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DEGRADATION OF FOREST IN NAINITAL HILL

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ABSTRACT

There is degradation in the forest ecosystem in the Uttrakhand hills and its sustainability is very important for the survival of humankind. There has been a loss of 268 sq. km of forest cover in Uttarakhand hills. The very dense forest cover has gone down to the tune of 86 sq. km whereas there is a tremendous loss of forest cover in moderately dense forests and it is to the level of 519 sq. km. Nainital has also lost 3 sq km of VDF and 107 sq. km of open forest(OF). The problem of Nainital is double fold one in city which is in an around Nainital lake and other area falls under reserve forest area which surround the Nainital city. The deforestation in city area is on account of construction activities which is going on unabated despite many movements against it. There is a sinister method of killing a tree in the city area and there seems to be a connivance in the entire process of drying a tree. Around 317 trees have been found dry and illicitly felled in the city whereas the number of green trees felled illicitly are recorded to be 101, the situation changes dramatically when the illicit felling is seen in private and nazul areas. In private and nazul areas the number of green trees felled is more compared to dry trees. In the forest areas outside city the total number of trees felled are found to be 822 and the poles cut illegally were 546. The degradation in forest ecosystem has major fall outs in term of decline in water discharge, increase in temperature rise and dryness etc. The Forest footprint is a new and emerging concept which may quantify the loss of forest in term of deforestation and its impact on ecological services.

INTRODUCTION

Nainital is one of the most beautiful hill stations in the country and probably, the only hill station in Uttaranchal which has large lake in the middle of the city. Nainital is rightly called as the city of lakes not because it has a series of beautiful lakes in and around the city but its tourism industry thrives on it. Nainital is situated at the height of 1930 mts. above sea level and has an area of 2658 sq. miles. It comprises of both hill as well as plain areas. The plain areas are very fertile and sustain a good agricultural ecosystem. Nanital hill is also very rich in floral as well as faunal biodiversity. Nainital has a total forest area of 60114.57 hact. which comprises of both coniferous as well as broad leaved forest Nainital is situated between north latitude 28°51' and 29° 57' and between east latitude 78° 43' and 80° 5'. The maximum and minimum temperature has been recorded as 34.5°C and 0°C respectively.

Formation of the Himalayas: There was a super continent called Gondwana land in the southern hemisphere and India was an integral part of that ancient land mass. It split apart during Mesozoic period (between 205 and 65 million years ago) to form what we know as South America, Africa, Australia, Antarctica, Madagascar and India. A part of the land mass separated from the continent of Africa at about 100 to 105 million years ago and moved eastwards. Some times between 87 and 86 million years ago, India broke away from Madagascar and drafted northeastward, and it conversed at the rate of 18 to 19 cm. per year towards the continent of Eurasia. It rode as a passive passenger on the crusted plate that form the flora of what is known as Tethys Ocean. The leading edge or frontal part of the drifting Indian plate comprise of prism shaped succession of sedimentary rocks resting on the foundation of a complex metamorphic and granites rocks older than 2500 million years. Convergence of India and Asia as the India approach Asia in frontal part of the drifting plated sank gradually. The part immediately to the south of Asia also sagged given rise to an elongated, deep depression-an oceanic trench. The initiation of- the sinking of the ocean floor was accompanied by fissuring of the adjoining continental crust. The crustal splitting triggered magmatic and volcanic activities on a grand scale all along the margin of the continent of Asia. Molten magma was emplaced as huge disquadrant bodies of

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batholiths, stocks and dykes of granites. The magmatic phenomenon culminated in making of the great mountain arc stretching from Kohistan in Northern Pakistan to Kailash in Tibet. Dockine of India with Asia Ploughing through the thick pile of sediments that had rapidly accumulated in the oceanic trench and on the ocean floor the drifting India touched and docked with Island in the Kohistan-Kargil sector. India had travelled more than 7000 Km. since it had broken away from Africa about 20-30 million years earlier. As the pressure of the converging continents grew, the sediments of the ocean trench and the ocean floor together with the volcanic rocks of the Island arc were pushed onto the continental margin of India in Waziristan and Khurram in Northern Pakistan and Cuafiang in Southern Tibet. It took nearly ten million years for welding of two continents. The collision zone, marking the Asia-India junction is known as Indus-Tsangpo Suture. The river Tsangpo and Sindhu today occupy this junction.

Himalaya

The Himalaya is among the youngest mountains of the world, and it is still undergoing structural changes and growing. This is evident from the increasing heights of its peaks. The tectonic turmoil of growing up is manifest in the upheavals occurring in the giant frame and in spells of twitching and quivering into which the Himalaya is frequent thrown. The world's highest and youngest mountain massif was formed as a result of the coming together and eventual collision, of India and mainland Asia. The stupendous pile of sedimentary rocks lying in the frontal part of the Indian subcontinent was compressed, squeezed and wrenched into a grant edifice called the Himalaya. As the northward-moving India pressed against Asia, mountain ranges were molded around the projecting promontories of the India landmass. A yew remarkable feature is the festoons of curved mountain ranges that make spectacular knee-bends at the northwestern and northeastern corners. In Kashmir the whole of the mountain system abruptly turns southward, making an acute angle near the pivotal point. In the northeast, the mountain ranges bend around the Namcha Barwa knot. The 2400 km-long and 300 to 400 km-wide expanse of the Himalayan province is divisible into four physiographic domains. Each of these domains has its distinctive geological identity, its peculiar structural architecture, its own distinctive assemblage of rocks, and contrasted physiographical layout.

Recognized as terrains, the Himalayan domains are known as the Siwalik in the south, the Lesser Himalaya in the middle, Himadri of Great Himalaya further north, and the Tethys Himalaya in the far north. The Siwalik terrain in the south is separated from the Indo-Gangetic plains by a series of reverse faults. These faults are concealed under a discontinuous apron of gravelly debris that slipped down the hillsides, and or detritus deposited by mountain river at the points of their emerging into the plains. The outer ranges of the Lesser Himalaya abruptly rise to elevation of 2000 to 2500 meter against the Siwalik hills, In the northwest the Pir Panjal-Dhauladhar Ranges are more than 3500 m high, and in south-central Nepal the Mahabharata forms a 3000 m and higher mountain rampart. In the central sector, stretching from Nepal through Uttaranchal to Himachal Pradesh, the middle belt of the Lesser Himalaya has comparatively mild relief, being characterized by a rather undulating landscape, rounded hilltops and gentler slopes. Rivers and streams flow quietly without landscape, rounded hilltops and gentler slopes. River and streams flow quietly without hurry, but rush through gorges where they cross recently faulted-up mountain blocks. The lesser Himalayan terrain comprises a very thick succession of sedimentary and associated volcanic rocks, ranging in age from more than 1600 million years to about 540 million years, and overlain by sheets of metamorphic rocks of Precambrian antiquity and granites belonging to two periods-1800 to 2000 million years and 500to 540 million years. Once thickly covered by forests but presently considerably destitute of the sylvan cover over the greater part, the lesser Himalaya is the most populated terrain of the Himalayan province.

Forest Cover in Uttrakhand

Uttarakhand formerly known as Uttaranchal, is a state in the northern part of India. It is often referred to as the *Devbhumi* due to many Hindu temples and pilgrimage centers found throughout the state. Uttarakhand is known for its natural beauty of the Himalayas, the Bhabhar and the Terai. On 9th November 2000, this 27th state of the Republic of India was created from the Himalayan and adjoining northwestern districts of Uttar Pradesh. It borders the Tibet on the north; the Mahakali Zone of the Far-Western Region, Nepal on the east; and the Indian states of Uttar Pradesh to the south and Himachal Pradesh to the west and north-west as well as Haryana to its south-western corner. The state is divided into two divisions, Garhwal and Kumaon, with a total of 13 districts. The interim capital of Uttarakhand is Dehradun, the largest city in the region, which is a railhead. The natives of the state are generally called Uttarakhandi or more specifically either Garhwali or Kumaoni depending on their place of origin. According to the 2011 Census of India, Uttarakhand has a population of 10,116,752, making it the 19th most populous state in India. The total geographical area of uttrakhand is 53483 sq km of which the forest cover is 45.32%. There has been a perceptible degradation in forest cover in uttrakhand. The following table shows the district wise forest cover change during two assessment years. From the above table it is evidently Clare that there is a huge degradation in very dense and moderately dense forest cover in Uttrakhand and the problem gets more compounded on the fact that the entire flora and fauna have not been surveyed and enlisted as yet therefore, it is almost impossible to know that how much biodiversity has been lost till today. The reasons for this degradation is well known but despite this knowledge forest department has not been able to stem the rot.

Forests in Nainital

The total recorded forest in Nainital is 60114.57 hact. The organization which has the mandate of managing this forest is the Uttaranchal Forest Department. Administratively the entire forest area has been divided into eight forest ranges each one of them is manned by none other than a Forest range officer. Each range has been further divided into sections and beats manned by Section officer and Beat officers respectively. On top of the range officers there may be one or two Assistant Conservator of Forests depending upon the requirement and placements. On the top of the district forest bureaucracy there is one Divisional Forest Officer (DFO) at the district level. The entire resources lie in the hands of DFO to carry out scientific management of the forest. A regular forest management plan is being prepared after every ten years which contains present prescription of the forest management and also the future proposals for the scientific management of the forest.

Table 1. District wise Forest Cover Change Matrix

District	Geo graphical Area	2013 Assessment				2015 Assessment				Change in Forest Cover			
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total	Very Dense Forest	Mod. Dense Forest	Open Forest	Total	V.D. F.	M.D .F	O.F.	Total
Almora	3,139	222	927	428	1,577	224	929	430	1,583	+2	+2	+2	+6
Bageshwar"	2,246	197	883	305	1,385	200	834	329	1,363	+3	+1	+24	-22
Chamoli	8,030	441	1,573	686	2,700	441	1561	679	2,681	N.C	-12	-7	-19
Champawat"	1,766	337	576	274	1,187	348	570	266	1,184	+11	-6	-8	-3
Dehradun"	3,088	583	695	332	1,610	620	647	35	1,602	+17	-48	-297	-8
Pauri Garhwal"	5,329	520	2,095	676	3,291	519	1954	796	3,269	-1	-141	+120	-22
Haridwar"	2,360	25	333	257	615	27	301	260	588	+2	-32	+3	-27
Nainital"	4,251	605	1,899	570	3,074	602	1939	463	3,004	-3	+40	-107	-70
Pithoragarh"	7,090	571	1,113	416	2,100	509	1013	580	2,102	-62	-100	+164	+2
Rudraprayag	1,984	241	592	297	1,130	241	591	298	1,130	N.C	-1	+1	NC
Tehrigarwal	3,642	298	1,232	618	2,148	296	1239	621	2,156	-2	+7	+3	+8
Udham Singh nagar	2,542	175	236	135	546	157	246	103	506	-18	+10	-32	-40
Uttarkashi"	8.016	570	1,957	618	3,145	570	1,778	724	3,072	NC	-179	+106	-73
Grand Total	53,483	4,785	14,111	5,612	24,508	4,754	13,602	5,884	24,240				-268

Source – India state of forest report (2013 and 2015) Ministry of environment, forest and climate change.

Very Dense Forest	All lands with tree canopy density of 70% and above.
Moderately Dense Forest	All lands with tree canopy density of 40% and more but less than 70%.
Open Forest	All lands with tree canopy density of 10% and more but less than 40%.
Scrub	Degraded forest lands with canopy density less than 10%.

Table 2. Specieswise area statement of Nainital Forest Division

Sl. No.	Main Species	Area in hact	Percentage of the total forest area
1.	Pine (Pinus roxburghii)	29751.91	49.49201
2.	Oak (Quercus leucotrichophora)	12929.43	21.50798
3.	Tilonj (Quercus floribunda)	2001.41	3.329326
4.	Kharsu (Quercus Lanuginosa)	212.4	0.353325
5.	Rianj (Quercus semicarpiflolia)	822.2	1.467531
6.	Fir (Abies pindrow)	32.9	0.054729
7.	Deodar (Cedrus deodara)	116.5	0.193797
8.	Kail (Pinus wallichiana)	77.2	0.128421
9.	Spruce (Picea smithiana)	3.2	0.005323
10.	Sura (Cupressus torulosa)	106.71	0.177511
11.	Sal (Shorea Robusta)	2371.2	3.944468
12.	Khair/Shisham (Acasia catechu/ Dalbergia Sisso)	10	0.016635
13.	High Altitude	605.8	1.007742
14.	Low Altitude	6592.5	10.96656
15.	Rocks	3101.36	5.159082
16.	Blank	1219.9	20.29292
17.	River bed	90.4	0.15038
18.	Exotic	0.22	0.000366
19.	Plantation area	8.72	0.014506
20.	Aesculus indica & Juglance regia	0.61	0.001015
	Total area of Division	60114.57	100

Source-Management plan of Nainital forest division (2008-09 to 2017-18).

The management plan is prepared under the supervision of the very senior forest officer and this also requires the approval of State Govt. as well as the Govt. of India. Nainital is very rich in floral and faunal diversity.

Problem in Nagarpalika Forest

The major problem which threatens the nainital city is the forest in an around nainital lake.

Table 3. Table showing year wise illicit felling in protected & reserve forest area of Nainital Municipality area

S.No.	Year	Protected /Reserve Forests			
		Dry	Green	Total	% of illicitly felled dry trees
1	2	3	4	5	6
1	1995-96	28	7	35	80
2	1996-97	17	7	27	71
3	1997-98	10	7	17	59
4	1998-99	5	1	6	83
5	1999-2000	49	-	49	100
6	2000-01	24	-	24	100
7	2001-02	20	4	24	83
8	2002-03	17	11	28	61
9	2003-04	20	6	26	77
10	2004-05	18	6	24	75
11	2005-06	3	11	14	21
12	2006-07	-	-	-	-
13	2007-08	8	11	19	42
14	2008-09	4	0	4	100
15	2009-10	53	22	75	70.66
16	2010-11	11	0	11	100
17	2011-12	7	0	7	100
18	2012-13	6	0	6	100
19	2013-14	9	1	10	90
20	2014-15	5	0	5	100
21	2015-16	0	3	3	-
22	2016-17 (20 September 2016)	4	36	40	-
	Grand Total	317	101	418	

Source- Data collected from Nainital forest division, (2016).

Table 4. Table showing year wise illicit felling in private holding & Nazul areas of Nanital Municipality area

S.No.	Year	Private/Nazul Compounds			
		Dry	Green	Total	% of illicitly felled dry trees
1	2	3	4	5	6
1	1995-96	14	5	19	74
2	1996-97	3	7	10	30
3	1997-98	4	1	5	80
4	1998-99	1	6	7	14
5	1999-2000	9	5	14	64
6	2000-01	3	7	10	30
7	2001-02	4	1	5	80
8	2002-03	9	9	18	50
9	2003-04	6	24	30	20
10	2004-05	7	-	7	100
11	2005-06	6	12	18	33
12	2006-07	-	11	11	-
13	2007-08	-	37	37	-
14	2008-09	1	20	21	4.76
15	2009-10	0	10	10	-
16	2010-11	3	18	21	14.29
17	2011-12	0	5	5	0.00
18	2012-13	1	17	18	5.56
19	2013-14	0	1	1	-
20	2014-15	9	4	13	69
21	2015-16	7	3	10	70
22	2016-17 (20 September 2016)	4	5	9	44
	Grand Total	94	212	304	

Source- Data collected from Nainital forest division, (2016).

This has both kinds of forests i.e. coniferous as well as broad leaved. The following table gives us the species wise area statement and their percentages against the total area of the Nainital Forest Division.

Problem of Nainital Forest

The problem of Nainital Forest can be discussed in two heads namely Nagarpalika a Forest (or City Forest) an other outside City Forest.

This forest is called nagarpalika forest City forest. The total area of this forest is 507.07 hact (Management plan of Nainital Nagarpalika forest by M.K. Joshi, 2208 to 2018). Technically this forest is protected forest which is governed by Indian Forest Act 1927. There are a few patches of private land in the midst of protected forest. Mostly the Forest is of subtropical pine forest and Himalayan temperate forest type. (According to champion and seth classification). The city forest mainly constitutes of (Quercus floribunda) and (Pinus roxburghii). The major problem in the city forest is the uncontrolled construction of residential and commercial buildings and it has

crossed its carrying capacity long ago. The following table shows the illegal felling over the years in the city forest. From the above Table 3 it is evident that total 454 trees were illicitly felled in between 1995 and 2016 of which 318 trees were dry and 133 trees were green. Therefore, it could be safely concluded that 70% of the felled trees were dry. It cannot be assumed that all the dry felled trees were dried chemically and then applied for felling but experience tells us that 99% of the cases were artificially dried trees only). The gradual loss of tree cover/vegetation has led to drying up of many natural water streams which were the primary source of drinking water. Nanital Lake is the catchment area of the major water reservoir providing water to the local population. When table 3 is compared to Table 4 then a different scenario emerges. The number of illicit felling is more in reserve forest and protected forest of Nainital Municipality area than the private holdings and nazul department. If felling goes unabated like this the entire reserve and protected forest land will be devoid of trees and vulnerable to encroachment by land mafias. The Table 4 has altogether a very different story to tell. Here also the number of green felled trees are more than dry felled trees. The loss of forest cover or vegetation not only leads to shrinkage in water streams but also hastens up the process of soil erosion. Almost all the trees on the Nainital hill (in and around Nainital Mall Road) hills are slightly bent on the axis and it is only because the land mass has started moving downward on account of excessive tree felling, heavy constructional activities and grazing.

Deforestation in forest outside city

Table 2 is showing species wise tree percentage in total numbers of trees in Nainital Forest Division clearly depicts that Nainital has 49.5 percent pine forest. This forest is very dry and occurrences of forest fire are very frequent in this kind of forest. This forest also does not support any undergrowth therefore; process of soil erosion is faster than the other forest type which has good undergrowth. The pine needles which fall in the forest floor also take a very long time to decompose therefore; nutrition flow to the soil is also very poor. The fire in the pine forest spreads very fast because of many reasons firstly, the pine needles are highly inflammable and the resin contain in the tree itself make it more vulnerable, Secondly, the cone of the pine tree rolls down the hill and spreads forest fire to the bottom. The repeated forest fires make the pine forest and its soil very dry. Process of climate change has also compounded the problem of hill forest ecosystem over the last many years. This would be very interesting to study the process of species shifting in the hill forests. It could be possible that pine forest shift over to oak forest and thereby, reducing it in size or eliminating it altogether over a period of time. The above table also shows the gradual reduction of other important species in their area which may not be the result species shifting alone but a combination of many other factors. This cannot be understood as a case study of Nainital in isolation but may be a complex phenomena spread over a very vast area.

Other factors for degradation of forest eco system

Forest disturbances are events which cause change in the composition and structure in the forest eco system other than normal mortality and recruitment. Illegal felling is one of the most important factor as it not destroys balance of the eco system but also eliminates seed bearer trees or mother trees.

Forest fires in the hills are very common and repeated forest fire ultimately finishes any species forever. Nainital forest can be broadly kept in subtropical pine forest, Montane wet forest and Himalayan moist temperate forest. It has been found that these forests fall in following fire incidence class.

Table 5. illicit felling in nainital hill forest outside city forest

Sl. No.	YEAR	No. of Trees Illicitly Felled	No. of Poles Illicitly felled	Total
1	2	3	4	5
1	2000-01	125	0	125
2	2001-02	77	0	77
3	2002-03	70	8	78
4	2003-04	41	0	41
5	2004-05	46	0	46
6	2005-06	38	0	38
7	2006-07	84	18	102
8	2007-08	74	0	74
9	2008-09	6	10	16
10	2009-10	2	11	13
11	2010-11	48	10	58
12	2011-12	34	50	54
13	2012-13	37	151	188
14	2013-14	13	94	107
15	2014-15	63	51	114
16	2015-16	47	117	164
17	2016-17 (20 September 2016)	17	26	43
	Grand Total	822	546	1338

Source- Data collected from Nainital forest division, (2016).

The problem with the nainital lake

Nainital is known by a huge lake situated at the center of the city. The span of the Nainital lake is 132.5 acres and the total population resides in an area of 1173 hact. The total population of Naintal town is approximately 85000 and 72% of which lives in the lake catchment area. Therefore, there is a tremendous pressure on the lake ecosystem. Not only the township had sewage problem but it had a host of complex problems which make Nainital lake a dying lake ecosystem. Looking at the whole problem in its entirety a public interest litigation was filed in Hon'ble Supreme Court by one of the social activist. Hon'ble Supreme Court constituted a one man commission to find out the truth in the claim and counter claims of the petitioners and various implementing agencies respectively. On receipt of the commission report the Hon. Court passed following characters. "We have dully considered the findings of the commissioner and his recommendations. According to us, there cannot be two opinions about some preventive and remedial measure to be taken on war footing, as any delay would cause further degradation and complicate the matters. In our considered view, the following steps deserve to be taken urgently.

Sewage water has to be prevented at any cost from entering the lake. 2. So far as the drains which ultimately fall in the lake are concerned, it has to be seen that building materials are not allowed to be heaped on the drains to be prevent situation of the lake. 3. Care has been taken to see that horse dung does not reach the lake. If for this purpose the horse-sand has to be shifted somewhere, let this go. The authorities would examine whether trotting of horses around the lake is also required to be prevented. 4. Multi-storeyed group housing and commercial complexes have to be banned in the town area of Nainital. Building of small residential houses on flat areas could, however, be permitted. 5. The offence of illegal felling of trees is required to be made cognizable. 6. Vehicle traffic on the

Mall has to be reduced. Heavy vehicles may not be permitted to ply on the Mall. 7. The fragile nature of Ballia Ravine has to be taken care of. The cracks in the revetment of Ballia Nala have to be repaired urgently. Hearing may still be going on or over but one thing is sure that Government agencies have failed to deliver.

Deforestation opens up the soil and expose them to soil erosion and water runoff besides, reducing water percolation through the root system. Pathak *et al* (1985) cited a study on the ground water interception and it's infiltration in to the soil carried out in different forest types in central Himalayan forest and a very interesting result was obtained.

Table 6.

Sl. No.	Forest Type Group	Fire incidence Class			
		Heavy	Moderate	Occasional	No fire
1.	subtropical pine forest	4.49	24.08	44.90	26.53
2.	Montane wet forest	0.00	4.77	52.37	42.86
3.	Himalayan moist temperate forest	1.18	12.60	41.51	41.71

Source – India state of forest report (2013 and 2015) Ministry of environment, forest and climate change.
Heavy Fire- When More than of the 50% of the forest area is affected by fire
Moderate fire when 10 to 50% area is affected by fire
Mild Fire – When less than 10% area is affected by fire.

Table-7. Apportionment of Rainfall in Central Himalayan Forests (Pathak *et al*., 1985)

Dominant species: Pine: Pinus roxburghii Sarg., MB; mixed broadleaves, especially Quercus galauca Thumb., Mixed 0ak: Quercus leucotrichophora, Q. floribuna Lin1., Sal; Shorea robusta Gaertn.f.

Forest	Canopy %	Rain fall mm	Through fall %	Stem flow %	Interception %	Litter Intercep-tion %	Ground vegetation interception and Infiltration %	Over land Flow %
Pine	90	1234	74.7	0.3	25.0	7.2	58.9	0.8
Pine +MB	38	1179	91.5	0.4	8.0	7.2	83.5	1.3
M. Oak/Pine	78	915	82.8	0.4	16.8	8.9	73.8	0.6
Mixed Oak	81	1364	84.7	0.4	14.9	9.4	75.2	0.5
Sal	89	1153	82.4	0.9	16.7	9.8	72.8	0.7

Had it not been so the Hon'ble supreme court would not have taken command in its own hands. On a visit to Nainital any one could see polythene bags, garbage and sewage still coming into the Nainital lake. Until unless the construction activities comes to a total halt the problem of debris coming into Nainital lake cannot be fully stopped. It seems stopping construction is neither implemented nor seems possible because locals may keep renovating and making their own houses and they cannot be stopped but the Government can reduce this activity by shifting many state Government offices to place like Haldwani, Ramnagar, Rudrapur etc. Once the offices are shifted a sizeable chunk of population may also go along with the office. The locals could be encouraged to change into paying guest accommodation mode. The hotels may be discouraged. This process will not only facilitate taking off extra load of the hill but locals will also earn some extra money. It is heard that Uttranchal Government has banned multi storage building in lake development area, it is supposed to be a step taken into right direction. The fauna of the Nainital lake has to be kept healthy so that they keep cleansing its water and for this a strict vigil has to be maintained that no sewage comes to Nainital lake. Desilting of Nainital lake may also be carried out but requires very strong technical input and experts opinion before carrying it out. Nainital requires a total change in its developmental approach not because forest needs it but the entire country needs it otherwise we are sitting at yet another disaster to come in full force.

Impact of deforestation

The immediate impact of deforestation seems to be on hydrology, soil erosion, change in forest composition and climate change. Planning commission in its study during 9th five year plan found that annually 10 million metric ton of topsoil is washed away on account of deforestation.

It was found that maximum ground vegetation interception and infiltration was found in the mixed forest as shown in the table-7. The forest ecosystem in itself a wonderful living entity and it not only keeps all its component evolving but also keeps underground water recharge active and alive. K.S.Valdiya and S.K.Bartarya (1989) found in their studies found that weather of Bhimtal-Hairakhan-Khansyun belt in Nanital has become warmer and drier with the perceptible change in rainfall. The average rain fall over Bhimtal has declined by 34% (in between 1958 and 1970) and during the same period 9.3% of the forest cover was lost due to a variety of reasons therefore, there is a perceptible relationship between temperature rise, dryness and less of rainfall with deforestation. They have also found that there is a distinctive decline in water discharge and this decline is 25 to 75%. The Himalaya is very rich in biodiversity and is home to about 13000 species of flowering plants (J.S.Singh 2006). The Indian Himalayan region (IHR) as a whole supports nearly 50% of the total flowering plants in India of which 30% is endemic to this region. The region is also called as " Water Tower of the Earth" and approximately 10-20% of the area is covered by glaciers whereas 30-40% remains under seasonal cover of snow. Despite the rich resources in water the water flow down the stream is diminishing (J.S.Singh 2006). The impact of mountain deforestation on hydrological systems seems to be a matter of scale and time (Ives 1989) Man induced changes in Himalayan ecology is well documented. Forest clearances in the highland of the watershed, if safety measures are not taken well in advance, causes increased runoff and accelerated soil erosion (Messerli and Hoffer 1995).

Ecosystem Service Valuation

Any forest ecosystem is consisted of essentially two things, ecosystem structure and ecosystem functions. Ecosystem structure refers to individuals and communities of plants and animals whereas ecosystem functions refer to different

functions carried out by the ecosystem namely, water discharge and spring rejuvenation, fuel wood and fodder production, maintenance of soil fertility, nutrient cycling, carbon sequestration, water cycle etc. (Dally *et al.,* 2007) . Various methods have been used to estimate the values of various ecosystems, notable among them is the estimation done by Costanza (Costanza *et al.,* 1997). According to this study 17 ecosystems services were identified and valued at US rates at the price value of 1994. The total value of these ecosystem services emanating from the forests was valued at US $ 2007 per hact/year for tropical forest and US $ 302 per hact/year for temperate forest. Based on this value the ecosystem services for the entire Himalayan states including the state of Assam was evaluated to be US $ 1150/hact/year (SP Singh 2007). Nowadays the forest footprints have been very loosely used and this has not been measured in as yet in any forest ecosystem. Forest foot print may be defined as the amount of deforestation in forest and its impact on the ecosystem services.

Conclusion

The Himalayan forest ecosystem is very fragile and disturbance in any one of its components not only affects it adversely but also starts infringing upon local population and their needs. Nainital has started feeling water scarcity not only during summer but in winter also. Forest fire has reached the doorsteps in the rural rural areas and started taking human and livestock toll. The illicit felling data provided by the forest department is always on a very conservative side and not fully known unless the forest area is thoroughly searched and investigated. The front line staff mandated to protect our forests is not in the required strength as their numbers should have been per unit area wise. In Nainital forest division one forest guard is supposed to look after about 120 to 150 hact of forest area which is not humanly possible for a human being to criss cross the entire area on foot without any other resources. The financial resources are very meager and never match the requirement therefore; looking at these problems a check on deforestation seems unlikely in the forests.

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