

THE LINKAGES BETWEEN CLIMATE CHANGE AND BIODIVERSITY: A CASE STUDY OF HAMIRPUR DISTRICT IN HIMACHAL PRADESH, INDIA

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Abstract: Climates have changed and are still constantly changing at all scales, from local to global, and over varying time-spans. There have been, however, surges of change over time which meteorologists and earth scientists are continually trying to clarify and explain. Global climatic change due to increasing atmospheric concentrations of greenhouse gases has dominated the environmental agenda since the mid 1980s. There is no doubt that over the last 100 years or so, human action has significantly increased the atmospheric concentrations of several gases that are closely related to global temperature. It seems likely that these increased concentrations, which are said to continue to rise in the near future, are already affecting global climate, but our poor knowledge and understanding of the workings of the global heat balance make the current and future situation uncertain. Since the atmosphere is intimately linked to the workings of the biosphere, hydrosphere and lithosphere, the projected changes in climate will have significant effects on all aspects of the natural world in which we live. Therefore there is no bigger challenge in the world today than how we respond to the scientific evidence that our climate is warming- for which the human race is responsible.

On the other side, Biodiversity is the key indicator of a healthy planet and healthy society. Forests support ecosystem services which, in turn, support mankind, providing food, shelter and medicines for the people who live in and near them. Such a precious resource should be guarded jealously, but that is simply not happening. The global warming destroys plants and species we have barely discovered, robbing mankind of potential medicines. It also causes hardship for many of those people who rely on these wonderful natural resources. The demands placed on the world's forests are great and growing. Losses of biodiversity have now become widespread and current rates are potentially catastrophic for species and habitat integrity.

However, the impacts of climate change are most seriously felt in the Himalayan regions because latter belong to the most vulnerable ecosystems and lives of the people are closely entangled with the natural resource base, as 90% of the population is dependent on agriculture and animal husbandry. Any change in the natural resources of the region due to climate change will have far reaching repercussions. Himachal Pradesh faces an urgent need to adapt to certain measures for the expected impacts of this global phenomenon. The environment has thus become a focused issue in the state. A multidisciplinary approach at the government, societal and individual level is required to nullify the effects of climate change. The state government is moving ahead on the path of development with utmost care to ensure that in no way the environment of the state is disturbed by the developmental activities. The state government has taken many initiatives to protect the environment. Keeping environment protection at the top most of the government developmental agenda, the hilly state Himachal Pradesh is poised to emerge as the first carbon neutral state not only in India but also in the Asia subcontinent.

Thus Climate change is thus not just an environmental issue but is also an economic issue, a social issue, a security issue and, above all, a moral issue. There are also many challenges faced by the people living in and around the forests. Like striking a balance between biodiversity protection and their sustainable use, while increasing the share of benefits, also poses major challenges. Measures like adoption of new bio diverse habitats to ensure that they cope with human impact, climate change and alien species invasion can be useful.

The present study is an attempt to co-relate the linkages between Climate Change and Biodiversity. The study basically tries to concentrate on the spatial and temporal aspects of Climate in Himachal

Pradesh. It tries to analyze the status of biodiversity in the state and focuses on the relationship between Climate Change and Biodiversity. The study highlights the impact of Climate Change on Biodiversity as well as the importance of biodiversity in reducing climate change. Thereafter it discusses various policy measures and management techniques to delimit and minimize the issue for a secure sustainable environment in future. This is the focus of the paper.

Keywords: Biodiversity, Climate Change, Environment, Species extinction, Sustainable Environment.

INTRODUCTION

There is no bigger challenge in the world today than the fact that our climate is changing and to how we respond to the scientific evidence that our climate is warming, for which the human race is majorly responsible.

The paper tries to focus on the spatial and temporal perspectives of climate in the region of Himachal Pradesh. It analysis the state of biodiversity in the region and lastly tries to co relate the linkages between climate change and biodiversity. Major concentration is on how the change in climate affects biodiversity which leads to species extinction giving examples from Himachal Pradesh. Further the study also highlights the importance of biodiversity in reducing climate change.

Thus we take a hypothesis as 'climate change is one of the factors responsible for biodiversity loss'.

Study area

The study area is the region of Himachal Pradesh, situated in the lap of western Himalayas, in northern India. It has a geographic area of 5.57 million hectares. The state is mountainous with altitude ranging from 350 m to 6975 m above the mean sea level. It is located between Latitude 30° 22' 40" N to 33° 12' 40" N and Longitude 75° 45' 55" E to 79° 04' 20" E. The questionnaire has been conducted in Hamirpur district of Himachal Pradesh. Hamirpur District is situated between 76° 18' to 76 ° 44' East longitudes and 31° 25' to 31° 52' North latitude. The tract is hilly covered by Shivalik range. The elevation varies from 400 meters to 1100 meters having the configuration ranging from the almost flat-lands that border the portion of rivers Beas to the lofty heights of cliffs and precipitous slopes of hill-ranges covered with Pines.

Geographically, Himachal Pradesh can be divided into four distinctly identifiable zones based on variations in altitude, climate, geology, soil, flora, fauna and topography as follows. Himachal is also

said to be the fruit bowl of the country with orchards scattered all over the place. The drainage system of Himachal is composed both of rivers and glaciers. India has a total population of 1,21,01,93,422 persons in 2011. Out of this the rural population is 83,30,87,662 persons and urban population constitutes 37,71,05,760 persons in 2011. The population of Himachal in 2001 stood at 60,77,248 which rose to 68,56,509 persons in 2011 as per the provisional results of the Census of India. Rural population was 54,82,367 in 2011 which rose to 61,67,805 in 2011 and Urban population from 5,94,881 in 2001 to 6,88,704 in 2011.

The small hilly state is sparsely populated with less than half of Delhi's population and about 40 times its area. Endowed with natural attractions, tourism is one of the key contributors to the state's income. The state is largely an agro-based economy with about 71 per cent of its population dependent on farming, horticulture and livestock for their livelihood. The main crops are wheat, corn (maize), barley, rice and potatoes. It is one of the leading fruit and vegetable producing states in the country.

MATERIALS AND METHODS

Data: The present study has been carried out by both the primary survey which has been conducted in the Hamirpur district of Himachal Pradesh. The data gathered is further compiled in bars and Pie charts. And then in terms of Secondary data major help has been taken from the Internet, forest department report of Himachal Pradesh, Indian meteorological department, Census handbook of H.P, GLCF website for satellite imagery and various articles and research papers have been consulted. A proper understanding of the term biodiversity and its distribution in the region of Himachal Pradesh has been analyzed. For the climate change, the reports of the Government and on the basis of local experiences of people, data has been formulated.

Biodiversity in the Region: Himachal Pradesh is a land rich in Biodiversity. According to UNCBD biodiversity is defined as "the variability among living organisms from all sources including, *inter alia*, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems." IPCC also emphasizes these three levels—that is, genetic, species, and ecosystem. According to the Himachal Pradesh forest Department [1], Forests in Himachal Pradesh currently cover an area of 37.033 km, which is about 66.5 per cent of the geographical area of the state [2]. Out of a total 45,000 plant species found in the country, as many as 3295 species (7.32 per cent) are

reported in Himachal Pradesh and out of 77,450 species of animals. Himachal Pradesh harbours 5,721

species, amounting to about 7.4 percent of the Indian fauna. At present there are 32 wildlife sanctuaries,

Table: 1 Particulars and Characteristics of each climatic zones

Particulars and Characteristics	Shivalik Zone	Mid-Hill Zone	High Hill Zone	Trans- Himalayan Zone
Altitude	Up to 800 m	800 m -1600 m	1600 m -2700 m	2700 m -3600 m
Type of area	Valley areas and Foothills	Hilly and Mountain ranges	Alpine Zone	Lahul Spiti and Kinnaur range
Climatic Conditions	Sub Tropical	Slightly Warm temperature	Cool temperature with humidity	Dry and extremely cold conditions
Rainfall in mm	1500	1500-300	1000-1500	500
Percentage of Total Geographical area	30%	10%	25%	35%

Source: Census Atlas of Himachal Pradesh.

and 2 national parks which consists of 77 species of mammals, 463 species of birds, 44 species of reptiles, 436 species of aquatic fauna and more than 3500 species of plants [3]. The six major forest types in the state are Tropical Dry deciduous, Subtropical Pine, Subtropical dry evergreen, Himalayan moist Temperate, Himalayan Dry Temperate, and sub alpine/Alpine forests. Thus the rich flora and fauna of the region also poses some serious implications from

RESULTS AND DISCUSSION

Changing Climate of Himachal Pradesh

According to the State Centre on Climate Change, Himachal Pradesh [4] the current scenario of climate change in Himachal Pradesh depicts a rise in temperature by 1.6 degree c in the last century (Bhutiyani.2007). Climate Change and precipitation variations based on rainfall data from 1866-2006 shows decreasing trend in monsoon precipitation. (Bhutiyani.2009). Thus the rainfall trends in the four different elevation site of Himachal Pradesh and their vicinity show that rainfall changes are lower in the mid hill than uplands and lowlands. On an average, rainfall amount in the Himachal Pradesh are 26.5 to 1365 mm lower than in the 1980s decreasing by 1.9 to 44.0mm per year. Baspa, a tributary of the Satluj river have reported that due to warmer winters melting and retreat of snow cover was observed even in the months of Dec. and Jan. at altitude of 5400 metres above sea level and average stream run-off of Baspa river in the month of Dec. from 1966-1992 had

the climate.

Climate of the region: The climate of Himachal Pradesh has a huge variation due to variation in altitudes ranging from 450-6500 metres. The hills are divided into four zones namely Shivaliks, lesser Himalayas/mid-hill zone, Greater Himalayas/ high-hill zone and Trans Himalayan zone. The climatic feature of each zone is described in the Table 1:

gone up by almost 75%. Steady rise in stream run-off of Baspa from 1980 onwards matches with average global temperature rise during the same period. (Kulkarni et.al., 2004). Also analysis of the temperature trend in the Himalayas and its vicinity shows that this phenomenon of temperature increase is greater in the uplands than in the lowland areas. On average, air temperatures in the Himalayas are one degree centigrade higher than in the 1970s rising by 0.06 degree C per year. Regional changes in climate have already affected diverse physical and biological systems in many parts of the mountain regions. Shrinkage of glaciers, thawing of permafrost, late freezing and earlier break up of ice on rivers and lakes, pole ward and altitudinal shifts of plant and animal species, decline in plant and animal population, and early emergence of insects have been observed (IPCC, 2001) [5].

Thus from the above discussion it is clear that the climate of Himachal Pradesh is changing. It is clear from various evidences. The air temperature in the state is one degree centigrade higher than in the year

1970. The average temperature of Shimla has increased by about 1 C during the last 100 years. The average snowfall in the state decreased from 272.4 cm in the year 1976-80 to 77.20 cm in the year 2001-04. 2005-06 went without snow in Shimla. Due to this change there has been a change in other ecosystems as well which is hampering the ecological balance in the state.

According to the personal survey conducted in the district Of Hamirpur on the changes in climate, similar patterns of change were noticed in the view of the local respondents:

On the basis of the questionnaire conducted on the effects of climate change on the temperature pattern, 54 percent respondents reported that there is a sharp increase in temperature while 46 per cent opined that there was a slight decrease in temperature. Similarly in terms of rainfall, 94 per cent respondents said that over the last few years climate change has affected the rainfall pattern with decrease in rainfall while 3 per cent said that rainfall pattern has increased and is nearly same. On account of the maximum effect of climate change that has brought change in the weather seen through increase in temperature, rainfall variability, less snowfall, glacier melting, 21 percent respondents favoured increase in temperature as the most affected condition. On the other hand 14 per cent said rainfall variability, 4 per cent said less snowfall while 3 per cent favoured glacier melting as the most affected sign.

Biodiversity

According to the personal survey conducted in the district of Hamirpur has a total forest land of 25744 hectares. On the basis of the finding from the people the planted vegetation in the district consists of Jamun, Amla, Haradh, Sandalwood, Poplar, Eucalyptus and Reetha. The naturally grown vegetation includes Pines, Mango, Dulburgia, sp. Accia, sp. ficcus. sp. The dominant animal of the region are pig, monkey and fox.

On the basis of the questionnaire conducted 84 per cent of respondents believe that change in climate is due to humans while 16 per cent respondents believed it was a natural phenomenon. The people of the district largely believed that there was lack of public awareness about the issue due to which humans contribute more to climate change. Similarly on asked about the Causes for biodiversity loss, issues like Climate Change, invasion of non natural species, habitat loss, management practices, lack of public awareness, lack of funding are threats came into limelight. 38 per cent of respondents said that biodiversity loss was largely due to climate change, about 27 per cent were in opinion of habitat loss, 30 per cent said it was due to lack of public awareness

while 5 per cent favoured the management practices for the loss

Climate change in Himachal Pradesh: a case study

The Scientists from HP State Council for Science, Technology & Environment [6] collected data on indicators of climate change in Himachal Pradesh as observed by natives belonging to different regions, age groups, professions etc and the following result was founded out. This is again a primary survey done by these scientists and a report on the local opinions of the natives was thus formulated. Some indicators according to them are as follows:

Indicators of Climatic change in Himachal Pradesh

1. Rabi season is forwarded and reduced due to delayed and less rainfall.
2. The yield of wheat crop has reduced owing to high maximum and minimum temperatures during last decade.
3. The demand on irrigation resources is increasing otherwise yield is affected negatively.
4. The area under rice crop diverted to maize due to non availability of water.
5. Incidence of diseases and pests increasing due to rise in temperatures.
6. The soil moisture decreasing and thus demand on irrigation facility increasing.
7. Water sources are drying up.
8. Kikar, Tali (Shisham), Deodar, Ban trees are on decline.
9. Water fowls, ducks, birds, house sparrows, vultures, crows are on decline.
10. Population of honeybees, butterflies is decreasing.
11. Incidences of forest fires are on rise.
12. Incidences of drought and floods are on rise.
13. Pine forests invading heights.
14. Area under apple is being diverted to vegetables owing to global warming

LINKAGES BETWEEN CLIMATE CHANGE AND BIODIVERSITY

Thus from the above discussion, it is clear that climate change is posing a threat to the biodiversity of the region. The Millennium ecosystem Assessment ranks climate change among the main direct drivers affecting ecosystems. The consequences of Climate Change on the species component of biodiversity thus include: Changes in distribution, Migration of species, increased rate of extinction, changes in habitat, changes in reproduction timings, changes in intensity and length of growing season affecting flora, it also poses a threat on the medicinal plants.

On the other hand biodiversity can reduce the impacts of climate change. The human intervention to reduce the green house gas sources or enhance

carbon sequestration while adaptation to climate change refers to adjustments in natural or human systems in response to climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. The conservation of forests is particularly important since they contain 80 per cent of all the carbon stored in terrestrial vegetation. Deforestation and land-clearing activities emit about 1.7 billion metric tons of carbon per year into the atmosphere. Hence, the conservation of forests offers important opportunities to protect biodiversity and slow climate change. Practices like Afforestation, reforestation and reduced deforestation to sequester carbon and reduce emissions should be adopted. In Himachal, many plant species such as Bauhinia Variegata, leucaena leucocephala etc have been used for rehabilitation of mined out and degraded areas. Thus Biodiversity and climate change are closely linked, and each impacts upon the other: Biodiversity is threatened by human-induced Climate Change, but on the other hand, Biodiversity resources can reduce the impacts of climate change on population and ecosystem.

MAJOR FINDINGS

On the basis of the questionnaire conducted in the district of Hamirpur majority of the people blamed climate change as the reason for biodiversity loss. Public awareness about climate change was an important aspect that the people of Hamirpur considered of high importance. On asked about the initiatives that they would adopt or ask the government to adopt to reduce the effect of climate change on biodiversity and to conserve biodiversity, mostly people favored public participation on the issue, afforestation techniques and preventing the forests from fire.

According to the questionnaire the fauna that have become extinct in the region included vultures, hare, leopard, peacock, bulbul, eagle, domestic sparrow, jackal, porkupine. Plant Species of High importance according to the respondents included bamboo, betula, banyan tree harar, behra, tulsi (occissum), citrus, and basil. Woody weeds (bushes) have increased in the area. Ageratum is a weed that has increased its abundance. It degrades the grasslands by out-competing the native grasses. Animal species of high importance included sheep, goats and cow. If this practice continues then in the near future there will be an imbalance in the food chain due to the disappearance of some plants and animal species. Practically, perhaps we cannot stop the global warming or its impacts. But certainly its impacts can be delayed/ slowed down with some sensible and sustainable human interventions. Because it is only the human being who need the biodiversity and not

the biodiversity which needs us.

Suggestions

The suggestions which can be adopted by the government as well as the local community are of high importance. Public participation plays a major role in this field. On being asked about the initiatives from the local people in the questionnaire majority of people said afforestation and preventing forest fires.

For Policy Makers, Government and Planning

Generating knowledge for MAPs and their conservation, Nursery and planting technologies of the species like, Juniperus macropoda, Salix spp., local Poplars, Hippophae rhamnoides, Elaeagnus angustifolia, Rosa webbiana, Capparis spinosa, Ephedera gerardiana, Cratagus sp., Ribes sp., Collutea sp. Caragana sp. etc. can be developed. As these are found in the alpine and arid areas which has thin population and harsh conditions which require specific technology, Documentation of floral wealth and standardization of technologies for eco-rehabilitation and Eco-restoration of degraded forests, Ex situ and in situ conservation should be established.

For Communities/ Local People

Methods such as productivity enhancement through people's participation, Community Based Participatory Programmes for Eco-Development and Conservation, Establishment of demonstration plantations, Eco-restoration models. People can be Involved as a National partner in participatory action research for sustainable forest management through H.P. Forestry Sector Reforms Project. People can develop participatory action research methodology with other stakeholders. Local clubs (eco clubs) should be raised and general awareness should be created among the people regarding the effect of their general activities on the environment.

CONCLUSION

Trees and forests play a very vital role in regulating our climate. Trees remove carbon dioxide from the atmosphere through photosynthesis as they grow and store it as carbon in carbohydrates, lignin and cellulose. The carbon is stored in the biomass- the trunks, branches, foliage, roots etc- and in organic carbon in the soil. In young forests carbon is sequestered at the high rates while in mature forests sequestration slows, respiration and decomposition increase and the carbon balance more or less reaches a steady state. Forests therefore act as our carbon storehouses. When new forests are created, they sequester carbon and become a sink of carbon. But when existing forests are cleared, the carbon is released and acts as a source of green house gases.

Forests can therefore be used as a tool in developing solutions to the problem of climate change. Planting new forests, restoring degraded forests and managing existing g forests using sustainable management practices can all be used as ways to increase carbon sequestration.

A changing climate has strong implications for biodiversity. Studies of fossil and pollen distribution show that species are very sensitive to climate changes. When the climate changes, species often die out in their present areas and colonize new areas. Therefore, as the climate changes in the future, there will be disruption of natural communities and extinction of populations and species. Species track their climatic optima, and retract their ranges where conditions are unsuitable. These shifts are the sum of many local pressures on extinction and colonization due to factors such as physiology and interactions with other species. For plants, increases in heat and decreases in moisture can have direct effects on survival and reproduction. It is unlikely that all species will be able to evolve new tolerances with sudden changes in climate, leading to shifts in community composition and impacts on ecosystem dynamics.

Climate change thus threatens the survival of many species. Species may become extinct due to loss of natural habitats as they are unable to move rapidly enough into new regions. Isolated populations are easily wiped out on Climate Change. Therefore the risk is lower for species with continuous distributions or extensive

Therefore we all need to build on the new momentum. A clear strategic response from the forest sector is mandatory to tackle climate change and to deal with its consequences. Taking action to mobilize resources and develop practical measures to reduce the rate of deforestation, to restore forests in areas where they have been lost or heavily degraded, and to manage the world's forests on a sustainable basis is both essential and urgent. Various measures by the Himachal government have been taken to reduce the effect of climate change on biodiversity. As the chief minister also stated "Himachalis are committed to increase the forest area and also undertake various measures to improve air quality in the region," If the number of herbivores decreases, the carnivores are affected. But only the human species does not contribute to the ecology. If we became extinct, there would hardly be any problems for other species or for the ecology. In fact, most ecological problems will be solved if human become extinct. Arguably human constitute the most intelligent species on the planet. Yet, science indicates that "intelligent human are nothing but a burden on planet. Normally in a

classroom the more intelligent a student, the more potential he has to make a positive contribution.

Thus to conclude, "Technology created crises and Technology can only help in overcoming them"

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