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Challenging the use of extreme event attribution for loss and damage

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Abstract

The Paris agreement recognizes “the importance of averting, minimizing and addressing loss and damage associated with the adverse effects of climate change, including extreme weather events and slow onset events”. Hence, it raises the question of discriminating extreme events between those influenced and not influenced by climate change. Extreme event attribution (EEA) is the ensemble of scientific ways to interpret the question “was this event influenced by climate change” and answer it. The relevance of EEA for climate negotiations was debated before the adoption of the Paris Agreement and is still discussed in post Paris Agreement literature. To inform this debate, we propose a phenomenological approach based on interviews. Parker et al. [2017] analyzed interviews from a mix of loss and damage stakeholders at COP 19, and highlighted a variety of opinions regarding the relevance of EEA for loss and damage. We propose to go further by focusing on two distinct groups of stakeholders: EEA scientists and loss and damage delegates (or their advisers). We find that delegates perceive EEA as a useful tool for awareness raising. We outline a number of hurdles raised by both groups, which may hinder EEA to be part of a practical loss and damage mechanism.

1 Introduction

In December 2014, at COP19, Filipino head negotiator Yeb Saño delivered a poignant speech1 to denounce the inaction in international climate negotiations while the Philippines were devastated in the wake of super Typhoon Haiyan: “To anyone who continues to deny the reality that is climate change, I dare you to get off your ivory tower and away from the comfort of your armchair. [...] you may want to pay a visit to the Philippines right now.” He pointed out the role of anthropogenic climate change in the occurrence of this disaster: “We must stop calling events like these as natural disasters. [...] It is not natural when science already tells us that global warming will induce more intense storms.” Through the example of typhoon Haiyan, he was specifically promoting the inclusion of loss and damage within the work of the United Nations Framework Convention on Climate Change (UNFCCC): “if we have failed to meet the objective of the Convention, we have to confront the issue of loss and damage. Loss and damage from climate change is a reality today across the world.”; “We call on this COP to pursue work [...] until the promise of the establishment of a loss and damage mechanism has

been fulfilled”. However, there is no scientific consensus regarding the influence of climate change on typhoons
Schiermeier [2013]. This challenges the importance of the *attributability* of extreme events – i.e. the technical
possibility to attribute them – in regards to the key messages some of the actors need to deliver. More specifically,
this questions the place of extreme event attribution (EEA), the science studying the influence of climate
change on specific event, in the context of climate change negotiations, and more precisely in loss and damage.

Loss and damage in the context of the UNFCCC is hard to comprehend because it does not have a consensual definition. Since Yeb Saño’s speech, loss and damage has gained traction in the negotiation [Mace and
Verheyen, 2016, Vanhala and Hestbaek, 2016] through an ambiguous frame and a lack of clear definition (“The
reason loss and damage was easy was that nobody knows what it means yet” [Vanhala and Hestbaek, 2016]). Loss and damage are included in the Paris agreement (Article 8 of the agreement [2015]). Boyd et al. [2017]
investigate the different meanings of loss and damage through interviews with thirty-eight key stakeholders. They identify four perspectives. The *Adaptation and Mitigation perspective* considers loss and damage as all the
impacts of anthropogenic climate change, which the Convention as a whole aims to avoid. In this perspective,
there is no need for an additional loss and damage mechanism, as the goal of mitigation and adaptation is precisely
to avert and minimize loss and damage. The *Risk Management perspective* links loss and damage to ongoing
efforts in disaster risk reduction (DRR). The *Limits to Adaptation perspective* presents loss and damage as the
residual impacts of climate change which were not avoided through mitigation and go beyond the possibilities
of adaptation. The *Existential perspective* is centered on the need to address the inevitable harm the most
vulnerable populations already face because of climate change.

Depending on the chosen perspective, the attributability of weather-related impacts is not always necessary
to deal with loss and damage [Warner and van der Geest, 2013]. However, it is expected that the UNFCCC
should deal with impacts that can be related to climate change. Before loss and damage became a hot topic
in the negotiations, Allen [2003], Allen and Lord [2004], and Allen et al. [2007] already discussed the potential
of attribution of extreme events to allow wronged citizens to appeal for compensation and liability. In fact,
the perceived social need to attribute extreme weather impacts to climate change was the motivation stated
by Allen to start investigating the scientific possibilities to perform attribution for specific extreme events that
causa a lot of damage. He considers this solution as “apolitical” [Allen, 2003], in stark contrast with the
political battles led within the UNFCCC surrounding loss and damage. A big difference between the arguments
of Allen [2003], Allen and Lord [2004], and [Allen et al., 2007] and UNFCCC loss and damage is that the former
considers compensation of losses mainly from an Annex I country system, while the latter applies specifically
to the most vulnerable (non Annex I) countries. Allen’s view hence misses a part of the problem, especially
because Annex I countries losses are often of economic nature, while non Annex I countries also deal with
non-economic losses (e.g. loss of life, loss of culture). However, his view may lead to faster results, for several
reasons: it is easier to attribute events in Annex I countries [Huggel et al., 2016, Mera et al., 2015], and Annex I
countries victims have a better access to national and international law. We note that there are disagreements
within the UNFCCC regarding the scale (national, regional, or global) at which loss and damage should be
addressed [Vanhala and Hestbaek, 2016].
Hulme et al. [2011] alert against the potential use of weather event attribution for the allocation of adaptation funding (note that when their article was published, loss and damage was only emerging in negotiations and that the WIM did not exist). They highlight three main problems behind the idea that adaptation funding should go to the impacts which are directly related to anthropogenic climate change through attribution (a position that was defended by Pall et al. [2011] and Hoegh-Guldberg et al. [2011]). First, EEA relies on models to estimate changes of probability, which introduce large uncertainties and subjectivity in the results. Surminski and Lopez [2015] also raise the issue of the unreliability of models, which are the basis of FAR calculation. Second, EEA measures changes in hazards, not in risks. It hence ignores potential changes in risks related to changes in exposure or vulnerability, and is still far from dealing with the political, social and ethical components of impacts. In line with this point, Huggel et al. [2013, 2015] argue that for EEA to be relevant to international climate policy it has to expand from the evaluation of changes in hazards to changes in risks. Third, they argue that the allocation of funds through attributability frames adaptation in a compensatory way rather than on building capacity with respect to vulnerability.

With the establishment of loss and damage as a major topic in the run-up to the Paris agreement and afterwards, scientists started to highlight the issue of establishing a link between impacts and anthropogenic climate change. Following the adoption of the WIM, James et al. [2014] explain that “From a scientific perspective, […] the first challenge in implementing the WIM would be to estimate where and when loss and damage can be attributed to anthropogenic climate change”, which calls for detection and attribution and EEA information. They point out that this potential scientific input has been largely ignored in negotiations. They are concerned “that a body of scientific evidence is growing, which is highly relevant to the WIM, yet is seen as a distraction from the negotiations” and call for a better communication between scientists and policy makers (see also Parker et al. [2015]).

In parallel, with the growth of EEA as a scientific topic, a more general discussion on the motivation of scientists to do EEA and on who could be the potential users emerged. The use of EEA results as material to back up a liability case, possibly in the context of UNFCCC loss and damage is among the four motivations proposed by Hulme [2014]. Stott and Walton [2013] do not mention loss and damage as a potential domain of application, while Sippel et al. [2015] do. What is interesting here is that both EEA and loss and damage have been growing concurrently, and that a part of the scientific community has established a link between both topics.

A few articles discuss the relevance of EEA for loss and damage. Some of them consider that EEA has an essential part to play. Thompson and Otto [2015] argue that EEA is a necessary scientific input to provide restorative justice, which would be a basis for “healthy long-term international relations.” Beyond monetary compensation, it would be a way for big emitters to acknowledge their part in impacts suffered by the most vulnerable countries, and this acknowledgement would be a first step in the making of amends. According to Mace and Verheyen [2016], the role of attribution science is threefold: the attribution of emissions, the attribution of impacts to extreme events and EEA. They argue that the scientific establishment of a link between emissions and specific impacts put policy makers in a position where it is more advantageous for them to take action collectively in the UNFCCC than to risk being brought before a court of law. Verchick [2018] adopts
a similar point of view. He values EEA on the ground of the “unavoidable moral duty to know what’s going on”. EEA results could provide “substantial leverage” to push for ambitious mitigation, adaptation and loss and damage policy.

Others are less enthusiastic (although not as critical as Hulme et al. [2011]). Wallimann-Helmer [2015] remarks that not all loss and damage result from climate change. Some are related to natural variability. The type of responsibility differs between these two cases. EEA could help to distinguish which impacts would fall under corrective liability or remedial responsibility. However, he also asserts that corrective liability (related to attributable events) should be a secondary concern in regards to remedial responsibilities because loss and damage approaches are prospective in nature, and because it would be inappropriate to subsidize only the attributable fraction of loss and damage. This makes the utility of EEA only secondary. Surminski and Lopez [2015] criticize the conception that EEA could support the compensation of loss and damage, which could “distract from the importance of recognizing risk in its totality”, by focusing only on hazards. Boran and Heath [2016] argue that given the history and processes of the UNFCCC, the normative frame based on compensation and liability is bound to fail. They propose an alternative “risk-pooling logic”, in which EEA would strengthen insurance mechanisms. Huggel et al. [2016] discuss the type of climate information needed to feed different normative principles of justice. They show that a compensation process, which would be based on attribution results, would not be feasible with the current level of confidence in scientific evidence. In particular, they reveal an injustice in the scientific potential to attribute events depending on the region and on the type of impacts. This injustice is caused by the uneven quality of observational records. The most vulnerable countries are also those for which attributability is the lowest. Lusk [2017] discusses the social utility of event attribution, and concludes that the best social fit for EEA would be loss and damage. He however points out that EEA is not the only way to address loss and damage and that there is no certainty that it will ever be used in the UNFCCC arena. Roberts and Pelling [2018] point out that although it could be useful, EEA should not be a pre-requisite as there are still a lot of scientific challenges to deal with on the way to operationalization, which should not hinder efficient and rapid loss and damage action. Support should be given foremost to the most vulnerable, rather than the most attributable.

Parker et al. [2017] are the first to analyze stakeholders perceptions of event attribution. They conducted interviews within a panel of 31 stakeholders involved in loss and damage, carried between November 2013 and July 2014. They focus on two questions: how much is known about probabilistic event attribution, and how probabilistic event attribution might inform loss and damage. They conclude that there is little awareness of EEA between stakeholders, and that their perspective on its potential use diverge. The 31 stakeholders interviewed by Parker et al. [2017] are a mix of NGOs, social scientists, governmental and intergovernmental organizations, climate scientists and private sector representatives. The lack of agreement they found may be related to this diversity. The goal of this paper is to investigate if and how EEA could feed the loss and damage negotiations through the combination of two corpora of interviews: one exclusively with EEA scientists, and one exclusively with loss and damage delegates and their advisers. This was also an opportunity to update the results of Parker et al. [2017] post Paris agreement. We detail hereafter the methodology we followed to conduct and analyze the perspectives of both stakeholders groups on loss and damage and extreme event attribution.
Then, we present the results of this analysis. Finally, we discuss the implications of these results mean for the potential use of EEA for loss and damage.

2 Material and Methods

This paper adopts a phenomenological approach to the study of the science policy interface. Its objective is thus to contribute to the “understanding [of] unique individuals and their meanings and interactions with others and the environment” [Lopez and Willis, 2004].

It is based on two corpora of semi-structured interviews from two different groups of individuals. The first corpus consists of nine climate scientists working on Extreme Event Attribution (EEA), and the second of twelve delegates and affiliates working on loss and damage. Saturation has been used as the primary guiding principle for sample size (see Mason [2010]). A sample is saturated when adding new data (in this case, conducting other interviews) does not provide new information. Saturation has been verified through the repeated removal of each and every corpus individual from the corpora and checking that this procedure did not influence the results. The relatively small sample size may be explained by the relative homogeneity and small size of the target populations, the focused nature of our inquiry and the saliency of the issue at hand for the interviewee (for a description of the populations see below). For comparison, Creswell [1998] identifies a minimum sample size of five for interview-based phenomenological studies, while Morse [1994] identifies this minimum as being six.

2.1 Selection of interviewees

We targeted two populations from the general group of stakeholders involved in loss and damage, which was already studied by Parker et al. [2017] and Boyd et al. [2017]. The first population consists of climate scientists working on EEA. The science of EEA originated in 2003 [Allen, 2003]. The community expands regularly and now includes researchers from most of the Annex I countries and China. We can consider that our target population consists of scientists participating in the European project EUCLEIA (EUropean CLimate and weather Events: Interpretation and Attribution), and/or in the IDAG (International ad hoc Detection and Attribution Group), and/or who wrote an article about EEA, for example in one of the special issues of the BAMS (Bulletin of the American Meteorological Society) explaining the events of the previous year. Although this population is quite large (e.g. there are 132 articles in the six published yearly issues of the BAMS), it is homogeneous. Indeed, most groups working on EEA have coauthored articles with other groups. Their background is either in physics or statistics. They are mostly men.

For the first corpus, our sample consists of nine climate scientists. They were selected based on their publications and involvement in EEA research. They all came from different laboratories based in Europe, North and South America. An effort was made to cover different types of methodologies. Five of them were interviewed during the IMSC (International Meeting on Statistical Climatology, held in Canmore, Canada, in June 2016), two others were interviewed in person during other occasions and the last two via skype, between June 2016 and
January 2017. The nine interviewees included eight men and one woman. Five have a background in physics and four in statistics. We chose to only interview holders of a PhD and with a permanent position as they are more likely to be in contact with stakeholders outside the world of research.

The second targeted population consists of people closely involved in the loss and damage negotiation process. The targeted group are the 20 members of the Warsaw Implementation Mechanism (WIM) executive committee (Excom) and/or the persons who participated to the closed to observers negotiations on loss and damage at COP19. This second group includes less than 50 persons, as not all delegations are present for the negotiations on loss and damage, which are still a rather small (but highly political) topic within the UNFCCC. This population is gender balanced and evenly distributed between Annex I and non-Annex I countries.

For the second corpus, the sample consists of twelve interviewees involved in the loss and damage negotiations. Eight of them were Parties delegates, including five members of the WIM Excom. Out of the twelve interviewees, three were Annex I countries delegates. Three others were advisers to delegates, all to non Annex I countries. Five interviewees were delegates from non-Annex I countries. The last one was a member of the UNFCCC secretariat. This corpus is hence imbalanced in favor of non-Annex I countries. This is related to a certain reluctance of Annex I countries delegates to participate to these interviews. We could only get European Annex I delegates. However, the Annex I countries delegates provided rather homogeneous answers, hence the sample of three seemed to be enough to characterize their position. The twelve interviewees included seven men and five women.

The first target of these interviews were members of the WIM Excom whom we contacted before COP22. Starting from the ones who accepted, we asked each interviewee to recommend others, following a snowball sampling technique. Seven interviews were conducted during the COP22 in Marrakesh in 2017, and five others were done via skype afterwards. Due to the political nature of the topic, a part of the persons we contacted were too suspicious to accept an interview (especially members of Annex I countries).

### 2.2 Interview procedure

We conducted semi-structured interviews. The chart of confidentiality follows the Chatham House rule, as agreed with the interviewees before the beginning of the interview. The climate scientists were asked to define extreme events, detection and attribution, and extreme event attribution, what was their personal contribution to EEA, how they came to work on it, why they were interested in it, what was their criteria to consider that an EEA exercise they engaged into was successful, whether they were in contact with potential users, if yes what were their expectations and if not why not, whether they considered EEA to be useful, and in what manner, and how they imagined the future of EEA. Two questions were specifically on loss and damage, whether they knew about it (if not, we explained), and which role they thought EEA could play regarding loss and damage.

The delegates and affiliates were asked what was their personal definition of loss and damage, what was the state of loss and damage during/after COP22, what was their role regarding loss and damage, how they would...
define extreme weather events and measure their impacts in the context of the Paris agreement, why did the WIM Excom define an action area about slow onset events and not about extreme weather events, how they imagined the implementation of loss and damage, what is the role of science in loss and damage, whether they work with scientists and about the future of loss and damage. Four questions were specifically on EEA. We asked them how an extreme weather event would be attributed to climate change in the context of loss and damage, what they thought of the attribution of individual extreme weather events, what would be their ideal contribution from climate science on the attribution of extreme weather events and how they would deal with the events for which the uncertainties are too high for science to attribute them to climate change.

The questions related to slow onset events vary a bit from one interview to the other because we specifically asked the members of the Excom why there was an action area about slow onset events and none about extreme weather events while we could not ask the same question to people who were not part of the process of defining those action areas. We asked them how they understood the place of both slow onset events and extreme weather events in the negotiations.

We chose not to directly ask the delegates whether they knew about EEA or not in order to gauge how they would interpret our questions, and whether they would bring up EEA results by themselves. We also wanted to give them latitude to describe the type of attribution science they would like without describing pre-existing methodologies.

All the interviews were recorded, with the consent of the interviewees, and later transcribed for the analysis. We only used a part of the questions of both corpora for the analysis presented in this chapter. The first corpus has also been used in Jézéquel et al., 2018. The questions of the second corpus regarding the definition of loss and damage have been explored by other researchers using their own corpus of interviews and we considered we had nothing new to add on that topic Boyd et al., 2017.

2.3 Data Analysis

The interview transcripts were analyzed using a qualitative, iterative, inductive, phenomenological approach, in three steps. First, we identified nine themes covering the content of the interviews: the definition of extreme weather events by climate scientists, and by delegates, the definition of impacts by delegates, delegates knowledge of the influence of anthropogenic climate change on extreme weather events, delegates knowledge of EEA, the opinion of climate scientists on EEA for loss and damage, the one of delegates, delegates on the difference between slow onset events and extreme weather events, and delegates on uncertainties regarding the attribution of some extreme weather events to anthropogenic climate change. The second step was to select the excerpts of interviews related to each of those themes. The third step was to build the tables presented in the supplementary material from those excerpts.
3 Results

3.1 Delegates knowledge of EEA and scientists knowledge of loss and damage

Two years before the 2015 Paris Agreement, stakeholders involved in loss and damage had various, and often incorrect knowledge of EEA [Parker et al., 2017]. A year after the Paris Agreement, despite calls [James et al., 2014] and initiatives [Parker et al., 2016] from scientists for better communication towards stakeholders, our survey shows that the diagnostic stays the same. Table 1 summarizes the understanding of twelve delegates and affiliates on both the general influence of anthropogenic climate change on extreme events and EEA. Less than half of them had prior awareness of EEA. The understanding of both the challenges and the concepts associated with EEA vary from one interviewee to the other. The general understanding of how extreme weather events are affected and will be affected by climate change also differs from one delegate to the other. Most of them declare that climate change affects the severity and the frequency of extreme events, without discriminating between regions of the world and types of events. The Intergovernmental Panel on Climate Change (IPCC) establishes this variability in the influence of anthropogenic climate change on different types of events and in different regions in its last assessment report [Bindoff et al., 2013] and specifically in its special report on extreme events [Seneviratne et al., 2012]. This shows that those research findings have not been assimilated by all the negotiators.

Conversely, only a minority of EEA scientists interviewed in this study had previously heard of loss and damage (Table 2). This indicates that a very small part of the EEA community actively researches how to integrate EEA results in loss and damage. Both topics are quite complex to comprehend for the other group. EEA is, as stated by one of the delegates, “very technical” (D3). Loss and damage is a political concept. It has been integrated in the negotiations without a clear definition [Boyd et al., 2017]. This might not evolve in the future, since the blurriness associated with the topic is the result of a compromise between the positions of Annex I and non-Annex I countries [Vanhala and Hestbaek, 2016]. The understanding gap between the EEA and the loss and damage communities makes it currently difficult for EEA to be integrated into the loss and damage negotiations. More communication between the two groups would be a necessary condition for EEA to be used in the context of climate negotiations [James et al., 2014].

Delegates also generally consider the knowledge on extreme weather events to be greater than that on slow onset events (see Table ??). Slow onset events include “sea level rise, increasing temperatures, ocean acidification, glacial retreat and related impacts, salinization, land and forest degradation, loss of biodiversity and desertification.” [CP.16, 2010] However, the scientific understanding of how climate change affects some extreme events is yet lower than for slow onset events [James et al., 2014]. This discrepancy could be twofold. First, the IPCC released a special report on extreme events in 2012 [Seneviratne et al., 2012], which is interpreted by this “issue is fairly well covered” (D11). Second, although anthropogenic climate change may have an influence on extreme events, they have happened before. Stakeholders have historical experience dealing with them and there are already many ways to address their impacts. For example, D2 states that “the rapid onset events like floods, hurricanes, and event droughts, are well-known phenomena that occurred naturally before human-induced climate change.”
Table 1: Delegates knowledge of the relationship between extreme weather events and anthropogenic climate change. Complete quotes supporting this table are available in the supplementary material (Table 4 and 5).

### 3.2 Potential uses for EEA in loss and damage

In order to better understand how EEA could be used in loss and damage, we interrogated the delegates on their vision of EEA in relation to loss and damage and the climate scientists on their vision of loss and damage
<table>
<thead>
<tr>
<th>Knew L&amp;D</th>
<th>Which role do you think EEA could play regarding loss and damage (L&amp;D)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Maybe useful for liability but complicated:</td>
</tr>
<tr>
<td></td>
<td>– acceptability of the science by a court.</td>
</tr>
<tr>
<td></td>
<td>– failure to mitigate vs failure to adapt.</td>
</tr>
<tr>
<td>C2</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Uncomfortable with the idea:</td>
</tr>
<tr>
<td></td>
<td>– the science is not robust enough yet.</td>
</tr>
<tr>
<td></td>
<td>– the robustness/attributability depends of the types of events and</td>
</tr>
<tr>
<td></td>
<td>of the region: unfairness in attributability.</td>
</tr>
<tr>
<td>C3</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Useful to determine what should be compensated. The way to</td>
</tr>
<tr>
<td></td>
<td>implement is still mysterious.</td>
</tr>
<tr>
<td>C4</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Confused:</td>
</tr>
<tr>
<td></td>
<td>– would be necessary to evaluate what is related to climate change.</td>
</tr>
<tr>
<td></td>
<td>– justice problem regarding the geographical distribution of</td>
</tr>
<tr>
<td></td>
<td>attributability.</td>
</tr>
<tr>
<td></td>
<td>– compensation and liability are explicitly removed from the Paris</td>
</tr>
<tr>
<td></td>
<td>agreement.</td>
</tr>
<tr>
<td>C5</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Useful to determine what should be compensated.</td>
</tr>
<tr>
<td>C6</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Not convinced:</td>
</tr>
<tr>
<td></td>
<td>– the real problem is to find ways to mitigate.</td>
</tr>
<tr>
<td></td>
<td>– problem of reproducibility of the science with just one planet.</td>
</tr>
<tr>
<td></td>
<td>– could slow decision making.</td>
</tr>
<tr>
<td>C7</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Does not think it will play a major role for L&amp;D. 2 possible other</td>
</tr>
<tr>
<td></td>
<td>other options:</td>
</tr>
<tr>
<td></td>
<td>– EEA for quantitative risk assessment (part of L&amp;D and adaptation,</td>
</tr>
<tr>
<td></td>
<td>has nothing to do with liability).</td>
</tr>
<tr>
<td></td>
<td>– indirect influence on L&amp;D through liability cases outside of the</td>
</tr>
<tr>
<td></td>
<td>UNFCCC.</td>
</tr>
<tr>
<td>C8</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Not convinced of the use of EEA for L&amp;D:</td>
</tr>
<tr>
<td></td>
<td>– uncertainty.</td>
</tr>
<tr>
<td></td>
<td>– non-linearity of the impacts.</td>
</tr>
<tr>
<td></td>
<td>– apportionment of the blame between emitters.</td>
</tr>
<tr>
<td>C9</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Against the use of EEA for L&amp;D:</td>
</tr>
<tr>
<td></td>
<td>– all the money would go to the lawyers.</td>
</tr>
<tr>
<td></td>
<td>– non-linearity of the impacts.</td>
</tr>
<tr>
<td></td>
<td>– complexity of choosing between different ways to count.</td>
</tr>
<tr>
<td></td>
<td>– international help should be based on resources, not on</td>
</tr>
<tr>
<td></td>
<td>attributability.</td>
</tr>
</tbody>
</table>

Table 2: Answers of the climate scientists regarding the possible use of EEA for L&D. Complete quotes supporting this table are available in the supplementary material (Tables 6).
on the fact that the impacts of climate change are already being observed. EEA could also act as a basis to put pressure on Annex I countries to meet their responsibilities. It becomes more complicated upon devising how EEA could be part of a concrete loss and damage mechanism, directly linking an extreme weather event with some kind of international help. Our analysis of the interviews unveiled six serious hurdles of technical and ethical natures, which hinder a concrete use of EEA for loss and damage.

<table>
<thead>
<tr>
<th>Relevance of EEA for L&amp;D</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 EEA could be useful for awareness raising for mitigation.</td>
<td></td>
</tr>
<tr>
<td>EEA could be dangerous:</td>
<td></td>
</tr>
<tr>
<td>– if framed in the compensatory way (ethical problem of accepting that you cause impacts on other countries and get away with it with money).</td>
<td></td>
</tr>
<tr>
<td>– problem of maladaptation vs lack of mitigation.</td>
<td></td>
</tr>
<tr>
<td>D2 EEA could be useful:</td>
<td></td>
</tr>
<tr>
<td>– for understanding of the role of climate change on extreme events.</td>
<td></td>
</tr>
<tr>
<td>– but it is a “second order problem”.</td>
<td></td>
</tr>
<tr>
<td>D3 EEA could be dangerous:</td>
<td></td>
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<tr>
<td>– it puts the light on climate change while there are other drivers of impacts.</td>
<td></td>
</tr>
<tr>
<td>D4 EEA could be useful:</td>
<td></td>
</tr>
<tr>
<td>– to determine what is L&amp;D.</td>
<td></td>
</tr>
<tr>
<td>– to raise awareness among policy makers.</td>
<td></td>
</tr>
<tr>
<td>D5 EEA could be dangerous:</td>
<td></td>
</tr>
<tr>
<td>– apportionment of responsibility between emitters is not easy.</td>
<td></td>
</tr>
<tr>
<td>– only the mediatized events would be addressed.</td>
<td></td>
</tr>
<tr>
<td>– paying only for the attributable part is morally wrong.</td>
<td></td>
</tr>
<tr>
<td>D6 Does not understand the need for EEA because the science is “easy”.</td>
<td></td>
</tr>
<tr>
<td>D7 EEA has potential in a forward looking framing.</td>
<td></td>
</tr>
<tr>
<td>D8 EEA is useful to put pressure on big emitters to take their responsibilities towards vulnerable countries.</td>
<td></td>
</tr>
<tr>
<td>D9 EEA is useful to put pressure on big emitters to take their responsibilities towards vulnerable countries.</td>
<td></td>
</tr>
<tr>
<td>D10 EEA is useful because it is the only way to measure the contribution of anthropogenic climate change to an event.</td>
<td></td>
</tr>
<tr>
<td>D11 EEA is important to discriminate what part of the impacts is related to ACC and what comes from maladaptation.</td>
<td></td>
</tr>
<tr>
<td>D12 EEA is useful to raise awareness among policy makers.</td>
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</tbody>
</table>

Table 3: Answers of the delegates regarding the possible use of EEA for L&D. Complete quotes supporting this table are available in the supplementary material (Table 7).

Climate scientists are sometimes uncomfortable with the use of their results given the current state of EEA, which is still a relatively new branch of climate science, and lacks robustness in some cases. For instance, subject C2 stated that he would be “uncomfortable […] if you would use our current methodology to make any
statements about it and describe dangerous events.” C8 is also uneasy about the inherent uncertainties of EEA results. This worry is related to the robustness of the current methodologies [Hulme et al., 2011]. Indeed, to this day, there are examples of EEA case studies leading to quantitatively, and sometimes qualitatively, varying results about the same event, depending on the methodology and model used [Angéil et al., 2017, Hauser et al., 2017]. If EEA results are to be included in a loss and damage mechanism, they would need to be robust, so that other EEA studies could not contradict them.

Another technical problem resides in the differences in our capacity to attribute different kinds of events in different regions (e.g. C2, C4 and C9). Some events are easier to attribute than others: it is simpler to get robust results for heat-related events than for precipitations, and attributing storms and hurricanes [on Extreme Weather Events and Attribution, 2016] is a still an unresolved challenge. Additionally, EEA studies in particular and climate sciences in general are more robust when they rely on long observational records. However, Annex I countries are generally better covered than non-Annex I countries. This is particularly true for African countries [Huggel et al., 2016]. Therefore, the most vulnerable countries are also those for which scientists are less prone to attribute an extreme event to anthropogenic climate change. Although there are articles proposing to extend EEA to attributable extreme weather events in Annex I countries [Mera et al., 2015], the current UNFCCC mandate addresses loss and damage “in developing countries that are particularly vulnerable to the adverse effects of climate change” [CP.19, 2013].

Even if those technical challenges were dealt with and the science were able to calculate the attributable part of any extreme event impact, there would still be political hurdles in the attribution of responsibility. Interviewees from both corpora raised the problem of the apportionment of responsibility based on emissions (C8 and D5). The apportionment of the emissions and their related responsibilities is not only an EEA problem but has been a constant issue since the beginning of the negotiations. There are different ways to calculate the contribution of a country to global emissions depending on the components of anthropogenic forcings (CO₂ only, different greenhouse gases, land-use changes, etc.), the start year of the emissions, the year the impacts of climate change are evaluated, whether one should account for emissions within a territory, or for consumption-based emissions, or for emissions per capita, or for the total emissions of a country, and the indicator of climate change (e.g. global mean surface temperature) [Skeie et al., 2017]. Otto et al. [2017] propose a mechanism to apportion the attributable part of the impacts of an extreme event between emitters. They show that emission apportioning choices impact responsibility distribution. Without an agreement on how to apportion anthropogenic emissions responsibilities in the UNFCCC, we can question whether this problem will be solved in the context of a hypothetical loss and damage implementation mechanism based on EEA.

Ahead of this, there are also subjective choices to make in the framing of an EEA case study [Jézéquel et al., 2018], which has led to a debate regarding the framing most useful to stakeholders [Lloyd and Oreskes, 2018]. Different framing options lead to answering different questions regarding the influence of climate change on individual extreme events. The subjective choices scientists have to make depend on the objective of the study. It hence should be concerted with the relevant stakeholders, in order to answer their questions [Otto et al., 2016] (also see Table ??). Loss and damage delegates, however, are probably not the stakeholders suited
to the task. Indeed, one of the first subjective choice in an EEA study regards the precise definition (duration and region) of the studied event, which has a quantitative impact on the results [Cattiaux and Ribes, 2018]. When asked how they would define extreme weather events and their impacts, delegates typically answered that this type of technical question was outside their field of expertise (see Appendix ?? Tables ?? and ??). This means that both communities consider that the choice and definition of the events of interest and of the relevant way to link these events to anthropogenic climate change should be done by the other community. Another responsibility dilemma lies between the one who failed to mitigate and the one who failed to adapt (C1, D1, D3, D11). This relates in part to a point raised by Hulme et al. [2011] that EEA could only be useful if it attributed changes in impacts, not changes in hazards. Only a few EEA case studies tackle impacts [Mitchell et al., 2016, Schaller et al., 2016]. There is still a long way before attributing the large variety of economic and non-economic losses. In particular, dealing with (possibly by quantifying) cultural and non-economic losses poses operational and ethical problems [Wrathall et al., 2013]. This point is important because the observed increase in damages related to natural disasters has been shown to be due to an increase in exposure and vulnerability rather than an increase in hazards [Visser et al., 2014].

Delegates may point out that EEA could lead to a situation where the politicians would only pay for the attributable part of the event (e.g.: D5). This is especially troublesome when considering that impacts are not linear (C8 and C9): “a lot of these things involve a threshold […] the straw that breaks the camel’s back, the non linearities become extraordinarily difficult to deal with.” (C9). This is illustrated by D2 when recounting the impacts of the Haiyan typhoon in 2013. “Philippines is well adapted to typhoons. […] Haiyan came, they got the warning, they went to the shelters, they died in the shelters. Haiyan was a super typhoon. The shelters were not built to withstand a super typhoon.”

For all of these reasons, it is hard to believe that EEA may be part of a concrete legally-binding loss and damage mechanism within the UNFCCC. Apart from its ‘softer’ role in raising awareness, concrete uses of EEA could possibly happen outside of the climate negotiations. Delegates (as well as C7) identify the disaster risk reduction community as the relevant stakeholders regarding technical issues on natural disasters. Hence, this community has more chances to grasp the concept and limits of EEA and to integrate its results in their work. There have also been recent arguments for [Marjanac and Patton, 2018] and against [Lusk, 2017] the use of EEA for liability purposes in courts outside of the UNFCCC jurisdiction. Whether EEA will be needed in those contexts remains to be explored by scientists in a separate analysis of each stakeholder group’s needs [Sippel et al., 2015].

4 Discussion and conclusion
At first sight, the introduction of loss and damage “associated with the adverse effects of climate change, including extreme weather events” [agreement, 2015] calls for a tool to determine which extreme weather events are effectively related to climate change. However, despite the lobbying of a few scientists, EEA does not blend
in negotiation texts. Six hurdles delegates and scientists associate with the use of EEA for loss and damage
emerge from the analysis of the interviews we present here. The first two hurdles are technical: the lack of
confidence in EEA results, and the lower attributability of events in the most vulnerable countries. Four other
hurdles regard the attribution of responsibility that could ensue from EEA results. This could lead to politically
complicated (possibly impossible) choices: the apportionment of responsibilities between emitters, the definition
of the extreme events, the apportionment of responsibilities between the ones who failed to mitigate and the
ones who failed to adapt, and the risk of only dealing with the attributable part of an event.

The relationship between EEA and loss and damage sheds light on the relationship between science and
negotiations within the UNFCCC. For comparison, we can take the example of the 2 threshold, which is an
example of co-construction between science an policy within the UNFCCC [Randalls, 2010, Aykut and Dahan,
2011, Cointe et al., 2011]. At COP15 in Copenhagen, the choice of a long term goal was at stake. Two options
were the 2 threshold, which made it into the final decision, and a fixed amount of emissions. Cointe et al. [2011]
analyze the reasons for the success of the 2 threshold. One of the main point they develop is that “it is less
accurate and less clearly measurable than concentrations, which affords it an ambiguity that is very useful in
the negotiation process: we can point relatively precisely to the moment when 450ppm of atmospheric CO
2 to be expected, but much less precisely to the moment when the average global temperature will have risen
2 above the pre-industrial baseline.” Flexibility and blurriness are essential for the political process. Policy
is not rational, it thrives on “constructive ambiguity” [Geden, 2016]. The example of EEA is representative
of scientists’ lack of understanding of the type of scientific information to which the UNFCCC is porous. As
Geden [2018] puts it : “climate researchers need to understand processes and incentives in policy making and
politics to communicate effectively.”

Despite the fact that EEA, as a very technical and precise science, is not adapted to the negotiation process,
the fact that loss and damage is supposed to deal with events related to climate change remains legitimate.
Aykut et al. [2017] introduced the concept of a globalization of the climate problem, meaning “the inclusion of
new issues and actors into the climate regime”. Through a compilation of articles on specific topics based on
the ethnographic analysis of COP21, they show how climate change negotiations integrate other international
policy topics, which are not necessarily directly linked to climate, like fossil-fuel regulation [Aykut and Castro,
2017], or security and migration [Maertens and Baillat, 2017]. Loss and damage (at least the part on extreme
weather events) include disaster risk reduction issues in the COPs. The integration of disaster risk reduction
within COPs presents two main advantages. It profits from the general momentum and mediatization of the
climate arena, which is huge compared to traditional disaster risk reduction forums (e.g. the Sendai protocol,
which is cited by a few of the interviewed delegates). It also opens the possibility of a shift of responsibilities
in case of disasters. As D8 puts it: “One of the important things about the climate change convention and the
international climate change regime is that there is a responsibility in the convention for Parties, for developed
country parties, to finance adaptation and resilience building. Whereas in all of the other international arenas
that are related the responsibility falls on the country itself.” Another interesting point is that the original loss
and damage proposal only included loss and damage associated with sea level rise [Vanuatu, 1991]. We do not
have the material to treat this question, but it would be interesting to investigate when and how extreme weather
events (and the associated disaster risk reduction issues) were included in the UNFCCC loss and damage. This could help to understand which groups are behind this inclusion of disaster risk reduction, within the UNFCCC.

The analysis presented in this article confronts the perspectives of two groups of stakeholders on the potential inclusion of EEA results in a loss and damage process: EEA scientists and loss and damage delegates. It shows that for now, EEA results could only feed awareness raising, rather than the negotiation itself. A third major stakeholder group was not included in this study: the NGOs. This is an important limit of the results presented there. Indeed, this group plays an key part in the climate regime both within and without the UNFCCC arena (e.g. de Moor et al. [2017] on the role of climate activists and Morena [2017] on the role of philanthropies at COP21). Interviews with NGO representatives would be needed to understand whether they would find EEA results useful, and for which purpose (e.g. awareness raising, lobbying) they could use it.

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