Input from the ECI for the Excom's draft initial two year workplan for the implementation of the functions of the Warsaw International Mechanism

This document is provided by the Environmental Change Institute, University of Oxford, in response to the call for inputs from the Executive Committee of the Warsaw International Mechanism, ahead of the next meeting scheduled for 31 July and 1st August 2014.

One of the functions of the Warsaw mechanism (para 5 (a)) is to "enhance knowledge and understanding of comprehensive risk management approaches to address loss and damage associated with the adverse effects of climate change" [1]. The importance of "assessing the risk of loss and damage associated with the adverse effects of climate change" [2] has also been recognised. The Environmental Change Institute, along with partners including the University of Reading and the UK Met Office, is conducting research to investigate the changes in the risk of extreme weather events, such as heatwaves, flooding, and drought. This research could provide important information to enhance understanding of the risk of loss and damage, however it also has many uncertainties which need to be considered if it is to be used to guide policy decisions.

Dialogue is needed between scientists and parties to the UNFCCC about what climate science can offer, and how it might contribute to climate change policy. The workplan of the WIM provides an opportunity for such dialogue. This document will give an overview of the key concepts, recent advances, and future developments in the field, alongside suggestions for the workplan.

The Science of Attributing Extreme Events

Warming of the climate system is unequivocal, predominantly due to anthropogenic GHG emissions [5], but the implications for regional climates are less clear. Some slow-onset events such as sea level rise are direct consequences of large-scale warming and can therefore be linked directly to past emissions. In many regions, however, extreme weather events, like heatwaves, floods, and droughts, are associated with greater loss and damage.

An increase in average temperatures will lead to an increase in the frequency or magnitude of some extreme events [6]. However, the chaotic nature of weather means that it is generally impossible to say, for any specific event, that it would not have occurred in the absence of human influence on climate. In a simple analogy, a dice may be loaded to come up six, but a six could have come up anyway without the loading.

Many people therefore think that it is impossible to attribute extreme weather events to past GHG emissions, even in principle. The emerging science of Probabilistic Event Attribution (PEA) [7], however, increasingly allows a quantitative assessment of the extent to which human-induced climate change is affecting local weather events [8-11]. This assessment focuses on "attributable risk": quantifying whether and how much past emissions have contributed to the probability of an extreme event occurring: how have we loaded the weather dice?

Assessments of attributable risk are based on large numbers of climate model experiments, called “ensembles”. Large ensembles are needed to assess the frequency of extreme events (which are, by definition, rare) and how this frequency may be changing. PEA studies compare how often a particular extreme weather event occurs in model experiments representing the “world as it is” (with human influence on climate) with how often the same type of event occurs in experiments representing the “world that might have been” (with the estimated impact of human influence on climate removed, allowing for uncertainty in this impact).

The science of PEA is relatively new, the first studies having been conducted only ten years ago [8], but the field is growing rapidly. Since 2012, an annual report has been published in the Bulletin of the American Meteorological Society to establish the role of anthropogenic emissions on events from the previous year [13,14], and many of the most widely-reported recent events have been investigated, including the 2010 Russian heatwave and 2011 East African drought [11,15]. There are now efforts to develop operational attribution systems.

Autumn 2000 flooding in England and Wales: model results indicate that twentieth century anthropogenic GHG emissions increased the risk of floods of this magnitude by about a factor of two. [10].

Pakistan floods 2010: a model evaluation study suggests that the model in question cannot provide reliable results for this event. This does not preclude further research but highlights that assessment is more difficult for some events than others. [19]

There are many uncertainties in attribution studies. Particular challenges are the availability of long-term meteorological observations and the reliability of climate model simulations of the climate conditions generating an extreme weather event. Uncertainties are present in all PEA studies, but there is generally higher confidence in studies focusing on heatwaves [8] than those focussing on extreme precipitation [10,15,16]. Investigation of hurricanes and typhoons is currently limited by the ability of global climate models to simulate these events.

There is also variation between regions in the ability to attribute events, due to differences in regional climates, availability of observational data, and modelling capability. The majority of PEA studies to date have focused on events in mid-latitudes [8,10,11], but there is increasing interest in event attribution for tropical regions [15,17]. Promising approaches are being explored to conduct robust attribution studies in parts of the world with sparse observational data [18]. However, in some regions PEA studies have been inconclusive due to model weaknesses [19].

Another important scientific development that is directly relevant to the Warsaw mechanism is extending PEA from hydro-meteorological events (e.g. heatwaves, floods, droughts) to their socioeconomic impacts (e.g. crop failure). Attribution studies [20] are currently exploring the use of impact-relevant combinations of climate variables [21,22]. Quantified assessment of the socioeconomic loss and damage due to extreme weather events attributable to human influence on climate is possible in principle, but uncertainties increase due to confounding factors in the impacts of extreme weather events.

Probabilistic Event Attribution in practice

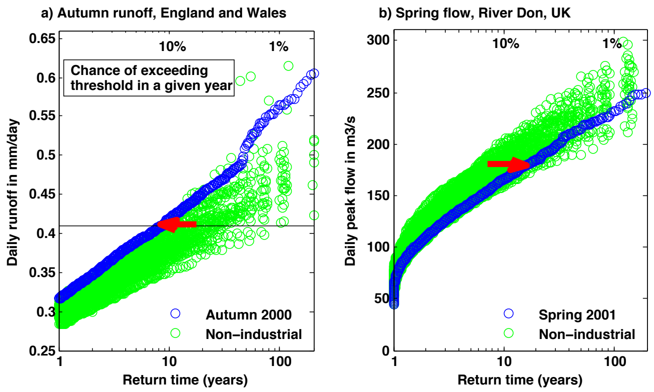

Figure 1 adapted from Figure 10.18 IPCC AR5 WG1 chapter 10.6 [5]. Return times of run-off (an indication of flooding) for simulations of the “world as it is” (blue) compared to the “world that might have been” without anthropogenic GHG emissions (green). Panel (a) is for Autumn 2000 in England and Wales [10] with the black line showing the threshold exceeded in observations and panel (b) is for a different season and catchment [12].

Figure 1 shows results from two recent PEA studies. The data is presented in so-called “return time plots”, used to illustrate small changes in the probability of rare events. Here river runoff is shown, as a measure of flooding. The magnitude of runoff is shown in the vertical direction, and the frequency of exceeding any given runoff threshold is indicated in the horizontal direction. Each dot on the graph is a model simulation of “possible weather” under the given climate conditions. The blue dots are the “world as it is” under observed conditions, while the green dots represent the “world that might have been” in a climate without the impact of past anthropogenic GHG emissions.

Plot (a) shows that, in this study, in the current climate (the blue dots), the chance of exceeding the critical runoff threshold observed in 2000 of 0.42 mm/day is one-in-ten in any given year. In the “world that might have been”, with various estimates of the impact of pre-2000 GHG emissions removed, it would have been more like one-in-twenty. So, on average, GHG emissions increased the risk of this kind of autumn flood by around a factor of two (the red arrow points to the left), but with a large range of uncertainty.

Plot (b) shows that not all damaging extreme weather events are being made more frequent by human influence on climate. This looks at a spring-time flood triggered by rapid melting of accumulated snow. This kind of event has been made less frequent by past GHG emissions (the red arrow points to the right).

Suggestions for the workplan of the Warsaw International Mechanism

Scientific research designed to better understand the risk of extreme weather events has clear relevance for addressing loss and damage. In order to help developing countries cope with loss and damage, it is important to understand the risk of extreme weather events in the current climate, and how this is changing. The science of PEA could also be used to help identify which losses and damages have a climate change signal which might be used to determine which regions or events should be addressed under the WIM.

However, there are many uncertainties associated with this kind of scientific research: and uncertainties are generally larger for extreme events than for slow-onset events, larger for some extreme events than others, and larger for some regions than others. Intensive research is currently underway to address the scientific challenges outlined above, but some uncertainties will remain, and the concern has been raised that robust assessments may be biased towards countries whose history or meteorological conditions happen to make attribution questions more tractable [23].

The Warsaw international mechanism will, under paragraph 7(c) “convene meetings of relevant experts and stakeholders” [1], and this provides a good opportunity for dialogue about what the science can offer, and under what circumstances it might be appropriate to base policy decisions on results from attribution studies. If the science is thought to be useful, the mechanism could also “promote the development of...information” (paragraph 7(d), [1]) through discussion of the most helpful way to conduct the science. There is more than one scientifically valid way to frame the scientific questions [17], and this is an opportune time for the policy community to establish broad principles about how they would like these questions to be addressed.

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