Impact of Human Disturbance on Forest Vegetation and Water Resources of Nainital Catchment

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Abstract: Nainital is a prime example of Lake Township that has been severely impacted by human activities owing to expansion of urbanization. The impacts of these pressures are felt in varied ways and from varied sources. During the few decades increasing local population 6903 (1901) to 38559 (2001) and the logarithmic increase in tourist influx into the watershed has effected the water resources and biodiversity of the area. A significant number of water resources have dried up in the past two to three decades. The present study is an attempt to document and relate the population rise and increase in the jungles of concrete in the past 50 years in the Nainital catchments to its impact on the forest cover forest density, biodiversity and water resources. Certain herb and shrub species that were abundant in the oak forests (*Q. leucotrichophora* and *Q. floribunda*) have now disappeared. In Nainital catchment area in un-disturbed sites the tree richness is 11, shrub richness is 19 and herb richness is 51, whereas in disturbed forest the richness is declining and is 7 for tree species, 19 for shrubs and 31 for herb species. The study is important as it indicates the changes that are occurring in forests that are degrading because of relentless biotic pressure. [Nature and Science. 2009; 7(10): 74-78]. (ISSN: 1545-0740).

Key Words- Anthropogenic pressure, Plant Richness, Catchment.

Introduction

Lake Nainital lies in a densely populated valley in the Kumaun Himalaya and is one of the most popular tourist resorts in Northern India. The existence of the lake Nainital was first reported by P. Baron in 1841. Nainital is a prime example of Lake Township that has been severely impacted by human activities owing to expansion of urbanization. During the few decades increasing local population and the logarithmic increase in tourist influx into the watershed has affected the water resources and biodiversity of the area. A key study in Himalayan hydrology is to assess the role of forests in maintaining the hydrological services. Scientific studies from Uttarakhand record many instances of accelerated soil erosion, landslide activities, increasing flood hazards and diminishing discharge in springs and rivers all associated with forest degradation and loss of forest cover (Valdiya, 1987).

In the Uttarakhand, mountains springs emanating from a variety of land use recharge zones are the main sources of fresh water for household consumption. Although spring water yield is largely a function of geological attributes, the land use and land cover are known to influence the spring water yield, water quality and longevity of spring discharge and season discharge patterns (Valdiya and Bartarya, 1991, Negi and Joshi, 1996). Therefore, each spring shows different discharge patterns. Geology rock type and anthropogenic pollution in the recharge area are also known to influence water quality and quantity. In recent decades, gradual drying up of these springs, low discharge during dry months and perennial spring becoming seasonal have been reported all across the region (Singh and Pande, 1989; Singh and Rawat, 1985). It has been observed that land cover change, biotic interference in the fragile watershed have caused soil erosion, depletion in soil organic matter and concomitant loss in the water absorption by soil resulting in a too much and too little water syndrome (Valdiya and Bartarya,1989).

The land use/ land cover of Nainital watershed and adjacent hills indicates that the hill resort is still substantially covered with forest. The total catchments area is approximately 5.70km^2 of which the built-up area is about 20% and is alarmingly increasing. Oaks (*Quercus leucotrichophora* and *Q. floribunda*), which are hardwood evergreen species make most of the forests. Only towards China Peak a conifer (*Cupressus torulosa*) dominates.

The present study is an attempt to document and relate the population rise and increase in the jungles of concrete in the last few decades in the Nainital catchments to its impact on forest biodiversity and water resources.

Material and Methods:

Nainital is located at 20º24´N latitude and 79º29´E longitude near the Main Boundary Thrust (MBT) that separates the Siwaliks from the lesser Himalaya. The elevation at Lake Level is 1938m and encompassing hills (7 in number) rise from 2139 to

2611m above the sea level. The basic pattern of climate is governed by the monsoon. The summer precipitation (June end to September end) brought by the monsoon accounts for 75% to 80% of the annual rainfall, which generally ranges between 200cm and 250cm. The mean temperature at Nainital (at 1938m altitude) ranges between 8ºC in January and 20ºC in June. Winter snowfall is common and some surrounding hills are cooler than areas around the lake.

In the present study the study was divided in two sections. To study the richness and diversity of the disturbed and undisturbed forests analysis was done following Curtis and McIntosh (1950) by placing 10 random quadrats of 10X10m for trees, 5X5m for shrubs and 1x1m for herb species. Data of Upreti (1982) on vegetational parameters collected in 1982 was referred for comparisons.

The data related to different form of anthropogenic pressure were collected from different government agencies and EERC report (2002). Data on spring and water recharge zones of Dr. G.L.Shah (unpublished) was used.

Result:

1. Morphological Features of Lake Nainital:

The morphometric features of lake Nainital are given in Table 1. Presence of 100m wide ridge in the middle divides the lake into two parts with different maximum depth. As a consequence the water of the two parts does not mix during thermal stratification (Rawat, 1987).

The tree layer, richness decline in 03 sites while in Nirmala convent there was no change in species richness (Table 2). There was sharp decline in density of individuals in 3 sites (Government house, St. Xaviers and China Peak). The total basal area was more or less similar in all the sites except St. Xaviers where it declines from 19.90m^2 /ha to 11.61 m^2 /ha. This decline could be due to the heavy construction at this site.

Shrub layer richness increases in government house site whereas in all other sites there was decline in species richness (Table 3). The density of shrubs also declines except at Nirmala convent site where it increases from 89.5indi/ha to 135.4indi/ha (Table 3).

As for herbs, over the period of two decades the species richness declined at three sites whereas in Nirmala convent site there was a slight improvement (Table 4). However the decline was marginal. The density of trees at Nirmala Convent site has increased significantly in the last two decades. Protection afforded to this site because of a boundary wall of the school appears to be the principal reason for this increased tree density.

3. Comparison of Status of Natural Springs and Recharge Zones Over a Period of Seven Decades-

In the Nainital catchments area total 8 water springs are present. A very special feature about these springs is that all these springs are situated in the altitudinal range of about 6100-7000ft. About seven decades before all these springs are perennial with enough water but now the situation is very critical. Of these totals eight springs now only three are perennial and remaining five are completely dry on with low discharge in the summer months. There are total 5 recharge zones of Nainital lake. But now due to heavy construction and development of car parking in these areas the recharge area has decline by 15 to 50%.

4. Effect of different forms of Anthropogenic Pressure on Nainital lake catchments.

There are four major types of anthropogenic pressures on Nainital lake catchment

(a) **Sedimentation and erosion**.- carbonate rock lithology, which is more susceptible to weathering, high precipitation and frequent landslides accounts for a higher sedimentation rate in Nainital lake (0.69cm/year) (EERC Report, 2002). Besides these natural factors heavy anthropogenic pressure like increased construction and construction based activities further increased it. Between 1895 and 1979 the mean depth of Lake Nainital has reduced from 21.43 to 18.55 m.

(b) **Human population**- The census of 2001 has estimated the permanent population in the catchment area of Nainital to be 3984. This indicates that nearly 100people/year was added during last decade. The catchment also hosts a large floating population of about 5000persons during the peak tourist season who mostly works as coolies, boatmen, horsemen etc.

(c) **Vehicular traffic**- Another indicator reflecting the increased tourism activity and anthropogenic pressure in recent past is the number of vehicles entering the town. The EERC (2002) data shows that the number of light vehicle that entered the town during the peak tourism month has increased by about 46% in pat three years (2000-2002). The revenue earned through toll tax in June has increased from less than 6 lakhs in 2000 to close to 8 lakhs in 2002. One of the implications of increased tourist vehicle pollution. This pollution is already being felt and could become a major problem to human health and plants.

Discussion

The lake systems of the region have served as centers of population. They provide a range of ecosystem services: supporting services, provisioning services, regulating services and cultural services. Change in these services affect human well being through impacts on security, the basic material for a good life, health and social and cultural relations (Cruz 2004). The threat posed to the lake region is owing to the eco-disturbances caused in the nucleus of the area i.e. Nainital town and its lake basin. Whatever happens in Nainital, whether it is increase in tourism or construction activity, it triggers a chain reaction else where. It is disturbing that the very existence of Nainital is threatened.

The natural resources in the lake region are being used erratically and ruthlessly due to increasing population pressure and resultant increase in demand for shelter, arable land, grazing area, fodder, fuel wood etc along with growing needs of tourism. It is therefore, increasingly realized that the formulation and implementation of the process of development planning in the region must be consistent with the natural resource base and its ecological productive potential (Rawat & Shah 2005).The goal of ecologically sustainable development with economically viable growth. Since land is the primary and fundamental natural resource and it is the basis of the genesis, management and sustainable development of all other natural resources, land management has acquired critical importance in this fragile region. The region, therefore, deserves specific attention and priority conservation measures for protecting the lake and their environment.

Table1. Morphological Features of Lake Nainital (Source: EERC Final Report 2002)

a. Maximum length (m)-	1423
b. Width (m)-	253-423
c. Maximum depth (m)*-	27.3 in northern half
	25.5 in southern half
d. Mean depth (m)-	18
e. Surface area (ha)-	48
f. Watershed area (km^2)-	5

Note- * the reason for giving maximum depth in the two halves is because the ridge divides the lake into two parts.

Table.2. Tree Layer Changes at four sites on the Northern and North-Eastern aspects of Nainital catchment (Source: Upreti, 1982)

Site	**1982**			**2004-05**		
	Species richness	**Density indi./ha**	**Total basal area m^2/ha**	**Species richness**	**Density indi./ha**	**Total basal area m^2/ha**
Government house	11	1434	48.48	6	1140	48.27
Nirmala Convent	4	348	36.20	4	630	37.79
St. Xaviers	7	605	19.90	5	260	11.61
China Peak	5	500	27.96	4	440	27.05

Table 3. Shrub Layer variation at four sites on the Northern and North-Eastern aspects of Nainital catchment (Source: Upreti, 1982)

Site	**1982**		**2004-05**	
	Species richness	**Density indi./100m^2**	**Species richness**	**Density indi./100m^2**
Government house	22	137.27	23	105.2
Nirmala Convent	10	89.5	7	135.4
St. Xaviers	13	143	7	65
China Peak	10	136.5	8	105

Table 4. Herb Layer variation at four sites on the Northern and North-Eastern aspects of Nainital catchment (Source: Upreti, 1982)

Site	1982	2004-05
	Species richness	Species richness
Government house	89	84
Nirmala Convent	24	25
St. Xaviers	42	36
China Peak	33	29

Table 5. Condition of Springs water in 1936 & 2007

Location of Spring	Altitude (ft)	Status in 1936	Current Status
1. Spring Field	6675	Perennial	Perennial
2. Chuna Dhara	6550	Perennial	Dry in summer
3. Near Spring Field cottage	6550	Perennial	Perennial
4. Rajpura	6525	Perennial	Low discharge (Feb. -June)
5 Near Lake View	6730	Perennial	Low discharge (Feb. -June)
6. Near Mount. Rose	6575	Perennial	Dry in summer
7. Near Bhabar Hall	6375	Perennial	Little water, still alive
8. Parda Dhara	6100	Perennial	Perennial

Table 6. Recharge areas of Nainital Lake in 1936 & their current status-

S.No.	Recharge area	Total area m^2	Current Status
1	Sukhatal	33369	A major car parking and settlement reduced the recharge area by approx 25%
2	Oak Park	13220	Area reduced by approx 35%
3	Sleepy Hollow	10872	Area reduced by approx 35%
4	Near Dalhausi villa	4597	Area reduced by approx 15%
5	Sherwood	4790	Area reduced by approx 50%, because of car parking

Table 7. Urban population and its growth trends in Lake Region
(Source: Census of India, 1991, series 25, Part ix-A& PCA 2001, vol4)

Year	Population	Percent growth
1961	16080	+22.8
1971	25167	+56.51
1981	26093	+3.61
1991	30951	+18.62
2001	39840	+28.72

Table 8 Anthropogenic Pressure in Nainital: A Comparison (Source Shah, 2007)

Indicators	Basedon Survey (1936-37)	Information as 2001
Permanent Population	10673 (1931 census)	39840
Tourist No.	--	3,10,000
Hotels No.	09	120
Shops No.	50 (estimated) in 4 markets	900
Residences No. (Bungalows, states, houses etc)	851	8000
Floating Population	---	5000 (estimated)
Others (Banks, Schools, Offices etc)	95	200

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References-

[1] Census of India, series 25, Part ix-A& PCA 2001, vol 4. 1991.

[2] Cruz, Rebecca D. The role of communication, education and public awareness in Lake basin Management, Thematic Paper, Lake Basin Management Initiative, Malaysia. 2004.

[3] Curtis, J.T. and McIntosh, R.P. The interrelation certain analytical and synthetic phytosociological characters. Ecology 1950; 31:434-455.

[4] EERC report Integrated Management of water resources of Lake Nainital and its watershed: An environmental Economics Approach. EERc, Indira Gandhi Institute for Developmental Research, Mumbai. 2002.

[5] Negi, G.C.S and Joshi, V. Geohydrology of springs in a mountain watershed: The need for problem solving research. Current Science 1996; 71(10)-772-776.

[6] Rawat, A.S. and Shah, G.L. Impact of human interference and land use changes on Nainital Lake region. Paper presented in the National Seminar on Hydrological aspects of rejuvenation of Urban lakes, Udaipur, India, October 2005 and published in Urban Lakes in India, National Institute of Hydrology,Roorkee, India 2005;vol.1.

[7] Rawat, J.S. Morphology and morphometry of the lake Naini. Kumaun Lesser Himalaya. Journal of the Geological Society of India, 1991;30:493-498.

[8] Shah, G.L. Nainital: Evolution and development of a Himalayan lake township. Journal of Eco-Development. 2007;15(1)-105-113.

[9] Singh, A.K. and Pande, R.K. Changes in spring activity: Experiences of Kumaun Himalaya, India. The Environmentalist 1989; 9(1)-75-79.

[10] Singh, A.K. and Rawat, D.S. Depletion of oak forests threatening springs: An exploratory study. The National Geog. J. India 1985;31(1):44-48.

[11] Upreti, N. A study on pyotosociology and state of regeneration of oak forests at Nainital. Ph.D. thesis, Kumaun University, Nainital 1982.

[12] Valdiya, K.S. Environmental Geology: The Indian Context. Tata Mcgraw Hill.ew Delhi: 1987; 83pp.

[13] Valdiya, K.S. and Bartarya, S.K. (). Hydrological studies of springs in the catchment of the Gaula River, Kumaun Lesser Himalaya. Mountain Research and Development 1991; 113:239-258.

[14] Valdiya. K.S. and Bartarya, S.K. (Diminishing discharges of mountain springs in a part of Kumaun Himalaya. Current Science 1989; 58(8):17-426.

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