



Measures to reduce climate change effects within climate tipping points-A review

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Abstract

Mitigation of global warming provides adaptation strategies at regional, national, and global scales, including the sustainable development in every sphere of physical life to review, analyze and stimulate the development, implementation of mitigation and adaptation strategies. Millions of people are now at risk to human rights for their right to life, water, food and health. Extreme weather events, crop failures and other emergencies related to climate change are projected to occur with greater frequency in future. Many countries are already facing increased difficulties in environmental problems due to the economic and food crises and growing populations. In practice, we can cost-efficiently achieve the goal of addressing climate change by reduction in fossil fuel, use of renewable energy and green hydrogen, sustainable transport system, climate smart agriculture, carbon farming, plantation through social and agro-forestry, organic farming and restoration of ecosystem, etc. Both the climate change adaptation and mitigation strategies significantly affect each other, therefore it is important to see what consequences of their interconnected nature can have on development. The objective of this paper is to create an awareness among the people about dangerous consequences of climate change and their probable mitigation strategies.

Keywords: climate change, mitigation strategies, renewable energy, green hydrogen, climate smart agriculture and methane

Introduction

Climate change is not a hoax. It is happening in almost all places in the world but in a slow space. Climate change mitigation strategies are also available but these measures should be taken into consideration before climate tipping points i.e. before threshold points. Climate change is due to manmade activities from the past to facilitate life style of our ancestors. It is an ongoing process happening from ancient times slowly and gradually. However, in the 20th century many argue that we have entered the Anthropocene (Crutzen and Stoermer, 2000). The different ecosystems and communities around the world are being affected by global warming at an increasing rate. It has been found that global temperatures rose about (1.1°C) from 1901 to 2020 resulting in damaging consequences for sea level rise. In addition, there are changes in weather patterns like the occurrence of flood drought and much more leading to disrupting activities in social life including health. Global warming again aggravated by mis-utilization of water, energy, transportation, wildlife, agriculture, ecosystems and faulty practices regarding industry development. We are living in society so the impacts of climate change on different sectors of society are interrelated which are reflected in our daily life. The extreme drought and flooding can damage the ecosystem and infrastructure and influence harm in food production and human health. Climate change greatly influences food availability and limits worker activity and increases human diseases and mortality in general and vulnerable society due to environment pollution in particular. It has been observed that the impacts of climate change are uneven across the society (neighborhoods or individuals), country and even in the world. The scientists and policymakers of the world believe that there is still time to avoid the most negative impact of climate change by reducing emissions to zero (Net Zero) as early as possible. Correcting measures and adoption of strategies are being taken at a slower pace as compared to changes happening. So we have to expedite adopting climate change mitigation strategies as quickly as possible and before tipping point after that correcting measure will not be effective.

Fast changing phenomenon of the world

According to (NOAA, 2021)

- Global temperatures rose about 1.8°F (1°C) from 1901 to 2020.
- Sea level rise has accelerated from 1.7 mm/year throughout most of the twentieth century to 3.2 mm/year since 1993.
- Since 1980, the arctic glaciers have been shrinking. In a study of average thickness of 30 well-studied glaciers revealed that there has been marked decrease in thickness about more than 60 feet (loss).
- The area covered by sea ice in the Arctic at the end of summer has shrunk by about 40.0% since 1979.
- The amount of carbon dioxide in the atmosphere has risen by 25.0% since 1958, and by about 40.0% since the Industrial Revolution.

- Due to warming of the atmosphere, arctic snow is melting earlier compared to long-term averages. To protect our future generation from severe consequences of global warming and climate change, we have to do the following work or to adopt the following points.

1. Minimum use of fossil fuel

Burning fossil fuels like oil, coal, and gas, we expedite the current global warming crisis as well. Fossil fuels produce large quantities of carbon dioxide, which trap heat in the atmosphere and lead to climate change. The burning of fossil fuels, particularly from power and transportation sectors, accounts for major carbon emissions into the atmosphere. Fossil fuels also emit dangerous mercury emissions, sulfur dioxide emissions, which contribute to acid rain and the vast majority of soot i.e. particulate matter in our air. So we have to think of alternative sources of energy over fossil fuel in the near future.

2. Encouragement in Renewable Energy

Energy derived from natural resources is called renewable energy which replenishes themselves in less. Sunlight, wind, rain, tides, waves, biomass and thermal energy stored in the earth's crust are the valuable sources of renewable energy that we have. They are virtually inexhaustible and cause little climate or environmental damage. Renewable energy from wind, solar (Fig-1), geothermal, hydroelectric, and biomass provides substantial benefits for our climate and our health and is very cost effective. We can use them effectively by implementing favourable government policies for our people.



Fig 1: 30-GW renewable energy park, Gujarat (Internet source)

3. Shift to sustainable transport.

In 1992, the outcome document-Agenda 21 of the United Nation's Earth Summit emphasized the role of transport in sustainable development. Meanwhile, fossil fuel-powered cars, trucks, and boats are the main contributors of poisonous carbon monoxide and nitrogen oxide, which produces smog (and respiratory illnesses) on hot days over the total transport system of the world. Carbon dioxide (CO₂), carbon monoxide (CO), nitrogen dioxide (NO₂), sulphur dioxide (SO₂) and methane (CH₄) are the main pollutants and other greenhouse gases which contribute mainly to global warming effects by trapping heats from the solar system and ultimately resulting in climate change phenomenon. Sustainable transport sector must be developed where effective public interventions to reduce CO₂ emissions are needed. The adaptation measures are needed to reduce the vulnerability to climatic changes. Recent research reports show that the CO₂ emissions in the transport sector are about 30.0% in the case of developed countries and about 23.0% in the case of the total man-made CO₂ emissions worldwide. In UN Framework Convention on Climate Change (UNFCCC), there was a consensus to reduce CO₂ emissions by a minimum of 50% from transport at the latest by 2050. Regarding economic growth and accessibility, sustainable transportation can be adopted. Sustainable transport system could achieve better integration of the economy of a country while respecting the environment and natural resources. For achieving better social equity, health, resilience of cities, urban-rural linkages and productivity of rural areas, a sustainable transport system using solar or electric cars, buses and other vehicles are the most effective. For the achieving our target the following steps to be taken into consideration

- Launching of electric (Fig-2) and solar vehicles, Advanced engine management systems with innovative vehicle technologies, and efficient vehicle power trains, etc.
- The use of sustainable biofuels, not only of the first generation but also of the second and third generations i.e. biodegradable fuels from algae.

- Development of an improved transport infrastructure together with Intelligent Transport Systems (ITS) to avoid traffic congestion.
- For awareness, consumer information should be made public (campaigns for eco-driving)



Fig 2: Pollution-free transport started (Delhi/India), 03 Nov 2018 (Internet source)

4. Refurnish Your Homes

To reduce global warming, the use of LED bulbs and tubes and other appliances are very effective. If your homes still run on CFL bulbs, change them with LED bulbs and other electric appliances. You can take individual climate action by adopting LED lighting, which is one of the most cost-effective ways to consume very little electricity and in addition these last long. By this way, you would increase your home's energy efficiency and save your electricity bills.

5. Improve Farming and Encourage Vegan Diets.

Climate change causes rising temperatures resulting in droughts, heat waves, and storms, making it harder to grow crops and raise livestock in recent times. The good news is that organic systems of farming emphasize keeping soil healthy and help farmers and ranchers to increase resilience to the impacts of changed climate. Organic farming captures and stores more carbon (CO_2) in the soil (carbon sequestration) (Fig-3, 4). They also release fewer greenhouse gases to the environment. Healthy soils form the foundation of organic production and lead to sustainable crop production. As a result of organic farming, healthy soils with structure (tilth) allows to absorb and hold moisture, drain well, maintain adequate aeration, and foster deep and healthy crop root systems. Healthy soil from organic farming sustains future crops through dry spells, require less irrigation water, and undergo less ponding, runoff, and erosion from further heavy rains. Animal farming which causes methane emission should be reduced. Dependency on animal foods should be minimized. We should shift our food pattern to vegan diets. Reduction of dairy farming is also reducing CH_4 production. In addition, Biogas fuel production may be encouraged.



Fig 3-4: Organic farming moong followed by makhana, at RCM, Darbhanga, Bihar.

6. Climate Smart Agriculture and Carbon Farming.

Agriculture currently generates 19–29% of total greenhouse gas (GHG) emissions. It is a part of climate change. Additionally, 1/3 of food produced globally is either lost or wasted. So grow and consume food according to the need to reduce stress on the environment. Climate-smart agriculture (CSA) is an integrated approach to managing landscapes with special reference to cropland, livestock, forests and fisheries to ensure food security and reduce climate change. Smart agriculture practices help in achieving both the challenging tasks without any disturbance to the environmental system. These practices include eco-friendly practices that control the rate of land degradation and soil fertility loss due to drought, salinity, water-logging, and soil erosion. The recent research reports revealed that agriculture sector plays a critical role in GHGs mitigation by lowering the 10.0% of N₂O emission, 42.0% by carbon offset through biofuel production, 32.0% by absorbing CO₂ emission, and 15.0% by reducing methane emission (IPCC, 2007, Arif *et al.*, 2020) ^[5]. Increased productivity, enhanced resilience and reduce emission are the major objectives of climate smart agriculture.

- Increased productivity with improved varieties, smart irrigation practices, and reduced post harvest losses is the need of the hour. Production of more and quality food to improve nutrition security and combat malnutrition and boost incomes are now on focus. It has been explored that 75.0 percent of the world's poor live in rural areas. These huge populations mainly rely on agriculture and allied sciences for their livelihoods.
- According to climate change, enhanced resilience related to crop performance has immense scope. The sincere and hard efforts are needed for reducing vulnerability to flood, drought, pests, diseases and other climate-related risks.
- Reducing emissions is the prime objective, like pursuing lower emissions for each calorie or kilo of food produced, avoiding deforestation from agriculture and identifying ways to absorb carbon out of the atmosphere.
- Farmers should adopt or cultivate the crop or crop varieties according to the changed weather and climate of the local areas.
- Zero tillage technology, eliminating burning of crop residue and carbon farming must be adopted. Carbon farming is a new way of farming to sequester atmospheric carbon in the soil. Carbon that otherwise ends up as CO₂ in our atmosphere, causing climate change must be absorbed by the plant as much as possible. More carbon is sequestered, (about 1/3rd amount) up 15.0 cm soil depth. Small adjustments on farm level- like applying fertilizers rich in carbon, reduced or no-tillage, or planting cover crops. The cultivation of fruit based multitier cropping system (Fig-5) and the agro-forestry successfully stored or converted atmospheric CO₂ into the organic form.
- New thrust in research must be given to climate smart agriculture particularly in India. Expedition of the present agricultural research including agronomic practices, breeding, production technology development, resource management innovation, etc. are important for increasing yield and also increases the resilience to the climate change problems, which leads to extreme heat and precipitation, pest, and crop disease. The economically important crops such as oilseeds, pulses and soybean, vegetables are more vulnerable to climate change. Hence, the advanced agricultural research may directly improve efficiency and boost crop productivity along with reducing the impact of climate change on the farming systems all over the world.



Fig 5: Fruit based multitier cropping system, Jharkhand, India

7. Introduction of short duration and productive wetland crop varieties

Wetland crops are rice, water chestnut, makhana and some leafy vegetables like ipomoea and helecha. Long duration varieties, requiring more water which emits more methane from the wetland. Short duration varieties

and their agronomic management may reduce significant CH₄ emission. There are several rice varieties available in India. We are giving examples of some of the short duration varieties like ADT-36 ADT-37, ASD-16, ADT-43, ADT-45 for Tamil Nadu; IET-17430, Asu and Ashoka for W.B.; CR Dhan 40, Anand, Ajoy, Kiran for Odisha; Abhishek (Fig-6) Anjali, Bandana (Fig-7) and for Jharkhand and IET 15644, Nellore Mashuri and Swetha for Andhra Pradesh. Field based organic makhana and red water chestnut cultivation and short duration fishery are also helpful in this regard. Community based approach and pilot projects to more production from short duration crops and fisheries are essential for eco-friendly wetland agriculture.



Fig 6-7: Short duration rice variety Abhishek and Bandana in Jharkhand.

8. Drainage of polluted and excess water

After doing agriculture, excess water must be drained to the river or other outlets. It will reduce the methane (CH₄) production from the wetland ecosystem. Polluted water from unused ponds and lakes reduces methane production and risk of onset of different diseases when the quality of river water or stagnant fresh water deteriorates, it contributes to global warming and can go up an order of magnitude. According to Keegan (2021), microbes break down various forms of carbon and nitrogen they receive usually through respiration (aerobic or anaerobic) resulting in release of methane and N₂O. Research reports show that when the quality of water of rivers and stagnant pools are deteriorated, the concentration of CO₂ and CH₄ are increased even tenfold while N₂O concentrations are boosted by almost 15.0 times. Living streams are useful. Excess freshwater from lakes and ponds must be drained off as early as possible. Community based approach and new Government policies related for reducing CH₄ emission are essential to combat climate change effects.

9. Judicious use of electrical energy

Through the combustion of fossil fuels, approximately 40.0% of global CO₂ emissions are emitted from electricity generation to generate heat needed to power steam turbines. The viable alternative is to implement the Smart Grid (SG) that can be regarded as a vision, a concept, a framework, or an umbrella for a modernized, evolutionary, next generation step of our electrical power system. One of the major goals is decarbonizing the planet or countries that are part of the world, which have been set for up to 2050. In the process of decarbonising, the production of an element like hydrogen which is so called green hydrogen, is the key, as this is currently responsible for more than 2.0 % of total global CO₂ emissions. Our way of life needs an increasing amount of watts to function with less CO₂ emissions. The latest estimates of International Energy Agency (IEA) (2019), predict that global energy demand will increase by between up to 30.0 % by 2040. For that much energy, if we go for coal and oil the economy will be weakened and the planet will be having more CO₂ that exacerbates more pollution and serious climate change. However, decarbonising the planet suggests a different world in 2050, which will be more costly but one that is more accessible, efficient and sustainable, and driven by clean energies such as green hydrogen. In nature, hydrogen is the most abundant chemical element but it is highly inflammable, so storage requires more care. According to the IEA's statement, the global demand for hydrogen for use as a fuel has tripled since 1975 and reached 70.0 million tonnes a year in 2018. The special feature of green hydrogen is that it is a clean energy source that only emits water vapour and leaves no residue in the air, unlike coal and oil.

The long-standing relationship of Hydrogen with industry is well known to us. Since the beginning of the 19th century and till date, this gas has been used to fuel cars, airships and spaceships. The concept of the decarbonisation of the world economy provides an ample opportunity and a process that cannot be postponed, that usher in a more prominent role of green hydrogen in future. The prediction of the World Hydrogen Council is that its production costs fall by 50.0 % by 2030.

Then, it will undoubtedly be looking at one of the most important fuels of the future in mitigating several climate change effects. The new government policies related to utilizing green hydrogen are important in the near future. If we go for individual duties, we will advise the consumer that uses only the electric light and power as and when required. Do not spend more power as luxury. Everyone should take action to minimize global warming.

10. Restoration of the ecosystem by planting and maintaining greenery

Of late we are experiencing the rapid global climate change and are intimately entwined with the health problems and changes in the proper function of the biosphere. Climate change is impacting ecosystems through the increased ocean acidification by absorbing atmospheric carbon dioxide concentrations (Malhi *et al.*, 2020) [8]. Due to burgeoning population and rapid civilization pressures on natural freshwater ecosystems, including degradation, defaunation and fragmentation, resulted in threatening of livelihood security of rural people. Due to climate change some living ecosystems become hotspots of vulnerability and resilience. Ecosystem restoration by planting suitable plants (Fig-8, 9), preventing pollution and developing eco-resorts, we can reduce climate change effects. Furthermore, maintaining a diverse, resilient and well-functioning biosphere is the need of the hour. Wetland proves more methane (CH₄) (Walter *et al* 2006) [14] and biogas provides more NO₂ by combustion (Thomson *et al.*, 2019). Social forestry and agro-forestry (Fig-10) must be taken into consideration for dry land or semi dry land ecosystems. Community based approaches by the local government may play an important role to address the issues of the climate change effects.



Fig 8-9: Restoration of ecosystem of plateau at Jharkhand, India.



Fig 10: Restoration of ecosystem in agro-forestry system, A.P., India (Internet Source)

11. Maintenance of cleanliness and avoid burning of disposed substances

Several scientists suggest that improving water, soil and air quality really can make a significant difference. Clean cultivation produces quality crops which can fetch more money from trading and ensure quality food to the consumer. Due to rapid urbanization, waste production rates have increased in recent years. Civic waste and agricultural waste are generally burnt, which leads to the production of greenhouse gases. An estimated 41.0% of global waste is burned openly. An estimated 620.0 million tons of waste per year are burned openly (Cogut, 2016). It has been found that in developing, low income countries that figure is even higher and the process is not controlled. Nowadays, disposed matters are very huge in quantity, therefore, fires are either started intentionally or occur spontaneously to reduce waste volume and thereby reduce health hazards. Burning of the waste leads to production of various toxic pollutants into the air and also can exacerbate soil and water pollution and thereby food contamination. In addition a significant amount of greenhouse gases are pumped into the atmosphere every year. Besides, polycyclic aromatic hydrocarbons, dioxins and furans, all of which are carcinogenic, cause many health problems including respiratory diseases or complications. Countries such as China, India and Brazil that are large generators of waste and still use faulty practices to reduce waste. Creating a well-executed waste collection program, or disposal mechanism is needed. Worldwide consensus should be

developed about disposal of waste materials. So alternative ways to burn like solid waste management through the production of biogas and thereby organic fertilizer are necessary.

12. Maintenance of peace among nations and avoiding war

War often leads to environmental pollution by producing more CO₂ SO₂ and NO₂ and other toxic gases which traps heat energy resulting in quick global warming. Even when an atomic bomb is exploded, plutonium in the device undergoes fission and releases enormous amount of heat energy (10.0 million °C) (Parmar, 2022) [11]. Electromagnetic radiation destroys various life forms of an ecosystem and damages buildings and different cultural heritages. Peace among the nation must be maintained and avoided the war (Fig-11) that causes havoc damages in civic amenities and various life forms. Instead of war we should take climate action now (Fig-12) to save the world from impending danger from global warming.



Fig 11: Indian embassy in Ukraine



Fig 12: Peace and climate action (Photo: Climate Reality Hub)

Future perspectives

- To create attention of the local as well as state government about the importance of stopping global warming and invoke policies for rectification. Media can contribute to climate change mitigation by educating citizens about climate change such as about some of the reasons for mitigation, even advertising and journalism also advance the climate emergency in various ways (Boykoff and Maxwell, 2011 and Hart, 2015) [1, 15].
- Correcting measures must be taken with threshold points i.e. climate tipping points. We have the opportunity to live decently with minimum resources and very much with existing resources (Millward-Hopkins, 2020) [9].
- Every Government should take policies to control of global warming to give clean air, water and soil to future generation.
- Every country should set a net zero emission target in the future, eg., for the USA net zero by 2050 and India by 2070.
- Climate action can lessen poverty and inequality worldwide by keeping communities safe from global warming and extreme weather and creating communities of well-being, reducing inequality and alleviating poverty, if each country imposes a substantial carbon tax that could be used to benefit the poor (Swenarton, 2021).
- To combat global warming is a gigantic task, so everyone must think of making their environment clean and healthy by sincere efforts which are applicable to them.

Conclusion

Severe consequences of the climate crisis can be resolved if we take preventive measures within the climate tipping point to avert reverse reactions. Implementations of different strategies, conduct awareness raising, outreach, education and training for major groups and to promote clean and better environment are very much essentials.

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