Surveying climate services: What can we learn from a bird's eye view?

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March 14, 2017

Abstract

Billed as the creation and provision of timely, tailored information for decision making at all levels of society, climate services have garnered a great deal of attention in recent years. Despite this growing attention, strategies to design, diagnose, and evaluate climate services remain relatively ad hoc – and while a general sense of what constitutes "good practice" in climate service provision is developing in some areas, and with respect to certain aspects of service provision, a great deal about the effective implementation of such service remains unknown. This paper reviews a sample of more than 100 climate service activities as a means to generate a snapshot of practice in 2012. We find that a "typical climate service" is provided by a national meteorological service operating on a national scale to provide seasonal climate information to agricultural decision makers online. Our analysis shows that the field of climate is still emerging – marked by contested definitions, an emphasis on capacity development, uneven progress toward co-production, uncertain funding streams, and a lack of evaluation

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activities. The paper reflects on the relative contribution of this sort of sampling activity in informing “good practice.” It also offers suggestions for how both sampling and case studies efforts can be better designed to increase the potential for learning. The paper concludes with some observations on the relative contribution that broad-based analyses can play in informing this emerging field.

Key words

Climate services; adaptation; evaluation; good practice; case study

1. **Introduction**

Climate services involve the production, translation, transfer and use of climate knowledge and information in climate-informed decision making and climate-smart policy and planning. Such services are intended to facilitate adaptation to climate variability and change, widely recognized as important challenges to sustainable development in rich and poor countries alike (Asrar, Ryabinin, & Detemmerman, 2012; Wahlström, 2009). Interest in climate services has grown in recent years, particularly since the 2011 initiation of the Global Framework for Climate Services (GFCS), an international structure focused on improving the production, delivery, and application of climate information around the world (Hewitt, Mason, & Walland, 2012).

This growing interest reflects an assumption that advancement in this area will produce gains in social and economic well-being; despite this assumption, there is active debate on what climate services are, where they are most effective, and how they should be designed to best deliver societal benefits. Questions regarding the kinds of information on which climate services should be based, the sorts of problems they can most effectively address, and the institutional arrangements needed to support them continue to consume planning efforts, as the users and providers of climate services engage in a simultaneous and loosely coordinated process of learning by doing.

Some aspects have been more studied than others. Indeed, relatively more attention has been paid toward assessing particular attributes of the climate information itself – including, for instance, the quality of the data that underlies specific services (Bhowmik & Costa, 2014; Brunet & Jones, 2011; Girvetz et al., 2013; Overpeck, Meehl, Bony, & Easterling, 2012) and the verification of climate predictions (Goddard et al., 2012; Hyvärinen, Mtilatila, Venäläinen, & Gregow, 2015; Mason & Chidzambwa, 2008), among other things. In the social science realm, efforts have focused on defining the parameters of “usable” science (see for, instance, Dilling & Lemos, 2011; Tang & Dessai, 2012); identifying factors that improve the communication of climate information (for example: Lorenz, Dessai, Paavola, & Forster, 2013; Marx et al., 2007; Taylor, Dessai, & Bruine de Bruin, 2015); and in assessing the impact of specific services (see for instance Clements, Ray, & Anderson, 2013; Thornton, 2007).

To our knowledge, however, a broad-based review of the existing practice of operational climate services has not yet been attempted. The current paper fills this gap by analyzing a unique dataset of more than 100 self-reported descriptions of climate service activities, which were submitted to the Global Framework for Climate Services and the Climate Services

Partnership in 2012 (detailed descriptions of the **Data** and **Methods** are found in Section 2). In doing so, the paper creates a snapshot of the state of the field shortly after the initiation of the GFCS (**Results** appear in Section 3), allowing for a point of comparison as the field continues to develop. The paper also offers observations on what can – and cannot – be learned from this kind of broad sampling activity (this **Discussion** occurs in Section 4), ending with some **Conclusions** regarding how best to design future sampling efforts in order to more effectively advance learning (Section 5).

2. **Methods**

2.1 **Data**

The paper draws on the written descriptions of 101 climate services, collected independently, though in a coordinated fashion, by the Climate Services Partnership (CSP) and the World Meteorological Organization (WMO) in 2012. Both entities used the same template (see Appendix 1) to solicit self-reported descriptions of climate service activities, with the goal of identifying good practice; both organizations called these “case studies,” though the methodology used was an open-ended survey, rather than a social science case study per se.

These results of this joint activity were published in conjunction with the second International Conference on Climate Services (September 2012) and an extraordinary session of the World Meteorological Congress focused on the implementation of the Global Framework for Climate Services (October 2012), respectively.

While the authors of both CSP and WMO studies responded to the same template to design their responses, some differences in the way the studies were collected, edited for publication, and categorized by the different organizations complicated the combining of data sets. For instance, the responses ranged in length and quality across both collections, with the longest piece nearly 9000 words long and the shortest closer to 1000.

In addition, four climate services are described in both collections. As the goal of our analysis is not to contrast CSP and WMO documents but to use both collections to learn about the practice of climate service design and implementation, we analysed these duplicates together, using information from both texts to create a more comprehensive view of the service in question. As a result, eight CSP/WMO documents were consolidated into four combined studies in our analysis.

Another complication stemmed from the fact that three responses challenged our understanding of “climate services” as defined earlier in this paper. These were removed entirely from the study, though a more thorough treatment of these cases appears in the Discussion section.

Finally, four studies collected by the WMO provide a general overview of the activities of a project of climate service provider without delving into the details of a particular service. These documents describe broad concepts and goals but do not provide enough detail to answer many of the questions we used in our analysis; as such, these too-broad responses were included in overarching analyses, but left off analyses that addressed more specific questions. A full listing of the 101 climate services included in the analysis is found in Appendix 2.

2.2 **Analysis**

Our method of analysis follows the climate-service evaluation framework proposed by Vaughan & Dessai (2014). Designed to help guide future work on climate service evaluation, this framework identifies four factors drawn from the literature on the use of seasonal and long-term climate information that influence the benefits and relative success of climate services. These factors are described in brief below.

Problem identification and the decision-making context: The contexts in which climate services are provided naturally condition their success. Indeed, in some cases the strongest impediments to the adoption of climate information are contextual or institutional, rather than technical. Conversely, certain situations create opportunities for climate services to be more impactful than others. [For more on this, see for instance (Kenneth Broad & Agrawala, 2000; Millner & Washington, 2011)]. Our analysis of the responses explored questions including where and in what sectors climate services are provided and whether or not such services are designed with specific users in mind.

Characteristics, tailoring and dissemination of the climate information: The success of a climate service depends on the quality of the climate information that underpins it; it also depends on the extent that information is appropriately tailored to meet users need and the ability of users to access information in a timely fashion. [See for instance (Furman, Roncoli, Crane, & Hoogenboom, 2011; Harrison & Williams, 2007)]. We analyzed studies to identify the timescale of the climate information provided, whether or not the services report information describing the "quality" of the information (i.e., data quality control, forecast verification, etc.), and any contextual information included in the service.

Governance, process and structure of the service: Climate services require the development of structures that can facilitate interactions between dispersed institutional and administrative mechanisms, projects, and financial resources. In this context, the structure and governance of a climate service are important determinants of the effectiveness of the service itself. [For more on this see (Broad, Pfaff, & Glantz, 2002; Lemos, Kirchhoff, & Ramprasad, 2012)]. Our analysis explored the scale on which services are provided, the kinds of actors involved in service provision, the mechanisms by which the service connects to users, and how the services are funded.

Socioeconomic value of the service: Assessing the effectiveness of a climate service should involve some assessment of its economic value and the value it has to individuals or to society writ large. Indeed, benefits from climate services may take many forms and may accrue to the individual, the collective or the natural environment. [For more on this, please see (Clements, Ray, & Anderson, 2013a)]. Though none of the documents in the current study identify the economic impact of their services, our analysis reports on those that discuss efforts to evaluate the services in question.

Our analysis used this framework to develop a series of questions (see **Table 1**) addressed by the template (see Annex 1).

Studies were coded to facilitate the identification and aggregation of information specific to each question. While all documents responded to the same template, the fact that they were self-reported means that there was also some variation in both the topics and the level of detail. In some cases, information relevant to our research questions appeared at different places in the document. In other cases, requested information was not explicit in the material; in these cases, we report how many studies reported relevant information before describing the responses themselves.

2.3 **Caveats**

While the CSP/WMO case study collection represents the most comprehensive detailing of climate service activities to date, it is important to remember that it is a "sample of opportunity" rather than one specifically designed for the purposes of this analysis. This brings with it several caveats, including:

We cannot assume that the breath of the case study collection reflects a representative sample; since we have no way of knowing how many climate services currently exist, we are not capable of stating whether or not this sample is representative of that larger group.

We are not able to control for the role that selection bias may play on the case study collection. CSP case studies were collected primarily from CSP members, while the WMO solicited studies from its own network – including its 191 member states – which is likely to have affected the number of case studies received from national meteorological or hydrological services (see, for instance, the discussion on African climate services under "Results).

We cannot independently verify information included in the case studies. Since nearly all case studies were reported by people involved in providing the service in question, some may (or may not) exaggerate accomplishments or selectively omit challenges. All case studies are likely to highlight the topics the authors found most important, perhaps sacrificing topics of interest to our analysis.

While these caveats are important to consider, they do not impede our ability to draw meaningful insights from the case study collection as a whole – which, while imperfect, represents a sample of 101 climate service activities in 106 countries and involving more than 133 different organizations and is the most comprehensive source of information on climate services in the world to date.

3. Results

Our analysis of the 101 responses engages specific questions around the four factors that influence the relative success of climate services.

3.1 Problem identification and decision making context

Where are climate services provided? The regional foci of responses are included in **Table 2**. It is important to note, however, the role that sampling methods may play in these numbers. For instance, the WMO solicited responses from each of its member states, so while there are 26 responses focused on Africa, this must be considered in light of the fact that 53 member states in Africa were asked to submit an example of their work. Conversely, 28 case studies were submitted from the area that constitutes WMO Region II (Asia), which comprises 35 member states. In some cases, international organizations submitted studies that cover more than one country or region; as a result, the sum of the number of regions studied exceeds the total number of studies themselves. Nine climate services are considered to be global in scope.

What sectors do climate services engage? As illustrated in Table 3, the most commonly engaged sectors include agriculture (24), water (15), disasters (13), and health (9). A description of the 24 studies that are classified as pertaining to "capacity development" is included in the Discussion session. Roughly one-third of the case studies were assigned to more than one category – engaging, for instance, water and capacity building, or agriculture and ecosystems.

What kinds of services are implemented where? To get a sense of whether some sectors are more actively engaged in certain locations, we compared regions and sectors, revealing that the responses that engaged with agriculture were more common in Africa and Asia than in Australia, Europe or North America. Water-related case studies were most commonly drawn from Europe, including, for instance, analyses of the impact of climate change on the Nieman and Danube rivers (ICPDR, 2012; Korneev, 2012). More details are found in **Figure 1**, below.

Do climate services engage specific users? To help explicate the extent to which existing climate services were targeted to specific problems and/or how these problems were understood, we analyzed the number of responses that mentioned specific users. We considered studies as targeted to users whether these groups included specific organizations or broad groups (for instance, "farmers," "disaster risk managers," etc.). We found that 50 of the 101 cases mentioned users in this way. Of this group, 48 discussed involving users in the development of the service in any capacity. Users include both individuals (e.g., specific farmers, humanitarian workers, disaster managers, extension agents) and organizations (planning ministries, railway companies); seven case studies also appeal to the general public (e.g., the Health Heat Warning System).

When possible, we also considered the decisions that the service was intended to inform. These range considerably, but include those related to farm management (e.g., planting, seed selection, harvest, etc.); disaster risk reduction (including preparedness and prevention); and transport (planning and infrastructure investment). Cases that directly mention users are roughly five times as likely to operate at sub-national than at global scales. Twelve cases report operating at more than one scale.

What kinds of user organizations do services engage? The data allows us to describe the specific user organizations mentioned in the studies, which includes government offices, humanitarian organizations, private companies, and researchers, among others. More information on user types is found in **Table 4**, below.

3.2 Characteristics, tailoring, and communication of climate information

What is the timescale of information provided? For those studies that included this type of information (83/101), seasonal information was by far the most prevalent, though weather and long-term information was also used by nearly 30% of studies as well. More details are found in Table 5, below.

Do climate services measure/report the quality of their information? While the quality of information was not explicitly addressed by the case study template, we have attempted to characterize the extent to which case studies discussed the quality of information in several ways. For instance, 10 case studies in the collection mention the verification of their forecasts. Another 22 mention the quality control of data that goes into their analysis.

Do climate services solicit user input to design the services? It was not possible to develop quantitative measures of information tailoring; we did, however, count 48 case studies that specifically discussed user engagement in the development of the service, soliciting input through workshops, consultation, or surveys.

How is information communicated to potential users? For those that provided this information (66/101), websites were far and away the most prominent mode of information provision. More information is found in **Table 6**.

3.3 Governance, process and structure of the service

On what scale is the service provided? As illustrated in **Table 7**, more services operate on national scales (39) than on regional (23) or subnational (18) scales. Seven of the documents mention services that provide information on a global scale.

Who is involved in the service provision? We used the organizational affiliation of the authors of the submitted documents as a proxy for those organizations involved in the service provision. For the most part, this includes research institutes (52 out of 132 named organizations) and meteorological agencies (34 out of 132). Universities (20/132) and humanitarian organizations (11/132) also have a sizeable presence in the list of organizations that contributed to the collection.

How do climate services connect to users? The connection between climate service users and providers is described in an early section on problem identification. Of course, this is also a governance issue, as climate services must create a context for sustained interaction between users and providers; as mentioned above, only 50 of the 101 studies mention specific connection with users. We are also able to characterize the extent to which the studies describe the processes by which providers stay in contact with users even after the service has launched. For instance, 14 case studies suggest they solicit ad hoc feedback from users, while another 10 mention consultation workshops that help the providers to understand how information is used.

How are climate services funded? The case study collection provides a general sense of the funding models that currently support climate services. For instance, of the 42 case studies that describe the funding schemes that support the services in question, 25 are funded by the national government receiving the service; another 23 are donor funded on a project basis. Only 11 of the services in question describe their funding as "sustainable"; eight are able to operate on little or no funding, primarily by piecing together budgets associated with existing activities that benefit from climate services.

3.4 Socioeconomic value of the service

What evaluation methods are used? The case study template specifically asked authors to describe mechanisms for evaluation. Of the 37 that do so, 10 describe forecast verification, a method of evaluating the quality of the forecast itself; another 10 describe consultation workshops by which climate service providers receive user feedback. Fourteen case studies say the climate service providers receive this feedback in an informal ad hoc fashion; another nine use surveys. Two case studies describe independent evaluators contracted to assess the extent to which the service contributed to project goals; several studies mention website statistics as a valuable source of information regarding how many people are using the service.

No studies mention efforts to economically value the climate service, though it seems likely that authors would have reported information on this type of evaluation were it available.

4. **Discussion**

Analysis of this unique dataset has allowed us to make several observations about the overall state of climate service implementation, including the extent to which certain practices are common to services around the world.

The dataset confirms, for instance, that climate services are provided in all regions and in a range of different sectors – though there are relatively more services that engage sectors including agriculture, water, disasters, and health than other sectors (e.g., energy, transport, etc.). Services based on seasonal climate information are more common than those based on other types of information. Nearly half the climate services in question are targeted to government offices, though services are also targeted to the private (18%) and third sectors (22%) in relatively equal numbers. The majority of climate services are provided on websites.

The dataset also allows us to make several overarching observations about the state of the field – identifying the faint outline of what could be called a typical climate service (4.1), while revealing the relatively inchoate nature of the field (4.2). Ways to improve this overview, and our analysis of it, are also considered (4.3).

4.1 A typical climate service

Based on the frequency with which certain characteristics appear in the dataset, we surmise that a “typical” climate service is provided by a national meteorological service – frequently in conjunction with a research institute – and that it operates on a national scale to provide seasonal climate information (paired, perhaps, with weather forecasts and/or long-term climate information) to agricultural decision makers online (see **Appendix 3**).

It is possible that our sample – and thus our characterization of a typical climate service – may be influenced by the entities that requested the studies: For instance, given the direct communication with the World Meteorological Organization, national-level climate service providers may be somewhat overrepresented in our study. On the other hand, the fact that much of the world’s climate data is in the hands of national meteorological agencies ensures these actors will be heavily involved in the production, dissemination and distribution of climate services for years to come (Overpeck, Meehl, Bony, & Easterling, 2011).

Other aspects of this characterization of a “typical service” are consistent with the literature – including the relative focus on seasonal forecasting. The field of seasonal climate prediction is more advanced than that of decadal or long-term forecasting (though not more advanced than monitoring or observations) and there is also a relatively extensive literature on the use of seasonal forecasts for decision making. In some cases, this literature has been used as an analogue to understand information uptake, indicating the extent to which scholars and service providers have focused on the use of information at this scale, particularly following the 1997/1998 El Niño (Adger, Huq, Brown, Conway & Hulme 2003; Lemos et al 2003).

The focus on agriculture also seems born out by other types of information. Indeed, 63% of respondents to a recent survey on research priorities for climate services identified climate services for agriculture as most developed, when compared to other sectors including water, health, financial services, and disaster risk management (Vaughan, Buja, Kruczkiewicz, & Goddard, 2016). It is likely this is due in part to the directness of the connection between climate variability and the impacts of human welfare: Whereas health-related climate impacts are frequently moderated by disease vectors (for instance, mosquitos), the impacts of climate on agriculture track basic climatological factors, including rainfall and temperature. This direct connection made it easier for people to observe, understand, and respond to climate fluctuations over centuries, leading to a more developed understanding of how climate information can link to decision making.

In this context, the relatively well-developed field of agro-meteorology also means that there is a trained cadre of professionals and extension officers able to interpret and employ climate information in agricultural decision-making (Sivakumar, Gommes, & Baier, 2000); while hydro-meteorologists perform the same function in the water sector, there is no corollary for health or disaster managers. These experts bolster the capacity of the sector to absorb and act on climate information.

4.2 An emerging field

While existing climate services may more frequently target agricultural users, our analysis makes it clear the field is still emerging – marked by contested definitions, an emphasis on capacity development, uneven progress toward co-production, uncertain funding streams, and a lack of evaluation activities.

Contested definitions. One indication of this is the fact that the World Meteorological Organization has used a rather broad scope for incorporating studies in their own collection, even to the point of including several studies that do not meet most traditional definitions of climate services. Indeed, two of these studies describe new methods to collect information about the climate system, rather than efforts to tailor that information to specific decisions. A third describes a low-carbon growth service that helps businesses understand how they may reduce their greenhouse gas emissions.

The services in these studies are not just very different from each other; they are also clearly at odds with the WMO definition of climate services, expressed on the website in this way: "Climate services provide climate information in a way that assists decision making by individuals and organizations"(www.gfcs-climate.org). That these services would be included in the WMO case study collection seems to reflect the contested nature of a term whose meaning is still being debated; consensus on what counts as a climate service, and what does not, is likely to continue to consolidate in coming years and may remain fluid (Hulme, 2009).

Emphasis on capacity development. Another indication of the emerging nature of climate services is the relative emphasis on capacity development within the dataset.

This focus squares well with the priorities of the Global Framework for Climate Services, which explicitly includes capacity development as one of the "five pillars" of the framework. As articulated in the Capacity Development Annex to the GFCS Implementation Plan, the GFCS specifically seeks to develop the human resources needed to advance the other four pillars of the framework, which include: observations and monitoring; research, modeling, and prediction; climate services information system; and the user interface platform (WMO, 2014). The GFCS also strives to bolster the basic requirements (including national policies/legislation, institutions, infrastructure and personnel) needed to enable GFCS-related activities to occur.

In this context, it is interesting to note that the 24 documents in this dataset that deal with capacity development fall roughly into three categories, including those that seek to build capacity by training individuals, mostly with respect to the analysis or use of climate information; those that make climate data and/or information available to researchers and decision makers; and those that seek to build and/or strengthen the institutions that produce or use climate services. These do not necessarily map well to the five pillars of the GFCS, meaning that some GFCS-priority topics (e.g., observations and monitoring, and some aspects of the user interface platform) are not being addressed. Better targeting the user community in capacity development efforts may be one area in which growth is needed.

Uneven progress toward co-production. As noted above, a growing literature has sprung up around climate services, particularly involving the use of seasonal forecasting. The literature seems to converge around the need to engage users in the "co-production" of climate services in order to ensure that products are useful, useable, and used (Lemos et al., 2012; McNie, 2007; Roncoli et al., 2008; Ziervogel & Downing, 2004). While the importance of "co-production" is certainly reflected in the collected documents, the interpretation of this term is relatively irregular.

There are, for instance, several case studies that detail extensive efforts to communicate with users regarding climate information needs. One such case study describes the efforts of the Australian Bureau of Meteorology to solicit and incorporate user feedback into the presentation and dissemination of their seasonal climate outlook. This process – which included targeted interviews, a survey, focus groups, and user testing – provided the BoM with a better understanding of how their users understand and employ seasonal climate information; it also afforded users the opportunity to advance their understanding of and confidence in the seasonal climate outlook itself (Boulton, Watkins, & Perry, 2012).

While this example seems to reflect good practice as reflected by the literature on user engagement (e.g., Lemos & Morehouse, 2005; Steynor, Padgham, Jack, Hewitson, & Lennard, 2016), more than half the case studies in the collection did not mention specific users, nor the process by which those users were incorporated into the development of the service. This seems to reflect rather uneven progress toward the co-production of climate services, with some services exemplifying the demand-driven principles and many others retaining the “loading dock” approach (Cash, Borck, & Patt, 2006).

Uncertain funding streams. Another observation can be made regarding the funding streams on which climate services depend. While funding to support climate services comes primarily from national governments (25) and donor organizations (23), only 11 of the case studies describe the funding that supports the service as sustainable. Other services rely on project funding and have sometimes had to scramble for funding to support continued operations.

This is true of even relatively long-running services, including the West African Regional Climate Outlook Forum (PRESAO), which began in 1998 but has not yet been institutionalized with funding from regional budgets. The PRESAO case study in particular makes clear that financial sustainability will rely heavily on the development of documents that illustrate the economic value of this sort of climate services and to policymakers and donors (Kadi, 2012). This is echoed by those who see sustainable funding as one of the main challenges to the Regional Climate Outlook Forum process (Ogallo, Bessemoulin, Ceron, Mason, & Connor, 2008).

Dearth of evaluation activities. No case studies explore the economic value of their service or mention attempts to do so. Those engaged in evaluation rely mostly on the ad hoc feedback of users' groups with whom they are in regular contact and/or slightly more formal processes, including surveys and user workshops. These processes provide the climate service provider with a better understanding of the users' needs and capability, in the interest of co-production, but do not necessarily advance the work of informing investment decisions.

4.3 **Improving upon our bird's eye view**

We have used the collected documents to provide a birds-eye view of the state of the field of climate services in 2012. But while the analysis offers a reasonable snapshot of climate services in 2012, it is important to note how difficult it is to use these cases to identify "good practice" in the way that those who solicited the studies may have liked. Indeed, because these studies are self-reported, primarily from the point of view of the climate service provider, it is relatively hard to get a sense of which services are more or less successful, or why; authors are not incentivized to be forthcoming regarding challenges or failures and there is little objective evaluation to refer to. What's more, it is difficult to use the studies to understand the users' experience of the services, or the extent to which individual climate services and/or climate services in general are able to improve social and economic well-being.

This is unfortunate given that the documents were dubbed “case studies” by the coordinating organizations – and case study research is uniquely suited to addressing these kinds of detailed questions. Indeed, the case study approach can be particularly useful in documenting specific practice and experiences; in identifying causal links between interventions and outcomes; and in enlightening situations in which an intervention has no clear, or clearly defined, set of outcomes (Yin, 2014). Case studies are also valuable in developing and elaborating theory, which creates opportunities for the sort of analytic generalization that could shed empirical light on current hunches regarding what constitutes good practice in climate services development and delivery (Ford et al., 2010).

That the 2012 collection does not lend itself to this kind of analytic generalization calls attention to the need to shift focus regarding the development of such case studies moving forward. In setting priorities for further efforts, two items that deserve particular attention include (1) a focus on analysis in addition to sampling; and (2) a focus on efforts to evaluate the relative contribution of specific climate services. More on each of these items are described below.

Sampling versus analysis. A primary goal of the 2012 data collection activity was to capture the breadth and depth of climate services that were being offered at the time. Since the effort coincided roughly with the launch of the Climate Services Partnership and the implementation of the Global Framework for Climate Services, this kind of sampling activity was interesting to the sponsoring organizations, both of whom were motivated to document and learn about contemporary practice to support larger efforts to advocate for climate service development around the world.

Capturing the breadth of activity in this field is still a worthy goal, of course, though it does not necessarily have to be carried out through case studies. Indeed, the GFCS Compendium of Projects, which lists GFCS projects that meet certain basic criteria, makes a good start in sampling current efforts. To the extent that it is able to facilitate easy monitoring of key indicators (e.g., target sector, timescale of information, provision method, user groups, etc.), this kind of sample could allow researchers, practitioners, and the donor community to maintain a general overview of the climate services community as it evolves over time.[**] Similar efforts are organized by the European Joint Programming Initiative "Connecting Climate Knowledge for Europe" (Monfray & Bley, 2016) where the mapping of climate service providers has been undertaken for a few European countries (e.g., Manez, Zolch, & Cortekar (2014) for Germany)

This sort of overview can also fuel the development of hypotheses that can be investigated through the production of case studies that are exploratory and/or explanatory in nature –

[**] While the compendium is an important contribution, we must also note that it currently falls short in describing both the breadth and depth of climate services. Indeed, the compendium describes just the scope, objectives, activities, benefits, and deliverables of just 40 GFCS projects, with another 10 “contributing” that projects not funded through the GFCS included on the website. This results in a partial picture of a small-subset of activities. Bolstering this activity (by including for instance, information on quality control measures, modes of communication, the scale of services provided, and the sustainability of services, etc.) should be an important priority moving forward.

using such studies to develop and hone hypotheses for further inquiry, and to explain the causal links between specific interventions and the ultimate outcomes. Building off existing work (Hellmuth, Mason, Vaughan, van Aalst, & Choularton, 2011; Hellmuth, Moorhead, & Williams, 2007; Hellmuth, Osgood, Hess, Moorhead, & Bhojwani, 2009), this sort of effort would employ multiple-case research methods that could advance the identification and refinement of principles, improving our understanding of the forces and factors that limit the applicability of such principles in certain situations.

To this end, case study researchers will need to greatly expand the range of topics they explore – moving beyond efforts to document climate services in specific regions or sectors, to engage with thornier issues (e.g., ethics, institutional arrangements, sustainability, etc.). Case study authors will also need to pay careful attention to concerns of validity and reliability in order to avoid common criticisms of case studies as anecdotes from which it is impossible to generalize (Bennett & Elman, 2006; Flyvbjerg, 2006). Case study authors may also make efforts to perform analyses that are similar with regards to the questions explored and the methodologies used by other authors; in this sense, the field will begin to develop a host of case studies that can undergo specific meta-analyses allowing us to learn more about the implementation of climate services in different contexts.

The development of a priority list of these hypotheses and methodologies is something that climate services coordinating bodies may like to take up. At the very least, the current analysis suggests that topics regarding capacity development, co-production, funding, and evaluation should be included.

Case studies & climate service evaluation. The case study collection highlights several challenges related to evaluation. First, the fact that the case studies were all self-reported makes it very difficult to use them to impartially assess the services in question. At the same time, the content of the case studies underscores just how few climate services are engaged in any kind of formal evaluation – relying, at best, on informal communication with users to gather feedback on information needs as well as on current and planned activities.

Of course, this reflects a challenge of resources as evaluative activities require dedicated efforts. It is clear, however, that the climate services community will need to prioritize the development of formal monitoring and evaluation protocols, and the involvement of independent evaluators. Without a strong push to improve evaluation, the community will struggle to justify its own efforts to improve service development and delivery; it will be challenged as well in attracting and sustaining funding from public and private sector actors interested to get the most out of their investment. This is especially true with regards to economic valuation, which can describe the return on investment from climate services in different contexts, and regarding the extent of uptake and use of climate services. To answer questions regarding good practice, however, climate service providers will need to assess the extent to which services are operating effectively along all aspects of the value chain.

Indeed, while climate service evaluators should avail themselves of the full suite of evaluation methodologies, the role of case studies in evaluation bears special mention in this paper. In contrast to survey or quasi-experimental methods, case studies are able to capture the complexity of services, and of the contexts in which they operate, making them particularly well suited to identify strengths and weaknesses, or to explain previously identified causal links, in this emerging field (Rogers 2000). Case studies are also useful in providing initial feedback in cases in which climate services take years to develop or in which the impacts of information use are expected to develop over long periods of time.

5. **Conclusion**

This paper analyzes a unique dataset comprising the self-reported descriptions of 101 climate service activities, collected separately but in a coordinated fashion by the Climate Services Partnership and the World Meteorological Organization, in 2012.

The dataset provides a birds-eye view of the emerging field of climate services, confirming that climate services are provided in all regions and in a range of different sectors – and that services that engage agriculture, water, disasters, and health are relatively more common than those that engage other sectors (e.g., energy, transport, etc.). Services based on seasonal climate information are found to be significantly more common than those based on other types of information, although a range of other timescales (historical, monitoring, weather, decadal, long-term) are also included in the study. While nearly half the climate services in question are targeted to government offices, services are also targeted to the private (18%) and third sectors (22%) in relatively equal numbers.

The dataset reflects a diversity of climate services – but it also allows for the identification of certain attributes that are more common than others. For instance, the most common type of service reported involves seasonal climate information provided by national meteorological services, in conjunction with research institutes, to agricultural actors over the Internet. A large number of case studies also deal with capacity building, either through individual education, the development of information portals, and the bolstering of institutions involved in the production and or use of climate services.

The prevalence of case studies focused on capacity building illustrates the extent to which climate services are still an emerging field; other factors that seem to confirm this characterization include the fact that several case studies do not match the definitions of climate services provided by the World Meteorological Organization, and the fact that many case studies do not discuss specific users (Capela Lourenco, Swart, Goosen, & Street, 2016) but rather focus on the supply-driven provision of climate information. In addition, very few climate services maintain sustainable funding streams; even fewer evaluate their progress.

While a number of caveats limit the utility of the 2012 dataset, it remains the most comprehensive source of information on climate services in the world to date and is thus useful in providing a snapshot of existing practice. The caveats do not impede our ability to draw meaningful conclusions from the case study collection as a whole, but they do highlight the challenge inherent to efforts to keep an account of progress in this rapidly changing field. Efforts to sample climate services, such as the GFCS Compendium of Projects, will need to be expanded, and kept up to date, if researchers are to be able track changes to the climate service community as a whole and keep tabs on the extent to which such services contribute to society's efforts to adapt to climate variability and change.

It is important to note as well that while this dataset is useful in providing a general overview of the field, it is less useful in providing a sense of good practice. To advance this discussion, case studies will need to move past a simple accounting of practice to explore and explain current strengths and weaknesses of climate services from a more theoretical perspective. To this end, case studies should develop hypotheses for future inquiry, and explain causal links between particular interventions and ultimate outcomes. Case studies also have a key role to play in climate service evaluation, complementing experimental and quasi-experimental methods, and supplementing them in cases in which such methods may be inappropriate or premature.

ACKNOLWEDGEMENTS

Part of this research was conducted under the auspices of the Climate Services Partnership's, with support from the Climate Change Resilient Development project of USAID. Suraje Dessai is supported by the European Research Council (ERC) under the European Union's Seventh Framework Programme for Research (FP7/2007–2013), ERC Grant agreement 284369, the EUPORIAS project, grant agreement 308291, and the UK ESRC Centre for Climate Change

Economics and Policy (ES/K006576/1). The authors acknowledge Meaghan Daly, who provided useful comments on an earlier draft.

Appendices

Appendix 1: Case study template

Global Framework for Climate Services and Climate Services Partnership
Case Study Solicitation
January 2012

Introduction

The **Climate Services Partnership** (CSP) was formed at the first International Conference on Climate Services (ICCS) to advance climate services around the world. In doing so, the CSP supports the **Global Framework for Climate Services** (GFCS), a formal international system that facilitates the coordinated support of climate services worldwide.

In an effort to advance common goals, the GFCS and the CSP are soliciting case studies that document experiences in the provision, development and application of climate services. Case studies should detail the perspective of users of climate information as well as that of providers of such information. They should highlight successful strategies, detail challenges, and share lessons learned.

Case studies will form an integral part of the GFCS implementation plan. The plan, currently being drafted by over 100 experts worldwide, will be presented before an Extraordinary Congress of the World Meteorological Organization (WMO) in October 2012; it will guide the activities of the GFCS in the years ahead. Case studies provided by WMO Members will be collected into a single document and distributed at the October 2012 Extraordinary Congress as well.

The Climate Services Partnership will distribute case studies through an online knowledge capture portal. In making case studies available to the broader community, the CSP hopes to offer perspective on approaches that can be adopted or adapted by other interested parties.

Though each case study will of course be unique, authors should attempt to answer as many of the question posed by the case study guidelines as possible. Questions, comments, or suggestions should be directed to:

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Global Framework for Climate Services
WMO
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Climate Services Partnership
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GFCS/CSP Case Study Guidelines

Please describe your climate service activity in the following terms.

a. WHAT?

i. Briefly describe the service being provided. What socioeconomic issue/problem does your project/service address? What audience does it target?

ii. Briefly describe the climate and contextual information that is incorporated into service.

- What kinds of climate information are used? What are the sources of this information (National Meteorological Service/other)? How is information accessed (including, for instance, format, cost)?
- Is information regarding socioeconomic factors a part of the service? If so, what is the source of this information and how is it accessed?
- Is the information tailored to specific users? Who is responsible for tailoring information (user/provider/ joint team)?
- How is climate information used in decision making?

b. HOW?

i. Processes & mechanisms

1. ***Stakeholder identification***: Who are the stakeholders involved in the process and how were they identified? How did the group decide to focus on this issue? Who was involved in making this decision?
2. ***Stakeholder involvement***: Please describe the full chain or network associated with your activity and any mechanisms to facilitate the dissemination of information. Who do you give information or advice to? Who gives information or advice to you? Describe the channels used to access climate information products and services.
3. ***Funding mechanisms***: Briefly describe the program's business model. Is the program supported by donor, government, or private sector funding, or by some combination thereof? Are their challenges to financial sustainability? Is it possible to upscale this project? What investments have been made in infrastructure?
4. ***Implementation***: Does the service involve one or more institutions? If more than one institution is involved, what are their roles in the management of the project? How are decisions made?
5. ***Evaluation***: Is there a process by which the project/service is evaluated? Are there mechanisms to understand the value of the decisions informed by the service? Are there processes for soliciting user feedback and adjusting the

service in response? Are their concrete examples of this activity facilitating adaptation to climate change?

ii. Capacities

1. ***Present***: What human, infrastructural, institutional and procedural capacities were necessary to build your service? Please describe the level of climate expertise in user organizations and the extent to which these organizations rely on external support for interpretation of information.
2. ***Lacking***: What capacities were lacking and how were they overcome (for instance, joint projects, interchange of personnel, etc.)?
   i. Describe a challenge you faced in matching information products or services available to needs.
   ii. Describe any innovations that were put in place to meet needs.

c. WHAT NEXT?

i. What are goals for the future of the project/service?
ii. Could your program be scaled up? Could lessons learned be transferred to other sectors and/or locations? What did and did not work?
iii. What are the main challenges moving forward?

d. PRINCIPLES of the GFCS:

Authors are also encouraged to indicate which, if any, of the Principles of the Global Framework on Climate Services (listed below) are reflected in their service and how they have been included. More on the background, history and ongoing activities of the GFCS can be found under www.wmo.int/gfcs.

Principle 1: All countries will benefit, but priority shall go to building the capacity of climate-vulnerable developing countries.
Principle 2: The primary goal of the Framework will be to ensure greater availability of, access to, and use of climate services for all countries.
Principle 3: Framework activities will address three geographic domains; global, regional and national
Principle 4: Operational climate services will be the core element of the Framework.
Principle 5: Climate information is primarily an international public good provided by governments, which will have a central role in its management through the Framework.
Principle 6: The Framework will promote the free and open exchange of climate-relevant observational data while respecting national and international data policies.
Principle 7: The role of the Framework will be to facilitate and strengthen, not to duplicate.

Principle 8: The Framework will be built through user – provider partnerships that include all stakeholders.

Appendix 2: Complete list of case studies included in the analysis

Table 1A here

Appendix 3: A typical service in agriculture?

Our perspective regarding a "typical" climate service is based on a tabulation of the most common characteristics across a number of different categories. In this sense, it does not mean that a majority of the cases in the collection describe national-level agriculutural climate services that provide users with seasonal information over the web. On the other hand, it is not difficult to identify cases within the collection whose services match this archetype exactly. Two examples are included below:

In Ethiopia, the National Meteorological Agency uses the Enhancing National Climate Services (ENACTS) initiative to integrate local observations and global monitoring data, and provides information to agricultural and other users, through online map rooms (Dinku & Sharoof, 2012).

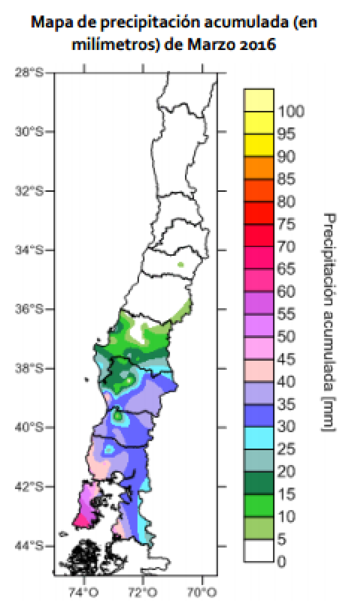

Figura 2. Mapa de precipitación acumulada durante marzo de 2016 entre las Regiones de Coquimbo y Los Lagos. En el lado derecho se muestra la escala de colores con los valores en milímetros. Datos: RED AGROCLIMA-

The Agroclimate Outlook is a monthly bulletin produced by the Dirreción Meteorológica de Chile (DMC) and freely available in the organization's website. It contains information about the predicted seasonal climate conditions that are most likely to prevail during the next three months (Quintana, Piuzzi & Carrasco, 2012).

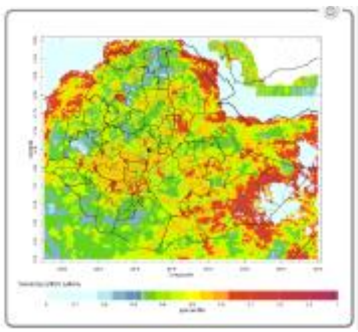

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Table 1: Factors and key questions address by the study

Factors that define the success of climate services	Key questions addressed by the studies
Problem identification, decision-making context	∗ Where are climate services provided? ∗ What sectors do climate services engage? ∗ What kinds of services are implemented where? ∗ Do climate services engage specific users? ∗ What user organizations do services engage?
Characteristics, tailoring and dissemination of the climate information	∗ What is the timescale of information provided? ∗ Do climate services measure/report the quality of information? ∗ Do climate services solicit user input on the design of services? ∗ How is information communicated to users?
Governance, process and structure of the service	∗ On what scale is the service provided? ∗ Who's involved in the service provision? ∗ How do climate services connect to users? ∗ How are climate services funded?
Socioeconomic value of the service	∗ What evaluation methods are used? ∗ Do studies provide a metric of the economic impact of the service in question?

Table 2: Regional focus of case studies

WMO Region	Number of Studies	Number of WMO Member States	Relative representation
Africa (I)	26	53	49%
Asia (II)	28	35	80%

South America (III)	8	12	67%
North America, Central America, Caribbean (IV)	11	20	55%
South-West Pacific (V)	7	19	37%
Europe (VI)	20	49	41%
Global	9	-	-

Table 3: Thematic focus of case studies

Thematic focus	Number of studies
Capacity development	24
Agriculture	24
Water	15
Disasters	13
Health	9
Communities	8
Energy	7
Information products	6
Ecosystems	6
Urban issues	5
Transport & infrastructure	4
Data access	4
Financial services	1

Figure 1: Regional vs. thematic focus of case studies

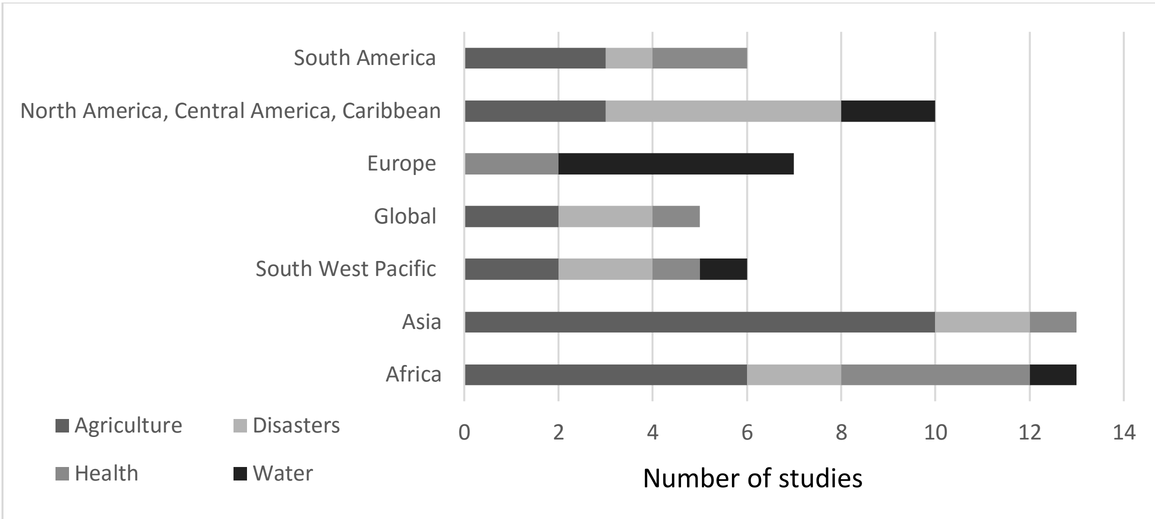

Table 4: User types mentioned in case studies

User type	Number of studies
Government	36
Humanitarian organization	17
Private companies	14
Researchers	10

Timescale	Definition	Number of studies
Seasonal	three to six months	56
Weather	one day to two weeks in the future	25
Long-term	several decades to centuries in the future	23
Historical	past observations	10
Monitoring	current conditions	7
Decadal	one year to several decades in the future	5

Table 6: Methods for the provision of climate information

Provision method	Number of studies
Website	61
Text/email	13
Meeting	10
Report	8
Workshop/training	5
Bulletin/newsletter	3
Twitter/Facebook	2
Technical paper	1

Table 7: Geographic scale of the service

Geographic scale	Number of studies
National	39
Regional	23
Subnational	18
Global	7

Table 1A:

Title&	First&uthor	&Organization&
Climate(services(and(agriculture(in(the(Caribbean	Adrian(Trotman	Caribbean(Institute(for(Meteorology(&(Hydrology(
Reducing(crop(loss(through(Climate(Field(School(@@he(Indonesia(Experience	AE(Sakya	Indonesian(Agency(for(Meteorology,(Climatology,(and(Geophysics
Provision(of(climate(services(in(Tanzania	Agnes(Kijazi	Tanzania(Meteorological(Agency
Climate(change(adaptation:(when(there(is(a(will,(there(is(a(rail(way!	Alexander(Vetich(	International(Union(of(Railways
When(world's(collide:(urbanization,(climate(change,(and(disasters	Allen(L(Clark	Pacific(Disaster(Center,(USA
New(Zealand's(climate(change(and(urban(impacts(toolbox	Andrew(Tait	National(Institute(of(Water((and(Atmospheric(Research
Engaging(users(in(the(production(and(delivery(of(information(in(Africa	Anna(Steynor	University(of(Capetown
Climate(information(for(disaster(management(and(decision(making:(the(IRI@FRC(partnership	Ashley(Curtis	International(Research(Institute(for(Climate(&(Society(
Extreme(precipitation(event:(the(Weather(Public(Alert(System(of(the(Chilean(Weather(Service	Benjamin(Caceres	Direccion(Meteorologica(de(Chile(
Early(warning(systems(for(food(security(in(Eastern(Africa:(Linking(the(Food(Security(Outlook(with(the(Climate(Outlook(Forum	Carlo(Scaramella	World(Food(Programme(
Building(the(capacity(of(smallholder(rice(farmers(under(a(changing(climate(in(Nigeria	Catherine(Nnamani	Research(Group(for(Climate(Change(Adaptation(in(Nigeria(
Building(the(seasonal(streamflow(forecasting(service	Claire(Hawksworth	Australian(Bureau(of(Meteorology(
Climate(education(for(the(public(health(sector	Cynthia(Thomson	IRI;(Mailman(School(of(Public(Health(
Communicating(climate(variabilty:(La(Nina(Drought(Tracker	Daniel(Ferguson	University(of(Arizona(
The(Climate(Change(Mitigation(and(Adaptation(International(Training(Programme	Daniel(Homestedt	Swedish(Meteorological(and(Hydrological(Institute(
Climate(services(and(disaster(risk(reduction(in(the(Caribbean	David(Farrell	Caribbean(Institute(for(Meteorology(&(Hydrology(
Indigenous(stories(and(climate(services	David(Griggs	Monash(Sustainability(Inistitute;(Yorta(Yorta(Nation
Low(Carbon(Growth(Plan(for(Australia:(providing(climate(services(to(businesses	David(Griggs	Climate(Works(Australia
User@entered(design(approach(to(the(seasonal(climate(outlook	Elizabeth(Boulton	Climate(Information(Services,(Australian(Bureau(of(Meteorology(
Making(climate(science(useful:(cross@egional(learning(from(Kenya(and(Senegal	Emma(Visman	King's(College(
Understanding(climatic(processes(on(Earth:(the(invaluable(contribution(of(satellites	European(Space(Agency	European(Space(Agency
Devils(Lake(Decision(Support(System:(Using(climate(information(to(manage(flood(risk	Fiona(Horsfall	National(Oceanic(&(Atmospheric(Administration(
Climate(services(for(agricultural(production(in(Guinea(Bissau	Francisco(Gomes	National(Institute(of(Meteorology,(Guinea(Bissau
MOSAICC:(an(interdisiplinary(system(of(models(to(evaluate(the(impact(of(climate(change(on(agriculture	Francois(Delobel	Food(and(Agricultural(Organization(
Data(sharing(and(collaboration:(Regional(and(National(Climate(Outlook(Forums(in(South(America(	Gabriella(della(Croce	International(Center(for(Research(on(the(El(Nino(Phenomenon(
Climate(information(for(public(health:(Filling(knowledge(gaps(and(building(connections(	Gilma(Mantilla	International(Research(Institute(for(Climate(&(Society(
Adaptation(to(climate(change(in(the(mountain(forest(ecosystems(of(Armenia	Government(of(Republic(of(Armenia	Government(of(the(Republic(of(Armenia
Climate(information(applications(in(famine(early(warning(and(decision(making(systems	Greg(Husak	Climate(Hazards(Group
Applying(science(to(society:(the(Climate(Service(Center	Guy(Brasseur	Climate(Service(Center,(Germany
An(integrated(climate(service(for(the(river(basin(and(coastal(management(of(Germany:KLIWAS(	H(Moser	Federal(Institute(of(Hydrology,(Germany(
Climate(services(in(Hong(Kong:(accomplished(through(partnership(and(outreach(	Hilda(Lam	Hong(Kong(Observatory
Climate(Services(Across(Borders	ICA&D(Team	KNMI
The(Danube(River(Basin(climate(adaptation(strategy	ICPDR	International(Commission(for(the(Protection(of(the(Danube(River(
Short@erm(weather(forecasting(for(disaster(preparedness(in(Venezuela	Ingrid(Garcia	Center(for(Scientific(Modeling
The(use(of(seasonal(climate(forecasts(to(inform(decision(making(and(management(in(the(renewable(energy(sector(of(Samoa	JA(Smith	Australian(Bureau(of(Meterology,(Samoa(Met(service,(Electric(Power(Company,(AusAID
Developing(the(capacity(of(Central(Asian(national(planning(agencies(to(model(climate(impact(scenarios(and(develop(adaptation(strategies(	Jaako(Nuottokari	Finnish(Meteorological(Institute(
Climate(change(impacts(on(Indonesian(fisheries	Jason(Lumban(Goal(	Bogor(University,(Instiute(of(Fisheries(and(Marine(Affairs(for(Research(and(development,(National(Institute(of(Aeronautics(and(Space
Building(resilience(to(future(climate(change(in(ports:(Terminal(Maritimo(Muelles(el(Bosque(in(Colombia	Jean(Cristophe(Amado	Acclimatise
ENACTS(Ethiopia:(partnerships(for(improving(climate(data(availability,(accessibility,(and(utility	Jessica(Sharoff	Ethiopia(Met(Department;(University(of(Reading;(University(of(East(Anglia
R4(Rural(Resilience(Initiative(in(Ethiopia	Jessica(Sharoff	International(Research(Institute(for(Climate(&(Society(
Multinational(efforts(to(produce(regional(climate(prediction(for(informed(decision@making	Jin(Ho(Yoo	Asia@acific(Economic(Cooperation(Climate(Center
Climate(change(impact(of(Indonesian(fisheries(	Jonson(Lumban(Gaol	Bogor(Agricultural(University(
The(use(of(a(seasonal(fire(early(warning(tool(for(managing(peat(fires(in(Indonesia(	Joyce(Wong	International(Research(Institute(for(Climate(&(Society(
Seasonal(climate(prediction(in(Chile:(the(Agroclimate(Outlook	Juan(Quintana	Direccion(Meteorologica(de(Chile(
Making(climate(change(information(available(online	Juha(Karhu(	Climate(Service(Center,(Finnish(Meteorological(Institute;(Finnish(Enviromental(Institute;(Aalto(University
Desert(Locust(Information(Service(	Keith(Cressman	Food(and(Agricultural(Organization(
IBTrACS:(A(collaborative(effort(to(consolidate(tropical(cyclone(best(track(data(worldwide	Kenneth(Knapp	World(Data(Center(for(Meteorology(

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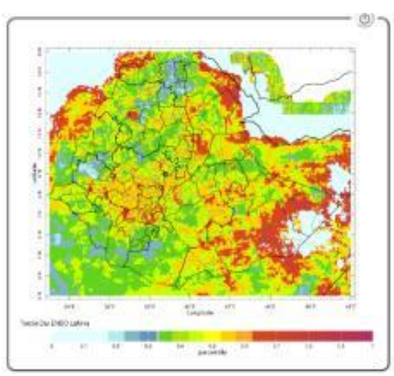
Climate variability and change: perceptions, experiences, and realities	KPC Rao	ICRISAT, KMD
Climate variability and change: perceptions, experiences, and realities	KPC Rao	International Crops Research Institute for Semi-Arid Tropics
Identifying climate impact on the incidence of meningitis epidemics	Laurence Cibrelus	World Health Organization
Developing climate services: the role of the energy sector	Laurent Dubus	EDF
Development of climate services in Sweden to support climate change adaptation	Lena Lindstrom	Swedish Meteorological and Hydrological Institute
Health Risk Management in a Changing Climate: Using climate information to help manage malaria and diarrheal disease in TZ	Lindsay Bouton	Tanzania Red Cross Society
Atmospheric Climate Information for Urban Planning: Beijing Municipal Climate Center	Linwei Liu	Beijing Climate Center, CMA
Strengthening hydromet services in Mozambique	Louise Cronenberg	World Bank
Delivering advisory services by mobile phone	LS Rathore	Indian Meteorological Department
Reaching farming communities in India through the Farmer Awareness Programmes	LS Rathore	Indian Meteorological Department
Identifying local climate impacts on weather and water: LCAT	Marina Timofeyeva	National Oceanic and Atmospheric Administration
Insurance against drought and destabilization of energy costs in Uruguay	Mario Bidegain	Direccion Nacional de Meteorologia, Uruguay
Seasonal to decadal climate forecasts for renewable energy: connecting to users through the ARECS initiative	Mel Davis	IC3
Global Drought Monitoring Portal	Michael Brewer	National Oceanic & Atmospheric Administration
Enhancing coppoeration in climate services through the sub-regional virtual climate change centre	Milan Dacic	Republic Hydrometeorological Service of Serbia
Forecasting for disaster: Climate help desk for humanitarian action and decision making in Africa	Mohammed Kadi	African Center for Meteorological Applications for Development
Climate information and development: regional climate outlook forums in Africa	Mohammed Kadi	African Center for Meteorological Applications for Development
Climate Information in support of the health sector: Madagascar	Nirivololona Raholijao	Madagascar Directorate General of Meteorology
Building a scientific basis for climate change adaptation -- the research program on climate change adaptation	Nobuo Mimura	Ibaraki University, University of Tsukuba, Waseda University, Remote Sensing Technology Center of Japan
Climate information services for herder families in Mongolia	NWHS, Mongolia	National Weather and Hydrological Service, Mongollia
The developmetn of climate scenario fact sheets for engineers or instrastructure relevant climate indicators	Ouranos	Ouranos
Creating an atlas of climate scenarios for forest management in Quebec	Ouranos	Ouranos
Climate local information in the Mediterranean region: responding to users needs	Paolo Ruti	Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA); Energy, Environment and Water Research Center; National Center for Meteorological Research (France); International Centre for Theoretical Physics; Catalan Institute of Climate Sciences National Observatory of Athens (NOA); Centro Euro-Mediterraneo; TEC Services Consulting; Plan Blue; Potsdam Institute for Climate Impact Research; University of East Anglia; GREVACHOT; Joint Research Center; Meteorological and Hydrological Service of Croatia; University System of Maryland; University of California
Climate outlooks for food security in Central America	Patricia Ramirez	Regional Committee for Hydraulic Resources, Central America
Mainstreaming climate information for agricultural activities in Kenya	Peter Ambenje	Kenya Meteorological Department
Seasonal forecasting for Africa: water, health management, and capacity building	Philipe Dandin	Météo-France
Partnerships on water resources management in France	Phillipe Dandin	Meteo-France
Drias, the futures of climate: a service for the benefits of adaptation	Phillipe Dandin	Meteo France, CERFACS, CNRS
Data rescue: a necessary look at climate	Phillipe Dandin	MeteoFrance
Building resilience to climate-related hazards	PPCR	Ministry of Environment, Science, and Technology's department of Hydrology and Meteorology (Nepal); Civil Aviation Meteorology Authority, Yemen Meteorological Service (CAMA/YMS)
Climate information services for food and agriculture	Ramaswamy Selvaraju	Food and Agricultural Organization
Preparing for ENSO events in the Pacific	Rebecca McNaught	International Federation of the Red Cross & Red Crescent Societies
Teaching journalists to understand climate change	Reija Ruuhela	Finnish Meteorological Institute
North American Drought Monitor	Richard Heim	National Oceanic & Atmospheric Administration
Supporting decision making in the sugar industry with integrated seasonal climate forecasting	Roger C. Stone	University of Southern Queensland
Governing drought information systems	Roger Pulwarty	National Oceanic & Atmospheric Administration
The Heat Health Warning Systems as an Example of Climate Services at the Deutscher Wetterdienst	S. Rosner	Deutscher Wetterdienst
Drought & precipitation monitoring in the Caribbean	Sari Blakely	Caribbean Institute for Meteorology & Hydrology
Innovative approaches to engaging communities in participatory dialogues that enhance community disaster preparedness	Selina Maenzanise	American Red Cross
Climate science and services to support decision making	Seok Joon Cho	Korean Meteorological Administration
The Chilean Ultraviolet Radiation Network: Monitoring and forecasting the UV index for health protection	Solangela Sánchez Cuevas	Dirección Meteorológica de Chile
Climate services for large engineering projects in China	Song Lianchun	China Meteorological Agency
Improved livelihoods and building resilience in the semi-arid tropics: science-led, knowledge-based watershed management	Suhas P Wani	International Crops Research Institute for Semi-Arid Tropics
ENACTS Ethiopia: Partnerships for improving climate data availability, accessibility, and Utility	Tufa Dinku	International Research Institute for Climate & Society

Box 1: A typical service

Our perspective regarding a "typical" climate service is based on a tabulation of the most common characteristics across a number of different categories. In this sense, it does not mean that a majority of the cases in the collection describe national-level agricultural climate services that provide users with seasonal information over the web. On the other hand, it is not difficult to identify cases within the collection whose services match this archetype exactly.

Two examples are included below:

In Ethiopia, the National Meteorological Agency uses the Enhancing National Climate Services (ENACTS) initiative to integrate local observations and global monitoring data, and provides information to agricultural and other users, through online map rooms (Dinku & Sharoff, 2012). This map shows the historical probability of seasonal average monthly rainfall occurring in the upper, middle or lower tercile, given the state of the El Niño Southern Oscillation during the same season.



Source: Ethiopia Climate Analysis & Application Maproom: www.ethiometmaprooms.gov.et:8082/maproom/Climatology/Climate_Forecast/ENSO_Prob_Precip.html

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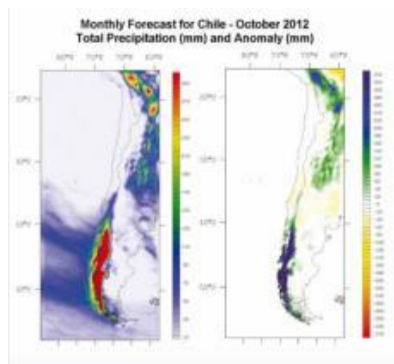
The Agroclimate Outlook is a monthly bulletin produced by the Dirección Meteorológica de Chile (DMC) and freely available in the organization's website. It contains information about the predicted seasonal climate conditions that are most likely to prevail during the next three months (Quintana, Piuzzi, & Carrasco, 2012). This graphic shows a monthly forecast for total and anomaly precipitation in 2012.



Source: Quintana, Piuzzi & Carrasco, 201