CLIMATE INSTITUTE

#  EXTREME WEATHER

Most of the potentially damaging consequences relating to climate change are associated with extremes - the number of heat waves, floods or severe storms, for example. Since extreme weather events cause loss of life and property, it is important to understand what impact climate change may have on their occurrence.

Global climate change affects different regions of the earth in different ways. Although the accuracy of regional climate forecasts is improving, they are still uncertain. However, we do know that a warmer atmosphere will result in a greater number of tropical storms, extreme heat waves, droughts and floods.



Figure :Weather Pattern

# Tropical Storms

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ince 1970, tropical cyclone activity has increased in the North Atlantic. Activity is measured not only by the frequency and number of storms that develop, but also by their intensity and duration (collectively named the Power Dissipation Index). A marked increase in the PDI began around 1970, though a less-defined (but still substantial) increase began in the early 1950’s.

With regards to actual numbers of tropical storms, an analysis published by the U.S. Climate Change Science Program identified three distinct periods in the 20th century during which the average number of tropical storms increased and then continued to remain at the elevated level. Beginning in 1900 and lasting until around 1930, there was an average of six tropical cyclones (four hurricanes and two tropical storms) per year in the Atlantic basin. During the 1930’s and early 1940’s, however, the average number of annual cyclones increased to 10 (five hurricanes and 5 tropical storms). These frequencies remained relatively stable (never decreasing to their pre-1930’s levels, but also never increasing) until close to the end of the century. But in the ten years between 1995 and 2005, the average number per year grew to 15- eight hurricanes and seven tropical storms. In other words, on average there were more storms classified as hurricanes (eight) at the end of the century than the average total number of storms (six) per year at the beginning of the century.

Tropical storm formation relies upon a variety of different meteorological conditions. First, local sea surface temperatures must be around 26.5 °C (80 °F). When evaporation occurs from warm surface waters, it creates high humidity in the atmosphere. High humidity then leads to thunderstorm development and if multiple thunderstorm systems converge, a tropical depression (a storm with a vortex and rotation) is formed. The newly created vortex draws in additional heat from the surface of the ocean and releases it into the atmosphere in the form of rainfall as the water vapour condenses. Simultaneously, high winds are created from the energy being released by the heat of the ocean. The more heat available at the surface, the higher the potential winds may be. Once wind speeds exceed 35 mph, the system becomes a tropical storm and is assigned a name.

While analyzing the number of tropical storms each year is a fairly

simple way of noting changes over time, various studies have identified

how the strength of the storms has changed as well. A 2005 study published in the journal Nature examined the duration and maximum wind speeds of each tropical cyclone that formed over the last 30 years and found that their destructive power has increased around 70 percent in both the Atlantic and Pacific Oceans. Another 2005 study, published in the journal Science, revealed that the percentage of hurricanes classified as Category 4 or 5 (the two strongest categories on the Saffir-Simpson scale) has increased over the same period.

It is important to consider that two of the driving forces behind hurricane formation (sea surface temperatures and humidity levels) have been influenced by climate change. There has been a measurable increase (about 1.3 degrees in the past 100 years) in sea surface temperatures in regions where tropical cyclones typically originate. Also, the sharpest increases in SSTs took place in the years prior to the changes in storm frequency, with an SST rise of approximately 0.7 degrees Fahrenheit leading up to 1930 and a similar rise leading up to 1995 and continuing even after. Air humidity has also increased in recent history; about 4% since 1970. Increases in both of these factors lead to conditions more conducive to tropical storm development.

In the future, it is likely that tropical storm intensity will continue to strengthen. Model simulations suggest that wind speeds will increase by 1 to 8% and rainfall rates will increase by 6 to 18% for every 1°C rise in sea surface temperatures. Therefore, as climate change leads to progressively warmer ocean temperatures, tropical storm intensity will increase as well.

# Heat Waves

While they might be some of the largest and most damaging, tropical storms are not the only types of extreme weather influenced by climate change. Another likely consequence of an overall warmer atmosphere includes greater numbers of heat waves and fewer periods of extreme cold. This is because the excess emissions of greenhouse gases by humans results in both warmer temperatures and a greater variability in the weather, which can lead to extremes. The climatological record of the past several decades offers evidence for these trends. While most recent winters in North America and Asia have been milder than average, a number of countries have experienced record summer heat. A heat wave in May of 2002 claimed over 600 lives in India as temperatures soared to 122° F (50° C). The summer of 2003 saw one of the highest weather-related death tolls in European history as 52,000 people died as a result of heat extremes.

However, the periods of extreme heat do not necessarily mean that in the winter, snowfall amounts will be reduced. Warmer air is capable of holding more moisture- so a generally warmer atmosphere will hold more precipitation, even in the winter. As with heat waves, the frequency of such events, are generally decreasing, but their intensity is increasing (as shown by the devastating blizzards in February 2010 in the mid-Atlantic region). While it is impossible to blame any one extreme weather event on climate change, these recent trends indicate that longer and more intense heat waves will occur in the future. According to the WMO, though these severe heat waves are likely to be found all over the world in the coming century, places in the western U.S., northern Africa, central Asia, southern Africa, and Australia are especially vulnerable.

One of the most important effects of a heat wave is the potential effect on human health. Illnesses that are caused by prolonged exposure to high temperatures include cramps, fainting, and heatstroke, and these can eventually lead to death. The key to preventing such illnesses is the accessibility of air conditioning. But in the future, as heat extremes become more common, the reliance on air conditioning could cause problems for people in areas that are both adapted to high temperatures and those that are not. In regions like the southern United States, which are today accustomed to high heat and where air conditioning is common, the increasing demands on power generators could further potential problems as the intensity of heat waves increases. And in areas like the north-western United States and Europe, where few places have air conditioning today because extremely high temperatures are unusual, problems include making air conditioning available and ensuring that there is enough power to supply them.

# Floods and Drought

One of the physical consequences of a warmer atmosphere is an increased capacity to hold moisture. According to the Clausius-Clapeyron relation, the amount of water vapour that can be stored in the atmosphere increases rapidly with temperature. A warmer planet is also most likely a wetter planet, as more evaporation can occur.

An increase in the frequency or intensity of floods would be catastrophic in many low-lying places around the world. Asian countries are particularly at risk, as low-lying areas (like river deltas and small islands) are densely populated. In Bangladesh alone, over 17 million people live at an elevation of less than 3 ft (1 m) above sea level, and millions more inhabit the flat banks of the Ganges and Brahmaputra Rivers. Another consideration is that poorer countries like Bangladesh do not have the financial resources to relocate their citizens to lower risk areas- nor are they able to create protective barriers. And while an obvious impact of flooding is its ability to displace millions of people, there is also the problem of maintaining a clean water supply. Floodwaters can contaminate drinking water, and sea level rise can lead to the contamination of private wells, leading to catastrophic results.

The possibility for major flooding events is not just limited to Asian countries. The Organization for Economic Co-Operation and Development (which is an international organization) recently announced the 10 cities most vulnerable to flooding. Six of the 10 are in Asia: Mumbai, Shanghai, Ho Chi Minh City, Calcutta, Osaka, and Guangzhou. The other four, however, are in the United States: New York City, Miami, Alexandria, and New Orleans. All are coastal, low-lying, and densely populated.

While flooding is generally considered to be of greater concern for poorer, developing countries, wealthier locations face their own set of problems. In the U.S., for example, waterfront real estate is highly desirable. Wetlands and coastal areas like barrier islands help protect the mainland from flooding and storm surges by acting as a buffer. As more building occurs in these areas, this natural buffer disappears, leaving the homes and businesses at risk. As long as people continue to build in these at-risk areas, flooding will continue to be a major problem.

While average global rainfall is predicted to increase with climate change, not every location on the planet would experience greater rainfall. Evaporation and precipitation occur at different places, and while wet regions could receive even more rainfall if the planet warms, drier regions may experience even more acute shortages of water as evaporation is accelerated in those areas. The Sahel, for example, has become drier over the past several decades, accelerating desertification and placing an even greater premium on already-stretched water supplies. According to the WMO, the western United States and Mexico, the Mediterranean basin, northern China, Southern Africa, Australia, and parts of South America are other regions highly likely to experience harsh drought conditions in the future.

As research continues into the effects of global climate change on extreme weather, it is important to consider the human and economic toll of extreme weather events. A potential increase in frequency or intensity of these events is another strong reason why we must take action to counteract global climate change.



Figure : Storm