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Communication Structures and Decision Making Cues and Criteria to Support Effective Drought Warning in Central Malawi

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Early warning systems trigger early action and enable better disaster preparedness. People-centered dissemination and communication are pivotal for the effective uptake of early warnings. Current research predominantly focuses on sudden-onset hazards, such as floods, ignoring considerable differences with slow-onset hazards, such as droughts. We identify the essential factors contributing to effective drought dissemination and communication using the people-centered approach advocated in the WMOs Multi-Hazard Early Warning System Framework (MHEWS). We use semi-structured interviews with key stakeholders and focus group discussions with small-scale farmers in the Mangochi and Salima Districts of Malawi. We show that the timely release of seasonal forecast, the tailoring of the drought warning content (and its timing) to agricultural decision making, and the provision of several dissemination channels enhance trust and improve uptake of drought warning information by farmers. Our analysis demonstrates that farmers seek, prepare, and respond to drought warning information when it is provided as advice on agricultural practices, rather than as weather-related information. The information was found to be useful where it offers advice on the criteria and environmental cues that farmers can use to inform their decisions in a timely manner. Based on our findings, we propose that by focusing on enhancing trust, improving information uptake and financial sustainability as key metrics, the MHEWS can be adapted for use in monitoring the effectiveness of early warning systems.

Keywords: Malawi, people centered design, effectiveness, communication and dissemination, drought warning, extreme events forecasting, developing countries

INTRODUCTION

The intensification of climate-related disasters and their catastrophic impacts are increasingly affecting the most vulnerable populations (UN, 2019). To reduce the impacts disasters have, approaches are shifting from humanitarian response-driven strategies toward preparedness and resilience-building with local communities as part of Disaster Risk Reduction (DRR)

(Staal, 2015; UNDRR, 2015; Hilhorst, 2018), with an emphasis on early warning systems (EWS). The 7th global target of the Sendai Framework for Disaster Risk Reduction (UNDRR, 2015) calls for substantial improvements in multi-hazard early warning systems. Dissemination and communication of warning information is a key and challenging aspect of such early warnings systems, and need to be developed effectively to help reduce the harm caused by extreme weather events (Taylor et al., 2018). Ultimately, the effectiveness of EWS depends on whether warnings trigger the taking of early preventative action by end-users (Rai et al., 2020).

To facilitate the development of warnings that are actionable, a people-centered paradigm has been promoted. The essential elements of this paradigm—community engagement, integration of local perceptions and information tailored to those at risk—are recognized to enhance trust in the warning information and increase its uptake (WMO, 2015, 2018). The MHEWS framework (WMO, 2018) has been developed by the WMO from the Sendai framework and provides guidelines on the development of an effective people-centered approach to communication and dissemination of early warning information. Aligned with the MHEWS, emerging approaches—such as impact-based forecasting and the use of adapted and local communication channels and services—have helped transform hazard-only forecast data into useful information for those at risk by incorporating peoples' perception of risks and needs and improving local understanding of a hazard's potential impact (Sivakumar, 2006; Luther et al., 2017; Taylor et al., 2018; WMO, 2018). Recent examples from Kenya and Zimbabwe—such as the development of local media (e.g., a local community radio), using local languages in communication and extension services, and integrating local knowledge—show that such approaches improve the contextualization of information, increase the sense of ownership in the messages delivered, and enhance trust, and thus uptake, of warning information (Sivakumar, 2006; Pulwarty and Sivakumar, 2014; Andersson et al., 2019). EWS user needs and their perception of risks are context-specific elements that must be considered to provide enough evidence of a threat and prompt early actions by those at risk (Choo, 2009; Parker et al., 2009; Pulwarty and Sivakumar, 2014). Context relevant social and environmental cues and criteria also closely relate to agro-climatic indices, measures of an aspect of the climate that has specific agricultural significance, as Mittal et al. (2020) (this issue, submitted) defined for Malawi. Environmental cues are environmental indicators that exhibit the hazard, and social cues relate to indicators present in the social environment of the user (Choo, 2009).

Current early warning systems have, however, mainly concentrated on hazards associated with immediate impacts, such as floods, earthquakes, and hurricanes, and less on slowly developing hazards such as droughts. For the latter, the development of early warning processes is challenging as drought definitions and perceptions vary from place to place (Monacelli et al., 2005). Drought is a hazard that has been characterized as a natural long-term phenomenon with cumulative impacts (Pulwarty and Sivakumar, 2014), initiated by a prolonged deficiency in precipitation (Villagrán de León et al., 2013; Pulwarty and Sivakumar, 2014). As a result of the deficient precipitation, a cascade of impacts on the surrounding environment and diverse societal and economic sectors can ensue; this makes droughts a context-specific hazard that is difficult to identify (Wilhite, 2000; Monacelli et al., 2005; Pulwarty and Sivakumar, 2014). As a result, drought risk management focuses on crisis-driven strategies rather than proactive approaches (Pulwarty and Sivakumar, 2014). Across Africa droughts represent one of the major life-threatening hazards with significant impacts on the agricultural sector (IPCC, 2019), warranting the need to develop effective systems to improve the uptake of drought warning information (Lumbroso et al., 2016). In this context, user-centric climate services have been promoted as a way to enhance drought resilience in agriculture (Villagrán de León et al., 2013; Roudier et al., 2014; Mungai, 2017; Mahon et al., 2019).

Climate services are primarily developed through National Hydrological and Meteorological Services (NHMS) (Sivakumar, 2006; Mahon et al., 2019) and help transform weather information into relevant warnings for end-users. Lack of funds, relevant skills, institutional and human capacities, and policy support are recognized as barriers to the development of such services (Sivakumar, 2006; Mahon et al., 2019). In addition, feedback from end-users though which the evaluation of EWS can improve its design, development and implementation, are lacking (Sivakumar, 2006). Climate information tends to be developed following a value chain approach, where weather data generated by climatic centers are (re)packaged through various actors and then fed to end-users without engaging them in the development process, causing information to lack of contextualization and thus limiting the uptake on climate information by communities (Vogel et al., 2019).

To contribute to drought preparedness strategies through the provision of actionable drought early warnings, this paper explores the key factors that contribute to effective drought warning communication and dissemination. Our study in Malawi reflects on these factors within the context of the people-centered-approach advocated in the MHEWS. It has been recognized that the implementation of the MHEWS in Malawi has been constrained by issues such as the late release of information by the government, the lack of accessibility (in terms of reception of information by end-users) and reliability of the information, as well as the lack of understanding of the information provided (Venäläinen et al., 2015; Šakić Trogrlić and van den Homberg, 2018). The development of a tailor-made drought warning communication and dissemination process is recognized as a major challenge (Government of Malawi, 2018) that needs to be addressed to encourage the uptake of drought warning information.

This paper first provides background information on the drought warning system in central Malawi, followed by a description of the methods used for data collection and analysis. The results section outlines the key factors that were found to contribute to effective drought warning communication and dissemination through an analysis of; (i) how drought warnings have been generated to meet farmers' needs; (ii) how they have been disseminated within the governmental and humanitarian sector actors and communicated to farmers; (iii) how farmers respond to the warning; and, (iv) how, why and if drought warnings are effective from a farmer's perspective. Finally, the discussion and conclusion section position these factors within the context of MHEWS framework, illustrating how the established process is aligned to the framework, as well as reflecting on how the framework can be built on and adapted for use in monitoring the effectiveness of early warning systems.

STUDY AREA

Malawi has a sub-tropical climate comprising of a wet season from November until April, and a dry season from May to October. Precipitation is highly variable due to the topography of the country (Bucherie, 2019). Furthermore, the climate of Malawi is correlated to the ENSO effect (Šakić Trogrlić and van den Homberg, 2018). Malawi is listed as one of the poorest countries and most vulnerable to climate change (UNDP, n.d.). It is a country prone to disasters, where droughts constitute one of the major natural hazards causing food insecurity, which has led to the high involvement of humanitarian and non-governmental organizations (NGOs) (Šakić Trogrlić and van den Homberg, 2018). After endorsing the Hyogo Framework, Malawi has shifted its approach to disaster risk reduction to align with the Sendai Framework and focus on preparedness and resilience building with local communities to cope with food insecurity (Government of Malawi, 2018).

Although there is scarce literature available on the drought warning communication and dissemination process in Malawi (see Šakić Trogrlić and van den Homberg, 2018; Streefkerk, 2020), recent studies reveal that there is a mostly top down system in place for the dissemination of drought warning information (Streefkerk, 2020) from the national level to local level, though most authorities involved in the design of the drought warning remains at the national level. The drought early warning system consists of the provision of a seasonal forecast, first agreed upon at the Southern African Regional Climate Outlook Forum (SARCOF), and by the Department of Climate Change and Meteorological Services (DCCMS) in Malawi. SARCOF leads a regional climate outlook prediction process embraced by the Southern African Development Community (SADC). This community is composed of sixteen countries, including Malawi (WMO, n.d.). The seasonal forecast showing the rainfall predictions for the season is then downscaled to national level and disseminated by DCCMS through mainly the agricultural and disaster management departments to the local communities. Various means of dissemination such as organized gatherings, radio program, text messages, and word of mouth are used to ensure that a maximum number of farmers are reached. Nevertheless, the lack of staff capacity and the limited access by the population to mobile phones, radio sets, or internet limits the accessibility to drought warning information.

METHODS

Figure 1 provides an overview of our research methodology. We use the MHEWS framework (WMO, 2018) to structure our analysis. This was developed from the Sendai framework and provides guidelines on the development of effective communication and dissemination processes through a people-centered approach. The warning communication and dissemination element is one of the four elements of people-centered early warning systems and aims at ensuring that those at risk receive warning information in an understandable and useful way. The other three elements are the knowledge of disaster risk; the detection, monitoring, analysis and forecasting of the hazards and possible consequences; and, the preparedness and response capabilities (WMO, 2018). Within the warning communication and dissemination element, the guidelines in the framework (**Appendix 1**) are clustered in three dimensions: (i) the organizational set-up; (ii) the communication systems and equipment; and (iii) the effective communication of impact–based early warnings to prompt early actions by those at risk. As the MHEWS provides no clear distinction between communication and dissemination, for the purpose of this paper, we use the characteristics outlined by the EU IPR Helpdesk (Scherer et al., 2018) and adapt them to our context. Dissemination is defined as the means used to spread the warning information within official governmental and humanitarian channels to reach farmers, while communication relates to the strategy and measures in place to format the message in the most adapted way for farmers (end-users here). Although our focus is on the warning communication and dissemination element of EWS, this cannot be completely separated from the warning generation and the action taken by farmers on reception of drought warnings, which belong, respectively to the monitoring and warning elements, and to the response capability element of the MHEWS framework.

Data Collection

The channels and the actors identified to be relevant to the dissemination and communication are based on Streefkerk (2020). To understand how drought warnings are communicated, focus group discussions (FGD) were carried out with five groups of small-scale farmers, two in the Salima district and three in the Mangochi district (refer to **Table 1**) (**Figure 2**). To build on Streefkerk (2020), we chose the same districts and the same group of farmers. Group sizes varied between 5 and 11 people, among which half-represented women. We carried out 25 semi-structured Key Informer Interviews (KII) with stakeholders including governmental bodies, UN agencies, and NGOs (i.e., CADECOM, Malawi Red Cross, NASFAM, Malawi Lake Basin Programme, Oxfam) in Lilongwe, Mangochi, and Salima districts. The selection of NGOs was guided by those that were identified by farmers as relevant to the communication and dissemination process.

Key Informer Interviews (KII)

KII were carried out either by a phone call or in person, and in English (with a translator where required) using an open-ended questionnaire (**Appendix 2**). Stakeholders were contacted via e-mail, and questionnaires were sent upon request prior to the meeting. Prior to the start of any interview, permission to record the interview was requested. Each interview lasted for around

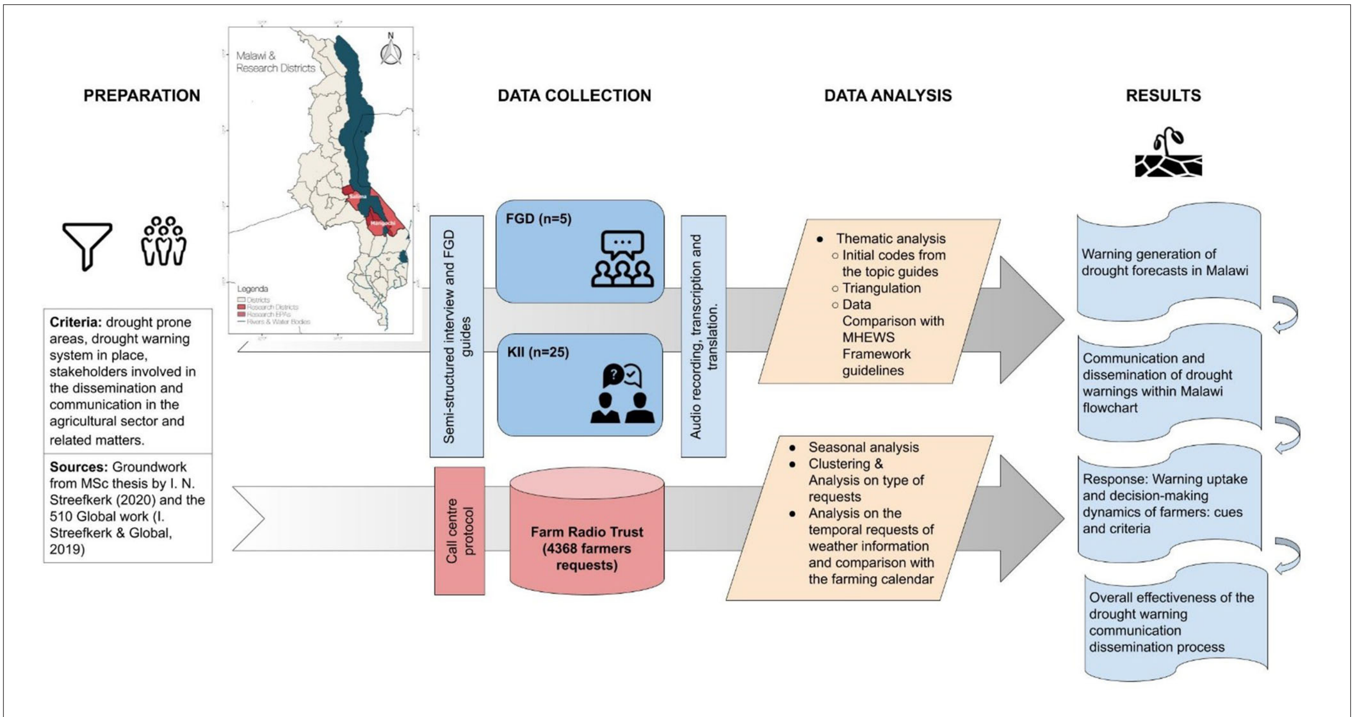

FIGURE 1 | Research methodology overview.

TABLE 1 | List of stakeholders that were either interviewed or part of the focus group discussions.

Level	Stakeholders
National level	Farm Radio Trust WFP UNDP
District level	DoDMA District Desk Office–Salima District Agricultural Development Office (DADO)—Salima DoDMA District Desk Office—Mangochi District Agricultural Development Office (DADO)—Mangochi Meteorological District Office Mangochi
Area	Agriculture extension officer Maiwa (3 officers, interviewed in a group) Agriculture extension officer Mbwadzulu (3 officers, interviewed in a group) Agriculture extension officer Nankumba (2 officers, interviewed in a group)
Local	NGOs: Oxfam, CADECOM, Malawi Lake Basin, NASFAM, Malawi Red Cross (3 Members)
Local	Informal Cape Maclear (2)
Local- FGD	Farmers Salima: Location 1 and 2: Khombedza Farmers Mangochi: Maiwa, Mbwadzulu, and Nankumba

30–40 min. The information gathered through KII included state of current drought early warning systems, the information flow between different institutions and the communication of drought to other institutions, or end-users. At the district level, more in-depth questions on the process of contextualization of weather forecast at the district level and the use of climate information by farmers were asked. Interviews with NGOs and UN agencies focused on obtaining insight into their involvement in the dissemination and communication of drought warning in Malawi, as well as the uptake of the information by their own organizations to inform early actions. Discussion also included information on the organization structures and communication processes, and uptake of climate information by farmers.

Focus Group Discussions

The consolidated criteria for reporting of qualitative research (COREQ) were used to guide the preparation of FGD strategy and reflect on the data quality (Tong et al., 2007). As such the following criteria were considered:

- The name and occupation of the facilitator (s) and translator;
- Background information on the translator such as the gender and experience;
- The number of participants, demographic data: names, the occupation, gender;
- Time of the day, the duration of the FGD;
- Observations on the communication dynamics;
- Observation on the quality of transcriptions.

Focus group discussions with farmers were carried out in Chichewa, the local language, and then translated and transcribed for analysis. In the first part of each session, a farming calendar was constructed with farmers and the discussions was held around the type and sources of information used for their decision-making process, under normal conditions. The second part of the session consisted of understanding how drought was perceived and understood by farmers, followed

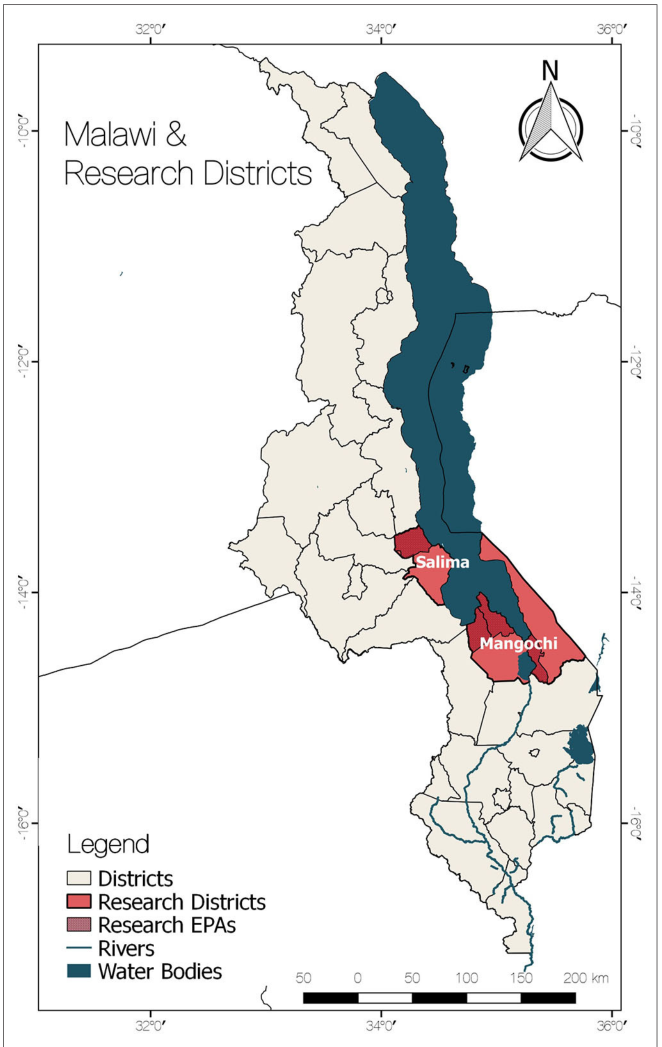

FIGURE 2 | Map of Malawi and districts considered in this research.

by how their farm decisions were influenced by drought warnings from different sources (**Figure 3**). The last part of the session consisted of a discussion on issues encountered and recommendations to improve the current early warning dissemination and communication (**Appendix 2**). Further information was gathered from the Farm Radio Trust (FRT) database collecting all farmers' questions. FRT categorizes these requests by Crop type/ Regional/District/Gender/Categories and Query. For this study, we focused on the tab "Categories" as it provides more details in terms of the nature of the request. Examples of categories are: Organic Manure, Pest and Disease Control, Livestock related, Weather information, Soil and Water conservation, Irrigation etc. Information from FRT was obtained for the period from November 2018 to November 2019, with the exception of the months of March and June 2019, where the records were not available.

One of the limitations of the study is that it depends predominantly on participant recall and perception, rather than on direct observations of EWS dissemination, communication, and uptake. We lack existing baseline data for pre- and post-EWS intervention comparison or the capacity for procedural monitoring, this is a point that we return to in the discussion, with regards to recommendations for EWS evaluation.

Data Analysis

Our analysis of the drought warning generation, and its dissemination and communication is based on the qualitative method of data coding (Saldaña, 2016). In the context of a qualitative inquiry, a code is most often a word or short phrase that symbolically assigns a "summative, salient, essence-capturing, and/or evocative attribute to language-based or visual data" (Saldaña, 2016). By looking for patterns, similarities and/or relationships of what people say on a topic, information is clustered manually using Excel into a main code. Each code is composed of the various stakeholders' perspectives on that particular theme. The information is triangulated by checking it against the information provided by KII and validated. Findings were then compared with the MHEWS conceptual framework guidelines on the effectiveness of the warning dissemination and communication processes (**Appendix 1**) by looking if elements listed in the framework could be found in the system in place in Malawi.

Regarding the use of warning information, the MHEWS framework states that the impact-based warning needs to prompt action by the target group, but it does not provide more information regarding how to assess this element. Therefore, to analyze the use of drought warning information in farm decisions, the protocol developed by Doksæter Sivle and Kolstø (2016) was adapted for this study. This protocol was designed to analyze the use of weather information by the public in Norway by looking at the factors that affect the amount of information used, the type of information used, the dynamic that people follow to carry out different activities, and the evaluation of uncertainty. This analysis was based on identifying the criteria and associated indicators that people use to make their decision paths for various activities. In this study, the data analysis followed a similar protocol. Our analysis of the focus group discussions focused on (i) identifying the farming activities carried out under normal and drought conditions, (ii) determining the conditions (criteria) outlined by farmers that needed to be met to carry out each activity, and (iii) identifying the indicators (cues) that farmers used to decide whether those conditions are met. The source and type of information received is the same across the farmer groups, except for the presence and frequency of support provided by NGOs to different groups. Also, the extension officers in both districts have been trained through the Participatory Integrated Climate Services for Agriculture (PICSA) program (Dorward et al., 2015) implying that the information is communicated at consistent levels of comprehensibility to farmers in both districts. The program trains extension officers to interpret and understand the climate information and predictions to help them better explain the seasonal forecast to farmers. Regarding data from the FRT, weather related requests from the database were

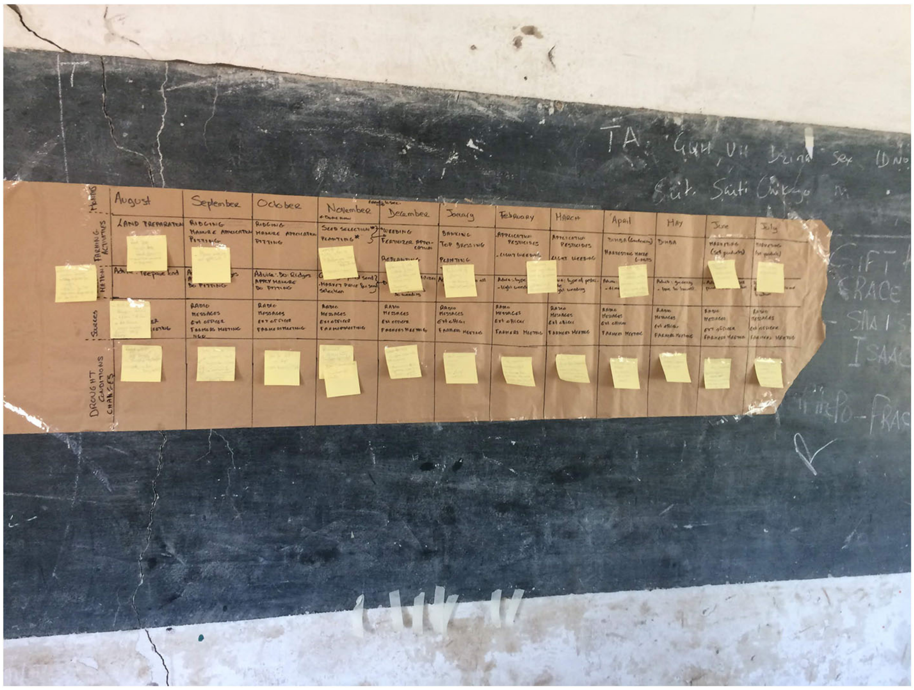

FIGURE 3 | The farming calendar that was built during focus group discussions with farmers. First row: Farming activities, Second row: Information received, Third row: Sources of information, Last row: Changes when there are drought conditions.

compiled and plotted to give a chronological view of the amount of requests during the farm season. This permitted to analyze whether, and if so when the weather information is more relevant to farmers.

Through analysis of the data from the FGDs and combining with the Farm Radio Trust data on the type of information requested by farmers, it was possible to assess whether and how the warning information was received, understood, and used by farmers. This improved our understanding of farmers' response to drought warnings.

RESULTS

Generation of Drought Warning

In Malawi, drought warnings targeting farmers are only developed through the seasonal forecast process. The process usually starts upon the release of the seasonal forecast by the Department of Climate Change and Meteorological Services (DCCMS). For the past 2 years, the seasonal forecast has been downscaled to the district level, and even to the area-specific administrative level for certain districts, before it is disseminated to various actors, as expressed by 15 out of 25 KII. At the National Content Development Committee (NCDC), 5 out of 25 KII explained that the data are then discussed among the various stakeholders (DAES, NASFAM, FRT, WFP etc.), and advisories for different districts, as well as mitigation measures to cope with different hazards, are formulated for farmers.

The seasonal forecast is provided at the district level in the form of a poster (**Figure 4**), in both English and local language "Chichewa." Tweleve out of twenty-five KII explained that the poster provides an estimate of the potential rainfall in the district, characterized by statements such as "above, below, or normal rainfall." When a statement "below normal" is issued, DCCMS associates it with the expected occurrence of dry spells. When a dry spell is expected to be prolonged during the rainy season for a period of 2–3 weeks and above, the message delivered to communities includes that potential drought conditions may occur, and, as such, drought mitigation measures are recommended *"When we disseminate to communities, we don't go deeper: we only say normal, below or above normal and then add the implications. If you have below normal: practice on conservation agriculture and technologies that encourage high moisture in the soil, early maturity seeds etc." (Governmental authorities).*

During an extreme year, these messages are reported to be issued more frequently. They consist of a warning that drought is coming and conservation agriculture measures should be taken. These types of drought warnings have been characterized by the providers as impact-based messages. *"For example we say if dry spells continue these are the impacts on the crops and this is what you should do" (Governmental authority)*. However, based on the focus group discussions, all farmers describe the message as being solely an advice providing guidance on the most suitable farming practices for the seasonal forecast provided. Additional to the seasonal forecast, 10-day agro-meteorological bulletin, weekly

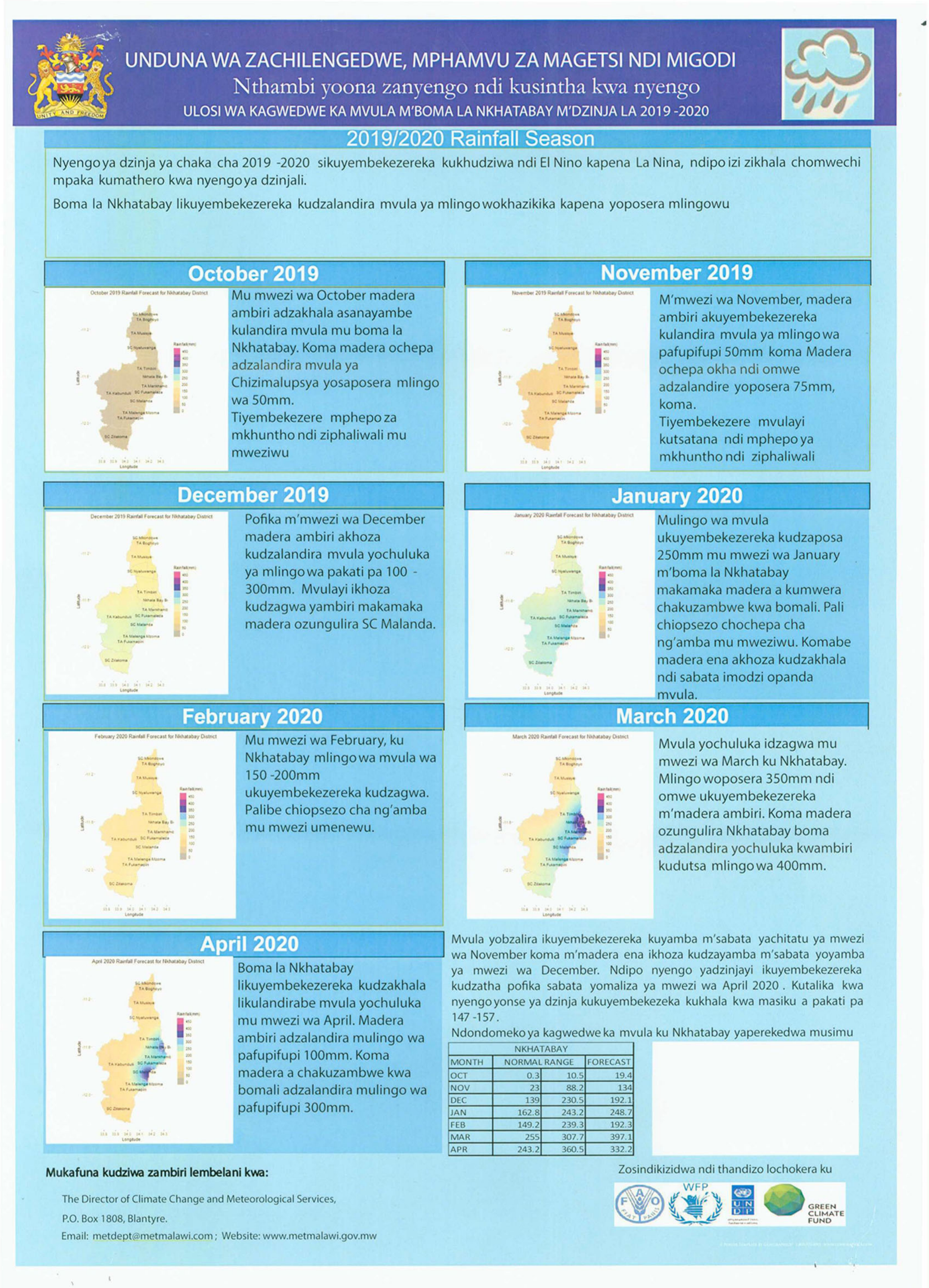

FIGURE 4 | Seasonal forecast for the Salima District 2019–2020.

weather statements, 5-day forecasts, and daily forecasts providing updates on rainfall and wind are disseminated through various channels, including radio, text-messages, newspaper, e-mails, WhatsApp groups, and on the DCCMS website. Other sources of dissemination include community gatherings, the use of loud-hailer via car or van around the village.

The Dissemination and Communication Strategy

The process of dissemination of drought information is conceptualized in **Figure 5** and has been described by 19 out of 25 KII. Once the warning information has been generated, it is transmitted to the District Agricultural Development Office (DADO), the District Civil Protection Committee (DCPC), and district meteorological offices. Stakeholders from these organizations then gather in a district coordination meeting to adapt the climate information to their districts, and agree upon the strategy to disseminate information at the local level. National level structures also provide backstopping support to these dissemination strategy meetings at district level. We identified two channels through which information is disseminated: the agricultural advisory channel and the disaster risk management advisory channel (**Figure 5**). In the agricultural advisory channel, information is passed on to the agricultural extension officers, who then pass it on to lead farmers and communities. In the disaster risk management advisory branch, DCPC has the role of disseminating information to the Area Civil Protection Committee (ACPC) and Village Civil Protection Committee (VCPC), which then provide the information to communities. As one government stakeholder explains; *"(...) after that we communicate with communities through the structures from district level up to community level. [There are] civil protection committees responsible for all disaster related issues (. . .). At TA level, there is an area civil community and at village level a community civil committee. Those committees: disseminate the climate information and any weather related information. At TA and village they disseminate what the district gives. But then it depends, sometimes they meet and plan together as a community and combine the guidance given by district and adapt it with communities."*

In Malawi, humanitarian agencies are extensively involved in disaster response related matters and in the dissemination of information. As described by 16 out of 25 KII, NGOs are involved mainly in the implementation of plans at the area and local administrative levels. Their role varies depending on the aim of each NGO. In contrast, UN agencies like UNDP and WFP are more directly involved in the production of climate information at national and district level, rather than at area and local level (apart from supporting the local disseminators, where necessary). For drought preparedness and warning communication, the main support provided by humanitarian agencies and NGOs is to release funds that these organization have received from donors to support food security measures. These funds help the drought warning development through enabling stakeholders meetings, the production of seasonal forecast posters, capacity building on the understanding and interpreting seasonal forecast, and increased access to information by reaching areas where extension officers cannot go. *"In DRR, we work with local government structures: district counsels (with CPC), ACPC and VCPC). We provide support to those structures through capacity building." (NGO). "We provide financial support to contingency plans for certain districts, training of committees and governmental staff." (NGO).*

Our finding from the FGD show that the main channels used for the communication of drought warnings were in order of usage frequency community gatherings, extension officers, NGOs, certain radio programmes, and text-messages. Of these, in all focus group discussions, farmers preferred as channels, extension officers, and radio. Extension officers facilitate communication amongst farmers during community gatherings, while the Farm Trust Radio (and other local radio broadcasters) has a greater reach to farmers and communities. The contribution of Farm Trust Radio is greatly appreciated, as shared during FGD: "*We want any communication about weather changes to be through radio [as] it's very easy for us to know the information*" and "*the best mode of communication is the radio because it [is] easy and faster.*" NGOs were found to coordinate with extension officers and use similar channels to help spread warning information. However, the presence of NGOs is sporadic, as lead farmers have to rely on other channels more readily available. *"NGOs come and go, they appear and disappear (. . .) NGOs don't have EPA on the ground, they use DADO extension officers and they only support when they have money. The dissemination of information is mainly done by extension officers, NGOs are sometimes part of it but not systematically." (Governmental authority).* As a whole, it was found that a clear communication strategy to the farmers does not exist. As highlighted in FGDs, climate information is disseminated by multiple means to ensure maximum accessibility. However, the type of information, its provider and its timing are not defined *a-priori* as pointed out by a humanitarian agency: "*The dissemination is the main challenge institutions need to work with, it needs to be clear with the different procedures, need to come up with a strategy to disseminate those information. There is no dissemination in place for drought, it is done but there is a need for a proper strategy, rather than people talking about it from place to place."*

Furthermore, based on discussions with extension officers, the preference of farmers for extension services has increased since the introduction of Participatory Scenario Planning (PSP) and the Participatory Integrated Climate Services for Agriculture (PICSA) training and provision of participatory tools. "*The training permits farmers to understand how weather works and make decisions with the current forecast. (..) for the training, lead farmers were very happy and understand better rainfall patterns. "(Governmental authority).* The PICSA training under WFP is relatively recent in the Mangochi and Salima districts (last 2 years) and 11 out of 25 KII (8 being extension officers) expressed that it has increased the ability of extension officers—and hence also farmers—to get a better understanding of how weather information relates to farming activities. In addition, through the participatory tools provided, advice on farming practices that is adapted to the individual can be generated. These services are primarily provided during community gatherings and are the main strategy in place to contextualize information and engage communities in the development of the drought early warning. Based on feedback obtained from extension officers and farmers, the output of these services is promising as it provides understandable advice that has increased farmers trust, favoring the uptake of drought warning information. "*There is a difference*

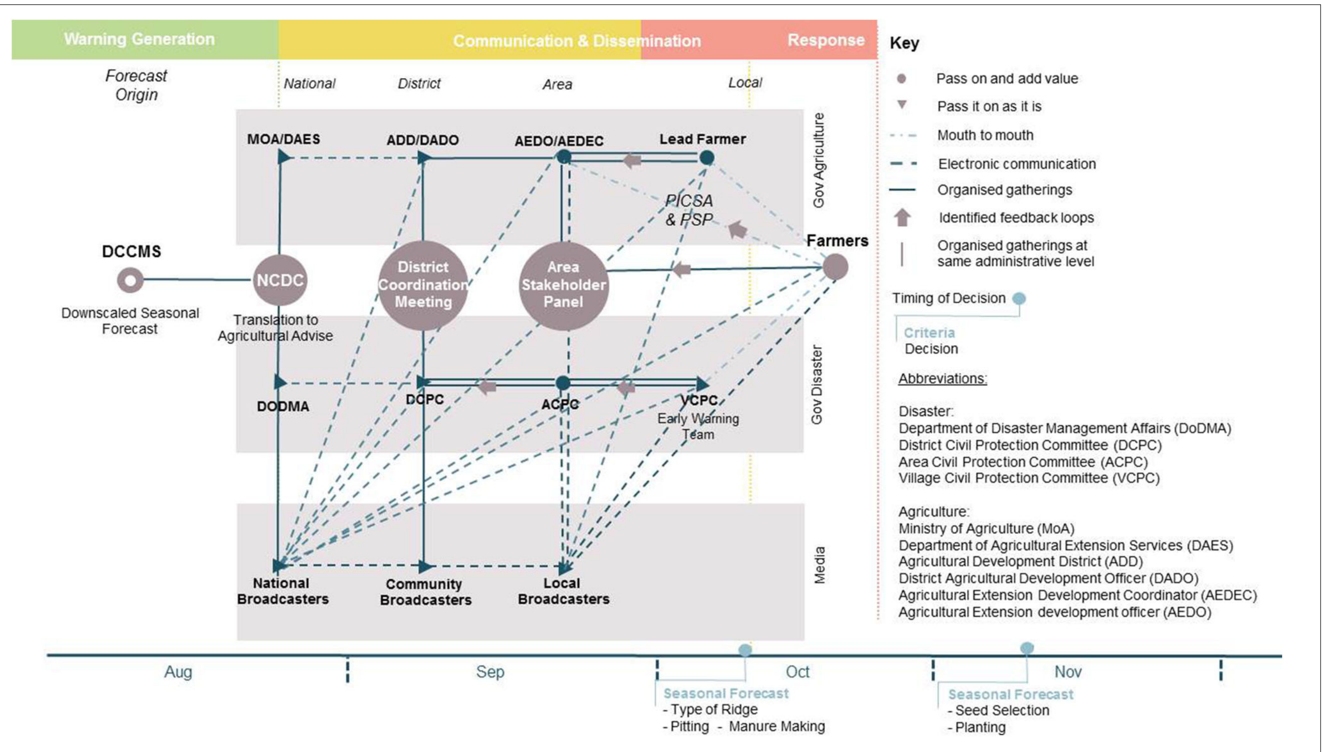

FIGURE 5 | Flowchart representing the organizational set-up and the dissemination and communication processes in place for drought warnings.

since the PICSA training. We used to transmit the information as it is and it was based on assumption. Now there is more information, and there is a higher understanding. Now farmers are better trained but not yet they are able to adapt to the weather forecast. They use the advice that is being given." (Governmental authority).

Feedback mechanisms were found at the Area-Local administrative level (**Figure 5**) and mentioned by 4 KII involved at these administrative levels. For farmers the first contact with mandated authorities is during community gatherings with the extension officers or VCPC members. At the area stakeholder panel and village agriculture committee, farmers are also present and can give feedback. As explained by governmental officials *"[the area stakeholder panel] is a forum where all agricultural staff and small-scale farmers and medium farmers, commercial farmers and NGOs representatives collaborate and talk to each other"* and "*VCPC go to communities with issues to discuss.*" Farm Radio Trust has also developed a call center aimed mainly at supporting farmers by answering their requests and getting their feedback. No information was provided on whether these feedbacks are discussed during the National Warning Content Committee.

Warning Uptake and Decision-Making Dynamics

Farm Radio Trust data showed that 3,090 out of 3,292 (94%) of requests were related to farmers seeking advice on farming practices, and only 202 (6%) to weather information. Weather information consists of requests on weather updates and rainfall forecast. Despite the small number of requests for weather information, the trend over 2018–2019 shows higher demand for weather-related information between November and May, with the highest peak in February (**Figure 6**). As outlined in the farming calendar (**Table 2**), this coincides with the period where most farming activities occur. From June until August crops are mainly sold and therefore weather conditions are less relevant. February follows the main planting season that ends in January making weather conditions critical to crop development (**Table 2**). This suggests farmers seek weather-related information when it is most relevant to their activities, demonstrating the importance of timeliness of information.

Table 2 shows the decision-making processes described by FGDs. Highlighted in gray are farming activities associated with measures taken to mitigate drought impacts. Criteria correspond to the conditions necessary to take the decision to carry out a farming activity. Cues correspond to the environmental and social indicators and to the advices provided with the seasonal forecast, that are used to inform if criteria are met (Doksæter Sivle and Kolstø, 2016).

Overall, the decision-making process follows the cropping cycle, with decisions being made on either what activity should be done, or when to carry out an activity. Decisions made were related due to the interdependence of farming activities. For example, farmers replant when the first-planted crops fail. Another criterion for replanting could be good soil health after harvesting, allowing for an additional crop. Decisions such as the type of ridging, seed selection, pitting, manure application, and dimba (gardening for personal food provision) are conservation

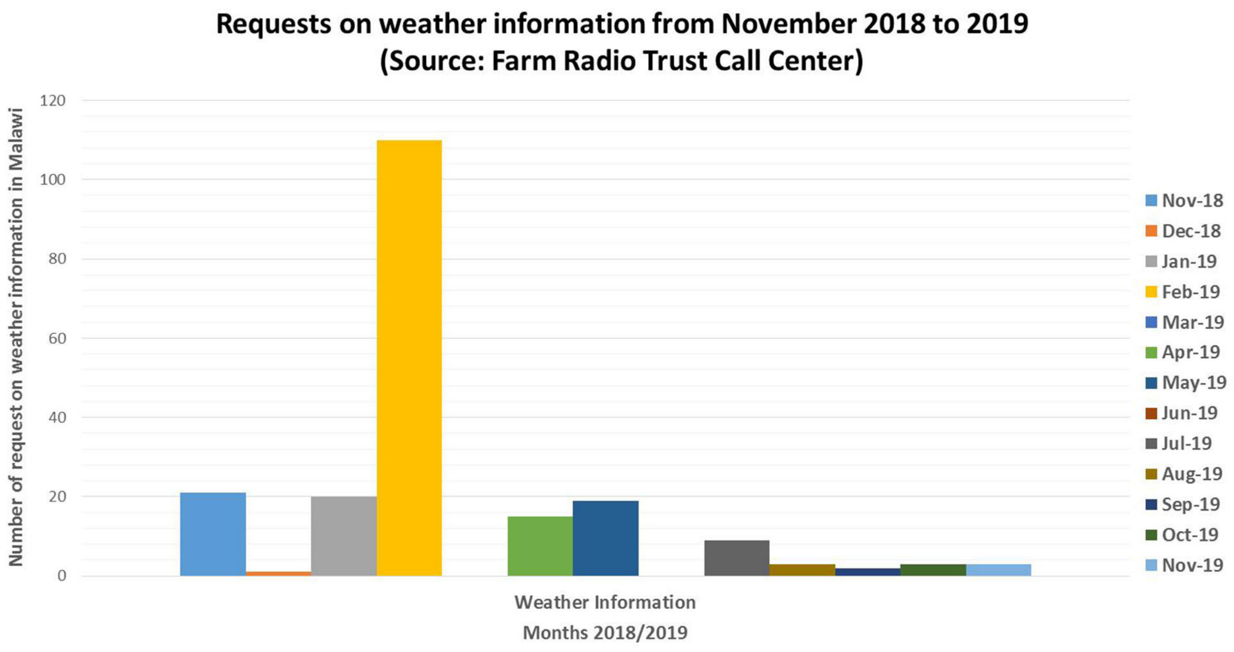

FIGURE 6 | Requests by farmers on weather information from November 2018 to 2019.

agriculture activities that are carried out when the amount of rainfall is forecasted to be below normal rainfall and a subsequent development of droughts is envisaged (criteria).

Criteria and cues were found to be very similar from one farmer group to another. To further analyze the decision-making dynamics, information from the different FGD were combined on the basis of the farming activity. This analysis permitted to distill how farmers respond to the information. The results from the farming calendars (**Table 2**) show that the decision making by farmers consists of two types of decision "what to do" and "when to do it" (**Table 2**), as explained previously. To decide upon how to carry out these activities farmers use various cues that come from either the guidance in the form of advisories or weather information based on local observations (environmental cues) (**Table 2**). To assess how the warning information, primarily in the form of advisories, is used we analyzed which sources of information were used for the decisions to carry out farm activities. To do this, we calculated the number of correlations between the types of decision (when/what) and the associated source of information (environmental cues/advice) used to take this decision. Results were plotted on **Figure 7**, and show a clear correlation between "What to do–Advice" and "When to do it–Environmental cues." Social cues were not mentioned by farmers. These results could be explained by the fact that farmers respond well to the guidance provided in comparison to the weather updates. According to farmers, the uptake of the weather updates is low because of a lack of access. This analysis thus demonstrates that farmers respond to drought warning information when it is provided as advice on agricultural practices, rather than weather-related information.

DISCUSSION

The shift toward people-centered systems has been promoted as a key mechanism to enhance trust and improve uptake of warning information for the end-users to take appropriate disaster preparedness measures (Pulwarty and Sivakumar, 2014; WMO, 2015, 2018). Malawi has adopted this new approach in the development of its early warning communication and dissemination systems (Government of Malawi, 2018). Focusing on end users trust in, and uptake of, early warning information as key measures of success of this dissemination and communication, we identify four characteristics of effective people-centered EWS: (i) a sectoral system focusing on agriculture and farmers' needs, (ii) the provision of several dissemination channels, (iii) the provision of local dissemination services, and (iv) the timely provision of relevant information.

However, we also recognize that there is more work to be done in the monitoring and evaluation of EWS communication and dissemination. Here, we adopt trust and uptake as metrics of the effectiveness and rely heavily on stakeholder perceptions and recall as approaches for capturing these metrics. Efforts to better conceptualize the multidimensional nature of trust and action at the science-policy-practice interface (Stern and Coleman, 2014), can help to guide such efforts. Similarly the purposeful design of EWS implementation for evaluation, and the use of longitudinal and action-research methodologies that can directly observe, monitor and attribute changes in behavior associated with EWS, can help build a more robust evidence base around what works (Tall et al., 2018).

TABLE 2 | Example of decision-making dynamics for farmers in Mangochi.

FGD	What/when	Farming activities	Criteria	Cues	Months
3	When	Land preparation	Dry conditions prevailing	Environmental cues: High heat (relative)	August
3	When			Environmental cues: Tree regeneration	August
3	When		After ceremonial activities	Traditional: Always in August	August
3	What	Ridging	Normal weather predicted	Advice to carry out normal ridging	September/October
3	What	Ridging	Drought weather predicted	Advice to carry out box ridging	September/October
3	When	Ridging	Dry conditions prevailing	Environmental cues: High heat (relative)	September/October
3	When	Manure making	Drought weather predicted	Advice to carry out this farming activity	October
3	When	Manure application	Dry conditions prevailing	Environmental cues: Dust storm for signs of rainfall, high heat (relative) and tree regeneration	October
3	When	Pitting	Drought weather predicted	Advice to carry out this farming activity	September/October
3	When	Pitting	Dry conditions prevailing	Environmental cues: High heat (relative)	September/October
3	What	Seed selection	Weather prediction: Drought or normal	Advice on type of seeds	November/December
3	What	Seed selection	Best quality (grading)	Advice from extension officers or other media and personal observations	November/December
3	What	Seed selection	Market prices	Advice from extension officers or other media	November/December
3	When	Planting	Enough Rain (moist soil)	Environmental cues: High heat and Thunderstorms	November/December
3	When	Weeding	Presence of weeds	Environmental cues: Bad weeds	December
3	What	Fertilizer app	Type of crops planted and weather prediction	Advice on what fertilizer to use	December
3	When	Fertilizer app	Soil moist and after planting	Environmental cues: The soil is seen moist and not dry	December
3	What	Replanting	Weather forecast	Advice on what to replant	December/January
3	When	Replanting	Failure of seeds	Environmental cues	December/January
3	When	Replanting	Enough moisture content left	Advice on when to replant	December/January
3	When	Banking	After Planting and need for heavy rainfall	Advice on when to start banking (and how)	January
3	When	Top dressing	Soil moist and after planting	Environmental cues and advice on when to carry out top dressing	January
3	When	Thinning	N/A	N/A	January
3	What	Application pesticide	Type of pests present	Advice on what pesticide to apply	February/March
3	When	Application pesticide	Dry conditions prevailing	Environmental cues: No rainfall but need moist soil so during the dry spell 1–2 weeks	February/March
3	When	Light weeding	Presence of weeds	Environmental cues: After heavy rains	February/March
3	What	Dimba (gardening)	Drought weather predicted	Advice on what to plant for Dimba	April/May
3	When	Dimba (gardening)	Drought weather predicted	Advice on when to start Dimba	April/May
3	When	Harvesting	Dry conditions prevailing	Environmental cues: Dry and crops ready for harvesting	April
3	When/To whom	Marketing (selling products)	Market	Advice on when to start selling products, what they should keep for themselves and linking farmers with buyers	June/July

N/A means Not Available. Environmental cues are based on local knowledge from farmers. Advices are given by extension officers or other media based on the rainfall patterns from the seasonal forecast.

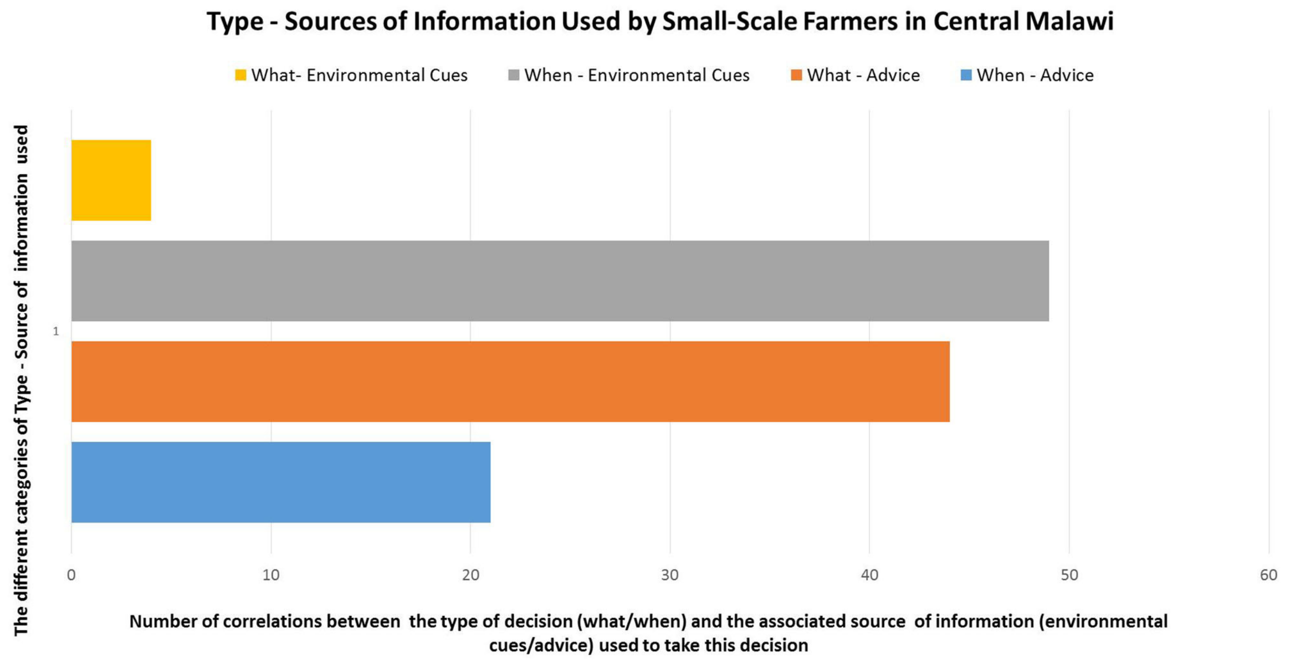

FIGURE 7 | The type and sources of information the most used for farming decisions.

Sectoral System Focusing on Agriculture and Farmers' Needs

The drought warning dissemination and communication process was found to be, to a certain extent, tailored to farmers' needs through a sectoral system focused on agriculture. Indeed, based on the focus group discussions it was found that only information relating to drought mitigation measures were used and found relevant. The timing to carry out farming activities is based on farmers' own environmental indicators. The drought warning information is embedded within the climate information provided by DCCMS and disseminated upon the release of the seasonal forecast through a value chain approach in climate services, which is also found in other such processes in Africa (Sivakumar, 2006; Mahon et al., 2019; Vogel et al., 2019). The communication process covers a creation/conceptualization of the warning information to the district context and the dissemination strategy consists of transferring this information within the governmental and humanitarian channels. During this process, the warning information provided consists of an impact–based seasonal forecast downscaled to the district context and based on scientific knowledge. At the local level the communication process consists of the translation of those advisories by the district administrative level entities to communities to enable an understanding of what these advisories mean for their farming practices. During this process, a bridge between scientific and local knowledge and the integration of local perception on drought and risk is attempted to enable an understanding of the warning information and enhance an uptake on drought warnings.

In the MHEWS framework, the distinction between dissemination and communication is not explained (WMO, 2018) and the different functions expected to be accomplished under these two mechanisms are not elaborated. The form of engagement of end-users is mentioned to be key when developing a people-centered approach, as supported by (Steen, 2011), and we argue that observing procedural participation, as well as behavior change (Tall et al., 2018) of different stakeholder groups involved in communication and dissemination processes, can contribute to the evaluation of people-centered EWS approaches.

Dissemination Channels, Accessibility, and Trust

The accessibility of information—which encompasses a consideration of the channels through which information is provided and whether or not end users have the means (technology, contact with extension officers, etc.) to receive information—is critical for effective EWS. However, if accessibility is to be adequately understood and evaluated, it is important that there is a focus on both the means of information provision and the ways in which these are accessed (or not accessed) by end users.

The MHEWS framework (WMO, 2018) emphasizes the need to develop multiple channels to reach as many people as possible. This may increase the likelihood that information is received, in one form or another, and help to add greater perceived credibility to that information, providing that the multiple channels offer information that is consistent (the opposite affect may be true if information is inconsistent). However, a simple counting of the number of information channels, does not pay adequate attention to questions of what information is being received, through which channels, and by whom.

A variety of channels were found to be operational in Malawi. However, not all provide messages that are specific to the geographic context and the farming activities and decision-making needs of the farmers. Our results suggest that this has a significant bearing on the extent to which farmers are able to utilize that information.

Moreover, end users place varying levels of trust in different information sources, both because of the extent to which the information is context specific (Molinari and Handmer, 2011) and because of their perceptions of the information generators and providers associated with it. In reality it may be difficult to distinguish between trust placed in the process of producing climate information (what Stern and Coleman (2014) describe as procedural trust) and the information itself (what Stern and Coleman (2014) describe as rational trust) by the end-users, but this is an important aspect of their experience of different information and information sources.

Whilst the number of active information channels might provide a useful indicator of the extent to which information reaches end users, effectively evaluating EWS requires a more nuanced analysis of both accessibility and trust in information.

Provision of Local Dissemination Services

Similar to Kenya and Zimbabwe, the development and empowerment of local services through PICSA and PSP, agricultural extension services, local radio, and lead farmers were found to be highly appreciated as a communication and dissemination strategy in Malawi. These were identified as a key mechanism in establishing trust in the drought information (Sivakumar, 2006; Pulwarty and Sivakumar, 2014; Andersson et al., 2019). The uptake in Malawi has improved since localized and downscaled climate information is provided. The sense of proximity to the information—by communication coming from sources known to end-users, or through the contextualization of warning content to the local situation—creates a sense of ownership and trust that results in a higher uptake of drought warning information (Pulwarty and Sivakumar, 2014; Andersson et al., 2019). The affinity to local services improved since the development of the PICSA program as this has provided higher competencies to extension officers to communicate and interpret the information. This in turn enables farmers to better understand and use the climate information provided. This study reveals, however, that challenges remain in enabling an effective communication and contextualizing information at the local level. For instance Kniveton et al. (2015) argue for the integration of climate information with local knowledge systems, but also acknowledge the challenges given the inherent uncertainty of weather and climate information. Local knowledge varies from one place to another and is poorly documented, making the co-production of EWS with farmers difficult from the national stakeholder perspective. Furthermore, with regards to the understanding of the nature of drought, this study found disparities in drought perception between the producer of climate information and the farmers. Droughts are mainly described by mandated authorities, UN and NGOs as a prolonged lack of rainfall following the planting season for a duration of 2–3 weeks or more. Perceptions of the farmers coincide with this definition. However, additional hazards such as fall army worms and even floods are considered as elements causing drought to farmers in Mangochi district though this was not found to be the case in Salima district. This disparity in drought perception clearly shows a need to actively engage farmers to avoid inadequate early farming actions when a drought warning is issued. In addition, these differences in drought perceptions highlight the need to clearly characterize what constitute a drought in the context Malawi, and re-adjust the communication strategy for the farmers and communities.

Timely Provision of Relevant Information

This study shows that the uptake of drought warnings is associated with the downscaling of weather information to the district and area administrative level and the provision of the seasonal forecast in a timely manner. The drought warnings delivered are characterized as impact-based information, complemented by advisory information on farming practices, the location and the timeline for farming practices to mitigate droughts. Though only scarcely relevant impact information was included, contextualization to the local situation is believed to increase the understanding and trigger the taking of early actions by end-users (Choo, 2009; Potter et al., 2018). However, our results show that the element that is considered most relevant is the guidance provided on (drought) mitigation measures such as conservation agriculture or farming practices. The drought warning is not used by farmers for decision-making related to timing of their activities. Daily or weekly weather updates are not often used as cues because farmers are not able to access them via the channels through which they are communicated, or because there is a lack of trust in those updates that are received. Weather updates contain weather-only information and are provided uniformly across all sectors, without the sector-specific guidance considered most relevant in drought warnings. However, discussions at Cape Maclear with fishermen, pointed out that there the weather updates are closely paid attention to. This may be because they will go out on the lake to fish only when the weather conditions are adequate, and the information is therefore considered as highly relevant to them. The direct relevance of the information to the risk assessment of the end users, in this case, is well-understood and explains the high use of weather updates to decide upon fishing or not. For farmers, the relationship between forecast information and the outcomes of their responses (i.e., their decisions about land management) are less straightforward. Daily weather updates are not translated into farming information and advice, which can explain a lack of uptake by farmers. Data from FRT showed that few requests (6%) were made for the weather updates and thus supports the fact that this information is not widely used to cue the carrying out of most farming activities. Only following the planting season, the weather updates are considered relevant and important, and are therefore requested more frequently.

We point out that the MHEWS framework (WMO, 2018) does not include a way to assess this important component of understanding. Molinari and Handmer (2011) propose a behavioral model to quantify warning effectiveness. The MHEWS framework does assess understanding indirectly via the ability of tailor-made impact-based information to prompt the taking of action. In Malawi, the actions we found to have been taken show that, indeed, drought warning mitigation guidance is used in the decision-making process of farming activities. However, this does not necessarily imply that drought warnings are understood; it just shows that advice on improving farming practices as a whole is used in the decision-making. Clear links between drought warnings and understanding may be difficult to establish by looking only at the action taken by farmers, particularly given that the perception of drought may differ.

The Dependency on Humanitarian and NGO Assistance

Overall, the timely provision of relevant drought warning information has triggered the uptake of early action by farmers. However, the accessibility to these services is limited to areas where there is NGO and humanitarian support. We found that these organizations provide extensive financial support to enable the development of these services. For instance, the PICSA training is supported by WFP or UNDP, while other projects provide funds that enable extension officers to access remote regions and to have more capacities to meet communities needs. The high financial dependency on humanitarian and NGO assistance tends to be, however, project-oriented and implemented for a certain period, jeopardizing the long-term development and provision of warning information to farmers (Harvey et al., 2019). This support is sporadic in time and space, thus bringing into question the sustainability and effectiveness of the drought early warning communication and dissemination at the country level. While the dissemination and communication process tends to align mostly to the guidelines in the MHEWS framework (WMO, 2018) when supported by donors, the question this raises to the sustainability due to this specific dependency is not elaborated in the framework.

CONCLUSION

The timely provision of downscaled information, complemented with tailored advice has been shown to improve the uptake of warning information as witnessed by our analysis in the districts of Mangochi and Salima in Malawi. A people-centered approach is useful for enhancing trust and enabling an effective uptake of drought warning information. Focus group discussions and interviews supported by literature permitted us to identify that trust in, and uptake of, drought EWS in Malawi is enhanced by proximity. Relevance of information is achieved through the inclusion of local context and communication through locally recognized channels such as well-trained and trusted agricultural extension officers, lead farmers, and Farm Radio Trust.

The MHEWS framework supports a people-centered approach to the generation, communication, and dissemination of EWS, but it has some limitations as an evaluation tool for the effectiveness of EWS. Drawing on our findings, we argue that further disentangling the dissemination and communication processes within EWS, and observing participation, behavioral change and trust by stakeholders across these distinct processes can contribute to understanding what works, where and why in people-centered EWS approaches.

From the data collected, the adoption of a people-centered approach to early warning shows that this has improved the tailoring of drought Early Warning Systems to farmers' needs, and contributed to the perception by farmers interviewed in Malawi that the information provided is useful. Information provided that contained advisories on what actions farmers should take are of most use as farmers requested and responded to that information more readily than advisories on when to take actions. While improvements toward a people-centered-approach for drought EWS were identified, a high dependency on financial support from donors and lack of available funds at local levels for such initiatives was found. Although further introduction of digital communication methods could help reduce costs, other key elements such as training of agricultural extension officers and logistics also depend on donor funding. This is problematic for the further development and sustainability of these systems. Financial sustainability is currently not strongly embedded in the MHEWS framework. This should, however, be included as they may well jeopardize the effectiveness of the approach.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because all data available are qualitative and confidential. Participants are identifiable and therefore data cannot be shared. Requests to access the datasets should be directed to Alexia Calvel, alexia.calvel@gmail.com.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

AC: main writer of the article based on M.Sc. Thesis. MW, MH, and ACF supervised and contributed to the writing of the article. IS, NM, SW, CB, and CL helped to improve the conceptualization of the field work and research work and contributed to the writing.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fclim.2020.578327/full#supplementary-material

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