FORECAST-BASED FINANCING: DEVELOPING TRIGGERS FOR DROUGHT

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Abstract
Forecast-based Financing (FbF) is a rather new concept within the humanitarian world, which enables actors to act before a likely disaster, based on forecasts. In this study, two scoping studies and five interviews with FbF experts were conducted to find out how to develop useful triggers for drought. The study finds that the triggers must be contextualized, as drought differ a lot across the globe. To accommodate the complexity of drought both meteorological data, as well as societal data, such as market analysis should be used as triggers. Impact and vulnerability analyses should also be conducted and integrated when developing the triggers since they are key for the understanding of where the hazard potentially can evolve into a disaster. FbF requires extended cooperation between the stakeholders and therefore, how best to include the stakeholders in the project and enhancing their ownership of it must be considered. Despite the promising future of FbF, there are still some challenges that must be overcome when developing an FbF drought project. First, the lack of a universal drought definition causes confusion and potential problems for the collaboration in a project. Secondly, there is a lack of data in many of the settings where FbF is being implemented, which makes it difficult to develop useful and accurate triggers.

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Contents

List of abbreviations

EA – Early Action

EWEA – Early Warning Early Action

IFRC – International Federation of Red Cross and Red Crescent Societies

IFRC CC – International Federation of Red Cross and Red Crescent Societies' Climate Centre

IRI - Columbia University's International Research Institute for Climate and Society

FAO – Food and Agricultural Organization of the United Nations

FbF – Forecast-based Financing

PSDI – Palmer Severity Drought Index

SPI – Standardized Precipitation Index

UNISDR – United Nations Office for Disaster Risk Reduction

WFP – World Food Programme

WMO – World Meteorological Organization

1. Introduction

In 2015, 187 UN member States agreed on the 'Sendai Framework for Disaster Risk Reduction 2015-2030', which sets out to "Prevent new and reduce existing disaster risk […], increase preparedness for response and recovery, and thus strengthen resilience." (UNISDR, 2015: p. 12). The Sendai Framework builds on and expands the focus on the more proactive disaster risk reduction (rather than disaster response) which its predecessor, the Hyogo Framework for Action laid the foundation for in 2005. Aligning with this focus on a proactive approach to disasters, a new disaster preparedness concept, broadly known as trigger-based actions, has emerged in the humanitarian sector in recent years. In 2015, it was formalized in cooperation between the Red Cross Red Crescent Movement and the World Food Programme (WFP). Within many organizations the mechanism is also called Forecast-based Financing (FbF). In short, it is a concept where forecasts are used to enable timely disbursement of funds to engage in advanced preparedness actions before a likely disaster – most often it is weather and climate forecasts but FbF is also being tested for other hazards. When setting up the system, pre-defined triggers are determined and linked to relevant actions. Once the triggers are met, funding is released to start the linked activities (IFRC Climate Centre, n.d.). This way, FbF responds to Priority 3 and 4 of the Sendai Framework, which are "Investing in disaster risk reduction for resilience" and "Enhancing disaster preparedness for effective response and to Build Back Better in recovery, rehabilitation and reconstruction" (UNISDR, 2015: 14). So far, the pilot projects within the Red Cross Red Crescent Movement have mostly focused on floods (e.g. in Mozambique and Bangladesh), cold waves (in Peru) and cyclones (in the Philippines) (German Red Cross, n.d.; IFRC Climate Centre, n.d.). Drought is often mentioned as an obvious hazard to include in FbF initiatives, however limited focus has yet been given to this hazard. There are, though, other organizations engaged in FbF activities who are implementing drought projects, including the Food and Agricultural Organization of the United Nations (FAO) (FAO, 2017). But why is it even interesting to look at Forecast-based Financing in relation to drought?

Drought is among the natural hazards that have the largest worldwide impact every year, having affected[1] more than one billion people in the period 1994-2013. This means that 25 % of the disaster affected people in the period were affected by drought, even though drought only made up 5 % of the disasters in the same period (CRED, 2015). As seen in the following table, drought occurs in all parts of the world and has vast human and economic impacts.

[1] 'People requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance', http://emdat.be/Glossary

Table 1: Droughts in the world from 1994-2013 grouped by continent

Continent	Occurrence	Total deaths	Total affected	Total damage ($)
Africa	130	21,127	217,169,342	1,657,200,000
Americas	81	57	27,107,316	39,844,939,000
Asia	78	1,014	865,936,602	32,669,460,000
Europe	22	2	1,278,769	12,637,709,000
Oceania	12	60	883,019	2,923,000,000
Total	323	22,260	1,112,375,048	89,732,308,000

Created through the EMDAT database, 23.01.2018, www.emdat.be

Most notably in recent times, severe drought was one of the core elements in the devastating famine in Somalia 2011-2012 that caused more than 260,000 deaths[2] (Nyakairu & Martin, 2013). Early warnings of a famine were already published in mid-2010, however it was not until mid-2011 that the donors really started to fund actions and at that time it was too late for many people (Save the Children & Oxfam, 2012). Drought stands out from many other natural hazards, such as floods and cyclones, as it is a so-called slow-onset disaster. One of the issues with drought is that its slow-onset nature makes it difficult to distinguish between the different phases of the disaster cycle, thus making it more complicated to determine which actions are needed when. Despite being a slow-onset disaster, the response to drought still needs to be immediate. The impacts of drought are non-structural and more widely spread than those of most other natural hazards, making it difficult to assess the impacts and respond to them (Coppola, 2011; WMO, 2006). Generally, the international community has tended to be slow in responding to droughts, thus the need for a quicker system with secured funds is immense (Save the Children & Oxfam, 2012). The idea behind FbF, is that funds are secured from the onset of the project, thus they can be released immediately as the first warning is issued, leading to the possibility of engaging in preparedness initiatives before the event and a more rapid response in case the event unfolds. To be able to do that accurate triggers are needed, that can forewarn an upcoming drought, which however, is made difficult by among other things the abovementioned issues with drought.

1.1 Research aim and questions

With regards to the complexity of drought as a hazard and the potential of Forecast-based Financing to contribute to better drought management in the future, the aim of this thesis is to investigate how appropriate triggers can be developed for drought, which stands out from most of

[2] This number is not part of EM-DAT's data, as the deaths were caused by the famine and therefore only partially and indirectly from drought.

the other hazards being subject to FbF. This will be done through one overall research question and four sub-questions:

Within Forecast-based Financing, how can appropriate triggers be developed that enable timely and accurate preparedness and early response actions against a forecasted drought?

- What is known about Forecast-based Financing and similar mechanisms in scientific literature?
- What is known about drought forecasting in scientific literature?
- What are the requirements for setting up a Forecast-based Financing system, especially regarding triggers?
- Which challenges are there when developing Forecast-based Financing triggers for drought?

1.3 Delimitations

The focus of this thesis is drought in a humanitarian setting in low-income countries, thus the results should first and foremost be applied to that context. The literature used is mainly scientific articles and to a much lesser extent grey literature, such as reports and manuals. It is also important to highlight that the results are from the perspective of the international humanitarian community and not the local authorities working with FbF.

2. Key terms and concepts

In the thesis several terms and concepts will be used, which are important to understand when reading the thesis. The following will therefore be a review of the most central terms and concepts.

Drought: There exists no universally accepted definition of what a drought is. The World Meteorological Organization (WMO), describes drought as "[…] an insidious natural hazard characterized by lower than expected or lower than normal precipitation that, when extended over a season or longer period of time, is insufficient to meet the demands of human activities and the environment." (WMO, 2006: 4). WMO (2006) distinguishes between four different types of drought:

1. **Meteorological drought** is when an area experiences a deficiency in precipitation over a certain period. How much deficiency and the amount of time will differ from region to region, as it relates to the normal local conditions.
2. **Agricultural drought** happens when there is insufficient water in the soil to sustain crop cultivation. This will not be determined as much by the amount of precipitation as by a range of other factors such as the type of soil and slope.
3. **Hydrological drought** relates to surface and sub-surface water resources, like lakes and reservoirs, and their levels in relation to the average conditions. These resources have a range of usages, such as irrigation and domestic water supply, and there is thus no direct correlation between precipitation and hydrological drought.
4. **Socio-economic drought** reflects the supply and demand of water for various commodities or economic goods in a broader societal perspective, such as drinking water or hydroelectric power. It occurs when the overall supply is lower than the demand.

Whereas meteorological drought is seen as a natural phenomenon, the three other types are closer connected to human activity relying on the use of water. WMO (2006), points out that meteorological drought is the most frequent drought type, as the others require longer time to evolve, thus meteorological drought is the first type to be detected with the other types potentially following.

When using the term drought, without any specification of the type, in this thesis it refers to the term that covers all four drought types.

Forecast-based Financing: FbF is a mechanism where forecasts are being used to initiate preparedness activities before a likely but not certain disastrous event. These activities are agreed when setting up the system, thus they can be implemented as soon as they are triggered by the system. When setting up the system, the funds are also secured so that it does not become a question of financing whether to trigger actions or not. FbF is not supposed to be a substitute for more traditional disaster risk management, but rather a supplement that can enhance both disaster risk reduction initiatives and disaster response actions (IFRC Climate Centre, n.d.).

Despite the many names of the concept in various organizations they will all be referred to as Forecast-based Financing (FbF) in this thesis.

Trigger: In a report from 2014, the International Federation of Red Cross and Red Crescent Societies (IFRC), FAO, WFP, Save the Children and Oxfam describe a trigger as "Trigger points are key changes in the indicators that make up the early warning system. For the system to work swiftly, these triggers for action need to be agreed in advance. Some triggers are simple changes in the value of an indicator, and others are more complex or nuanced." (IFRC et al., 2014: p. 5). More narrow trigger definitions exist and are used by various organizations; however, the above definition is the one that will be used in this thesis. An appropriate trigger is thus, a trigger which allows enough time to be able to implement actions that can reduce or prevent the consequences of a likely disastrous event.

Two types of triggers exist, the automatic and the subjective trigger. With the *automatic trigger*, actions are triggered based on already agreed Standard Operating Procedures (SOPs) as soon as the trigger is met, thus limiting the real-time decision-making as much as possible. *Subjective triggers* allow human judgement to be introduced once the trigger is met, thus making the trigger more of an advisory notification about a potential incoming event, on which the involved actors need to decide whether to implement the pre-agreed actions (Wilkinson et al., 2018).

3. Methodology

To answer the research questions, two scoping studies and an interview study were conducted. In this chapter the methodology behind these studies will be described.

3.1 Scoping study

To investigate and map the existing literature on Forecast-based Financing and drought, two scoping studies were carried out; one on FbF and one on drought. A scoping study is defined by Daudt, van Mossel & Scott (2013: p. 8) as a study that "aim[s] to map the literature on a particular topic or research area and provide an opportunity to identify key concepts; gaps in the research; and types and sources of evidence to inform practice, policymaking and research". This is a definition that builds on previous definitions, used by Arksey & O'Malley (2005) and Levac, Colquhoun & O'Brien (2010). Especially to "map the literature on a particular topic or research area and provide an opportunity to identify key concepts", was the main reason for choosing this methodology, as it is central to answering the research questions. Scoping studies, in general, differ from systematic reviews by trying to give a broad overview of the existing literature within a specific area, without referring to a particular study design or the assessed quality of the studies included (Arksey & O'Malley, 2005).

Arksey & O'Malley (2005) have developed an analytical framework for conducting a scoping study, which contains the following five stages:

- Stage 1: identifying the research question.
  To be able to carry out a scoping study it is important to identify a research question that can guide the search strategy. The terms used, and the wording of the research question will have a great influence on the results of the study and the nature of the literature found.
- Stage 2: identifying relevant studies.
  Here, it is defined which studies are deemed relevant to include. This include language, year of publication, what kind of databases are to be searched and developing a search query string.
- Stage 3: study selection.
  Based on the definition of relevant studies, the search results must be gone through to select studies that have relevance for the research question. The selection can be done first by roughly going through the study titles and then afterwards by reading the abstracts of the remaining studies as the focus narrows.

- Stage 4: charting the data.
  The selected studies are read through and the relevant data and information extracted.
- Stage 5: collating, summarizing and reporting the results.
  The results of the scoping study are presented and gives an overview of the existing literature within the field.

This analytical framework was used for both scoping studies. The exact procedure will be described for each of the two studies, in the following sections.

3.1.1 Forecast-based Financing scoping study

The first scoping study is about Forecast-based Financing in scientific literature. The application of Arksey and O'Malley's analytical framework is described below.

Stage 1: identifying the research question

As mentioned earlier it is vital to have a research question which the scoping study is reflecting on and trying to answer. For this scoping study, the question is *what is known about Forecast-based Financing and similar mechanisms in scientific literature?* This question might seem rather broad in relation to the aim of the thesis, however, it was deemed appropriate since FbF is such a new concept. It would therefore not be feasible to ask a more specific question, as this would have resulted in very few or no results. Thus, it was important to make a broad search to see what scientific literature has actually been produced about this topic.

Stage 2: identifying relevant studies

It was decided to conduct the literature search in the Scopus database. Scopus is an abstract and citation database of peer-reviewed literature run by the Dutch publishing company Elsevier. The database was chosen because it is the largest abstract and citation database, which covers numerous research areas and disciplines (Elsevier, n.d.).

To search for the relevant studies the following search query string was developed, using the Boolean approach. Keywords were identified, through numerous test searches, and based on these, useful synonyms or words used synonymously were chosen to find as many relevant studies as possible.

Forecast* OR Trigger OR Warning	AND	Finance* OR Action OR System	AND	Disaster OR Emergency OR Humanitarian OR Hazard OR Catastrophe	AND	Climate OR Weather

This search string resulted in 2,623 results without any limitations regarding language, type or year of publication. Only articles in English published in 2013 or later were considered which reduced the number to 597. Since FbF was formally introduced in 2015, 2013 was chosen as the distinctive year to make sure that articles about FbF that was written prior to the formalization were not missed.

Besides consulting a database, Arksey & O'Malley (2005) present a few other strategies for retrieving relevant literature. One of these strategies is to reach out to relevant organizations and networks to get their inputs. For this scoping study, IFRC's Climate Centre was consulted to provide additional materials.

Stage 3: study selection

The titles of the 597 articles were read through for a rough selection. The criteria for this selection were that the studies should focus on 1) weather forecasting or warning systems; 2) a humanitarian context, and; 3) be used for disaster preparedness activities.

The title selection led to 24 articles. The abstracts of these articles were read through to determine which articles should be read in full, which narrowed the number down to 11 articles.

Reaching out to IFRC's Climate Centre provided five additional scientific articles, however only one of them was not a duplicate from the Scopus search. Furthermore, by going through the reference lists of the 11 articles from Scopus and the one from the Climate Centre, added three additional articles. The final number of articles that were read in full length, therefore, ended at 15. Of these 15 articles in the study only ten of them proved to be relevant after reading them in full.

Stage 4: charting the data

For charting the data, the articles were read through focusing on different aspects of Forecast-based Financing. This data was put into an excel sheet to give an overview and create a table of quotes from the ten articles. First, it was noted if the articles specifically referred to Forecast-based Financing or if they referred more generally to Early Action (EA). Based on the research questions of this thesis and after reading through the first couple of articles, four sub-groups were created, and the articles were read through to discover what they said about the different sub-groups. The sub-groups were: 1) The background of FbF; 2) Design of FbF/EA; 3) Trigger development; and 4) Challenges with FbF/EA. Each of the sub-groups were given a color that was used to mark passages in the articles where it referred to that sub-group, which created a comparable overview of each sub-group.

The results of this scoping study can be found in section 4.1.

3.1.2 Drought scoping study

The second scoping study deals with scientific literature on drought and how to forecast it. Again, Arksey and O'Malley's analytical framework is applied for the study.

Stage 1: identifying the research question

The identified research question forming this study was *what is known about drought forecasting in scientific literature?* This question was chosen to get an overview of the knowledge about forecasting droughts.

Stage 2: identifying relevant studies

The Scopus database was also chosen to conduct the scientific literature search for this study.

To search for relevant studies the following search query string was developed, using the Boolean approach. Keywords were identified, through numerous test searches, and based on these, useful synonyms or words used synonymously were chosen to find as many relevant studies as possible.

Drought	AND	Forecast* OR Warning	AND	Disaster OR Emergency OR Humanitarian OR Hazard OR Catastrophe	AND	Characteristic OR Index OR Signal OR Indicator OR Threshold OR Trigger

The above search string resulted in 297 hits without any limitations set. Due to the relatively few articles and because drought studies are not a new field, there was not put any limitations on the year of publication into the search. Limiting the search results to only show scientific articles in English, reduced the number of hits to 187.

Stage 3: study selection

The titles of the 187 articles were read through focusing on articles about the ability to forecast droughts. Based on this, 53 articles were selected, and their abstracts were read through. After reading the abstracts, 32 articles remained. These 32 articles were read in full length, however 12 of them were found to be irrelevant to the study, mainly due to their very technical nature and numerous calculations, which was found unfeasible for this study. Thus, the final number of articles in the analysis of the study was 20.

Stage 4: charting the data

As in the FbF scoping study, an excel sheet was created to chart the data from the articles. First, the geographical region of the article was noted. Three sub-groups were identified, based on the research questions and following a read-through of a few of the articles, within which the articles were analyzed. The sub-groups were 1) Drought characteristics/indices; 2) Design of the drought forecasting system; and 3) Challenges in forecasting drought. Once again, each sub-group was given a color that was used to mark passages in the article where it referred to that sub-group.

The results of this scoping study can be found in section 4.2.

3.2 Interview study

Besides the two scoping studies, an interview study was also carried out to explore the thoughts, practices and experience on developing triggers among people working with FbF. Five interviews were carried out during March and April 2018.

3.2.1 Respondents

For the interview study, the idea was to get as broad a perspective as possible on how to develop feasible drought triggers. Therefore, the aim was to get respondents working with Forecast-based Financing from three different perspectives; namely people from academia, FbF practitioners and experts on drought forecasting. This was also done to examine the relationship between how triggers are developed in practice and how they theoretically should be developed. Thus, the target group were experts and the interviews were so-called expert interviews where it is the knowledge of the respondent rather than the respondent as a person that is of interest (Flick, 2009). Deeke's (1995) definition of experts as those "[…] persons […] who are particularly competent as authorities on a certain matter of facts" is applied (Deeke, 1995: p. 7-8). According to Flick (2009), there can be various aims of conducting an expert interview. The aim of conducting expert interviews in this thesis was to explore and get orientation on a new field of study - in this case how triggers are and should be developed within the field of FbF - to provide a thematic structure (Flick, 2009).

The respondents for the interviews were found using two methods that Flowerdew & Martin (2005) call 'gatekeepers' and 'cold calling'.

Gatekeepers are persons in an organization that can grant access to people with a certain knowledge or expertise (Flowerdew & Martin, 2005). Gatekeepers from Lund University, the Danish Red Cross and IFRC's Climate Centre were used to get access to experts from the World Food Programme, IFRC's Climate Centre and the research consortium ForPAc.

Cold calling is when persons that are deemed interesting from a research perspective are contacted without any prior contact or arrangements (Flowerdew & Martin, 2005). Here, it was done by going through reports on FbF and websites of organizations and then identifying organizations and persons working with the topic. These organizations and persons were then sent an email

explaining the topic of the thesis and asking if they would be interested in participating in an interview.

In total 26 organizations or individuals working with FbF or FbF-related areas such as drought forecasting were identified and contacted through one of the two described methods with the aim of scheduling an interview. In the end five interviews were set up and conducted.

3.2.2 Interview questions

The interview questions were developed by using the research questions and the results of the two scoping studies that were conducted. This way it was ensured that the questions were relevant for the thesis and that the results from the scoping studies could be examined and discussed further. The questions were therefore developed during and immediately after conducting the two scoping studies.

Since one of the aims of the interviews were to get various perspectives, the interview questions were tailored to the three different categories corresponding to the three types of respondents; FbF practitioners, academia and drought forecasting experts. This way, only questions relevant for the specific respondent would be posed and the opportunity arose to focus more on the respondents' area of work.

The three sets of interview guides can be found in appendix 3.

3.2.3 Conducting the interviews

All five interviews were conducted through Skype, due to the geographical distribution of the respondents on three different continents. The respondents received the interview questions in an email a few days prior to the interview for them to prepare. As it were expert interviews and since the questions were not about any issues where the immediate opinion was of interest, it was only seen as positive that the respondents were able to get the questions beforehand. This enabled them to answer the questions in the best possible way and answer questions that might not fall within the respondents' everyday responsibilities.

As recommended by Martin & Flowerdew (2005), the interviews were recorded, which was done using the software Callnote. Some of the advantages by recording an interview, is that the interviewer can focus more on interacting with the respondent and the conversation will flow more naturally (Martin & Flowerdew, 2005). The respondents were asked in an email before the interview if it would be okay to record it. As the first thing before starting with the questions at the interview,

the respondents were once again asked for permission to record the interview and were informed that the recording would solely be used for transcribing in relation to the thesis. Lastly, before starting the actual interview, the respondents were also asked if their name and the organization they represent could be referred to in the thesis. All of this was done to respect the privacy of the respondents and to make them feel comfortable about participating.

The actual interview, was started out by a short description of the research question and the thesis in general. Then the respondent was asked how their organization works with FbF and their own role in this before a rather open question about FbF or drought would be posed. This way the respondent had the opportunity to get comfortable and start off with some broad reflections. The interviews were conducted as semi-structured interviews, which are characterized by having a set of questions prepared but with the opportunity to pose follow-up questions and to explore new issues that arise during the interview (Flick, 2009).

In some of the cases, follow-up questions emerged after the interview and these were emailed to the respondents who then answered via email. These answers are used on equal terms with the answers from the interviews in the results section.

3.2.4 Analysis of the interviews

Based on the recordings, the interviews were transcribed. To analyze the transcripts, a technique referred to by Martin & Flowerdew (2005) as 'open coding' was applied. In open coding, the transcripts are read carefully, and alongside this topics or codes are developed. Reading through the transcripts, five codes were created from which the interviews would be grouped into and analyzed. These five codes were: 1) FbF requirements; 2) Trigger design; 3) Trigger data; 4) Stakeholders; and 5) Challenges when developing triggers. The five transcripts were then read through once for each code to highlight where in the interviews the topic of the codes was touched upon. This resulted in a compilation of quotes relating to one or more of the codes. The quotes were processed individually for each code, thus ending in five paragraphs presenting the results for each of the codes.

After the analysis was conducted, the results were sent to each of the respondents giving them an opportunity to comment and unravel potential misconceptions.

The results of the interviews can be found in chapter 5.

3.3 Sum-up on methodology

By combining different methodological approaches for answering the research question, triangulation was sought. First, two scoping studies of the existing scientific literature were conducted – one on FbF and one on drought forecasting. The results of these two studies were used as the foundation for carrying out an interview study with experts in Forecast-based Financing. The interview study reached out to both practitioners, academia and forecasting experts, thus reflections on the topic from different standpoints and perspectives were brought forward. In the following part of the thesis, the results of these methodological approaches are presented.

4. Results of the scoping studies

To examine the existing knowledge about FbF and drought within the scientific literature two scoping studies were conducted. These are the results of those studies.

4.1 Scoping study on Forecast-based Financing

The research question of the first scoping study was *what is known about Forecast-based Financing and similar mechanisms within scientific literature?* The results have been grouped into four categories which match the four sub-groups that were created for charting the data. Out of the ten articles in the study four of them specifically referred to FbF, whereas the remaining six referred to early warning and early action more generally. The articles were published between 2010[3] and 2018, with six of them published in 2015 or later, including all four of the articles specifically referring to FbF.

4.1.1 The background of FbF

Within the analyzed articles there is consensus that there is a need for innovative approaches and a break with previous ways of managing climate and weather-related hazards, which in 2012 were responsible for 98 % of all displacements due to disasters in the world (Marin & Naess, 2017). This need became especially apparent after the famine in Somalia in 2011, where warnings up to a year before the famine were largely neglected, however, this is far from the only example of a lack of action upon issuance of early warnings (Lautze et al., 2012; Coughlan de Perez et al., 2015). In 2010, Suarez & Tall requested a mechanism where actions are pre-defined and tied to forecasts, something which is echoed by several of the other authors and which is now becoming a reality with FbF (Braman et al., 2013; Muller, 2014; Coughlan de Perez et al., 2016). This kind of anticipatory approach has the potential to not only save many lives but also a lot of money that would otherwise have to be spent on response (e.g. Coughlan de Perez et al., 2016; Coughlan de Perez et al., 2017; Costella et al., 2017; Lumbroso, 2018). One study even provided specific numbers from a case in Bangladesh, where every dollar spent on the FbF programme saved three dollars in beneficiary losses (Costella et al., 2017). Thus, there is obviously a big interest, among the authors, in promoting FbF, which is seen as a vital tool to support decision-makers and manage weather and climate related risks in the future.

[3] The two articles from before 2013 were found through the reference lists of the other articles.

4.1.2 Design of FbF/EA

An early warning allows communities and respondents to take anticipatory action, which potentially can save lives and property that would otherwise have been lost in a disaster (Marin & Naess, 2017). By determining and linking triggers and actions together, and secure funding for these before an actual event has occurred, FbF goes one step further than traditional early warning systems. Triggers are a central part of the mechanism, as they determine how much lead time there will be available to act. Actions must therefore be identified, which are possible to carry out within the lead time that each trigger offer (Coughlan de Perez et al., 2015). Actions within FbF could be, but are not limited to, cash programmes, distribution of jerrycans and water purification tabs, digging trenches or handing out seeds (Costella et al., 2017). All actions have a so-called 'action lifetime' which describes how long this action will be of use once implemented. For instance, trenches might be useful for up to three months before they erode (Coughlan de Perez et al., 2016). Since weather forecasting systems are probabilistic, there will always be some level of uncertainty embedded in the forecasts. This implies that the actors must be willing to 'act in vain', should a forecast not materialize (Suarez & Tall, 2010). However, due to the action lifetime, actions might not have been taken in vain if the event happens three weeks after it was forecasted if it is still within the action lifetime. The actions would therefore still be of use and regarded as a success, even though the forecast failed (Coughlan de Perez et al., 2016). These type of actions, that remain useful beyond the initial forecast, are also known as no-regret actions and are obviously preferred the longer they last and the more impact they have (Braman et al., 2013).

Several of the authors pinpoint the importance of cooperation and partnership between actors for FbF to be a success. The people at risk need to be involved in the process both because of their local knowledge and for their participation in early actions (Lumbroso, 2018 and Muller, 2014). Furthermore, partnerships must be developed between various agencies and organizations, for instance meteorological institutes and disaster management agencies. If FbF is to be a success it must be carried out as a coordinated effort between the relevant actors (Costella et al., 2017). Related to this, FbF must be adjusted to the local context of the specific intervention since relevant actors, feasible triggers and actions, as well as characteristics of the specific hazard will vary greatly from location to location. Changes will even happen in the same location's risk profile which requires continuously updating of the FbF mechanism (Coughlan de Perez et al., 2016; 2017).

4.1.3 Trigger development

Only two of the ten articles touch upon the development of triggers for FbF and that is even in a very light sense. Lumbroso (2018), emphasizes the need for clear decision-making structures

regarding triggers to develop systems that are capable of mobilizing actions across different societal levels. Thus, the stakeholders must be involved in the trigger development and consensus must be reached on which triggers to use. Coughlan de Perez et al. (2016) describe how triggers for floods were developed in Uganda using historical data, such as humanitarian records and media reports, to quantify the discharge in a river which would result in flood, also called a danger level. Thereafter, the probability level of the forecast was determined, which would set the level for when actions should be taken. For this, it was instrumental to decide on how often it was acceptable to act in vain due to an inaccurate or false forecast. Since no local forecasting system was available, the Global Flood Awareness System (GloFAS) was tested to see whether a global system could be used in areas with limited local data. Coughlan de Perez et al. (2016), concluded that GloFAS did allow the actors to implement early action with the probability of acting in vain less than 25%. However, one of the main reasons for this was the long action lifetime of the early actions, which meant that the implemented actions were still useful if the event materialized at a later stage. Global systems could, thus, be used as a foundation for local decision-making, however with more false alarms than a local system would usually provide. The global system should therefore not be an excuse for not developing local forecasting capacity (Coughlan de Perez et al., 2016).

4.1.4 Challenges with FbF/EA

The studied literature suggests that there are substantial challenges that need to be overcome for FbF to be a success. First, in many parts of the world there is a lack of meteorological data as well as forecasting capacity, which obviously is vital for providing warnings and defining triggers (e.g. Lumbroso, 2018; Coughlan de Perez et al., 2017; Suarez & Tall, 2010). Another big challenge in implementing FbF is the lack of funding opportunities and political will to act before a disaster strike. Coughlan de Perez et al. (2015), refer to a study showing that only 12 % of disaster-related financing in the 20 previous years was invested before a disaster had hit. This is among other things due to the uncertainty that forecasting systems inherently contain and the unwillingness to act in advance of a likely, but not certain, disaster event (Lumbroso, 2018; Braman et al., 2013; Coughlan de Perez et al., 2015). The uncertainty also presents another challenge, which is that of the 'cry wolf effect'. According to this, people will not take warnings seriously if multiple warnings do not materialize into disastrous events. To keep confidence in the system, the triggers must therefore be designed so that they balance between allowing enough lead time for early actions to be carried out but still be certain enough to warn for a likely event (Coughlan de Perez et al., 2015; Costella et al., 2017).

Due to the need for involvement of many stakeholders many of the authors have found challenges with communication and coordination among these stakeholders. In many places there have been an overlap of mandates between different authorities, which have caused confusion about roles and responsibilities of the various actors and led to inefficient systems. Also, the capacity to understand and act on warnings by authorities and communities has been a challenge. (Braman et al., 2013; Muller, 2014; Coughlan de Perez et al., 2015; Costella et al., 2017).

4.1.5 Conclusion on the scoping study

As the scoping study has revealed, there is a rather limited number of scientific articles available about Forecast-based Financing. Especially trigger development is an almost untouched topic, which even further emphasize the need for more research into how good triggers can be developed. What the scoping study did find was that it is widely agreed that close cooperation and a contextualization of FbF are important factors if FbF is to be implemented successfully. However, a lack of data and forecasting capacity at the local level often become a hindrance along with communication and coordination among the multiple stakeholders. It is, although, worth noting that the papers presented build on experience and not actual measuring of effect. The results might therefore be different if effect measuring research were conducted.

4.2 Scoping study on drought forecasting

The research question for this scoping study was *what is known about drought forecasting in scientific literature?* The results of the study have been grouped into the three identified sub-groups presented earlier 1) Drought characteristics/indices; 2) Design of the drought forecasting system; and 3) Challenges in forecasting drought. The 20 articles which was found to be relevant for the study were published between 2006 and 2017. Geographically eight of the articles examined drought in Africa, four in Europe, two in Asia and one in North America, while the remaining five had no explicit geographical focus.

4.2.1 Drought characteristics/indices

There is a broad consensus among the authors that drought is a complex hazard resulting from a wide variety of factors and with huge impacts in the areas where they occur. The wide variety of factors are both meteorological, geographical and societal (e.g. Bachmair et al., 2016; Hao et al., 2017; Ali et al., 2017). The indices of an incoming drought are thus many and varied and include level of precipitation, wind, humidity, temperature, groundwater levels, stream flow, water

demands and soil moisture (Zargar et al., 2011; Pulwarty et al., 2014; Ali et al., 2017). All these characteristics are however dependent on the region in which they occur, as droughts can occur in every type of climatic zone and is thus not only prevalent in arid areas. This is because drought is measured against the average conditions of a certain area. The large regional differences are part of the complexity of drought and are one of the reasons why a universal definition of drought has not been agreed (Balint et al., 2013). The local context is thus important to keep in mind as it plays a huge role in determining drought in that area (Zargar et al., 2011; Hao et al., 2017). Manatsa et al. (2010), highlights that the Intergovernmental Panel on Climate Change (IPCC), predicts that climate change will result in even larger impacts and severity of droughts in the future, thus making it even more important that drought can be reliably forecasted.

Finally, Balint et al. (2013), point out that the term drought is often used in cases of food shortages, however this is inaccurate as food shortages can have many origins that are not linked to drought. This can result in inefficient management of both droughts and food shortages as they may not have any connection.

4.2.2 Design of the drought forecasting system

The United Nations Office for Disaster Risk Reduction (UNISDR), describes successful early warning systems as containing four elements, namely 1) knowledge of the risk faced; 2) technical monitoring and warning service; 3) dissemination of meaningful warnings to those at risk; and 4) public awareness and preparedness to act (Pulwarty et al, 2014). This part of the scoping study focuses on point 2) technical monitoring and warning service.

There is a wide range of indexes that can be used for forecasting drought. Two of the most popular ones are the Standardized Precipitation Index (SPI) and the Palmer Severity Drought Index (PSDI).

The SPI solely looks at precipitation and calculates current conditions against at least the 30 previous years of data from the same area. The result is presented as a number on a scale from 2 (extremely wet) to -2 (extreme drought). Thus, the SPI does not only measure dry spells but also wet periods (Zargar et al., 2011). The SPI has been recommended by WMO as the index to be used since 2009 (Okpara et al., 2017). One of the reasons for this is the standardization, which makes it possible to compare drought conditions from different areas (Nguyen et al., 2017).

The PSDI goes beyond precipitation by also considering soil moisture and evapotranspiration, thus providing a more comprehensive insight into the drought conditions. However, the index was developed to be used in the Great Plains of the US and it is less applicable to markedly different areas (Zargar et al., 2011).

It is widely agreed that these indexes alone are not sufficient when forecasting drought (e.g. Pulwarty et al., 2014; Hao et al., 2016; Bachmair et al., 2016). The factors described in the section above, should be taken into consideration and modelled to fit the local context. Besides these factors, it is also suggested by some authors to integrate the population's vulnerability and potential impacts of the drought into the forecasting system, for instance crop losses or water supply shortages, which will make it easier for decision-makers to prioritize their resources and act towards the areas most at risk (Naumann et al., 2014; Bachmair et al., 2016; 2017). Some studies also point out that there is a potential in using local traditional knowledge when forecasting droughts, with the reservation that the local knowledge, in general, is very specific for the location of which they originate (Pulwarty et al., 2014; Chisadza et al., 2015).

Finally, Bachmair et al. (2016) and Balint et al. (2013), point out that there are no indicators that are universally better than others and that the local context is essential in determining which indicators would be best to use.

4.2.3 Challenges in forecasting drought

One of the most obvious challenges when forecasting drought is the lack of a universal definition. The lack of an objective way to characterize drought provides challenges in the drought planning and management, thus making it difficult to implement preparedness measures and evaluate the impacts of drought (Zargar et al., 2011; Paulo & Pereira, 2006). The underlying reason for the lack of a universal definition is the complex nature of drought, which again makes it challenging to make efficient early warning systems for it (Naumann et al., 2014). Nguyen et al. (2017) even claim that drought is 'widely considered to be the most complex and least understood of all the natural hazards'.

The lack of a clear definition is also visible at other levels of drought forecasting. Several of the authors point out that practitioners struggle to identify accurate, quantifiable thresholds for triggering action and that there is a lack of consensus between various sectors (Bachmair et al., 2016; Enenkel et al., 2016; Hao et al., 2017). It is claimed that the thresholds used are arbitrary cutoff points without scientific validation, thus making the transition to a drought event blurry, which is only enhanced by the lack of a standardized way of defining accurate thresholds that can be used to trigger action (Bachmair et al., 2016; Enenkel et al., 2016). These challenges also exist when using local traditional knowledge in forecasting systems (Chisadza et al., 2015).

Looking at one of the most used indexes for drought forecasting, the Standardized Precipitation Index, it also faces some challenges. The biggest challenge of using SPI is that it requires at least

30 years of historical data to develop appropriate parameters that can represent meteorological drought in that region. However, in many developing countries that amount of historical data is not available (Jayanthi et al., 2014).

Lastly, Hao et al. (2017) and Bachmair et al. (2017), highlight that the current meteorological ways of forecasting, in general, have challenges when it comes to forecasting droughts with a greater lead time than 1-2 months, and that the accuracy of when and where a deficit in precipitation turns into a drought could and should be improved.

4.2.4 Conclusion on the scoping study

The scoping study has shown that when forecasting drought, it is important to take a lot of factors, beyond meteorological, into consideration. The meteorological forecast is important; however, the lack of precipitation alone will not determine if a drought disaster occurs. Thus, societal and geographical factors must also be considered, which automatically make the forecasting context specific. Some authors advocated for the inclusion of vulnerability and impact into the forecasts. Two of the major challenges when forecasting drought are the lack of data and the lack of a universal definition, which generates confusion and makes it difficult for practitioners to develop useful triggers.

5. Results of the interview study

In the following section the results of the interview study will be presented. Five semi-structured interviews were conducted with FbF experts. First, the five respondents and their organizations will be presented briefly. Then the results will be presented individually for each of the five codes that were created: 1) FbF requirements; 2) Trigger design; 3) Trigger data; 4) Stakeholders; and 5) Challenges when developing triggers.

5.1 The respondents

Respondent 1 is a Forecast-based Financing Project Manager at headquarters level in the **World Food Programme (WFP)**. WFP is a UN organization describing itself as 'the leading humanitarian organization fighting hunger worldwide, delivering food assistance in emergencies and working with communities to improve nutrition and build resilience' (WFP, n.d.). The organization was one of the central actors in developing the FbF concept and has been working with it since 2015. FbF projects are being implemented by WFP in Nepal, Bangladesh, the Philippines, Haiti and the Dominican Republic. The main focuses of the projects are flooding, hurricanes and multi-hazard events, with drought only being a part of the project in the Dominican Republic. The respondent has since 2015 acted as a global focal point for WFP's FbF activities, which among other things includes technical backstopping of projects and sharing of best practices between the projects.

The second respondent (**Respondent 2**) is an Early Warning Early Action (EWEA)[4] consultant at the **Food and Agriculture Organization of the United Nations (FAO)**. The mandate of FAO is to support and protect livelihoods. FAO started working with EWEA in 2015 and is currently coming out of the pilot stage to implement a broader roll out in their projects. Drought is among the main hazards in FAO's EWEA projects, which also include cyclones, pest and diseases, animal health, flooding and volcanic eruptions. FAO has EWEA projects in Somalia, Kenya, Ethiopia, Sudan, Niger, Madagascar, Paraguay, Mongolia, the Philippines and the Pacific Islands. The respondent's role at FAO is to produce the Early Warning Early Action Report on Food Security and Agriculture and furthermore be part of the team that goes out to the countries to establish on the ground EWEA systems.

Respondent 3 is a climatologist working for the **International Federation of the Red Cross and Red Crescent Societies' Climate Centre (IFRC CC)** providing technical advice to the

[4] Early Warning Early Action is the term used for Forecast-based Financing in FAO.

Climate Centre and the Mozambican Red Cross Society. The mission of the Climate Centre 'is to help the Red Cross and Red Crescent Movement and its partners reduce the impacts of climate change and extreme-weather events on vulnerable people.' (IFRC Climate Centre, n.d.). The Red Cross Red Crescent Movement has FbF projects in more than ten countries, however the basis of the interview was the Movement's FbF project in Mozambique, since that is the project which the respondent is mainly involved in. In Mozambique, FbF was introduced in 2015 and it is geared towards floods and cyclones with the project still being in the pilot phase. For that phase, drought was also considered, however it was deemed unfeasible for the pilot stage, due to its slow-onset nature which was considered to be a challenge for the FbF learning process.

To broaden the perspective an interview was also conducted with the Director and Senior Research Scientist of **Columbia University's International Research Institute for Climate and Society (IRI).** IRI was established in 1996 by the U.S. National Oceanic and Atmospheric Administration (NOAA) and its mandate is to work with developing countries in providing climate information on sub-seasonal, seasonal and decadal time scale. The institute particularly works with WFP and IFRC on providing climate forecasts to be used in FbF projects and the respondent (**Respondent 4**), has been involved with FbF since the initial talks of FbF commenced in 2014. IRI was invited to the FbF talks because their seasonal forecasts' probabilities can be used as quantitative measures of risk, due to IRI's approach to the correction and calibration of climate prediction models.

The final respondent (**Respondent 5**) is based at the University of Sussex in the United Kingdom and is working as a co-investigator at the research consortium **ForPAc**, which consists of researchers from the UK and Eastern Africa. The aim of ForPAc is to 'improve drought and flood forecasts over a range of 'seamless' lead times and overcome barriers to acting on such forecasts through systematic decision support methods.' (ForPAc, n.d.). In the ForPAc project researchers, NGOs and governmental institutions in Kenya are brought together to see whether weekly to seasonal forecasts can be used to develop preparedness actions to mitigate the potential impacts of hazards. In Kenya, the project is focused on drought and flooding and the research is currently in its second year. The respondent is leading a work package which aims at defining the baseline risk in drought by looking at historical data and try to define and characterize drought risk in Kenya.

5.2 Forecast-based Financing requirements

When an organization or authority wants to set up a Forecast-based Financing system there is a range of requirements that need to be in place to allow the system to be successfully implemented. These requirements are broad and most of them are applicable for various hazards and not only

drought. The requirements are divided into organizational requirements and technical requirements.

First, the country or area need to be prone to hazards that can be forecasted with a long enough lead time to be able to carry out meaningful preparedness activities. Furthermore, it needs to be a place where the implementing organization can add value. Respondent 2, for example highlights that for FAO to engage it needs to be a context where livelihoods can be protected, thus crisis has not already erupted. Organizationally, since FbF is dependent on good collaboration with stakeholders, there need to be acceptance by the existing political system to set up the system when implementing FbF on a national level. One respondent mentioned the importance of having people on the ground that buy into the idea of FbF and are passionate about it, both within the implementing parties and among the stakeholders, as well as having the technical experts that can provide these people with support. Related to this there need to be a mindset of focusing on developing the capacity of the local government for FbF to be a success and not setting up a separate system - a standpoint that was brought forward by multiple respondents. In general, the respondents emphasized the importance of involving the stakeholders and keeping a good relationship with those as one of the key aspects for being able to implement FbF successfully (see section 5.5 for more on the stakeholders). As pointed out by several of the respondents, it is not only the stakeholders on the ground that are important; there also needs to be a financial mechanism which trusts the system and is willing to risk acting in vain from time to time, thus providing the financial means to be able to perform preparedness activities based on early warnings. To support this, Respondent 4 notes that a cost-benefit analysis could be done to discover if it is possible to acquire enough reliable data to carry out FbF activities. Finally, multiple respondents mentioned that it is vital to be patient as an organization and be willing to adjust the system along the way and give it time to deliver results, especially as long as FbF is such a new mechanism, that for most organizations is still in the pilot phase.

Technically, the capacity to appropriately define and analyze the risk that the hazard possess must be in place to be able to identify the areas most at risk and to develop triggers. To develop the triggers, all the respondents agreed that there need to be available reliable data on relevant parameters (see section 5.4 for more). Specifically for drought, it is also important that historic data is available, as these are vital when forecasting drought. For the data to be used, according to Respondent 2, there need to be mechanisms in place that make it possible to establish an early warning system. Thus, the respondent does not see it as a must that there already is an existing early warning system in place, as this can be developed if the right data is available. However, what

do need to be in place is appropriate forecast skill that can produce good and reliable forecasts and ideally these forecasts are verified to know how reliable and precise they are. Respondent 2 mentions that institutions at global, regional and local level can be used to help strengthen the forecast, thus making it possible to implement FbF activities even though the local forecast skill is limited.

To sum up the requirements for setting up an FbF system, Respondent 1 does it with the following quote:

> ”So there needs to be, from our standpoint, a reasonable functioning weather service and a reasonable functioning disaster management authority. Where they are able to respond – they have to be able to already do that; just respond to a disaster. Because if you want them to act early you are making the assumption that they are already acting after the disaster. […] So, I think, there needs to be a baseline level of technical and organizational capacity.”

5.3 Trigger design

When developing the triggers to be used, first, there need to be a clear idea of what a good trigger is. The respondents had fairly different views on this but they all agreed that a good trigger must make it possible to implement appropriate preparedness actions before a likely event. However, from there two rather different kinds of definitions emerged. One definition of a good trigger is that it is a forecast that exceeds both the danger level and the probability level and where forecast skill, and uncertainty thresholds are incorporated. The trigger must also be agreed upon by all stakeholders. The other definition has a broader and more loosely perception of a good trigger:

> ”With drought a good trigger, for me, it is multiple. […] So, it is this combination of elements that tell a story, where if all of them is pointing to an abnormality that builds that confidence. So, when they all trigger together, or when a majority of them trigger together, you have that confidence to be like ‘okay, something is going on here’ because an abnormality is like when you start to see the start of an event. So, for me there is no one perfect trigger, it is using multiple sources.” (Respondent 2).

This approach was further backed by another respondent when specifically talking about triggers for drought. It is, however, worth noting that the first definition referred to a good trigger in general, whereas the second specifically referred to drought.

Another important thing to settle before developing the actual triggers is whether to use automatic or subjective triggers. Both respondents 1 and 3, stated that they use automatic triggers in their projects, as this allow them to act as soon as the trigger is met without having to negotiate with the stakeholders, thus not wasting valuable time. Respondent 5 expanded on the benefits of automatic triggers by mentioning that they are less subject to human manipulation. However, forecasts are always probabilistic, and action might therefore be triggered in vain, which is less likely to be caught when using the automatic triggers.

In FAO they use subjective triggers and Respondent 2 pulled out an example of how they have benefitted from this:

> "So, for instance in Sudan, it is a very interesting case at the moment, because you had the price of sorghum increase but the price of goat decrease – well, usually it is supposed to decrease because, as you know, livestock conditions start to deteriorate during drought and therefore their market value can be reduced. However, in Sudan the government went through a revamp of the economic policy, which removed some subsidies, so therefore we saw an increase [in the price of goat] which is an abnormal trend. So, you got to be careful. See, this is where the human judgement and understanding the current context really take into effect, cause if that trigger was not met, well it would not have been met, you would not have picked that up, because of the wider economic policy."

Furthermore, Respondent 5 adds that by using subjective triggers, the level of political acceptance will be enhanced as you will not take the expertise and decision-making away from the local authorities. The same respondent, however, points out that this can also be used to stall the decision-making process and ultimately thwart the chance of using the window of opportunity that FbF provides.

Finally, several of the respondents mentioned that the triggers should not be static. There can be a wide range of factors that can affect the triggers, and in some periods, population groups might be more vulnerable than during other periods – for instance after a recent shock. It is therefore, important to constantly monitor the parameters that the triggers are based on and adjust the triggers accordingly.

To illustrate the different ways that the trigger system can be designed, the following will be a short description of how two organizations have done it in their projects.

The Mozambican Red Cross Society are setting up automatic triggers for flooding and cyclones. The triggers are based on meteorological data combined with datasets on vulnerability and

exposure. These datasets could for instance be farming practices, livelihoods and living conditions, which are then paired with exposure to a certain hazard to identify who will be hit the hardest by that hazard. When the danger level and probability level of a trigger is exceeded, specific actions tied to that trigger is immediately implemented.

FAO have set up their early warning system in three phases, which corresponds to their level of confidence of a future event. The organization makes use of a whole range of triggers, which are then assigned a weigh reflecting the influence and importance of that indicator. All the triggers that are met will then be tallied together, and the percentage based on weigh will be calculated, which will then provide the level of confidence that a drought is coming. As FAO use subjective triggers, this data will then be used to meet with the stakeholders and decide whether to act or not.

5.4 Trigger data

When starting to design the triggers, one respondent put emphasis on that there most likely already exist triggers within the country. These are developed by the national weather services and they can be used as a foundation to build upon and refine.

Several of the respondents indicated that they started out by looking at previous disasters in that area, to try and identify what were the indications before those events, and then examine if these indicators can be forecasted and used in future systems. One respondent also pointed out the importance of looking at the current conditions in the area, since the impact of a drought will be a lot different if the area is already hit by or recovering from a drought.

All respondents agreed that meteorological data, such as rainfall and temperature are vital parameters to look at when forecasting a potential drought. However, the respondents also all said, that this data is not sufficient to develop appropriate triggers. As Respondent 4 pointed out, the weather forecast is not able to provide the same lead time as a seasonal forecast, and there are also some uncertainties related to the methodology of the weather forecasts, that needs to be taken into consideration. To create seasonal drought forecasts, ocean surface temperatures are vital as there is a correlation between these and the development of drought conditions on land. Furthermore, El Niño/La Niña is also highlighted as a strong global indicator of upcoming potential drought events. Finally, Respondent 4 said that they also use the Standardized Precipitation Index to forecast droughts, as it is a rather straightforward method, even though it requires extensive historical data.

All the above parameters are taken into consideration when creating a seasonal forecast. Respondent 4 pointed out, however, that it was not only important to provide forecasts but also

to assign probabilities and uncertainty to those forecasts. Only when assigning these parameters to the forecasts will it be possible for the organizations to take appropriate actions and conduct feasible cost-benefit analyses, to see if the forecast is certain enough to implement actions.

The respondents, furthermore, agreed that these forecasts then need to be paired with vulnerability and exposure to the relevant hazard. This applies to both vulnerability of population groups and industrial sectors, as the actions can then be directed towards these, because, as one respondent said, the organizations do not have funds to take early actions for an entire region or province. For this, historical data can also be used to identify the most vulnerable in the society. Related to the vulnerability and exposure is also impact and impact-based forecasting. In impact-based forecasting, the important factor is not as much what the weather will be like, but rather what the weather will do. Thus, as mentioned by Respondent 5, drought conditions may emerge, but it does not necessarily mean that a crisis will occur, as the community might not be impacted by the drought in any severe way. This could, for instance, be done by forecasting crop conditions a month or a season ahead. Therefore, the respondent also pointed towards impact-based forecasting as a cornerstone in future FbF projects.

Some of the respondents expressed that the abovementioned parameters (forecasts, vulnerability and impact) were the type of data that they had used to develop their triggers. However, other respondents used even more parameters for their triggers. Respondent 5 explicitly mentioned that because drought has such a close connection to food security, triggers should not only relate to meteorological factors, but also incorporate natural and bio-physical together with socio-economic and cultural triggers.

One of the non-meteorological parameters that was mentioned several times was market analysis, meaning monitoring the markets and looking for abnormalities that could indicate stress in the agricultural sector – for example rising prices on certain crops. Another agricultural parameter is the monitoring of livestock body conditions, such as weight and diseases, as well as movement of livestock since abnormal livestock movement can be caused by inadequate feed at the animals' normal grazing areas.

To illustrate the wide variety of parameters that can be used to give an indication of an upcoming drought, Respondent 2 provided the following example from their project in the Philippines:

> "[…] when drought is imminent, they have a lot of rats come out. So, if you see the population of rats boom, that is a sign that drought conditions are starting to emerge and that they are searching for food as well and most likely attack crops."

With all these kinds of data to forecast a drought event, the respondents were asked about the possibility of developing universal drought triggers, to which all of them agreed that this would be problematic, if not impossible. The triggers will be dependent on the context in which they are set up, since the impact of a drought on society will vary based on that society's vulnerability, resilience level and socio-cultural and political factors. Thus, it will not be feasible to develop one set of triggers and use them in various contexts, as the triggers need to be tailored to the specific context of the country in which they are being used. However, as it was highlighted by respondents 2 and 4 it is possible to create a repository with various kinds of general indicators for inspiration, but they must always be contextualized before they are put into use.

5.5 Stakeholders

One of the things that was emphasized a lot by all the respondents, was that FbF will only be a success if it is a result of extensive collaboration between the relevant stakeholders. As Respondent 4 put it:

> "It is not something that we can sit in New York and do on our own. It has been extremely collaborative and iterative in terms of the definition of drought that is meaningful to them and that might even change from one country to another – how much confidence they need to have in that forecast in order to actually act […]."

Since the stated aim of most of the projects on a longer term is to build up the capacity within the local authorities to manage the FbF system themselves, it becomes evident that the local authorities need to be brought on and buy into the concept. One respondent even mentioned that it could be a potential problem of sustainability if the key local stakeholders are not involved in the project.

But who are these important stakeholders? Depending on the mandate of the organization, the respondents all mentioned various governmental institutions, such as Ministry of Agriculture, Ministry of Livestock or water authorities. Furthermore, the national meteorological departments also play a vital role in all the projects along with the disaster risk management authorities of the given country. Different NGOs and other humanitarian organizations were also highlighted by several of the respondents. On a regional and global basis, institutions like IRI, WMO and regional weather and climate centers, for example the African Center of Meteorological Application for Development (ACMAD), were mentioned as important partners. One respondent also pointed

towards the organizations and companies working with index insurance[5]. They could be useful partners, especially in relation to drought, where they in some places already have developed parameters for when a drought will impact a society. If these parameters can be forecasted, then it possesses a great potential.

It is, thus, a wide variety of actors that are involved and as one respondent said, when asked about who should be involved in the development of triggers:

> "Again, it depends on where you are setting up that system. But I think it goes anywhere from the communities that will use the system, or eventually use the system, to more governmental and political institutions that are working with that as well. Because those who holds the money, those who holds the decisions, plus those who will be impacted by the thing are important." (Respondent 5).

The respondents all agreed that the stakeholders should be involved from the first steps of setting up the system. In two of the organizations, the stakeholders had been involved already when deciding which areas to include in the projects. It was also pointed out that when developing triggers for drought, it is extremely important to gather the stakeholders and together agree on the definition of a good trigger in that project. There are two reasons for this; first, since there is no universal drought definition the stakeholders might have different perceptions of what a drought is, and secondly, the slow-onset nature of the drought, according to one respondent, makes it subjective when an area is going from a non-drought situation to a drought situation. Thus, there need to be consensus around the table if the triggers are going to be adhered to later in the project.

By involving the stakeholders in all facets of the setup, the aim is to enhance the ownership, thus paving the way for a governmental takeover in the future. One way of doing this, which is being practiced by a couple of the organizations, is not to trigger action based on forecasts from regional and global actors. As Respondent 3 explains:

> "Yes. We have access to those products [global forecasting systems] because they are often freely available. But we cannot act based on those products because of collaboration. So that information is supposed to come from the meteorological service. So, if you trigger action without the involvement of the meteorological service, then it is a problem. So, we have

[5] 'Index insurance is a relatively new but innovative approach to insurance provision that pays out benefits on the basis of a predetermined index (e.g. rainfall level) for loss of assets and investments, primarily working capital, resulting from weather and catastrophic events. Because index insurance doesn't necessarily require the traditional services of insurance claims assessors, it allows for the claims settlement processes to be quicker and more objective.' (Global Index Insurance Forum, n.d.).

access to those products, but we wait until we have the official forecast from the meteorological service."

Thus, the regional and global forecasts can be of advisory use, but for the sake of collaboration the actual forecast needs to come from the local authorities. This approach is, to some extent, also being used in FAO, where the regional and global forecasts have their own triggers, which are being weighed less than the country's meteorological service. At IRI, who produce global forecasts, Respondent 4 added that they also work with the approach that it should be the local meteorological institutions that issues the warnings. However, they are not always able to do that and therefore their capacity must be developed, and global forecasts can then serve as a demonstration and support while doing so.

It is, however, not only meteorological data that the local stakeholders bring to the table. As mentioned by one respondent, much of the data that can be used is already being produced in the different ministries and governmental institutions but, in some places, it is not being shared among the stakeholders. Here, FbF can be used as a tool to enhance the knowledge sharing and communication between different actors, thus building up knowledge and improving the actors' situational awareness. One way to do this is to arrange meetings on a monthly or bi-monthly basis, and to send out monthly bulletins to all the stakeholders with updates on recent developments.

When using subjective triggers, the stakeholders also play an important role when the triggers are met in deciding whether to act or not based on the available data.

5.6 Challenges when developing triggers

One of the main challenges, which was mentioned by multiple respondents, is the lack of a universal drought definition. Without a proper definition it potentially becomes difficult to agree on what a drought is and is not, thus making it complicated choosing which parameters to use to forecast a drought. Linked to the challenge of a proper definition is the creeping nature of drought, which makes it difficult to figure out and agree on exactly when an area transitions from non-drought to drought and the other way around. Drought is a complex phenomenon and this needs to be considered when developing triggers for it. This is also reflected in a quote by one of the respondents:

"[…] if it does not rain for a while and the crops are completely damaged and then all of the sudden it starts raining and everyone think that everything is okay. And meteorologically it looks okay. So, we have a big problem there and we see it right now in Southern Africa

actually and it really confuses people. It is really challenging to communicate that to people and this is what is needed to be reflected in FbF." (Respondent 1).

The respondent continued, saying that they therefore work with multiple drought definitions in their projects, which was true for the other respondents as well – even though some of them admitted that this could add to the confusion. One respondent even said that, for him, the existing FbF drought projects were not so much drought projects but rather food security projects and should thus be designed and acknowledged as such.

Another challenge that came up numerous times is the lack of data – both historical and current data. In terms of historical data, it concerns data that can be used to assess the forecast skill of the meteorological services and data that is being used to feed into drought indexes such as the SPI. Furthermore, there might also be a lack of data on historical impacts, as highlighted by one respondent:

"It is not easy to get the impacts. For instance, we know that tropical cyclones affect Mozambique regularly, but then those impacts are not properly recorded. For instance, if you go and look for a tropical cyclone that hit Mozambique in the 1980s, you do not have much records of that. So, that is really a challenge to collect information in terms of vulnerability and exposure. We are struggling with that." (Respondent 3).

When it comes to data about current conditions it also concerns data about where the vulnerable people are living and what they do for a living, as well as data on crop production, crop practices and soil data, which is especially important when assessing agricultural drought.

Even with the data used for seasonal and weather forecasts, there are challenges as these forecasts also have a degree of uncertainty. Respondent 4 expands on this by referring to satellite data:

"There is satellite information, but the satellites can be so biased. What the satellites is basically telling you is what is the temperature on the top of the clouds. It does not really tell you what is falling on the ground – but there is just this association, typically, between the temperature on top of the clouds and whether or not those clouds are raining. So, satellite information would not be a reliable thing either."

Politically declaring a drought can also possess some challenges, as some governments will be reluctant to officially declare a drought. Declaration of a drought is followed by an expectation that money will be allocated for the response to this, however the government might not be willing to,

or have the financial means to do this, thus they would rather avoid declaring the drought in the first place. Furthermore, a drought declaration has the potential to harm economic activities in the area as it might reduce tourism and investments. One respondent even mentioned that they have a project where they have to call it 'dry spells' instead of 'drought', as the government will not accept the event as a drought. In this case, the organization was still able to trigger action, however it could potentially be a big hurdle when agreeing on the trigger levels and when deciding whether to act or not.

Finally, many of the respondents expressed that the lack of experience with acting within FbF projects makes it difficult, as there are only few examples where action has been triggered, thus making it a slow process to get lessons learned and optimize the concept. One respondent pointed to the fact that many of the pilot projects are being carried out in few communities in a limited geographically area and then it has, so far, been communities elsewhere who have been hit by the disaster. Thus, the triggers and procedures only rarely get tested. One solution to this, which was mentioned, is to scale up the projects and make them cover larger areas to enhance the probability of getting to act and earn some valuable experience.

5.7 Conclusion on the interview study

The interview study has shown that developing triggers for drought is a complex matter, where many factors need to be considered. The respondents put emphasis on the local authorities' capacity and willingness to engage in FbF as cornerstones in both the start-up and management of FbF projects. There proved to be many ways of designing and using the triggers in the various projects, as well as types of data which is put into them, but all agreed that meteorological factors, vulnerability and impact must be central in all triggers. Finally, several challenges still exist when developing triggers, relating to the lack of data and a clear drought definition, political support and minimal experience, so far, with the FbF concept.

6. Discussion

6.1 Discussion of results

In this section, the results of the two scoping studies and the interview study will be discussed to answer the overall research question of the thesis.

The scoping study on drought revealed that there are many factors that contribute to a drought hazard evolving into a disaster. As most of the respondents agreed during the interviews, this must therefore be reflected in the triggers that are set up for drought. Thus, these triggers must be many and varied so that they cover both natural and societal factors. The fear by opening for a wider perception of triggers, is that it can lead to confusion and disagreement between different stakeholders about which factors that would be relevant to consider, making the process considerably more time-consuming and blurry (Oxfam, 2017). Judging from the results of both the scoping studies and the interviews this, however, seems to be a necessary step that the involved parties are ready to invest in. The variation of triggers is not only applicable for the type of indicators used but also in relation to the context in which the triggers are to be used. Both the literature and respondents mentioned that a contextualization of triggers must be done, since the drought indicators and danger levels will vary a lot from country to country based on culture, vulnerability and the organization of the society. Therefore, it is also widely agreed that useful universal triggers cannot be developed.

In both the literature and interviews it was emphasized that impact and vulnerability data must be an important part of trigger development. Impact data can for instance be how a dry spell over a certain period will affect the crops that are being cultivated, while vulnerability relates to farming practices and living conditions that will determine how affected the different population groups will be. An example could be that a forecast warns that dry spells in the raining season will result in crops being affected. Then the most vulnerable people will be the farmers with the least drought resistant crops. By integrating these factors, the actors can, for instance, focus on the areas and populations that are most at risk, meaning the areas where the hazard could evolve into a disaster. This approach is further backed in a WMO report from 2006: ”Drought by itself is not a disaster. Whether it becomes a disaster depends on its impact on local people, economies and the environment and their ability to cope with and recover from it.” (WMO, 2006). Thus, without data on vulnerability and impact, actions could be implemented that are unproductive or even counter-productive. The demand for this kind of data is in line with the broader disaster risk management community, where there has been a shift towards talking about natural hazards, and not natural disasters. Thus, proclaiming that there is no such thing as a natural disaster, but rather a natural hazard, that can evolve into a disaster if it encounters vulnerable people or activities (e.g. Wisner

et al., 2003; Bankoff, 2010; Ras, 2017). It is therefore, important to go beyond triggers on meteorological factors by also looking at vulnerability and impact.

When setting up an FbF system a decision also needs to be taken on the design of the triggers and whether these should be subjective or automatic. One could argue that the slow-onset nature of a drought allows the time for human judgement and discussions with the stakeholders to assess and validate the triggering. The argument for this model, is that the triggers can be faulty and that societal developments can influence the triggers in a way that does not reflect the actual situation. As pointed out by one respondent, however, it is important that these discussions are not used as a political excuse for dragging out the process and in doing so miss the window of opportunity to act early.

Another aspect that was highlighted in both literature and interviews was the need for close cooperation with the various stakeholders. FbF must be the result of extensive collaboration and build on a common understanding of the hazard that FbF is addressing to be a success. In the literature a project using a global forecasting system was mentioned. However, in the interviews some respondents were very cautious about this approach, as many of them emphasized the importance of having the local institutions issuing the warnings. The reasoning behind this being that it would enhance ownership, thus making a future handover to the local authorities of the FbF project possible.

Looking at the challenges which exist when developing triggers for drought, there are quite a few that need to be addressed. The lack of a universal drought definition is mentioned numerous times in both literature and interviews as being one of the main hurdles when trying to identify feasible triggers. Without a common definition, different organizations might have different views on what a drought is and therefore also different views on which factors are indicating a future drought. Furthermore, it also becomes unclear exactly when the transition from non-drought to drought happens and therefore when to commence which actions. However, Lloyd-Hughes from University of Reading, argues that it will not be possible to create a universal, workable drought definition. In an article from 2013, he argues that drought cannot be seen in isolation of water resource management practices, which obviously are different across the globe. He therefore concludes "that for most practical purposes `drought' in the `universal' sense is unquantifiable. In general, universal drought cannot be defined without knowledge of the climatologically expected values for the availability of stored water for a given need." (Lloyd-Hughes, 2013: p. 12). Lloyd-Hughes, therefore advises that drought should be discussed in more subjective ways relevant for the specific context. This falls well in line with one of the respondents, who emphasized the need

for thorough discussions with the stakeholders at the onset of the project to gain a common understanding of drought in their context.

It was also found in the studies that availability of data was a hindrance for developing useful triggers. In many places, the type of data that is demanded is not being generated in such a fashion that it can be used as reliable inputs to the triggers. For some of the needed data this is also closely connected to the forecast skill of the local authorities, which in some places were found to be questionable.

Finally, an article and one respondent mentioned, that in some cases the drought FbF projects were not as much geared towards drought as they were geared towards food security. If the actual purpose of the FbF project is to mitigate food insecurity, then this should clearly be stated in the project. Despite often being regarded as very closely connected, drought and food insecurity does not necessarily have a connection. Therefore, FbF projects aiming at reducing food insecurity should expand to also include triggers that are not only related to drought, such as armed conflict, population pressure on land and overgrazing, as these also are contributors to food insecurity (Balint et al., 2013). On the other hand, drought can also lead to impacts that are not directly related to food security, such as water-borne diseases, lower electricity production (from hydroelectricity) and migration (Respondent 3). There is therefore a need for a clear distinction between if the project is focusing on drought or food security (or drought-induced food security), as this will affect the triggers that are used. If this is not done, it could lead to inefficient drought management and potentially failure to forecast an upcoming event.

6.2 Discussion of methodology

To answer the research question two scoping studies and five interviews were conducted. When conducting a scoping study, one of the defining parts is generating a search query string, as it will define which articles are found in the database. Even though the two search query strings were developed through several test searches, there could still be compositions that would have provided more comprehensive results. It can therefore not be ruled out, that important literature has been passed by due to the limitations of the search query string developed. Especially, for the drought scoping study, there are potential omissions as this field possess a lot of terms and technical discussions that are difficult to comprehend for non-experts. For future research, it could therefore be useful to engage a drought expert when developing the search query string. Also related to the literature, the sparse use of grey literature in the thesis, means that information and lessons learned from various organizations might have been missed. However, it was chosen to focus on the

scientific literature to also provide an overview of the knowledge on the topic within the scientific community.

When identifying respondents for the interviews, one of the methods was to use gatekeepers. The risk by using gatekeepers is that it is the gatekeepers that decide who they facilitate contact to based on their understanding of the project. It is therefore, important to describe the purpose of the project and which role and topics the respondent is expected to talk about. The strength of the results could also have been further enhanced by interviewing people from other organizations working with FbF and drought, as they could have brought new knowledge and perspectives or have strengthened the impressions from the interviews that was carried out. Finally, it would have been interesting to get the perspectives on the topics discussed in this thesis from some of the local authorities, as they might differ from the ones presented here. Unfortunately, it was not possible to schedule any interviews with persons from this segment despite numerous attempts. Due to this the generalizability of the thesis is limited to the side of the humanitarian organizations as the thesis does not include any perspectives from local authorities.

6.3 Future research opportunities

With FbF still being a rather new concept there remain a lot of issues that have not yet been covered by scientific literature. During this study potential new study areas have emerged, which could be interesting to research further in the future. A few of the respondents brought up index insurance (see footnote 6) and that companies working with that already use pre-defined triggers for drought. It would therefore be interesting to examine what these companies use as triggers, how they have developed them, and their experiences hereof, as there could be some valuable lessons learned that would be feasible to transfer to FbF.

As mentioned in the discussion, there are claims that some FbF projects are more about food security than drought. It would therefore be interesting to go into depth with specific drought FbF projects to examine if this is true, and if so how it impacts the projects.

7. Conclusion

This study set out to answer the research question on how to develop useful triggers for drought in a Forecast-based Financing system. To do this, two scoping studies and an interview study were carried out. The results of these studies showed that it would not be possible to develop triggers that can be applied universally since drought is a very context specific hazard emerging as a result of different factors. The triggers must therefore also be tailored to the context in which they are to be used and cover a range of different aspects. First, vulnerability and impact should be integrated into the triggers as those factors are vital in determining if the hazard will evolve into a disaster. Seasonal and weather forecasts should be assigned probability and uncertainty levels to aid the decision-making process and cost-benefit analysis of potential actions. Furthermore, non-meteorological factors such as market prices on crops and livestock movement were also highlighted as useful parameters to develop triggers on. FbF is the result of a joint effort where many stakeholders play important parts. Especially the local authorities are important actors, as the aim of many FbF projects is to build up their capacity and eventually handover the system to them. To enhance their ownership, they should therefore be engaged in all parts of the projects. In some projects, it will thus only be based on the local authorities' forecasts that actions will be taken, since it would harm the collaboration if the authorities were to be overruled by global or regional forecasting systems. Finally, a decision needs to be taken whether to operate with automatic or subjective triggers, with the first one being quicker and more efficient, and the latter, as it was seen in one project, giving the opportunity to detect abnormal outsider impacts on the triggers.

The development of drought triggers possesses numerous challenges that needs to be addressed if the system is to be efficiently implemented. Especially two challenges were highlighted again and again. First, since there is no universal drought definition it can be challenging to achieve common ground between the stakeholders in the understanding of what a drought is and when it starts. This can lead to confusion around which triggers would be feasible to use. Therefore, a thorough discussion among all the stakeholders should be facilitated to agree on a common definition and aim of the specific FbF drought project. The other major challenge is the lack of data in many of the areas where FbF is being introduced. This regard both historical and societal data, which is not or has not been generated and therefore cannot be used to inform the development of triggers.

If Forecast-based Financing is to fulfill its potential, as being a vital part of reducing losses and hardship caused by drought, the abovementioned challenges must be overcome and the presented perspectives on developing triggers be considered.

8. Literature

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Appendices

Appendix 1: List of literature included in the Forecast-based Financing scoping study.

Appendix 2: List of literature included in the drought forecasting scoping study.

Appendix 3: Interview question guide.

Appendix 1 – Literature for scoping study on FbF

The following is a list of the literature used in the scoping study on Forecast-based Financing:

Braman, L. M., van Aalst, M. K., Mason, S. J., Suarez, P., & Ait-Chellouche, Y. & Tall, A. (2013).

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Appendix 2 – Literature for scoping study on drought

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Appendix 3 – Interview questions

Here are the interview guides used as the foundation for the five semi-structured interviews, grouped into practitioners, academia and forecasting experts.

Questions for FbF practitioners:

- How do you see the future role of FbF in humanitarian work?
- What are the requirements for setting up an FbF system?
    - Technically?
    - Organizational?
- What is a good trigger?
- How do you develop the triggers you use?
    - Who are involved in this process?
    - What kind of information is needed (is it only meteorological or also other types)?
- Which factors are relevant to look at when forecasting a drought?
- Do you link drought indicators to impact and vulnerability?
    - How?
    - What does this mean for the triggers you choose?
- Which drought definition do you work with? And why?
- How much time is needed to carry out meaningful drought preparedness activities?
- Which preparedness activities for drought do you carry out?
    - If a drought is projected within the next couple of months, what can be done to prevent/mitigate its consequences?
- Which system(s) do you use for drought forecasting?
- Do you always work through local meteorological institutes? Or are there global systems you can use in areas where the meteorological capacity is low?
- Have the triggers on any of your drought projects been met? What were the key learnings from this?

Questions for drought experts:

- How does drought impact a society and at which levels?
- Which factors are relevant to look at when forecasting a drought (only meteorological?)?
- As I understand it, most drought forecasting systems use historic data:
    - What can be done in places where only limited data is available?
    - Will the methods for measuring drought be less accurate in the future due to climate change?
- Why is drought more difficult to predict than for example floods?
- If a drought is projected within the next couple of months, what can be done to prevent/mitigate its consequences?
- Can indexes such as SPI and PSDI be used for forecasting or only monitoring?
    - How do such indexes contribute to Early Warning Systems?
- Would it be possible to develop useful universal triggers for drought?

Questions for academia:

- What are the requirements for setting up an FbF system?
    - Technically?
    - Organizational?
- What is a good trigger?
    - Should triggers only relate to meteorological factors or also other factors? Which?
- What is the relationship between triggers and vulnerability and impact – is that something that should be integrated? And if so, how is that done?
- Which stakeholders should be involved in the trigger development phase – and why?