



To cite this article: Dr. Shree Prakash and Dr. Anita Kumari (2024). ECONOMIC DEVELOPMENT AND CLIMATE CHANGE IN INDIA: A REVIEW STUDY, International Journal of Research in Commerce and Management Studies (IJRCMS) 6 (5): 180-199 Article No. 286 Sub Id 549

ECONOMIC DEVELOPMENT AND CLIMATE CHANGE IN INDIA: A REVIEW STUDY

Dr. Shree Prakash¹ and Dr. Anita Kumari²

¹Assistant Professor (commerce) in Deen Dayal Upadhyay Government P.G. College, Saidabad, Prayagraj

²Assistant Professor and HoD (Zoology) in Digvijai Nath P.G. College, Civil Lines, Gorakhpur, UP

DOI: <https://doi.org/10.38193/IJRCMS.2024.6511>

ABSTRACT

Global warming has become a reality in present times posing a serious threat to existence of human lives on this earth. Increasing instances of natural calamities have caused huge loss of precious human lives and property in recent past and such casualties have become more frequent in recent times than ever before. Achieving higher rate of economic growth has now become a compulsion for every nation and commands a central place in framing of various state policies in their quest for alleviation of poverty and bringing improvement in standard of living of people residing in that country especially poor and downtrodden sections of society. Economic growth entails using various natural resources in production of goods and services but when it takes the form of race causing over-exploitation of natural resources then it results in inflicting severe damage to natural environment due to excessive emission of greenhouse gases. Developed countries are far ahead in this race of achieving economic growth and so they are now being followed by developing and under-developed countries. Gradually, the world community has started realizing the huge cost that humanity is paying for environmental damage and so there is daunting challenge before every country to cut down carbon emission and release of greenhouse gases but none wants to compromise on their growth agenda. Developing countries object to the pressure mounted by developed world arguing that since developed countries are main contributors to this menace and so they should compensate by way of extending financial support to them to help them adapt to green technologies in years to come. It is to be noted that economic development is the cause as well as remedy for protecting against climate change and so there needs to a judicious development policy which incorporates climate change perspective without compromising on achieving high rate of economic growth. Different countries around the world have started revisiting their erstwhile models of economic growth and so it is highly needed that India too to conform to modern global practices to minimize damage to natural environment.

This study is an attempt to investigate into the recent events of climate change in India and assess its impact on economic development in India in recent past. Further, this study aims to throw light on recent initiatives taken to minimize the effect of climate change in Indian context and suggest various



other steps that needs to be undertaken to minimize environmental degradation without compromising on growth agenda.

KEYWORDS: Climate Change, Economic Development, Economic Growth, Risk Mitigation Initiatives in Indian Context

INTRODUCTION

The investigation of various factors that affect employee well-being represents an essential domain of academic research. The concept of employee wellness encompasses the overall health and satisfaction of individuals within the workplace. The concept of well-being encompasses a holistic understanding of an individual's physical, mental, and emotional health, reflecting a state of balance and fulfillment in various aspects of life. It is often characterized by the presence of positive emotions, life satisfaction, and a sense of purpose, which collectively contribute to an overall sense of thriving. In contemporary discourse, well-being is increasingly recognized as a multidimensional construct that influences and is influenced by social, economic, and environmental factors, thereby necessitating a comprehensive approach to its assessment and enhancement.

Economic Development remains as a major national agenda before all developing countries in their quest to meet basic human needs of food, shelter, clothing and minimum standard of living to all of citizens residing in those countries. Majority of world population living in these countries still suffer from problems of rampant poverty, unemployment, illiteracy, lack of basic access to primary health care, malnutrition, safe drinking water and sanitation and so their economic development in of utmost importance to make the world a just and equitable place to live in for all. Achieving higher rate of economic growth has now become a compulsion for every nation and commands a central place in framing of various state policies in their quest for alleviation of poverty and bringing improvement in standard of living of people residing in that country especially poor and downtrodden sections of society. Economic growth entails using various natural resources in production of goods and services but when it takes the form of race causing over-exploitation of natural resources then it results in inflicting severe damage to natural environment due to excessive emission of greenhouse gases.

Economic development process has taken heavy toll on mother earth gradually causing rise in its temperature due to higher emission of green-house gases causing significant changes in the weather patterns and increasing instances of melting of glaciers, flash floods, droughts, cyclones, hurricanes, abnormal increase or decrease in rainfall, water scarcity, desertification, drop in crop-yield, rise in sea level, spread of unforeseen diseases, and sudden natural disasters. Global warming has become a reality in present times posing a serious threat to existence of human lives on this earth. Increasing instances of natural calamities have caused huge loss of precious human lives and property in recent

past and such casualties have become more frequent in recent times than ever before. Climate change has become one of the most pressing challenges of the 21st century posing significant risks not only to the environment, human health and food security, but also economic development. Certainly, economic development has become undeniable priority for every nation despite greater danger looming large about the ill effects of climate change and so there is need of integrating an appropriately designed climate change policy for adaptation and mitigation for climate change with economic development policy of every country. Climate change is gradually threatening sustainability of life, livelihood and the ecosystem and so the economists and policymakers worldwide are sharpening their focus on mitigating such risks. It is also a fact that most of the developing countries are unequally placed compared to developed world in terms of adopting mitigation strategies to tackle ill effects of climate change due to paucity of sufficient financial resources and technological know-how to support their minimum developmental programmes and in such a situation adaptation and implementation of a climate change mitigation policy would certainly prove to be an additional burden for them and so they need judicious support in terms of financial resources and technologies for capacity building to adopt to new world economic order.

There has occurred several instances of extreme weather events in recent past that have disrupted normal life in India. A recent report suggests that India lost nearly \$69 billion in 2019 alone due to climate change related events which is comparatively much higher than losses of \$79.5 billion during the period 1998-2017. The Global Climate Risk Index 2021 has ranked India 7th in the list of most affected countries in terms of exposure and vulnerability to climate risk events. India has also gradually started facing continues climate change related crisis like extreme heat, temperature, scanty monsoon, floods and rising sea levels and its impact on overall macro-economic and social environment like never before. The Reserve Bank of India (RBI) has recently estimated that India could lose up to 4.5 percent of its [GDP](#) because of climate change related risks by 2030 due to lost labour hours from extreme heat and humidity in weather. Further, climate change reflected in rising temperature and changing patterns of monsoon rainfall in India could cost the Indian economy 2.8 percent of its GDP and depress the living standards of nearly half of its population by 2050. Further, RBI's Department of Economic and Policy Research (DEPR) in its latest report on Currency & Finance 2022-23 states that India may lose anywhere around 3 to 10 percent of its GDP annually by 2100 due to climate change in the absence of adequate risk mitigation policies. This is despite the fact that India's carbon emission per capita is the lowest in the world, averaging only one-quarter of the global average and one-twentieth of the U.S. rate. While India places a higher priority on economic development needs of the nation to face economic challenges but equally it recognizes environmental challenge too with a globally aligned policy for reduction in emission of greenhouse gas (GHG).

This study is an attempt to investigate into the impact of climate change on economic development in

India in recent past and throw light on recent initiatives taken to minimize the effect of climate change in Indian context. Further, attempts would be made to look into various other steps that need to be undertaken to minimize environmental degradation without compromising on growth agenda.

REVIEW OF LITERATURE

Studies by Grossman and Krueger (1995) and Hitz and Smith (2004) suggest that economic growth may bring an initial phase of deterioration but later on, due to the adoption of better abatement technologies, it might bring some improvement to the quality of the environment.

Study by Hope (2006) found that although climate change may initially have some positive effects for some developed countries compared to developing countries because they are comparatively well placed by adopting appropriate risk mitigation strategies to tackle its ill effects but it will be destructive for all in the long run.

Studies by Nordhaus (1991), Yohe and Schlesinger (2002), Stern et al. (2006) and Tol (2008) have found that poorest countries and people living in these countries feel the adverse impacts of climate change most and suffer from them the most as these countries are more vulnerable to the negative effects of rising sea level and the impact on water resources, ecosystems, crop production, fisheries and human health. Stern et al. 2006 found that in the next fifty years, world temperatures are expected to rise 2-3°C. This increase will have severe consequences on economic development as it will affect water quality, agricultural productivity and human health. It was further calculated that about 5 per cent of global GDP per annum would be lost by these impacts.

Adger (2006) found in his study that in less developed countries a large percentage of the population is dependent on climate-sensitive sectors and there is low capacity to develop and implement adaptation strategies. Nevertheless, these countries have to bear the cost for promotion and adoption of different mitigation strategies.

Study by Sathaye et al. (2006) suggests that the impact of mitigation strategies in underdeveloped countries will only be gradually felt in the long run by future generations.

Smith and Wandel (2006) found that poor communities living in underdeveloped countries are more vulnerable to natural hazards due to limited adaptive capacities.

Studies by O'Brien et al. (2004), Parry et al. (2007) and Lucas and Simone (2011) found that the effects of climate change are not homogeneous within countries; it was found that agriculture, coastal zones and elderly people are more heavily affected than their counterparts.

Dell et al. (2008) found that because of climate change the growth rate of poor countries would be reduced by 0.6 to 2.9 percentage points.

Fankhauser and Tol (2005) study found that climate change affects people's propensity to save and thus has negative effect on capital accumulation in the country which in turn has the effect of reducing economic growth. By using different growth model specifications, it was found that dynamic effects are relatively larger as compared to direct or static impacts of climate change.

Study by Lecocq and Shalizi (2007) suggests that GDP is adversely affected indirectly by variations in demand structure even though there is no direct effect of climate change on it.

Mendelsohn and Dinar (1999) concluded that climate change resulting into higher temperatures reduces grain yields of several crops. They also found that individual farmers in India and Brazil played a very crucial role in their attempt to minimize the effects of global warming on agriculture. Greiner (2004; 2005) found that an increase in GHG emissions negatively affects the aggregate output and the marginal productivity of capital and that increased level of risk mitigation initiatives might reduce GHG emissions which would lead to higher economic growth.

Crippa et al. (2021) found that India was the third largest national emitter in 2020 (behind China and the United States), emitting 2.4 gigatons of carbon dioxide due to its large population.

India is among one of the most vulnerable country sufferings from the impacts of climate change in recent years. Climate change has been gradually bringing alteration in growing seasons of many crops in India and it has been causing significant damage to productivity and health (Mani et al., 2018) because of the fact that majority Indians are found to work in agriculture and other climate sensitive sectors (Chand and Singh, 2022).

Objectives of the Study

This study aims at achieving the following objectives:

- i) To establish the fact that there is real climate change happening in India and assess its impact on economic development in India in recent past.
- ii) To throw light on recent initiatives taken to minimize the effect of climate change in Indian context.
- iii) to look into various other steps that needs to be undertaken to minimize environmental degradation without compromising on growth agenda.

Data and Research Methodology

This study is based on data collected primarily from secondary sources. Data is collected from

publications made in reputed journals and various other publications done by government and semi-government organizations. It is basically a descriptive study.

Climate Change in India

A recently published report suggests that the average temperature across India rose by 0.62°C over the last 100 years (Government of India, 2021) which is at slower rate than the global average. Rise in average temperatures has gradually led to more frequent and severe heatwaves across the country it has been observed that western and southern India experienced 50% more heatwave events compared to past 25 years during 1985-2009. It is estimated that heatwaves in 2013 and 2015 killed more than 1,500 and 2,000 people respectively across the country (Mazdiyasnani et al., 2017). Krishnan et al. (2020) observed that India is experiencing both more frequent dry spells and more intense wet spells during the summer and monsoon season and this climate change is expected to cause water shortages which could affect more than a billion people by the 2050s across Asia including India. India has varied ecological zones including alpine ecosystems, arid and semi-arid deserts, humid subtropical landscapes and both wet and dry tropics depending upon varied climatic conditions found in these regions. There are several ecological hotspots which are more prone to ill effects of changes in climate affecting standard of living of people living in these hotspots. These hotspots are gradually increasing in numbers with climate changes and an estimate project that by 2050 approximately 148.3 million people in India will be living in severe hotspots (Mani et al., 2018). A study done by Mohanty and Wadhawan (2021) found more than 80 percent of India's population lives in districts highly vulnerable to extreme weather events. Different regions of the country experience diverse levels of climate change impacts due to diversity in climatic conditions and geographic locations and topography. Unprecedented rise in temperature is gradually causing more frequent episodes of sudden heavy rainfall across the subcontinent and an estimate suggests that there was a threefold increase in extreme precipitation events between 1950 and 2015 in central India (Roxy et al., 2017). This has contributed to rise in instances of floods which is blamed for huge loss of property and death of thousands of people and displacement of millions. The most tragic example is floods seen in the northern part of India in June, 2013 which came in form of early monsoon rains combined with glacial lake outburst due to melting of the snow cover at the top of mountains that usually otherwise melts by the time of full-fledged arrival of the monsoon. The consequent landslides, debris flows and flooding killed over 5,800 people and caused catastrophic damage to housing and infrastructure (Singh et al., 2014). It is also worth noting that although heavy precipitation events have become more common but there has been a steady decline in the total amount of rainfall during monsoon season (Mishra et al., 2012; Turner and Annamalai, 2012). A study by Krishnan et al. (2020) found that the average precipitation is estimated to have fallen around 6 percent during 1951-2015. Singh et al., (2016) in their study found that glaciers in Hindu-Kush Himalaya have retreated at an average rate of 18 metres a year over the last four decades which constitute approximately fifty percent of glaciers found outside

the Polar Regions. The melting of glaciers has made-up short-term deficiency in freshwater supplies but it would endanger continuous availability of freshwater in perennial rivers which are lifeline to billion people living on its banks (Xu et al., 2009). Flash floods caused by the combination of monsoon rains and spring snowmelt caused floods swept away temples and residential buildings and killed over 4,000 people (Arcanjo, 2019). Again, In February 2021, the disastrous outburst of the Himalayan glacier in Uttarakhand led to more massive floods in the region which killed over 100 people (Doman and Shatoba, 2021). These recent climatic changes have multiplied risk and vulnerability of economic development initiatives in the India particularly agricultural sector due to insufficiency of consistent rainfall and deterioration in ground level water because agriculture in many regions is dependent on groundwater (Zaveri et al., 2016). It is estimated that around a billion people in India face severe water scarcity for at least one month of the year whereas 180 million face severe water scarcity all year round (Mekonnen and Hoekstra, 2016).

Unnikrishnan et al. (2015) in their study found that there is gradual rise in sea levels due to increase in average temperature of earth resulting into melting of polar glaciers and an estimate suggests that the north Indian Ocean rose by an average of 3.2 mm per year during 1993-2012 whereas average rate of rise in the Bay of Bengal was over 5 mm a year during the same period. This causes inundation of coastal areas which is serious reason of concern in India because it has vast coastal areas. Coastal communities, particularly those in low-lying areas, are therefore already facing the prospect of permanent inundation, chronic flooding and violent winds. A third of India's population live along the coast (Swapna et al., 2020), and as of 2000 over 60 million of them lived less than 10 metres above sea level (McGranahan et al., 2007). It has been observed that instances of cyclonic storms have increased manifold in recent past than ever before and an estimate suggests that seventy percent of global casualties from cyclones and storm surge last century occurred in the Bay of Bengal (Ali, 1999) – but they are gradually becoming more severe and frequent (IPCC, 2019). The super cyclone Amphan in 2020 was the most powerful ever recorded in the region with sustained wind speeds of over 240 km per hour (Khan et al., 2020). More recently, the Himalayan states have emerged as the hotspot for climate change because they have fragile ecology. Incessant torrential rainfall in 2023 in Uttarakhand and Himachal Pradesh has caused severe damage to mountains in forms of huge instances of landslide casualties. Uneven rainfall during monsoon season is causing huge damage to agriculture productivity in India.

Impact of Climate Change on Economic Development in India

Climate change may alter the growth trajectory of any country in terms of its negative impact on reduction in productivity especially in agriculture sector, destruction of productive assets and alteration in investment priorities by way of diversion of investments from productive investment toward adaptation technologies. Sustainable development and inclusive growth has now become a

buzzword in the economics literature across different countries of the world especially in developing countries to deal with problems of environmental degradation, poverty and inequality. They are now considered as central objective of a sound development policy of any modern state facing problems of climate change and uneven distribution of income and wealth. Low-income countries are much more vulnerable to climate change than richer nations (World Bank 2010a). This is because of the fact that developing countries like India are comparatively highly exposed to temperature thresholds in many areas and have higher level of economic sensitivity to climate change events due to their greater reliance on agriculture and allied sectors. Further, they have a lower adaptive capacity to deal with climate change. Climate resilience has gradually emerged as very important development concern and so economic growth policies need to be compatible with the adaptation needs of developing countries to climate change. The ability to absorb climate stress, in particular, depends on factors that are highly correlated with economic growth, such as good institutions, strong health and sanitation systems, high levels of education and a well-developed financial sector (Tol and Yohe, 2007, Barr et al., 2010). Since growth and development address shortcomings in these variables, the implication is that growth must be important element of attempts to reduce vulnerability to climate change (Klein and Persson 2009, McGray et al. 2007). Dell et al. (2008, 2009) in their study found that rise in temperature tended to reduce economic growth persistently on annual basis and over a long-term time horizon. Mechler (2004) found that the Hurricane Mitch which hit Honduras in 1998 has the effect of reduction in the country's GDP growth rate by as much as five percentage points and thus it can be stated that extreme weather events can have a significant adverse effect on growth in the short run. Raddatz (2009) in his study found that climatic natural disasters have had a moderate but significant negative effect on real GDP per capita over the past four decades. He calculated that, at a conservative estimate, the macroeconomic cost of a climatic disaster affecting at least half a per cent of a country's population reduced real GDP per capita by 0.6%. A study by Landon-Lane et al. (2009) found that at the time of the great Dust Bowl in the USA in the 1930s, climatic stress hit the banking system, impairing financial intermediation and recovery for a prolonged period. Thus climate-related disasters can have long echoes through the financial system. Lis and Nickel (2009) showed how natural disasters tend to have an adverse impact on government budgets.

It is important to note that high level of economic growth increases the adaptive capacity of the country to cope with climate change events. Level of economic growth can either increase or decrease the sensitivity of a country to climate change depending upon the fact that whether that country is under-developed or developed one. Economically developed countries have been able to diversify away from agriculture into manufacturing which is comparatively immune from the severity of climate change impacts. In contrast, developing countries depend to a large extent on agricultural and allied sector and thus are naturally more exposed to climate change events. However, the empirical evidence suggests that the positive effects of economic growth tend to dominate over negative impact of it.

Raddatz (2009) study found that climate-related disasters had a higher GDP impact in low-income countries than in middle-income countries, which were in turn more affected than high-income ones. Dell et al. (2008, 2009) in their study found that higher temperatures reduced economic growth rates only in poor countries, and not in rich ones. There is further evidence from case studies that poverty tends to exacerbate due to increased costs of adaptations to climate change (O'Brien et al. 2008). Benson and Clay (1998) suggested a U-shaped relationship between development and vulnerability to climate change: the economic impact of climate-related stocks such as drought was higher for economies that had moved from a 'simple stage' of water-intensive agriculture and subsistence sector to an 'intermediate stage,' characterized by labor-intensive low-technology manufacturing, but vulnerability was lower where economies had become more diversified and developed.

Climate change has the effect of gradually slowing the pace of poverty reduction and increasing inequality in India. Burke and Tanutama, 2019 in their study found that the fastest warming districts have seen gross domestic product (GDP) grow on average 56% less than those that have warmed the slowest (Burke and Tanutama, 2019). It can be stated that without rapid corroborative action plan in line with global norms to reduce greenhouse gas emissions rise in average temperatures may actually reverse the development gains achieved in recent decades in India. Kahn et al. (2019) in their study predicted that climate change could reduce India's GDP by around 2.6% by 2100 even if the global temperature increase is held below 2°C; however, this rises by up to 13.4% in a 4°C scenario. These results are based on projections of temperature and precipitation changes and its effect on labour productivity in different sectors. Dhiman et al. (2010) in their study concluded that climate change may also affect labour productivity in different other ways, for instance by increased incidence of endemic vector-borne diseases such as malaria, dengue, chikungunya, filariasis, Japanese encephalitis and visceral leishmaniasis. Kompas et al. (2018) investigated into impact of climate change on economic development in India in form of decline in agricultural productivity, rise in sea-level and health expenditure and projected that 1°C of global warming would cost India 3% of GDP a year; at 3°C, that cost rises to 10% a year. Cazcarro et al. (2018) study found that over sixty percent of cropland and pastureland in the Ganges-Brahmaputra-Meghna and Mahanadi deltas regions is devoted to satisfying demand from elsewhere, thereby sustaining transportation, trade and services sectors as well as agriculture. Thus, the complete climate change-induced disappearance of this activity would entail local economic losses ranging from 18–32% of GDP. Nixon (2020) found that India's GDP would currently be around 25% higher if it did not have to bear the current costs of global warming and predicted that with 3°C of warming GDP would be 90% lower in 2100 than it would have been without climate change. Skoufias et al. (2011) in their suggested that the combination of rising cereal prices, declining wages in the agricultural sector and the slower rate of economic growth attributable to climate change could increase India's national poverty rate by 3.5% in 2040 compared to a zero-warming scenario; this equates to around 50 million more poor people than there otherwise would

have been in that year. Strikingly, while both the urban and rural poor will suffer from higher cereal prices, rural landholders will not experience significant income changes, as higher cereal prices offset declining agricultural productivity (Jacoby et al., 2011). Nagchoudhary and Paul (2020) in their study found that the super cyclone Amphan in 2020 affected 13 million people and caused over \$13 billion in damage after it made landfall in West Bengal.

Recent Initiatives Taken to Minimize the Effect of Climate Change in Indian Context

The effort to reach global consensus around climate policies has been spearheaded by the United Nations (UN), although originally, its focus was more on the utilisation of the environmental or natural resources for greater economic development (Jackson, 2007). Among the international organizations, it was the WMO which has been instrumental in generating international cooperation on climate matters and strengthening post-second World War advances in climate research (Zillman, 2009). Environmental conservation caught the attention of the UN for the first time in the first Earth Summit held in Stockholm in 1972, which led to the creation of the UN Environment Programme (UNEP), the first landmark in global cooperation and consensus on climate change. The second landmark event occurred in the form of creation of the Inter-Governmental Panel on Climate Change (IPCC) in 1988 by the UNEP and the WMO for regular scientific assessments on climate change and their implications for informed policy making. Till now, there have been six assessment cycles carried out by the IPCC in this regard. The third landmark was the Paris Agreement in 2016, about three decades later. This agreement makes it compulsory for all signatories to undertake targeted efforts to combat climate change. It was aimed at ensuring that GHG emissions from human activity are maintained at the same levels as can be absorbed by the environment - known as net zero - between 2050 and 2100. There have been numerous global dialogues and interventions leading up to and following the Paris Agreement. The achievements of climate policy action can be ascertained using several parameters. Almost all countries have committed to timelines for the transition to net zero emissions, with the majority committing to achieve this target by 2050. Further, 23 percent of these countries have made the target a legal obligation, 18 per cent have proposed to make it into a legal obligation and remaining 59 per cent have made their pledges in official policy documents. All these countries together account for around 73 per cent of global CO₂ emissions. India's contribution to cumulative global emissions of GHGs has been limited, although its cumulative emissions have increased during 1950-1990 and 1991-2020. Its contribution to consumption-based emissions is however significantly lower than production-based emissions vis-à-vis major developed countries. In India, per capita CO₂ emissions have been on a rise in recent decades, as in China and Russia; however, the energy intensity of GDP (use of primary energy per unit of GDP) has been on a steady decline since the 1990s across almost all countries, including India. India's involvement in climate change negotiations can be broadly divided into three phases (Youdon and Bajaj, 2022). In the first phase (1992-1997), India's priorities were mainly concerned with preservation of the interests of developing and least developed countries

by advocating the principles of equity, and common but differentiated responsibilities in meeting targets for emission reductions. In the second phase (2000-2009), India focused on climate finance, technology sharing and the creation of an adaptation fund for climate action by developing countries. During the third phase covering COP15 in Copenhagen in 2009 to the Paris Agreement in 2016, India supported green transition through a more flexible, cooperative, and holistic approach for formulating its National Action Plans on climate change. A strong commitment to climate action is reflected in various national development policies and programmes adopted by India in recent decades.

- i) India has committed to accommodate the Panchamrit, which includes raising the non-fossil-fuels-based energy capacity of the country to 500 Gigawatt; meet 50% of its energy requirements from renewable energy by 2030 and 45 per cent reduction of carbon intensity by 2030. The vision of Panchamrit stresses on promoting sustainable lifestyles among common people and bring climate justice to protect the poor and vulnerable from the adverse impacts of climate change. The updated Nationally Determined Contributions (NDCs) reaffirm India's commitment to work towards a low carbon emission pathway, while simultaneously endeavouring to achieve sustainable development goals (SDGs). Under this initiatives India aims at achieving the target of net zero emissions by 2070. India is gradually inching towards becoming a global leader in solar energy due to better execution of the National Solar Mission through creation of policy conditions for its diffusion across the country.
- ii) India has been gradually gearing up to make following policy reforms to achieve the objective of net zero emission (a) By rationalizing utilization of national resources with due regard to energy security; (b) By increasing the use of biofuels, green hydrogen fuel and electric vehicle penetration; (c) Through development of an integrated, efficient and low-carbon transport system; (d) Through promotion of adaptation measures in urban design; and (e) CO₂ removal through innovation, technology transfer, climate-specific finance and capacity building with international support.
- iii) India is keen to form knowledge networks by facilitating data sharing and information exchange at the institutional level to share its experience and learnings with the rest of the world by participating in research and development activities.
- iv) India aims to mitigate the growing GHG concentration in the atmosphere by attempting to harness the potential of increased mangroves forest cover to absorb more carbon emissions than landed tropical forests. Accordingly, dedicated commitments have been made towards conservation and management of mangroves. Mangroves and coastal wetlands form the first line of defense for coastal communities against increased storm surges, flooding, and hurricanes.
- v) The Ministry of Science and Technology launched the National Mission for Sustainable Himalayan Ecosystem in 2010 to understand the implications of climate change on the

- Himalayan ecosystem in order to conserve and protect its biodiversity. A separate Mission for Green India was launched by the Ministry of Environment, Forests and Climate Change in 2014 to provide livelihoods to 3 million people through forest based activities and carbon sequestration capacity.
- vi) The Mission LiFE, i.e., Lifestyle for the Environment, launched by the Prime Minister in 2022, is now a global movement to connect the powers of the people for the protection of the earth. Mission LiFE makes the fight against climate change democratic, because everyone can contribute within one's capacity.
 - vii) Perhaps the most significant single stimulus to national climate policy making was the 2008 National Action Plan on Climate Change (NAPCC). This plan underlines the fact that India's climate approach is guided by the pursuit of co-benefits arising from it rather than an initiative just to comply with international pressure. It is supposed to have benefits for enabling India towards achievement of its national development objectives because of associated climate gains that would accrue from execution of this plan in long run. It can be stated that the most significant national objective that promises climate co-benefit is developing various sources of renewable energy to ensure energy security at present time when it needs to meet energy requirement of rising growth rate. National Action Plan on Climate Change aims at creating awareness among the representatives of the public, different agencies of the government, scientists, industry and the communities on the threat posed by climate change and the steps that can be undertaken to counter it. Government of India has established an adaptation fund and provided initiatives under its National Action Plan for climate change.
 - viii) To strengthen initiatives undertaken to conserve energy under the Energy Conservation Act of 2001, the Ministry of Power launched a similar Mission in 2011 known as National Mission for Enhanced Energy Efficiency (NMEEE) to make energy savings. India has co-founded the International Solar Alliance (ISA) with France in 2016 and announced a National Hydrogen Mission to increase the dependency on green energy.
 - ix) National Adaptation Fund for Climate Change (NAFCC), a central sector scheme, was initiated in 2015-16 to support adaptation activities in the States and Union Territories (UTs) of India that are vulnerable to the adverse effects of climate change. NAFCC is implemented in project mode, and to date, 30 projects have been sanctioned in 27 States and UTs with a total project cost of ₹847.5 crore. NAFCC supports adaptation action, in, inter alia, agriculture, water, forestry, livestock, and restoring ecosystems. Presently, there are more than 28 projects that are under implementation under this initiative.
 - x) India has taken several plantations drives at different levels for increasing its forest cover area significantly over the past decade. It ranks third globally in average annual net gain in forest area between 2010 to 2020, adding an average 2,66,000 ha of additional forest

- area every year during the period, or adding approximately 0.38 per cent of the 2010 forest area every year between 2010 to 2020.
- xi) India has taken serious action that shows its commitment towards mitigation of pollution caused by littered single use plastics. The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 as amended from time to time regulate the import of identified plastic waste into the country by SEZ and EOUs. The regulation prevents the import of plastic waste and its dumping by other countries in India and makes provision for recycling of plastic waste generated in the country. India piloted a resolution on "Addressing Single Use Plastic Product Pollution" which was adopted by the Fourth United Nations Environment Assembly held in 2019. The resolution recognizes the need for the global community to act on the single use plastic products pollution. The adoption of this resolution was a significant step. The Ministry of Environment, Forest and Climate Change, Government of India has prohibited manufacture, import, stocking, distribution, sale and use of identified single-use plastic under the Plastic Waste Management Amendment Rules, 2021.
 - xii) The waste management infrastructure in the States/UTs is also being strengthened through the Swachh Bharat Mission. The Swachh Bharat Mission has been very successful mission and is reckoned globally for bringing unprecedented cleanliness and hygiene in India which has minimized instances of spread of various diseases.
 - xiii) It is made compulsory for India companies to contribute a certain portion of their profits for corporate social responsibility (CSR) initiatives which includes reporting about initiatives undertaken to protect environment and energy conservation. Many bluechip companies have been increasing incorporating sustainability reporting as part of their corporate annual report. Indian companies have come forward to gradually embrace ESG (Environmental Social Corporate Governance) compliance but still there exists large gaps as organizations are grappling with evolving expectations on ESG compliance and disclosure from investors, boards, governments, and consumers. They need to account for emerging global regulations on sustainable finance, climate disclosures, biodiversity, and social and governance dimensions, including gender diversity and living wages, within a couple of years.

Thus, it can be stated that India has used the challenge of climate change to propagate climate resilience action globally and has in fact emerged as a leading voice from the emerging world at global stage. India's progress in adaptation and mitigation of climate change is evident from the rise in its Climate Change Performance Index (CCPI) in recent years. It is undertaking numerous policy actions as part of the global commitments while pushing outwards the boundaries of its development priorities.

Future Initiatives to be Undertaken in India

India may lead the path by taking the following initiatives in future to ensure climate resilience in the country and ensure its propagation globally.

- i) Government of India announced about the issuance of Sovereign Green bonds in the Union Budget 2022-23 for financing its initiatives for bringing reduction in the carbon intensity of the economy significantly. Green Bonds are financial instruments that generate proceeds for investment in environmentally sustainable and climate-suitable projects. Green bonds have become very important instrument for raising funds especially different major countries in the past including the UK, France, Germany, the USA, and China. IMF data indicates that green bonds of value around US\$ 620 billion were issued across the world in the year 2021. As per SEBI's data on green debt securities, during the period of 2017 to September 2022, 15 Indian corporates have issued green bonds of value ₹4,539 crore.
- ii) India can enhance its carbon sequestration potential by expanding its forest and tree cover, restoring degraded lands, promoting agro forestry, and adopting low-carbon farming practices. Carbon sequestration can not only offset carbon emissions but also provide multiple co-benefits such as biodiversity conservation, soil fertility improvement, water security, livelihood support, and disaster risk reduction.
- iii) India can build its climate resilience by strengthening its disaster management systems, improving its early warning and forecasting capabilities, investing in climate-proof infrastructure, developing climate-smart agriculture, enhancing health care services, and empowering local communities and institutions.
- iv) India is expected to promote Green Transportation Revolution in the country. There is a need to promote electric vehicles (EVs) by establishing a robust charging infrastructure network and offering incentives for EV adoption. Introducing innovative public transportation solutions such as electric buses, shared mobility services, and smart traffic management systems can reduce congestion and emissions.
- v) Climate Smart Agriculture is the need of hour in India by combining traditional farming with increased use of modern technology in agriculture. There is a need to encourage sustainable farming practices by promoting organic farming, agro-forestry, and precision agriculture. Integrating technology-driven solutions such as remote sensing, IoT devices, and AI-based analytics can optimise resource utilisation, reduce water consumption, and enhance crop productivity.

CONCLUSION

It can be stated that economic development is the cause as well as the remedy of climate change in

India and so it should focus on promoting pro-climate sustainable development in the country in the long run rather than short run rapid development at any cost. There is need of providing for level playing field for developing country like India to enable it properly adjust and adapt to climate change initiatives at par with practices in developed countries to ensure global success of these initiatives. It is worth noting that both economic development as well as climate policy actions is necessary to protect future generations in developing countries like India against paying heavy price of underdevelopment and deterioration in climate. In order to make their fair contributions towards mitigation for climate change, developing countries including India should implement all feasible no-cost measures delivering mitigation co-benefits. They should also seek opportunities for implementation of other additional measures if the developed world comes forward to contribute towards meeting the incremental costs of these measures. It would be counter-productive for developing country like India in terms of their economic and social progress as well as their local environmental goals, to divert scarce resources from these priorities to mitigation measures involving uncompensated incremental costs.

The present study finds that there is gradual rise in temperature causing several climate change events in India which may have a negative impact on its growth rate in the long term. India needs to work towards building climate proof developmental infrastructure, well planned green and technology savvy urbanization, increased access to credit, and greater energy efficiency and access to help it mitigate the negative impact of climate changes. Further, it needs to put in place a broad strategy to mitigate the negative impact of climate change by increasing its focus on investment in human capital and improvement of infrastructure, especially in carbon intensive regions and hotspots which are more prone to climate damages (Mani et. al., 2018). It may be suggested that climate change is more likely to constrain the growth prospects for rural India as compared to urban regions. Therefore, there is need of adopting a properly planned approach towards developing rural parts of India for ensuring both uncompromised growth as well as enabling them adapt to climate change challenges effectively. There is need of designing and implementing judicious environmental policies and planning as well as general economic welfare initiatives over the medium- to long-run keeping in mind various challenges and uncertainties posed by climate change. Climate change is not a problem faced by India only but the whole world together and so there is requirement of initiating concerted efforts involving different countries facing the world to ensure both sustainability of economic development and existence of human beings now and in the future. However, it also offers an opportunity for developing country like India to adopt a cautious yet sustainable approach to economic development.

REFERENCES

- Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, vol. 16, No. 3, pp. 268-281.
- Akram, N. (2012). Is Climate Change Hindering Economic Growth of Asian Economies? *Asia-Pacific*

Development Journal, Vol. 19, No. 2.

Ali, A. (1999). Climate change impacts and adaptation assessment in Bangladesh. *Climate Research*, 12(2): 109–116 (www.academia.edu/2266271/Climate_change_impacts_and_adaptation_assessment_in_Bangladesh).

Arcanjo, M. (2019) The future of water in India. Climate Institute (<http://climate.org/thefuture-of-water-in-india/>).

Barr, R. et al. (2010). Adaptation Investments: A Resource Allocation Framework. in: *Mitigation and Adaptation Strategies for Global Change*, DOI: 10.1007/s11027-010-9242-1.

Benson, C. and Clay, E. (1998). The Impact of Drought in Sub-Saharan African Economies. World Bank Technical Paper; No. 401; World Bank; Washington DC.

Bowen, A. et al. (2012). Climate change, adaptation and economic growth. *Climatic Change*, 113 (2). pp. 95-106. ISSN 0165-0009.

Burke, M. and Tanutama, V. (2019). Climatic constraints on aggregate economic output. NBER Working Paper 25779 (www.nber.org/papers/w25779).

Cazcarro, I. et al. (2018). Biophysical and socioeconomic state and links of deltaic areas vulnerable to climate change: Volta (Ghana), Mahanadi (India) and Ganges-Brahmaputra-Meghna (India and Bangladesh). *Sustainability*, 10(3): 893 (<https://doi.org/10.3390/su10030893>).

Chand, R. and Singh, J. (2022). Workforce Changes and Employment: Some Findings from PLFS Data Series [NITI Aayog Discussion Paper]. NITI Aayog, Government of India. https://www.niti.gov.in/sites/default/files/202204/Discussion_Paper_on_Workforce_05042022.pdf.

Crippa, M. et al. (2021). GHG emissions of all world countries: 2021 report. Publications Office of the European Union. <https://doi.org/10.2760/173513>.

Dell, M. et al. (2008). Climate change and economic growth: evidence from the last half century. Working Paper, No. 14132. Cambridge, MA: National Bureau of Economic Research.

Dell, M. et al. (2009). Temperature And Income: Reconciling New Cross-Sectional and Panel Estimates. *American Economic Review Papers and Proceedings*, 99(2): 198-204.

Dhiman, R.C. et al. (2010). Climate change and threat of vector-borne diseases in India: are we prepared? *Parasitology Research*, 106: 763–773 (<https://doi.org/10.1007/s00436-010-1767-4>).

Doman, M. and Shatoba, K. (2021). Tracing the path of destruction in India's Himalayas. ABC Net, 10 February (www.abc.net.au/news/2021-02-11/satellites-capture-scale-of-indianglacier-collapse/13137924?nw=0).

Fankhauser, S. and Tol, R.S. (2005). On climate change and economic growth. *Resource and Energy Economics*, vol. 27, No. 1, pp. 1–17.

Government of India (2021). Statement on climate of India during 2020. Press release, 4 January (https://reliefweb.int/sites/reliefweb.int/files/resources/Statement_of_Climate_of_India-2020.pdf).

Greiner, A. (2004). Anthropogenic climate change in a descriptive growth model. *Environment and Development Economics*, vol. 9, No. 5, pp. 645-662.



- Greiner, A. (2005). Anthropogenic climate change and abatement in a multi-region world with endogenous growth. *Ecological Economics*, vol. 55, No. 2, pp. 224-234.
- Grossman, G.M. and Krueger, A.B. (1995). Economic growth and environment. *The Quarterly Journal of Economics*, vol. 110, No. 2, pp. 353-377.
- Hitz, S. and J.B. Smith (2004). Estimating global impacts from climate change. *Global Environmental Change*, vol. 14, No. 3, pp. 201-218.
- Hope, C.W. (2006). The marginal impact of CO₂ from PAGE2002: an integrated assessment model incorporating the IPCC's five reasons for concern. *Integrated Assessment Journal*, vol. 6, No. 1, pp. 19-56.
- IPCC (2019). IPCC special report on the ocean and cryosphere in a changing climate. In press. Geneva: IPCC.
- Jackson, P. (2007). From Stockholm to Kyoto: A Brief History of Climate Change. *UN Chronicle*, 44(2). <https://www.un.org/en/chronicle/article/stockholm-kyoto-brief-history-climatechange>.
- Jacoby, H. et al. (2011). Distributional implications of climate change in India. Policy Research Working Paper 5623. Washington DC: World Bank (<https://doi.org/10.1596/1813-9450-5623>).
- Kahn, M.E., Mohaddes, K., Ng, R.N. et al. (2019). Long-term macroeconomic effects of climate change: a cross-country analysis. Working Paper 26167. National Bureau of Economic Research (www.imf.org/en/Publications/WP/Issues/2019/10/11/Long-TermMacroeconomic-Effects-of-Climate-Change-A-Cross-Country-Analysis-48691)
- Khan, M.J.U. et al. (2020). Towards an efficient storm surge and inundation forecasting system over the Bengal delta: chasing the super-cyclone Amphan. *Natural Hazards and Earth System Science*, Pre-print (<https://doi.org/10.5194/nhess-2020-340>).
- Klein, R. and Persson, A. (2009). Financing adaptation to climate change: issues and priorities. ECP Report No. 8, European Climate Platform, Stockholm.
- Kompas, T. et al. (2018). The effects of climate change on GDP by country and the global economic gains from complying with the Paris Climate Accord. *Earth's Future* 6(8): 1,153–1,173 (<https://doi.org/10.1029/2018EF000922>).
- Krishnan, R. et al. (2020). Assessment of Climate Change over the Indian Region: A Report of the Ministry of Earth Sciences (MoES), Government of India. Springer Singapore. <https://doi.org/10.1007/978-981-15-4327-2>.
- Landon-Lane, J. et al. (2009). Droughts, Floods and Financial Distress in the United States. NBER Working Paper, No. 9490.
- Lecocq, F. and Shalizi, Z. (2007). How might climate change affect economic growth in developing countries? Policy Research Working Paper, No. 4315. Washington, D.C.: World Bank.
- Leiserowitz, A. and Thaker, J. (2022). Climate Change in the Indian Mind. National Survey by the Yale Program on Climate Change Communication (YPCCC) and the Centre for Voting Opinion and Trends in Election Research (CVoter).

- Lis, E.M. and Nickel, C. (2009). The impact of extreme weather events on budget balances and implications for fiscal policy. European Central Bank, Working Paper 1055, May.
- Lucas, B. and Simone, V. (2011). Climate change and uneven development. *The Scandinavian Journal of Economics*, vol. 113, No. 4, pp. 825-845.
- Mani, M. et al. (2018). South Asia's Hotspots: The Impact of Temperature and Precipitation Changes on Living Standards. International Bank for Reconstruction and Development / The World Bank. <https://doi.org/10.1596/978-1-4648-1155-5>.
- Mazdiyasi, O. et al. (2017). Increasing probability of mortality during Indian heat waves. *Science* 3(6): e1700066 (<https://doi.org/10.1126/sciadv.1700066>).
- McGranahan, G. et al. (2007). The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. *Environment and Urbanization*, 19: 17–37 (<https://doi.org/10.1177/0956247807076960>).
- McGray, H., A. et al. (2007). Weathering the storm. Options for framing adaptation and development. World Resources Institute, Washington DC.
- Mechler, R. (2004). Natural Disaster Risk Management and Financing Disaster Losses in Developing Countries. Karlsruhe: Verlag für Versicherungswissenschaft.
- Mekonnen, M.M. and Hoekstra, A.Y. (2016). Four billion people facing severe water scarcity. *Science Advances* 2(2): e1500323 (<https://doi.org/10.1126/sciadv.1500323>).
- Mendelsohn, R., and Dinar, A. (1999). Climate change, agriculture, and developing countries: does adaptation matter? *World Bank Research Observer*, vol. 14, No. 2, pp. 277-293.
- Mishra, V. et al. (2012). A prominent pattern of year-to-year variability in Indian summer monsoon rainfall. *Proceedings of the National Academy of Sciences, USA* 109: 7213–7217 (<https://doi.org/10.1073/pnas.1119150109>).
- Mohanty, A. and Wadhawan, S. (2021). Mapping India's Climate Vulnerability—A District Level Assessment. Council on Energy, Environment and Water, accessed through <http://www.ceew.in/sites/default/files/ceew-study-on-climate-change-vulnerability-index-and-district-level-risk-assessment-pdf>.
- Nagchoudhary, S. and Paul, R. (2020). Cyclone Amphan loss estimated at \$13 billion in India, may rise in Bangladesh. Reuters, 23 May (www.reuters.com/article/us-asia-stormindia/cyclone-amphan-loss-estimated-at-13-billion-in-india-may-rise-in-bangladeshidUSKBN22Z0HE).
- Nixon, J. (2020). The economic impact of global warming. An Oxford Economics White Paper. Oxford: Oxford Economics.
- Nordhaus, W.D. (1991). To slow or not to slow: the economics of the greenhouse effect. *Economic Journal*, vol. 101, No. 407, pp. 920-937.
- O'Brien, G. et al. (2008). Climate Adaptation from a Poverty Perspective. *Climate Policy*, Vol. 8, pp. 194-201.
- O'Brien, K.L. et al. (2004). Vulnerable or resilient? A multiscale assessment of climate impacts and



- vulnerability in Norway. *Climatic Change*, vol. 64, No. 1-2, pp. 193-225.
- Parry, M. et al. (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.
- Picciariello, A. et al. (2021). The costs of climate change in India: A review of the climate-related risks facing India, and their economic and social costs. Accessed through link <https://www.zbw.eu/econis-archiv/handle/11159/5584>.
- Raddatz, C. (2009). *The Wrath of God: Macroeconomic Consequences of Natural Disasters*. World Bank Policy Research Working Paper No. 5039, World Bank, Washington DC.
- RBI (2023). *Report on Currency and Finance 2022-23: Towards A Greener Cleaner India*. Department of Economic and Policy Research (DEPR), RBI accessed through link <https://rbi.org.in/Scripts/AnnualPublications.aspx?head=Report%20on%20Currency%20and%20Finance>.
- Roxy, M.K. et al. (2017). A threefold rise in widespread extreme rain events over central India. *Nature Communications*, 8(708) (<https://doi.org/10.1038/s41467-017-00744-9>).
- Sathaye, J. et al. (2006). Climate change, sustainable development and India: global and national concerns. *Current Science*, vol. 90, No. 3, pp. 314-325.
- Singh, D. et al. (2014). Severe precipitation in Northern India in June 2013: causes, historical context, and changes in probability. *Bulletin of the American Meteorological Society*, 95(9): S58–S61 (<https://deeptis47.github.io/papers/Singh2014a.pdf>).
- Singh, S. et al. (2016). Changing climate and glacio-hydrology in Indian Himalayan Region: a review. *WIREs Climate Change*, 7(3): 393–410 (<https://doi.org/10.1002/wcc.393>).
- Skoufias, E. et al. (2011). *The poverty impacts of climate change: a review of the evidence*. Policy Research Working Paper 5622. Washington DC: World Bank.
- Smith, B. and Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, vol. 16, No. 3, pp. 282-292.
- Stern, N. et al. (2006). *Stern Review: the Economics of Climate Change*. London: HM Treasury.
- Swapna, P. et al. (2020). Sea-level rise. in R. Krishnan, J. Sanjay, C. Gnanaseelan et al. (eds). *Assessment of climate change over the Indian region*. Singapore: Springer.
- Tol, R.S.J. (2008). Why worry about climate change? A research agenda. *Environmental Values*, vol. 17, No. 4, pp. 437-470.
- Tol, R.S.J. and G.W. Yohe (2007). The Weakest Link Hypothesis for Adaptive Capacity: An Empirical Test. *Global Environmental Change*, 17: 218-227.
- Turner, A.G. and Annamalai, H. (2012). Climate change and the South Asian summer monsoon. *Nature Climate Change*, 2: 587–595 (<https://doi.org/10.1038/nclimate1495>).
- Unnikrishnan, A.S. et al. (2015). Sea-level-rise trends off the Indian coasts during the last two decades. *Current Science*, 108(5): 966–971.



World Bank (2010a). World Development Report 2010. Development and Climate Change. World Bank, Washington DC.

Xu, J. et al. (2009). The melting Himalayas: cascading effects of climate change on water, biodiversity, and livelihoods. *Conservation Biology* 23(3): 520–530 (<https://doi.org/10.1111/j.1523-1739.2009.01237.x>).

Yohe, G.W. and Schlesinger, M.E. (2002). The economic geography of the impacts of climate change. *Journal of Economic Geography*, vol. 2, No. 3, pp. 311-341.

Youdon, C. and Bajaj, P. (2022). India's Approach and Position on Climate Change Governance. National Maritime Foundation. [https:// maritimeindia.org/indias-approach-and-positionon-climate-change-governance/](https://maritimeindia.org/indias-approach-and-positionon-climate-change-governance/).

Zaveri, E. et al. (2016). Invisible water, visible impact: groundwater use and Indian agriculture under climate change. *Environmental Research Letters*, 11(8) 084005 (<https://iopscience.iop.org/article/10.1088/1748-9326/11/8/084005>).

Zillman, J. W. (2009). A History of Climate Activities. World Meteorological Organization (WMO) Bulletin, 58(3), 141.