The application of climate forecasts and agrometeorological information for agriculture, food security, forestry, livestock and fisheries

G. Maracchi7, F. Meneguzzo8, M. Paganini9

Abstract

Late in the ’70s, as a consequence of the dramatic drought that occurred in West and East Africa, the famine struck millions of people. The affected areas were faced with the need to provide the appropriate tools to facilitate the mobilization of measures aimed at mitigating the impact of recurrent droughts. The technological evolution of the 90’s in telecommunications (the Internet) and information technology (hardware and software) enabled the experimentation of innovative operational approaches. Still in evolution, the Food Early Warning Systems go towards the integrated management of the structural vulnerability analysis, addressing the environmental aspects as well as socio-economic ones.

Enhanced seasonal forecasting for the Sahelian region and deeper knowledge about teleconnections and their effects in this area of the world have permitted to better predict and anticipate eventual food crises as well as difficult situations that especially rural populations could face.

Additional input as well as validation of the available information about the development of the season and of food security conditions are brought by the monitoring activities. The monitoring of the environmental and agricultural production is produced by several Institutions and represent relatively long series of historical data.

All this information leads to a better knowledge of the structural conditions of the sahelian countries as well as a more accurate prediction of the current variability in order to increase the food security of local populations.

Introduction

The main emphases of the existing food security systems have been to collect and organize climate, land use, demographic and economic data, and to improve understanding of the physical processes involved at various spatial and temporal scales. This has allowed the realization of operational tools to manage weather related uncertainties, mainly erratic rainfall, and the possible impacts of climate variability. Also the National Meteorological Services have implemented, since 1983, agrometeorological assistance programmes with the objective to contribute to national and regional strategies and operations dedicated to enhancing crop production and food security.

The present paper is a proposal for a broader experimentation of contributions to harmonize the efforts made to reduce food insecurity by improved regional capacity to produce and apply seasonal climate prediction in the Sahel.

The use of seasonal prediction for decision-making would contribute to the adaptation to global change. This can be achieved by further research and networking and organizing meetings, as well as training for technical personnel of the Sahelian organizations and the international institutions dealing with those issues.

7 Prof. Giampiero Maracchi, G.Maracchi@ibimet.cnr.it, IBIMET – CNR, Phone: +39 055 30 89 10, Fax: +39 055 30 14 22
8 Dr. Francesco Meneguzzo, meneguzzo@lamma.rete.toscana.it, LaMMA –Regione Toscana. Phone +39 055 8976213, Fax +39 055 8969521
9 Michela Paganini, M.Paganini@ibimet.cnr.it, IBIMET – CNR, Phone: +39 055 30 89 10, Fax: +39 055 30 14 22
Food Security

On the basis of the current knowledge, the present document first wants to highlight the main food security systems existing and working in West Africa, the parameters on which they base their analysis, as well as the type and information contents of the final outputs.

Agrhymet SISP

SISP has been developed after several years of experience in the Sahelian region. The main aim of SISP is to use and integrate different information sources and different analysis procedures to allow the meteorological services a dekadal growing season monitoring and provide national early warning systems with useful information about the evolution of crop conditions.

The system has a modular structure and an easy user interface oriented to provide National Meteorological Services with a simple methodology for agro-climatic characterizations, season monitoring, crop growth assessment and yield forecasting, based on the most common and easily obtainable agrometeorological parameters.

USAID FEWS-net

Baseline information comprises a set dedicated to answering the fundamental question of how people survive in most years. Within homogenous zones and economic groupings, the basic requirement is to piece together how typical households obtain food, cash income, and spend their money in most years. The relative importance of these options provides the critical reference point for understanding how shocks will affect these households. Hazard information is brought together in order to answer the question: what is the nature and magnitude of the problem facing particular communities?

A hazard can be thought of as an external cause or catalyst that results in specific economic consequences within a particular geographic area. Typical hazards might include wars, droughts/floods, or even policy changes.

Typical shock factors would be changes in production levels (crop, livestock, fishing or wild food) or changes in markets (either in terms of physical access or prices) or even changes in transfers (such as government entitlement programs).

Risk or Outcome Analysis is conducted in order to answer the question: what effect will the problem (as specified by the hazard information) have on households’ access to food (as described by the vulnerability information)?

The output can be under form of: Spreadsheet Analysis/Emergency assessments/Scenarios/Linking the information to decision-making.

Diagnostic Hydrique des Cultures – Champs pluviométriques

The spatial version of the DHC software has been developed with the support of CIRAD/CA. The input data are not submitted to the data collection, because they are based on methods of rainfall estimate from METEOSAT images (resolution of 25 km). The input data of the model are the CCD, maximum and minimum temperatures. The final results deal with the calculation of the seasonal forecast on the 1st of August and with the estimation of various crop yields.
WFP - Vulnerability Analysis and Mapping

Given this understanding of the causal structure of vulnerability, the analysis of vulnerability should begin with the identification of individual sources of income for distinct population groups. An understanding of the structure of income for each group of concern is critical to assess the risks that households face in their productive activities, as well as their ability to cope with those risks. The analysis of vulnerability is typically undertaken in three stages:

- Identifying the important income sources for each population group;
- Analysing the causal structure of vulnerability to understand why particular population groups are vulnerable;
- Reconciling the analysis of risk and coping capacity across income sources into an overall analysis of current or chronic vulnerability conditions.

FAO – Global Information and Early Warning System

The System’s goal is to provide policymakers and policy-analysts with the most up-to-date and accurate information available on all aspects of food supply and demand. In doing so, it provides regular bulletins on food crop production and markets at the global level and situation reports on a regional and country-by-country basis.

Climate Characteristics

West Africa has generally a dry tropical climate. It is under the seasonal alternation of moist air from the monsoon coming from oceanic high pressure and dry air from the Sahelian latitudes. The main characteristics of the climate can be defined as follows:

- Two marked seasons; a rainy season (hivernage) and a dry season;
- A unimodal rainfall curve;
- A dry season which is at least as long as the rainy one;
- A total absence of a cool season (the annual minimum monthly temperature is > 18° C); and
- An increasing aridity from south to north.

Teleconnections

Various leading modes of variability at the planetary and regional scale, as identified by means of statistical analysis of near surface, mid- and upper-atmosphere quantities, as well as at the ocean surface, were found in recent years, which represent and explain the climate variability at different extents, on different time scales and over different areas (and area size). Few of such modes do in turn produce recognisable effects, in a causal chain, to several areas somewhere over the Earth, sometimes at a regional basis and occasionally even at very remote areas, either (both) simultaneously or (and) at lagged times, over specific seasonal periods or year-round.

The leading modes which have been identified as the most important with regards to the atmospheric consequences to relevant areas in the world are the El Niño – Southern Oscillation (ENSO), the North Atlantic Oscillation (NAO) and the recently discovered Jet Stream Waveguide circumglobal teleconnection pattern. Regional teleconnection patterns, are also important to specific regions, such as to the West Africa monsoon.

One of the most widespread teleconnection patterns is the NAO/AO, whose effects concern mostly eastern North America, Europe, the Mediterranean and northern Africa and are synthetically represented in the Figure 1.
The main features of the West Africa monsoon (figures 2 and 3) are connected to the anomalies of sea surface temperature, with stronger effect from the Guinea Gulf and to a lesser extent from other Tropical oceans (Pacific, Indian).

At least the onset of the West Africa monsoon is driven by SST anomalies in the Guinea Gulf. Warmer SST lead to delayed monsoon, and the SST trend in the month of May just suggests a strong increase. The monsoon could thus be occurring later and later in the summer. Late summer Guinea SST show relevant stationary, and their effect to the monsoon is limited, if any. Instead, warmer air temperatures could cause more rainfall in late summer in the Sahel.
The average of the weather over periods longer than a month represents the most recognized definition of the concept of climate caused by multiple factors, among which the effects of changes in sea surface temperatures in the Pacific Ocean. Because those changes can influence temperature and rainfall patterns in regions that are far away from the Pacific we easily understand how the knowledge of teleconnections is critical for seasonal prediction and food security issues.

Existing climate predictions

The International Research Institute for Climate prediction

The IRI Forecasting Research Group provides a seasonal climate forecast. This forecast is a net assessment (or distillation) of information from a variety of climate prediction tools, including:

- Coupled ocean-atmosphere model predictions of tropical Pacific SST covering the forecast period. Particularly heavy weighting has been given to predictions from the coupled model operated by the NOAA National Centers for Environmental Prediction, Climate Modelling...
Branch. This model suggests a continuation of near-average conditions during the first forecast season;
- Statistical forecasts of Indian Ocean and Atlantic Ocean sea surface temperature developed by the IRI;
- The response of Atmospheric global circulation model (GCM) predictions to the present and predicted SST patterns;
- Statistical analyses;
- Appropriate Regional Climate Outlook Forum consensus guidance.

In the precipitation outlook, maps show expected precipitation probabilities in tercile classes. The maps indicate probabilities that seasonal precipitation will fall into the wettest third of the years (top number), the middle third of the years (middle number) or the driest third of the years (bottom). The output has a resolution of 2.8° and is issued twice a year.

Omotosho – Prediction of the onset of growing season

The present rainy season onset prediction scheme for West Africa is the result of a recent study by Prof. J. Bayo OMOTOSHO from Nigeria. The method is empirical/dynamical and uses the U-component of the wind at the surface and upper levels. It requires that the:

- Difference between the U-component of the wind at 3000 m (700 mb) and that at the surface must be between –20 m/s and –5 m/s;
- Difference between the U-component of the wind at 7500 m (400 mb) and that at 3000 m (700mb) must be between 0 and 10m/s.

Please note that the rainy season onset prediction for West Africa as a whole is a new development and is being made for the first time. The forecast should therefore be used with caution. An update to this prediction will be made by the 2nd June 1999.

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>STATIONS</th>
<th>PREDICTED ONSET DATE</th>
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<tbody>
<tr>
<td>Niger</td>
<td>Niamey</td>
<td>18 May – 06 June</td>
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<td>Maradi</td>
<td>16 May – 06 June</td>
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<td></td>
<td>Birni N’Konni</td>
<td>16 May – 06 June</td>
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<td>Gaya</td>
<td>12 May – 02 June</td>
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<td>Burkina</td>
<td>Bobo-Dioulasso</td>
<td>26 May – 15 June</td>
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<td>Faso</td>
<td>Dedougou</td>
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<td>Gaoua</td>
<td>23 May – 12 June</td>
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<td>Boromo</td>
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<td>Kayes</td>
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<td></td>
<td>Tombouctou</td>
<td>13 June – 01 July</td>
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Table 1: 1999 predicted onset date for some West African stations

The method gives the date of the rainy season onset 2 to 3 weeks ahead after the above conditions have been satisfied for 3 consecutive weeks. The scale of the analysis is over the Sahelian region, from the Senegal to Chad.
IBIMET – short term prediction of the onset of the growing season

The development of this methodology has followed three different steps in order to assess the onset and the development of the growing season in Mali, with particular attention to the determination of the seeding date.

**Step I** – Study of the average decade of onset of the growing season on long series of data. The data utilized were the rainfall data bank of the AGRHYMET Regional Centre, and the tool used has been the Data Bank Management System of the AP3A project.

**Step II** – Determination of the seeding date and evaluation of the crop installation using the SISP system.

**Step III** – Operational application of the climate predictions: the philosophy of this application is to utilize the information already available on the Internet. The first step has thus concentrated in the seeking of the sites concerning the meteorological information, the types, the availability and the update rate of this information. The scope of the exercise is to predict the seeding decades for the different zones in order to produce – with a certain advance – advise to the peasants concerning the most opportune moment to seed.

**Monitoring activities**

The monitoring activities represent an added value to the system analysis both because they allow to evaluate the conditions of the wet season on the agricultural and food situation as well as the conditions and the effectiveness of the Early Warning Systems and of the mechanisms of crisis management.

Several tools exist dealing with food security and primary production in the Sahelian region. Most of them are based on the meteorological stations and the field enquiries; recently a portion of the monitoring activities dealt with remote sensed information, supposed to be more objective, near real-time and validated data sets.

**Conclusions**

It is debatable whether or not the West African region is in any way unique with regard to seasonal climate forecasting – i.e. are there any aspects of the causes of climate variability unique to this part of the world? There is little doubt, however, about the extreme nature of climate variability observed over the last century or so.

For tropical West Africa, Hulme (2001) sees two general paradigms with regard to our current understanding of the observed climate swings in the African Sahel: first, remote forcing of rainfall through ocean-atmosphere interaction and, second, regional feedback processes involving land cover characteristics. Within the former paradigm, the possibility that anthropogenically induced changes in global atmospheric composition are affecting Sahelian climate must be considered. Within the latter paradigm, the ‘neglected’ role of Saharan-Sahelian dust aerosol should be considered (Hulme, 2001). However, the effects of any artificial influence on global or regional climate should eventually be assimilated by better, coupled ocean-atmosphere dynamical modelling techniques.

Hulme (2001) acknowledges the association between the variability of Sahel rainfall and SSTAs (local or remote) made by Ward (1998) and other authors (e.g. Chang et al., 1997) before calling for more research into the possible effects of localized, land-based feedback loops. Hulme cites the work of Xue (see, for example, Xue and Shukla, 1998), who has used GCM modelling to simulate the effects of land cover modification on the long-term rainfall trends, in a call for further research in this field.
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General references


ENSO


Food security


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