Seasonal forecasting for Africa: water, health management and capacity building

Philippe Dandin, Jean-Pierre Céron, Isabelle Charon, Jean-Michel Soubeyroux, Yves M. Tourre, Christian Viel, François Vinit, Météo-France, Direction de la Climatologie; Jean-Claude Bader, Institut de Recherche pour le Développement (IRD); Michel Déqué, Flore Mounier, Jean-Philippe Piedelièvre, Météo-France and CNRS, Centre National de Recherches Météorologiques; Laurent Labbé, Centre Africain pour les Applications de la Météorologie au Développement (ACMAD); Cécile Vignolles, Centre National d'Etudes Spatiales (CNES)

Seasonal forecasting takes advantage of the close and energetic interaction between the ocean and the atmosphere. The ocean — which forms most of the Earth's surface – is a slowly varying-changing component of the Earth system, providing a signal that can be exploited for prediction at seasonal timescales. The tropical ocean belt is the primary source of predictive skill at timescales ranging from weeks to months, with a direct impact in the tropics. This enables high predictive skill for seasonal forecasting in many regions of the world, albeit with very different behaviours.

In Africa, many actors take advantage of seasonal climate information, with applications ranging from operational decision processes to research, education and awareness of climate variability, change and impacts. A few valuable examples highlight the principles of the Global Framework for Climate Services (GFCS). Some of them bring obvious benefit which can be estimated, or exhibit virtues required by the framework. Others teach us lessons and shed light on the essential conditions for achieving success in establishing a valuable seasonal forecasting service — or on a larger scale, a climate service:

- Find the parameters, areas and time-lags where skill exists — they can be far from the basic information routinely handled by national meteorological and hydrological services (NMHS)
- Bring together a need, users, scientists covering the domains to be analysed and climatologists
- Share and correlate a few decades of data from both the application sector and the forecasting system — needless to say, success comes from sharing and tenacity.

Image: © IRD

Traditional cultures along the Senegal River, Kayes, Mali

Of course it isn't as simple as that. The first task is to estimate what information can be forecast. Actors come from various domains and cultures, and communication is a long-term endeavour. Data are sparse, missing, and unavailable or often considered as assets that cannot be released. The approach is probabilistic and results are not guaranteed at each trial, so a long-term view is needed to appreciate the benefits; but understanding and accepting the principle of a decision-making process with uncertainties is not that straightforward. And last but not least, the road is long between geophysical or impact forecasts, and decisions or results involve many other factors, quite often having to deal with policy, culture, economy or opportunity. The devil hides in the details, and the value of the forecast must be assessed in the real and complex chain of decision-making — for example, can seasonal forecasting provide manageable information for health when major decisions are taken years in advance? Many difficulties lie ahead when climatologists and users start to consider taking advantage of seasonal climate forecasting, but the potential for applications and success is important and worth the effort.

For climatologists dealing with past and future climates, seasonal forecasting is the application of climate sciences and modelling that permits very quick feedback, and hence continuous progress and development of skills and services. Seasonal forecasting takes full advantage of the entire climatologist's toolbox (numerical climate models, downscaling, observations, statistics, etc). It also implies a deeper knowledge of climate dynamics and geophysics, considers the atmosphere, ocean, continental surfaces, their interactions and climate dynamics. Atmosphericians, oceanographers, agronomists and other impact sectors' specialists have to interact closely. For climatologists, who get involved in forecasting and can be exposed to users' feedback — as well as meteorologists, who can extend the range of their capabilities from weekly or monthly to seasonal timescales — the benefit of elaborating seasonal forecast is tremendous, because of the exchanges and feedbacks. This also explains why capacity building is a key aspect of seasonal forecasting, which definitely must be perceived as a major climate service to develop knowledge and know-how for meteorological services and their users. Seasonal forecasting is a complicated activity and using it requires a real partnership involving mutual education and confidence as well as long-term commitment.

Water management in Western Africa

A flagship application of seasonal forecasting is the yearly forecast for the Organisation pour la mise en valeur du fleuve Sénégal (OMVS), which was created in 1972 to manage the Senegal River basin. The Senegal River is of vital importance for the bordering countries: Senegal, Mali and Mauritania. One of the river's main characteristics is its strong inter-annual variability. During the twentieth century, the average yearly flow varies by a factor of six between dry and humid years, with record flows in 1936-1937 (1,349 m^3/s) and 1984-1985 (above 220 m^3/s). Such variability of course makes water management more difficult.

Water is decisive for agriculture and irrigation. In order to optimize its use, a dam was inaugurated in 1988, close to Manantali. A few years later, the dam started to supply electricity, adding to its expected benefits which were to improve river navigability and stimulate improved agriculture through irrigation. Seasonal forecasting is used to help manage the dam, as described in the Madrid conference proceedings.[1] The water resource management of the Manantali dam is notably based on the scheduling of water releases to flood the downstream valley and consequently to allow recession cultures. Will the end of the rainy season be good enough to allow a sufficient water release for recession cultures and the safety of hydropower production along the dry season? An outlook before the autumn for the next three months helps in taking relevant decisions, making it possible to answer that key question. The natural flow is forecast at Bakel station, far from the dam down the river.

Luckily, the Senegal River has been monitored for a long time. Based on historical flow records, a correlation could be established between seasonal forecasting and flows. Good scores are obtained, including for extreme events. Seasonal forecasting is especially able to capture the critical events — good or bad rainy years — for the dam management. The information is delivered by mid-August each year to OMVS, which can then contribute to the decision-making process, especially on the artificial flooding of the Senegal floodplain, allowing recession culture to start by mid-November.

The Manantali dam seasonal forecast is a brilliant example of climate information being fully integrated to the decision process, and is considered to be one of the necessary inputs leading to decision and then action. IRD and Météo-France also forecast the natural flow of the Niger river, at the Koulikouro station, far from the Sélingué and the future Fomi dams. The correlation is slightly weaker, one of the reasons being that the length of the observations is smaller. Such integrated application illustrates the ingredients required for a successful climate service while delivering benefits of high value:

- Optimization of electricity production with increases up to 40 per cent (in relationship with the year)
- Securing of 50,000 hectares for recession culture four years out of five (compared to one out of five with climatology alone)
- Savings of around 10 per cent of water resources.

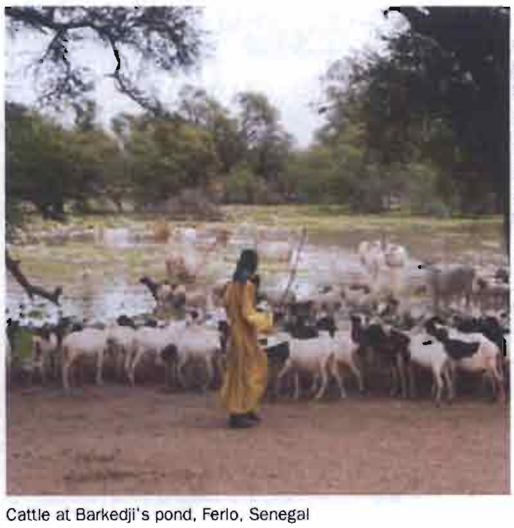

Image: © Centre de Suivi Ecologique (CSE), Dakar

Cattle at Barkedji's pond, Ferlo, Senegal

Cross-cutting partnerships

Water management is a good example of the benefits of seasonal forecasting in Africa, and no doubt similar applications can be found elsewhere or in other domains such as crop yields or health management. Interesting investigations are underway in that field, which covers a large spectrum of potential application. Tackling vector-borne diseases is one of the biggest challenges, but of vital interest because of the high impact on human and animal health, and the economy. Rift Valley Fever (RVF), chikungunya, dengue and malaria, among other diseases, share a common factor: mosquitoes. The lifecycle of mosquitoes is a subtle balance between temperature and rainfall, and suitable sequences are necessary for the development of the larvae. Being able to better characterize the role and relationship between vector, virus and climate variability could lead to better adaptation strategies across the tropical belt, both for cattle management (in the case of RVF) and for humans.

This has been addressed in several projects tackling diseases and species with input from Météo-France, in French overseas territories (for example, dengue in New-Caledonia) or Africa. The main input to risk mapping is precipitation: a project carried out with the Centre National d'Études Spatiales (CNES), the Pasteur Institute, Météo-France and local sanitary agencies in Senegal, taking advantage of satellite images to capture risk areas, has focused on the contribution of seasonal forecasting for reducing the exposure to RVF vector risk. One result was a proposition for adapted strategies for cattle management, an area where many factors play a role. This clearly implies that local actors take part in the adaptation process and enrich the climate service with downstream real-life constraints in order to create a valuable service. It was proven that seasonal forecasting can contribute to an early warning system, taking advantage of various sources of information, and of a partnership between all stakeholders and experts able to deliver that information.

Another project is dealing with malaria — different disease, mosquito, and mechanisms to understand. It aims to use seasonal forecasting for shaping a departmental early warning system. It also follows the 'tele-epidemiology' conceptual framework built by CNES, based on the use of satellite images. Burkina Faso is at the interface between Northern Guinea and the Southern part of the Sahel. It has a temporally limited rainfall season. The climatology shows high seasonality (with important annual differences in terms of precipitation and temperature), causing mosquito populations to fall each year to levels that prevent transmission. For a malaria season to occur, the mosquito population must grow rapidly after the onset of the monsoon, with the right temperature, precipitation and relative humidity in place for at least three months.[2] These factors are the basis for a warning system taking advantage of climate information.

A field campaign has enabled the NMHS to deliver meteorological parameters for 11 villages of the Nouna area. The observations were employed to validate high-resolution meteorological products used with the remote sensing and entomological data in order to calibrate a mosquito environment malaria risk model and evaluate zones potentially occupied by mosquitoes. The second contribution of climatologists qualitatively evaluated the potential of departmental seasonal forecasts. The focus was on the meteorological parameters that are important for the mosquito environmental malaria risk model: temperature, rainfall and relative humidity. These are the same as the ones of the 'fuzzy logic' model for the distribution of stable malaria in sub-Saharan Africa.[3] This kind of approach is an extension of the Boolean ones, enabling the evaluation of meteorological conditions not only as fully suitable or not-suitable, but also to obtain a gradient of suitability. Climate information refines the assessment of the situation.

These types of model were first designed to estimate transmission potential and extrapolations were attempted to evaluate disease outcome. The results showed that there is no real direct possible extrapolation between transmission potential and disease outcome. Moreover, there is often no direct link between meteorological parameters and even transmission potential. This explains the additional use of remote sensing data in the mosquito environmental risk model to convert the meteorological parameters, not only as suitability gradients but also as productive suitability gradient information. Such studies illustrate how complicated the application of related climate information can be, and of course how critical interaction between various scientific communities is for solving such issues, as well as the implication of all existing information resources — satellite, epidemiological, climatological information etc.

Capacity building in Africa

One key issue when tackling societal application of seasonal forecasting is the knowledge available in both the climate and the user communities. From this perspective, capacity building becomes crucial. The Climate Outlook Forums (COFs) provide very good example of capacity building to the benefit of both communities, especially in West Africa with the Presao, one of the first COFs. During the pre-forum workshops, climate knowledge is built or improved thanks to the presence of regional and international climate experts. Such meetings can be tailored to the user domain (like for the water resource domain in

Presao) and they are one of the top priorities of the Commission for Climatology, including dedicated COFs like the Malaria Outlook Forums.

In the frame of the GFCS, a key issue is to ensure that the most advanced science is efficiently transferred to the operations, so the best climate science can be immediately used for decision-making and action. The capacity building done during the pre-forum workshops are a perfect opportunity to prepare these evolutions on both sides, including users. For example, the Presao Second Generation introduced the use of Global Production Centers (GPC) information to forecast the main characteristics of the rainy season and tailor products to regional and national users in a more sustainable and relevant way, as the products can be prepared for each period they are needed.

In addition, some countries are sharing climate characteristics across different World Meteorological Organization (WMO) regions like the Mediterranean Basin. This led to the concept of transregional COFs and to some challenging capacity building exercises as the climate knowledge, national capabilities, stakes, and consequently the impact of current climate variability can be very differently perceived across wide areas like these.

Météo-France, as GPC, leader of the RA VI Regional Climate Centre network node for long-range forecasting and also as NMHS, has been deeply involved in such activities since the beginning of the COFs in 1998. It is one of the driving forces of the Presao Second Generation in West Africa and supports new COF initiatives such as the one in South-East Europe or the COF planned for the South-West Indian Ocean (September 2012).

Lessons learned

Seasonal forecasting recalls for the need for — and benefit of — long-term observation and series.

The Manantali hydrological or vector-borne disease applications show that valuable climate information can be delivered today, taking advantage of the state-of-the-art products and knowledge available in the WMO GFCS framework. While direct application of seasonal forecasting into decision-making processes is not that simple, and there is a need for research efforts on subjects which are as yet poorly known, some examples already pave the way for further work and lessons can be learned from these. Clearly, the availability of long series of observation, both for climate data and impact data, is a determining factor. In previous centuries, various organizations have aimed at developing the economic use of the Senegal River waters, and for that purpose made observations. Long records are therefore available today, and of the utmost importance for setting up a climate service that can tackle a high variability and grasp some past occurrences of extreme events. And it stands to reason that monitoring the terrestrial system today is a key to understanding, predicting and optimizing activities in the future.

Hydrologists from the French Research for Development Institute and climatologists from Météo-France have worked together to build a predictive system based on seasonal forecasting. It was proven that seasonal forecasting could capture the yearly variability of precipitation, enabling flow and extreme events — being generated by extremely dry or wet years — to be reasonably well predicted. Meteorologists alone would never have achieved success in efficiently work on the Senegal River's flow regimes. They needed to join forces with hydrology scientists.

Similarly, without the user being at the core of the decision-making process, and without the strategy for the development of the Senegal River basin being structured as an international organization, having a perfect knowledge of all the requirements for the various uses of water in the area, knowing the ins and outs of the dam management and all other hidden agendas, the information would have been void. Science is difficult enough: all stakeholders have to join forces to make climate information alive and fruitful!

Image: © ACMAD

Météo-France, CCI and Western African climatologists exchange views on the coming rainfall season during the PRESAO meeting at ACMAD, Niger in 2008

CLIMATE EXCHANGE

World
Meteorological
Organization
Weather • Climate • Water

Climate ExChange

World
Meteorological
Organization
Weather • Climate • Water

DISCLAIMER

The views expressed in this publication are those of the individual authors and do not necessarily reflect the views of the publisher.

This publication may be freely quoted. Acknowledgement of the source is requested. Requests for the reproduction or translation of this publication should be directed to the publisher.

ISBN 978-0-9568561-3-5

Tudor Rose

Published by Tudor Rose
www.tudor-rose.co.uk