Climate Change

Impacts on Water and Agriculture in West Africa

Fula woman from Mali with a water jug (Source: Barrière – IRD, 2013)

Summary

Synthesis

Climate change is going to affect all aspects of the water cycle. The quantity and distribution of precipitation, the frequencies and duration of droughts, as well as evaporation rates and the water balance at plot level will be impacted by climate change.

The African monsoon, which regulates the lives of 300 million West Africans, is evolving: the monsoon's year-to-year variability will increase, as will the occurrence of extreme rainfall.

Agricultural activity will be more or less strongly affected by this change depending on the agro-ecological zone and particular economic activity.

The main scientific studies concur: mean annual runoff and groundwater recharge will decrease and competition for water will be exacerbated by growing demand for water by other uses, such as hydro-electric generation.

Studies conducted by the African Monsoon Multidisciplinary Analysis (AMMA) are clear in stating that the variability in precipitation both in space and in time will be a real constraint on farm production.

Society will need to adapt.

Yet we should not underestimate the complexity of any given approach; thus, irrigation schemes should be consulted and agreed upon by all downstream principals and water users involved, even from a neighbouring country.

Many methods and their local variations exist to mitigate the vagaries of water availability. Most try to increase production while at the same time reducing dependence on, and vulnerability to, inputs and limiting their negative effects on the environment.

Techniques include water saving methods and methods to conserve biomass and soil fertility.

Introduction

The first part of this report will present regional precipitation forecasts and their potential impacts on agricultural activities. We will cite the work of Sultan et al. at AMMA (2005) and McCartney et al. (2012) as well as work undertaken at the International Food Policy Research Institute (IFPRI).

The second part will first review the complexity of water management due to the multiple claimants on water use and then take a look at adaptive mechanisms to water management.

Translation: Peter Gaechter, SOS Sahel

The African Monsoon

"The Monsoon shapes the lives of 300 million West Africans. The intensity and duration of its rains determine the harvests and water resources – and therefore the level of food security. In less than four months, from June to September, the Monsoon brings the greater part of the year's rainfall". (extract from IRD scientific news-sheet n°328, 2009)

CSIRO: *Australian Commonwealth Scientific and Industrial Research Organisation*

MIROC: *Model for Interdisciplinary Research on Climate (University of Tokyo)*

AMMA: *African Monsoon Multidisciplinary Analysis (AMMA, http://www.amma-international.org)*

1. Impacts on water and agriculture

1.1. Impacts on water: work by de Mc Cartney et al.

Repercussions of climate change on water resources in the Volta River Basin shows significant uncertainties as to the severity of its impacts.

On the whole, annual average precipitation, mean runoff and groundwater recharge will all decline. This decline in water resources comes with an increased basin-wide demand for water for the production of energy (hydropower) and for irrigation.

The authors demonstrate that, in an optimistic scenario (Scenario A1B of the IPCC), irrigation delivery will cover 75% of demand by mid-century; by 2100 the situation will have worsened: only 32% of demand will be covered.

Work by CILSS for example shows the inter-seasonal variability of flows between1950-1969 and recent years. Water rises rapidly, there is an important reduction in the amplitude of the rise in water levels in Mali, and a two-month shift of the centre of this rise from February to December, as well as an increase in the low water period from two months (May and June) to four (March to June).

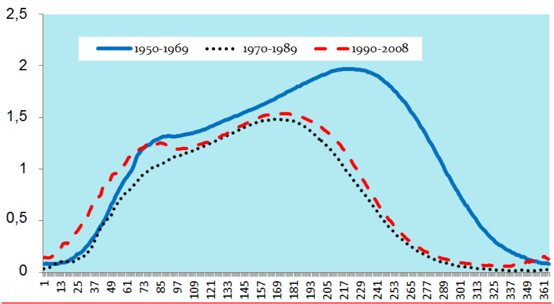

Figure 1 - Inter-seasonal variability of flows at Niamey (Niger) expressed in ,000 m³/day (Source: CILSS)

1.2. Impacts on agriculture: work by AMMA

Certain constraints on agricultural activities have been well documented in recent times. Thus Sultan et al. at the African Monsoon Multidisciplinary Analysis (AMMA) show that excessive variations in rainfall both in time and in location are a real brake on agriculture.

To show how, the authors used the response of potential yields with a variety of millet with a 90-day growing season at Niamey as a function of the date of seeding, using real, observed climatic data from 1968-1990.

The ideal seeding date, that which maximized yields, is closest to the regional onset of the monsoon. Simulated yields are much higher on those dates than those for "traditional" seeding dates based upon the appearance of rainfall locally.

Knowledge of the regional climatic dynamics (a prediction of the onset of the monsoon on a sub-regional scale) may thus have a major impact on regional cereal production.

1.3. Impacts on agriculture: work by IFPRI

According to IFPRI (2013), climate change will affect productivity of the principal crops in the region (maize, millet, rain-fed rice, groundnut, etc.), but especially sorghum and groundnut, with declines of between 5% and 25%, combined with a loss of cultivable land in the North of the Sahel:

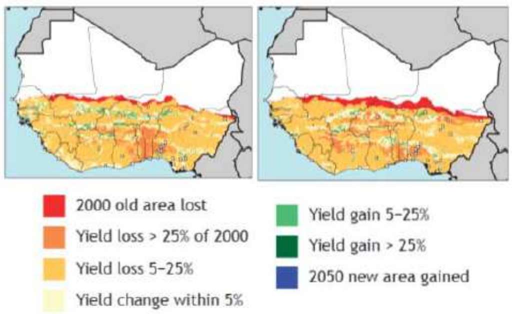

Figure 2 - Variations in yields for sorghum in 2050 compared to 2000. CSIRO model left, MIROC right (Source: IFPRI, 2013)

For sorghum the decline will be significant (>25%) for Togo, Benin and adjacent zones in Ghana and Nigeria. Both models predict declines in the Sudanian zone from Senegal to Nigeria.

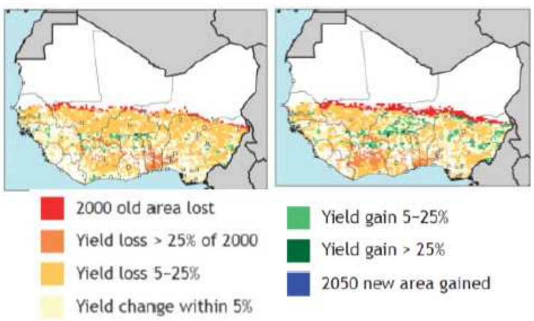

Figure 3 - Variations in yields for groundnut in 2050 compared to 2000. CSIRO model left, MIROC right (Source: IFPRI, 2013)

For groundnut production, the two models agree on a small general decline in the coastal zone of Guinea, Liberia and Sierra Leone. In northern Ivory Coast, in Ghana, Burkina Faso and Nigeria, local production may however increase by between 5% and 25%.

2. Methods for adaptation

2.1. A complex setting

African populations will have to adapt to climate change, especially to fewer and increasingly less regular rains. Water management must improve, whatever its designated use – whether for human or animal consumption or for agriculture. The complexity of the methods should not be underestimated.

Irrigation, for example, is often showcased as a central method to reduce the vulnerability of agricultural production systems. Yet large-scale irrigation schemes may exacerbate competition for water resources between, for example, agricultural and pastoral users.

Wells, often used by nomadic and transhumant herders, may dry out in the medium and long term, and water quality may also be affected.

Figure 4 – Well in a dried out riverbed, Dierma region, Burkina-Faso (Source: BOURNOF - IRD)

Irrigation methods that use water sparingly will need to be favoured.

With this in mind, the activities planned in the "agricultural water" component of the Regional Agricultural Investment Program (RAIP) of ECOWAS provide for the "strengthening of irrigation development initiatives", particularly by "sharing the most convincing experience of the sub-region" by:

- Using small-scale methods of irrigation which use water sparingly;
- Developing lowland areas;
- Constructing water collection and storage works.

Figure 5 – Improved water management using the *System of Rice Intensification"* (SRI) in Benin (Source: Agrhymet, 2014)

2.2. Regulating water use

In a case study of the Korsimoro reservoir in Burkina Faso by De Fraiture et al. (2014) the authors show that "pirated" irrigation can swiftly exceed authorized irrigation.

Small vegetable producers above the reservoir may be seen as innovative pioneers who exploit the reservoir profitably but also as "water pirates" who expropriate water to the detriment of the official downstream groups of users.

Local water committees (CLE), such as those established in the Nakanbé Basin in Burkina Faso, are able to manage water resources on the scale of the sub-catchment areas.

2.3. A multitude of methods

Many methods and their local variations exist to mitigate the vagaries of water availability. These methods have been described in numerous technical documents sometimes even before international meetings put the spotlight on adaptive responses (Roose, 1994).

These methods are an attempt to increase production while at the same time reduce dependence on, and vulnerability to, inputs and limit their negative effects on the environment.

Figure 6 – The gardens at Akodédé, Bagzanes, Niger (Source: ANTHELME – IRD))

Large-scale irrigation plans threaten to exacerbate competition for water resources among, for example, agricultural and pastoral users.

The gardens at Akodédé, Bagzanes, Niger

Among the rocky chaos on plateaus of clay soils at 1500 m, irrigated gardens grow wheat and citrus fruits and figs but also potatoes and peaches

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In the Sahel for instance, sorghum stalks are spread on the ground, about 2 or 3 per m^2. The straw provides organic matter, reduces evaporation from the soil and breaks wind erosion. It is a small contribution to maintaining soil fertility.

Applying synthetic fertilizers to assist plant growth is another one of these methods but is often impractical for financial reasons.

Figure 7 - Potatoes in an irrigated valley at the foot of dry debris cones - Ribeira das Patas Basin, Santo Antao, Cape Verde (Source: BOULVERT – IRD, 2013)

Hien et al. (2004) suggest a classification of these methods into 4 groups (in Burkina Faso, but applicable elsewhere):

1. Water and soil conservation techniques using mechanical means (stone walls, crescents, water breaks, ravine treatment) and biological methods (mulching);

Figure 8 – Preparing a field of Zai pits in Yatenga province, Burkina Faso (Source: HIEN – IRD, 2004)

Figure 9 – Field of stone crescents in Nayala province, Burkina Faso (Source: SOS Sahel)

2. Methods that require a cultural shift : (subsoiling, scarification, flat ploughing, hilling, rip-furrowing);

3. Agroforestry methods (revegetation, reforestation, grass strips, swards, hedgerows, windbreaks, assisted natural regeneration), especially parks with *Faidherbia albida* ;

Figure 10 –*Faidherbia albida* (Source: LEMASSON – IRD)

4. Intensified farming methods (composting, manure, synthetic fertilizers)

Groves of Faidherbia albida

The tree is a member of the Fabaceae *family and has an inverted cycle, it sheds its leaves in the rainy season and grows them in the dry season.*

A leguminous plant that enriches the soil, a dense stand of Faidherbia *(50 trees/ha or more) is like a cultivated field. Under its canopy,* Striga hermothica, *a parasitic plant which is most harmful to sorghum, will not grow.*

Stands of Faidherbia *are often found in the presence of a breed of sedentary cows which are a vector of its propagation. The cattle gather beneath the trees and consume the tree's pods.*

As they pass through the animal's gut, the seeds lose their waxy cuticle and germinate easily in their droppings. The kads (in Wolof) are an important extra source of forage for the animals during the dry season.

Currently the trees are grown in the Ségou region of Mali, in Maradi and Zinder, in Niger, and recently in northern Ghana.