



Current Water Crisis Issues and Impacts of Decreasing Forest Cover in Indian Highlands: Case Study from a Himalayan State of India

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Abstract

The Himalayan states of India are biologically rich with various natural resources, yet due to various anthropogenic or natural causes, the resources and inherited services are getting reduced day by day, at a larger scale creating different threats to the lives of local people. The current study assess the inter-connections between the changes in the vulnerable ecosystem like forest cover and increasing water scarcity in Himachal Pradesh, a Himalayan state in India. The survival rate of floras are reported to be decreasing at a very alarming rate, directly causing severe water crisis in Shimla, the famous tourist destination of India and other villages of Himachal Pradesh. Apart from finding out different natural causes for this crisis, financial review has also been carried out in this study to analyse the State Government budget for Himachal Pradesh for different schemes and strategies related to Forests and Water Resources. The review results show climate-relevant expenditures for forestry by State Government is 27% compared to 66% in the water sector. Finally our study shows that increase in Government budget for expenditures in forest sector will help to curb water crisis to certain extents in the highland states of India. The findings would be applicable for many other countries with similar geographical parameters as well.

Keywords: Deforestation; Water crisis; Public Finance, Climate change; Government Expenditure; Himachal Pradesh; Himalayan State of India

Introduction

The criticality and current deteriorating state of water all over the world is an alarming issue and researchers are trying to find out different solutions to come out from this worldwide problem. Like, afforestation could be one solution as it affects the hydrologic cycle in many positive ways, e.g., forest play an important role in the hydrological cycle by affecting rates of transpiration and evaporation and influencing the flow and storage of water to the watershed [1]. A decline in the forest cover of the mountain regions prevents the formation of glaciers and snow, causing decreasing water flow in the rivers. At much larger scales, extensive forests can cycle moisture between the land and the atmosphere and thus, large-scale clearing of natural forest may have detrimental effects on regional and national water cycles. In many countries like Brazil, India, China, Malaysia, Romania and Spain, deforestation and soil degradation have created water quality problems, which are now being addressed through reforestation [2]. Thus, the

establishment, conservation, and management of forests are tasks that most countries should focus on, in order to ensure healthy watersheds.

However, sometimes it's seen that with the growing demand for water and the changing pattern of local precipitation due to global warming, plantation of forestry has faced an increasing number of water related conflicts worldwide [2].

A study by Malmer, et al., 2018 reviews the biophysical nature and inter-linkages between forests and water, and their role to different policies on ecological services and benefits provided by the forests. As per FAO, deforestation of the mixed indigenous forest is a major threat to water catchments and the quality and quantity of freshwater globally [3]. A study by Pearson (1907) done in Gujarat of India, found that depth to groundwater in wells located inside forests was 4.74 deeper under forests than outside, i.e., the depths to groundwater was shallower under the non-forest site (100m outside a forest) compared to the well in the forest (1200m inside a mixed teak forest) and also was much more responsive to rainfall. This was perhaps the first empirical study of evapotranspiration by forests in India [2].

Water scarcity in any region is an outcome of both physical and economic mechanisms [4]. Economic mechanisms involve anthropogenic contributions towards water shortage, which may include poor water resource management, land use change or landscape alteration, sedimentation, water pollution and urbanisation amongst others [5]. Besides deforestation, increased or decreased rainfall and temperature too have a direct effect on water availability, and will, evidently, lead to changes in the distribution of forest cover spatially and/or qualitatively [6].

These interconnectedness of forest cover and water has a huge impact on maintaining the sustainability of a city or a habitat as biodiversity and ecosystem services from forests and wetlands are important components for livelihood [7]. Nepal, a country situated in the Himalayan range, is home to 29.3 million people, with rich biodiversity resource, was facing sudden cloudbursts, unpredicted flooding and other natural hazards [8]. The community through their indigenous knowledge and bioengineering initiative (greenbelt development) have planted 6500 varieties of native trees along the river bank, which has resulted in the prevention of soil erosion, enhanced groundwater recharge and micro-climate regulation, along with economic paybacks from forest products [9].

Our case study area Himachal Pradesh (HP) state in India faces serious water crisis specially during summer. Tourism which includes huge numbers of foreigners and domestic travellers is the main economic source for this region which gets hugely affected due to this severe water crisis. The tourist arrival has been rising constantly over the years thus leading to an increased demand of water. Shimla, the capital of HP has in the past witnessed deforestation on account of building of roads, structures, power lines, power stations, water lines, treatment plants, sales of private land and encroachments etc. The loss of forest has affected the water cycle of the city hugely. In April and May 2018 several fire cases (due to public negligence, lightning or grass requirements of villagers) were registered in this area which too caused rise in temperature of the city and affected natural water sources.

All these inter-connectivity and inter-linkages of water and forests can be seen in all spheres from its inclusion in all the MEAs and Existing SDGs [10]. However, there are various factors that hinder the execution of afforestation and other forest conservation activities which are the primary task of the Forest Departments. And hence the need of adequate funding becomes a critical aspect of the forest operations. In India, the source of funding for the State forest departments includes budgetary allocation from the State, Centrally Sponsored Schemes as well as other mechanisms such as the grant-in-aid received through the Finance Commission. The forest department financial provisioning is released every year in their annual report which shows the allocation under each scheme and the utilization heads. Thus there is a need for a financial

analysis to judge whether the funds are sufficient or whether there are full utilizations of the grants or not, both in the forestry and water sectors.

However, in this regard, in Figure 1, we depict the cyclic relation, how degradation of natural resources like forests, water etc, may lead to lower productivity and delivery of respective services, the effect on livelihood vulnerability and subsequent effect on the economic crisis. The gap between natural resource degradation and its resulting financial crisis can be fulfilled by relevant government initiatives and investment in natural assets, their conservation and sustainable use [11].

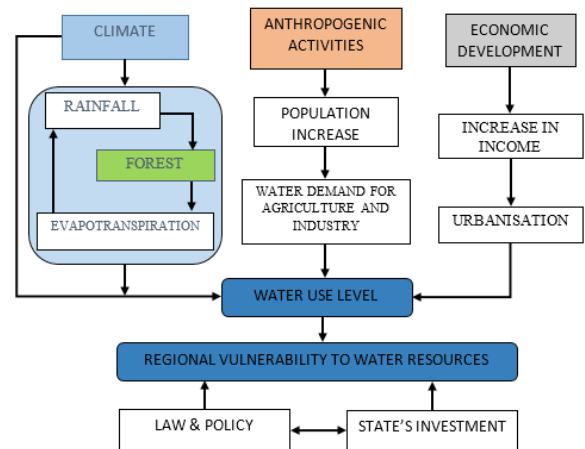


Figure 1: Inter-relationship between Natural resources and economic crisis.

Source: Kulshreshtha [12].

Rationale & Objective

The inter-linkages between forest and hydrologic cycle are well-established facts and also that deforestation and water crisis, resulting from natural phenomenon or anthropogenic actions severely impact the human population. One mitigation measure to these negative consequences could be the financial assistance from respective State Governments, through efficient sector-specific schemes, technological innovations, management strategies and investments. Our case study, carried out in the Indian Himalayan state of Himachal Pradesh, will identify the inter-linkages between forest and water availability in that area and would analyse budget expenditure regarding forest and water-related activities and their climate relevancy. The identified gap between investments in the above-mentioned sectors will be a finding for further focus and subsequently various ways to acknowledge the gap.

Case Study Area

As discussed in the introduction, Himachal Pradesh, a Himalayan state of India faces severe water crisis, especially in the summers which creates a severe negative impact in the economy

and the livelihood of its people. In this study, we have picked up this region and tried to see the effect of reduction of forest cover in the severe water crisis in this region and tried to analyse the lack in public budget and also its lack of proper utilization in the forestry sector of HP, and finally tried to coming out with subsequent way forward which could help to overcome this situation.

Himachal Pradesh is situated in the north-western part of Himalaya, covering an area of 55,673 km², with wide altitudinal variations ranging from plains to mountain peaks [13]. The state experiences variation in temperature and rainfall, soil, and vegetation, and cropping patterns due to altitude, aspect, slope and micro-climatic conditions. Previously fed by five major rivers, HP at present is supported by only one river, i.e., Beas [14]. As per 2011 census the population of Shimla city, the capital of HP is 169578 lakhs and if the adjacent areas (about 16 water supply zones) and floating population (tourists and commercial commuters) are also included it is around 2.85 lakh that requires a supply of 41.58 MLD (Million Liters per Day) water @ 140 lpcd. However, the supply is just 33 MLD with a shortage of about 8 MLD. During summers on account of weather variations of the past and the instantaneous reasons the deficiency fluctuates up to 15 to 20 MLD.

Also, the vulnerability of the State is high due to an array of natural hazards in the state, which includes earthquakes, flash floods, avalanches, landslides, glacial lake outburst due to active plate tectonic margins and altered climatic conditions.

The National Forest Policy, 1988 recommended that forests should cover at least two thirds or 66 per cent of the geographical area in a hill State like Himachal Pradesh. Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct to Dec 2017, the Forest Cover in the HP is 15,433.52 sq. km which is 27.72% of the State's geographical area. In terms of forest canopy density classes, the State has 3,112.71 sq. km under Very Dense Forest (VDF), 7,125.93 sq. km under Moderately Dense Forest (MDF) and 5,194.88 sq. km under Open Forest (OF). In the year 2019 forest Cover in the State has increased by 333.52 sq. km as compared to the previous assessment reported in ISFR 2017 [13]. It was reported in Action Programme on National Forestry-India [15] that the forests of HP had undergone considerable changes due to rapid and unplanned development of infrastructure, extension of agriculture, horticulture, development projects and demand for forest products. In addition, it was also reported that the unregulated and unaccounted extraction of fuelwood, fodder (excessive felling) and unsilviculture fellings for meeting the demands of right holders under Timber Distribution system, the condition of forest resources had led to the fast deterioration of the quality of forests and their crown density. The State is unique in the India as it took a lead in imposing a ban on green felling since 1984. The average annual removal since then is only in the form of salvage and Timber Distribution Rights to the right holders as per

settlement reports.

However, the bottom line is that the actual forest cover in Himachal Pradesh is inadequate and the same needs to be increased in order to improve the water crisis situation in HP.

Methodology

Method used

Apart from studying the underlying causes of natural and anthropogenic causes of the water crisis in the State, the analysis of State Government's budget for forestry department and water resource department, and also, the appropriation account for the same have been carried out in this study to have a thorough understanding of State Government's expenditure on these sectors. All government schemes related to forestry and environment were analysed for four consecutive years, 2015-16, 2016-17, 2017-18, 2018-19 regarding activities supporting forestry and/or water resources and likewise, the total actual expenditure for these sectors were calculated and compared to the total actual expenditure of the State. Finally, the investment parity between two inter-linked resources like forests and water are identified.

Comparing with the SAPCC investment for the given time-period, the percentage of climate relevant activities are also identified. Climate relevant activities take into account all the positive and negative expenditure, either direct or indirect in nature. Subtraction of positive and negative expenditures gave the total climate relevant expenditure for the year 2016-17.

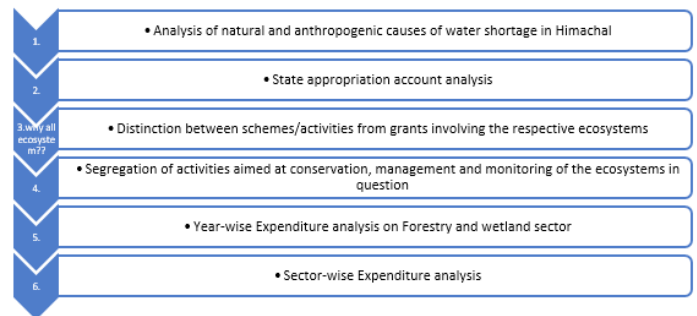


Figure 2: Case Study Methodology.

Climatic Parameters

As discussed, apart from the deforestation issues, there are climatic parameters which creates negative impacts on the water availability as well as the water quality in the Himalayan region like HP. We would try to analyse those parameters below:

Temperature Trends

The long-term temperature trend is studied in the State for a time period of 1951-2010 by [16] and it shows a decreasing trend in Annual mean minimum temperature of -0.01°C/year whereas

a total increase of 0.02 °C/year in annual mean temperature. The higher temperature in the State can be made evident from the given trends in Table 1.

Variables	Temperature Trend (°C/year)
Annual Mean Maximum Temperature	+0.6
Annual Mean Minimum Temperature	-0.01
Annual Mean Temperature	+0.02
Seasonal Mean temperature (Winter)	+0.02
Seasonal Mean temperature (Monsoons)	+0.03
Seasonal Mean temperature (Post- Monsoons)	+0.02
Seasonal Mean temperature (Summers)	+0.01

Table 1: Temperature trend in Himachal Pradesh.

Source: (GGGI, TERI, DEST 2005) [17].

Rainfall Trends

The annual average rainfall over the state of Himachal Pradesh for the period 1951-2010 indicates a decreasing trend, which is -3.26 mm/year, the seasonal rainfall for summer (0.31 mm/year) shows an increasing trend for the same time period whereas the winter, monsoon and post-monsoon seasons show a decreasing trend of -0.18 mm/year, -2.85 mm/year and -0.21 mm/year respectively, as given in Table 2 [16].

Rainfall trends per year (in mm)	Deviation
Winter	-0.18
Summer	+0.31
Monsoon	-2.85
Post Monsoon	-0.21
Annual	-3.26

Table 2: Rainfall trend in Himachal Pradesh.

Source: (Rathore, Attri and Jaswal 2013) [16].

Drought Trends

Overall warming projected over the State in the near future and this increase in minimum temperature will have many impacts on natural resources present in the State. Mean Annual Maximum temperature over the State is projected to increase by 1.1-1.9 degrees and the Mean Annual Minimum Temperature also is projected to increase over the Study domain area in the range 1.5-1.9 degrees [17].

Forest Fire Trends

Forest fires/combustion of biomass has a direct link with water scarcity in terms of quantity and quality. Fire in forests can

create concerns over water quality, and less commonly, water yield. In Australia, Spain and USA, fire seasons are becoming longer and more extreme due to drier and warmer climate. Forest management is very important to reduce fire risk and detrimental effects of wildfire on water quality.

It alters the mediation of flow and storage of water and through deposition of atmospheric pollutants (dry deposition of combustion products) in water supply channels (Martin 2016), causes vegetation loss, exposing the soil to intense impacts of rainfall, runoff and solar radiation causing hydrophobicity and change in soil properties, flooding, soil erosion and downstream degradation of watersheds [18].

In case of Himachal Pradesh the forest fire incidences have hiked, affecting a total area of 25300.92 ha in a single year span (2018-19) compared to an area of 9408.09 ha in (2017-18). Forest fire incidents reported in (2016-17) affecting total area of about 19535.76 ha is much higher than (2015-16)(Himachal Pradesh State disaster Management Authority) [19]. Therefore, forest fires can also be held responsible for the problem of water scarcity in terms of unavailability and inaccessibility of clean drinking water.

Year	Forest Fire Incidences	Areas affected (hectare)
2015-16	672	5749.95
2016-17	1832	19535.76
2017-18	1164	9408.09
2018-19	2469	25300.902

Table 3: Forest fires incidents in Himachal Pradesh.

Source: Himachal Pradesh State Disaster Management Authority [19].

On the other hand with persisting water crisis, the forest cover is also minimising due to their lower survival rate.

Government Expenditure Review and Analysis

Comparison between Year-Wise Expenditure on Forestry

Expenditures related to issues and schemes on forestry are identified from the State Appropriation account for financial years 2015-16, 2016-17, 2017-18 and 2018-19. The total state budget for those financial years are Rs. 22,381 Crores, Rs.25,740 Crores, Rs. 35,783 crores Rs.41,440 crores respectively.

For year 2015-16 and 2016-17 it was evident from the analysis that total grants allocated by the state is high, whereas the expenditure on the forest is very negligible, amounting to approximately about Rs.77 Crores and Rs.78 crores respectively. For year 2017-18 and 2018-19 this forest expenditure review showed that out of the total grants allocated by the state to forestry

and environment department is Rs.145.37 crore. And the actual expenditure for the year is Rs.54.606 crore. For the year 2018-19 the budget allocated for various schemes related to forestry is Rs.142.88 crore and the actual expenditure is Rs.50.5133 crore.

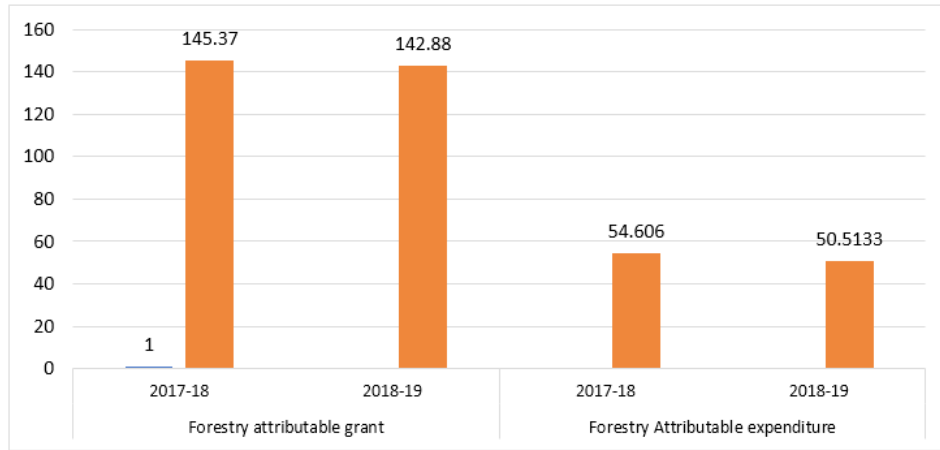


Figure 3: Year-wise Expenditure Review (2015-16). **Figure 4:** Year-wise Expenditure Review (2016-17).

Figure Forestry sector grant and expenditure for year 2017-18 and 2018-19 (in Crore) [19,20].

In the Financial year 2016-17, the actual expenditure for the State is 25,740 Crores, where the allotment for forestry remains almost same with 78 Crores of State budgets. Also as shown in the below figure, a huge share of grant (how much?) i.e Rs.90.76 crore and Rs. 92.37 crore provided by the State Forest Department is left utilized for the year 2017-18 and 2018-19. . (Economics and Statistic Department).

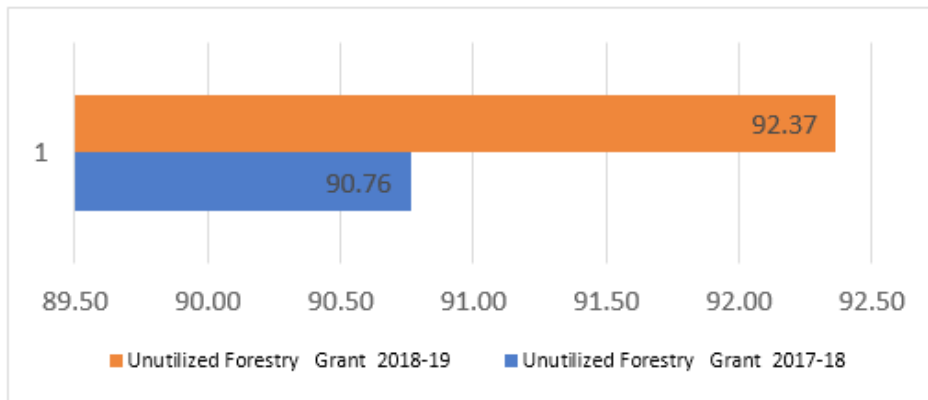


Figure 5: Unutilized biodiversity Grant for year 2017-18 and 2018-19 (in Crore) [19,20].

Comparison between Year-Wise Expenditure on Water Related Sector

The expenditure on water-related activities for some financial years 2015-16, 2016-17, 2017-18 and 2018-19 was also worked upon. An amount of 292 Crores was spend for year 2015-16. It was observed to be Rs. 175 Crores for year 2016-17. For year 2017-18 and 2018-19 the water related expenditure was found to be Rs.119.56 crores and Rs.160.57 crores respectively. The schemes and strategies in the water sector have acquired more investment than forestry for the same financial years [21,22].

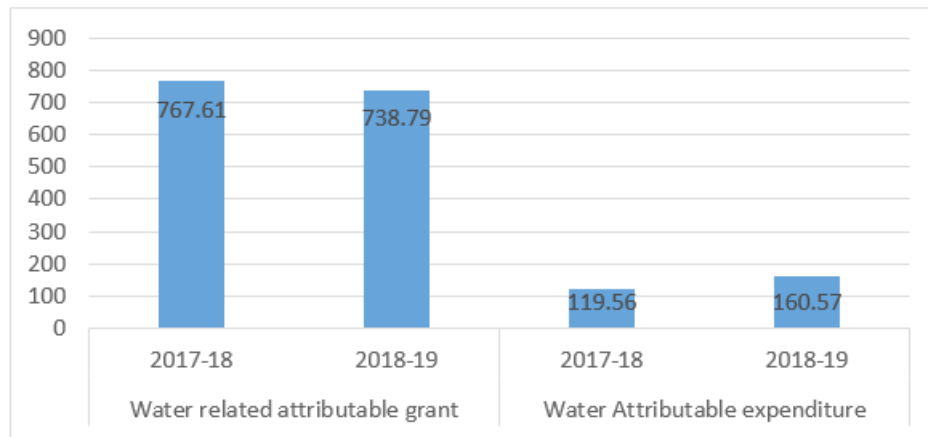


Figure 6: Water Sector related grants and expenditure for year 2017-18 and 2018-19 (in Crore) [21,22].

From the Forest Expenditure Review it can be seen that a huge share of grant provided by the State Forest Department is left unutilized for the year 2017-18 and 2018-19.

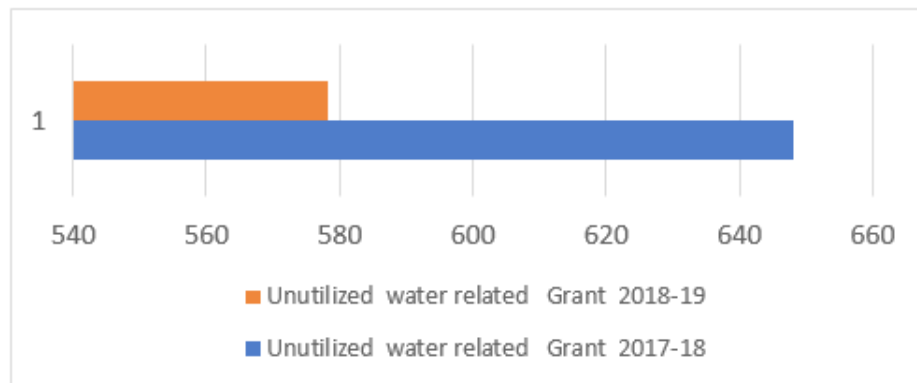


Figure 7: Unutilized Grant of Water sector for year 2017-18 and 2018-19 (in Crore).

Comparison between State Action Plan for Climate Change (SAPCC) spending's for Forest and Water Sector

Comparing the budget allocation for these two sectors, we see that though overall investment for activities undertaken for various grants has increased in the forestry sector, this maximisation has not acknowledged the importance of investment in the forestry sector.

The data has also been extracted after analysing the State Action Plan on Climate Change and the State Appropriation account. The comparison is clear between the expenditures allotted in both forest and water sectors in Himachal Pradesh. The data shows that SAPCC spending requirement per year for the forestry sector in the State is Rs.23 Crores, whereas it is comparatively lower in the Water sector that is Rs.18 Crores. The Actual Expenditure for the financial year 2016-17 in forest-related activities was approximately Rs.365 Crores, out of which on Rs.99 Crores were climate-relevant. In the case of Water specific schemes and strategies, the actual expenditure was around Rs.2787 Crores and climate-relevant spending amongst the total was Rs.1834 Crores.

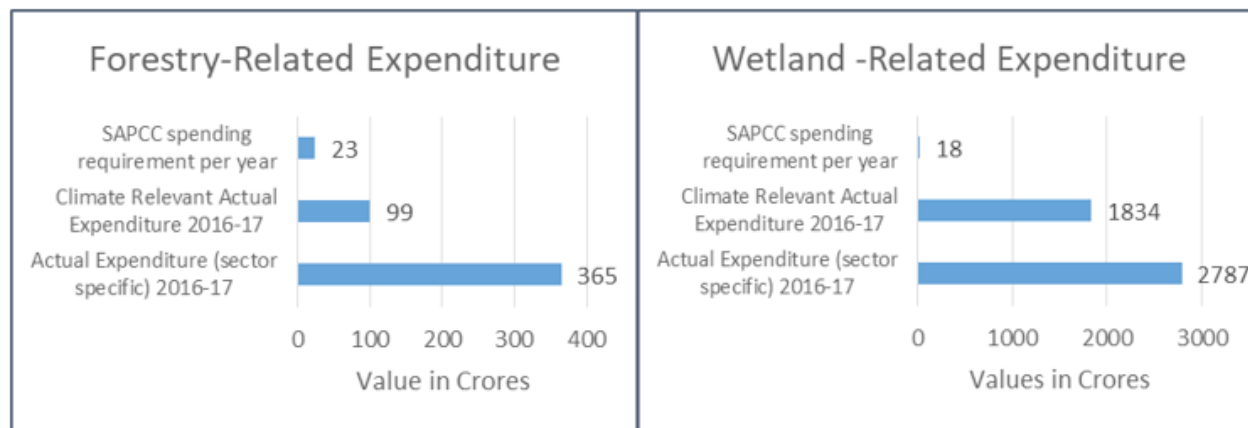


Figure 8: Sector-wise Expenditure Review (Forestry sector). **Figure 9:** Sector-wise Expenditure Review (Water sector).

An increase of 67% in expenditure can be observed in the water sector from the year 2015-16 to 2016-17, and a 1% increase in the forestry sector. For the study year of 2016-17, the climate-relevant expenditure in the forestry sector is only 27% of the sector-specific actual expenditure, whereas it is as high as 66% of the sector-specific actual expenditure in water/wetland sector. One Major finding from the appropriation account analysis was that there has been no expenditure directly aiming at conservation, protection or rejuvenation of high-altitude wetlands in Himachal, instead they are more focused on activities that may indirectly provide the service.

Discussion

To maintain the good health of forest areas in terms of the services, conservation of the biodiversity and other benefits being provided by the forests is a very important task. There are various factors that hinder the execution of forest health related work. Currently the task of the Forest Departments of each State has been doing the job of maintaining and increasing the forest cover of India. Hence the need of adequate funding becomes a critical aspect of the forest operations in each State. The source of funding for the State forest departments includes budgetary allocation from the State, Centrally Sponsored Schemes as well as other mechanisms such as the grant-in-aid received through the Finance Commission. The forest department financial provisioning is released every year in their annual report which shows the allocation under each scheme and the utilization heads.

For estimation of expenditure on maintaining areas under forests, the projections of the XIII Finance Commission for Non-Plan Revenue Expenditure have been used. It was estimated that the allocations that are needed in of restoring degraded forest area of Himachal Pradesh is nearly Rs. 300.00 crore to Rs. 307.07 crore [23].

The actual allocation made by the XIII Finance commission is 100 crores only. Our findings on expenditure review of forestry department of Himachal Pradesh for year 2014-15, 2016-17, 2017-18, 2018-19 shows that the Forest attributable grant is Rs. 77 crores, Rs. 78 crores, Rs. 54.606 crore and Rs. 50.5133 crore respectively which is even much lower than the required allocated budget [19,20].

The scheme funding, central funding and the state funding all act complementary to each other which may result in the overall crisis of funds by the State forest departments. In case of funding for various schemes the state allocation for forest departments is pruned or left unutilised. This results in overall financial restrictions to the scheme funding and expectations to the scheme targets plus the regular maintenance, for which the forest departments find it hard to use up the funding. The state budget should ensure that this doesn't happen, to ensure a smooth functioning of the forest departments.

Similarly, the Government of Himachal Pradesh has sought a grant for rehabilitation and source-level augmentation of water supply in chronically dry and arid mid-Himalayan regions. Regions which are chronically water scarce, a grant of Rs. 150 crores were recommended. Projected Maintenance Expenditure for Irrigation for Himachal Pradesh was found to be Rs. 237.79 crores for the year 2014-15 [24]. It is evident from our analysis that the actual expenditure for water resource for financial year 2015-16, 2016-17, 2017-18, 2018-19 is Rs. 292 Crores, Rs. 175 Crores, Rs. 119.56 crores and Rs. 160.57 crores respectively. These expenditure values are much low as compared to the suggested expenditure value provided for the maintenance of water supply or irrigation in the state. The Government of Himachal Pradesh is committed to reverse the process of degradation of natural resources and improve the productive potential of natural resources and incomes of rural households.

From our findings it is also very evident that a large share of Grant by State Forest Department or Water Sector is left unutilised. Therefore, more schemes can be incorporated to utilise the grant and work for the betterment of the state.

Conclusion

From the Study, it may be concluded that the condition of natural resources in Himachal is driven by government expenditures on both, specific sectors and natural global phenomenon. Water scarcity being the major problem in the State, not only effects the water requirement of the increasing population but also for the survival of the ecosystem, by decreasing the soil water content. There are several issues that need management through ecosystem or economical approach/initiatives.

- Water bodies are mostly glacier-fed and receding glaciers due to climate change may lead to uncertainty in the water supply to ecosystems, resulting in drying of high altitude wetlands. Also, due to concretisation, the natural filtration process is absent in highly populated hills, therefore during rainy days, the water flows directly to streams or rivers without getting utilised in the land features. Schemes and investments, therefore, must be aligned towards the enhancement of natural filtration and retention either through water harvesting projects with soil conservation components or plantation of native endemic tree species. National Plan for Conservation of Aquatic Ecosystems is a scheme dedicated towards the management of water bodies, which should also be efficiently incorporated into the main expenditure.
- Forest fire management can be a potential mitigation effort towards water and soil conservation. This natural or anthropogenic induced hazard is responsible for the loss of large extent of forest area, affecting soil quality parameters like nutrient content and pH. Also, afforestation on these lands shows lower survival rates, lower carbon sequestration rates and more vulnerable to erosion. This can also be mitigated through organic matter addition in the soil for better water retention and productivity.
- Regarding the ecosystem linkages, approaches should be considered where watershed protection is implemented through forest protection. A time-consuming task, where water body rejuvenation, water level expansion, water quality improvement and watershed management will be a certain output of plantation.
- The climate-relevant expenditure analysis is an efficient approach to identify initiatives opted by specific sectors towards its contribution to climate change adaptation and mitigation. For example, in forestry, even though there is

sufficient expenditure, forest density has not yet increased, because of channelization of funds for non-relevant or neutral activities.

- The schemes and investments in State are sector-specific in nature that lacks interdependency in terms of conservation, management and development of the respective resources. Convergence of umbrella schemes like MGNREGA with State-schemes viz. Intensification of Forest Management, Disaster management, Mission on Climate Change and Adaptation can be considered a holistic approach to resource enhancement in the State.

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