Climate Information for Development:
An Integrated Dissemination Model

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Abstract

This paper describes a new conceptual model of climate research and seasonal forecast dissemination for West Africa. The model was developed based on a survey of 600 climate information end-users and 27 organizations in 4 West African countries i.e. Burkina Faso, Mali, Niger, and Nigeria. The motivation for the study is that despite significant advances in climate research and climate forecasting, the majority of African countries continue to suffer the full impacts of climate variability with serious adverse implications for economic growth and development. These countries are yet to experience the benefits of climate research for mitigating impacts. The major challenges can be summarized as including access to, and ability to respond to, climate research information both on the part of vulnerable groups as well as institutions and agencies charged with managing the impacts of climate variability. Additionally, funding agencies outside the continent drive much of the research on African climate dynamics through their funding priorities and preferences thematically and regionally. Indeed, few African countries have the requisite resources, technical expertise and, in some cases, political commitment to accord the necessary priority to climate and environmental research. This situation is likely to continue for some time. It is important therefore that the affected African countries develop innovative strategies that allow them to take advantage of the results of climate research. Structurally, the proposed model consists of a regional archiving and database development for all research related to West African climate variability. The goal is to improve access to emerging research findings and technologies and to avoid duplication of efforts. A second major component includes an institute dedicated to the testing, validation, and adaptation of research for practical applications under local conditions. The model clearly illustrates the pathways of climate research information flow and linkages between the research community, policy makers, the media and end users. The overarching goal of the model is to fill a void that results from the absence of a formal climate information system in West Africa and the weakness and informality of the existing links among the disparate units that produce climate information. Although developed based on research in West Africa, the model can easily be adapted for other parts of Africa to improve access to climate information and facilitate its utilization for development and mitigating economic losses.

Possible panel sessions:

- Science and Technology Policies for African Development
- Sustainable uses of African Natural Resources for Development

Introduction and Goal

The impact of climate variability on the economies and development of the countries of SubSaharan Africa (SSA) is well documented (Berg, 1975; Benson, 1994; Benson and Clay, 1986; 1998; Jury, 2002; World Bank, 1991). In 1984, the World Bank produced an index to compare trends in per capita food production from 1961-1983 for SSA, Latin America and Asia. The index revealed a persistent negative trend for SSA in sharp contrast to upward trends in the other two regions. The decline appeared especially pronounced during the major drought episodes of 1968-73 and 1981-84, signifying the possible impacts of drought on food productivity.

Twenty years after the World Bank assessment the situation has not changed appreciably despite significant advances in climate research and climate forecasting. The majority of African countries continue to suffer the full impacts of climate variability with serious adverse implications for economic growth and development. This paper describes a new conceptual model of climate research and seasonal forecast dissemination for West Africa. The overarching goal of the model is to fill a void that results from the absence of a formal climate information system in West Africa and the weakness and informality of the existing links among the disparate units that produce climate information.

The paper is divided into four sections. Section one provides examples of climate impacts on economic performance; section two looks at possible complicating factors that emerge in the climate development link; section three briefly reviews the status of climate research and seasonal forecasts information dissemination in West Africa; and finally, section four presents and discusses the features of the proposed integrated information dissemination model.

Examples of Climate Impacts on Economic Performance

Major floods that occurred in Central and Southern Mozambique in late 1999 and early 2000 illustrate clearly climate-economy dynamics. The floods displaced 500,000 people and caused

major damage to key infrastructure including houses, roads, water, and communication facilities. The direct and indirect economic losses attributed to these floods were estimated at over US$600 million (more than double the annual export earnings). According to the World Bank (2000, cited in Abt Associates Inc,. 2002) "The magnitude of the disaster affected economic activity in such a profound way –with particular impact on agricultural and industrial production – and over such a large area, that the macroeconomic impacts in 2000 were enormous." Summarizing the impacts of the floods, the Mozambican State Budget (cited in Abt Associates Inc., 2002) noted, "The floods resulted in a sharp fall in GDP from 7.5 percent in 1999 to 1.6 percent in 2000, inflation reached a high of 12.7 percent in 2000 as compared with 2.9 percent in 1999, and the exchange rate depreciated sharply at an annualized rate of 28.2 percent in 2000 from a rate of 7.7 percent in 1999." This example illustrates that even low frequency or episodic climatic events can have profound economic impacts on a region or state.

Elsewhere, Benson (1994) showed that major drought in 1992 over much of southern Africa led directly to a decline of 9%, 8%, and 3% in the GDP of Zambia, Zimbabwe, and South Africa respectively and increased significantly the unemployment rate in those countries. Jury (2002) showed that variations in the March-November rainfall in South Africa explain nearly 50% of GDP annual growth rate. The study suggests that swings of climate are manifested in South Africa's GDP fluctuations on the order of U.S. $5 billion. Tarhule (2005) provides yet another example of the economic impact of climate hazards. On July 20, 1998, major flooding occurred in an important commercial market (*petite marche*) in Niamey, the business and commercial capital of Niger. The floods washed away an inestimable amount of trade goods and over 500,000,000 CFA (approximately US$830,000) in cash currency (*Le Sahel*, July 23, 1998). The loss from this one flood event exceeded the total annual budget for social welfare for all of Niger's 11 million inhabitants.

The reasons for the connection between African climate variability and economic impacts are obvious. First, human welfare and seasonal rainfall variability are strongly interlinked throughout most of SSA, arguably more so than in most other regions of the world. Whereas drought might lead to higher food prices elsewhere, in many parts of Africa, it frequently leads to famine resulting in mass starvation of thousands of people and agricultural losses that disrupt the

region's fragile economy. The reason for this is that agricultural production is at a near subsistence level and the margin between normal food supply and starvation is extremely small even during normal years. As a result, there usually is very little food to carry over from one year to the next so that feast or famine cycles proceed in rhythm with the seasonal rains. Additionally, climate-induced food shortages reduce tax revenues while increasing expenditure on relief, social welfare, and the logistical costs of food related imports (Benson and Clay, 1998).

Second, rain-fed agriculture is the single largest employer of labor in SSA. In West Africa, approximately 75% of the labor force is engaged in one form of agriculture or another (up to 90% in some countries such as Niger and Burkina Faso. Moreover, it is important to point out that climate impacts generally permeate throughout the society and may affect even sectors not traditionally associated with or directly reliant on climate. In a study on climate information use in West Africa, Tarhule and Lamb (2003) found that most respondents (90%) regardless of their primary occupation expressed great concern about the impacts of climate variability and drought. This finding came as no surprise because many so-called office workers in Africa also engage in some kind of agriculture to supplement their income. Furthermore, as noted above, adverse climatic conditions frequently translate directly to higher food prices impacting everyone.

Third and finally, agriculture (read, rain-fed agriculture) contributes a significant proportion of GDP in many African countries (on average about 40% for West Africa as a whole, but up to 70% in some countries e.g. Liberia). Thus, fluctuations in GDP frequently reflect major shocks in the agricultural sector.

Possible Exacerbating Factors

Owing to major regional changes in socio-economic activities, population growth, and environmental degradation, some researchers fear that the economic impacts of climate variability may get worse rather than improve in the years ahead. In West Africa, as elsewhere in Africa, new socio-economic dynamics continue to superimpose upon, and further complicate the climatic problem. Previously, nomadic livestock herders migrated out of the semi-arid Sahel zone during the dry season or periods of prolonged drought. This out-migration mitigated drought impacts by easing pressure on water and grazing resources. During the past few years

however, nomadic herders have found their migratory routes increasingly blocked (due to increased urbanization and expanded agricultural activities), forcing them to spend longer periods (sometimes year round) in the Sahel.

Rapid population growth also portends serious problems for climate impacts. West Africa's current population growth rate is estimated as 2.45%, noticeably smaller than the 3% growth rate prevalent during the 80s and 90s but still among the highest rates in the world. Major urban centers are growing even faster with growth rates of between two to three times those of the national population. To feed the burgeoning population, agriculture and livestock grazing have expanded correspondingly, often extending into marginal areas ecologically unsuited to such activities (*see* Glants, 1994). Expansion in cultivated acreage has especially been large because production tonnage has remained static during the past three decades. In other words, increased crop output has been achieved primarily through expansion of cultivated area, with serious consequences for ecological sustainability. Demand for firewood in the urban centers contributed further to massive deforestation in the surrounding areas. Around major cities like Niamey, tree cover has been so reduced that from the air, the city itself appears as by far the most heavily wooded area within a radius of 30 to 40 km (Foley et al., 1997). With the runoff moderating vegetation cover removed, increased erosion and sediment production from the exposed surfaces clog already limited urban storm drainage system (see Späth, 1997), increasing flood risk (*see also*, Tarhule, 2005). This particular example qualifies primarily as environmental abuse but the role of such degradation in amplifying climate hazards makes it relevant to the present discussion.

The Status of Climate Research and Information dissemination in West Africa

The above analysis suggests that for many African countries, development, however defined, depends critically on their ability to mitigate the impacts of climate variability and hazards, especially floods and droughts. As with most natural hazards, the capacity for dealing with climatic hazards depends principally on the extent to which (i) the problem is understood, (ii) such knowledge is accessible to potential victims, and (iii) society and vulnerable groups have the ability to act upon the information provided (O'Keefe and Wisner, 1975; Van Apeldoorn, 1981. See also Stern and Easterling, 1999; O'Brien et al, 2000; Tarhule and Lamb, 2003). If we

understand this three point criteria as proceeding sequentially, then West Africa as a whole could be said to be somewhere between criterion (i) and (ii). Beginning in response to the disastrous drought of 1968-73, considerable research and monitoring effort has been directed at trying to understand the physical causes, dynamics, and socio-ecological impacts of Soudano-Sahel drought (e.g., Charney, 1975; Lamb, 1978; Folland et al., 1986; Nicholson and Entekhabi, 1986; Hulme, 1992; Nicholson, 2000). This effort is still on-going with new initiatives like AMMA (African Monsoon Multidisciplinary Analysis), an international project to improve the scientific knowledge of the West African monsoon (WAM) and its variability with an emphasis on daily to interannual scales. The project held its first international conference only last week in Dakar, Senegal. AMMA builds substantially on a previous long-run study, the Sahel-HAPEX initiative, which investigated the links between hydrologic and atmospheric processes and their role in Sahel droughts (see, Le Barbé and Lebel, 1997).

In contrast to the more than three decades long concerted efforts to understand the causes of droughts, only during the past 10 years or so has there been any attempts to systematically evaluate how, or even if, the results of such research are accessible to communities and activities at risk (i.e. criterion [ii] above). To a degree, this delay reflects difficulties with understanding the causes of droughts, which must necessarily precede any program of information dissemination. Even so, substantial progress has been made. Recent advances concerning the causal mechanisms have now led to reasonably skilful season-ahead climate forecasts (up to three months in advance). Such information can now be applied to benefit society including "the reduction of weather/climate related risks and vulnerability, increased economic opportunities, enhanced food security, mitigation of adverse climate impacts, protection of environmental quality, and so forth" (Garbrecht et al., 2005). For West Africa specifically, this new knowledge has provided the foundation for the annual West Africa Climate Outlook Forums, which have issued seasonal rainfall predictions since 1998 (Regional Climate Outlook Forums Review Organizing Committee, 2001). Similar developments have occurred elsewhere in SSA. Major regional organizations notably the African Centre of Meteorological Applications for Development (ACMAD; Niamey, Niger), National Hydrological and Meterorological Services (NHMS), and the Centre Regional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationelle (AGRHYMET; Niamey, Niger) have taken the lead in disseminating

climate forecast information. Additionally, Famine Early Warning Systems (FEWS) established by the United States Agency for International Development (USAID) also provide assessments of vulnerability to drought and famine for up to six months in advance, based on consideration of rainfall, vegetation, crop yields, and, increasingly, social information (Stern and Easterling 1999; U.S. Agency for International Development 1999, 2000). In many countries, Multi-disciplinary Forecast Monitoring Groups comprised of analysts from ACMAD and the national hydrological and meteorological services have been established to develop consensus regarding each seasons rainfall forecast and to disseminate and monitor the response to that forecast. Tarhule and Lamb (2003) provide further discussion on the pathways of information flow.

The above changes relate primarily to procedures and structures within government agencies charged with managing the impacts of climate variability. Other efforts have focused on the village level and the ultimate consumers of climate forecast information. For example, the Office of Global Programs (OGP) in the U.S. National Oceanic and Atmospheric Agency (NOAA) has been especially active in sponsoring pilot studies to evaluate constraints and opportunities in utilizing climate forecast information as well as the best practices, structures, and mechanisms for delivering such information to vulnerable groups. One example is the Climate Forecasting for Agricultural Resources (CFAR), which is investigating incentives and constraints to implementing seasonal forecasts in Burkina Faso (e.g., Kirshen and Flitcroft 2000; Roncoli et al. 2001, 2002; Ingram et al. 2002). A second NOAA-funded project based in Ghana within the subhumid zone is currently developing a decision support system for agricultural applications of climate forecasts and the CLIMAG (Climate Prediction and Agriculture) initiative, based in Mali and funded by the U.S. National Science Foundation, is also focused on reducing food insecurity and vulnerability of agro-ecosystems caused by the interactive effects of global climate change, resource degradation and seasonal climate fluctuations in Suodano-Sahelian West Africa.

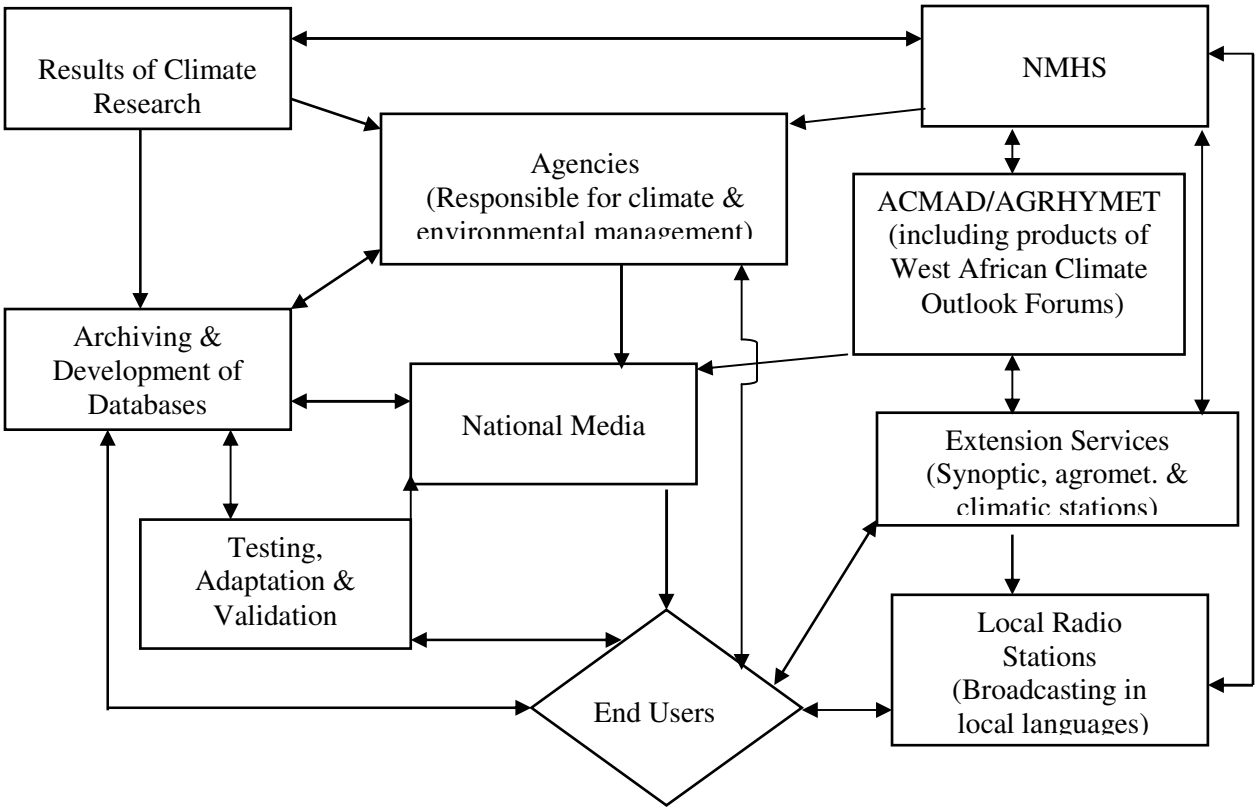
A number of experiments related to the most appropriate technologies for disseminating climate information are also being carried out. One of these is the USAID-funded demonstrated project RANET (Radio and Internet technology for communication of weather and climate information to rural communities for sustainable development in Africa). The goal of RANET is to bring NMHS and related information to the village level in Africa by pioneering the use of new

communication technologies (from satellite and Internet reception by local radio stations, to FM radio transmission, to wind-up radio listening in villages). RANETs initial success in southwestern Niger has been globally recognized (see *Financial Times* 19 June 2001, p. 15) and *Washington Post* 12 August 2001, p. B1).

An Integrated Approach to Information Dissemination

The developments and initiatives discussed above can potentially allow Africa to simultaneously mitigate risks and take advantage of favorable climatic conditions to secure positive social and economic outcomes. To reach that objective however, there is a need for greater synergy and systematic links between policy, the various research programs, and stakeholders. The conceptual model presented here provides a framework for achieving those objectives. The model was developed based on the findings of a survey of 600 climate information end-users and 27 organizations in 4 West African countries i.e. Burkina Faso, Mali, Niger, and Nigeria. Tarhule and Lamb (2003) present detailed discussion of the results of that survey. The proposed model builds upon climate forecast dissemination concepts at ACMAD, as well as gaps and shortcomings identified in existing dissemination structures.

Figure 1: Conceptual model of climate research seasonal forecast information dissemination for West Africa. The extreme right hand column is based on information dissemination ideas



developed at ACMAD (From Tarhule and Lamb, 2003).

The model has the following unique characteristics.

(1) Institutional structures for monitoring, archiving, and adapting potentially beneficial research findings must be strengthened or established where none exist currently. This is important because few African countries currently have the resources or technical capability to fund major climate and environmental research programs. The model above recognizes that scattered in the pages of various academic journals and technical reports are the results of climate studies and experiments that could potentially benefit many vulnerable groups and planning agencies. These results often remain unutilized because of low literacy levels, lack of access, and the absence of structures that can facilitate their translation into practice. It calls for the establishment of a new agency charged with monitoring emerging research findings that might have relevance or applications to African situations. This agency would maintain an archive and database of such results

that could be assessed and queried by researchers, policy makers, media organizations, and funding agencies. This would facilitate more rapid propagation of best practices and minimize duplication of efforts. In lieu of entirely new agencies, existing organizations, such as ACMAD, could take on this additional responsibility.

It must be stressed that the approach suggested here is a 'backdoor" way for African countries to possibly utilized research findings that they cannot produce themselves. Ultimately however, Africa must take control of its research. A society cannot develop by being dependent on external science and technology. Africa must produce and retain indigenous scientists and research facilities with sufficient technical expertise to solve her problems.

(2) Testing, validation, and adaptation of research findings. Results of research culled from journal articles would seldom be directly applicable to specific local conditions. For this reason, there will be a need to test and validate such results using local data and circumstances and to develop the best adaptation strategy. This role is recognized in the third box of the first column of figure 1.

(3) Information flow is a two-way process. Many existing arrangements for climate information dissemination appear to be linear and unidirectional. While much effort is devoted to getting information to stakeholders and user groups, far less priority is attached to receiving feedbacks that might improve both the quality of the information as well as the dissemination process. The proposed framework remedies this deficiency.

(4) It links climate research and forecast dissemination pathways with agencies responsible for managing the effects of climate variability, the news media and end users in a coherent, logical structure. To appreciate this expanded scope, it is worth considering that the extreme right column of Figure 1 is the forecast dissemination structure that was proposed at ACMAD. The framework can accommodate nested, finer scale information flow pathways without a need for major reconfiguration. For example, information does not get dumped in a vacuum within the end user node: contacts receive information and then transmit it through appropriate channels in the village information flow network. Notice that this level of detail does not affect the overall structure of the proposed framework.

Conclusions

Societal welfare in many parts of Africa is linked strongly to cycles of climatic variability and hazards because a majority of the population depends directly on rain fed agriculture. The linkage between climatic variability and agriculture has implications on the GDP of African countries because the agricultural sector comprises about 40% of GDP for many of these countries. It is imperative therefore those African countries mitigate climate effects if meaningful development is to take hold. Some social thinkers have argued that true development is akin to an ecological process in which a society increases its capacity for dealing with the environment including extreme environmental conditions that produce disasters (cited in Apeldoorn, 1981). This process involves three stages including understanding the problem, broadly disseminating information about the problem and an ability to act upon the information. A review of the situation for West African suggests the region is probably between steps one and two. While much effort has been made to understand the major climatic hazard i.e. drought, only now is concerted effort being made towards disseminating information broadly to vulnerable groups. The paper proposed a conceptual framework of information structure and flow pathways as a contribution towards that dissemination effort. The proposed structure integrates the disparate components presently involved in information dissemination. It represents the first systematic structure of information flow that can be applied at a national or regional scale. Successful implementation will contribute significantly to improved dissemination and use of climate forecast information for precautionary planning and risk management.

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