What impacts are we likely to see with 1, 2, 3, 4, 5 & 6°C of global warming? (~1600 words)

The following is taken from the 'Climate Change Impacts' entry of 'The Complete Guide to Climate Change' (by Brian Dawson and Matt Spannagle, 2009).

How do impacts vary with different amounts of global warming?

Most scientists agree that the incremental impact of each 1 degree C rise in average global temperatures is unlikely to be equal. Changes will be nonlinear, such that a global mean temperature rise from 2 degree to 3 degrees C is likely to have much greater and far-reaching impacts than a rise from 1 degree to 2 degree C. There are also likely to be certain thresholds and critical points beyond which an abrupt change may occur, such as the total collapse of an ecosystem or a sudden change in ocean circulation patterns.

Many other existing or emerging environmental problems, such as land degradation, large-scale alterations to hydrological systems (e.g. excessive water diversions from rivers and lakes), and industrial pollution will tend to be amplified by a changing climate.

These factors increase uncertainty and make it difficult to predict the specific impacts of a given increase in global temperature. Nevertheless, sufficient information is now available to enable a reasonably confident assessment of the type and scale of impact for a given temperature change and to identify potential critical temperature thresholds that will trigger abrupt changes. For example, the current scientific consensus is that the temperature threshold that will trigger the eventual total deglaciation of the Greenland ice cap is believed to lie in the range of 2.5 to 3 degrees C above preindustrial levels (see ice sheets and glaciers).

Estimates of global mean temperature change over this century vary from as low as 1.5 to an alarming 10 degrees C. Most studies provide a more limited range of temperature increases, such as follows: 2020 - 1.1 to 1.4 degrees C; 2050 - 1.7 to 2.9 degree C; and 2080 - 2.4 to 4.3 degrees C [4]. These ranges are typically used to link certain impacts to different levels of global temperature increase.

Most climate impact studies focus on impacts of temperature increases ranging up to 4 degrees C. Few identify likely impacts for higher temperature increases since temperature rise is likely to be less than 5 degrees C by 2100 and because the uncertainty of impacts increases considerably once mean global temperatures increase more than 3 – 4 degrees C. Most impact assessment studies also usually assume sea levels will increase by 0.5 -1.0 m and that ocean pH falls by a further 0.2 - 0.3 pH points (on top of the 0.1 pH fall already observed) by 2100.

Based on the findings of several major assessment studies [5], some key impacts for different temperature changes are:

Up to 1°C

Ten percent of global ecosystems will be adversely affected; accelerated melting, retreat, and possible loss of most South American, Himalayan, and African glaciers. Increased coral reef

bleaching and mortality; reduced crop yields in some regions (especially Africa); accelerated sea ice loss and permafrost thaw; possible further species extinction; several unique biodiversity rich ecosystems will face increased vulnerability to damage or loss, including the Dryandrea forests (Western Australia), the North Queensland rainforests, the Sundabans of Bangladesh and the Fynbos and Karoo in South Africa.

While these impacts are substantial, or even devastating, at the local level, on a global scale the impacts of a 1 degree C warning will not be significant, and most communities, and many ecosystems, are likely to cope with a temperature change of this magnitude.

Between 1 and 2°C

Decreased agricultural yields become wore widespread in the tropics and subtropics with possible yield increases in higher latitudes; 1 - 3 billion people could experience increased water stress and up to 200 million additional people at risk of hunger; an expected spread and increased incidence of malaria and dengue; increased infrastructure damage and losses due to extreme weather events; over 90% of the world's coral reefs subject to serious damage, and many could be permanently lost; up to half of frogs and many reptiles could face extinction, as well as possible extinction of several Arctic species in the wild and significant losses in global bird populations - overall species loss could reach 20%; 60% of tundra would become unstable; mobilization of the Kalahari sand dunes and significant drying in several regions, particularly North Africa and the Mediterranean; up to 50% loss of Kakadu wetlands (Australia), Dryandrea (Australia), Succulent Karoo (South Africa), and Chinese boreal forests and 40% loss of Queensland rainforests (Australia).

Between 2 and 3°C

Complete loss of the Kakadu wetlands, the Succulent Karoo, Dryandrea forests, and Chinese boreal forests; near total loss of the world's existing coral reefs and wide-spread collapse of the Queensland rainforest ecosystems; 50% loss of the Fynbos (South Africa); up to half European and all Australian alpine species at risk of extinction; 20 - 70% loss of migratory bird habitats; and possibly 30 - 40% of all species at risk of extinction; approaching or exceeding the estimated trigger point for complete deglaciation of Greenland (with eventual 7 m sea level rise); possible destabilization of the West Antarctic Ice Sheet (with eventual additional 6 m of sea level rise); large impacts on global cereal production (with possibly 5 - 10% losses in crop yields in lower latitudes) and an additional 400 million people at risk of hunger; possibly half the world's population at risk of exposure to dengue fever and an additional 300 million people to malaria; substantial increase in people at risk from heat waves and extreme weather events; increased vulnerability of the Amazon rainforest ecosystem to significant transformation or collapse; widespread thawing of the permafrost resulting in significant increases in methane and CO_2 emissions and total loss of summer Arctic sea ice.

Between 3 and 4°C

Large losses of agricultural production across most regions with the possible exception of the higher latitudes; declines in grain yields in the lower latitudes and increased food prices could place an additional 600 million people at risk of hunger; 60% of the world's population exposed to dengue; potentially more than half of all species at risk of extinction; complete collapse of the Arctic ecosystem and total loss of summer ice over the Arctic Ocean; two-thirds of the Tundra and up to one-quarter of coastal wetland ecosystems lost; possible increased instability of the methane hydrates at higher latitudes with potential large-scale methane releases over the next few centuries; substantial slowing, or even possible shutdown of the thermohaline (ocean circulation); noticeable increase in storm intensity and extreme weather events; Amazon rainforest ecosystems may totally collapse and possibly becoming a major source of (CO_2) emissions; significant chance of the terrestrial land carbon pool transitioning from a carbon sink to a carbon source; much higher risk of collapse of the West Antarctic Ice Sheet.

Between 4 and 5°C

Serious and widespread declines in crop yields and some countries would suffer near complete collapse of their agricultural systems (particularly, parts of South Asia, the Mediterranean, and Africa) with major implications for world food security; major socioeconomic impacts associated with collapse or transformation of marine and terrestrial ecosystem changes and health and water impacts, affecting a majority of the world's population; high probability of collapse of the West Antarctic Ice Sheet with a subsequent commitment (combined with Greenland) to long-term sea level rise of at least 10 - 15 m over the next 300 - 500 years and also committing many existing coastal marine ecosystems to destruction; complete collapse of the Amazon ecosystem, almost certain transition of the land carbon pool from sink to source; up to two-thirds of all species committed to extinction; much larger risk for significant methane hydrate releases and shutdown of the thermohaline ocean circulation.

Beyond 5°C

Very few estimates of potential impacts of temperature increases above 5 degrees C are contained in the literature due to high uncertainty surrounding the impacts of such high temperature changes. However, based on the extent and magnitude of the impacts that are likely to occur below 5 degrees C, it is expected that the impacts would become much more severe and widespread at temperature changes beyond 5 degrees C. Changes of this magnitude may commit the earth to runaway climate change where emissions from nonhuman-related sources (natural processes) become the self-sustaining driving force for even more global warming Very few estimates of potential impacts of temperature increases above 5 degrees C are contained in the literature due to high uncertainty surrounding the impacts of such high temperature changes. However, based on the extent and magnitude of the impacts that are likely to occur below 5 degrees C, it is expected that the impacts would become much more severe and widespread at temperature changes beyond 5 degrees C. Changes of this magnitude may commit the earth to runaway climate change where emissions from nonhuman-related sources (natural processes) become the self-sustaining driving force for even more global warming (see climate change feedbacks). Few climate events of this magnitude have occurred in the earth's past history, particularly at the rate of temperature change that

could eventuate over the next two centuries if we are unable to stabilize atmospheric greenhouse gas concentrations at moderate levels. Climate change has potentially far reaching consequences for humans and other living organisms that presently inhabit the earth. There is a growing consensus that global temperature increases of greater than 2 degrees C will deliver a range of impacts that could constitute dangerous anthropogenic interference with the planet's climate system and contravene the United Nations Framework Convention on Climate Change). Few climate events of this magnitude have occurred in the earth's past history, particularly at the rate of temperature change that could eventuate over the next two centuries if we are unable to stabilize atmospheric greenhouse gas concentrations at moderate levels. Climate change has potentially far reaching consequences for humans and other living organisms that presently inhabit the earth. There is a growing consensus that global temperature increases of greater than 2 degrees C will deliver a range of impacts that could constitute dangerous anthropogenic interference with the planet's climate system and contravene the United Nations Framework Convention on Climate Change (see dangerous climate change). Temperature increases exceeding 4 degrees C are likely to be catastrophic and must be avoided. While decision makers have difficulty dealing with issues that way take several centuries to fully manifest themselves, it must be born in mind that what the global community does in the next 20 - 50 years will determine the type of temperature increases the planet will be committed to over the next 100 - 200 years and to impacts that could become progressively worse for many centuries, and possibly persist for several millennia.

Notes

[4] See Parry et al. 2004, Hare 2006, and Warren 2006

[5] Ibid.