



INFLUENCE OF CLIMATE CHANGE ON BALANCED ECOSYSTEM, BIODIVERSITY AND SUSTAINABLE DEVELOPMENT: AN OVERVIEW

Ashok Kumar Verma

Department of Zoology,
Government Post Graduate College Saidabad, Prayagraj (U.P.), India

*Corresponding author: akv.gdcz@gmail.com

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Abstract: Earth's climate is always changing and the world is heating up. The increasing concentrations of greenhouse gases in the Earth's atmosphere are causing the planet's climate system to retain more energy and therefore global warming. The main cause of global warming is anthropogenic. As a consequence, the dangers become big for our native plants, animals and humans as well. Nowadays, global warming and climate change are imparting an insurmountable challenge for the entire biota including humans. Natural ecosystems are one of our most precious resources, critical for sustaining life on the Earth. Healthy ecosystems and rich biodiversity are fundamental to life on our planet for sustainable development. Climate change is already influencing every region on Earth, in multiple ways. Some of such influences of climate change on the balanced ecosystem, biodiversity and sustainable development are discussed here.

Keywords: Biodiversity, Climate change, Ecosystem, Human activities, Sustainable development.

INTRODUCTION

Climate is the usual weather of a place, can be different for different seasons. A place might be mostly warm and dry in the summer. The same place may be cool and wet in the winter. Different places can have different climates. Weather describes the conditions outside right now in a specific place. For example, rain, snow, wind etc. are the weather events. It might rain one day and be sunny the next, sometimes it is cold and sometimes hot. Weather changes from place to place. It can change in just a few hours. Climate, on the other hand, is more than just a few hours, one-two days, weeks and describes the weather conditions that are expected in a region at a particular time of year or average weather in a place over many years.

Climate is not static but rather a fairly dynamic kind of thing. To a lesser or greater degree, it is ever-changing (Lal, 2015). Climate change is the global phenomenon of climate transformation characterized by changes in the usual climate of the planet mainly due to anthropogenic activities (You matter, 2020). Global climate change refers to the average long-term changes over the entire Earth. The Earth is now in a period of rapid climate change, with global temperatures rising (NASA, 2014).

Climate change is a broad term used to refer to changes in the Earth's climates, at local, regional, or global scales, and can also refer to the effects of these changes on the ecosystem, biodiversity and human being. Climate changes typically take

many thousands of years; hence, human civilization has evolved during a period of relatively constant climate. It does mean that buildings, urban areas, and even human physiology are not well adapted to relatively rapid changes in climate over several decades or centuries (Kershaw, 2017). The impacts of climate change on people and nature are increasingly apparent. Unprecedented flooding, heat waves, and wildfires have cost billions in damages. Habitats are undergoing rapid shifts in response to changing temperatures and precipitation patterns (NAS, 2020). Beyond this, the various effects on populations are likely to modify the web of interactions at the community level. In essence, the response of some species to climate change may constitute an indirect impact on the species that depend on them (Prakash and Srivastava, 2019).

Climate change is bringing multiple different changes in different regions, which will all increase with further warming. The world's climate is changing, and it will continue to change throughout the 21st century and beyond (IPCC, 2021). Climate change in the current era is expected to be exceedingly rapid, likely at least 10 times faster than the global warming that occurred after the last ice age. The changes we experience will increase with additional warming. The global average means surface temperature for the period from 2017-2021 is among the warmest on record, estimated at 1.06 °C to 1.26 °C above pre-industrial (1850-1900) levels. In every year from 2017 to 2021, the Arctic average summer minimum and average winter maximum sea-ice extent were below the 1981-2010 long term average. In September 2020, the Arctic sea-ice extent reached its second-lowest minimum on record (WMO, 2012).

The five key signs of climate changes are (a) increase in global concentration of carbon dioxide and other greenhouse gases, (b) increase in global surface temperature, (c) decline of the arctic sea ice, (d) decrease in land ice and (e) rise in sea level. In this present review article, the author tried to explain certain influences of climate change on the balanced ecosystem, biodiversity and sustainable development.

GLOBAL WARMING AND CLIMATE CHANGE

Global warming and climate change are not synonyms, contrary to popular belief. Global warming refers only to the rising temperature of the Earth's surface whereas climate change includes the 'side effects' of warming such as the glaciers melting at a faster rate, sea levels rising, cloud forests dying, heavier rainstorms, or more frequent drought (Kennedy and Lindsey, 2015). In other words, global warming is one symptom of the much larger problem of human-caused climate change.

There is a long-term global warming trend and not all areas of the world are warming equally. Warming is more noticeable over land than over water and towards the poles. The Arctic is warming 2.8 times faster than the rest of the Northern Hemisphere (Box *et al.*, 2019). Increasing temperatures also lead to the melting and shrinking of glaciers. Glaciers are shrinking five times faster now than they were in the 1960s (Zemp *et al.*, 2020). The temperature of the oceans has also risen by an average of 0.11 °C each decade between the years 1971-2010 (IPCC AR5, 2014). Warming has increased crop yield in some high-latitude areas because the higher concentration of carbon dioxide in the atmosphere acts as a fertilizer so that plants can manage their water more efficiently (Daliakopoulos *et al.*, 2017). The world is currently on track for a rise of between 6.3° and 13.3°F, with a high probability of an increase of 9.4°F by 2100 (Climate Central, 2012).

THE ANTHROPOGENIC GREENHOUSE EFFECT

John Tyndall (1820-1893) was a prominent 19th-century Irish physicist, who made discoveries in the realms of infrared radiation and the physical properties of air, proving the connection between atmospheric CO₂ and what is now known as the greenhouse effect in 1859 (Baum, 2016). Tyndall discovered that the most common components of the atmosphere *i.e.* nitrogen and oxygen were transparent to both visible and infrared radiations. Whereas gases such as carbon dioxide, methane, and water vapour were not transparent in the infrared and concluded that such gases must have a great influence on our climate (Kershaw, 2017).

Climate change is mainly due to global warming and the main cause of global warming is the enhanced greenhouse effect due to anthropogenic activities. The greenhouse effect is a natural phenomenon that is essential to maintain the temperature of the earth at a normal habitable level. The appropriate temperature at the earth surface is maintained by the energy balance of the sun rays that strike the earth and heat that is radiated back into space. Five major gases *namely* carbon dioxide (CO₂), methane (CH₄), water vapour, nitrous oxides (N₂O) and chlorofluorocarbons (CFCs) absorb the solar radiations, act as a blanket spread over the earth surface and increases the temperature of the environment (Gupta, 2017). These are called greenhouse gases.

In nature, CO₂ is exchanged continually between the atmosphere, plants, and animals through photosynthesis, respiration and decomposition, and between the atmosphere and ocean through gas exchange. A very small amount of CO₂ (roughly 1% of the emission rate from fossil fuel combustion) is also emitted in volcanic eruptions, which is balanced by almost an equivalent amount removed through the chemical weathering of rocks. The additional CO₂ from fossil fuel burning and deforestation has disturbed the balance of the carbon cycle, because the natural processes that could restore the balance are too slow compared to the rates at which human activities are adding CO₂ to the atmosphere (NAS, 2020). As a result, a substantial amount of the CO₂ emitted from human activities accumulates in the atmosphere thereby increasing the greenhouse effect. However, Covid-19 followed by lockdown caused only a temporary reduction in carbon emissions.

Unfortunately, human activities like the burning of fossil fuels, unsustainable agriculture, deforestation, industrialization, unplanned urbanization, natural wetland destruction, indiscriminate development etc. are badly involved in the thickening of the blanket of greenhouse gases that prevents the heat from being re-radiated in outer space. The thicker blanket due to the increasing concentration of greenhouse gases has disturbed the climate

equilibrium of the globe. This is the enhanced greenhouse effect, responsible for global warming. The global average temperature has risen by around 0.8 °C since 1880 (IPCC AR5, 2014).

CLIMATE CHANGE AND BALANCED ECOSYSTEM

The interaction of matter and energy forms a system of abiotic (non-living) and biotic (living) components. The abiotic components are non-living chemical and physical parts of the environment while biotic components include plants, animals and microbes. The living organisms are unique and different from non-living as they display growth, metabolism, respiration, reproduction and consciousness (Verma, 2017a). An ecosystem is a set of life forms (biotic components) interacting with one another and with the non-living elements (abiotic components) of their environment. The ecosystem is, therefore, a community of organisms and their physical environment interacting together (Ashok, 2016). The system of abiotic and biotic components together constitutes an ecosystem. Almost every ecosystem maintains its environmental insurance system (Maser, 2009).

An ecosystem has two processes to maintain the ecological balance *namely* (a) the cyclic flow of materials from the abiotic environment to the biosphere and then back to the abiotic environment and (b) upholding the equilibrium of interaction inside food webs. Both these processes must be maintained in the ecosystem and any interference with these cycles disrupts and affects ecological balance (Verma, 2018).

The effects of climate change on balanced ecosystems threaten to jeopardize the numerous economically valuable goods and services that ecosystems provide to human societies. In some cases, climate change directly influences economic returns by affecting harvest levels. Ultimately, the value of ecosystems must also be considered in the form of moral, cultural, and aesthetic levels. Efforts to lessen the detrimental effects on species and ecosystems from climate

change should focus on maintaining habitats as well as on maintaining overall ecosystem structure and species composition (Malcolm and Pitelka, 2001).

The rapid anthropogenic climate change that is being experienced for few decades is intimately entwined with the health and functioning of the ecosystem. Climate change interacts with other pressures on ecosystems such as demographic increase, huge and indiscriminate exploitation of natural resources, urbanization, widespread industrialization, deforestation and so on (Malhi *et al.*, 2020). There is a need to understand the ecological dynamics of these climate impacts, to maintain the ecosystems in a balanced state (Verma, 2017b), which is necessary for flourishing the biotic components including humans. Climate change due to global warming is not beneficial for a balanced ecosystem. Even a small change in average temperature can have a significant effect on ecosystems. The interconnected nature of ecosystems means that the loss of species can have knock-on effects upon a range of ecosystem functions (AAS, 2021).

CLIMATE CHANGE AND BIODIVERSITY

Rich biodiversity and healthy ecosystems are fundamental to life on our planet. Biodiversity or biological diversity refers to the existence of a wide variety of plant and animal species in their natural environments or the diversity of plant and animal life in a particular habitat. The biodiversity is explored and described normally at three levels *namely* ecosystem diversity, species diversity and genetic diversity. The ecosystem diversity is the diversity of habitats, which includes the different life forms within. Species diversity refers to the variety of species within a region. Genetic diversity is the diversity of the basic units of hereditary information (genes) within a species, which are passed from one generation to the next.

Genetic diversity acts as a shock absorber and buffers in biodiversity (Verma, 2017c). The climate change can decrease the genetic diversity of populations due to directional selection and rapid migration, which could, in turn, affect ecosystem functioning and resilience (Botkin

et al., 2007). In general, biodiversity loss is not good for the globe as it disturbs the ecological balance (Kumar and Verma, 2017). Climate change has a clear cut impact on biodiversity (Arya, 2019; Prakash, 2021). Biodiversity is declining at a rapid pace, and species extinction rates have also accelerated. The loss of biodiversity is one of the most critical current anthropogenic problems, threatening valuable ecosystem services and human well-being (Ceballos *et al.*, 2015).

Due to anthropogenic activities, once-extensive plant communities have been reduced in size and broken into smaller patches. This habitat reduction and fragmentation pose a problem because it limits the ability of many species to migrate to areas with favourable conditions. Species on mountain-tops, peninsulas and islands will have a similar problem. In general, those species with restricted climatic envelopes, small populations and limited ability to migrate are most likely to suffer in the face of rapid climate change. Some species, primarily microorganisms and invertebrates with short generation times, might be able to adapt to changing conditions or evolve in response to climate change but a large number of species have adverse influence on their physiology (AAS, 2021). There is a need to increase our understanding of the effects of climate change on biodiversity, and make a practical action plan to mitigate such effects.

CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT

Sustainable development means 'meeting the needs of the present without compromising the ability of future generations to meet their own needs'. It is a complex and broad-based concept that includes: (a) economic sustainability, (b) ecological sustainability, (c) social sustainability and (d) cultural sustainability. Sustainable development has both intra-generational and inter-generational equities and several approaches and the principles that it incorporates are directly or indirectly applicable to developmental activities (Verma, 2019).

The conservation of natural resources refers to the management of their maximum use to the present

generation while maintaining its potential to meet the requirements of future generations. This newer concept of development has come to be known as 'Sustainable Development', which is defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. This definition was given by the Norwegian Prime Minister, Gro Harlem Brundtland (1987), who was also the Director General of the World Health Organization (WHO) from 1998-2003.

Some significant measures for sustainable development include (a) use of eco-friendly and appropriate technology, (b) reduce, reuse and recycle approach, (c) promotion of environmental education and awareness, (d) improvement in social, cultural and economic dimensions, and (e) resource utilization as per carrying capacity. In order to achieve sustainable development, everyone has to understand the eco-centric worldview, which states that the earth resources are limited and belong to all the species that exist in nature. Though humans have the right to draw their requirements from the natural resources but certainly not to the extent that degrades the environment and harms other species and living beings.

The 2030 agenda for Sustainable Development with 17 Sustainable Development Goals (SDGs) and 169 associated targets encompasses a comprehensive developmental agenda integrating social, economic and environmental dimensions. This Agenda is a plan of action for people, the planet and prosperity. It also seeks to strengthen universal peace in larger freedom. The 2030 Agenda for sustainable development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future (UN, 2015).

CONCLUSIONS

Human activities are the main cause of global climate change. In nutshell, one can say that we have reached a tipping point on the need for climate action. The disruption to our climate and our planet is already worse than we thought, and

it is moving faster than predicted. Covid-19 followed by lockdown since has caused a temporary reduction in carbon emissions and recovery process; hence Covid-19 recovery efforts should be aligned with national climate change and air quality strategies to reduce risks from cascading climate hazards.

To achieve sustainable development, humans should (a) aware of the environmental ethics and danger of greenhouse gases, global warming and climate change, (b) minimize anthropogenic activities, (c) provide water, sanitation, sustainable energy and healthy life to all by promoting inclusive education and development, (d) care for earth, environment, ecosystem and biodiversity and facilitate the environmental peace and harmony with equity between the countries and continents across the globe.

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