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Re-balancing climate services to inform climate-resilient planning – A conceptual framework and illustrations from sub-Saharan Africa

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ABSTRACT

Making climate-resilient planning and adaptation decisions is, in part, contingent on the use of climate information. Growing attention has been paid to the "usability gap" and the need to make information both useful and useable to decision-makers. Less attention has, however, been paid to the factors that determine whether, once created, useful and useable information is then actually used. In this Perspectives piece, we outline a framework that puts together the pieces necessary to close the "usability gap" – highlighting not only what is required to make information useful and useable, but also what is required to ensure that useful and useable information is actually used. Creating useful information is subject to understanding and being able to deliver metrics that address identified needs in a range of decision-making contexts. Creating useable information requires legitimate and credible information that is visualised and communicated in ways that are accessible and understandable. The framework highlights traditionally under-recognized enablers necessary to promote effective use of the growing availability of useful and useable climate information in decision-making; supportive institutions, appropriate policy frameworks, capacity of individuals and agency to make decisions. Whilst this is not enough in itself to effect information use, we argue that greater focus on these enablers can re-balance the activities promoted through climate services and increase the likelihood of successful use. We illustrate the framework with case examples of co-producing climate information for the tea and water sectors in sub-Saharan Africa.

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1. Introduction

Making climate-resilient planning and adaptation decisions for effective climate risk management is, in part, contingent upon the use of climate information (Jones et al., 2015). Significant efforts have led to the increasing availability of climate information at a range of temporal and spatial scales (Dinku et al., 2014; Hewitt et al., 2020) – and such information is steadily becoming more accessible (Hewitson et al., 2017). This has, however, often not translated into more effective adaptation (Lemos et al., 2012). Even when information is available, there remain obstacles to its access and effective use in decision-making, termed a "valley of death" (Buontempo et al., 2014), or "usability gap" (Lemos et al., 2012). In this Perspectives piece, we present a conceptual framework that outlines key enabling conditions to ensure that availability of useful and useable climate information is used to inform climate-resilient planning. We illustrate its application with examples from sub-Saharan Africa.

2. Growth of climate services

The climate services agenda has arisen to address this usability gap, and to generate information that can be used in planning (Hewitt et al., 2012). Climate services refers to the generation, provision and contextualisation of information and knowledge derived from climate research for decision-making at all levels of society (Vaughan and Dessai, 2014). Although having data available is a prerequisite (Goddard, 2016), a climate services approach recognizes that there is a need to better characterize and understand the problem context, typically through bringing together producers and users of information (whether in person or remotely) (Dilling and Lemos, 2011; Lemos et al., 2019).

The process of generating tailored and targeted information frequently (although not always) requires new modes of knowledge construction, including co-production. Co-production can be undertaken through a number of methods and approaches, including transdisciplinarity, action research, or through boundary agents, knowledge brokers or embedded researchers (Cvitanovic et al., 2015; Meadow et al., 2015; Vincent et al., 2018). Although there are a range of lenses of co-production, the iterative interactional aim of co-production is to generate information that is useful and useable (Bremer and Meisch, 2017; Bremer et al., 2019).

There have been increasing attempts in recent years to generate information that is useful and useable, including through co-production. Enabling and supporting these attempts requires partnerships and collaboration between different parties (including non-traditional partnerships), since producers of climate information are not always equipped with the skills to understand user needs or communicate to users (Porter and Dessai, 2017). These partnerships and collaborations can take place through a range of approaches or methods. At regional level, for example, Regional Climate Outlook Fora (RCOF) bring together producers and users to generate regional level climate information products that are useful for society (Daly and Dessai, 2018). At national and local level, scenario planning is increasingly popular, where the implications of particular weather and climate conditions for different sectors are interactively developed and evaluated (e.g. Bizikova et al., 2014; Ojoyi et al., 2017). Participatory scenario planning involves users at grassroots level (for example farmers) and producers, typically enabled by an intermediary such as a Non-Governmental Organisation (NGO) that plays the role of a knowledge broker (Dayamba et al., 2018; Harvey et al., 2019; Tembo-Nhlema et al, 2019).

New methods of knowledge production and innovative partnerships have helped to address the usability gap by informing the generation of information that meets user needs and is presented in understandable ways. However, less attention has been paid to investigating whether or not useful and useable information – once generated with a focus on user needs – is then actually used (Vaughan and Dessai, 2014; Lemos et al., 2018). We address this gap by presenting a conceptual framework that highlights enablers that are under-recognized, but that need to be in place to ensure that useful and useable information is being used when demand exists (e.g. Vogel et al., 2019). By making these potential enablers explicit, we provide an analytical tool to re-balance the activities promoted through climate services to improve their effectiveness in climate-resilient planning.

3. Creating useful information

The first component of generating effective climate services for adaptation is creating useful information. This requires an understanding of decision-making contexts, users' climate information needs, climate metrics that address users' needs, and the ability to deliver identified metrics. This has been undertaken for a variety of sectors in a range of geographical contexts, including crop and pastoral agriculture (e.g. Carr et al., 2016; Lotter et al., 2018; Onzere et al., 2018; Guido et al., 2019), fisheries (Ouedraogo et al., 2018), health (Connor et al., 2010), and cities and urban environments (Steynor et al., 2016).

The process of identifying what information will be useful to the intended users is rarely simple or neutral. It is, in fact, often intensely political – and those whose needs are represented can create winners and losers in terms of the resulting adaptation decisions (Nost, 2019). Heterogeneity amongst users and different needs of different people mean that wider inclusion is essential to avoid reinforcing power imbalances (Daly and Dilling, 2019). In the agriculture sector in sub-Saharan Africa, for example, where gender roles determine the particular activities undertaken by men and women, gender differences are reflected in information needs (Carr et al., 2016). In addition, needs are not static, but rather change over time (Carr et al., 2019). The process of identifying those metrics that can address the needs in the decision context is also rarely simple, and may not always reveal metrics that can be easily derived by producers of climate information. This process tends to require extensive engagement and iteration with potential users (Dilling and Lemos, 2011; Prokopy et al., 2017), and can involve the application of (a combination of) a variety of methods, including surveys, workshops, interviews and participatory rural appraisal (e.g. Carr et al., 2019; Vincent et al., 2017; Steynor et al., 2016).

4. Creating useable information

Once the decision context has been explored and understood, and the diversity of needs established, it should be possible to generate legitimate and credible information that is useful to the user(s). The next critical stage is to make that useful information useable. In the past, significant attention has been paid to the communication channels and media used for making information available (e.g. Hampson et al., 2014), with recognition that there are gender differences in preferred media and modes of communication (Gumucio et al., 2019; Carr and Onzere, 2018; Tall et al., 2014), and a need for timeliness (Tembo-Nhlema et al., 2019).

Usability goes beyond availability, and requires that the useful information is effectively visualized before being communicated in a timely manner that ensures it is accessible and understandable to the intended user(s). The ways in which weather and climate information are visualized by producers (e.g. meteorologists and climatologists) are highly technical and, frequently, impenetrable to non-specialists. Presentation of probabilistic seasonal forecasts information in terciles and envelopes and model ensembles in climate projections impedes potentially useful information being useable by decision makers (e.g. Patt and Gwata, 2002; Nissan et al., 2019). Interpreting scientific skill in forecast/projection generation, the language of uncertainty, temporal and spatial scale and the presentation of information in plots and graphs are not always well aligned with users' understanding and needs (Hansen et al., 2011; Briley et al., 2015; Otto et al., 2016; Singh et al., 2018; Vincent et al., 2017; Kirchhoff et al., 2019; Nissan et al., 2019).

More than the nature of the information itself, choices made when constructing visualisations, such as presenting percentile information versus showing the range, can also influence the interpretation by users (Daron et al., 2015). A study undertaken with planners found that minima and maxima were easier to interpret compared with 10th and 90th percentiles; but also that coloured bars were easier to interpret compared to different scale, marker and non-coloured bar graphs (Vincent et al., in prep).

Making useful information useable can take place in various ways. One option is to build capacity of users to access and interpret scientific presentations of information – for example considering the probabilistic nature and uncertainty (e.g. Future Climate For Africa (FCFA), 2016; Conway et al., 2017). Another option is to visualize and present the information in ways that may be more easily understood. Climate risk narratives and storylines, for example, can frame risk relative to events, as opposed to probabilities (Shepherd et al., 2018; Jack et al., 2020), and can be co-produced with experts to explore future uncertainties (Dessai et al., 2018). Interpretations of the scientific information, for example as scenarios or advisories, are also an option, typically brokered by an intermediary with understanding of both the producer and user contexts (e.g. Harvey et al., 2019). In all cases, such visualisations should take into account risk perceptions of the target audience (Steynor and Pasquini., 2019).

5. Ensuring useful and useable information is used

Creating useful information and visualising and communicating it in a way that is useable reflects the supply side of climate services – although deciding what information is relevant and how it should be presented is necessarily informed by understanding of user context and the demand side. The oft-overlooked link in the chain is whether useful and useable information is then practically

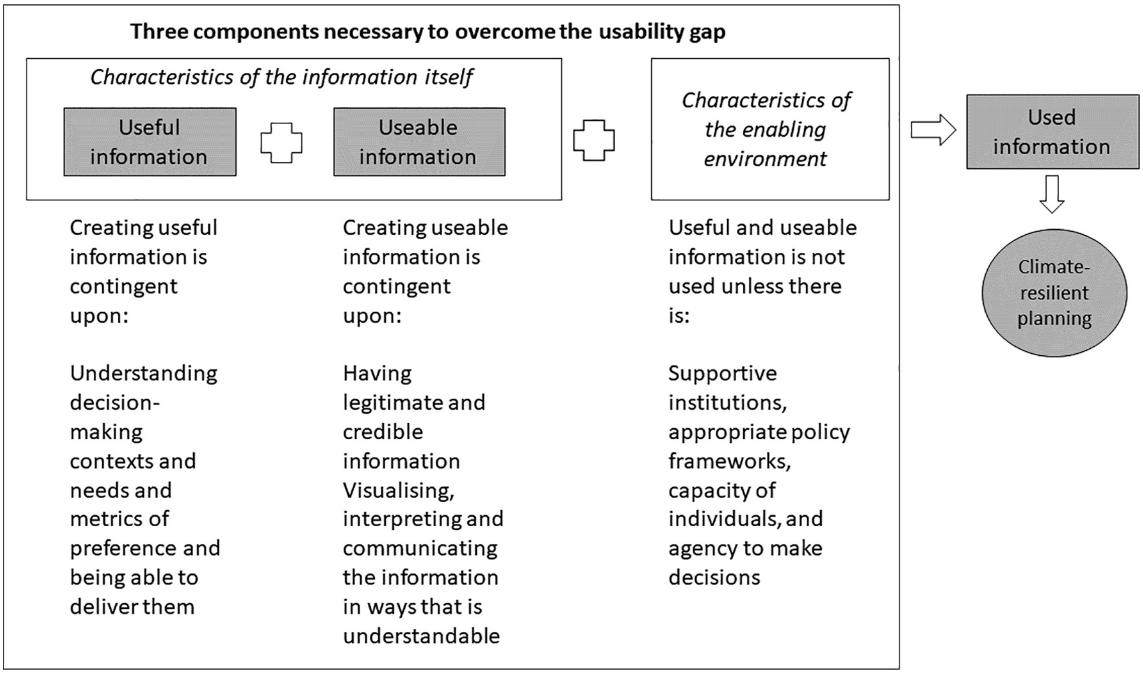

Fig. 1. Conceptual framework outlining how to create useful and useable information that with greater attention to crucial enabling conditions is used to enable climate-resilient planning.

used to inform climate-resilient planning enable adaptation and, critically, what is required to make this happen. Our framework (Fig. 1) emphasizes additional elements that lack sufficient attention in the literature and practice and that need to be in place in addition to demand, to enable the "usability gap" to be closed. These include appropriate policy frameworks, supportive institutions, capacity of individuals, and agency to make decisions (e.g. Vaughan et al., 2017; Pardoe et al., 2018; Mataya et al., 2019). The framework derives from the established literature on barriers modified by our additional insights from extensive transdisciplinary research experience, with very different degrees of success, to understand and promote more informed use of climate information across sub-Saharan Africa. We argue that the basket of activities and priorities supported through more mainstream climate services needs to be re-balanced with these elements in mind, such that any barriers to their existence can be identified, prioritised and addressed.

Barriers to the use of climate information in planning also require focused attention. Incoherence or gaps in a policy framework can act as barriers to information use. In Malawi, for example, the recently-approved Meteorological Policy does not create a supportive framework for the institutionalization of participatory scenario planning at national or district level, despite growing evidence that this method generates useful and useable information (Tembo-Nhlema et al., 2019). At the local district level, failure to comprehend the realities of how planning takes place further contributes. For example, use of information is impeded if there is no cognizance of land ownership structures or gender roles in agricultural planning (Carr and Onzere, 2018). To counteract this, supportive institutional and policy frameworks are necessary to increase the likelihood that useful and useable climate information will be incorporated into decision-making (Cvitanovic et al., 2019). This has been recognized in the Global Framework for Climate Services, which has supported the development of National Frameworks for Climate Services in a number of countries (Hewitt et al., 2020).

As well as a supportive institutional and policy framework, capacity and agency need to exist at all stages in the chain from producer to user (often through intermediaries). National meteorological and hydrological services are often constrained in their capacity (Venäläinen et al., 2015), with climate services typically only available through separately-funded donor projects (Nkiaka et al., 2019). The politics of how adaptation planning takes place, barriers to cross-sectoral coordination, and hierarchies of decision-making within ministries and departments can all inhibit agency and capacity of staff to act – even where motivation and capability exists (Pardoe et al., 2018; England et al., 2018; Mataya et al., 2019). High level political support (including budget commitments) at all levels of administration for recognizing the importance of climate change and the existence of a climate emergency needs to be present to provide an incentive for planning for climate futures (Pasquini et al., 2015).

Fig. 1 outlines the established barriers to being useful and useable on the left and central columns and adds the enabling factors (right column) that we view as crucial for actually achieving practical use in climate-resilient planning (right circle) to enable adaptation. As well as structural change, smaller scale (and more specifically targeted) incentives such as the mandating of, and appropriate funding for, multi-stakeholder collaborations in climate services projects, and building and nurturing relevant strategic partnerships with appropriate intermediaries can enable this (Arnott et al., 2020; Brasseur and Gallardo, 2016). This framework applies regardless of the level of decision-making, whether policy, sector, or grassroots level. We present two examples of how it can be used to identify and overcome the barriers to useful and useable information being used.

6. Co-producing useful and useable climate information for use in the tea sector

The tea sector is important to the economy and livelihoods across sub-Saharan Africa, particularly the continent's largest tea-producing countries, Kenya and Malawi. It has, however, typically received less attention than other crops with regards to climate change – a gap which may impede climate-resilient planning. The tea bush is highly sensitive to climate, and small climatic differences may non-linearly impact tea yield and quality (Larson, 2015). With an economic life cycle of up to 100 years (Carr, 2018) medium-range climate projections are important to enable climate-resilient planning.

Definitions of useful information were elaborated with small and large scale tea farmers, scientists from tea research institutes and representatives from the Tea Boards in Kenya and Malawi. In exploring the decision context, we found that potential for heat stress or moisture deficit are the biggest threats to tea yield. In particular, temperature-related metrics of concern are heat wave frequency (e.g. 5 or more consecutive days above 35 °C in Malawi and 27 °C in Kenya) and occurrence of cold nights (less than 12.5 °C in Malawi and 6 °C in Kenya). Rain-related metrics of concern were identified to be number of rainy days (over 1 mm), total rainfall, number of consecutive dry days and incidence of 10 day dry spells (Mittal et al., in prep). By combining new long-term station observations obtained from tea stakeholders with global climate model projections, site-specific information for identified climate metrics and the associated uncertainty was produced for mid to end-of-century timescales (Mittal et al., in prep).

Instead of the usual approach of developing ensemble mean temperature and rainfall projections, information was communicated using visualisations that reflected user-defined metrics and preferences. Along with the iterative two-way engagement between users and producers of information that helped build trust, legitimacy and credibility, the tailored communication helped make the information more useable by large-scale and smallholder producers alike. Interactions with tea stakeholders reiterated findings elsewhere that they are comfortable with uncertainty and preferred this to a single definitive future (Howe et al., 2019).

Since tea is a commodity crop it is typically not directly governed by government policy, giving private-sector producers greater autonomy in decision making. Tailored climate information can enhance tea sector stakeholders' understanding of potential climatic changes relevant to the crop. To ensure that this useful and useable information is actually used requires, however, an enabling environment, sufficient capacity and agency to act. An appropriate enabling environment in this case is therefore likely to be management decisions for commercial estates and the contracts that govern smallholder producers. Many of the managers responsible for such decisions were involved in the co-production process, through which their understanding was enhanced and the credibility and legitimacy of the information was established. Decisions that they now have to make would need to use such information to ensure climate-resilient planning, such as choice of tea cultivars, greater use of soil mulching and shade trees to reduce surface temperatures, potential changes to tea farming locations and opportunities for water management (e.g. irrigation).

7. Identifying barriers to the use of climate information in infrastructural decisions

The importance of the policy and institutional framework and capacity and agency that enables use of useful and useable information is particularly relevant in national planning decisions. Infrastructural decisions, for example relating to dams for hydropower and to manage water availability for agriculture and environmental flows, are expensive and have long lifespans so are often targeted for useful and useable climate information. However, operationally climate change impacts are rarely considered in planning new projects (Lumbroso et al., 2015). This is the case in Tanzania, where plans are under way to construct a major new hydropower dam, the Julius Nyerere Hydropower Project, in the Rufiji river basin.

As intentions to pursue the construction of the dam were announced researchers were, in parallel, developing useful and useable climate information to help inform the river basin's development plans. Stakeholders in the Rufiji basin helped identify the potential trade-offs in development aims relating to expansion of irrigated agriculture and hydropower, and downstream effects on environmental flows with importance for tourism and fisheries. With this information, impact modellers linked a regionalised global hydrological model with a water resource system model that simulates the operation and effects of dams and irrigation in the basin (Siderius et al., 2018; Geressu et al., 2020). This enabled testing of different combinations of management options, allowing identification of options that perform well across multiple performance indicators, and stress testing under different climate change scenarios (Conway et al., 2019). The model set-up was developed through a series of consultations with stakeholders, and is based on open access source models as opposed to proprietary models that are often used – thereby ensuring that the information can be available for use by decision-makers.

However, despite producing useful and useable climate information, specifically tailored to the river basin situation, the research project timeframe and the institutional environment have not been conducive to the optimal use of this information. High level political commitment to the intervention, even in light of evidence of performance risks for the dam, has meant that according to the IUCN (2019) the decision to proceed has been justified on the basis of now-outdated studies from the initial consideration of the site decades ago. Instead, performance criteria in the model are rather used to explore water management options in light of the decision for the dam to be constructed, and to identify adaptation options that perform acceptably under the range of conditions projected by climate models. While the work has not been formally used, the process has provided a platform from which different actors can engage further through interactions that are more informed about climate risk. Although these effects are less tangible, harder to quantify and in themselves not sufficient, the actions are a necessary part of the route to effective use of climate information.

8. Conclusion

In both our case studies, considerable investment in time, resources and expertise went into the process of stakeholder engagement and joint design of information and decision support models/heuristics to create useful and useable information. However, it should be noted that the step to actual use still lacked some of the enabling conditions in Fig. 1. One element to consider is greater focus on the demand side – to strengthen requirements to conduct climate risk assessments that demand information so that they are formally part of decision processes. This could be undertaken either through modifying certification standards in the case of tea and other commodities, or by modifying (or just implementing existing standards in some cases) infrastructure risk assessments through engineering standards, screening of finance from ODA sources (e.g. Klein et al., 2007), or requirements for disclosure of climate-related financial information to investors as called for by the Taskforce on Climate-Related Financial Disclosure (TCFD, 2019).

Increasing recognition of the need to make climate-resilient planning and adaptation decisions has prompted the development of new forms of climate information. Despite increasing efforts within the field of climate services, there often remains a usability gap. Here, we have synthesized existing literature and presented two case study analyses to outline a framework that highlights under-recognized enablers that need to be in place to ensure useful information is generated, that it is useable among the target audience, and that this useful and useable information is then actually used. These include appropriate policy frameworks, supportive institutions, capacity of individuals, and agency to make decisions. To date, there has been more progress in supplying useful information and making it useable, but less progress with ensuring it is used. By adding emphasis to these enabling conditions, this framework gives greater insight to what needs to be in place to improve the effectiveness of climate services for climate-resilient planning.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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