



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss



Designing user-driven climate services

What we can learn from the Climandes project:
A checklist for practitioners, scientists and policy makers



When in 2009, at the Third World Climate Conference (WCC-3), governments, scientists and stakeholders, collectively agreed to establish the Global Framework for Climate Services (GFCS) to guide the development of science-based climate services for decision-making, the global community recognized that climate services were critical in managing climate risk and adaptation. WCC-3 also recognized the significant gap between suppliers and users of climate services. Existing climate services were not tailored to user needs, and often did not reach the final user.

The design of the GFCS therefore incorporated an innovative component, the User Interface Platform (UIP), to ensure interaction between users and providers of climate services. Being innovative, the UIP is a new concept not entirely understood and therefore pursued timidly. Emerging examples of user interfaces however prove their importance for effective implementation of climate services.

The example provided by the Climandes project in Peru, reinforces the need for establishing UIPs. Users need information that is relevant to them, is understandable, is communicated through means they have access to, from sources they trust. To fully tap the benefits of climate services, a UIP has to incorporate sectoral expertise and include user guidance through co-development.

While the UIP is critical for the development of products and services, an important element for improving the usefulness of climate information, is capacity development of the providers. Set-up as a twinning project, Climandes demonstrated the benefits of peer-to-peer learning assuring continuous support and coaching.

Thus, the Climandes project provides good lessons on how cooperation can support effective implementation of climate services and on how a UIP enables user-centric climate services. I am pleased to see the benefits of establishing a UIP in Peru and wish to congratulate the national meteorological services in Peru (Senamhi) and Switzerland (MeteoSwiss) for not hesitating in pioneering this effort.

A global vision for local impacts

Climate services provide a decision aid for governments, organizations and individuals derived from information about the past, current and future climate. Enhanced access to weather and climate information is a critical component for reducing climate risks and increasing the resilience and societal preparedness to climate variability and change. This is especially true for developing countries and countries with emerging economies where adaptation options are limited. In this way, climate services contribute to the pursuit of global development agendas.

Implementing the global agenda at the local level

Climate change constitutes a substantial challenge for developing countries and countries with emerging economies due to their often limited adaptation capacities. People and regions that are socially or economically marginalized are particularly at risk as climate-related hazards will further exacerbate their already constrained livelihoods¹. In the coming decades, climate change is expected to amplify existing climate risks and create new ones for society.

In 2015, the international community set new global targets for the period 2015–2030 for disaster risk reduction (Sendai Framework), climate change mitigation and adaptation (Paris Agreement) and sustainable development (Agenda 2030). Climate services support the achievement of these three global agendas. For the Sendai Framework, weather and climate predictions on a broad range of spatial and temporal scales are a fundamental element of multi-hazard early-warning systems, which in turn are the key to enabling proper disaster preparedness to safeguard lives and livelihoods. Under the Paris Agreement, improved communication of scientific information on climate variability, trends and extremes contributes to climate risk assessments and supports the promoted National Adaptation Plans (NAPs). Finally, the majority of the 17 sustainable development goals (SDGs) are climate-sensitive, which renders climate services critical for achieving these goals.

Well aware of this cross-cutting importance of climate, the third World Climate Conference in 2009 decided to launch the Global Framework for Climate Services (GFCS) with the aim to improve availability, quality and access to climate services to better deal with climate-related risks. The GFCS recognized that developing countries and countries with emerging economies are often lacking even basic weather and climate information and, therefore, are given a high priority in the implementation of the Framework.

In 2012, the Swiss Agency for Development and Cooperation (SDC) launched Climandes (Servicios climáticos para el desarrollo) under the Global Program Climate Change and Environment as one of the first GFCS pilot projects. This cooperation project between the Peruvian National Meteorological and Hydrological Service Senamhi and the Swiss Federal Office of Meteorology and Climatology MeteoSwiss aimed at developing and providing climate services tailored to the agricultural sector of the Andean highlands with emphasis on food security and subsistence farming. As such, Climandes can be considered an innovative example of how to transform the GFCS into practical solutions at the local level and hence improve the resilience of agricultural communities in the Peruvian Andes.

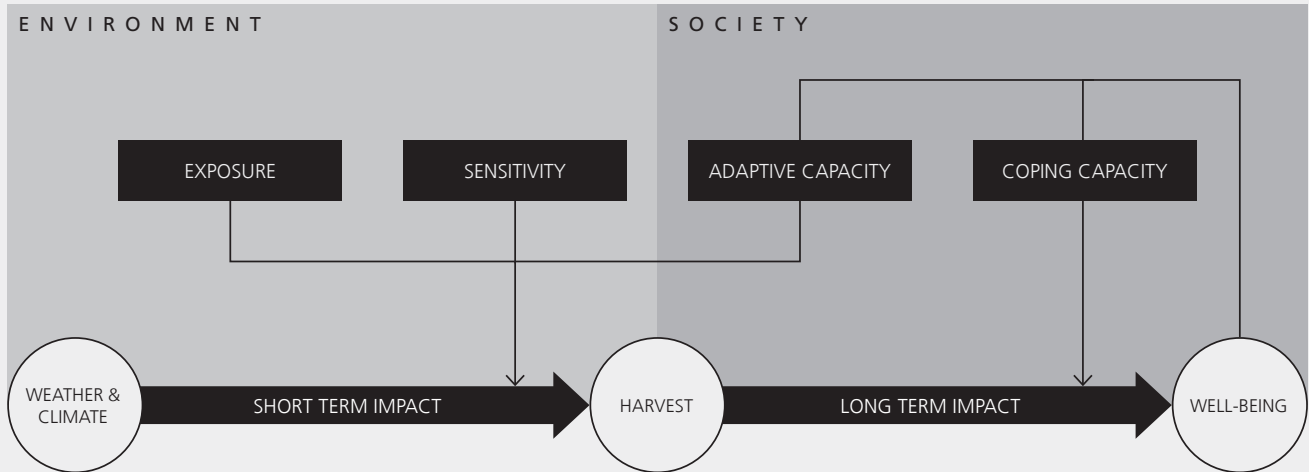
The importance of small-scale agriculture and enhanced access to weather and climate information

In Latin America, Sub-Saharan Africa or East and South Asia, small-scale farmers provide almost three quarters of food calories, hence playing an essential role in sustaining food security, jobs and income in rural areas of developing countries and countries with emerging economies². However, small-

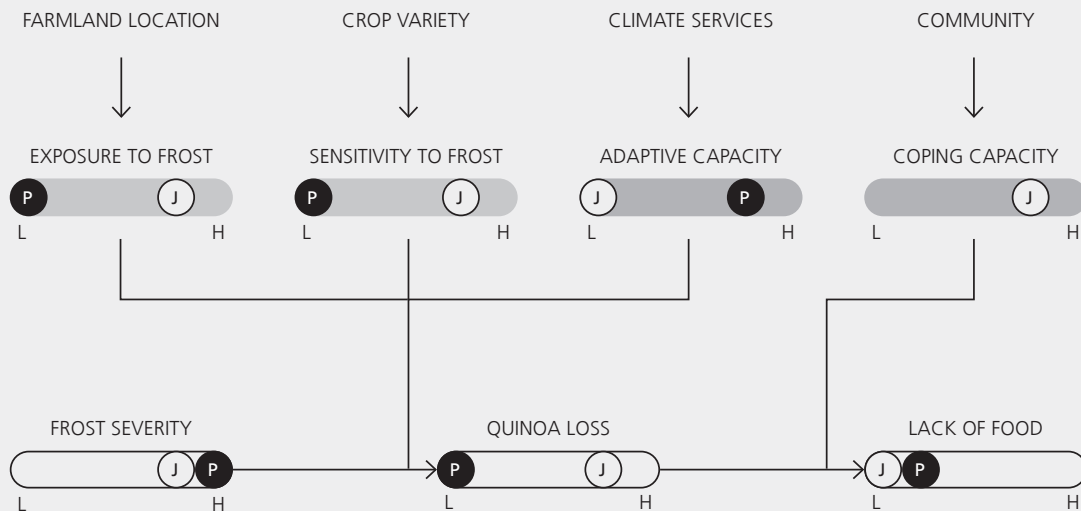


The underlying concept of socio-economic vulnerability to weather and climate events

Socio-economic vulnerability towards climate-related hazards is composed of an environmental and societal dimension. The environmental dimension refers to the magnitude of the weather and climate event, how often someone is hit (exposure) and how sensitive he or she is towards it (sensitivity). The societal dimension refers to the ability of a specific population to prepare for an up-coming event (ex-ante adaptive capacity) and to overcome the associated impacts (ex-post coping capacities). For small-scale farming, weather and climate events may translate into short term impacts on harvest and often into long-term impacts on well-being by endangering their livelihoods.



EXAMPLE - FROST



Ⓜ Juan Ⓟ Pablo L low H high

Why do Juan and Pablo experience different quinoa losses from the same frost event?

Juan's farmland lies in a shallow basin where a pool of cold air forms during the night (higher exposure to frost). Due to better yields, he uses a more productive but less frost-resistant crop variety (higher sensitivity). Furthermore, he lives in a remote area that has no radio signal. Therefore, he does not receive the frost warning from a local radio station and cannot trigger corresponding protective measures (low adaptive capacity). During a heavy frost night in February, Juan loses almost half of his quinoa production.

Pablo lives in the same community as Juan, but his farmland lies on the slope (lower exposure to frost). Julissa, a friend of Pablo is working at an agricultural research institute and is developing new frost-resistance quinoa varieties that are less pro-

ductive but more robust to frost (lower sensitivity to frost). Julissa regularly receives weather and climate information from the Peruvian meteorological service Senamhi. Due to her agronomic background, she is able to overlay this piece of information with her agronomic knowledge and the state of the growing season. She then provides tailored agricultural advice to local communities and individual farmers (climate service). Based on this information, Pablo protects his cultures in accordance with the expected conditions (high adaptive capacity). During the frosty night in February, Pablo suffers no quinoa loss. Luckily, Pablo is sharing a part of his quinoa harvest with other community members like Juan who would otherwise lack food (coping capacity).

holder farming is frequently exposed to socio-economic, cultural and environmental risk factors that affect the production system. In 2016, El Niño-driven weather patterns and political instability caused an intensification of global food insecurity³. An analysis of the 2016 El Niño event, which affected more than 60 million people worldwide, revealed that a major part of the exposed population was uninformed and unprepared for the pronounced climate anomalies⁴. Tailored communication of weather and climate information is critical to reducing the impact of agro-climate hazards by enabling proactive action to reduce yield losses. Although information on adverse events is available, too often it is not known, accessible or understood by large user groups, particularly smallholder farmers in remote rural areas⁵.

Climate services that are co-developed with and tailored for specific users or user groups are not well anchored at the institutional level of many meteorological services, especially in developing countries and countries with emerging economies. To address these shortcomings and following the GFCS guidelines, the Climandes project developed a prototype of a User Interface Platform (UIP) designed to enable a strong engagement with key stakeholders. These encompass the information providers, intermediary users such as sectoral experts and representatives as well as local communities and small-scale farmers.

Impacts of climate-induced disasters and the crucial role of poverty

To plan an intervention that aims at strengthening climate resilience, it is paramount to understand the target populations' vulnerabilities. Socio-economic vulnerability towards climate-related hazards is a combination of the magnitude of the weather and climate event, the exposure and sensitivity of people and assets to this event, as well as the adaptive and coping capacity of a specific population → P.6. In the case of small-scale farming, extreme weather and climate events translate into immediate short-term impacts such as crop losses, depending on exposure, sensitivity and adaptive capacity. For subsistence farmers, significant crop failures additionally imply long-term consequences, typically including strained livelihoods and increased food insecurity. These consequences can be explained by a combination of the farmers' large dependence on home-grown food and insufficient capacity to recover from external shocks due to the absence of savings as well as other social and financial protection. As a result, a single event can push vulnerable people into poverty, a status which is likely to keep them locked into poverty traps and thus thwart years of improved welfare. In the context of disaster risk management and adaptation planning, the nexus of poverty and vulnerability has recently gained much attention⁶. The Climandes project paid particular attention to this nexus by evaluating the smallholders' ability to manage climate-induced crop failures depending on their individual wellbeing. This information helps to better anticipate the social effects of the implementation in order to make climate services more inclusive⁷.

Disaster risk reduction measures can be triggered at various points to mitigate the impacts of weather and climate events

The exposure and sensitivity to adverse weather and climate events can be reduced, for example by properly choosing the location of land to be farmed and using robust crop varieties respectively. Climate services such as early warnings allow farmers to trigger preventive measures (adaptive capacity). Additionally, an improved ability to recover from disasters can reduce the negative long-term impacts of events on the farmer's livelihood and welfare (coping capacity). Such recovery mechanisms include the enhancement of access to social and financial protection mechanisms like crop insurance, safety nets, savings and governmental aid.

Objectives of this publication

This publication assembles the practical experiences of project Climandes. It outlines the project's approach and reports key findings and lessons learnt, with a particular focus on user participation. The publication is meant to provide examples of 'best practices', providing guidance for similar initiatives in developing countries and countries with emerging economies. It is not intended to be a comprehensive manual, but rather a systematic description of essential steps that appeared to be indispensable for the implementation of effective and sustainable climate services tailored to user needs.

The publication is organized as follows: first, we describe the context for the implementation of Climandes and the project's approach; the following two sections present key results and insights from the project and illustrate applied research activities; we conclude with a discussion of our main findings and recommendations for practical applications.

A two-stage approach for evidence-based action

To be effective, the design of climate services requires the active involvement of people and communities. To make sure their voices are heard and climate services are relevant to their needs, we propose a two-stage approach for a pilot User Interface Platform implementation. The first stage provides robust evidence required to plan the intervention. The second stage involves a series of climate field workshops accompanied by monitoring and evaluation activities.

Climate service implementation is a multidisciplinary effort

In 2014 the GFCS stated that user dialogue and feedback is only just beginning and that gaps therein were impeding the process of moving from data to decisions. The GFCS introduced an innovative concept – the User Interface Platform (UIP) – and encourages the development of UIP models that are not overly sector-specific, but instead identify and clearly articulate the common aspects of a UIP that make it sufficiently flexible to meet the needs of a wide range of climate-sensitive sectors. On the other hand, the GFCS recognized that, even though the geographical scope of the UIP is targeted to the global, regional, and national levels, possibly with multi-sectorial reach, actual implementation actions take place at the local level and often focus on a specific sector. There is an evident need to reconcile the scale gap between ‘changing the world at once’ and ‘helping individuals’. This scale gap is exemplified in many regions where existing weather and climate information exist, but do not cover the ‘last mile’ to reach remote rural communities who are most in need of such information. All these issues make the design and implementation of climate services a very complex, inherently multidisciplinary challenge that involves a variety of stakeholders ranging from an individual smallholder farmer to national governmental institutions. It combines expertise from natural and social sciences as well as traditional knowledge in order to understand the decision-making processes of the users.

While the GFCS proposed guidelines to setup a UIP to address these challenges⁸, the specific activities of such a platform are not well defined or specified in any implementation-ready manner. In fact, a review of the GFCS recently concluded that ‘the purpose and functioning of a UIP is not well understood by many climate service producers and users’⁹. We responded to this inherent difficulty by setting up a pilot GFCS UIP in a way that reflected the needs of targeted groups, allowed regular interaction and training, built trust in the climate service provider and motivated users to engage in a monitoring and evaluation activity. In a nutshell, we found that a significant user engagement is a key element for implementing climate services and reaping their benefits.

The Climandes two-stage approach of a GFCS pilot User Interface Platform

In our quest to ensure that all relevant voices are heard and climate services respond to their needs, we implemented the pilot UIP in a structured two-stage approach → p.10. The approach was set up to promote a close user engagement from the very beginning of the project that helped to design climate services that are in line with the users’ demands. We conceived the first stage to provide the robust evidence necessary to plan subsequent interventions. In the second stage, we implemented climate field workshops to facilitate interaction with climate service end-users in two rural communities, along with the corresponding monitoring measures to evaluate the intervention’s performance and impact.



The Climandes two-stage approach in the pilot region Puno

We implemented a GFCS pilot User Interface Platform (UIP) using a two-stage approach that is built around evidence-guided action with early involvement of the user community. The applied approach is generic and transferable to other region and climate-sensitive sectors. The intervention took place in Puno, a semi-arid highland area in the southern Andes of Peru where smallholder farmers are especially exposed to the impacts of adverse weather and climate events due to high inter-annual climate variability and weak adaptive and coping capacity.

STAGE I

EVIDENCE FOR ACTION

To gain evidence for the intervention, we conducted a representative survey with 726 small-scale farmers in 15 districts in the Puno region. The investigation aimed at assessing the smallholders' climate vulnerability in terms of exposure, adaptive and coping capacities, as well as the current use of and prevailing barriers to weather and climate information.

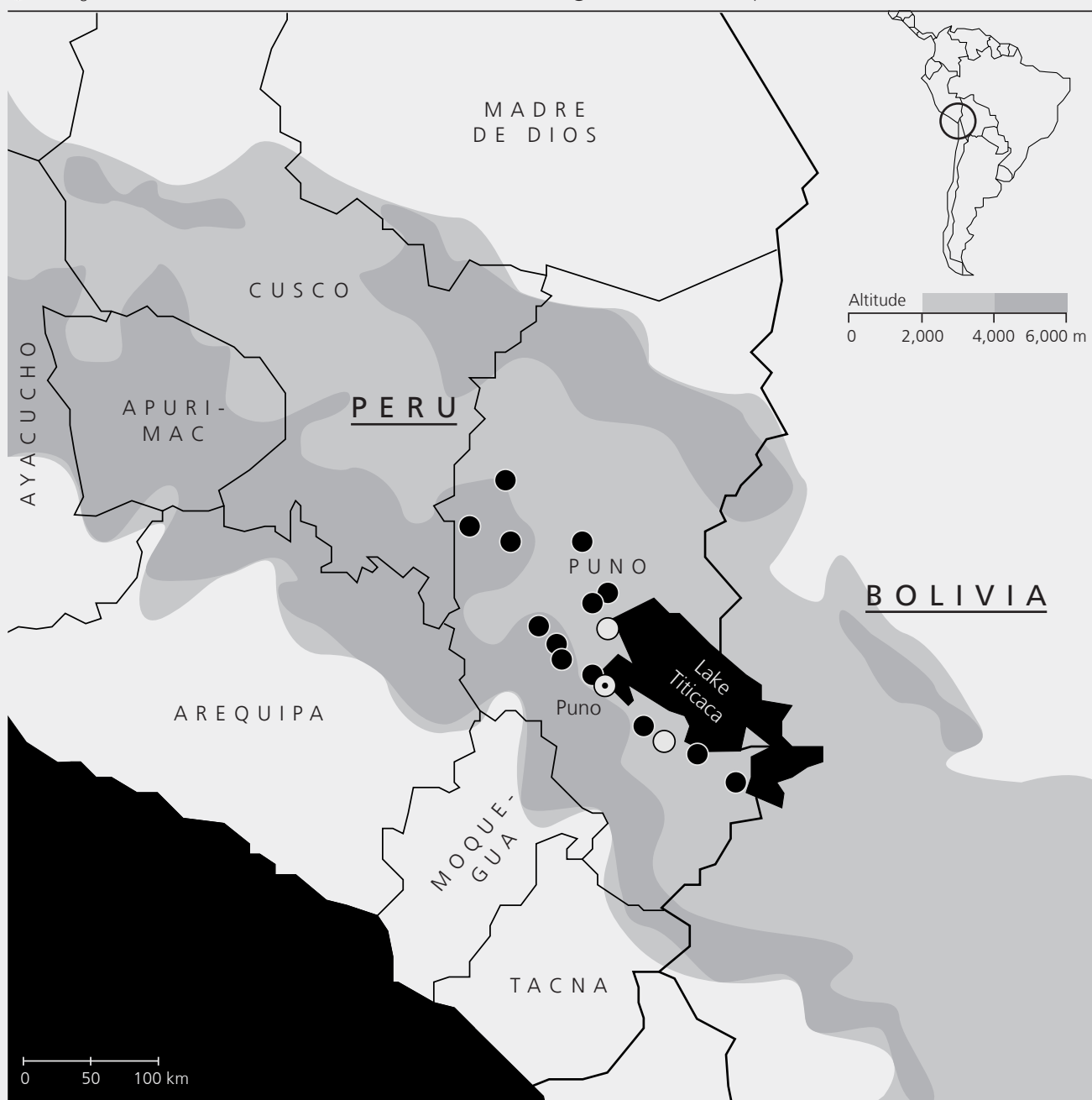
STAGE II

TRANSLATING EVIDENCE INTO PRACTICE

The intervention consisted of a series of monthly climate field workshops in the two agrarian communities Churo López (Aymara community) and Ccamara (Quechua community) during the growing season 2017/18. The workshops aimed at establishing a continuous feedback mechanism, sensitizing farmers about the use of weather and climate information, overcoming key factors limiting their use and evaluating the impact of the project.

● Investigated district

○ Climate field workshop



The first stage involved a mapping of stakeholders, aimed at identifying all relevant actors, integrating sectoral expertise and building strategic alliances. We further carried out a comprehensive assessment of vulnerability to climate-induced hazards through a household survey including a representative sample of more than 700 small-scale farmers (< 10 ha) covering a total of 60 peasant communities in 15 districts in the northern (Quechua) and southern (Aymara) regions of Puno → P. 10, MAP. The survey aimed at assessing the end-users' characteristics, knowing their major climate-related problems for agricultural production, evaluating their decision-processes and eliciting their needs for weather and climate information. Based on this data, we then estimated the potential economic value of improved access to information. Communicating potential socio-economic benefits in monetary terms to policy makers is expected to raise their awareness and foster sufficient and sustainable public investment in climate services. Finally, we identified major barriers to the utilization of weather and climate information among end-users.

The second stage of the intervention translated the previously generated evidence into practice. We paid particular attention to the development of a user-tailored service focusing on targeted communication and user involvement through the setup of a community outreach strategy (climate field workshops). These workshops were geared to facilitate effective uptake of the information provided, as well as to build trust among users on the weather and climate information offered. Workshops were designed as a pilot intervention to evaluate the potential for scaling-up effective user-driven climate services in the future.

The workshops were built on the UIP guidelines proposed by the GFCS⁸. These guidelines include (1) the setting up of a mechanism to receive feedback from the user community, (2) building a continuous dialogue between users and providers of climate service, (3) improving the climate literacy of the user community and (4) developing evaluation and monitoring tools to measure whether the implementation delivers the expected results.

Characteristics of the implementation context and target population

The pilot implementation took place in Puno, one of the two pilot regions of the project. Puno is located in the southern highlands of the Peruvian Andes with an average altitude around 4,000 m a.s.l.

Its climate is characterized by dry conditions in the austral winter from May to September and wet summers from October to April, with occasionally occurring frost. El Niño–Southern Oscillation influences both seasonal temperature and precipitation variability. El Niño (La Niña) is related to warmer (cooler) than usual temperatures. El Niño (La Niña) summers are also drier (wetter) than usual, although this relation is less robust^{10,11}. Future climate scenarios predict a decrease in precipitation and a growing risk of drought by the end of the 21st century¹².

Puno has a population of 1.4 Million inhabitants, who account for 5% of Peru's population. Puno is among the four Peruvian regions identified as having a very high level of food insecurity¹³. Although contributing only 15% to the region's GDP, 43% of the economically-active population works in the agricultural sector, with a majority of small-scale subsistence farms¹⁴. Due to the short duration of the growing season (from October to April), the extensive nature and the low technological development of agricultural production systems and climate and soil constraints, agricultural productivity lies well below the national average. More than 96% of the population relies on rain-fed agriculture for their livelihoods, which makes the region especially susceptible to weather and climate conditions.

The main food crops are potatoes, quinoa and broad beans. Livestock farming provides an additional source of income. For quinoa, the demand on international markets has recently risen due to recognition of its nutritional value. For the majority of small-scale farmers in Puno, however, home-grown quinoa is still an essential food source. This crop has been grown for more than 7,000 years, mainly using traditional cultivation methods without pesticides or mineral fertilizers. The cultivation of quinoa, in contrast to many other crops, is well adapted to the harsh climate conditions of the Altiplano. Due to the high importance of quinoa for the local population, it was chosen as a pilot crop for the project implementation.

Evidence for action

The household survey revealed that small-scale farmers in the project region Puno frequently suffer from significant crop failures due to climate-induced hazards, especially frost and drought events. Due to their limited ability to recover from these events, harvest losses directly translate into food security problems. We found a considerable potential for increased utilization of weather and climate information. However, the adoption of this information and integration into decision-making appears to be compromised by a lack of acceptance, accessibility, comprehension and accuracy.

Vulnerability to hazards depends on farmers' socio-economic status

In order to have a meaningful measure for production and yield losses among individual producers that participated in the household survey, we compared farmers' actual harvest with their historical baseline. Our analysis revealed that frost and drought events are the most frequent (exposure) and damaging (sensitivity) natural hazards which was also reflected by the farmers' perception → p. 14, HAZARD.

Farmers were clustered into three income groups based on their possessions. Poorer farmers seem to be more sensitive to crop losses due to natural hazards compared to their better-off counterparts. Unequal distribution of income within a community and exposure to frost negatively impacted relative harvest levels. The use of weather and climate information for production and the number of viable protection measures were positively associated with the actual harvest.

Considering that frost and drought are the two hazard types having the greatest impact, the majority of the study participants stated that they could make good use of early warnings to reduce crop losses by taking preventive measures (adaptive capacity).

Throughout all income classes, the ability of an individual farmer to recover from crop failure (coping capacity) is limited. The largest share of farmers (53%) is forced to reduce their food intake due to lack of savings or stored crops. In the case of financial shortages, farmers switch to strategies that further increase pressure on their already constrained livelihoods: selling of livestock, stored food or other assets (86%) and engagement in casual external work (33%). Formal social and financial protection mechanisms are very limited: 2% of the farmers have crop insurance and 5% have access to bank credits → p. 14, COPING CAPACITIES.

Considering that a large number of the targeted actors practice subsistence farming, using up to two thirds of their production for self-consumption and due to the low coping capacities observed, crop failures directly translate into food shortages. In particular, poor households whose dependence on homegrown food is higher, exhibit significant problems of food insecurity which peaks in January, shortly before the next harvest starts → p. 14, FOOD SHORTAGE.

A frost warning for subsistence quinoa farming potentially values 2.7 million USD for the Puno region

The estimation of the socio-economic benefits of enhanced access to weather and climate information is essential to better understand the likely returns of public investment in climate services, as well as for the purposes of formulating public policies. However, such evaluations are particularly scarce for interventions in developing countries and countries with emerging economies. To address this deficiency, we estimated the value of a frost warning for smallholder farmers in Puno. The estimate is based on a stochastic life-cycle model that builds on the relevant context information from the household survey and simulates a quinoa farmer's production and consumption decisions over a representative farming year. Based on the model, a specific frost warning is estimated to generate an increase of approximately 10% of

3



4



their actual quinoa harvest. Translated into a monetary value and extrapolated to the total cultivated area of quinoa, this leads to a potential increase of 2.7 million USD per year for the Puno region.

Why do farmers not incorporate weather and climate information into their decision-making?

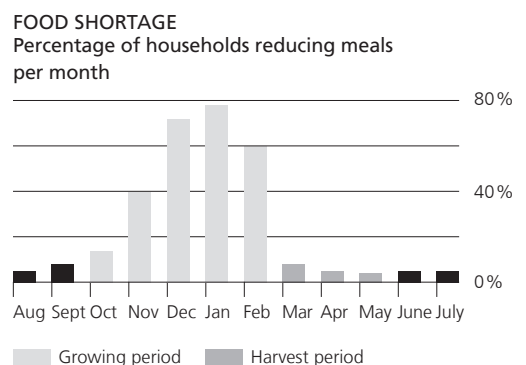
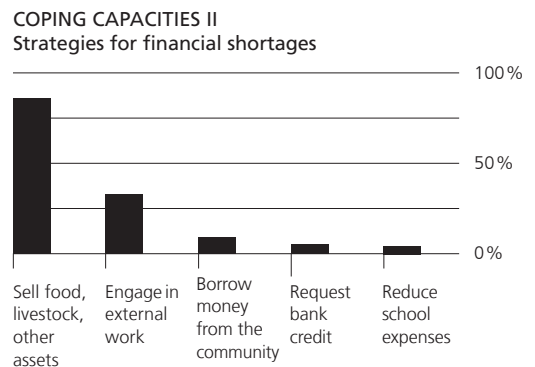
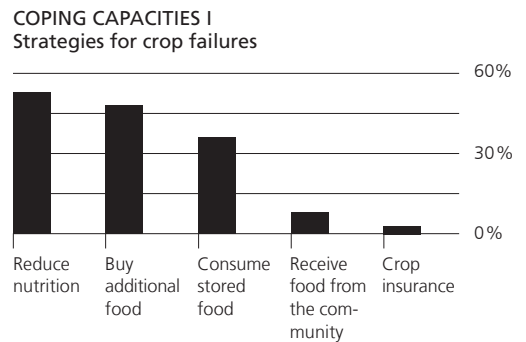
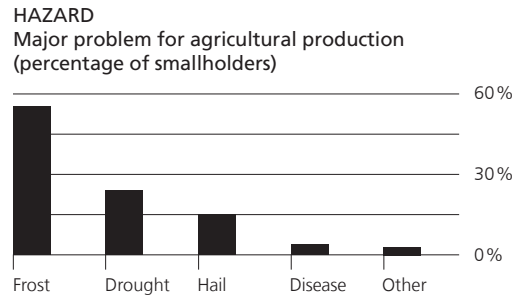
The model we applied in the previous section assumes that a farmer correctly interprets and trusts the forecasted warning and knows how to apply the corresponding preventive measures. This is a strong assumption since the actual use of climate services by smallholder farmers in developing countries and countries with emerging economies remains a major challenge, as has already been shown in the context of Sub-Saharan Africa⁵. Even if climate services are available, they often fail to provide the information in a way that is meaningful to end-users. In order to properly design the climate services, the current barriers that limit the use of weather and climate information by the end-users were analyzed. Four aspects were especially evident → P. 16. Firstly, the acceptance of science-based information is not complete. Secondly, access to information was not ensured for all farmers. Thirdly, farmers perceive the information currently disseminated as confusing and hard to understand. And finally, the information currently provided is insufficiently detailed for the specific location of their community.

The evaluation of agricultural adaptation decisions

The household survey revealed that farmers apply preventive measures to protect crops from extreme events. The implementation of such adaptation measures requires resources and generates costs that put a burden on farmers’ already constrained livelihoods. Evaluating the economic viability of these adaptation options provides therefore a useful decision-basis for farmers, communities and local governments to better anticipate the economic consequences of their agricultural decisions. We therefore evaluated two different adaptation measures that could potentially reduce crop losses based on a real option approach: (1) changing the variety of quinoa to more frost-resistant species and (2) cultivation in elevated fields, called Waru Waru (in Quechua) or Sukakollo (in Aymara). The latter is an ancestral cultivation practice which is expected to increase yields and offer resistance to harsh climate conditions such as frost and dry spells.

Results indicate that switching to a more robust crop variety can significantly improve the farmers’ revenues through higher yields. In the case of the elevated fields, production is not worth undertaking for individual farmers, or the community, unless there is further evidence that this cultivation method results in a significantly increased productivity. This finding concurs with the observed trend that elevated fields in the region have been abandoned in 3 out of 4 cases. The applied real option approach proved to be a flexible tool to determine not only whether an option should be undertaken but also the optimal timing of doing so.

Main results of the vulnerability assessment. These reveal the most severe climate hazards for production, the population’s low ability to cope with shocks and their precarious livelihoods reflected in the form of food insecure periods.



Translating evidence into practice

In order to address climate-related vulnerability and overcome the identified key constraints we set up a series of climate field workshops in two communities in Puno. With this community outreach, we showed that user participation leads to a greater credibility of the national meteorological service, a more positive perception of the accuracy of the information provided and enhanced consideration in daily production activities.

Community outreach: A promising strategy for designing user-driven climate services

The evidence generated in the first stage of Climandes unveiled the discrepancy between the weather and climate information currently provided and user requirements and expectations. This was manifested through low confidence in the information provided by the national meteorological service Senamhi. It became clear that incorporating scientific weather and climate information into agricultural decision-making in remote rural regions like the Altiplano requires the active involvement of those targeted communities. In order to make available information meaningful for the end-users, we needed to overcome the four identified key constraints to utilization presented in the previous chapter. To address this challenge, we undertook a community-based approach by conducting a series of monthly climate field workshops in two agricultural communities in Puno during the growing season 2017/18 → p.10, MAP. These workshops were organized and carried out by a multidisciplinary team, among them meteorologists and agronomists from the regional office in Puno and the headquarter of Senamhi in Lima, as well as local non-governmental and governmental stakeholders interested in climate resilience and agriculture. The objectives of these workshops were to sensitize farmers about the use of weather and climate information, overcome key factors limiting their use, as well as establish a continuous feedback cycle between the user and provider community → p.16.

To monitor and evaluate the outcome of the intervention, we developed a monitoring and evaluation approach that helped to continuously adapt the climate service to the user's needs and measure their impact. The approach consisted of two elements: (1) After each workshop, the facilitator responsible provided feedback on the workshop using a standardized form aimed at documenting the content and development of a given session; (2) Over the workshop series, we repeatedly tracked specific indicators reflecting farmers' acceptance, comprehension and perceived accuracy of the information provided through a structured questionnaire.

What is the potential impact of close user interaction?

Results indicated that the workshops fostered a strong increase of trust in the meteorological service Senamhi and in the weather and climate information it produces → p.17. This was not only reflected by a growing trust in the institution (credibility) but also by the perception that the information provided coincided with reality (accuracy). Farmers reported that they considered this information in their decision-making (adoption) and that, in doing so, it actually improved their prospects for production. The understanding of weather and climate information was still a critical point in the user community we worked with and did not improve significantly over the period of intervention (comprehension). Given the users' noticeable reservations about modern climate and weather information and their prior lack of experience in interpreting this information, it will probably require longer interventions to enhance the assimilation of new information.

A community outreach through climate field workshops

The monthly climate field workshops organized in two agrarian communities in Puno directly addressed the four identified barriers to utilization of weather and climate information.

1

LACK OF ACCEPTANCE

Preference for environmental predictors One out of two farmers in the region favors traditional indicators over science-based information and considers these methods as sufficient for decision-making.

COMBINING WEATHER AND CLIMATE INFORMATION WITH TRADITIONAL KNOWLEDGE TO ENHANCE ACCEPTANCE

Local traditional knowledge was widely used for predicting weather and climate by farmers in the study region. This knowledge served as a crucial entry point for discussing the information provided by the meteorological service. Each workshop started with a comparison between the previsions of a local community representative based on environmental predictors and a forecast presented by a meteorologist from Senamhi. This activity served to illustrate

the potential complementarity between scientific information and the traditional indicators in order to gain a robust foundation for decision-making. In order to value and preserve this ancestral traditional knowledge, Climandes made great efforts in documenting the natural indicators currently used in practice and published a book titled 'Willay', using the Quechua expression for reading natural signs (Willay – Midiendo el Tiempo sin Instrumentos).

2

LACK OF ACCESS

Lack of and unequal access to forecasts & warnings Almost 20% of the farmers are uninformed of upcoming weather and climate events. Low access is particularly prevalent in poor, less educated and female farmers.

IMPROVING THE DISTRIBUTION CHANNELS TO PROVIDE ACCESS TO CLIMATE DATA AND INFORMATION

In the initial workshop, farmers were asked to present their preferred communication medium for receiving weather and climate information. In response to farmers' requests, we established two distribution channels to better reach the target population. Local radio stations enable isolated communities to receive weather and climate information and agricultural advice. Thus, the first service consisted in transmitting the daily forecasts through two local radio stations in the pilot areas (La Decana in Juliaca and Onda Azul in Puno) in local languages Quechua and Aymara as well as in Spanish. As the coverage for mobile phone networks

is high and sharply increasing in rural regions (One out of two farmers in the target group owned a mobile phone), Climandes established, as second service, a text message service (SMS). The messages included weekly weather forecasts and early warnings of frost and drought events. According to feedback from farmers receiving these messages, they passed the information on to another four people on average in their community. In order to strengthen credibility of information and communication with farmers, it was essential that the SMS were disseminated by specialists from the Senamhi regional office.

3

LACK OF COMPREHENSION

Forecast is poorly understood 42% of producers perceive the information currently disseminated as hard to understand. These comprehensive issues are particularly prevalent in less educated and female respondents.

IMPROVING CLIMATE LITERACY FOR A BETTER COMPREHENSION OF WEATHER AND CLIMATE INFORMATION

A core element of the climate field workshop was the capacity-building of the user community. Local Senamhi meteorologists covered weather and climate aspects such as the general principles and limitations of scientific forecasts, characteristics of the local climate, the El Niño phenomenon, cloud types, as well as causes of high-impact events like frost, drought

and hail. Local agronomists complemented this input with corresponding measures to protect crops from agro-climate hazards. Farmers were shown how to interpret the weather and climate information they receive via radio and text messages. Users gave feedback on the information provided which led to modifications of the content and distribution of the information.

4

LACK OF ACCURACY

Forecast not accurate at local scale Information currently provided is not accurate enough for the specific community to take decisions.

DISCUSSING LOCAL IMPLICATIONS OF WEATHER AND CLIMATE INFORMATION TO ADDRESS THE ACCURACY ISSUE

All weather and climate information is by nature uncertain with the level of uncertainty typically increasing with forecast lead time. The highly complex terrain of the Puno region makes localized forecasts very difficult, even on short-time scales. This difficulty is also associated with the low density of available weather stations (one station per roughly 1,700 km²). To avoid unrealistic expectations by the farmers, the limitations of weather and climate information were regularly discussed with participants during the workshops. With this in mind, the implications of the most recent forecast for their specific area was ana-

lyzed and discussed. Also, the choice of the kind of weather and climate information communicated to the users has to be adapted in a smart and careful way to the specific user groups. For instance, long-term information such as seasonal forecasts or even climate scenarios is not appropriate for individual smallholder farmers, as they are usually characterized by a high degree of uncertainty. Delivery of such information, typically communicated in a deterministic way, is potentially counterproductive, as it will inevitably lead to many false or missed alarms and counteract the increased trust in the meteorological service.

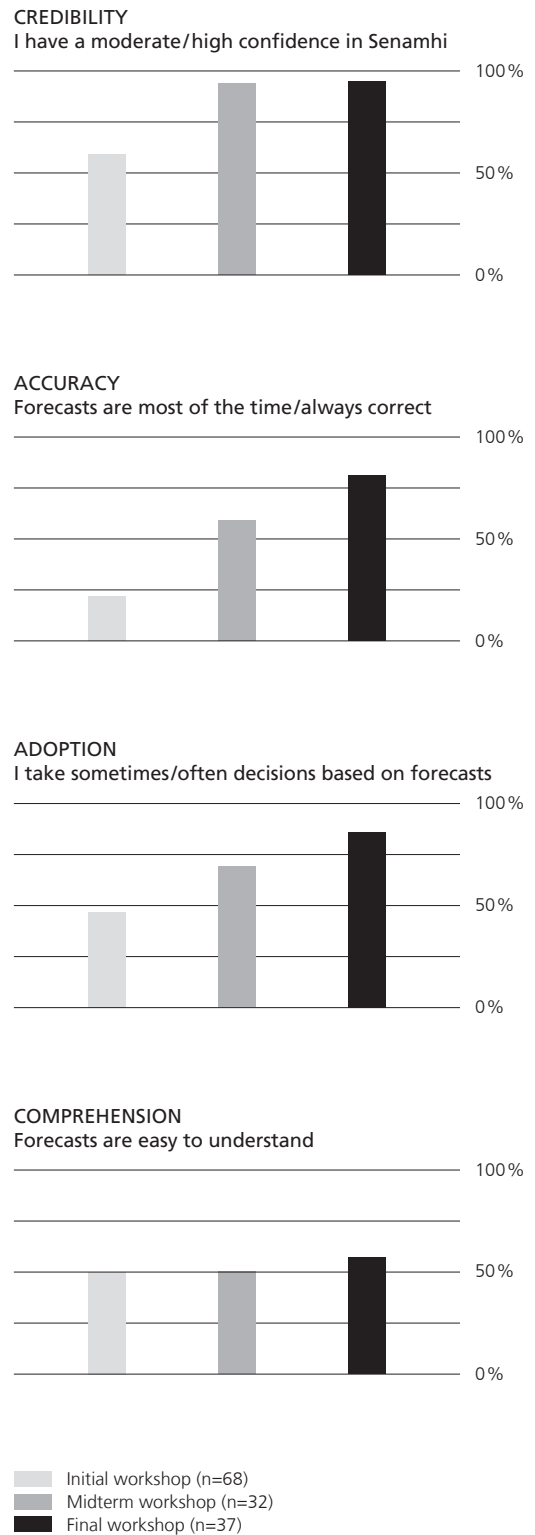
Beyond climate service implementation

Through our study results and implementation experience, we have learnt that – besides the fundamental necessity of weather and climate information – there are other critical factors to enhance the resilience of the most vulnerable population but these were beyond the scope of our mandate. Nevertheless, we would like to discuss complementary issues to climate services that became evident. A key finding of this project is the target population’s low capacity to overcome shocks such as high-impact weather and climate events. The evidence brought forth by the project made it clear that access to formal financial services, crop markets, social protection and governmental aid have to be strengthened in order to mitigate the long-term negative consequences arising from these events.

The results highlight the low access to formal insurance against crop losses with only 2% of the households being insured. Risk transfer can prevent farmers from selling their livestock and other assets, abandoning their farmland to find alternative work elsewhere and borrowing money or reducing nutrition. Therefore, micro-insurance services based on weather indices have gained increasing attention in recent years in the framework of development cooperation.

A further prominent vulnerability factor was the low incomes compared to other sectors and hence the lack of savings required to recover from the effects of a high-impact event. Smallholders could benefit from better access to market systems to receive better crop prices. Although the majority of production in the project region Puno is extensive, only a very small share of the smallholder farmers certify their production as organic, even though prices are significantly higher for certified crops (+33%). The main reason for not certifying the products is lack of knowledge (84%) and – to a lesser degree – the high administrative burden (13%). Farmer cooperatives like Agrobosque in the Peruvian region Madre de Dios, for example, help their members sell their quality products for better market prices, by providing direct market access and organic certification.

After the initial, midterm and final workshop held in the two communities, we asked farmers to fill out a survey. The results demonstrate some perceived benefits of our intervention.



What we can learn from the Climandes project

Through our intervention, we provide a proof-of-concept that the GFCS User Interface Platform is a suitable vehicle to bridge the gap between the weather and climate information user and provider communities. We found that for climate services to be user-driven, it needs to be developed based on evidence gained from social, economic and natural sciences and by applying participative research and implementation approaches. Our two-stage approach for a pilot UIP proved to be suitable for upscaling in other contexts and sectors.

A proof-of-concept for the GFCS User Interface Platform to provide user-driven climate services

The User Interface Platform (UIP) was probably the single most decisive factor in successfully bridging the supplier-user gap. Hence, Climandes provides a proof-of-concept for the relevance of the UIP concept as a basis for user tailored climate service implementation. We implemented a GFCS pilot UIP using a two-stage approach that is built around evidence-guided action. This approach turned out to be a key factor for the success of the Climandes project, which is mainly due to the involvement of the user community from a very early stage. This community not only includes small-scale farmers as the final end-users, but also involves intermediary users such as private and public partner institutions that transformed the climate data and information into agro-climate advice. As exemplified by this user-supplier interaction, the project confirmed the importance of incorporating sectoral and transdisciplinary expertise to provide meaningful end-to-end climate services.

Although Climandes focused specifically on smallholder farming in the Andean highlands, the proposed two-stage approach to set-up a UIP involves a number of generic elements that can be transposed and applied to other sectors with quite different user profiles, while continuing to ensure a user-driven process. We therefore provide a checklist for the proposed two-stage approach for designing user-driven climate services → p.21.

Community outreach requires decentralized resources

The regional office of Peru's meteorological service proved to be the mainstay for effective provision of climate services. Not only were the personnel responsible for the production and distribution of the weather and climate information but, more importantly, they had the hands-on knowledge of the hazards to which local communities are exposed, as well as the ability to reach out and engage with the local population. Thus, our experience made it clear that the implementation of a UIP based on community outreach is resource-intensive and requires enhanced capacities of technical staff in meteorological offices in peripheral regions. Particular attention must therefore be paid to the decentralization of meteorological services in the implementation countries.

Filling scientific, technical and operational gaps on the provider side

Although this publication mainly focused on the user's perspective of climate services specifically the UIP, Climandes made great efforts and progress in the other technical and provider-oriented components of the GFCS framework. We put particular emphasis on the quality of observational data because spatially and temporally complete, high resolution climate data are required for climate services to be reliable.

Also, we developed daily gridded datasets of precipitation and temperature, as these are necessary for analyzing the past climate in more spatial detail and for increasing the spatial resolution of the statistical forecasts, which are carried out operationally at Senamhi. We investigated the skill of Senamhi's seasonal forecasts using statistical and dynamical forecast models. Besides temperature and precipitation, parameters tailored to the phenological cycle were analyzed (e.g. frost days or dry days during the growing season), yielding significant skills for some temperature-based parameters and only marginal skills for precipitation and parameters based on the latter. Given the substantial uncertainty at the seasonal range level, these forecasts do not seem to be of direct use for individual farmers. Rather, we see a potential value at a more institutional level, where seasonal forecasts can raise the awareness for releasing humanitarian funding, trigger risk-reducing actions, enhance preparedness and response and thus make disaster risk management overall more effective.

The twinning approach – A success story

We deem that the twinning approach chosen for the Climandes project implementation was a recipe for success. The main focus and effort of the intervention has been in the development of capacities in the climate and user communities. All activities were developed in a partnering collaboration between the regional and national offices of Senamhi Peru and MeteoSwiss, and can be seen as an effective peer-to-peer, on-the-job training and also as a means of building personal professional networks.

Capacity development was complemented with a series of both online and classroom courses covering all themes of the project and providing training on specific climate-service related topics. The courses were attended by international participants, also fostering the exchange between professionals of the meteorological services of the region, for example through monthly online briefings on seasonal forecasts. The course material remained available upon registration on the platform for online courses from the Peruvian meteorological service.

Increasing resilience of the most vulnerable through inclusive climate services

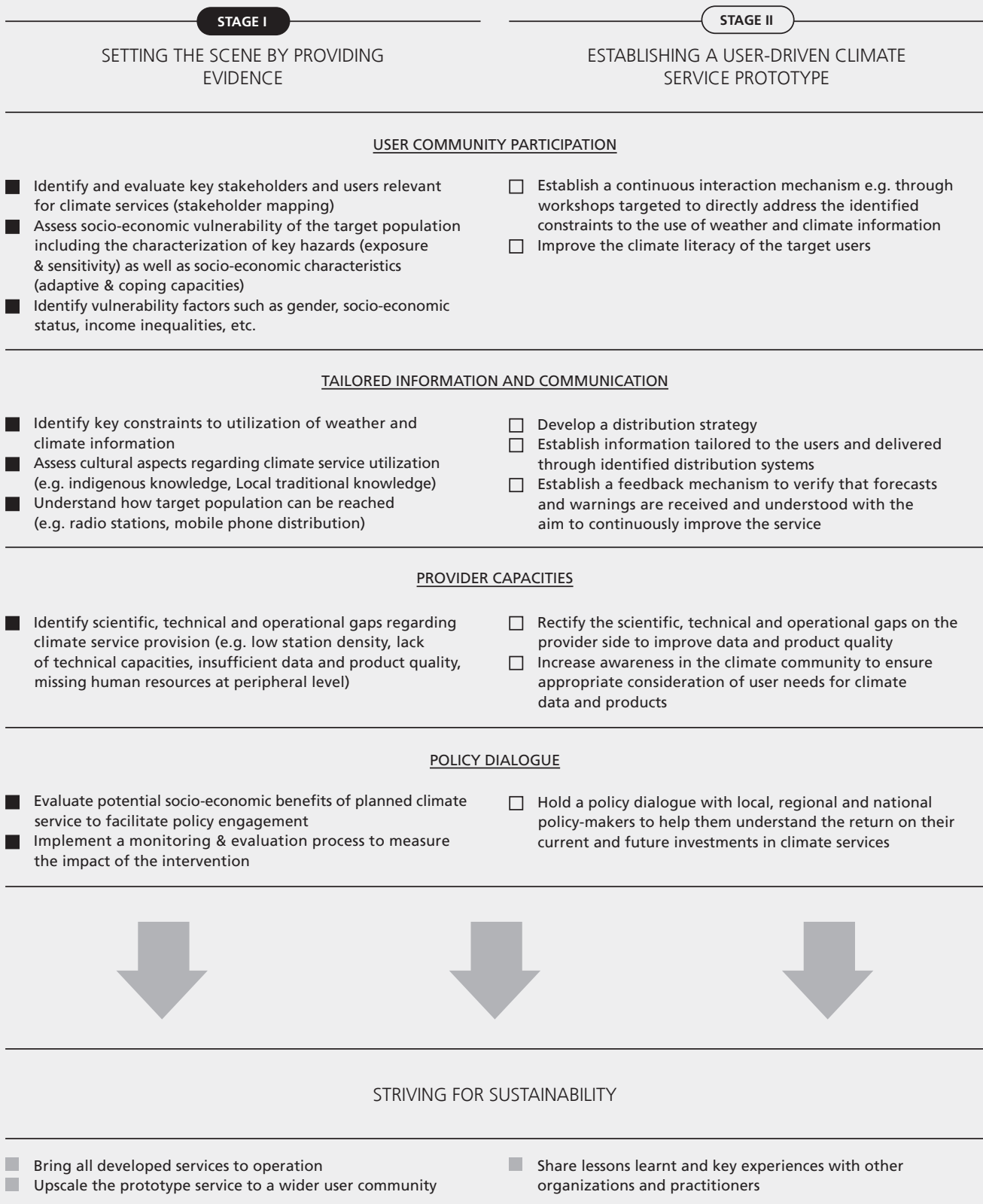
The Climandes project demonstrated that improved access to weather and climate information for the most vulnerable people significantly enhances their disaster preparedness and therefore contributes to protecting their livelihoods. The estimated potential socio-economic benefit of enhanced use of climate and weather information is likely to exceed the costs of developing and maintaining the provision of that information. However, the project shed light on the great challenges facing climate service implementation in developing countries and countries with emerging economies.

Through the user-participatory approach, we managed to overcome identified key constraints in the utilization of weather and climate information. As a matter of fact, our experience suggests that the co-developed climate service implemented enhanced the user communities' trust in scientific information and improved their adoption in agricultural decision-making in order to tap the potential socio-economic benefits that climate services provide.

In the face of the global climate change challenge, Climandes caters to the great need for climate service interventions in developing countries and countries with emerging economies. As such, it is well in line with, and can be seen as a significant contribution to the GFCS. Climate services are public goods, for which unrestricted and unlimited access should be guaranteed for the entire population. In other words, we should strive to make climate services more inclusive, by paying particular attention to the needs and constraints of the most vulnerable and marginalized population groups, which encompass the poor, the low-educated and women, as underlined by the evidence gained in this project.

Checklist for the design of user-driven climate services

Based on our expertise gained in the Climandes project, we provide a checklist for the proposed two-stage approach to designing user-driven climate services. This approach has been piloted in the agricultural sector but can be applied to other sectors as well in a generic way. These stages encompass an accurate assessment of the implementation context (setting the scene by providing evidence), base the implementation processes on this assessment (establishing a user-driven climate service prototype) and ultimately, an operationalizing and upscaling of the implementation to a wider region (striving for sustainability).





- 1 *Farmers prepare their fields at the beginning of the rainy season. The majority of the production is extensive, dominated by small-scale subsistence farms of which more than 96% rely on rain-fed practice.*
- 2 *A typical village in the Altiplano at an average altitude of around 4,000 m a.s.l. The main food crops cultivated are potatoes, quinoa and broad beans which are grown during the austral summer (from October to April). Livestock breeding provides an additional source of income.*
- 3 *Heavy frost at dawn during the flowering phase of the cultures poses a significant threat to farmers. Half the farmers stated that frost is the major problem for agricultural production in the region.*
- 4 *In addition to frost, drought is the most critical event for agricultural production. In 2016, when this picture was taken, the Peruvian government declared a state of emergency for the Puno region due to prolonged drought during the cultivation period. The picture shows an abandoned raised field. Some of these traditional production systems, which are called 'waru-waru' in Quechua or 'Sukakollo' in Aymara, are still in use by farmers in the region.*
- 5 *Developing meaningful climate services requires a good understanding of the needs of the user community and the corresponding barriers to the use of weather or climate information. A local Senamhi employee during the household survey in Puno in 2016 with a small-holder farmer.*
- 6 *Farmers participated in the development and provision of weather and climate information. During the climate field workshops in Puno, they learned what to expect from forecasts, how to combine it with their traditional knowledge and how to translate the information into protective action.*
- 7 *In the Andean highlands, the population is highly vulnerable to weather and climate events due to the high exposure and low socio-economic capacities. In the face of the global climate change challenge, climate service interventions like Climandes are critical to enhance the resilience of marginalized groups and thus contributes to the pursuit of global development agendas.*

Adaptive capacity

Adaptive capacity describes the ability of an individual, community or society to prepare for a coming hazard and take actions to alleviate its adverse impacts.

The adaptive capacity to mitigate damage depends upon the available resources (e.g. financial), decision options as well as available information.

Climate services

A climate service is a decision aide for governments, organizations and individuals and seamlessly derived from information about the past, current and future climate. Design and implementation of a specific climate service requires in-depth and iterative engagement with the users in order to tailor it to their key characteristics and needs. Effective climate services support climate-smart decisions and in this way lead to increased social and economic resilience to climate variability and change¹⁵.

Coping capacity

Coping capacity is the ability of people, organizations, and systems, using available skills, resources, and opportunities, to address, manage and overcome adverse conditions; in the case of climate to an extreme event such as a drought, a frost or an extreme precipitation event.

Exposure

Exposure describes the exposition of people, livelihoods, resources and infrastructure to environmental hazards. The exposure matters, as an environmental hazard only becomes a risk if people or infrastructures are exposed and vulnerable to this hazard.

Hazard

A hazard describes the potential occurrence of a natural or human-induced physical event that may cause loss of life, injury, or other health impacts, as well as damage and loss of property, infrastructure, livelihoods, service provision, and environmental resources. Climate-induced hazards are hazards from atmospheric phenomena, which have the potential to affect humans, their structures or activities adversely. This includes all kind of events that deviate strongly from the climate mean, such as cold waves, dry periods or heavy precipitation events. More specifically, agro-climatic hazards are climate hazards with adverse effects for the agricultural system.

Resilience

Resilience describes the capability of a system or part of a system to absorb or recover from the effects of a hazardous event and return to its former functionality.

Risk transfer

Risk transfer describes the process of shifting the financial consequences of a risk from the asset at risk to another, in many cases, less vulnerable party. A risk transfer can occur formally through insurance or through government aid.

Sensitivity

Sensitivity describes the degree to which a system (a community or an ecosystem) reacts and responds to a climate change or event. This includes both beneficial and problematic responses, resulting for example in food insecurity due to unfavorable climate conditions and yield loss.

User Interface Platform

The User Interface Platform is one of the five main pillars of GFCS necessary for a functioning climate service system. It provides a structured means of interaction for users, researchers and climate service providers to bridge the gap between the science and user community and to guarantee the climate services meet users' needs. The design of a UIP can vary sector-specifically, but importantly, its design is based on evidence of the users' needs⁷.

Vulnerability

Vulnerability refers to the predisposition of a community, system or asset to be susceptible to the damaging effects of a hazard through a set of characteristics and circumstances. This can include for example a low adaptive capacity relative to a hazard or a high sensitivity towards it.

REFERENCES

- 1 IPCC (2012). Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. Special Report of the Intergovernmental Panel on Climate Change: Cambridge University Press.
- 2 Samberg, L. H., Gerber, J.S. Ramankutty, N., Herrero, M. and West, P.C. (2016). Subnational distribution of average farm size and smallholder contributions to global food production. *Environmental Research Letters*, 11(12), 124010.
- 3 FAO, IFAD, UNICEF, WFP and WHO (2017). The State of Food Security and Nutrition in the World 2017. Building resilience for peace and food security. Rome, FAO.
- 4 Frei, H., Huggel, C., Steinemann, M. (2016). The El Niño phenomenon and related impacts. Climate Change Environment, Nexus Brief, Nr. 2. SDC Climate Change and Environment Network. Berne, SDC.
- 5 Carr, E. R and Onzere, S. N. (2017). Really effective (for 15% of the men): Lessons in understanding and addressing user needs in climate service from Mali. *Climate Risk Management*.
- 6 Hallegatte, S., Vogt-Schilb, A., Bangalore, M. and Rozenberg, J. (2017). *Unbreakable*. Washington DC, World Bank.
- 7 Huyer, S., Hansen, J., Rose, A., Vaughan, C., Van Huysen, T. (2017). What We Know about Gender and Rural Climate Services. CCAFS Info Note.
- 8 WMO (2014). Annex to the Implementation Plan of the Global Framework for Climate Services – User Interface Platform Component. Geneva, WMO.
- 9 Gerlak, A. K., Zack, G. Knudson, C. (2017). Mid-term Review of the global framework for climate services. Geneva, WMO.
- 10 Lavado Casimiro, W. S., Labat, D. , Ronchail, J. , Espinoza, J. C. and Guyot, J. L. (2013), Trends in rainfall and temperature in the Peruvian Amazon–Andes basin over the last 40 years (1965–2007). *Hydrological Processes*, 27 (20), 2944–2957.
- 11 Garreaud, R. D. (2009). The Andes climate and weather. *Advances in Geosciences*, 22,3.
- 12 Neukom, R., Rohrer, M., Calanca, P., Salzmann, N., Huggel, C., Acuña, D., Christie, D. A. and Morales, M. S. (2015). Facing unprecedented drying of the Central Andes? Precipitation variability over the period AD 1000–2100. *Environmental Research Letters*, 10(8), 084017.
- 13 INEI (2012). IV Censo Nacional Agropecuario 2012. Instituto Nacional de Estadística e Informática. Lima, INEI.
- 14 INEI/MINAM (2013). Resultados Definitivos: IV Censo Nacional Agropecuario–2012. Instituto Nacional de Estadística e Informática/Ministerio del Ambiente. Lima, INEI/MINAM.
- 15 WMO (2013.) What Do We Mean by Climate Services? WMO Bulletin, 62. Geneva, WMO.

IMPRINT

Moritz Flubacher, Noemi Imfeld, Andrea Rossa,
Federal Office of Meteorology and Climatology
MeteoSwiss, Zurich, Switzerland
www.meteoswiss.ch/climandes
Correspondence to international@meteoswiss.ch

Lizet Cristobal, Hugo Ramos, Nelly Paredes,
Marlene Dapozzo
Servicio Nacional de Meteorología e Hidrología
del Perú Senamhi, Lima, Peru
www.senamhi.gob.pe/climandes

Filippo Lechthaler
Swiss Tropical and Public Health Institute,
Basel, Switzerland
www.swisstph.ch

Alexandra Vinogradova, Lucas Bretschger
Federal Institute for Technology, Zurich, Switzerland
www.ethz.ch

Carlos Vargas, Anca Balietti, Marc Chesney
University of Zurich, Zurich, Switzerland
www.uzh.ch

Mario Rohrer
Meteodat GmbH
www.meteodat.ch

Concept & Design
Studio Malta, Zürich, Switzerland
www.studiomalta.ch

Picture credits
Marlene Dapozzo: 5; Renny Daniel Diaz Aguilar:
1, 3, 7; Moritz Flubacher: Front, 4; José Carlos Huamán
Ramírez: 6; Stefan Hunziker: 2

Citation
MeteoSwiss/Senamhi, 2018. Designing user-driven
climate services. What we can learn from the Climandes
project: A checklist for practitioners, scientists and
policy makers. Publication of MeteoSwiss and Senamhi.

© MeteoSwiss/Senamhi, August 2018

Acknowledgment

We thank the World Meteorological Organization
(WMO) for their support of the project Servicios
Climáticos con énfasis en los Andes en apoyo a las
Decisiones (Climandes), project no. 7F-08453.01
between the Swiss Agency for Development and
Cooperation (SDC) and the WMO. Special thanks for
the peer review of this publication go to Filipe
Lúcio (GFCS office, WMO) and Guillermo Podestá
(Rosenstiel School of Marine and Atmospheric Science,
University of Miami).

PARTNERS

Funding



Implementing partners



Coordination



