Unless we change direction, the world will warm 3-5 degrees Celsius

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Global temperature is likely to rise 3.3-5.6 degrees Celsius by the end of this century, unless international climate negotiations in Paris next year are more effective than expected, according to a report released Monday by the MIT Joint Program on the Science and Policy of Global Change. The predicted temperature increase surpasses the threshold identified by the United Nations as necessary to avoid the most serious impacts of climate change, altering precipitation patterns and heightening the pressures of population and economic growth.

"Our world is rapidly changing," says John Reilly, co-director of the MIT Joint Program and a coauthor of the report. "We need to understand the nature of the risks we're facing so we can prepare for them."

Publication of the report, "2014 Climate and Energy Outlook," comes on the heels of last week's UN Climate Summit in New York City, where more than 120 heads of state gathered in preparation for climate negotiations next year. The agreement that comes out of the 2015 talks will inform global climate action after 2020, when existing measures agreed to in Copenhagen and Cancun expire.

The outlook report extends the existing measures after they end to evaluate global changes under possible post-2020 climate action. It uses UN population data and projects economic growth to explore the connections between socioeconomic factors and changing climate, land use, and water.

"Population and economic growth are key drivers of change," Reilly says. "Developing countries like China and India are growing fast, and will play a big role in future emissions. They're also facing the unique challenge of trying to plan for this growth under a changing climate."

The MIT team expects world energy use to double by 2050, largely due to increased energy use in developing countries, where booming industry and larger, wealthier populations will have more access to personal vehicles. Globally, clean energy sources will make some headway, but energy use will continue to be largely dominated by fossil fuels. As a result, global emissions are expected to double by the end of the century. To stay below the warming threshold, global emissions need to peak soon, if not immediately, the report concludes.

The outlook also examines a more ambitious climate agreement, based on expectations of what countries might pledge in the 2015 climate talks. The more ambitious pledges will further reduce greenhouse gas emissions, it finds, but even with these pledges the world will release enough greenhouse gases by 2040 to make it unlikely that warming will stop at 2 C.

"There is some uncertainty associated with these estimates," says Erwan Monier, a research scientist at the Joint Program and a coauthor of the report. "The fact is that there is uncertainty about future emissions, and also in the climate's response to those emissions. Yet, it is clear that we are not meeting the 2 C target based on current efforts alone."

New this year is a focus on how these changes impact water resources, which will have to support a growing population's need for food and energy. The "2014 Climate and Energy Outlook" evaluates water stress, or the amount of water used in an area for irrigation, industry, and household use, compared with how much freshwater is available in that area.

By the end of the century, freshwater supplies will increase 15 percent as hotter temperatures speed up the hydrological cycle, leading to more rain and snow. Global water use will keep pace, and is expected to increase 19 percent.

Water use is expected to skyrocket in India, China, parts of the Middle East, and North Africa, even though some of these countries, like India, will see more rain and snow. Hotter temperatures will lead to more precipitation, but it may fall at the wrong time of the year, after the growing season is over, or may runoff into the ocean.

Globally, most water is used for irrigation. As industrial and household water use grow, they can edge out irrigation, just as more water is needed for irrigation to feed more people.

"These pressures on water will mean increased focus on making sure there is enough water where and when it is needed," says Charles Fant, a postdoctoral associate at the Joint Program and a coauthor of the report. "This can be done by transporting water to where it is needed, building more storage, or conservation and efficiency efforts."

Solutions like these are often difficult to put in place, Fant cautions, as they are expensive and may be damaging to the environment.

"Preparing for these issues now simplifies things quite a lot for the future," Fant says.

More information: The report is available online: globalchange.mit.edu/research/ … /special/2014Outlook

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