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Website- www.aarf.asia, **Email** : editor@aarf.asia , editoraarf@gmail.com

Role of Climate Change on the Sustainable Economic Development

Dr.Sanjog D. Tupe
Associate Professor and Head
Department of Commerce
Sant Gadge Maharaj Mahavidyalaya, Hingna, Dist. Nagpur

Abstract :

The diversity and extremes of India's climate and geography are characteristic of its society as well. Religious and cultural diversity is a major feature of Indian life.

The current climate of India is highly diverse, ranging from the subfreezing Himalayan winters to the tropical climate of the south.Global observations suggest that climate change is well under way. At continental, regional, and ocean basin scales, numerous long-term changes in climate have been observed, including widespread changes in precipitation amounts; ocean salinity; wind patterns; and aspects of extreme weather including droughts, heavy precipitation, heat waves, and the intensity of tropical cyclones. This climate change had impacting on the nation's economy in many spears. The climate change is adversely impacting on the economic development of the nation. So it is necessary to manage sustainable economic development by adopting climate change or to minimize the climate change conditions. This paper focus on how climate change is impacting on the sustainable economic development.

Keywords : Climate Change, economic development, sustainable development

Introduction :

In both its greenhouse gas emissions and its vulnerability to climate change, India is one of the most significant countries in the world. With a large and growing population, India's emissions of greenhouse gases are increasing. Moreover, potential climate impacts in India are severe: sea level rise, changes in the monsoon, increased severe storms and flooding, more drought, and severe water stress. Recently, climate variability in the form of floods and cyclones has resulted in destruction of crops, property and infrastructure, as well as in negative impacts on human health and well-being. All of these impacts set back general socio-economic development.

Global climate projections, given inherent uncertainties, indicate several changes in India's future climate:

- Global observations of melting glaciers suggest that climate change is well under way in the region, with glaciers receding at an average rate of 10–15 meters per year.
- If the rate of glacial melt increases, flooding is likely in the river valleys fed by these glaciers, followed by a diminished flow, resulting in a scarcity of water for drinking and agricultural irrigation.
- All models show a trend of general warming in mean annual temperature as well as decreased range of diurnal temperature and enhanced precipitation over the Indian subcontinent.
- A warming of 0.5o C is likely over all India by the year 2030 (approximately equal to the warming over the 20th century) and a warming of 2-4^{o} C by the end of this century, with the maximum increase over northern India.
- Increased precipitation is likely to come in the form of fewer rainy days but more days of extreme rainfall events, with increasing amounts of rain in each event, leading to significant flooding.
- Fine precipitation (drizzle-type) that replenishes soil moisture is likely to decrease.
- Increased warming is likely to lead to higher levels of tropospheric ozone pollution and other air pollution in India's major cities.
- Most global models suggest that the Indian summer monsoons will intensify with a warming climate. The timing may also shift, causing a drying during the late summer growing season.
- Climate models also predict an earlier snowmelt, which could have significant adverse effects on agricultural production, both irrigated and non-irrigated.
- Growing emissions of aerosols from energy production and other sources may suppress rainfall, leading to drier conditions with more dust and smoke from the burning of drier vegetation, affecting both regional and global hydrological cycles and agricultural production.

In both its greenhouse gas emissions and its vulnerability to climate change, India is one of the most significant countries in the world. With a large and growing population, India's emissions of greenhouse gases are increasing. Moreover, potential climate impacts in India are severe: sea level rise, changes in the monsoon, increased severe storms and flooding, more drought, and severe water stress. Recently, climate variability in the form of floods and cyclones has resulted in destruction of crops, property and infrastructure, as well as in negative impacts on human health and well-being. All of these impacts set

back general socio-economic development. Rural dwellers' continuing dependence upon agriculture for food and livelihood (17.5 percent of gross domestic product (GDP) and more than 60 percent of the labor force)ix makes the Indian people particularly vulnerable to climate variability and change.

The diversity and extremes of India's climate and geography are characteristic of its society as well. Religious and cultural diversity is a major feature of Indian life. The strong Hindu traditions have been synthesized with and challenged by other religions, notably Islam, Christianity, and Sikhism. India has at least 300 known languages, 24 of which have at least one million speakers each. There are differences, sometimes amounting to estrangement, between the North, with its history of grand-scale invasions, and the relatively stable South. Religious divisions became geographical divides when Muslim Pakistan (1947), then Bangladesh (1971), were created, and ethnic and caste-related strife continues among groups. However, the connectedness of the extended family is a core feature of Indian life. Together with a sense of civil society's claims on individuals and families, the extended family knits the society together and emphasizes interdependence

Climate Change :

Climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural, such as through variations in the solar cycle. But since the 1800s, human activities have been the main driver of climate change, primarily due to burning fossil fuels like coal, oil and gas.

Burning fossil fuels generates greenhouse gas emissions that act like a blanket wrapped around the Earth, trapping the sun's heat and raising temperatures.

Examples of greenhouse gas emissions that are causing climate change include carbon dioxide and methane. These come from using gasoline for driving a car or coal for heating a building, for example. Clearing land and forests can also release carbon dioxide. Landfills for garbage are a major source of methane emissions. Energy, industry, transport, buildings, agriculture and land use are among the main emitters.

Climate change can affect our health, ability to grow food, housing, safety and work. Some of us are already more vulnerable to climate impacts, such as people living in small island nations and other developing countries. Conditions like sea-level rise and saltwater intrusion have advanced to the point where whole communities have had to relocate, and protracted droughts are putting people at risk of famine. In the future, the number of "climate refugees" is expected to rise.

In a series of UN reports, thousands of scientists and government reviewers agreed that limiting global

temperature rise to no more than 1.5°C would help us avoid the worst climate impacts and maintain a livable climate. Yet policies currently in place point to a 2.8°C temperature rise by the end of the century.

The emissions that cause climate change come from every part of the world and affect everyone, but some countries produce much more than others. The 100 least-emitting countries generate 3 per cent of total emissions. The 10 countries with the largest emissions contribute 68 per cent. Everyone must take climate action, but people and countries creating more of the problem have a greater responsibility to act first.

Internationally, India has played a key role in climate negotiations at several points. India broke the impasse at the first Conference of the Parties by leading the development of a common statement that became the basis for the Berlin Mandate. More recently, India hosted the eighth Conference of the Parties to the Framework Convention on Climate Change in 2002. India, bolstered by nongovernmental organizations such as the Tata Energy Research Institute (TERI) and the Centre for Science and Environment (CSE), focuses on per capita emissions (low in India and high in most developed countries) and on cumulative emissions (also low in developing countries and high in developed countries), as the indicators that developed countries should undertake mitigation first. Government officials press developed nations to establish and conform to emissions reduction goals and to engage in technology transfer to developing countries

The current climate of India is highly diverse, ranging from the subfreezing Himalayan winters to the tropical climate of the south. The states of Assam and West Bengal experience extremely damp, rainy, and humid conditions, while the regions of Rajasthan and Gujarat make up part of the arid Great Indian Desert. Based on precipitation and temperature, India can be divided into six climatic regions: the Himalayas, Assam and West Bengal, the Indo-Gangetic Plain, the Western Ghats and coast, the Deccan (the interior of the Peninsula south of the Narmada River), and the Eastern Ghats and coast.

The Indian Meteorological Service divides the year into four seasons, two of which are characterized by monsoon conditions. Winter occurs from December through February, when conditions are generally relatively dry and cool. March through May is considered to be summer, as the conditions are usually hot and dry. During this period temperatures throughout non-Himalayan India reach the upper 30s°C and can reach as high as 48°C during the day in the pre-monsoon months.

The southwest monsoon season occurs from June through September, when the predominating southwest maritime winds bring rains to most of the country. One branch of the southwest monsoon, known as the Arabian Sea monsoon, generally breaks on the west coast early in the season and spreads across South Asia by early July. The other, known as the Bay of Bengal monsoon, spreads over Assam during June and travels along the Indo-Gangetic Plain toward New Delhi, merging with the Arabian branch to bring rains

farther north. The southwest monsoon provides almost 80 percent of the annual rainfall to most of the country. It is critically important to agricultural production; predictions of its timing are used by agronomists and farmers to determine optimal dates for plantings.

Global observations suggest that climate change is well under way. At continental, regional, and ocean basin scales, numerous long-term changes in climate have been observed, including widespread changes in precipitation amounts; ocean salinity; wind patterns; and aspects of extreme weather including droughts, heavy precipitation, heat waves, and the intensity of tropical cyclones. Studies of the tropical Indo-Pacific region show unusual warmth in the 20th century, and many isotope records show a trend toward warmer conditions in the tropical Indian Ocean. In most multi-centennial coral series, the late 20th century is shown to be warmer than any time in the past 100 to 300 years. Some studies have suggested that the South Asian (Indian) monsoon, in the drier areas of its influence (northwest India), has recently reversed its millennia-long orbitally driven, lowfrequency trend toward less rainfall. This recent reversal in monsoon rainfall also appears to coincide with a synchronous increase in inferred monsoon winds over the western Arabian Sea, a change that could be related to increased summer heating over and around the Tibetan Plateau. Globally, estimates of the potential destructiveness of tropical storms and hurricanes show a substantial upward trend since the mid-1970s, with a trend toward longer storm duration and greater storm intensity. Storm activity is generally correlated with tropical sea surface temperature. The distributions of global minimum and maximum temperatures have shifted to higher values, consistent with overall warming. More warm extremes imply an increased frequency of heat waves. However, cold extremes have warmed more than the warm extremes over the past 50 years. Further indications include the observed trend toward fewer frost days associated with the average warming in most mid-latitude regions. A prominent indication of a change in extremes is the evidence of increases in heavy precipitation events over the mid-latitudes in the past 50 years, even in places where mean precipitation amounts are not increasing. For very heavy precipitation events, increases are reported as well, but results are available for only a few areas.

Recent warming in sea surface temperatures (SSTs) is strongly evident at all latitudes, although there are inter-hemispheric differences. Much of the surface of the Indian Ocean has warmed since 1955, with the major exception of the 5°S to 20°S latitude belt. The Southern Ocean (south of 35°S) in the Atlantic, Indian, and Pacific sectors has generally warmed. The regions that exhibit cooling are mainly in the shallow equatorial areas and in some high-latitude regions. In the Indian Ocean, cooling occurs at subsurface depths centered on 12°S (South Equatorial Current) at 150 m depth and in the Pacific centered on the equator and 150 m depth. In the tropical and eastern subtropical Indian Ocean (north of 10°S), warming in the upper 100 m is consistent with the significant warming of the sea surface from 1900 to

1999. The surface warming trend during the 1900 to 1970 period was relatively weak but increased significantly in the 1970 to 1999 period, with some regions exceeding 0.2°C per decade. Models suggest that upper-ocean warming in the South Indian Ocean can be attributed to a reduction in the strength of the southeast trade winds and associated decrease in the southward transport of heat from the tropics to the subtropics.

Local and regional changes in the character of precipitation also depend a great deal on atmospheric circulation patterns determined by El Niño, the North Atlantic Oscillation (NAO),xxi and other patterns of variability. India's rainfall features show strong variability but little in the way of a century-scale trend, even as the linear trends of rainfall decreases for 1900 to 2005 were 7.5 percent in western Africa and a similar decrease was observed when averaged over the broader southern Asia region as a whole. Over much of northwestern India, the 1901 to 2005 period shows precipitation increases of more than 20 percent per century, but the same area shows a strong decrease in annual precipitation in the 1979 to 2005 period. Very dry land areas across the globe have more than doubled in area since the 1970s, an observation that has been associated with precipitation decreases related to ENSO and with subsequent increases primarily due to surface warming. The tendency of the warming to be more pronounced in winter is a conspicuous feature of the observed temperature trends over India, one that is likely to continue.

Causes of Climate Change :

Uncertainties about monsoonal changes will affect farmers' choices about which crops to plant and the timing of planting, reducing productivities. In addition, earlier seasonal snowmelt and depleting glaciers will reduce river flow needed for irrigation. The large segment of poor people (including smallholder farmers and landless agricultural workers) may be hardest hit, requiring government relief programs on a massive scale.The most important impacts of climate change will likely include the following:

- **Agriculture :** High-input, high-output agriculture will be negatively affected even as demands for food and other agricultural products rise because of an increasing population and expectations for an improved standard of living. Millions of subsistence and smallholder farmers will experience hardship and hunger through being less able to predict climate conditions. To a certain extent, trade may compensate for these deficits.
- **Water:** Glacier melt may yield more runoff in the short term but less in the medium and long terms. More severe storms (especially cyclones) will cause more damage to infrastructure and livelihoods and exacerbate salt water intrusion in storm surges. Changes in the timing and amount

of monsoon rains will make the production of food and other agricultural products more uncertain, so that, even in good-weather years, farmers will be more likely to make decisions leading to lower-productivity.

- **Exacerbation of Inequality:** The welfare of those who are affected by climate change and who have limited means to adapt may act as a force that can change governments, strain public budgets, and foster unrest. About one-third of Indians are extremely poor, and 60 percent depend upon agriculture for their livelihoods.
- **Energy:** As India searches for additional sources of energy to meet rising demand, climate change mitigation efforts may constrain its use of indigenous and imported coal, oil, and gas, while development of nuclear energy will be slow at best and likely to encounter opposition. Other non-emitting technologies will require technology transfer and capacity-building.
- **Migration:** India receives immigrants from a number of countries. Under climate change conditions, it may be flooded with many more, particularly from Bangladesh. Such migration may exacerbate tension between the two countries as well as putting a strain on Indian central and state governments.

Sustainable Economic Development

Earth's natural resources are limited. Sustainable development revolves around the consuming needs of future generations. The goal of sustainable development is to secure a good living opportunity for present and future generations, that is, we should use natural resources sustainably. A sustainable economy is based on economic decisions made by society (laws and regulations), consumers and businesses. Economic sustainability refers to balanced growth that is not based on the loss of resources or indebtedness. Economic sustainability can be achieved through efficient recycling and the use of renewable resources. In the long term, it is important for the whole world and all generations to consider the carrying capacity of the environment. This section looks at sustainable development from the perspective of each economic decision-maker.

Society plays an important role in promoting sustainable economic development. It is important to consider the environmental impact in all investments. In order to live and prosper, people need products and services (goods). A person produces the commodities needed through the factors of production. The production factors are natural resources, labor, machinery and equipment (capital). In simple terms, a

person (the labor force) produces the goods and services needed from natural resources through capital (accumulated machinery, equipment, and economic capital).

Impact of Climate Change on the Sustainable Economic Development

India, being a country in the tropical region is exposed to climatic risks and is vulnerable to climate change impacts on several sectors such as agriculture, forestry, health and biodiversity. Realizing the importance of impacts and adaptation to climate change, the Government of India has initiated studies to quantify the impacts of climate change on important sectors under the overall coordination of the Ministry of Environment and Forests since 2004.India submitted the Initial National Communication to the United Nations Framework Convention on Climate Change (UNFCCC). Subsequently, the MoEF has coordinated an Indian network for Coordinated Climate Change Assessment (INCCA) which submitted the report in 2010. The Second National Communication to UNFCCC was submitted in 2014. Keeping the importance of climate change, the Ministry of Environment and Forests is re-designated in 2015as Ministry of Environment, Forests and Climate Change, the nodal Ministry on Climate Change issues in India. It is now coordinating the work for Third National Communication to UNFCCC.

Since 1990, India as a country has moved aggressively from a centrally planned economy to private ownership of businesses and trade liberalization. It has "developed a diversified industrial base and sophisticated financial sector. Its software subsector—one of the most dynamic in the world—has experienced a sustained and rapid growth." Over the past 25 years, the annual growth rate has been 6 percent, accelerating to a five-year annual average of 8.8 percent, investment at 30 percent of GDP, and booming foreign direct investment. India has made substantial strides in fostering human capital by reducing infant mortality, increasing life expectancy, and improving literacy. The central, democratic government provides stability and some curbs to unbridled free market-ism (or barriers to growth in an alternative characterization), and hordes of entrepreneurs provide the impetus for growth.

On the positive side, India's democracy results in equity slightly higher than the global average. The dependency ratio (the percentage of the population dependent on the percentage of the population in the work force) is relatively high, indicating that many people are available for the work force, supporting relatively few people other than themselves.

However, the poor condition of people engaged in agriculture and/or born into lower castes reduces the robustness of the overall economy. Climate change, adding to existing problems of the agricultural system, may worsen conditions for the large poor segment of the population enough to severely tax the economic and industrial resources of the central and state governments.

Thus, the impacts of climate change are likely to be felt first and foremost in the agricultural sector and associated water availability, with many people affected by lower food productivity (e.g., hunger, malnutrition, and its consequences for education and productive economic life) and burdens on the central and state governments in dealing with smallholders and landless workers who will require assistance. Educational and employment inequalities will exacerbate these conditions. Some (or many) of these workers will migrate to urban areas, placing stress on cities. The need to add to or replace infrastructure affected by climate change (e.g., in the energy and transportation sectors, as well as irrigation systems) will present additional economic costs. Finally, migrants, particularly from Bangladesh, will affect India's economy by providing competition for low cost labor.

Solution to Climate Change for Sustainable Development

Despite the initial reticence of the business community, an increasing number of studies and activities show that measures aimed at dealing with global climate change are a golden opportunity for ensuring sustainable development and driving economic growth. As explained by the World Commission on the Economy and Climate in a report at the end of 2018, adopting ambitious climate measures may generate profits of USD$26 billion by 2030, creating 65 million new jobs with low carbon emissions.

According to study, to build a more resilient, beneficial growth model for people we must accelerate structural transformation in five key economic sectors:

- **Clean energy systems :**Decarbonisation of the energy system coupled with decentralised, digitised electrification technologies could give a billion more people access to modern energy services.
- **Smarter urban developments :**More compact, connected and coordinated cities would save US$ 17 billion by 2050 and stimulate economic growth by improving access to work and housing.
- **Sustainable land use :**A switch to more sustainable farming methods combined with strict forestry protection could generate economic benefits of around 2 billion dollars per year.
- **Smart water management :**In areas with a water shortage, GNP could fall by up to 6% in 2050. This could be prevented by making more efficient use of water through technological improvements and investment in public infrastructure.
- **Circular industrial economy :**Today, 95% of the value of the material from plastic packaging - up to 120 billion dollars a year - is lost after the first use. Policies that encourage more circular and efficient use of materials could improve global economic activity and reduce waste and pollution.

Conclusion

In an attempt to meet the Sustainable Development Goals, it becomes imperative to recognize that climate change, the economy, migration, and conflict are interconnected and are a function of larger global challenges. Moreover, it appears that agriculture is the main mechanism behind this interconnection. This implies that effective policies aiming at reducing the vulnerability and strengthen the resilience of agricultural communities could substantially increase the likelihood that the Sustainable Development Goals would be met by 2030. The need for new (or the redesigned old) policies and programs that foster sustainable agriculture will require creative responses that are international in scope yet tailored to unique local and regional situations. Thus, reaching the SDG targets will simply not be possible without a strong and sustainable agricultural sector.Society and government should speed up investment in sustainable infrastructure, harness the power of the private sector, boosting innovation and increasing the transparency of the value chain, and adopt a people-centric focus to ensure equitable growth and a fair transition.

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