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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 speech<sup>1</sup> 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 you 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

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<sup>1</sup><http://www.climatechangenews.com/2013/11/11/its-time-to-stop-this-madness-philippines-plea-at-un-climate-talks/>

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

38  
39 Loss and damage in the context of the UNFCCC is hard to comprehend because it does not have a con-  
40 sensuous definition. Since Yeb Saño’s speech, loss and damage has gained traction in the negotiation [Mace and  
41 Verheyen, 2016, Vanhala and Hestbaek, 2016] through an ambiguous frame and a lack of clear definition (“The  
42 reason loss and damage was easy was that nobody knows what it means yet” [Vanhala and Hestbaek, 2016]).  
43 Loss and damage are included in the Paris agreement (Article 8 of the agreement [2015]). Boyd et al. [2017]  
44 investigate the different meanings of loss and damage through interviews with thirty-eight key stakeholders.  
45 They identify four perspectives. The *Adaptation and Mitigation perspective* considers loss and damage as all the  
46 impacts of anthropogenic climate change, which the Convention as a whole aims to avoid. In this perspective,  
47 there is no need for an additional loss and damage mechanism, as the goal of mitigation and adaption is precisely  
48 to avert and minimize loss and damage. The *Risk Management perspective* links loss and damage to ongoing  
49 efforts in disaster risk reduction (DRR). The *Limits to Adaptation perspective* presents loss and damage as the  
50 residual impacts of climate change which were not avoided through mitigation and go beyond the possibilities  
51 of adaptation. The *Existential perspective* is centered on the need to address the inevitable harm the most  
52 vulnerable populations already face because of climate change.

53  
54 Depending on the chosen perspective, the attributability of weather-related impacts is not always necessary  
55 to deal with loss and damage [Warner and van der Geest, 2013]. However, it is expected that the UNFCCC  
56 should deal with impacts that can be related to climate change. Before loss and damage became a hot topic  
57 in the negotiations, Allen [2003], Allen and Lord [2004], and Allen et al. [2007] already discussed the potential  
58 of attribution of extreme events to allow wronged citizens to appeal for compensation and liability. In fact,  
59 the perceived social need to attribute extreme weather impacts to climate change was the motivation stated  
60 by Allen to start investigating the scientific possibilities to perform attribution for specific extreme events that  
61 caused a lot of damage. He considers this solution as “apolitical” [Allen, 2003], in stark contrast with the  
62 political battles led within the UNFCCC surrounding loss and damage. A big difference between the arguments  
63 of Allen [2003], Allen and Lord [2004], and [Allen et al., 2007] and UNFCCC loss and damage is that the former  
64 considers compensation of losses mainly from an Annex I country system, while the latter applies specifically  
65 to the most vulnerable (non Annex I) countries. Allen’s view hence misses a part of the problem, especially  
66 because Annex I countries losses are often of economic nature, while non Annex I countries also deal with  
67 non-economic losses (e.g. loss of life, loss of culture). However, his view may lead to faster results, for several  
68 reasons: it is easier to attribute events in Annex I countries [Huggel et al., 2016, Mera et al., 2015], and Annex I  
69 countries victims have a better access to national and international law. We note that there are disagreements  
70 within the UNFCCC regarding the scale (national, regional, or global) at which loss and damage should be  
71 addressed [Vanhala and Hestbaek, 2016].

72

73 Hulme et al. [2011] alert against the potential use of weather event attribution for the allocation of adap-  
74 tation funding (note that when their article was published, loss and damage was only emerging in negotiations  
75 and that the WIM did not exist). They highlight three main problems behind the idea that adaptation fund-  
76 ing should go to the impacts which are directly related to anthropogenic climate change through attribution  
77 (a position that was defended by Pall et al. [2011] and Hoegh-Guldberg et al. [2011]). First, EEA relies on  
78 models to estimate changes of probability, which introduce large uncertainties and subjectivity in the results.  
79 Surminski and Lopez [2015] also raise the issue of the unreliability of models, which are the basis of FAR  
80 calculation. Second, EEA measures changes in hazards, not in risks. It hence ignores potential changes in risks  
81 related to changes in exposure or vulnerability, and is still far from dealing with the political, social and ethical  
82 components of impacts. In line with this point, Huggel et al. [2013, 2015] argue that for EEA to be relevant  
83 to international climate policy it has to expand from the evaluation of changes in hazards to changes in risks.  
84 Third, they argue that the allocation of funds through attributability frames adaptation in a compensatory way  
85 rather than on building capacity with respect to vulnerability.

86  
87 With the establishment of loss and damage as a major topic in the run-up to the Paris agreement and  
88 afterwards, scientists started to highlight the issue of establishing a link between impacts and anthropogenic  
89 climate change. Following the adoption of the WIM, James et al. [2014] explain that “From a scientific per-  
90 spective, [...] the first challenge in implementing the WIM would be to estimate where and when loss and  
91 damage can be attributed to anthropogenic climate change”, which calls for detection and attribution and EEA  
92 information. They point out that this potential scientific input has been largely ignored in negotiations. They  
93 are concerned “that a body of scientific evidence is growing, which is highly relevant to the WIM, yet is seen as  
94 a distraction from the negotiations” and call for a better communication between scientists and policy makers  
95 (see also Parker et al. [2015]).

96  
97 In parallel, with the growth of EEA as a scientific topic, a more general discussion on the motivation of  
98 scientists to do EEA and on who could be the potential users emerged. The use of EEA results as material to  
99 back up a liability case, possibly in the context of UNFCCC loss and damage is among the four motivations  
100 proposed by Hulme [2014]. Stott and Walton [2013] do not mention loss and damage as a potential domain of  
101 application, while Sippel et al. [2015] do. What is interesting here is that both EEA and loss and damage have  
102 been growing concurrently, and that a part of the scientific community has established a link between both topics.

103  
104 A few articles discuss the relevance of EEA for loss and damage. Some of them consider that EEA has an  
105 essential part to play. Thompson and Otto [2015] argue that EEA is a necessary scientific input to provide  
106 restorative justice, which would be a basis for “healthy long-term international relations.” Beyond monetary  
107 compensation, it would be a way for big emitters to acknowledge their part in impacts suffered by the most  
108 vulnerable countries, and this acknowledgement would be a first step in the making of amends. According to  
109 Mace and Verheyen [2016], the role of attribution science is threefold: the attribution of emissions, the attri-  
110 bution of impacts to extreme events and EEA. They argue that the scientific establishment of a link between  
111 emissions and specific impacts put policy makers in a position where it is more advantageous for them to take  
112 action collectively in the UNFCCC than to risk being brought before a court of law. Verchick [2018] adopts

113 a similar point of view. He values EEA on the ground of the “unavoidable moral duty to know what’s going  
114 on”. EEA results could provide “substantial leverage” to push for ambitious mitigation, adaptation and loss  
115 and damage policy.

116

117 Others are less enthusiastic (although not as critical as Hulme et al. [2011]). Wallimann-Helmer [2015]  
118 remarks that not all loss and damage result from climate change. Some are related to natural variability. The  
119 type of responsibility differs between these two cases. EEA could help to distinguish which impacts would fall  
120 under corrective liability or remedial responsibility. However, he also asserts that corrective liability (related  
121 to attributable events) should be a secondary concern in regards to remedial responsibilities because loss and  
122 damage approaches are prospective in nature, and because it would be inappropriate to subsidize only the  
123 attributable fraction of loss and damage. This makes the utility of EEA only secondary. Surminski and Lopez  
124 [2015] criticize the conception that EEA could support the compensation of loss and damage, which could  
125 “distract from the importance of recognizing risk in its totality”, by focusing only on hazards. Boran and Heath  
126 [2016] argue that given the history and processes of the UNFCCC, the normative frame based on compensation  
127 and liability is bound to fail. They propose an alternative “risk-pooling logic”, in which EEA would strengthen  
128 insurance mechanisms. Huggel et al. [2016] discuss the type of climate information needed to feed different  
129 normative principles of justice. They show that a compensation process, which would be based on attribution  
130 results, would not be feasible with the current level of confidence in scientific evidence. In particular, they reveal  
131 an injustice in the scientific potential to attribute events depending on the region and on the type of impacts.  
132 This injustice is caused by the uneven quality of observational records. The most vulnerable countries are also  
133 those for which attributability is the lowest. Lusk [2017] discusses the social utility of event attribution, and  
134 concludes that the best social fit for EEA would be loss and damage. He however points out that EEA is not  
135 the only way to address loss and damage and that there is no certainty that it will ever be used in the UNFCCC  
136 arena. Roberts and Pelling [2018] point out that although it could be useful, EEA should not be a pre-requisite  
137 as there are still a lot of scientific challenges to deal with on the way to operationalization, which should not  
138 hinder efficient and rapid loss and damage action. Support should be given foremost to the most vulnerable,  
139 rather than the most attributable.

140

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

153 Then, we present the results of this analysis. Finally, we discuss the implications of these results mean for the  
154 potential use of EEA for loss and damage.

155

## 156 **2 Material and Methods**

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

160

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

171

### 172 **2.1 Selection of interviewees**

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

184

185 For the first corpus, our sample consists of nine climate scientists. They were selected based on their publi-  
186 cations and involvement in EEA research. They all came from different laboratories based in Europe, North and  
187 South America. An effort was made to cover different types of methodologies. Five of them were interviewed  
188 during the IMSC (International Meeting on Statistical Climatology, held in Canmore, Canada, in June 2016),  
189 two others were interviewed in person during other occasions and the last two via skype, between June 2016 and

190 January 2017. The nine interviewees included eight men and one woman. Five have a background in physics  
191 and four in statistics. We chose to only interview holders of a PhD and with a permanent position as they are  
192 more likely to be in contact with stakeholders outside the world of research.

193

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

200

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

210

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

216

## 217 **2.2 Interview procedure**

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

226

227 The delegates and affiliates were asked what was their personal definition of loss and damage, what was the  
228 state of loss and damage during/after COP22, what was their role regarding loss and damage, how they would

229 define extreme weather events and measure their impacts in the context of the Paris agreement, why did the  
230 WIM Excom define an action area about slow onset events and not about extreme weather events, how they  
231 imagined the implementation of loss and damage, what is the role of science in loss and damage, whether they  
232 work with scientists and about the future of loss and damage. Four questions were specifically on EEA. We  
233 asked them how an extreme weather event would be attributed to climate change in the context of loss and  
234 damage, what they thought of the attribution of individual extreme weather events, what would be their ideal  
235 contribution from climate science on the attribution of extreme weather events and how they would deal with  
236 the events for which the uncertainties are too high for science to attribute them to climate change.

237

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

243

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

248

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

## 254 **2.3 Data Analysis**

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

264

## 265 3 Results

### 266 3.1 Delegates knowledge of EEA and scientists knowledge of loss and damage

267 Two years before the 2015 Paris Agreement, stakeholders involved in loss and damage had various, and often  
268 incorrect knowledge of EEA [Parker et al., 2017]. A year after the Paris Agreement, despite calls [James et al.,  
269 2014] and initiatives [Parker et al., 2016] from scientists for better communication towards stakeholders, our  
270 survey shows that the diagnostic stays the same. Table 1 summarizes the understanding of twelve delegates and  
271 affiliates on both the general influence of anthropogenic climate change on extreme events and EEA. Less than  
272 half of them had prior awareness of EEA. The understanding of both the challenges and the concepts associated  
273 with EEA vary from one interviewee to the other. The general understanding of how extreme weather events  
274 are affected and will be affected by climate change also differs from one delegate to the other. Most of them  
275 declare that climate change affects the severity and the frequency of extreme events, without discriminating  
276 between regions of the world and types of events. The Intergovernmental Panel on Climate Change (IPCC)  
277 establishes this variability in the influence of anthropogenic climate change on different types of events and  
278 in different regions in its last assessment report [Bindoff et al., 2013] and specifically in its special report on  
279 extreme events [Seneviratne et al., 2012]. This shows that those research findings have not been assimilated by  
280 all the negotiators.

281  
282 Conversely, only a minority of EEA scientists interviewed in this study had previously heard of loss and  
283 damage (Table 2). This indicates that a very small part of the EEA community actively researches how to  
284 integrate EEA results in loss and damage. Both topics are quite complex to comprehend for the other group.  
285 EEA is, as stated by one of the delegates, “very technical” (D3). Loss and damage is a political concept. It  
286 has been integrated in the negotiations without a clear definition [Boyd et al., 2017]. This might not evolve in  
287 the future, since the blurriness associated with the topic is the result of a compromise between the positions of  
288 Annex I and non-Annex I countries [Vanhala and Hestbaek, 2016]. The understanding gap between the EEA  
289 and the loss and damage communities makes it currently difficult for EEA to be integrated into the loss and  
290 damage negotiations. More communication between the two groups would be a necessary condition for EEA to  
291 be used in the context of climate negotiations [James et al., 2014].

292  
293 Delegates also generally consider the knowledge on extreme weather events to be greater than that on slow  
294 onset events (see Table ??). Slow onset events include “sea level rise, increasing temperatures, ocean acidifi-  
295 cation, glacial retreat and related impacts, salinization, land and forest degradation, loss of biodiversity and  
296 desertification.” [CP.16, 2010] However, the scientific understanding of how climate change affects some extreme  
297 events is yet lower than for slow onset events [James et al., 2014]. This discrepancy could be twofold. First,  
298 the IPCC released a special report on extreme events in 2012 [Seneviratne et al., 2012], which is interpreted  
299 by this “issue [is] fairly well covered” (D11). Second, although anthropogenic climate change may have an  
300 influence on extreme events, they have happened before. Stakeholders have historical experience dealing with  
301 them and there are already many ways to address their impacts. For example, D2 states that “the rapid onset  
302 events like floods, hurricanes, and event droughts, are well-known phenomena that occurred naturally before  
303 human-induced climate change.”

	Influence of anthropogenic climate change (ACC) on extreme weather events (EWE)	Knowledge of extreme event attribution (EEA)
D1	ACC contributes to existing EWE, but does not induce totally new weather events.	– “Difficult to say that one event in its entirety is attributable to climate change.” – Has not heard about EEA.
D2	ACC increases the severity, intensity and frequency of extreme events.	– It is possible to calculate the difference in magnitude or in probability caused by ACC for a specific EWE within a matter of days. – Has heard of EEA.
D3	ACC increases the unpredictability of EWE Explicit reference to IPCC.	– Impossible to attribute one event to ACC – Has heard about EEA. – EEA is “a way to say whether CC is 30% or 20%, it is very technical.”
D4	ACC increases the frequency, and the intensity of EWE	Has not heard about EEA. Outside of field of expertise.
D5	ACC increases the frequency, the impacts and the magnitude of EWE. Explicit reference to IPCC.	– Has not heard about EEA. – Attributing one storm to ACC is “impossible, non scientific even.”
D6	ACC explains the occurrence of extreme events like hurricanes. The refusal to link EWE to ACC comes from political reasons, not from science.	– Has not heard about EEA. – Does not understand the need for EEA because the science is “easy”.
D7	No specific statement.	– Has heard about EEA.
D8	ACC increases the frequency, and the severity of extreme events. ACC is not the only driver of EWE.	Refuses to answer the question. Outside of field of expertise
D9	The frequency, the severity and the location of current EWE are a result of ACC. ACC is not the only driver of EWE.	– Has heard about EEA. – There are other factors than ACC in EWE.
D10	No specific statement.	Refuses to answer the question. Outside of field of expertise
D11	The influence of ACC on EWE depends on the type of events and on the region studied. Explicit reference to IPCC.	– “it’s difficult to attribute just one event to climate change, scientifically.” – Has not heard about EEA.
D12	ACC increases the number of EWE. ACC is not the only driver of EWE.	– EEA is difficult because of “climate variability”. – Has heard about EEA. – Even if we cannot “fully” attribute, we may attribute a part of the event to ACC.

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).

304

### 305 3.2 Potential uses for EEA in loss and damage

306 In order to better understand how EEA could be used in loss and damage, we interrogated the delegates on  
307 their vision of EEA in relation to loss and damage and the climate scientists on their vision of loss and damage

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

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).

308 in relation to EEA. Their answers are summarized in Tables 2 and 3. A significant part of the climate scientists  
309 are not convinced of the potential usefulness of EEA for loss and damage and a few delegates think that EEA  
310 could be ill-used and dangerous. Most of the delegates, especially those from non-Annex I countries, agree that  
311 EEA could be useful to some extent. They think that EEA could help to raise awareness among policy makers

312 on the fact that the impacts of climate change are already being observed. EEA could also act as a basis to  
 313 put pressure on Annex I countries to meet their responsibilities. It becomes more complicated upon devising  
 314 how EEA could be part of a concrete loss and damage mechanism, directly linking an extreme weather event  
 315 with some kind of international help. Our analysis of the interviews unveiled six serious hurdles of technical  
 316 and ethical natures, which hinder a concrete use of EEA for loss and damage.

317

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

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).

318 Climate scientists are sometimes uncomfortable with the use of their results given the current state of EEA,  
 319 which is still a relatively new branch of climate science, and lacks robustness in some cases. For instance, sub-  
 320 ject C2 stated that he would be “uncomfortable [...] if you would use our current methodology to make any

321 statements about it and describe dangerous events.” C8 is also uneasy about the inherent uncertainties of EEA  
322 results. This worry is related to the robustness of the current methodologies [Hulme et al., 2011]. Indeed, to  
323 this day, there are examples of EEA case studies leading to quantitatively, and sometimes qualitatively, varying  
324 results about the same event, depending on the methodology and model used [Angélil et al., 2017, Hauser et al.,  
325 2017]. If EEA results are to be included in a loss and damage mechanism, they would need to be robust, so  
326 that other EEA studies could not contradict them.

327  
328 Another technical problem resides in the differences in our capacity to attribute different kinds of events in  
329 different regions (e.g. C2, C4 and C9). Some events are easier to attribute than others: it is simpler to get  
330 robust results for heat-related events than for precipitations, and attributing storms and hurricanes [on Extreme  
331 Weather Events and Attribution, 2016] is a still an unresolved challenge. Additionally, EEA studies in partic-  
332 ular and climate sciences in general are more robust when they rely on long observational records. However,  
333 Annex I countries are generally better covered than non-Annex I countries. This is particularly true for African  
334 countries [Huggel et al., 2016]. Therefore, the most vulnerable countries are also those for which scientists are  
335 less prone to attribute an extreme event to anthropogenic climate change. Although there are articles proposing  
336 to extend EEA to attributable extreme weather events in Annex I countries [Mera et al., 2015], the current  
337 UNFCCC mandate addresses loss and damage “in developing countries that are particularly vulnerable to the  
338 adverse effects of climate change” [CP.19, 2013].

339  
340 Even if those technical challenges were dealt with and the science were able to calculate the attributable  
341 part of any extreme event impact, there would still be political hurdles in the attribution of responsibility.  
342 Interviewees from both corpora raised the problem of the apportionment of responsibility based on emissions  
343 (C8 and D5). The apportionment of the emissions and their related responsibilities is not only an EEA problem  
344 but has been a constant issue since the beginning of the negotiations. There are different ways to calculate  
345 the contribution of a country to global emissions depending on the components of anthropogenic forcings (CO<sub>2</sub>  
346 only, different greenhouse gases, land-use changes, etc.), the start year of the emissions, the year the impacts of  
347 climate change are evaluated, whether one should account for emissions within a territory, or for consumption-  
348 based emissions, or for emissions per capita, or for the total emissions of a country, and the indicator of climate  
349 change (e.g. global mean surface temperature) [Skeie et al., 2017]. Otto et al. [2017] propose a mechanism to  
350 apportion the attributable part of the impacts of an extreme event between emitters. They show that emission  
351 apportioning choices impact responsibility distribution. Without an agreement on how to apportion anthro-  
352 pogenic emissions responsibilities in the UNFCCC, we can question whether this problem will be solved in the  
353 context of a hypothetical loss and damage implementation mechanism based on EEA.

354  
355 Ahead of this, there are also subjective choices to make in the framing of an EEA case study [Jézéquel  
356 et al., 2018], which has led to a debate regarding the framing most useful to stakeholders [Lloyd and Oreskes,  
357 2018]. Different framing options lead to answering different questions regarding the influence of climate change  
358 on individual extreme events. The subjective choices scientists have to make depend on the objective of the  
359 study. It hence should be concerted with the relevant stakeholders, in order to answer their questions [Otto  
360 et al., 2016] (also see Table ??). Loss and damage delegates, however, are probably not the stakeholders suited

361 to the task. Indeed, one of the first subjective choice in an EEA study regards the precise definition (dura-  
362 tion and region) of the studied event, which has a quantitative impact on the results [Cattiaux and Ribes,  
363 2018]. When asked how they would define extreme weather events and their impacts, delegates typically an-  
364 swered that this type of technical question was outside their field of expertise (see Appendix ?? Tables ?? and  
365 ??). This means that both communities consider that the choice and definition of the events of interest and  
366 of the relevant way to link these events to anthropogenic climate change should be done by the other community.

367  
368 Another responsibility dilemma lies between the one who failed to mitigate and the one who failed to adapt  
369 (C1, D1, D3, D11). This relates in part to a point raised by Hulme et al. [2011] that EEA could only be useful if  
370 it attributed changes in impacts, not changes in hazards. Only a few EEA case studies tackle impacts [Mitchell  
371 et al., 2016, Schaller et al., 2016]. There is still a long way before attributing the large variety of economic and  
372 non-economic losses. In particular, dealing with (possibly by quantifying) cultural and non-economic losses  
373 poses operational and ethical problems [Wrathall et al., 2013]. This point is important because the observed  
374 increase in damages related to natural disasters has been shown to be due to an increase in exposure and  
375 vulnerability rather than an increase in hazards [Visser et al., 2014].

376  
377 Delegates may point out that EEA could lead to a situation where the politicians would only pay for the  
378 attributable part of the event (e.g.: D5). This is especially troublesome when considering that impacts are not  
379 linear (C8 and C9): “a lot of these things involve a threshold [...] the straw that breaks the camel’s back, the  
380 non linearities become extraordinarily difficult to deal with.” (C9). This is illustrated by D2 when recounting  
381 the impacts of the Haiyan typhoon in 2013. “Philippines is well adapted to typhoons. [...] Haiyan came, they  
382 got the warning, they went to the shelters, they died in the shelters. Haiyan was a super typhoon. The shelters  
383 were not built to withstand a super typhoon.”

384  
385 For all of these reasons, it is hard to believe that EEA may be part of a concrete legally-binding loss and  
386 damage mechanism within the UNFCCC. Apart from its ‘softer’ role in raising awareness, concrete uses of EEA  
387 could possibly happen outside of the climate negotiations. Delegates (as well as C7) identify the disaster risk  
388 reduction community as the relevant stakeholders regarding technical issues on natural disasters. Hence, this  
389 community has more chances to grasp the concept and limits of EEA and to integrate its results in their work.  
390 There have also been recent arguments for [Marjanac and Patton, 2018] and against [Lusk, 2017] the use of  
391 EEA for liability purposes in courts outside of the UNFCCC jurisdiction. Whether EEA will be needed in those  
392 contexts remains to be explored by scientists in a separate analysis of each stakeholder group’s needs [Sippel  
393 et al., 2015].

## 394 395 **4 Discussion and conclusion**

396 At first sight, the introduction of loss and damage “associated with the adverse effects of climate change, in-  
397 cluding extreme weather events” [agreement, 2015] calls for a tool to determine which extreme weather events  
398 are effectively related to climate change. However, despite the lobbying of a few scientists, EEA does not blend

399 in negotiation texts. Six hurdles delegates and scientists associate with the use of EEA for loss and damage  
400 emerge from the analysis of the interviews we present here. The first two hurdles are technical: the lack of  
401 confidence in EEA results, and the lower attributability of events in the most vulnerable countries. Four other  
402 hurdles regard the attribution of responsibility that could ensue from EEA results. This could lead to politically  
403 complicated (possibly impossible) choices: the apportionment of responsibilities between emitters, the definition  
404 of the extreme events, the apportionment of responsibilities between the ones who failed to mitigate and the  
405 ones who failed to adapt, and the risk of only dealing with the attributable part of an event.

406

407 The relationship between EEA and loss and damage sheds light on the relationship between science and  
408 negotiations within the UNFCCC. For comparison, we can take the example of the 2 threshold, which is an  
409 example of co-construction between science and policy within the UNFCCC [Randalls, 2010, Aykut and Dahan,  
410 2011, Cointe et al., 2011]. At COP15 in Copenhagen, the choice of a long term goal was at stake. Two options  
411 were the 2 threshold, which made it into the final decision, and a fixed amount of emissions. Cointe et al. [2011]  
412 analyze the reasons for the success of the 2 threshold. One of the main point they develop is that “it is less  
413 accurate and less clearly measurable than concentrations, which affords it an ambiguity that is very useful in  
414 the negotiation process: we can point relatively precisely to the moment when 450ppm of atmospheric CO<sub>2</sub> are  
415 to be expected, but much less precisely to the moment when the average global temperature will have risen  
416 2 above the pre-industrial baseline.” Flexibility and blurriness are essential for the political process. Policy  
417 is not rational, it thrives on “constructive ambiguity” [Geden, 2016]. The example of EEA is representative  
418 of scientists’ lack of understanding of the type of scientific information to which the UNFCCC is porous. As  
419 Geden [2018] puts it : “climate researchers need to understand processes and incentives in policy making and  
420 politics to communicate effectively.”

421

422 Despite the fact that EEA, as a very technical and precise science, is not adapted to the negotiation process,  
423 the fact that loss and damage is supposed to deal with events related to climate change remains legitimate.  
424 Aykut et al. [2017] introduced the concept of a *globalization of the climate problem*, meaning “the inclusion of  
425 new issues and actors into the climate regime”. Through a compilation of articles on specific topics based on  
426 the ethnographic analysis of COP21, they show how climate change negotiations integrate other international  
427 policy topics, which are not necessarily directly linked to climate, like fossil-fuel regulation [Aykut and Castro,  
428 2017], or security and migration [Maertens and Baillat, 2017]. Loss and damage (at least the part on extreme  
429 weather events) include disaster risk reduction issues in the COPs. The integration of disaster risk reduction  
430 within COPs presents two main advantages. It profits from the general momentum and mediatization of the  
431 climate arena, which is huge compared to traditional disaster risk reduction forums (e.g. the Sendai protocol,  
432 which is cited by a few of the interviewed delegates). It also opens the possibility of a shift of responsibilities  
433 in case of disasters. As D8 puts it: “One of the important things about the climate change convention and the  
434 international climate change regime is that there is a responsibility in the convention for Parties, for developed  
435 country parties, to finance adaptation and resilience building. Whereas in all of the other international arenas  
436 that are related the responsibility falls on the country itself.” Another interesting point is that the original loss  
437 and damage proposal only included loss and damage associated with sea level rise [Vanuatu, 1991]. We do not  
438 have the material to treat this question, but it would be interesting to investigate when and how extreme weather

439 events (and the associated disaster risk reduction issues) were included in the UNFCCC loss and damage. This  
440 could help to understand which groups are behind this inclusion of disaster risk reduction, within the UNFCCC.

441

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

450

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