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Global meltdown: scientists isolate areas most at risk of climate change

- Experts assess point at which it is too late to act
- Disastrous repercussions of warming are spelled out

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Ian Sample, science correspondent
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Ice boulders left behind after a flood caused by the overflowing of a lake in Greenland. Photograph: Uriel Sinai/Getty images

Scientists have long agreed that climate change could have a profound impact on the planet; from melting ice sheets and withering rainforests, to flash floods and droughts.

Now a team of climate experts has ranked the most fragile and vulnerable regions on the planet, and warned they are in danger of sudden and catastrophic collapse before the end of the century.

In a comprehensive study published today, the scientists identify the nine areas that are in gravest danger of passing critical thresholds or "tipping points", beyond which they will not recover.

Although the scientists cannot be sure precisely when each region will reach the point of no return, their assessment warns it may already be too late to save Arctic sea ice and the Greenland ice sheet, which they regard as the most immediately in peril. By some estimates, there will not be any sea ice in the summer months within 25 years.

The next most vulnerable area is the Amazon rainforest, where reduced rainfall threatens to claim large areas of trees that will not re-establish themselves. The scientists also expressed concerns over the Boreal forests in the north, and have predicted that El Niño, the climate system which has a profound impact on weather from Africa to North America, will

become more intense. The scientists are so concerned they have called for an early warning system to monitor each of these fragile ecosystems.

The international team, whose study appears in the Proceedings of the National Academy of Sciences, represents some of the world's most prestigious organisations, including the Potsdam Institute for Climate Impact Research in Germany, the University of East Anglia and Oxford University's Environmental Change Institute. The scientists polled 52 environmental experts and combined their responses with discussions among 36 leading climate researchers at a workshop at the British embassy in Berlin. Each was asked to rank regions at greatest risk of climate change in the next century.

"There's a perception that global warming is something that will happen smoothly into the future, but some of these ecosystems go into an abrupt decline when warming reaches a certain threshold," said Tim Lenton, an environmental scientist at the University of East Anglia and lead author of the study.

"If we know when the different tipping points are, we can use them to inform targets to limit global warming. It gives us something to aim for," he added.

Last year, the UN's expert panel of climate scientists warned average temperatures could increase by as much as 6.4C by the end of the century, with a rise of 4C most likely. Such a rise would bring food and water shortages to vulnerable parts of the world, displace millions of people and wipe out hundreds of species.

In the latest study, the scientists calculate Arctic sea ice will go into irreversible decline once temperatures rise between 0.5C to 2C above those at the beginning of the century, a threshold that may already have been crossed. There is already a 50% chance that the Greenland ice sheet will soon begin melting unstoppably, although it could take hundreds of years to melt completely. The meltwater would raise global sea levels by seven metres.

A temperature rise of 3C could see more intense El Niños, with profound effects on the weather from Africa to North America.

Warming of 3C to 5C could reduce rainfall in the Amazon by 30%, lengthening the dry season. The Boreal forests could also pass their tipping point, with large swaths dying off over the next 50 years. In Africa, more rainfall may regreen the Sahel region, but the west African monsoon could collapse, leading to twice as many unusually dry years by the end of the century. The Indian summer monsoon is predicted to become erratic and in the worst case scenario, begin to flip chaotically, unleashing flash floods one year and droughts the next.

Measurements of the western Antarctic ice sheet show the balance of snowfall and melting has shifted and it is now shrinking. According to the study, a local warming of more than 5C could trigger uncontrollable melting, adding five metres to sea levels within 300 years. Under the same warming, Atlantic currents that power the Gulf Stream could be severely disrupted.

"If you can get some warning that you're nearing one of these thresholds, you can get to work on adapting to it. You could work harder on reducing emissions, or you might use it as impetus to try other options," said Lenton.

Explainer: What could happen next

If greenhouse gas emissions continue unchecked, the global average temperature will reach 2C above pre-industrial levels by 2050, according to the government's 2006 Stern report on climate change.

One of the first impacts will be droughts and floods, as rainfall increases at high latitudes and drops in the tropics. Some glaciers will disappear, though crop yields in some countries could rise, scientists believe.

Last year, a report from the Intergovernmental Panel on Climate Change, concluded that human activity was "very likely" to be behind most of the warming seen in recent decades. It predicted a rise of between 2.4C and 6.4C by 2100.

The most likely rise, of 4C by the end of the century, would cause droughts across Africa, and a fall in harvests of 15% to 35%. Globally, crop yields would fall 10%.

Sea levels would rise by up to 59cm, with Bangladesh and Vietnam among the worst hit, along with coastal cities such as New York, London, Tokyo, Kolkata and Karachi. In Britain alone, there would be 1.8 million people at risk of flooding. The western Antarctic and Greenland ice sheets would begin to melt irreversibly and Europe would lose 80% of its Alpine glaciers. Across the Arctic, half of the tundra is at risk.

A 4C rise is predicted to drive 20% to 50% of land species to extinction and put 80m more Africans at risk of malaria as mosquitoes thrive.