A conversation with Kirsten Zickfeld on 04/17/13

Participants

- Kirsten Zickfeld — Assistant Professor, Simon Fraser University, Department of Geography
- Ben Rachbach — Research Analyst, GiveWell
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Note: This set of notes was compiled by GiveWell and gives an overview of the major points made by Kirsten Zickfeld. Some of the information that Dr. Zickfeld shared was based on her knowledge of the literature rather than on her research in particular.

Summary

GiveWell spoke with Kirsten Zickfeld to learn about tipping points associated with global warming.

Tipping Points

The two risks that Dr. Zickfeld characterized as most concerning are the tipping points related to melting of the ice in Greenland and West Antarctica and the release of methane from the melting of Arctic permafrost.

Interventions

As possible interventions to reduce the negative impacts associated with climate change, Dr. Zickfeld highlighted:

- Halting the creation of new large-scale fossil fuel infrastructure
- Disseminating information about climate change to the broader public
- Reducing carbon emissions
- Further research on tail risks from climate change

Tipping points from climate change

The two risks associated with climate change that Dr. Zickfeld considers most concerning are:

1. Melting of ice in Greenland and/or West Antarctica

2. Self-reinforcing methane emissions from melting permafrost near the North Pole.

Melting of ice in Greenland and/or West Antarctica

The potential for a melting feedback loop

If the global temperature increases by more than 2-3°C, it is more likely than not that will result in all of the ice in Greenland melting. However, this would take several centuries. Over the next 100 years, the rise in seal level coming from Greenland's ice melting is expected to be no larger than 0.5 meters. Nevertheless, the sea level rise contribution from the Greenland ice sheet could start to be significant by ~2050.

The impacts of ice melting

The primary impact that ice melting would have is that the earth's sea levels would rise. This would have a negative impact on communities that live in low-lying areas, including some communities in North Africa, Asia (for example, in Bangladesh), and the Pacific Islands. In particular,

- Coastal assets and infrastructure could be damaged.
- People could be displaced from their homes.
- The flooding caused by typhoons and hurricanes could increase.
- The fresh water on the Pacific Islands could be contaminated by salty water, depriving islander communities of drinkable water.

Melting of permafrost

Permafrost is soil that is below the freezing point of water. Permafrost contains a large amount of organic material, which is dormant because the temperature is too low for bacteria to decompose it. But if the permafrost melts, bacteria would consume the organic material, releasing significant amounts of methane, which is a potent greenhouse gas.

If the permafrost starts melting and releases methane into the atmosphere, global warming will increase. This could result in a feedback loop in which the melting of permafrost and the corresponding increase in global warming reinforce each other until all of the permafrost is melted, and most of the carbon within it released into the atmosphere.

Most of Earth's permafrost is in the Arctic. The amount of carbon in this permafrost is estimated to be 1700 gigatons (1 gigaton = 1 billion tons). This is about twice the amount of carbon in the Earth's atmosphere. So the increase in carbon dioxide resulting from permafrost melting could be very large. Part of the carbon released from permafrost takes the form of methane rather than carbon dioxide, but methane in the atmosphere eventually oxidizes and turns into carbon dioxide.

All of the carbon in permafrost being released would result in an increase in global temperature of about 3.5°C. This would take several centuries, and would greatly increase all of the negative impacts associated with climate change.

The sea ice in the Arctic Ocean is melting very rapidly, and the temperature in the area is increasing twice as fast as the global average temperature. The Arctic permafrost is starting to melt. By the end of this century, several hundred gigatons of carbon could be released due to the permafrost-carbon feedback. Researchers have started to incorporate this feedback into models only recently, so the probability distribution associated with the risk is unknown.

Other tail risks

- If sea ice melts, the Arctic will become warmer, and this could change the Earth's temperature gradients and hence the atmospheric circulation. There is research that suggests that circulation changes associated the decline in Arctic summer sea ice might already have caused recent severe winters in Europe. There is a very high probability that the Arctic ice will be ice free in the summer in the next 10-20 years, but the impact that this will have on the Earth's atmospheric circulation is uncertain.

- There is a danger of global warming causing the Amazon rainforest to die, resulting in the forest releasing carbon into the atmosphere. The amount of carbon would be far less than the amount that could be released by permafrost. However, the rate at which the carbon enters into the atmosphere could be much faster than the rate at which the carbon from permafrost enters the atmosphere.

The impact of a large increase in global temperature

The proceedings from the "4 Degrees and Beyond International Climate Conference" contains many excellent papers discussing various impacts that a 4+°C increase in global temperature would have.

Possible interventions to avoid dangerous climate change

Preventing the creation of new fossil fuel infrastructure

There are several proposed projects to create infrastructure to extract and transport fossil fuels. For example, there are several proposals to create fossil fuel pipelines in Canada. If these projects are carried out, there is a risk of locking our energy system in to a high carbon pathway that increases greenhouse gas emissions for decades to come. To avoid dangerous climate change it's important to prevent these projects from progressing.

Disseminating information

A large part of what's needed to reduce climate change is public support. Climate deniers disseminate false information claiming that climate change due to fossil fuel emissions isn't occurring or its impacts are highly uncertain. There's a need for funding for the dissemination of accurate information about climate change.

Some efforts along these lines are

- Climate change education in high schools
- Blogging about climate change
- The creation of compelling movies depicting climate change

Blogging may not be very impactful, because it could be that the people who read the relevant blogs already believe that climate change due to carbon emissions is a problem. Movies may have more impact than written materials. There's a recent movie titled *Chasing Ice*, with compelling visuals, which raises awareness of the melting of ice due to global warming.

Reducing carbon emissions

Avoiding dangerous climate change requires significantly reducing our reliance on fossil fuels and making a transition to cleaner energy. Preventing a 2°C or greater temperature will require an 80% drop in carbon emissions by 2050 and complete elimination of carbon emissions soon thereafter.

Research on tail risks

Some research that would help assess climate change tail risk is

- Further empirical measurements of the rates of ice melting at the Earth's poles and the rate at which methane is escaping from permafrost.

- Climate models that take into account ice dynamics, and that model permafrost methane feedback.

Research on climate change tail risk is underfunded. There is no dedicated funding for exploring these risks in Canada. There is more funding available in Europe, under the European Union Framework Program.

People and organizations for GiveWell to talk to

Regarding tipping points associated with the melting of ice sheets:

- The National Snow and Ice Data Center (NSIDC)

- Anders Levermann at the Potsdam Institute for Climate Impact Research
- Jeremy Fyke at the Los Alamos National Lab.
- Gwenn Flowers at Simon Fraser University

Regarding the melting of ice in Arctic in particular:

- Judith Curry at the Georgia Institute of Technology
- Jennifer Francis at the Institute of Marine & Coastal Sciences at Rutgers University

Regarding the impact of climate change on the Amazon rainforest:

- Peter Cox at the University of Exeter

Regarding the probabilities of tipping points associated with climate change in general:

- Tim Lenton at University of Exeter.

Regarding raising awareness, and advocacy:

- Bill McKibben, Founder of 350.org, a grassroots movement to stop climate change.