

## ECOSYSTEM SERVICES OF NATURAL LAKE IN NAINITAL, UTTARAKHAND

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### ABSTRACT

*Nainital- a celebrated lake town of Uttarakhand region of Indian Himalayas, has a personality of natural landscape of mountainous character transformed as a popular settlement of administrative, economic and educational prominence. The natural lake of Nainital commands a mass appeal to the tourists and locals alike. The ecosystem boundary of Nainital lake, has been highlighted through number of discontinuities coinciding here. Besides, the ability of this lake ecosystem to deliver services to the locals, and in much larger dimension for the tourists, has been assessed in this study. This has enabled to determine the services valued by the tourists and local inhabitants, and classify ecosystem services along functional lines using categories of provisioning, regulating, cultural and supporting services. The evaluation of services is qualitative in nature in this work, rather than quantitative such as accounting. The assessment of the condition of ecosystems, the provision of services, and their relation to well-being of all the people in this lake region, should be fulfilled by adopting an integrated approach.*

Nainital a lake town in the Himalayas, has a distinct identity with a wide variety of natural, rural and urban landscape of mountainous character. The focal point of Nainital is a natural lake which draws scores of tourists every season. Primarily, this lake system has served as the prominent centre of population in this hill region. The ecosystem boundary of Nainital lake has been highlighted through number of services provided. Besides, the ability of this lake ecosystem to deliver services to the locals, the mass tourism assumes much larger dimension in this context.

Nainital is located approximately at 79°5' East longitude and 29°4' North latitude. Naini lake is situated at an elevation of 1938 m, covering an area of 11.73 sq kms. Almora district lies to the north of Nainital and to its south lies the Udham Singh

Nagar district. In the east, the Champawat district and in the west, district of Pauri Garhwal are located.

Nainital, right from the days of its advent remained a place of administrative power and authority, gradually grown into a prominent centre of education with a number of reputed boarding schools and institutions, and also a landmark of kumaoni culture. But its most notable identity poses it as a hugely popular tourism destination of Uttarakhand. Though the emergence of tourism in this hill destination has been impressive in last few decades, but now it has assumed totally different proportion. 'Himalayan mountain tourism is a relatively new industry that has seen explosive but uncontrolled, demand-led growth in the past three decades; tourists have simply arrived in areas

formerly visited by the occasional people, and the regions have reacted to meet their needs'. (Patricia East and others,1998). All the activities are concentrated in and around lake, putting great stress on this water body which is undeniably the soul of this town. What makes Nainital one of the most sought after destination by travellers, lies in the fact that it is located at a motorable distance of average 8 hours from some of the large urban centres of northern India which come under the severity of tropical heat during summer season. Nainital is known for its salubrious climate with average range of monthly maximum and minimum temperatures of 28 degree C and 7 degree C, respectively. It is located at 304 km from Delhi, 360 km from Dehradun the state capital, and 388 km from Lucknow. Ever since the automobile revolution happened in eighties, the mediocre strata of society have acquired greater mobility, and they are quite inclined to use private vehicles for the getaways for recreational purpose, most of the times on impulse.

The five significant aspects of its 'personality' as a hill town, namely, seat of administrative power as the district headquarter and its imperial connection; as an educational centre of much repute, with some of the institutions founded over a century ago; as the cultural centre with profound traditional traits; as a rich biodiversity and ecological region of the Himalayas, and very importantly, as a tourism destination with strong mass appeal. Though it has grown impressively in terms of business, services, cultural and educational assets, but its standing as the tourism destination is overriding all others.

The 'ecosystem services' are the benefits people obtain from ecosystems. The definitions indicate

that ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life. They maintain biodiversity and the production of ecosystem goods, such as seafood, forage timber, biomass fuels, natural fibre, and many pharmaceuticals, industrial products, and their precursors (Daily 1997:3). The term 'services' to encompass both the tangible and the intangible benefits humans obtain from ecosystems. It is difficult to determine whether the services provided by this lake ecosystem is a 'good' or a 'service' therefore they are generally regarded as the ecosystem services only. Ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive, directly or indirectly, from ecosystem functions (Costanza et al. 1997:253).

The ecosystem services include provisioning, regulating, and cultural services that directly affect people and supporting services needed to maintain the other services. Provisioning services are such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling. An assessment of the condition of ecosystems, the provision of services, and their relation to human well-being requires an integrated approach. The human activities, have added even greater complexity by changing, to a large degree, the nature of such environments. This enables a decision process to determine which service or set of services is valued most highly and how to develop approaches to maintain services by managing the system sustainably.

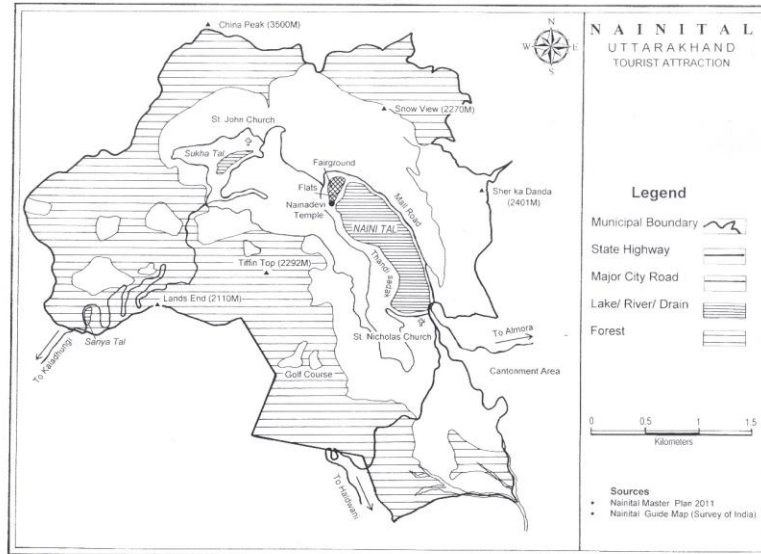
**ECOSYSTEM SERVICES CATEGORISATION**

Provisioning Services (Products obtained from ecosystem)	Regulating Services (Benefits obtained from regulation of ecosystem processes)	Cultural Services (Non material benefits obtained from ecosystems)	Supporting Services (Services necessary for production of all other ecosystem services)
<ul style="list-style-type: none"> <li>• Food</li> <li>• Fresh water</li> <li>• Fuel</li> <li>• Fibre</li> <li>• Biochemical</li> <li>• Genetic resources</li> </ul>	<ul style="list-style-type: none"> <li>• Climate regulation</li> <li>• Disease regulation</li> <li>• Water regulation</li> <li>• Water purification</li> <li>• Pollination</li> </ul>	<ul style="list-style-type: none"> <li>• Spiritual and Religious</li> <li>• Recreation and Ecotourism</li> <li>• Aesthetics</li> <li>• Inspirational</li> <li>• Educational</li> <li>• Sense of place</li> <li>• Cultural heritage</li> </ul>	<ul style="list-style-type: none"> <li>• Soil formation</li> <li>• Nutrient cycling</li> <li>• Primary production</li> </ul>

This lake town characterises a high mountain ecosystem comprising a distinct lake system. A useful ecosystem boundary is the place where a number of discontinuities coincide, for instance in the distribution of organisms, soil types, drainage basins, or depth in a water body. The ecosystem boundary of Nainital lake has been highlighted through number of discontinuities coinciding here. The natural lake of Nainital emerges as the focal point of this tourist town, disbursing a significant range of ecosystem services to the tourism enterprise.

The lake such as Naini lake comes under the category of ecosystem of inland water. Since it is situated in the high altitudes of Himalayas it also justifiably comes under the ecosystem of mountains

with steep and highlands. Naini lake in Nainital has an isolated inner basin. Naini lake is curvilinear water body of natural origin of tectonic nature. It is about 1.4 km long with NW-SE orientation, its maximum width is 0.46 km, and the total surface area is 0.48 km<sup>2</sup>. The catchment of the lake is characterized by dynamic processes of mass wasting in the form of debris flow, landslides, soil creep, rock fall and land subsidence. The morphological features of the lake basin consist of a transverse ridge dividing the lake into two parts- the lake plain and the lake deep along with the scarps, debris fans fringing the shores. The mean depth of Naini lake is 18.55 m, and the maximum depth being 27.30 m in northern half and 25.5 m in southern half. The mean water retention time or the residence time for the lake is computed as 1.16 years (EERC Report, 2002).



## PROVISIONING SERVICES

The provisioning services of Naini lake primarily relate to the water provided by this natural lake. Though the water as the provisioning service is interrelated with the regulating services and cultural services. Naini lake receives the rain water as runoff from the higher surroundings and the natural inflow from the springs in the peripheral areas. Nainital is situated mainly on the slopes of hills which are surrounding Nainital lake spread over 132.5 acres. According to NCDP study 93 percent of the total water supply comes from infiltration and bore wells located at the periphery of the lake, remaining 7 percent of water comes from surface source. Nainital water supply is based on a complex system of pumping. From the infiltration well, and from two lakeside tube wells, water is pumped to a ground reservoir in the water works. This reservoir also receives water from Pardardhara spring. From this reservoir water is pumped to rapid gravity filters. Based on the net water distributed, average availability of water at consumer end is calculated as 135 lpcd. This indicates that the present level of supply is quite satisfactory. Since all the shallow tube wells and infiltration well are being directly recharged by lake water for all practical purposes, lake is the main source of water for Nainital at present.

As per NCDP Report the total hardness of lake water and tubewell is found to be 390 and 340 respectively which is slightly higher than the desirable limit of 300 mg/l (as CaCo<sub>3</sub>). Other water quality parameters are all within permissible limits. Govt. of Uttarakhand sanctioned a water softening Plant of 10 mld capacity. By 2021 one more such plant would be needed.

## REGULATING SERVICES

The regulating services provided by Naini lake, in many respects, holds an important place in the ecosystem services.

### **Water regulation:**

The timing and magnitude of runoff, flooding, and aquifer recharge. All the runoff drains into the water body and replenishes the water as provisional services. It acts as a sponge against flooding in the vicinity with high relief. Hence, it regulates the water quantity and flooding and groundwater recharge. The catchment area of Nainital lake forms the major part of municipal area. Most of the drains emerging from the hills surroundings the town are falling in the lake. Other drains

outside the lake catchment area have their outfalls in Sukhatal. At the time of high water discharge in the catchment area the level of lake rises which is released through a stream named Baliya Gadhera in the east which carries the surplus water of the lake thus mitigating the flood hazard. The water security provided thus by the lake is an important regulating service.

#### **Climate regulation:**

Ecosystems influence climate both locally and regionally. For example, at a local scale, changes in land cover can affect both temperature and precipitation. The Nainital lake is about 1.4 km long and about 0.46 km wide. The settlement of Nainital surrounds it in dense pattern. This lake acts as a regulator of temperature and precipitation. The dense fog descends over it as the temperature of water lowers than the terrestrial surroundings. The micro climate of this tectonic valley is controlled by this natural water body of Nainital lake. In summer, winter and rainy seasons the weather shows remarkable influence by the presence of extensive water surface of this lake.

#### **Water purification and waste treatment:**

Ecosystems can be a source of impurities in fresh water but also can help to filter out and decompose organic wastes introduced into inland water ecosystem. Aquatic plants help absorb harmful fertilizers and pesticides, as well as heavy metals and toxins drained into it. Another issue of environmental significance is related to the sewage mass flowing into the lake water. At the onset of Nainital urban growth the sewage disposal system was planned for a modest size hill settlement. Rapid urbanization and inadequate sewer system led to the problem of overflowing of sewage into storm water drains, ultimately discharging into Nainital Lake. The

accumulation of organic matter is responsible for the high concentration of nitrogen and phosphorus, and the concentration of dissolved oxygen is lower than the critical level of 0.9 mg/l during winter. (Pant and Bisht, 1980). According to a water quality evaluation (Dash et al. 2008), the lake water can not be used without treatment, which has high turbidity, dissolved and suspended solids and contamination besides high magnesium hardness, making it unfit for drinking purpose.

#### **Regulation of human diseases:**

Changes in ecosystems can directly change the abundance of human pathogens, such as cholera, and can alter the abundance of disease vectors, such as mosquitoes. The test results of raw water of lake show presence of coliform organism in the lake.

## **CULTURAL SERVICES**

The natural lakes Wetlands have played an important part in settlement development as a focal point and are of significant religious, historical or aesthetic value to many cultures around the world. They are also often inviting places for popular recreational activities including boating, fishing, photography etc.

*Aesthetics and Tourism:* In 1840s Nainital attracted the Europeans who had a fine sense of landscape appreciation. They were so much captivated by the pristine beauty of this lake that they started to evolve this destination as a summer retreat. Today also it remains a hill station thronged with visitors during summer months. According to the data available, Nainital had become a popular hill resort by 1847. In 1845 Nainital Municipal Board was officially formed, which was the second Municipal Board of North Western Provinces in British regime. Nainital assumed much importance when it became the summer seat of the North Western Provinces in

1862. Later, in 1960's Uttar Pradesh government officials preferred to make long sojourns during summer months here. Population of Nainital town (NPP/ Municipal Board) has increased from 38,630 in 2001 to 41,377 in 2011.

The scenic lake of Nainital has a mass appeal to the tourists visiting this destination. The placid and calm water of this natural lake holds strong aesthetic value for the locals and outsiders alike.

### **Heritage and Sense of place:**

The heritage resources of Nainital have a profound value. Though they are not *per se* the services of Nainital lake but the lake remains the core element in the sense of place in Nainital. In fact, the name of this hill town totally identifies with 'Nainital' means Naini lake. All the esteemed heritage structures were profoundly inspired and drawn by this natural lake. They include Pilgrim lodge, the first cottage in 1841, residence of Jim Corbett, Nainital Nagar Palika building, Boat club, Old churches and many private cottages of colonial times. The Cultural Resource Mapping of Nainital District carried out by INTACH lists the important cultural and heritage resource. Nainital boasts of some of the most revered buildings such as Rajbhavan, High Court, etc. Other heritage structures in the city include churches such as St. Johns Church and Union Methodist Church.

### **Spiritual and Religious:**

The lake of Nainital has number of old shrines and temples situated on the serene environs in its vicinity. Naina Devi temple, Pashan devi temple, Marut temple and Shani temple are some the most well known religious landmarks on the lake sides. For many the calmness and serenity of a natural lake evoke spiritual and philosophical responses. In this sense Naini lake plays an inspirational role in the lives of

many over long years. The Naina devi fair is the highpoint of people's sense of this location.

### **Recreation and Livelihoods:**

The recreational pursuits in relation to Naini lake are many. A quiet walk around Naini lake through 'Thandi Sadak' is a part of lifestyle of many locals here, whereas the tourists are engaged mostly on the Mall Road amidst the hustle bustle. The edge effect of this water body is defined by the road around it. In the fair weather and tourist season the lake is filled with all hues and colours of boats. Sometimes the boat race enthral the tourists. Naini lake supports livelihoods for many through boating. The boatmen of Nainital depend on the demand by the tourists for boating in half round or full round of lake. Boating is not only an occupational pursuit but also a way to establish a bond between the local boatmen and the tourists who very often engage themselves to understand the local culture, language and lifestyle.

## **SUPPORTING SERVICES**

The supporting services are necessary to support all other services. They differ from provisioning, regulating, and cultural services in that their impacts on people are either indirect or occur over a very long time. Some other examples of supporting services are primary production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat. Compared to many other ecosystems, lakes are one of the most productive habitats with greater species diversity nutrient recycling and niche specialization than most other ecosystems.

Naini lake retains the silt which is drained into this water body specially during the rainy season. In 1895, the capacity of the lake was 31,699 m<sup>3</sup>. It became drastically reduced to 26,202 m<sup>3</sup> by 1979. That means the depth was less by 5,491 m<sup>3</sup> in 84 years. This reduction in the capacity of the lake at

the rate of  $65.37\text{m}^3/\text{year}$  is due to the increasing rate of siltation. (Rawat,1987).

The evaluation of services is qualitative in nature in this work, rather than quantitative such as accounting. The understanding of the condition of ecosystem, the provision of services, and their relation to well-being of all the people in this lake region is important. It is found that ecosystem services of this lake system are pushed to the brink by the excess pressure of mass tourists here, often at the expense of locals. It is evident that the resource managers need to initiate a decision process to curtail the mass tourism in this region by seeking the alternative tourism or by using interventions such as use of technology and administrative regulations to maintain the ecosystem services of this lake in terms of equity for the local stakeholders as well as the outsiders who visit to take benefit of the ecological services of this lake.

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