Scientific Facts on

Impacts of a 4°C global warming

Source document:
World Bank (2012)

Summary & Details:
GreenFacts

Level 2 - Details on Impacts of a 4°C global warming

This is a faithful summary of the leading report
produced in 2012 by the World Bank:
"Turn down the heat ~ Why a 4°C warmer world must be avoided."

The full Digest is available at: https://www.greenfacts.org/en/impacts-global-warming/

This PDF Document is the Level 2 of a GreenFacts Digest. GreenFacts Digests are published in several languages as questions and answers, in a copyrighted user-friendly Three-Level Structure of increasing detail:

- Each question is answered in Level 1 with a short summary.
- These answers are developed in more detail in Level 2.
- Level 3 consists of the Source document, the internationally recognised scientific consensus report which is faithfully summarised in Level 2 and further in Level 1.

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1. A 4°C world

This report spells out what the world would be like if it warmed by 4 degrees Celsius, which is what scientists are nearly unanimously predicting will happen by the end of the century if no significant policy changes are undertaken.

It is a stark reminder that climate change affects everything. The solutions lie in effective risk management and ensuring all our work, all our thinking, is designed with the threat of a world in which warming reaches 4°C above preindustrial levels (hereafter referred to as a 4°C world) in mind.

The President of the World Bank Group, is very clear in its foreword of the report : The explored consequences of an increase of the global earth temperature of 4°C are indeed devastating.

Among the foreseen consequences are:

- the inundation of coastal cities;
- increasing risks for food production potentially leading to higher malnutrition rates; many dry regions becoming dryer and wet regions wetter;
- unprecedented heat waves in many regions, especially in the tropics;
- substantially exacerbated water scarcity in many regions;
- increased frequency of high-intensity tropical cyclones;
- irreversible loss of biodiversity, including coral reef systems.

The scientific evidence, is unequivocal about the fact that humans are the cause of global warming, and that major changes are already being observed: global mean temperature is now 0.8°C above pre industrial levels; oceans have warmed by 0.09°C since the 1950s and are acidifying. Sea levels rose by about 20 cm since pre-industrial times and are now rising at 3.2 cm per decade; an exceptional number of extreme heat waves occurred in the last decade; major food crop growing areas are increasingly affected by drought.

The World Bank is well aware of the uncertainties that surround these scenarios and that different scholars and studies sometimes disagree on the degree of risk, but the fact that such scenarios cannot be discarded is sufficient to justify strengthening current climate change policies.

This why the global conclusion of the report is that the projected 4°C warming simply must not be allowed to occur—the heat must be turned down. Only early, cooperative, international actions can make that happen.

The Highlights of the report in 13 Questions and Answers

2. Floods, droughts, and extreme weather

This report provides a snapshot of recent scientific literature and new analyses of likely impacts and risks that would be associated with a 4° Celsius warming within this century. It is a rigorous attempt to outline a range of risks, focusing on developing countries while recognizing that developed countries are also vulnerable and at serious risk of major impacts from climate change. It underlines that a series of recent extreme events worldwide continue to highlight the vulnerability of not only the developing world but also of wealthy industrialized countries.

3. Avoiding a 4°C world, a matter of commitment

With decisive action, a 4°C world can be avoided and warming can likely be held below 2°C. Numerous studies show that there are technically and economically feasible emissions pathways to achieve this. Thus, the level of impact that developing countries and the rest of the world experience will be a result of government, private sector, and civil society decisions and choices about climate change which includes, unfortunately, inaction. The global community has committed itself to holding warming below 2°C to prevent "dangerous" climate change (as laid out in the Cancun agreement of the UNFCCC in 2010), but the sum total of current policies—those already in place and those that have been pledged—will very likely lead to warming far in excess of these levels. Indeed, present emission trends put the world plausibly on a path toward 4°C warming within the century.

4.

A world in which warming reaches 4°C above preindustrial levels, would be one of unprecedented heat waves, severe drought, and major floods in many regions, with serious impacts on human systems, ecosystems, and associated services.

A global mean temperature difference of 4°C is close to that between the temperatures of the present day and those of the last ice age, when much of central Europe and the northern United States were covered with kilometers of ice, and the current change—human induced—is occurring over a century, not millennia.

If the currently planned actions are not fully implemented, a warming of 4°C could occur as early as the 2060s. Such a warming level by 2100 would not be the end point: a further warming to levels over 6°C would likely occur over the following centuries.

The impacts are likely to hit the world's poorest regions the hardest, since they have the least economic, institutional, scientific, and technical capacity to cope and adapt. Small Island Developing states (SIDS) and Least Developed Countries (LDCs) have identified that a global warming of 1.5°C as the level above which there would be serious threats to their own development and, in some cases, survival. Among the likely impacts are:

- Even though absolute warming will be largest in high latitudes, the warming that will occur in the tropics is larger when compared to the historical range of temperature and extremes to which human and natural ecosystems have adapted and coped. The projected emergence of unprecedented high-temperature extremes in the tropics will consequently lead to significantly larger impacts on agriculture and ecosystems.
- Sea-level rise is likely to be 15 to 20 percent larger in the tropics than the global mean.
- Increases in tropical cyclone intensity are likely to be felt disproportionately in low-latitude regions.
- Increasing aridity and drought are likely to increase substantially in many developing country regions located in tropical and subtropical areas.

5.

Uncertainties remain in projecting the extent of both climate change and its impacts. The impacts of the extreme heat waves projected for a 4°C world have not been evaluated, but they could be expected to vastly exceed the consequences experienced to date (heat-related deaths, forest fires, harvest losses) and potentially exceed the adaptive capacities of many societies and natural systems. The authors of the report take a risk-based approach in which risk is defined as impact multiplied by probability: an event with low probability can still pose a high risk if it implies impact with serious consequences. Although it is often difficult to make comparisons across individual assessments, this report identifies a number of extremely severe risks for vital human support systems. Large-scale and disruptive changes in the earth system are generally not included in modeling exercises, and rarely in impact assessments. One example of such a change would be the collapse of the West Antarctic Ice Sheet, which would lead to much larger sea level rise than projected in the present analysis. As global warming approaches and exceeds 2°C, the risk of crossing such tipping points in the Earth system increases, along with abrupt climate change impacts and unprecedented high-temperature climate regimes. There might also be such tipping points in some economic sectors in response to high levels of global warming. For example, such effects on crops are likely to be extremely relevant as the world warms to 2°C and above, since many plants have a maximum temperature at which they can grow. However, most of our current crop models do not yet fully account for this, or for the potential increased ranges of variability (for example, extreme temperatures or new invading pests and diseases that can take over in areas where it was too cold for them to thrive in the past). Projections of damage costs for climate change impacts typically assess the costs of local damages, including infrastructure, and do not provide an adequate consideration of cascade effects (for example, value-added chains and supply networks) at national and regional scales. Thus, given that uncertainties remain about the full nature and scale of impacts, there is also no certainty that adaptation to a 4°C temperature increase is possible. A 4°C world is likely to be one in which communities, cities and countries would experience severe disruptions, damage, and dislocation, with many of these risks spread unequally. It is likely that the poor will suffer most and the global community could become more fractured, and unequal than today.

6.

Seven main unequivocal effects of greenhouse gas emissions already observed have continued to intensify, more or less unabated:

1. The concentration of the main greenhouse gas, carbon dioxide (CO_2), has continued to increase in the atmosphere from its preindustrial concentration to over 391 ppm in September 2012, with a rate of rise now at 1.8 ppm per year;
2. The present CO_2 concentration is higher than at any time in the last 15 million years, as indicated by paleoclimatic and geologic evidence ;
3. Global mean temperature is now about 0.8°C above preindustrial levels and continue to increase;
4. The global oceans have continued to warm, with about 90 percent of the excess heat energy trapped by the increased greenhouse gas concentrations since 1955 stored in the oceans as heat.
5. In the meantime, the rate of loss of ice has more than tripled since the 1993–2003 period. The Arctic sea ice reached a record minimum in September 2012, at one half of the average minimum sea ice extent since 1979.
6. The average increase in sea levels has been about 15 to 20 centimeters around the world over the 20th century and now increases by about 3.2 cm per decade. Should this rate remain unchanged, this would mean over 30 cm of additional sea-level rise in the 21st century. The accelerating melting of ice from the

Greenland and Antarctic ice sheets could add substantially to sea-level rise in the future, about 15 cm by the end of the 21st century.

7. An increased frequency and intensity of heat waves is observed with, in some climatic regions, increased in intensity of extreme precipitation and drought. Observations indicate a tenfold increase in the surface area of the planet experiencing extreme heat since the 1950s.

7.

The largest warming will occur over land and range from 4°C to 10°C. Increases of 6°C or more in average monthly summer temperatures would be expected in large regions of the world, including the Mediterranean, North Africa, the Middle East. Almost all summer months are likely to be warmer than the most extreme heat waves presently experienced and, for example, the warmest July in the Mediterranean region could be 9°C warmer than today's warmest July.

Recent extreme heat waves such as in Russia in 2010 are likely to become the new normal summer in a 4°C world. Tropical South America, central Africa, and all tropical islands in the Pacific are likely to regularly experience heat waves of unprecedented magnitude and duration. In this new high-temperature climate regime, the coolest months are likely to be substantially warmer than the warmest months at the end of the 20th century.

8.

Sea-level rise will vary regionally; it is projected to be up to 20 percent higher in the tropics and below average at higher latitudes. Ten large coastal cities account for two-thirds of the population that will be exposed to extreme floods. There are highly vulnerable cities for instance in Mozambique, Madagascar, Mexico, Venezuela, India, Bangladesh, Indonesia, the Philippines, and Vietnam. For small island states and river delta regions, rising sea levels are likely to have far ranging adverse consequences, especially when combined with the projected increased intensity of tropical cyclones, loss of protective reefs due to temperature increases and ocean acidification. Changes in wind and ocean currents due to global warming and other factors will also affect regional sea-level rise, as will patterns of ocean heat uptake and warming.

Warming of 4°C will likely lead to a sea-level rise of 0.5 to 1 meter, and possibly more, by 2100, with several meters more to be realized in the coming centuries. Sea-level rise would likely be limited to below 2 meters only if warming were kept to well below 1.5°C. Even if global warming is limited to 2°C, global mean sea level could continue to rise, with some estimates ranging between 1.5 and 4 meters above present-day levels by the year 2300.

9.

One of the most serious consequences of rising carbon dioxide concentration in the atmosphere occurs when it dissolves in the ocean and results in acidification. A substantial increase in ocean acidity has been observed since preindustrial times. A warming of 4°C or more by 2100 would correspond to an increase in acidity of the ocean unparalleled in earth's history. Evidence is already emerging of the adverse consequences of acidification for marine organisms and ecosystems, combined with the effects of warming, overfishing, and habitat destruction.

The combination of thermally induced bleaching events, ocean acidification, and sea-level rise threatens large fractions of coral reefs even at 1.5°C global warming. Coral reefs in particular are indeed acutely sensitive to changes in water temperatures and pH, and intensity and frequency of tropical cyclones. Reefs provide protection against coastal floods, storm surges, and wave damage as well as nursery grounds and habitat for many fish species. By the time the warming reaches 2.4°C, in the 2060s, it is likely that coral reefs in many areas would start to dissolve.

10.

With extremes of temperature, heat waves, heavy rainfall and drought are projected to increase with warming. Although the most adverse impacts on water availability are likely to occur in association with growing water demand as the world population increases, some estimates indicate that a 4°C warming would significantly exacerbate existing water scarcity in many regions, particularly northern and eastern Africa, the Middle East, and South Asia, while additional countries in Africa would be newly confronted with water scarcity on a national scale due to population growth.

- Drier conditions are projected for southern Europe, Africa (except some areas in the northeast), large parts of North America and South America, and southern Australia, among others.
- Wetter conditions are projected in particular for the northern high latitudes—that is, northern North America, northern Europe, and Siberia—and in some monsoon regions. Some regions may experience reduced water stress compared to a case without climate change.
- Changes to the hydrological cycles associated with severe risks of floods and droughts in some regions, which may increase significantly even if annual averages change little.

With a 2°C temperature increase :

- River basins dominated by a monsoon regime, such as the Ganges and Nile, are particularly vulnerable to changes in the seasonality of runoff, which may have large and adverse effects on water availability.
- Mean annual runoff is projected to decrease by 20 to 40 percent in the Danube, Mississippi, Amazon, and Murray Darling river basins, but increase by roughly 20 percent in both the Nile and the Ganges basins.

All these changes would approximately double in magnitude with a 4°C temperature increase.

11.

Recent research suggests that large-scale loss of biodiversity is likely to occur with a temperature increase of 4°C. Climate change and high CO_2 concentration would drive the earth´s ecosystems into a state unknown in human experience. In fact, climate change seems likely to become the dominant driver of ecosystem shifts, surpassing habitat destruction as the greatest threat to biodiversity.

Ecosystems will be affected by more frequent extreme weather events, such as forest loss due to droughts and wildfire, and the impact of these is likely going to be exacerbated by changes in land use and agricultural expansion; increasing vulnerability to heat and drought stress will likely lead to increased mortality and species extinction.

In Amazonia, forest fires could as much as double by 2050 with warming of approximately 1.5°C to 2°C above preindustrial levels. Changes would be expected to be even more severe

in a 4°C world. Ecosystem damage would be expected to dramatically reduce the provision of ecosystem services on which society depends (for example, fisheries and the protection of coastline that afforded by coral reefs and mangroves).

12.

In 2007, the Intergovernmental Panel on Climate Change projected that global food production would increase for local average temperature rise in the range of 1°C to 3°C, and may decrease beyond these temperatures but new results suggest instead a rapidly rising risk of crop yield reductions as the world warms and observations indicate a significant risk of high-temperature thresholds being crossed that could substantially undermine food security globally with a 4°C temperature increase.

Large negative effects have been observed at high and extreme temperatures in several regions including India, Africa, the United States, and Australia. For example, significant effects have been observed in the United States when local daily temperatures increase to 29°C for corn and 30°C for soybeans. In addition to these risks is the adverse effect of projected sea level rise on agriculture in important low-lying delta areas, such as in Bangladesh, Egypt, Vietnam, and parts of the African coast. Sea-level rise would likely impact many mid-latitude coastal areas and increase seawater penetration into coastal aquifers used for irrigation of coastal plains. Further risks are posed by the likelihood of increased drought in mid-latitude regions and increased flooding at higher latitudes.

13.

Large-scale extreme events, such as major floods that interfere with food production, could bring about nutritional deficits and an increase in the incidence of epidemic diseases. Flooding can introduce contaminants and disease agents into healthy water supplies and increase the spread of diarrheal and of respiratory illnesses. The effects of climate change on agricultural production may exacerbate under-nutrition and malnutrition in many regions—already major contributors to child mortality in developing countries.

Whilst economic growth is projected to significantly reduce childhood stunting, climate change is projected to reverse these gains in a number of regions with warming of 2°C to 2.5°C, especially in Sub-Saharan Africa and South Asia, and this is likely to get worse at 4°C. Despite significant efforts to improve health services (for example, improved medical care, vaccination development, and surveillance programs), significant additional impacts on poverty levels and human health are predictable. Changes in temperature, precipitation rates, and humidity influence vector-borne diseases (for example, malaria and dengue fever) as well as hantaviruses, leishmaniasis, Lyme disease, and schistosomiasis.

Further health impacts of climate change could include injuries and deaths due to extreme weather events. Heat-amplified levels of smog could exacerbate respiratory disorders and heart and blood vessel diseases, while in some regions climate change–induced increases in concentrations of aeroallergens (pollens, spores), could amplify rates of allergic respiratory disorders.

14.

Economic growth and population increases over the 21st century will increase the pressure on a planetary ecosystem that is already approaching critical limits and boundaries. Climate change will likely undermine further the resilience of many natural and managed ecosystems.

The projected impacts on water availability, ecosystems, agriculture, and human health could lead to large-scale displacement of populations and have adverse consequences for human security and economic and trade systems. Projections of damage costs for climate change impacts do not provide an adequate consideration of cascade effects at national and regional scales. For example, if a resource is undermined by climate change impact, it could disturb a supply chain for a manufactured product, which in turn leads to a shortage that could impact the exploitation of another resource, etc… However, in an increasingly globalized world that experiences further specialization in production systems, and thus higher dependency on infrastructure to deliver produced goods, damages to infrastructure systems can lead to substantial indirect impacts. Seaports are an example of an initial point where a breakdown in infrastructure could trigger impacts that reach far beyond the particular location of the loss, in addition their cumulative and interacting effects are not still well understood.

With pressures increasing as warming progresses toward 4°C, and combining with non climate–related social, economic, and population stresses, the risk of crossing critical social system thresholds will grow. At such tipping points, the existing institutions would likely become much less effective at supporting the needed adaptation actions or could even collapse. One example is a risk that sea-level rise in atoll countries exceeds the capabilities of controlled, adaptive migration, resulting in the need for complete abandonment of an island or region. Similarly, stresses on human health, such as heat waves, malnutrition, and decreasing quality of drinking water due to seawater intrusion, have the potential to overburden health-care systems to a point where adaptation is no longer possible, and dislocation is forced.