IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Climate Change And Its Impact On Agriculture, Horticulture And Forestry In Himachal Pradesh

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Abstract

Due to the delicate ecosystem and the sensitive Himalayas, the impacts of climate change are significantly more noticeable in Himachal Pradesh. The Himachal range is therefore a good proxy for climate change. The three primary industries – forestry, horticulture and agriculture are the backbone of the state as they have a direct or indirect impact on the national economy. Scientists and researchers are trying to identify the causes and variables behind the shift in these industries. Research from various industries has shown that large and sudden changes, including shifts in snowline, timberline, apple belt and cooler variations, among others, have a direct impact on apple quantity and quality. Numerous data from these researches indicate that the climate of the state of Himachal Pradesh is changing. However, there is a serious lack of observational data on the effects of climate change on ecosystems and biodiversity in the Himalayan region, which includes the Himachal Himalaya. However, using previously available data, the database needs to be strengthened and holes filled. The more reliable the outcomes, causes and patterns of climate change, the more climate data related to different sectors are available, which can help in future model predictions in the state.

Keywords: Climate Change, Ecosystem, Agriculture, Horticulture, Forestry and Productivity.

Introduction

Changes in average conditions in an area over a longer period of time, such as temperature and precipitation, can be explained by climate change. For example, 20,000 years ago, glaciers surrounded much of the United States. The United States today has fewer glaciers and a cooler climate. The term "global temperature change" describes long-term average changes around the world. This includes changes in precipitation and climate patterns, as well as the fallout from global warming, which includes rising sea levels, retreating mountain glaciers, earlier-than-usual ice melting in Greenland, Antarctica, and the Arctic, and altered flowering and planting times (Climate Kids, 2020). The World Resources Institute Climate Analysis Indicators Tool (WRI CAIT) reports that 68.7% of India's total emissions in 2014 came from the energy sector, which dominated the country's greenhouse gas profile (WRI CAIT 4.0, 2017). In the energy market, the production of electricity and heat accounted for 49% of emissions, with the majority (24%) coming from manufacturing and construction. Enteric fermentation accounted for 45% of agricultural emissions, making agriculture the second largest cause (19.6% of total emissions) (FAOSTAT, 2018). Industrial Processes (IP), Land Use Transition and Forestry (LUCF) and Waste contributed 6.0 percent, 3.8 percent and 1.9 percent to gross pollution in 2014. Three major phases of climate change effects are

observed worldwide. Global temperature changes will affect physical, biological and human processes. The definition of normal temperature for the entire globe may sound unusual. After all, the highest and lowest temperatures on Earth are likely to be more than 100°F (55°C) apart at this point. Temperatures vary from night to night and from seasonal peaks in the Northern and Southern Hemispheres (NOAA, 2020). This means that some areas of the planet are quite cold while others are quite wet.

Mountain or Himalayan Ecosystem

Mountains are among the most fragile ecosystems and are the most vulnerable to catastrophic accidents. If the mountains deteriorate or refuse to offer critical resources, the costs can be high. However, these guidelines are not adequately reflected in regional, national and international policies and priorities (Pandey, 2012). Melting glaciers are also the biggest issue for climate change in the Himalayas. However, one-tenth of the world's known high-altitude insects, animal species and half of India's native plant species are also present in this area (Padma, 2014). Himalayan habitats are expected to be highly vulnerable in the potential climate, Chaturvedi et al (2011). As part of the Himalayan mountain ecosystem, Himachal Pradesh is home to a large number of natural resources. The state has special forests and diverse ecosystems with significant altitudinal differences. Any change in temperatures or rainfall patterns can adversely affect the entire ecosystem. Additionally, Himalayan ecosystems are highly vulnerable due to stress from forest land diversion, increasing human pressure, natural resource extraction, infrastructure growth, mining and other related challenges. The effect of these existing stressors is likely to be amplified by climate change, which would be another, Ravindranath et al (2006). A study of temperature patterns in the Himalayan region shows that temperature changes are greater in the highlands than in the lowlands, Shrestha et al (1999). Observed impacts of historical patterns include migration of apple orchards to higher elevations, disappearance of some tree species, drying up of conventional water supplies, improved bird species and populations, and reduced crop yields and increased susceptibility to winter planting due to shifts in rainfall patterns and planting dates (Asian Development Bank , 2010). District-level mapping of Himachal Pradesh using a combination of biophysical, social and engineering measures (1960–1990) shows lowest adaptive capacity of Chamba and Kullu and maximum adaptive capacity for Kangra, Hamirpur, Una, Solan and Sirmour districts, O. 'Brien et al. (2004). Hamirpur, Una, Solan, Bilaspur and Sirmour districts have been identified as highly exposed and vulnerable to climate change, while Kullu and Shimla have a moderate degree of exposure, Upgupta et al (2015).

Agriculture

Agriculture in Himachal Pradesh is a way of life for the rural community. It is the basis of the state economy and the primary livelihood of the people in the state. Himachal Pradesh's economy is primarily agro-pastoral and predominantly rural, with more than 92 percent of the population living in villages directly or indirectly dependent on agriculture and related activities (Sarial, 2019). Agriculture is the primary occupation of the people of Himachal Pradesh and it is the only state in the world with 89.96 percent (Census, 2011) of its population in rural areas. Dependence on agriculture/horticulture is also prevalent as it offers direct

employment to nearly 62 percent of the total population of the state (Economic Survey H.P. 2018-19). Climate change is one of the most important environmental problems facing humanity, with implications for food development, natural resources, fresh water availability and health, etc. Human behavior is allowing the temperature of the planet to rise (IPCC, 2007 and Liverman, 2007, 2008). Agricultural production in general could decline by 10 to 25 percent by 2080, and the yield decline in rainfed agriculture could be as much as 50 percent (Cline, 2007). Wheat is the most vulnerable crop that can be affected by climate change, especially the rainfall pattern of the rabies season, as more than 80 percent of the area where this crop is grown receives rain. A direct relationship between rainfall and wheat production has been clearly established by Sharma et al (2011). Over the past 38 years (1975-2013), the number of cold nights in the months from December to February has decreased and warm nights have increased. Similarly, in the last 46 years (1964 - 2010), the annual rainfall increased until 1986 for 22 years and then started to decrease. In the period from 1964 to 2000 (36 years), there were 16 droughts, of which 5 were major droughts. In all zones, the temperature is rising, the snowfall is decreasing. In high hills in the temperate dry zone, rainfall increases and snowfall decreases, causing further landslides due to loose layers (Sarial, 2019). Currently, the productivity of cereals in Himachal Pradesh is falling below the national average. Wheat productivity in the state is in the range of 2 tonnes per hectare as against about 3 tonnes per hectare nationally. Similarly, for rice, productivity at the state level is around 1.5 tonnes per hectare compared to 2.4 tonnes per hectare at the national level. However, Himachal Pradesh has a comparative advantage in vegetable crop productivity of 19.3 tonnes per hectare compared to the national average of 17 tonnes per hectare. This clearly shows the opportunities for diversifying agriculture by increasing the area planted with vegetables. Climate variability in Himachal Pradesh has a clear impact on crop productivity, shift of apple belt to higher altitude and lower apple area replaced by vegetables (Rana, 2011).

Horticulture

Horticulture has emerged as one of the potential sectors in accelerating the growth of the state economy and increasing the income of farmers. Nature has endowed Himachal Pradesh with a wide range of agro-climatic conditions due to which there is a huge potential for the cultivation of high-value horticultural crops. The Government of Himachal Pradesh is aware of the potential for development of horticulture in the state and considers horticulture as a priority area in development plans. It is a matter of great satisfaction that due to the pragmatic policy adopted by the state government and unequivocal acceptance of the development programs by the farmers, the state has achieved a transformation in the horticulture sector in the last fifty years. Majority of the farmers in the many suitable areas of the Himalayan region grow major tropical and temperate horticultural crops and vegetables commercially. The main tropical fruit crops in the Himalayan region are citrus, mango, litchi, pineapple, guava and papaya and some temperate fruits such as apple, plum, peach, walnut and pear. Apple is the primary fruit crop of Himachal Pradesh and has emerged as a dominant cash crop in fruit crops in recent years. The apple alone accounts for 46 percent of the total area planted with fruit and 76 percent of the total fruit production. The area under apple trees increased from 400 hectares in 1950–51 to 88,560 hectares in 2005–06. (Anonymous, 2006). The harvest itself amounts to more than 987 million crowns of gross domestic product. Production volume was stable at 540.30 metric tons with a

productivity of 5.6 tons in 2006. (Anonymous, 2006a). The required cooling hour for a common apple variety is 800-1100. (Byrne and Bacon, 1992). Apple production has been steadily improving but production has been declining at the rate of 0.016 tonnes per hectare per year (Vijayshri Sen, 2010). The causes attributed to it were climate fluctuations, soil, crop improvement, etc., primarily productivity-reducing variables, climate was difficult to control. Climatic changes in the form of irregular rainfall, rise in temperature, shorter days used as a cooling period began to affect the strong agricultural production systems in the hills and ultimately the food stability of the people. Due to declining apple production, a change in crop trend from apple to pomegranate and vegetables was noted in Himachal Pradesh, Gautam et al (2014). The Himachal Pradesh Center for Climate Change (HPCCC) has conducted a number of studies to assess the impact of climate change on horticultural crops in various regions. Many slow-growing fruit crops require large investments in orchard development. Rapid change/shifting of fruit species or varieties will be a challenging and painful losing exercise under the influence of climate change which may hinder growth. Recent findings have shown that in Shimla district, orchards at relatively higher altitudes have been replaced by high-chilling orchards that require low-chilling apple cultivars (Royal Delicious) that require cultivars and other fruit crops such as kiwifruit, pears, peaches and plums and vegetables. In the center of the hills of Shimla district there is a tendency to completely change the cultivation of apples and potatoes. This is supported by the declining trend in snowfall and apple productivity in Himachal Pradesh. Apple development decreased from 10.8 to 5.8 tonnes per hectare, Awasthi et al (2001). Because many crops with chilling requirements are woody, processing areas are difficult to transfer. For example, when replanting orchards and plantations over the next decade, it may be wise to choose low-chilling forms to replant. This is just one example of the impending consequences of global warming and environmental change.

Forests

The forests of Himachal Pradesh play a key role in the special western Himalayan ecosystem, maintaining the dignity of the upper basins of India's five major rivers (Chenab, Ravi, Beas, Sutlej and Jamuna), sustaining the agro-pastoral livelihood of the mountain peoples and balancing the economy of this small hill state. The forest cover in the state is 15,433.52 square kilometers, which is 27.72 percent of the state. In terms of forest canopy density classes, the state has 3,112.71 square kilometers under very dense forest (VDF), 7,125.93 square kilometers under medium dense forest (MDF) and 5,194.88 square kilometers under open forest (OF) . (ISFR, 2019). According to the Intergovernmental Panel on Climate Change (IPCC, 2014), climatic and non-climatic pressures are expected to have a significant impact on forest environments in the 21st century, causing widespread habitat destruction, biodiversity loss and reduced ecosystem services. In a study, roughly 20 to 30 percent of plant and animal species would face a high risk of extinction if the global average temperature increase reached 2-3 °C above pre-industrial levels (Fischlin, 2007). Several researches have been conducted recently to determine the impact of climate change on the forest environment in India, for example Chaturvedi et al (2011); Gopalakrishnan et al (2011). However, most of these studies neglect to assess the expected growth at the regional level Upgupta et al (2015). In the Himalayas, there is a distinct lack of systematic research and observational findings on species-level impacts of climate change Gautam et al (2013). Few available studies address the predicted sensitivity to temperature.

One example is recent research that notes a decline in apple productivity in some parts of Himachal Pradesh because the chilling requirements necessary for proper flowering and fruiting are no longer being met.

Impact of Climate Change on Agriculture, Horticulture and Forestry in Himachal Pradesh

Majority of the farmers in the many suitable areas of the Himalayan region grow major tropical and temperate horticultural crops and vegetables commercially. The main tropical fruit crops in the Himalayan region are citrus, mango, litchi, pineapple, guava and papaya and some temperate fruits such as apple, plum, peach, walnut and pear. Apple is the primary fruit crop of Himachal Pradesh and has emerged as a dominant cash crop in fruit crops in recent years. The apple alone accounts for 46 percent of the total area planted with fruit and 76 percent of the total fruit production. The area under apple trees increased from 400 hectares in 1950–51 to 88,560 hectares in 2005–06. (Anonymous, 2006). The harvest itself amounts to more than 987 million crowns of gross domestic product. Production volume was stable at 540.30 metric tons with a productivity of 5.6 tons in 2006. (Anonymous, 2006a). The required cooling hour for a common apple variety is 800-1100. (Byrne and Bacon, 1992). Apple production has been steadily improving but production has been declining at the rate of 0.016 tonnes per hectare per year (Vijayshri Sen, 2010). The causes attributed to it were climate fluctuations, soil, crop improvement, etc., primarily productivity-reducing variables, climate was difficult to control. Climatic changes in the form of irregular rainfall, rise in temperature, shorter days used as a cooling period began to affect the strong agricultural production systems in the hills and ultimately the food stability of the people. Due to declining apple production, a change in crop trend from apple to pomegranate and vegetables was noted in Himachal Pradesh, Gautam et al (2014). The Himachal Pradesh Center for Climate Change (HPCCC) has conducted a number of studies to assess the impact of climate change on horticultural crops in various regions. Many slow-growing fruit crops require large investments in orchard development. Rapid change/shifting of fruit species or varieties will be a challenging and painful losing exercise under the influence of climate change which may hinder growth. Recent findings have shown that in Shimla district relatively higher altitude orchards have been replaced by high-chilling orchards that require low-chilling apple cultivars (Royal Delicious) that require cultivars and other fruit crops such as kiwifruit, pears, peaches and plums and vegetables. In the center of the hills of Shimla district there is a tendency to completely change the cultivation of apples and potatoes. This is supported by the declining trend in snowfall and apple productivity in Himachal Pradesh. Apple development decreased from 10.8 to 5.8 tonnes per hectare, Awasthi et al (2001). Because many crops with chilling requirements are woody, processing areas are difficult to transfer. For example, when replanting orchards and plantations over the next decade, it may be wise to choose low-chilling forms to replant. This is just one example of the impending consequences of global warming and environmental change.

Conclusion

The lower and middle atmosphere, where almost all weather occurs, warms due to the greenhouse effect. Evaporation and air moisture content increase with increasing temperature. Water vapour is a greenhouse gas, so this process is a self-reinforcing feedback loop. Excess water vapour is also trapped during thunderstorms. This makes them more intense, bigger and potentially longer lasting. This in turn causes the rain and snow to intensify and lead to an increased risk of flooding. Extra drying aggravates natural dryness and drought. This increases the risk of heat waves and forest fires. Scientists have identified human activities as the cause of recent climate trends. They are now able to estimate the impact of climate change on extreme weather events. They call this process attribution of extreme events. For example, such research might examine historical data for a particular region and conclude that a particular heat wave has been more intense as a result of climate change. In addition, shifts in the start of the season and changes in the length of the season have been reported in many regions of the world. As a result, the timing of extreme weather events such as heavy rainfall and heat waves changes in tandem with the shift in season. There is no doubt that various studies (related to climate change) witness that the climate of Himachal Pradesh is changing. The studies selected in Himachal Pradesh to analyze the impact of climate change on various sectors (agriculture, horticulture and forestry) are limited to a specific region of the state. Hence, there is a significant need to cover those areas of the state which are also facing serious climate threat to create and enhance a solid picture of climate change in Himachal Pradesh. Another problem we face in assessing the impact of climate change in Himachal Pradesh is missing data (missing sites, monitoring and maintenance problem, etc.). However, with the available data and aberrations, it is difficult to predict the state of climate change. Therefore, there is an urgent need to create baseline data where we are facing challenges and complement this data with pre-existing data to project the overall climate scenario in the state.

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