



CLIMATE INFORMATION SERVICES RESEARCH INITIATIVE



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Cover Photo: Female farmers in Zinder, Niger. Credit: Sean Sheridan, Mercy Corps

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Final Report

Climate Information Services Research Initiative

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ACRONYMS AND ABBREVIATIONS

CCAFS	Climate Change, Agriculture and Food Security
CIS	Climate Information Services
CRS	Catholic Relief Services
CS	Climate Services
GFCS	Global Framework for Climate Services
HURDL	Humanitarian Response and Development Lab – Clark University
ICCS	International Conference on Climate Services
ICRAF	World Agroforestry Centre
IRI	International Research Institute for Climate and Society – Columbia University
NGO	Non-Governmental Organization
NMHS	National Meteorological and Hydrological Services
PAC	Practical Action
SSA	Sub-Saharan Africa
USAID	United States Agency for International Development
WCS	Weather and climate services
WMO	World Meteorological Organization
WS	Workstream

EXECUTIVE SUMMARY

Throughout Sub-Saharan Africa, smallholder farmers are at the frontlines of an increasingly variable and changing climate. Frequent and severe climate shocks and stresses threaten farmers' lives and livelihoods, challenging the role agriculture could play in promoting economic growth, food security, poverty reduction, and community resilience. Timely, accurate, and useful farmer-focused weather and climate information services (CIS) can lessen these vulnerabilities by informing decisions of smallholder farmers to manage those climate risks.

Valuable research exists on the impact of climate variability and change on farmers and the types of climate-related information farmers need for decision-making. However, critical gaps limit the understanding of how climate information services can best meet the decision-making needs of farmers, and the factors that most influence the effectiveness – delivery, uptake, and use – of climate information services.

In response to these gaps, the United States Agency for International Development (USAID) funded the Learning Agenda on Climate Services in Sub-Saharan Africa, which included the Climate Information Services Research Initiative (CISRI) project. CISRI sought to generate knowledge and evidence to inform the development of climate information services that effectively meet African farmers' decision-making needs in a variable and changing climate. This was accomplished through desk research, field-based research, collaboration with local and national partners, and pilots of new methodologies and approaches. The project was led by Mercy Corps in consortium with several partners, including the Humanitarian Response and Development Lab at Clark University (HURDL), the International Research Institute for Climate and Society at Columbia University (IRI), CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), World Agroforestry Centre (ICRAF), Practical Action, and Catholic Relief Services (CRS).

The research undertaken by the CISRI consortium focused on synthesizing and analyzing existing knowledge on climate information services programs, and identifying gaps and inefficiencies in climate information services systems. In addition, CISRI developed innovative approaches to strengthening climate information services systems and evaluating the uptake and effectiveness of climate services. The project highlighted that CIS in Sub-Saharan Africa will only succeed in addressing the risks created by a variable and changing climate if users and their needs are involved as a critical component in all aspects of the CIS system. Considering climate information services as a system in which users are one of the vital elements is key for improving CIS moving forward. Otherwise, climate information services cannot effectively benefit those who are most vulnerable to climate risks.

Through the CISRI project, the consortium generated research, methodologies, and learning to inform how climate information services can best meet the decision-making needs of farmers, and the factors that most influence its effectiveness. This will contribute to a better understanding of how to improve the design of climate information services programs moving forward, ultimately advancing the impact of future development investments on the livelihoods of farmers in Sub-Saharan Africa.

BACKGROUND AND CONTEXT

Climate Change in Sub-Saharan Africa

Every society across the world is facing growing climate-related risks that threaten assets, livelihoods, and overall well-being. These challenges are especially pressing in developing nations, where vulnerability to climate-related impacts is comparatively high and capacity to adapt or cope is very often low. Inability to manage the risks – from rising sea levels to extreme weather events – hinders the most vulnerable populations from achieving and protecting development gains.

Africa is one of the most vulnerable continents to climate variability and change due to its high exposure to climate shocks and stresses and relatively low adaptive capacities. In Sub-Saharan Africa (SSA), rain-fed agriculture, which is vital for a large percentage of the rural population and contributes significantly to GDP, is particularly vulnerable.

Importance of Climate Information

Both climate change and climate variability are expected to disproportionately impact the lives of poor and vulnerable people around the world - now and in the future. Weather and climate information is critical to help people make more informed decisions and manage the risks of a changing climate, especially for those who depend on rainfall (e.g., farmers and pastoralists). Providing decision-makers with timely, accurate, and useful climate and weather information could help inform decisions that enhance agriculture production and mitigate or avoid yield and harvest losses. These outcomes improve food security, lift agriculture incomes, and increase farmers' resilience to future shocks.

While innovative approaches to generating and communicating climate information show promise, evidence gaps exist in understanding their effectiveness. These gaps are compounded by the fact that much of the information that exists has not been synthesized in a manner that easily informs the design and implementation of CIS. Addressing this will require understanding and documenting the factors that affect the uptake and use, as well as the effectiveness, of CIS. Further research and interpretation is needed to explore how such information can be used to inform the appropriate design of climate information services in particular contexts.

Learning Agenda on Climate Services in Sub-Saharan Africa

The United States Agency for International Development (USAID) funded the development of an agenda to address these gaps: The Learning Agenda on Climate Services in SSA. Work under this agenda has generated new information, while also pointing the way toward priority research and operational gaps that must be filled to improve the development, delivery, uptake, and impact of climate information services for African agriculture. By aligning the efforts of donors, researchers, local governments, and partners toward these priority issues, this work can inform the development of more effective, sustainable, country-led climate information services programs.

The Climate Information Services Research Initiative (CISRI) was designed to enhance understanding of the user end of the climate information services system. CISRI investigated the factors that impact access and use of climate information services, and applied new methodologies for

strengthening the effectiveness of CIS systems, as well as evaluating CIS effectiveness in SSA. Led by Mercy Corps, CISRI drew on the expertise of its consortium partners: the Humanitarian Response and Development Lab at Clark University (HURDL), the International Research Institute for Climate and Society at Columbia University (IRI), CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), World Agroforestry Centre (ICRAF), Practical Action, and Catholic Relief Services (CRS).

The main components of the Climate Information Services Research Initiative were:

- **Synthesis of the State of the Art and Evidence**
Synthesis and critical analysis of existing knowledge on climate information services to identify strengths and weaknesses with respect to knowledge, evidence, and evaluation.
- **Systems Analysis of Climate Information Services**
Participatory systems mapping and analysis to identify lessons, inefficiencies, and breakdowns in climate information services to inform the development of good practices to improve future climate information investments and interventions.
- **Piloting Evaluation Approaches**
Piloting methodologies in select climate information services programs in Rwanda and Senegal to evaluate the uptake and effectiveness of existing climate information services, targeting identified knowledge and evidence gaps.

SYNTHESIS OF EVIDENCE

While there are still significant gaps in knowledge and evidence regarding the uptake, use, and effectiveness of CIS, there is also a substantial body of knowledge and experience that could inform strategies for investing in CIS by funders. Unfortunately, much of the existing knowledge has not been synthesized, and as a result, investments in climate information services do not benefit from that knowledge, nor do they ensure that learning continues to advance understanding of how best to design and implement climate information services for agricultural stakeholders in Africa.

Workstream 1, Synthesis of Evidence, focused on synthesizing and analyzing existing knowledge on CIS programming, identifying gaps, and generating peer-reviewed publications that expand current theory and evidence. The Workstream conducted a comprehensive review of knowledge and evidence from fragmented sources, including scholarly articles, grey literature (i.e. project and institutional reports), and institutional experience, with a focus on Sub-Saharan Africa. The analysis was used to produce three papers:

USERS AND NEEDS. A literature review of the state of current knowledge about the users of climate information services and their needs, as well as gaps in knowledge and a learning agenda for acquiring further knowledge to fill the gaps.

EVALUATION. A literature review of studies that have evaluated outcomes and/or impacts of agricultural weather and climate services in Africa, highlighting areas that have received relatively more attention, as well as persistent gaps.

GENDER EQUALITY. A literature review of the existing knowledge base on gender equality challenges in climate services, an assessment of gender-based differences, and identification of promising pathways for making climate services more responsive to the needs of rural women.

Identifying CIS Users and Their Needs

In recent years, CIS have been integrated into development agendas as a means of achieving development goals in a variable and changing climate, shifting the emphasis from 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. Then, service designers work to establish how climate information could be useful in the context of their lives, and create a plan to deliver credible, salient, and legitimate climate information that meets one or more of their needs.

However, despite warnings about the ways in which potential users might be excluded from a CIS, 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 about which populations can best be helped by climate information, 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.

CISRI conducted research and produced a paper that presents a literature review of the state of current knowledge about the users of climate information services and their needs, as well as gaps. However, it goes beyond a review to focus on what we do not know, and presents a learning agenda 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 CIS research and practice. The paper speaks to current good practices in CIS design, management, and evaluation, while pointing the way to better practices.

The paper uses Mali's Agrometeorological Advisory Program, a complex and increasingly well-documented story of CIS design, to illustrate 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. This case highlights the importance of identifying the diverse 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:** 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.
2. **Identifying and overcoming barriers to use:** accounting for effective demand in the target populations, and working with social barriers that inhibit the rapid uptake and use of this information.
3. **How best to scale:** understanding which tools, such as drought monitoring and prediction, seasonal forecasts, and seasonal onset, are most effective in a given context and why.

In addition to the 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.

APPROACH

The paper rests on the analysis of 55 documents, both peer reviewed and grey literature, examining 44 projects and studies in Sub-Saharan Africa. 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.

EXISTING EFFORTS

How are Users Identified or Targeted?

- The vast majority of CIS projects surveyed for this paper were designed with users already defined, rendering the empirical identification of users moot.
- In other cases, targeting is a product of path dependence induced when the project builds on previous projects, contributing new data or refining an area of focus. Such expansions and contributions target users based on the framings that led to the original project.
- Finally, there are cases where targeting is related to the opportunities created at the intersection of different institutional and/or sectoral interests, thus, the empirical engagement with the question of who the users were and what their needs might be was largely confined to refining existing targets.

Efforts to identify CIS users and their needs employed:

- **Literature searches:** the quality of reviews is constrained by the amount and currency of the information available about that user group
- **Surveys:** the close link between project goals, user identification, and user needs identification, makes surveys a challenging tool. Surveys also rest on fixed questions that often reflect the initial biases of the survey designer.
- **Participatory approaches:** other projects identify user needs through participatory approaches (e.g. vulnerability and capacity assessments). They aim to address some of the gaps and shortcomings of literature searches and surveys, but often exhibit many of the same assumptions as more survey-based approaches.

Who is Targeted?

In Sub-Saharan Africa, CIS targets the following users:

- Most frequently target **agriculturalists**
- Less frequently target **agropastoralists**, and they are often targeted along with another group
- Even fewer projects target **pastoralists**
- Only occasionally are key **governmental** and other stakeholders targeted

What Needs Are Targeted?

In Sub-Saharan Africa, CIS targets the following needs:

- Mitigation of **famine and food insecurity**
- Prediction of **crop yields** at a field scale
- Informing rain-fed agricultural **production decisions** and designing **early warning systems**

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.

NEW DIRECTIONS

The paper outlines critical gaps in current practices and literature, framed around the four themes highlighted above. Below is an outline of each area and the significant knowledge gaps within the area.

1. Designing Effective Needs Assessments

- a. How often does bias obscure important information about users and needs?
- b. What is the impact of project design bias on project outcomes?
- c. 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?
- d. 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?

2. Identifying and Overcoming Barriers to Use

- a. Are there broad categories of effective demand constraints that might inform CIS co-production efforts?
- b. What are the most effective means of implementing the co-production of CIS with user populations?

- c. Are there broad categories of social constraints to CIS use that might inform CIS design and co-production efforts?
- d. What are the climate science constraints that limit the efforts of climate service providers to meet user needs?

3. Scaling CIS Up and Down

- a. Over what spatial level or social groupings can a particular CIS be scaled?
- b. What is valid extrapolation for CIS?
- c. What is the value of extrapolated data, whether upscaled or downscaled, for a particular CIS?

4. Changing Conditions and Changing Knowledge

- a. How might the literature on agrarian change (and deagrarianization) in Sub-Saharan Africa identify current and likely future CIS needs?
- b. How might CIS planning leverage existing understandings of climate change and its impacts on specific ecologies such that current sources of information used to inform livelihoods decisions change or fail?
- c. 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?
- d. How does learning about CIS change the behaviors of users and their demands for information?

LEARNING AGENDA

The paper proposes a prioritization for filling the knowledge gaps, which is structured over time to sequence efforts based on 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

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

Category 3: Major independent research projects

Category 4: To build into future projects

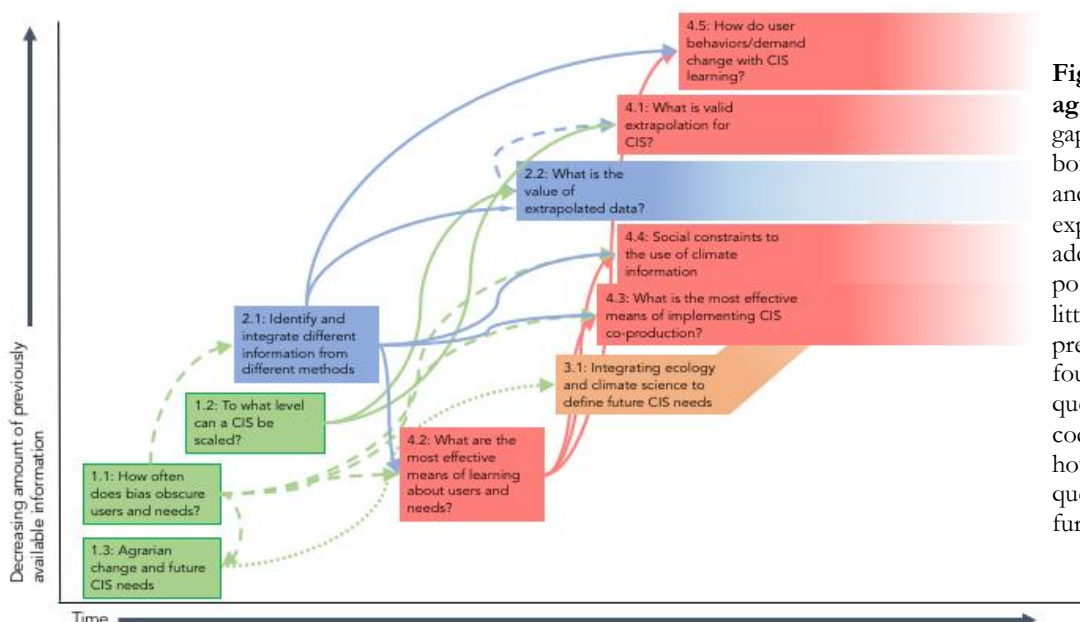


Figure: The learning agenda. Knowledge gaps are shown as boxes indicating when and for how long we expect them to be addressed. Their vertical position indicates how little information is presently available. The four categories of questions are color-coded and arrows show how answers from a question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

Evaluating Agricultural Weather and Climate Services

Even though weather and climate services are expected to improve the capacity of Africa's agricultural sector to manage the risks of climate variability and change, there is a lack of evidence regarding the effectiveness of agricultural weather and climate services (WCS) in Africa. This evidence gap can be traced in part to idiosyncrasies of the WCS communities, originally dominated by scientists with more experience evaluating the quality of information than in understanding the impact of its use. Even as the discipline has grown a number of challenges continue to complicate the evaluation of WCS, thwarting the efforts of skilled evaluators and tempting information providers to defer evaluation, or to rely on more easily tracked but less meaningful metrics. The lack of objective evidence has prevented the development of a more complete understanding of the role that climate services can and do play in African agricultural development.

In this aspect of Workstream 1, CISRI reviewed 59 studies that have evaluated outcomes and/or impacts of agricultural WCS in Africa. A paper of this work highlights areas that have received relatively more attention, as well as persistent gaps. The paper develops a learning agenda for the evaluation of agricultural WCS in Africa to guide efforts to generate evidence.

APPROACH

The evaluation of weather and climate services is primarily concerned with the following three areas:

1. Documenting the extent to which potential users are able to **access and use** services;
2. Estimating the actual or potential **impact and/or value** of services;
3. Identifying those elements of **design and implementation** that lead to better outcomes.

The paper reviewed 59 evaluation studies – both peer-reviewed and grey literature. By topic area, there were 34 studies covering access, 31 studies covering use, and 16 studies covering impact (of which 6 were ex post methods and 11 were ex ante methods). The studies spanned 22 countries – 26 studies in West Africa, 21 studies in East Africa, 17 studies in Southern Africa, and 1 study in Central Africa.

The majority of studies evaluated services built on forecast information at weather, sub-seasonal, or seasonal climate time scales, or were ambiguous with regards to the kind of information that was provided.

EXISTING EVIDENCE

Factors that influenced access, use, and impact varied based on characteristics of the service, the user, and the context in which both operated. While the evaluation of WCS outcomes is relatively straightforward, estimates regarding access and use of these services are uneven (covering a small number of communities in 22 of 54 African countries) and highly variable (with access ranging from ~2-86%, depending on the service and the population). Meanwhile, just 16 studies estimated the impact of WCS with respect to yields and/or income. Developed with a variety of methods, these estimates are also wide ranging (some users lose, while others experience up to 66% marginal gains) and illustrate how impact is conditioned on a number of characteristics of the service, the user, and the context in which both operate.

Variable Access to Information

Evidence indicated that Africans' **access** to weather and climate services varies based on region, livelihood strategy, demographic characteristics, and information type. Reported access to WCS ranged widely (2-86%).

Differing Levels of Use

Evidence regarding the **use** of agricultural WCS varied based on livelihood strategy, among other things. While evidence indicates that farmers use WCS in a variety of circumstances, pastoralists' use of WCS appears more limited. This is corroborated by studies that show that only certain types of information are useful to pastoralists, who face a very different suite of decisions than farmers. Farmers reported using WCS more often than pastoralists.

Impact and Value

Evidence regarding the **impact** and potential impact of agricultural WCS on yields and/or incomes is generally positive – though also relatively varied, depending on the context, climate, and crop, as well as the type and accuracy of the information in question

While the impact estimates described above are developed using surveys or modelled analysis, other studies solicit the “**value**” of WCS from potential users directly by asking or eliciting what users would be willing to pay for WCS information or services in the future, and thus the benefit farmers would expect to receive from the use of such services. Adjusted to 2017 rates (USD), these estimates have ranged from \$1.19 to \$15.36 for improved seasonal forecasts.

Design and Targeting

Many studies have generated evidence regarding the degree that elements of **design, implementation, and targeting** affect access, use, and/or impact. A number of studies have focused on the role that **user characteristics** have played in conditioning the access, use, and impact of weather and climate services. These studies have primarily focused on livelihood strategy and identity, including for instance, gender, education, and socioeconomic status. Studies have also considered **service design** – the role of information type (e.g., weather-scale information, flood forecasts, grazing forecasts, onset date, seasonal forecasts) and dissemination channel (e.g., radio, TV, internet, SMS, participatory workshops) in influencing access and use. Several authors have shown that information is more impactful under certain **context-specific** conditions (e.g., drier or wetter than normal) and certain agroecozones.

EVALUATION METHODOLOGIES

There are several characteristics of WCS that impose challenges to evaluation and continue to complicate the evaluation of WCS:

1. Non-rival, non-exclusionary: information can easily be passed along social and family networks, but the information transferred through informal networks may be incomplete or distorted.
2. Stochastic nature of the climate: the use, impact, and mechanism of impact, can vary from year to year, and the number of years required to sample the range of variability can be expected to exceed a typical project cycle. Furthermore, climate conditions may confound impact.
3. Impact through changes in management decisions: changes in decisions are influenced by other agricultural development interventions, and by farmers' varying goals, skills, and constraints.

Outcome Evaluation

Studies regarding access to WCS fall under the heading of outcome evaluation, since they take stock of changes in the behaviors and practices that result from an intervention. To date, most of what is known about access to WCS in Africa's agricultural sector has been gathered through household surveys and analyzed using descriptive statistics that do not control for selection bias.

A growing body of work examines access to WCS from a qualitative perspective. This work examines how different categories of social difference are associated with access to or exclusion, and provides an opportunity to deepen the understandings generated through surveys by offering explanations for patterns and trends. CISRI expanded upon this in the Piloting Evaluation Approaches Workstream 3.

Studies that explore the use, rather than access, of climate services employ a wider variety of methods – qualitative designs (e.g., focus groups, key informant interviews) and/or quantitative designs (e.g. surveys, discrete choice experiments) and results are reported using statistics and/or qualitative analysis.

Eliciting how individuals use WCS depends on the ability of those individuals to attribute changes in particular management decisions to information. Obtaining management plans from individuals before and after they have been exposed to information increases confidence. The non-excludability of information makes it difficult to compare decisions between samples of farmers with and without access, and many seasons may be required to provide a complete understanding of use of information.

Impact Evaluations

Impact evaluations are designed to generate evidence regarding the ultimate impacts of an intervention, whether those impacts are direct or indirect, intended or unintended. While this type of evidence is critical for understanding the role that WCS can play in building the resilience of Africa's agricultural sector, there is far less evidence regarding impact than access and use (e.g. only 22 out of the 66 evaluations reviewed in 2019 used this approach), and these methods have significant limitations. Methods to evaluate the impact can be classified into two categories:

Ex-post empirical studies of the benefits of WCS-informed decisions. While these methods are time and resource intensive, there is a relatively large literature that explores the difficulties, including the attendant strengths and weaknesses of experimental and quasi-experimental design. Another method used to generate evidence of impact involves test plots. Test plots have the potential to overcome challenges of farmer recall and the elicitation of sensitive economic information.

Ex-ante methods that model or estimate how potential uses of information could improve production, livelihoods or other impacts of interest. These include appraisal studies, as well a range of other approaches as a means to estimate, rather than analyze ex post, the potential impact of planned or existing services. For instance, experimental economics methods provide farmers an opportunity to simulate how they might use climate services. Modeling approaches can also be used to estimate the potential value. Finally, a discrete choice experiment (DCE), a survey-based econometric technique, elicits the maximum price a user would be willing to pay for information, thus implicitly value.

SYNTHESIS OF EVIDENCE AND METHODOLOGICAL GAPS

Evidence Gaps – Outcomes

- Estimates regarding access to weather and climate information vary considerably. A more complete mapping of who has access to what kind of information, as well as the factors that enable or constrain access, would help to inform the investment and design.
- Evidence regarding the use of agricultural WCS is uneven in nature. The literature rarely explores the extent to which WCS are used by government and non-government agencies – and it makes almost no mention of how/whether private organizations use such information.
- Many studies were performed without baseline analyses, making it difficult to identify changes.
- Using quantitative methods only does not offer a complete understanding of access and use. Qualitative methods can be useful in covering the most common and impactful uses of WCS.

Evidence Gaps – Impact

- The evidence of the extent to which different groups benefit differently from WCS is limited.
- Studies have defined impact almost entirely to yields and/or incomes, despite the fact that WCS can have a host of impacts, and impacts can accrue to individuals, society, and environment.
- Models have rarely been fully validated – making it difficult to assess the robustness of results.
- There is a gap in the use of economic approaches to appraise the benefits of WCS – to better design new services, justify prior investments, and develop the case for allocation of resources.
- Combining methods to triangulate estimates of impact and complement strengths are minimal.
- The knowledge base on how to generate and use impact information to improve the design and/or implementation of agricultural WCS is lacking.

LEARNING AGENDA

Through this paper, CISRI created a learning agenda that serves as an evidence-building roadmap, prioritizing areas that hold the most potential to advance our understanding of how WCS can and do contribute to improved agricultural outcomes in Africa.

Improving the Targeting

Fill geographical gaps. There is very little evidence regarding access and use of WCS in Central and Northern Africa. Even in the relatively well studied regions there are sizable evidence gaps, with no evidence at all for many countries. Geographical gaps also exist within countries.

Broaden evidence regarding users and uses. There is more evidence regarding access and use by farmers than by pastoralists and for staple rather than cash crops; very little regarding government/nonprofit; and none regarding the private sector. We must also continue to disaggregate populations.

Explore enablers and barriers. Further qualitative and quantitative approaches are needed to flesh out enabling and constraining factors, such as the role of communication strategies as well as different dissemination mechanisms. The business models that sustain WCS have rarely been evaluated.

Improving the Impact

Explore a broader range of impacts. There is a need to broaden the standard analysis of farm level yields/ income to develop information regarding the impact of WCS on the wider economy, society, and the environment. At the same time, economic analyses have the potential to improve design.

Compare and validate results. Comparing impact estimates from different approaches will help to characterize the applicability, use and performance of particular methodologies, and the credibility, consistency, and comparability of evidence.

Comparative analysis. Very few studies consider how WCS compare to alternative interventions that may build agricultural resilience. Econometric approaches offer a way to fill this gap; other methods, including validated models and benefits transfer methods, should also be explored.

Improving the Design

Understand the influence of stochasticity. Given the interaction between use and impact and the stochastic variability of climate, future studies should develop a better sense of the relationship between the stability of impact estimates and the number of years sampled.

Interpret existing results. Many existing WCS in Africa’s agriculture sector are operating sub-optimally and there is no guidance on how this existing information could be used to improve outcomes and impacts; developing this guidance will help advance the field.

Develop guidelines for benefits transfer. While the field of economics has generated guidance regarding benefits transfer methodologies, these have not yet been applied to the WCS context.

Gender-Responsive Rural Climate Services

Gender considerations can critically influence smallholder farmers’ access and capacity to act on weather and climate information, as well as subsequent livelihood benefits. While climate services can be a promising means of empowerment and resilience building for rural women, they risk reinforcing the gender-based inequalities that are prevalent in other institutional structures if they fail to understand and effectively target the needs of women.

Research during the CISRI project studied the existing knowledge base on gender equality challenges in climate services. CISRI produced a paper that both assesses the evidence about gender-based differences in access, use, and benefits from climate services for farmers in the developing world, and identifies promising pathways for making climate services more responsive to the needs of rural women.

APPROACH

The paper reviews 43 publications identified through online search engines as well as the authors’ professional networks. It includes peer-reviewed publications and grey literature published from 2000-2018 that included empirical results from sectors related to agriculture, food security, and rural development. Evidence from the publications was categorized and analyzed according to whether gender-related factors influenced 1) access, 2) use, or 3) benefit from climate services. Gender-related factors have the potential to influence the value of climate services by enabling or constraining the degree of benefit from improved management decisions, capacity to use information to improve management, or access to climate-related information.

Out of the 43 publications, 37 address Sub-Saharan Africa, while eight address countries from South Asia. Oceania and Northeast Africa are addressed minimally, in multi-country studies only. The majority of publications address access, while only 18 studies explore use. Benefits perceived from climate services is an area understudied in the literature, addressed by just six publications. It is important to note that across the publications, there is a variation in the data collection methods used and the source of data collection, thereby determining the extent of gender analysis possible.

RESULTS

Access

Gender differences

Whether farmers **access** particular climate-related information products is determined by: 1) the types of information products that the national meteorological service and other providers make available, 2) access to the communication channels used to disseminate them, and 3) demand for the information. A significant portion of the research focuses on factors that influence access to several types of communication channels that are or could be used, and much less is analyzed concerning the demand.

Gendered rates

The data collected through the CISRI research highlights that in most instances men access information more than women; but, the range of studies may be too narrow to support this as a generalization. In some instances, the difference is significant, while some rates of access are similar. There are also differences with respect to type of information. For example, several studies show that men have more access to information on droughts and early warning information than women.

Influences

Biased institutions and differences in group participation and networks.

Peer groups and networks can serve as important means for the flow of useful climate knowledge, and group-based approaches can help farmers share knowledge and build resilience to climate risk. It is important to recognize that culturally-entrenched beliefs about women's and men's roles can limit who is able to meaningfully access certain groups/networks. Additionally, strong male biases can undergird the structures of external and local organizations targeting agricultural production and food security, such that women are restricted from participating in the group processes these institutions promote.

Access to information through media and ICT.

Interactive radio programming and ICTs are increasingly being used to communicate agriculture and climate information to smallholder farmers, with promising opportunities to reach farmers at expanding scales. Despite this potential, women may face gender-specific limitations to access and control of ICTs and communication assets, related to cost barriers and education constraints. And for services to be useful to women, they must be aligned with their livelihood goals and incorporate time-saving mechanisms. Understanding gendered content preferences can be critical in designing interventions that are equally beneficial to women and men.

Use and Benefit

Gender differences

The research shows that while minimal studies address gender factors that influence **benefits** from climate services, a significant portion do analyze factors that condition women's and men's **use** of information. In particular, they emphasize how sociocultural norms concerning gender labor roles and responsibilities can influence resources and decision-making processes under women's and men's control, which affects the types of information that is most useful. Gender division of labor, resource control, and decision-making power can also influence women's and men's differential capacities to act.

Gendered rates

Few studies report rates of women's and men's **use** of different types of weather and climate information. The studies suggest that it is difficult to discern particular gender patterns in use, and that there is heterogeneity in gender trends concerning use. Few of the publications reviewed address **benefits** to women and men farmers from use of climate services, and those that do tend to address perceived benefits. The variations in gender patterns in use of and benefits point to the need to understand underlying factors influencing how and when women and men act upon information.

Influences

Influences on differing climate service needs.

Norms that define women's and men's roles and responsibilities according to gender and seniority and that critically condition resource access can influence the type of information that women and men find useful. Other research shows the influence of gendered household and farm labor roles on implementation of weather and climate information.

Constraints on use of information.

Several studies demonstrate that differences in access to resources can limit women's abilities to use climatic information relative to men. In this way, the analysis highlights the significance of inequalities in meaningful access to inputs for gender-equitable action on climate information. Other studies find that women have less access to the financial capital and productive assets (e.g., farming equipment and seeds) needed to act on climate-based advisories. Gender norms, control of productive resources, and decision-making can interact significantly to condition differences in use of information. Intersecting influences of gender, seniority, and ethnicity can be important to take into account, as well.

STRATEGIES FOR ACHIEVING GENDER-RESPONSIVE CLIMATE SERVICES

The following are potential pathways that CISRI identified for developing gender-responsive climate services, with a special focus on women who are most often disadvantaged by current approaches:

ICT and media-based communication channels tailored to women's assets and needs help enhance women's access to routine weather information and advisories. Limited resources, including financial and technological, and low literacy levels can restrict women's access and control of ICTs in comparison to men. Household labor responsibilities and disproportionate unpaid care work burdens can also limit women's time available to listen to media-based services. For example, some studies suggest that women lack the means to purchase radios and the time to listen to them, thus limiting their access. Women stated that even if they receive information, they lack the resources, such as land, equipment, and agricultural inputs, to act on the information. It is critical that interventions using ICTs carefully consider household trends in accessing communication assets and other resources.

Communication channels that include women's groups are effective means to promote women's access to weather and climate services. In general, farmers' associations and cooperatives underserve or effectively exclude women due to membership criteria based on land ownership and other capital requirements. Even when women are part of farmer groups, the groups may not be sensitive to the differing needs of women and women may not have equal access to resources. The inclusion of community-based and female-dominated groups in communication channels can help to circumvent the gender barriers to access to and equal inclusion in characteristically male groups and, therefore, create a new pathway for information sharing. As a result, women can benefit from access to climate information, agro-advisories, and related technical trainings shared via these groups.

Partnerships with civil society organizations can be important to facilitating women's access to extension services and externally-based communication channels. In some contexts, gender norms that limit public interactions between women and men can restrict women's access to trainings. For example, research suggests that projects often disseminate climate information at village assemblies, which are not well attended by women for a variety of reasons, including their husbands' opposition to their attendance, time poverty, lack of resources for travel, competing family responsibilities, and security issues. Furthermore, women report that their husbands often do not share the climate information learned at meetings. To address this challenge, gender-focused local organizations could be effective partners in identifying gender-sensitive communication channels to assist.

Climate services that are relevant to women's climate-sensitive decisions are necessary to ensure that the information is useful to them. Gender norms concerning labor roles, control of resources, and decision-making influence the types of information most useful to women and their capacity to use the information to manage risks. For instance, in some cases women expressed challenges in being able to act on the information they received due to lack of decision-making control over and access to land. Despite this barrier in farm management, women reported using climate

information for reasons beyond agriculture, such as to secure their children and family during the rainy season when a storm is predicted. Effective climate services must identify women's and men's information needs specific to their service area and tailor information to meet everyone's needs.

LEARNING PRIORITIES

Below are several research opportunities identified through CISRI that could assist in ensuring that climate services truly serve the needs and interests of women and men most vulnerable to climate risk.

Understand what combination of communication processes best enable women to understand and act on information. A critical opportunity lies in identifying when communication channels like ICTs, group learning, and gender-sensitive facilitation more effectively enable women to interpret and act upon information. While ICTs may be particularly helpful for communicating information at a weather timescale, other communication channels might be better-suited to enable women's understanding and use of other types of information, such as seasonal forecasts.

Identify how gender interacts with other socioeconomic attributes to shape access preferences and information needs. Socio-economic attributes such as age, seniority, and ethnicity can influence women's and men's household decision-making roles, access, and control of resources and technology, and the social groups and networks accessible to them. It will be important to use methodologies that permit differentiation of types of farmers and identification of their delivery preferences and needs.

Assess the influence of climate services on women's participation in decision-making. In some cases, climate services may help local actors challenge limiting gender roles. For example, access to weather forecasts has helped women to make informed agricultural decisions, and their increased role in decision-making has then influenced a shift in gender roles, wherein men are no longer seen as the sole decision-makers. Evaluation of the conditions that may enable access to information to contribute to women's enhanced role in decision-making is a key knowledge gap. Along with enabling conditions, it is important to acknowledge and understand that efforts to empower women could change traditional gender roles, which could result in more exclusionary practices if men feel their roles are threatened.

Integrate climate services with rural development efforts that seek to overcome women's resource constraints. Limited resource control and lack of opportunity to participate in agricultural decision-making can significantly restrict women's capacity to make full use of climate information. This then acts as a deterrent on women's demand for and interest in climate information. While it can be difficult for climate services programs alone to address the extreme challenges that marginalized groups confront, coordination with other efforts can be a key opportunity to enhance impacts.

Reports: Synthesizing the Evidence

- Carr, E., Goble, R., Rosko, H. M., Vaughan, C., Hansen, J. (October 2017). *Identifying Climate Information Services Users and their Needs in Sub-Saharan Africa: A Learning Agenda.*
- Vaughan, C., Hansen, J., Roudier, P., Watkiss, P., and Carr, E. (December 2017). *Evaluating Agricultural Weather and Climate Services in Africa: Evidence, methods, and a learning agenda.*
- Gumucio, T., Hansen, J., Huyer, S., and van Huysen, T. (June 2018). *Gender Responsive Rural Climate Services: A Review of the Literature.*
- Gumucio, T., Hansen, J., Huyer, S., van Huysen, T., Schwager, S. (July 2018). *Info Note: Identifying Pathways for More Gender-Sensitive Communication Channels in Climate Services.*
- Gumucio, T., Hansen, J., Huyer, S., van Huysen, T., Schwager, S. (July 2018). *Info Note: Strategies for Achieving Gender-Responsive Climate Services.*

All resources are available at: www.climatelinks.org/projects/learningagendaonclimateservices.

SYSTEMS ANALYSIS OF CIS

Climate information services have the potential to support sustainable and resilient development for smallholder farmers facing devastating risks from climate variability and change by providing timely, accurate, and useful climate and weather information. Unfortunately, this information is often not available to those who need it most, and when it is, users often face a number of challenges in accessing and using the information.

For smallholder farmers to benefit from CIS, their needs and perspectives must be at the heart of the conversation around CIS design and delivery. This ensures that the information provided is appropriately contextualized and is accessible and useful. Bringing farmers' voices together with other key stakeholders from across climate information services systems, and strengthening their capacity to participate meaningfully in multi-stakeholder discussions on climate information, is critical to ensure CIS are effective. With a rich array of perspectives and space for empowerment and feedback from farmers, stakeholders are better able to interrogate system challenges in a holistic way, expand the range of potential solutions, and build consensus for action to improve the system. Without such systemic analyses, climate information services will fail to address contextual challenges and needs of their users; potentially decreasing the benefits of climate information services for livelihood decisions and wellbeing outcomes.

Building upon research in Workstream 1 (users and their needs and gender responsive services), Workstream 2 investigated existing climate information services systems by developing and piloting a new participatory systems mapping and analysis methodology with a focus on empowering stakeholders within the system, identifying inefficiencies and breakdowns within the broader system, and building consensus to improve the system. The Workstream included:

PARTICIPATORY CIS SYSTEMS DEVELOPMENT METHODOLOGY. The creation of the Participatory Climate Information Services Systems Development Methodology and guide, which consists of a five stage approach to improving the quality and inclusive delivery of CIS through a holistic, systems-level approach.

PILOTS: SENEGAL AND NIGER. Pilot studies of the methodology were conducted in Niger and Senegal. Participants identified opportunities and intervention points to improve men's and women's access to and use of CIS, forged new stakeholder partnerships to facilitate CIS delivery, and identified locally-driven solutions. These outcomes informed ongoing CIS programs for farmers, and sought to improve the CIS system more broadly.

New Methodology: Participatory CIS Systems Development

The Participatory Climate Information Services Systems Development (PCISSD) methodology is based on a bottom-up process of empowerment and inclusive stakeholder engagement. This unique methodology aims to build understanding and relationships across a climate information services system – from meteorological service providers to farmer end users – with the goal of catalyzing locally-led improvements that more effectively meet farmers' needs. The approach is a 5 stage process to assess the factors that affect the functioning and efficiency of CIS systems.

The basis for this approach is grounded in the success of other participatory approaches working alongside smallholder farmers. Participatory Integrated Climate Services for Agriculture (PICSA) is a

community-level approach, which utilizes participatory tools and processes to enable farmers to use climate information in planning and decision making. Rather than solely focusing on the ability of farmers to use climate information, the new PCISSD methodology aims to take a systems-level approach to improving systems to more effectively support sustainable and resilient development. The methodology allows stakeholders to address the multitude of challenges that typically exist across a CS system, from data collection to analysis and communication of information to users' ability to access and apply information.

METHODOLOGY

The methodology, which consists of five stages, takes a holistic view to improving the overall effectiveness of a CIS system, brings together key CIS stakeholders from across the system, creates space to empower and strengthen the capacity of users to provide more robust feedback, and facilitates consensus-building for action to improve the system.

The objective of the methodology is to support practitioners and CIS stakeholders in answering the following questions:

- What are the factors that influence users' access to and use of CIS?
- Where are the breakdowns and constraints in the delivery, access, and use of CIS?
- What are the most effective approaches and channels for improving users' access to and use of climate information?
- What opportunities exist for CIS stakeholders along the communication chain to improve the functioning of the system to better meet users' needs?

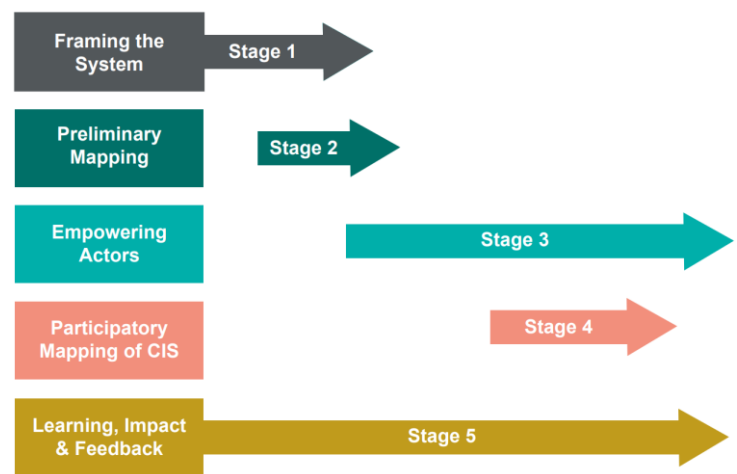


Image: the five stages of the Participatory CIS Systems Development methodology

The methodology is designed to ensure stakeholders at every level of the system have the capacity and skills to contribute to the design and delivery of more effective CIS systems. Once the preparatory Stages 1 and 2 are over, a key aspect of the methodology is the empowerment stage (3). It includes identifying the most marginalized stakeholders within the system and building key competencies and skills. The goal is to prepare stakeholders to articulate their needs and to participate equally in the co-creation of solutions with more powerful actors involved in the system.

Another key aspect of the methodology is an ongoing process of collaboration, learning, and adaptation, which is outlined in Stage 5. Ideally this stage will continue after Stages 3 and 4 end, to accompany and track the process of system change over time. And finally, the core of the approach is Stage 4 – a series of workshops which bring together stakeholders from all levels to map the system. After mapping the whole system, participants identify barriers and opportunities within the delivery of information, such as a need to communicate information in local languages and simple terms, but they also go beyond the information delivery to identify barriers and opportunities within the broader system – in the enabling environment and supporting services. Participants then prioritize key blockages and opportunities/ideas for action, and build consensus for an action plan to improve the system.

CLIMATE INFORMATION SERVICES SYSTEMS MAPPING

In order to understand how an information chain is functioning, it must be assessed within a systems' perspective. This requires looking at the full context within which a climate information system operates: the multiple sources of information that reach users, the influences of social, political, and economic factors, and the resources and services that enable access and use. Taking a systems perspective can reveal new connections, uncover influences from other information sources, and give a fuller picture of constraints and opportunities for improvement.

At different points in the methodology, stakeholders will map the Climate Information System using three key elements outlined below:

- A. **CIS Information Chain:** the flow of information between actors who produce climate information, the intermediaries who help communicate it, and the ultimate users.
- B. **Supporting Services:** critical inputs, services, and resources that facilitate access, understanding, and application of climate information.
- C. **Enabling Environment:** political, economic, social, and cultural factors in the enabling environment that influence dissemination, access, and use in positive or negative ways.

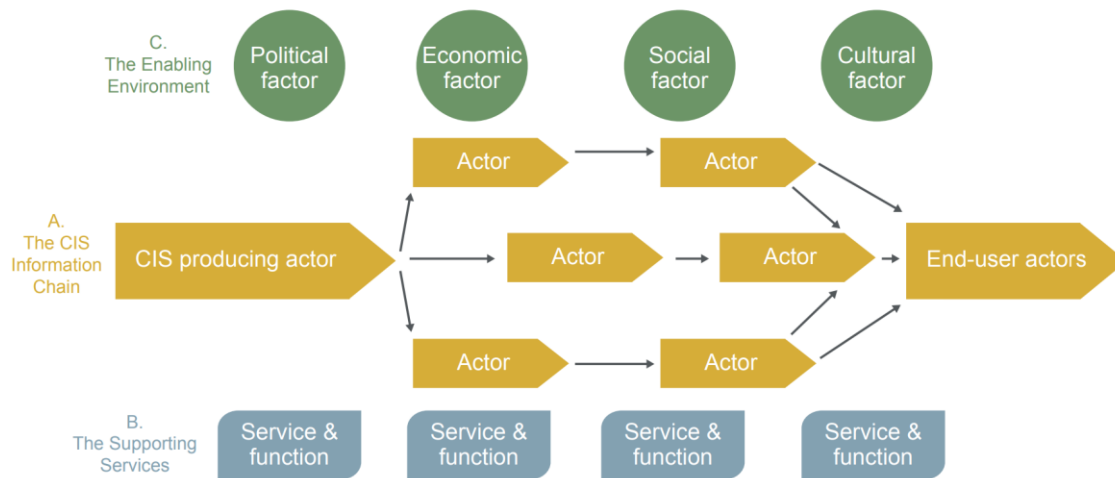


Image: CIS systems map. Note: this is a model and the map will likely be much more complex in reality.

Pilots: Niger and Senegal

Pilot studies of the methodology were conducted in both Niger and Senegal during the CISRI project. Participants identified opportunities and intervention points to improve men's and women's access to and use of CIS, created a shared understanding of the CIS system, and identified locally-driven improvements. These outcomes informed ongoing CIS programs for farmers, and sought to improve CIS systems more broadly.

Shared understanding of the system. At the preliminary national level mapping workshops CIS providers often did not understand how information flowed to farmers, leaving out critical components that farmers identified in village level mapping workshops, such as village assemblies and development committees, NGO trainers, village chiefs, telephone, word of mouth, and women's groups. In contrast, at the village level workshops, farmers' maps often ended with radio stations, extension agents, or NGOs, demonstrating that they did not understand the role of CIS providers or national level actors. When the actors came together, they were able to create a shared understanding of the CIS system, which enabled them to identify barriers and areas of improvement.

Locally-driven improvements. After a preliminary workshop with national actors and fourteen participatory village-level workshops with over 140 farmers, a diverse group of climate services actors from across Niger, including farmers, radio broadcasters, extension agents, meteorologists, government officials, and NGO workers, came together in a culminating workshop in Niamey. Thanks to the PCISSD methodology, every actor, whether a smallholder farmer, a meteorologist, or a mayor, had the capacity to meaningfully engage in the conversation and action planning. With this diversity of voices and perspectives, participants were able to interrogate challenges and drive locally-driven improvements to climate services in Niger. By the end of the workshop, actors had exchanged information and made action plans for improving the system. Some examples include:

- A. Design a method for diffusing information via mayors and commune early warning groups.
- B. Bring together government technical actors to synthesize seasonal forecast information and prepare short messages to share with local radio stations and village groups.
- C. Work with radio stations to transmit messages in local languages.

FINDINGS

While participants raised various issues during the methodology pilots, the three issues that surfaced in all pilots and in desk research were: use, timeliness, and access.

- **Use** – Farmers are sometimes unsure of what the information means for them and their farms. Information is often not provided at the scale that is useful to farmers. Resource-poor farmers often lack the means to act on the information they receive.
- **Timeliness** – Climate information often arrives after critical decision-making points have passed, due to: overstretched extension agents, lack of radio coverage, and poor communication between the government and other actors from the national to village level. Delays due to uncertainty of forecasts must be balanced with the need for time-sensitive information.
- **Access** – Information is not in the local language, broadcasts occur at inopportune times (such as when farmers are in fields or busy with domestic chores), and information does not align with farmers' needs, such as warnings of pests, winds, and dry periods.

LESSONS LEARNED

There are several critical design recommendations that emerged from piloting the PCISSD methodology during the CISRI project. The following could result in better outcomes for CIS:

Thoughtfully-designed and thorough consultations may result in considerably different focus areas than the basic forms of consultations that CIS program designers often do. The PCISSD methodology brings together a greater diversity in perspectives, which allows participants to more holistically interrogate the context-specific challenges hindering the effective functioning of the CIS system. This ensures that the opportunities for improvement identified are tailored to the needs of the users. Through the PCISSD approach used in the CISRI project, CIS stakeholders can identify the specific knowledge, needs, and perspectives across the system and use that information to develop a system that is more efficient and effective because it includes and responds to user feedback.

Empowerment and inclusive stakeholder engagement across all levels of a CIS system can build understanding and trust among stakeholders and subsequently catalyze substantively more effective ways of developing CIS systems. While some of the solutions proposed through the workshops have been recommended in previous research, the process of collaborating to identify the solutions in an inclusive way built trust among the entire CS community and put the ownership into all of the actors' hands. For many national-level CIS producing actors, such as members of the Meteorological Services, the culminating participatory mapping workshop was the first time they had sat at the same table and heard insights and challenges directly from the users themselves.

The pilots have begun to demonstrate how the PCISSD process can catalyze sustainable, locally-driven improvements in the CIS system to more effectively meet smallholder farmers' needs. The approach offers a more in-depth picture of decision-making needs and processes of users. This can assist in improving monitoring and evaluation, and help to build evidence for policy makers and donors to make more informed decisions about CIS.

Gender issues, and how gender intersects with other socioeconomic attributes, are critical to explore in order to understand how subsets of populations have different needs and capacities to access and use information. For example, women farmers in the pilots in Niger stated that due to gender norms, they were more likely to lack access to extension agents or radios. Instead, they relied on information shared via word-of-mouth, which risks distortion and inaccuracy. Even if they received the information, they lacked the assets and resources, such as land, equipment, or inputs, to act on the information in a timely and useful manner. The PCISSD process ensures that these topics are addressed by including a wide range of stakeholders and perspectives.

LEARNING PRIORITIES

The PCISSD approach piloted in Niger and Senegal demonstrates the value of bringing together key stakeholders from across the CIS system, creating space for empowerment and more robust feedback from farmers, and facilitating consensus-building for action. Several opportunities that are ripe for future learning surfaced through the CISRI project:

Further testing of participatory methodologies and use of longer-term engagement tools. While the short-term scope of the pilots did not allow sufficient time to see longer term changes in the systems, it showed promise that bringing actors together can stimulate a dynamic exchange and create the foundations for change. Longer-term engagement could strengthen our understanding of how the PCISSD approach can be modified to be a continuous and sustainable process, resulting in a feedback mechanism between key actors across the system that consistently identifies and acts upon opportunities to improve the CIS system.

Long-term monitoring and evaluation data to provide evidence of the impact and effectiveness of participatory processes. It is critical to capture data that measures the impact of participatory methodologies to better understand the ways in which they improve the effectiveness of climate services, and to what extent they could impact longer term outcomes, such as behavior change, livelihood, and resilience outcomes, differently than more traditional processes.

Reports: Systems Analysis of CIS

- Lambert, K., Koutcha, M., Henly-Shepard, S., Lewis, A., Amadou, L., Allen, M. (January 2018). *Climate Information for Those Who Need It Most: Contributions of a Participatory Systems Mapping Approach in Niger.*
- Sambou, S., Lewis, A., Rokhaya Gaye, S., Allen, M., Lambert, K. (June 2018). *Participatory Climate Information Services Systems Mapping in Senegal.*
- Sambou, S., Lewis, A., Rokhaya Gaye, S., Allen, M., Lambert, K. (June 2018). *Cartographie des systèmes de service participatifs Informations climatiques au Sénégal.*
- Sene, B., Lewis, A. (July 2018). *CISRI Bulletin: Mapping Climate Information Services in Senegal.*
- Lambert, K., Allen, M., Lewis, A., Blumenstock, A. (March 2019). *Participatory Climate Information Services Systems Development: Methodology Guide.*

All resources are available at: www.climatelinks.org/projects/learningagendaonclimateservices.

PILOTING EVALUATION APPROACHES

It is challenging to evaluate the impact of climate information services because the information they provide has value only when users can act on it. For example, the most accurate seasonal precipitation forecast may have tremendous value to a man whose responsibility it is to cultivate rain-fed grains and who owns his farming equipment. A man who has to borrow farming equipment may value the forecast but lack the capacity to act on it in a timely manner. And this same forecast may have little to no value for women in either household if they are not allowed to make decisions about rain-fed cultivation. As this example shows, the pathway from delivery of information to observed outcomes, such as increased yields, are influenced by complex and often context-specific social and economic factors, such as access to appropriate seeds or needed agricultural equipment, or the authority to make decisions about the cultivation of a particular farm plot. Different users of a CIS will have different abilities to act on weather and climate information. To effectively monitor and evaluate CIS, therefore, requires approaches to monitoring and evaluation (M&E) that identify and analyze these complex factors.

Building on work in Workstream 1 and Workstream 2, the CISRI project developed and piloted innovative approaches and methodologies for evaluating the uptake and effectiveness of climate information services in meeting the users' needs, and targeted knowledge and evidence gaps.

QUALITATIVE AND QUANTITATIVE METHODOLOGIES. The project piloted quantitative and qualitative methodologies in Rwanda and Senegal, documented learning, and highlighted lessons and key recommendations for improvements in assessing the impact and effectiveness of climate information services programs.

SYNTHESIS. A joint analysis was used to identify and explain the impact of a specific CIS model on farmers' behavior and outcomes, using ethnographic data to rigorously interpret survey findings. The synthesis of two types of studies – qualitative and quantitative – achieved results that could not have been obtained in a single study, and drew a number of useful lessons about the evaluation and synthesis processes offering a template for future work.

Qualitative Approach for CIS Monitoring and Evaluation

CIS for agriculture and development are useful only when farmers have the ability to make changes in their activities and practices based on the information received. Different users of a CIS will have different abilities to act on information, and therefore effective CIS design begins with the empirical identification of potential users and their climate information needs. At the same time, user expectations of CIS, environmental conditions, and the social and economic factors shaping utilization of weather and climate information can change during the implementation of a project. To effectively monitor and evaluate CIS therefore requires approaches to identify and analyze these complex factors.

CISRI implemented two qualitative pilot assessments of CIS users and their needs in Senegal and Rwanda to test innovative evaluation methodologies on ongoing programs, and to develop general lessons that could contribute toward improving the design and evaluation of CIS interventions. Specifically, CISRI tested the utility of the Livelihoods as Intimate Government (LIG) approach as a means of identifying different users and the factors that shape their weather and climate information needs, for the Multi-disciplinary Working Group (MWG) model in Senegal and the Climate Services for

Agriculture Initiative (CSAI) in Rwanda. A growing literature demonstrates that understanding the potential users of CIS, and their needs for weather and climate information, allows for the design of monitoring and evaluation efforts that are aimed at likely impacts. Further, because the potential impacts of climate information are never evenly distributed across a population, better understanding users and their information needs, allows for assessment of impact in a particular place or population.

APPROACH

The pilots utilized the Livelihoods as Intimate Government (LIG) approach, which views livelihoods as ways of living in particular places – not merely the activities pursued by individuals. Because it treats livelihoods as more than instrumental activities aimed at material ends, LIG incorporates a much wider range of stressors, including social stressors that emerge within particular places, into explanations of people’s goals, decisions, and actions. This broader lens is critical for understanding why people do or do not use CIS, therefore providing critical information for both CIS design and evaluation. In design, LIG analysis allows projects to better tailor interventions for impact, while in the context of monitoring and evaluation, it allows for better explanations of impact by identifying conditions where CIS can and cannot achieve desired development goals.

To avoid introducing bias, LIG does not make assumptions about potential users, or their needs and capacities to use weather and climate information. LIG first identifies structures of resource access and use, climate and non-climate related livelihood stressors as explained and prioritized by users, and the context of livelihood decision-making. Investigators then stratify the population by shared vulnerabilities, which allows for situations where some members report a particular stressor or shock as a vulnerability, while others do not. Understanding how different people living in the same place understand and experience shocks and stressors differently serves as an entry point to livelihoods decision-making. LIG acts as a powerful tool to empirically identify users and capture a broader range of their needs for both project design and project monitoring and evaluation

FINDINGS: UPTAKE AND IMPACT OF CIS

The pilots identified different potential users of CIS and their needs for weather and climate information within each livelihoods zone, as well as projected pathways of uptake and impact if the CIS is implemented in a manner that meets different user needs. These pathways help improve monitoring and evaluation by identifying who is likely to experience impacts and the character of those impacts.

Senegal: Impact Pathways

- A barrier to CIS use is a lack of trust in the information, and a lack of training in use of the information. As Workstream 2 suggests, trust might be hastened by an inclusive feedback/engagement mechanism for end users from the beginning of the development of the CIS. M&E should account for any training and identify any new pathways of potential impact that might emerge from the education or empowerment of users to understand and engage with the CIS.
- The stratification of the population by assemblages of vulnerability shows that groups have very different responses to climate information. Understanding how different people will use information helps ensure that M&E are focused on measuring the most likely responses.
- Shifts in variety selection in response to recommendations from the CIS will likely be concentrated among the wealthiest and most secure, as they have access to the assets that allow for the purchase and planting of new and different varieties. Understanding the different ways in which various members of a population are able to use climate information will define likely pathways of impact to be monitored, and serve to adjust expectations of impact.

- As households become more secure, women's opportunities to engage in new activities, including activities from which they were previously excluded, will increase. In such households, women are unlikely to threaten the status of the male head of the household, who will himself be more secure. In more challenged households, playing one's role is seen as a path to safety, and therefore changes in women's activities will be viewed as a threat to safety and stability of the household and will be constrained.

Rwanda: Impact Pathways

- Roles and responsibilities around farming activities are not as clearly gendered as in other contexts, however some still exist. For example, some women could not engage in market-focused agricultural production without the permission of their husbands, and may encounter barriers to the use of information about certain crops whose principle value is for market sale.
- Those performing labor on the farms of others are not able to respond to forecasts or other forms of agricultural advisory until later in the season, which presents a challenge. As this is true even in a context like Rwanda, where seed and other inputs are available for these households, it is therefore likely to be a limitation on potential CIS impact in many settings.
- As farmers diversify their livelihoods away from agriculture, climate information becomes less important to them. This is true even when they have access to resources necessary to take advantage of this information on their farms.
- Within both livelihoods zones, as individuals and households become less secure, they are likely to adopt CIS as a defensive strategy that protects against loss, rather than maximizes income. In this situation, farmers are unlikely to take on greater risk by experimenting with new techniques or strategies, but might use climate information to better inform their existing strategies.

LESSONS

These pilot assessments identified lessons for effective CIS design, monitoring, and evaluation:

Identity and social barriers influence CIS uptake. The social barriers to CIS uptake and use in a given livelihoods zone take shape around roles and responsibilities associated with particular identity categories, including gender, seniority, and ethnicity. These social barriers rarely take shape around a single identity or issue. It is necessary to identify social constraints to the use of climate information to properly target and calibrate monitoring and evaluation efforts. To better calibrate CIS M&E, it may be helpful to follow certain processes in M&E design:

- Stratify the community into vulnerability groups to identify who is vulnerable to which shocks and stressors.
- Identify the principle aspects of identity that shape roles and responsibilities in the area.
- Identify the decisions that are associated with the roles and responsibilities of different people in the population.

Factors shaping the use of CIS scale to the livelihoods zone. Project design and M&E methodologies aimed at understanding the factors that shape the use of weather and climate information, and thus the underlying decision-making of different CIS users, produce evidence valid at the scale of the livelihoods zone. Popularized by the Famine Early Warning System Network (FEWS-NET), livelihoods zones are geographic regions characterized by shared socioeconomic and agroecological situations, and broadly similar livelihoods activities. Factors shaping the uptake and use of weather and climate information are rarely applicable beyond the livelihoods zone in which they are identified.

Potential impacts of CIS go beyond yields and incomes. Indirect impacts on food security and improved capabilities for coping with adverse climate conditions could be important. The activities that climate information might influence are closely linked to local understandings of identity (particularly gender), roles, and responsibilities. Thus, CIS impact should be identified not only in terms of material outcomes, but also in terms of changes in the ways in which people conduct livelihoods activities, and who conducts those activities. Qualitative tools, such as the LIG approach piloted in these assessments, allow for the identification of these broader changes and impacts.

Quantitative Approach for CIS Monitoring and Evaluation

Although various co-design and co-production models have been used to tailor CIS in different parts of the world, there is hardly any rigorous evidence assessing their effectiveness in meeting users' needs. The main objective of CISRI's quantitative studies is to assess the effectiveness of specific CIS programs. In Senegal, CISRI investigated the Multidisciplinary Working Group (MWG), a participatory model that fosters interactions among different actors who produce, translate, transfer, and use CIS, to ensure that climate information is appropriately tailored to meet the needs of end-users. Through this work, CISRI analyzed the effectiveness of the MWG in improving farmers' awareness, access, and uptake of CIS, as well as how this information is used to inform decision-making by users.

APPROACH

The study used a unique sampling design that aided the categorization of farmers into four broad comparison groups that are not mutually exclusive: 1) farmers exposed to the MWG; 2) farmers not exposed to the MWG; 3) farmers using CIS; and 4) farmers not using CIS.

The study considers the use and uptake of different types of CIS – seasonal forecasts on the total amount of rainfall onset and cessation; weather forecasts for 2-3 days and 10 days; and instant forecasts of extreme weather events. The data, consisting of interviews with 795 smallholder farmers, was collected using an innovative automated data collection and management system. The sampling design was complemented by using rigorous econometric techniques, specifically the Average Treatment Effect (ATE) framework, to account for selection bias and estimation bias that may result from farmers not having equal access to information and knowledge of the different CIS.

FINDINGS

The descriptive statistics point to a positive and significant association between farmers exposed to MWG and their awareness, access, and use of CIS using classical estimation approaches. However, such classical approaches – which assume all sampled farmers have full information and access to a technology – often leads to biased estimates. It is, therefore, necessary to correct for such bias by using appropriate models that account for selection bias when estimating CIS adoption rates.

The first analytical section uses an econometric model – the counterfactual ATE framework – that corrects for the bias caused by unequal access to CIS information in terms of awareness and access among the sampled households.

The analysis revealed the following results:

- In locations where the MWG is operational, there were significantly more farmers who were exposed to CIS in terms of awareness and access.
- The presence of an MWG significantly increases farmers' uptake and use of CIS by approximately 30%.

Based on results from the adoption model, and an estimate that around 740,000 rural households in Senegal have been exposed to CIS, this analysis predicted that if the MWG model were scaled out to all parts of rural Senegal, the 30% increase in CIS uptake would be equivalent to about 205,000 households. Similarly, the population adoption gap for CIS, which measures the unmet demand for CIS resulting from households' lack of awareness and/or access, is estimated to decline from 10% (approximately 81,000 households) to 5% (approximately 41,000 households) when the MWG is introduced. These findings have significant policy implications in that scaling the MWG model has great potential in increasing the uptake and use of CIS in Senegal.

The second analytical section goes deeper into assessing the effectiveness of MWGs in influencing farmers' uptake and use of CIS. It also covers the resulting impact on behavioral outcomes and farm management practices, using an instrumental variable to correct for selection bias. Results indicate that the presence of an MWG influences behavioral changes in farming decisions for the different types of CIS used.

Results include:

- In locations where farmers are exposed to MWGs, there is a 25% higher chance that they will use total accumulated rainfall forecast for the season to inform their farming decisions.
- Farmers revealed that they mostly use seasonal forecasts of total accumulated rainfall to guide in making decisions such as the crop types and varieties to consider growing for that season.
- Farmers exposed to the MWG used seasonal forecast of onset of rains to inform their decisions on timing of planting and land preparation, while the 10-day forecast was used to inform decisions on fertilizer use.
- When considering the link between use of seasonal forecasts and observed farm management practices, the use of seasonal forecasts was generally associated with a higher proportion of farmers using improved seed, fertilizers, and manure, but negatively with crop diversity in MWG locations.

LESSONS

The assessment and findings highlighted two broad lessons:

There is a positive association between the existence of the MWG model and farmers' awareness, access, and use of CIS, as well as in influencing farm management decisions. This is encouraging and suggests that participatory approaches in the provision of tailored climate information and advisory services can lead to higher uptake and use among end-users.

These results demonstrate that the MWG model may well be instrumental in increased uptake of CIS. This could offer lessons in the design, implementation, monitoring and evaluation, and scaling of similar initiatives to the rest of Senegal and other countries in Africa and beyond.

It is important to highlight that this study does not analyze the impact of CIS use on higher-order welfare outcomes such as household food security, income, or poverty, which requires long-term seasonal data collected from the same farms.

Synthesis: Improving the Monitoring and Evaluation of CIS

Most assessments of CIS identify and measure impact through broad associations between access to and/or use of CIS and changes in various behaviors and outcomes. While such impact assessments rigorously identify these associations, they cannot differentiate between the various factors that brought about the observed change. Through Workstream 3, CISRI wrote a report that seeks to improve the rigor and explanatory power of CIS monitoring and evaluation. It does so by identifying pathways of change by which individuals take up and employ the delivered information to produce an observed change in behavior or outcome, and synthesize it with conventional large-scale survey data to explain changes associated with the implementation of CIS.

In this report, we describe and then synthesize the findings of two different efforts to identify and explain the impact of a specific CIS, the Multidisciplinary Working Group (MWG) model, on farmers' behavior and outcomes, using ethnographic data to rigorously interpret survey findings and identify impacts on the behavior of specific users. The first effort is a **large randomized survey** comparing the livelihoods of those with access to and using the MWG to those without access and who do not claim to use climate information to inform their livelihoods. The second is an **intensive ethnographic exploration** of livelihoods decision-making that identified likely pathways through which weather and climate information might inform the livelihoods decisions of different residents. Further, this pilot offered an opportunity to more broadly identify the challenges such synthesis presents, and suggest means of managing these challenges to enable similar syntheses for other CIS.

FINDINGS

The synthesis of two very different types of studies achieved results that could not have been obtained in a single study. There were several important findings from the synthesis:

- **There is clear evidence of behavioral change: access to and use of the MWG model is impacting user decision-making.** Though it is a new program, there is already evidence for the impact of the MWG on a variety of livelihoods decisions, crossing all parts of the agriculturalist population of the livelihoods zone examined for this project.
- **Access to and use of the MWG informs and appears to encourage farmer efforts to invest in critical agricultural inputs such as improved seeds and chemical fertilizer.** This pattern was most pronounced for the use of chemical fertilizer, and less pronounced in improved seeds, which may reflect either the presence of local varieties well-suited to existing environmental conditions, the reliability of different aspects of the CIS (for example, where short-term weather forecasts are very reliable even if seasonal forecasts are not), or local preferences related to taste or other crop characteristics which shape seed selection.
- **CIS impacts are produced through sustained efforts.** The impact of the MWG on the overall material situations of its users is not immediate. Despite the observed changes in decisions and investment, those with access to and using the MWG did not have higher levels of draught animal or productive assets than those without access and not using the information. However, this is a very new program, and durable impacts on the asset situations of users may take several more seasons to become apparent. This suggests that in this zone farmers incorporate climate information into their decision-making through pathways that start with agricultural production, which then yields income that can be invested in durable assets.

LESSONS

Synthesizing Disparate Datasets

Meaningfully and carefully stratifying data sets on users and their needs. In the context of M&E, the impacts of CIS will be uneven across a population, and therefore aggregate measures of uptake, use, and impact will obscure critical differences that make the adjustment of existing programs, and the effective learning from completed programs, difficult. Meaningful stratification represents the situations of different users of CIS and their needs, and should pay attention to the social characteristics that shape the roles and responsibilities of individuals. This requires empirical evidence for the distribution of vulnerability and resilience in the population. A detailed, qualitative vulnerability assessment can provide the data needed to meaningfully stratify a representative set of users.

Appropriately measuring uptake and use. When CIS projects assume that success is demonstrated through high rates of information awareness, uptake, and use, they are likely misrepresenting impact because climate information is most often useful for only a subset of a given population. The uptake of CIS should not be gauged against the whole population, but the proportion of the population with the authority and ability to use weather and climate information.

Identifying and measuring impacts. The impacts of a CIS, and the different information it provides, are often highly differentiated within a given population of users and are relatively narrow in their ability to catalyze livelihood changes. Measures of impact that aggregate these different users can overgeneralize impacts, while overlooking specific impacts important to particular users.

Characterizing confidence and limits on findings. Decision-making structures are slow to change and likely to endure across a project cycle (except in the context of catastrophic change or events when even durable decision-making structures could undergo rapid change). Outcomes of decisions will vary with the economy, weather, and other factors that can change season by season, producing potentially large differences of the same CIS. Evaluating across seasons could capture the different outcomes of these CIS-informed decisions, and any changes to the decision structure that might result from those outcomes.

The synthesizing process. Assessing the impact of an intervention such as a CIS requires quantitative measurements of change generalizable to a population and qualitative explanations of the pathways by which that change came about. Such synthesis can be sequenced, for example, one might use qualitative work to establish initial interpretive frameworks, which then inform the interpretation of data from ongoing survey collection. The nature of the synthesis should be determined by the questions at hand, starting at the impact one expects to measure, and the character of the CIS. The greater the degree of coordination between data collection methods, the more comprehensive the possible synthesis.

Measuring impacts by interpreting change. Changes in material circumstances and outcomes can be driven by a wide range of factors, and can change quickly and be difficult to rigorously attribute. Livelihoods decision-making tend to be durable, barring catastrophic shocks, and as a result it is reasonable to expect that understandings of such decision-making will hold for at least five years. Verifying the ongoing validity of initial understandings of livelihoods decision-making is possible through much less intensive targeted investigations. For example, repeated surveys aimed at the different decisions and outcomes can identify when decisions or outcomes appear to change, triggering targeted ethnographic investigations into those changes to explain their sources and importance.

Livelihoods Zones as Units of Analysis

A central question for CIS is the number of people who can be served by a single service. Because effective CIS address clearly defined users and needs, it is impossible to design a CIS that addresses the needs of each household or community in a given country. The evidence in this report strongly suggests that FEWSNET livelihood zones provide an optimal spatial scale for the design of a CIS.

1. Within a livelihoods zone, the decision-making structures, available activities, available resources, and local environment are similar enough for identification of users and needs, and the meaningful measurement of CIS impact.
2. Beyond a livelihoods zone invokes new users, decision-making, resources, and environments.

Templates for Synthesis

Template 1: Synthesis when there has been little coordinated planning of data collection.

1. Test how similar the sampled populations are in the different studies.
2. Identify surrogate measures that capture the disaggregation into vulnerability groups.
3. Use in-depth qualitative analysis to interpret and provide explanations for observed differences between users and non-users of CIS in larger randomized quantitative datasets.

Template 2: Synthesis when there has been coordinated planning of data collection.

1. Coordinate the choice of sampling questions and the selection of people to sample.
2. Sequence studies to allow qualitative data to inform the design of quantitative data collection.
3. Ensure coverage of livelihood zones includes a range and variety of individuals
4. Investigate possibilities for longer-term longitudinal information to track impact over time.

For Both Templates: Characterize uncertainty to ensure synthesis is rigorous and valid.

1. Identify variables that can change quickly versus those that will change more slowly.
2. Identify ways the timeframe of data collection might introduce uncertainty into the synthesis.
3. Identify how changes in conditions might impact fast and slow variables.

Reports: Piloting Evaluation Approaches

- Vaughan, C., Hansen, J., Roudier, P., Watkiss, P., and Carr, E. (December 2017). *Evaluating Agricultural Weather and Climate Services in Africa: Evidence, methods, and a learning agenda*.
- Carr, E., Rosko, H., Onzere, S., Goble, R., Kalala, T. (June 2019). *Senegal's Multidisciplinary Working Group CIS Model: A Qualitative Assessment of CIS Users and their Needs*.
- Onzere, S., Carr, E., Rosko, H., Kalala, T., Davis, J. (June 2019). *Rwanda's Climate Services for Agriculture Initiative and the Participatory Integrated Climate Services for Agriculture: A Qualitative Assessment of CIS Users and their Needs*.
- Carr, E., Onzere, S., Goble, R. (October 2019). *Summary Report: Innovative Qualitative Approaches for CIS Monitoring and Evaluation*.
- Chiputwa, B., Wainaina, P., Makui, P., Nakelse, T., Zougmore, R., Ndiaye, O. (October 2019). *Evaluating the Impact of the Multidisciplinary Working Group Model on Farmers' Use of Climate Information Services in Senegal*.
- Carr, E., Goble, R., Onzere, S., Chiputwa, B. (October 2019). *Synthesis Report: Improving the monitoring and evaluation of CIS to facilitate learning and improve outcomes*.

All resources are available at: www.climatelinks.org/projects/learningagendaonclimateservices.

ANNEX A: MONITORING AND EVALUATION DATA

Detailed monitoring and evaluation data is available in the attached excel spreadsheet, including full information for each of the performance indicators summarized below.

Performance Indicators

INDICATORS	TARGET – Life of Project	ACTUAL – Life of Project
Number of events in which the project collaborates and shares its research, evidence, materials and/or learning products	13	31
Number of page views on project's climatelinks.org website	TBD	5,918
Number of institutions with improved capacity to assess or address climate change risks supported by USG assistance	37	103
Number of scientific studies published or conference presentations given as a result of USG assistance for research project	12	18
Number of technologies or management practices under research, under field testing or made available for transfer as a result of USG Assistance	6	7

Publications

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Conferences, Workshops, and Knowledge Dissemination

International Conference on Climate Services (ICCS 5), *Identifying users and their needs for climate services: A review of methods and practices*, March 2017, Cape Town, South Africa

International Conference on Climate Services (ICCS 5), *Evaluation of Agricultural Climate Services in Africa - A Review of Recent Work*, March 2017, Cape Town, South Africa

International Conference on Climate Services (ICCS 5), *Evaluating climate services: A review of methods*, March 2017, Cape Town, South Africa

International Conference on Climate Services (ICCS 5), *Mapping Climate Services Across Africa*, March 2017, Cape Town, South Africa

GFCS Stakeholder Coordination Workshop, *Defining a Roadmap for Scaling up Weather, Water and Climate Services in Africa*, May 1-2, 2017, Saly, Senegal

Scoping Workshop for the design and development of a GFCS Help Desk, WS1 outputs and evaluation activities, and how they might contribute to GFCS activities, June 19-20, 2017, Offenbach, Germany

UN Climate Change Conference 2017: COP23, CISRI Learning Agenda, Activities and Progress to Date, November 6-18, 2017, Bonn, Germany

Climate Smart Agriculture Global Science Conference, November 28-30, 2017, Johannesburg, South Africa

ODI Webinar, *Users and producers of climate information services in sub-Saharan Africa: exploring roles and needs*, February 28, 2018, Webinar

Meeting with USAID Sahel Regional Office and FFP Meeting, shared research findings from CISRI pilot in Tillabery and preliminary findings from the second pilot in Zinder, April 10, 2018, Niamey, Niger

American Association of Geographers Conference, *New Directions in Identifying Users and Needs for Climate Information Services*, April 2018, New Orleans, LA, USA

American Association of Geographers Conference, *New Directions in Monitoring and Evaluating Climate Information Services*, April 2018, New Orleans, LA, USA

Gender and Resilience Working Group, shared findings about gender-related differences in CIS access and use, drawing from the WS2 participatory mapping, April 30, 2018

Understanding Risk Conference, *Mind the Gap: Translating Climate and Earth Observation Data into Village-Level Action*, May 2018, Mexico City, Mexico

Understanding Risk Conference, *Communicating Earth Observation Data: A Picture is Worth a Thousand Actions*, May 2018, Mexico City, Mexico

Cracking the Nut Conference, CISRI findings from WS2 participatory mapping, June 12-13, 2018, Antigua, Guatemala

Interaction Forum: Climate Information Services for Climate Resilient Development Conference, CISRI findings from users and needs study, gender study, and participatory mapping, June 13, 2018, Washington, DC

CIS Learning Agenda Conference, *What are we learning about climate information services delivery? Examining climate services from production to uptake*, June 18, 2018, Cape Town, South Africa

Adaptation Futures Conference, *Evaluating agricultural weather and climate services in Africa: Evidence, methods, and a learning agenda*, June 2018, Cape Town, South Africa

Adaptation Futures Conference, *Diversity in Climate information services in Sub-Saharan Africa: End User and Sector Inclusion*, June 2018, Cape Town, South Africa

Adaptation Futures Conference, *Identifying Climate Information Services Users and their Needs in sub-Saharan Africa: A Learning Agenda*, June 2018, Cape Town, South Africa

Adaptation Futures Conference, *CIS Demand: Looking at the User End of CIS*, June 2018, Cape Town, South Africa

Adaptation Futures Conference, *What are we learning about CIS delivery?*, June 2018, Cape Town, South Africa

ECOWAS Forum, *Participatory Climate Information Services Systems Mapping*, September 2018, Abidjan, Côte d'Ivoire

SERVIR Annual Global Exchange (SAGE) Workshop, Presentation of CISRI findings from Participatory Systems Mapping Methodology-Workstream 2 and Users and Needs-Workstream 1, October 9-13, 2018, Bilbao, Spain

Moving Climate Services Forward: a WB/WMO/USAID Learning Event, *Identifying CIS Users and their Needs*, November 27, 2018, Washington, DC, USA

Moving Climate Services Forward: a WB/WMO/USAID Learning Event, *Can CIS Serve African Farmers' Context-Specific Needs at Scale?*, November 27, 2018, Washington, DC, USA

Moving Climate Services Forward: a WB/WMO/USAID Learning Event, *Participatory Method to Amplify End User Voices in CIS Systems*, November 27, 2018, Washington, DC, USA

Moving Climate Services Forward: a WB/WMO/USAID Learning Event, *Building Meaningful CIS Evaluations*, November 27, 2018, Washington, DC, USA

American Geosciences Union Fall Meeting: Bridging the Methodological Divide, Evaluating Weather and Climate Services, December 10-14 2018, Washington, DC, USA

MESH Networking for the UK Climate Services Community Meeting, Findings from the Climate Information Services Research Initiative, February 28, 2019, Bristol, UK

International Conference on Community-Based Adaptation, Learnings from Workstream 2 Participatory Systems Mapping Methodology April 1-4, 2019, Addis Ababa, Ethiopia

General Assembly of the European Geosciences Union (EGU), Present the evaluation paper and evaluation methodology work, April 7-12, 2019, Vienna, Austria