Climate Change and Its Impact on Forest Quality: A Review

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Abstract
As a result of climate change, temperature, rainfall and carbon dioxide are altering forests and livelihoods of their inhabitants, especially tribal communities in India, our review examines recent studies that discuss changes in the forest environment. The study attempted to answer following research question**;** how climate change effects of forest quality, forest-based livelihoods, and tribal community? It focused on the direct and indirect effects of climate change on the forest industry, in order to translate their results into reducing the social and economic effects of climate change on forest dwellers.

Keywords: Climate change, Forest quality, Forest-based livelihoods, Tribal community.

INTRODUCTION

Climate change is manifested in several forms according to the country (pattern of rainfall and the difference in temperature), and there are also differences between the population according to their vulnerability to climate change and their economic and social characteristics (Davidson et al., 2003).

There are three important factors which determine livelihood vulnerability: exposure, sensitivity and adaptive capacity. Exposure refers to the fact that certain properties, systems, people, etc. are present in hazardous locations where they may be subject to damage or loss (Ghimire et al., 2010; Mwatu et al., 2020). Rainy seasons bring about exposure to rain variability through the timing of rain events, the length of time between rain events, the frequency of rain events and the length of dry spells during a particular rainy period. A sensitivity measure indicates how sensitive an object or person is to certain risks in their environment. It's defined as the ratio between change and the magnitude of an effect (Paavola, 2008).

Socio-economic factors play an important role in determining whether someone is at high or low exposure to the risks associated with climate change. Adaptability is the degree to which an individual or organization can respond effectively to extreme changing conditions. Determining vulnerability assessment is dependent upon both the risk analysis and research frameworks selected by researchers (Adger, 2006). It was developed by combining different fields including disaster response geosciences, meteorology, sociology, anthropology, environmental science, and economic sciences.

Vulnerability stems from exposing hazards to community members' current means of earning income and their responses to them by taking action to protect themselves (Holzmann, 2008). If farming communities are vulnerable to a given risk, their vulnerability will be determined by the actions they take after exposure to that risk. The integrated approach is an important part of the IPCC (Integrated Planning for Climate Change) approach. Vulnerability is defined by the Intergovernmental Panel on Climate Change (IPCC) as "the likelihood of experiencing negative consequences due to exposure to hazards (IPCC, 2014). Vulnerability is considered from two perspectives: externally (environmental exposures) and internally, related to humans (sensitivities and adaptive capacities).

The impact of climate change on the livelihood and survival strategies of the rural population in India is now certain to vary, depending on the region, climate variability and extreme weather events. In the case of the indigenous people who live in forests and depend on them for their livelihoods, differences in temperature and rainfall patterns naturally affect the forest ecosystem and directly affect these communities (Naidoo et al., 2013).

Generally speaking, climate impacts are likely to be most severe for low-income households in rural regions of India wh o rely heavily on forests for their livelihoods. The uncertainty regarding the extent of the consequences of exposure has not been sufficiently understood due to insufficient knowledge of the impacts of changes in temperature and precipitatio n patterns on forest ecosystems.

As in most parts of India, forests play an important role in the lives of millions of people in the country. Rural Indian families and a large number of urban homes rely heavily on forests for sources of sustenance and economic activity. For centuries, forests and their by-product have provided significant benefits for poor people living in rural communities.

Compared to woody products, non-wood forest products are likely to experience a greater degree of impact from climate changes. Indirect and direct effects of climate change are experienced by both woody and non-woody forest products. It is clear that forest ecosystems have a great deal to do with the climatic conditions and human interference that determine their ability to continue to provide sustainable goods and services, that are essential to rural livelihoods and welfare (Sonwa et al., 2012).

Not only could climate changes affect the forests and agriculture sectors, but they may also have serious repercussions on other sectors that are either directly or indirectly related to these two sectors. This means that, due to the backward and forward links between different sectors, when one sector is volatile, it can cause other sectors to be unpredictable. (Birkmann, 2006).

METHODOLOGY

This study reviews the relevant literature using; 1) climate change effects on forest, 2) climate change, forest-based livelihoods. A systematic review of the literature has been done, where the research article followed different criteria to review the existing body of knowledge (Table 1).

Table 1: Criteria followed by researcher to cover the research question.

Criteria	Details	Reasons
Data base	Scopus, Web of science with reputed journals	Literature review will be more comprehensive
Time period	Updated articles	To include the study of all ancient and modern concepts.
Terms included in search	“Climate change adaptation and forest”; “Climate change and forest”; “Climate change and Forest based livelihood”; “Climate change and livelihoods”; “Climate change and tribal community in forest”	To collect all research papers related to the research.
Potential audience of this review	Scholars, policy makers, students who interest on this subject	Knowing the target audience will help determine the objectives of the study.
Type of documents	Article, reviews, reports, books…etc.	Different types.

LITERATURE REVIEW

1. Climate Change Effects on Forest

1.1. Temperature, precipitation concentration change

Studies have proven that the change in temperature and rainfall in the long term has a significant impact on forests and the presence of a double layer of carbon dioxide (Diffenbaugh, 2009; Solomon & Kirilenko, 1997).

The distribution of vegetation cover has been modelled through multiple studies, and there has been an expansion in the migration of some species as a result of climatic changes and an increase in the speed of migration of these species and the gradual disappearance of some of them (Kirilenko & Solomon, 1998; Malcolm et al., 2002).

One researcher emphasized the rapid migration of trees (Clark, 1998). Regardless of the different effects of changes in temperature and precipitation, the rate of forest growth is increasing, but in general the distribution in land uses and plant species is the result of climatic changes and their effects (Caspersen et al., 2000).

1.2. Climate change and forest quality

1.2.1. Fires, insects, pathogens, and extreme events

Climate changes such as changing the frequency and intensity of fires, and extreme events such as high winds may have led to the spread of insects and pathogens in forests (Davis & Holmgren, 2001, pp. 1990–2000).

1.2.2. Change in supply

Different yield models showed that climate change significantly affected the yield volume of global timber production as it affected location changes and increased vegetation cover. This was accompanied by a warmer climate and a high concentration of carbon dioxide in the atmosphere, which led to a decrease in timber prices in the market and an impact on supply (Perez-Garcia et al., 2002).

1.2.3. Change in demand

Huge pressures faced by the timber sector as a result of the increasing demand for the use of charcoal wood and its use as one of the alternative energy sources, in particular, with the lack of energy resources from oil derivatives (Solberg et al., 2003).

1.2.4. Timber production

The change in the uses of wood and the purpose of its production is the biggest problem facing the future trend, and supplying wood away from the tropics and temperate regions is also a new and rising trend (Sohngen et al., 1999).

1.2.5. Stream water quality in forest

Climate pattern changes, including shifts in precipitation rates and temperatures, can significantly affect the water bodies' qualities and their composition. During storm events, changing hydrology, and increased surface temperatures within watersheds may result in changes in the chemical and biological properties of these waters. Leading to situations where the ecosystem exceeds its threshold for tolerating certain types of pollution. Water-related issues tend to be most pronounced when there are periods of drought, which often coincide with times of increased temperatures. These reactions could potentially affect the quality of drinking and irrigation water (Murdoch et al., 2000, p. 1; Rosén et al., 1996).

1.2.6. Physical quality of forest soils

Climate change affects the soil content of carbon (C) in forests by changing the rate at which trees take up gases from the atmosphere (CO_2) and release gases into the air (CH_4). However, the exact nature of these changes remains unclear. A general rule of thumb is that warm soil temperatures generally result in faster decomposition rates for organic materials. However, there are other factors that affect microbial activity, so predicting which effects will be present in any particular situation may not always be easy (Burger & Kelting, 1999; Schoenholtz et al., 2000; Swift et al., 1979).

1.2.7. Wood fuel consumption, institutional quality, and forest degradation

As more greenhouse gases are being added to our atmosphere, they are likely to cause variations in the rate at which trees grow, and an overall change in the quality of the wood they produce (Niklaus & Falloon, 2006; Sulaiman et al., 2017).

1.2.8. Air quality

According to IPCC (Intergovernmental Panel on Climate Change) reports it's predicted that the climate will continue to warm, but at different rates across the region, resulting in increased temperatures, altered rainfall patterns, greater occurrences of extreme weather events, and increasing concentrations of carbon dioxide and ozone in the atmosphere (Carvalho et al., 2011; Pachauri et al., 2014).

2. Climate Change, Forest-Based Livelihoods

2.1. Factors influencing vulnerability of forest-based communities to climate change

"Livelihoods" means the different types of jobs and ways people get paid for. Rural livelihoods are central to any analysis that focuses on understanding the impacts of global warming in rural communities. Different types of forests have different levels of vulnerability, which would mean that the people who rely on those forests for their livelihoods would have to use different strategies. This implies that some ways of making a living may be more likely to be affected by climate change. In light of this, climate risk may therefore be higher with some livelihood strategies (Somorin, 2010).

In rural communities reliant on forests, climate variability and change are not the only factors affecting their vulnerability. It is likely that the susceptibility of one system will have an impact on the sensitivity of other systems, due to the extensive interrelationships between forest and human systems (Shah et al., 2013).

Weak infrastructural and logistical support (e.g., poor roads) for rural communities may hinder sustainable natural resource use and land stewardship in remote regions, including forests, thereby increasing their vulnerability. Climate change is likely to affect household incomes and living standards, and these effects could be exacerbated by rising inequality of economic status , due to their inability to adapt to changes in weather patterns (Thomas et al., 2007).

2.1.1. High dependence on forest resources

Compared with most urban communities, The majority of rural communities in India have poor governance structures, government services, and employment opportunities, resulting in a high dependency on forest resources for income and survival (Agrawal, 2015). Due to their reliance on climate-sensitive forest resources and livelihood occupations, these communities are at increased risk from climate variability and change like temperature and rainfall, thus they could lose their livelihood occupations if the forest changes.

The rapid spread of deforestation and degradation of forests in the area are evidences of using forest resources unsustainably by local communities due to the current methods of harvesting and utilizing forest resources in these communities. Furthermore, deforestation and forest degradation are now so widespread that they pose a significant threat causing serious economic hardships concerning the progress and degrading rural wellbeing (Kauppi et al., 2018).

Fisher et al., (2010) found that people who rely heavily on forest resources tend to be poorer and live closer to their natural environment than others. They also have lower education levels and are more likely to be conservative and fearful of environmental changes. So, they have lower adaptive capacities to environmental changes.

2.1.2. Unemployment and poverty

Since the local economy is not strong enough to provide people with well-paying land stable jobs, most rural households struggle with low incomes. As a result, rural communities suffer from high levels of poverty. Many rural residents are dependent on government support, for example social grants, for their incomes due to inadequate employment opportunities. Leading to seasonal income generation and informal trade in agricultural and forestry products. This what makes rural people are less able to cope with climate-related and socioeconomic stresses in rural areas due to these factors that are contributed to poverty (Barjis et al., 2013)

2.1.3. Population pressures

Forests are being harvested more often and new farmland is being cleared to meet the growing population demand. Furthermore, a greater than 85 percent share of rural lands are occupied by commercial farmers, restricting access to rural households who wish to grow their own crops. Climate change is made more vulnerable by all of these factors, which contribute to increased soil degradation (Madzwamuse, 2010).

2.1.4. Poor healthcare service facilities

Recent medical advancements in India have improved access to primary care, there remain disparities in the availability of medical care across regions. There is still a need to develop health care facilities in rural areas, and rural hospitals and clinics are often inadequately equipped and understaffed (Balarajan et al., 2011).

In his study , Lu, (2012) noted that household members who experienced multiple deaths within the last two years were found to be at greater risk of dissolving into single parent families, migrating out of their communities, and falling into poverty.

Many rural communities lack healthcare facilities, which in combination with social and economic status of people could hinder rural development and well-being. Climate change would probably be exacerbated as a result.

2.1.5. Inadequate formal skills

Rural farmers in India usually don't have the necessary education or skill sets to generate an additional source of income from non-agricultural /non-forestery activities (Sharma & Deppeler, 2005). A large portion of community members depend on forests for their survival, ranging from gathering firewood and other products from the forest, to making charcoal out of them. These practices result in deforestation.

2.1.6. Inadequate skills and capacity for forest management

It is important to adapt effectively to climate change if we want to avoid its worst impacts. However, effective adaptation requires adequate capacity in terms of knowl-edge, information, infrastructure, and skilled people. There is a need to develop appropriate policies and strategies at different levels, from local communities to national governments. One of the major reasons behind the vulnerabilities of rural communities is an absence of appropriate institutional frameworks and social policies which prevent people from managing their resources sustainably (Hachileka, 2009).

2.2. Climate change and tribal communities

Climate change is one of the important issues at the global level, as it affects the geographical distributions of endangered plants and animals and limits their natural habitats. The results of the research indicated that in India it is expected that there will be significant climatic impacts and geographic shifts of species and their distributions (Khanal et al., 2022). India is suffering from climate change, where there is an increase in green gas emissions above India, the important one is water vapor, which leads to enhanced temperature degrees. It's found there are changes in high troposphere layer above India between 30-60 Kgm/m2/year (Patel & Kuttippurath, 2022). Carbon dioxide in the atmosphere over India also contributes to climate change, as it is mainly emitted from burning fossil fuels. The role of tree biomass in carbon cycle regulation (Mandal et al., 2022).

In India, severe deviations in the amount of rainfall were observed, as the results showed an increase of 10% in the rates of seasonal rainfall, and it was also found that there is an increased risk associated with a significant shift from days with light rain to days with moderate or heavy rain, and this warns of the occurrence of extensive floods Scope and significant impacts on Indian food production and overall domestic outcomes (Katzenberger et al., 2022).

Black carbon and organic carbon are considered one of the main causes of climate change, as they contribute significantly to it in India, especially in air pollution and the impact on human health, as well as on forest fires and agricultural land. Carbon dioxide is quite high (Karthik et al., 2022).

Higher rates of fire activity could have serious effects not just on rural communities reliant on timber production, but also on India's relatively small wood products industry. They would affect India's economy because they would harm its forests, which contribute about 1.7 percent of GDP. From sawn timber, panels, wooden furniture, plywood's, to veneers, paper, bamboo, rattan ware, and pine resins India has a rich history of producing wooden and non-wooden forestry products (FAO, 2022).

According to Forest economic survey in India (2019), On the basis of Indian government's records 54.45% of forests are subject to occasional fires, it is common for forests suffer from a wide range of fires every year. 7.49% are exposed to moderate fires and 2.40% to high levels of fire. 35.71% have not yet been affected by fires of any significance There are significant resources such as carbon which tied up in trees are destroyed by wildfires every single year These losses negatively affect the supply of products and services provided by these natural assets.

Fires were found to be the most significant threat to sustainable forests, with serious implications for the well-being and income of local rural communities. Across India, the highest number of fire detections was recorded in Odisha (51.968) followed by Madhya Pradesh 47.795 and Chhattisgarh (38.106) (Table 2).

Table 2: Top ten states according to number of forest fire detected includes large continues and repeated forest fires

SI. No	State	Nov 2020-June 2021
1	Odisha	51968
2	Madhya Pradesh	47795
3	Chhattisgarh	38106
4	Maharashtra	34025
5	Jharkhand	21713
6	Uttarakhand	21487
7	Andhra Pradesh	19328
8	Telangana	18237
9	Mizoram	12846
10	Assam	10718

Source: India state of forest report (2021)

Fire effects can result in shifts in plant communities and in the associated ecological processes of regeneration. These shifts could be expected to influence ecosystem structure and function, including the abundance and diversity of animal populations within these ecosystems. According to estimates by various researchers, between 10% and 12% of the Indian population depends on forestry and related activities for its survival (Lippe et al., 2021).

A majority of the Northwest Frontier Province (NWFP) collection in India, nearly 70%, occurs in the tribal regions of the country. Forestry employs approximately 55% of the total workforce in India. The share of NWFPs in the total household income varies widely across states. For example, in Gujarat, the share was between 20.1% and 34.1%, whereas in West Bengal, it ranged between 26.5% and 55.5%. Another study found that tender leaves could be used for making bidi cigarettes, which would create jobs for nearly four million people annually. It was noted that Indian forests' industries provide an abundant source of income nearly to 50 percent, of 20 to 30 percent of the country's workforce, which makes them important economic drivers (Yadav & Basera, 2013)

Climate changes could have serious consequences not only for the country's natural resources and its environment, but also on the country's nature conservation and tourism industry, which provides income and jobs opportunities in rural communities. Travel and leisure activities contribute 9.2 percent of India's gross domestic product (GDP) (Chaudhary et al., 2020).

A study predicts that climate change could seriously affect this industry, causing a significant damage in economic activities particularly in rural areas, leading to a loss of revenue for up to nine percent of the country's GDP. Furthermore, the impacts, including the implications, for example of increasing temperature on pest infestations and pathogen infections affecting native and plantation forest ecosystems, are among the most critical issues facing these environments today.

According to the Ministry of Tribal Affairs, tribal peoples comprise 8.6% of the Indian population, or 104 million people. There is no uniformity among the different Indian regions regarding their levels of vulnerability, it varies by state, location, and social group. There are significant differences between vulnerable regions due to their varying topography, climatic conditions, and ecosystem types, as well cultural factors. socio-economic statuses and needs among different populations. Vulnerable communities have been provided with various means through which they can adapt to climate change.

CONCLUSION

With respect to forests in India's tribal communities, this study reviewed the real and imminent consequences of climate changes. Discussions regarding the role of forests in reducing or increasing vulnerability of tribal communities to the impacts of climate change have brought attention to issues related to their management and use.

Even though households use a variety of coping mechanisms to deal with the effects of changes in climate. However, these methods may not be sufficient for maintaining stable and resilient livelihoods when faced with future changes in climatic conditions.

Poor forest use and management capacity; lack of employment opportunities; high levels of unemployment; rapid urbanization; and inadequate access to health care services underpin rural communities' vulnerabilities to climate change. These factors mean that forests provide essential resources for rural livelihoods and their loss could undermine community resilience to climate change. Making sure to address these concerns are included into an adaptive design could guide against maladaptive outcomes. With the aid of this study, it will improve the capability of existing resources, infrastructure and facilities to better serve individuals and communities in their ability to adapt to climate change impacts.

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