Current Advances in the Science of Climate Prediction: Capacity for Agricultural Applications in Africa

L.A. Ogallo[2]

Introduction

Climate plays a key role in the socio-economic activities of many sectors in Africa where many of the national economies depend heavily on rain dependent agricultural activities. Fluctuations in climate conditions such as the occurrence of climate extremes result in significant fluctuations of the production system and impact negatively on the economies. Climate of any specific location determines the crops that can be grown, the farming system that can be adopted, the sequence and timing of farming operations. For crop production total temperature characteristics; annual amount of rainfall and, seasonal distribution; variability both temporal and spatial; reliability within and between seasons and years; soil type; intensity and infiltration into the soil; balance between rainfall and evapo-transpiration among others are also important. During the crop-growing season there are periods, such as the grain formation stage, when lack of water becomes critical for growth.

Rainfall is therefore the most important climate parameter for agricultural production in Africa. Rainfall received at any place is determined by the climate of the specific location. Inter-annual climate variability that often leads to recurrences of climate extremes such as floods and droughts often have far reaching impacts on agricultural production. Climate monitoring and timely early warning of climatic extremes, with respect to onset, severity, cessation, duration, time evolution, geographical extent, and impact on associated agricultural production systems such as water resources, transportation, energy, among many other socio-economic sectors and formulation of appropriate strategies, can be used to improve agricultural production in Africa. This paper highlights the major challenges to climate prediction in Africa for agricultural applications.

The keys issues addressed in this presentation include:

- Impacts of climate extremes on agriculture in Africa and livelihood of peasant farmers;
- Needs for climate prediction and early warning for agricultural applications;
- Advances in the science of climate prediction;
- Current African capacity in climate prediction;
- Challenges and way forward: Strategies for applications of climate prediction in agricultural sector Africa. Recommendations to WMO, NMHSs, scientists, universities/research institutions and the sectoral users.

Climate Information Required for Agriculture

Climate information required for agriculture varies from one application to another and sometimes from one region to another. The required information can however be classified as:

- Future expectations: Will it rain on my farm tomorrow; when? How about next month/ year? How much?
- Current / near real time information;
- Past climate information for agricultural planning and management.

[2] Drought Monitoring Centre Nairobi and Met Dept., University of Nairobi

Such information includes rainfall amount, onset, and cessation; mean temperature, maximum and minimum; distribution of wet, dry, cold/warm spells, extreme weather/climate events.

Such information is often required at farm level. It should be noted that many major rivers in Africa are shared by several countries that requires close coordination if the use of such water resources is to be optimized without creating regional conflicts. Thus application of climate information in agriculture has both national and regional perspectives.

The State of Climate Prediction and Capacity in Africa

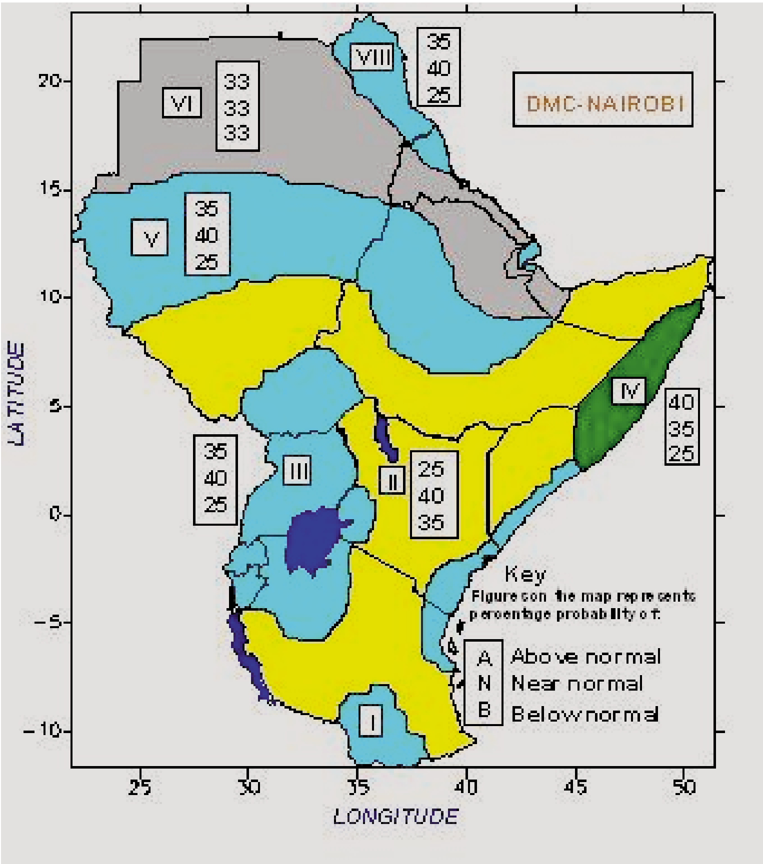
The fundamental tool in prediction is availability of a good climate model. In general, climate models may be classified as:

- Statistical models;
- Dynamical methods;
- Hybrid: Dynamical-Statistical model.

Statistical methods use statistics derived from historical data (history of the past) to predict the future. Statistical models range from simple models derived from simple probability and regression principles to complex and non-linear statistical models with predictors derived from complex empirical orthogonal functions. Such models assume that the future will obey natural laws of the past and present, which in terms of statistics may be referred to as a stationary system. Most of the models used in Africa are largely statistical. In Africa, the capacity to ensure that the NMHSs use of similar statistical models within the various sub-regions of Africa has been undertaken by ACMAD and the DMCNs during the within the auspices of the regional climate forums. Some examples of seasonal prediction products derived from statistical methods are shown in figure 1.

Dynamical models attempt to mathematically represent the known biogeophysical characteristics of the Earth's climate system. Most of the known biogeophysical processes are very complex and are not easy to represent with simple mathematical equations. Dynamical models are therefore often very complex and require very high computing power. In order to predict the future, current observations are usually used as initial conditions to integrate the dynamical model to the future.

The hybrid models are models that attempt to combine both dynamical and statistical approaches. Dynamical models use models of the global climate system often referred to as general circulation, (GCM) models. Dynamical, including regional, models are available at few climate centres of the advanced countries. Apart from South Africa and a few other African countries, many African countries rely largely on the advanced centres GCM products without adequate capacity to interpret and verify the skill of such models in the region. This is a serious challenge to ACMAD and the DMCNs. DMC-Nairobi is currently running some trial dynamical models in conjunction with IRI through support by USAID. Some of the DMCN dynamical products are given in figure 2.



Climate outlook for October to December 2002

Fig 1a: Greater Horn of Africa (GHA) in October to December 2002 season climate outlook by DMCN

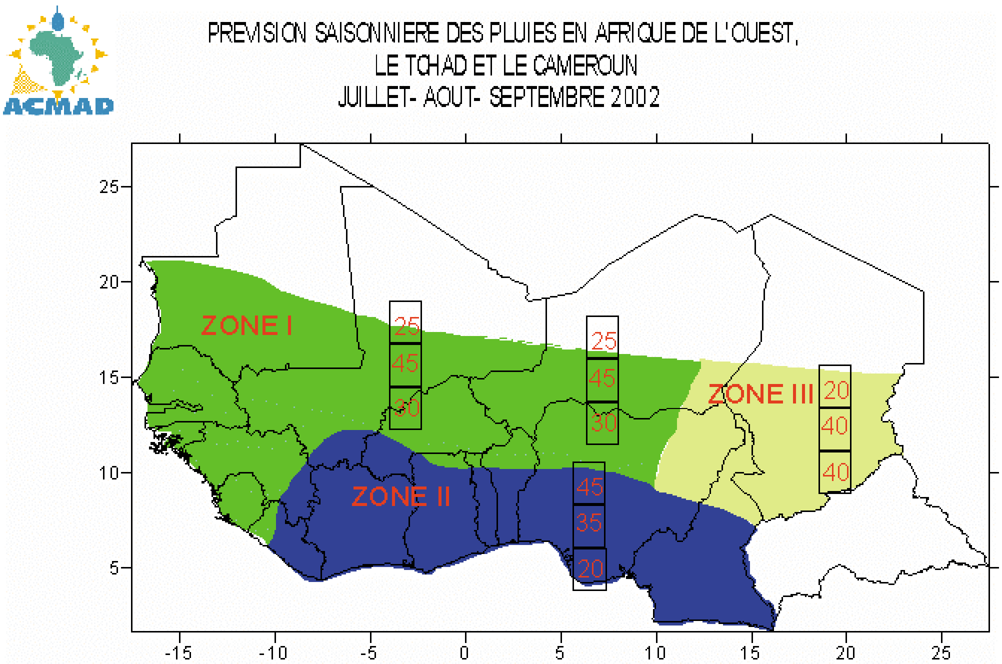


Figure 1b: The Sahel climate out look by ACMAD

Seasonal Prediction of Rainfall in West Africa, Chad and Cameroon (July-August-September 2002)

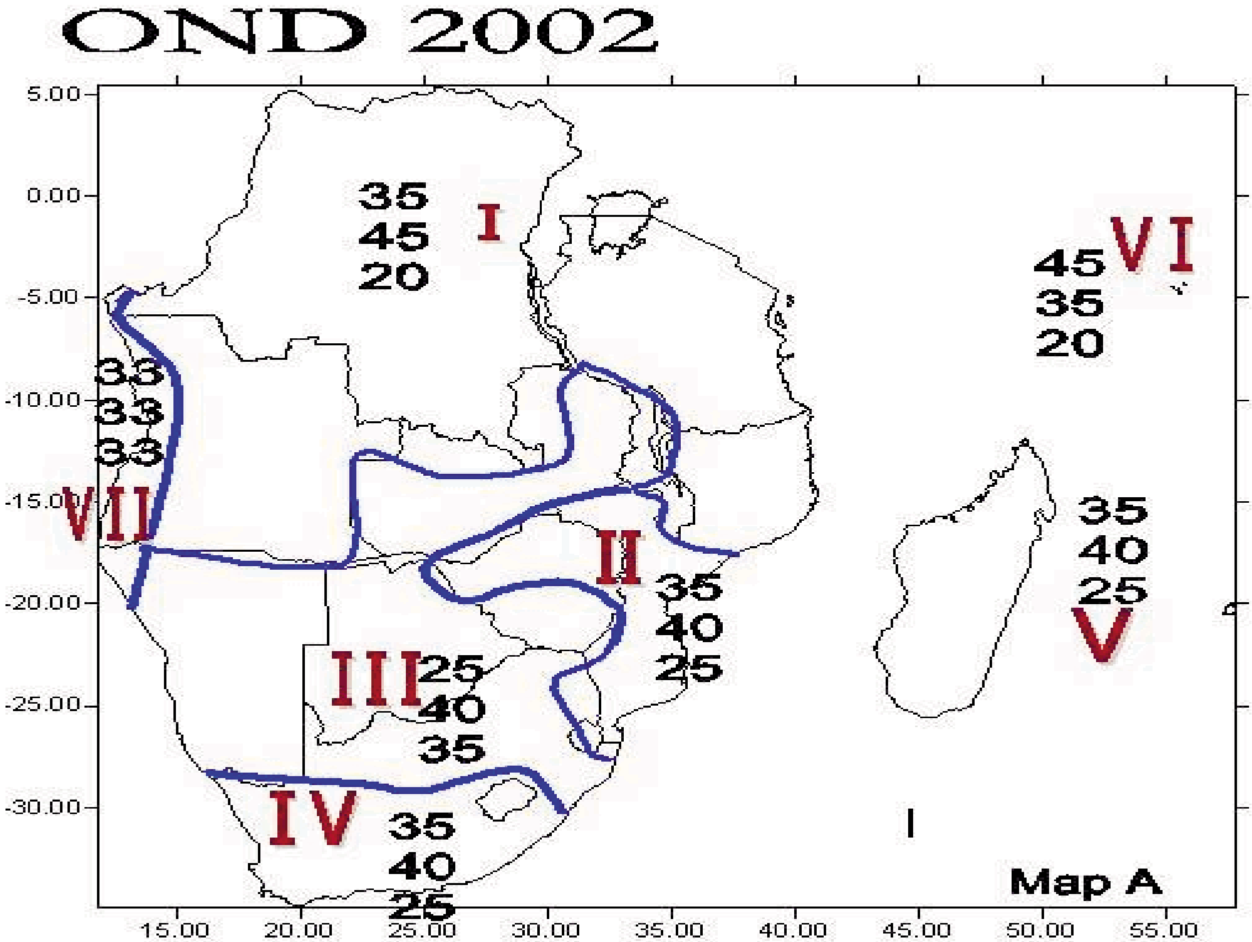


Fig 1c: SARCOF Climate out look by DMCH

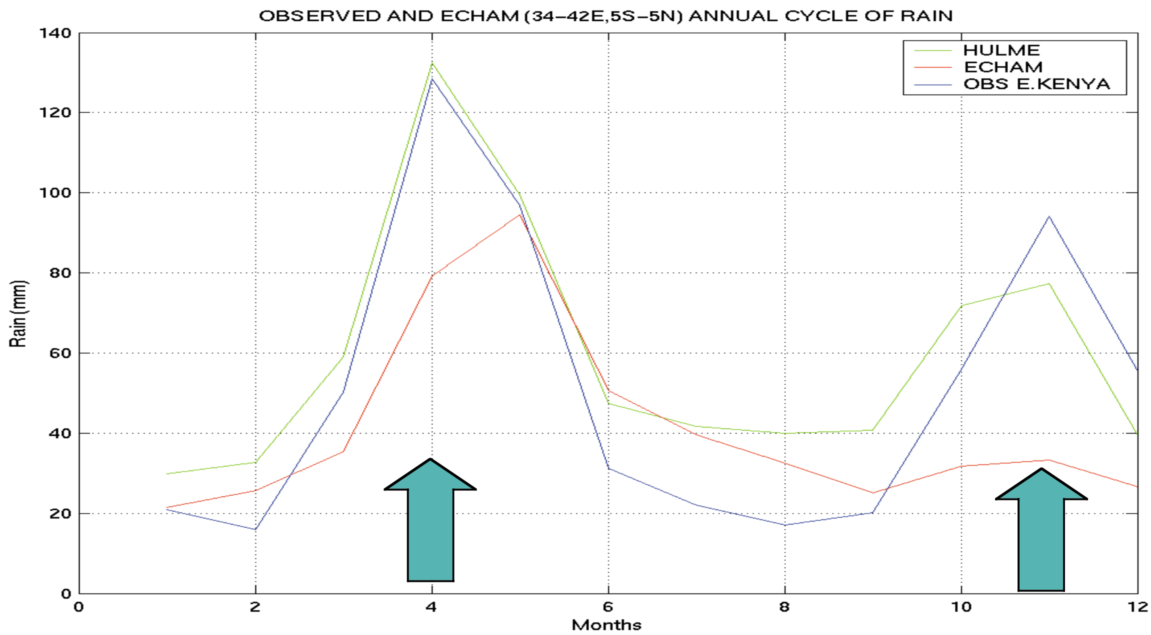


Fig 2 Climatology and ECHAM Skill a). Seasonal Patterns

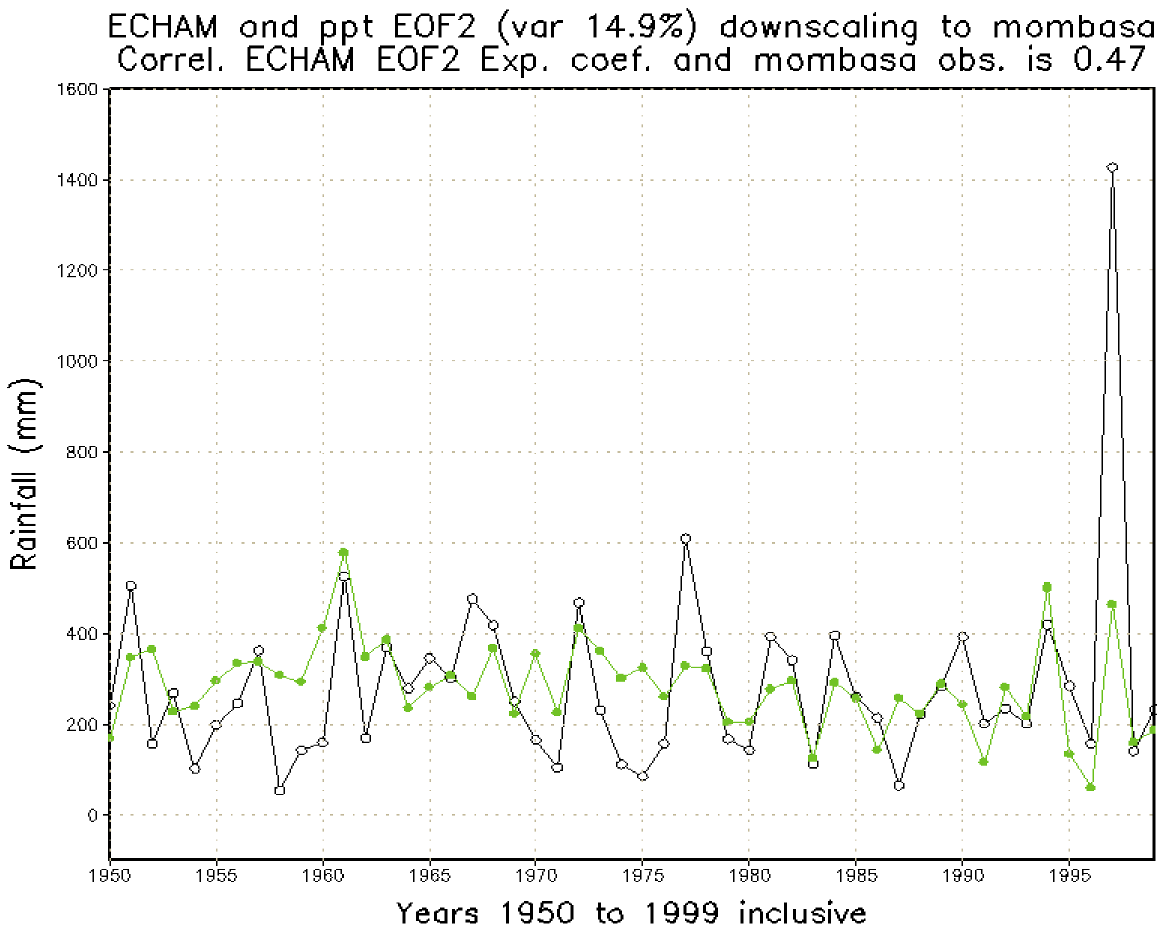


Fig 2b Inter-annual variability

In general, the skill of any model depends on the required time and spatial scales for prediction (Table 1). In general, the skill decreases with the increase in the temporal scale, but increases with an increase in the spatial scale.

	SPATIAL SCALE OF PREDICTION			
TEMPORAL SCALE OF PREDICTION		LOCAL / MICRO SCALE	REGIONAL / MESO SCALE	LARGE/ MACRO SYNOPTIC SCALE
	SHORT RANGE			
	MEDIUM RANGE			
	LONG / EXTENDED RANGE			

Table 1. Prediction time and spatial scales

Challenges and way forward

The recommendations that could be used by WMO, NMHSs, climate centres, scientists, universities, and the users include how to address the following issues among others:

- Building of regional capacity for climate modelling and prediction especially down-scaling of information for agricultural uses;
- Address issues related to dynamical and probabilistic products, especially with respect to the specific requirements of users such as amount, onset date, wet/dry spells etc. that are required by many users;
- Verification by both the climate group and the users;
- Timely availability for information;
- Observation and reliable data base;
- Development of climate/weather-agro models;
- Strengthen the capacity of African climate centres and the NMHSs;
- Strengthen linkages with international centres;
- Availability of an integrated national disaster management policy with climate well factored;
- Education, awareness and training of users;
- Need for a pilot application project to address some of the listed challenges.