Climate risk management in western South America: implementing a successful information system

by Rodney Martínez Güingla* and Affonso Mascarenhas*

Introduction

Six years after opening, in January 2003, the International Center on "El Niño" Research (CIIFEN) has succeeded in consolidating its presence in Central and South America by providing climate information services designed principally for users and decision-makers. One of CIIFEN's most significant challenges in its short life, however, has been to demonstrate through practical experience how to improve the management of climate information as a central pillar of genuinely people-centred early-warning systems.

CIIFEN's mission focuses on promoting and implementing fundamental and applied research projects to improve understanding of El Niño/La Niña and climate variability and change in order to help improve early warning on a regional scale and reduce the social and economic of climate impacts.

This document offers a brief summary of CIIFEN's contributions to the management of climate risk in western South Americ and how its activities have developed in line with its mandate and future plans for the region.

Conceptual elements of a regional early-warning system

The United Nations International Strategy for Disaster Risk Reduction (ISDR) gave a clear definition of early warning systems in 2009. The backbone of the concept of CIIFEN's operation is what we regard as a slightly modified early-warning scheme based on four main themes:

- Development of climate prediction;
- Construction of climate risk maps applied to development sectors;
- Building information systems;
- Establishing mechanisms to ensure that governments respond to early climate warnings and take action (Figure 1).

Based on our vision, we explain the complex path from early climate warning to risk management. When this climate information actually provokes a response from governments, it takes

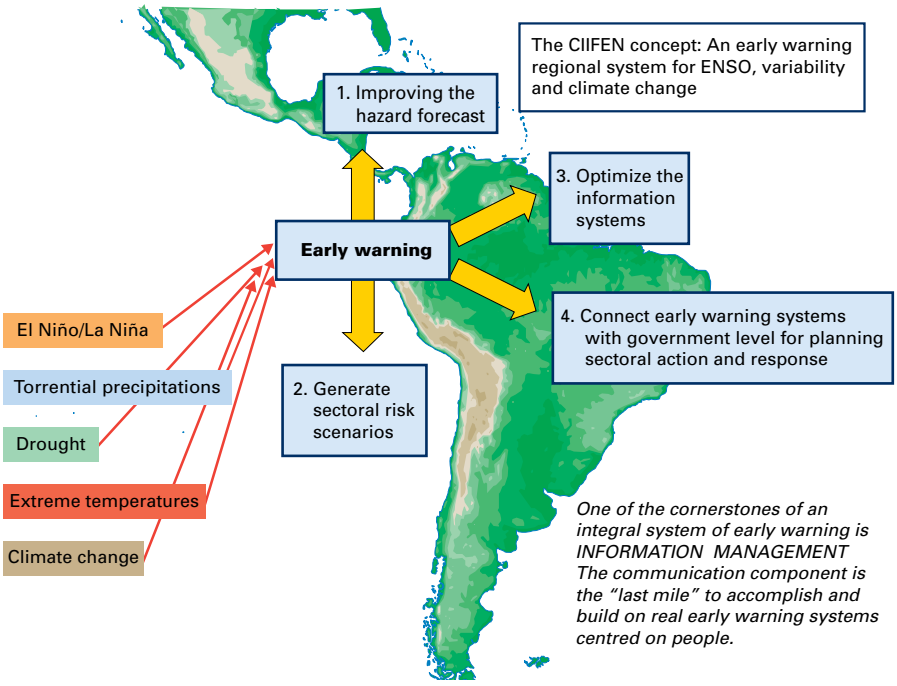


Figure 1 — Conceptual elements of CIIFEN Operations, Martínez (2004)

1 International Centre on Research "El Niño" (CIIFEN)

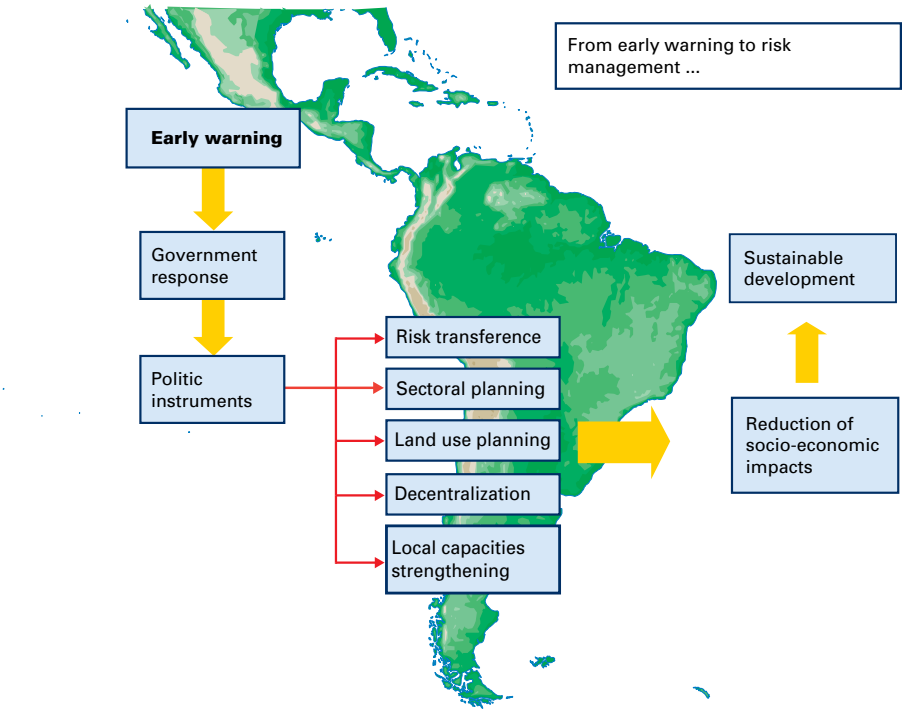


Figure 2 — Conceptual elements of Early warning to risk management systems, Martínez (2004)

the form of policy instruments which may be implemented as a variety of mechanisms of differing complexities: regional planning, decentralization, risk transfer and environmental management, among others. National governments can also strengthen the capacities of National Meteorological and Hydrological Services (NMHSs) and research centres, constantly improving the computing resources and building personnel capacities so that they can at last lead their countries along a path of truly sustainable development (Figure 2).

It is not sufficient, however, to have a conceptual scheme and merely talk about it. CIIFEN had to validate this scheme in the field by means of a pilot implementation. CIIFEN had this great opportunity when the Inter-American Development Bank approved, in the category Regional Public Goods, the project "Climate information applied to agricultural risk management in the Andean countries", which involved the National Meteorological and Hydrological Services of Bolivia, Chile, Colombia, Ecuador, Peru and Venezuela under CIIFEN coordination.

Early warning system

The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss.

this definition encompasses the range of factors necessary to achieve effective responses to warnings. A people-centred early warning system necessarily comprises four key elements: knowledge of the risks; monitoring, analysis and forecasting of the hazards; communication or dissemination of alerts and warnings; and local capabilities to respond to the warnings received. The expression "end-to-end warning system" is also used to emphasize that warning systems need to span all steps from hazard detection through to community response.

Source: UNISDR Terminology on Disaster Risk Reduction

Building a climate information system for agroclimatic risk management in the Andean countries

This project was launched in June 2007 and is, by its nature and structure, one of the main ones of regional scope focused on climate risk management. Its objective was to help reduce the socio-economic impact of the action of the climate on farming activity in the countries of the Andean region by setting up a climate information system as a Regional Public Good, focusing on the needs of farmers, supporting decision-making and risk management in the agricultural sector.

The project had the following components:

- System for processing data and climate information.
- Information dissemination system.
- Institutional strengthening.

Regional climate database for western South America

Under the first component, in the National Meteorological and Hydrological Service of the six countries of western South America, the project undertook a complex process of recovery and conversion of data from meteorological stations for digitizing and quality-control processing. At the same time, it worked on the design of a regional climate database that culminated in the input of the 3 879 035 records of precipitation and maximum and minimum temperature from 169 meteorological stations in the region. A digital interface was built for displaying historical data (available at http://vac.ciifen-int.

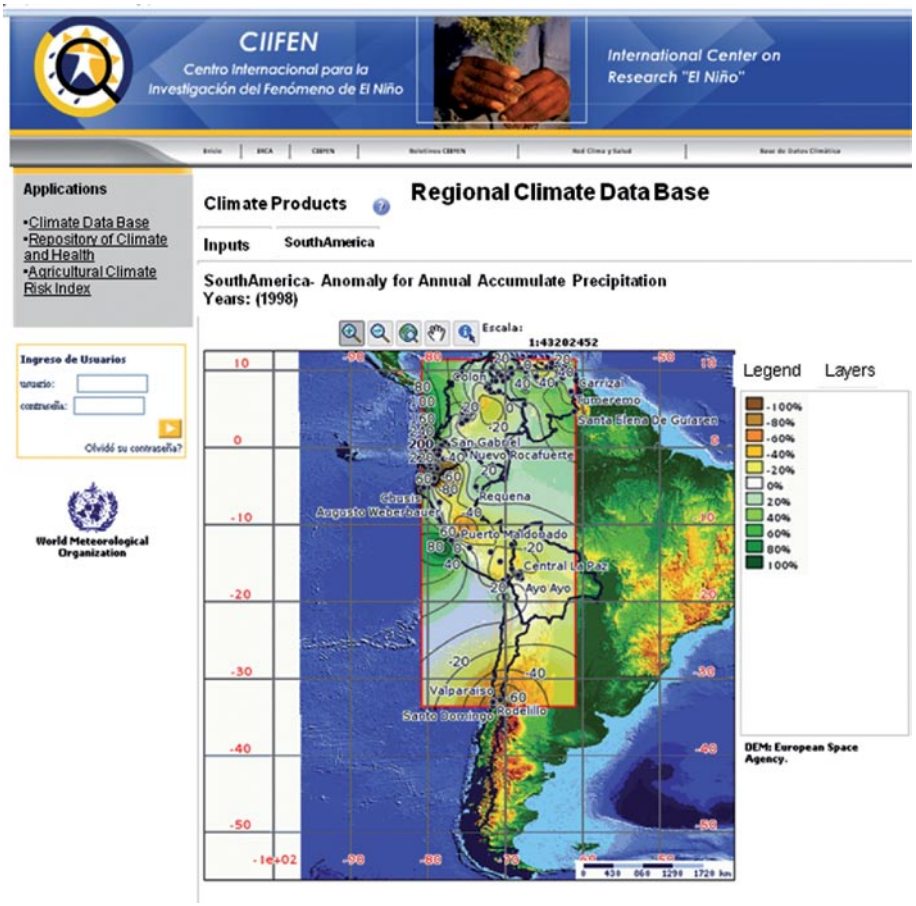


Figure 3 — Regional Climate Data Base for western South America
http://vac.ciifen-int.org

org) with daily data from 1960 to the present. This major step forward in regional interchange and integration of climate data is a first, and heralds a new chapter in cooperation between meteorological services in the region. The regional climate database is run and maintained by CIIFEN and an agreement for its operation was approved and signed by the NMHSs of the six countries and CIIFEN (Figure 3).

Statistical and dynamic modelling

The project made a considerable effort to improve climate forecasting capabilities (1-3 months) in the six countries. Since one of the pillars of a climate information system must be to base forecasts on reliable information to reduce subjectivity and increase robustness, it was based on statistical tools and numerical models designed as far as possible to match the conditions in each country. This particular activity was a major challenge for CIIFEN and the project team on account of the major imbalances between the countries taking part in the project in this area.

Despite the various considerable constraints on implementation, we were able to provide workstations for the countries and work was carried out on two fronts at the same time. For statistical modelling, we used the Climate Predictability Tool with the countries, which is a world-renowned tool for statistical downscaling developed by the International Research Institute for climate and society (IRI). Regional workshops were combined with experts accompanying each country's teams. The valuable experience of the forecasting teams was organized in terms of selection and use of both atmospheric and oceanic prediction parameters. We worked to validate forecasts and, after a long process, the six NMHSs were fully capable of generating seasonal forecasts, and in some cases monthly and bi-monthly ones. With some differences, over the lifetime of the project, these statistical forecasts reached the operational phase in all the countries, in most cases providing forecasts for a hitherto unavailable time horizon. For numeric modelling we used the climate mode of the MM-5 and WRF models. On this component, too, we worked closely with the NMHSs and held two regional training workshops on numerical modelling. The numerical experiments are continuing and are now operational in at least three countries (Figure 4).

Decision-support systems

One of the most important pillars of CIIFEN initiatives is decision-support tools. For the agricultural sector in particular, we designed a geographical information system representing spatially the vulnerability of a number of selected crops for each country in which the project was implemented, including multiple layers of information that can be used to define levels of exposure to climate and levels of resilience based especially on social, economic, political and institutional parameters. Among other factors, the territory is characterized in terms of land use, water-retention capacity, topography and texture. In the case of crops, the phenological cycles and their various climate requirements were estimated on the basis of historical information and information obtained in the field. Likewise, for crops, we considered sensitivity to pests and diseases more related to the climate. The layers of information for estimating vulnerability were weighted according to the region and the crop and then crossed with dynamic layers derived from forecasts of seasonal rainfall, maximum and minimum

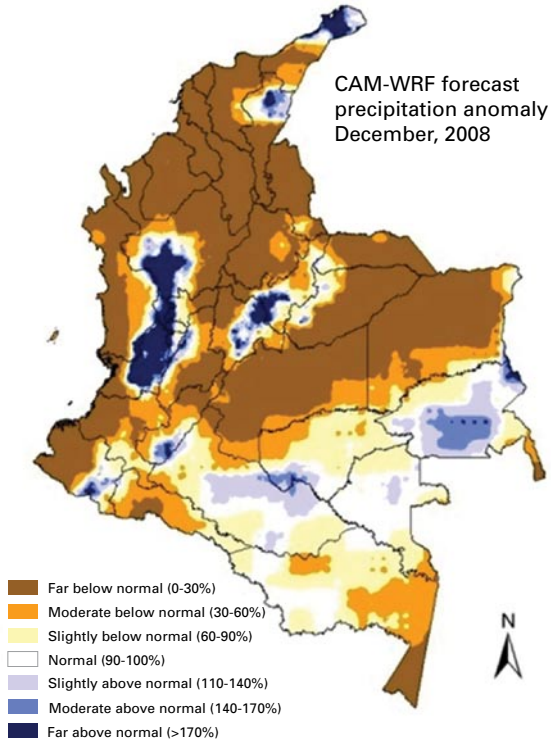


Figure 4 — Operational Seasonal Forecast produced by IDEAM, Colombia for December 2008

temperatures, to produce dynamic maps of agroclimatic risk by crop. We validated the system in each country and worked closely with the experts in each NMHS. Finally the system can generate maps that are updated with each new forecast to provide three-month risk scenarios, available every two months or monthly. Users can display the vulnerability layer, the forecast and also the associated risk for the coming season using a very simple colour scale on the map. The system was designed to be updated via the website (http://ac.ciifen-int.org/sig-agroclimatico/. (Figure 5).

Community information systems

The project invested a major effort to work on the most critical phase of the process of disseminating the information, reaching end-users without further interference or intermediaries. To achieve this, once all the technological systems reached the operational phase, we worked intensively in the selected areas of each country to map players, forge alliances and contact and connect with the media. A special effort was made to involve the private sector, which was quite successful. We obtained support from mobile telephone companies to send climate warning messages free of charge in Ecuador to a large network of users. Similarly, we succeeded in including products generated by some of the NMHSs in magazines circulated widely in the farming sector at no cost to the producers. We made important alliances with community radio stations, even succeeding in broadcasting climate bulletins in native languages. Other important achievements included demonstrating the feasibility of setting up effective climate information systems that meet the needs of the most remote users (Figure 6).

We carried out an assessment of user perception of the climate information in the pilot areas in all six countries. Access to, understanding and use of, the information improved from 30-35 per cent of the target population at the start of the project to 60-65 per cent by the end. One of the main indicators of the success of this initiative was the response of the national or local authorities. During the final phase of the project, government funding was given to replicate the initiative in other areas and improve the installed capacity. The information system was provided for advanced or technical users and for decision-makers in business and government over the Internet, and the products are easy to use and understand. However, the system was also provided for end-users through alternative methods and more complex forms, such as radio, local communications systems, agricultural networks or community associations. Both communities provided their points of view on the information and the presentation format was altered several times to satisfy demand as far as possible.

The effectiveness system is now measured through demand. Users with access to e-mail can join the system and the number of users increased by no less than 80 per cent in two years. Meteorological services have a long list of main users of the information that they disseminate regularly. The list is also constantly expanding to include users receiving the information by radio, the media and mobile phones (the mass media in the Andean region).

Leaders of communities in various countries have been trained to use the climate information. Educational material has been prepared to train trainers in the use of climate information and to take advantage of NMHS information. This material was designed taking account of the specific social and cultural features of the communities in each country.

Another indicator of success related to alliances for cooperating with the private sector. Through formal agreements with the NMHSs, additional long-term support was guaranteed through the publication of seasonal climate forecasts and other data free of charge for training purposes in the communities linked to these industries, including specific support measures.

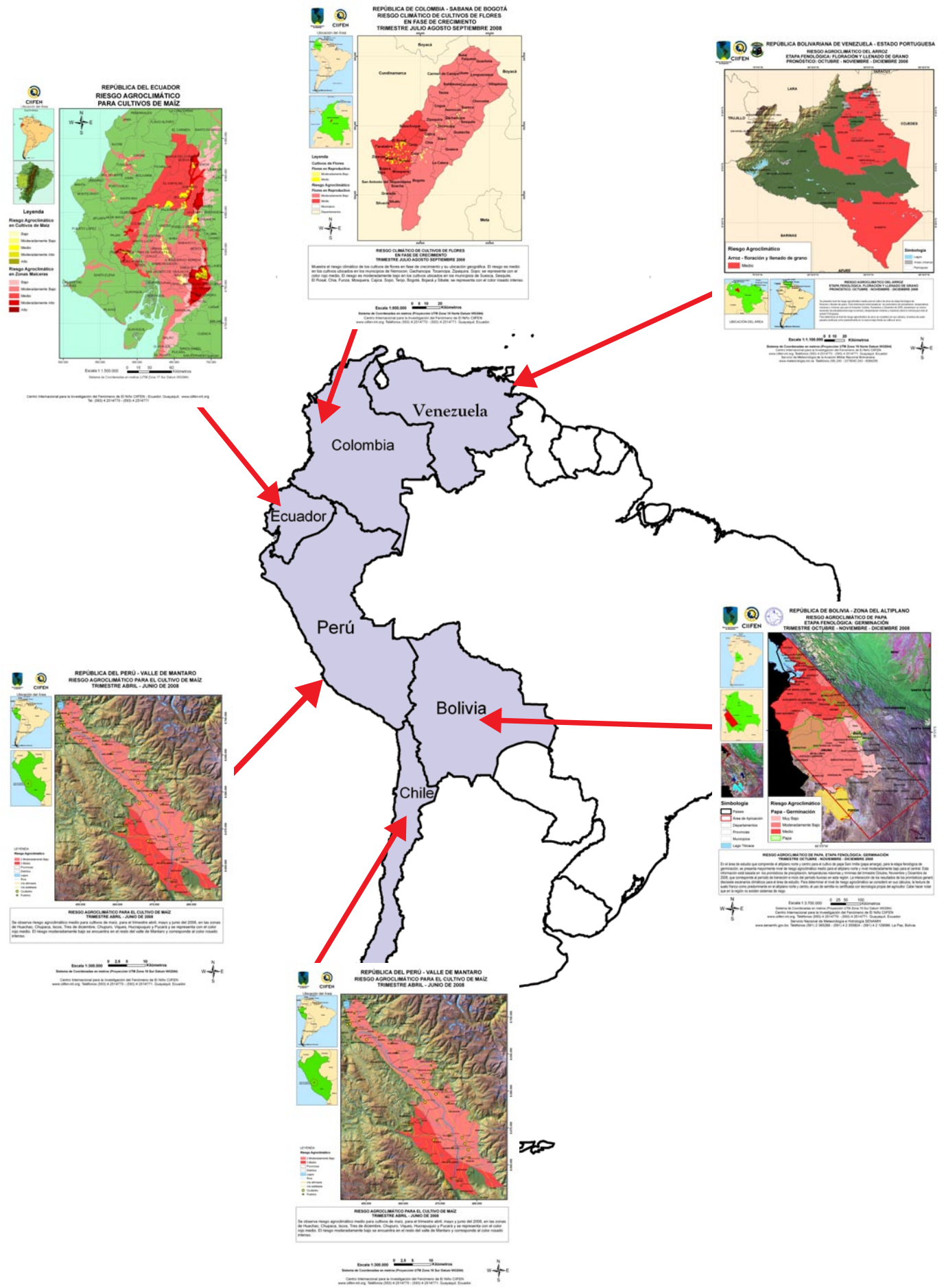


Figure 5 — Climate Risk Maps on western South America
http://ac.ciifen-int.org/sig-agroclimatico/

Figure 6— (a) Climate dissemination systems in western South America
(b) Alliances with local media and private sector to disseminate Climate Information.

Principal results of the climate information system for western South America.

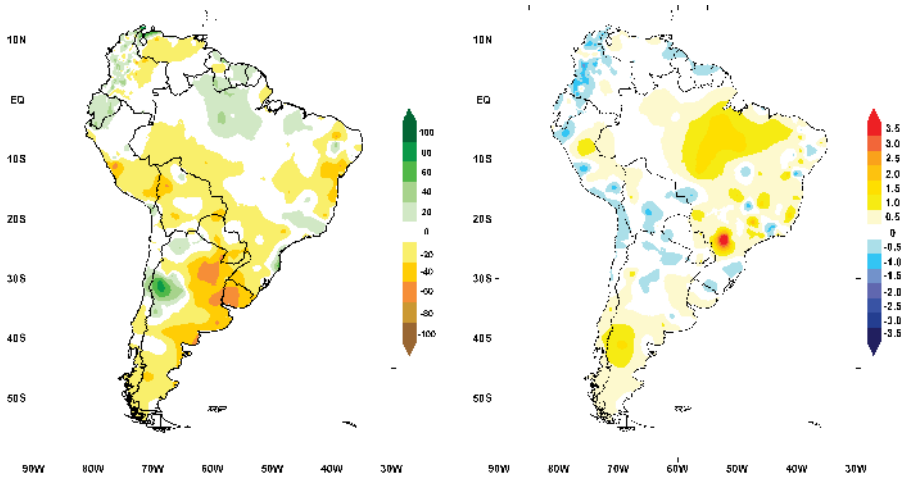
- The first regional climate database to be implemented in western South America;
- Capabilities enhanced by the application of statistical and dynamic downscaling in the region;
- Application of the operational dynamic of climate risk maps for agriculture in the region;
- Implementation of self-sustainable community climate information networks, with support from the authorities for the data networks, media and private sector;
- Intense capacity building in the region, closely linked to the implementation system;
- Application of regional agreements between the region's NMHSs and the networks;
- Positive political response by the local and national authorities with the system that will serve to replicate the initiative in other areas and for other crops with national funding.

CIIFEN contributions to the Bulletin of the American Meteorological Society: State of the climate

At the 14th session of the WMO Commission for Climatology (CCL-XIV), in Beijing in November 2005, Recommendation 5.5.3 was adopted, requesting WMO to ensure that editions of the *Bulletin of the America meteorolgoical Society* (BAMS) would strive for a regional balance in terms of coverage and greater involvement of the National Meteorological and Hydrological Services. CIIFEN took on this responsibility and from that year coordinated an exercise that was both unprecedented and very fruitful for generating the contribution of WMO's Regional Association III (South America) to the annual BAMS State of the climate publication.

Since 2006, with the active participation of the Region's NMHSs and coordination by CIIFEN, we succeeded not only in incorporating a large number of the Region's stations in the analysis (up from 516 in 2005 to more than 900 in 2009) but also increased participation in this important publication by authors from various South American countries. To date, our ever-increasing contributions have been published in the BAMS State of the Climate 2005, 2006, 2007 and 2008 (Figure 7). Assembling and sharing climate information is another useful function of information services as it allows the conversion of basic historical assessment and analysis data that is highly relevant for forecasting and estimating indices.

State of the climate in South America in 2007



Annual mean temperature anomaly (°C) 2007-South America.
Sources: National Meteorological Service from: Argentina, Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, CPTEC (Brazil) and NCDC/GHCN (USA)
Reference period 1961-1990
Data compilation and processing: CIIFEN

Annual precipitation anomalies (% normal) South America.
Sources: National Meteorological Service from: Argentina, Bolivia, Chile, Colombia, Ecuador, Uruguay, Paraguay, Peru, Venezuela, CPTEC (Brazil) and NCDC/GHCN (USA)
Reference period 1961-1990
Data compilation and processing: CIIFEN

Figure 7 — Regional Anomalies Maps published on South America Chapter from BAMS State of the Climate 2005.

Western Coast of South America Climate Outlook Forum (WCSA-COF)

Since 2003, CIIFEN, under the auspices of WMO, has coordinated the Western Coast of South America Climate Outlook Forum (WCSA-COF), with the participation of the National Meteorological and Hydrological Services of Venezuela, Colombia, Ecuador, Peru, Bolivia and Chile. So far, seven forums have been held in Guayaquil, Ecuador (2002, 2003, 2004); Santiago de Chile (2005); Armenia, Colombia (2006); La Paz, Bolivia (2007); and Caracas, Venezuela (2008). The next one will be held in Cuzco, Peru, in the last quarter of 2009. This event was originally intended to produce by consensus the seasonal climate outlook for the region, but it has now become a forum for intense dialogue and interaction between users in the member countries.

WCSA-COF has now become the platform for NMHSs to improve the dialogue with end-users in the various sectors and to analyse and improve the seasonal forecasting operations in the region. The interface mechanism between climate information providers and users in the communities also allows a better understanding between users and encourages better adoption by them, thereby reducing adverse results. The seasonal forecast for the region is the outcome of a monthly debate and consensus between all the NMHSs. All members share a common methodology involving a number of parameters which have been agreed and are being improved year after year. Special efforts are now being made to apply a verification technique. Once a consensus is achieved, the forecast is sent out by e-mail to more than 15 000 users throughout Central and South America and a few other contacts in other continents. The COFs have provided the NMHSs and CIIFEN with a substantial legacy of experience and lessons learned regarding user profiles, expectations and concerns, that has helped to understand the climate information and the complex process of managing it at regional and national levels as the fundamental bases for early warning and risk-management systems.

CIIFEN information products

CIIFEN maintains an operational information system serving a large number of users (more than 15 000) registered by means of a subscription system in Central and South America, Europe and Asia. Of visits to the CIIFEN products section, 77 per cemt come from Central and South America, 19.4 per cent are from Europe, the USA and Canada and the remaining 3.6 from Asia, Africa and other regions.

CIIFEN's operational products (Figure 8) are:

- Sea-surface temperature images for the eastern Pacific (weekly);
- CIIFEN bulletin on the state of El Niño/Southern Oscillation (ENSO), focusing on impacts in Central and South America (monthly);
- Seasonal forecast for western South America (monthly);
- Oceanographic analysis of the eastern Pacific (monthly)

Climate change, risk management and adaptation

Climate change is a regular item on the CIIFEN agenda. From the conceptual point of view, the agendas of climate change, risk management and environmental management are not necessarily parallel or independent. The common ground is where the population interacts with the ecosystems and goes about its business. Climate variability is a constant factor that is being affected by climate change. But, in practice, people alter the land, degrading the ecosystems and creating the risk of increased social, economic and environmental vulnerability.

Capacity-building courses

- Regional workshop for South America on managing and rescuing climate data, 2003 (15 countries)
- Regional workshop for South America on climate applications in agriculture, 2003 (16 countries)
- Regional workshop for South America on climate applications in the health sector, 2004 (14 countries)
- Regional workshop on regional ocean and climate modelling, 2004 (8 countries).
- Alexander Von Humboldt international conference: The El Niño phenomenon and its global impact, 2005 (75 countries, 350 participants).
- International workshop: El Niño and its impact on the Pacific basin, 2005 (23 countries)
- Ibero-American workshop on climate change and risk management, 2006 (21 countries)
- Regional workshop: ENSO and its social and economic impacts, 2006 (14 countries).
- Regional workshop on climate-change indices and indicators, 2006 (6 countries)
- Regional workshop on statistical modelling, 2007 (6 countries)
- Regional workshop on dynamic modelling, 2007 (6 countries)
- Regional workshop on agricultural climate risk mapping, 2008 (6 countries)
- Regional workshop on advanced numerical modelling, 2008 (6 countries)
- Ibero-American workshop on seasonal forecasting, 2008 (20 countries)
- Regional workshop on processing climate data, 2008 (6 countries)
- Regional Climate Outlook Forums III, IV, V, VI, VII and VIII, 2003, 2004, 2005, 2006, 2007, 2008 (6 countries)
- More than 35 local workshops conducted at community level throughout Bolivia, Chile Colombia, Ecuador, Venezuela and Peru
- Regional course on statistical modelling, Maracay, Venezuela, 2007
- Regional course on dynamic modelling I, Lima, Peru, 2007
- Regional course on mapping agroclimatic risk, Guayaquil, Ecuador, 2008
- Regional course on dynamic modelling II, Guayaquil, Ecuador, 2008
- Course on climate data analysis and processing, Maracay, Venezuela, 2008
- Training courses for experts in the region at IRI, 2007, 2008

CIIFEN's work focuses on risk management for the local climate as the main tool for devising strategies to adapt at local level because this is the best stage to understand and tackle environmental, social and cultural aspects. Working at local level requires close contact with the authorities and the community, and this does not require scenarios for 80 or 100 years. CIIFEN is promoting the use of RClimdex to establish trends of indicators and indices of climate change on much shorter timescales with a better local approximation. There is also a need to understand the relationships between climate, territory and humans that can partly explain future climate vulnerability. CIIFEN considers that climate risk management can be adapted in the present and resilience achieved gradually.

CIIFEN has taken part in two projects related to climate change, the first on the determination of indices of climate change indicators for the coast of Ecuador and an initial report of these results with possible trends in land use in the area from previously determined climate-risk zones; the work took place in close coordination with the Ecuadorian NMHS (National Meteorological and Hydrological Institute).

A second experience for CIIFEN was its participation in the analysis of the vulnerability to climate change of the biodiversity and population of the Galapagos Islands. This project was supported by Conservation International and the World Wildlife Fund and allowed the conceptual framework described above to be applied to a specific case.

Strengthening capabilities

In all its projects, CIIFEN has worked hard to strengthen capabilities and

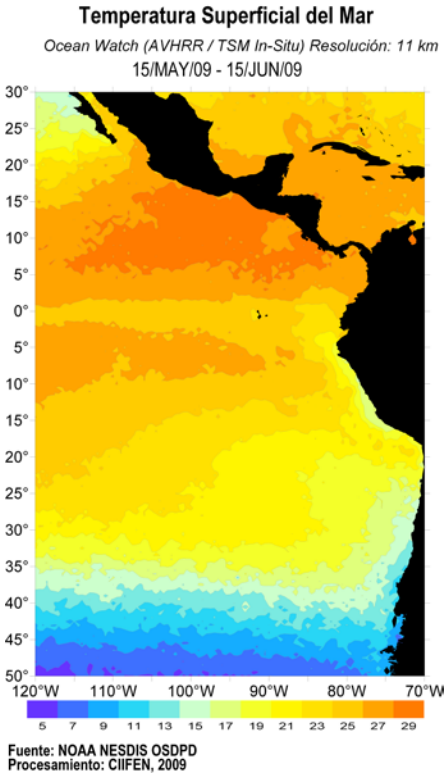


Figure 8 — CIIFEN´s operational Products

set up regional working groups. In recent years, as part of our projects, we have devised many training courses in line with a whole strategy for strengthening capabilities for the provision of climate services (see box on previous page).

As a result, more than 150 experts in the region have been trained, and three active networks or working groups have been consolidated:

- Regional numerical modelling group;
- Regional seasonal forecasting group;
- Regional climate-change indicators group.

Worthy of a special mention is the recent Ibero-American workshop on seasonal forecasting attended by 52 participants from 19 countries and, which is to be held again in the second half of 2009, in Guayaquil, Ecuador.

Final comments

After a difficult path towards consolidation, CIIFEN is celebrating its sixth anniversary in a phase of positive development and a strong position in western South America. There is a growing number of ongoing projects and interaction with the region's institutions , as well as the number of members are growing. Many challenges in prospect that motivate us in our work and enable us to believe that our work on climate applications, user interface, climate risk management and feasible adaptation have been positive and well received by all institutions, organizations and donors. Over CIIFEN's short life we have much to share and much more to offer to benefit the region, so the future looks increasingly promising.

Acknowledgments

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