp.	Endemic all over Sikkim	March	10 – 30

The control of Leaf Blight of maize can be achieved by spraying 0.2% Indofil M-45 (2 g L^{-1}) and Rust can be controlled by spraying either the earlier fungicide or by 0.1 % (1 gL^{-1}) Bavistin (Carbindazim). Stem borer can be controlled with Furadon (Carbofuron) or phorate (Thimet) granules or by spraying Quinolphos (1.5 ml L^{-1}). Addition of any wetting agent along with the fungicide spray solution like Indtron @ 1 ml L^{-1} is recommended.

- Varieties resistant to northern blight, southern blight and rust (*Helminthosporium* sp and *Puccinia sorghi)* are Ganga Safed-2, NLD White, Vl-73, SKM-2, POP-22, Murli maize, Kulu local, RCM-1-1, DMR-2, Phil, Popcorn and Trop. Blanco.

Production and post-harvest management

Non-seasonal rains play a crucial role in the harvest and subsequent yield of maize as in any other crop, which is a similarity with the mainland India. Post-kharif and rabi crops do not face any such problem when the harvest can be done at the normal cob moisture levels, unlike the pre-kharif and kharif sown maize that mature during the rainy season. Harvesting on rainy days should be avoided and before storing it must be ensured that cobs are well dried. Maize cobs are generally hung tied together in bunches in sheds or indoors with low moisture (20 to 25 per cent) to prevent incidence of stored grain pests and rotting. Stored cobs should not be exposed to rain or high humidity. Maize yields at the farmers' level ranges from 8 to 20 q ha^{-1}. Despite all odds there exist great promise of achieving enhanced yields.

The 'food security' factor

From the preceding sections one cannot assess the latent reasons for the farmer's persistence with the maize crop despite not so encouraging economic returns per unit area (returns of approximately Rs. 4000/- (US$ @80) per hectare per season)). Sikkim is a region with an entirely mountainous terrain with deep valleys and steep slopes. The steeply sloping side slope (> 50 per cent) covers an area of 43 per cent and rest land has slopes in the range of 15 to 33 per cent (NBSS&LUP, 1992). If the USDA Land Capability Classification were strictly implemented, most of the land would fall under the Categories IV to VIII, rendering the land unsuitable for any kind of cultivation. Yet, 14.73 per cent land is cultivated, of which majority land under the plough has more than 50 per cent slope. As stated earlier, maize occupies 38 per cent of the land under cultivation. While the efforts of Government of India to introduce non-traditional crops (like rapeseed and mustard, safflower and even wheat to a certain extent) have gained ground in a non-traditional area like Sikkim, maize has held its forte. Just not that it is the only crop that has garnered acreage progressively over the last three decades. This perhaps can be related to its ability to generate enough yields weathering all climatic aberrations. Maize instills an assurance of food security amongst the farming community because of its earlier stated capacity and insurance against crop failure through returns from the intercrops.

Technological interventions towards raising future production levels

The low yield levels of maize can be attributed to an assortment of reasons, genetic degradation of varieties by inbreeding and outcrossing, partial or non-implementation of recommended cultural practices such as planting geometry, optimum plant population, soil acidity and nutrient management, disease and pest management, and soil conservation measures.

Farmers themselves can prevent the degeneration of the quality of the local/traditional planting material and bring about improvement in quality and yield levels by adopting simple procedure of selection of plants for seed purpose. The standard planting geometry must be followed that will ensure appropriate plant population. Emphasis has to be laid on identification and selection of matured cobs at harvest from outstanding plants of medium height, strong erect stalk, disease and insect-pest free, two fully developed cobs that have complete husk cover and others. Border rows must be excluded for this purpose. Number of plants selected should be 20 to 30 per cent more than the actual seed requirement of the next year's sowing. Selected cobs must be healthy, flint or semi-dented, uniform in colour, big in size that are free from disease, insect-pests and rotting. During storage care must be taken to keep the seed material very dry and free from diseases and stored-grain pests. Since maize is highly cross-pollinated plant with a wealth of genetic variation the selection of seed material every year will not only avoid degeneration but also substantially improve their yield potential by two to five per cent. This will also serve as a seed bank leading to the conservation of the traditional cultivars' germplasm. Identification of the right variety suitable for majority maize growing area of Sikkim preferably composites too needs immediate attention. Annual replacement of seeds in the case hybrids could lead to lower level of adoption by the farmers though some hybrids have shown good performance in the last few seasons. The farmers have expressed dissatisfaction with the loss in the quality of hybrid seeds during storage.

Transfer of technology regards the use of proper cultural, soil acidity and fertility management practices and insect-pest management, line sowing along the contours among other like planting geometry specification must be continuously disseminated delay. It must also be ensured that these practices are strictly adhered to. The practice of intercropping or relay cropping of N-fixing beans or pulse-type beans must be continued. This will lead to accretion of valuable nitrogen and increase the yield of the main crop maize. Maintenance of right plant population is mandatory for realizing reasonable yields. Having an effective marketing organization in addition to a facility for value addition and product diversification can serve as an incentive for further addition to the productivity.

Upgrading existing cultural practices

In view of the rising costs of chemical fertilizers coinciding with reduction in the subsidy, judicious use of this costly input gains further relevance. Farmers in Sikkim tend to apply varying quantities of fertilizers in combination with improper cultural practices that result in low yields. The ideal practice would be to grow maize with optimum application of manure and fertilizers under correct cultural practices resulting in higher net returns per unit area. Other shortcomings in the cultural operations involve avoiding systematic planting geometry, intercultural operations and weed management. Planting maize in furrows along the contour, adequate management of acidity, maintenance of optimum plant population, intercropping and integrated nutrient management would result in higher economic returns. Since majority of the maize cultivated are traditional varieties it is imperative to ascertain their commercial value. As this crop has a role of livelihood component it is necessary to diversify the traditional subsistence agriculture to include more remunerative crops.

Utilization

Versatility of maize grains is very well known. Four different types of maize are grown in Sikkim viz., regular, sweet corn, popcorn and baby corn. In Sikkim though the acreage and productivity is low when compared with other maize producing states in India and other countries, the local uses are many. As staple food maize grains broken on a stone grinder and hand-pound is consumed as rice or mixed with rice in a 50:50 ratio. The green cobs are consumed extensively as the main food both in the roasted and steamed forms. The green cobs harvested at the milk stage are ground to make '*chapatis*' or local bread. It is also used to brew local liquor either solely or in combination with millet. '*Sattu*' or '*champa*' prepared by grinding maize to powder form alone or with wheat and/or barley, and considered to be highly nutritious is consumed along with tea and also used as infant food. Dry grains are partially roasted in oil and then hand-pound into thick cup-shaped form and eaten with hot tea. It is also used to extract corn oil. Popcorn is also produced. The cobs with coloured grains have aesthetic value and can be used for indoor decoration.

Conclusion

Maize has been an important field crop in Sikkim from time immemorial as documented by pioneers like Thapa (1966) and Singh (1977) and the maize-based cropping system has withstood the test of time. The introduction of the high yielding varieties though has ushered in a new era and hope, farmers in Sikkim must realize that these will definitely reap rich harvests only when the recommended crop management practices are strictly adhered to. This includes integrated nutrient management wherein optimum levels of nutrients are supplied and amelioration measures are adopted to manage the soil acidity. Sikkim is bestowed with climatic conditions that are suited to produce highest maize yields. While efforts are on to replace the traditional low yielding varieties it is also very essential to conserve the traditional genepool of the state for crop improvement programmes. *Murli* maize, a popcorn variety with multiple cobbing characteristics that could have been exploited for achieving higher yields at the national level has almost vanished from the farming scenario of Sikkim.

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DEGRADING ENVIRONMENT AND GROWING POPULATION OF THE INDIAN HIMALAYA

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INTRODUCTION

The Himalaya, lying in Indian sub-continent, constitutes one of the greatest and youngest folded mountain systems in the world rising from about 300 m to more than 8000 m above sea level. It is a mountain region of majestic grand-eur and high geographical significance. It acts as protector, regulator and creator of natural resources, climate and soil. The rapidly increasing population, settlement and development are exhibiting environmental transformation in the form of deteriorating environment, depletion of natural resources and conditions of poverty. There has been large scale deforestation, overgrazing and expansion of agriculture on forest and marginal lands, resulting in micro – climatic changes, loss of wild life, change in water level and river regions, soil erosion, flood and landslides, all of which brought about hardships increasing environmental degradation in the ecologically fragile and geologically sensitive Himalayan region. Increasing population is not sole responsible factor; while less enlightened government and non-government agencies and unawareness of the people are equally liable for this degradation process.

The Himalaya, which plays a vital role not only in Indian but also in sub-continental economy, is in the grip of environmental degradation. Aspects of population, which are highly correlated with it, are discussed here. Figures pertaining to demographic scenario are based on Census 1991 and 2001, and overview regarding the environmental stress is based on published works.

About the Himalaya

The Himalaya makes the northern boundary of India extending from eastern border of Pakistan to the western frontiers of Myanmar having a length of about 2500 km and width of about 160 to 400 km. Extending between $70^0$47' and $97^0$22' east longitudes and $21^0$57' and $37^0$15' north latitudes, the Himalaya encompasses an area of about 5,17,733 km^2, *i.e.,* 15.75% of the area of the country. Administratively, the Indian Himalaya is divided into three broad regions - the Western Himalaya, consisting the states of Jammu and Kashmir and Himachal Pradesh, includes illegally occupied areas by Pakistan and China. The Central Himalaya consists of Uttaranchal, and the Eastern Himalaya comprises the states of Sikkim, Arunachal Pradesh, Mainpur, Tripura, Mizoram, Nagaland and hill districts of Assam and West Bengal. It is worth to mention here that the Himalayan region of West Bengal Hills consists of Darjeeling district only and the Assam Hills consists of the districts of North Cachar and Karbi Anglong. About 15% area of the Uttaranchal state (partially plains of Dehradun, Pauri, Nainital and fully plains of Haridwar and Udham Singh Nagar) is below 600 meters, *i.e*., continuation of Indo-gengetic plain, tarai and Bhabar.

From the northern boundary of the alluvial plain to the extreme north upto the Indian boundary, the Himalaya is divided into several geo-tectonic divisions - the Outer Himalaya (Siwaliks, Duns, Dwars, Tarai and Bhabar), the Lesser Himalaya having a number of fertile river valleys, the Great Himalayas, a zone of high snow peaks, glaciers and source of several rivers, and the Trans Himalaya a region across the Himalaya (rain shadow zone). These latitudinal divisions are separated from one another by thrusts and faults such as Himalayan Frontal Fault (H.F.F) extending between the Siwaliks and the Bhabar, Main Boundary Thrust (M.B.T) lying between the Siwaliks and the Lesser Himalaya, Main Central Thrust (M.C.T.) separating the Lesser and the Great Himalaya and Trans Himadri Thrust (T.H.T) lying between the Great and the Trans Himalaya. The total population of the Indian Himalaya is 4,03,11,039 persons in 2001 accounting for about 3.92% population of the country.

Degrading environmental profile

With the alarming devastation caused by massive landslides, accelerating soil erosion, reduced soil productivity, drying up springs, frequent earthquakes and uncontrolled floods, the Himalaya is facing

a number of environmental hazards, which are manifestations of ruthless deforestation, rapid growth of population, negligence of administration and unawareness of the society on environmental issues.

The Himalayan rivers are eroding catchment areas at the mean rate of 0.1 cm per year, i.e., 100 cm in 1000 years, which is five times faster than it was in recent geological past (Menard,1963). The Ganga alone at Kolkata carries annually 411 m.t. of sediments (324 m.t. in suspended state and 83 m.t. as dissolved chemical load), implying erosion in the catchments at a rate of 549 t/km^2/yr (Abbas and Subramanian, 1984). The construction of 44000 km road in the Himalaya generates about 2640m^3 of debris (Valdiya, 1985). About 39% of the road bed is affected by rockfall and 38% by slamping, i.e., about 24 debris chutes/km^2 (Haigh *et al*., 1989). At the average rate of 550 m^3/km/year the total landslide debris on Himalayan roads would be of the order of 24 m.m^3 annually (Valdiya, 1987). Haigh (1984) discovered 72 landslides larger than 10 m^3 and total landslides sediment yield of 1105 m^3/km along 66km reach of Mussoorie-Tehri road in 1978. It is well known that the whole Himalaya is dissected by various faults and thrusts. These areas are vulnerable for landslides, slumping, mass wasting, etc. Similar micro studies have been conducted by several other geologists and geographers in the Himalaya.

The Himalaya also suffers from overgrazing problem. For instance, this incidence in Uttaranchal Himalaya is 2.4 to 4.5 times higher than the carrying capacity of forest (Singh and Saxena, 1980). The annual depletion of forest is amounting to 3.76 million m^3 per year, i.e., at the rate of 5.8% per year (Shah, 1985). An interpretation of land imagery indicates that only 28.7% of Indian Central Himalaya is now forested and only 4.4% of the area has a forest with greater than 60% crown density (Singh *et al.,* 1984). Maximum land degradation occurs in the civil forest areas because of uncontrolled and unscientific anthropogenic activities. The degradation of forest has accelerated soil erosion and tragic landslides in an unprecedented manner (Bahuguna, 1981) and floods in the adjoining plains (Reiger, 1981; Ashish, 1983). It is estimated that out of the total net sown area of 7.32 x 10^5 ha, about 6.40 x10^5 ha of agricultural land suffers from severe erosion problem (Shah, 1982). The land used for agriculture is gradually being lost (Reiger, 1981). It is predicted that at the rate of 3.9 quintals per capita consumption, the carrying capacity of forest will overreach by 2031 AD (Shah, 1982). There is a perceptible decrease in spring discharge and seepage in more than 40% of the villages in *Gaula* catchment of Kumaun Himalaya. The extent of this decrease is between 25% and 73% in the past 5 to 50 years (Valdiya and Bartarya, 1991). The water discharge of the river Dabka in Kumaun Himalaya has decreased by 39.45% during the period of 1976-80. If this decrease continues for next 15 years, many such streams would be dry except in the monsoon seasons (Pant and Jalal, 1992). Evergrowing of population is leading to more farming and the cultivated area and the cattle population is increasing at the rate of 1.5% and 0.18% per year, respectively (Shah, 1982).

The carrying capacity of the Himalaya is decreasing day by day due to the heavy pressure of both human and livestock population. A large number of youths from the central Himalaya are migrating to other more developed parts of the country (Pant, 1992 and 1994).

A majority of the rural people does not get sufficient nutrition in their diet; consequently they suffer from nutrition deficiency related diseases (Pant 1994, 1996 and 1998). The largest number of epicenters is located in the Himalayan belt where the strongest seismicity is attributed to the movements along the MBT and MCT (Valdiya, 1992). The Himalaya falls under the 4th and 5th maximum intensity earthquake prone zone. The change in micro climate is also noticed in the Himalaya. The glaciers are receding very rapidly. A number of vegetational and wild animal species are in the endangered stage. Environmental hazards are not merely natural disasters but the result of increasing human activities and less visionary or plannings of the development agencies.

Demographic profile

Based on 1991 and 2001 Censuses, the present study highlights the changing scenario of population structure of the Himalaya. Nepal and Bhutan could not be studied as desired due to non-availability of reliable and complete data. Basically, the present study is worked out with the help of 1991 and 2001 Censuses in Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Sikkim, Arunachal Pradesh, Nagaland, Mizoram, Tripura, Manipur and Hills of Assam and West Bengal (see notes at the end).

Distribution

The distributional pattern of the population structure differs from one place to another. These sectoral aspects are particularly determined by the environmental conditions which have both restrictive and permissive connections to human activities. Mostly the population of the Himalaya is concentrated in Tarai, Bhabar, Duns, Dwars and lower valleys of the rivers, owing to their favourable environmental conditions such as conducive climate, availability of drinking water, fertile soil, well irrigational provisions and infrastructurally more developed nature while the mountainous parts possess adverse conditions and are sparsely populated. According to the 2001 Census, Jammu and Kashmir has the largest population accounting to 0.98% of the country's population. Uttaranchal with a population of 84,79,562 persons, accounting to 0.83% of the country's population, has the second largest population. Sikkim with a population of 5,40,493 persons, accounting to 0.05% of the total population of the country, has the smallest population. Mizoram has a population of 8,91, 058 accounting for 0.09% of total population of India (Table 1).

Table 1: Country's population in the Himalayan States.

S.No.	State/Region	Percentage of country's population		
		1981	1991	2001
1.	Jammu and Kashmir	0.88	0.92	0.98
2.	Himachal Pradesh	0.63	0.61	0.68
3.	Uttaranchal	0.85	0.84	0.83
4.	Sikkim	0.05	0.05	0.05
5.	Arunachal Pradesh	0.09	0.10	0.11
6.	Nagaland	0.11	0.14	0.19
7.	Manipur	0.21	0.22	0.23
8.	Mizoram	0.07	0.08	0.09
9.	Tripura	0.03	0.33	0.31
10.	Assam Hills	N.A.	0.40	0.39
11.	West Bengal Hills	0.15	0.16	0.16

Source: Anon. 1991 and 2001. (Vide Note given in the end).

N.A. Stands for not available.

Table 1 shows the similar pattern of population distribution during 1981, 1991 and 2001.

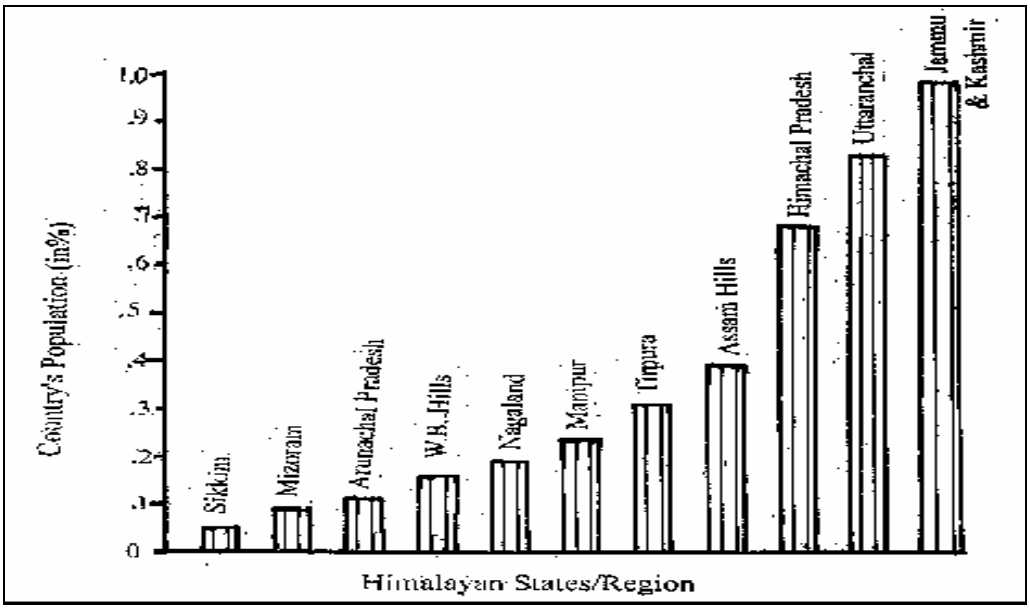

Figure 1. Country's population in the Himalayan states/regions, 2001

Growth and density

The Indian Himalaya has registered 24.75% growth during the 1991 to 2001 which is higher than the country's average (21.34%). Among the Himalayan states, Nagaland registered maximum (64.41%) growth during this decade which is far above the national average. Baring Manipur, Nagaland and Sikkim, decadal growth has declined in all other states of the Indian Himalayan Region (Table 2). In case of Manipur, Nagaland and Sikkim, it has gone up, respectively, from 29.29%, 56.08% and 28.47% in the previous decade to 30.02%, 64.41% and 32.98% in the current decade (Table 2).

Table 2: Growth and distribution of population

S. No.	State/Region	Population (number)			Growth (%)		
		1981	1991	2001	1971-81	1981-91	1991-01
1.	Jammu & Kashmir	5987398	7718700	10069917	29.59	30.34	29.04
2.	Himachal Pradesh	4280818	5111079	6077248	23.71	20.79	17.53
3.	Uttaranchal	5725972	7113483	8479562	27.45	24.23	19.20
4.	Sikkim	316585	405505	540493	N.A.	28.47	32.98
5.	Arunachal Pr.	631839	858392	1091117	35.15	36.83	26.21
6.	Nagaland	774930	1215573	1988636	50.05	56.08	64.41
7.	Manipur	1420953	1826714	2388634	32.46	29.29	30.02
8.	Mizoram	493757	686217	891058	53.16	39.70	29.18
9.	Tripura	2053058	2744827	3191168	31.91	34.30	15.74
10.	Assam hills	N.A.	3294770	3987306	N.A	N.A.	21.02
11.	W.B. Hills	1024269	1335618	1605900	N.A.	26.91	23.54
Himalaya		N.A	32310878	40311039	N.A.	N.A.	24.75
India		6813329097	846387888	1027015247	N.A.	23.86	21.34

Source: Anon, 1991 and 2001.

The main cause of this growth in population in Manipur, Nagaland and Sikkim is immigration from the less developed areas, it may be national or international. The growth of population in Himalayan states of Himachal, Uttaranchal and Assam Hills, has recorded growth lesser than the national average (Table 3).

Table 3: Distribution of districts by ranges of percentage decadal growth in the Indian Himalaya, 1991-2001

Ranges of Decadal (%) Growth	India		Himalaya	
	No.	Percentage	No.	Percentage
<10.00	58	9.78	7	7.70
10.00-19.99	203	34.23	25	27.47
20.00-29.99	240	40.47	29	31.87
30.00-39.99	61	10.30	19	20.88
40.00-49.99	12	2.02	3	3.29
50.00+	19	3.20	8	8.79
Total	593	100.00	91	100.00

Source: Anon, 2001.

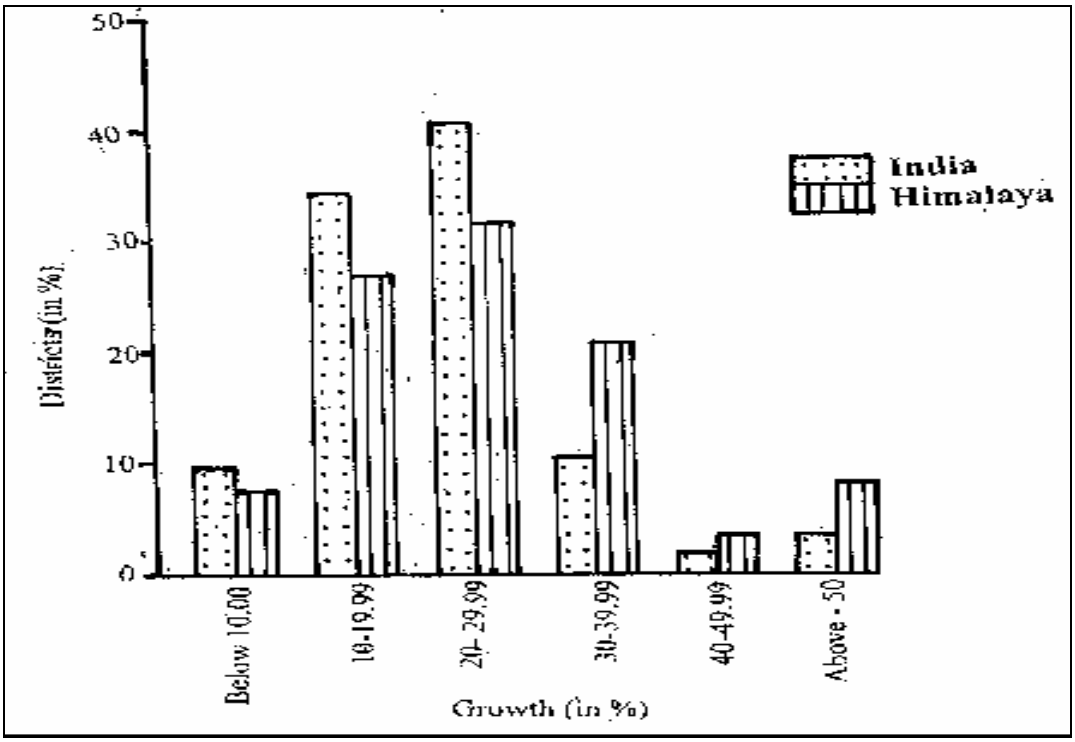

Figure 2. Distribution of districts by ranges of % decadel growth in Himalaya and India, 1991-2001

Table 3 gives the distribution of the districts in each state of Himalaya and India by the ranges of percentage decadal growth during 1991-2001. Out of the total 7.7% districts of the Himalaya and 9.78% districts of India have registered decadal growth rate less than 10%. Maximum 74.70% districts of India and 59.34% districts of the Himalaya have registered 10 to 29.99% growth during the decade of 1991-2001. About 3.20% and 8.79% districts in the country and the Himalaya, respectively, have registered high growth rate more than 50%. Among them as many as five districts belong to Nagaland state itself.

In the Indian Himalaya the density (No. of persons/Km^2) increased from 62 in 1991 to 78 in 2001. This means that the pressure in the Himalaya has increased by 16 persons/km^2 during the decade. However, the population density in the Himalaya is far less than that of the country. It is because of the rugged topography and adverse climatic conditions and most of the area is not suitable for human habitation.

According to the 1991 and 2001 Census, West Bengal Hills has the highest density 413 and 510 persons/ km^2, respectively (Table 4). Since the district of Darjeeling is a tea producing and tourist area, the population pressure is always high. During the decades of 1981, 1991 and 2001, the Himalaya witnessed the increasing trend in population density. The population density in the Himalaya ranges minimum from 13 persons/km^2 in Arunachal Pradesh to maximum 510 persons/km^2 in W.B. Hills (Table 4).

Sex ratio

The analysis of sex ratio reveals the numerical relationship between women and men, and is expressed as number of females per thousand males. A ratio of 1000 indicates equal balance of males and females in the population, less than 1000 denotes deficit of women (low sex ratio), and more than 1000 indicates numerical surplus of women (high sex ratio) in the population. The sex ratio of the Himalaya is 933 in 2001, which is equal to national average (933). The provisional results of census 2001, indicates an increase in the sex ratio (933) in comparison to the previous census (918) in the Himalaya. Total sex ratio ranges between 875 in Sikkim state to 970 in Himachal Pradesh in 2001. Out of the total 11 states in the Himalaya, 9 states have shown improvement in sex ratio in comparison to previous Censuses (Table 4).

Table 4: Density and sex ratio in the Indian Himalaya

S. No.	Stage/Region	Density (persons/km^2)			Sex ratio (females/1000 males)		
		1981	1991	2001	1981	1991	2001
1.	Jammu & Kashmir	59	77	99	892	896	900
2.	Himachal Pradesh	77	93	109	973	976	970
3.	Uttaranchal	109	133	159	920	936	964
4.	Sikkim	45	57	76	835	878	875
5.	Arunachal Pradesh	8	10	13	862	859	901
6.	Nagaland	47	73	120	867	886	909
7.	Manipur	64	82	107	971	958	978
8.	Mizoram	23	33	42	919	921	938
9.	Tripura	196	263	304	946	945	950
10.	Assam hills	N.A.	148	179	N.A.	930	935
11.	West Bengal Hills	325	413	510	888	914	943
	Himalaya	N.A.	62	78	N.A	918	933
	India	216	267	327	934	927	933

Source: Censuses of India, 1981, 1991 and 2001

It is evident that 26.98% of the total districts of India have sex ratio of below 900 (Table 5). Similarly 23.08% of the total Himalayan districts have low sex ratio, i.e., less then 900 females per 1000 males. It is seen that 13.15% districts at national and 14.28% at Himalaya have recorded high sex ratio. The largest number of such districts in Himalaya is from Uttaranchal (8) followed by Himachal (3) while Manipur has two districts in this category. It is noteworthy that those districts having more urban population have recorded low sex ratio due to the male immigration in these districts from the less developed districts while the districts having more rural area/population have recorded high sex ratio due to out migration of males to more developed places in search of employment (Pant, 1995).

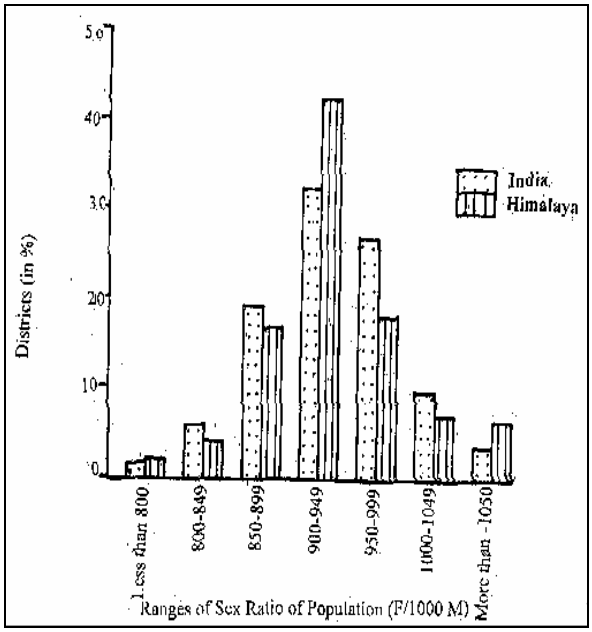

Figure 3. Ranges of sex ratio of population (F/1000M)

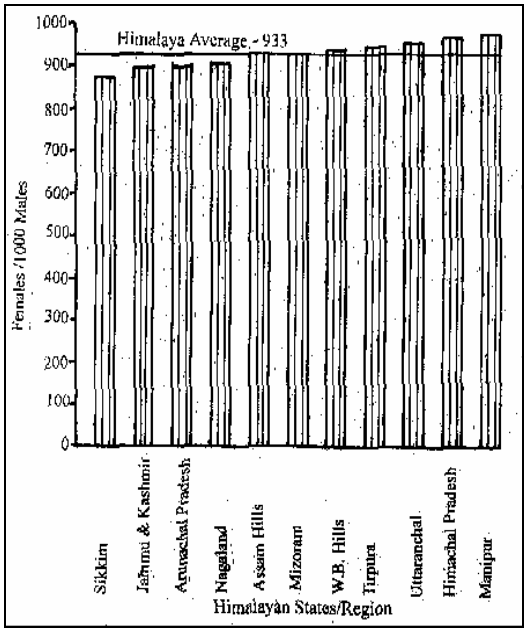

Figure 4. Sex ratio in the Himalayan states, 2001

Table 5: Distribution of districts by ranges of sex ratio of population in the Indian Himalaya, 2001.

Ranges of sex ratio (F/1000M)	India		Himalaya	
	Number	Percentage	Number	Percentage
Less than 800	8	1.35	2	2.20
800-849	34	5.73	4	4.40
850-899	118	19.90	15	16.48
900-949	194	32.72	40	43.96
950-999	161	27.15	17	18.68
1000-1049	58	9.78	7	7.69
1050+	20	3.37	6	6.59
Total	593	100.00	91	100.00

Source: Anon, 2001

Literacy

Literacy is one of the important social aspects on which information is obtained on every individual in Census. For the purpose of Census 1991 and 2001 a person aged seven and above, who can both read and write with understanding any language is treated as literate. Table 6 shows the literacy rates for the year 1991 and 2001. Like India, the whole Himalayan region has had an expected progress in the literacy aspect during 1981 to 1991 and 1991 to 2001. Maximum literacy rate was found in Mizoram (88.49 %) where 90.69 % male and 86.13% females are literate which is quite higher than the national and Himalayan averages. It is due to the educational programmes launched by the missionaries from the earlier days of independence. Out of the total states in the Himalaya, eight states - Himachal Pradesh (97.13%), Uttaranchal (72.28%), Manipur (68.87%), Nagaland (67.11%), Sikkim (69.68%), Tripura (73.66%), Mizoram (88.49%) and West Bengal Hills (72.87%) have registered higher literacy than the national average (65.37%). The literacy percentage in Jammu and Kashmir (54.46 %) and Arunachal Pradesh (54.74%) is quite lower than the Himalaya (69.44 %) and national average (65.37%).

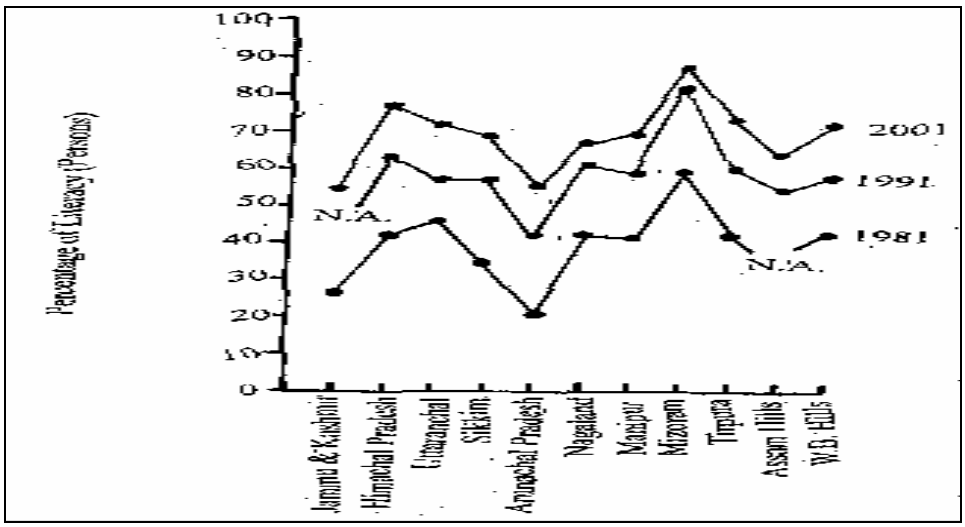

Figure 5. Percentage of literacy (persons) in the Himalaya, 1981 to 2001

The highest proportion of male literates has been observed in Mizoram (90.69%) followed by Himachal Pradesh (86.02%). Other three states with more than 80% male literacy are Uttaranchal (84.01%), Tripura (81.47%) and West Bengal Hills (81.28%). On an average in Himalaya, the female literacy at the 1991 Census was very low (49.19%). The same has now gone up to 60.79% in 2001. In fact, the improvement in female literacy has been faster (11.6% points) than that of males (8.16% points) and total persons (9.8% points). However it is lesser than the nation (persons 13.16, males 11.72 and females 14.8% points).

Mizoram with 86.13% female literacy leads among all states in the Himalaya followed by Himachal (68.08%) and Tripura (65.41%) in female literacy. Jammu and Kashmir has the lowest percentage of female literates (41.82%) followed by Arunachal Pradesh (44.2%) and Assam Hills (55.73%). Female literacy is one of the important indicators of social development.

Table 6: Literacy by sex in the Himalaya (%)

S.N.	State/region	1981	1991			2001		
		Person	Person	M	F	Person	M	F
1.	Jammu & Kashmir	26.66	N.A.	N.A.	N.A.	54.46	65.75	41.82
2.	Himachal Pradesh	42.47	63.86	75.36	52.13	77.13	86.02	68.08
3.	Uttaranchal	46.06	57.75	72.79	41.63	72.28	84.01	60.26
4.	Sikkim	34.05	56.94	65.70	46.76	69.68	76.73	61.46
5.	Arunachal Pradesh	20.78	41.59	51.45	29.69	54.74	64.07	44.24
6.	Nagaland	42.57	61.65	67.62	54.75	67.11	71.77	61.92
7.	Manipur	41.36	59.89	71.63	47.60	68.87	77.87	59.70
8.	Mizoram	59.88	82.27	85.61	78.60	88.49	90.69	86.13
9.	Tripura	42.12	60.44	70.58	49.65	73.66	81.47	65.41
10.	Assam hills	N.A	54.06	63.77	43.25	64.58	70.85	55.73
11.	W.B. Hills	42.47	57.95	67.07	47.84	72.87	81.28	63.92
	Himalaya	N.A	59.64	69.16	49.19	69.44	77.32	60.79
	India	43.57	52..21	64.13	39.29	65.37	75.85	54.16

Source: Anon, 1991-2001. M: Male, F: Female, NA: Not available.

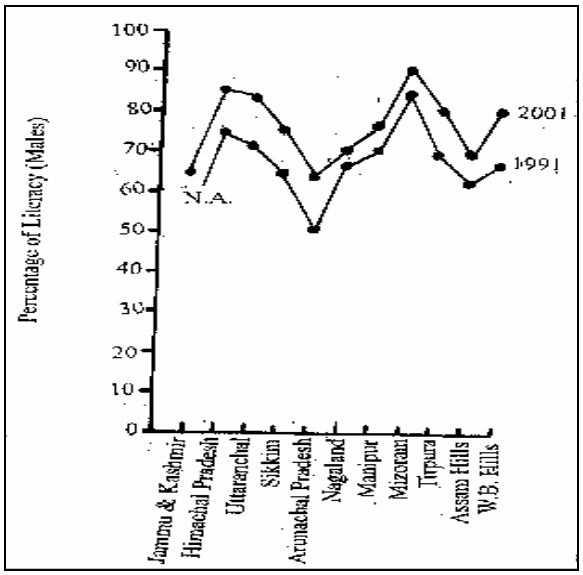

Figure 6. Male literate (%) in the Himalaya, 1991 & 2001

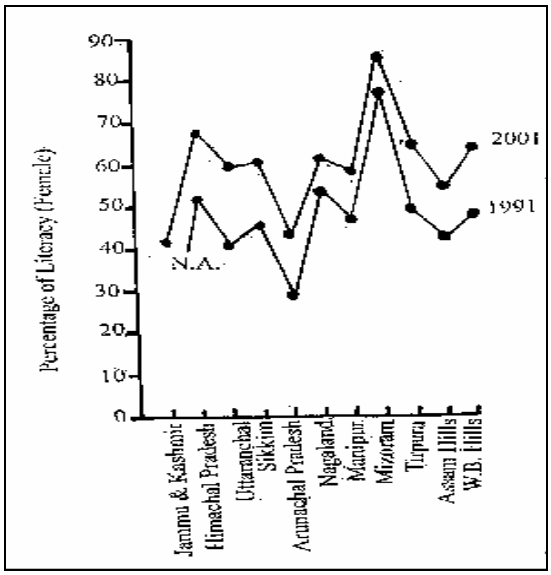

Figure 7. Female literate (%) in the Himalaya, 1991 & 2001

Tables 7 to 9 give the distribution of districts in different ranges of literacy rates for persons, males and females at the national level and the Himalaya. About 4.4% districts in the country and 1.11% of districts in the Himalaya are having literacy rates below 40%. It is observed that out of total districts of the country and the Himalaya, 35.7% and 46.67% districts have registered more than 70 % literacy rates, respectively. About 9.98% and 14.44% districts in the country and the Himalaya have literacy rate of 80% and above, respectively. About 2.20% and 4.44% districts in the country and the Himalaya, respectively, have reported literacy rate of 90% and above. Four of these districts are located in the Mizoram state of Himalaya.

Table 7: Distribution of districts by ranges of literacy rates (persons) in the Himalaya, 2001

Ranges of literacy rate (%)	India		Himalaya	
	Number	%	Number	%
30.0 – 39.9	26	4.40	1	1.11
40.0 - 49.9	55	9.31	11	12.22
50.0 – 59.9	127	21.49	17	18.90
60.0 – 69.9	172	29.10	19	21.11
70.0 – 79.9	152	25.72	29	32.22
80.0 – 89.9	46	7.78	9	10.00
90.0 +	13	2.20	4	4.44
Total	591	100.00	90	100.00

Source: Anon, 2001.

There are 3.38% and 1.11% districts in the country and in the Himalaya, respectively, with male literacy rate below 50%. Among these one district falls in the Himalaya (Nagaland). Nearly 70.2% districts of the country and 66.67% districts of the Himalaya have reported male literacy of 70% and above (Table 8)

Table 8: Distribution of districts by ranges of literacy rate (male) in the Himalaya, 2001.

Ranges of literacy rate (%)	India		Himalaya	
	Number	%	Number	%
30.0 – 39.9	01	0.17	-	-
40.0 -49.9	19	3.21	01	1.11
50.0 – 59.9	46	7.78	13	14.44
60.0 – 69.9	110	18.61	16	17.78
70.0 – 79.9	190	32.15	19	21.11
80.0 – 89.9	195	33.00	32	35.56
90.0 +	30	5.08	9	10.00
Total	591	100.00	90	100.00

Source: Anon, 2001.

Table 9 gives distribution of districts by the different ranges of female literacy rate. Nearly 7.62% and 5.56% districts in the country and in the Himalaya, respectively, have female literacy rates below 30%. About 42.81% districts of the country and 34.44% districts of the Himalaya have registered female literacy rate below 50%. (Table 9).

Table 9: Distribution of districts by ranges of literacy rate (female) in the Himalaya, 2001.

Ranges of literacy rate (%)	India		Himalaya	
	Number	%	Number	%
10.00 – 19.9	2	0.34	-	-
20.00 – 29.9	43	7.28	5	5.56
30.0 – 39.9	81	13.70	10	11.11
40.0 - 49.9	127	21.49	16	17.78
50.0 – 59.9	138	23.35	16	17.78
60.0 – 69.9	118	19.97	24	26.67
70.0 – 79.9	59	9.98	13	14.44
80.0 – 89.9	16	2.71	4	4.44
90.0 +	7	1.18	2	2.22
Total	591	100.00	90	100.00

Source: Anon, 2001.

In the Himalaya, Mizoram, Himachal Pradesh, Uttaranchal, Nagaland, Manipur and Tripura have 7,5,2,1 and 1 districts, respectively, with female literacy rate of 70% and above. Only 1.18% of the country and 2.22% districts of the Himalaya (Mizoram) have reported female literacy rate of ninety percent and above (Table 9). Traditionally, there has been some bias against female education in the Indian society and until very recent past, education was not usually considered important for females. The spread of modernisation, urbanization and westernization associated with the notion of egalitarianism has contributed to reduction of disparity between the male and female literacy rates. However, regional disparities still exist. There is a high correlation between the male and female literacy rates. The districts with lower male literacy rate also tend to have lower female literacy rates. Generally it is also observed that districts with higher literacy rates have lower male-female disparity in literacy rates.

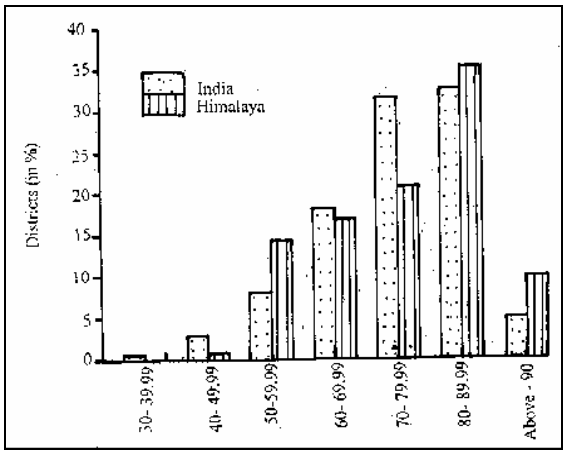

Figure 8. Distribution of districts by ranges of male literacy in Himalaya & India, 2001

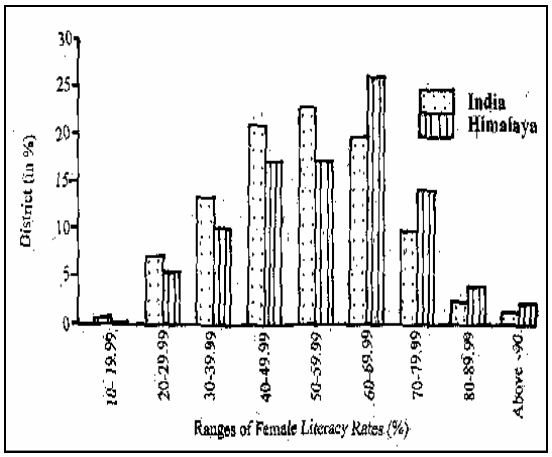

Figure 9. Distribution of districts by ranges of female literacy in Himalaya & India, 2001

Urbanisation

Urban population figures for 2001 Census are yet not published/available. Therefore the analysis is based on data available for 1991 Census. Most of the Himalayan states are witnessing a slow change in the ratio of rural urban population. The Himalayan region has mostly rural population, but steadily the developing towns are attracting large proportion of this rural population. Due to better infrastructural facilities tourism, trade and services in those small towns, immigration towards them has considerably increased.

Table 10: Rural-urban population in the Himalaya (%)

S. N.	State/Region	1981		1991	
		Rural	Urban	Rural	Urban
1.	Jammu & Kashmir	78.95	21.05	N.A.	N.A
2.	Himachal Pradesh	92.38	7.62	91.30	8.70
3.	Uttaranchal	79.70	20.30	76.90	23.10
4.	Sikkim	83.85	16.15	90.88	9.12
5.	Arunachal Pradesh	93.44	6.56	87.79	12.21
6.	Nagaland	84.48	15.52	82.72	17.28
7.	Manipur	73.57	26.43	72.31	27.69
8.	Mizoram	75.33	24.67	53.08	46.20
9.	Tripura	89.01	10.99	84.74	15.26
10.	Assam hills	N.A.	N.A.	90.36	9.64
11.	W.B. Hills	72.45	27.55	69.29	30.71
	Himalaya	82.32	17.68	80.01	19.91
	India	76.66	23.34	74.28	25.72

*Source: Anon, 1991. Data for 2001 are yet not published. * Excludes Jammu and Kashmir.*

Among Himalayan states, the maximum urban population is in Mizoram where 46.2% of total population was urban, followed by West Bengal Hills (30.71%) and Manipur (27.69%). The percentage of urban population of these three states is more than that of the nation (Table 10). There were some rural population dominated regions too, the more conspicuous being Himachal Pradesh, Sikkim, and Assam Hills where the percentage of rural population was above 90%. All the states of the Himalaya taken together has a urban population of 19.99% only. If was quite lower than that of the national average (25.72%). During 1981-1991, the states having high growth in urban population was Mizoram (160.27%), Arunachal Pradesh (152.98%), Tripura (85.75%) and Nagaland (74.74%), while the regions having moderate urban growth were West Bengal Hills (45.38%), Uttaranchal (45.34%), Himachal Pradesh (36.46%) and Manipur (34.73%). In Sikkim the urban population declined considerably (-27.60%).

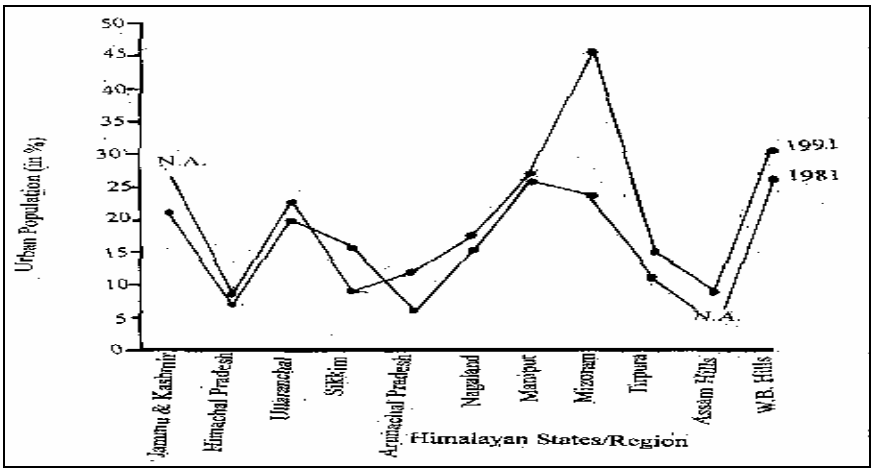

Figure 10. Urban population in the Himalaya

CONCLUSION

The study concludes that for the last many decades the Himalaya endures several environmental problems including soil erosion, deforestation, overgrazing, landslides, floods, siltation, decreasing soil fertility, drying of springs, increasing of slums, health hazards, *etc.* It can be suggested that all development efforts for the region should be made according to demographic traits and needs, and keeping in mind the availability of the resources and ecologically fragile and geologically sensitive nature of the Himalayan environment. A separate population policy should be framed for the Himalaya. Any approach adopted for planning in this region must consider the aspects of man and his environment.

There is an urgent need to improve the education status of the people particularly of females, which is too low in the Himalayan states. More employment generation programmes should be launched in the region. Local participation must be considered at the time of policy framing.

ACKNOWLEDGEMENT

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NOTES:

1. The population of India includes the estimated population of entire Kachchh district, Morvi, Maliya-Miyana and Wankaner talukas of Rajkot district, Jodiya taluka of Jamnagar district of Gujrat state and entile Kinnaur district of Himachal Pradesh while the literacy data are not included where population enumeration of Census of India, 2001, could not be conducted due to natural calamities.
2. The population figures for Jammu and Kashmir have been interpolated for the year 1991 as the 1991 Census could not be conducted in the state due to disturbed conditions.
3. The literacy rates for the year 1981 relate to the population aged five years and above while the year 1991 and 2001 relate to the population aged seven years and above.

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TRADITIONAL CONSTRUCTION PRACTICES IN THE SEISMICALLY ACTIVE AREAS OF UTTARANCHAL

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Himalaya is the youngest mountain chain of the world. It was evolved by the compressive intercontinental deformation due to the collision between Indian and Eurasian plate, during Cenozoic era (50 million year ago). The Himalayan mountain range is geodynamically very active, where some tectonic expands are still going on, and therefore, frequent occurrences of earthquakes cannot be ruled out. The area was visited by many earthquakes in the past (Valdiya, 1993). It has been observed that the earthquakes in Himalaya were mostly caused due to disturbances along areas of tectonic dislocation viz., along faults and thrusts. In such areas the rocks are already under stress, and are prone to further dislocation. Most of the earthquakes had their epicenter along the Main Boundary Thrust (MBT) and Main Central Thrust (MCT). The strain build-up in the central sector of the Himalaya has been relaxed several times by earthquakes of moderate or low intensity. All major thrusts extend longitudinally throughout the Himalaya and are quite deep. Rocks located on their both sides are under great stress due to continuous underthrusting of Indian plate. This accumulates the elastic strain because of continuous deformation along these thrusts. This elastic strain is fully or partly released by the earthquakes of moderate to high density. A great earthquake alone can release the enormous strain energy that is accumulated in the last hundred years (Yeats, R. S; 1998). Certain parts of Central Himalaya are not visited by any great earthquake in the recent past. Strain building up in these areas alarms an immediate threat of a great earthquake.

The present study is focus based on earthquake prone zone of central part of Indian Himalaya region (IHR) namely Uttaranchal state. The state mostly falls under seismic zone V of Bureau of India Standards (BSI), which is highly susceptible to earthquake disaster. On the basis of earthquake history of the region, emphasis has been give on traditional building architecture to mitigate this unavoidable natural hazard.

Earthquake in Uttaranchal

Uttaranchal state is located between 77^0 34' 27" E to 81^0 02' 22"E longitude and 28^0 53' 24"N to 31^0 27' 50" N latitude. Earthquakes regularly shake this region and several seismic events of M >6 are recorded in the last century. Leading scientific reports indicate that the next great Himalayan earthquake might occur in this region, as it lies in a seismic gap between the rupture zones of great historic earthquakes (Valdiya, 1993). The major earthquakes in the region in last century are:

16 June 1902 - East of Gangotri (Uttarkashi District), based on the damages on the buildings and other structures it was assumed that the magnitude of this earthquake was 6.0.

13 June 1906 - East of Gangotri (Uttarkashi District), there were minor damages due to this earthquake (M=6).

28 August 1916 - This was one of the major earthquakes in the region; the magnitude of this earthquake was recorded at various places in the range of 7.1-7.5. The epicenter of the of the quake was centered near Mount Api. It also caused extensive damages to masonry buildings at Dharchula, in the region bordering Nepal.

27 July 1926 - The epicenter of this earthquake (M=6.0) was located North of Baling, Pithoragarh District along Indo-China Border.

18 October 1927 – Another earthquake (M=6.0) was recorded at the same place as on 27 July 1926. The epicenter of this earthquake was situated near to the south of the Indo-China Border in Pithoragarh District.

28 December 1958 - This earthquake (M=6.25) occurred along MCT. The epicenter of this earthquake was located in the NE of Bageshwar town.

31 December 1958 – This was the resultant minor earthquake following the major earthquake on 28 December.

24 December 1961 - Indo-Nepal Border region (Nainital Districts), the intensity of this earthquake was recorded as 6.0.

13 July 1962 – The epicenter of this earthquake (M< 6.0) was located near to the NNE of Badrinath (Chamoli district).

14 July 1962 - East of Chamoli, earthquake of (M=6.0) may also be the result of the movement along the Main Central Thrust.

26 September 1964 – The epicenter of the earthquake (M= 6.2) was located NW of Dharchula (Uttaranchal), India.

27 June 1966 – This earthquake (M= 6.0) with epicenter at the East of Pithoragarh town caused moderate damages.

20 May 1979 –The epicenter of this earthquake was located near the village Dhamigaon, Pithoragarh district and the magnitude was about 6.0.

29 July 1980 –This was one of the most disastrous earthquakes in the region, which caused heavy damage to the community. The epicenter of the earthquake was located near the eastern part of the Uttaranchal, nearly 50-kilometer east of the Pithoragarh. The magnitude of the earthquake was recorded as 6.8. About 150 - 200 persons were killed and hundreds injured. Extensive damage occurred in several towns in western Nepal as well as in Pithoragarh district of India. The vibration of the earthquake was even felt at Kathmandu and New Delhi, places quite far away from the epicenter.

21 October 1991 – The epicenter of this devastating earthquake (M>6.8) was located near Pilang village (Uttarkashi District). About 750 to 2000 people were killed in the Garhwal region of Uttaranchal.

29th March 1999 –The activity along the MCT perhaps caused this earthquake (M=6.5). The epicenter of the earthquake was located near Gopeshwar (Chamoli District). About 115 people were killed in the Garhwal region due to this earthquake.

Building architecture

Perhaps the biggest irony of the moment is that earthquakes do not kill people but buildings do. Some high rise buildings plummeted into a concrete graveyard raising the stench of death. Any collapse would cause friction of metal leading to big boom. Experts say that there is a lesson to be learnt in this crying. All good constructions did witness the tremors, conceded no building can be made perfectly quake resistant. To perform well in an earthquake, a building should possess four main attributes, namely simple and regular configuration, adequate lateral strength, stiffness and ductility. Buildings having simple regular geometry and uniformly distributed mass and stiffness in plan as well as in elevation, suffer much less damage than building with irregular configurations. The key lies in strengthening the joints between the vertical columns and horizontal beams, around which reinforce cement concrete (RCC) structure are built. Building collapses when the joints come apart with beams falling over the columns. It just takes some extra steel to reinforce junction and make the building quake resistant. It is that elementary just like a piece of better tailoring. In terms of the bottom line, the additional investment is less than one percent of total.

The traditional construction practice of buildings in Uttaranchal is mainly in the form of random rubble stone masonry using undressed stones. The wall is made of two separate sections, outer and inner widths. The space between two widths is filled with stone rubble. Another practice is masonry work with slate wafers. The dressed stones and slate wafers are stacked lightly with very little or no mud mortar in between. This type of wall has a tendency to split and buckle into two separate widths due to lack of interlocking. However, the masonry wall with slate wafers performed better than those with random rubble masonry. The construction of brick or concrete block masonry with mud or cement mortar is newly introduced in rural and urban areas. The performance of such buildings has been, in general, better than that of the stone masonry buildings (Anonymous, 1999). Masonry works in buildings with lintel bands of cement concrete or wood performed in a better way. Various dwellings built in recent years in

villages and towns have R.C.C. lintel bands, which performed well during earthquake due to cross-linking of ties.

Performance of buildings during the earthquake events of Uttarkashi (1991) and Chamoli (1999)

A survey carried out of the Chamoli earthquake found that the structure with cross ties performed satisfactorily. In the earthquake prone Uttaranchal hills, folk wisdom places great emphasis on quality of construction. Apart from the proper selection of sites, the foundation was laid using the interlocking technique (*Jor-tor*) in which stones were wielded with one flat stone and the space between was filled with fine rock pieces. Similar attention was paid to the corners. No wonder many temples have managed to survive the quakes that shake the area routinely. The survey of the different parts of greater Himalaya indicated that the inhabitants constructed their houses with the designed anti seismic arrangement. They might be the sufferer of earthquake in the past, hence they applied indigenous technique of house construction. The building weight was distributed into different components with horizontal and vertical wooden beams embedded into the stone-masonry wall. Such type of structures can be seen in the entire hill region (photo on cover page) of Uttaranchal, *i.e*., Harshil, Dharali, Mukhba, Gunji, Kutti, Garbyang, Malari, Mana, Niti , Khati Jaitoli, etc. Due to this design some of the triple storied traditional buildings successfully survived several seismic shocks in the last century.

Disaster mitigation

Earthquakes are, perhaps, the most unpredictable environmental hazard. Despite several efforts by scientists across the world, successful prediction is not generally possible. Consequently, the protection of people against seismic hazard depends currently on the identification of especially perilous areas (active faults) and avoiding these as the sites of constructions, the development and enforcement of appropriate building codes, and the education and training of the population about in emergency procedures to be followed during and after the seismic shock. Some specific attention required to be taken care in this regard are:

- Disaster management plan specific to need of the rural and urban areas is to be formulated for the region.
- Disaster management plan should also consider people's perspective about hazard on a priority basis.
- Mitigate measures need to be taken up during the onslaught and also as the post disaster management measures.
- Topographical variations, which affect the seriousness of hazard, should also be considered under the disaster management plan.
- Awareness campaign should always be carried out from time to time with the help of local (villagers) and NGOs. The people should know in advance where they have to rush and carry the injured for treatment in case of emergency.
- Primary health center (PHC) must have the stock of medicines, which could be made available to the villagers in particular.
- The team of doctors and paramedical staff should be alert to meet the emergency at the district, *tehsil* and block levels, so that they could be asked to take action in case of any disaster.
- Mobile telephony or modern communication means map be provided in the region vulnerable to earthquake for better coordination of mitigation work.

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A SUCCESS STORY OF HAND PUMPS IN THE STATE OF UTTARANCHAL

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INTRODUCTION

In Nov 2000, 13 hilly district of Uttar Pradesh were excluded from it and were included in newly created 27th state of Indian Republic named as Uttaranchal. The state of Uttaranchal is bound in north & east by International boundary of Tibet (China) and Nepal, respectively, whereas western & southern boundary is being formed by the state of Himachal Pradesh and mother state Uttar Pradesh. Three sides are covered by mighty Himalayan range. The total geographical area of the state is 53485 km^2 (Samal *et al*., 2003) of which 65% is covered by forest. The population density is 159 persons/km^2 in 2001 (Nandy and Rao, 2001). The principal languages are Hindi, Garhwali and Kumauni. The tourism is the main attaraction of the state with a number of tourist/pilgrimage centers viz., Mussoorie, Nainital, Almora, Lansdowne, Badrinath, Kedarnath, Gangotri, Yamunotri, Hemkund, Valley of Flower, Corbett National Park, Dudhwa National Park, Rajaji National Park, Haridwar, Rishikesh, Ranikhet, Kausani, etc.

The holy Ganga (Bhagirathi) & Yamuna originate in Upper Himalayan region from Gangotri & Yamunotri, respectively, forming a vast Indo-Gangetic fertile plain. Besides, a number of important rivers viz, Ramganga, Kosi, Sarju, Kali, etc., originate from the high peaks of Himalaya. Himalayan ranges vary in height from about 300 meters to more them 7000 meters above mean sea level. The general pattern of drainage is transverse, i.e., from north to south, cutting deep valleys and gorges.

Geology

On the basis of elevation, complexity of physical features and geological chronology and structures, the Himalayan region can be sub-divided from south to north into the following three parallel zones:

(a) The outer Himalayas or Siwalik range
(b) The lesser Himalayas
(c) The Greater Himalayas

The Outer Himalayas (Siwalik)

Siwalik range is the youngest of the Himalayan ranges facing the plains towards south and running in a northwest-southeast direction (more in eastwest direction) passing through the northern parts of Saharanpur, southern portion of Dehradun and Garhwal and the middle portion of Nainital district. The width of the Siwalik zone varies from 6 to 30 km (wider in west and decreasing in width towards east). Its height above the mean sea level generally varies between 300 and 700 metre, but the crests vary in height between 750 and 1200 metres. The Siwalik ridges are largely forested. The rivers generally flow across the range through deep gorges. Beyond this range, towards north are flat longitudinal valleys or 'Duns' which separate it from the lesser Himalayas.

The Siwalik group of rocks are of Miocene to Pliocene age and are overlain to Bhabhar and Tarai belt of Quarternary to Recent age, occuring as elongated belt trending roughly in NW-SE direction, Bhabhar are followed by Tarai. These are consisting of cobbles, gravels, boulders, coarse sand and silt. The junction of Bhabhar with Tarai is marked by a spring line with flowing conditions. The major rock formations in Siwaliks are limestone, boulders, schist along with doon gravels & krol and infra krol belt.

The Lesser or Middle Himalayas

This zone extends in a varying width of about 60-90 km. (more than 100 km towards east) between the valleys and Siwaliks to the south and the Greater Himalayas to the north. In this zone, height, generally varies between 1000 and 3000 metres. Almora, Nainital, Pithoragarh, Mussoorie, Tehri, Ranikhet, Uttarkashi, Pauri, lansdowne Cantt and Srinagar are the important towns situated in this zone.

This region can be subdivided into the following two smaller physiographic regions: (a) The Himachal ranges, and (b) The Himachal Valley and Lake basins. Some of the most attractive features of the Middle Himalayas are its lake basins or Tals extending in a belt, about 25 km long and 4 km wide, in Nainital district. Besides the famous Nainital lake basin (which provides site for the famous Nainital town), there are other lake basins such as Bhimtal, Naukuchiatal, Sattal, Punatal, etc. On the basis of river basins separated by water dividing crests, this region can be divided into four sub-regions (which from west to east) : (1) Tons-Yamuna Basin (2) Bhagirathi-Alaknanda Basin (3) Ramganga-Kosi Basin and (4) Sarju-Kali Basin.

The Greater or Inner Himalayas (Himadri)

This is the oldest and the most complex of the young mountain series. This zone of the Greater Himalayas has a varying width of about 40-60 km. (the greatest width lying in eastern and western margins of Chamoli district, where it is about 70-75 Km). The Main Central Thrust of Himalaya separates it from the Lesser Himalayas. Its altitude above sea level, ranges generally from 3,000 to 8,000 metres. Except the lower valleys, this zone is always under snow cover. In this region, there are situated some of the highest and glaciated Himalayan peaks, of which Nanda Devi (7,817 m) is the highest. Some of the other high peaks include Kamet (7,756 m), Badrinath (7,138m), Trishul (7,120 m) and Dunagiri (7,066m). All of them including Nanda Devi lie in Chamoli. A few other important peaks are Chaukhamba (7,138 m), Kedarnath (6,940 m), Nandakot (6,861 m), Gangotri (6,614 m) and Bandar Punch (6,315 m). From the Gangotri glacier (5,611 m) and the Jamnotri glacier (6,315 m), both in Uttarkashi district, originate the most sacred rivers of India – The Ganga (known here as Bhagirathi) and the Yamuna (or Jamna).

Gangotri glacier, having a length of about 25-30 km. and width of 2 km is most important glacier of the Himalayas. Milam (19 km Long) is also an very important glacier of this region. Pindari, Kamet, Kedarnath and Jamnotri are among other glacier.

The middle Himalayas and the Greater or Inner Himalayas are the most complex young mountain series with middle Miocene to Lower Pleistocene age. The area is constituted by ligneous, metamorphic and meta sedimentaries group of rocks along with number of Thrust plane, faulted valleys, joints, etc. Tectonic complications are more severe in lower & higher Himalayas.

Objective of the study

For sustainable development of a society it is essential that the natural resources are made use of in a judicious manner for the benefit of not only existing population but also to meet the needs and aspiration of future generation. Drinking water is one such precious commodity for which a planned strategy is needed not only for immediate demands but for sustainability for future needs also. The hilly regions of Uttaranchal and the plain areas of Tarai & Bhabhar are endowed with vast reservoirs in the form of rivers, streams, springs, ponds & ground water. In the undulating hilly terrain of Himalayan region a number of perennial rivers and stream are available in abundance but all in the valley portion from which water can only be available, either, through gravity supply or through multistage pumping, increasing huge expenditure on public exchequer, whereas the major rural population are on high hills in scattered form with no water. Thus there is plenty of surface water, but it cannot be utilized.

About 90% of the rural population of this region depends upon the natural springs for their daily water demand. That is why the villages in the hills are clustered around the springs. In most of the time two or three villages share a spring. Much of the time and labour is consumed to fetch a pail of water. Due to natural or anthropogenic disaster, these springs are facing reduced discharge, thus, giving serious setback to water demand and supply of the region. Besides this due to population pressure, unplanned construction, change in landuse pattern, garbage disposal, etc., most of the springs are being contaminated along with declining of discharge.

Recongnising the urgent need for improved water supply and water management to 80% rural population of hilly region for the state of Uttaranchal a vast scheme was launched through U.N. International Water Supply and Sanitation Decade 1977. The idea of providing drinking water to the rural masses through deep bore India-Mark-II handpump was envisaged, which later came as a boon to the remotely scattered villages, those previously had no assured source of water or it was available in the

form of spring, which are either too far away or go dry in pre-monsoon period. Initially govt. and public response was not good but after the success of these handpump, the programme of handpump gained popularity and now there is a heavy demand from public and also from various agencies, which are involved for water supply, *i.e.,* Jal Sansthan, Jal Nigam *etc.*

Methodology for geohydrogeological investigation

In the hilly terrain of Uttaranchal, springs are facing reduced discharge giving serious setback to water demand and supply. In such a situation one has to depend on alternative source, i.e., ground water which moves out in the form of spring or seepage. Up slopes areas in general and very gentle slopes in particular, are conducive to develop good hydraulic gradient, adequate recharge and quicker movement of ground water. Colluvial and alluvial deposits retain and transmit significant amount of ground water. The toe of talus cones, alluvial fan, middle to lower part of ancient landslide debris fan, cross section of various lineaments, fault, contact between pervious & impermeable bed rocks, weathered zones, etc., are good location for the seepage zone and subsequently for ground water occurrence. Following methodology is suggested for location of H.P. points:

Carry out reconnaissance survey to identify various rocks, lithology & landform of the area.

(a) Measure the structural patterns (joints, fracture, cleavage etc.)
(b) Study & measure the existing drainage pattern, drainage texture and drainage anomalies along with pattern.
(c) Find out the thickness of weathered debris along with landslide zone and geomorphology of the area.
(d) Find out the vegetation cover type, vigour, morphologic & taxonomic, etc.
(e) Find out the soil, texture, moisture content etc.
(f) Use survey of India toposheet for annotation along with remote sensing data for identification of potential zones.
(g) Climate: Precipitation, temperature, evaporation, humidity etc.
(h) Surface water: Run off distribution, nature of surface water bodies.
(i) Quality aspect.

Role of ground engineers for identification of Hand Pump sites

In the year 2001 & 2002, U.P. Jal Nigam and Garhwal Jal Sansthan had requested M/s Ground Engineers (Roorkee office : Post Box 125, Roorkee) to carry out Geohydrological investigations in various districts. Viz. Dehradun, Rudraprayag, Pauri Garhwal, Tehri Garhwal and Chamoli of Garhwal Himalaya and Almora, Nainital, Pithoragarh, Bageshwar and Champawat of Kumaon Himalaya for selection of sites for the installation of Handpumps. On the request of various Executive Engineers of the respective districts a team of consultants, i.e., Geohydrologists and Civil Engineers visited the sites for detail field investigation. The districts wise point surveyed has been given vide annexure-I & II.

The study has revealed a good number of successful points in Garhwal & Kumaon Himalaya with a success rate of above 90%. From the success it can be concluded that India Mark-II hand pumps are the obvious answer to the mammoth problem of rural water supply. In order to serve its purpose following points must be followed:

1. The handpump must be installed at a focal point but away from the contaminated source so that village folk may be able to use.
2. Designing must be based on minimum discharge of 10-15 lpm taking into consideration the time required to get it recouped.
3. Hand pump should be installed @ one hand pump every 150 population.
4. For potability of the water, stray or domesticated animals should be kept away.
5. Quality assessment must be carried out for each and ever hand pumps along quality treatment.

CONCLUSION

Based on the investigation so far carried out in parts of Garhwal and Kumaon Himalayas it can safely be concluded that ground water can be successfully tapped through hand pump and small capacity tubewells. But before drilling a hand pump, proper spot wise hydrogeological investigation must be carried by making judiciously measurements of various structural units/landforms etc. All the

geohydrogeological investigations should be carried out by very competent hydrogeologists, who are well versed with the complex Himalayan geology and have keen aptitude in the field of ground water. Thus the socio-economic scenario can be elevated by enhancing hand pump scheme in various part of Himalaya. However due to frequent failure of rainfall, some of the handpumps may go dry during the lean period, for this an alternative source, i.e., roof top rain water harvesting, check dams and Kundi may also be adopted for water storage and ground water recharge.

Annexure - I
Details of Handpump Sites

Sl. No.	Distt.	Number of sites	Remark
1.	Dehradun	24	Garhwal Himalaya
2.	Rudraprayag	30	Garhwal Himalaya
3.	Pauri Garhwal	106	Garhwal Himalaya
4.	Tehri Garhwal	11	Garhwal Himalaya
5.	Chamoli	49	Garhwal Himalaya
6.	Nainital	6	Kumaon Himalaya
7.	Almora	3	Kumaon Himalaya
8.	Pithoragarh	10	Kumaon Himalaya
9.	Bageshwar	7	Kumaon Himalaya
10.	Champawat	8	Kumaon Himalayas

Note: As per feed back data from U.P. Jal Nigam & Jal Sansthan. The percentage of Success is above 90%. The discharge of Handpump vary from 10-25 lmp or more.

Annexure -II
Village wise details of Hand Pumps sites in Garhwal – Kumaon Himalaya

S.N.	Name of District	Village	Height above msl (m)	Number of sites	Remarks
1-3 (A)	**Dehradun**	Nagthat	2000	3	Garhwal Himalaya
4		Makhri	1600	1	
5		Purodi	2000	1	
6		Langa Pokhri	2000	1	
7		Manihar wala (Guniyal Gaon)	700	1	
8		Panjithlai	1500	1	
9		Phedu Lani	1800	1	
10		Dasau	1750	1	
11-15		Buraskhand	2450	5	
16		Tambudhar	2450	1	
17		Kaflni	2450	1	
18		Firclump	2158	1	
19-24		Mussoorie	2165	6	
1 (B)	**Rudraprayag**	Rudraprayag Tehsil	860	1	
2		Gulabrai Zila Panchyat	860	1	
3		Rudraprayag (Kudrat Jal)	860	1	
4		Rudraprayag (Petrol Pump)	860	1	
5		Ratura	820	1	
6		Gholtir	800	1	
7		Nagrasu	760	1	
8		Tilwara	764	1	
9		Sumadi (Near GIC)	876	1	
10		Sumadi Proper	876	1	
11		Agastya Muni	880	1	

12		Jawahar Nagar	820	1	
13		Chandrapuri	950	1	
14		Syalsaur (Bhatwari	827	1	
15		Guptkashi	1550	1	
16		Rampur	1880	1	Garhwal Himalaya
17		Soneprayag	1800	1	
18		Gaurikund	2079	1	
19		Bella	840	1	
20		Ratura	860	1	
21		Surnerpur	800	1	
22		Raintoli	1160	1	
23		Khankra	N.A.	1	
24		Ookhirnath	1600	1	
25		Bhiri	980	1	
26		Nagarasu	760	1	
27		Naugaon	N.A.	1	
28		Narayan Koti	1080	1	
29		Chopta	2680	1	
30		Agastya Muni-Vijai Nagar	743	1	
1(C)	**Pauri Garhwal**	Gawani	1000	1	
2		Liyakhal	1300	1	
3		Kimri Seriakhal	1300	1	
4		Ghiroli Pokhra	1650	1	
5		Masmauli	1300	1	
6		Beerokhal	1800	1	
7		Bajro	N.A.	1	
8		Sindauri	1400	1	
9		Parinda	1500	1	
10		Sunsi	1300	1	
11		Ghaniakhal	1820	1	
12		Gadai	850	1	
13		Pawo	600	1	
14		Champeshwar	800	1	
15		Bhoorpani	800	1	
16		Bela Bazar	950	1	
17		Seeko	1827	1	
18		Khatseeru Srikot	1674	1	
19		Patal	1341	1	
20		Parag Dairy	600	1	
21		Upldha	550	1	
22		Nilbarr	1214	1	
23		Peepal Pani	1611	1	
24		Jakchti	1605	1	
25		Nagar	1000	1	
26		Kandhar Pani	1200	1	
27		Bhati	1225	1	
28		Narasin	N.A.	1	
29		Baganikhal	950	1	
30		Danda Nagraj Temple	1000	1	
31		Margun (Harizan Basti)	650	1	
32		Khandukhal	650	1	

33	Saurn	540	1	
34	Kyarth	1470	1	
35	Dobhia Talla	1672	1	
36	Kandakhal	1500	1	
37	Muni Sakri	1200	1	
38	Paukhal	1100	1	Garhwal Himalaya
39	Sunargaon	800	1	
40	Devikhall	1200	1	
41	Devakhal	1500	1	
42	Sendhikhal	800	1	
43	Sirubari	600	1	
44	Dhauntiyal	570	1	
45	Dudharkhal	1520	1	
46	Gawana	600	1	
47	Mallukhal	1000	1	
48	Nanidanda	1500	1	
49	Sirala	1374	1	
50	Pawanpura	1427	1	
51	Dungli	1044	1	
52	Sondh Gadera	1705	1	
53	Bharakhal	1273	1	
54	Kaljikhal	1700	1	
55	Ranikhet	1840	1	
56	Ghandiyal Khal	140	1	
57	Satpali	1100	1	
58	Naugaonkhal	1750	1	
59	Pankhet	1550	1	
60	Verikhal	1000	1	
61	Devrajkhal	1700	1	
62	Choupatiya	1700	1	
63	Banekh	1400	1	
64	Dhadukhal	1100	1	
65	Bilkhet	700	1	
66	Kaiserpur	650	1	
67	Pattisain	600	1	
68	Naoniyakhet	1200	1	
69	Galikhal	1000	1	
70	Digolikhal	1200	1	
71	Kinalikhal	2000	1	
72	Khalyunkhet	1600	1	
73	Dhumakhot	1500	1	
74	Tildharkhal	NA	1	
75	Dadarnandi	NA	1	
76	Devikhal	NA	1	
77	Maita Kund	NA	1	
78	Jandadevi	NA	1	
79	Devrajkhal	NA	1	
80	Dabkhal	NA	1	
81	Lansdowne	NA	1	
82	Khundauli	NA	1	
83	Faldakot	NA	1	
84	Balsi	NA	1	

85		Satpali	NA	1	
86		Ringwadi	NA	1	
87		Rikhad	NA	1	
88		Biraukhal (PHC site)	NA	1	
89		Biraukhal (Market)	NA	1	
90		Rikhnikhal (Inter College)	NA	1	
91		Rikhnikhal (Dak Bunglow)	NA	1	
92		Chakuliyakhal	NA	1	
93		Binak	NA	1	
94		Bharet	NA	1	
95		Brigukhal	NA	1	
96		Boregaon	NA	1	
97		Kasiyali	NA	1	
98		Satpuli	NA	1	
99		Ruriagaon	NA	1	
100		Kaliasaur	NA	1	
101		Ekeshwar	NA	1	
102		Sakinkhet	NA	1	
103		Seeron	NA	1	
104		Ghamandpur	NA	1	
105		Maganpur	NA	1	
106		Nanidanda	NA	1	Garhwal Himalaya
107		Dumakot	NA	1	
1 (D)	**Tehri Garhwal**	Lachhmauli	520	1	
2		Ranihat Chauras	540	1	
3		Naithana Chauras	540	1	
4		Silkakhal	1650	1	
5		Thapali Chauras	550	1	
6		Sumadi Bhandar	700	1	
7		Lawadi	1236	1	
8		Tunet	950	1	
9		Hindolakhal	1300	1	
10		Chaka Palkot	1500	1	
11		Bhadrakali Mandir	650	1	
1-2 (E)	**Chamoli**	Gauchar	440	2	
3		Karanprayag (CNP Bend)	775	1	
4		Langasu	793	1	
5		Kaldu Samuh (Kaleshwar)	800	1	
6		Mallakhet	816	1	
7		Nand Prayag	803	1	
8		Pursadi	NA	1	
9		Birahi	994	1	
10		Mayapur	1360	1	
11		Pipal Koti	1285	1	
12		Tangni Talli	1600	1	
13		Pakhi	1500	1	
14-15		Helang	1600	2	
16		Selang	1600	1	
17-22		Joshimath	1890	6	
23		Govindghat	1828	1	

24-25		Pinaulaghat	1756	2	
26		Vishnuprayag	1446	1	
27		Paithalidhar	1320	1	
28		Varagana Mandal (Main Bazar)	NA	1	
29		Chhinka	NA	1	
30-32		Pokhari (I)	1850	3	
33		Chhali Khal Walli	1900	1	
34		Thali	2100	1	
35		Mohan Khal	2200	1	
36		Bhikona	2040	1	
37		Devasthan	1875	1	
38		Sarmola (Bharpoor)	1240	1	
39		Khal	1720	1	
40		Devtoli	969	1	
41		Karnaprayag	NA	1	
42		Deyarkot	1550	1	
43		Nagkot	1040	1	
44		Kankhul	NA	1	
45		Gharkot	NA	1	
46		Simli Industrial Estate	1060	1	
47		Diwali Khal	2220	1	
48		Mahal Chauri	-	1	
49		Dhunarghat	1700	1	
1-2 (F)	**Nainital**	Chukum	490	2	Kumaon Himalaya
3-4		Kalakhet	1900	2	
5		Ramnagar	361	1	
6		Renehi		1	
1-3 (G)	**Almora**	Bhikiyasain	1000	3	
1 (H)	**Pithoragarh**	Chauwati	1800	1	
2		Narayan Nagar	1740	1	
3		Jaurasi	NA	1	
4		Jhajardeval	4550	1	
5		Takana Chowk	1600	1	
6		Bin	1520	1	
7		Kasni	1517	1	
8		Wadda	1600	1	
9		Munakot	1530	1	
10		Aincholi	1540	1	
1 (I)	**Bageshwar**	Kathpuria Chinna	1750	1	
2		Dharamghar	1900	1	
3		Ramari	1950	1	
4		Kailkhuria	995	1	
5		Maharishi Vidhya Mandir (Bilauna sera)	990	1	
6		Paldi Chhena	1800	1	
7		Bageshwar Degree College	975	1	
1 (J)	**Champawat**	Darshni	1233	1	
2		Teet Bazar	1090	1	
3		Bhairaun Pul	1120	1	
4		Jaisor	1208	1	
5		Pulla Bazar	1876	3	

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Evaluation Workshop of ENVIS Nodes

A four-day workshop on "Performance Evaluation of ENVIS Nodes" was held on 13-16 June 2003 at Bangalore. The workshop, was organized by the C.P. Ramaswami Aiyar Environmental Education Centre (CPREEC) with financial support of Ministry of Environment and Forests, Government of India, and was inaugurated by Shri Harjith Singh, Senior Advisor to the Ministry. A book, entitled "Diversity of Coastal Plant Communities of India", written by researchers from the Botanical Survey of India (BSI), was released by Shri Singh on the occasion.

In her keynote address, Dr. Indrani Chandrasekaran, Director, Ministry of Environment and Forests, Government of India said that all the ENVIS Centres would share the information available with themselves. The Environmental Management Capacity Building Technical Assistant Project (EMCBTAP) of the World Bank aims to promote, support, and assist education and personnel training programmes designed to enhance environmental information and utilization capabilities. The workshop was meant for directors, scientists, and project managers of the different ENVIS Nodes in the country.

Short Communication

ROOF GARDENING: A MODERN ART OF BEAUTIFICATION

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A garden always provides a space to relax but the limitation of space in big cities and towns has already set the door for enjoying the beauty at home. It is therefore, the need of the hour to earmark some area on the roof top for raising various plants so as to bring the real magic of nature to your home with some previous planning and thoughts.

Planning of roof garden

A roof garden is not a botanical garden and can be planned in the same way as that of kitchen garden. However, before planning a roof garden one should have the idea about the bearing capacity of the roof and drainage facilities as well to avoid any seepage in future. In order to create a pleasant garden, first one has to create a mental picture of his requirement. The kind and number of plants should be limited. Utility crops such as vegetables and one or two blossoming fruit plants may have to be accommodated in the plan. The rest area should be left for ornamental plants. An edible shrub is equally useful as it attracts a variety of birds that make the garden a more interesting place.

The view of the garden from the ground floor is very important and there should be something pleasant and colourful to look at from ground level as it gives the visitors their first impression of the way the family lives. Therefore, proper arrangement of the pot grown plant is essential to make them more attractive. Arranging the pot grown plants in a single row by maintaining their height on the outer most wall gives a fantastic look whereas mass effect on roof floor in triangular or round form keeping red in the middle, yellow and pink on either side gives a very contrasting and eye catching look to the spectators.

Selection of roof site and container

A roof garden is an outdoor refreshing place and must be viewed and enjoyed from more than one side. Shaded area, if any, can be used as a utility area such as work area and sitting place while the open space may be used for planting. A flowering plant should never be kept in the shade for a long period while a shady location should always be selected for foliage and delicate plant.

Various types of pot and container can be used for growing plants at roof tops. Usually earthen pots are the best and if the weight bearing capacity of the roof is less, it is better to use plastic or fibre-glass container. Empty tins and flower boxes can also be used but care should be taken that these must have a drainage hole, otherwise the plant may suffer from poor drainage. With regard to pot size, it will depend upon the growth habit of the plant. Use slightly bigger container for dwarf trees and shrubs while other plants can do well in medium to small sized pots.

Choice of plants

A wide variety of plants can be used for growing on roof tops but it is necessary to choose the plants with shallow root system which will not penetrate the roof floor in long run. At the same time, it is also advisable to grow such plants that flower at various periods of year and are very easily be maintained at roof top. Delicate plants must be avoided for this purpose. The following plants are well suited for such type of gardening:

- *Foliage plants:* Asparagus, coleus, croton, diffenbachia, dracena, paperomias, philodendron rubber plant, etc.

- *Flowering plants:* Seasonal flowers like antirrhinum, aster, balsam, calendula, celosia, cosmos, daisy, dianthus, gaillardia, marigold nasturtium, pansy, phlox, verbena, zinnia, etc., and perennial flowers like carnation, chrysanthemum, dahlia, rose, tuberose, etc.
- *Shrubs:* Acalypha, bougainvillea, camellia, china rose, geranium, jasmine lantana, etc.
- *Trees:* Ashoka tree, bottle brush, chrismis tree, silk cotton tree, etc.
- *Climbers:* Antigonon, begnonia, gloriosa, ipomea and passiflora, etc.
- Cactii and succulents: Agave, aloe, kalanchoe, opuntia, cehpalocereus, notocactus nyctocereus, etc.
- *Fruits:* Gooseberry, strawberry, peach, pear, pineapple pomegranate, etc.
- *Vegetables:* Bringal, broccoli, chillies, lettuce, tomoto, etc.

Soil

Generally a soil layer of 10-20 cm thickness is sufficient for planting various foliage and flowering plants. A good soil mixture for roof gardening must consist of soil, sand and well rotten FYM in 2:1:1 ratio for flowering plants but for foliage plants, a mixture containing equal part of soil and organic manure is the best.

Potting

Before potting, the container should be thoroughly washed and sterilized with 5% formalin solution. A small piece of curved pebble should be placed over the drainage hole to prevent its blocking. For proper growth and drainage, the coarse sand should be placed at the bottom over which a mixture of soil and organic manure may be added to fill up the container leaving 2.0-3.0 cm pot brim for irrigation. Planting is to be done by making a hole in the center so that any injury to young plant or its roots may be avoided. While planting, the soil around the plant is pressed to hold it firmly in the growing medium. A light watering is required immediately after planting and should be done with the help of rose cane. After that the plants are kept in the shade for about a fortnight before being placed at their actual location on the roof.

Repotting

The pot should be checked once in a year during monsoon season (June-July) and repotting is required if the roots of the plant are found to bound the entire pot. Repotting may also be required if any plant looks too large for its pot or the water passes through the pot too quickly. Repotting is done either in bigger pot or in the same pot with fresh garden soil and manure after light root pruning.

Final touches

The secret of a successful garden mainly lies in the harmony of the surrounding. Therefore, some special features like greenhouse, lily pools, rockery etc. may be added later but these garden features must be in mini-form. For a greenhouse, use aluminum pipes for longer duration and bamboo poles for shorter duration. In such greenhouses, floor surface can be used for container plants; the walks for climbing plants and the air space for the plants in hanging basket. A rock garden should not exceed 0.5-1.0 m height while a lily pool must be painted with a light blue colour inside and any contrast colour outside. In order to minimize weight load on the roof, these garden features may be constructed with asbestos, fibre-glass, plastic or aluminum sheets. Aluminum sheets are comparatively cheaper and can easily be molded according to the desired shape of these features. These are then placed inside the soil on the roof surface to bring harmony to your garden.

Aftercare

The plants grown at roof tops require various cultural operations for effective management of the garden. Among these, pinching of 2.0-2.5 cm shoot tips is a regular practice to make the plants become bushy. In shrubs and fruit trees, pruning is required to check excessive growth once in a year after their flowering. Likewise, training is essential to give a definite shape to the plant while stacking is a must in climbers to keep them upright. Regular weeding of plants is very essential to keep the garden free from pests and diseases. During summer and rainy season the plants should be protected from strong wind and

scorching sun as the roofs are always exposed to these conditions. The protection against such extreme conditions can be provided by putting a screen or an overhead pergola structure made up of bamboo sticks which can last 3-4 years. For permanent structure, one can use wrought iron or aluminum but the cost will be high.

Apart from this, watering has a direct impact on the over all performance of the roof garden as most of the plants may die due to inadequate or over-watering. The water requirement of the plant increases during its flowering stage and the frequency will be much higher if it flowers during summer season. Cactii and succulents require less frequent watering as compared to all other plants. Keeping this in view, watering is done when the soil just starts drying but always before it is completely dried up. In order to conserve the moisture when a person is away from his house for few days or so, it will be an excellent idea to put one end of a saturated rope piece near the plant and other end in a bucket containing water. The same can also be achieved by wrapping the pot and the plant in a polyethylene sheet.

Roof gardening in the Himalayan region of India is at its take off stage but the extreme of weather in the rest part of India hampers the growth and development of house plants. Therefore, it will be useful if the technology for the successful growing of house plants at roof tops is standardised to enable more people all over the country to enjoy the beauty.

Selected Abstracts

Ahmad, Mukhtar; Mishra, Ramakant; Gupta, Hemant and Ahmad, M. Jamal 2002. **New fungal disease of poplar defoliator, *Clostera cupreata* butler (Lepidoptera: Notodontidae)**. *Indian Journal of Forestry*, 25(1): 79-81. Forest Research Institute, Dehradun 248006, Uttaranchal. [DIAMETER; FUNGAL DISEASES; FUNGI]

Larvae of the poplar defoliator, *Clostera cupreata* Butler (Lepidoptera: Notodontidae) were recorded dying due to the infection of a fungus identified as *Aspergillus flavus* Link. This is the first record of *A. flavus* infecting the larvae of *C. cupreata*. Pathogenecity of the fungus was confirmed by developing its culture and infecting the fresh larvae in the laboratory. Application of the fungus is discussed in the light of its carcinogenic mycotoxin-Aflatoxin B1.

Atul; Sharma, shivesh and Punam 2002. **Germination studies on some economically important nitrogen fixing tree species of Himalayas**. *Indian Journal of Forestry*, 25(1): 104-108. Department of Agroforestry and Environment, Himachal Pradesh Krishi Vishvavidyalaya, Palampur, Himachal Pradesh. [GERMPLASM; NITROGEN FIXING; SEED GERMINATION]

Germplasm of three economically important nitrogen fixing tree species *Acacia catechu, Alnus nitida* and *Dalbergia sissoo* of Himalayas were procured from their classified seed zones. The seed stocks were tested to find out the effect of month of seed collection, storage, scarification treatment and incubation temperature on the germination behaviour of these species. In case of *Alnus nitida*, significantly higher germination was obtained in cold water treatment and no significant differences were noticed by incubating seed at three different temperatures. Similarly *Acacia catechu* had significantly highest germination in seeds procured during February, treated with acid and kept at 25 or 30^{o}C in 1-3 and 4-6 months of storage periods. Whereas, in *Dalbergia sissoo*, the seeds procured in January stored for three months, treated with cold water and subjected to 20^{o}C showed significantly higher germination. But, with the increase in storage time and cold water treatment, maximum germination was obtained only when seeds were subjected to 30^{o}C. Germination potential of seeds varied with the month of collection and storage period had a significant effect on it.

Bhasin, Veena 2002. **Traditional knowledge research: Recycling human waste among Ladakhis**. *Journal of Human Ecology*, 13(3): 177-180. Department of Anthropology, University of Delhi, Delhi 110007, India. [ENVIRONMENTAL SUSTAINABILITY; INDIGENOUS KNOWLEDGE; TRIBES]

A major challenge facing environment and development organization is the waste management. In the present paper, how Ladakhis have been reusing the human waste instead of waste disposal and in doing so are helping their subsistence agriculture has been reported.

Bhatt, Arvind; Sharma, C.M. and Khanduri, V.P. 2002. **Growing stock variations in different *Cedrus deodara* forests of Garhwal Himalaya**. *The Indian Forester*, 128(8): 903-916. Department of Forestry, HNB Garhwal University, Srinagar (Uttaranchal). [DIAMETER CLASS; GARHWAL HIMALAYA; MOISTURE CONTENT; SOIL MOISTURE]

The population structure and growing stock variations under various diameter classes were recorded in five distinct natural forests of *Cedrus deodara* of Garhwal Himalaya. In all, 25 sample plots (five on each site) of 0.1 ha were laid out randomly to observe the variation in the structure of growing stock under different sets of environmental conditions. The results have manifested that the highest total growing stock value (761.70±58.73m^3/ha) among all the diameter classes was recorded in Dewarkhal area (site No. 3, at the highest altitude, 2300m amsl) in Uttarkashi District, where highest total basal cover (TBC) (60.5424±4.6362m^2/ha) and minimum density 9313±23.44 tree/ha) of *C. deodara* individuals, along with highest potassium content (372.27±6.15 kg/ha) in the soil were present. On the other hand the lowest total growing stock value (298.54±99.65 m=3/ha) was observed in Devidhar area (site No.4, at the lowest altitude, 1900m amsl) in Rudraprayag District, where the lowest TBC (34.2763±9.9157 m^2/ha) and the

highest density (438±43.08 trees/ha) of *C. deodara* with lowest values of moisture contents (17.57±1.20%) in the soil were recorded.

Bhuyan, Putul; Khan, M.L. and Tripathi, R.S. 2002. **Regeneration status and population structure of Rudraksh *(Elaeocarpus ganitrus* Roxb.) in relation to cultural disturbances in tropical wet evergreen forest of Arunachal Pradesh.** *Current Science*, 83(11): 1391-1394. Department of Forestry, North-Eastern Regional Institute of Science and Technology, Nirjuli 791109, India; Department of Botany, North Eastern Hill University, Shillong 793022, India. [BIOLOGICAL CONSERVATION; DENSITY; POPULATION STRUCTURE; SEEDLING]

Density, population structure and regeneration status of Rudraksh *(Elaeocarpus ganitrus Roxb.)* were recorded in four stands of a tropical rainforest exposed to varying magnitude of disturbance. The population was discontinuous as a few size classes of the species were absent. The density of adult trees is 21 individuals per hectare in the undisturbed stand, 19 in the mildly disturbed stand, 14 in the moderately-disturbed stand and 12 in the highly-disturbed stand. The regeneration was recorded in the undisturbed (two saplings and 200 seedlings/ha), mildly-disturbed (four saplings and 200 seedlings/ha) and moderately-disturbed (100 seedling/ha) stands, while no regeneration (saplings and seedlings were absent) was recorded in highly disturbed stand. The highest basal area was recorded in the undisturbed stand (4.2 m^2/ha), intermediate (2.8 and 2.6 m^2/ha) in the mildly and moderately-disturbed stands and least (1.9 m^2/ha) in the highly disturbed stand. Seedling survival and growth were more in the undisturbed stand. No cut stump was recorded in the undisturbed and highly-disturbed stands. Sprouting ability of the cut stumps was more in the natural stands compared to the plantation. As the Rudraksh showed sporadic occurrence, its biological conservation is necessary.

Chandra, S. and Joshi, S.C. 2002. **Diurnal and seasonal variation in CO_2 levels in the surface air of Garhwal Himalaya**. *Indian Journal of Forestry*, 25(2): 205-208. G.B. Pant Institute of Himalayan Environment and Development, Garhwal Unit, Srinagar (Garhwal) 246174, Uttaranchal, India. [GARHWAL HIMALAYA; GREEN-HOUSES; SEASONAL VARIATIONS]

Systematic measurements of atmospheric CO_2 in the surface air of the study site during the period from February 1996 to January 1997 showed seasonal and diurnal variability in the atmospheric CO_2 concentration, with highest values in the morning and lowest values in the afternoon. The data also showed a winter-summer oscillation in CO_2 levels with a minimum in July-August and a maximum in March. These diurnal and seasonal fluctuations may be related to the photosynthetic activity of vegetation of this region.

Chauhan, Ravinder 2001. **Joint family in a changing society: A case study of Himachal Pradesh**. *The Indian Journal of Social Work*, 62(4): 573-583. Department of Sociology, Government College for Women, Shimla, Himachal Pradesh. [DEMOGRAPHIC VARIABLES; HIMACHAL PRADESH; HOUSEHOLD; SOCIO-ECONOMIC]

Is the joint family breaking down and undergoing a process of `nuclearisation'? Forces of change have been felt in various social institutions like caste, religion, marriage and family due to several factors. Education is considered to be the most powerful agent of change, thereby helping people form a fresh outlook towards one's environment. Keeping in mind the fact that education is a powerful tool of change, a study was conducted to assess the attitudes of youths towards the joint family system. The article presents the findings of this study.

Chauhan, T.P.S.; Lochan, Rajeev; Siddiqui, Abad Ahmad; Yadav, Anand and Singh, B.D. 2002. **Studies on some pests of mulberry *(Morus alba*) in Uttar Pradesh and Uttaranchal**. *Journal of Non-Timber Forest Products*, 9(1/2): 73-77. Regional Sericultural Research Station, Sahaspur 248197, Dehradun, Uttaranchal, India. [DOON VALLEY; LEAF FALL; PESTS INFESTATION]

A survey study was undertaken in Sericultural Zones falling in different agroclimate of hill, tarai and plain areas of Uttar Pradesh and Uttaranchal during 1998, 1999 and 2000. A few lepidopterans and coleopteran have been identified as pest on mulberry. The seasonal occurrence of major pests causing damage to mulberry foliage to the economic threshold level have been studied. A calendar in infestation of different pests has been drawn with special reference to the major pests on mulberry. Pest damage touched

the economic threshold level during June and July with increase in pest population. The pest population came down with the pruning of mulberry bushes during the July-August. The pest population increased again with the leaf sprout and rich the high level during the month of September to November. The pest population then decreased in the month of December due to leaf abscission and fall in winter conditions.

Chettri, Nakul; Sharma, Eklabya; Deb, D.C. and Sundriyal, R.C. 2002. **Impact of firewood extraction on tree structure, regeneration and woody biomass productivity in a trakking corridor of the Sikkim Himalaya**. *Mountain Research and Development*, 22(2): 150-158. Ashoka Trust for Research in Ecology & Environment (ATREE), Eastern Himalayan Programme (EHP), Bhujiapani, Bagdogra 734422, West Bengal; Mountain Farming Systems Division, International Centre for Integrated Mountain Development, GPO Box 3226, Kathmandu, Nepal; Department of Zoology, North Bengal University, Raja Rammohanpur, West Bengal 734430; G.B. Pant Institute of Himalayan Environment and Development, North-East Unit, Vivek Vihar, Itanagar, Arunachal Pradesh 791113, India. [FIREWOOD EXTRACTION; FOREST COVER; PRODUCTIVITY; REGENERATION; SPECIES DIVERSITY; SUBALPINE FOREST; TEMPERATE FORESTS]

Forest cover types, tree distribution pattern, species diversity, net woody biomass productivity, and firewood extraction rates were studied along a trekking corridor (Yuksam-Dzongri) in Khangchendzonga Biosphere Reserve, Sikkim, India. For the last 2 decades the area has been facing immense pressure on its natural resources because of an increase in the numbers of tourists and the lack of effective regulation by park authorities. To assess this situation the study sites were categorized as closed canopy (CC) forest and open canopy (OC) forest (disturbed) at upper forest (UF) and low forest (LF) sites, on the basis of firewood extraction pressure from the community and tourism enterprises. The results showed significant variations in diversity, richness, structure, productivity, and regeneration among different canopy types. OC forest showed greater plant diversity than CC forest. Firewood extraction pressure was remarkably greater in the LF near the major settlement than in the UF, Local conservation initiatives and the interventions of an eco-tourism project have had visible impacts on firewood use by the community and on tourism enterprises. Although alarming, the rate of woody bio-mass extraction was nonetheless lower than the annual productivity rate of the stands. Participatory management and compliance by tourism enterprises with a code of conduct on alternative fuel use along the trekking corridor would help promote the conservation and maintenance of biodiversity.

Chowdhery, H.J. 2001. **Orchid diversity in North-East India**. *J. Orchid Soc. India*, 15(1-2): 1-17. P-8, Brabourne Road, Kolkata 700001, India. [AGRO-CLIMATIC; DIVERSITY; NORTH-EAST; ORCHID]

The North-East India, due to its agro-climatic diversity and high humidity and rainfall, forms the richest orchid belt in the country. Of the estimated 1230 species of orchids known from India, between 750-800 species occur in this region. A comparative analysis of distribution of orchid species with North-Eastern region revealed that the maximum diversity of orchids is found in Arunachal Pradesh followed by Sikkim, while it is the least in Tripura. Incidentally, the region also has the highest concentration of monotypic genera. This paper provides an account of vegetational types of different orchid habitats in North-East India. The endemic, rare, and threatened species of the region are also listed.

Cole, Victoria and Sinclair, A. John 2002. **Measuring the ecological footprint of a Himalayan tourist center**. *Mountain Research and Development*, 22(2): 132-141. Natural Resources Institute, University of Manitoba, 200 Dysart Road, Winnipeg, MB R3T 2N2, Canada. [ECOLOGICAL FOOTPRINT ANALYSIS; MOUNTAIN DEVELOPMENT; MOUNTAIN TOURISM; SUSTAINABILITY]

Finding ways to assess and measure the impact of tourism and its associated development on sustainability is critical to developing long-term sustainability plans for regions such as the Indian Himalayas. Among the methods proposed is ecological footprint (EF) analysis or appropriated carrying capacity analysis. EF analysis estimates the area of productive land and water ecosystems required to produce the resources that a population consumes and to assimilate the wastes that the population produces in supporting itself. This study used EF analysis to quantify the sustainability of Manali, a rapidly growing tourist center in Kullu District, Himachal Pradesh, India. It considered the changes in the size of Manali's footprint since the advent of mass tourism in the early 1980s, the direct impact that tourists are having on the

size of the footprint, and the challenges of applying this analysis in a developing world context. Data regarding landuse, goods and services, and population were colected through local interviews and available data. The results indicate that between 1971 and 1995, the overall EF of Manali town grew from 2102 to 9665 ha, an increase of over 450%; the EF of Manali is now 25 times greater then its size. This indicates that Manali is increasingly relying on outside ecosystems for its sustenance. The article highlights areas of focus for future sustainability planning, including waste management, decreasing fossil fuel dependence, ecofriendly tourism, and creating greater environmental awareness, particularly among tourists.

Das, D.C. 2002. **Hydrology of soil profile and sub-strata to improve hydrologic performance of watersheds**. *Journal of soil and Water Conservation*, 1(2&3): 182-196. Watershed Management & Natural Resources, Agricultural Finance Corporation Ltd.(AFC), New Delhi, India. [BIOMASS; SOIL MOISTURE; SOIL PROFILE; WATERSHED DEVELOPMENT]

Variations in inflow to naulas'/bauries vis-a-vis climatic aberration and anthropogenic disturbance revealed centrality of seepage for perenniality of naula-a seepage collection tank, springs, small streams and infiltration well (a modified naula)- all traditional perennial water resources of Central Himalayas of India. Erosion and deforestation have affected them. The identity of rainwater when absorbed, stored and transhifted within hydrologically operative depth is not only distinct but also very important in the hydrologic continuum or whole. Storage and movements are different in soil profile and sub-strata. Finally due to geological settings that provide a gradient and space for transitory accumulation seepage comes out as inter-flow or push through outflow. Seepage volume and rate depend on infiltration and penetration of rainwater and storage in two segments. Appropriate vegetative cover, if created and soils preserved, over 80 per cent of rainfall is retained while surface runoff restricted to 20 per cent seepage lines maintain the perenniality of the sources. Seepage as a hydrologic process while soil profile and sub-strate as real source for dependable water supply should figure in watershed development planning as well as research.

Durgapal, Anjala; Pandey, Anita and Palni, L.M.S. 2002. **The use of rhizosphere soil for improved establishment of conifers at nursery stage for application in plantation programmes**. *Journal of Sustainable Forestry*, 15(3): 57-73. Department of Botany, Government P.G. College, Berinag, District - Pithoragarh, Uttaranchal; G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263643, Uttaranchal, India. [CEDRUS DEODARA; GROWTH PROMOTION; MYCORRHIZAL INFECTION; PINUS WALLICHIANA; PLANTATION; RHIZOSPHERE; SOIL TREATMENTS]

Nursery experiments were carried out to develop a very simple and easy to use method to enhance mycorrhizal associations in *Cedrus deodara* and *Pinus wallichiana* by using appropriate rhizosphere soil for plantation programmes to be carried out at degraded sites. Soil treatment under study were (i) non-forest/degraded soil, (ii) mixed soil (rhizoshpere: non-forest soil, 1:9), and (iii) pure zhizosphere soil. Rhizosphere soil inoculation resulted in improved seed germination and subsequent plant growth. Mixed soil was found to be even better than pure rhizosphere soil in the case of *Cedrus deodara*, while both treatments were at par for *Pinus wallichiana*. An almost two-fold increase in seed germination was recorded over non-forest soil in both species. Influence on subsequent growth was also studied twelve months after seed sowing. Improvement in plant growth was observed in terms of root number, root diameter, collar diameter, shoot height, stem diameter, needle number, root and shoot biomass ($p<0.05$). Rhizosphere soil treatments enhanced nutrient (N,P,K) uptake in the two plant species ($p<0.01$). Mycorrhizal infection increased by 70.3% and 53.8% in *C. deodara* and 67.5% and 73.6% in *P. wallichiana*, over control due to the use of mixed and pure rhizosphere soil, respectively. Higher mycorrhizal infection coincided with greater fungal population in the soil samples due to rhizosphere soil inoculation. Fungal population in the mixed soil consisted of a larger proportion o P-solubilizing fungi, namely *Aspergillus niger, Penicillium fellutanum, P. pinophilum*, and *Cladosporium oxysporum*.

Gardner, R.A.M. and Gerrard, A.J. 2002. **Relationships between runoff and land degradation on non-cultivated land in the middle hills of Nepal**. *International Journal of Sustainable Development and World Ecology*, 9(1): 59-73. Royal Geographical Society with the Institute of British Geographers, 1 Kensington Gore, London; School of Geography and Environmental Sciences, The University of Birmingham, Edgbaston, Birmingham, UK. [NEPAL; RAINFALL; RUNOFF; SOIL EROSION; VEGETATION]

Rainfall-surface water runoff relationships have been examined for 912 rainfall events during the 1992 and 1993 monsoon seasons on 15 erosion plots on a variety of non-cultivated land uses in Middle Hills, Nepal. Vegetation cover and type examined ranged from grassland and relatively undisturbed mixed broadleaf forest to subtropical Sal forest, in various states of degradation, and bare ground. Runoff was frequently generated on most plots and often by relatively small rainfall amounts (less than 5 mm) and low rainfall intensities (3 mm/h). Ground cover and canopy cover were significant factors in determining amounts of runoff. Runoff coefficients ranged from 1-2% under grassland and mixed broadleaf forest to 57-64% on the bare sites. Coefficients for Sal forest were between these two extremes; specific values depended on the level of degradation induced by human activity. The most degraded forest sites experienced runoff coefficients of 33%. Ground cover beneath the trees, especially leaf litter, was more effective in reducing runoff than the mount of canopy cover. Canopy cover was more effective during the less intense storms but was ineffective when the rainfall intensity was high. The results suggest that a minimum ground cover of 60% will keep runoff to within 10% of total rainfall amounts for most normal monsoons in the Middle Hills. This will also reduce the risk of gullying and surface soil erosion. It is the nature of the forest that is important and not its total area. In the study area, although the total area under forest had not change, some of the forest had become more degraded with a corresponding increase in mean runoff rates. Increased runoff can occur even if the area under forest increases. Estimates on levels of degradation based solely on changing forest areas are likely to be inaccurate.

Gardner, R.A.M. and Gerrard, A.J. 2003. **Runoff and soil erosion on cultivated rainfed terraces in the Middle Hills of Nepal**. *Applied Geography*, 23(1): 23-45. Royal Geographical Society with the Institute of British Geographers, 1 Kensignton Gore, London, UK; School of Geography and Environmental Sciences, The University of Birmingham, Edgbaston, Birmingham B15 2TT, K. [AGRICULTURAL TERRACES; NEPAL; RUNOFF; SOIL EROSION]

The paper presents runoff and soil erosion measurements from plots on outward-sloping rainfed agricultural terraces in the Likhu Khola drainage basin, Middle Hills, Nepal, for the pre-monsoon and monsoon periods of 1992 and 1993. Runoff coefficients ranged from 5% to over 50%, depending on the nature of the rainfall event and the characteristics of the terraces. Total rainfall amount provided the highest level of explanation for the variation in runoff. Soil losses ranged from 2.7 to 8.2 t ha^{-1} for 1993 and up to 12.9 t ha^{-1} for 1992. The higher losses were associated with red, finer-grained soils. The majority of these rates are lower that the rates of soil loss that have been commonly perceived for the Middle Hills of the Himalaya. However, they are broadly similar to rates obtained from the few other studies that have examined runoff and erosion under traditional rainfed cultivation. The results suggest that a re-evaluation of the degree of land degradation in such areas may be necessary. Relationships between soil loss and rainfall characteristics were highly variable but were improved considerably when vegetation cover was included. This indicates that the maintenance of some form of ground cover is advisable if runoff and erosion are to be minimized.

Garkoti, S.C.; Akoijam, S.B. and Singh, S.P. 2002. **Ecology of water relations between mistletoe (*Taxillus vestitus*) and its hos oak *(Quercus floribunda*).** *Tropical Ecology*, 43(2): 243-249. Department of Botany, Kumaun University, Nainital 263002, Uttaranchal. [INFESTATION; LEAF CONDUCTANCE; PARASITE; QUERCUS FLORIBUNDA; TAXILLUS VESTITUS; WATER POTENTIAL]

The infestation of *Quercus floribunda* trees by *Taxillus vestitus* is common in Himalaya. Seasonal gas exchange and water relations of *T. vestitus* and its host *Q. floribunda* were studied under natural field conditions in Nainital, Indian Central Himalaya. Leaf water potential and leaf conductance were followed through the growing seasons on *T. vestitus* and infested *Q. floribunda*. consistent with the reports elsewhere for other species of mistletoe, *T. vestitus* frequently transpires more rapidly than its host, and maintains a more negative water potential. Predawn and midday water potentials for *Q. floribunda* are in the range of -9.0 (Rainy season) to -12.3 (Summer season) and -4.4 (Rainy season) to -20.5 (Summer season) bars, respectively where as for that of mistletoe, it is -1.6 (Rainy season) to -14.9 (Summer season) bars and -5.9 (Rainy season) to -25.2 (Summer season) bars, respectively during predawn and midday. A gap in water potential between host and mistletoe occurred throughout the study period, which increased with the severity of moisture. During all seasons T. vestitus out transpired the host. It appears that the low water potential

enables the mistletoe to have access to host water all the time higher transpiration further enhances water uptake and hence possible intake of valuable elements for growth. Both the species studied showed stomal control during the dry season, which seems to be determined by the increase of the evaporative demand.

Gupta, Atul; Seghal, R.N.; Panwar, Pankaj and Thakur, I.K. 2002. **Selection of rust *(Melampsora* spp.) resistant trees of *Populus ciliata* in Himachal Pradesh**. *Indian Journal of Forestry*, 25(1): 96-98. Department of Tree Improvement and Genetic Resources, University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh 173230. [COLLAR DIAMETER; HIMACHAL PRADESH; NURSERY]

Natural population of *Populus ciliata*, were screened for *Melampsora* spp. rust resistant trees. Maximum resistance against rust was observed in Rahla provenance. Rust infection was more in provenances at lower altitudes as compared to higher altitudes.

Gupta, S.K. and Singhal, R.M. 2002. **Joint Forest Management in the states of Uttar Pradesh & Uttaranchal of India : A critical appraisal**. *Journal of Non-Timber Forest Products*, 9(1/2): 78-82. Tehri Forest Division, New Tehri, Tehri Garhwal, Uttaranchal; Indian Council of Forestry Research & Education (ICFRE), Dehradun 248006, Uttaranchal. [ENVIRONMENTAL CONSERVATION; FOREST ECOSYSTEM; JOINT FOREST MANAGEMENT; NATURAL RESOURCE MANAGEMENT]

The state of Uttar Pradesh adopted JFM in 1997 and the state of Uttaranchal continued to adhere to the same after formation of new state with a view to develop a sense of ownership among local communities about forest resources. Attitudinal change, institutional development, and participation of local communities in the management through sharing of authority and responsibility towards protection and maintenance of forests along with distribution of usufructs were the salient features of the programme. Labour contribution by village communities and involvement of NGOs were envisaged to strengthen the participation of communities in the programme. But, it has been revealed that irrational allocation of finance and stressing more on saving for Village Development Fund are creating unhealthy situation for amelioration of village forest ecosystem and villagers' economy, which need appropriate attention.

Hazra, Jayati 2002. **Health and Development of North East India**. *Geographical Review of India*, 64(1): 21-32. Department of Geography, University of Calcutta, Kolkata 700019, India. [CULTIVATION; DIVERSITY; ECOLOGICAL CONDITIONS; NORTH-EAST; SOCIO-ECONOMIC DEVELOPMENT]

North-east India comprising seven states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura, known as seven sisters, portrays a complex combination of factors which has affected the health of the population in various ways. The region has remained relatively isolated and under developed even after 50 years of independence, partly due to its location, and partly for the adherence of the people of their traditional lifestyle. It is joined to the rest of the country by a narrow corridor hardly 80 kms. in width. The rest of the territorial boundary is shared by the neighbouring states of Bhutan, China, Myanmar and Bangladesh. The free movement of people and goods across the border, interfered with the stability, law and order situation and the health and well-being of the people of the region. Apart from the Brahmaputra valley, most of the North-East consists of rugged terrain with hot, humid climate, except where modified by relief. The population of the North-East comprise diverse ethnic stock, who migrated into the area in different periods of history, from China, Tibet, Myanmar, and Thailand and more recently after independence from Bangladesh. Migration from the plains of north India has been less significant. This diversity has resulted in conflicts, which tell on the mental health of the people. Despite the adverse ecological conditions, the people of the North-East enjoy better health conditions than most of India. Health ranks fifth among the indicators of well-being in terms of poor performance, but varies considerably within the states, Arunachal Pradesh, Assam and Tripura record poor health while the eastern hill states of Manipur, Meghalaya and Nagaland enjoy better health conditions. The spatial health pattern of the Northeast shows both uniformity and diversity. Uniformity of pattern is seen for those communicable diseases which are strongly influenced by ecological factors, like acute diarrhoea, respiratory ailments, leprosy and malaria. These diseases are widespread through out the area. Cultural parameters provide diversities in health characteristics. This is portrayed in the incidence of cancers, and sexually transmitted diseases and AIDS. While sexually transmitted disease in common among the tribal population, AIDS has secured a firm ground in Manipur, and to some extent in Nagaland. Cancer in Nagaland and Manipur is associated with the food

and other cultural habits. Health care facilities though poor in the North-Eastern states of India is compensated by the low population densities and the existence of alternative tribal or folk medicine.

Jana, M.M. 2002. **Application of remote sensing in the study of geomorphic processes and lanforms in piedmont zone of Darjeeling Sub-Himalaya**. *Journal of the Indian Society of Remote Sensing*, 30(1&2): 61-72. Department of Geography and Applied Geography, North Bengal University, Darjeeling 734430. [GEOMORPHIC PROCESSES; LANDFORMS; REMOTE SENSING; SOIL EROSION]

The piedmont zone, located between the foothills of Darjeeling Sub-Himalaya and the flat plains of North Bengal is elongated from west to east and its average height varies from 150 m in the north to 50 m in the south. Morphologically, the region is divided into three distinct physiographic units. Many large and small rivers originated from the Darjeeling Sub-Himalayas intersect it. Most of these rivers have their large catchment area in the mountainous tract. The study area has about 350 cm of annual rainfall and peak discharge in the river is very high during monsoon period. Rivers carry large amount of sediments, gravels, and pebbles both in suspension and traction and these materials are deposited in the foothills of the Sub-Himalaya as fan deposits and on the riverbeds making braided channels. Landforms in the study area are mainly complex and their origins are influenced by neo-tectonic and fluvial activities. Many rivers terraces, palaeo-channels, out wash plains, valley-fills and channel bars are formed in the region due to both erosion and depositional processes. These processes and modifications of landforms are still going on in the region.

Jana, M.M. and Haque, Khondoker Emamul 2002. **Suitability of Groundwater for Agriculture in the Terai Area, Darjeeling District**. *Geographical Review of India*, 64(3): 262-271. Department of Geography and Applied Geography, North Bengal University, Darjeeling 734430. [GROUND-WATER; LAND-USE; WATER MANAGEMENT]

An attempt has been made in this paper to determine the suitability of groundwater for agricultural uses on the basis of chemical characteristics. The results were obtained for the parameters of pH, electrical conductivity (Ec), thorium (Th) and major ions of calcium (Ca), magnesium (Mg), sodium (Na), Potassium (K), Chlorine (CI), bicarbonate (HCO_3), sulphates (SO_4), nitrates (NO_3), boron (B) and iron (Fe). The main parameters like Sodium Absorption Ratio (SAR), Residual Sodium Carbonate (RSC), Soluble Sodium per cent (SSP), Permeability Index (PI) are determined to evaluate the suitability. A classification following USSLS and descriptive interpretation were further attempted.

Jasrotia, A.S.; Dhiman, S.D. and Aggarwal, S.P. 2002. **Rainfall-runoff and soil erosion modeling using remote sensing and GIS technique - A case study of tons watershed**. *Journal of the Indian Society of Remote Sensing*, 30(3): 167-180. Department of Geology, University of Jammu, Jammu 180006; Department of Civil Engineering, Birla Vishvakarma Mahavidyalaya, Vallabh Vidyanagar 388120, Gujarat, India; Water Resources Division, Indian Institute of Remote Sensing,Dehradun 248001, Uttaranchal, India. [REMOTE SENSING; SATELLITE DATA; SOIL CONSERVATION; SOIL EROSION]

In the present study, the rainfall-runoff relationship is determined using USDA Soil Conservation Service (SCS) method. The coefficient of determination (R^2) is 0.99, which indicates a high correlation between rainfall and runoff. The runoff potential map was prepared by assigning individual class weight and scores input map. Annual spatial soil loss estimation was computed using Morgan, Morgan and Finney mathematical model in conjunction with remote sensing and GIS techniques. Higher soil erosion was found to occur in the northern part of the Tons watershed. The soil texture in the affected area is coarse loamy to loamy skeletal and soil detachment is higher. Moreover the land use has open forests, which does not reduce the impact of rainfall. The average soil loss for all the four sub-watersheds was calculated, and it was found that the maximum average soil loss of 24.1 t/ha occurred in the sub-watershed 1.

Joshi, Basant Kumar 2002. **Effect of landuse and elevation on soil properties of Bhetagad Watershed - A case study from Indian Central Himalaya**. *Journal of soil and Water Conservation*, 1(2&3): 109-117. G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263643, Uttaranchal. [ELEVATION; LAND-USE; NUTRIENT CONCENTRATION; SURFACE COVER; WATERSHED]

This study concern to measure the effect of vegetal cover, elevation and practices on Physico-Chemical properties of the soil of two forest and three grassland soil of the Bhetagad watershed of Kumoan Himalaya. Keeping in view the availability of all type of aforesaid land use categories within the watershed, two different elevation ranges, 1200-1400m amsl and 1800-2000 m. amsl were considered for present study. The annual precipitation and daily average mean of temperature was observed higher for lower elevation. All the studied landuse sites generally had low soil moisture and higher nutrient concentration for upper profile, except available P and K. The Surface cover, tree density, total tree basal area and crown cover, influencing to physical and chemical characteristics of the soil. The soil moisture was observed higher for higher elevation and also increases with increasing the surface cover, tree density, tree basal cover and crown cover. The soil of reserve forest had higher soil moisture and nutrient concentration except few exception. Nutrient concentration was significantly lower for grazing land and open pine forest.

Joshi, P.K.; Rashid, Humayun and Roy, P.S. 2002. **Landscape dynamics in Hokersar Wetland, Jammu & Kashmir - An application of geospatial approach**. *Journal of the Indian Society of Remote Sensing*, 30(1&2): 1-5. Indian Institute of Remote Sensing (NRSA), Dehradun; Directorate of Environment & Remote Sensing, Srinagar, Jammu & Kashmir. [BIOTIC INTERFERENCES; LAND-USE; REMOTE SENSING; SATELLITE DATA]

Geospatial presentation of habitat has become a key issue for planning, conservation and management of any ecosystem. Hokersar wetland, one of the best resorts of migratory waterfowl in Kashmir, is under anthropogenic pressure and siltation due to floods. This has resulted in the degradation and change in the habitat quality of varied aquatic flora and fauna. Moreover, the seasonal changes affect the water level and land cover characteristics of the landscape. In the present study temporal mapping of the wetland has been carried out using the data sets for the autumn and spring seasons to assess the landcover/landuse dynamics. The temporal change analysis, in the urban sprawl and the wetland, has been carried out to assess the rate to changes in the wetland and its environs. The wetland initially comprised of patch of marshy waterfowl habitat with some open water bodies. It has been fragmented into a large number of land uses because of anthropogenic activities. The increase in the settlement has been observed proportionate to the rate of fragmentation in the wetland. This study has created an information base, which will help to design conservation schemes for long term maintenance of the wetland.

Kakati, L.N. and Doulo, V. 2002. **Indigenous knowledge system of zootherapeutic use by chakhesang tribe of Nagaland, India**. *Journal of Human Ecology*, 13(6): 419-423. Department of Zoology, Nagaland University, Hqs. Lumami, Post Box 12, Mokokchung 798601, Nagaland, India. [CHAKHESANG TRIBE; INDIGENOUS KNOWLEDGE SYSTEM; NAGALAND]

Zootherapeutic use of different animals and animal parts to treat common human ailments like wound, child delivery, burn, swelling, stomach pain, anaemia, bone fracture, gastritis, malarial fever, urethritis, constipation, cough, asthma, dysentery, chicken pox etc. among Chakhesang tribe of Phek district, Nagaland has been discussed. Detail information has been obtained on the traditional therapeutic use of twenty three different animal species of which certain become rare or endangered. The authors suggest for establishment of human-nature interaction for sustainable utilization of animal resource through domestication of wild species by means of traditional farming system.

Kant, Shashi and Kour, Iqbal 2001. ***Nervilia plicata* (Andr.) Schltr. - A new record for Jammu & Kashmir state (India)**. *J. Orchid Soc. India*, 15(1-2): 33-34. Department of Botany, University of Jammu, Jammu 180006, India. [ECOLOGY; JAMMU & KASHMIR; ORCHID]

Nervilia plicata (Andr.) Schltr., a neottioid species of ground orchids is reported for the first time from Jammu & Kashmir. Its description and the relevant ecological and phytogeographical informations are provided.

Kar, Bimal K. 2002. **Socio-economic status of women in north-east India**. *Geographical Review of India*, 64(2): 115-132. Department of Geography, Gauhati University, Guwahati 781014. [DIVERSITY; NORTH EAST INDIA; SOCIO-ECONOMIC STATUS; TRIBALS]

Females, that constitute about half of the human population, often face diverse nature of socio-cultural and economic problems. This is more conspicuous in the developing countries like India in various forms in different socio-economic levels of the society. India's north-east comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura is no exception to this situation. The nature and intensity of problems of women, however, vary both spatially and socially depending on a range of historical and ecological factors and the prevailing socio-economic and cultural practices of the region. In this paper an attempt is made to find out the spatial disparity in socio-economic status of women and to analyze the correlates associated with it in North-East India. Necessary data for the study have been taken at district level primarily from the Census of India. The method adopted here is the Principal Component Analysis for determination of composite scores of women's status at district level.

Kayang, H. 2002. **Fungi inhabiting alder phylloplane**. *Indian Journal of Forestry*, 25(2): 164-170. School of Life Sciences, Department of Botany, Mawlai Umshing, Permanent Campus, North Eastern Hill University, Shillong 793022, India. [DENSITY; FUNGI; NITROGEN FIXATION]

A total of 37 fungal species belonging to 26 genera of fungi were isolated from the phylloplane of alder *(Alnus nepalensis* D. Don) at different growth stages of the leaves in open and closed alder forests. The fungi increased gradually from folded to senescent stage and the peak was obtained at the maturity of the leaves. The least population was obtained at the bud or folded stages soon after flushing. *Penicillium fumiculosum, Alternaria alternata* and *Aspergillus nidulens* were dominant species immediately after flushing. When the leaves were undergoing maturation and entered into the senescent stage *Cladosporium herbarum, Trichoderma viride* and *Fusarium oxysporium* became dominant. The leaf spot disease caused by *Septoria alnifolia* of deuteromycetous pathogen was also observed during the study period.

Kulkarni, Anil V.; Randhawa, S.S.; Rathore, B.P.; Bahuguna, I.M. and Sood, R.K. 2002. **Snow and glacier melt runoff model to estimate hydropower potential**. *Journal of the Indian Society of Remote Sensing*, 30(4): 221-228. Marine and Water Resources Group, Space Applications Centre, Ahmedabad 380015; Himachal Pradesh Remote Sensing Cell, 34, SDA Complex, Kasumpti, Shimla 171002. [MOUNTAIN GLACIERS; REMOTE SENSING; SATELLITE DATA; SOIL MOISTURE]

Himalayan region has high concentrations of mountain glaciers. Large extent of this region is covered by seasonal snow during winter. Runoff generates from melting of these snow and glaciers is one of the important sources of water for the Himalayan Rivers. Glaciers and snowfields are distributed throughout the Himalayas and form a source of numerous stream. Due to steep slopes, all such streams have potential sites for hydropower generation. If this potential is fully utilized, it will help in generating power from environmentally friendly Run-of-River (RoR) hydropower stations. Considering these aspects, a stream flow simulation model was developed for small streams. This will help in estimation of average seasonal unrestricted hydropower potential of snow and glaciated streams for winter, summer, monsoon and autumn seasons. Information generated through remote sensing technique as glacier, permanent snow cover, seasonal snow cover, altitude of snow and glaciers were used in conjunction with daily maximum and minimum temperature, rainfall and discharge. The model was developed for Malana nala located in Parbati River basin near Kullu in Himachal Pradesh. It was validated at adjacent Tosh nala in the same basin. Seasonal runoff computed from the model is comparable with observed data for all seasons except monsoon. Good results in autumn, winter and summer seasons demonstrates usefulness of runoff model to assess hydropower potential of snow and glaciated streams and therefore, the model was applied to ungauged Sorang Gad and Kirang Khad. In winter runoff was estimated as 1.8 and 1.69 cumecs for Kirang Khad and Sorang Khad. In winter runoff was estimated as 1.8 and 1.69 cumecs for Kirang Khad and Sorang Gad, respectively. This is important, as viability of hydropower station depends upon winter stream runoff. These results suggest that the model is useful tool to assess initial estimate of hydropower potential for large number of snow and glaciated streams, for which no hydrological data is available.

Kumar, Kishor; Hamrick, Mark W. and Thewissen, J.G.M. 2002. **Middle eocene prosimian primate from the Subathu group of Kalakot, northwestern Himalaya, India**. *Current Science*, 83(10): 1255-1259. Wadia Institute of Himalayan Geology, 33 General Mahadeo Singh Road, Dehradun 248001, India; Department of Cellular Biology and Anatomy, Laney Walker Blvd, CB2915, Medical College of Georgia,

Augusta GA 30912, USA; Department of Anatomy, Northeastern Ohio Universities College of Medicine, Rootstown, OH 44272, USA. [CROWN-HEIGHT; FLUVIAL CONDITION; FOSSIL; GEOLOGICAL MAP]

An upper molar tooth of a possibly new but unnamed prosimian primate (Mammalia, Primates) is described from the Middle Eocene, in the uppermost part of the Subathu Group exposed east of Babbian Gala near Kalakot (northwestern Outer Himalaya) in the Rajauri District, Jammu and Kashmir, India. To the best of our knowledge, this is the first pre-Siwalik primate from India and the only primate tooth identified thus far in a remarkably rich and varied land mammal fauna known from the red beds of the Subathu Group. Its occurence is significant, as the Eocene primates of the Indian subcontinent are important for understanding the early primate radiation is Asia.

Kumar, Vishnu and Shamet, G.S. 2002. **Vegetative propagation of Himalayan yew (*Taxus baccata* Linn.) through branch cuttings**. *Journal of Non-Timber Forest Products*, 9(1/2): 32-36. Department of Silviculture and Agroforestry, Dr. Y.S. Parmar University of Horticulture & Forestry, P.O. Nauni-Solan 173230, H.P. [HIMALAYA; TAXOL; TAXUS BACCATA]

The study was conducted to determine the effect of various chemicals including auxins crown position, cutting portion and preconditioning (girdling) treatments on rooting behaviour of *Taxus baccata*- a taxol tree of moist temperature Himalaya. Application of 0.75% IBA + 5% captan + 5% sucrose in August resulted in highest 72.22 per cent rooting in the species. The girdled cuttings produced significantly higher rooting than non-girdled ones. Similarly, the lower portion of cuttings resulted in significantly better success as compared to upper ones.

Kusre, B.C. and Patra, S.C. 2002. **Soil erodibility in Tlawng River Catchment of Mizoram and suggested conservation measures**. *Journal of soil and Water Conservation*, 1(1): 91-96. North Eastern Regional Institute of Water and Land Management, Dolabari, P.O. Kaliabhomora, Tezpur 784027, Assam. [DEGRADATION; DISPERSION RATIO; ERODIBILITY INDICES; SOIL EROSION; SUSPENSION PERCENT; WATERSHED MANAGEMENT]

North Eastern Region is faced with serious problems of soil erosion. Immediate attention to control erosion is necessary in the river basins for which water resources projects are identified. Tlawng river in Mizoram having a catchment area of 0.27 M Ha in Mizoram out of state's total geographical area of 2.1 M Ha needs immediate attention. The erodibility in the catchment was studied by Middleton method. The dispersion ratio was varying from 12.31 to 51.45 and the suspension ratio ranged from 8.0 to 25.0 indicating the soil to be highly erodible. Suggestions for conservation in the river basins are incorporated.

Mahajan, Sudhir; Panwar, Pankaj and Kaundal, Deepak 2001. **GIS application to determine the effect of topography of landuse in Ashwani Khad Watershed**. *Journal of the Indian Society of Remote Sensing*, 29(4): 243-248. GIS Lad-cum-Computer Centre, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan 173230, H.P. [CLIMATIC CONDITIONS; GIS; LAND-USE; SATELLITE DATA]

The landuse status of Ashwani Khad watershed has been obtained using IRS-ID satellite data for 1999 and further topographic analysis has been carried out using GIS software-ARC/INFO and ARCVIEW. It has been found that of the total geographical area (85.30 km^2) of the Ashwani Khad watershed which lies between $30^o50'$ to 31^oN latitude and $77^o05'$ to $77^o15'E$ longitude in Himachal Pradesh, 54.53% constituted wasteland, 33.55% agriculture and least 11.92% forest. The altitude, aspect and slope have exhibited marked effect on land utilization. Agriculture and wasteland have been found maximum in mid altitude (1300-1500m) and moderate slopes (13.2-26.4 degree), whereas, agriculture and forest have been maximum in flat and north aspect.

Manchanda, M.L.; Kudrat, M. and Tiwari, A.K. 2002. **Soil survey and mapping using remote sensing**. *Tropical Ecology*, 43(1): 61-74. Regional Remote Sensing Service Centre, Dehradun 248001. [CARBONATES; MINERALOGY; MOISTURE CONSERVATION; ORGANIC MATTERS; REMOTE SENSING; SALINITY; SPECTRAL BEHAVIOUR; TEXTURE]

Soil survey constitutes a valuable resource inventory linked with the survival of life on the earth. The technological advancements in the field of remote sensing and Geographical Information System have

been a boon for such surveys. Present paper describes the role of remote sensing and Geographical Information System (GIS) technologies for mapping and characterizing soils at various scales. The spectral behaviour of soil and its components, which is fundamental to deriving information from remote sensing data, is also discussed with illustrations. Furthermore, the scope of present day remote sensing data for varying levels information generation is also reviewed.

Manjkhola, Sumit and Dhar, Uppeandra 2002. **Conservation and utilization of *Arnebia benthamii* (Wall. ex G. Don) Johnston - a high value Himalayan medicinal plant**. *Current Science*, 83(4): 484-488. G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263643, Uttaranchal. [CONSERVATION STRATEGY; HIGH ALTITUDE; MEDICINAL PLANT; SEED GERMINATION]

The investigation on conservation and utilization of *Arnebia benthamii* (Wall. ex G. Don) Johnston was carried out to identify optimum stage of the collection of propagules, improve upon the rooting of root cuttings and identification of optimum conditions for seedling survival. Individuals at reproductive maturity were found suitable for collection of propagules because of the occurence of 3-5 buds at the terminal growing end of the root. These buds can be effectively utilized for vegetative propagation. Chilling for 40 days significantly *($P < 0.05$)* improved rooting of root cuttings. Seedling survival and growth performance were significantly *($P < 0.05$)* higher at a high-altitude village Lata, thereby facilitating the establishment of herbal gardens in the vicinity of natural population. This activity will not only reduce pressure on the natural population, but also has the potential to generate rural economy. Further, the possibilities of revegetating the degraded natural habitats and creating nursery centres at low-altitude areas are discussed. This study will help in developing conservation strategy for optimum utilization of *A. benthamii*.

Misra, S.C. and Bora, S.S. 2002. **Cultivating walnut scientifically**. *Indian Horticulture*, 47(2): 13-14. Govt. Fruit Research Centre, Pithoragarh, Uttaranchal. [CULTIVATION; INSECTS; PROPAGATION]

The walnut is a potential nut tree for the hills region. Till now there are no scientific cultivation practices of walnut available to the growers. Therefore, farmers should be imparted technical know-how adequately to earn more from their native nut crop.

Mughal, A.H. and Bhattacharya, P. 2002. **Agroforestry systems practiced in Kashmir valley of Jammu and Kashmir**. *The Indian Forester*, 128(8): 846-852. Division of Forestry, S.K. University of Agricultural Sciences and Technology (K), Srinagar (J&K); Faculty of Ecosystem and Technical Forestry, Indian Institute of Forest Management, Bhopal (M.P.). [AGROFORESTRY SYSTEM; JAMMU AND KASHMIR; NATURAL ECOSYSTEM; SILVI-AGRICULTURE]

Traditional agroforestry systems were identified for the first time in the Kashmir Valley as till date no work was reported from the area in the field. Agroforestry systems identified were boundary plantations, Agri-silviculture, Horti-silviculture, Horti-pasture, Horti-silvi-agriculture and Kitchen gardens. A broad evaluation of the systems show that only three tree species i.e. *Populus deltoides, Salix alba* and *Robinia pseudoacacia* are extensively planted. Adequate representation of all the components is lacking in the systems and in some of the models tree component is far less and utilization of space in these system is not efficient, besides the yield of agricultural crops is also less. Thus there is a need to make the models viable by the intervention of scientific agroforestry which need to be devised for the areas.

Nagrare, V.S. 2001. **Pests of orchids and their management in Sikkim - A survey**. *J. Orchid Soc. India*, 15(1-2): 65-68. National Research Centre for Orchids, Pakyong 737106, Sikkim, India. [MANAGEMENT; NATURAL CONDITION; ORCHID]

Mites, scales, slugs, mealy, bugs, cabbage moths, grasshoppers, snails and nematodes are reported to infest orchids in Sikkim. Mites and scales are serious preset of cymbidiums, mealy bugs of cattleyas, and slugs of both cattleyas as well as phalaenopses. Mites can be easily managed with fortnightly sprays with kelthane (2.0-2.5%) and mealy bugs with monthly sprays with phosphamidon (0.2%). While the pests cause 5% loss in flower production under protected conditions, cymbidiums grown under natural conditions were free from pests.

Nautiyal, B.P.; Prakash, Vinay; Bahuguna, R.; Maithani, U.; Bisht, H. and Nautiyal, M.C. 2002. **Population study for monitoring the status of rarity of three Aconite species in Garhwal Himalaya**. *Tropical Ecology*, 43(2): 297-303. High Altitude Plant Physiology Research Centre, Post Box # 14, HNB Garhwal University, Srinagar (Garhwal) 246174, Uttaranchal, India. [ACONITE; ALPINE; DEGREE OF CONSTANCY; SUB-ALPINE]

Alpine and subalpine regions of Garhwal Himalaya were surveyed quantitatively for the population study to determine the status of three aconites viz., *Aconitum balfourii, A. heterphyllum* and *A. violaceum*. Population data of these three aconites revealed that they are restricted to specific pockets and had very low population density. Illegal and over exploitation of these species pose threat to their existence. However, to assign the categories of threats population status of aconites has not been quantified so far. Present study summarizes the population dynamics of identified aconite species in Garhwal Himalaya. Observations reveal that on the basis of population density and degree of constancy (occurrence) used to assign threat categories, all the three *Aconitum* species are endangered. Furthermore, these observations would be helpful in monitoring the threat categories in future on the basis of population reduction.

Negi, C.S.; Nautiyal, Sunil; Dasila, Lokesh; Rao, K.S. and Maikhuri, R.K. 2002. **Ethnomedicinal plant uses in a small tribal community in a part of Central Himalaya, India**. *Journal of Human Ecology*, 14(1): 23-31. Department of Zoology, Govt. P.G. College, Pithoragarh, Uttaranchal; G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263643, Uttaranchal; G.B. Pant Institute of Himalayan Environment and Development, Garhwal Unit, Srinagar (Garhwal), Uttaranchal, India. [CONSERVATION; MEDICINAL PLANTS; SOCIO-ECONOMIC DEVELOPMENT; TRADITIONAL HEALTH CARE SYSTEM; TRADITIONAL KNOWLEDGE; TRIBAL COMMUNITY]

The Raji tribe a smallest group among the native societies of Central Himalaya, inhabiting in Kumaon region bordering to Nepal, has strong faith and belief in traditional health care system, viz. herbal treatment. The living condition of Rajis is extremely poor and neither they have better access to modern health care and nor they have information pertaining to the same. The 50 plant species are documented here pertaining to the uses in traditional health care system of this under developed tribal community. The importance of documenting indigenous knowledge base related to ethnobotany, as described here becomes important in view of rapid socio-economic and cultural changes.

Negi, Hans Raj and Gadgil, Madhav 2002. **Cross-taxon surrogacy of biodiversity in the Indian Garhwal Himalaya**. *Biological Conservation*, 105(2): 143-155. Biodiversity Division, Institute of Himalayan Bioresource Technology (Council of Scientific & Industrial Research), Post Box No.6, Palampur (H.P.) 176061; Centre for Ecological Sciences, Indian Institute of Science, Bangalore 560012, India. [α-DIVERSITY; β-DIVERSITY; CROSS-TAXON SURROGACY; GARHWAL HIMALAYA; LIVERWORT; MACROLICHEN; MOSS]

Biodiversity surveys were conducted in 13, 10x15m^2 plots located between 1400 to 3700 m above mean sea level in a range of habitats in temperature mixed Oak and Coniferous forests through sub-alpine to the alpine grasslands in Chamoli district of Uttaranchal state in the Indian Garhwal Himalaya. Cross-taxon congruence in biodiversity (α-diversity and β-diversity) across macrolichens, mosses, liverworts, woody plants (shrubs and trees) and ants was investigated, so as to examine the extent to which these groups of organisms can function as surrogates for each other. Although woody plants provided a major substrate for macrolichens and mosses, there was no species-specific association between them. Woody plant species richness was highly positively correlated with mosses (r^2=0.63, P<0.001), but the relationship was not particularly very strong with lichens and liverworts. While there was a significant correlation in the species turnover (β-diversit) of macrolichens with mosses (r^2=0.21, P<0.005), the relationship was relatively poor with the woody plants. On the other hand, negative correlations emerged in the species richness of ants with those of macrolichens, mosses and woody plants (r^2=-0.44, P<0.05), but most of the complementarity (turnover) relationships among them were positive. Since diversity between taxonomic hierarchies within the group was consistently significantly positively correlated in all these taxa, the higher taxonomic categories such as genus and family may be employed as surrogates for rapid assessment and monitoring of species diversity. Although no single group other than macrolichens has emered as a good indicator of changes in species richness in all other groups, some concordant relationships between them conform to the

hypothesis that species assemblages of certain taxonomic groups could still be used as surrogates for efficient monitoring of species diversity in other groups whose distribution may further predict the importance of conserving overall biodiversity in landscapes such as the Garhwal Himalaya.

Negi, Mamta; Singh, Ravindra and Jain, P.P. 2002. **Studies on non-traditional oilseeds**. *Journal of Non-Timber Forest Products*, 9(1/2): 64-66. Centre of Advanced Studies in Chemistry of Forest Products, Forest Research Institute, Dehradun 248006, Uttaranchal. [EDIBLE PLANTS; FATTY ACID; OILSEEDS]

Tree borne oilseeds which have been discussed and advocated at various levels, are important sources of edible and non-edible oils. Fatty oil from *Garuga pinnata* seeds has been found to be rich in oleic acid C18:1 (n-9), 36.14%; and an unusual fatty acid C18:1 (n-12), 34.93%, whereas the fatty oil from *Prunus cornuta* has been found to be rich in oleic acid (46.26%) and palmitoleic acid (17.05%), hence these oils may find their utility as a source of these acids. This is the first report on these seed oils.

Negi, S.S. 2002. **Chilgoza or neoza pine - An important NTFP of the tribal areas of Kinnaur, H.P**. *Journal of Non-Timber Forest Products*, 9(1/2): 70-72. Conservator of Forests, Rampur, Himachal Pradesh. [BIOTIC PRESSURE; NATURAL REGENERATION; SEEDLING]

Chilgoza is a valuable Non-timber forest product obtained from *Pinus gerardiana* tree in the dry trans-Himalayan tracts of Kinnaur in Himachal Pradesh. This paper discusses the silviculture, natural regeneration, artificial regeneration techniques and utilization patterns of chilgoza pine. This is an attempt to document the silviculture and utilization of chilgoza pine based on the first hand experience of the author.

Pande, P.K.; Negi, J.D.S. and Sharma, S.C. 2002. **Plant species diversity, composition, gradient analysis and regeneration behaviour of some tree species in a moist temperate Western Himalayan Forest Ecosystem**. *The Indian Forester*, 128(8): 869-886. Centre for Forestry Research & Human Resource Development, Chhindwara (M.P.); Presently at Botany Division, Forest Research Institute, Dehradun (Uttaranchal). [DIVERSITY; FOREST ECOSYSTEM; ORGANIC MATTERS; SEEDLING]

Vegetation composition, species diversity, distribution pattern and other parameter of vegetation analysis along with the population structure and regeneration behaviour of some tree species in a Western Himalayan forest of Chakrata Forest Division (Uttaranchal) were studied. The possibility of future composition changes was also explored. The whole area is divided into three sites as per their aspect and altitudes (site-I - alt. 1,700 masl, aspect N-E; site-II - alt. 2,050 masl, aspect, N, and site-III, alt., 2,100 masl, aspect, N-W). The communities for these sites were identified as *Cedrus deodara* forest (site-I), *Cedrus deodara-Quercus leucotrichophora-Pinus wallichiana* (site-II) and *Q. leucotrichophora-C. deodara-P. wallichiana* (site-III). Total density range for the tree species (plant 100 m^{-1} was 4.51-6.64; 23.56-41.62 for shrubs and 7,280-11,920 for herbaceous species; while the range for total basal cover (cm^2100m^{-2}) was in between 0.332-0.938 for trees; 9.50-18.81 cm^2100m^{-2} for shrubs and 235-323 cm^2100m^{-2} for herbaceous species. Most of the species in all the sites showed contiguous pattern of distribution, however some species were also randomly distributed. Maximum diversity of trees was observed for site-III and for herb and shrubs species diversity values were highest for sites II and III respectively. However, lowest diversity was recorded for the herbaceous layer in site-III. Further, increasing altitude showed increase in tree diversity. Concentration of dominance showed reverse trend to diversity. Sites II and III were most similar sites, whereas sites I and III were most dissimilar sites. Highest turnover of tree species was recorded between sites I and III; for shrub species, these were site-II and III and maximum turnover for herb species was recorded between sites I and II. In all the studied sites, the dominant species has shown good regeneration potential as evidenced by the presence of adequate number of seedling, sapling and distribution of boles among almost all gbh classes.

Pandey, Anita; Nadeem, M. and Palni, L.M.S. 2002. **Improvement in seed germination of Himalayan yew through simple soil treatments**. *Indian Journal of Forestry*, 25(2): 109-113. G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263643, Uttaranchal. [MICROBIAL ANALYSIS; SEED GERMINATION; TAXUS BACCATA]

Seed germination in *Taxus baccata* subsp. *wallichiana* was investigated using soil from the forest as well as non-forest areas, including sterilized soil. Results obtained fro various soil treatments indicated the presence of certain antigermination factors in the rhizosphere soil of *T. baccata*, which seem to be of

microbial origin. Seed germination was found to improve in autoclaved *Taxus* forest soil. The aril portion of *Taxus* seed inhibited germination. Since *Taxus* plants were found growing under the shade of *Cedrus deodara* trees, probably sharing similar rhizosphere communities, seed germination of *Taxus* was also tried in *Cedrus* forest soil, which too was found to be inhibitory. Similar to *Taxus* rhizosphere soil, in this case also, germination improved in autoclaved soil. Pine rhizosphere soil and non-forest soil treatments resulted in higher seed germination, indicating the absence of antigermination factors. Highest seed germination (up to 70%) was recorded in non-forest soil under polyhouse conditions, when the seeds were sown after removing the aril. These results are indicative of the association of specific microbial population with *Taxus* rhizosphere, not favouring its own seed germination. The study has implications in afforestation or reforestation programmes.

Pandey, G. 2002. **Popularizing under-exploited fruits for consumption**. *Indian Horticulture*, 47(3): 18-21. CITH, Regional Station, Mukteswar, Nainital 263138, Uttaranchal. [COMMERCIAL NURSERY; EDIBLE FRUITS; SHIFTING CULTIVATION]

The plants are solar-powered refineries solar energy and providing food, fuel and shelter to mankind. Approximately, 800 plant species are consumed as food plants by the tribal population of India. Of them, 300 plant species alone occur in north-eastern hills region. Apart from commonly available popular fruits, there are a plenty of promising wild edible fruits known to be grown in this region. Although identity of these plants are really threatened because of existing *jhum* practice (shifting cultivation). However, before going to the endemic state, these plant species are to be conserved and actual damage/availability, growing potential, disease/insect attack, marketing status and processing potential need to be thoroughly studied for future use.

Prakash, Om; Nagar, P.K.; Lal, Brij and Ahuja, P.S. 2002. **Effect of auxins and phenolic acids on adventitious rooting in semi-hardwood cuttings of *Ginkgo biloba***. *Journal of Non-Timber Forest Products*, 9(1/2): 47-49. Division of Biotechnology, Institute of Himalayan Bioresource Technology, Palampur 176061, H.P. [DIAMETER; ROOT FORMATION; STEM CUTTING]

The effect of IBA and two phenolic compounds have been examined for stimulatory effects on rooting of semi-hardwood cuttings of mature *Ginkgo biloba* L. trees. IBA alone did not exert a favourable influence on rooting but in combination with polyphenols, viz., catechin and phloroglucinol improved rooting and root growth characteristics. Amongst various treatments, IBA (500 mg/1) + catechin (5 mg/1) is superior over other treatments since 96% rooting was observed in this combination. This treatment could be used successfully for vegetative propagation of this species.

Purohit, V.K.; Palni, L.M.S.; Nandi, S.K. and Rikhari, H.C. 2002. ***In vitro* regeneration of *Quercus floribunda* Lindl. through cotyledonary nodes: and important tree of Central Himalaya**. *Current Science*, 83(3): 312-316. G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263643 (Uttaranchal). [CENTRAL HIMALAYA; DIAMETER; MICROSHOOTS; PLANT GROWTH REGULATORS AND ROOTING]

A regeneration protocol has been developed for *Quercus floribunda* Lindl. using cotyledonary nodes (with attached cotyledons but without radicle and primary shoot) as explants. Multiple shoots were induced on woody plant (WP) or MS medium supplemented with 6-benzyladenine (BA), either alone or in combination with gibberellic acid (GA_3). BA (22.19 uM) was much more effective in WP medium for induction of multiple shoots; addition of GA_3 (2.89 uM) resulted in thinner but slightly longer shoots. Rooting (83.3%) of regenerated shoots involved a two-step procedure where the microshoots were treated with indole-3-butyric acid (100 uM) for 24 h followed by transfer to plant growth regulator-free half-strength WP medium. Ninety per cent plantlets were successfully established in eartern pots containing soil and farmyard manure (3:1).

Pyasi, S.K. and Singh, J.K. 2002. **Dynamic approach to Model rainfall-runoff process- A case study**. *Journal of soil and Water Conservation*, 1(2&3): 118-125. Department of Agricultural Engineering, Birsa Agricultural University, Kanke, Ranchi 834006; Department of Soil and Water Conservation Engineering,

PCT, G.B. Pant University of Agricultural and Technology, Pantnagar 263145, Uttaranchal. [RAINFALL; WATERSHED MANAGEMENT]

An efficient runoff prediction dynamic model on weekly basis has been developed for the Naula Watershed of Ramganga Reservoir, a hilly catchment of Himalaya in Uttar Pradesh, India. The model requires weekly rainfall, antecedent precipitation index (API), antecedent runoff index, number of rainy days in a week and the calender week number as the independent variables for the prediction and generation of weekly runoff. Both linear and non-linear model were developed and the coefficient of multiple determination (R2) were 83 per cent and 78 per cent, respectively. The qualitative comparison of linear and non-linear model showed the better performance of linear model for different years. It was observed that runoff volume of three successive weeks prior to the week under consideration showed a significant effect on the runoff of that particular week. The three preceding runoff events affect the runoff flow of the current week, quantitatively by 44.48 per cent, 32.13 per cent and and 23.03 per cent respectively. This study is different from the earlier studies made by several researches in the sense that the varying weightage has been assigned to different preceding event accepted to effect the output of present event.

Rautela, Piyoosh; Rakshit, Rahul; Jha, V.K.; Gupta, Rajesh Kumar and Munshi, Ashish 2002. **GIS and remote sensing-based study of the reservoir-induced land-use/land-cover changes in the catchment of Tehri dam in Garhwal Himalaya, Uttaranchal (India)**. *Current Science*, 83(3): 308-311. Indian Institute of Remote Sensing, 4, Kalidas Road, Dehradun 248001 (Uttaranchal). [BUFFER ZONE; GIS; LAND-USE; REMOTE SENSING]

Large dams, though necessary for national growth, adversely affect the life-support strategy of large number of people living in the submergence zone and the hinterland of the reservoir. With the help of GIS-based techniques and land-use/land-cover map prepared with the help of satellite remote sensing tools, it is estimated that the Tehri reservoir in the upper catchment of Ganga river would directly affect 2687 ha of agricultural land and another 3347 ha around the reservoir rim would be rendered unfit for cultivation.

Sagta, H.C. and Nautiyal, S. 2002. **Effect of water stress and antitranspirants on chlorophyll contents of *Dalbergia sissoo* Roxb. leaves**. *The Indian Forester*, 128(8): 893-902. Plant Physiology, Botany Division, Forest Research Institute, Dehradun (Uttaranchal). [DALBERGIA SISSOO; SEEDLING; WATER STRESS]

Four months old seedlings of *Dalbergia sissoo* Roxb. were subjected to water stress treatment by withholding watering for 7, 14, 28 days and compared with the control (daily watering). In addition, seedling were treated with two concentrations of three antitranspirants viz., Cycocel (CCC), Maleic Hydrazide (MH) and Sodium Benzoats (SB) with the objective of maintaining water economy in seedling through reduced loss of water by limiting the transpiration. The study was carried out for 6 months to determine the stress tolerance and changes in chlorophyll content of this species. Variations with in the treatment of water stress, antitranspirants concentrations and monthes were found highly significant ($P<0.01$). The increasing level of water stress and antitranspirants concentration decreases the chlorophyll contents (*a, b* and total). The maximum chlorophyll contents in leaves were observed in plants untreated by antitranspirants at daily watering. However, the minimum chlorophyll contents were observed at 28 days watering interval under all the treatments. Higher concentration of antitranspirants decreases chlorophyll contents more adversely as compare to lower concentrations. Sodium benzoate was found to be more effective to decrease the chlorophyll content as compared to other antitranspirants at lower concentration. The effect of water stress in compination with antitranspirants found to reduce the chlorophyll-*b* content to larger extent as compared to chlorophyll-*a).*

Saha, A.K. and Gupta, R.P. 2002. **GIS-based Landslide Hazard Zonation in the Bhagirathi (Ganga) Valley, Himalayas**. *Int. J. Remote Sensing*, 23(2): 357-369. Department of Earth Sciences, University of Roorkee, Roorkee 247667, Uttaranchal. [DRAINAGE; GARHWAL HIMALAYA; GIS; LANDSLIDE HAZARD INDEX]

Landslides cause widespread damage in the Himalayas. Landslide Hazard Zonation is important to take quick and safe mitigation measures and make strategic planning for the future. A part of the Bhagirathi Valley in the Garhwal Himalaya was selected for landslide hazard zonation. The study utilized different

types of data including Survey of India topographic maps, geological (lithological and structural) maps. IRS-1B and -1D multispectral and PAN satellite sensor data and field observations. The processing of multi-geodatasets was carried out in a raster GIS environment. The various data layers generated and co-registered were: landuse/landcover, buffer map of thrusts, buffer map of photolineaments, lithology, buffer map of drainage, slope angle and relative relief. Data integration was carried out using the ordinal scale (qualitative) relative weighting rating technique to give a Landslide Hazard Index (LHI) value. The breaks in the LHI frequency diagram were used to delineate various landslide hazard zones, namely, very low, low, moderate, high and very high. Field data on landslides were employed to evaluate and validate landslide hazard zonation map. It is interpreted that the distribution of landslides is largely governed by a combination of geo-environmental condition like proximity (>500m) to the thrust zone, presence of Munsiari Formation (Higher Himalayan Crystalline) and barren or less-vegetated areas.

Sahu, R.K. and Agarwal, V.K. 2002. **Location of seed-borne fungi associated with forest tree seeds of horse bean *(Parkinsonia aculeata)*, lead tree *(Leucaena leucocephala)* and rusty shield bearer *(Peltophorum ferrugineum)***. *The Indian Forester*, 128(8): 887-892. Centre of Advanced Studies in Plant Pathology, G.B. Pant University of Agriculture & Technology, Pantnagar (Uttaranchal). [EMBRYO FORMATION; SEED COAT PATTERNS; SEED-BORNE FUNGI]

The fungi namely *Aspergillus flavus, A. fumigatus, A. niger, Curvularia lunata, Fusarium equiseti, F. longipes, F. pallidoroseum, Fusarium* sp., *Paecilomyces variotii, Penicillium pinophilum, Rhizoctonia solani* and *Rhizopus stolonifer* were recorded from the seed coat, endosperm and embryo of normal and discoloured seeds of Horse bean *(Parkinsonia aculeata)*, whereas *Apispora montagnei, Aspergillus aculeatus, A. flavus, A. fumigatus, A. niger, Curvularia clavata, C. lunata, Fusarium equiseti, F. pallidoroseum, F. moniliforme, Fusarium* spp., *Rhizoctonia solani* and *Rhizopus stolonifer* were found associated with the seed coat, endosperm and embryo of the normal and discoloured seeds of lead tree (*Leucaena leucocephala).* On the other hand, *Aspergillus flavus, A. fumigatus, A. niger, A. ustus, Aspergillus* sp., *Curvularia lunata, Fusarium compactum, F. longipes, F. pallidoroseum, Fusarium* sp. and *Penicillium aurantiogriseum* were detected in the seed coat, endosperm and embryo of the normal and discoloured seeds of rusty shield bearer (*Peltophorum ferrugineum*). In general, the per cent incidence of fungi recovered from the discoloured seeds was greater in comparison to the normal seeds.

Sarin, Aparna and Chahal, M.S. 2002. **Erythrocyte enzyme variation in Brahmin and Rajput population of Himachal Pradesh. II. Solan district**. *Journal of Human Ecology*, 13(3): 191-195. Department of Human Biology, Punjabi University, Patiala 147002, Punjab, India. [CASTE POPULATIONS; ERYTHROCYTE ENZYME POLYMORPHISMS; HIMACHAL PRADESH]

Data are presented on phenotype and allele frequency distributions of seven polymorphic red cell enzymes in two predominant caste populations of Himachal Pradesh viz. the Brahmin and Rajput inhabiting southern district of Solan. The result of this molecular biology investigation demonstrate that apparently there was similarity in genetic constitution of the present two caste groups. Furthermore, either group was found to be homogeneous with its counterparts reported earlier from different other regions (districts) of this north-west Indian state.

Semwal, R.L.; Maikhuri, R.K.; Rao, K.S.; Singh, K. and Saxena, K.G. 2002. **Crop productivity under differently lopped canopies of multipurpose trees in Central Himalaya, India**. *Agroforestry Systems*, 56(1): 57-63. G.B. Pant Institute of Himalayan Environment and Development, Garhwal Unit, P.B. 92, Srinagar (Garhwal); G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263643, Uttaranchal; School of Environmental Sciences, Jawaharlal Nehru University, New Delhi 110067, India. [PHOTOSYNTHETICALLY ACTIVE RADIATION; TEMPERATURE RESPONSE; TRADITIONAL PRACTICES]

Tree-crop mixed farming is the predominant traditional landuse in the Central Himalaya. Knowledge on the effect of lopping the overstory of trees on the productivity of understory of intercropped food crops is limited. Five levels of lopping regime (no lopping, 25%, 50%, 75% and 100% lopping of branches) were established in a 6-year-old mixed plantation of locally valued multipurpose trees in a village at 1200 m altitude. Wheat (*Triticum aestivum* L.) mustard *(Brassica campestris* L.) and lentil *(Lens*

esculenta Moench) were intercropped during winter season, and rice *(Oryza sativa* L.), foxtail millet *(Setaria italica* (L.) P. Beauv.) and barnyard millet *(Echinochloa frumentacea* Link) during warm rainy season following traditional practices. No lopping resulted in only 16% of estimated photosynthetically active radiation available in full lopping treatments in case of winter crop and 12% in case of rainy season crops. Mean day temperature was lower by 2°C in no lopping treatments as compared to full lopping treatments in both seasons. There were no significant differences in grain and by product yields between no lopping and 25% lopping, and between 75% and full lopping treatments in all crops except lentil. For winter crops, grain yields in no lopping treatments were only 16 to 21% of the yields in full lopping treatments compared to 3 to 5% in rainy season crops. By-product yields from winter crop in no lopping treatments were 29 to 32% of the full lopping treatments compared to 6 to 8% in rainy season crops. Farmers frequently practice full lopping during winter season. This study shows that loss of crop yields may not be significant if 25% of branches are retained.

Sharma, J.N. 2002. **Managing pre-mature leaf fall in apple**. *Indian Horticulture*, 47(2): 4-5. Apple Scab Laboratory, Dr. Y.S. Parmar University of Horticulture and Forestry, Kotkhai, District Shimla 171002, Himachal Pradesh. [COST-EFFECTIVE; FUNGICIDE; LEAF FALL]

The apple plantation in Himachal Pradesh has been ravaged by pre-mature defoliation for the last 5 years. Pioneer work done in the Apple Scab Laboratory, Kotkhai (district Shimla) has led to its proper diagnosis and control. This problem is caused by the hitherto unknown fungal disease Marssonina blotch *(Marssonina coronaria)* which appears as brown to dark brown spots of varying sizes on mature whorl leaves in summer. The infected leaves loose their normal greencolour becoming yellow and drop-off prematurely. Under excessively humid conditions, defoliation serves that only fruits nearing maturity are seen hanging on naked branches and the problem is commonly designated as `pre-mature leaf fall'. Clear dark brown spots also appear on fruits, reducing fruit-bearing capacity of trees drastically in the following seasons. The fungus was isolated and cultured on synthetic media and its pathogenecity has been proved. Protective sprays of mancozed, propineb, dodine, carbendazim, thiophanate methyl, dithianon and ziram controls it satisfactorily. A cost-effective fungicidal spray schedule has also been recommended.

Sharma, J.R. 2002. **Wood-rotting fungi of temperate Himalaya- An assessment and conservation**. *Indian Journal of Forestry*, 25(2): 221-239. Botanical Survey of India, 192, Kaulagarh Road, Dehradun 248195, Uttaranchal, India. [CONSERVATION; DIVERSITY; NATURAL RESOURCE MANAGEMENT; WOOD-ROTTING FUNGI]

Species of wood-rotting fungi of the order Aphyllophorales form an integral part of the temperate forested Himalayan ecosystems and play the primary role of formation of forest soils by decomposition of substrates. There exists a high diversity in species composition and richness, host preferences and type of wood rots caused by them. The essential but a mammoth task of studying their rich diversity has been limited by taxonomic and logistic difficulties in collecting and defining fungal species. The various difficulties like seasonal fluctuations, succession of substrates and other consideration have led to problems in assessing and documenting their diversity. Dynamics during decomposition of substrate and mechanism of its decay are also emphasized. The various threats to the wood-rotting fungi as a whole and the conservation measures required to be undertaken are also evaluated.

Sharma, P.C.; Sharma, D.D. and Sharma, K.D. 2002. **Making instant chutney powder from wild apricot**. *Indian Horticulture*, 47(1): 33-34. Department of Post-harvest Technology, Regional Horticultural Research Station, Sharbo, District Kinnaur 172107, Himachal Pradesh; Department of Social Science, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan 173230. [HOUSEHOLD; SOCIO-ECONOMIC STATUS; WILD APRICOT]

Technology for preparing `instant chutney powder' from wild apricot- a fruit grown abundantly in tribal areas of Himachal Pradesh, has been standardized. The response of 150 tribal women indicated that the product is of excellent quality with yellowish to dark green colour, good flavour and excellent taste. The respondents prefered 100g packing of the product over 500g or 1 kg pack. The technology is perceived to be quite simple, economical, compatible and easily adoptable which can improve the socio-economic status of the tribal women.

Sharma, R.C.; Khan, Y. and Gupta, A.K. 2002. **Development of *Melampsora* leaf rust in nursery grown *Populus ciliata***. *The Indian Forester*, 128(8): 926-930. Department of Mycology and Plant Pathology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. [CLONES; DISEASE INDEX; LEAF RUST; METEOROLOGICAL FACTOR]

Development of *Melampsora* leaf rust in *Populus ciliata* reveals that clones, which were disease free during July, got infected in the month of August. Clone Kufri has least disease while Theog was most susceptible. Desease development was rapid between July and August months. PCM 5195, 5011, 5180 and 5157 hybrids of *P. ciliata* x *P. maximowiczii* had least disease while PCM 5084 and 5053 were highly susceptible. The development of disease was negatively correlated with temperature but positively with relative humidity and rainfall.

Sharma, R.K.; Pathania, N. and Chandel, R.S. 2002. **Cultivating ginger himgiri in Himachal Pradesh is remunerative**. *Indian Horticulture*, 47(3): 31-33. Seed Technology and Production Centre, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh 173230. [FARM YARD MANURE; GINGER; LOAM SOILS]

All ginger varieties grown commercially in Himachal Pradesh are susceptible to soft rot, but Himgiri is quite tolerant to rhizome rot. It thrives well under mid and low hills of Himachal conditions and offers a tremendous potential for its commercial cultivation.

Sharma, Rita; Sharma, G. and Sharma, E. 2002. **Energy efficiency of large cardamom grown under Himalayan alder and natural forest**. *Agroforestry Systems*, 56(3): 233-239. G.B. Pant Institute of Himalayan Environment and Development, Sikkim Unit, P.O. Tadong, Gangtok, Sikkim 737102, India; Mountain Farming Systems Division, International Centre for Integrated Mountain Development, G.P.O. Box 3226, Kathmandu, Nepal. [ALNUS NEPALENSIS; AMOMUM SUBULATUM; ENERGETICS; ENERGY-FIXATION; SIKKIM HIMALAYA]

Energy efficieny of agroforestry systems of large cardamom grown under N_2-fixing Himalayan alder (alder cardamom) and natural forest (forest-cardamom) was studied in the Sikkim Himalaya. Large cardamom *(Amomum subulatum*), the most important perennial cash crop of the region, is widely cultivated with Himalayan alder *(Alnus nepalensis)* as shade tree. Energy fixation, storage, net allocation in agronomic yield, and heat release and exit from the system were respectively 1.57, 1.44, 2.24 and 2.22 times higher in the alder-cardamom compared to the forest-cardamom system. Energy conversion efficiency and net ecosystem energy increment were also higher in the alder-cardamom than the forest-cardomom system. Energy fixation efficiency and energy conversion efficiency of large cardamom increased under the influence of Himalayan alder. Energy efficiency in N_2-fixation of Himalayan alder was also high (67.5 g N_2 fixed 10^4 kJ^{-1} energy). Quantum and flux of energy increased in the alder-cardamom compared to the forest-cardomom system that optimized the production potential of the cash crop under the influence of the Himalayan alder. Climatic sympatry of the large cardamom and Himalayan alder, and their synergetic energy efficiency makes this association ecologically and economically viable for the mountain regions.

Singh, Dhan; Vasistha, H.B. and Pandey, Rajiv 2002. **Role of agroforestry interventions in development of mined degraded watersheds of Doon Valley**. *Indian Journal of Forestry*, 25(1): 7-20. Forest Research Institute, Dehradun; Indian Council of Forest Reasearch & Education, Dehradun, Uttaranchal. [AGRO-FORESTRY; ORGANIC MATTERS; SOIL MOISTURE; WATERSHED MANAGEMENT]

The ecosystem of Doon Valley is greatly influenced by open cast mining for limestone, marble, dolomite and phosphorite, etc. The mining on the watershed has resulted in denudation of hill slopes, loss of vegetation and soil cover, decrease in soil moisture retention, nutrient holding and water recharging capacity and thereby changing the total hydrological picture of the region. Land degradation in the region has become the most important problem when dealing with the watershed management. Poor moisture availability in addition to various other physico-chemical characteristics and nutrient deficiency, are responsible for poor growth of plants. In order to restore the vegetation cover, productivity in term of fuel, fodder and to regulate the hydrological behaviour of the watershed, micro-interventions using silvipastoral system, i.e., planting of

grasses in between trees and shrubs have been carried out in mined degraded areas. The impact of micro-interventions on autogenic progression of other species, soil physico-chemical attributes and infiltration characteristics after seven years of restoration have been studies in Bhitreli micro-watershed of Doon Valley and results discussed in the present paper.

Singh, Subodh Kumar and Misra, K.K. 2002. **Effect of tree age and season on root distribution pattern of bael *(Aegle marmelos* (L.) correa)**. *Journal of Non-Timber Forest Products*, 9(1/2): 43-46. Department of Horticulture, G.B. Pant University of Agriculture and Technology, Pantnagar 263145, Uttaranchal. [DISTRIBUTION PATTERN; RADIAL DISTANCE; SEASONAL VARIATIONS]

The investigation was carried out on 3- and 13-year-old phenotypically similar and healthy budded trees of bael cv. Pant Shivani in autumn of 2000 and spring of 2001 as per free monolith method of root excavation. The experiment was laid out in factorial randomized block design with two replications involving four factors, viz., season, age, radial distance and depth. The results showed that the tree age significantly influenced the various categories of roots. The 13-year-old tree gave significantly higher dry weight of roots than 3-year-old trees. Seasonal variation did not affect the root distribution patter in bael. The maximum dry weight of active roots was observed at 0-60 cm radial distance from the tree trunk and at 0-20 cm depth from the ground level. The interaction between tree age and soil depth in dry weight of medium and total roots were found to be significant while rest interaction were non-significant.

Singh, T.P.; Singh, S.; Roy, P.S. and Rao, B.S.P. 2002. **Vegetation mapping and characterization in West Siang District of Arunachal Pradesh, India - a satellite remote sensing-based approach**. *Current Science*, 83(10): 1221-1230. Indian Institute of Remote Sensing (NRSA), Dehradun 248001, Uttaranchal; Department of Geo-engineering, College of Engineering, Andhra University, Visakhapatnam 530003, India. [BROAD-LEAVED FOREST; GPS; LAND-COVER; SATELLITE DATA]

Vegetation mapping is a primary requirement for various management and planning activities at the regional and global level. It has assumed greater importance in view of the shrinkage and degradation in forest cover. Usage of remotely sensed data for mapping provides a cost-effective method. In the present study vegetation cover assessment has been done using remotely sensed data in West Siang District of Arunachal Pradesh. Standard method was adopted for ground data collection by establishing the correlation between satellite data and various vegetation types. Ground data were collected extensively and sufficient information was obtained. Vegetation classification was performed using traditional methods of image recognition. The discrimination among the various forest types is restrained on satellite data owing to the environmental set-up, intermixing of species/vegetation and topography. However, to achieve higher accuracy, other methods have been considered. Hybrid approach of classification has been adopted where modification of spectral classification with the aid of ancillary data set has been found useful. The study area has been classified into twenty-three categories. The vegetation cover types extracted from classification showed good relationship with altitudinal zones. Correspondence with field-gathered GPS points for vegetation classes showed 85.29% overall accuracy. Hybrid classification approach gives an opportunity to refine the classification to acceptable limits for various activities related to management and planning.

Sinha, Amita 2002. **A study of bacterial contamination of Banganga stream, Katra (J&K)**. *Journal of Non-Timber Forest Products*, 9(1/2): 97-100. Centre for Environmental Management of Degraded Ecosystem, Benetto Jurez Marg, University of Delhi, South Campus, New Delhi 110021. [JAMMU & KASHMIR; MICROORGANISM; POLLUTION LOAD]

In this paper, an attempt has been made to study the bacterial contamination in the Banganga stream, Katra, J&K, in order to make an assessment of water quality and the potential danger to the local people, animal population and the pilgrims due to pollution load from very large tourist traffic. No such study is available from the areas so far. The pilgrim traffic to the holy town has witnessed a phenomenal increase in recent years. In the present study, the total viable count (TVC), total coliform, faecal coliform and the faecal streptococci were studied. The counts were found highest during summer and lowest during winter. Bacterial counts were also taken during "Navratra" (April & October) periods when the pilgrims rush is at its peak generating greater pollution load. The present study indicates that the Banganga water is not fit

for use and an immediate need is to treat the sewage before throwing it into the stream, which has a low self-purification capacity.

Sinha, S.K.; Hegde, S.N. and Bhowmik, G. 2001. **Differential effect of gamma irradiation on morphogenesis of PLBs of *Renades* `Arunodaya' hybrid and its parent species *Aerides rosea* and *Renanthera imschootiana***. *J. Orchid Soc. India*, 15(1-2): 39-48. Orchidology Division, State Forest Research Institute, P.B. No. 159, Itanagar 791111, India, Department of Biotechnology, Gauhati University, Guwahati 781014, India. [GERMINATION; NORTH-EAST; ORCHID; SEEDLING]

The morphogenetic response of τ-irradiated (0,1,2,3,4 and 5 Krad doses) 15-day-old undifferentiated protocorm like bodies (PLBs) raised *in vitro* was studied with respect to percentage of proliferation, multiplication, leaf and root primordia initiation, and mortality parameters. PLBs of *Aerides rosea* were the most radiosensitive and were followed by *Renanthera imschootiana* and *Renades* `Arunodaya' in this respect. Proliferation of PLBs was impaired with different negative polynomial regression trends. Multiplication and leaf primordia initiation showed a positive a trend in hybrid, and a negative trend in parent species. Initiation of leaf primordia showed a prominent secondary peak in *Renanthera imschootiana*. Mortality of PLBs in both the parent species were directly proportional to the dose exposed, whereas it followed negative polynomial regression trend in the hybrid.

Tewari, Salil K.; Subhanjana; Shukla, A.K. and Pandey, S.B.S. 2002. **Genetic divergence in Shisham *(Dalbergia Sissoo* Roxb.)**. *Indian Journal of Forestry*, 25(1): 21-24. Department of Genetics & Plant Breeding (Agroforestry Project), G.B. Pant University of Agriculture & Technology, Pantnagar 263145, Uttaranchal; Resource Survey & Management Division, FRI, Dehradun, Uttaranchal. [DIAMETER; DIVERSITY; GERMPLASM; SEEDLING]

Genetic divergence using Mahalanobis D^2 analysis among 15 genotypes of shisham with twenty component characters at 5 years of age led to their grouping into six clusters. Three genotypes fall in cluster I, four in cluster II, three each in cluster III and IV, and only one in cluster V and VI. Maximum and minimum distances were observed between cluster IV and V and cluster III and V, respectively.

Thakur, I.K.; Gupta, Atul and Thakur, Vidya 2002. **Germination of scarified seeds of *Grewia optiva***. *Indian Journal of Forestry*, 25(2): 158-160. Department of Tree Improvement and Genetic Resources, University of Horticulture and Forestry, Nauni, Solan 173230,Himachal Pradesh. [AGRO-FORESTRY; GERMINATION; SEEDLING]

Study was carried out to evaluate the effect of aqueous solution of sulphuric acid in reducing the endocarp/seed coat dormancy of *Grewia optiva* seeds. Soaking the seeds in dilute sulphuric acid (N/10 H_2SO_4) for 36 hours was observed to be the most effective method for breaking this type of seed dormancy followed by N/20 H_2SO_4 for 6 hours under glass house conditions.

Thakur, N.S.Azad; Kumar, Rajesh and Mane, S.S. 2002. **Prospects of *hatkora* cultivation in Mizoram**. *Indian Horticulture*, 47(1): 8-9. ICAR Research Complex for NEH Region, Mizoram Centre, Kolasib 796081. [CITRUS MACROPTERA; CULTIVATION; FRUIT CROPS; MIZORAM]

Mizoram endowed with varied climates - humid subtropical to warm temperate-is ideal for growing a number of horticultural perennial crops. Of the lesser-known fruit crops, *Citrus macroptera*, a locally familiar plant *hatkora*, is quite promising. At present, this is being grown by a few farmers in western parts of the state, just to meet the local demand, the total production being 2,000 tonnes annually from 250 ha area.

Thakur, Vidya and Thakur, I.K. 2002. **Seed polymorphism and its effect on germination and growth of *Robinia pseudoacacia* Linn**. *Indian Journal of Forestry*, 25(2): 147-149. Department of Tree Improvement and Genetic Resources, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan 173230, Himachal Pradesh. [ENVIRONMENTAL CONDITION; GERMINATION; SEEDLING]

Present paper describes the occurrence of seed polymorphism in respect of colour in *Robinia pseudoacacia*. Three coloured seeds, viz., black, brown and grey were noted. Their tree to tree variation in distribution proportion was found to vary with sites. All coloured seeds were tested for their germination and

growth. Black colour seeds had maximum germination per cent and best growth performance as compare to grey and brown seeds.

Uniyal, A.K.; Bhatt, B.P. and Todaria, N.P. 2002. **Provenance variation in seed characteristics of *Grewia oppositifolia* Roxb. - A promising agroforestry tree crop of Central Himalaya, India**. *Indian Journal of Forestry*, 25(2): 209-214. Department of Forestry, H.N.B. Garhwal University, Srinagar (Garhwal) 246174, Uttaranchal, India. [AGRO-FORESTRY; CENTRAL HIMALAYA; GERMINATION; SEEDLING]

Provenance survey of *Grewia oppositifolia* Roxb. was undertaken to identify suitable seed sources for production of quality seedlings for mass afforestation in agroforestry systems in Central Himalaya. Significant (P=0.05) variations were recorded for seed characters among provenances. Elevational range of seed source exhibited significant (P=0.05) positive correlation with seed length, thickness and weight. This is an indication that some of these phenotypic variations may also have genetic base within the natural range of distribution. On average, the provinances Chilledi, Simswara and Malsi were found to be the best on the basis of seed morphological characters. This preliminary investigation may be used for further genetic improvement of *Grewia oppositifolia*.

Uniyal, S.K.; Awasthi, Anjali and Rawat, G.S. 2002. **Mapping fragile mountain watersheds using topography with remote sensing**. *Tropical Ecology*, 43(1): 203-212. Wildlife Institute of India, Post Box No. 18, Chandrabani, Dehradun 248001, Uttaranchal. [FOREST CONSERVATION; MAPPING; UTTARANCHAL]

The complexity and inaccessibility of Himalayan terrain inhibits intensive field survey where remote sensing as a tool can help in exploring such ecologically important and inaccessible areas. The IRS-1C LISS-III data was used to study the forests of Bhagirathi valley in Uttaranchal. The maps were derived using hybrid approach (a combination of supervised and unsupervised classification). A total of ten classes were identified. A knowledge-based classification was used to delineate different conifers, low valley grasslands and scrub from the alpine regions. This approach uses integration of species distribution pattern and digital elevation data in GIS domain. Masking and recording were found useful in removing the noise caused due to shadows and clouds. Finally a total of eight forests and four non-forest classes were segregated and mapped. Of the eight vegetation types broadleaved-conifer mixed dominated the area (24.6%) followed by broadleaved forest (10.5%) whereas the non-forest classes together accounted for 27.6% of the area. Distribution of vegetation in different altitudinal zones, aspects and slopes was also analyzed. It was found that in the lowest and highest altitudinal zones, the forest cover was less compared to middle elevation zone.

Upadhaya, K.; Pandey, H.N.; Law, P.S. and Tripathi, R.S. 2003. **Tree diversity in sacred groves of the Jaintia hills in Meghalaya, northeast India**. *Biodiversity and Conservation*, 12(3): 583-597. Department of Botany, North-Eastern Hill University, Shillong 793022, India. [SACRED GROVE; TREE DISTRIBUTIONAL PATTERN; TREE DIVERSITY; TROPICAL FOREST]

Biodiversity of woody species was investigated in Ialong and Raliang sacred groves of the Jaintia hills in Meghalaya, northeast India. These groves represent the climax subtropical broad-leaved forest of the area. A total of 738 individuals belonging to 82 species, 59 genera and 39 families was identified in a 0.5 ha plot of the Ialong sacred grove, whereas the same area in the Raliang sacred grove had 469 individuals of 80 species, 62 genera and 41 families. About 32% species were common to both groves. lauraceae, with 10-17 species, was the dominant family. The canopy and subcanopy strata were respectively composed of 28 and 33% of the total tree species in the forest. The number of species as well as stem density were greater for the trees of lower dbh (5-15 cm) class compared to the higher (> 66cm) dbh class. The majority of the species showed a contagious distribution pattern and low frequency. The basal area varied from 57.4 to 71.4 m^2 ha^{-1}. Species richness within the forest varied from 3 to 15 per 100 m^2 in Ialong and 3 to 12 per 100 m^2 in Raliang. The dominance-distribution curves showed high equitability and low dominance in both groves.

Vetaas, Ole R. and Grytnes, John-Arvid 2002. **Distribution of vascular plant species richness and endemic richness along the Himalayan elevation gradient in Nepal**. *Global Ecology & Biogeography*,

11(4): 291-301. Centre for Development Studies, University of Bergen, Stroemgaten 54, N-5007 Bergen, Norway; Department of Botany, University of Bergen, Allegaten 41, N-5007 Bergen, Norway. [ELEVATIONAL GRADIENT; ENDEMICITY; GLACIATION; HARD BOUNDARIES; ISOLATION; POLYPLOIDY; SPECIES DIVERSITY]

Species richness and endemic richness vary along elevation gradients, but not necessarily in the same way. This study tests if the maxima in gamma diversity for flowering plants and the endemic subset of these plants are coherent or not. The study was conducted in Nepal, between 1000 and 5000 m a.s.l. The results reject the idea of corresponding maxima in endemic species and species richness in the lowlands tentatively deduced from Stevens' elevational Repoport effect. They confirm predictions based on hard boundary theory, but hard-boundaries should be viewed as dynamic rather than static when broad-scale biogeographical patterns with a historical component are being interpreted.

Viswanath, S.; Singh, R.P. and Thapliyal, R.C. 2002. **Seed germination patterns in a Himalayan moist temperate forest**. *Tropical Ecology*, 43(2): 265-273. Institute of Forest Genetics and Tree Breeding (IFGTB), Forest Campus, R.S. Puram, Coimbatore 641002, Tamilnadu; Forest Tree Seed Laboratory, Forest Research Institute, Dehradun 248006, Uttaranchal; Department of Forest, Kumaon University, Nainital 263002, Uttaranchal, India. [DISPERSAL; ELEVATION GRADIENT; GERMINATION SYNDROMES; MEAN LENGTH OF DORMANCY; SEED DORMANCY; SYNCHRONIZATION]

A study was conducted in a Himalayan moist temperate forest in Mandal to identify the patterns of seed germination and major germination syndromes operating in the forest and to understand the role of primary selective factors in controlling germination in the plant community and how groups of species respond to such factors. The germination pattern was bimodal with the peak time of emergence in June followed by February-March. Along the altitudinal gradient (1650 to 2600 masl), the maximum number of seedlings emerging per transect was at the middle elevations of which more than 80% was understorey species while in the higher elevations canopy tree species seemed to dominate in the regeneration transect. The mean length of dormancy (MLD) of species recorded in field nursery trials in Mandal ranged from 10 days to 285 days. Seasonal analysis of the germination pattern revealed that maximum number of species dispersed their seeds during dry season (Oct-Jan) as compared to rainy or pre-rainy season. Three germination groups: delayed-rainy (DR), intermediate-dry (ID) and rapid-rainy (RR) were identified as the major germination syndromes in the study area. Among the four ecological groupings of species, the season of seed dispersal and dispersal type explained most the variance, in MLD among species. The synchronization in the pattern of emergence within species and between species in Mandal forest was best illustrated by the pattern of seedling emergence in the four oak species *(Quercus semecarpifolia, Q. floribunda, Q. leucotrichophora* and *Q. glauca* and four under storey species *(Euonymus tingens, Symplocos paniculata, Lindera pulcherrima and Sarcococca hookerana).*

Zomer, R.; Ustin, S. and Ives, J. 2002. **Using satellite remote sensing for DEM extraction in complex mountainous terrain: landscape analysis of the Makalu Barun National Park of eastern Nepal**. *Int. J. Remote Sensing*, 23(1): 125-143. International Centre for Research in Agroforestry (ICFRE), United Nations Avenue, Gigiri, P.O. Box 30677, Nairobi, Kenya; Centre for Spatial Technologies and Remote Sensing Department of Land, Air and Water Resources, Veihmeyer Hall, University of California, Davis CA 95616, USA; International Mountain Society, Department of Geography, Carleton University, Ottawa, Canada K1S 5B6. [GIS DATASET; REMOTE SENSING; SATELLITE DATA; WATERSHED]

The design and management of national parks and other protected areas requires a broad base of physiographic and geo-ecological information about the landscape. This paper evaluates the effectiveness of satellite remote sensing for photogrammetric stereo-mapping and digital elevation model (DEM) extraction within remote mountainous terrain. As a case study, a landscape analysis of the Makalu Barun national Park and Conservation Area of east Nepal (27.5^{o}N, 87.0^{o}E) was examined. The study area is a highly complex and rugged mountain landscape, with extreme topographic relief and an elevation gradient spanning more than 8300m. A DEM extracted from stereo SPOT imagery resulted in a median disagreement of 58 m when compared to a DEM generated from a conventionally digitized GIS dataset of topographic contours (scale=1:250 000). Visual comparison of the two DEMs showed substatial agreement at the landscape scale, while larger scale comparison of 100m contours revealed some localized differences. The SPOT extracted

DEM provided equal or better basis for orthorectification of satellite imagery when compared to the conventional DEM. Derivative landscape analysis outputs, such as hydrological modelling, drainage networks and watershed boundaries, compared well with results based upon the conventional dataset. Intermediate map products useful for field research and mapping included production of an orthorectified satellite base-map image. Additionally, a fused multisensor high resolution image of the study area, combining Landsat Thematic Mapper (TM) and SPOT imagery at 10m resolution, was orthorectified to produce a false-colour satellite image map highlighting the spectral discrimination between land cover classes.

New ENVIS Website

The ENVIS Secretariat has launched a new ENVIS website at URL: www.envis.nic.in. His Excellency the Vice-President of India, Shri Bhairon Singh Shekhawat Ji on 5th June 2003, World Environment Day launched the site.

The new ENVIS site is a repository of information on environment. ENVIS network offers a hub which acts as a platform for inter nodal interaction. The entire website has been designed and organized to provide and easy access to the multitude of environment related information available with the website of ENVIS Centres/Nodes.

ENVIS Government Node: Assam

www.envisassam.org has been launched on state environment related issues of Assam. The ENVIS website on Assam is under Environmental Management Capacity Building Technical Assistant Project (EMCBTAP) of ENVIS Secretariat, New Delhi and has been launched by the Assam Science Technology and Environment Council (ASTEC), Guwahati. The site provides viable information on environment, geographical/geological profile, natural hazards, urbanization, solid waste, industrialization, pollution, energy, agriculture, health, and tourism related to the state of Assam.

News & Views

Murky deals

The Rs. 500-crore Save Dal Project, which the National Conference government devised together with the Centre in 1997 for the revival and conservation of Dal lake, has beneficiaries. But the once picturesque lake of Kashmir, which attracted tourists from around the world, continues to perish. Vigilance probes found that officials at the Jammu and Kashmir Lakes and Waterways Development Authority, which was set up to implement the project, had manipulated records to the tune of Rs. 15 crore. Now, Centre has washed its hands of the project and saving the lake is no longer top priority of cash-strapped state.

Tariq Bhat for THE WEEK: March 2, 2003

Govt. finds 600 illegal buildings around Dal

Jammu & Kashmir Urban Housing Development Minister said the government had identified around 600 illegal constructions in the vicinity of Dal lake. Among the buildings, are official residences of former chief minister of the state, director general of police, houses of former legislators, VIP huts and hotels. Sources said many heads are going to roll as large number of constructions by influential people in the lake's forbidden area have been done with permission from the concerned authorities. However, the government is making a comprehensive plan of action to be taken against all the illegal constructions, according to the Minister.

Mufti Islah for INDIAN EXPRESS: March 8, 2003

Sikkim forest cover up 6.75 pc

There was a net increase of 479 km^2 in forest cover till 1997, which amounted to 6.75% of total area of the state. According to state forest report, over 44% of total geographical area of Sikkim accounted for forest cover. The target afforestation in the reported year under 20-point programme was 11,000 hectares of which the department achieved over 11,106 hectares by plantation including 300 hectares which have been converted under non-timber forest product and medicinal plants.

THE ASSAM TRIBUNE: March 9, 2003

New technology developed for *jhum* cultivation

Shifting cultivation, popularly know as *jhum*, is one of the best agricultural practices of the world, admitted Arup Rai, soil conservationist of North Cachar Hills. He developed a new scientific technology named Modified Scientific Shifting Cultivation Technology (MOSS-CULT), taking the idea from Sloping Area Land Technology (SALT) and Mizoram New Method of Cultivation (MNMC), which requires to fill up the affected area with nutrients by fixing the atmosphere nitrogen into soil and to restore the equilibrium of the soil with a provision of natural forest cover on the ridgeline of the watershed areas. He is in favor of continuing the *jhum* cultivation; the traditional heritage of the ethnic groups in the hills and requested the *jhumias* to do it scientifically.

S. Bhattacharjee for THE ASSAM TRIBUNE: March 18, 2003

Rare bird reappears in Himachal after a gap of 25 years

A rare migratory Eurasian bird has been spotted for the first time in the Pong, one of the largest man-made wetlands in Himachal Pradesh. Pong wetland in the picturesque Kangra valley has seen a rise in the arrival of migratory birds every winter and the graylag goose has arrived in the wetland, some 25 years after it was built. The number of migratory birds touched the figure 1,15,201 this year, according to Conservator of forests and wildlife circle.

ASIAN AGE: March 18, 2003

Sub-standard fertilizers affecting fruit, vegetable growth in valley

Notwithstanding the good spell of rains and snowfall, the growth of fruit and vegetable market in the Kashmir valley has suffered as setback due to the supply of sub-standard chemical fertilizers,

according to vice president of Jammu & Kashmir Fruits and Vegetable Growers and Dealers Association. Though the state is dependent on horticulture, but the fruit growers' problems are not being taken up seriously by the government, as a result of which quality and yield of the fruit is going down day by day.

KASHMIR TIMES: March 31, 2003

Shimla Corporation Plant: threatening ecology more than managing waste

The waste management plant set up by Municipal Corporation is violating environment protection laws. Non-biodegradable waste is being dumped in the forest areas along the roadside without obtaining permission from the concerned authorities. The non-composted garbage has become an environment hazard in the area. The strong stench emanating from the heaps of untreated garbage has mad it difficult for the public residing in the vicinity of the composting pant situated at Darni Ka Bagicha.

Gaurav Bisht for INDIAN EXPRESS: May 4, 2003

Govt to focus on ecological security

The Himachal Pradesh Government has decided to shift the focus from commercial forestry to ecological security and sustainable livelihood. The main objective of the Rs. 60 crore reform project is to make basic changes in the existing forest policy, which has led to unsustainable and inequitable exploitation of forest resources, to facilitate sustainable improvement in the livelihood of the poor forest dependent people. The functions of the forest department will be redefined accordingly and it will be restructured to achieve the goals set under the reforms programme. The reforms will also take care of legislative changes required to remove the constraints to private forestry, unhelpful land use policies and inequitable distribution of rights

Rakesh Lohumi for THE TRIBUNE: May 5, 2003

Manipuri ponies facing extinction

The indigenous Manipuri pony, though small in size, is known for its swiftness, sturdiness and tolerance in the game of polo, is on the verge of extinction from the birthplace of the game (polo). Efforts to develop and preserve the local breed of ponies at Regional Pony Development Farm at Tingkai Khunou in Bishnupur district of Manipur suffered a fatal fate. The farm was set up by North Eastern Council (NEC) in 1988, and was taken over by the state government in 1992, with the aim of breeding the original local pony breed and developing them. But they are on the verge of extinction due to abundant fodder and lack of nutritious food.

THE ASSAM TRIBUNE: May 5, 2003

Forest cover under threat

The large-scale outbreak of forest diseases in the hills of Himachal Pradesh is causing concern to the environmentalists, who fear that the process, if not checked, could spell doom for the fast depleting forest resources which are already under strain due to increasing pressure of population. The Himalayan Research Group, an NGO engaged in forestry research, warns that Himalayan forests would be subjected to increased onslaughts of disease causing organisms in future. The forest department must come out with a comprehensive plan to tackle the situation, but they do not have the necessary infrastructure to detect and manage such diseases.

Rakesh Lohumi for THE TRIBUNE: May 12, 2003

Shrinking ice

Glaciers in the Himalayas are receding faster than in any other part of the world and, if the present rate continues, the likelihood of them disappearing by the year 2035 is very high, according to a study of Asian glaciers by the International Commission for Snow and Ice (ICSI). In the case of Gangotri glacier, reconstruction studies show that the glacier has shrunk from 70km in its prime to its present length of 26km. Recession rates have varied over the years – from 10 to 11 meter per year, with a sharp rise in late seventies, up to 25 meter per year in 1994 and 1998, and the similar phenomena has been the recorded with other glaciers in the Himalayas.

D.S. Chauhan for SAHARA TIMES: May 17, 2003

Uttaranchal offers Rs 80,000 subsidy on electric van

The Uttaranchal government is offering a subsidy of Rs 80,000 on the sale of each "*Bijlee*" vehicle, a zero emission electric transit van being manufactured by automobile major Mahindra and Mahindra. The government decision to offer subsidy is aimed at replacing *Vikrams*, which are the key mode of transport in the state capital and are causing pollution. Initially, this subsidy is being offered to only those customers, who hold *Vikram* licenses in Dehradun, the state capital.

BUSINESS STANDARD: May 20, 2003

Master plan in the offing to develop Pong wetland

The Himachal Pradesh state government will soon put together a master plan in develop the Pong wetland of Kangra district – ecologically declared as an international wetland recently. Forest Minister said that a task force consisting of officers of the concerned departments had been set up to prepare an approach paper and a blue print project in this regard. A body to be christened as Pong Wetland Society – would be formed to raise funds for the project and various NGOs, eminent persons, institutions would be the members of the society, according to the minister.

Suresh Khatta for INDIAN EXPRESS: May 25, 2003

5,000 hit by fluoride poisoning in 15 Karbi Anglong villages

Thousands of villagers have been affected, many of them crippled for life, by drinking water containing excessive levels of fluorides in some parts of Karbi Anglong districts of Assam. The worst affected area was the Takelanguin, where more than 600 people out of the 2,300 surveyed were affected by the hydro-flourosia, according to Chief Engineer of Public Health Department. While scientists had claimed that the northeastern region was safe from fluoride, it was detected for the first time in the middle of last year in Takelanguin area in Karbi Anglong district, where several cases of both dental and skeletal fluorosis were initially found. The fluoride content in water in the area varies from 5 to 23mg per litre, while permissible limit is 1.2mg per litre. The district council authorities have been identified tube wells with high fluoride content and launched a scheme for supply of fluoride-free water.

THE SENTINEL: May 26, 2003

Kufri to house snow leopards, Tibetan wolves

Apart from the natural salubrious surroundings dotted with mighty deodars and rhododendrons, the famous Kufri hill resort, will provide added attraction to the tourists in the form of snow leopards and Tibetan wolves that will be kept in the Himalayan National Park (HNP), situated 15 km from Shimla. The Central Zoo Authority has given permission in principle to keep pair each of snow leopards and Tibetan wolves at HNP, which would be brought from the Darjeeling Zoo under exchange programme.

INDIAN EXPRESS: May 29, 2003

Beas may change course to stretch Kullu runway

The Centre's ambitious plan to expand the Bhuntar airport in Kullu, Himachal Pradesh is sure to raise the hackles of environmentalists, because expansion work assigned to the Airport Authority of India (AAI), can not be undertaken without diverting the course of the Beas river. The AAI, on its part put the ball in the Himachal Government's court, saying they were willing to undertake runway expansion provided the State government gave them the reclaimed land after diversion of Beas free of costs and free from all other encumbrances. But the Centre has now made it clear that it's for AAI to do the job.

Shishir Gupta for INDIAN EXPRESS: June 1, 2003

Herbs can help make Uttaranchal a leading state

The time has now come again to begin research on herbs in a modern and scientific manner, and call for preventing the over-exploitation of herbs from forests and promoting their cultivation in Uttaranchal has been raise. Gopeshwar based Herbal Research Institute, whose development had been stifled by politicians and bureaucrats, strongly advocated for development by the Government. Herbs have the potential to generate huge employment opportunities and can help to prevent migration form the

hills. With appropriate knowledge inputs and government support in this regard, may change in the economy of the State.

GARHWAL POST: June 8, 2003

Tripura tortoises face extinction

The large number of tortoises, which attracted tourists and pilgrims for last three centuries in the Kalyan Sagar lake, adjacent to the historic Tripuraswari temple, Udaipur in South Tripura is playing a heavy price for modernization, as the wall constructed in the four sides of the lake is depriving the tortoises of a natural habitation. The extent of natural habitat for the tortoises has been minimized drastically and they are not finding any space for taking rest and for laying eggs. The report submitted by the Tripura State Pollution Control Board team said all the tortoises, one of the rarest species in India, may get extinct shortly if immediate action is not taken.

Sanjib Deb for ASIAN AGE: June 10, 2003.

Sikkim lakes flood-prone due to global warming

Fourteen lakes in north Sikkim, formed and engorged by melting glaciers, may be prone to flood, and this is only the tip of the iceberg, an inventory warns by Kathmandu-based International Centre for Integrated Mountain Development (ICIMOD). The Mountain Environment and Natural Resources Information Systems (MENRIS) of ICIMOD has started a project from June 1999 to develop an inventory of glaciers, glacial lakes and floods related with glacier lakes in the Hindukush-Himalayan mountain region. The glaciers area nature's renewable store-house of freshwater, but accelerated global warming is causing them to retreat, resulting long-term loss of natural freshwater storage could have devastating downstream effects. The survey tries to cover the mountainous region of 3,500km from Afghanistan to Myanmar, sustaining over 150 million people. The countries in between are Pakistan, Nepal, China, Bhutan, Bangladesh, and India.

Sudeshna Sarkar For THE STATESMAN: June 11, 2003

Kalam ignites herbal 'revolution' in N-E

Northeast is a storehouse of medicinal plants and exotic herbs, as well as practitioners of ancient herbal lore, according to the President A.P.J. Abdul Kalam, during his visit to the Northeast. For the last five decades the traditional Khasi and Garo chiefs of Meghalaya have been fighting for the constitutional recognition of their rights and customary practices, which they claim have substantially been usurped by the State and district councils. The President told the visiting MPs from the region that the global market for the herbal medicine was a whopping $60 billion, and therefore, he suggested that India should go herbal for enormous economic benefits and also provide health care for the poor.

Sanat K Chakraborty for THE PIONEER: June 20, 2003

Manipur has most HIV cases per million

According to 2002-2003 Status Report of the National AIDS Control Programme, Manipur accounts for nearly 8% of India's total HIV-positive cases, whereas the state contributes just 0.02% of Country's total population. This puts the state third in the list of states with highest number or reported cases, behind Maharashtra and Tamil Nandu. The rate of infections per million populations in Manipur is 6 times higher as compared to Maharashtra and 20 times higher than in Tamil Nandu. This is the alarmingly highest rate not only in the country but also in the world.

SAHARA TIMES: June 21, 2003

Parasitic plant threatens Valley of Flowers

G.B. Pant Institute of Himalayan Environment and Development (GBPIHED) warned that the rich floral wealth of the Valley of Flower National Park at Garhwal Himalayas is facing a new threat – proliferation of 'Dodder', a parasitic plant. According to the scientists of GBPIHED, the plant, which coils around stems of the host plants and thrives on the nutrition, it drains from them, has been found on different species of medicinal and flowering plants across the valley in patches. Surveys by scientists have shown that infestation by Dodder adversely affected the size and density of the host plants, especially

those that showed low density. The Indira's Hand, a critically endangered species, which is used in several indigenous systems of medicine such as Ayurveda, Unani and Tibetan systems, found to be heavily infested by the parasite.

P. Sunderarajan for THE HINDU: June 22, 2003

Uttaranchal plans disaster management for all districts

The Disaster Mitigation and Management Centre (DMMC) here is preparing district disaster management action plans for all 13 districts of Uttaranchal. Set up in October 2001, the DMMC had so far developed 12 training modules, 192 village disaster management action plans (VDMAPs) for the most vulnerable villages in the Himalayas. A detailed database for the entire hill state based on geographical information system (GIS) and remote-sensing techniques is being prepared by the DMMC.

BUSINESS LINE: June 26, 2003

Hindi Section

संवरेगी नैनीताल की झीलों की किस्मत

नैनीताल की झीलों को संवारने के लिए राज्य सरकार ने इससे संबंधित परियोजना तैयार कर इसे केन्द्र सरकार को भेजने का कार्य पूरा कर लिया है। उम्मीद है कि केन्द्र इस परियोजना में राज्य को 70 करोड़ रूपये तक की मदद करेगा। परियोजना में नैनी झील के साथ ही भीमताल, नौकुचियाताल, सातताल व खुरपाताल का विकास और सौंदर्यीकरण किया जाना शामिल है। केन्द्रीय वन एवं पर्यावरण मंत्रालय ने इस परियोजना को प्रायोजित किया है। राज्य के शहरी विकास विभाग ने इन झीलों को संवारने की पूरी परियोजना तैयार की है। कुछ झीलों में पानी प्राकृतिक झरनों व जल धाराओं से आता है। झीलों के आसपास आबादी लगातार बढ़ने, प्रदूषण में इजाफा होने, कूड़ा फेंके जाने और सफाई का ख्याल न रखे जाने के कारण उनका नियोजित विकास नहीं हो पा रहा है। सरकारी रिपोर्ट के मुताबिक नैनी झील की गहराई भी गंदगी फेंके जाने के कारण कम हो गई है। भूस्खलन से भी झील पर असर पड़ रहा है। झीलों के सौंदर्यीकरण की परियोजना पूरी तरह आधुनिक प्रौद्योगिकी का सहारा लेकर तैयार की गई है। परियोजना तीन साल की है, तथा इसमें पर्यटन की दृष्टि से भी झीलों को संवारा जाएगा।

अमर उजाला : मार्च 6, 2003

नदी का पानी साफ रखने में सहायक है महाशीर

समुद्र तल से दो हजार मीटर की ऊंचाई व जल के न्यूनतम छह डिग्री व अधिकतम 35 डिग्री सेल्सियस तापमान में पानी को शुद्ध रखने वाली महाशीर मछली बहुतायत में पाई जाती है। धारचूला से बूम तक महाकाली नदी में सुनहरी महाशीर मछलियों का एक बड़ा आसरा रहा है। इसके अलावा महाकाली की सहायक रामगंगा, सरयू, गोरी, लधिया, लोहावती आदि नदियों में भी यह पाई जाती है। आज जबकि जल प्रदूषण की गंभीर समस्या बनी हुई है, लेकिन महाकाली के पानी को शुद्ध रखने में इस मछली का बड़ा योगदान रहा है। महाशीर मांसाहारी मछली है। यह नदी के पानी को दूषित करने वाले जैव रसायन, अधजले शवों व नदी में प्रवाहित होने वाले मृत पशुओं को खा जाती है। इसके अतिरिक्त यह कीड़े मकोड़ों व पानी के साथ प्रवाहित होने वाले जीवों को लील जाती है अपने वजूद के लिए पानी का उपयुक्त तापमान पाकर इसके द्वारा आज तक महाकाली नदी को प्रदूषित होने से बचाया हुआ है। संतुलित प्राकृतिक खनिजों व जीवनदायिनी जड़ी–बूटियों के रस को अपने साथ लाने वाली इस नदी का जल सुपाच्य व मीठा होने के साथ गरिष्ठ भोजन को बहुत कम समय में पचा देता है। मानवीय क्रूरताओं के चलते इस नदी में ब्लास्टिंग करने, ब्लीचिंग पाउडर डालने, नदी के प्रवाह में जाल डाल कर इन महत्वपूर्ण महाशीर मछलियों का शिकार किए जाने से अब इनकी तादात कम होती जा रही है। पंचेश्वर में सरयू व महाकाली नदी का संगम मत्स्य आखेट के लिए एशिया का एक महत्वपूर्ण स्थान माना जाता है। देश के कौने–कौने से आने वाले मत्स्य आखेटक यहां महाशीर की कम होती संख्या से बेहद चिंतित हैं सड़क निर्माण में प्रयुक्त होने वाले विस्फोटकों के नदी में डाले जाने से महाशीर के अस्तित्व को भारी खतरा पैदा हो गया है। मत्स्य वैज्ञानिकों ने छोटी व प्रजनक मछलियों के शिकार, पानी में मिट्टी, कंकड़ व पत्थरों के बढ़ते अनुपात, प्रजनन एवं संवहन क्षेत्रों में विस्फोटकों व कीटनाशकों के प्रयोग पर गंभीर चिंता जताई है।

अमर उजाला : अप्रैल 3, 2003

उत्तरांचल अतिसंवेदनशील भूकंप जोन में

यह तथ्य चौंकाने वाले भले ही हों, पर भू वैज्ञानिक अध्ययन के अनुसार पूरा उत्तरांचल राज्य भूकंप की दृष्टि से सिस्मिक जोन पांच (अति संवेदनशील जोन) में आता है। एक तरह उत्तरांचल भारत का अकेला ऐसा राज्य है, जिसका पूरा भूभाग सिस्मिक जोन पांच व चार में बसा है। यहां भूकंप की अधिकतम तीव्रता रिक्टर स्केल पर 9 एमएम होने का आकलन किया गया है। भूकंप की दृष्टि से उत्तरांचल के चमोली जिला, अल्मोड़ा का उत्तरी अर्द्धांश व जिला पिथौरागढ़ का दो तिहाई भाग जो लोहाघाट के पास चिरा के उत्तर में स्थित है, भूकंप की दृष्टि से सबसे अधिक संवेदनशील है। यह क्षेत्र अति संवेदनशील जोन में आता है जहां भूकंप की तीव्रता 9 एमएम और उससे अधिक हो सकती है। भू वैज्ञानिकों के अध्ययनों के अनुसार पूरे हिमालयी क्षेत्र में 2500 मिमी की लंबाई में मेन बाउंड्री थ्रस्ट (एमबीटी) अथवा मेन सेंट्रल थ्रस्ट (एमसीटी) रेखाएं कुछ वर्षो से लगातार गतिमान हैं। इस कारण ही सुप्त भूस्खलन भी पिछले एक दशक से अधिक क्रियाशील हो गए हैं। भू वैज्ञानिकों के अनुसार गंगा टीयर फाल्ट जो दिल्ली, हरिद्वार की भीतरी सतह (रिज) भी कहलाती है, पूरे गढ़वाल क्षेत्र को उत्तर पूर्व दिशा में प्रतिवर्ष 2 से 3 सेमी तक ढकेल रही हैं। भू वैज्ञानिकों की चेतावनी के बावजूद राज्य में भूकंप रोधी भवन तकनीक लागू करने को कोई समग्र नीति राज्य के लिए अब तक नहीं बनी है।

अमर उजाला : अप्रैल 3, 2003

बाइस साल बाद फिर दिखेगी नंदादेवी की बहारें

विश्व धरोहर खूबसूरत नंदादेवी राष्ट्रीय उद्यान दो दशक बाद पहली मई से पर्यटकों के लिए खुलने जा रहा है। लेकिन साल भर में सिर्फ पांच सौ पर्यटकों को ही अनुमति मिलेगी। लगभग दो दशक पहले पर्वतारोही अभियानों की वजह से क्षेत्र के वन्यजीवों और वनस्पतियों को हो रहे नुकसान की वजह से यहां प्रवेश पर प्रतिबंध लगा दिया गया था। नंदादेवी उद्यान को संयुक्त राष्ट्र संघ ने विश्व धरोहर घोषित किया था। नंदा देवी राष्ट्रीय पार्क, नंदादेवी बायोस्फियर रिजर्व का कोर क्षेत्र है। वर्ष 1982 में पार्क बनने से पहले नंदादेवी चोटी के बेस कैंप सरसों–पाताल के 97 वर्ग किमी क्षेत्र को 1939 में सेंचुरी घोषित कर दिया था। उत्तरांचल के तीन जिलों चमोली, पिथौरागढ़ तथा अल्मोड़ा के 2236.74 वर्ग किमी क्षेत्र में यह उद्यान फैला हुआ है। इसका सबसे अधिक क्षेत्र चमोली जनपद में है। इस समूचे क्षेत्र को दो भागों में विभक्त किया गया है। इसका 624.62 वर्ग किमी कोर क्षेत्र तथा 1612.12 वर्ग किमी क्षेत्र बफर जोन से जाना जाता है। बफर क्षेत्र में मनुष्य की गतिविधियां मान्य थी, लेकिन कोर क्षेत्र पूर्ण रूप से मानव की गतिविधियों के लिए प्रतिबंधित था। शासन ने बीती पांच अप्रैल को उद्यान पर्यटकों के लिए खोलने के आदेश दिये हैं। भौगोलिक दृष्टि से भी इसका महत्वपूर्ण स्थान है। देश की सबसे ऊंची दस चोटियों में आधी से अधिक चोटियां इसी इलाके में पड़ती है। इनमें नंदादेवी, त्रिशुल, नंदाघुघटी आदि है।

अमर उजाला : अप्रैल 28, 2003

उत्तरांचल भी बनेगा एशियन गैंडे का आशियाना

उत्तरांचल के वन्यजीवों के कुनबे में एक नये सदस्य को लाने की तैयारियां चल रही है। भारी–भरकम काया वाला अतुलनीय बलशाली वह जीव है एक सींग वाला एशियन गैंडा (एशियन राइनोसिरस)। सरकार का इरादा दुर्लभ हो चले इस जीव का आशियाना ऊधमसिंह नगर जनपद की सुरंई रेंज में बनाने का है। जीव जगत के इस अनूठे जीव को सूबे में लाने के लिए विस्तृत अध्ययन कराया जा रहा है। केंद्र सरकार के समक्ष इस संबंध मे बात रखी जा चुकी है। ऊधमसिंह नगर जिले की सुरंई वन रेंज को पारिस्थितीकीय अनुकूलन की वजह से गैंडे के मिजाज के लिए मुफीद पाया गया है। यह वन रेंज खटीमा तहसील में आती है। गौरतलब है कि आज विश्व में गैंडों की संख्या काफी कम रह गई है। उसके सींग से बनने वाली कथित शक्तिवर्धक दवाओं की वजह से अंधाधुंध शिकार ने गैड़ों को दुर्लभ जीवों की श्रेणी में खड़ा कर दिया है। गैड़ों की निरंतर घटती तादात की वजह से उसे शिडयूल–1 की जमात में रखा गया है वर्तमान में पूर्वोत्तर राज्यों, खासकर असम में गैंड़े अभी बहुतायत में हैं। पड़ोसी देश नेपाल के तराई क्षेत्र में भी गैंड़े सुरक्षित हैं। गैडों को उत्तरांचल की जैव विविधता का हिस्सा बनाने के प्रयास लंबे समय से चल रहे हैं। सूत्रों के अनुसार सरकार का इरादा पूर्वोत्तर अथवा नेपाल से कुछ गैंडों को यहां लाकर बसाने का है। सरकार को लगता है कि इससे राज्य की जैवविविधता तो समृद्ध होगी ही, प्रकृति प्रेमी पर्यटकों को भी लुभाया जा सकेगा।

अमर उजाला : अप्रैल 28, 2003

अंतिम सांसें गिन रहे हैं हिमालय के दुर्लभ कस्तूरी मृग

बागेश्वर जिले के उच्च हिमालयी क्षेत्रों में दुर्लभ कस्तूरी मृगों तथा अन्य दुर्लभ जन्तुओं का शिकार पिछले कुछ वर्षो से धड़ल्ले से किया जा रहा है। विभिन्न प्रकार की दवाइयों व यौनवर्द्धक के रूप में उपयोग में लाई जाने वाली कस्तूरी का लालच इसके पीछे है। आठ हजार से लगभग 16 हजार फुट तक की ऊंचाई में अठखेलियां करने वाला यह मृग संरक्षण के अभाव में असमय ही मौत का शिकार हो रहा है। शिकारियों के चलते इसकी भावी पीढ़ी जन्म लेने से पहले ही गर्भ में काल का ग्रास बन रही है। कस्तूरी मृग कश्मीर से लेकर उत्तरांचल के उच्च हिमालयी क्षेत्रों में पाया जाता है। दो फुट ऊंचा व लगभग साढ़े तीन फुट लम्बा यह मृग आम मृगों की ही तरह होता है। नर व मादा में से केवल नर मृग की ही नाभि में कस्तूरी होती है मादा मृग वर्ष में छह माह के अंतराल में दो बार बच्चो को जन्म देती है और दोनों बार दो–दो बच्चों को जन्म देती है जिससे इनका प्राकृतिक संतुलन बना रहता है। गर्भकाल में मादा मृग झुण्डों में रहते हैं और इनका बसेरा ग्लेशियरों के आसपास रहता है। उस वक्त शिकारियों का कहर इन पर टूटता है तो अधिकांश मादाएं गर्भ में पल रहे मृग के भार से तेज न दौड़ पाने की वजह से गोलियों का शिकार हो जाती हैं। साथ में इसके भोजन जड़ी–बूटी पर भी मानवीय व तस्करों का दबाव बढ़ता जा रहा है। हर वर्ष बुग्यालों में लगने वाली आग का एक मुख्य कारण अवैध शिकार भी है और यह आग फिर बर्फ गिरने के बाद ही बुझ पाती है। अक्सर जड़ी–बूटी का सेवन करने वाला यह मृग भोजन की कमी के चलते पत्तियों का भी सेवन करता है जिसके चलते इसे कृत्रिम रूप से पालना भी इसके प्राकृतिक स्वरूप को नष्ट करना ही है। बागेश्वर जिले की सीमा पर स्थित कोटमन्या में कस्तूरी मृग विहार में न तो मृगों को स्वछन्द वातावरण मिल पा रहा है और न ही इनकी कस्तूरी में तासीर। कस्तूरी मृग हिमालय के जिस क्षेत्र में स्वछन्द जीवन बिताते हैं, उन्हीं क्षेत्रों में इन्हे संरक्षण देने की भी आवश्यकता है जिस गति से इनका शिकार हो रहा है, उस पर यदि सरकार अब भी न चेती तो ग्लेशियरों का यह चिरसंगी मृग कुछ बरसों बाद दिखना बंद हो जाएगा।

अमर उजाला : मई 29, 2003

पहाड़ में तापमान 43 डिग्री तक पहुंचा

जेठ की तपती धूप ने इस बार कहर बरपाते हुए समूचे तराई–भावर को भी लू की चपेट में ला दिया है। गर्मी का आलम यह है कि पहाड़ की घाटियों में भी तापमान 43 डिग्री तक जा पहुंचा है। नैनीताल शहर में पारा कभी 27 डिग्री से ऊपर नहीं पहुंचा आज यह 31 डिग्री सेल्सियस को छू गया। यही हालत अल्मोड़ा और पिथौरागढ़ की भी रही। पिथौरागढ़ जिले के घाटी के इलाके क्रमशः धारचूला, झूलाघाट, घाट, थल आदि का तापमान 43 डिग्री तक जा पहुंचा। भीषण गर्मी के चलते पहाड़ में पानी की इतनी बड़ी किल्लत भी पहली बार हुई है। कई जगह लोग बूंद–बूंद पानी को तरस गये हैं। अलबत्ता बर्फानी नदियों का जल स्तर जरूर बढ़ गया है। इधर पहाड़ से लगी भावर पट्टी भी बुरी तरह तप रही है। गर्मी ने इस बार वर्ष 1998 में पड़ी भीषण गर्मी का रिकार्ड तोड़ दिया।

दैनिक जागरण : जून 5, 2003

सूख जाएगी पतितपावनी गंगा की धारा

सदियों से उत्तर भारत की जीवनरेखा बनी हुई गंगा नदी का अस्तित्व खतरे में है। गंगा के उद्गम स्थल गंगोत्री का गोमुख ग्लेशियर तेजी से पिघल रहा है। अगर यही हाल रहा तो वर्ष 2025 तक ग्लेशियर पूरी तरह पिघल जाएगा और गंगा की धारा तब सूख जाएगी। सैकड़ों वर्षों से धर्म और संस्कृति का अभिन्न हिस्सा बने रहने वाली गंगा के अंत की यह कल्पना बेचैन करने वाला है पर विज्ञानी और पर्यावरणविदों की यह आशंका ठोस तथ्यों पर आधारित है। उनके अनुसार ग्लेशियर का घटना पृथ्वी के गरम होने और उद्गम स्थल के पास प्रदूषण को माना जा सकता है। जाने माने पर्यावरणविद् और उत्तरांचल के विख्यात चिपको आंदोलन के नेता सुंदरलाल बहुगुणा ने बृहस्पतिवार को जालंधर में कहा कि गंगोत्री ग्लेशियर की हालत काफी चिंताजनक है। उन्होंने कहा कि हिमालय के निचले इलाके में वनों की अंधाधुंध कटाई ने संकट को बढ़ाया है। यह वन इलाका बर्फीले पहाड़ों तक गरम हवाओं को जाने से रोकता था। नतीजन ग्लेशियर तेजी से पिघलने लगे। उन्होंने कहा मानवजाति को अपने भविष्य की जरा भी चिंता है तो हिमालय क्षेत्र में वृक्षारोपण का काम बड़े स्तर पर तत्काल शुरू कर दिया जाना चाहिए। पर्यावरणविदों का कहना है कि गंगोत्री ग्लेशियर प्रतिवर्ष दस मीटर की दर से घटता जा रहा है। लगभग 150 साल में ग्लेशियर दो किलोमीटर घट गया।

अमर उजाला : जून 6, 2003

पानी का 'रिचार्ज' स्तर गिरने से नदियां सूखी

वैज्ञानिकों का मानना है कि सालभर में होने वाली कुल बारिश का कम से कम 31 प्रतिशत पानी धरती के भीतर रिचार्ज के लिए जाना चाहिए तभी गैर हिमनद नदियों तथा जल स्त्रोतों से लगातार पानी मिल सकेगा, जबकि हाल में वैज्ञानिकों द्वारा पर्वतीय क्षेत्र के संदर्भ में किए गए एक अध्ययन में रिचार्ज का जो स्तर पाया गया वह बहुत चिंताजनक है शोध के मुताबिक कुल बारिस का औसतन सिर्फ 13 प्रतिशत पानी धरती के भीतर जमा हो रहा है। शेष पानी बहकर नदियों के जरिए समुद्र में चला जाता है। धरती के भीतर पानी जमा न होने के कारण ही नदियां व जल स्त्रोत सूख गये हैं। इस कारण बरसात में बाड़ की समस्या भी खड़ी हो रही है। महत्वपूर्ण तथ्य यह है कि अमेरिकी वैज्ञानिकों ने 1982 में पूर्वी अमेरिका के कुछ समृद्ध वनों के भू–भाग में एक शोध करके यह पाया कि साल भर में होने वाली कुल बारिश का 31 प्रतिशत पानी धरती के भीतर जमा होना चाहिए तभी संबंधित क्षेत्र में स्थित नदियों जल स्त्रोतों आदि में पर्याप्त पानी रहेगा। इस शोध के बाद ही रिचार्ज का मानक 31 प्रतिशत तय हुआ। कुमाऊं विश्व विद्यालय अल्मोड़ा परिसर में भूगोल विभाग के रीडर डा0 जे0एस0 रावत ने पिछले छह साल में अल्मोड़ा जिले पर केंद्रित अपने शोध में जो स्थिति पाई है वह वास्तव में चिंताजनक है। शोध में उन्होंने पाया कि बांज के वन क्षेत्र में बारिश के पानी का रिचार्ज 23 प्रतिशत, चीड़ के वन क्षेत्र में 16 प्रतिशत, कृषि भूमि में 18, बंजर भूमि में 5 तथा शहरी क्षेत्र में पानी का रिचार्ज मात्र 3 प्रतिशत है जो कि 31 प्रतिशत से काफी कम है। यदि औसत निकाला जाए तो भी रिचार्ज का स्तर मात्र 13 प्रतिशत है जो मानक से 18 प्रतिशत कम है। शहरी क्षेत्र में तो रिचार्ज की स्थिति बहुत चिंताजनक है। सड़कें, भवन तथा अन्य निर्माण कार्यो से शहरी इलाकों में बारिश का मात्र 3 प्रतिशत पानी ही धरती के भीतर जमा होता है, जबकि शहरों में पानी की खपत गावों की अपेक्षा कई गुना अधिक है। रिचार्ज का स्तर गिरने से ही पहाड़ में जल स्तर कम हो गया है क्योकि धरती के भीतर पानी जमा नही होगा तो गर्मी के मौसम में एक स्तर के बाद जलस्त्रोतों से पानी आना बंद हो जाएगा।

अमर उजाला : जून 9, 2003

पहाड़ की चोटी पर करोड़ों वर्ष पुराने 'समुद्री जीवाश्म'

भारत–चीन सीमा पर फौजी जिंदगी के अलावा प्रकृति का एक अद्‌भुत चमत्कार भी है। पहाड़ की 17 हजार फीट ऊँची चोटी पर समुद्र! सौ साल पुराना यह समुद्र पलक–पांवड़े बिछाए लफथल में आपका इंतजार कर रहा है। मगरमच्छ, कछुआ, घोंघा, सीप, केंचुआ, व्हेल, शार्क, सांप और स्टार फिश जैसे समुद्री जीवों की अनगिनत किस्में आपके स्पर्श को यहां बेताब है। आपकी पसंदीदा मछलियों की ढेरों किस्में भी लफथल में जहां तहां बिखरी हैं। ये मछलियां खाई नहीं जा सकती हैं क्योंकि करोड़ों वर्ष बासी है उत्तरांचल के चमोली जनपद स्थित लफथल की चोटी पर फेली समुद्री जीवों की लंबी श्रृंखला दरअसल जीवाश्मों की शक्ल में मौजूद है। आज जहॉ हिमालय है पांच करोड़ साल पहले वहां टेथिस सागर हुआ करता था। लफथल वो इलाका है जो उस वक्त टेथिस सागर की तलहटी में था। टेथिस से हिमालय बनने की प्रक्रिया में तब प्रागेतिहासिक काल की नदियों द्वारा तात्कालिक महाद्वीपों से लाई गई मिट्टी की तहों में समुद्री जीव दब गए। पृथ्वी की गर्मी और दबाव से वो धूल की परतें चट्टानों में बदल गई। पृथ्वी के लगातार बलों ने इन चट्टानों को पहाड़ की चोटी तक पहुंचा दिया। उत्तरांचल के मानचित्र पर लफथल क्षेत्र भले ही उपेक्षित पड़ा है मगर टेथिसिसन पर्वत श्रृंखला की इस चोटी पर सौ करोड़ से पांच करोड़ साल पुराने समुद्री इतिहास बेहिसाब बिखरा पड़ा है। लफथल पहुंचकर यह देखना भी सचमुच कोतुहल भरा है कि हिमालय में जब समुद्र की शुरूआत हुई थी तो तब कैसा रहा होगा उसके जीवों का जीवन। लफथल में 500 मिलियन वर्ष पुराने रीड वाले (कोन्ड्रोन प्रजाति) के समुद्री जीवों के अवशेष भी है तो 250 मिलियन वर्ष पुराने मछली के जीवाश्म भी। शिफेलोपोडा प्रजाति के जीव तो यहां यह भी बताते है कि 130 मिलियन वर्ष पूर्व टेथिस सागर की गहराई 1000 मीटर रही होगी। लफथल की शक्ल में मिले कुदरत के इस नायाब तोहफे को उत्तरांचल और केन्द्र सरकार भले ही पूरी तरह भूल गई है बावजूद इसके यहां फैले अवशेष समुद्र विज्ञान की एक पूरी कहानी बयां करते हैं। पांच करोड़ साल पहले तक कैसा रहा होगा टेथिस सागर? समय के साथ क्या बदलाव आए? पानी के खारेपन और तापमान ने समुद्री जीवों को कितना प्रभावित किया इसका पूरा ब्यौरा भी लफथल में मौजूद है।

दैनिक जागरण : जून 10, 2003

भविष्य में प्यास बुझाने का एकमात्र विकल्प पिंडर परियोजना

कोसी, रामगंगा व गोमती नादियों के सूखने की स्थिति में केवल पिंडर नदी को ही एकमात्र विकल्प माना जा रहा है। अभी तक इन तीन नदियों पर ही दर्जनों शहर व हजारों गांव पानी के लिए निर्भर हैं। लेकिन इनके जल स्तर में लगातार कमी सर्वाधिक चिन्ता का बिषय बनी हुई है। इसका विकल्प केवल पिंडर नदी है जो हिमालय से बहती है। 36 वर्ष पूर्व इस नदी से बहुउद्देशीय परियोजना की कल्पना की गयी तथा बीस वर्ष पूर्व इसका सर्वेक्षण हुआ था। चमोली (गढ़वाल) जनपद के हिमाच्छादित क्षेत्र पिंडर घाटी से बहने वाली सदानीरा इस नदी से पानी ग्वालदम तक लाया जा सकता है। 9 हजार फिट की ऊँचाई से 6 हजार फिट तक लाया जाने वाला यह पानी ग्रेविटी सिस्टम (गुरूतवाकर्षण पद्धति) से ग्वालदम पहुंचेगा। पूर्व में किये गये सर्वे के मुताबिक यह लगभग 300 किलोमीटर लम्बी परियोजना है। ग्रेविटी सिस्टम से इस परियोजना का पानी कौसानी पहुँचेगा, जहॉ लघु झील व विद्युत परियोजना बनायी जा सकती है। इसके बाद इस पानी को क्रमशः गोमती (बागेश्वर), कोसी (अल्मोड़ा), रामगंगा नदी (चौखुटिया) में प्रवाहित किया जा सकता है। इस तरह इस महत्वाकांक्षी योजना से इन तीनों नदियों का जल स्तर बढ़ जायेगा, जिससे लाखों लोग अपनी प्यास ही नहीं बुझायेंगे, बल्कि सिंचाई के लिए भी पानी उपलब्ध हो जायेगा। यदि 300 किमी लम्बी पिंडर परियोजना का कार्य होता है तो इससे चमोली जनपद ही नही बल्कि अल्मोड़ा, बागेश्वर तथा नैनीताल जनपद के वृहत्तर क्षेत्र की कायाकल्प ही हो जायेगी।

दैनिक जागरण : जून 16, 2003

बढ़ती आबादी और पर्यटकों की भेंट चढ़ रहा है ब्रह्म कमल

हिमालय में लगातार बढ़ रहे जनसंख्या के दबाव और संरक्षण के अभाव के चलते उत्तरांचल का राज्य पुष्प ब्रह्म कमल विलुप्ति के कगार पर पहुंच गया है। दरअसल, उत्तरांचल में पर्यटकों, पर्वतारोहियों और घुमक्कड़ों को यह जानकारी नही है कि यह फूल कितना दुर्लभ है। इस जानकारी के अभाव में वे इसे आम फूलों की तरह जड़ से ही तोड़ देते हैं। इससे धीरे–धीरे इस फूल की प्रजाति ही समाप्त हो रही है। उत्तरांचल से लेकर कश्मीर तथा मध्य नेपाल के हिमालयी क्षेत्रों में लगभग 12 से 15 हजार फुट तक की ऊंचाई पर नमी युक्त जलवायु वाले क्षेत्रों में खिलता है यह फूल। यहां के लोगों की धार्मिक आस्था से जुड़े ब्रह्म कमल की खूबसूरती भी बेजोड़ होती है। यहां की पौराणिक मान्यता के अनुसार इस दुर्लभ पुष्प को सदियों से हिमालय के केदारनाथ में भगवान शिव को अर्पित कर विशेष प्रसाद के रूप में बांटा जाता है। इस पुष्प की आयु मात्र तीन माह, जुलाई से सितम्बर के मध्य तक की होती है। इस पुष्प के पौधे में 5,7 व 12 वर्ष में सिर्फ एक ही बार फूल आते हैं, जिससे इसके दर्शन अति दुर्लभ होते हैं। सास्वेरा ओबवाल्टा (डी.सी.) एड्यू कम्पोजिट के वैज्ञानिक नाम वाले इस पुष्प की महक तेज होती है। इस पुष्प के फल नुकीले व भूरे गुच्छे के रूप में दिखाई देते हैं। हरा व पीलापन लिए हुए इसका पुष्प टहनियों में नहीं, बल्कि पत्तियों से निकले कमलपात में खिलता है। इसकी जड़ें बहुत दूर–दूर तक मोटाई में फैली होती है और इस पौधे की पत्तियों से ही ढकी रहती हैं। जड़ से तोड़ने पर इसकी प्रजाति ही समाप्त हो जाती है। उत्तरांचल सरकार ने ब्रह्म कमल पुष्प को इसकी इन्हीं विशेषताओं के चलते राज्य पुष्प का दर्जा दे तो दिया लेकिन सरकार ने इस दुर्लभ पुष्प के संरक्षण के प्रति हमेशा उदासीनता ही दिखाई है। यहां तक कि वैज्ञानिको द्वारा वर्षों से हिमालय की जड़ी–बूटियों व पुष्पों पर किए जा रहे अनुसंधान भी मात्र कागजो तक ही सीमित रहे हैं।

नवभारत टाइम्स : जून 26, 2003

उत्तरांचल हिमालय में संचार के परम्परागत माध्यमों का संरक्षण एवं विकास

गणेश खुगशाल 'गणी'
वरिष्ठ पत्रकार, 126, विकास मार्ग, पौड़ी (गढ़वाल) उत्तरांचल

उत्तरांचल का अपना एक अलग ऐतिहासिक एवं धार्मिक महत्व रहा है। इसकी अपनी भौगोलिक विशिष्टता, सांस्कृतिक अस्मिता एवं सामाजिक पृष्ठभूमि रही है। इन सबके मूल में उसका अपना आर्थिक एवं दिन प्रतिदिन का कठिन जीवन, उसकी कार्य संस्कृति तथा श्रम के प्रति निष्ठा भी कम महत्वपूर्ण नही है। जिस प्रकार वैविध्यपूर्ण यहां का पारिस्थितिकी परिवेश है, उसी प्रकार यहां का सूचना संचार भी प्राचीन काल से विविध रूपों में परिवर्तित होता आ रहा है।

उत्तरांचल का लोकसाहित्य, लोकसंगीत, लोकसंस्कृति, लोकगाथा, लोकनाट्य, लोककथा, जनश्रुतियां, किंवदन्तियां, लोकोक्तियां, कहावतें, व्रत त्यौहार, पहाड़ियों पर लगने वाले कौथीग (मेले), लोकाचार, मान्यताएं, मिथक विशिष्ट पहनावा आदि तथा युग युग से चली आ रही परम्पराएं सभी जनजीवन का सहज व सशक्त स्वरूप प्रस्तुत करती हैं। इनमे भौगोलिक पारिस्थितिकी से जुड़ा हुआ ज्ञान–विज्ञान का ऐसा भंडार अंतर्निहित है, जिसका न केवल वर्तमान अपितु भविष्य में भी समाज के लिए विशेष महत्व है, उत्तरांचल के परम्परागत संचार माध्यम भी इसमें सम्मिलित हैं।

प्राचीन काल से ही उत्तरांचल में संचार के परम्परागत माध्यमों के रूप में प्रतीकों, बिम्बों, स्थापत्यकला लोकगीत, लोकनृत्य, नाटिकाओं, मुखौटों, वाद्यी, औजी, डोलजात्रा एवं वाद्य यंत्रो आदि का प्रयोग होता आ रहा है। हालांकि आज जनसंचार माध्यमों एवं सूचना–क्रांति के युग में इनकी घोर उपेक्षा हो रही है, तथा कई लोक माध्यम व लोक परम्पराएं लुप्त होने के कगार पर पहुंच गई हैं, जबकि हमारी संस्कृति, इतिहास, पौराणिक–धार्मिक मान्यताओं, सामाजिक प्रचार–प्रसार व संरक्षण में इनकी महत्वपूर्ण भूमिका अदा करने वाले इन सशक्त माध्यमों के सम्बन्ध में क्रमवद्ध एवं तथ्यात्मक अध्ययन का नितान्त अभाव बना हुआ है, हालांकि आज भी इनका विशिष्ट महत्व एवं उपयोगिता है।

संचार जीवन का आधारभूत सत्य है। इसके बिना हमारी सम्पूर्ण भावधारा एवं चिन्तन प्रवाह 'आत्मकेन्द्रित' होकर रह जाता है, और हम उसका आदान प्रदान तथा प्रचार–प्रसार पूरे समाज में नहीं कर पाते। मोटे तौर पर संचार माध्यम मनोभावों के –'सम्प्रेषण' एवं अर्थ निर्वचन के महत्वपूर्ण साधन होते हैं। यद्यपि संचार का प्रक्रम सर्वव्यापी है, किन्तु मानव भाव–सम्प्रेषण एवं सार्वजनिक गतिविधियों, सामाजिक–राजनीतिक घटनाओं एवं सूचनाओं के प्रक्षेपण की दृष्टि से इसका विश्वव्यापी महत्व है। विद्युत–क्रौध, मेघ–गर्जन, झंझावात, नदी की कलकल ध्वनि, पुष्प प्रस्फुटन आदि प्राकृतिक उपादानों में एक अस्फुट संचार ही तो निहित है। यदि एक नवजात शिशु अपने माता–पिता के साथ चीख चिल्लाकर संवाद स्थापित करता है, तो एक वयस्क उच्चरित भाषा के द्वारा भाव सम्प्रेषण करता है। मूक बधिर सांकेतिक भाषा के द्वारा अपनी भावनाओं को अभिव्यक्त करते है। गीत, नृत्य, अभिनय, संगीत, काव्यकला, चित्रकला, स्थापत्य कला आदि संचार के अतिरिक्त किसी भी देश की पारिस्थितिकी एवं भौगोलिक संरचना को व्यक्त करने में सक्षम हैं।

'संचार' (Communication) शब्द की व्युत्पति लेटिन भाषा के 'कम्युनिको' (Communico) से हुई है, जिसका शाब्दिक अर्थ है साझेदारी। प्रो0 विलवरश्राम के अनुसार 'संचार' में एक व्यक्ति या व्यक्तियों के समूह के साथ एक या सामान्यता की स्थापना समाहित होती है, जबकि डेनिस मैकवेल मानव संचार को एक व्यक्ति से दूसरे तक अर्थपूर्ण सन्देशों के सम्प्रेषण के रूप में देखते हैं।

इस प्रकार संचार माध्यम एक संकेत हैं, एक लक्षण है, एक समझौता है– परस्पर सूचनाओं के आदान–प्रदान विचार विनिमय तथा भाव सम्प्रेषण का। इस प्रकार से पारम्परिक संचार माध्यम वह संकेत व चिह्न होते हैं, जिनमें प्रकरणवश यह तय किया जाता है कि अमुक देशकाल में, अमुक परिस्थिति उत्पन्न होने पर अमुक संकेतों के द्वारा पूरे जनसमुदाय को उसकी सूचना दी जाएगी। अतः ऐसे में एक परम्परा सी बन जाती है कि जब ऐसी घटना घटित हो तो उन तय किए गए संकेत माध्यमों से एक स्थान से दूसरे स्थान तक बातें संचारित या प्रसारित हो जाएंगी। उत्तरांचल के पारम्परिक संचार माध्यम इसके अपवाद नही है।

वैसे सूचना–सम्प्रेषण एवं भाव प्रक्षेपण का कार्य भाषा और लिपी भी करती हैं, किन्तु जहां भाषा में उच्चारित सार्थक शब्द समूहों को मौखिक संवाद के द्वारा आमने–सामने वाला व्यक्ति ही सुन–समझ सकता है,

वहां पर इसी कार्य को ध्वनि चिह्नों के द्वारा लिपि विश्वव्यापी बना देती है। 'प्रिंट मीडिया' एवं 'इलेक्ट्रानिक मीडिया' इसी के संवाहक हैं। आजकल 'दृश्य श्रव्य' सामग्री इन्हीं संचार माध्यमों के उपयोगी एवं बहुउद्देशीय माध्यम हैं, किन्तु जब ये आधुनिक संचार माध्यम उपलब्ध नहीं थे, तो भी मानव आदिम काल से अपने विचारों व भावों को सम्प्रेषित करने के लिए विभिन्न पशु–पक्षियों, प्राकृतिक उपादानों के चित्रों, सूत्र या गांठ बांधकर भाव सम्प्रेषण की प्रक्रिया एवं प्रतीकों के द्वारा, यह कार्य संपादित करता रहा। आज भी इनका प्राथमिक एवं ऐतिहासिक महत्व कम नही हैं। पूर्वजों की प्रारम्भिक अवस्था एवं विकास के तमाम ज्ञान–विज्ञान के स्त्रोत यही संचार के माध्यम रहे, जिनसे मानव समाज आज भी लाभान्वित होता आ रहा है।

विभिन्न क्षेत्रों के सुदूर अन्तवर्ती भागों के लोगों को पारस्परिक एकता के सूत्र में आवद्ध करने व संकटों के समय आगाही देने की दृष्टि से भी इन माध्यमों की उपयोगिता आज भी कम महत्वपूर्ण नही है। इस बात की पुष्टि, इस तर्क संगत तथ्य से की जा सकती है कि अनेकानेक, आधुनिक संचार माध्यमों टी0वी0, रेडियो, डाक–तार, टेलिफोन, समाचार पत्रों के होते हुए भी आपातकाल या 'अर्जेन्ट' सूचनाओं को प्रसारित करने के लिए प्रशासन द्वारा स्थानीय स्तर पर 'मुनादी' पीटकर जन–जन को आसन्न स्थिति व परिस्थिती से अवगत कराया जाता है। आज भी विद्युत साधनों के बावजूद सुदूरवर्ती क्षेत्रों में 'ढेबरी' (दीपक) की सार्थकता कम नहीं हुई है। इस दृष्टि से हमारे पारम्परिक संचार माध्यम व जीवनयापन के साधन हमारी विरासत हैं।

इस प्रकार से पारम्परिक संचार माध्यम भाषा तथा लिपि को भी लांघकर अधिक लोक प्रचलित हैं। दूसरे शब्दों में पारम्परिक संचार माध्यमों का लोकमान्यता प्राप्त अपना व्याकरण और मुहावरा होता है, जिनके स्थानापन्न अन्य आधुनिक संचार माध्यम कदापि नही हो सकते।

हमारे पारम्परिक जन संचार के माध्यम हमारी ग्राम्य संस्कृति की देन हैं। इस कारण ग्रामीण परिवेश में जन्मे ये माध्यम संचार के ऐसे प्रभावशाली वाहक का कार्य करते हैं, जिनकी पहुंच गांव में रहने वाले विभिन्न समुदायों तक होती है और इन समुदायों का अंतिम व्यक्ति भी इन माध्यमों के साथ आसानी से तादात्म्य स्थापित कर लेता है। दरअसल संचार के पारम्परिक या लोक माध्यम आम लोगों के माध्यम होते हैं। वे लोगों के धार्मिक, सांस्कृतिक और सामाजिक जीवन के अभिन्न अंग होते हैं। लोक माध्यमों की विश्वसनीयता लोगों के जीवन से उनकी निकटता और पहचान के कारण बनी रहती है। इन माध्यमों की विषय वस्तु काफी प्रभावशाली होती है, जो दर्शकों श्रोताओं को पूर्णरूपेण प्रभावित करने में सक्षम होती है।

उत्तरांचल के विभिन्न जनपदों की ऐतिहासिक, भौगोलिक, आर्थिक, सामाजिक, धार्मिक व सांस्कृतिक दृष्टिकोण से पर्याप्त समानताएं एवं समीपताएं रही हैं। परम्परागत संचार माध्यमों पर इनका प्रभाव स्वाभाविक ही है। फिर भी कई क्षेत्रों में भिन्न परम्पराएं यहां की विविधताओं को भी उजागर करती हैं। परन्तु, आज के बदलते परिवेश तथा टेक्नोलॉजी के युग में इस क्षेत्र के परम्परागत संचार माध्यमों की स्थिति पर भी इस परिवर्तन का व्यापक रूप से प्रभाव पड़ा है। इस दृष्टि से इन माध्यमों की कार्यशैली, उपयोगिता तथा प्रभावशीलता का ज्ञान, आज के परिप्रेक्ष्य में जन–सामान्य का होना अपेक्षित ही नहीं आवश्यक भी है।

तथ्यपरक विश्लेषण से ज्ञात होता है कि उत्तरांचल की सामाजिक संरचनाओं के अनुरूप पारम्परिक संचार माध्यम, आज भी अपनी सार्थकता अर्थवत्ता एवं प्रासंगिकता बनाए हुए हैं। जागर, मांगल, संस्कार कृत्य, डोलजात्रा, वाद्ययंत्र तथा औजी, वाद्यी, फिक्वाल, जोगी–जोगिनें आदि आज भी न केवल अपनी पारम्परिक सामाजिक पहचान ही बनाए हुए हैं, बल्कि पारम्परिक संचार माध्यमों को जीवित भी रखे हुए हैं।

यों तो, साहित्य में मेघ (कालिदास का मेघदूत), पवन (ऐरे पवन तेरो सगरो गमन–घनानंद) शुक (हीरामन तोता जायसी) (कबूतर, चन्द्रकांता– देवकीनंदन खत्री) आदि सन्देश सम्प्रेषण के माध्यम रहे हैं, किन्तु लोक साहित्य में इनकी और व्यापक भूमिका रही है। उत्तरांचल के खुदेड़ गीत, घुघुती, कफ्फू, कागा, हिलांस, भौंर, पौन और सुआ के संचार सम्प्रेषण और संदेश वाहक भावनाएं आज भी लोकपरम्पराओं में रचे बसे हैं।

उत्तरांचल में धर्म के साथ जहां संगीत, साहित्य नृत्य कलाओं का घनिष्ठ सम्बन्ध रहा है, वहीं लोकगीतों की स्वयंसिद्धि है कि उसमें सदा से लोक समाहित रहा है। उत्तरांचल में आदिम धर्म की विभिन्न प्रवृतियों के दर्शन अनेक रूपों मे होते है। उनमें लोकगीत भी प्रमुख हैं। उत्तरांचल में मेलों के गीत सिर्फ मनोरंजन के साधन, पूजा पद्धति, घटना विवरण, वीरगाथाएं या व्याख्यान ही नहीं होते बल्कि लोकगीतों के माध्यम से संवाद भी सम्प्रेषित किए जाते हैं। इनसें इतिहास को संरक्षित किया जाता रहा जिससे भावी पीढ़ियों तक उसकी जानकारी पहुंच सके। उत्तरांचल के लोकगीतों में प्रकृति पूजा, यक्ष और नागपूजा, विभिन्न राशियों की पूजा के गीत, स्थानीय देवताओं के जागरगीत, स्थानीय त्यौहार गीत, संस्कारगीत, जन्म, नामकरण, चुडाकर्म, अनेक विवाहगीत, मांगलगीत,

मृत्यु संस्कार संबंधी गीत, ऋतुगीत, खुदेड़गीत, चैती, सावन, भादों के गीत, बालगीत व ऐतिहासिक गीत मुख्य रूप से गाए जाते हैं।

प्राचीन काल में जब आज जैसी संचार की सुविधाएं उपलब्ध नहीं थीं, डाक आदि की भी सुचारू व सहज सेवा नहीं थी, आवागमन के लिए सड़कों व वाहनों का अभाव था तब अपने रिश्तेदारों, परिचितों मित्रों आदि की कुशलता न मिलने से चिंता स्वाभाविक ही थी। इस चिंता को कम करने के लिए उत्तरांचल में अलग–अलग ऋतुओं में विभिन्न मेलों का आयोजन होता रहा है। ऐसे मेलों से उत्तरांचल मे अपने सगे–सम्बन्धियों व अन्यों के मामले मे जानकारियों का आदान–प्रदान करने की परम्परा रही है। उत्तरांचल में प्रायः सभी थौल (कौथीग, मेले विशेष प्रकार के मनोरंजन व कौतुकता लिए मेले) मुख्यतः जहां धार्मिक महत्व की विभिन्न घटनाओं का स्मरण व संदेश दिलाने के लिए आयोजित किए जाते हैं, वहीं उनमें मनुष्य के सामाजिक विकास का धरातल भी मौजूद है।

उत्तरांचल के परम्परागत लोकगीतों व लोकनृत्यों से भी विशेष अवसरों पर ज्ञानार्जन होता है। यहां थड़िया–चौंफला, सराऊं, पाण्डवनृत्य, मुखौटा नृत्य की परम्परा है। सांस्कृतिक दृष्टि से उत्तरांचल के लोकसंगीत में बाद्यी बाजगी, औजी का महत्वपूर्ण योगदान है। वे ढोलक, ढोल–दमाऊ व मशक (बाज) वाद्य प्रयोग करते हैं। उत्तरांचल मे संगीत के लिए ढोल, दमाऊ, नगाड़ा, हुड़का, डौंर–थाली, शंख, तुरी, रणसिंह, भंकोरा, मोछंग, अलगोजा तथा तोड़ा का उपयोग किया जाता है। ढोल दमाऊ विभिन्न अवसरों पर बजाये जाते हें। तुरी व रणसिंहा युद्ध के वाद्य हैं। भंकोरा केवल देवपूजा, नौबत, धुंएल के समय बजाए जाते हैं। मेढ़े के सींग को भी वाद्य के रूप मे प्रयोग किया जाता है जिसे तोड़ा कहा जाता है। ढोलक का उपयोग ढाक्की, वाद्यी या बेड़ा जाति के लोग करते हैं। हुड़का चारणों का वाद्य है डौंर (डमरू) थाली को घण्डियाला (देवपूजन) के अवसर पर बजाया जाता है।

धुएंल रूद्र प्रकृति का ताल है जिसको संध्या समय देवपूजन के लिए बजाया जाता है। नौबत सुबह को बजायी जाती है। इसी प्रकार शबद मंगल अवसरो और देवपूजन मे बजाया जाता है। मृत्यु और युद्ध के वाद्य की बिलकुल भिन्न शैलियां है। इन निश्चित शैलियों मे जो अभिप्राय व्यक्त होते है, वे दूर से ही सुनकर समझे जा सकते है। वाद्य को सुनकर ही उसका देवपूजा, मृत्यु, विवाह, यात्रा आदि का सम्बन्ध ज्ञान सरलता से हो सकता है।

धार्मिक दृष्टि से भी उत्तरांचल में परम्परागत संचार माध्यम बड़े उपयोगी एवं प्रभावी संचार के माध्यम रहे हैं। डोलजात्रा, फिक्वाल, अठ्वाड़, जोगी–जोगिनें, मैजी, रन्त रैबार के सशक्त व पारम्परिक माध्यम रहे हैं। उत्तरांचल मे भादौं (भाद्रपद) के महीने में धार्मिक स्थानों की पैदल यात्रा की जाती है। जिसे डोलजात्रा कहते हैं। यहां परम्परागत रूप से चल रही डोलजात्रा का रिवाज आज भी प्रचलन में है। डोलजात्री उत्तरांचल मे सूचना के आदान–प्रदान के बेहतरीन माध्यम रहे है तथा यह कार्य आज भी परम्परागत ढंग से किन्तु अल्प रूप से जारी है।

उत्तरांचल मे भिक्षाटन की परम्परा भी है। टिहरी जिले के सेम–मुखेम क्षेत्र से भिक्षा के लिए दूर–दूर तक जाने वाले लोगों को फिक्वाल कहा जाता है। घर गृहस्थी से जुड़े ये लोग वर्ष मे एक बार भिक्षाटन के लिए निकलते है। ऐसी मान्यता है कि ये लोग नागर्जा (नागराजा) की आज्ञा से भिक्षा मांगते है। 'फिक्वाल' जीविकोपार्जन के लिए भिक्षा नही मांगते है बल्कि अपने कुल देवता की प्रसन्नता के लिए भिक्षाटन करते है। ये लोग ज्योतिष हस्तरेखा के ज्ञाता भी होते है। सेम मुखेम क्षेत्र के लोगों द्वारा भिक्षा मांगने की परम्परा पुरातन है जो आज भी निर्वाध रूप से चल रही है। 'फिक्वाल' एक गांव से दूसरे गांव में ही नही बल्कि एक जनपद से दूसरे जनपद में जाकर भी भिक्षा मांगते है। जिनसे उन्हें विभिन्न क्षेत्रों की पूरी जानकारी होती है। इसलिए 'फिक्वालों' को भी बेहतरीन व विश्वसनीय 'संदेशवाहक' समझा जाता रहा है।

उत्तरांचल के मंदिरों–मढ़ियों में रहने वाले साधुओं को जोगी तथा सन्यासिनों को जोगिन व मैजी कहा जाता है। उत्तरांचल के अधिकांश शिवालयों मे जोगी रहते हैं। मैजी (जोगिन) कहीं मंदिरों मे और अधिकांशतः गांवों मे मढ़ियां बना कर रहती हैं। जोगी–जोगिन समय–समय पर उत्तरांचल के अन्तराल मे भिक्षाटन के लिए निकलते हैं। उत्तरांचल मे जोगी–जोगिनों के माध्यम से भी रैबार (संदेश) भेजने की परम्परा है। अठ्वाड़ (आठ दिन तक देवी की पूजा) भी धार्मिक दृष्टि से महत्वपूर्ण होते है। 'अठ्वाड़' कौथीग परम्परा के अन्तर्गत आती है। जिसमें बकरों, मेढ़ों और बागी (नरभैसों) की बलि देकर देवी की पूजा की जाती है।

उत्तरांचल में औजी, शिल्पकारों की एक जाति है। इस जाति के लोग ढोल बजाने में पारंगत होते हैं, कहीं इन्हें ढोली भी कहा जाता है, औजी 'ढोल सागर' के भी ज्ञाता होते हैं। ढोल सागर का पुरातन और नवीन साहित्य–संगीत, योग–भोग, शक्ति–भक्ति आदि विभिन्न युग्मों के ताने बाने से बुना हुआ है। औजी ढोल का

उपयोग जहां संदेश भेजने में प्रवीणता के साथ करते हैं वहीं ढोल के तालालय के साथ प्राचीन ऐतिहासिक सूचनाओं का संचार भी गा–गाकर जन–जन में करते रहे हैं। इससे आम आदमी प्राचीन ज्ञान को मनोरंजन के साथ–साथ ग्रहण करते हैं।

विभिन्न अवसरों पर 'बाद्यी' ढोलक की थापों के साथ गीत–गाकर व नाचकर अपना जीविकोपार्जन करते है। 'बाद्यी' पहाड़ के आशुकवि कहे जाते हैं। ये ऐतिहासिक विरासत की जानकारियों के संवाहक का कार्य तो करते ही हैं तात्कालिक स्थितियों, परिस्थितियों से सम्बन्धित गीतों की रचना भी करते हैं। वाद्यी सामाजिक रीति–नीतियों आचार–दुराचार पर पैनी नजर रखते हैं। वे साहसी तथा हितकारी कार्य करने वालो को प्रोत्साहित करने तथा गलत कार्य करने वालो को हतोत्साहित करने के लिए गीत बनाकर गांव–गांव जाकर ऐसे गीत गाते हैं। इतना ही नहीं वे गांव–गांव जाकर एक गांव की सूचना दूसरे गांव में पहुंचाने का कार्य भी करते है। इन लोक कलाकारो की उपेक्षा के कारण यह परम्परा लुप्त होने के कगार पर है, जबकि इस कला की प्रभावशीलता आज भी महत्वपूर्ण है।

लोकगीतो की भांति लोकगाथाएं, लोककथाएं, लोकोक्तियां आदि भी संचार के सशक्त माध्यम रहे हैं। ऐतिहासिक गाथाओं से जहां गोरखा व मुगल आक्रमणों के अत्याचारों का संदेश प्राप्त होता है, वहीं वीर गाथाओं से माधोसिंह भण्डारी, तीलू रौतेली, लोदी रिखोला, कप्फू चौहान जैसे वीरों के असीम त्याग एवं वीरता का संचरण होता है।

निस्संदेह उत्तरांचल में संचार के परम्परागत संचार माध्यमों की एक समृद्ध विरासत है, इनकी उपयोगिता एवं प्रभावशीलता आज भी लोकप्रियता के साथ–साथ अपना विशिष्ट महत्व रखती है। हालांकि इनकी 'पहुंच' संचार के वर्तमान माध्यमों की तुलना में काफी कम या सीमित है फिर भी लोगों के मस्तिष्क पर गहरी छाप छोड़ने में ये पूर्ण समर्थ हैं तथा आज भी प्रभावशाली रूप में इनका उपयोग किया जा सकता है, परन्तु आधुनिकता की वर्तमान चमक दमक में ये परम्परागत संचार माध्यम घोर उपेक्षा से ग्रस्त हैं, इनमें से कितने आखिरी सांसे गिन रहे है। आवश्यकता इस बात की है कि लोक परम्परा के वाहक इन परम्परागत माध्यमों को संरक्षित किया जाए, ताकि भावी पीढ़ी उपभोक्तावादी संस्कृति की आंधी में अपनी संस्कृति की जड़ों से कट न जाये।