IMPACT ON GLACIER AND ICE MELT IN COMBATING CLIMATE CHANGE: A STUDY TOWARDS FUTURE RESEARCH

Prof. Bharat Raj Singh,
Director General (Technical),

Prof. Manoj Mehrotra, Director,
School of Management Sciences, Lucknow-226010

Summary

Climate Change is an impact of Global warming and due to this Glaciers and Ice-lands / Caps are melting very fast. Consequently, weather and climate are badly damaged. Storms are a fact of life for Curole. Even relatively small storm surges in the past two decades have overwhelmed the system of dikes, levees, and pump stations that was managed, upgraded in the 1990s to forestall the Gulf of Mexico's relentless creep.

The current trend is consequential not only in coastal Louisiana but around the world. Never before have had so many humans lived so close to the coasts: More than a hundred million people worldwide live within three feet (a meter) of mean sea level. Vulnerable to sea-level rise, Tuvalu, a small country in the South Pacific, has already begun formulating evacuation plans. Megacities where human populations have concentrated near coastal plains or the river deltas — Shanghai, Bangkok, Jakarta, Tokyo, and New York — are at risk. The projected economic and humanitarian impacts on low-lying, densely populated, and desperately poor countries like Bangladesh are potentially catastrophic. The scenarios are disturbing even in wealthy countries like the Netherlands, with nearly half its landmass already at or below sea level.

India has a total coastline of 7516.6 km, out of which mainland coastline consists of 6100 km and islands' coastline consists of 1197 km. Indian coastline touches nine states and four union territories. The nine states are Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha and West Bengal, need evacuation every year during cyclone / hurricane as frequency is increasing.

1.0 Introduction

During continual researches, scientists are finding that glaciers reveal clues about global warming. How much does our atmosphere naturally warm up between Ice Ages? How does human activity affect climate? Because glaciers are so sensitive to temperature fluctuations accompanying climate change, direct glacier observation may help answer these questions. Since the early twentieth century, with few exceptions, glaciers around the world have been retreating at unprecedented rates. Some scientists attribute this massive glacial retreat to the Industrial Revolution, which began around 1760. In fact, several ice caps, glaciers and ice shelves have disappeared altogether in this century. Many more are retreating so rapidly that they may vanish within a matter of decades.

Scientists are discovering that production of electricity using coal and petroleum, and other uses of fossil fuels in transportation and industry, affects our environment in ways we did not understand before. Within the past 200 years or so, human activity has increased the amount of carbon dioxide in the atmosphere by 40 percent, and other gases, such as methane (natural gas) by a factor of 2 to 3 or more. These gases absorb heat being radiated from the surface of the earth, and by absorbing this heat the atmosphere slowly warms up. Heat-trapping gases, sometimes called “greenhouse gases,” are the cause of most of the climate warming and glacier retreat in the past 50 years. However, related causes, such as increased dust and soot from grazing, farming, and burning of fossil fuels and forests, are also causing glacier retreat. In fact, it is likely that the earliest parts of the recent glacier retreats in Europe were caused by soot from coal burning in the late 1800s.

As dramatic as the retreat of one glacier may be, scientists learn the most about global climate by studying many glaciers. The World Glacier Monitoring Service (WGMS) tracks changes in more than 100 alpine glaciers worldwide. Forty-two of those glaciers qualify as climate reference glaciers because their records span more than 30 years.

The WGMS reports, glacier mass balance changes in millimetres of water equivalence. (There are 25.4 millimetres in an inch.) If all the lost or gained glacial ice were converted to water and spread evenly over glacier surface area, the depth of that water layer is the water equivalence. In State of the Climate in 2018, the American Meteorological Society reported that mean annual glacier mass balance was (-) 921 millimetres for the 42 reference glaciers, and (-) 951 millimetres for all glaciers monitored in 2017.

Daniel Fagre quotes “If we don't have it, we don't need it," as we throw on our backpacks. We're armed with crampons, ice axes, rope, GPS receivers, and bear spray to ward off grizzlies, and we're trudging toward Sperry Glacier in Glacier National Park, Montana. It falls in step with Fagre and two other

"This glacier used to be closer," scientists says as we crest a steep section. A trailside sign notes that since 1901, Sperry Glacier has shrunk from more than 800 acres (320

research scientists from the U.S. Geological Survey Global Change Research Program. They're doing what they've been doing for more than a decade: measuring how the park's storied glaciers are melting. So far, the results have been positively chilling. When President Taft created Glacier National Park in 1910, it was home to an estimated 150 glaciers. Since then the number has decreased to fewer than 30, and most of those remaining have shrunk in area by two-thirds (67%). Fagre predicts that within 30 years most if not all of the park's namesake glaciers will disappear.

"Things that normally happen in geologic time are happening during the span of a human lifetime," says Fagre **[1-2]**.

2.0 Glacier & Ice-melt Impacts Climate

Scientists assess the planet's health see indisputable evidence that Earth has been getting warmer, in some cases rapidly. Most believe that human activity, in particular the burning of fossil fuels and the resulting build-up of greenhouse gases in the atmosphere, have influenced this warming trend. In the past decade scientists have documented record-high average annual surface temperatures and have been observing other signs of change all over the planet: in the distribution of ice, and in the salinity, levels, and temperatures of the oceans.

hectares) to 300 acres (120 hectares). "That's out of date," to stopping to catch back its position, as it is now less than 250 acres (100 hectares)."

Fig 1: Polar ice caps in Greenland, Antarctica, melting 6 times faster than in 1990s

Everywhere on Earth ice is changing. The famed snows of Kilimanjaro have melted more than 80 percent since 1912. Glaciers in the Garhwal Himalaya in India are retreating so fast that researchers believe that most central and eastern Himalayan glaciers could virtually disappear by 2035. Arctic sea ice has thinned significantly over the past half century, and its extent has declined by about 10 percent in the past 30 years. NASA's repeated laser altimeter readings show the edges of Greenland's ice sheet shrinking. Spring freshwater ice breakup in the Northern Hemisphere now occurs nine days earlier than it did 150 years ago, and autumn freeze-up ten days later. Thawing permafrost has caused the ground to subside more than 15 feet (4.6 meters) in parts of Alaska. From the Arctic to Peru, from Switzerland to the equatorial glaciers of Man Jaya in Indonesia, massive ice fields, monstrous glaciers, and sea ice are disappearing, fast.

When temperatures rise and ice melts, more water flows to the seas from glaciers and ice caps, and ocean water warms and expands in volume. This combination of effects has played the major role in raising average global sea level between four and eight inches (10 and 20 centimetres) in the past hundred years, according to the Inter-governmental Panel on Climate Change (IPCC).

Scientists point out those sea levels have risen and fallen substantially over Earth's 4.6-billion-year history. But the recent rate of global sea level rise has departed from the average rate of the past two to three thousand years and is rising more rapidly—about one-tenth of an inch a year. A continuation or acceleration of that trend has the potential to cause striking changes in the world's coastlines.

Driving around Louisiana's Gulf Coast, Windell Curole can see the future, and it looks pretty wet. In southern Louisiana coasts are literally sinking by about three feet (a meter) a century, a process called subsidence. A sinking coastline and a rising ocean combine to yield powerful effects. It's like taking the global sea-level-rise problem and moving it along at fast-forward.

The seventh-generation Cajun and manager of the South Lafourche Levee District navigates his truck down an unpaved mound of dirt that separates civilization from inundation, dry land from a swampy horizon. With his French-tinged lilt, Curole points to places where these bayous, swamps, and fishing villages portend a warmer world: his high school girlfriend's house partly submerged, a cemetery with water lapping against the white tombs, his grandfather's former hunting camp now afloat in a stand of skeleton oak snags. "We live in a place of almost land, almost water," says the 52-year-old Curole.

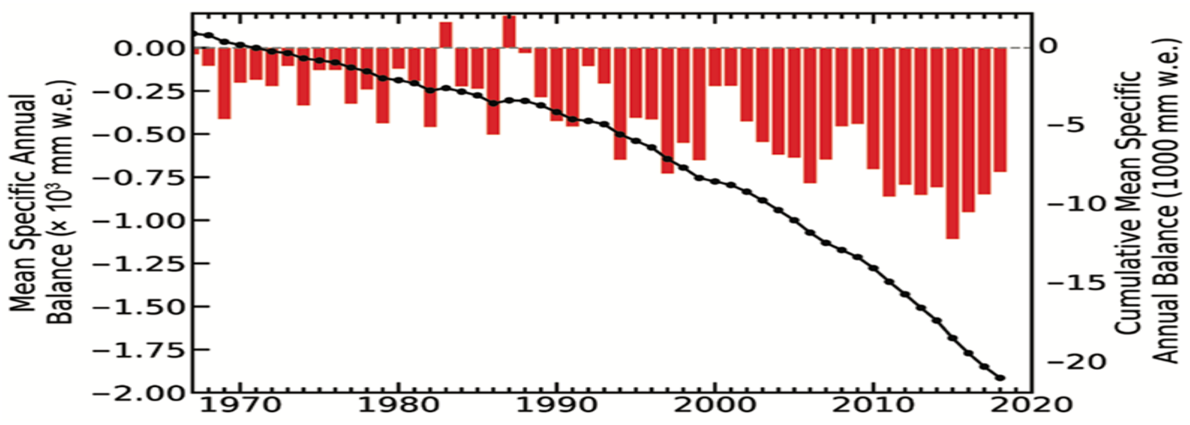

Figure 2: Mass balance of the World Glacier Monitoring Service (WGMS)
Credit: State of the Climate in 2018. Bull. Amer. Meteor. Soc

The above **Fig.2** shows that mass balance of World Glacier Monitoring Service in which 37 reference glaciers are considered each year since 1968 (red bars), along with the total mass loss over time (black line), which is updated on 16 March 2020.

2.1 Weather versus Climate

2.1.1 What is the difference between weather and climate?[3]

Weather is the day-to-day state of the atmosphere, and its short-term variation in minutes to weeks. People generally think of weather as the combination of temperature, humidity, precipitation, cloudiness, visibility, and wind. We talk about changes in weather in terms of the near future: "How hot is it right now?" "What will it be like today?" and "Will we get a snowstorm this week?"

Climate is the weather of a place averaged over a period of time, often 30 years. Climate information includes the statistical weather information that tells us about the normal weather, as well as the range of weather extremes for a location.

We talk about climate change in terms of years, decades, centuries, even millions of years. Scientists study climate to look for trends or cycles of variability, such as the changes in wind patterns, ocean surface temperatures and precipitation over the equatorial Pacific that result in El Niño and La Niña, and also to place cycles or other phenomena into the bigger picture of possible longer term or more permanent climate changes **[4]**.

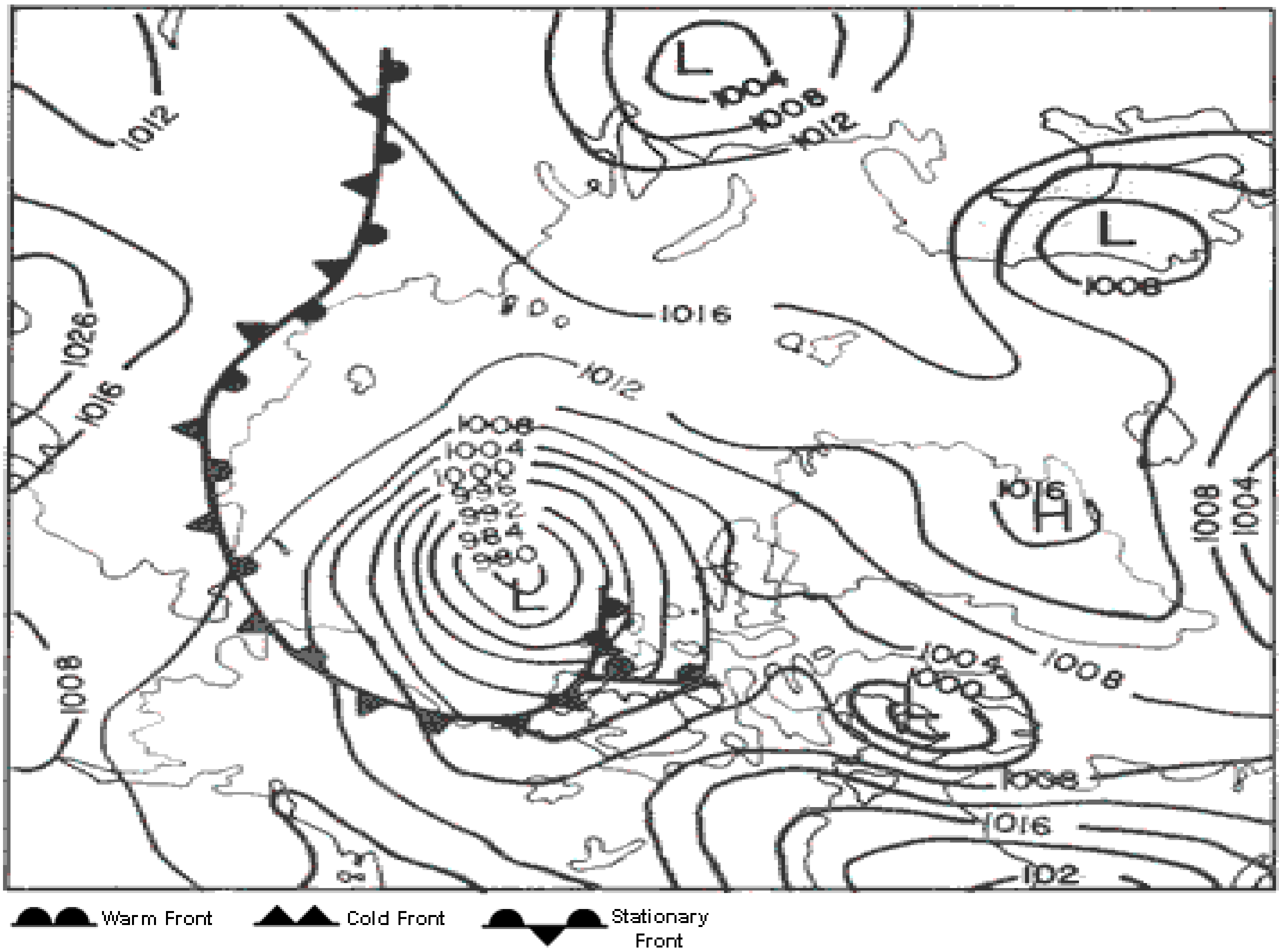

Figure 3: A synoptic chart for 28 August 1980
Credit: M. Serreze and R. Barry (1988).

2.1.2 Forecasting weather and predicting climate

Weather forecasters try to answer questions like: What will the temperature be tomorrow? Will it rain? How much rain will we have? Will there be thunderstorms? Today, most weather forecasts are based on numerical models, which incorporate observations of air pressure, temperature, humidity and winds to produce the best estimate of current and future conditions in the atmosphere. A weather forecaster then looks at the model output to figure out the most likely scenario. The accuracy of weather forecast depends on both the model and on the forecaster's skill. Short-term weather forecasts are accurate for up to a week. Long-term forecasts, for example seasonal forecasts, tend to use statistical relationships between large-scale climate signals such as El Niño and La Niña and precipitation and temperature to predict what the weather will be like in one to six months' time**.**

Forecasts — whether generated by artificial intelligence, meteorologists, or indigenous elders — often rely on past weather patterns to predict the future, but climate change is making the past a less effective predictor of the future.

Climate predictions take a much longer-term view. These predictions try to answer questions like how much warmer will the Earth be 50 to 100 years from now? How much more precipitation will there be? How much will sea level rise? Climate predictions are made using global climate models. Unlike weather forecast models, climate models cannot use observations because there are no observations in the future.

2.2 Arctic Climate

Like other places on Earth, the weather in the Arctic varies from day to day, from month to month, and from place to place. But the Arctic is a unique place for weather and climate, because of the special factors that influence it. Sunlight is perhaps the most important of those factors. Above the Arctic Circle, the sun disappears in the winter, leaving the region dark and cold. What light does reach the region in the winter comes in at a low angle. In summers, the sun shines around the clock, bringing warmth and light. The Arctic also experiences frequent inversions. Inversions occur when cold air settles close to the ground, with warm air on top of it. Inversions separate the air into two layers, like oil and water: this tends to slow down the winds close to the surface. Over cities, inversions can trap pollutants, creating smoggy conditions that last until the inversion clears **[4-5]**.

Scientists separate the Arctic into two major climate types. Near the ocean, a maritime climate prevails. In Alaska, Iceland, and northern Russia and Scandinavia, the winters are stormy and wet, with snow and rainfall reaching 60 cm (24 inches) to 125 cm (49 inches) each year. Summers in the coastal regions tend to be cool and cloudy; average temperatures hover around 10 degrees Celsius (50 degrees Fahrenheit).

Figure 4: An inversion layer. —*Credit: Willie Angus*.

Away from the coasts, the interior regions of the Arctic lands have a continental climate. The weather is dryer, with less snow in the winter and sunny summer days. Winter weather can be severe, with frigid temperatures well below freezing. In some regions of Siberia, average January temperatures are lower than (-) 40 degrees Celsius [(-) 40 degrees Fahrenheit]. In the summer, the long days of sunshine thaw the top layer of permafrost and bring average temperatures above 10 degrees Celsius (50 degrees Fahrenheit). At some weather stations in the interior, summer temperatures are warmer than 30 degrees Celsius (86 degrees Fahrenheit).

3.0 Rising Sea Level

Rising sea level, sinking land, eroding coasts, and temperamental storms are a fact of life. Even relatively small storm surges in the past two decades have overwhelmed the system of dikes, levees, and pump stations that he manages, upgraded in the 1990s to forestall the Gulf of Mexico's relentless creep. "It could have been probably more evacuations than any other person in the country- says Curole".

The current trend is consequential not only in coastal Louisiana but around the world. Never before have had so many humans lived so close to the coasts: More than a hundred million people worldwide live within three feet (a meter) of mean sea level. Vulnerable to sea-level rise, Tuvalu, a small country in the South Pacific, has already begun formulating evacuation plans. Megacities where human populations have concentrated near coastal plains or the river deltas- Shanghai, Bangkok, Jakarta, Tokyo, and New York; are at risk. The projected economic and humanitarian impacts on low-lying, densely populated, and desperately poor countries like Bangladesh are potentially catastrophic. The scenarios are disturbing even in wealthy countries like the Netherlands, with nearly half its landmass already at or below sea level.

Rising sea level produces a cascade of effects. Bruce Douglas, a coastal researcher at Florida International University, calculates that every inch (2.5 centimeters) of sea-level rise could result in eight feet (2.4 meters) of horizontal retreat of sandy beach shorelines due to erosion. Furthermore, when salt water intrudes into freshwater aquifers, it threatens sources of drinking water and makes raising crops problematic. In the Nile Delta, where many of Egypt's crops are cultivated, widespread erosion and saltwater intrusion would be disastrous since the country contains little other arable land.

In some places marvels of human engineering worsen effects from rising seas in a warming world. The system of channels and levees along the Mississippi effectively stopped the millennia-old natural process of rebuilding the river delta with rich sediment deposits. In the 1930s oil and gas companies began to dredge shipping and exploratory canals, tearing up the marshland buffers that helped dissipate tidal surges. Energy drilling removed vast quantities of subsurface liquid, which studies suggest increased the rate at which the land is sinking. Now Louisiana is losing approximately 25 square miles (65 square kilometres) of wetlands every year, and the state is lobbying for federal money to help replace the upstream sediments that are the delta's lifeblood.

Local projects like that might not do much good in the very long run, though, depending on the course of change elsewhere on the planet. Part of Antarctica's Larsen Ice Shelf broke apart in early 2002. Although floating ice does not change sea level when it melts (any more than a glass of water will overflow when the ice cubes in it melt), scientists became concerned that the collapse could foreshadow the breakup of other ice shelves in Antarctica and allow increased glacial discharge into the sea from ice sheets on the continent. If the West Antarctic ice sheet were to break up, which scientists consider very unlikely this century, it alone contains enough ice to raise sea level by nearly 20 feet (6 meters).

Even without such a major event, the IPCC projected in its 2001 report that sea level will rise anywhere between 4 and 35 inches (10 and 89 centimeters) by the end of the century. The high end of that projection—nearly three feet (a meter)—would be "an unmitigated disaster," according to Douglas.

Down on the criticalities, all of those predictions make Windell Curole shudder. "We're the guinea pigs," – Curole says surveying aqueous world from the relatively lofty vantage point of a 12-foot-high (3.7-meter) earthen berm mound. "I don't think anybody down here looks at the sea-level-rise problem and puts their heads in the sand." That's because soon there may not be much sand left.

Rising sea level is not the only change Earth's oceans are undergoing. The ten-year-long World Ocean Circulation Experiment, launched in 1990, has helped researchers to better understand what is now called the ocean conveyor belt.

Oceans, in effect, mimic some functions of the human circulatory system. Just as arteries carry oxygenated blood from the heart to the extremities, and veins return blood to be replenished with oxygen, oceans provide life-sustaining circulation to the planet. Propelled mainly by prevailing winds and differences in water density, which changes with the temperature and salinity of the seawater, ocean currents are critical in cooling, warming, and watering the planet's terrestrial surfaces—and in transferring heat from the Equator to the Poles.

4.0 India's Coastline and Amazing Facts

India has major part of its land covered by water. So development of ports, coastal connectivity, shipping industry and coastal economic zones are some of the crucial departments that government needs to stress upon.

The central government has taken a lot of efforts to develop India's coastline. To analyse the same, Free Press Journal has organised a panel discussion named 'India's Coastline – Engine and Wheel of Economic Growth' in which questions like, how much has India achieved during the past four years, and how can India make all these sectors grow better and thus make India that much more vibrant will be discussed **[7].**

4.1 Some Interesting and Lesser Known Facts about India's Coastline

- India has a total coastline of 7516.6 km, out of which mainland coastline consists of 6100 km and islands' coastline consists of 1197 km.
- Indian coastline touches nine states and four union territories. The nine states are Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha and West Bengal. Union Territories include Daman & Diu, Puducherry, Andaman & Nicobar Islands and Lakshadweep Islands.
- Gujarat has the longest sea coastline in India of 1,600 km.
- It is believed that formation of coastline of India is the result of continental drift of Gondwanaland.
- India's mainland coastline is divided into two parts- Eastern coastline and Western coastline.
- Large parts of the coastal plains of India are covered by fertile soils on which different crops are grown. Rice is the main crop of these areas.
- Fishing is an important occupation of the people living in the coastal areas of India.
- The Eastern coastline includes Eastern Ghats and the Bay of Bengal and extends from Ganga Delta in the North to Kanyakumari in the South.
- The Eastern coastline can be divided into three parts according to states, Orissa coastal plain, Andhra coastal plain and Tamil Nadu coastal plain.
- The Eastern coastline of India consists of rivers like the Mahanadi, the Godavari, the Krishna and the Cauvery.
- The Western coastline, on the other

hand, extends from Rann of Kachchh in the north to Kanyakumari in the South.

- It is divided into three parts, Konkan coast, the Karnataka coast and Kerala coast.
- Western coastline consists of the Indian Ocean, which is the only ocean to be named after a country.
- Coconut trees grow all along the Western coast. The sands of Kerala coast have large quantity of Monazite, which is used for nuclear power. Low lying areas of Gujarat are famous for producing salt.

Figure 5: Alphan Cyclone hit West Bengal on 16th May 2020

4.2 About India's Coastline — Engine and Wheel of Economic Growth

The Free Press Journal in association with JNPT had organized a conference on INDIA'S COASTLINE – ENGINE AND WHEEL OF ECONOMIC GROWTH at ITC Grand Central, Parel in Mumbai on October 22, 2018 at 2:30 pm onwards. Union Minister for Road Transport & Highways, Shipping and Water Resources, River Development & Ganga Rejuvenation Nitin Gadkari was be the Chief Guest and Keynote Speaker.

The engine running the conveyor belt is the density-driven thermohaline circulation ("thermo" for heat and "haline" for salt). Warm, salty water flows from the tropical Atlantic north toward the Pole in surface currents like the Gulf Stream. This saline water loses heat to the air as it is carried to the far reaches of the North Atlantic. The coldness and high salinity together make the water denser, and it sinks deep into the ocean. Surface water moves in to replace it. The deep, cold water flows into the South Atlantic, Indian, and Pacific Oceans, eventually mixing again with warm water and rising back to the surface.

Changes in water temperature and salinity, depending on how drastic they are, might have considerable effects on the ocean conveyor belt. Ocean temperatures are rising in all ocean basins and at much deeper depths than previously thought, say scientists at the National Oceanic and Atmospheric Administration (NOAA). Arguably, the largest oceanic change ever measured in the era of modern instruments is in the declining salinity of the sub-polar seas bordering the North Atlantic.

Robert Gagosian, president and director of the Woods Hole Oceanographic Institution, believes that oceans hold the key to potential dramatic shifts in the Earth's climate. He warns that too much change in ocean temperature and salinity could disrupt the North Atlantic thermohaline circulation enough to slow down or possibly halt the conveyor belt—causing drastic climate changes in time spans as short as a decade.

The future breakdown of the thermohaline circulation remains a disturbing, if remote, possibility. But the link between changing atmospheric chemistry and the changing oceans is indisputable, says Nicholas Bates, a principal investigator for the Bermuda Atlantic Time-series Study station, which monitors the temperature, chemical composition, and salinity of deep-ocean water in the Sargasso Sea southeast of the Bermuda Triangle.

5.0 Absorption of Carbon Dioxide

Oceans are important sinks, or absorption centers, for carbon dioxide, and take up about a third of human-generated CO2. Data from the Bermuda monitoring programs show that CO2 levels at the ocean surface are rising at about the same rate as atmospheric CO2. But it is in the deeper levels where Bates has observed even greater change. In the waters between 820 and 1,476 feet (250 and 450 meters) deep, CO2 levels are rising at nearly twice the rate as in the surface waters. "It's not a belief system; it's an observable scientific fact," Bates says. "And it shouldn't be doing that unless something fundamental has changed in this part of the ocean."

While scientists like Bates monitor changes in the oceans, others evaluate CO2 levels in the atmosphere. In Vestmannaeyjar, Iceland, a lighthouse attendant opens a large silver suitcase that looks like something out of a James Bond movie, telescopes out an attached 15-foot (4.5-meter) rod, and flips a switch, activating a computer that controls several motors, valves, and stopcocks. Two two-and-a-half liter (about 26 quarts) flasks in the suitcase fill with ambient air. In North Africa, an Algerian monk at Assekrem does the same. Around the world, collectors like these are monitoring the cocoon of gases that compose our atmosphere and permit life as we know it to persist **[8-15]**.

When the weekly collection is done, all the flasks are sent to Boulder, Colorado. There, Pieter Tans, a Dutch-born atmospheric scientist with NOAA's Climate Monitoring and Diagnostics Laboratory, oversees a slew of sensitive instruments that test the air in the flasks for its chemical composition. In this way Tans helps assess the state of the world's atmosphere **[16].**

5.1 By all accounts it has changed significantly in the past 150 years.

Walking through the various labs filled with cylinders of standardized gas mixtures, absolute manometers, and gas chromatographs, Tans offers up a short history of atmospheric monitoring. In the late 1950s a researcher named Charles Keeling began measuring CO2 in the atmosphere above Hawaii's 13,679-foot (4,169-meter) Mauna Loa. The first thing that caught Keeling's eye was how CO2 level rose and fell seasonally. That made sense since, during spring and summer, plants take in CO2 during photosynthesis and produce oxygen in the atmosphere. In the fall and winter, when plants decay, they release greater quantities of CO2 through respiration and decay. Keeling's vacillating seasonal curve became famous as a visual representation of the Earth "breathing [**17]**.

Table 1: 100-Year Global Warming Potential (GWP)
Selected compounds (per kg.)

SNo.	Name	Formula	GWP
1.	Carbon Dioxide	CO2	1
2..	Mrthane	CH4	28
3.	Nitrous Oxide	N2O	265
4.	HCFCs	Various	80-2,000
5.	HFcs	Various	4-12,400
6.	CFCs	Various	4,600-14.000
7.	Nitrogen Trifloride	NF3	16,100
8.	Trifluoromethyl Sulfer Pentafluoride	SFSCF3	17,400
9.	Sulfur Hexafluoride	SF6	23,500

Something else about the way the Earth was breathing attracted Keeling's attention. He watched as CO2 level not only fluctuated seasonally, but also rose year after year. Carbon dioxide level / concentration has climbed from about 315 parts per million (ppm) from Keeling's first readings in 1958 to more than 375 ppm today. A primary source for this rise is indisputable: humans' prodigious burning of carbon-laden fossil fuels for their factories, homes, and cars.

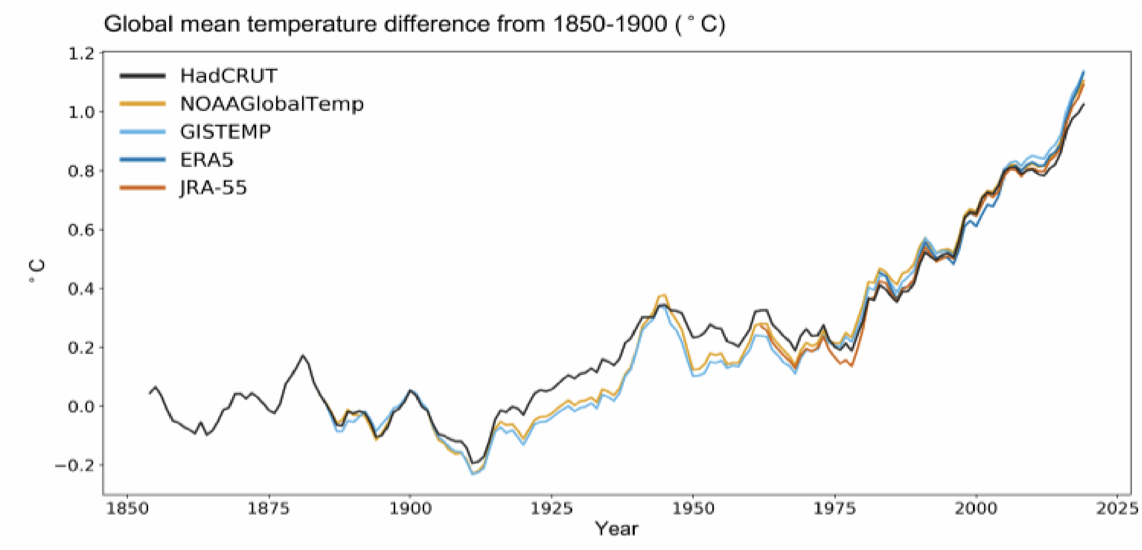

Figure 6: Global Climate in 2015-2019: Climate change accelerates
(Copyrighted Source: Met Office)

Tans shows a graph depicting levels of three key greenhouse gases—CO2, methane, and nitrous oxide—from the year 1000 to the present. The three gases together help keep Earth, which would otherwise be an inhospitably cold orbiting rock, temperate by orchestrating an intricate dance between the radiation of heat from Earth back to space (cooling the planet) and the absorption of radiation in the atmosphere (trapping it near the surface and thus warming the planet) [**18-24**].

6.0 Future Impact on Climate Change

Tans and most other scientists believe that greenhouse gases are at the root of our changing climate. "These gases are a climate-change driver," says Tans, poking his graph definitively with his index finger. The three lines on the graph follow almost identical patterns: basically flat until the mid-1800s, then all three moves upward in a trend that turns even more sharply upward after 1950. "This is what we did," says Tans, pointing to the parallel spikes. "We have very significantly changed the atmospheric concentration of these gases. We know their radiative properties," he says. "It is inconceivable to me that the increase would not have a significant effect on climate."

Exactly how large that effect might be on the planet's health and respiratory system will continue to be a subject of great scientific and political debate—especially if the lines on the graph continue their upward trajectory.

Eugene Brower, an Inupiat Eskimo and president of the Barrow Whaling Captains' Association, doesn't need fancy parts-per-million measurements of CO2 concentrations or long-term sea-level gauges to tell him that his world is changing.

"It's happening as we speak," the 56-year-old Brower says as we drive around his home in Barrow, Alaska—the United States' northernmost city—on a late August day. In his fire chief's truck, Brower takes me to his family's traditional ice cellars, painstakingly dug into the permafrost, and points out how his stores of muktuk—whale skin and blubber-- recently began spoiling in the fall because melting water drips down to his food stores. Our next stop is the old Bureau of Indian Affairs school building. The once impenetrable permafrost that kept the foundation solid has bucked and heaved so much that walking through the school is almost like walking down the halls of an amusement park fun house. We head to the eroding beach and gaze out over open water. "Normally by now the ice would be coming in," Brower says, scrunching up his eyes and scanning the blue horizon.

We continue our tour. Barrow looks like a coastal community under siege. The ramshackle conglomeration of weather-beaten houses along the seaside gravel road stands protected from fall storm surges by miles-long berms of gravel and mud that block views of migrating gray whales. Yellow bulldozers and graders patrol the coast like sentries.

The Inupiat language has words that describe many kinds of ice. *Piqaluyak* is salt-free multiyear sea ice. *Ivuniq* is a pressure ridge. *Sarri* is the word for pack ice, *tuvaqtaq* is bottom-fast ice, and shore-fast ice is *tuvaq*. For Brower, these words are the currency of hunters who must know and follow ice patterns to track bearded seals, walruses, and bowhead whales.

There are no words, though, to describe how much, and how fast, the ice is changing. Researchers long ago predicted that the most visible impacts from a globally warmer world would occur first at high latitudes: rising air and sea temperatures, earlier snowmelt, later ice freeze-up, reductions in sea ice, thawing permafrost, more erosion, and increases in storm intensity. Now all those impacts have been documented in Alaska. "The changes observed here provide an early warning system for the rest of the planet," says Amanda Lynch, an Australian researcher who is the principal investigator on a project that works with Barrow's residents to help them incorporate scientific data into management decisions for the city's threatened infrastructure.

Before leaving the Arctic, I drive to Point Barrow alone. There, at the tip of Alaska, roughshod hunting shacks dot the spit of land that marks the dividing line between the Chukchi and Beaufort Seas. Next to one shack someone has planted three eight-foot (2.4-meter) sticks of white driftwood in the sand, then crisscrossed their tops with whale baleen, a horny substance that whales of the same name use to filter life-sustaining plankton out of seawater. The baleen, curiously, looks like palm fronds.

So there, on the North Slope of Alaska, stand three makeshift palm trees. Perhaps they are no more than an elaborate Inupiat joke, but these Arctic palms seem an enigmatic metaphor for the Earth's future. There is bigger question – *What would be the existence of living creature on the earth during next century?* [**25-30**].

7.0 Conclusion

From the above recent study, it is found that major causes of rising the fever of earth is; due to exploitation of our earth minerals and hydrocarbons especially: Coal, Crude oil, Diesel, Petrol and Gases, being used in transport and industries for generation of mechanical and electrical energy and also un-organized way of developments without balancing nature damage. Thus following points are concluded:

- Mass balance of World Glacier Monitoring Service shows that glaciers will be a history within few decades on the earth as per recent decline recorded on 16th March 2020.
- Rising of sea level produces a cascade effects, which shows that every inch (2.5 centimeters) of sea-level rise could result in eight feet (2.4 meters) of horizontal retreat of sandy beach shorelines due to erosion?. It will submerge most of the low-lying coastal areas of courtiers surrounded by the ocean, Like: India, Japan, Thailand, and Netherlands etc.[**3**]
- Severe cyclone, Hurricane, Tsunamis, Heavy Snow fall, Rainfall and Earthquakes etc. will create major causalities all over the world **[31].**
- Every year major funds will be pumped to disaster management to evacuate people from coastal area to safer places [**32**].
- Countries like: USA, Canada, France, Britain, Germany, Italy etc. will face severe cold waves, snow fall, heavy down pour and living will not be conducive, people will be forced to mitigate to find new safer place [**32**].

According to my earlier researches, there is one future projection – as earth speed is likely reducing in milliseconds that will create more challenges to face earth quake of high rector. As sea level is rising- radii of earth at lateral axis, create more friction impacts; ultimately it may likely to reduce the earth speed [**32**].

8.0 Reference

[1] Daniel B Fagre, Ph.D., Lisa McKeon, Land Resources, Climate Research and Development Program, Region 5: Missouri Basin, Northern Rocky Mountain Science Center (NOROCK).

[2] J.B. Bosson, M. Huss, E. Osipova,2019, Disappearing World Heritage Glaciers as a Keystone of Nature Conservation in a Changing Climate, published on 29 April 2019; DOI: 10.1029/2018EF001139.

[3] Bharat Raj Singh and Onkar Singh, (2013), A Study About Realities of Climate Change: Glacier Melting and Growing Crises; Book- Climate Change – Realities, Impacts Over Ice Cap, Sea Level and Risks; DOI: 10.5772/3459, chapter-2, page 39-40 & 63, published on 15 Jan 2013, at InTech Publisher, Croatia.

[4] Lei Hu, Arlyn E Andrews, Kirk W Thoning et. al, Enhanced North American carbon uptake associated with El Niño, Research Climatology-Science Advances, 05 Jun 2019, Vol. 5, no. 6, eaaw0076, DOI: 10.1126/sciadv.aaw0076.

[5] Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, 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.

Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. 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.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Anthropogenic and Natural Radiative Forcing.

[6] Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz and R. Van Dorland (2007) "Changes in Atmospheric Constituents and in Radiative Forcing". In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[7] Free Press Journal, India (2018), website: http://www.freepressjournal.in/events/coastline/

[8] "6.12.2 Direct GWPs" Archived 2007-03-29 at the Wayback Machine in IPCC Third Assessment Report – Climate Change 2001. GRID-Arendal (2003)

[9] Hong, Angela C.; Cora J. Young; Michael D. Hurley; Timothy J. Wallington; Scott A. Mabury (28 November 2013). "Perfluorotributylamine: A novel long-lived greenhouse gas". Geophysical Research Letters. 40 (22): 6010–6015. Bibcode: 2013GeoRL..40.6010H. doi: 10.1002/2013GL058010.

[10] Etminan, M.; Myhre, G.; Highwood, E. J.; Shine, K. P. (2016-12-28). "Radiative forcing of carbon dioxide, methane, and nitrous oxide: A significant revision of the methane radiative forcing: Greenhouse Gas Radiative Forcing". Geophysical Research Letters. **43** (24): 12, 614–12, 623. doi:10.1002/2016GL071930.

[11] Alvarez (2018). "Assessment of methane emissions from the U.S. oil and gas supply chain". Science. **361** (6398): 186–188. doi:10.1126/science.aar7204. PMC 6223263. PMID 29930092.
This is so, because of the reaction formula: $CH_4 + 2O_2 \rightarrow CO_2 + 2\ H_2O$. As mentioned in the article, the oxygen and water is not considered for GWP purposes, and one molecule of methane (molar mass = 16.04 g mol^{-1}) will yield one molecule of carbon dioxide (molar mass = 44.01 g mol^{-1}). This gives a mass ratio of 2.74. (44.01/16.04≈2.74).

[12] New Greenhouse Gas Discovered, PFTBA Has Higher Global Warming Impact Than CO2. Ibtimes.com (2013-12-10). Retrieved on 2014-04-23.

[13] Radiative efficiency definition of Radiative efficiency in the Free Online Encyclopedia. Encyclopedia2.thefreedictionary.com. Retrieved on 2014-04-23.

[14] Newly discovered greenhouse gas '7,000 times more powerful than CO2' | Environment. theguardian.com. 10 December 2013.

[15] New greenhouse gas discovered by U of T chemists | Toronto Star. Thestar.com (2013-12-11). Retrieved on 2014-04-23.

[16] S. Basu, Scott J. Lehman, John B. Miller, Pieter P. Tans, (2020), Estimating US fossil fuel CO2 emissions from measurements of 14C in atmospheric CO2, Proceedings of the National Academy of Sciences 117(24):201919032; DOI:10.1073/pnas.1919032117.

[17] Charles David Keeling, (2018), Scripps Institution of Oceanography, The study of atmospheric carbon dioxide (CO_2) at the newly established Mauna Loa Observatory of the U.S. Weather Bureau (now a part of NOAA).

[18] Conference of the Parties (25 March 1998). "Methodological issues related to the Kyoto Protocol". Report of the Conference of the Parties on its third session, held at Kyoto from 1 to 11 December 1997 Addendum Part Two: Action taken by the Conference of the Parties at its third session (PDF). UNFCCC. Retrieved 17 January 2011.

[19] "Testing 100-year global warming potentials: Impacts on compliance costs and abatement profile", "Climatic Change" Retrieved March 16, 2018

[20] Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases Annex IV.
These are normalized absorbance spectrum; these must be compensated for using the Beer–Lambert law for atmospheric concentrations, http://www.chem.arizona.edu/chemt/C21/sim/gh/ this plot provides a resultant application: Sunlight#Composition and power Carbon dioxide #In the Earth's atmosphere.

[21] "IPCC AR5 - Anthropogenic and Natural Radiative Forcing (Chapter 8 / page 663)"(PDF). 2013.

[22] Matthew Elrod, "Greenhouse Warming Potential Model." Based on Elrod, M. J. (1999). "Greenhouse Warming Potentials from the Infrared Spectroscopy of Atmospheric Gases". Journal of Chemical Education. **76** (12): 1702. Bibcode:1999JChEd..76.1702E. doi: 10.1021/ed076p1702.

[23] "Glossary: Global warming potential (GWP)". U.S. Energy Information Administration. Retrieved 2011-04-26. An index used to compare the relative radiative forcing of different gases without directly calculating the changes in atmospheric concentrations. GWPs are calculated as the ratio of the radiative forcing that would result from the emission of one kilogram of a greenhouse gas to that from the emission of one kilogram of carbon dioxide over a fixed period of time, such as 100 years. https://web.archive.org/web/20160131050350/http://www.grida.no/climate/ipcc_tar/wg1/247.htm

[24] CO2e - www3.epa.gov. Retrieved 2020-06-27.

[25] Park, Doo-Sun R., Sukyoung Lee, and Steven B. Feldstein. 2015. Attribution of the Recent Winter Sea Ice Decline over the Atlantic Sector of the Arctic Ocean. *Journal of Climate* 28(10): 4027–4033. doi:10.1175/JCLI-D-15-0042.1, *(Research Pub:nsidc.org).*

[26] Roy, François, et al. 2015. Arctic sea ice and freshwater sensitivity to the treatment of the atmosphere-ice-ocean surface layer. *Journal of Geophysical Research - Oceans* 120(6): 4392-4417. doi: 10.1002/2014JC010677. *.(Research Pub:nsidc.org).*

[27] Sumata, Hiroshi, et al. 2015. Uncertainty of Arctic summer ice drift assessed by high-resolution SAR data. *Journal of Geophysical Research - Oceans* 120(8): 5285-5301. doi:10.1002/2015JC010810, *(Research Pub:nsidc.org).*

[28] Tiwari, Sarita, Sarat C. Kar, and R.

Bhatla. 2015. Examination of snowmelt over Western Himalayas using remote sensing data. *Theoretical and Applied Climatology*. Art. #1506. doi: 10.1007/s00704-015-1506-y, *(Research Pub:nsidc.org).*

[29] Han, Lijan, et al. 2013. Spatial Variations in Snow Cover and Seasonally Frozen Ground over Northern China and Mongolia, 1988-2010. *Global and Planetary Change* 116: 139-148. doi: 10.1016/j.gloplacha.2014.02.008, *(Research Pub:nsidc.org).*

[30] Denison, Steve; Forster, Piers M; Smith, Christopher J (2019-11-18). "Guidance on emissions metrics for nationally determined contributions under the Paris Agreement". Environmental Research Letters. **14** (12): 124002. doi:10.1088/1748-9326/ab4df4. ISSN 1748-9326.

[31] Bharat Raj Singh and Onkar Singh, (2012), A Study About Realities of Climate Change: Glacier Melting and Growing Crises; Book- Global Warming – Impacts and Future Perspective, DOI:10.5772/2599, chapter-3, page 114, published on Sep 2012, at InTech Publisher, Croatia.

[32] Bharat Raj Singh and Onkar Singh, (2015), Dire Consequences on Little Shifting of the Earth's Spinning Angle – An Investigation Whether Polar Ice Shrinkage may be the Cause?, Book- Global Warming - Causes, Impacts and Remedies; DOI:10.5772/58506, chapter-3, page 66-67, published on April 2015, at InTech Publisher, Croatia.