

A CRITICAL ISSUE FOR TOMORROW'S TEACHERS: GLOBAL WARMING AND NATURAL HAZARDS

(MANDEEP, RESEARCH SCHOLAR ,GURU KASHI UNIVERSITY, TALWANDI SABO)

(Dr. A.K. Kansal as a guide)

ABSTRACT

This paper is an immense attempt to understand a critical issue for tomorrow's teachers on global warming and natural hazards. Global Warming is damaging the Earth's climate as well as the physical environment. Global Warming is not just a matter of warming weather, more floods or stronger hurricanes. It is a wake-up call to Terra Firma. Scientists predict the earth is facing 40-to-60 years of climate change, even if emissions of carbon dioxide and other global warming gases stopped today. One inevitable consequence of the greenhouse gases already in the atmosphere will be an increase in the frequency and severity of natural disaster events. **Global Warming, Natural Hazards, and Emergency Management** documents the imperative need for communities to prepare for the coming effects of climate change and provides a series of in-depth, road-tested recommendations on how to reduce risks for communities and businesses.

INTRODUCTION

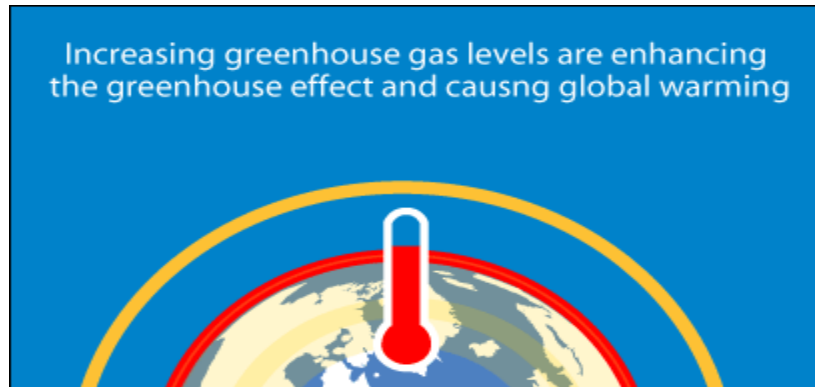
The world has witnessed numerous disasters over the centuries and although most are man-made due to wars and terrorism, mother nature certainly dishes out her fair share of damage. While there are many criteria as to what would be considered the "worst" natural disaster ranging from lives lost to cost incurred, the earthquakes, typhoons, and tsunamis are all horrific in their own right. **Global warming** is affecting many places around the world. It is accelerating the melting of ice sheets, permafrost and glaciers which is causing average sea levels to rise. It is also changing precipitation and weather patterns in many different places, making some places dryer, with more intense periods of drought and at the same time making other places wetter, with stronger storms and increased flooding. These changes have affected both nature as well as human society and will continue to have increasingly worse effects if greenhouse gas emissions continue to grow at the same pace as today. A **natural hazard** is a naturally occurring event that might have a negative effect on people or the environment

GLOBAL WARMING

The planet's climate is constantly changing, warming and cooling periodically; it is a naturally balanced cycle which has been occurring since the dawn of time. However, during the last century there has been a noticeable warming period which may not be entirely due to the natural cycle. In 1996, the Intergovernmental Panel on Climate Change (IPCC) report on the subject announced that there has been a 0.60C since the mid 19th century. It is not understood why this period of warming is occurring so rapidly, it is thought that human activities may be playing a part in exacerbating the natural heating cycle of the planet.

Global warming is the current increase in temperature of the Earth's surface (both land and water) as well as its atmosphere. Average temperatures around the world have risen by 0.75°C (1.4°F) over the last 100 years about two thirds of this increase has occurred since 1975. In the past, when the Earth experienced increases in temperature it was the result of natural causes but today it is being caused by the accumulation of greenhouse gases in the atmosphere produced by human activities.

The natural greenhouse effect maintains the Earth's temperature at a safe level making it possible for humans and many other life forms to exist. However, since the Industrial Revolution human activities have significantly enhanced the greenhouse effect causing the Earth's average temperature to rise by almost 1°C. This is creating the global warming we see today. To put this increase in perspective it is important to understand that during the last ice age, a period of massive climate change, the average temperature change around the globe was only about 5°C.



A long series of scientific research and international studies has shown, with more than 90% certainty, that this increase in overall temperatures is due to the greenhouse gases produced by humans. Activities such as deforestation and the burning of fossil fuels are the main sources of these emissions. These findings are recognized by the national science academies of all the major industrialized countries.

CAUSES FOR GLOBAL WARMING

The greenhouse effect is the planet's natural way to heat the earth. It involves short wave radiation entering the Earth's atmosphere from space where it is converted into heat, which has a longer radiation wave length. Greenhouse gases absorb this longer wavelength, preventing it from being reflected back into space. Greenhouse gases maintain the Earth's surface temperature at an average of 15°C rather than the 218°C. The higher levels of greenhouse gases in the atmosphere are exacerbating the natural cycle and are increasing the Earth's average temperature.

The cause of global warming is the increasing quantity of greenhouse gases in the atmosphere produced by human activities, like the burning of fossil fuels or deforestation. These activities produce large amounts of greenhouse gas emissions which are causing global warming. Greenhouse gases trap heat in the Earth's atmosphere to keep the planet warm enough to sustain life, this process is called the greenhouse effect. It is a natural process and without these gases, the Earth would be too cold for humans, plants and other creatures to live.

The natural greenhouse effect exists due to the balance of the major types of greenhouse gases. However, when abnormally high levels of these gases accumulate in the air, more heat starts getting trapped and lead to the enhancement of the greenhouse effect. Human-caused emissions have been increasing greenhouse levels which is raising worldwide temperatures and driving global warming.

- ❖ Greenhouse gas emissions and the enhanced greenhouse effect
- ❖ Deforestation

Greenhouse gas emissions and the enhanced greenhouse effect

Greenhouse gases are produced both naturally and through human activities. Unfortunately, greenhouse gases generated by human activities are being added to the atmosphere at a much faster rate than any natural process can remove them.

Greenhouse gases can be produced naturally and from human activities. The main greenhouse gases are carbon dioxide, ozone, water vapour, methane and chlorofluorocarbons (CFCs). There are many others that also contribute to global warming. Carbon dioxide can be produced by natural processes and by human activities. Plants use carbon dioxide during photosynthesis which is usually naturally balanced with the amount of carbon dioxide produced by organism respiration. The burning of fossil fuels and forests has increased the overall amount of the carbon dioxide in the atmosphere during the past 200 years, which is believed to be 30% higher than before the Industrial Revolution.

Global levels of greenhouse gases have increased dramatically since the dawn of the Industrial Revolution in the 1750s. Only a small group of human activities are causing the concentration of the main greenhouse gases (carbon dioxide, methane, nitrous oxide and fluorinated gases) to rise:

- The majority of man-made carbon dioxide emissions is from the burning of fossil fuels such as coal and oil so that humans can power various vehicles, machinery, keep warm and create electricity. Other important sources come from land-use changes (ex: deforestation) and industry (ex: cement production).
- Methane is created by humans during fossil fuel production and use, livestock and rice farming, as well as landfills. An increase in cattle and sheep farming has led to a dramatic rise in methane production. Ozone is a naturally existing layer which is found between 12-50 kilometres above the Earth. Its role is to absorb ultra violet radiation entering the Earth's atmosphere.
- Water vapour plays a key role in global warming and the greenhouse effect. Water vapour in the form of clouds can either cool the Earth's surface by blocking the sun's rays, but can also increase the temperature of the Earth's surface by acting as an insulating blanket. Water vapour can act as a positive feedback mechanism in climate change. Water vapour in the form of clouds heats up the Earth, exacerbating the greenhouse effect; this increases the rate of evaporation and therefore the amount of water vapour in the atmosphere which in turn exacerbates the greenhouse effect.
- Nitrous oxide emissions are mainly caused by the use of synthetic fertilizers for agriculture, fossil fuel combustion and livestock manure management.
- Fluorinated gases are used mainly in refrigeration, cooling and manufacturing applications.
- Chlorofluorocarbons (CFCs) are found in aerosol sprays, fridges and other sources. CFCs are very persistent and can last up to 60 years. CFCs are thought to be the cause of a dramatic widening of the hole in the Earth's ozone layer in the 1980's. Ozone is important as it protects the Earth's surface from ultra violet radiation (UV). If the ozone is damaged more UV light can get through to the Earth's surface which could cause a higher incidence of human skin cancer.

Deforestation

Deforestation has become a massive undertaking by humans and transforming forests into farms has a significant number of impacts as far as greenhouse gas emissions are concerned. For centuries, people have burned and cut down forests to clear land for agriculture. This has a double effect on the atmosphere both emitting carbon dioxide into the atmosphere and simultaneously reducing the number of trees that can remove carbon dioxide from the air.

When forested land is cleared, soil disturbance and increased rates of decomposition in converted soils both create carbon dioxide emissions. This also increases soil erosion and nutrient leaching which can further reduce the area's ability to act as a carbon sink.

EFFECTS OF GLOBAL WARMING

Global warming is damaging the Earth's climate as well as the physical environment. One of the most visible effects of global warming can be seen in the Arctic as glaciers, permafrost and sea ice are melting rapidly. A continuing increase in the Earth's average temperature could have a dramatic effect on the world as a whole. It is predicted that a rise of as little as 40C could lead to the melting of glaciers, ice sheets and ice caps around the world. There is currently approximately 25 million cubic kilometres of ice on the Earth's surface. The melting of the Greenland Ice Cap alone could increase the sea level by 7.4 metres, inundating all low-lying coastlands. An increase in temperature could lead to more frequent heat waves, higher rates of evaporation and precipitation, which could certainly increase the strength and frequency of tropical cyclones. Global warming is harming the environment in several ways including:

- Desertification
- Increased melting of snow and ice
- Sea level rise
- Stronger hurricanes and cyclones

Desertification

Increasing temperatures around the world are making arid and semi-arid areas even drier than before. Current research is also showing that the water cycle is changing and rainfall patterns are shifting to make areas that are already dry even drier. This is causing water shortages and an intense amount of distress to the over 2.5 million people in dry regions which are degrading into desert. This process is called desertification.

Increased melting of snow and ice

Around the world, snow and ice is melting at a much faster pace than in the past. This has been seen in the Alps, Himalayas, Andes, Rockies, Alaska and Africa but is particularly true at the Earth's poles.

Perennial ice cover in the Arctic is melting at the rate of 11.5% per decade and the thickness of the Arctic ice has decreased by 48% since the 1960s. During the past 30 years, more than a million square miles of sea ice has vanished, an area equivalent to the size of Norway, Denmark and Sweden combined. The continent of Antarctica has been losing more than 100 cubic kilometres (24 cubic miles) of ice per year since 2002. Since 2010, the Antarctic ice melt rate has doubled.

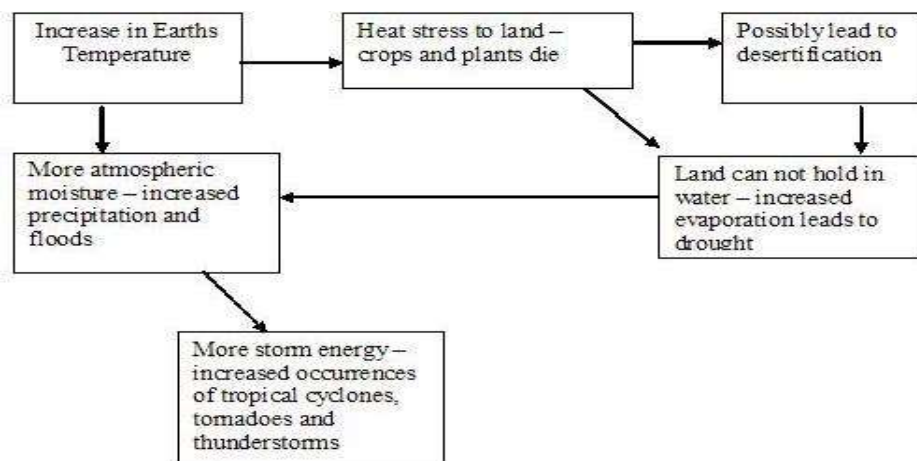
Sea level rise

The Earth's sea level has risen by 21 cm (8 inches) since 1880. The rate of rise is accelerating and is now at a pace that has not been seen for at least 5000 years. Global warming has caused this by affecting the oceans in two ways: warmer average temperatures cause ocean waters to expand (thermal expansion) and the accelerated melting of ice and glaciers increase the amount of water in the oceans.

Stronger hurricanes and cyclones

Tropical cyclone activity has seen an obvious upswing trend since the early 1970s. Interestingly, this matches directly with an observed rise in the oceans' temperature over the same period of time. Since then, the Power Dissipation Index which measures the destructive power of tropical cyclones has increased in the Pacific by 35% and in the Atlantic it has nearly doubled. Global warming also increases the frequency of strong cyclones. Every 1 degree C increase in sea surface temperature results in a 31% increase in the global frequency of category 4 and 5 storms.

Below are a number of boxes illustrating the possible effects of an increase in the Earth's temperature.



NATURAL HAZARDS

A **natural hazard** is a naturally occurring event that might have a negative effect on people or the environment. A widely accepted definition characterizes natural hazards as "those elements of the physical environment, harmful to man and caused by forces extraneous to him. More specifically, in this document, the term "natural hazard" refers to all atmospheric, hydrologic, geologic (especially seismic and volcanic), and wildfire phenomena that, because of their location, severity, and frequency, have the potential to affect humans, their structures, or their activities adversely. The qualifier "natural" eliminates such exclusively manmade phenomena as war, pollution, and chemical contamination. Hazards to human beings not necessarily related to the physical environment, such as infectious disease, are also excluded from consideration here. Natural hazard events can be grouped into two broad categories. Geophysical hazards encompass geological and meteorological phenomena such as earthquakes, coastal erosion, volcanic eruption, cyclonic storms, and drought. Biological hazards can refer to a diverse array of disease and infestation. Other natural hazards such as floods and wildfires can result from a combination of geological, hydrological, and climatic factors.

Many geophysical hazards are interrelated for example, submarine earthquakes can cause tsunamis, and hurricanes can lead to coastal flooding and erosion. It is possible that some natural hazards are intertemporally correlated as well. A concrete example of the division between a natural *hazard* and a natural *disaster* is that the 1906 San Francisco earthquake was a disaster, whereas living on a fault line is a hazard.

HOW NATURAL ARE NATURAL HAZARDS?

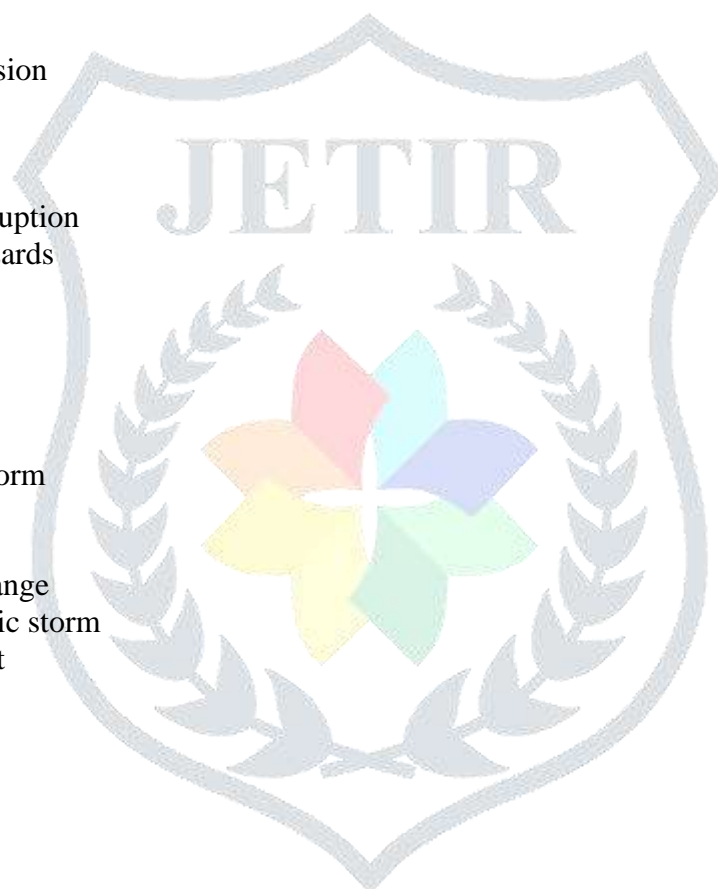
Notwithstanding the term "natural," a natural hazard has an element of human involvement. A **physical event**, such as a volcanic eruption, that does not affect human beings is a **natural phenomenon** but not a natural hazard. A natural phenomenon that occurs in a populated area is a **hazardous event**. A hazardous event that causes unacceptably large numbers of fatalities and/or overwhelming property damage is a **natural disaster**. In areas where there are no human interests, natural phenomena do not constitute hazards nor do they result in disasters. This definition is thus at odds with the perception of natural hazards as unavoidable havoc wreaked by the unrestrained forces of nature. It shifts the burden of cause from purely natural processes to the concurrent presence of human activities and natural events.

Although humans can do little or nothing to change the incidence or intensity of most natural phenomena, they have an important role to play in ensuring that natural events are not converted into disasters by their own actions. It is important to understand that **human intervention can increase the frequency and**

severity of natural hazards. For example, when the toe of a landslide is removed to make room for a settlement, the earth can move again and bury the settlement. **Human intervention may also cause natural hazards where none existed before.** Volcanoes erupt periodically, but it is not until the rich soils formed on their ejector are occupied by farms and human settlements that they are considered hazardous. Finally, **human intervention reduces the mitigating effect of natural ecosystems.** Destruction of coral reefs, which removes the shore's first line of defense against ocean currents and storm surges, is a clear example of an intervention that diminishes the ability of an ecosystem to protect itself. An extreme case of destructive human intervention into an ecosystem is desertification, which, by its very definition, is a human-induced "natural" hazard.

TYPES OF NATURAL HAZARDS

- Geological hazards
 - Avalanche
 - Earthquake
 - Coastal erosion
 - Lahar
 - Landslide
 - Sinkholes
 - Volcanic eruption
- Meteorological hazards
 - Blizzard
 - Drought
 - Hailstorm
 - Heat wave
 - Maelstrom
 - Cyclonic storm
 - Ice storm
 - Tornado
 - Climate change
 - Geomagnetic storm
 - Water spout
- Flood
- Wildfire
- Disease



Geological hazards

Avalanche

An avalanche occurs when a large snow (or rock) mass slides down a mountainside. An avalanche is an example of a gravity current consisting of granular material. In an avalanche, lots of material or mixtures of different types of material fall or slide rapidly under the force of gravity. Avalanches are often classified by the size or severity of consequences resulting from the event.

Earthquake

An earthquake is a phenomenon that results from a sudden release of stored energy that radiates seismic waves. At the Earth's surface, earthquakes may manifest with a shaking or displacement of the ground; when the earthquake occurs on the seafloor, the resulting displacement of water can sometimes result in a tsunami. Most of the world's earthquakes (90%, and 81% of the largest) take place in the 40,000-km-long, horseshoe-shaped zone called the circum-Pacific seismic belt, also known as the Pacific Ring of Fire, which

for the most part bounds the Pacific Plate. Many earthquakes happen each day, few of which are large enough to cause significant damage.

Coastal erosion

Coastal erosion is a physical process by which shorelines in coastal areas around the world shift and change, primarily in response to waves and currents that can be influenced by tides and storm surge. Coastal erosion can result from long-term processes as well as from episodic events such as tropical cyclones or other severe storm events.

Lahar

A lahar is a type of natural event closely related to a volcanic eruption, and involves a large amount of material originating from an eruption of a glaciated volcano, including mud from the melted ice, rock, and ash sliding down the side of the volcano at a rapid pace. These flows can destroy entire towns in seconds and kill thousands of people, and form flood basalt. This is based on natural events.

Landslide

A landslide is a mass displacement of sediment, usually down a slope.

Sinkholes

A sinkhole is a localized depression in the surface topography, usually caused by the collapse of a subterranean structure such as a cave. Although rare, large sinkholes that develop suddenly in populated areas can lead to the collapse of buildings and other structures.

Volcanic eruption

A volcanic eruption is the point in which a volcano is active and releases its power, and the eruptions come in many forms. They range from daily small eruptions which occur in places like Kilauea in Hawaii, to megacollossal eruptions (where the volcano expels at least 1,000 cubic kilometers of material) from supervolcanoes like Lake Taupo (26,500 years ago) and Yellowstone Caldera. According to the Toba catastrophe theory, 70 to 75 thousand years ago, a supervolcanic event at Lake Toba reduced the human population to 10,000 or even 1,000 breeding pairs, creating a bottleneck in human evolution. Some eruptions form pyroclastic flows, which are high-temperature clouds of ash and steam that can travel down mountainsides at speed exceeding an airliner.

Meteorological hazards

Blizzard

A blizzard is a severe winter storm icy and windy conditions characterized by low temperature, strong wind and heavy snow.

Drought

Scientists warn that global warming and climate change may result in more extensive droughts in coming years. These extensive droughts are likely to occur within the African continent due to its very low precipitation levels and high climate.

Hailstorm

A hailstorm is a natural hazard where a thunderstorm produces numerous hailstones which damage the location in which they fall. Hailstorms can be especially devastating to farm fields, ruining crops and damaging equipment.

Heat wave

A heat wave is a hazard characterized by heat which is considered extreme and unusual in the area in which it occurs. Heat waves are rare and require specific combinations of weather events to take place, and may include temperature inversions, katabatic winds, or other phenomena. There is potential for longer-term events causing global warming, including stadial events (the opposite to glacial "ice age" events), or through human-induced climatic warming.

Maelstrom

A maelstrom is a very powerful whirlpool. It is a large, swirling body of water with considerable downdraft. There are virtually no documented accounts of large ships being sucked into a maelstrom, although smaller craft and swimmers are in danger. Tsunami-generated maelstroms may even threaten larger crafts.

Cyclonic storm

Hurricane, tropical cyclone, and typhoon are different names for the same phenomenon: a cyclonic storm system that forms over the oceans. It is caused by evaporated water that comes off of the ocean and becomes a storm. The Coriolis effect causes the storms to spin, and a hurricane is declared when this spinning mass of storms attains a wind speed greater than 74 mph (119 km/h). *Hurricane* is used for these phenomena in the Atlantic and eastern Pacific Oceans, *tropical cyclone* in the Indian, and *typhoon* in the western Pacific.

Ice storm

An ice storm is a particular weather event in which precipitation falls as ice, due to atmosphere conditions. It causes damage.

Tornado

A tornado is a natural disaster resulting from a thunderstorm. Tornadoes are violent, rotating columns of air which can blow at speeds between 50 mph (80 km/h) and 300 mph (480 km/h), and possibly higher. Tornadoes can occur one at a time, or can occur in large tornado outbreaks associated with supercells or in other large areas of thunderstorm development. Waterspouts are tornadoes occurring over tropical waters in light rain conditions.

Climate change

Climate change is a long-term hazard which can increase or decrease the risk of other weather hazards, and also directly endangers property due to sea level rise and biological organisms due to habitat destruction.

Geomagnetic storm

Geomagnetic storms can disrupt or damage technological infrastructure, and disorient species with magnetoception.

Water spout

A tornado formed over water.

Flood

A flood results from an overflow of water beyond its normal confines of a body of water such as a lake, or the accumulation of water over land areas.

Wildfire

Wildfire is a fire that burns in an uncontrolled and unplanned manner. Wildfires can result from natural occurrences such as lightning strikes or from human activity.

Disease

Disease is a natural hazard that can be enhanced by human factors such as urbanization or poor sanitation. Disease affecting multiple people can be termed an outbreak or epidemic.

In some cases, a hazard exists in that a human-made defense against disease could fail, for example through antibiotic resistance.

MULTI-HAZARD ANALYSIS

Each of the natural hazard types outlined above have very different characteristics, in terms of the spatial and temporal scales they influence, hazard frequency and return period, and measures of intensity and impact. These complexities result in "single-hazard" assessments being commonplace, where the hazard potential from one particular hazard type is constrained. In these examples, hazards are often treated as isolated or independent. An alternative is a "multi-hazard" approach which seeks to identify all possible natural hazards and their interactions or interrelationships.

Many examples exist of one natural hazard triggering or increasing the probability of one or more other natural hazards. For example, an earthquake may trigger landslides, whereas a wildfire may increase the probability of landslides being generated in the future. A detailed review of such interactions across 21 natural hazards identified 90 possible interactions, of varying likelihood and spatial importance. There may also be interactions between these natural hazards and anthropic processes. For example, groundwater abstraction may trigger groundwater-related subsidence.

Effective hazard analysis in any given area (e.g., for the purposes of disaster risk reduction) should ideally include an examination of all relevant hazards and their interactions.

REFERENCES

Church, John A., and Neil J. White (2011). "Sea-Level Rise from the Late 19th to the Early 21st Century." *Surveys in Geophysics* 32, no. 4-5, 585-602.

Comiso, J.C., and D.K. Hall (2014). Climate trends in the Arctic as observed from space. *WIREs Climate Change*, 5, 389–409.

Hansen, J., R. Ruedy, M. Sato, and K. Lo. (2010). Global Surface Temperature Change. *Reviews of Geophysics* 48(4): RG4004.

Hunter, John (2010). "Estimating sea-level extremes under conditions of uncertain sea-level rise." *Climatic Change* 99, no. 3-4, 331-350.

Le Treut, H., R. Somerville, U. Cubasch, Y. Ding, C. Mauritzen, A. Mokssit, T. Peterson and M. Prather (2007). Historical Overview of Climate Change. 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*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2007.

McMillan, M., A. Shepherd, A. Sundal, K. Briggs, A. Muir, A. Ridout, A. Hogg, and D. Wingham(2014). *Increased ice losses from Antarctica detected by CryoSat-2. Geophys. Res. Lett.* 41, 3899–3905.

National Research Council (2008). *Ecological impacts of climate change*. Washington, D.C.: National Academies Press.

Shakun, Jeremy D., and Anders E. Carlson(2010). A global perspective on Last Glacial Maximum to Holocene climate change. *Quaternary Science Reviews* 29(15-16), 1801-1816.

"Global temperatures." **U.K. Met Office(2014).** <http://www.metoffice.gov.uk/climate-change/guide/science/monitoring/global>.

^ <http://link.springer.com/article/10.1007%2Fs11069-012-0294-2>

^ <http://onlinelibrary.wiley.com/doi/10.1002/2013RG000445/abstract>

^ <http://onlinelibrary.wiley.com/doi/10.1002/2013RG000445/abstract>

^ <http://onlinelibrary.wiley.com/doi/10.1002/2013RG000445/abstract>

^ <http://meetingorganizer.copernicus.org/EGU2014/EGU2014-3049.pdf>

^ <http://water.usgs.gov/edu/earthgwlandsubside.html>