IDENTIFYING CLIMATE INFORMATION SERVICES USERS AND THEIR NEEDS IN SUB-SAHARAN AFRICA: A LEARNING AGENDA

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Identifying Climate Information Services Users and their Needs in sub-Saharan Africa: A Learning Agenda

A Learning Agenda on Climate Information Services in sub-Saharan Africa

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ACRONYMS AND ABBREVIATIONS

ACTED	Agency for Technical Cooperation and Development
ADA	Adaptation Consortium
AFRRI	African Farm Radio Research Initiative
AMEU	Appraisal, Monitoring and Evaluation Unit
CCAFS	Climate Change, Agriculture and Food Security
CIS	Climate Information Services
CFAR	Climate Financing for Agricultural Resources
CINSERE	Climate Information Service for Increased Resilience in Senegal
CISRI	Climate Information Services Research Initiative
CL-CRSP	Global Livestock Collaborative Research Support Program
DEWS	Drought Early Warning Systems
DFID	UK Department for International Development
GFCS	Global Framework for Climate Services
HURDL	Humanitarian Response and Development Lab
IFPRI	International Food Policy Research Initiative
IRIS	Senegalese River Basin Initiative
LIG	Livelihoods as Intimate Government
PARIMA	Pan-Asia Risk and Insurance Management Association
PICSA	Participatory Integrated Climate Services for Agriculture
SARCOF	Southern African Regional Climate Outlook Forum
SERVIR	Sistema Regional de Visualización y Monitoreo de MesoAmerica
USAID	United States Agency for America Internal Development
WMO	World Meteorological Organization
ZBRI	Zambezi River Basin Initiative

EXECUTIVE SUMMARY

In recent years, climate information services (CIS) have been integrated into development agendas as means of achieving development goals in a variable and changing climate, shifting the emphasis of CIS from the packaging of existing climate analysis toward addressing pressing social concerns. Today, the starting point for making an effective CIS is attention to the potential users of the service and their particular needs. The design and management of effective services requires the identification the intended users of climate information, work to establish how climate information could be useful in the context of their lives, and plans to deliver credible, salient, and legitimate climate information that meets one or more of their needs. However, the practical experience of identifying these users and needs remains uneven across the field. Different projects have taken different approaches and made different assumptions, often with limited testing either. There are gaps in our knowledge related to who can best be helped by climate information, what climate information meets user needs, the most productive means by which to identify these populations and their needs, and how to generalize knowledge about users and needs.

This paper presents a learning agenda for acquiring further knowledge about the users of CIS and their needs. As a learning agenda, it reviews the state of current knowledge on this subject. However, it goes beyond a review to focus on what we do not know, and to argue for what is needed to answer or fill those gaps in knowledge. Further, it prioritizes these gaps, organizing a process of inquiry that builds upon itself to inform both CIS research and practice. Thus, this paper speaks to current "good practices" in CIS design, management, and evaluation, while pointing the way to better practices in the future.

INTRODUCTION

Climate information services (CIS) involve the production, translation, transfer, and use of climate information for individual and societal decision-making. In recent years, CIS have been integrated into development agendas as means of achieving development goals in a variable and changing climate, shifting the emphasis of CIS from the packaging of existing climate analysis toward addressing pressing social concerns. Thus, where once CIS might have been framed around generating and making climate information available to people who might use it in whatever manner they wished, today the starting point for making an effective CIS is attention to the potential users of the service and their particular needs. A designer of services must first identify the intended users of climate information, work to establish how climate information could be useful in the context of their lives, and plan to deliver credible, salient, and legitimate climate information that meets one or more of their needs. Similar attention to users and their needs is needed for an effective management of services, one that responds to the ways in which design goals are or are not being met. For example, are the potential users receiving the information and is it helpful for decision-making? And, can the services be improved? Attention to users and user needs is also critical for broader, cross-project concerns, such as justifying support for programs, priority setting, and planning future efforts.

However, despite long-standing warnings about the ways in which potential users might be excluded from a CIS (e.g. Archer 2003), the practical experience of identifying these users and needs remains uneven across the field. Different projects have taken different approaches and made different assumptions, often with limited testing of approaches and assumptions. There are gaps in our knowledge related to which populations can best be helped by climate information (especially with regard to understanding the heterogeneity of user populations), what climate information meets user needs, and the most productive means by which to identify these populations and their needs. Further, there has been very little exploration around the critical question of how to generalize knowledge about users and needs. How much locale-specific knowledge is needed for effective design? What are the implications of the necessity for some specificity in planning and priority setting?

This paper presents a learning agenda for acquiring further knowledge about the users of CIS and their needs. As a learning agenda, it reviews the state of current knowledge on this subject. However, it goes beyond a review to focus on what we do not know, and to argue for what is needed to answer or fill those gaps in knowledge. Further, it prioritizes these gaps, organizing a process of inquiry that builds upon itself to inform both CIS research and practice. Thus, this paper speaks to current "good practices" in CIS design, management, and evaluation, while pointing the way to better practices in the future.

We begin with the case of the Mali Agrometeorological Advisory Program. It illustrates the complexity that can arise in characterizing CIS users and their associated needs, the significance of targeting specific users and needs, and the challenges in delivering broad-based benefits through a CIS. As such, it serves to illustrate the importance of identifying users and understanding their needs to CIS design and implementation. At the same time, it points to three themes in existing literature and practice on CIS design related to the identification of users and their needs: 1) designing effective assessments of users and their needs, 2) identifying and overcoming barriers to CIS use, and 3) how best to scale up a CIS. In addition to the three themes, the Mali case serves as a reminder that service provision generally is expected to extend over many years. Over that time, many circumstances can change within the communities served and in the expectations of service funders and providers. Anticipating and keeping track of future changes represent a further set of challenges that constitute a fourth, cross-cutting theme. There is, as yet, little systematic discussion of these challenges in the literature.

After a brief discussion of the methodology behind the literature review, we begin with a review of dominant practices associated with the identification of users and their needs in CIS. This review focuses on projects that targeted specific users and needs, the goals and assumptions that guided these projects, and what we have learned from these efforts. We then discuss the gaps in current practices and literature, framed around the three themes brought forth by the Mali case. In each area, we discuss current efforts to fill these gaps, and suggest what is needed to further address these gaps. We follow with a brief discussion of how projects and programs can better adapt to changing circumstances and changing goals, the fourth cross-cutting theme, and how such adaptation can relate to a learning agenda. We close with lessons derived from the review, framed as a practical learning agenda. The agenda identifies areas of needed research and synthesis, guidance for assuring that the agenda serves the multiple needs for knowledge about users, and further guidance for making it achievable in practice. In aspiring to practicality, there is also guidance for keeping the agenda alive and for adapting it over time.

COMPLEXITY: METEO MALI

Mali's Agrometeorological Advisory Program is a complex and increasingly well-documented story of CIS design that illustrates the importance of understanding the users of a CIS and their needs (Hellmuth et al. 2011; Carr and Onzere 2017; Carr 2014a; Carr, Onzere, et al. 2015; Carr and Owusu-Daaku 2016). The program was designed in the early 1980s to address acute, drought-associated food insecurity by providing weather and tailored agricultural advice to farmers that would lead to better agricultural decisions and an increase in yields and food availability (Moussa and Traore 2014). This effort therefore targeted variable and insufficient rainfall as the key stressor impacting agricultural yields and food availability in the country. Because it was designed and implemented by Malians with experience and expertise in agrarian communities, the program demonstrated a deep understanding of the variable agency and vulnerability of its target users.

Rather than assume that all farmers in southern Mali experienced drought in the same way, or would be able to employ these advisories in the same way, the program produced a CIS targeted to the needs of senior men who owned draught animals and plows as the key users of this information (Carr and Owusu-Daaku 2016; Carr, Onzere, et al. 2015; Carr and Onzere 2017). These men were responsible for the cultivation of rain-fed staple grains, and therefore the information delivered by the advisories focused on these crops and the key decisions related to their cultivation. This included information about the onset of seasonal rainfall, the likely amount of rainfall during the season, and the likely duration of the season. All of this information was translated into advisories that suggested optimal varieties by cycle length for these crops depending on the location of the farmer and the likely seasonal conditions in that place.

Strongly-held social roles and responsibilities among the targeted user populations across Southern Mali excluded women, and all but the most senior men in each extended family, from agricultural decision-making. Further, only those senior men heading families that owned ploughs and animal traction had the material ability to respond to advisories in a timely manner, and thus tailor their variety selection to the expected characteristics of the season. Consequently, the Malian designers of this service understood that these wealthier senior men were the only members of the agrarian population with the authority and ability to act on the new climate information (Carr, Onzere, et al. 2015; Carr and Onzere 2017). As the goal of the program was to alleviate short-term acute food insecurity by rapidly boosting production, this targeting was the most effective means to their chosen end.

Thus, in its initial design, the Agrometeorological Advisory Program was a CIS whose design was deeply informed by a contextual understanding of what crops were to be targeted to address the problem of food insecurity, who made decisions about those crops, and who had the ability to act on new information to make different decisions. The program's identified needs (advisories that would better help farmers pick varieties appropriate to seasonal precipitation such that they maximized yields) were informed by an understanding of the users that preceded project

design, carefully considering the relationship between users and needs when deciding what information to provide. The assessment of the program suggests that this design was successful in its targeting of users and information. While the assessment could not calculate the benefit of these advisories in terms of yield or income due to methodological, temporal, and budgetary constraints, more than 25 years after the design of the project senior men who owned the agricultural equipment necessary to respond to the advisories were still closely following the advice regarding variety selection (Carr 2014a; Carr, Onzere, et al. 2015). This strongly suggests that these farmers, who have access to traditional sources of information that might inform decisions to plant other varieties, find these advisories useful and of some positive impact.

As the scaling-up proceeded across southern Mali, however, farmers, members of the government, representatives of industry, and development donors suggested new types of information that would be of use to both existing users and new users, and these suggestions were incorporated into ever-more complex advisories (Moussa and Traore 2014). Critically, this new information was not necessarily needed to address drought and acute food insecurity, as these conditions had largely passed during the project's pilot phase. Instead, as the project scaled up, it began to take on a wider set of perceived needs and users. The delivery of the program, however, remained the same. As this new information was added to the existing program, there is no evidence of a reconsideration of the relationship between needs and users presumed by each new piece of information.

The same assessments of the program's impact demonstrating men's continued use of advisories after 25 years (Carr 2014a; Carr, Onzere, et al. 2015) also demonstrate that, for example, these more complex, comprehensive advisories are not reaching many, if any, women. Despite the wide range of information available in the advisories, it appears that the user base remains constrained to relatively wealthy, powerful older men. However, these findings cannot be interpreted as a failure of initial project design. As Carr and Onzere (n.d.) argue, at the time of its design, the advisory program was focused on the particular vulnerabilities of a very specific set of users. A more accurate framing of this program and its outcomes is that it was the victim of a flawed scaling-up, and a failure to adapt to changing conditions, including an end to severe drought and changing donor and government priorities.

As the acute drought and food insecurity that motivated the design and implementation of this CIS dissipated, more and more diverse information was attached to what had once been a very clear, specific system delivering information targeted at a particular challenge to those individuals who could use the information to address the challenge. In this process, the group of presumed users of the service became ever-broader without a continuing assessment of whether this new, broader universe of users wanted, needed, or could use this information. Recent donor pressure has contributed to this challenge. As the advisory program has been recently pushed from a means of boosting food availability toward a vehicle for rural adaptation or even resilience-building, the program has to address the needs of a wider range of rural Malians, which inherently means delivering new and different information. For example, while women have little control over rainfed staple grain production, they often are responsible for irrigated gardening in the dry season. Such production does not require climate information, except perhaps to warn of excessively low groundwater levels that might hinder irrigation. Instead, these women require market price information that might suggest when and where demand and therefore profits for their production is greatest.

The successes and failures associated with Mali's Agrometeorological Advisory Program highlight the importance of **identifying the diverse users of CIS**. But this case also highlights three specific challenges that designers of CIS face when identifying users and needs. The first of these is balancing the need to engage with and appropriately assess the vulnerabilities, opportunities, and needs of what are always heterogeneous populations with the desire to target specific populations and needs in CIS design. This national-scale program's initial success rested on an understanding of the heterogeneity of the potential users (and their roles and responsibilities) even at the level of the household. This example is consonant with a wider literature exploring the intersection of livelihoods, vulnerability, and identity. This literature demonstrates how vulnerabilities (and opportunities) take shape around

identity-based roles and responsibilities, which in turn shape the activities in which individuals participate (Gaillard 2010; Blakie 1985; Carr 2013; Carr, Abrahams, et al. 2015). However, the initial design was lost over time, replaced by the assumption that this design would work for scaled up, more complex advisories. That experience highlights the importance of carefully assessing users and updating understandings of users and their needs and capabilities as new information arrives and program goals change.

In showing the uneven use of these advisories, the case of the Agrometeorological Advisory Program also demonstrates that the **design of needs assessments** is critical to project outcomes. In Mali, the program designers drew on their personal experience of agrarian need for climate information, and the social roles, responsibilities, and resultant decisions embedded in the agrarian livelihoods this CIS was targeting, to design the initial project. Assessments of climate information needs that uncritically smooth over the heterogeneity of users and the livelihoods decisions for which they are responsible (for example, by conducting only head-of-household surveys) are likely to similarly miss opportunities and/or needs for some in a given population. In the case of the advisory program, women's needs are not seen or addressed by this project. Further, we cannot speak of "men's" or "women's" need for climate information, as differences among men and women (related to their authority over decision-making and their capability of responding to advisories) speak to their specific concerns and needs. Of course, in the case of the advisory program this was a problem particular to the scaling up of the program, which took it from its initial design context and applied it to wider questions and a wider population in a manner that was never intended by the designers. Thus, this case raises questions about the tools through which we might learn about potential users and their needs.

Second, this case raises the question of **identifying and overcoming barriers to CIS use**. The initial design of the advisory program identified user needs via the experience of the individuals who conceived the project, and eventually furthered this identification via the expertise and experience of various parts of the Malian government engaged with agriculture and agricultural extension. This expertise allowed for a design that accounted for effective demand in the target populations, and worked with social barriers that inhibited the rapid uptake and use of this information. However, as additional services were added to the advisories, it is unclear the extent to which the information was added at the behest of farmers who used the advisories, and it is equally unclear who was responsible for the continued assessment of changing demand for services over time. What is clear is that the creation of ever-more complex advisories did not result in dramatically larger or more diverse user populations, suggesting that the new information added to the advisories was not considered in light of effective demand, itself shaped by social roles and responsibilities in the target population. In short, the addition of new information to the initial program did not account for barriers to the use of that information in the same way as under the initial program design.

Third, it raises the question of **how best to scale up a CIS**, and to what level a well-designed CIS might be scaled. In the case of the advisory program, its initial goals and information scaled up to different parts of southern Mali because the various ethnicities engaged in agriculture in this part of the country structured their livelihoods decision-making in very similar ways (Carr and Onzere 2017; Carr, Onzere, et al. 2015). Thus, the project could be taken to spatial scale in areas where it was appropriately designed for the social context in which agricultural livelihoods take shape. However, it was difficult to take to social scale, as the social constraints on women's and junior men's demand remained in place because of the relatively consistent social context. While the field of CIS has developed a base of knowledge that broadly identifies tools that are of use to those living in agrarian settings in sub-Saharan Africa, such as drought monitoring and prediction, seasonal forecasts, and seasonal onset, far less is known about which of these tools are most effective in a given context and why. As a result, the CIS and development communities face challenges when trying to prioritize tools in situations where resources are limited.

Each of these broad areas, along with the challenge of meeting changes over time, represents a concern within the literature and practice of CIS. We now turn to a review of literature and practice to lay out the state of knowledge regarding these challenges.

APPROACH TAKEN IN THE REVIEW

This paper rests on the analysis of 55 documents, both peer reviewed and grey literature, examining 44 projects and studies in sub-Saharan Africa. The geographic scope of this analysis is shaped by the interests of the USAID Africa Bureau-funded Climate Information Services Research Initiative (CISRI) supporting this work. The material reviewed includes project documents describing the rationale and methods of design for the CIS in question, evaluation documents that provided similar descriptions, and academic studies that either directly or indirectly spoke to the rationale and methods of design for a particular project. Below, we divide our assessment of these projects and their associated literatures into "mainstream" and "new directions." For the purposes of this review, mainstream approaches are those prevalent in the majority of the literature, for long periods of time (more than 15 years), while new directions are projects and needs assessment efforts that deviate from established practice in an effort to develop different understandings of users and/or their needs than commonly seen in the literature and practice of CIS. Some of these new directions were suggested long ago, by only now are gaining traction in the CIS community. Table 1 broadly categorizes mainstream projects in terms of their location, period of operation, spatial scale, approach to identifying users, and approach to identifying user needs, while Table 2 does the same for new directions. In our discussion of both the "mainstream" and "new directions" literature we take note of the built-in assumptions made about users and their needs. These assumptions may be explicit, but more often are implicit. We also note the tools used to identify users and needs and how the choice of tools embodies assumptions.

Table 1: Mainstream projects reviewed in this manuscript

Project	Location	Project Period	Scale	Methods	References
African Farm Radio Research Initiative (AFRRI)	Tanzania Uganda Mali Ghana Malawi	2007-2010	National	Community rapid appraisals	Gates Foundation (2016), Perkins, Ward & Leclair 2011
Mali Agrometeorological Advisory Program (Meteo Mali)	Mali	1982-present	Village	LIG approach	Hellmuth et al. 2013, Carr et al. 2015
Senegalese River Basin Initiative (IRIS)	Senegal Mauritania Mali Guinea	2014-present	Regional	Vulnerability and Capacity Assessments	Diallo 2017a, Diallo 2017b
Zambezi River Basin Initiative (ZRBI)	Angola Botswana Malawi Mozambique Namibia Zambia Zimbabwe	2009-2018	Regional	Vulnerability and Capacity Assessments	IFRC Southern Africa 2010

Project	Location	Project Period	Scale	Methods	References
Global Framework for Climate Services (GFCS) Adaptation Programme in Africa projects (4) projects	Burkina Faso Malawi Tanzania	2011-present (selected projects 2014-2016)	District	Questionnaire and key informant interviews	Hampson et al. 2014, Coulibaly et al. 2016a, Coulibaly et al. 2016b, Daly et al. 2016
ClimDev-Africa	Continental Africa	2012-2014 (pilot), additional phases	Continental	Project coordinating	Mohamedahmed & Diabi 2010, ClimDev-Africa 2016
AfriClimServ	Continental Africa	2011-present	Continental	Project coordinating	AfriClimServ 2017
METAGRI OPS	West Africa	2012-2014	Regional	Multidisciplinary working group	METAGRI 2015, WMO 2015
Participatory Integrated Climate Services for Agriculture (PICSA)	Kenya Tanzania Malawi West Africa	2012-present	Village	PICSA approach	Dorward et al. 2015
ACTED 2013	Uganda	DEWS 2008-present, evaluation 2012	District	HH survey, focus group discussions, key informant interviews	ACTED Appraisal, Monitoring and Evaluation Unit (AMEU) 2013
Climate Financing for Agricultural Resources (CFAR)	Burkina Faso	1997-present	Village	Semi-structured interviews and workshops	Ingram et al. 2002, Roncoli et al. 2008
IFPRI – Food and Water Security under Global Change: Developing Adaptive Capacity with a Focus on Rural Africa (3) projects	Ethiopia South Africa Kenya	2007-2009	District Regional	HH surveys and participatory rural appraisals	Bryan et al. 2009, Deressa et al. 2009, Bryan et al. 2013
SERVIR	Eastern and Southern Africa	2008-present	National	Geospatial data (GIS and remote sensing) and Earth observation data	SERVIR 2017
Grameen Foundation 2015	Uganda	1997-present	National	Working with partners and interviews	Grameen Foundation 2015
Pastoral Risk Management (PARIMA) via USAID and GL-CRSP	South Ethiopia North Kenya	2000-2002	Village	Econometric approach of HH interviews	Lybert et al. 2004
AGRHYMET	Burkina Faso Mali Niger	2015-present	Country	Literature review and survey	Mertz et al. 2016

Project	Location	Project Period	Scale	Methods	References
Adaptation Consortium (ADA) (DFID)	Kenya	2014-2018	National	Combined approach	Kiru 2014
Climate Information Services for Increased Resilience and Productivity in Senegal (CINSERE) (CCAFS	Senegal	2016-2019	National	Project coordination, participatory approaches	USAID 2016, CCAFS 2017
Regional Climate Outlooks (7)	Continental Africa	1997-present	Continental	Trainings, meetings, forums and outreach sessions	WMO 2015, Patt et al. 2005

Table 2: Studies taking new approaches to the identification of CIS users and needs reviewed in this manuscript

Author	Location	Scale	Methods
Glantz (1977)	West African Sahel	Regional	Questionnaire
Broad & Agrawala (2000)	Ethiopia	Household	Literature review
Ingram et al. (2002)	Burkina Faso	Village	Field survey, focus group, open-end interviews (key informants)
Archer (2003)	South Africa	Village	Mixed methods (surveys, interviews, meetings – statistically analyzed)
Tarhule & Lamb (2003)	West African Sahel	Regional	Field survey (questionnaire)
Ziervogel (2004)	Lesotho	Village	Surveys and participatory research (role playing games)
Patt et al. (2005)	Zimbabwe	Village	Workshops and interviews, relative harvest index
Ziervogel et al. (2005)	Lesotho	National	Agent-Based Social Simulation (ABSS), surveys, workshops and participatory tools (role play game)
Klopper et al. (2006)	South Africa	Regional	Interviews and retroactive test period
Roncoli et al. (2008)	Burkina Faso	Village	Semi-structured interviews
Deressa et al. (2009)	Ethiopia	Regional	HH surveys and multinominal logit model (MNL)
Hansen et al. (2009)	Kenya	District	General circulation model (GCM) and APSIM model
Sultan et al. (2009)	Senegal	Regional	Bioeconomic farm model
Ngugi et al. (2011)	Kenya	District	Interviews via questionnaire
Gebrehiwot & van der Veen (2013)	Ethiopia	Regional	HH surveys

Author	Location	Scale	Methods
Vellinga et al. (2013)	West African Sahel	Regional	Seasonal forecast models (Glosea) and reanalysis
Muhambi & Nhamo (2014)	Zimbabwe	District	Interviews and survey
Roudier et al. (2014)	Senegal	Village	Participatory approach
Carr, Fleming, Kalala (2016)	Senegal	Village	LIG approach
Carr & Owusu-Daaku (2016)	Mali	Village	LIG approach
Carr & Onzere (2017)	Mali	Village	LIG approach
Egeru (2016)	East Africa	District	Semi-structured interviews, focus group, key informant interviews
Mertz et al. (2016)	Burkina Faso, Mali and Niger	Country	Literature review and survey questionnaire
Nyamwanza & New (2016)	Zimbabwe	District	Semi-structured interviews
Zongo et al. (2016)	Burkina Faso	Village	Surveys

MAINSTREAM EFFORTS TO IDENTIFY USERS AND NEEDS

Most of the time the identification of CIS users, their needs for climate information, and the goals of a given CIS program or project have been so closely linked as to make the explicit investigation of users and needs apparently redundant; however, many assumptions, which may or may not have empirical support, can be obscured by this linkage.

How are users identified or targeted?

Historically, the bulk of CIS targeted particular populations and their perceived need for new climate information, though some were aimed at institutional users like government ministries. These projects drew legitimacy and momentum by enhancing existing CIS and/or leveraging institutional contexts where efforts around CIS could draw on existing knowledge, interest, and funding. It is therefore not surprising that the vast majority of CIS projects surveyed for this paper were designed with users already defined, rendering the empirical identification of users moot. For example, in a project in Ethiopia and South Africa, Bryan et al. (2009) targeted farmers as their users because the project goal was to understand the factors influencing *farmer's* decision to adapt to perceived climate change. In their follow-up project, Bryan et al. (2013) expanded their project goal to include Kenya. Because the follow-up project builds from previous efforts in Ethiopia and South Africa with the targeted group as farmers, there is little chance to either verify or challenge this framing of the project.

The example of the project discussed by Bryan, et al. (2013) highlights another set of cases in which targeting is a product of path dependence induced when the project at hand builds on previous projects, contributing new data or refining an area of focus for an ongoing project. Such expansions and contributions target users based on the framings that led to the original project. For example, forecast advisories associated with the Southern African Regional Climate Outlook Forum (SARCOF) were originally conceived as a tool for aiding food security planners in response to El Niño related famine in the early 1990s. Only after the advisories were initially implemented in 1997 did the government of Zimbabwe extend the project to provide advisory information for *all* farmers (Patt 2006).

Patt notes that despite this effort to scale up the use of this advisory information, the information rarely reached the smallholder farming community. Instead, it was most useful for large-scale white commercial farmers (2006).

Finally, there are cases where targeting is related to the opportunities created at the intersection of different institutional and/or sectoral interests (Hampson et al. 2014; Grameen Foundation 2015; Tarchiani 2015; SERVIR Global 2017; ACTED Appraisal and Monitoring and Evaluation Unit (AMEU) 2013; "AfriClimServ" 2017; Mohamedahmed and Diabi 2010; Coulibaly, Mango, et al. 2015; Coulibaly, Kundhlande, et al. 2015; Deressa, Hassan, Ringler, Alemu, and Mohamud 2009). For example, two pieces reviewing the Global Framework for Climate Services' (GFCS) Africa Programme in Tanzania and Malawi (Coulibaly, Mango, et al. 2015; Coulibaly, Kundhlande, et al. 2015) note that the project was broadly intended to "improve climate services for agriculture, food security, health and disaster risk reduction in Tanzania and Malawi." The ambiguous language of the programme goals reflects an effort to build on existing interests and knowledge of these contexts (whether detailed enough or not) in these countries, while targeting opportunities to reduce the gap between routinely available information and what those engaged with the programme knew to be useful for farm decision-making. Thus, the empirical engagement with the question of who the users were and what their needs might be was largely confined to refining these targets and setting up a baseline for monitoring and evaluation.

Historically, explicit efforts to identify CIS users and their needs most frequently employed literature searches or used surveys to identify the needs of targeted users (Egeru 2016; Ingram, Roncoli, and Kirshen 2002; Bryan et al. 2009; Daly, West, and Yanda 2016; Mertz, Rasmussen, and Rasmussen 2016; Roncoli et al. 2008; Deressa, Hassan, Ringler, Alemu, and Mohamud 2009; Bryan et al. 2013; Coulibaly, Mango, et al. 2015; Coulibaly, Kundhlande, et al. 2015; ACTED AMEU 2013). **Literature searches** typically reviewed the sociocultural practices of targeted user groups, the prevalence of particular (climate-related) shocks and stressors, or both. The quality of the resultant reviews, however, is constrained by the amount and currency of the information available about that user group. Surveys are a particularly challenging tool to use for needs identification, given the close link between project goals, user identification, and user needs identification. **Surveys** rest on fixed questions that often reflect the initial biases of the survey designer. Thus, a survey that assumes a particular need might ask questions principally about that need, or about activities associated with that need, thus reinforcing the perceptions of the project. For example, in assessing user satisfaction with CIS for the GFCS program in Tanzania, Daly et al. (2016) employed surveys, semi-structured key informant interviews, and focus groups at the local, district and national levels in country. While the surveys differed in themes and locations, the research team agreed to a common set of questions allowing for qualitative comparison at each location. One question, asked near the end of the survey, was if the respondent was "aware of weather-related advisories issued by the Tanzanian Meteorological Agency (TMA)" (Daly, West, and Yanda 2016). While this represents an effort to avoid skewing the data in the survey by only asking direct questions about advisories after other data have been gathered, it still presents risks. Such a question tells the informant the purpose of the project. In less-thoughtful survey designs, asking such a question at the outset of the survey can bias the informants' answers to emphasize the importance of a given stressor, or the need for a particular tool, whether or not that informant would give the same answer without information on the interviewer's interests. But even in a more careful design such as that implemented by Daly, et al (2016), informants within a community or household will discuss their experiences of the survey with one another, thus transmitting this information to at least some subsequent informants, which might similarly bias the responses of those informants.

Other projects identify user needs through **participatory approaches** such as vulnerability and capacity assessments (Diallo 2017b; Diallo 2017a; IFRC Southern Africa 2010), the Participatory Integrated Climate Services for Agriculture (PICSA) approach (Dorward, Clarkson, and Stern 2015), and participatory rural appraisals (Bryan et al. 2009; Deressa, Hassan, Ringler, Alemu, and Yesuf 2009; Bryan et al. 2013). While these participatory approaches aim to address some of the gaps and shortcomings described above, as currently implemented they exhibit many of the same assumptions as more survey-based approaches. For example, participatory rural appraisals may minimize

interview bias by incorporating local knowledge and information into various design or implementation processes of intervention (e.g. Chambers 1995; Chambers 1997). However, the identification of who participates in such processes (targeting) remains rooted in assumptions about vulnerability and need common to contemporary CIS. As a result, they are vulnerable to the same gaps and challenges as more survey-based approaches.

A final set of projects provide **frameworks for project coordination** (Mohamedahmed and Diabi 2010; ClimDev-Africa 2016; "AfriClimServ" 2017; METAGRI 2015). These frameworks serve to bring together various projects, institutional partners and other key stakeholders (government leaders, end users, climate scientists). Among the many interests represented in these frameworks, the specific needs of different end users can easily be lost.

Who is targeted?

CIS in sub-Saharan Africa most frequently target **agriculturalists** (A. Patt and Gwata 2002; Hansen and Indeje 2004; Ziervogel 2004; Ziervogel et al. 2005; A. Patt 2005; Perkins, Ward, and Leclair 2011; Roudier et al. 2014; Nyamwanza and New 2016; Zongo et al. 2016; Rader et al. 2009; Melinda Gates Foundation 2017; Deressa, Hassan, Ringler, Alemu, and Yesuf 2009; Dorward, Clarkson, and Stern 2015; Bryan et al. 2009; Ingram, Roncoli, and Kirshen 2002; Bryan et al. 2013; Tarchiani 2015). Projects less frequently target **agropastoralists** (Daly, West, and Yanda 2016; Coulibaly, Mango, et al. 2015; Coulibaly, Kundhlande, et al. 2015), and when they do they often target them along with another group, such as farmers or pastoralists. Even fewer projects target pastoralists (Egeru 2016; Lybbert et al. 2007; W. K. Luseno et al. 2003; W. Luseno et al. 2016), and only occasionally are key **governmental** and other stakeholders in the service targeted (Kadi 2010; Vellinga, Arribas, and Graham 2013; National Aeronautics and Space Administration 2016; Regional Centre for Mapping of Resources for Development 2014; "AfriClimServ" 2017; Grameen Foundation 2015; "Climate Services Partnership" 2017; Tarchiani 2015; Mertz, Rasmussen, and Rasmussen 2016; SERVIR Global 2017; ACTED AMEU 2013). Finally some projects broadly targeted vulnerable communities (International Federation of Red Cross and Red Crescent Societies 2009; Diallo 2017a; Diallo 2017b) or aimed to bring together institutional partners ("AfriClimServ" 2017; Mohamedahmed and Diabi 2010; ACTED AMEU 2013).

What needs are targeted?

The majority of the projects reviewed for this paper based their targeting on either existing knowledge of potential users or opportunities to reach new users by leveraging or improving existing services and development initiatives. These projects therefore targeted needs that, while perhaps part of the literature or the tacit knowledge of the pr oject team, either were not verified with targeted users (W. K. Luseno et al. 2003; Grameen Foundation 2015; National Aeronautics and Space Administration 2016; Regional Centre for Mapping of Resources for Development 2014; "AfriClimServ" 2017; "Climate Services Partnership" 2017; Tarchiani 2015; Dorward, Clarkson, and Stern 2015) or which were tested largely as a means of refining initial targeting (Lybbert et al. 2004; A. Patt, Suarez, and Gwata 2005; Mudombi and Nhamo 2014; Orlove et al. 2010; Perkins, Ward, and Leclair 2011; International Federation of Red Cross and Red Crescent Societies 2014; International Federation of Red Cross and Red Crescent Societies 2011; Roudier et al. 2014; A. Patt and Gwata 2002; Hansen and Indeje 2004; Vellinga, Arribas, and Graham 2013; Daly, West, and Yanda 2016; Zongo et al. 2016).

These projects focused on addressing broad concerns related to the impacts of climate variability on various sectors, with a particular focus on the **mitigation of famine and food insecurity** within the agricultural sector. Projects explored the use of GCMs for **predicting crop yields** at a field scale (Hansen and Indeje 2004), predicting seasonal monsoons to **inform rainfed agricultural production decisions** such as crop and variety selection, planting dates, and input application (Vellinga, Arribas, and Graham 2013; Carr 2014a), and designing early warning systems for events and seasons that might compromise production (Kadi 2010; Broad and Agrawala 2000b; Sultan et al. 2010;

National Aeronautics and Space Administration 2016; "AfriClimServ" 2017; "Climate Services Partnership" 2017; Perkins, Ward, and Leclair 2011; ACTED AMEU 2013). For example, ACTED is interested in climate information for contributing to the **Drought Early Warning System** (DEWS) in Karamoja, Uganda to prevent the impacts of widespread famine and food insecurity (2013).

We note here that the focus on famine and food security in the event of disasters is a particular narrowing of the needs that users might have for climate information, one that can limit what is considered in CIS design and implementation. Other possibilities could include **maximizing expected yields, increasing the stability of production, or expanding the types of crops grown**. Or alternatively, a goal could be **better-informed farmers** who make their own decisions about the balance between taking risks to increase production versus avoiding the potential for bad yields.

NEW DIRECTIONS

Current practices in CIS design and implementation produce learning that results in improved design, delivery, and use of weather and climate information in development, disaster risk reduction, and adaptation efforts forward. However, these practices leave open a number of key questions around which we propose a learning agenda. Below, we lay out these questions, address the extent to which the literature has answered them, and point to the things we still have to learn if we are to answer them more fully and move the field forward.

Designing Effective Needs Assessments

The contemporary practice of CIS design carries the risk that the initial assumptions behind the targeting of specific populations will **bias the questions asked about the needs of that population**, their capacities, and the constraints they face, thus obstructing learning and the adaptive management of CIS projects. This, however, is not an inherent risk for CIS design or implementation. We identified eleven projects that sought out ways to identify users before the potential CIS's goals were set, most frequently through the use of randomized surveys of the population. For example, Tarhule & Lamb conducted a field survey in rural communities of West Africa to identify *potential* users of climate information (2003a). The Humanitarian Response and Development Lab (HURDL) at Clark University has employed a rapid ethnographic approach called Livelihoods as Intimate Government (LIG) (Carr 2014b; Carr 2013) to the identification of CIS users and needs on projects in Zambia (Carr, Abrahams, et al. 2015), Senegal (Carr, Fleming, and Kalala 2015), and Mali (Carr, Onzere, et al. 2015; Carr and Onzere 2017). LIG expressly holds in abeyance the question of who the distinct users of a CIS might be until fieldwork has been undertaken to identify the stressors which different members of the community perceive as sources of vulnerability. LIG analyzes all stressors perceived by the community, which creates a more holistic opportunity to understand the opportunities for and constraints on CIS use. For example, the use of CIS might be shaped not only by climate-related events and processes, but also economic shocks that reduce access to agricultural assets, or the sometimes-severe consequences for those that depart the roles and responsibilities associated with their identities (gender, seniority, ethnicity, etc.) by taking on a new livelihoods activity or practice.

Those projects which sought to identify users before potential CIS goals were set generally reference a wider, more heterogeneous set of users than seen in more conventionally targeted projects. For example, rarely did these projects limit themselves to agriculturalists. Instead, these projects often included or focused on agropastoralists and pastoralists (W. Luseno et al. 2016; Broad and Agrawala 2000a; Roncoli et al. 2009; Tarhule and Lamb 2003; Lybbert et al. 2004; Deressa, Hassan, Ringler, Alemu, and Mohamud 2009; Carr, Onzere, et al. 2015; Egeru 2016; Carr, Abrahams, et al. 2015), as well as specific actors in commercial or public sector information chains (Klopper, Vogel, and Landman 2006).

Given the close connection between identification of users and identification of needs, it is not surprising that these more recent efforts to empirically target users as part of CIS design tend to capture a more heterogeneous set of users' needs. As such, these projects have begun to open up the CIS implementation lens with regard to the different kinds of CIS needs that users might have. For example, when focusing on the use and utility of seasonal forecasts, these projects are first interested in the **Bareness and use of seasonal forecasts for supporting the users they have identified**, whether smallholder farmers, pastoralists or high-end users such as climate partners and commercial farmers (West, Roncoli, and Ouattara 2008; Ngugi, Mureithi, and Kamande 2011; Archer 2003; Ziervogel 2004; Ziervogel et al. 2005; W. K. Luseno et al. 2003; Mudombi and Nhamo 2014). This is a **wider set of users, with a wider set of needs**, than generally seen among projects that target users without empirical verification. Further, these projects move beyond interests in awareness and use of seasonal forecasts to include **understandings of the utility of these forecast** for helping and improving agricultural and crop management for smallholder farmers in parts of Sub-Saharan Africa (Ingram, Roncoli, and Kirshen 2002; Tarhule and Lamb 2003; Ziervogel 2004; A. Patt 2005; Mudombi and Nhamo 2014; Roudier et al. 2014; Carr, Onzere, et al. 2015). Finally, there are a few projects that are interested in **particular needs for a specific group of users**, such as the use of seasonal forecast for improving farmer-pastoral conflicts (Mertz, Rasmussen, and Rasmussen 2016) and the role of decadal climate information for anticipatory adaptation for climate variability (Nyamwanza and New 2016).

While efforts to carefully identify both users and their needs through empirical research appear to yield more nuanced, contextually-appropriate understandings, the success of such approaches rests on asking appropriate questions of the users, and asking those questions in a manner that facilitates learning from the users. This opens an important question for CIS: **how are we to identify and assess user needs in a manner that does not swamp information from the users with biases from the designers?** Answering this question remains a significant challenge for CIS, especially those targeting particular populations or needs.

A growing literature addresses this challenge, and suggests some ways forward for empirically identifying users and needs without starting from deeply embedded assumptions about one or both. Some projects used participatory methods (Archer 2003; Ziervogel 2004; Ziervogel et al. 2005; Roncoli et al. 2009; Roudier et al. 2014; Dorward, Clarkson, and Stern 2015) while others used ethnographic fieldwork (Carr, Onzere, et al. 2015). For example, Ziervogel and her co-authors (2005) use a role-play exercise to help farmers think through various situations regarding their growing seasons. Participatory role-play exercises allow farmers to address both familiar and unfamiliar situations, thus elaborating their decision-making and information needs. Roudier and his co-authors use a participatory approach focused on farmer workshops in two agro-ecological zones of Senegal, West Africa. These workshops include simulation exercises of crop management strategies that both engage farmers and allow for understanding how they may adjust their management strategies under different climatic conditions. These interactions allow farmers to understand participatory mapping, seasonal calendars, historical climate data, crop information tables, crop practices matrices, livestock option matrices, and livelihood option matrices. Others use rapid ethnographic approaches such as HURDL's LIG approach mentioned above (Carr 2013; Carr 2014b).

Co-production efforts, which in principal might seem like obvious means to this end, are in practice much more challenging to implement meaningfully. Constructive co-production requires answering several important questions, all centered on the question of who to co-produce with. For example, are there people with whom co-production is critical because their existing knowledge and understanding is needed to inform project design and implementation (as in the initial Mali project design)? And how do we know when this existing knowledge is in fact adequate? Without answers to these questions, it is difficult to determine when a detailed needs assessment is necessary. As in all participatory development approaches (for discussion, see Chambers 1995; Chambers 1997; Chambers 2008), efforts to co-produce climate services must negotiate the demands of donors, the institutional realities of

development implementation, the existence of biases that dismiss or downgrade the knowledge of the poor, the lack of knowledge and formal education among some users, and the difficulties in gaining the participation of a broad set of users, for example due to pervasive gender biases in a particular user population are all issues that have to be carefully considered. Identifying these barriers to co-production and addressing them requires research and thought, but to this point very little of this work has been conducted for CIS (c.f. Roncoli et al. 2011; Peterson et al. 2010)

Therefore, while many new directions have emerged around the identification of CIS users and their needs, there remain significant gaps in these efforts. While contemporary CIS practice is closing knowledge gaps around how to most effectively identify users and their needs, there remain significant questions to be answered.

1. **How often does bias obscure important information about users and needs?**

Targeting users and needs remains the most common mode of design for CIS. However, such targeting often reflects the interests, knowledge, and priorities of donors and implementers, not users. There are many pressures that promote such approaches, including donor and other funder demands for budget and performance. These pressures are likely to continue until there is clear evidence that such bias is pervasive and not easily managed by literature reviews or survey methodologies.

2. **What is the impact of project design bias on project outcomes?**

While it is clear that approaches that obscure information about users and their needs will challenge the efficacy of CIS projects, and that such bias could be pervasive, we must establish the impact of such bias on projects and their outcomes. Understanding the impact of bias on project outcomes is critical to appropriately deploying tools and building budgets. Multiple types of information are needed to identify impact: these include capturing the number of different kinds of users and needs identified by the project and the percentage of the target population able to use the information, establishing what part of the population (e.g. gender, economic status, social status, ethnicity, etc.) is reached and how this population makes use of the information, and characterizing the achievement of goals beyond income, such as disaster risk reduction or increases in population resilience.

3. **What are the differences in user and user needs identification gleaned through different methods? What methods are most effective in which situations? What kinds of things do they help us to learn, and how might different approaches be integrated to draw on strengths and eliminate gaps?**

When designing needs assessments for CIS, it is a mistake to seek out the ideal or correct method. Methods always involve tradeoffs in information or applicability. For example, while surveys can be applied to large populations relatively rapidly, they are often designed with assumptions about that population that overlook critical points of heterogeneity, and which therefore result in questions that do not draw out vulnerabilities and needs critical to some in the population. On the other hand, findings from more ethnographic tools, whether the traditional extended fieldwork often associated with academic research or rapid assessment approaches such as participatory rural appraisal, are often very place-specific, calling into question the generalizability of the findings of any such work to a larger population. More research is needed to 1) clearly identify the sorts of information that different methods can and cannot provide and 2) pilot innovative combinations of these approaches that might, for example, use ethnographic data to serve as a more rigorous basis for the interpretation of survey data, while at the same time using that survey data to test the generalizability of ethnographic findings.

4. How can we identify "enough" heterogeneity to enable effective initial project design such that differences among people in their use of climate information can be addressed and previously unseen heterogeneity can emerge?

People differ in their interests in using CIS and in their capabilities for using them. An effective CIS will be appropriately tailored to those differences to have a sufficiently broad impact. However, there are practical limits to how much tailoring is feasible, as CIS cannot be designed for the specific needs of each individual. As discussed under question 3 above, it is a mistake to expect and seek a "correct" scale for investigating heterogeneity. There are always tradeoffs between the depth of information and the practicality of obtaining it in a timely fashion. The challenge then is to create processes for users/needs identification that balance the broad opportunities provided by particular CIS capabilities with the identification of those characteristics of potential CIS users that are relevant to CIS design. The further challenge is to design projects to be adaptive so that changes in CIS can be made and new opportunities realized based on new knowledge about people's needs and interests, and changes to those needs and interests as users' knowledge increases and/or user/implementer/government/donor conditions change.

Identifying and Overcoming Barriers to CIS Use

The more complex findings of these new approaches to needs assessment speak to another major challenge for the design of CIS: the constraints on their use by targeted users. Effective demand constraint is a particular challenge which takes shape around the climate-related knowledge of targeted users. For example, rural farmers cannot be expected to articulate needs around climate information products or communication processes to which they have never been exposed, or which might be technically feasible if otherwise unavailable. Some of this constraint will be addressed through time and experience, as targeted users are exposed to a greater range of technically feasible information, and are engaged by participatory tools and processes in both project design and eventually monitoring and evaluation. This will improve user capacity to articulate their more context-specific and nuanced needs.

The literature on barriers to CIS use has been mainly focused on issues of access to information, timing of information, and building understanding of the information among users. More recently, a focus on wider **social constraints** to the use of climate information and CIS has emerged to address variable decision-making power and responsibility in target populations. The literature on this subject is relatively small, and heavily focused on **gender** targeting rain-fed grains (HURDL found similar situaions in Senegal: see Carr, Fleming, and Kalala 2016). In Zambia, rural residents' abilities to use flood early warnings depended on the timescale of the early warning (Carr, Abrahams, et al. 2015). Wealthier members of the community, who owned cattle in which their wealth was stored, could not relocate these animals with less than a few weeks' notice. Rather than abandon the animals, and risk being reduced in economic and social status, the men in this situation often chose to stay with their cattle in extreme flood events, even though this decision put their lives at risk. Thus, these individuals faced a significant social barrier to the use of early warning systems that has to be addressed if such warnings are to benefit all members of the community. as a constraint (e.g. Archer 2003a; Roncoli, Ingram, and Kirshen 2000; Roncoli et al. 2009; Carr, Fleming, and Kalala 2016; Carr, Abrahams, et al. 2015; Carr and Onzere 2017; Carr and Owusu-Daaku 2016). For example, HURDL's work in Mali, Senegal, and Zambia points to such social constraints to use. In southern Mali, women are not responsible for the cultivation of rain-fed grains, and have little authority over such production (Carr, Onzere, et al. 2015; Carr and Onzere 2017). Further, they face significant social sanctions if they depart expectations of their roles and take up the cultivation of such grains. As a result, they face extremely high social barriers to the use of agrometeorological advisories

There remain significant knowledge gaps in this area of inquiry.

1. **Are there broad categories of effective demand constraints that might inform CIS co-production efforts?** There are few studies of effective demand constraints on the co-production of CIS with targeted users. More studies are needed to identify and understand user goals, as well as to establish effective means of dialogue through which constraints might be overcome to increase the number of users of a given service and/or change the goals and targets of that service to those that are achievable and appropriate.

2. **What are the most effective means of implementing the co-production of CIS with user populations?** Co-production efforts are very challenging to implement meaningfully, but thus far very little work has been conducted in the CIS literature.

3. **Are there broad categories of social constraints to CIS use that might inform CIS design and co-production efforts?** The field of CIS needs substantially greater work on the **social constraints** to the use of climate information. Those studies that exist are very ethnographic and context-specific, and tend to focus on gender. A larger number of cases will enable synthetic efforts to identify common challenges across contexts and user groups, while identifying new social constraints to use that have not yet been considered by CIS designers and implementers.

4. **What are the climate science constraints that limit the efforts of climate service providers to meet user needs?** While the subject of much discussion in the climate science literature (e.g. Briley, Brown, and Kalafatis 2015; Porter and Dessai 2017; Kirchhoff 2013), the policy and implementation community engaged with CIS evinces a very thin understanding of the constraints providers of climate services face, and how those impact CIS use. For example, the current limits of climate science may preclude the sorts of forecasts that a particular subset of users' needs. Governments have to balance budgets and political realities when deciding how much to spend on CIS, and deciding who those CIS should serve, thus creating situations where certain user needs are unlikely to be met. Ministries within governments have to compete for funds by keeping diverse constituencies (for example, legislatures and end-user farmers) happy, forcing technical decisions to compete with political decisions. These and many other issues must be much more fully explored if we are to understand the spaces within which co-production can take place, and if we are to understand the design, implementation, and observed outcomes of different CIS.

Scaling CIS Up and Down

While recent work drawing out the heterogeneity of user populations and needs points the way to more comprehensive understandings of the range of needs in a given population and the likelihood a particular intervention will be taken up by its target population (whether due to questions of social context or effective demand), this work also presents unique challenge for CIS. These framings tend to focus at the scale of the community, and draw out intra-community and even intra-household differences. They have not addressed the generalizability of their findings. Yet within the CIS community there is significant interest in scaling services up or down for replication and use beyond a target area to respond to broader concerns of climate variability (Hansen et al. 2009; Kadi 2010; Grameen Foundation 2015). A common situation is an attempt to scale up a successful

localized or otherwise narrowly targeted project with a goal of serving a broader area and/or a more diverse population.

Scaling down raises a related set of questions. How much value can be added by developing, incorporating, and delivering more localized or otherwise specific information? For example, Hansen and his team are interested in the potential value of downscaling GCMs for seasonal precipitation forecasts in decision-making regarding maize planting and fertilizer management in high-risk smallholder agriculture (2009a). Thus for both scaling up and down, CIS are confronted with the critical questions: how can information at a particular spatial or social scale be extrapolated to other situations? With what confidence can such extrapolations be made, and are there identifiable factors that shape the generalizability of information? And what is the value of these extrapolations?

There is very little work exploring this issue, or even expressly discussing this issue, in the CIS literature. The Humanitarian Response and Development Lab (HURDL) at Clark University has, when employing the LIG approach, argued that the logics of livelihoods decision-making it explores are likely consistent across the livelihoods zone in which they were established. This argument is predicated on the assumption that the social and economic factors which shape livelihoods decisions are contingent on time, place, ethnicity, and local environment (Carr 2013; Carr 2014b) which are generally consistent across the livelihoods zones produced by the Famine Early Warning System (see, for example, Dixon and Holt 2010). However, this has only anecdotal support (see Carr, Onzere, et al. 2015) and has not been rigorously tested.

Knowledge gaps regarding the scaling of CIS include:

1. **Over what spatial level or social groupings can a particular CIS be scaled?**

What are the constraining factors that limit the spatial or social scalability of a CIS? Is it agroecology, governance, social structures and expectations, or some combination of these? How might we better understand and identify such scales?

2. **What is valid extrapolation for CIS?**

Research directed to the problem of extrapolation is also needed. It should focus on 1) identifying specific characteristics of a population that are critical to making CIS useful, and 2) seeking indicators of similarities and differences in populations that can guide choices in extrapolation and suggest where and when further detail is needed.

3. **What is the value of extrapolated data, whether upscaled or downscaled, for a particular CIS?**

While it may be possible to rigorously generalize findings about users and needs from a particular community across larger areas, what findings generate the most added value for CIS? Similarly, where downscaling climate information is possible, does that information add value to the CIS?

Changing Conditions and Changing Knowledge

Food production systems, and the wider rural livelihoods systems to which they belong, continue to evolve (see, for example, Bryceson 1997; Bryceson 2002; Harris and Orr 2014; Ward and Shackleton 2016; Alobo Loison 2015). So do the capabilities of CIS, as ongoing research improves our understanding of the climate system at a range of spatial and temporal scales (e.g. Doblas-Reyes et al. 2013; White et al. 2017; Meehl et al. 2014). While there is a large literature focused on the changing trajectories of rural livelihoods in sub-Saharan Africa, the CIS literature's

engagement with this body of thought is minimal at best. There is little to no research in the CIS literature that specifically identifies trends (either through primary research or reviews of existing literature on agrarian transformation) in agricultural or broader livelihoods practices that can predict new uses for climate information. Further, there is surprisingly little discussion of the ways in which changes in local environments tied to climate change (shifts in precipitation and temperature) might alter the behaviors and functions of existing plants and animals that agrarian populations use to guide their livelihoods decisions. This is a promising area of study.

Significant knowledge gaps exist around:

1. **How might engagement with the literature on agrarian change (and deagrarianization) in sub-Saharan Africa serve to identify current and likely future CIS needs?**

This gap includes questions about how the changing diversification of livelihoods that might drive increased *or* decreased reliance on CIS for livelihoods, how shifting livelihoods might change where agrarian populations are located, and how shifting livelihoods may change the size and composition of future CIS user populations.

2. **How might CIS planning leverage existing understandings of climate change and its impacts on specific ecologies such that current sources of livelihoods information change or fail?**

This question includes a focus on the timing of changes, such as when particular animals will shift migratory patterns or when particular trees might change the dates on which they fruit or change foliage. Such information may provide insights into when existing forms of climate information used by agrarian populations will no longer serve their decisions, and when new forms of climate information will become central to agrarian livelihoods.

3. **What current trends in climate research and what likely new knowledge from them can and should filter into CIS over the next 10 to 20 years?**

This question relies on the climate science community's ability to assess its own foci, and the likely rates of advance in their predictive capabilities. Ideally, this conversation would be informed by interaction with user-facing members of the CIS community to help focus climate science research agendas that can help prioritize advances in areas of known user need.

4. **How does learning about CIS change the behaviors of users and their demands for information?**

A large number of CIS projects are being implemented, and over time the target populations will learn about the strengths and weaknesses of these CIS and the information they provide. One critical driver of future effective demand will come from this learning.

The gaps in our understandings of how changing conditions and changing knowledge intersect with future CIS demand and capabilities cross-cuts all the other questions we have raised above. For example, even if we can identify effective scales to which the generalization of detailed local information is possible and effective for CIS design, will those scales remain steady over time or change with market, environmental, and other conditions? While certain constraints to the use of CIS might be very prevalent now (for example, those emerging around gendered roles that exclude women from much agricultural decision-making), will those constraints persist as incomes rise, education levels increase, and livelihoods diversify? All of these conditions of change have brought about significant

social changes in other contexts. Thus, for all of the questions raised above, there is a second set of questions that must be asked and answered (if possible):

1. What are the conditions of change that might reduce the validity of these findings or might introduce possibilities for revised findings?
2. For how long is this finding likely to be valid?
3. How frequently must we evaluate conditions to ensure our empirically-based initial assumptions have not departed significantly from conditions on the ground?
4. What mechanisms should CIS include to refresh and revise information in response to these challenges?

A LEARNING AGENDA FOR IDENTIFYING CIS USERS AND THEIR CLIMATE INFORMATION NEEDS

For us, a learning agenda presents an opportunity to move the field of CIS research and practice forward in a coherent manner by prioritizing the gaps we have identified above; at the same time, the agenda should also be practical. Thus the agenda should provide guidance for making use of existing and realistically attainable resources to build on promising work within or adjacent to CIS implementation and research. In this section then, we discuss what we feel should be prioritized as CIS continue to be designed and implemented, and how those priorities might best be met.

The context for learning, and thus filling these knowledge gaps, is a critical starting point for this agenda. Though some targeted research will be needed, there are likely to be only limited opportunities for independent research to address the gaps and questions we have raised. However, there are, and will continue to be, many CIS projects. If learning is incorporated into these projects, they could provide much of the information gathering needed. Collectively they could serve to facilitate critical analysis of the information and dissemination and use of findings.

Further, there are now multiple research groups with ties to various CIS projects (links to other related, but non-CIS projects may prove possible and productive over time). This will make the development and implementation of a cross-project learning agenda feasible if it is carefully and appropriately framed, and if expectations are calibrated to project realities. Each project will have different goals and arrangements, a different community and external context, and differences in methods of evaluation. As it is unreasonable to expect all research groups to reorient their work toward an external agenda, we propose that this learning agenda involve synthesizing information gathered across the groups, rather than establishing new controlled comparisons or tests. This approach is realistic for two reasons. First, such a cross-project effort could further the state of knowledge and thus improve the design and outcomes of participating projects by leveraging existing investments and work, leaving any new investment needed as a modest fraction of total project costs. Second, there are many potential users of the information beyond those engaged with the participating projects. They include: designers of new projects and project implementers; program planners; donors considering priorities; government agencies; and organizations with priorities adjacent to CIS (such as NGOs aimed at facilitating agricultural production). The production of knowledge that serves these wider users is an important collateral benefit that existing projects can claim in their performance reports, and donors can claim as evidence of thought leadership in CIS.

The primary goal of the learning agenda is to guide the development of better grounded and critical knowledge that will help improve existing climate services. But several secondary goals are also important and should be considered in project planning, design, and implementation. These are:

1. Supporting the broader knowledge base that can help improve living conditions in agricultural communities in sub-Saharan Africa. Climate information is only one of a number potential interventions for improvement and lessons from the CIS experience may have broader application;
2. Information gathered can and should be used to improve project management, helping to frame and support an adaptive management mode for CIS. Not all circumstances can be envisioned in project design, and not all assumptions will prove to be correct. Attention in the information gathering process to keeping track of what is working and testing assumptions can guide project adaptation;
3. Better communication between projects will be key to the synthesis needed in the learning agenda; it will also promote direct exchange of information and learning between projects that will assist ongoing planning, design, and implementation.

The implementation of a CIS learning agenda

A successful project-based learning agenda must frame learning as a means to more than accountability. While monitoring and evaluation should be tied to accountability, if accountability is framed in a punitive manner (and in development organizations it often is) there are incentives to avoid any learning that might cast project outcomes in a bad light, challenge project design or logic, or suggest needed changes in project implementation. Instead, the learning agenda must leverage the language of USAID's Evaluation Policy (USAID 2016, p.4):

> "Evaluations of country and regional strategies, projects, and activities that are well designed and executed can **systematically generate knowledge** about the magnitude and determinants of performance, permitting those who design and implement them—including USAID staff, host governments, and a wide range of partners—**to refine designs and introduce improvements into future efforts** [emphasis added]."

While the initial phase of this learning agenda must work with existing projects and existing monitoring, evaluation, and learning efforts, the longer-term success of the agenda relies on our ability to inform the processes of monitoring, evaluation, and learning that are now built into development programs, projects, and interventions. For example, USAID (2016, p.7) requires that such efforts be included in the design of each project:

> "For each project, consideration will be given during the design phase to the performance evaluation(s) and, in some cases, impact evaluation(s) that will be undertaken. This is part of the preparation of a Project Monitoring, Evaluation, and Learning Plan…Planning for evaluation and identifying key evaluation questions at the outset will both improve the quality of the project and activity design, and will guide data collection during implementation."

It is therefore imperative that those engaged in donor-funded CIS work with representatives of these organizations to bring this learning agenda to the table, as the gaps and questions presented here must be built into new projects if they are to be addressed effectively. If included as part of the learning agenda, donor staff will be motivated to participate, as doing so will result in better-informed monitoring, evaluation, and learning plans for new projects, and can identify opportunities to adaptively manage existing projects to capture the benefits of learning from their own and others' experience.

As new projects come online with the learning agenda represented in their monitoring, evaluation, and learning plans, researchers and implementers should approach their projects with a questioning spirit. Gathering information about the performance of the project in all its aspects, the degree to which project assumptions are holding up under the realities of implementation, and whether unexpected opportunities or challenges are emerging are opportunities to improve project performance while filling gaps in the CIS learning agenda.

The implementation of this learning agenda should not rely on formal research dissemination alone. Where possible and supported by donor and implementer staff, projects should develop means of rapidly disseminating findings, lessons, and outcomes with other projects to promote synthesis and mutual learning. Such efforts might include donor- or GFCS-coordinated webinars, workshops, and conferences where active engagement across projects is facilitated. It may be useful to extend such efforts to non-CIS efforts that have overlapping interests and concerns, such as food security programs distributing new seeds, asset-building livelihoods programs that facilitate access to agricultural resources, and health programs which target climate-sensitive diseases.

Topics to be emphasized in the learning agenda

We propose a tentative prioritization for filling the previously identified knowledge gaps. It is structured over time to sequence efforts based how answers to one set of questions depend on answers to others, on the availability of existing data, on potential findings from existing efforts and on possibilities for learning from new projects. The structure has four categories:

Category 1: Can be done by gathering data from existing/completed CIS, can be learned with existing data, and will set up critical follow-on efforts

1. How often does bias obscure important information about users and needs?
2. Over what spatial region or social groupings can a particular CIS be scaled? What factors affect that?
3. How might engagement with the literature on agrarian change (and deagrarianization) in sub-Saharan Africa serve to identify current and likely future CIS needs?

Category 2: Those that can be engaged through existing research teams and projects

1. What are the differences in information gleaned through different methods, and how might different approaches be integrated to draw on strengths and eliminate gaps?
2. What is the value of a particular CIS to its users? And how can that value be extrapolated for an upscaling or downscaling of the CIS? Such information can help assess the utility of particular CIS interventions now and in the future

Category 3: Major independent research projects

1. How might we define and target future CIS demand by integrating existing scientific understandings of climate change and its impacts on specific ecologies such that current local/traditional sources of livelihoods information change or fail?

1.a How might such integration inform the direction of future climate science research in support of CIS?

1.b How might such integration inform the likely future effective need for CIS in particular places, thus prioritizing future investments?

Category 4: To build into future projects

1. What is valid extrapolation for CIS?
2. What are the most effective means of learning about users and needs in a given place?
3. Where co-production is the most appropriate way to learn about user needs and designing CIS, what are the most effective means of implementing CIS co-production efforts?
4. What are the broad lessons we might learn about the social constraints to the use of climate information?
5. How does learning about CIS change the behaviors of users and their demands for information?

Figure 1 represents this structure: it shows as one dimension the sequence in time (that is, when we might expect answers and what questions must be answered to enable the productive engagement with subsequent questions); the second dimension indicates the amount we know about them (from low-hanging fruit where much is known and simple review and synthesis is required, to broad gaps in knowledge where there are no data, or perhaps even debate about what data to collect and how). In addition, the categories of questions are shown in different colors. Further, arrows in the figure represents the relationships between the specific questions, suggesting a sequence of inquiry that allows for the prioritization of efforts to fill these gaps going forward. To be implemented, a research agenda such as this must secure broad agreement, so this should be regarded as a tentative proposal. Furthermore any research agenda must be adjusted as new information becomes available. Nevertheless we believe the categorization and temporal structure provide a useful framework for setting an agenda.

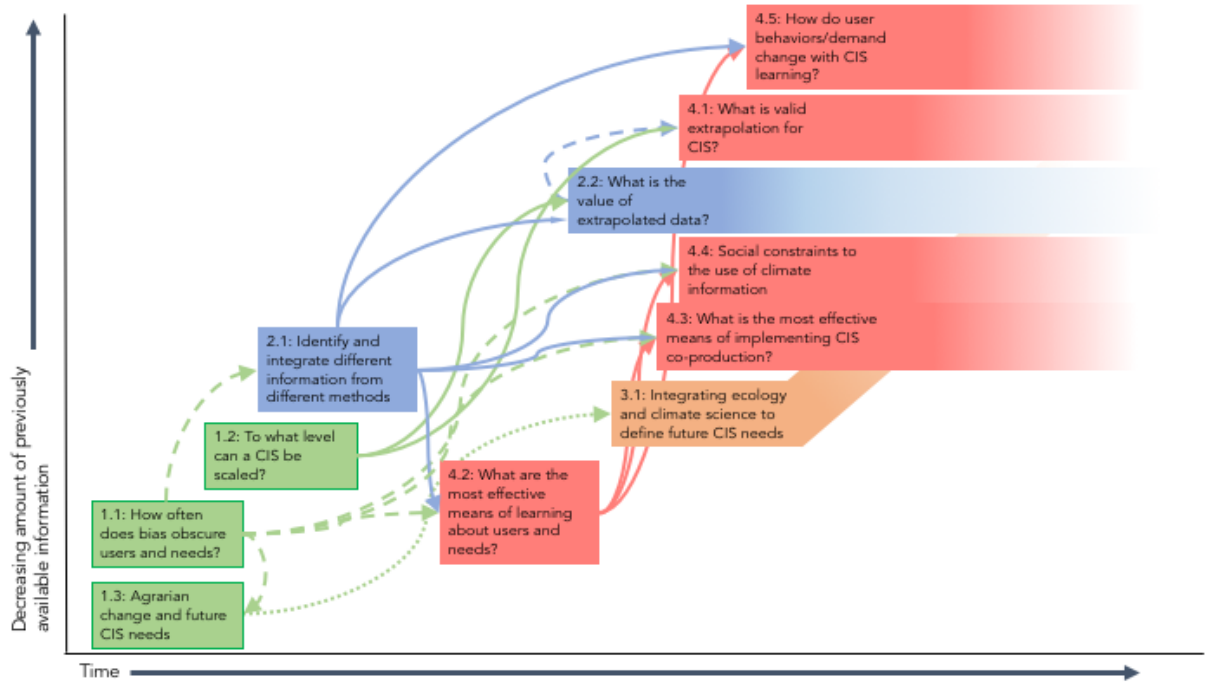

Figure 1: The learning agenda. Knowledge gaps are shown as boxes indicating when and for how long we expect them to be addressed. Their vertical position indicates how little information is presently available. The four categories of questions are color-coded and arrows show how answers from a question can be used by further questions.

Of these questions, the one likely to have the biggest impact on the effectiveness of climate services is **4.2: What are the most effective means of learning about users and needs in a given place?:** As the diagram illustrates, this is a pivot question between the organization of existing knowledge around CIS users and needs and subsequent questions about effective co-production, the social constraints to CIS use, and behavioral change in the context of CIS. Answers to this question will govern the design, implementation, and monitoring and evaluation of CIS programs going forward.

CONCLUSION

Investigations into the identification of CIS users and their needs is a burgeoning field, with the very small body of early work being rapidly overtaken by new researchers and a growing set of projects to examine. For the field of CIS

this is an exciting time, but also one that comes with the risk of unproductive duplication, or the emergence of major research themes that lack engagement with the needs of donors and implementers who will put the vast majority of CIS into play in coming years. The goal of our learning agenda is to move beyond the usual literature review that speaks to the work that has already been done, and the gaps in the literature that remain, to frame the ways in which those gaps might be filled through engagement with ongoing CIS practice. Further, we have attempted to prioritize the questions and gaps we have identified, as many gaps build from other gaps, thus allowing for the most effective use of limited research resources. Recognizing that many of the gaps and questions we have identified and prioritized here have been emerging in practice for some time, we hope the unique contribution of this learning agenda increases the value of ever-growing research into the users of CIS and their needs such that CIS policy and implementation improve, and CIS live up to their most exciting potentials.

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