Raising risk awareness in East Africa and India:
Stakeholder perspectives of extreme weather event attribution

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1 Introduction

Anthropogenic climate change is considered one of the biggest threats to global security and the safety of billions of people. How we live our lives, how we structure our societies and how we organise our economies are all contributing to making us increasingly vulnerable to a number of extreme weather events including droughts, floods, heat waves, storms. Whilst no one is totally safe from these hazards, the poorest communities are placed in an increasingly vulnerable situation with the least amount of resources available to them to cope.

The occurrence of extreme weather events is of course not new, and society has long been coping with them through adaptation measures. However, climate change is radically affecting the climate system and weather patterns that can make traditional adaptation strategies redundant.

To develop strategies to protect lives and livelihoods against climate change and particularly extreme weather events necessitates decision makers to have information and data on a wide range of issues including population, transport, water, housing, land management, industrial development, sea level rise, changing temperatures, and changing rainfall, to name a few. In addition, science is now being developed to consider if the risk of extreme weather events is changing either in terms of intensity or frequency due to climate change. The science of extreme event attribution (EEA) [often also known as probabilistic event attribution (PEA)] is relatively new in the climate change field with methodologies being developed, tested, and questioned as to their validity. However, it is not just the validity of the science that is being tested but also the role that the analyses have to play in a decision-making context. Research into EEA has shown that to be useful, it is necessary to understand who is using the science, how they are using the science, and where they are using the science. That is, understanding the context of the user is critical for the science to be used successfully and appropriately.

One of the recent sets of scientific analysis looked at the changing likelihood of three extreme weather events occurring in East Africa and India. The Raising Risk Awareness project has made a significant contribution to understanding how the risk of specific weather events in the region was affected by climate change. To supplement this scientific knowledge, we conducted interviews with stakeholders in the three countries to begin to understand how they do, and could, use the science so that any future analyses in the region can take account of user needs. This report first details other academic reports on extreme weather events and the implications for decision makers, then it summarises and illustrates the results of the interviews organised into three areas (usefulness of EEA, potential usefulness of EEA, and limitations of EEA), before drawing out some key conclusions.

2 Literature review

2.1 Climate Services

Climate services in general involve the timely production, translation, and delivery of useful climate data, information and knowledge for societal decision making (National Research Council, 2001). Interest in climate services and policy-relevant climate research has grown in recent years, partly because the quality of available information about the climate system has increased and partly because the demand for the services in the public and private sector has risen dramatically too (Lourenço, Swart, Goosen, & Street, 2015). Much work has been done to evaluate climate services in the agriculture sector, but much less in other sectors such as water management, energy, fisheries and transport (Clements, 2013; Vaughan, 2017).

The value of climate services and their use by policy-makers has been shown to be very context-specific. Several studies have focused on the circumstances under which climate services or information is most helpful to practitioners. Some of these studies have focused on the need for more research into better communication of the science (Vaughan et al., 2016; Pidgeon & Fischhoff, 2011), while others have stressed the importance of the co-production of knowledge and extended scientist–stakeholder dialogues, rather than 'predict-then-act' types of communication (Weaver et al., 2013). Other studies have focused on more specific examples of the provision of climate information. For example, Howarth and Painter (2016) assessed the usefulness of the AR5 IPCC report for a variety of policy makers in the UK, while Tang and Dessai (2012) focused on the use by British policy makers of the UK Climate Projections of 2009 (UKCP09) in adaptation decisions. International organisations like the Climate Services Partnership[1], the WMO Global Fieldwork for Climate Services[2], and CARE[3], have all provided detailed data bases, case studies, and analysis of when climate services in general can be most effective for policy makers. In general, climate services tend to form only one component of the multi-disciplinary information consulted by decision-makers[4].

Three of the key criteria often mentioned in this literature which determine if key stakeholders act on scientific knowledge or climate data are salience, credibility, and legitimacy (Cash et al., 2002, 2003). **Salience** refers to 'the relevance of information for an actor's decision choices, or for the choices that affect a given stakeholder', and usually means in practice the provision of information to a particular sector with the appropriate spatial (downscaled) and temporal scales; **credibility** involves 'the scientific adequacy of the technical evidence and arguments', and involves in practice collaboration with local researchers, robustness of the science, adequacy of methodologies, or the reputation of scientists; finally, l**egitimacy** reflects whether the research has considered stakeholders' needs and interests, and often includes such issues as the clear communication of

[1] http://www.climate-services.org/

[2] http://www.wmo.int/gfcs/

[3] For example, http://careclimatechange.org/courting-complexity-climate-services-lessons-participatory-scenario-planning/

[4] http://www.wmo.int/gfcs/what_are_climate_weather_services

uncertainty and limitations in the science, and clear consideration of the values and needs of different users.

So, for example, in the Tang and Dessai study (2012), stakeholders perceived the UKCP09 climate projections to be **credible** and **legitimate** because of their 'sophistication, funding source, and the scientific reputation of organizations involved'. (ibid., 300) But because of the inherent complexities of decision making and a potentially greater diversity in users, their **saliency** was found to be 'dependent upon the scientific competence and familiarity of the user(s) in dealing with climate information'. (ibid.) One of the findings of the Howarth and Painter study (2016) was that to better meet the criterion of **legitimacy**, 'there was a pressing need for a locally led translation, production and dissemination of succinct <IPCC> summaries by its users to ensure better alignment and relevance to local priorities and end user needs'. (Ibid., 10) One study has also evaluated the application of the three criteria to the uptake of climate information in the humanitarian sector, and particularly the International Red Cross (Coughlan de Perez and Mason, 2014).

2.2 Extreme event attribution (EEA)

Extreme event attribution (EEA) is a relatively new climate service tool which explores the role that various climate components play in changing the likelihood and severity of specific, localised extreme weather events (Easterling, Kunkel, Wehner, & Sun, 2016). The 'attribution' element involves working out if the chance of a particular event happening now is different from what it would be in a world that wasn't warming.

EEA has become increasingly researched by climate scientists and modellers (using a range of methodologies), in part because the media and the public increasingly ask questions regarding who or what is to blame for extreme weather events they are experiencing (Hulme, 2014; Carbon Brief, 2017). It has become closely linked to debates regarding loss and damage at UNFCCC and other fora (Huggel, Stone, Eicken, & Hansen, 2015; James et al., 2014). Hulme et al. (2011) critique EEA studies for the limitation of only considering the meteorological hazard (which is being assessed for attribution), rather than the overall risk, including vulnerability and exposure – which might be more important e.g. for prioritizing adaptation. As they conclude, 'the crucial point is that climate adaptation investment is most needed where vulnerability to meteorological hazard is high, not where meteorological hazards are most attributable to human influence'. (ibid., 765) Another potential limitation is that EEA studies do not consider the future probabilities of extreme events[4]. Finally, EEA science in many developing regions, and particularly Africa, faces the added challenge of large climatic variability (making detection more difficult) and fewer, or less reliable, observations over a long period of time (Otto et al., 2015).

EEA science has successfully been used to determine the role anthropogenic climate change has played in changing the risks of given events across a wide range of sectors, regions and climatic events. A comprehensive survey carried out in July 2017 by the website Carbon Brief (2017) of the 140 published studies on extreme events around the world found the following:

[4] https://www.nap.edu/read/21852/chapter/7

- <…> mounting evidence that human activity is raising the risk of some types of extreme weather, especially those linked to heat.
- 63% of all extreme weather events studied to date were made more likely or more severe by human-caused climate change.
- Heatwaves account for nearly half of such events (46%), droughts make up 21% and heavy rainfall or floods account for 14%.
- Of the 48 attribution studies that have looked at extreme heat around the world, 85% found that climate change had made an event of that kind more likely or more severe. This means a bigger proportion of studied heatwaves have been altered by climate change than any other studied type of weather.

The survey also showed that the majority of the 140 studies had been carried out in the USA, Europe and Australia, although this is slowly changing to include Africa and other regions of the world.

2.3 The use of EEA by policy makers

Whilst the understanding and the application of the science underpinning EEA is rapidly developing, the understanding of how decision-makers receive, assimilate and use EEA is still relatively unexamined. In contrast to the 140 case studies of EEA, there have been very few, both in the academic and grey (NGO) literature, on the role that EEA does, and can, play as a climate service for different types of policy makers.

Five of the most helpful and detailed studies are outlined in Chart 2.1. As can be seen, most of them have focused on industrialised countries, the exception being the study by West (2016) on Mexico. All five studies rely essentially on semi-structured interviews with a range of government, civil society and private sector representatives, with the sample size of interviewees ranging from 8 to 31. A variety of different economic sectors are also included. The central areas of questioning focus on defining the work areas of the interviewees, their use of climate data, prior knowledge of EEA, the relevance of EEA, and the potential usage of EEA. Chart 2.2 summarises the main findings of the five studies.

2.4 Conclusions

The results from the previous studies outlined in Chart 2.1 and 2.2 allow us to draw some general conclusions about the use of EEA. Although the studies focus on a wide range of different policy makers (from international negotiators in Sippel et al. (2015) to the Disaster Risk Reduction (DRR) community in West (2016)), it is clear that at the time of the studies, there was little understanding or familiarity with EEA, even for those actively engaged in international climate policy and/or adaptation. Most of the studies emphasised the importance of effective communication on EEA in language that was understandable to the policy makers. Most, but not all, seemed convinced that EEA had the potential to be useful. Clearly different stakeholders in different regions or areas have different needs in general for climate data. Perhaps the most significant finding is that all the studies concluded that the usefulness of EEA depended to a lesser or greater extent on its being presented alongside other climate information, which takes into account a wide range of variables such as time spans, spatial considerations, sectoral interests and other aspects of the policy making

context. Understanding the details of that context of where, how and by whom EEA information is being used is critical in targeting the research outputs to ensure that decision-making is appropriate and effective. Finally, we know that in developing regions, far less research has been done to identify stakeholder needs (Otto et al., 2015), which this study hopes to go some way to correct.

Chart 2.1 Studies of the use of EEA by policy makers and other decision makers

Study	Author(s)	Year	Region	Research focus	Interviewees (n)	Types of stakeholder	Research method	Main areas of questioning
Stakeholder perceptions	**Parker et al**	2016	Global	Loss and Damage (L&D) debate	31	Climate scientists 3; social scientists 7; NGOs 14; gov and intergov 6; p.s. 1	Semi-structured interviews; snowballing; grounded theory analysis	Prior knowledge of EEA; uses of EEA; L and D; PEA and L and D
Stakeholder input into EEA and Disaster Risk Reduction (DRR)	**West L.**	2016	Mexico	DRR; Mexican drought of 2011	8	NGO 2; gov 5; academic 1	Semi-structured interviews; snowballing;	DRR management; prior knowledge of EEA; role of EEA in enhancing DRR; Holistic Event Attribution
Stakeholder perspectives	**Sippel et al**	2015	Southeast Europe	Usefulness of EEA at regional scale; study of hot and dry summer of 2012	14	NGO 6; p.s. 2; Foundation 1; international org 2; research institutes 2; gov agency 1	Semi-structured interviews; case study presentation; coding analysis of interview material	Use of climate info; relevant and useful applications of EEA; potential implications of EEA; potential adverse outcomes; how different to be useful?
Stakeholders' needs and understanding	**Eucleia**	2015	Baltic Sea Region and Greater Paris area	Understanding of user needs and the value of EEA for regional stakeholders	16	Civil society 4; authorities and admin 6; p.s. 3; education 1; private/public partnership 2.	In-depth interviews with key stake holders; workshops	Role of regional climate services; Definition and potential relevance of EEA-related information; Quality criteria which determine the value of climate and EE-related and EEA information
Understanding stakeholder needs	**Stott and Walton (5)**	2013	US and Europe	Sectoral interests	Workshops	Insurance and legal; government departments and charities (humanitarian emergencies); Water sector; media	Content from Panel discussions	Relevance of EEA

Chart 2.2 Findings from studies on the use of EEA by policy makers

Study	Main Conclusions/Recommendations
Sippel et al	1. All stakeholders found the presented findings of an event attribution study in southeast Europe interesting, and most argued that results of this kind could potentially be usefully applied in their daily work. 2. Results indicate that this kind of research might become a useful tool in the day-to-day work of adaptation planners or to bolster investment decisions. However, future enquiries are needed to investigate in detail how those applications could be tailored more specifically, for example in the water, agriculture, or health sector. 3. The identified themes <...> indicate that detailed and fine-tuned attribution studies, with careful consideration of spatiotemporal scales as well as local meteorological peculiarities, and the (hydro) meteorological variables that are being attributed could add to the range of climate science products that are currently used by stakeholders in various sectors and regions. 4. Those products should be accompanied with a clear communication of the full range of methodological uncertainties. 5. Research into how probabilistic estimates of meteorological hazard <..> could be made more impact-relevant, for instance through the combination with different (observational) datasets or impact models, seems currently to be highly topical among stakeholders.
Eucleia	1. The stakeholders, particularly in the Baltic Sea case study, perceived EEA as a complex scientific endeavour attached to large uncertainties. Most of them never used or even heard of the possibility of EEA before. 2. A suitable product of EEA for regional stakeholders should accordingly be explicit with respect to what a EEA system <...> is, mention how it is different from related concepts, explain these aspects in an understandable way, and be able to translate scientific language into mother-tongue language. 3. To make implicit expectations explicit, a <EUCLEIA> product <..> needs to build upon a regular and context-specific stakeholder consultation and proactive engagement. 4. Most stakeholders found that <EEA> would not change their own motivation or way of taking action. They <said they would> rather be in need of information about vulnerability, potential impacts and promising adaptation options 5. Most stakeholders thought that EEA could <…> change the risk perception of others. Particularly the overall societal debate and public awareness-raising in terms of climate change were perceived to be potential fields of application.
Stott and Walton	1. Panel discussions involving <…> the insurance and legal sectors showed that weather and climate data are already extensively used, and that, theoretically, EA would have a role.

2. From an insurance perspective, it was suggested that attention needs to be given to temporal scales and patterns of events.

3. For charities, whilst attribution information is not of particular relevance to responding to humanitarian emergencies in the short term, it is valuable for long-term development and campaigning on poverty reduction where climate change is a major determinant of poverty over the next century. In addition, aid agencies are able to use attribution science to focus on aspects of vulnerability and the impacts of extreme weather on the poor.

4. Attribution information is seen as a useful communication tool that could be used to inform people of the immediacy of climate change and the need to prepare.

5. Journalists <..> explained how extreme weather events attract much public interest. However, they articulated their continued frustration with scientists' inability to communicate the complexity of attribution science to a lay audience. The issue of uncertainty within the science was also seen as problematic <...>, as this is still seen by many as 'not knowing'.

Parker et al.

1. The study found differing understandings of event attribution, along with debate within the scientific community and other relevant sectors about the usefulness of EEA for L&D policy

2. While the debate demonstrates that EEA could have roles in addressing L&D, the possibility of PEA having greater value relies on it being more effectively communicated in ways that are relevant to policymakers.

3. Scientists need to clearly communicate what EEA can provide, policy makers need to determine whether it could support their decisions and, if so, both groups need to discuss how PEA can best be applied.

West L.

1. Practitioners indicated that EEA could be integrated into DRR provided that study outputs are presented in a way that triggers risk reduction actions.

2. DRR practitioners felt that EEA could be relevant to their work, but differed in their opinion of the type of information they would need from attribution studies. Stakeholder needs related to attribution information vary even among members of a same group.

3. EEA can provide practitioners and disaster managers with information about potential changes in risk due to climate change soon after the event occurs. Current efforts to develop near real time attribution systems have the potential to play an important role in the successful integration of EEA into DRR.

3 Methodology and limitations

The interviews were semi-structured in the sense that a broad sequence of questioning was followed covering a set of similar areas, but with scope to delve into some areas of questioning in greater depth with different interviewees.

The structure of the questioning in each case was first, to understand the role of the interviewee in their organisation, and the landscape they make decisions in; then how climate or weather data are used, if at all; and finally, we focused on extreme weather, and more specifically on EEA and its potential usefulness. (See Appendix 2 for fuller outline).

Most of the interviews lasted about 30-40 minutes. This limited the possibility for the interviewer to give a fuller explanation of the science underpinning EEA, but where possible the interviewees were shown or read a country specific example of a mock event attribution statement (see Appendix 3), and asked to comment on it, albeit briefly.

In Kenya, due to time limitations a workshop was organised to engage decision and policy makers. The workshop followed the same structure as the interviews. However, although the workshop was recorded, it was not always possible to attribute specific quotes to sectors represented. Further details about the workshop can be seen in section 3.2 below.

The main limitation of our research method is 'availability bias', which in this instance means that the results were in part determined or influenced by the availability of those interviewed. A more robust method would have first identified representatives of key sectors useful to this study, but time restraints prevented this approach. So, for example, no international negotiators were interviewed which may have given different perspectives on the usefulness of EEA for example, in the negotiations around loss and damage.[1] However, if an international perspective was referred to, this was noted and, where appropriate, discussed further.

Secondly, in the summary of the interviews which follows, three key areas have been selected, and within those, some points have been stressed to the possible exclusion of others: the current usefulness of EEA; the potential usefulness of EEA; some of the limitations of EEA. The quotes have also been at times edited to be able to be read and understood easily as written text, which may have led to slightly different interpretations of the interviewees' words to what they intended.

The full list of the interviewees can be found in Appendix 1. In the case of Ethiopia, their main roles or areas of work are also included. In some cases, a 'snowballing technique' was employed by which more names for interviews were suggested by the interviewees.

Finally, only a few of the interviewees had any familiarity with the technical details of EEA, which may have put pressure on them to have an opinion as to its usefulness without a fuller understanding of what it means. The representatives of the NGOs in particular had little familiarity.

[1] See Parker et al., 2016, 'Stakeholder perceptions of event attribution in the loss and damage debate', *Climate Policy*, ISSN 1469-3062.

3.1 Ethiopia

Specific details of the methods and limitations relating Ethiopia are as follows:

- A variety of policy makers and decision makers from government ministries (7) and local and international NGOs (5) were interviewed, giving a total of 12.
- Interviews were conducted during the week of 11–17 June 2017 (and interviewee #12 later by Skype)
- It was not possible to include representatives of the private sector, the National Meteorological Agency (NMA), or certain ministries such as those responsible for energy or infrastructure.
- Only a few of the interviewees had any familiarity with the technical details of EEA (for example, interviewee #7 was well-versed in EEA science).

3.2 Kenya

Specific details relating to fieldwork in Kenya:

- Interviews were conducted on 8–9 June
- Time limitations meant that it was necessary to hold a workshop to maximise the opportunity of garnering a range of national level perspectives. 12 people were invited, 6 replied that they could attend, 4 attended along with 4 staff from the Kenya Meteorological Department (KMD) who work in extreme events. Following the workshop, 3 further interviews were arranged for the following day [Ministries of Transport, Agriculture and National Drought Management].
- The workshop was recorded but it was difficult to attribute specific comments to individuals in the transcriptions. So, all of the quotes are anonymous. In addition, those that were interviewed have been anonymised as agreed at the start of the interviews.

Sectors engaged:

Energy
Water management
Conservation
Transport
Drought Management
Agriculture
Meteorological services

3.3 India

Specific details relating to fieldwork in India:

- Interviews were conducted 15–23 June
- Interviews were conducted in Delhi to identify a national perspective and in Ahmedabad, Gujarat to understand a state perspective. Gujarat was chosen as the state has a well-developed understanding of climate change and the impacts of extreme events, though not necessarily on EEA.

- 22 meetings were conducted: Research [6], Government [8], NGOs [6], International organisations [2]. At many of the meetings more than one person was present though not all names were noted.
- Follow-up interviews via Skype were conducted with 10 of the participants to clarify key points and ideas and to further develop observations made at the time of the original meeting.
- The interviews lasted about 30–40 minutes and the follow-up ones 15 minutes.
- Because some of the interviewees did not want comments attributed to them, all interview quotes have been anonymised.

Sectors engaged:

Indian Met Dept.
Indian Met Society
Gujarat State Dept.
Gujarat State Disaster Management Authority
Urban planning
Health Care
Climate Change Department – Government of Gujarat
Indian Institute of Management
UNICEF
NGOs
National Disaster Management Authority (NDMA)
World Bank
The Energy and Resources Institute
Ministry of Earth Sciences
Media

4 Country studies

4.1 Ethiopia

For the ten years from 2005, the Ethiopian economy grew annually at around 10 per cent, in part driven by high levels of foreign investment, particularly from China, into infrastructure. According to the IMF, it has now overtaken Kenya to become the largest economy in East Africa. However, measured by GDP per capita, it is still one of the poorest countries in the region. Around 75% of its population relies on subsistence agriculture, and agriculture generates around 40% of the country's GDP.[1]

So, millions of Ethiopians remain very vulnerable to extreme weather events such as drought. 90% of smallholder farmers are dependent on rainfall agriculture. The perception of NGO and government sources consulted for this report is that in recent years the frequency of droughts has increased from once every five or ten years to once every two or three years, although with strong regional variations.[2] Part of the reason for the country's vulnerability is the recent changes to the predictability and intensity of the two main rainy seasons, the shorter spring *belg* rains from February up to May and the summer *kiremt* rains from June to September.

The Ethiopian government and NGO sector have considerable experience in drought prevention and response. The government is already implementing policies to reduce vulnerability to drought such as the Productive Safety Net Programme to increase resilience to food shortages. The prime minister himself chairs the disaster prevent and preparedness committee, which monitors weather reports from the National Meteorological Agency (NMA). A strategic multi-agency group led by the National Disaster Risk Management Commission (NDRMC) coordinates the government response. Ethiopia has a highly-centralised decision-making process, whereby policies are often decided at the centre and then disseminated to regions, zones, and the local district level (known as 'woredas').

Ethiopia has ambitious aims to be a middle income country, which the World Bank says could be reached as early as 2025.[3] As part of this aim, in 2011 it launched a low carbon development model knows as the Climate Resilient Green Economy (CRGE).[4] Amongst the CRGE's many objectives is to reduce the country's vulnerability to climate change impacts, and to lessen its greenhouse gas emissions (nearly 90% of which come from the land use sector such as forestry, livestock, crop production, and soil management).

The success of the CRGE is also dependent on securing significant flows of international finance, such as from the Green Climate Fund.[5] Indeed, one estimate taken from the interviews was that as much as 40% of the national budget comes from overseas aid and investment, equivalent to US$2-3

[1] John Aglionby, 'Big Read: Ethiopia', *Financial Times*, 4 July 2017.
[2] For example, interviewees #3 and #11.
[3] http://www.worldbank.org/en/country/ethiopia/publication/ethiopia-great-run-growth-acceleration-how-to-pace-it
[4] http://www.ethcrge.info/crge.php
[5] http://www.greenclimate.fund/who-we-are/about-the-fund

billion. The Ethiopian government is also very involved in international negotiations on climate change and climate initiatives such as the Global Green Growth Forum.[1] This general outward-looking approach should be taken into account when assessing the interviewees' openness to foreign initiatives on climate science or other types of climate services.

Finally, it is worth pointing out that the main source of information on weather and climate is the NMA, which was frequently cited in the interviews. Many interviewees stressed the pressing need for more capacity building and improved data collection for the NMA, and there were several different parallel initiatives going on being funded by international agencies. Appendix 4 is a partial list of other climate and weather data or sources consulted by the interviewees.

4.1.1 Usefulness of EEA

How useful EEA is, or could be, is very dependent on the context in which the interviewees are working. Key factors for shaping their response were the degree to which they interacted with foreign funders, the planning time span they were following, the economic sector they were working in, and their role in dealing with drought prevention or drought response. So for example, for NGOs or government departments applying for funding from international bodies like the Green Climate Fund (GCF) or Western governments, to be able to say an extreme event has become more likely as a result of anthropogenic climate change is very useful as a climate link helps to make the case for funding. Likewise, although no negotiators were interviewed, several interviewees made the observation that to be able to argue that Ethiopia is subject to extreme weather events, which may be becoming more likely as a result of man-made climate change, is very useful in making the case for international action to reduce carbon emissions. One interviewee cited the example of typhoon Haiyan battering the Philippines in November 2013 at the time of the Warsaw COP19, and how useful it would have been to know in real time any link to man-made climate change.[2]

The following are quotes from the interviewees to illustrate various points. They are identified by numbers which correspond to 1. Mulugeta Ayalew; 2. Wagayehu Bekele; 3. Ato Mohammed Deda; 4. Debause Bayleyegn Eyasu; 5. Yonas Gebru; 6. Zerihun Getu; 7. Grimaw Gezanegu; 8. Tesfaye Hailu; 9. Ben Irwin; 10. Bedassa Regassa; 11. Beletu Tefera Tegegne; 12. Mulugeta Worku. Full details of their roles can be found in Appendix 1.

[i] Making funding proposal submissions to international or bilateral funders

"When we're developing the pipeline proposals <to key finance bodies such as the Green Climate Fund (GCF)>, specifically climate focused projects, the challenge we're facing is the absence of data in trying to convince the financiers that the vulnerability of the communities we're targeting is directly affected by climate change. That's a main gap we have, and it has been a real challenge. It has also been very challenging to convince a financier that a project has a specific climate change

[1] http://3gf.dk/

[2] See Takayabu et al., (2015) *Environmental Research Letters*, 10, 064011. This research found that the worst-case scenario of a storm surge in the Gulf of Leyte may be worse by 20%, though changes in frequency of such events are not accounted for. It was published 18 months after the event.

element to it. <…> This type of information (EEA) is like the groundwork for us to convince the climate financers." (Interviewee #8)

- "So if we have the relevant Raising Risk Awareness (RRA) data, that we can make the link between climate change and those people's vulnerabilities, then the case is closed. We have had to read lots of papers, do research, and you can find some gaps in the information. For me, this project (RRA), it's very critical. Not only for me, but for Ethiopia and everybody else." (#8)

- "We haven't had this type of information so far. But if we did have it, it could be incredibly helpful. I mean I would tell you which kinds of events we can attribute to climate change in Ethiopia, if any at all, then I can pick this up, you can tell me this and that and this, and then I have like a solid concrete evidence to start my projects on." (#8)

- "In terms of climate finance, it's important to know that droughts can be partly man-made. We recently submitted a proposal to the Green Climate Fund (GCF), in which the objective was to build resilience in the most drought affected areas of Ethiopia. Last year we identified about two hundred districts out of a thousand and two hundred districts in the country, as hotspots of drought where they were the most affected and the most vulnerable areas. You know what the American board member of the GCF said? He said, what's new? Ethiopia is known to have been suffering from drought for a long period of time, so what is new? What has this to do with climate change? So this is one of the areas where we need that evidence, to seek financial and technological assistance from developed countries." (#1)

- "This sort of information would be very helpful in the sense that whenever you write proposals to foreign funders, including governments, you have to demonstrate that your case is really acceptable or convincing to others. So, if you can say that drought in Ethiopia in 2015 was 40% more likely as result of man-made climate change, it would give more weight and evidence to the reader of the proposal (particularly for those who do not believe in climate change!)." (#6)

- "I wouldn't necessarily put this science into the main project's proposal document. I would refer to it, and give details of the science so the funders could scrutinise it and the modelling behind it." (#6)

[ii] For international negotiations/responsibility:

- "Well, its most obvious application is at the high-level climate change negotiations. We would be able to say that we've now got evidence to show that countries which are polluting are having an impact on countries that are not." (#9)

- "Yes, I think it's helpful to have this information, because there are still some optimists who say 'there is no climate change'. And also, we're not only telling the international community how much we are affected by the drought. But also, we are trying to show what we are doing to combat this problem. We are doing our best, this much. So, we need the international community support. It is not only our asking for aid, it's their responsibility to help us." (#4)

- “So it's important not only for us, as I told you, but also for the international community it's important. In most cases, we are blaming the developed countries, the way they go, and that's why we are using the green economy. (#4)

- “To make the debate and the negotiations more intelligent, the greater we understand the different levels of change, the better. Because Africa is sort of crying "It's all down to the West and industrialization." It doesn't really help, it's unconvincing. It would be really interesting to say, "This percentage is because of <greenhouse gases> from industrialization but you've also got to look at twenty percent of change being due to local factors," or something like that”. (#9)

- “It could help in terms of the way it strengthens the arguments that polluting countries do actually come up with the money that's been committed through the Green Climate Fund or whatever it is. It could mean that there will be funds to actually try and do the work that we do.” (#9)

- “Even for some of our officials in some ministries, for our policy makers, we need to tell them how climate change affects the country, the economy, our natural resources, and so on. The leaders of the sectors in the CRGE, particularly. And it could help to have the analysis in real time of an extreme weather event and its link to climate change.” (#6)

[iii] Planning and sectoral interests

Some of the interviewees stressed that the usefulness of EEA was in part a function of the different economic or ministry sectors they worked in such as infrastructure, water or energy development. Roads or hydro-electric dams have a long lead-in planning time and are often national priorities, whereas agriculture has a much shorter time period for planning (drought prevention or drought response), from a minimum of one or two days to a maximum of maybe four months, and is often focused on the local level (‘woredas’).

- “And so for <droughts>, a seasonal forecast might be enough to mobilise resources for a disaster response. But if it is a long-term and if it is frequent, you need a strategic investment. You may need to invest in water storage infrastructure or infrastructure for the transportation of water from one region to another region. These are high cost investments and they require a long period of time to finish. So, dams for example might require a long period of time and a huge amount of resources. You need to save in advance, you need to design in advance, to plan in advance and for that you need a long-term forecast.” (#1)

- “And this is another very good reason to understand if it is manmade you would be able to anticipate if it is going to happen more frequently. If you know it is an act of God, it’s very difficult to answer whether it’s going to be frequent or not. If it is manmade then you can more easily understand it, so that is one of the purpose for having this kind of information. It would be particularly helpful for sectors with longer planning times like infrastructure, energy, and water.” (#1)

- “<This sort of information> would be useful for preparedness in the future, for planning, or to change even the development priorities, including for the Ministry of Agriculture. It would also be very useful in making the link to increased man-made emissions. But the main

problem is maybe, as a meteorologist I would say, the accuracy or reliability of this information." (#7)

- "Even though <EEA> is complicated, this is something that should be mastered by the policy makers at higher level, particularly in the Ministry of Agriculture. Otherwise talking about drought coming in every ten years, every five years and saying that on the media is not <as convincing>. The ministers, the experts, the advisors to the ministers, all in the ministry should understand and apply that. No question about that." (#5)

- "So it will help the community, particularly the government, <…> to arrange services, and to react to the upcoming extreme weather events." (#4)

- "Actually we don't work on disaster relief. For us, it's about building long-term resilience. Emergency responses can be met, but for our project's purposes, we try to design long-term sustainability, to reduce vulnerability and improve the resilience over a five-year period." (#1)

4.1.2 Potential usefulness of EEA

Several interviewees working for both governments and NGOs stressed the potential of EEA in several areas, including raising awareness within government and the general public, advocacy work, and contingency planning:

[i] Awareness raising at government/ministry level:

- "At a national level the Ethiopian government has a CRGE strategy. And when you understand the critical impact of climate change to your development efforts, at the government level, when you understand the impact of climate change to the society, to those communities, that basically would guide you to design the proper solutions to the society, that's what makes it sustainable. I mean once you know the problem, you can find a solution. So I think (EEA) is very important in a nutshell at the national level too." (#8)

- "Even for some of our officials in some ministries, for our policy makers, we need to tell them how climate change affects the country, the economy, our natural resources, and so on. The leaders of the sectors in the CRGE, particularly. And it could help to have the analysis in real time of an extreme weather event and its link to climate change." (#6)

[ii] For the general public:

- "We need to mobilise the public at this moment in time. One of the challenges that we have in many platforms is that people ask you why Ethiopia should care about the colour of its economy, its development. <….> The policy of this government is that we should follow a green pathway to development. So, to justify that, this kind of evidence will be important." (#3)

[iii] General

- "Therefore, having such information would definitely help our advocacy to base it more on an evidence focus. <…> It is true that we can use data from the NMA but sometimes it's also good to have information from another source. That my personal feeling. It is really hard

information that can be verified by other groups and academia because we can use that as an advocacy. If we get any information from the internet it's not wise now to use that for advocacy. We also need to use the climate science centre from any university might also be a good source of information. (#5)

- "If this information was available at a senior level of our organisation, it could help inform our contingency planning. But we would need workshops for our senior staff, and cascade this information down the organisation." (#3)
- "If this information was combined with information on the associated potential impacts of the extreme weather event in certain areas, then I can imagine this being useful as part of the climate information package we offer to our stake holders." (#12)
- "Another tool in the box". (#9)

[iv] Quantifying risk

Another way of assessing the potential of EEA is to assess the interviewees' understanding of the quantifying of risk and uncertainty:

- "Luckily the Prime Minister is a water engineer. So, he can understand probabilities. And uncertainties. For example, he can easily read the IPCC summary report." (#1)
- "We use probability assessments for example, for temperatures. The probability that the temperature is above, that the rainfall is above or normal, it's given in probabilistic terms." (#4).
- "Our extension workers can understand probabilities like 30% or 50% likely." (#7)
- "Normally in an <Agricultural Transformation Agency> ATA project, during and conducting agronomic advisory forums, regarding the uncertainty forms of probabilistic forecasting we use the tercile probability for understanding, for example, the Eastern part of the country. If it was going to be 30, 40, 50 percent. First, we have to try to teach them what this 30 means. Or for instance, 35, 40, 25. This is above normal, this is normal, and this is below normal. This represents 35% of the area; that part receives a normal level, and this area would receive 40%, and the remaining 25% (below normal)." (#7)
- "We use terms 'below average rainfall', 'average', 'above average'. (#9)
- "So we have to use scenarios: Very severe, severe, moderate". (#11)
- "Policy makers in Ethiopia are familiar with uncertainties in the science. For example, model projections for Ethiopia indicate that if climate change is a trend continuance, it may lose 2 to 10% of its GDP because of climate change. These are ranges generated by scientific data. Funders are aware of this types of uncertainty too." (#6)

4.1.3 Limitations of EEA

Some interviewees commented that EEA was only part of what they needed in assessing vulnerability; they wanted something that was more predictive, and down-scaled, particularly for drought prevention and response.

[i] Lack of relevance

- "To be frank I have some reservation because in most cases in working with a local community it is not complicated scientific information that they require. <…> What is required is that information is translated into its simplest form so that it can be applied by the community in its existing livelihood." (#5)

- "We need information that is specific to the communities that is down-scaled and easily understandable." (#4)

[ii] Lack of predictive capacity:

- "Having looked at the example <of EEA>, I have to say that the important part of how to predict what is going to happen is still missing. I can understand the example, but I need to know more about when it will happen again, after how many years. When should we expect this type of event to happen again?" (#2)

- "<What we are most interested in now> is a seasonal forecast. For example, they're using the seasonal forecast for insurance. The seasonal forecast, the probability of the rain is below or above normal – that is something that can help farmers insure their crops. That is why I say it would be good to have a predictive capacity that would help us for adaptation. In Africa, we are working on adaptation for climate change, and prediction is very important. Maybe in the future you may going to supply that?' (#2)

- "Knowing more about the possible frequency of these extreme events is helpful. But we also need to know the intensity of them (e.g. the lack of rainfall over how many days and the temperature increase). <For a complete picture of an impact on a particular area>, we also need to know the rate of natural resource depletion, the rate soil fertility is decreasing, land erosion, and population increase." (#11)

[iii] Lack of understanding of specific case study:

- "To be honest, it is a bit complicated for me because as I said I have little, even no, knowledge of climate science because I'm an ecologist by trade." (#5)

- "It looks very interesting. But as we've said, I need a one hour seminar really to understand how the technique works, what it's looking at, and what it really means. What is the significance of the information?" (#9)

- "Are these extreme events man-made or part of natural climate variability? It could be helpful to be able to say they are (partly) man-made. I should have the knowledge, because I should be able to explain it. What I would like is a sort of workshop." (#11)

- "This EEA information is very complicated even for the scientists, and particularly for policy makers." (#12)

[iv] Other data needed/measured:

Several experts working on drought pointed out that in making an assessment of the hazard or risk to vulnerable communities, the frequency or intensity of an extreme weather event is just one element for assessing vulnerability. For example, the interviewee from the National Disaster Risk Management Commission (#11) said ideally that for rainfall predictions alone, they needed onset cessation, distribution, coverage both partial and temporal, by area and by time span. In addition to temperature measurements, they also needed an assessment of how these were affecting crop and pasture conditions, pest status, and the health condition of animals. The health and nutritional conditions of local people, their water sanitation, and market conditions for their crops were also needed to get a full picture of their vulnerability.

- "We are doing these woreda disaster risk profiles. This is a profile that looks at the hazard, vulnerability and coping capacity of a specific area, a woreda. We have the baseline, which hazard is frequently occurring in that area, what is the exposure, the sensitivity, the vulnerability of that area, and the coping capacity of that area. We know the risks in that particular area. We have already collected data for 400 woredas. We have 800. The plan is to cover all woredas in the country. This is a very useful important information for us. We are going to base our Early Warning system based on this profile." (#11)

- "There is a vulnerability assessment and vulnerability capacity assessment is, that's sort of the entry point into the community. You can actually look at what's happening in the community." (#9)

- "The NMA's meteorological stations are these old manual types most of them scattered around cities and along main roads. The NMA's weather forecasts in the past were too general, and not regional enough. So, we have started a pilot project, and we established about 50 automatic weather stations in rural areas now. We concentrated on centres of farming, 50 of them in the four regions. For these areas now at least, locally specific data is generated automatically, every 15 minutes now, and with about 10 different variables being monitored, including maximum overall temperature, minimum, average, and also soil temperature; rainfall; soil moisture and humidity. (#4)

- "In the face of climate change it is the forecast data in some areas that we need about the rainfall or about the air temperature. You can easily communicate that and you can easily tell the impact and you can prepare the pastoralist or the farmer in terms of making this available and helping to build the resilience capacity of the local community. Communicating the data and information by itself might have no value for the farmer but there must be a way of linking that information to what is being done on the ground to build capacity." (#5)

- "More information is needed from regional or local areas on different economic sectors, particularly agriculture, and more reliable data from the NMA." (#6)

- “What is really needed is short-range weather forecasting on rainfall and temperature for so many different regions of Ethiopia, and it is very difficult for the NMA to do that at the moment”. (#12)

[v] If EEA showed no link between climate change and an individual extreme weather event:

> “At the highest level, the politicians might not like this kind of statement, you know, when I tell them like, listen, I mean, it's not because of climate change it's because of other reasons, they might not like it. As a technical person, if it's another reason, then I would have to find what the other reason is, and try to find a solution for it. I mean, for me, it works well, but if you pose the same question for a politician, he might give you a different answer.” (#8)

[vi] Difficulty of communicating the science

Many stressed the complexity of ‘translating’ and communicating EEA science, and indeed any climate science, across different levels, from top policy makers, to intermediaries, down to community leaders.

- “What is required is that information to be translated into its simplest form so that can be applied by the community in its existing livelihood.” (#5)

- “Knowledge is an important component of development. I believe that there is a big gap between policy makers and scientists in Ethiopia, and there is a bigger gap between science and society in Ethiopia in terms of speaking English. Our scientists speak English and they speak technical language so there is a need to translate that into local language. So, that for example translating this into a local Amharic language would take a number of pages and a number of thinking.” (#1)

- “We try to unpack <climate information> into a very basic understandable language and the sort of tyranny of acronyms that come at you. If someone like me who has worked for the last thirty years in the sector, struggles to try to understand what you're reading – what chance has an extension worker got?” (#9)

- “This sort of climate science is not easily understandable. At the community or local level, it is already a problem for experts or technical people to show them how to use rainfall data in general and understand it.” (#3)

- “This type of information is really difficult to communicate at the local level, for them to make sense of it. For example, what does a statement such as ‘there is a 55% chance of above average rainfall’ mean for local people?” (#12)

4.2 India

As a Federal state, India faces a number of difficulties when applying policy and implementing risk management strategies. For example, water management is devolved to the state level but there is little cooperation on how the resource is extracted between the different states, even those that may be neighbouring or upstream. This is also the case for disaster risk management as each state leads on its implementation. Decision making can also be hampered by 'siloed thinking' on climate change despite calls from NGOs to develop an integrated approach to finding solutions. However, NGOs are often seen as 'troublemakers' and so their advice may not always be welcomed. Small medium enterprises are often the ones who maximise pushback on the science because they pay more taxes.

There has been significant investment in building scientific capacity at the national level in supporting climate change decision-making but this has not always translated to the state level. Gujarat is better resourced than other states to provide climate data and risk management approaches to support policy, as it has a Department of Climate Change in the State Government. This could be a result of the state being prone to a range of disasters and people there being much more aware of such extreme weather events as a consequence. However, despite advances in climate science, urban areas and infrastructure remain vulnerable to environmental hazards such as flooding, in part because planning in other areas such as health have not kept pace.

There is still a recognition that more can be done scientifically to support decision making around climate change; for example, there is a need for better integration of climate models with dynamic impact models which incorporate hydrological factors. Better modelling is seen to produce better risk assessments which in turn raises awareness. In Gujarat there are also problems with historical legacy and how to implement new systems that reflect the new challenge of climate change.

The concept of climate change is still felt to be problematic in terms of how it is understood and how it is received. Whilst specific examples were not given by the interviewees, some suggested that it is best to avoid referring to climate change but rather, to talk in terms of economic gain and/or loss. Some did not see the relevance in attributing weather events to climate change as any emergency would still have to be dealt with regardless of its cause. This did not mean research into climate change should stop but more care should be taken with the decision-making aspect of it. Others said that it was acceptable to talk about climate change or to refer to it as climate variation. Finally, climate change is frequently conflated with other environmental issues such as deforestation, which is often the case when state governments are trying to access national and international funding.

Economically, energy is a significant sector in India as heavy investment has been directed to non-fossil fuel sources including solar and wind. The country has set an emissions reduction target of at least 33% by 2030 from 2005 levels. Closely aligned to the energy sector is the water sector as 70% of water is pumped and therefore needs energy. The agriculture sector is also key as it is responsible for about 18% of national GHG emissions, and provides a livelihood for nearly two-thirds of the population, many of them small farmers. Most of them lack a formal education which makes communication about climate change and the risks problematic.

Education, both in terms of school and professional training, and public awareness raising are seen as key strategies for dealing with climate change and the impacts of extreme weather events. The

mass media have been used effectively to disseminate understanding about heatwaves, whilst formal university education programmes are being developed specifically to look at climate change impacts. Online learning is seen as having a huge potential to support professionals in understanding climate change as it provides opportunities for the individual to work, earn and learn.

4.2.1 Usefulness of EEA

The perceived usefulness of EEA was strongly related to the sector in which interviewees were working. For example, those working for the national government or for international NGOs consistently stated they thought the analysis was important to do – although it might not yet be useful for decision-making. Those working at the state level or in contact with local populations had concerns that it would not be understood or would be of little use as it dealt with the past. One interviewee emphasized this point by using the example of an old man dying of a cough or sneeze: 'it didn't matter what caused it – the man was still dead'. There was an emphasis on the need to do more studies and to educate policy-makers before using findings to inform future decisions. The representative from the National Disaster Mitigation Authority noted that they reviewed five year seasonal trends and a series of EEA studies over time could be used to identify trends in causes and thus inform future predictions.

[i] To identify potential trends

- "It is good to carry on with these studies and once we have a critical number or mass of them, then people will start taking note of them. But single event attribution will not make much difference because you are not sure about anything. The next event the causes may be totally different, and then you may be the other way around."

[ii] To inform adaptation decisions

- "It is useful in two possible ways: one is if it can provide an idea of the change in probability of an occurrence of an event... that is very useful. The other is if there is no climate change footprint available, that is useful because policy makers can say 'ok we don't really need to change what we are doing to take climate into account'."

- "If a study can show that instead of getting that intensity of a heatwave once in ten years it will come once in three years, that allows policy makers to invest more money in adapting to heatwaves."

[iii] To influence the national mitigation agenda

- "It is largely about influencing policy action so the greatest climate change challenge in India is the expected impact on the monsoon; so using extreme events to find a signature that climate change influences the monsoon creates a higher priority for climate mitigation action than there currently is."

4.2.2. Potential usefulness of EEA

Most interviewees identified the potential usefulness of EEA to inform policy-decisions once a larger number of studies had been carried out. Their comments were largely consistent with their perceived current usefulness of EEA:

[i] To identify future trends & incentivise action:

- "We think there are multiple levels at which this information would be useful. For example, trying to educate policy makers that anthropocentric climate change is already impacting our weather. Second, for them to understand that this is therefore something that is likely to continue and increase in intensity or frequency in the future and hopefully worry about; and that could set off a disaster preparedness response or infrastructure response."

- "If a critical mass of studies is there and the findings are supported by the national weather agencies and effective agencies then the policy makers will naturally take note of it and initiate mitigation and adaptation measures. The studies help to educate the national weather agencies and the establishments also."

- "As the impact of climate change on extreme events rises, there will be a greater ability to forecast or predict these extreme events. This is extremely useful because it tells us where resources are to be invested.'

[ii] To inform negotiations on loss & damage

"…there is a third level that people don't think about and that is informing the negotiations on loss and damage. This is connected to the UNFCCC decisions around how loss and damage are handled. Scientists could do one part of it which is to attribute anthropogenic forces to these damaging events. At the current time this is an elephant in the room but requires policy makers to understand what it is possible to do with detection and attribution."

4.2.3 Limitations of EEA

All interviewees identified significant limitations of EEA for decision-making. These ranged from concerns regarding mixed messages and a lack of understanding, to uncertainty in the models and data gaps. Some interviewees identified the need to 'take the findings to the gym' to strengthen and streamline them. Others emphasized that the rural poor have a fatalistic attitude in which disasters are 'the will of God', so and information about changing risks would thus be unlikely to change their decision-making. In addition, interviewees emphasised many disasters were influenced much more by poor management or development than by the climate.

[i] Lack of education

- "At the moment I'm not sure the policy community fully understands what EEA means. Educating needs to happen in terms of letting them know the full implications and what they can do with the information."

- "For example with the studies we did, when we had two different results, that in itself was enough to raise eyebrows."

- ""It is extremely difficult to generalize policy makers in India or in any country because they come at all levels of government and all levels of sophistication in their knowledge base as well their ability to understand these studies. In the larger countries – both developed and developing – at the national level there should be no problem in understanding this but I am not so sure at the local level."

- "A lot of the policies that we are talking about changing are not at the national level policies; they are policies to be changed or introduced by the municipalities, the city corporation or the states or provincial governments so the level of knowledge at that level is often not as good as at the national level. So there is definitely a need there to have all of the caveats and limitations of these studies clearly spelled out and explained."

[ii] Limits of the methodology:

- "The scientific part of the limitations is contingent on whether we use a particular model or some other climate modelling framework. At the moment, it appears that some of these attribution statements are sensitive to that."

- "There is also some sensitivity to the observational record used. For example, if I use different data, does the attribution method still hold up? As a scientist, I am perfectly willing to accept these types of uncertainties. However, when we as scientists take this information and attempt to prepare a fact sheet for policy makers, do we brush these uncertainties under the rug? Do we highlight them? How do we explain them?"

- "The limitations with extreme events is as always the uncertainty of the timing, location and magnitude of these rare events. There will always be uncertainty regarding these. And so you can say that the frequency of these will increase as the greenhouse gases increase, but the limitations will be about specifically about when it is needed, where it is needed and how much is needed."

- ""One of the main limitations is data reliability and quite often that's my impression from the studies I have seen. There were lots of gaps in the data and lots of missing data and a result was that we couldn't draw any conclusions."

[iii] Using the past to predict the future:

- "Once an event has taken place and you attribute the causes that have contributed to it, the government won't take note of it. It is only going to make an impact if you can tell them in advance – like the IPCC has said that the variables are going to increase in scenarios of RCP <Representative Concentration Pathways[1]> there they will take note of it and prepare…One possible risk of an attribution study is that it is looking at one extreme event to identify the causes and if policy makers extrapolate the findings to other events that may or may not be correct."

- "So – while this might help with specific events, can it help with general statements about trends in the future? I see that as the big limitation. If people look at specific events with yes or no that is fine; but when you are dealing with multiple events and looking for trends a certain understanding is needed."

[1] Possible greenhouse gas trajectories used by the IPCC to model future climate change under a range of economic and social scenarios, with an increasing amount of greenhouse gases being emitted under each of the different pathways.

- “A single study is not going to be of any use. What we require are statistically significant findings. Studies should be done using extreme event attribution and we should get insight into what are the causes and what are the causal factors but to put them and expect them to be used by the policy makers is too ambitious.”

4.3 Kenya

The fluctuating pattern of extreme changes in rainfall leading to floods and drought are conditions that Kenya has long been experiencing. Often, the weather patterns are influenced by El Niño events that can increase their severity or their unpredictability. As a result, Kenya has developed early warning systems to help manage the impacts of such extreme weather events. In addition, concerted attempts are being made to better coordinate solutions and responses to disaster risk management.

Decision making is conducted at both the national level and at the level of the 47 counties in the country. Communication between the national and county levels can often be problematic as information either takes a protracted time to reach its audience, or it can get blocked or delayed. The large number of private external organisations in the country often adds to this bureaucracy.

Economically, the key sectors are agriculture, health, water, education with agriculture possibly being the most important as it forms the basis of the country's economy. However, agriculture is a high-risk sector both because it is vulnerable to extreme weather impacts and because the majority of farmers operate on a small scale. Pastoral farming is particularly vulnerable economically as it can take many years to recover stock that might have been lost.

The extremes in fluctuating water levels caused by frequent floods and droughts make water management a serious challenge. The resulting impacts extend to other problems such as floods destroying infrastructure, high temperatures buckling roads, storms blowing down power lines, or flooding leading to siltation of dams. The impacts are compounded by poorly constructed or maintained infrastructure.

In addition to the economic impacts, the interviewees noted a number of direct and indirect social implications associated with extreme weather events. Direct impacts include malnutrition through crop failure, dehydration, and forced migration. Extreme weather events can lead indirectly to increased crime and terrorism following power failures, schools closing and an increase in violent attacks.

Decision makers in Kenya already have access to a reasonably sophisticated level of modelling data such as seasonal forecasts, climate data, crop modelling, and crop yield indices. However, the sources for this are often external, making the need to develop domestic capacity a priority.

4.3.1 Usefulness of EEA

Overall, the perceptions of the role of EEA were positive, particularly for the agriculture and water management sectors. Continuing to work with the Kenya Meteorological Department [KMD] will build scientific capacity within the country making attribution statements more relevant to the stakeholders, and particularly farmers. The science could also be used to support the development of a more integrated approach to disaster risk management, so that different parties can be brought together to replace the current siloed and top down approach. Credible science, such as that provided by EEA, is a valuable communication tool and could add greater robustness to policy decisions. This robustness could also be enhanced through the development of a more nuanced spatial and temporal distribution of, for example, rainfall allowing more focused planning. The following statements reinforce these points:

[i] Informing a drought early warning system

- “Now all the information on extreme weather events is very key in extreme climate change issues, because what we are most interested is in the <agriculture> sector getting the early warning systems. Then after getting that warning system, the ministry is charged with developing advisories for the consumers, for the farmers and the other consumers “
- “In most cases, what happens is the response, you are responding to the event once it happened.”

[ii] Communicating climate change as an immediate threat

- “We need the linkage, we seriously need the linkage, we need to change that, it's very important because we have to explain to everybody that this is happening because of climate change.”
- “Yes. Because actually it's the climate change, which is a new thing, it's not the other things, the knowledge that drought will happen at one time or another and so anything that they will be told to do or when they are given information on drought, whether it's brought about by climate change or by whatever other causes, it is very important.”

[iii] Provide credibility to decisions

- “It provides confidence on the information brief when other institutions <e.g. world weather attribution> are involved.”

In response to the EEA statement not linking the event to a climate signal:

- “I think of course that's going to be contrary to what you have been saying. That will be contrary but the truth, you see in science, you follow the truth, but that's contrary to what we know at the moment. It's contrary to what we know as even the practitioners, but even that's the truth, then I think we can follow the truth but I don't know. Definitely somehow there'll be some confusion.”
- “Thank you very much, we really value the contribution of science to our work because that's the only way that you can influence policy and that's the only that you can be sure that you are communicating is the right information and you also maintain your credibility. Credibility is very important and you can only maintain credibility by having informed decisions and that informed decision comes from science.”

4.3.2 Potential usefulness of EEA

The interviewees provided more ideas with regards to potential uses rather than what they saw as current uses of the EEA science. This could have been as a result of their opportunity to discuss the science in the workshop and the interviews; however, the insights that they offered were consistent with the perceptions of the current uses.

[i] Building knowledge capacity at national and local level:

- “They <the farmers> really appreciate the radio information, the information that is sent through their phones, but in most cases, according to them, it's not exact… If you take for

example, that El Niño time, some people in some areas, they were told there was going to be El Niño and they experienced it, but in another big area they were told there would be El Niño, they never saw it."

- "So what I'm looking for is something that comes from wherever it comes and it is able to reach the farmer the way it is and the farmer being given the information that is right for their area."

[ii] Developing preparedness to disaster risk management:

- "The plans need to be refined more because I find what is developed for the sector is more or less things that happen on the day to day. There's really no specifics … the exact things that need to be done."
- "That is what we found, the preparedness part of it is missing."
- "Contingency plans, which I'm saying even at this level, the decision-making level, they are not as good as they ought to be"
- "We get the forecasts for the season first, I think which is very important for us. Getting the seasonal forecasts is very important for us and then mid-way we also get the monthly forecasts."

[iii] Support the development of good communications:

- "I think we need to look at channels that will make it move as fast as possible… we all work together."

[iv] Need for a coordinated approach to decision making:

- "We sort of sit everyone down and create these scenarios that if someone is saying this, this is the switch for this ministry if this is happening so that we are all in sync. We know if this is happening, this is what all the ministries should be doing."
- "It is a must, not recognizing the roles of the players is not an option, it is a must."
- "Because, for example, you, at your level, you are not supposed to go and deal with the farmers directly or the person that is the transport person directly, but the idea of getting all that together so that this information comes together to all the departments and the advisories all go down at the same time and given our condition."
- "I think that's very important what you're saying because it shouldn't target just the government. There are many players out there. I know there are those traditional players in climate risk management, but the others, very many others interested and doing a lot of other things in their own small way, but we all contribute towards the same goal."
- "We sort of sit everyone down and create these scenarios … We know if this is happening, this is what all the ministries should be doing."

- “At this level you could even give general <information> because at the national level you give very general advisories and each county goes and develops theirs. Sometimes when whatever comes out ‘down there’ <i.e. county level> may not be even having any relationship with what you said.”

- “It's going to be extremely bad. We want to act early, all of us collectively.”

[v] Support in developing finance schemes:

- “Agricultural insurance is a real challenge. Currently the ministry's doing two programs, I think, on climate insurance, one on crops, the other one on livestock.”

- “So the challenge of getting a specific area yield data for a period of time is a real challenge, so I believe the reason we went for maize and wheat is because those are the crops whose information is easier to get than the other crops. B but how about most commercial farmers are not maize and wheat farmers in Kenya, they are farmers growing horticulture, farmers growing other crops and now those ones are not being addressed by the insurance.”

[vi] Need to develop spatially and temporally relevant information:

- “So what I'm looking for is something that … is able to reach the farmer the way it is and the farmer being given the information that is right for their area.”

- “As a county, fine, but within that same county there is say very variant ecological locations.”

- “I think because of what the patterns say, they are going to be very important to us but while we know, if there'll be changes in precipitation, are there shifts in the temporal rainfall? Will it come earlier or is it going to come late? Is it going to be a lot of rain one day? A lot of rain two days? Or is it going to be distributed ... How will be the partial and temporal distribution because sometimes you can get a lot of rain. All that rain could be one day or it could be one location. We'll be interested to know if it's going to be increase of rain for example, if the precipitation is going to increase. Is it going to be uniform? Is it going to be in a particular region within a country or within Africa or is it going to be distributed equally? The issue of temporal distribution, if we can predict that then I think that will help us.”

- “Yes. Even as we look at the short-term issues, our focus is long-term because if you are to really deal with issues, the main focus is the long-term but we must also address the short term. As we address the long-term, we also address the short term. The reason why we take the monthly seasonal is because that has a very immediate direct impact. For the long-term focus and modelling issues, we're looking at the future. How will the future look like? Are we likely for example to change our cropping patterns? … What about the temperatures? Is it also the same?”

4.3.3 Limitations of EEA

Whilst EEA science is generally held in high regard, the interviewees did raise a number of points about its limitations. Analysis of extreme events need to be developed further to link events with impacts and, if possible, provide an economic value. EEA statements also need to provide as

complete a picture as possible to support a range of decisions. This could be partly achieved by further discussions with stakeholders to understand what the science will be used for, and how. The following quotes from the interviews and workshop reinforce these points:

[i] 'Incomplete' scientific outputs may not meet policy needs:

- "I want to look at it from a different perspective. I think okay, this is very interesting from a scientist … but from a political perspective it may not be the most important thing we should do. They probably would want to attribute everything to climate change, but what is it attributing to, and probably what we should be working on beyond looking at whether it's attributing to climate change. What are the drivers of these extreme events and how predictable are they in the future? What is their likelihood and time period? That is the kind of information that would give us something for the policy makers because we want information that they can act on, because if you tell them it's not attributable to climate change, then what next?"

- "We look this way, like we are concerned about climate change. We need to see the levels like greenhouse gases. We need to know what are their attributing factors, the number of industries, is this the type of fuel we are using?"

[ii] Need to be able to link events with impacts:

- "We need the climate forecasts, but we need the climate forecasts that actually involve also sectors like agriculture. Sectors that are affected, so they also provide information on how the sectors are likely to impact them and the recommendation is short messages and recommendations to various sectors and communities."

[iii] Lack of belief in EEA science:

- "It's very difficult to attribute the drought to climate change. You see a layman will say because of the issue of climate change has being in our agenda for quite some time and there's the tendency for us to attribute everything to climate change, but it's important. It's definitely for decision making purposes it is important to know to what extent this particular drought attributed, not entirely probably, what proportion of this, within a drought, what proportion of it is as a result of climate change or is it the entirely attributable to climate change? That information so far, as far as I know, we don't know. We can't be sure."

[iii] Channels of communication prevent the EEA science reaching grass roots:

- "Because the departments and the ministries all have their roles, but there are also those other channels that are able to reach farmers directly. I think those are the channels really that need to be used much more often when you can be able to tell the farmer, "This is going to be like this, this is what you need to do in this area."

- "When it has to go through the stages, of course, in most cases it reaches farmers late."

[iv] Poorly constructed EEA outputs:

In response to a critique of the EEA statement, the following comments were raised:

- “The average Kenyan policy-maker/reader wouldn’t have finished reading this document!!”
- “The graph is too scientific, not essential to policy makers”
- “Basically short messages to make sure that the information is also not very bulky”

5 Conclusions

The study was designed to gain a better understanding of the needs of decision makers in East Africa and India with regards to using extreme event attribution science. The overall conclusion is that the interviewees generally did see a positive role for the science across the three countries, but that the role is very much dependent on the stakeholder and the context of the decision being made. This finding is very much in line with previous studies on stakeholder needs for EEA science, as outlined in Section 2.

The different country contexts clearly affect the extent and manner in which EEA is received, used and applied. Our experience was that there was greater scepticism shown in India regarding the science and its role, whereas interviewees in Kenya and Ethiopia were more accepting and positive as to its application. The agriculture sector is clearly a potential beneficiary in all three countries. However, whilst in Kenya and Ethiopia the countries' economies are largely reliant on this sector, India's rapidly increasing and diversifying industrialised economy means that it is less vulnerable economically at the national level to extreme events such as drought and flooding. However, across the country, India is prone to experience a greater range of extreme weather events. Finance was seen as important in East Africa but less so in India; Ethiopia has been heavily reliant in recent years on foreign aid to boost their economy, and Kenya makes extensive use of insurance as a mechanism to protect their agricultural economy.

The extent to which decision making is devolved will also impact how the science is used across the region. In East Africa decision making is largely centralised making coordination easier, although problems persist about getting the information down to the local level. India, as a federal country, has devolved much of the planning around resource management and disaster planning to the state level making coordination between states highly problematic. This, therefore, provides a different challenge, particularly when implementing the crucial aspect of communicating EEA effectively. Although the focus of this report was not on communication, several interviewees stressed the importance of good communication in supporting good practice and ensuring a greater uptake and application of EEA in the decision-making process. The report by Budimir and Brown (2017) provides clear guidance on the complexity of how best to communicate the science to different users in India and Kenya, but this will need to be supplemented by research on how best to overcome bureaucratic barriers.

When asked to consider the EEA statements, interviewees in all three countries found a number of limitations, although these were not universal. Primarily the science was currently seen as 'lacking' in a number of areas: relevance to decision makers [Ethiopia and Kenya]; lacking details of impacts [Kenya]; as a forecasting tool [India and Ethiopia]; translation into non-technical language [all three countries]. Possibly due to the strength of the research in India, interviewees noted concerns around the attribution modelling process and how valid the outputs could be for a decision maker.

As has been seen from the literature review, saliency, legitimacy and credibility are critical aspects of climate information if it is to meet users' needs. Interviewees in all three countries saw that the EEA science had credibility although concerns were raised when an EEA statement may not show any climate signal as this would run counter to the general message about the importance of climate change and its impacts. In addition, interviewees saw that the EEA statements had saliency,

although this was less present in India, and particularly in the research institutes. Legitimacy was the weakest aspect of the EEA statements with concerns raised in East Africa about the technical/scientific language, complexity of the graphical information and sometimes conflicting information. Consideration of the limitations and potential uses of EEA noted in chapter 4 would increase saliency, legitimacy and credibility, particularly regarding the integration of EEA into dynamic models as suggested in India, or by presenting the science in conjunction with other information from other agencies such as NGOs.

The conclusions drawn from this study provide useful insights into the role that EEA can play in supporting decision making in the region, but care must be taken when using the results. The interviews only covered a limited number of sectors and a limited number of people within each sector. For instance, in India, applying understanding of how decision makers in Gujarat would use EEA may not be applicable to other states given the different hazards they are vulnerable to, and their different economic profile, populations, and state government structures. Further studies are required involving more decision makers across a broader range of sectors in order to more fully understand stakeholders' needs in the region. For East Africa, better understanding the needs of the agriculture sector will be critical for economic and societal security, along with further understanding of how the different financial mechanisms in Ethiopia and Kenya can benefit. Greater understanding is also required of how to structure scientific outputs to meet a range of needs and technical understanding, and when necessary, how to communicate results that show no climate change signal.

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Acronyms

AR5 IPCC	The Fifth Assessment Report, Intergovernmental Panel on Climate Change
ATA	Agricultural Transformation Agency
CRGE	Climate Resilient Green Economy
DRR	Disaster Risk Reduction
EEA	Extreme Event Attribution
EUCLEIA	EUropean CLimate and weather Events: Interpretation and Attribution
GCF	Green Climate Fund
KMD	Kenya Meteorological Department
NDMA	National Disaster Management Authority
NDRMC	National Disaster Risk Management Commission
NMA	National Meteorological Agency
PEA	Probabilistic Event Attribution
UKCP09	UK Climate Projections 2009
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	The United Nations Children's Fund
WMO	World Meteorological Organization

Appendix 1 Interviewees

Ethiopia

1. Mulugeta Ayalew, Advisor to the prime minister on climate change, director of climate change affairs.

Main function/areas of work: Assists prime minister in his national and international engagements on climate change.

2. Wagayehu Bekele, Director, Climate Change Adaptation and Mitigation, Agricultural Transformation Agency (ATA)

Main function/areas of work: Coordination of mainstreaming environment and climate concerns into the transformation agenda in all relevant ministries, and particularly the Ministry of Agriculture.

3. Ato Mohammed Deda, Head, Disaster Preparedness and Response Department, Ethiopian Red Cross

Main function/areas of work: Disaster relief reduction and disaster response.

4. Debause Bayleyegn Eyasu, Director General, Climate Change Implementation, Ministry of Environment, Forest and Climate Change (MEFCC)

Main function/areas of work: Coordinating the activities of other ministries in operational issues around climate change implementation

5. Yonas Gebru, Executive Director, Forum for Environment (NGO)

Main function/areas of work: Advocacy and communication, often in collaboration with government offices, at national and local level.

6. Zerihun Getu, CRGE Facility Coordinator, Ministry of Finance and Economic Cooperation (MOFEC)

Main function/areas of work: Mobilising resources for different sectors (forest, transport, agriculture) from foreign donors

7. Grimaw Gezanegu, senior project officer, Agricultural Transformation Agency (ATA)

Main function/areas of work: Improving NMA infrastructure, coordination with local farmers, training in forecast interpretation, communication

8. Tesfaye Hailu, Project Manager CDKN

Main function/areas of work: helping government bodies to apply to funding agencies or bodies like the Green Climate Fund.

9. Ben Irwin, Programme Manager, PRIME, CARE Ethiopia

Main function/areas of work: Introducing better systems of land management, and improving climate information for targeted communities.

10. Bedassa Regassa, meteorologist and technician, ATA, seconded to Ministry of Agriculture

Main function/areas of work: Supplying agricultural and climate information across the ministry and other agencies, and at the local level.

11. Beletu Tefera Tegegne, senior expert, National Disaster Risk Management Commission (NADRMC)

Main function/areas of work: early warning activities, including monitoring the analysis and prediction of impending disasters

12. Mulugeta Worku, senior project manager, Christian Aid (part of BRACED project)

Main function/areas of work: Building resilience and adaptation to climate extremes and disasters

India – Delhi

1. Ajit Tyagi, President, Indian Meteorological Society
2. Saurabh Bhardwaj, Fellow, Center for Global Environment Research, Earth Science and Climate Change Division The Energy and Resources Institute
3. Neha Bharti, Research Associate, Center for Global Environment Research The Energy and Resources Institute
4. Suruchi Bhadwal, Senior Fellow and Mentor, Center for Global Environment Research The Energy and Resources Institute
5. Joydeep Gupta, South Asia Director, The Third Pole
6. Kamal Kishore, Member, National Disaster Management Authority
7. Dr. K. J. Ramesh, Adviser & Scientist, Ministry of Earth Sciences
8. Dr. Akhilesh Gupta, Adviser and Coordinator, Climate Change Prog., Department of Science and Technology
9. Deepak Singh, Senior Disaster Risk Management, World Bank
   Anup Karanth, Senior Disaster Risk Management, World Bank
10. Surya Parkash, Head of knowledge management and communication Division, National Institute of Disaster Management, Ministry of Home Affairs, Govt of India
11. L.K. Sharma, freelance Journalist
12. Srinivas Krishnaswamy, CEO, Vasudha Foundation
13. Divya Sharma, Senior Consultant Urban Policy, Oxford Policy Management
14. Elizabeth Gogoi, Consultant, Oxford Policy Management
    Rishika Das Roy, Consultant Urban Policy, Oxford Policy Management

India – Ahmedabad

1. Amit Garg, Professor, Indian Institute of Management
2. Vishal Pathak, Senior Coordinator, All India Disaster Mitigation Institute
   Vandana Chauhan, Senior Coordinator, All India Disaster Mitigation Institute

3. S N Dave, WASH Specialist, UNICEF
4. Shwetal Shah, Technical Advisor, Climate Change Department, Government of Gujarat
5. Mukesh Shah, Joint Secretary, Climate Change Department, Government of Gujarat
6. Dileep Mavalankar, Director, Indian Institute of Public Health Gandhinagar
7. Megha Bhatt, Founder, SciTech Academics
8. G.K. Bhat, Chairman, TARU
9. P K Taneja, Director, Gujarat Institute of Disaster Management

Kenya

Workshop participants:

1. Emmah Mwangi, Kenya Meteorological Department
2. Mary kilavi, Kenya Meteorological Department
3. Geoffrey Ogutu, Kenya Meteorological Department
4. Joseph Mutisya, Kenya Meteorological Department
5. Benedict Aloo, Kenya Forest Service
6. Eugen Mnyamwezi, Ministry of Water and Irrigation
7. Simon Mwangangi, Kenya Power
8. David Murage, Kenya Power

Interviewees:

9. Veronica Ndetu, Ministry of Agriculture
10. Martin Eshiwani, Ministry of Transport
11. Sunya Orre, National Drought Management Authority

Appendix 2 Semi-structured interview questions

1. Understanding the role of the interviewees and the likely landscape they make decisions in:

1.1. Can you briefly describe your job and the broad range of your responsibilities?

Opportunity to identify the nature and the context of their decision-making duties. E.g. is it focused on a sector, a region, an industry.

1.2 How does your role fit into a broader organisation decision-making structure?

To understand to what degree the decision making is conducted in and how much autonomy they have. If they have to synthesise their reports with other data from other people, then this could impact on the nature of the information they receive so they can embed the data more easily. It will also start to identify what institutional barriers might exist.

1.3 What sort of time scales do you work with?

If policy is made on an annual basis they will need a different source of climate data than if they are making decisions based on decadal or multi-decadal. This is apparent when comparing agriculture departments with infrastructure ones.

1.4 What data or resources do you use when making policy decisions?

This will begin to identify what data sources they use in addition to any climate-related information. It will be interesting to find out if there are certain sources they are expected to use or avoid as a way of understanding what/who are considered legitimate sources. For example, policy makers in North Carolina can only use linear sea level rise projections even though sea levels are rising in a linear way, because of the Republican Senator's belief on climate change.

2. How climate change data is factored into their work:

2.1 In what ways does the weather play a role in your policy making?

This is a gentle way to start talking about the weather and to what extent they already consider it as part of their decision-making. For agriculture, it will be fairly obvious but for other departments such as infrastructure it might not be so obvious to them.

2.2 What weather information do you use and where do you get it from?

It will be necessary to try to get them to determine what sort of information they use [e.g. raw data, daily weather reports, seasonal forecasts, historical trends] and where do they get it from. Why do they use this source? If other providers could supply this information would they use it? An understanding of this will help establish issues around credibility. Also, can this be linked back to the earlier question about time horizons for planning, and does the weather data tie up with the planning horizons?

2.3 What have you found to be the limitations or barriers to using this weather information?

This will help us understand if there are issues around the information they are already using such as too technical, not technical enough, too much uncertainty, too expensive, too unreliable, takes too long to read etc.

3. Focus on extreme weather and more specifically EEA

3.1 Do you already plan for extreme weather events? If so, what events do you plan for and what information sources do you use?

As with the weather data we can to understand whether they are already considering extreme weather and how it fits into the policy making.

3.2 Would knowing the changing size of the event or whether it was becoming more/less frequent be useful? How?

We can begin to explore the potential role of event attribution without going into detail about the science. If they are not interested in these aspects, then EEA won't be of value regardless of its validity.

3.3. Would being able to link an extreme event to climate change be useful? How or why not?

Introduction of case study to the interviewee as an example of what is being done. If appropriate, key areas to discuss are:

- Temporal and spatial relevance
- Uncertainty
- Speed of analysis
- Ways they could complement this data with others

Additional Follow-up questions in India

- What (if any) is the current usefulness of extreme event attribution from a policy maker's perspective?
- What potential usefulness could it have for policy makers?
- What do you think are the limitations of EEA like the one attached?

Appendix 3 EEA Statements

Ethiopia

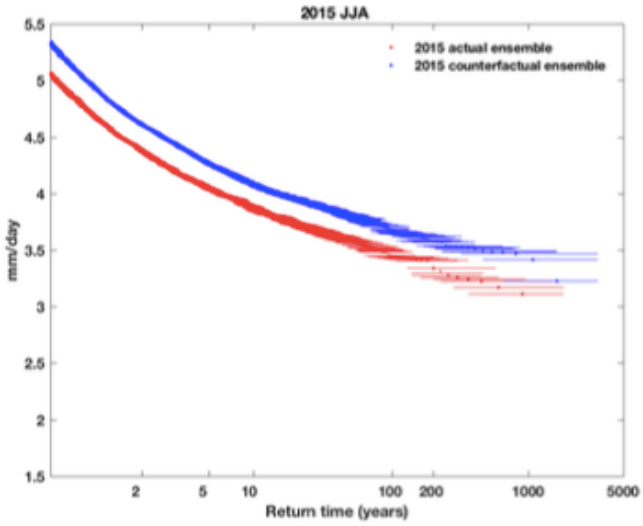
What happened to the rains in 2015–16?

A drought crisis in Ethiopia, triggered by erratic and severely depressed rainfall in early 2015, has affected 9.7 million Ethiopians. The Government of Ethiopia (GoE) and international humanitarian community have mobilised to meet emergency needs, including water, sanitation and hygiene (WASH), food and nutrition. This has taken place through a $1.62 billion appeal, which has only been partially met to date (2016 Ethiopia HRD). In response to the current drought, the GoE has allocated more than $700 million of its own resources mainly to address needs not included in the appeal, including by reprogramming infrastructure programmes (UNOCHA).

On 4 June 2015, Ethiopia's National Meteorological Agency (NMA) declared that the spring belg rains had failed. Soon after, the kiremt rains were severely delayed and erratic. From February through September 2015 the north, central and eastern parts of the country received only 50 to 75% of the rainfall normally expected over this time period. However, this departure from 'normal' only tells part of the story.

Using a scientific computing method, it was possible to study whether, and to what extent, human climate change led to this event occurring and what the chances are for this type of event to become either more frequent or more intense.

Climate scientists from the University of Oxford, UK using a new and innovative approach to climate science called probabilistic event attribution (PEA) found that the drought in 2015 was made more likely as a result of climate change. The technique uses computer models to compare today's climate [actual ensemble] with a climate that has no human caused climate change [counterfactual ensemble], and if there is a shift in the lines we can begin to infer that climate change influenced this type of event. The figure below shows the return time plot for the summer rainfall in 2015 that was associated with the drought showing an effect due to anthropogenic climate change increasing the risk of extremely dry seasons. What is a 1 in 100-year event in the world we live in in JJA [blue line], would have been an extremely rare event in the world that might have been [red line] with a return period of a thousand years (Sjoukje et al. in press).



NB This statement is for reference only and should not be used outside of the interviews.

Unpacking data on Kenyan drought

Climate scientists from multi international agencies, on 23 March 2017, released a detailed study of the Kenyan drought, whose main message is: prepare for more.

The scientists shared their findings at the conclusion of a three-day conference in Nairobi that brought together representatives from the government, private sector, Red Cross Red Crescent Movement and other humanitarian agencies.

The study says there's a detectable 'climate signal' – a measure of the influence of human-induced climate change – in the atmospheric temperatures behind the drought. Data indicates they were "higher than they would have been without the influence of climate change," according to a summary of the scientific findings made available online.

The summary cites a January 2017 FEWSNET report noting recent "hotter than normal temperature accelerated forage and water depletion across most of the pastoral and marginal agricultural areas."

The team, however, found no strong influence of climate change on rainfall in Kenya – regarded as the main determinant of surface water – but say they cannot exclude small changes in the risk of poor rains linked to climate change.

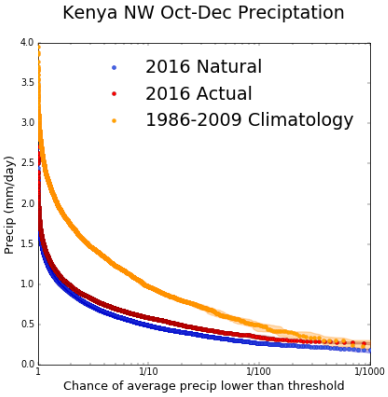
The scientists are part of the global World Weather Attribution (WWA) programme that assesses whether extreme climate-related events are more likely now than they would be in a world without climate change.

The WWA group, which for the Kenya study included, the Kenya Meteorological Department (KMD), the Red Cross Red Crescent Climate Centre and the Princeton-based Climate Central group, who are convenors of the WWA programme, as well as specialists from Melbourne and Oxford Universities and the Royal Netherlands Meteorological Institute.

The Nairobi conference wrapped up a year-long branch of the programme that also included the UK-based Climate and Development Knowledge Network, concentrating on several developing countries affected by climate-related disasters that may be intensified by human influence.

As Kenyans wait anxiously for the next rainy season, in scientific if not humanitarian terms, the drought that began in 2016 is not yet as exceptional as the 2011 disaster in the Horn of Africa, whose 'return interval' the attribution scientists assessed at 1 in 50–60 years.

"This finding underscores the use of climate information for early warning, early action initiatives to mitigate such disasters," said Dr Abbas Gullet, Secretary General, KRCS. With the frequency of such disasters, it is time that we explore the link between climate and disasters and take timely action," he added.


Kenya NW Oct-Dec Preciptation
2016 Natural
2016 Actual
1986-2009 Climatology
Precip (mm/day)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
1/10
1/100
1/1000
Chance of average precip lower than threshold

Unpacking causes of India's heatwaves

Climate scientists from multi international agencies studying the Indian Heatwave in 2015 have released their findings – which can be summarized as 'Prepare for more'.

The scientists shared their findings at a press conference together with representatives from the government, private sector, Red Cross Red Crescent Movement and other humanitarian agencies.

In May and early June 2015, Andhra Pradesh and the neighbouring Telangan region were affected by a heat wave that lasted from around 19 May to 3 June. The heat related number of causalities were reported to be >2000 (Ratnam et al., 2016).

The Indian government has been proactive in trying to identify the role increasing greenhouse gases are playing in changing the likelihood of such disasters. By identifying the role it plays in current events, they will be better prepared for the future.

The study found there's a detectable 'climate signal' – a measure of the influence of human-induced climate change – in the atmospheric temperatures behind the heatwave. Data indicates they were "higher than they would have been without the influence of greenhouse gases," according to a summary of the scientific findings made available online.

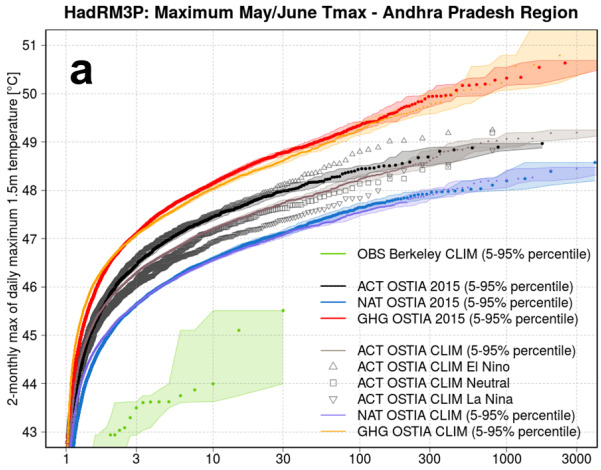
The study also explored how air pollution from aerosols and the El Nino cycle influenced the heatwave. They found that the aerosols reduced the odds of the event occurring while the El Nino event in 2015 slightly increased the odds of the event occurring.

The scientists are part of the global World Weather Attribution (WWA) programme that assesses whether extreme climate-related events are more likely now than they would be in a world without climate change.

The WWA group, which for the India study included, the India Meteorological Department (IMD), the Red Cross Red Crescent Climate Centre and as well as specialists from Melbourne and Oxford Universities.

The press conference wrapped up a year-long branch of the programme that concentrated on improving information for several developing countries affected by climate-related disasters that may be intensified by human influence.

"This finding underscores the use of climate information for early warning, and early action initiatives to mitigate such disasters," said a spokesperson from the Indian Government. With the frequency of such disasters, it is time that we explore the link between climate and disasters and take timely action," he added.


HadRM3P: Maximum May/June Tmax - Andhra Pradesh Region
a
2-monthly max of daily maximum 1.5m temperature [°C]
51
50
49
48
47
46
45
44
43
1
3
10
30
100
300
1000
3000
OBS Berkeley CLIM (5-95% percentile)
ACT OSTIA 2015 (5-95% percentile)
NAT OSTIA 2015 (5-95% percentile)
GHG OSTIA 2015 (5-95% percentile)
ACT OSTIA CLIM (5-95% percentile)
ACT OSTIA CLIM El Nino
ACT OSTIA CLIM Neutral
ACT OSTIA CLIM La Nina
NAT OSTIA CLIM (5-95% percentile)
GHG OSTIA CLIM (5-95% percentile)

Appendix 4 Other sources for data

Ethiopia

The interviewees gave a wide variety of sources they relied on for weather and climate:

Here is a sample:

- "NMA (rainfall and temperature), satellite data, crop data, soil moisture." (#7, #4)
- "The NAPA; the Central Statistics Agency, the Disaster Risk Management data, the World Food Programme, UNDP climate change, country profiles, the OHR hotspots identification, the IPCC reports." (#1)
- "Various sort of weather information groups like Fews.net, a US funded information network, on all sort of agricultural and climate information." (#9)
- "NMA and UK Met Office are helping us with better weather forecasting and prediction". (#12)

Kenya

Information source	**Type of information**
1. Met [KMD]	Weather patterns
2. Internet	Food security issues Infrastructure like roads
3. Electronic media	Weather focus Interviews [e.g. with climate scientists]
4. Print media	Weather patterns Market prices of livestock and food products
5. Visual/personal observations	Soil erosion Water for irrigation
6. Indigenous knowledge	Weather patterns
7. Local admin	Location of affected areas No. of affected areas Government interventions
8. Public barazas	Information from different professionals [e,g, health, agricultural officials, NGOs
9. County integrated development plans	Infrastructure distribution
10. NGOs [e.g. Red Cross]	Damaged crops Advocacy Interruption of normal lives

Information source	Type of information
1. [KMD] – radio	Scientific
2. [KMD] – TV	Scientific
3. [KMD] – newspaper	Scientific
4. Internet – journals	Scientific – data of previous events, analysis of previous events, attribution of previous events
5. Personal observations	
6. Workshops	Scientific, traditional forecasts, experiences
7. Newsletter – JOTO Africa	Scientific Social
8. Social media – WhatsApp	Scientific Social impacts
9. Social media – Twitter	Scientific – warning and advisory Social impacts Raw data Extent of event and damage
10. Books	Scientific
11. Indigenous knowledge – Nganiji community	Traditional forecast
12. Indigenous knowledge	Fauna
13. Telephone	Scientific advisory Social Raw data Extent of event and damage
14. Chief's barazas	Scientific – warnings and advisories Social – raw data [casualties], extent of event, extent of damage
15. NGOs – red cross, CARE Kenya	Scientific – warnings and advisories Social – raw data [casualties], extent of event, extent of damage experience

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