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"Some Consequences of Global Warming In the Context of Globalization"

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ABSTRACT
The effects of climate change are also projected to impact land use and recreation policies in the park, which will have a subsequent impact on the local economy. Glacier contributes approximately $150 million to Montana's economy each year and supports roughly 3,200 jobs in the state. In addition to Montana, Glacier also generates substantial revenue for neighboring states as well as areas in Canada. As the glaciers continue to retreat and disappear, it is likely that fewer people will continue to return to the park. Water ton Lakes National Park in Canada conducted a study on the effects of glacier loss and found that 19% of visitors would not return to the park and 37% would return less when given a description of how the park's landscape would be affected by climate change.

INTRODUCTION
The Earth's climate has exhibited marked "natural" climate changes, with time scales varying from many millions of years down to a few years. Changes in land and ocean floor topography have had major influences on global climate at time scales of 50 million to 150 million years.
Over the last two million years the onset and recession of the great Ice Ages were probably influenced by changes in the earth's orbit and the tilt of its axis, which caused systematic variations in the amount and distribution of solar radiation. Global average temperatures varied by about 5 - 7°C.
Since the end of the last ice age (14,000 - 10,000 years ago) globally averaged surface temperatures have fluctuated over a range of up to 2°C on time scales of centuries or more. Factors influencing these changes probably included fluctuations in the radiation output from the sun, and changes in circulation and overturning in the oceans. Increased amounts of greenhouse gases in the atmosphere will absorb more thermal radiation, and the Earth's surface and the lower atmosphere will warm. This extra warming is called the enhanced greenhouse effect.

The United Nations Framework Convention on Climate Change (UNFCCC) came into force on 21 March 1994. The ultimate objective of the Convention is:
... Stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system...

New Zealand is a party to the UNFCCC and has signed the Kyoto Protocol. The Kyoto Protocol commits us to returning our emissions of greenhouse gases back to 1990 levels, on average, over 2008-2012.
Energy emitted from the sun ("solar radiation") is concentrated in a region of short wavelengths including visible light. Much of the short wave solar radiation travels down through the Earth's atmosphere to the surface virtually unimpeded. Some of the solar radiation is reflected straight back into space by clouds and by the earth's surface. Much of the solar radiation is absorbed at the earth's surface, causing the surface and the lower parts of the atmosphere to warm.

The warmed Earth emits radiation upwards, just as a hot stove or bar heater radiates energy. In the absence of any atmosphere, the upward radiation from the Earth would balance the incoming energy absorbed from the Sun, with a mean surface temperature of around -18°C.

The presence of greenhouse gases in the atmosphere, however, changes the radiation balance. Heat radiation (infra-red) emitted by the Earth is concentrated at long wavelengths and is strongly absorbed by greenhouse gases in the atmosphere, such as water vapour, carbon dioxide and methane. As a result, the surface temperature of the globe is around 15°C on average, 33°C warmer than it would be if there was no atmosphere. This is called the natural greenhouse effect.

If extra amounts of greenhouse gases are added to the atmosphere, such as from human activities, then they will absorb more of the infra-red radiation. The Earth's surface and the lower atmosphere will warm further until a balance of incoming and outgoing radiation is reached again. This extra warming is called the enhanced greenhouse effect.

Methane is a so-called greenhouse gas. Greenhouse gases impact the environment through warming the atmosphere. The concentration of greenhouse gases has risen significantly in the past 200 years, in part due to human activities. One of the biggest contributors to the atmospheric methane concentration is farmed livestock, especially cattle and sheep. These animals produce methane naturally as part of their digestive process, and belch it, especially while 'chewing the cud'. As the human population has grown, the number of farmed animals has increased markedly to meet the human demand for food through meat and dairy products.

Global warming is now recognized by almost all scientists, and they recognize that humans are increasing the rate of global warming. Global warming has become a major concern of humanity since the middle of the 20th century. It was namely then that the first increase in the Earth's temperature was registered. The temperature became less than one degree higher, but on a global scale, this is very high. Global warming is increasing each year. Humanity's contributions to global warming are in the form of greenhouse gases, mainly carbon dioxide (CO2) and methane (CH4), which prevent heat from escaping the earth. The result is increasing temperatures, up to 4 degrees, across the planet. In such a condition, many forms of plant and animal life can and will die.

Regional impacts

Highlights of recent and projected regional impacts are shown below:

Impacts on Africa

Africa is one of the most vulnerable continents to climate variability and change because of multiple existing stresses and low adaptive capacity. Existing stresses include poverty, political conflicts, and ecosystem degradation.

- By 2050, between 350 million and 600 million people are projected to experience increased water stress due to climate change.
- Climate variability and change is projected to severely compromise agricultural production, including access to food, across Africa.
- Toward the end of the 21st century, projected sea level rise will likely affect low-lying coastal areas with large populations.
- Climate variability and change can negatively impact human health. In many African countries, other factors already threaten human health. For example, malaria threatens health in southern Africa and the Eastern Highlands.

Impacts on Asia

Glaciers in Asia are melting at a faster rate than ever documented in historical records. Melting glaciers increase the risks of flooding and rock avalanches from destabilized slopes.

- Climate change is projected to decrease freshwater availability in central, south, east and Southeast Asia, particularly in large river basins. With population growth and increasing demand from higher standards of living, this decrease could adversely affect more than a billion people by the 2050s.
- Increased flooding from the sea and, in some cases, from rivers, threatens coastal areas, especially heavily populated delta regions in south, east, and Southeast Asia.
- By the mid-21st century, crop yields could increase up to 20% in east and Southeast Asia. In the same period, yields could decrease up to 30% in central and south Asia.
- Sickness and death due to diarrheal disease are projected to increase in east, south, and Southeast Asia due to projected changes in the hydrological cycle associated with climate change.

Impacts on Australia and New Zealand

Water security problems are projected to intensify by 2030 in southern and eastern Australia, and in the northern and some eastern parts of New Zealand.

- Significant loss of biodiversity is projected to occur by 2020 in some ecologically rich sites, including the Great Barrier Reef and the Wet Tropics of Queensland.
- Sea level rise and more severe storms and coastal flooding will likely impact coastal areas. Coastal development and population growth in areas such as Cairns and Southeast Queensland (Australia) and Northland to Bay of Plenty (New Zealand), would place more people and infrastructure at risk.
- By 2030, increased drought and fire is projected to cause declines in agricultural and forestry production over much of southern and eastern Australia and parts of eastern New Zealand.
- Extreme storm events are likely to increase failure of floodplain protection and urban drainage and sewerage, as well as damage from storms and fires.
- More heat waves may cause more deaths and more electrical blackouts.

Impacts on Europe

Wide-ranging impacts of climate change have already been documented in Europe. These impacts include retreating glaciers, longer growing seasons, species range shifts, and heat wave-related health impacts. Future impacts of climate change are projected to negatively affect nearly all European regions. Many economic sectors, such as agriculture and energy, could face challenges.

- In southern Europe, higher temperatures and drought may reduce water availability, hydropower potential, summer tourism, and crop productivity.
- In central and eastern Europe, summer precipitation is projected to decrease, causing higher water stress. Forest productivity is projected to decline. The frequency of peatland fires is projected to increase.
- In northern Europe, climate change is initially projected to bring mixed effects, including some benefits such as reduced demand for heating, increased crop yields, and increased forest growth. However, as climate change continues, negative impacts are likely to outweigh benefits. These include more frequent winter floods, endangered ecosystems, and increasing ground instability.

Impacts on Latin America

- By mid-century, increases in temperature and decreases in soil moisture are projected to cause savanna to gradually replace tropical forest in eastern Amazonia.
- In drier areas, climate change will likely worsen drought, leading to salinization and desertification (land degradation) of agricultural land. The productivity of livestock and some important crops such as maize and coffee is projected to decrease, with adverse consequences for food security. In temperate zones, soybean yields are projected to increase. Sea level rise is projected to increase risk

of flooding, displacement of people, salinization of drinking water resources, and coastal erosion in low-lying areas. Changes in precipitation patterns and the melting of glaciers are projected to significantly affect water availability for human consumption, agriculture, and energy generation.

Impacts on North America

Projected change in seasonal mean surface air temperature from the late 20th century (1971-2000 average) to the middle 21st century (2051-2060). The left panel shows changes for June–July–August (JJA) seasonal averages, and the right panel shows changes for December–January–February (DJF). The change is in response to increasing atmospheric concentrations of greenhouse gases and aerosols based on a "middle of the road" estimate of future emissions (SRES emissions scenario A1B). Warming is projected to be larger over continents than oceans, and is largest at high latitudes of the Northern Hemisphere during Northern Hemisphere winter.

Warming in western mountains is projected to decrease snowpack, increase winter flooding, and reduce summer flows, exacerbating competition for over-allocated water resources.

- Disturbances from pests, diseases, and fire are projected to increasingly affect forests, with extended periods of high fire risk and large increases in area burned.
- Moderate climate change in the early decades of the century is projected to increase aggregate yields of rain-fed agriculture by 5-20%, but with important variability among regions. Crops that are near the warm end of their suitable range or that depend on highly utilized water resources will likely face major challenges
- .Increases in the number, intensity, and duration of heat waves during the course of the century are projected to further challenge cities that currently experience heat waves, with potential for adverse health impacts. Older populations are most at risk.
- Climate change will likely increasingly stress coastal communities and habitats, worsening the existing stresses of development and pollution

Impacts on Polar Regions

Climate change in the Arctic will likely reduce the thickness and extent of glaciers and ice sheets.

- Changes in natural ecosystems will likely have detrimental effects on many organisms including migratory birds, mammals, and higher predators.
- In the Arctic, climate changes will likely reduce the extent of sea ice and permafrost, which can have mixed effects on human settlements. Negative impacts could include damage to infrastructure and changes to winter activities such as ice fishing and ice road transportation. Positive impacts could include more navigable northern sea routes.
- The reduction and melting of permafrost, sea level rise, and stronger storms may worsen coastal erosion.
- Terrestrial and marine ecosystems and habitats are projected to be at risk to invasive species, as climatic barriers are lowered in both polar regions

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Impacts on Small Islands

Small islands, whether located in the tropics or higher latitudes, are already exposed to extreme weather events and changes in sea level. This existing exposure will likely make these areas sensitive to the effects of climate change.

- Deterioration in coastal conditions, such as beach erosion and coral bleaching, will likely affect local resources such as fisheries, as well as the value of tourism destinations.
- Sea level rise is projected to worsen inundation, storm surge, erosion, and other coastal hazards. These impacts would threaten vital infrastructure, settlements, and facilities that support the livelihood of island communities.

- By mid-century, on many small islands (such as the Caribbean and Pacific), climate change is projected to reduce already limited water resources to the point that they become insufficient to meet demand during low-rainfall periods.
- Invasion by non-native species is projected to increase with higher temperatures, particularly in mid- and high-latitude islands.

Inundation, displacement, and national sovereignty of small islands

According to scholar Tsosie, environmental disparities among disadvantaged communities including poor and racial minorities, extend to global inequalities between the developed and developing countries.

According to Barnett, J. and Adger, W.N. the projected damage to small islands and atoll communities will be a consequence of climate change caused by developing countries that will disproportionately affect these developing nations.

Sea-level rise and increased tropical cyclones are expected to place low-lying small islands in the Pacific, Indian, and Caribbean regions at risk of inundation and population displacement.

According to N. Mimura's study on the vulnerability of island countries in the South Pacific to sea level rise and climate change, financially burdened island populations living in the lowest-lying regions are most vulnerable to risks of inundation and displacement. On the islands of Fiji, Tonga and Western Samoa for example, high concentrations of migrants that have moved from outer islands inhabit low and unsafe areas along the coasts.

Atoll nations, which include countries that are composed entirely of the smallest form of islands, called motus, are at risk of entire population displacement. These nations include Kiribati, Maldives, the Marshall Islands, Tokelau, and Tuvalu. According to a study on climate dangers to atoll countries, characteristics of atoll islands that make them vulnerable to sea level rise and other climate change impacts include their small size, their isolation from other land, their low income resources, and their lack of protective infrastructure.

A study that engaged the experiences of residents in atoll communities found that the cultural identities of these populations are strongly tied to these lands. The risk of losing these lands therefore threatens the national sovereignty, or right to self-determination, of Atoll nations. Human rights activists argue that the potential loss of entire atoll countries, and consequently the loss of cultures and indigenous life aways cannot be compensated with financial means. Some researchers suggest that the focus of international dialogues on these issues should shift from ways to relocate entire communities to strategies that instead allow for these communities to remain on their lands.

Especially affected regions

The Arctic, Africa, small islands and Asian mega deltas are regions that are likely to be especially affected by future climate change. Within other areas, some people are particularly at risk from future climate change, such as the poor, young children and the elderly.

The Arctic

The Arctic is likely to be especially affected by climate change because of the high projected rate of regional warming and associated impacts. Temperature projections for the Arctic region were assessed by Anisimov et al. (2007). These suggested areally averaged warming of about 2 °C to 9 °C by the year 2100. The range reflects different projections made by different climate models, run with different forcing scenarios. Radiative forcing is a measure of the effect of natural and human activities on the climate.

Different forcing scenarios reflect, for example, different projections of future human greenhouse gas emissions.

Small islands

On small islands, sea level rise is expected to exacerbate inundation, erosion and other coastal hazards, and threaten vital infrastructure, human settlements and facilities that support the livelihood of island communities. In the coastal zone of Asia, there are 11 mega deltas with an area greater than 10,000 km2. These mega deltas are homes to millions of people, and contain diverse ecosystems. Climate change and sea level rise could increase the frequency and level of inundation of Asian mega deltas due to storm surges and floods from river drainage.

Ice-cover changes

Permanent ice cover on land is a result of a combination of low peak temperatures and sufficient precipitation. Some of the coldest places on Earth, such as the dry valleys of Antarctica, lack significant ice or snow coverage due to a lack of snow. Sea ice however may be formed simply by low temperature, although precipitation may influence its stability by changing albedo, providing an insulating covering of snow and affecting heat transfer. Global warming has the capacity to alter both precipitation and temperature, resulting in significant changes to ice cover. Furthermore, the behavior of ice sheets, ice caps and glaciers is altered by changes in temperature and precipitation, particularly as regards the behavior of water flowing into and through the ice .

Antarctica

The collapse of Larsen B showing the diminishing extent of the shelf from 1998 to 2002. The Antarctic Peninsula has lost a number of ice shelves recently. These are large areas of floating ice which are fed by glaciers. Many are the size of a small country. The sudden collapse of the Larsen B ice shelf in 2002 took 5 weeks or less and may have been due to global warming. Larsen B had previously been stable for up to 12,000 years. Concern has been expressed about the stability of the West Antarctic ice sheet. A collapse of the West Antarctic ice sheet could occur "within 300 years as a worst-case scenario. Rapid sea-level rise (>1 m per century) is more likely to come from the WAIS than from the Greenland ice sheet."

Greenland

As the Greenland ice sheet loses mass from calving of icebergs as well as by melting of ice, any such processes tend to accelerate the loss of the ice sheet. The IPCC suggest that Greenland will become ice free at around 5 Celsius degrees over pre-industrial levels, but subsequent research comparing data from the Eemian period suggests that the ice sheet will remain at least in part at these temperatures. The volume of ice in the Greenland sheet is sufficient to cause a global sea level rise of 7 meters. It would take 3,000 years to completely melt the Greenland ice sheet. This figure was derived from the assumed levels of greenhouse gases over the duration of the experiment. In reality, these greenhouse gas levels are of course affected by future emissions and may differ from the assumptions made in the model.

Glaciers

Glacier retreat not only affects the communities and ecosystems around the actual glacier, but the entire downstream region. The most notable example of this is in India, where river systems such as the Indus and Ganges are ultimately fed by glacial meltwater from the Himalayas. Loss of these glaciers will have dramatic effects on the downstream region, increasing the risk of drought as lower flows of meltwater reduce summer river flows unless summer precipitation increases. Altered patterns of flooding can also affect soil fertility.

The Tibetan Plateau contains the world's third-largest store of ice. Qin Dahe, the former head of the China Meteorological Administration, said that the recent fast pace of melting and warmer temperatures will be good for agriculture and tourism in the short term; but issued a strong warning:

"Temperatures are rising four times faster than elsewhere in China, and the Tibetan glaciers are retreating at a higher speed than in any other part of the world.... In the short term, this will cause lakes to expand and bring floods and mudflows. . . . In the long run, the glaciers are vital lifelines for Asian rivers, including the Indus and the Ganges. Once they vanish, water supplies in those regions will be in peril ."

Permafrost regions

Regions of permafrost cover much of the Arctic. In many areas, permafrost is melting, leading to the formation of a boggy, undulating landscape filled with thermokarst lakes and distinctive patterns of drunken trees. The process of permafrost melting is complex and poorly understood since existing models do not include feedback effects such as the heat generated by decomposition.

Precipitation and vegetation changes

Much of the effect of global warming is felt through its influence on rain and snow. Regions may become wetter, drier, or may experience changes in the intensity of precipitation - such as moving from a damp climate to one defined by a mixture of floods and droughts. These changes may have a very severe impact on both the natural world and human civilisation, as both naturally occurring and farmed plants experience regional climate change that is beyond their ability to tolerate.

A U.S. National Oceanic and Atmospheric Administration (NOAA) analysis published in the Journal of Climate October 2011, and cited on Joseph J. Romm's, climateprogress.org, found that increasing droughts in the Middle East during the wintertime when the region traditionally most of its rainfall to replenish aquifers, and anthropogenic climate change is partly responsible. Per Earth System Research Laboratory's Martin Hoerling “The magnitude and frequency of the drying that has occurred is too great to be explained by natural variability alone,” and “This is not encouraging news for a region that already experiences water stress, because it implies natural variability alone is unlikely to return the region’s climate to normal.”

Amazon

One modeling study suggested that the extent of the Amazon rainforest may be reduced by 70% if global warming continues unchecked, due to regional precipitation changes that result from weakening of large-scale tropical circulation.

Sahara

Some studies suggest that the Sahara desert may have been more vegetated during the warmer Mid-Holocene period, and that future warming may result in similar patterns .

Sahel

Climate models which realistically model the West African Monsoon predict "a doubling of the number of anomalously dry years by the end of the century".

Desert expansion

Expansion of subtropical deserts is expected as a result of global warming, due to expansion of the Hadley Cell.

Coastal regions

Global sea level is currently rising due to the thermal expansion of water in the oceans and the addition of water from ice sheets. Because of this, there low-lying coastal areas, many of which are heavily populated, are at risk of flooding.

Areas threatened by current sea level rise include Tuvalu and the Maldives. Regions that are prone to storm surges, such as London, are also threatened. With very high confidence, IPCC (2007) projected that by the 2080s, many millions more people would experience floods every year due to sea level rise. The numbers affected were projected to be largest in the densely populated and low-lying megadeltas of Asia and Africa. Small islands were judged to be especially vulnerable.

Ocean effects

North Atlantic region

It has been suggested that a shutdown of the Atlantic thermohaline circulation may result in relative cooling of the North Atlantic region by up to 8C in certain locations. Recent research suggests that this process is not currently underway.

Tropical surface and troposphere temperatures

In the tropics, basic physical considerations, climate models, and multiple independent data sets indicate that the warming trend due to well-mixed greenhouse gases should be faster in the troposphere than at the surface.

State of the Rockies Blog

Glacier National Park encompasses some of the most diverse wildlife populations in North America. As the name implies, the park is home to a number of glaciers, which play a crucial role in the region's ecology. It also is one of the few areas that boasts a full range of large mammals including grizzly and black bears, lynx, wolverines, wolves,mountain goats, bighorn sheep, mountain lions, and elk. With over 200 million visits annually, Glacier National Park is the eleventh most visited National Park in the U.S., contributing substantially to the surrounding economies. However, steadily increasing temperatures have caused its glaciers to melt at alarming rates. Currently only 25 of the 37 named glaciers in the park remain, and it is projected that by 2030 all of the glaciers in the park will be gone. As a result, Glacier is one of the most vulnerable national parks in the face of climate change. Warming temperatures and retreating glaciers will continue to impact wildlife and will also prove to have significant economic effects on the region. Peter Aengst of the Wilderness Society states: "Just one example of how climate change is impacting the Crown of the Continent is in Glacier National Park where the modeling and the science suggests that all of the glaciers there will be gone in literally less than 20 years and the park formally known as "Glacier National Park" will have no glaciers."

Effects on plants and wildlife:

Hiking through a range of elevations in Glacier, one cannot help but recognize the diversity of wildlife that flourishes throughout the park. From lush low elevation forests and thriving elk populations to high alpine ecosystems scattered with mountain goats and pika, the interconnectedness of the various habitats is a defining characteristic of the park. In the face of climate change, the effects of warming temperatures and a loss in precipitation will continue to be felt throughout all connected ecosystems in the park.

Warming temperatures have not only caused glaciers to retreat and disappear, but have also caused changes in annual snowfall and spring runoff patterns. Increased temperatures and drier summers have resulted in stressed forests characterized by upward moving tree lines and encroaching grasslands. At higher elevations where an increase in temperature is most pronounced, native plant populations that are adapted to the altitude and cold temperatures may be unable to survive the change. Furthermore, increased temperatures have already proven to correlate with an upward moving tree line and encroaching grasslands, which can

force out native alpine tundra plant species. The loss of high alpine meadows combined with the upward trend in tree growth has the ability to change the integrity of native ecosystems and alter the high elevation scenery for which the park is so famous. Lastly, warmer temperatures have also proven to support an increase in invasive species and insect outbreaks, which can have grave effects on plant and tree species, specifically at subalpine elevations.

Mountain goats are one of the many high elevation species in the park

A loss of habitat and an increase in non-native species are indicative of a warming climate. Many key species in Glacier, such as wolverines, lynx, and pika rely on cool high elevation climates for survival . Decreased snowpack has proven to be particularly detrimental to wolverine and lynx populations, which rely on snow cover for denning sites and food sources. In the case of the pika, which is unable to survive at temperatures over 80 degrees, a warming climate will have detrimental effects on their populations. Coldwater fish species, most notably native westslope cutthroat and bull trout populations will also be impacted as water temperatures rise and spring snowmelt decreases.

Consequences of global warming

Global warming has become a major issue. The amount of carbon dioxide in the atmosphere is so far beyond normal that the ice caps will continue to melt way past 2050 and we are continuing to add more. This will speed up global warming, giving us less time to prepare for the consequences or to invent new technology to prevent it.

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There have been 5 ice ages in the past 600,000 years. In the past 600,000 years carbon dioxide has never exceeded 300 parts per million. Today it is 450ppm, and in 2050 it will be 700ppm.

- Ocean ice at the North Pole does not increase sea levels when melted, but land ice in Greenland and Antarctica does.
- The ice thickness at the North Pole has decreased 40% in the last 40 years. The polar ice reflects 90% of sunlight. Without the ice only 10% will be reflected, thus further melting the ice and increasing ocean temperatures.

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