

Land-use Transformation: Challenging Carrying Capacity and Decaying Quality of Life in Nainital Lake Catchment area

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ABSTRACT

With an aim to develop an integrated approach for effectively managing natural and human environment this study covers major land use modifications in Nainital lake catchment and possible consequences in terms of environmental degradation and decaying the aesthetic values which have been considered having a great influence in the area and preserved the natural vegetation, directly connected with the ecosystem. The construction of the huge township will have a negative impact on the hydrology and water table of the area. The ground water levels have fallen very sharply in the study region and many springs, and water sources have dried up or have been reduced to mere trickles. This paper is very useful source of information about the preparation of future planning schemes in terms of carrying capacity of the town and surrounding area and provides information to develop awareness for environment in the minds of public as well as planners and stakeholders about how to improve and conserve the precious environment, which are gradually losing their importance.

Key Words : Land Use Transformation, Riparian Zone, Slope Instability, Carrying Capacity, Quality Deterioration

INTRODUCTION

“Lakes as seen through the eyes of nature have a very significant role in shaping the hydrological, ecological and environmental balance of the area surrounding it”. The Himalayan Mountain in India is one of the highly influenced areas in the world due to the human activities. Natural landscapes are an important ecological, economic, and socio-cultural resource that give the basis for the sustainability of any region and which contribute significantly to the quality of life of the local people (Environment Waikato, 2003; Brabyn, 2005). Effects of human activities on ecosystems are a big concern all over the world and it is particularly important to understand that how human decisions regarding land- use, influences the urban landscape where people dependency for variety of purposes is comparatively high. For the continued existence of the human being in any area the study of various aspects of the interactions between human and local ecosystems/landscapes is the key to understand the development process and simultaneously that can provide the basis for designing

and developing the strategies for future sustainable landscape development (Mander and Jongman, 1998; Roberts *et al.*, 2002). The amount, the rate and the intensity of land use and land cover change are very high in developing countries (Rao and Pant, 2001) and assessment of causes and consequences are the first step in developing a successful conservation and management scheme (Brandt and Townsend, 2006). Therefore, there is an urgent need to understand the future scenario development of the whole landscape in the mountainous hill environment specially emerging and fast growing urban centers of the Indian Himalayan region.

Study area:

Nainital is situated in the Lower Himalayas and is the result of tectonic activities and the upliftment of sediments between Tibetan plateau and the Indo-Gangatic plane. Nainital town which is mainly situated on the slopes of hills surrounding Naini lake spread over 132.5 acres at an altitude of 1938 mts. extended in 29° 23’ N latitude and 79° 30’ E longitude. Nainital Lake is a 1.5 km long crescent-shaped water body located along with the Nainital lake fault. Hills and forests surround the Lake, and restrict the physical expansion of the town largely. Surrounding hills are mainly comprising of Krol group of rocks *i.e.* slates, marls, sandstones, limestones and dolomites with a few intrusives in the form of small dykes, and these are highly folded and faulted due to polyphase deformation. Beside the geological setting of the area, unhealthy practices of the inhabitants, to obtain maximum gains without realizing the long-term consequences grossly exploited Naini Lake and surrounding areas over the years and made the surrounding slopes highly vulnerable to landslides and mass movement. The entire area has been swallowed by human habitation, with its attendant excesses in relation to the requirements of a healthy and economically productive environment (Fig. 1).

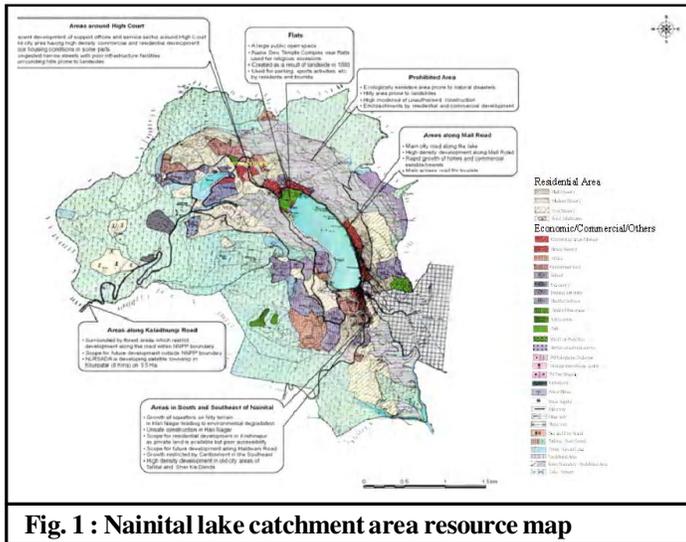


Fig. 1 : Nainital lake catchment area resource map

Key Issues:

A city or town evolves over time under certain physical, socio-economic and cultural imperatives. Nainital an old tourist hill station of Kumaun region has its own unique situation and related problems and issues emerged mainly in the form of man made disasters, disturbing homeostatic status of physical and natural phenomena and causing land use change and transformation, due to the number of unhealthy practices within the town periphery such as conversion of forest land into haphazard habitational and recreational centers and built up areas , lake riparian zone shifted into cemented areas and concrete roads, so the runoff has increased substantially which effects water retention and percolation capacity of soil and causing top groundwater level and adverse effects on ground water recharge zones, ecological imbalances influencing existence and natural growth of flora and fauna in the region. So as in the case of

transformation in cultural landscape, such as, unchecked, unauthorized construction and urban expansion, space congestion, slum area development, lack in the basic services , poor water supply

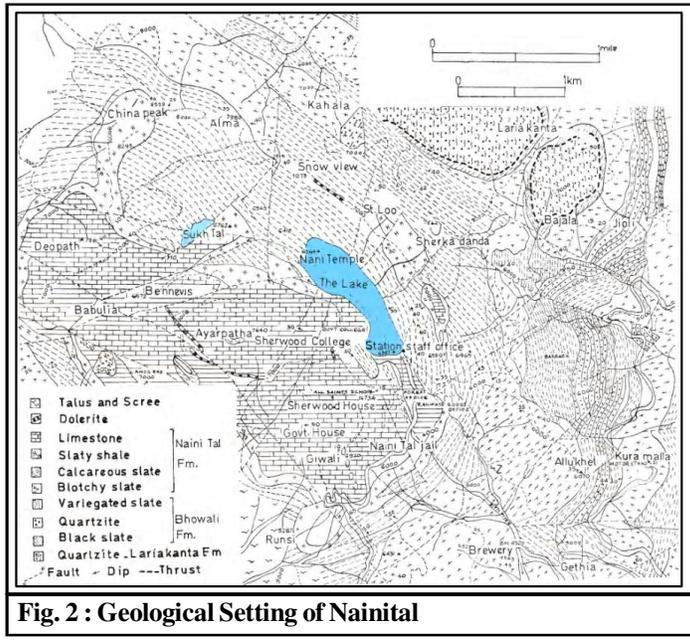


Fig. 2 : Geological Setting of Nainital

and drainage system, absence of road hierarchy, inadequate traffic carrying capacity, heavy pressure on existing single lane roads on the majority of the areas within town due to the rapid increase in the total number of traffic and private vehicles, inadequate road infrastructure and side protection barriers, with other safety measures, lack of proper intermediate public transport facility within the city. Thus, Nainital Lake and the surrounding catchment area have been subjected to the ravages of so-called advancement and development by humankind in the form of disasters. This has polluted the beautiful lake and shaken the unstable hill slopes. The core concern related to the topic is

the conversion of open space hillside slopes and lake surroundings including prime forested land, to lake riparian zone and recreational centers to residential and commercial use, characterized by extensive and inefficient land use patterns (Fig. 2).

METHODOLOGY

Background and purpose of this study look for to explore the causes and consequences of past and current land transformation trends and dynamics related to society, economy and environment. In this endeavor this study focuses mainly a lesser Himalayan lake town i.e. Nainital and identified the driving forces for landscape change in fragile lake environment and causes and consequences of the overall land use development and modification, current situation, its problems, key issues and the likely scenario of lake water, its quality, resources, system requirements and related aspects with emphasis on human and ecosystem interaction in the region. Changing natural ecosystems due to human activities need to have a long-term study of any region. Therefore, I have an impression that this work relates to the other same environment facing same environmental problems.

Research Objective:

The main objective of the study is to analyze the land use transformation and consequently the ecosystem responses in the Nainital. The study initiate to understand that why and how do peoples' decisions and behavior is changing under shifting natural, socio-cultural, political, technological and environmental conditions and to determine that consequently how the landscape have been changing in the region with emphasis that what will be the implications of such changes in long term and to understand the process that how the people have been changing their life and prioritizing the activities

due to variety of factors. Such analysis would be helpful to understand the whole landscape transformation and their planned development within the study region, which respects the natural, as well as man made environment, safeguards the inhabitants and improves their quality of life.

RESULTS AND DISCUSSION

Land Use Transformation with Lake Riparian Zone Encroachment:

Increasingly, environmental impacts associated with the land use transformation are becoming a significant concern in urbanization of town. The unchecked growth of urban amenities in the name of development reached on peak in recent years coupled with a lack of awareness of the relationship between human activities and land use modifications led to the rapid degradation of Nainital town as well as the lake environment. Over all development in land use has resulted in the high land use intensification in the study region. New residential as well as recreational developments in this town are typified by lot sizes varying horizontally and vertically from large arial extension with single floor to multistory buildings, or even larger, replacing the higher residential density of traditional urban areas and older architecture.

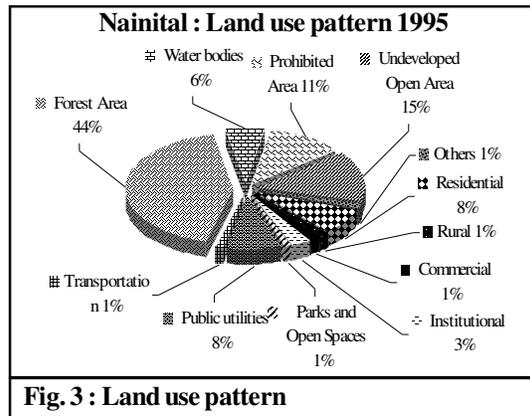


Fig. 3 : Land use pattern

United States agriculture department (USDA, 1998) defines a riparian area as “the aquatic ecosystem and the portions of the adjacent terrestrial ecosystem that directly affect or are affected by the aquatic environment. This includes streams, rivers, lakes, bays, and their adjacent side channels, flood plains and wetlands. In specific cases, the riparian area may also include a portion of the hill slope that directly serves as stream side habitats for wild life”. While the EPA Coastal Waters Guidance Manual (1993) defines riparian areas as “vegetated ecosystems along a water body through which energy, materials, and water pass”. As the definitions indicate, riparian zones are influenced by, and influence, the aquatic and hydrologic regimes of the water body. Development of the riparian areas, then, has an impact on both. It allows sediment to settle, provides infiltration, which replenishes ground water recharge, removes nutrients, provide important wildlife habitat, discourages excessive storm drain enclosures, prevents disturbance to steep slopes. Vegetation cover in riparian zone facilitate removal of non-point source pollution, including nitrate removal, plant uptake by nutrients, microbial processes and removal of surface-born pollutants. Riparian areas characteristically have a high water table and these systems encompass wetlands, uplands or some combination of these landforms. Thus, a riparian zone is an area managed to reduce the impact of an adjacent land use. For the unplanned expansion of Nainital town, a large portion of the lake has been filled and converted in to heavy built- up area due to the poor and non-practical rules and restrictions on illegal encroachments on the most sensitive surrounding areas of the lake. If this situation will remain unchecked no doubt there will be no open space left for water percolation and seepage. The carrying capacity of Nainital in terms of its population (Fig. 4) would be largely determined by the lake’s condition and stability of the surrounding mountains. The unplanned expansion of constructions has already exceeded the supporting capacity of the Nainital. Destabilization of hill slopes also means destabilization of the lake. The frequent occurrence of the

landslides means reduction in the capacity of the city to provide housing facility to the inhabitants. Mainly two factors are reducing the carrying capacity of the lake. First, is siltation, causing depletion in lake's capacity to hold water and second is lake water quality deterioration.

The ever-decreasing quality of the lakes indicates that its population supporting capacity has already been exceeded (Fig.4). The whole region has been cancerously scarred with the deforestation activity caused by the population onslaughts on these fringes and slopes, the numerous springs are last drying up and thus contributing to the low level of water. Increasing squatter settlements on the hilly terrain is leading to environmental degradation through disposal of solid waste and unhygienic conditions in these areas.

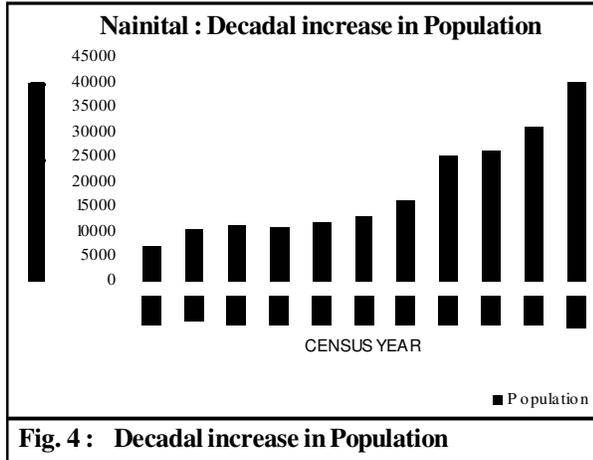


Fig. 4 : Decadal increase in Population

The floating population in the city in comparison to its permanent population is very high. Similarly, vehicular traffic flow is also recorded very high during peak summer and winter snowfall season. The way in which the urban environment has developed in recent decades has also contributed to mounting mobility problems. The rapid growth of residential areas in and around the periphery of town have led to escalating transport needs which cannot always be met satisfactorily by existing public transport infrastructures. An estimate shows the increase in motor vehicles during the year 2001 in Nainital and it was reached total number of 3650, of these 16.4% were private cars, 13.7% taxis, 68.5% two wheelers, while 1.4% were buses and trucks. During the summers, the mall road and the main bazaar are clogged with public and private vehicles and the flats the only public playing ground has become a parking zone. This concentration of transport use in relatively restricted areas has an important impact in terms of traffic congestion, pollution and influence on quality of life.

Slope Instability:

A pile of successive fans of debris extending along Naina peak because of the unrestricted heavy load of vehicular traffic, generates debris and weakens rock structure causing rock-fall along the hillsides which falls during rainy season runoff and then contributed to increase in the size of debris fans and accelerates the growth of newly formed cones. The shattered blocks of dolomites and quartzites often slip down from the precipitous slope. The 21km² basin of the Naini Lake is surrounded by hill- slopes having mean average slope value of 19°, the larger part being confined to the slope group of 20-25° (Rawat, 1987). The Naina peak scarp is almost vertical and is fringed at the base by a succession of

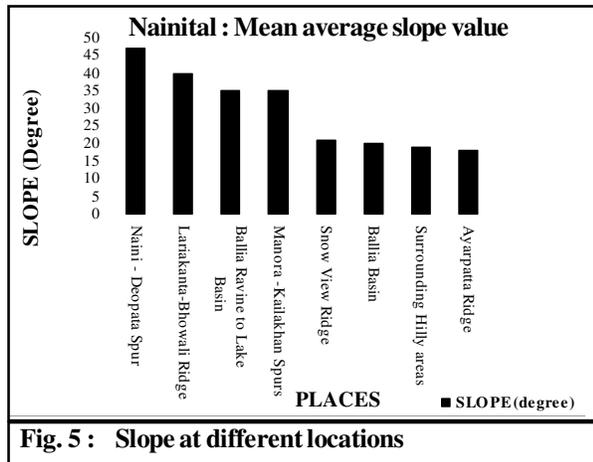


Fig. 5 : Slope at different locations

debris fans and cones. While the slopes of the manora and kailakhan spurs do not exceed 35°, the lariaakanta – bhowali ridge has much steeper slopes ($\geq 40^\circ$). The mean value of slope of the whole balia basin is about 20°, gradually increasing to 35° in the lake basin (Sharma, 1981). The naina – deopatta spur, the maximum slope value is 35° up to 47-49°. The mean slope of the snow view ridge is 21°. The Ayarpatta ridge slopes 5-35° (mean 18) northwest words the slope being characterized by convex bulges in the central part (Fig. 5). In a number of places, these slopes are broken by scarps, some of which represents fault facets. Significantly, the northerly slope of the Shiwalik range overlooking the balia stream is as steep as the slopes of the Nainital ranges. The instability of the slopes of the balia ravine is attributed to severe shattering and shearing of rocks related to possibly the Nainital fault, the active manora thrust and the many subsidiary faults developed sympathetically (Valdiya, 1981, 1986). Thus, no part of Nainital can be described as free from hazards of slope failure. The balia ravine is also prone to landslides, although this is a threat to which the people seem to have no response. The unplanned development of tourism and flouting of construction rules has scarred the lovely hillside and accelerated the pace of landslides and soil erosion from the adjoining hills causes heavy silt deposition in the lake (Plate 1).



Plate 1 : Heavy Debris Accumulation due to Landslide along the lakeside

Naini Lake Water Quality Deterioration:

Urbanization has detrimental effects on both water quantity and quality. The main problem of urbanization is the increase in impervious area. Increases in an impervious area increases runoff and decreases infiltration, which in turn decreases ground water storage and base flow of that particular water body in the affected area. Input of waste matter generated in the catchment along with the water courses has greatly damaged the lake’s water quality. The drinking water quality of lake has been continuously influenced by integrated environmental management problems. During the last few decades, organic pollution has been increasing at such a rate that even preliminary limnological studies show (Fig. 6 and 7) unmistakable symptoms. Elevated levels of nutrients in water can occur naturally or may be the result of nutrients input from human activities. The major nutrients are phosphorous and nitrogen. They often promote

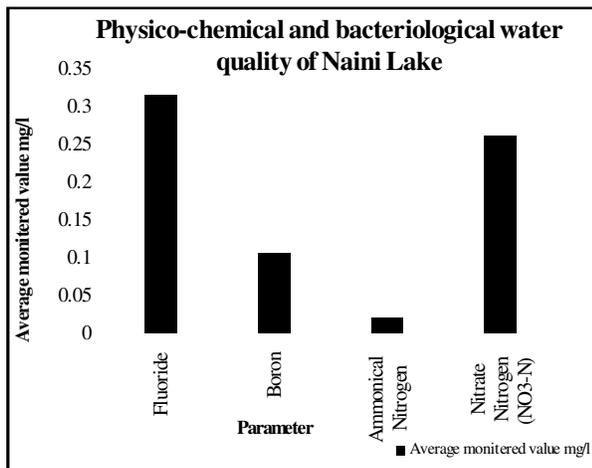


Fig.6: Naini lake water quality Chemical parameters

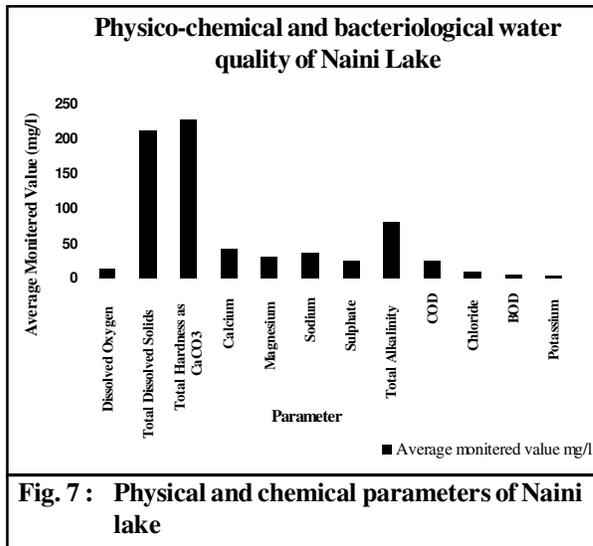


Fig. 7 : Physical and chemical parameters of Naini lake

excessive growth of algae and other organisms. The luxurious growth of potamogeton pectinatus, a plant always associated with organic pollution, in the littoral zones of the lake, is sufficient to indicate how heavily the water is polluted. Certain toxic substances such as ammonia, hydrogen sulphide and methane, evolve round the year in the bottom layers and have effected the aquatic population largely. The sediment itself fills the lake (Plate 1 and 2) and increases the water temperature, both of which detrimental to lake water quality. The presence of heavy metals, pesticides and other toxic substances in surface runoff as well as city drainage network is harmful to the aquatic ecosystem

and prevents the use of the lake water for human supply and recreation. The impact caused by presence of toxic substances is on the short term when it can be assessed by the rates of deaths caused after their discharge. The long term effects are more difficult to assess and usually leads to physiological damages which after growth and rates of reproduction, rendering the population more susceptible to diseases and stress. Now the Naini Lake waters offer nothing short of infection and disease. The tourism has played no less a role in contributing to the pollution of the atmosphere and physically of the lake area but also has created imbalance in the natural vista and phenomena. The connection between sewers and storm water drains, which exist all over the town, is the major cause of Naini lake water pollution. But unfortunately, Nainital town residents are forced to use such water because lake is the only water supply source within the town. Discharge of untreated waste water, disposal of solid waste and silt deposition are the major factors that cause pollution of the lake. Solid waste situation is gloomy in many

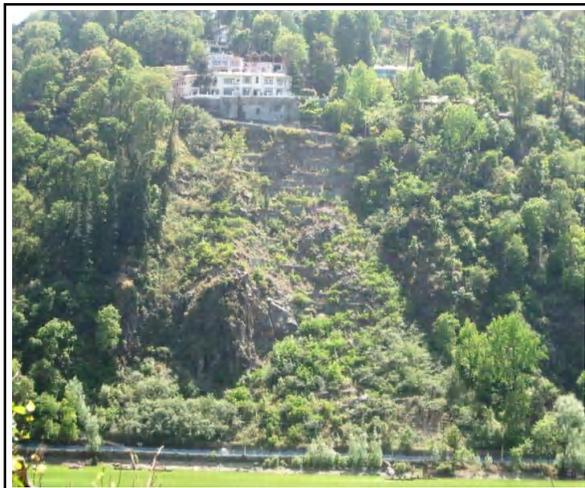


Plate 2 : Landslide prone unstable zone in Naini lake catchment area

pockets. There is no proper arrangement for solid waste collection, municipal collection is not uniform, collection by private sanitary worker is very little, the residents, therefore dump waste openly on street or down the hill slope. There is no scientific method of disposal. During rainy season, the drains overflow in the lower part and rainwater often get mixed with water from sewer. A significant part of the solid waste and plastics generated in the city find its way in to the lake either through the storm water drains or indiscriminate litter in the lake. Storm water, sewer and garbage disposal are not closely related in good city management, but usually they have a strong relationship due to the lack of public facilities and services related to water. These not only pollute

the lake water but also degrade the aesthetics’ of the lake (Plate 3).

Eutrophication :

In most locations where fecal coliforms (Fig. 8) are present, the water is also receiving nutrients, which may overlay enrich the lake, casing a condition called eutrophication. Sediment laden runoff carries with it phosphorous, which is the main culprit behind lake eutrophication. Phosphorous is the limiting nutrient in natural waters and when it occurs in over abundance, it causes algal blooms and, eventually, lake Eutrophication. The inflow of nutrients such as nitrogen and phosphorus to the lake water receiving the city drainage fertilizes the aquatic ecosystem, increasing the algae and

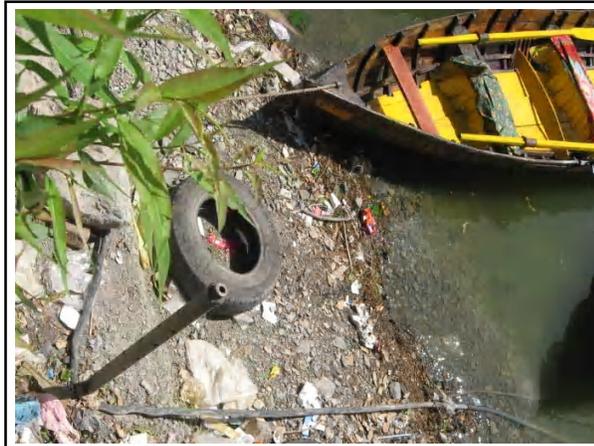


Plate 3 : Garbage disposal: no one’s concern

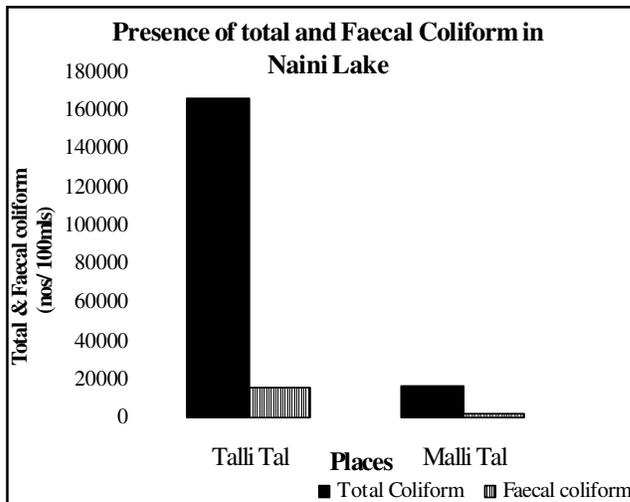


Fig. 8 : Faecal coliform in Naini Lake

superior aquatic plant population in the process of eutrophication. This process is possibly cause reduction of dissolved oxygen (Fig. 8) concentration in water, anoxic conditions at the bottom of the lake, fish kills and aesthetic changes resulting in major alterations in the ecological balance of the lake. At present algal boom is clearly seen in the Nainital Lake depicting the trophic status – which is in highly eutrophic condition. This problem is associated with lake due to the respectively long residence time. The swallowing lake is showing signs of advanced rate of pollution. This is evident from prolific growth and blooms of weeds, diminishing transparency, phenomenal increase in the amounts of phosphates,

nitrate, increase in the content of carbon dioxide, increasing hardness, and reduction in proportion of oxygen dissolved in the water (Fig. 6, 7, 8 and 9).

Aesthetic Alteration:

Nainital is becoming more and more commercialized, the level being raised beyond the reach of the common people. The hotel business is gradually being handed over to the people ,who are far more wealthy than the local people. This is going to impair the socialistic and cosmopolitan pattern the city has developed over the decades. The small hotel buildings are not only suited to the fragile hills, but are also within the reach of the local people with limited resources. However, the sudden spurt in tourism and the resultant price hike in land have rudely disturbed the equanimity of this society. The aesthetic values which have been considered having a great influence in the area and preserved the natural vegetation, directly connected with the ecosystem, are gradually losing their

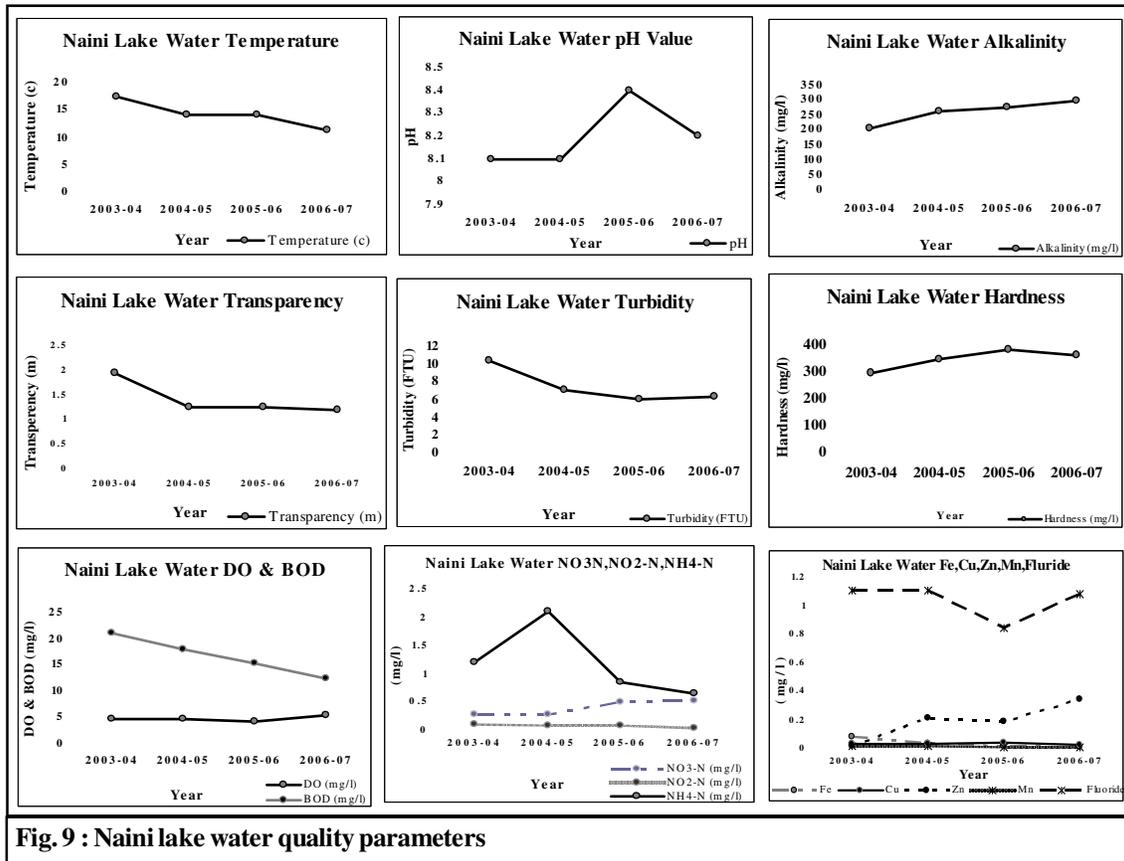


Fig. 9 : Naini lake water quality parameters

importance. The increased concentration of suspended sediments affects lake water transparency, increases turbidity and alters the color and appearance of the lake surface. Pollutant discharge produces odors, due to the decomposition of organics, which favor the formation of foam and fine layers of detritus or cause refuse to float on the water surface. All these changes and their magnitude of impact render the lake unattractive or even repugnant.

Results and Recommendation :

The human activities and decisions are influenced by several factors responsible for the observed land use and consequently the landscape change trends. Thus, pollution in the lake, illegal construction, land encroachment, faulty planning and the loop-sided development of tourism has caused considerable problems for Nainital town. Technology alone cannot solve this problem. Moral and legal conscience, arising from the inextricable whole, must become effective. To overcome these problems, efforts should be made to let the areas endowed with awe-inspiring beauties enjoying the natural way of existence. Restrictions on the use of land and water are the only practical means of avoiding further deterioration. Places falling in very sensitive zones and which are unable to sustain the mechanization of the road system, should be immediately banned. When making required road improvements, ways to minimize erosion and sedimentation entering the lake should be employed. Decentralization of tourism in Nainital and construction of satellite townships are the most important factors, which can reduce the pressure on Nainital. As far as Nainital urban scene development is

concerned, the institutions that are directly involved in the planning and management of the urban area have to be more dynamic, forward looking and management oriented. Urban development is multi-disciplinary subject involving cross section of institutions and organizations. Unfortunately, Uttarakhand does not have any training institute with exclusive focus on urban management planning and development. Thus, it is an urgent need to establish an urban planning and management institute at an earliest, so that the current trend towards haphazard growth and unplanned development of the urban areas can regulate and their natural as well as cultural environment might be preserve and sustainable. Networking is needed at several levels. Networking at the local level will help find and implement solutions that work within a specific context. By facilitating access to shared knowledge, local inhabitants, researchers, scientists may help planners and decision makers to find easier, more effective solutions to the problems related to the sustainable development of Nainital town, which limit the risks and costs of implementing new, unproven solutions. Increasing traffic congestion – with its adverse effects on quality of life in Nainital presents a major challenge for policy-makers. Spatial separation of human activities creates the need for travel and the transport of goods. However, transport also makes places more accessible and, thus, more or less attractive for the location of businesses, shops, leisure activities or residential housing. If residential as well as commercial areas are developed, for instance, with basic services, this will greatly reduce the transportation needs of a large part of the population and, at the same time, improve their quality of life.” Whenever possible, a project should also be designed to enhance quality of life. In addition, the time has come for the planners to catch up with the public. Through mechanisms such as public opinion surveys, neighborhood meetings, focus groups, and so forth, identify the quality of life factors the resident’s views as important. Through these same mechanisms, develop a set of objective criteria for evaluating how a specific growth scenario will affect each quality of life factor the inhabitant finds important. There is an urgent need for growing network of grassroots organizations dedicated to preserving a way of life that is rapidly disappearing from the hilly landscape especially in the study region. All development projects should preserve quality of life for both existing and future residents.

Conclusion:

Naini Lake is literally, by geography, and figuratively, by ambience, the heart of Nainital district. Some of the city’s oldest structures flank the Naini lake . The new shopping centers, office buildings, hotels, restaurants, apartments and condominiums join open space in cradling the lake. To reverse this process and to recreate a livable, vibrant and environmentally viable city, regional strategies, supported by local jurisdictions and encouraged by effective state and town-based policy initiatives are needed. Fundamentally, this means the need to address the causal factors that act as drivers of creating environmental degradation in the form of land use transformation in the area and systematically provide both regulatory controls as well as incentives to minimize the negative impact of manmade disaster creating environmental emergency within the lake catchment area. The study concludes with this notion that for maximizing the long-term benefits of natural resources based on sustained use potential and diverse regional resource endowments, it is important to determine the comparative growth advantage of this area by natural factors as well as social and economic factors.

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