CENTRE FOR ECONOMIC POLICY RESEARCH

CEPR CLIMATE CHANGE

Sixth CEPR/EAERE Webinar on Climate Policy: AR6of the IPCC – State of Science

26 November 2021 - 17:00 - 18:30 CET (Frankfurt/Paris/Amsterdam) – Online

On August 6, 2021, the Sixth Assessment Report (AR6) *Climate Change 2021: The Physical Science Basis*, of the International Panel on Climate Change (IPCC) Working Group I was released. It brings together and examines the latest advances in climate science, underpinning past, present and future climate change. Based on major scientific advances since the AR5 was published in 2013, the report offers a comprehensive view of the different components of the climate system and its changes to date, as well as a deep understanding of the human influence on climate variables.

For this Sixth CEPR/EAERE Webinar on Climate Policy, Friederike Otto (Grantham Institute at Imperial College London) gave a presentation on *Extreme Weather Events and Climate Change* and Anders Levermann (Potsdam Institute for Climate Impact Research) on *Sea level Rise and Climate Change*. Their presentations were followed by a discussion moderated by Ottmar Edenhofer (Potsdam Institute for Climate Impact Research, Mercator Research Institute on Global Common and Climate Change, CEPR and Climate Change RPN Associate Fellow) and a Q&A session with the audience.

Panellists:

Friederike Otto
Grantham Institute at Imperial College London

Anders Levermann
Potsdam Institute for Climate Impact Research

Moderator:

Ottmar Edenhofer
Potsdam Institute for Climate Impact Research, Mercator Research Institute on Global Common and Climate Change, CEPR & Climate Change RPN Associate Fellow

Key Points of the Webinar

- ### The role of human influence on global warming

The magnitude and speed of recent changes in the climate system are unprecedented over thousands of years, in every region across the world. In terms of global warming, each of the last four decades has been warmer than any previous one since 1850, with a faster increase in the global surface temperature since 1970 than in any other 50-year period over the last 2000 years.

The assessment report furthermore states, for the first time with no uncertain language, the unequivocal human influence on the warming of the atmosphere, ocean, and land. When quantifying the contribution of different human drivers to the 1.1. degree increase of the earth's surface compared with the late nineteenth centuries, it thus appears that *"(…) it is very likely that well-mixed GHGs contributed a warming of 1.0°C to 2.0°C, other human drivers (principally aerosols) contributed a cooling of 0.0°C to 0.8°C (…)".* Over the long term, almost no changes in global surface temperature come from natural drivers (0.1°C to +0.1°C) or from internal variability (0.2°C to +0.2°C)[1]. In other words, global warming can be entirely attributed due to human influence on the climate system.

Despite being the clearest indicator of the fact that the climate is changing, global mean temperature can be considered as an abstract number not experimented as such by individuals. The induced changes will and currently manifest themselves through modified likelihoods and intensity of extreme events.

- ### Extreme events & Climate Change

  - #### Attribution methods

Attribution methods aim to respond to the question of*: how climate change has altered the likelihood and intensity of extreme events?* They consist of comparing what the likelihood of an event in today's climate with the likelihood that this event would have had in a world without human-induced climate change, only composed of natural drivers. It does so by, after having decided on an event to analyse and

[1] IPCC, 2022: Summary for Policymakers [H.-O. Pörtner, D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem (eds.)]. In: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. In Press.

on its characterisation, creating a large record of simulated extreme weather events with state-of-the-art climate models and statistical methods using observational time series. Because the only difference between the two worlds is manmade driven climate change, the difference can be attributed to climate change and quantified by comparing the two likelihoods.

Assessment of human influence on weather and climate extremes

The AR6 is the first to systematically assessed how human influence is contributing to many observed changes in weather and climate extremes. Regarding hot extremes, the report thus highlights an increase in frequency and intensity of such events in all inhabited regions across the globe with "*high confidence that human-induced climate change is the main driver of these changes*"[2]. Less scientific literature, especially in the global south, is available regarding heavy precipitations. However, where observational data are sufficient for trend analysis, similar increase patterns are put forward with high confidence. Manmade climate change is likely again to be the key determinant of this evolution. Similarly, the report puts forwards, with medium confidence, that human-induced climate change contributed to the increase in agricultural and ecological droughts in already drought-likely areas.

Next to these extreme events for which enough evidence is available to produce aggregated figures, other extremes are at stake such as changes in tropical cyclones and compound events (*e.g.,* sea level rise combined with heavy rainfall) which often have the largest impacts. Scientists have increasing knowledge about extreme events, but still important gaps are remaining to have a comprehensive understanding of those and their consequences (*e.g.*, associated deaths). Furthermore, the definition of a meaningful characterization of an extreme event can be challenging, as it very much depends on different types of vulnerabilities (of ecosystems, economic systems, *etc*.). Attribution methods also require climate models able to reliably simulate the studied type of events, which for some parts of the world and types of extremes can be difficult in practice.

Sea level Rise and Climate Tipping Change

Sea Level Rise Scenarios

The thermal expansion of the ocean water, as global temperatures are increasing, has been the major contributor to global sea level rise in the past 150 years. The next cause is then the melting of mountain glaciers, while mass loss of ice sheets around the globe have increasingly and in an accelerated way contributed to the phenomenon over the last 20 years.

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[2] *Ibid.*

The AR6 offers prognostics of the evolution of global sea level change by 2100 under different Shared Socioeconomic Pathways (SSPs). The likely global mean sea level will rise by 0.28–0.55m under the very low GHG emissions scenario (SSPA – 1.9), and up to 0.98–1.88m under the very high scenario (SSP5-8.5) (medium confidence). However, the report also puts forward a curve, never shown in previous assessments, representing a very low likelihood event of high impact. It states that "*A Global mean sea level rise above the likely range – approaching 2m by 2100 and 5m by 2150 under a very high GHG emissions scenario (SSP5-8.5) (low confidence) – cannot be ruled out due to deep uncertainty in ice-sheet processes*"[3]. Such a scenario is associated with tipping element of the climate system.

- **Tipping point and destabilisation**

The dynamic definition of the term *tipping element* by Leverman et al. (2021) states that a system reaches a tipping point when its dynamics get dominated by a self-amplifying (positive) feedback until it reaches a qualitatively different state[4].

Such a phenomenon is for instance likely to have already happen in West Antarctica through a self-amplification feedback that began the discharge of the ice sheet into the ocean. Eastern Antarctica also constitutes a potential tipping element of the climate system, which in case of destabilisation, could elevate sea level by 3 to 4m. Similarly, the Greenland icesheet, preserved by the fact it reaches into a very cold atmosphere, could be impossible to maintain and irreversibly destabilised if a certain threshold of warming is passed. Furthermore, the North Atlantic current also constitutes a very uncertain tipping point: the melted water from Greenland into the North Atlantic lightens the water masses which could lead to a collapse of the Atlantic thermohaline circulation. It will be a major hit to the climate system generating several adverse effects such a redistribution of heat around the globe, sea level rise, an increase in precipitations in the tropics that will shift southwards affecting the Amazon rainforest, *etc.*

Alternatively, despite being often discussed as such, the permafrost thawing cannot be considered as a tipping element. Indeed, the positive feedback it generates - through the increase in global mean temperature and the release of methane into the atmosphere - is overwritten by the black body radiation on Earth. The latest being very strong negative feedback, it leads to, although at a higher level, a stabilisation of the global mean temperature. In another words, it shelves a self-amplifying effect of unstoppable global warming. However, this does not reduce the threat of climate change. In comparison of a threshold situation, which if exceeded would lead to an unavoidable increase in temperatures, the responsibility of further warmings is and will remain a human responsibility.

[3] *Ibid.*

[4] Leverman et al. (2021). Potential climatic transitions with profound impact on Europe. Review from the current state of six 'tipping elements of the climate system'. *Climatic Change*, 110, 845–878.