

Climate Change, Global Warming and Depletion of Ozone Layer

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Abstract

Climate change is the most critical and controversial issue facing the world in the twenty-first century. An abrupt climate change has occurred throughout the world. Alternately referred to as global warming, it refers to the rise in average surface temperatures on earth. Earth's global mean surface temperature has increased by about 1.0 c over the period 1880-2015. One of the main causes is thought to be the increase in atmospheric greenhouse gases. If greenhouse gas emissions are not decreased, several studies indicate that there will be a dangerous anthropogenic interference with climate within 40 years. The main source of global climate change is human-induced changes in atmospheric composition. There is still considerable uncertainty about the rates of change that can be expected and there is no good quantitative measure to determine when it is "too late" to start reducing greenhouse gas emissions in order to avoid dangerous consequences. The problem is that 'climate change' is no longer just a scientific concern, but encompasses economics, sociology, geopolitics, national and local politics, law and health just to name a few.

Introduction

The topic of global warming and climate change are currently being discussed widely in all modes of media. It is the most controversial and critical issue facing the world in the twenty-first century. Not a day passes when there is no coverage, no discussions on these topics. Discussions are also taking place on the related question resource limitations, given the manner in which humans are using the planet's limited resources.

The purpose of the paper is to provide some background of climate change, its impacts, current and future problems and the worldwide efforts that are being made to minimize the risks. The issues involved are complex. However, considering the fact, a large majority of the

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climate science community agrees that consequences posed by climate change are serious and could cause disastrous consequences if immediate action is not taken. The different sectors of the economy have been examining some risks and some different views do exist on way to mitigate its adverse effect.

Climate Change

Climate change is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time (i.e., decades to millions of years). Climate change may refer to a change in average weather conditions, or in the time variation of weather within the context of longer-term average conditions. Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, plate tectonics, volcanic eruptions. Since the industrial revolution (i.e.1750), humans have contributed to climate change through the emissions of GHGs and aerosols and through a change in land use, resulting in the rise of global temperatures. Increases in global temperatures may have different impacts, such as an increase in storms, floods, droughts, ice sheets, sea ice, and glaciers. Although the scientific community has been aware of the link between greenhouse gases and climate change for many years, world leaders have been slow to react and implement measures to mitigate the risks.

Key sources of information on climate change are synthesised by the successive reports of the Intergovernmental Panel on Climate Change (IPCC) created by the United Nations and the World Meteorological Organization in 1998. The prevalent view is that there is a significant anthropogenic contribution to the increase in atmospheric CO₂ and other GHGs resulting from fossil fuels emissions and deforestation.

In 1970, a paper by the club of Rome pointed out that limited planet resources cannot support unlimited exponential growth. By some estimates, we are now using 50% more resources than the sustainable level. The 8 billion population projected by 2030 is twice the 4 billion the earth had to feed as recently by 1974. Global warming is exacerbating the sustainability challenge as it may reduce agricultural production and will result in physical damage resulting from extreme weather events, sea-level rise, etc.

Climate change: how do we know?

“Scientific evidence for warming of the climate system is unequivocal”

- Intergovernmental Panel on Climate Change.

The Earth's climate has changed throughout history. Just in the last 650,000 years, there have been seven cycles of glacial advance and retreat, with the abrupt end of the last ice age about 7,000 years ago marking the beginning of the modern climate era and of human civilization. Most of these climate changes are attributed to very small variations in Earth's orbit that change the amount of solar energy our planet receives.²

The current warming trend is of particular significance because most of it is extremely likely (greater than 95 percent probability) to be the result of human activity since the mid-20th century and proceeding at a rate that is unprecedented over decades to millennia.

Earth-orbiting satellites and other technological advances have enabled scientists to see the big picture, collecting many different types of information about our planet and its climate on a global scale. This body of data, collected over many years, reveals the signals of a changing climate.

The heat-trapping nature of carbon dioxide and other gases was demonstrated in the mid-19th century. Their ability to affect the transfer of infrared energy through the atmosphere is the scientific basis of many instruments flown by NASA. There is no question that increased levels of greenhouse gases must cause the Earth to warm in response.

Ice cores which are drawn from Greenland, Antarctica, and Tropical Mountain glaciers show that the Earth's climate responds to changes in greenhouse gas levels. Ancient evidence can also be found in tree rings, ocean sediments, coral reefs, and layers of sedimentary rocks. This ancient, or pale climate, evidence reveals that current warming is occurring roughly ten times faster than the average rate of ice-age-recovery warming³.

² *Climate change: How do we know?*, GLOBAL CLIMATE CHANGE, NASA climate.nasa.gov/evidence/.

³ Paul Przyborski, *How is Today's Warming Different from the Past?*, EARTH OBSERVATORY, NASA. <https://earthobservatory.nasa.gov/Features/GlobalWarming/page3.php>.

What is Global Warming?

Global Warming, also referred to as climate change is the observed century-scale rise in the average temperature of the Earth's climate change⁴ and its related effects⁵. Multiple lines of scientific evidence show that the climate system is warming⁶. Many of the observed changes since the 1950s are unprecedented in the instrumental temperature record which extends back to the mid-19th century, and in pale climate proxy record covering thousands of years.⁷

In 2013, the Intergovernmental Panel on Climate change (IPCC) Fifth assessment report concluded that "It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century⁸." The largest human influence has been the emission of greenhouse gases such as carbon dioxide, methane, and nitrous oxide climate model projections summarized in the report indicated that during the 21st century, the global surface temperature is likely to rise a further 0.3 to 1.7 °C (0.5 to 3.1 °F) in the lowest emissions scenario, and 2.6 to 4.8 °C (4.7 to 8.6 °F) in the highest emissions scenario⁸, These findings have been recognized by the national science academies of the major industrialized nations⁹ and are not disputed by any scientific body of national or international standing.

Process of Global Warming

The earth receives energy through radiation from the Sun. GHGs plays an important role in trapping heat, maintaining the earth's level that can sustain life. This phenomenon is called the greenhouse effect and is natural and necessary to support life on life. Without the greenhouse effect, the earth will be cooler than it is today.¹⁰ In recent centuries, humans have contributed to an increase in atmospheric GHGs as a result of increased fossil fuels burning

⁴ Oxford English Dictionary, https://en.oxforddictionaries.com/definition/global_warming.

⁵ Justin Gillis, *Short Answers to Hard Questions About Climate Change*, NEW YORK TIMES, <https://www.nytimes.com/interactive/2015/11/28/science/what-is-climate-change.html>.

⁶ *Climate Change 2013: The Physical Science Basis*, IPCC, <http://www.climatechange2013.org>.

⁷ *Fifth Assessment Report*, IPCC, <https://www.ipcc.ch/pdf/assessment-report/ar5/>.

⁸ Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.), *Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis*. CAMBRIDGE UNIVERSITY PRESS, CAMBRIDGE, UNITED KINGDOM AND NEW YORK, https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf

⁹ *The national academies Sciences*, MEDICINE AND ENGINEERING, <http://nationalacademies.org/>

¹⁰ *Fourth Assessment Report*, IPCC, [https://www.ipcc.ch/pdf/assessment-report/ar4?sy/ar4wg1](https://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4wg1)

and deforestation. The rise in GHGs is the primary cause of global warming over the last century.

There are three main datasets that are referenced to measure global surface temperatures since 1850¹¹. These datasets show warming of between +0.8°C and +1.0°C since 1900¹². Since 1950, land-only measurements indicate warming trends of between +1.1°C and +1.3°C, as land temperatures tend to respond more quickly than oceans to the earth's changing climate.

While global warming is typically measured on multi-decadal time scales (30+ years), attributing trends over time periods of less than 30 years can be tricky, due to the influence of natural variability. Natural variability is defined as variations in climate that are due to internal interactions between the atmosphere, ocean, land surface and sea ice. Those variations occur with or without climate change and are often described as “noise” abnormal variations around a “normal” value. The El Niño Southern Oscillation (ENSO) cycle is considered to be the strongest source of internal natural variability due to the exchange of heat between the oceans and the surface along the equatorial Pacific. Because of this internal and natural variability, global warming does not necessarily occur linearly in response to the increase in GHG concentrations, and various periods of accelerated warming and warming slowdowns are a natural source of variability.

What is causing Global Warming?

The climate of the earth is affected by a number of factors. These factors include the output of energy from the sun (warming effect), volcanic eruptions (cooling effect), concentration of GHGs in the atmosphere (warming effect), and aerosols (cooling effect). Since the Industrial Revolution (i.e., 1750), the largest contributor to the increase in global warming is carbon dioxide (CO₂), followed by methane (CH₄). CO₂ concentrations have increased from 278 parts per million (ppm) in 1960 to 401 ppm in 2015—a 44% increase.

Since 1951, approximately 100% of warming is attributed to anthropogenic forgings, while more than 100% is due to greenhouse gases due to offsets in anthropogenic aerosols. Natural forgings and internal variability are considered to be negligible during this time period.

Water vapour has an important indirect effect on temperature increases resulting from

¹¹ Colin Morice, *Met Office Hadley Centre observations datasets*, METOFFICE, <https://www.metoffice.gov.uk/hadobs/hadcrut4/>

¹² *Temperature calculator*, SKEPTICAL SCIENCES.

increasing GHG concentrations. Increased global temperature resulting from GHGs increases the capacity of the atmosphere to hold water vapour, thus acting as positive feedback, as water vapour also produces a greenhouse effect. An increase in global temperature by 1°C results in approximately a 7% increase in atmospheric water vapour. “Therefore, although CO₂ is the main anthropogenic control knob on climate, water vapour is strong and fast feedback that amplifies any initial forcing by a typical factor of between two and three. Water vapour is not a significant initial forcing, but is nevertheless a fundamental agent of climate change”¹³.

Not all industrial emissions result in a warming bias. Aerosols resulting from industrial emissions have worked to offset about 26% of greenhouse warming due to blocking solar radiation from reaching the earth’s surface. There is, however, large uncertainty regarding the extent of influence that aerosols have on climate, mainly due to aerosol interactions with clouds.

GHGs (particularly CO₂) have a longer residence time in the atmosphere (~100 years) compared to aerosols (only 10 days). As a result, the short-term effect of industrial pollution can be cooling followed by long-term warming. Aerosols are expected to offset a lower percentage of greenhouse warming in most future scenarios due to residence time, which allows for the possibility of acceleration of future warming even without an acceleration of GHG concentrations¹⁴.

The greenhouse effect occurs when solar energy making contact with the earth’s surface is retransmitted to the atmosphere in the form of infrared thermal radiation. This radiation has a lower wave frequency than solar energy itself. GHG molecules absorb this thermal radiation at low frequencies, causing these molecules to vibrate. These greenhouse molecules then emit energy in the form of infrared photons, many of which return to the earth’s

¹³Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: *Anthropogenic and Natural Radiative Forcing*. In: *Climate Change 2013: The Physical Science Basis*. CAMBRIDGE UNIVERSIT PRESS, CAMBRIDGE, UNITED KINGDOM AND NEW YORK. http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf.

¹⁴ Juliane Fry, *Aerosols: The Last Frontier?* REAL CLIMATE. <http://www.realclimate.org/index.php/archives/2007/02/aerosols-the-last-frontier/>.

surface. Non-GHGs such as oxygen and nitrogen do not absorb thermal radiation¹⁵.

The greenhouse effect is measured in terms of Radioactive Forcing (RF) in units of watts per square meter (W/m²). Since the Industrial Revolution, the total RF is estimated to have increased by approximately 2.3 W/m² (1.1 W/m² – 3.3 W/m²; 90% confidence interval) mainly due to the net effect of increased GHG and aerosol concentrations in the atmosphere.

Climate Change Facts

Life and environment complement each other. Pure water, earth, air are the primary conditions of our healthy life. Climate change or global warming has become a major cause for concern throughout the world. Scientists from around the world have pressed the alarm bells over the rapidly changing climate of the Earth. The phenomenon of climate change has emerged as a major threat to mankind, affecting not only developed but all the countries of the world. The ice sheets in many parts of the world are melting, and sea levels are increasing. Concrete steps are required to prevent climate change if we want to save life on Earth. It is imperative that we need to preserve our environment and nature for both present and future generations. Following are some important facts about climate change:

1. One of the reasons behind the seriousness of climate change is the continuously growing population of the world, which is likely to surpass approximately 9 billion, i.e. 900 crores by 2040. Now the population is close to 7.5 billion, and China and India's "contribution" is more than 2.50 billion – more than a third!
2. In the last 50 years, the global population has doubled, but the consumption of natural resources has quadrupled.
3. The world's most affluent people numbering around 50 crores spread 50% of all carbon dioxide emissions, whereas 300 crores poor people cause only 6% pollution throughout the world.
4. It has been calculated that the quantum of 'greenhouse gases' emitted within just two weeks due to over 40000 participants in the Copenhagen Climate Change Conference – December 2009 was more than the total emissions generated by 600,000 Ethiopians throughout the year.

¹⁵ *Carbon Dioxide Absorbs and Re-emits Infrared Radiation*, UCAR. <https://scied.ucar.edu/carbon-dioxide-absorbs-and-re-emits-infrared-radiation>.

5. The annual expenditure of an average Bangladeshi citizen is far below that of two pet dogs of 'German Shepherd' species in Europe and America.
6. As per a 2005 UN report, exploitation of natural resources is so widespread that it is doubtful whether future generations can survive.
7. According to Christopher Flavin, president of the Worldwatch Institute, a globally focused environmental research organization, the modern culture of consumption has severely affected the environment; it has not led to a happy human life.
8. The over-exploitation of the world's resources has increased as now people have been indulging in mindless show-off, consumption and amassing physical means.
9. According to the statement of Erik Assadourian, a leading author of a report of the Worldwatch Institute, we have to change the culture of materialism developed in the last two centuries, but the unfortunate fact is that it is not limited to developed countries, but it is taking developing countries too in its grip very fast.
10. America used to emit the largest amount of pollution, but now China is also not far behind. China has now become the world's largest market for cars consumption.
11. On the other hand, we have a country like Ecuador, where the inhabitants of the world have taken the vow of worship of Mother Earth and they are insisting that they would not promote enjoyment based on the elements of consumption that the Earth cannot provide again and again.
12. Greenhouse gases absorb a large part of the energy from the sun and disperse it across the world, transmitting it to the four directions of the Earth for the existence of life – it is called Greenhouse Effect.
13. These gases make a natural cover or layer over the Earth and protect it from more heat. The sun's heat travels to many parts of the Earth and then goes back to space.
14. However, human activities are increasing the amount of these gases to hazardous levels, leading to climate change.
15. According to the World Meteorological Organization (WMO) of the United Nations Climate Agency, the average global temperature in 2016 was 1.1 degrees Celsius

above the previous period.

16. Human activities such as the use of coal, petrol and natural gas are greatly responsible for large-scale emission of greenhouse gases.
17. The fossil fuels are burnt in large amounts by the humans in the wake of growing urbanization, and industrialization, resulting in the excessive presence of greenhouse gases in the environment.
18. The layer of greenhouse gases that absorb part of the sun's energy is getting thicker. It is absorbing excess rays of the sun which are not going back to space.
19. As this layer is absorbing more heat it is increasing the temperature of the Earth.
20. In the last 100 years, the world's temperature has increased by at least 0.85 degree Celsius (53 degrees Fahrenheit). Not only this but during this time sea level also increased by 20 centimeters (8 inches).
21. For the past century, the average temperature of Antarctica is increasing by double the average temperature of the Earth. In Antarctica, the snow-covered area has decreased by 7 percent.
22. Heavy rains are occurring in some parts of North America, parts of northern Europe and of northern Asia, while the Mediterranean and South Africa are increasingly witnessing droughts.
23. According to an estimate, if the emission of greenhouse gases continues like this, the global temperature could rise by 3 to 8 degrees in the 21st century.
24. Power production based on coal, revolutionary changes in technology, vehicular emissions, coal mining, changes in the lifestyle of human beings (use of refrigerators, air conditioners, cars, etc), besides indiscriminate use of chemical fertilizers in modern agriculture are among the major causes of climate change.
25. All these activities are increasing the emission of greenhouse gases, particularly the carbon dioxide into the environment which is largely responsible for climate change, as it increases the pace of global warming.
26. Among other reasons, indiscriminate cutting of forests in the name of

industrialization by human beings has posed a major threat to the environment.

27. Indiscriminate cutting of forests in the name of industrialization by the human beings has been a major threat to the Earth, its environment as well as its climate.
28. By absorbing carbon dioxide, trees help us reduce the impact of greenhouse gases on the environment and thus help the Earth maintain its weather cycle.
29. With the decreasing number of trees due to deforestation, the amount of carbon dioxide is increasing vastly in the Earth's atmosphere.
30. There has been an indiscriminate cutting or burning of the forests by humans for their growing requirements for farming land as well as for settling their rapidly growing population.
31. The slash and burn farming, under which farmers cut down or burn trees on a mass level, is also responsible for reducing the green cover on Earth.
32. Logging operators resort to the cutting of trees in the forests all through the world to illegally supply wood to the paper industry.
33. Growing requirement of land for urban settlements is another reason fuelling deforestation.
34. It has led to disturbance or irregularities in the rain cycle, which is the biggest indicator of climate change.
35. Due to the adverse impact on the rain cycle, in some places of the world, a drastic rise or fall in temperature has been visible.
 - a. If there is snowfall in the northern hemisphere, melting of ice in the Arctic Ocean, and melting of glaciers, unseasonal rains, and volcanic eruptions have occurred across all continents.
 - b. In fact, the whole climate cycle is becoming irregular, resulting in problems of drought, excessive rainfall, flood, cyclone, etc.
 - c. Also, summers in various parts of the world are becoming colder or hotter and in some countries, the weather is becoming completely dry.

- d. Apart from deforestation, animal husbandry activities such as rearing of cows, pigs and chickens also result in emitting a large number of greenhouse gases.
- e. These activities have contributed to the irregularities in the climate cycle. Consequently, we are facing the worst climate change conditions today.
- f. Natural causes are no less responsible for climate change: ocean currents, shifting of the continents, volcanic eruptions, tilt in the axis of the Earth, natural deforestation, the collision of meteorites and comets, etc.
- g. The oceans are warming due to the melting of glaciers. It is estimated that within a half-century, the water level of the ocean will increase by about half a meter.
- h. Considered as a major constituent of the climate mechanism, oceans will greatly fuel the temperature of the Earth as their exposure to the sun's heat increases due to climate change.
- i. Global warming is responsible for disturbing the natural cycle of the global thermohaline circulation system (THC) which constitutes of heating, cooling, downwelling, and upwelling of the surface water by the oceans. This system gets determined through the flow of air, operated by the ocean currents.
- j. There are many adverse consequences of rising sea level such as the devastation of coastal areas, submerging of land into water, flood, soil erosion, side effects of saline water, etc.
- k. It was about millions of years back when the continents in which we are living today took their shape through the gradual drifting of the landmass. The shifting of the landmass leads to climate change as it shifts the position of water bodies across the world.
- l. Due to volcanic eruptions, huge amounts of dangerous sulphur dioxide (SO₂) gas, dust, ash, and vapor are emitted in the atmosphere. All these components are responsible for bringing drastic changes in the climate cycle of the Earth.
- m. Natural Deforestation on a mass level is one of the biggest causes of climate change. Forest fire, drought, tropical storms as well as volcanic activities

devastate acres of natural forests. Hurricanes cause damage to the rainforests each year to the extent that their recovery is possible only in centuries.

- n. When meteors and asteroids strike the Earth they cause enormous destruction and discharge high amount of gases and firestorms to thousands of miles, besides causing acid rains.
- o. The increasing demand for food due to the increasing population has created tremendous pressure on agriculture, where more production has become the norm, even if it means indiscriminate use of chemical fertilizers or pesticides with negative implications for climate.
- p. Climate change threatens bio-diversity as animals, birds, and plants live in the natural environment and are very sensitive to any adverse change in it.
- q. The poor and developing countries stand to suffer most due to climate change as they do not have adequate capacity and resources to deal with the dangers of climate change.
- r. On April 22, 2016, more than 130 countries including India signed the historic 'Paris Climate Change Agreement' to counter the rising threat of climate change.
- s. The Paris Agreement will be applicable to the year 2020.
- t. Under this agreement, developed countries will provide financial assistance to the developing countries to achieve carbon emissions targets annually from 2020 onwards.
- u. The Paris Agreement will increase the pressure on countries to prevent rising temperatures of the Earth and decrease greenhouse gas emissions.
- v. It includes 55 countries which emit more than 55 percent of the greenhouse gas.
- w. The developed countries must make 40 percent reductions in their carbon emission levels by 2020.
- x. Similarly, developing countries must reduce their emissions to the tune of 15

to 30 percent by 2020.

- y. Now, the pressure to bring about greenhouse gas emissions reduction in all countries and reducing global temperatures has increased the pressure to implement the agreement.
- z. At the same time, it proves that all the countries are increasingly conscious to overcome the rising global temperature.
- aa. The countries involved in the agreement want to limit the global warming to well below 2°

Environmental and Social Impacts of Climate Change

Climate change involves a variety of potential environmental, social, and economic impacts. In most situations, these impacts will be adverse; in a few isolated situations, these could be more favourable (such as increased crop yield). The severity of the adverse impacts will increase with the rise in the average global temperature. Even if global warming is kept within 2°C relative to pre-industrial levels, adverse impacts will be experienced and the world will need to take appropriate measures to adapt to new climate conditions. If in spite of the world efforts, the temperature increase goes beyond the 2°C threshold, it has been assessed that the consequences would become increasingly severe, widespread and irreversible. Canada has already become warmer by 1.5°C on average from 1950 to 2010¹⁶.

Floods and Droughts

Floods are expected to occur more frequently on more than half of the earth's surface. In some regions, they could decrease. During winter, snowfalls are expected to decrease in mid-latitudes, resulting in less significant snowmelt floods during the spring season. On the other hand, meteorological droughts (less rainfall) and agricultural droughts (drier soil) are projected to become longer or more frequent in some regions and some seasons.

Reduction in Water Resources

¹⁶Warren, F.J. and Lemmen, D.S., *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation*; GOVERNMENT OF CANADA, OTTAWA, ON, 286p
http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/assess/2014/pdf/Full-Report_Eng.pdf.

Renewable water supply is expected to decline in certain areas and expand in others. In regions where gains are expected, temporary deficits of water resources are still possible because of increased fluctuations of stream flow and of seasonal cutbacks. Clean water supply may also decrease due to a warmer environment inducing lower water quality. Such an overall decline in renewable water supply will intensify competition for water among agriculture, ecosystems, settlements, industry, and energy production, affecting regional water, energy, and food security.

Rising Sea Levels

In some regions such as the U.S. Eastern Coast, tides are reaching up to three feet higher than they used to 50 years ago¹⁷. Rising sea levels will have more and more negative consequences near the coasts—such as flooding, erosion of the coasts, and submergence of low-lying regions—putting at risk populations, infrastructure, animals, and vegetation near the coasts. Low-lying regions (like Bangladesh) and whole islands (like the Maldives and Kiribati) are at risk of destruction in the short term from rising ocean levels, floods, and more intense storm urges.

Changes in Ecosystems

In the past millions of years, climate changes have naturally occurred at slower paces, permitting the ecosystems to adapt. However, in the 20th century, many argue that we have entered the Anthropocene. Species extinction rate has exceeded by up to 100 times the “normal” pace (i.e., without anthropogenic impact). We are facing a major biodiversity crisis and we might even be entering a sixth “mass extinction”. In the 21st century and beyond, the risk of extinction that land and aquatic species are exposed to is higher under all RCP scenarios. As early as 2050, the rapid changes that are currently taking place are expected to jeopardize both land and ocean ecosystems, particularly under RCP 6.0 and RCP 8.5.

Economic Impacts of Climate Change

Climate science dates back almost 200 years when Joseph Fourier described in 1824 what we know as the greenhouse effect. Based on the Stern Review on the Economics of Climate Change, the price of doing nothing about climate change will be equivalent to an annual loss of 5% or more in global GDP, ad infinitum. If a broader spectrum of effects and

¹⁷ *Analysis & Opinion*, REUTERS. <http://blogs.reuters.com/>.

contingencies is included in the analysis, the estimated costs could reach 20% of GDP or more. Estimations and projections of economic costs are complex and rely upon a multitude of assumptions that are difficult to determine. They vary widely among different countries. “Further research, collection, and access to more detailed economic data and the advancement of analytic methods and tools will be required to assess further the potential impacts of climate on key economic systems and sectors.

Major Climate Laws

1. Clean Air Act, 1963 – It requires the Environmental Protection Agency (EPA) to develop and enforce regulations to protect the general public from exposure to airborne contaminants that are known to be hazardous to human health.
2. Energy independence and security act of 2007 – Introduces measures to expand the production of renewable fuels, reduce US dependence on oil, increase energy security and address climate change.
3. Climate change Act, 2008- An Act to set a target for the year 2050 for the reduction of targeted greenhouse gas emissions; to provide for a system of carbon budgeting; to establish a Committee on climate change; to confer powers to establish trading schemes for the purpose of limiting greenhouse gas emissions or encouraging activities that reduce such emissions or remove greenhouse gas from the atmosphere; to make provision about adaptation to climate change; to confer powers to make schemes for providing financial incentives to produce less domestic waste and to recycle more of what is produced; to make provision about the collection of household waste; to confer powers to make provision about charging for single use carrier bags; to amend the provisions of the Energy Act, 2004 about renewable transport fuel obligations; to make provision about carbon emissions reduction targets; to make other provision about climate change; and for connected purposes.

Mitigation and Adaptation for Climate Change

Climate change is one of the most complex issues facing us today. It involves many dimensions – science, economics, society, politics, and moral and ethical questions – and is a global problem, felt on local scales, that will be around for decades and centuries to come. Carbon dioxide, the heat-trapping greenhouse gas that has driven recent global warming,

lingers in the atmosphere for hundreds of years, and the planet (especially the oceans) takes a while to respond to warming. So even if we stopped emitting all greenhouse gases today, global warming and climate change will continue to affect future generations. In this way, humanity is “committed” to some level of climate change.

How much climate change? That will be determined by how our emissions continue and also exactly how our climate system responds to those emissions. Despite increasing awareness of climate change, our emissions of greenhouse gases continue on the relentless rise. In 2013, the daily level of carbon dioxide in the atmosphere surpassed 400 parts per million for the first time in human history. The last time levels were that high was about three to five million years ago, during the Pliocene era.

Because we are already committed to some level of climate change, responding to climate change involves a two-pronged approach:

1. Reducing emissions of and stabilizing the levels of heat-trapping greenhouse gases in the atmosphere.
2. Adapting to climate change already in the pipeline.

Mitigation – reducing climate change – involves reducing the flow of heat-trapping greenhouse gases into the atmosphere, either by reducing sources of these gases (for example, the burning of fossil fuels for electricity, heat or transport) or enhancing the “sinks” that accumulate and store these gases (such as the oceans, forests and soil). The goal of mitigation is to avoid significant human interference with the climate system, and “stabilize greenhouse gas levels in a timeframe sufficient to allow ecosystems to adapt naturally to climate change, ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner” (from the 2014 report on Mitigation of climate change from the United Nations Intergovernmental Panel on Climate Change, page 4).

Adaptation – adapting to life in a changing climate – involves adjusting to actual or expected future climate. The goal is to reduce our vulnerability to the harmful effects of climate change (like sea-level encroachment, more intense extreme weather events or food insecurity). It also encompasses making the most of any potential beneficial opportunities associated with climate change (for example, longer growing seasons or increased yields in some regions).

Throughout history, people and societies have adjusted to and coped with changes in climate and extremes with varying degrees of success. Climate change (drought in particular) has been at least partly responsible for the rise and fall in civilizations. Earth's climate has been relatively stable for the past 12,000 years and this stability has been crucial for the development of our modern civilization and life as we know it. Modern life is tailored to the stable climate we have become accustomed to. As our climate changes, we will have to learn to adapt. The faster the climate changes, the harder it could be.

While climate change is a global issue, it is felt on a local scale. Cities and municipalities are therefore at the frontline of adaptation. In the absence of national or international climate policy direction, cities and local communities around the world have been focusing on solving their own climate problems. They are working to build flood defenses, plan for heat waves and higher temperatures, install water-permeable pavements to better deal with floods and storm water and improve water storage and use.

According to the 2014 report on Climate Change Impacts, Adaptation and Vulnerability (page 8) from the United Nations Intergovernmental Panel on Climate Change, governments at various levels are also getting better at adaptation. Climate change is starting to be factored into a variety of development plans: how to manage the increasingly extreme disasters we are seeing and their associated risks, how to protect coastlines and deal with sea-level encroachment, how to best manage land and forests, how to deal with and plan for reduced water availability, how to develop resilient crop varieties and how to protect energy and public infrastructure.

The global temperature records reveal that the earth has become warmer by about 1°C since 1900. International efforts are aiming to limit the increase to 2°C. Different regions are already experiencing the effects of global warming through increased floods, extreme temperatures, droughts, hurricanes, etc. As the temperature continues to rise, deterioration is to be expected. The world will need to take such deterioration into account in the years to come.

Government and Resources

The following selected resources from U.S. government organizations provide information about options for responding to climate change.

1. Climate data initiative can help inform and prepare America's communities, businesses,

and citizens.

2. US climate resilience toolkit provides scientific tools, information, and expertise to help people manage their climate-related risks and opportunities, and improve their resilience to an extreme event.

Conclusion

The earth has been showing a rapidly warming trend. This has been primarily caused by the increasing concentration of the GHGs—particularly carbon dioxide. There is worldwide acceptance for the fact that the largest contributor to the increase in CO₂ concentration is the burning of fossil fuels and deforestation. The world community has accepted the need to limit the increase in the earth's temperature to 2°C and initiate changes to achieve this objective. This will require the world to move away from burning fossil fuels and effectively reach a stage of zero carbon emissions. The earth has limited resources. Also, there are limits on the vulnerability of some of its renewable resources. Humanity is using substantially more resources than the earth can renew. We all need to change the way we live to achieve a proper balance.