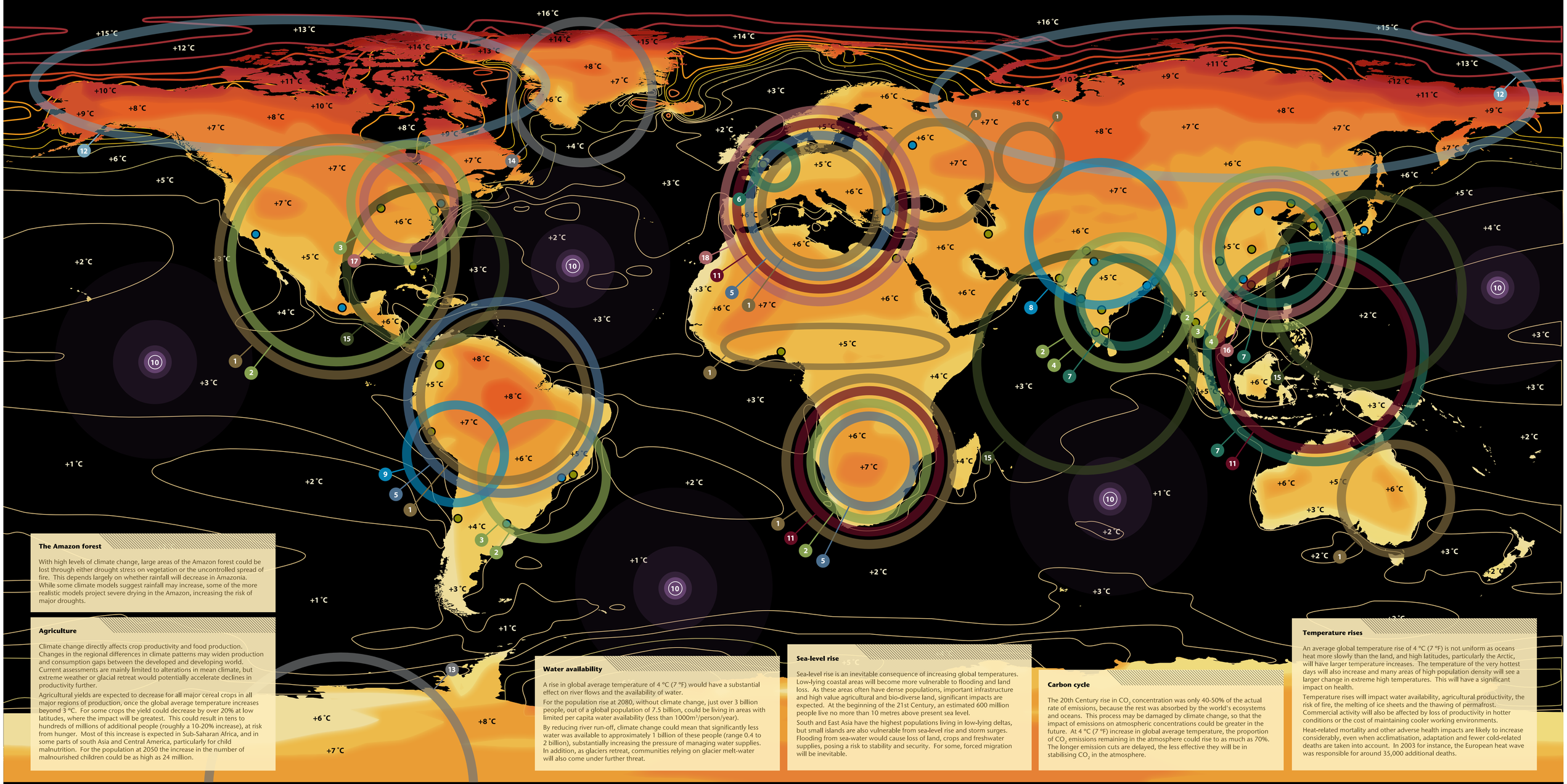
Met Office Hadley Centre | QUEST Quantifying and Understanding the Earth System | Walker Institute | Tyndall Centre for Climate Change Research

# The impact of a global temperature rise of 4 °C (7 °F)

HM Government




### The Amazon forest

With high levels of climate change, large areas of the Amazon forest could be lost through either drought stress on vegetation or the uncontrolled spread of fire. This depends largely on whether rainfall will decrease in Amazonia. While some climate models suggest rainfall may increase, some of the more realistic models project severe drying in the Amazon, increasing the risk of major droughts.

### Agriculture

Climate change directly affects crop productivity and food production. Changes in the regional differences in climate patterns may widen production and consumption gaps between the developed and developing world. Current assessments are mainly limited to alterations in mean climate, but extreme weather or glacial retreat would potentially accelerate declines in productivity further.

Agricultural yields are expected to decrease for all major cereal crops in all major regions of production, once the global average temperature increases beyond 3 °C. For some crops the yield could decrease by over 20% at low latitudes, where the impact will be greatest. This could result in tens to hundreds of millions of additional people (roughly a 10-20% increase), at risk from hunger. Most of this increase is expected in Sub-Saharan Africa, and in some parts of south Asia and Central America, particularly for child malnutrition. For the population at 2050 the increase in the number of malnourished children could be as high as 24 million.

### Water availability

A rise in global average temperature of 4 °C (7 °F) would have a substantial effect on river flows and the availability of water.

For the population rise at 2080, without climate change, just over 3 billion people, out of a global population of 7.5 billion, could be living in areas with limited per capita water availability (less than 1000m$^3$/person/year).

By reducing river run-off, climate change could mean that significantly less water was available to approximately 1 billion of these people (range 0.4 to 2 billion), substantially increasing the pressure of managing water supplies. In addition, as glaciers retreat, communities relying on glacier melt-water will also come under further threat.

### Sea-level rise

Sea-level rise is an inevitable consequence of increasing global temperatures. Low-lying coastal areas will become more vulnerable to flooding and land loss. As these areas often have dense populations, important infrastructure and high value agricultural and bio-diverse land, significant impacts are expected. At the beginning of the 21st Century, an estimated 600 million people live no more than 10 metres above present sea level.

South and East Asia have the highest populations living in low-lying deltas, but small islands are also vulnerable from sea-level rise and storm surges. Flooding from sea-water would cause loss of land, crops and freshwater supplies, posing a risk to stability and security. For some, forced migration will be inevitable.

### Carbon cycle

The 20th Century rise in $CO_2$ concentration was only 40-50% of the actual rate of emissions, because the rest was absorbed by the world's ecosystems and oceans. This process may be damaged by climate change, so that the impact of emissions on atmospheric concentrations could be greater in the future. At 4 °C (7 °F) increase in global average temperature, the proportion of $CO_2$ emissions remaining in the atmosphere could rise to as much as 70%. The longer emission cuts are delayed, the less effective they will be in stabilising $CO_2$ in the atmosphere.

### Temperature rises

An average global temperature rise of 4 °C (7 °F) is not uniform as oceans heat more slowly than the land, and high latitudes, particularly the Arctic, will have larger temperature increases. The temperature of the very hottest days will also increase and many areas of high population density will see a larger change in extreme high temperatures. This will have a significant impact on health.

Temperature rises will impact water availability, agricultural productivity, the risk of fire, the melting of ice sheets and the thawing of permafrost. Commercial activity will also be affected by loss of productivity in hotter conditions or the cost of maintaining cooler working environments.

Heat-related mortality and other adverse health impacts are likely to increase considerably, even when acclimatisation, adaptation and fewer cold-related deaths are taken into account. In 2003 for instance, the European heat wave was responsible for around 35,000 additional deaths.

1. High forest-fire danger projected to affect every populated continent. Regions moving into the high-danger category include: large areas of the United States; Mexico; South America, east of the Andes; southern and east Africa; the Sahel; eastern and southern Australia and southern Europe.
2. Maize and wheat yields reduced by up to 40% at low latitudes.
3. Soybean yield could decrease in all regions of production, including North and South America, southern and eastern Asia.
4. Decrease in rice yield of up to 30% in China, India, Bangladesh and Indonesia.
5. Water resources affected by up to 70% reduction in run-off around the Mediterranean, southern Africa and large areas of South America.
6. Sea-level rise combined with storm surges could pose a serious threat to people and assets in the Netherlands and south-eastern parts of the UK.
7. Sea levels could rise as much as 80 cm by the end of the century. Longer term, 4 °C (7 °F) would result in a much higher rise in sea level.
   Sea level increases are likely to be even greater at low latitudes, disproportionately affecting tropical islands and low-lying regions such as Bangladesh.
   For the population at 2075, a mean sea-level rise of 53 cm means that up to an additional 150 million people per year would be flooded due to extreme sea levels. Three-quarters of these people live in Asia. Up to 56 million people would be flooded along the Indian Ocean coast, 25 million along the east Asian coast and 33 million people would be flooded along the South-East Asian coast.
   Other vulnerable regions include Africa, Caribbean islands, Indian Ocean islands and Pacific small islands.
8. Half of all Himalayan glaciers significantly reduced by 2050, even at a global average temperature rise below 4 °C.
   The Indus river basin obtains 70% of its summer flow from glacial melt.
   In China, 23% of the population lives in the western regions where glacial melt provides the principal dry season water source.
9. Complete disappearance of glaciers from many regions in South America.
   In Peru's Cordillera Blanca summer run-off from glaciers reduced by up to 69% as the glacial area falls by 75%.
10. Marine ecosystems could be fundamentally altered by ocean acidification which would have a significant impact on fisheries. This could cause substantial loss in revenue and jobs. The loss of coral reef habitats due to acidification may seriously affect many commercial fish species and could prove disastrous for coastal communities relying on subsistence fishing of reef species.
11. Drought events occur twice as frequently across southern Africa, South-East Asia and the Mediterranean basin.
12. Almost complete disappearance of near-surface permafrost from Northern Siberia. Reduction of permafrost in Canada and Alaska. Infrastructure built on the permafrost foundation at risk.
13. It is not known how stable the West Antarctic Ice Sheet is, or whether a 4 °C (7 °F) global temperature rise will send it into irreversible decline. If this ice sheet did melt it would contribute a further 3.3 metres to long-term sea-level rise globally.
14. Greenland Ice Sheet has a 60% likelihood of irreversible decline. This would result in a very long-term sea-level rise of up to 7 metres globally.
15. Tropical cyclones could be more intense and destructive. Global population increases, particularly in coastal areas, and sea-level rise mean greater cyclone and hurricane related losses, disruptions to infrastructure and loss of life as a result of storm surges. For major cyclone disasters flooding from storm surges has been the primary cause of death.
16. Hottest days of the year could be as much as 6 °C (11 °F) warmer over highly populated areas of eastern China.
17. Hottest days of the year could become as much as 10-12 °C (18-22 °F) warmer over eastern North America, affecting Toronto, Chicago, Ottawa, New York and Washington DC.
18. Hottest days of the year across Europe could be as much as 8 °C (14 °F) warmer.

Disease patterns have changed with an overall increase in diarrhoea, vector-borne disease such as malaria and dengue fever, malnutrition and the health impacts of weather events such as flooding and drought.

| +°Celsius | Change in temperature from pre-industrial climate | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| +°Fahrenheit | 2 | 4 | 5 | 7 | 9 | 11 | 13 | 14 | 16 | 18 | 20 | 22 | 23 | 25 | 27 | 29 |

City populations: 5 - 10 Million; 10 - 20 Million

Source: UN Statistics Division Demographic Yearbook 2007

These impacts make no assumptions about adaptive capacity. For further information about this map go to: http://www.metoffice.gov.uk/climatechange/guide/effects/