



RESEARCH ARTICLE

WATER SUSTAINABILITY: ASSESSMENT OF WATER RESOURCES

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ABSTRACT

Growing water demand has put a burden on the availability and quality of water resources present in India. In 2010, per capita water availability was 1608 m³, which is expected to decrease to 1341 m³ by 2025 and to 1140 m³ by 2050. Factors accounting for this substantial decrease in availability of water resources are climate change, impact of urbanization and land use changes, energy choices of people, and growing populations. Change in climatic conditions leads to decrease in water availability and increase in water demand. Thus, it becomes difficult to cater for the water demand of the ever-increasing population. Climate change has also amended the water cycle in innumerable ways, leading to decreasing availability in water resources. Also, expanding impervious surfaces have altered the amount of percolation of water and thus declining ground water recharge. In some areas of the country, increased dependency on groundwater resources have burdened the aquifers in that region. Changing dynamics of water resources of India has an adverse impact on different economic sectors as well. Moreover, it becomes a critical issue in a country which is expected to reach the population of 1.6 billion by 2050. Thus, there is a need of monitoring and managing the water resources to avoid the problem of water shortage or degrading water quality in future. This paper explains in detail the reasons behind depleting water resources, focusing on impacts of climatic change and assesses the depleting water resources of hill town Nainital, Uttarakhand.

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INTRODUCTION

India, being a developing country, has majority of its population involved in primary sector majorly agriculture. Almost two-thirds of total workers in India earn their livelihood through agriculture and other allied sectors like forestry, animal husbandry and fishing. The primary sector of economy makes direct use of natural resources and includes sectors like agriculture, fisheries, horticulture, mining etc. With excessive use of water resources for various purposes, it is quite evident that the ground water levels have declined drastically in the last decade. As per the Central Ground Water Board, around 56% of the wells showed a decline in level in 2013 with declining rate being greater than that of preceding 10 years. It also stated that the agriculture sector is the biggest user of water resources followed by domestic and industrial sector. Although agricultural activities primarily use highest amount of water, numerous other reasons are responsible for the decline of ground water resources. Also, the condition of ground water resources is tantamount to the conditions of surface water resources. Lakes and rivers are drying out in many parts of the country, which again becomes a critical problem.

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Burgeoning population, increased human demand and overuse, extensive industrialization and irrigation, pollution and climatic conditions are some of the reasons responsible for water scarcity in India, and also globally. The question that arises is that, what makes *concern for water resources* need of the hour? The answer to this is quite simple and self-explanatory. Water is an essential element for human survival. Depleting water resources lead to droughts, and poor survival conditions in those areas. The current annual potential of the country is 1,123 billion cubic meters while it is expected that the country would need 1180 billion cubic meters of water annually by 2050. With 1,545 cubic metre annual decrease in per capita availability of water, and high population growth rates, there is least possibility of satisfying the future demands of the country with existing conditions. Hence, there is a dire need to conserve the water resources of India. And this is only possible with adequate and judicious use of water resources and, more importantly, recharging the aquifers of the region.

Role of Climate change

Climate change plays a very important role in degrading condition of water resources. As per UN Intergovernmental Panel on Climate Change (IPCC), a rise in global temperature of between 0.3^oC and 4.8^oC is predicted by the late 21st century.

As the earth's temperature continues to rise, devastating impacts on fresh water resources can be observed. This is primarily because, more than 50% of the world's freshwater comes from mountain runoff and snowmelt. The ramifications of climate change in a country like India would not be limited to decline in quantity of water resources; but the problems will magnify because of conflicts between communities over water disputes and recurring conditions of drought, affecting agricultural productivity and food security. The UN World Water Development Report illustrates the conditions of availability of freshwater resources in the world. It is observed that the freshwater resources in India are not in a good condition and these resources are under great stress.

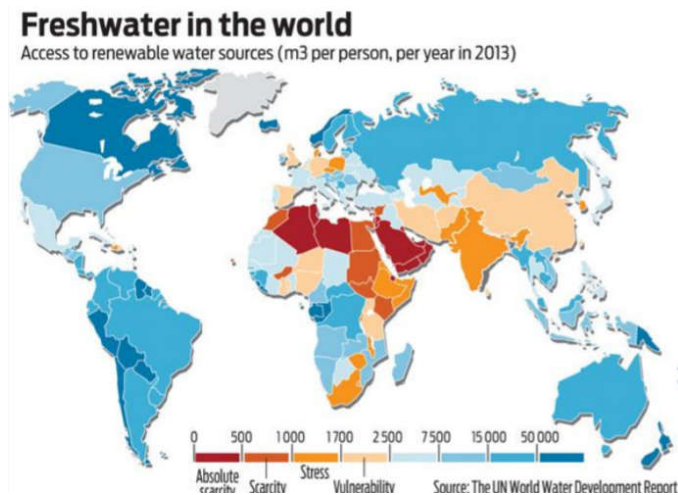


Figure 1. Global availability of freshwater resources, UNDP Report

The combined effects of climate change and over use of water resources are violating the water cycle, degrading aquifers and eroding ground water resources. Given the agrarian and power generation needs of the river systems in India, water scarcity poses great threats giving rise to upstream-downstream animosities. The process of water cycle, which basically includes evaporation, condensation, precipitation, infiltration and runoff, is being disturbed due to human activities and certain natural factors. This disturbance has also led to depleting water resources in the country. Rise in Earth's temperature leads to increased rate of evaporation but this evaporated water does not come back to the earth in equal amounts. Due to increasing construction of impervious surfaces, the rate of infiltration is decreasing which leads to decline in groundwater recharge and consequently drying out of water bodies. Deforestation also has a major impact on water cycle. Because of incessant cutting of trees, the land becomes drier and less stable. Whenever it rains, instead of infiltration of water there is increased run-off and leaching and which increases the chances of flooding and droughts. Another problem is mismanagement of dams. If the dams are not constructed and managed in an appropriate manner, they can result in droughts downstream with lower order streams completely drying up and leaving areas of un-watered land. An imbalance in water cycle can have disastrous impacts on human and plant life and thus it should be regulated.

Nainital, Uttarakhand

Nainital is one of 13 districts of the state of Uttarakhand. The hill town is known for its scenic beauty and acts as a major tourism hotspot in North India. The city is set around Naini

lake, named for its shape like 'eye', and is dependent on the lake for variety of purposes. With a population of 954,605, as per Census 2011, Nainital district is known as a part of Terai region. Terai means areas lying close to wetlands and which have good potential of groundwater availability. The district comprises of three broad physiographic divisions: The Lesser Himalayan Zone, the Himalayan Foot Hill Zone and the Piedmont Alluvial Tract, as shown in the map below.

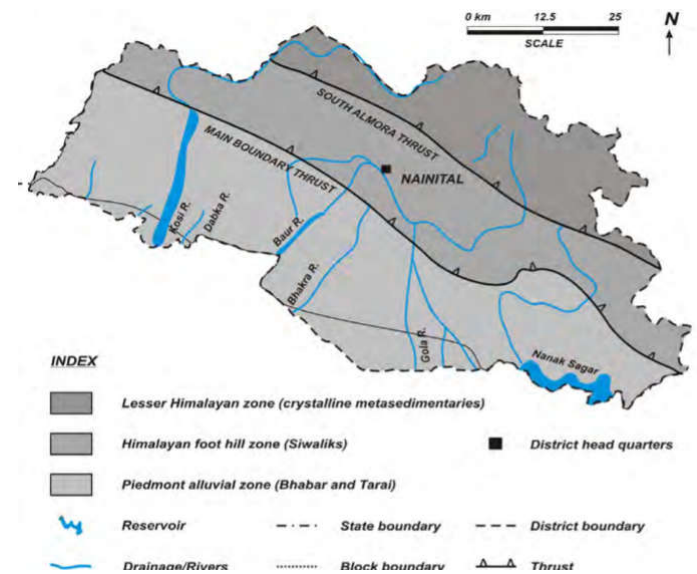


Figure 2. Physiographic divisions of Nainital District, CGWB 2010

More than 55% of the geographical area of the district lies in the first two zones, primarily comprising of sand stone, mudstone, slates, clay lenses and phyllites. These rock formations have poor porosity and yield adequate water only when secondary porosity develops due to weathering and disintegration along weak planes. Due to such conditions, certain measures need to be taken to ensure aquifer recharge in the region and maintain water sustainability.

Issue in the District

Despite being known for its picturesque beauty the Naini lake, sitting in the lap of mountains, is visibly struggling. According to a study conducted by Centre for Ecology Development and Research (CEDAR), the lake reached zero level 15 times since 2000 while this had only happened twice before 2000 (in 1923 and 1980). Usually, the zero level is reached in the months of May and June but in 2017, the lake dropped to zero level in January itself. Such conditions have deepened the concerns of tourists and residents of Nainital because the lake is not just a recreation spot but also the only source of town's water supply. Drinking water supply is indirectly sourced through tube wells dug in the vicinity of the lake. Numerous reasons can be listed down for aggravating conditions of groundwater in this region. In recent years, cutting of oak trees has increased incessantly and thus affected the groundwater tables. These trees help in groundwater recharge by holding water for a long time and releasing it very slowly which leads to perennial streams and rivulets. Another cause of this worsening situation is that the siltation rate of Naini lake is alarmingly high because of improper construction activities at the lakeside. Unbridled construction activities have also damaged the natural feeder springs in the recharge zone of the lake. Currently, almost 30 out of 60 natural springs, whose water used to flow towards the

lake, have dried up. Moreover, construction of more metaled roads reduces the pervious surfaces and increases the surface runoff during rains. This again leads to low recharge rates of groundwater tables. Further exacerbating the problem, the rainfall pattern is showing a disturbing trend since few years. Changing climate patterns have drastically reduced the amount of rainfall received over the years. All these problems have led to low groundwater tables and poor conditions of aquifers in the region and there is a need to conserve these resources.

Being a tourism hotspot, the district has seen high increase in construction activities since the last decade. Using remote sensing techniques, changing land use patterns of the district were analyzed and compared. The Land Use/Land Cover analysis of Nainital District for 2008 and 2016 shows that the percentage of built-up areas has increased in these 8 years with acute decrease in green areas. Deforestation, as discussed above, has major impacts on water availability and this is another reason for reducing water availability in the district. The forest area has decreased by more than 20% in just 8 years. While the built-up area has increased in these 8 years. These maps depict the rate of deforestation in the district and present a disturbing situation.

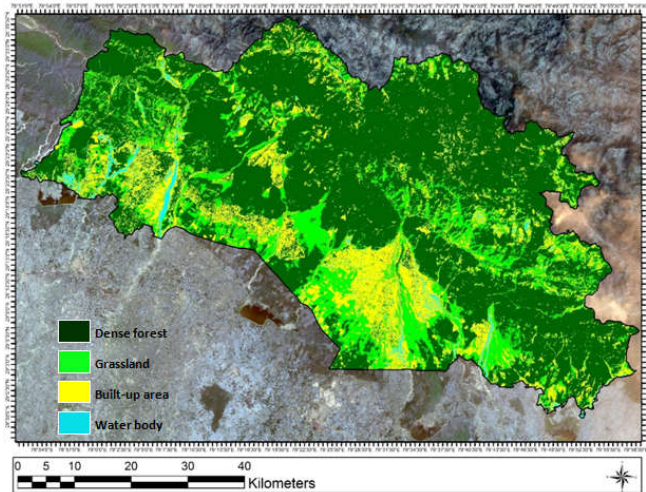


Figure 3. LULC of Nainital District in 2008

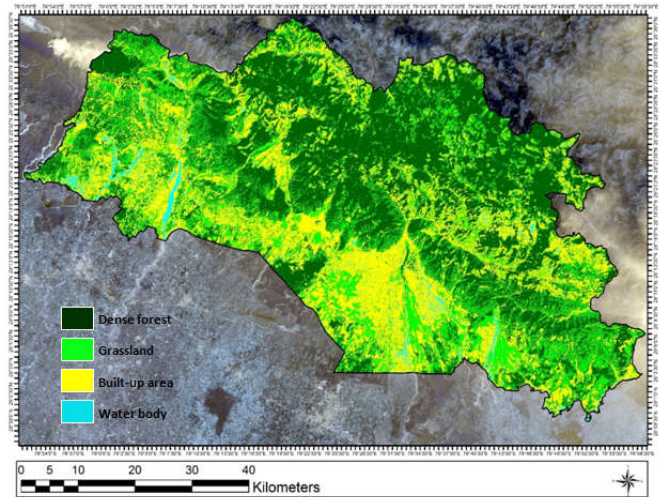


Figure 4. LULC of Nainital District in 2016

Certain measures can be taken to avoid issues of water scarcity in future. Excessive use of water resources should be avoided and optimum use should be done only with adequate recharging options. It is important to maintain conditions in which groundwater recharge can take place. Small surface water reservoirs can be developed at suitable locations so that there is an increased rate of aquifer recharge, the maintaining the surface water availability in the district. Due to sufficient rainfall in certain areas of the district, roof top rainwater harvesting seems a viable option and can be used for fulfilling the domestic requirements at least. Other than this, awareness for water resources is required in the region so that people understand the need of water sustainability and contribute towards water conservation.

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