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INFLUENCE OF GLOBAL WARMING ON HIMALAYAN REGION OF INDIA: A REVIEW

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ABSTRACT

Climate change and global warming is adversely affecting the whole world. Himalaya is no exception either. Due to global warming and several human activities in the last 2-3 decades, a number of environmental problems have occurred in Uttarakhand. Increase in the number of landslides, increase in the level of CO_2 on Himalaya, increasing cases of forest fires, alteration in vegetation, upward march of species, warming of atmosphere, adverse effects on biodiversity are some of these problems. Due to uncontrolled exploitation of natural resources, entire Himalayan region including Uttarakhand is facing several types of changes. The present study is an effort to point out the problems faced by Himalaya in Uttarakhand region and finding some solutions and suggestions to handle this grim situation.

Keywords **:** Climate change, global warming, Himalaya, Uttarakhand etc.

Introduction

Uttarakhand is one of the ten Himalayan states of India. Came into existence on 9th November 2000, Uttarakhand is one of the major states of India from the Himalayan Region, which is covered largely by snow clad peaks, dense forests with terrace farming, rich biodiversity, cultural heritage and known as the origin of a number of holy rivers. It is also famous for mountainous communities that are rich in culture and peerless heritage. As the name suggests, the term Uttarakhand means an "area of the north".

This state can be divided into two regions or divisions that are called Kumaon and Garhwal regions. The total land area of Uttarakhand is 53403km2, which is about 1.63% of total area of India. According to the census of 2011, the population of Uttarakhand is 10.1 million. Administratively, the state is divided into 13 districts, 95 development blocks, 7950 village panchayats. There are 16793 villages in the state; out of which, 15745are residential and 1048 villages are unpopulated. According to the census of 2011, more than 80% of the villages of the state have population less than 500. Out of 13 districts of Uttarakhand, 10 are mountainous and 3 are in the plains. The villages Almora, Bageshwar, Chamoli, Champavat, Nainital, Paudi Garhwal, Pithoragarh, Rudraprayag, Tehri and Uttarkashi are mountainous and the remaining districts of Dehradun, Haridwar and Udham Singh Nagar are plainy areas. 48% of the population of Uttarakhand dwells in mountainous areas while the remaining 52% resides in plains. 85% population of mountainous area is rural. The population of Almora and Paudi Garhwal is decreasing.

Like the rest of the world, Uttarakhand is also not unaffected by climate change and its effects. Due to this, several environmental problems have emerged. Rise in temperature, loss of biodiversity, migration, uneven distribution of rains, upward movement of flora and fauna due to pollution, adverse effects on glaciers, forest ecology, plant diversity, infiltration of invasive species and forest fires are some of the vital problems caused in this area. The present study is an effort to highlight these problems and provide some suggestions and viable solutions.

Adverse Impact of Himalayan Ecology

According to the third IPCC Report (2001), climate change will mostly affect the forest ecology in the near future. As per an estimate, the rise in average global temperature in forthcoming years will lead to the alteration of structure of species belonging to most of the ecological regions. Productivity of species and biodiversity will also be affected and this will cause various alterations in different ecologies. It is also evident that several species of plants and animals are moving upward in the hilly areas due to rise in the temperature and those species which are unable to do this are either endangered or are on the edge of extinction. Apart from this, several other changes in the structure and function of various species are becoming apparent because of global climatic changes.

Changes in the Phenology of Plant Species

Due to the effects of global warming, alteration in the phenology of several species is being evident. For example, flowering and fruit ripening are occurring before the expected time period in a number of plant species. For the

last few decades, the study of phenological-climatic activities have proved that the flowering period of many plants and reproduction period of several animal species has extended and this is the result of climatic changes. Such modifications in the phenology of some of these species are assenting on one side as they are capable of changing themselves, but depressing on the other side because it proves that these species are very sensitive to climatic changes. Though not all the species show alterations in their phenology; but it doesn't mean that they are unaffected by the climatic changes. In fact, their population may be under more danger.

The alterations in the phenology of these species with regard to the ecology cannot be described without studying the life of specific species and other aspects of ecological system are also affected by the climate change. If the phenology of any species is changing at a different rate with respect to other species of its ecological system, its timing with the climatic activities will be desynchronized and this desynchronizing of the species with the climate will cause tropical decoupling in the food cycle or food web. This can lead to serious consequences and cause huge loss to the biodiversity.

Infiltration of Invasive Species

Encroachment of some invasive species such as *Lantana, Eupetorium* and *Parthenium* etc. in the natural forests is increasing day by day and this is also related to climatic change. It is adversely affecting the root species of that area. Researchers have found that a number of foreign species are comparatively more successful in with respect to adapting traits for seasonal changes. Contrary to this, the indigenous species are very slow in adapting the changes in climate. Apart from this, the foreign and invasive species are widely adaptive in nature and occur widely in nature. Because of such properties, climate change is unable to affect them significantly. Contrary to this, the local and indigenous species are not spread in a very limited area and this is leading to endangering and extinction of a number of local species.

Effect on plant diversity

Himalaya is home to several medicinal and distinct plants and also the hotspot of global biodiversity. At present, because of climate change, a number of species are either endangered or have become extinct. The species found in Himalayan region are very sensitive to climatic adversaries due to limited and local reach. Because of such reasons, they are about to go extinct. Climate change and indefinite weather conditions have very adversely affected the pollination of species. Due to the changes in the ecological system, a number of pollinating insects such as bees, flies, butterflies, beetles, birds and several mammals have migrated from places of their origin. Scientists have proved that the main reason behind the extinction of several species is the migration of pollinating insects.

Effects on Ecological system

At present, caused by climatic changes, the weather alterations are heavily affecting all the ecological systems directly and indirectly. Because of irregularity of monsoon rains, the crop production is also widely affected. According to a report, in Kullu valley of Himachal Pradesh, the rains have reduced by about 7cm annually as compared from the year 1880 to 1990. For the same period of time, the average temperature has increased from 0.25ºC to 1ºC in the same area. A number of studies have concluded that in Kullu valley, apple production has also went down during the years 1981-2000. The researchers believe that due to increasing temperature, apple crop has also decreased in the lower Himalayan areas having higher temperatures. This has forced the apple producers to take their farming to higher areas. Chilling hours are very vital for the production of apples. Temperature below 5ºC for 10 weeks is essential as chilling hours for the apple crop.

Effects on Glaciers

The structure of Himalaya is very complicated and the mountains are dynamic which are very sensitive towards global warming. The glaciers of Himalaya are the source of most of the rivers flowing in the plains of northern India and these rivers are a huge source of water perennially. According to IPCC, the volume and thickness of glaciers across the world has reduced after 19th century. The reduction in volume and thickness of mountainous glaciers specifically is considered as the solid proof of global warming and a number of researches have proved this as a fact. The study of selected glaciers of Indian Himalaya has concluded that most of the glaciers are shifting from their original places. According to a study, one of the main and important glaciers of Himalaya, Gangotri glacier was measured to be about 25 kilometers in 1930, which was again measured to be only 20 kilometers in 1999. Because of climatic changes, the Himalayan glaciers are shifting back at a rate of 10-60 meters every year and a number of comparatively small glaciers (less than 0.2 Km^2) have already been completely vanished. During the last 50 years, the vertical shifting of glaciers is found to be up to 100 meters. Due to the shifting and melting of glaciers, the number and size of lakes in the related area is also increasing. This rapid development of lakes is increasing the threat of floods which has proved to be very hazardous in the previous years.

Rise in temperature

The global temperature rise is estimated to be 1.4-5.8º C for the next 100 years. The destructive results of this climatic change have already become obvious in the Himalayan region where glaciers and lakes are changing at a dreaded rate. Gangotri glacier is shifting back at the rate of about 18 meters every year. Shukla and Siddique (1999) have regularly studied the Milam glacier in Kumaun Himalaya and concluded that the snow in this glacier has been shifting back at the rate of about 9.1 meters per year between the year 1901 and 1997. During a study, Dobhal *et al*. (1999) found that the peak of Dokriani glacier in Garhwal Himalaya has shifted about 586 meters from 1962 to 1997 at a rate of about 16.5m per year. Apart from this, Mainti (2000) found that the same glacier shifted backward by 20 meters in the year 1998 only. The rate of melting of glaciers has increased by 10% and 30% in western and eastern Himalaya respectively which has caused the flow in the related rivers to go up by 3-4%. Because of increased flow in the plains, the number of cases of floods in this area is increasing day by day which has caused huge loss of life and property in vast areas of Uttar Pradesh, Jharkhand, Bihar and Odisha. Contrary to this, during the last few decades, the number of cases of irregular rains has also increased very much which has reduced the quantities of water in mountainous springs and waterfalls.

Similarly, the winter rains has also become unprecedented and reduced by a huge margin. A survey has revealed that about 45% waterfalls of water receiving areas of Gaula Riverin the midle Himalaya have either dried up or have become seasonal. As a result, floods and droughts both are affecting the infrastructure and livelihood of people.

Pattern change in rainfall

The adverse effects of climate change on the patterns of temperature and rainfall have been published in various esteemed journals by several researchers. For example, Bhutiyani *et al*. (2010), in the data (1866-2006) provided by three weather stations of North-Western Indian Himalaya, found that the average monsoon rainfall has decreased. Apart from these, several other published journals have discussed about the variations in the winter rainfall of Western Indian Himalaya. Dimri and Dash (2012) have described the lessening of coldness of winter season in this region from1901-2003.

According to Guha Thakurta and Rajeev (2008) an increase has been recorded in the pre monsoon (March-May) rains in Western Indian Himalaya. In this region, an increase in the number of hot days and a decrease in the number of cold days were reported from 1975-2006. By the weather data of Indian Weather Department from 2004-2012, it is evident that average rainfall and seasonal rainfall has remained very low excluding the year 2005.

Forest fire

Forest fires in Uttarakhand have been damaging the environment for several decades. The fire caused in the year 2012 was very deadly and covered a massive area of the forest. In the last decade, nearly 700 incidents of forest fire were reported burning forests expanding in vast areas of the state. Recurring forest fire has been a common phenomenon in any forest for a long time, but for the last 10 years, their frequency has increased in Uttarakhand. Additionally, these fires are not only impacting one state, but are also damaging the ozone layer, releasing toxic fumes and ultimately causing global warming and climate change across the world. Thus, counting some direct causality is not enough to measure the impact of toxic smog created by the forest fires. It is obviously the duty of every Indian to work for preventing the incidents of forest fires.

Effect on Socio-economic systems

Because of climate change, the socio-economic system of the people residing in the Himalayan region has been shattered. Economic activities in this region such as agricultural, cattle rearing, trade, tourism, fisheries etc. have been adversely affected in this area along with harmful effects caused to human health and natural resources. Due to climate change, the loss of biodiversity is causing poor and deprived sections of the society, because their livelihood is mostly dependent on the natural resources. The climate change is also affecting agricultural sector and this is causing a reduction in the production of cash crops such as rice, maize, barley etc. Offensive insect species are increasing in the fields to only affect the crop production.

Diminished production of fodder seedlings has caused a reduction in the income by cattle rearing and other related jobs. On the other hand, the change in the flowering time of crops like Saal, Amla, Maize etc. has caused a change in the time of seeding, ripening and maturing of several crops. This has forced a lot of people to leave farming as their livelihood and search for other means of earning.

The decline in production of agricultural crops because of climate change has brought with it a huge problem of food shortage to the people. As a result, people are suffering with disease as well as malnutrition. Apart from this, there is a wide range of health problems caused by the climate change in Himalayan region. The threat of several vector borne diseases such as malaria, bortonalasis, tick borne disease etc. has been very much increased. Some scientists have used the statistical model in their studies to conclude that climate change is highly affecting the vector-borne diseases.

With the increase in surface temperature and the irregularity in rainfall patterns, a change in the dispersal of vector-mosquitos and species has occured. Now higher areas are also affected by the mosquito attacks. Temperature rise in higher areas is providing appropriate atmosphere for the malarian protozoans resulting in higher population of mosquitos. Apart from these, an increase in cases of problems related to menstruation and vaginal infection in women along with skin and eyes related problems in children has also been reported.

Conclusion

The data of climate for the last 100 years has proved that global surface temperature of earth has increased by about 0.6 ºC. Apart from this; the temperature of earth is estimated to increase by about an average of 1.5 the end of this century, which is more than any time period since the last 1000 years.

In 1832, the concentration of CO_2 in air was about 284ppm, which now has gone up to 407ppm in the year 2016.Increase in the levels of greenhouse gases, especially in CO_2 is highly responsible for global warming and changes in rainfall patterns and other factors of the climate. In the current scenario, the researchers and policy makers related to Himalayan ecological system need to work in the field of climate change. This field has a wide scope.

The basic data of Himalaya is not available yet. The number of weather stations for collecting weather related data is very limited. Weather data is very significant and essential for presumption of sudden climatic consequences. For solving the problems such as drought and floods, a deep research is needed in the field of hydrological modeling.

For food security by rising temperature, incidences of uncertain rainfall and snowfall, new types of seeds must be developed. Apart from this, the construction of housing complexes, colonies and corridors has lead to the migration of indigenous species. The government and policy makers need to make a effective policy over this issue. The people of Himalayan region have made moderate changes in agricultural patterns according to the need of time and place. For example, the dwellers of Champavat district have substituted rice farming with Soyabeans. Similarly in high places, plants of peas, cauliflower, cabbage etc. are grown in kitchen gardens.

Strong will power of the people, sensitivity of common people regarding environment, formation and implementation of strong laws by governments and policy makers etc. are all vital for solving the problems of Himalayan ecological system caused due to climate change and everybody needs to take part in it for attaining a significant success.

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