Nile Basin Initiative

Eastern Nile Subsidiary Action Program
Eastern Nile Technical Regional Office

Climate Change Approach Paper

Final Report, June 2009

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ABSTRACT

The vision of the Nile Basin Initiative (NBI) emphasizes sustainable development of the common Nile Basin water resources. One of the main threats to this sustainable development is the process of climate change forced by evident changes in the chemical composition of the global atmosphere, since climate change redistributes the natural occurrence of the hydrologic phenomena that supplies water to different regions. The art of predication of regional climate change impacts is one of the frontiers of global change science. While global climate models agree in their predictions of global climate indicators such as global surface temperature and extent of polar ice sheets, the same models disagree on the predications about specific regional climates. The Nile basin is no exception. While global models seem to agree in predicting warming of surface temperature over this region, the same models disagree on even the sign of the predicted changes in rainfall and river flow. When it comes to the future of Nile water availability, our best answer would remain uncertain for years to come.

So how can we approach the issue of climate change given this uncertainty? Here, we propose a comprehensive, flexible, and low cost strategy that has five pillars: (1) improvement of regional predictions through local development and use of the new class of regional climate models; (2) development of the regional capacity for adaptation through: (i) minimization of irrigation water losses which should help to alleviate water shortages in the event of decreased flow, and (ii) addition of new reservoir storage capacity that can be used to manage water better in the event of increased flow; (3) limited good faith efforts in mitigation of climate change by combating anthropogenic deforestation and desertification in the region; (4) vigorous pursuit of the opportunities available: (i) through the Clean Development Mechanism (CDM) of the Kyoto Protocol to get certified emission reductions (CER) for any new hydropower project on the Nile, and (ii) through new international compensation schemes that may be developed in the future; and (5) enhanced efforts in education, research, and outreach to prepare the next generation of scientists, engineers, and policy makers who will deal with the issue of climate change as impacts become more evident and models become more accurate. All five pillars of the proposed strategy represent objectives that would be of great benefit to society and should be pursued under all circumstances.

1. Impacts of Climate Change on Water Resources in the Eastern Nile Region

(1.1) Introduction

The vision of the Nile Basin Initiative (NBI) is to "achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources". This is a brief and well articulated statement. A key word in this statement is "sustainable". What is sustainable? Eltahir (1999) defines a sustainable water resource as a "flux of water that is managed with the objective of maintaining the availability and quality of water for as long as the current climate prevails". According to this definition climate change is one of the main threats to sustainable development of water resources any where, since climate change redistributes the natural occurrence of the hydrologic phenomena that supplies water to different regions.

The process of climate change is caused by evident changes in the chemical composition of the global atmosphere. Figure 1 shows the observed trend in the concentration of carbon dioxide during the last 50 years. This radiatively active constituent of the atmosphere is well mixed with nearly uniform distribution everywhere. Similar trends were observed in other radiatively active gases (known as green house gases), namely nitrous oxide, methane, and chlorofluorocarbons. All these gases trap the radiation emitted by the earth surface and remit it back to the surface creating a tendency for surface warming. This initial warming increases the capacity of the atmosphere to hold water vapor, and hence increases the actual water vapor concentration. The latter is the most significant radiatively active constituent of the atmosphere. Hence, the initial warming is exacerbated by this water vapor feedback. This set of processes which are dominated by atmospheric radiation trigger a complex set of feedbacks and processes involving atmospheric convection, atmospheric dynamics, clouds microphysics, and rainfall formation processes. The exact nature of how these processes and feedbacks should be represented in climate models is not well understood and hence their representations vary from one climate model to another. As a result, the response to the increase in concentrations of carbon dioxide and other greenhouse gases varies from one climate model to another.

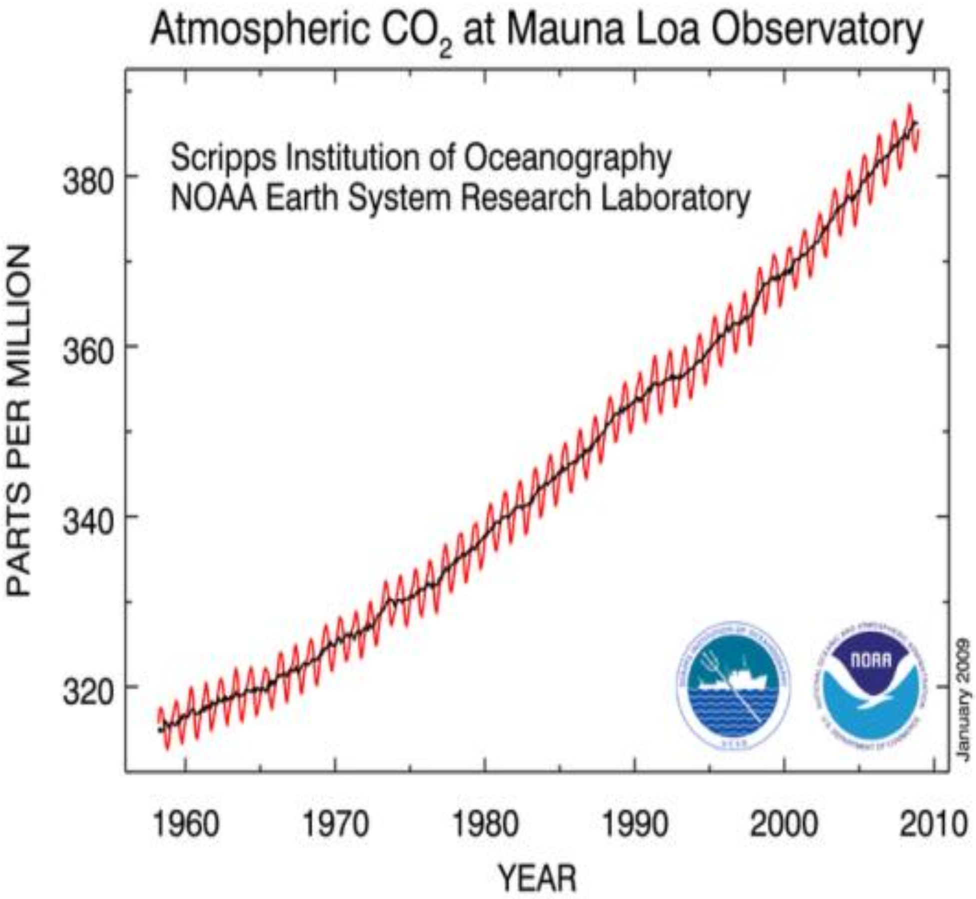

Atmospheric CO_2 at Mauna Loa Observatory
Scripps Institution of Oceanography
NOAA Earth System Research Laboratory
PARTS PER MILLION
380
360
340
320
1960
1970
1980
1990
2000
2010
YEAR
NOAA
January 2009

Figure 1

General circulation models (GCMs) are mathematical representations (programmed in. computer codes) of atmospheric and oceanic properties and processes that attempt to describe earth's climate system. Developed in 1960s, they have become the primary tools in analyzing effects of climate change (AIP 2004b). There are several different GCMs in use, including: UKMO (United Kingdom Meteorological Office), GISS (Goddard Institute for Space Studies, New York, NY), GFDL (Geophysical Fluid Dynamics Laboratory steady-state, Princeton, NJ), GFDLT (Geophysical Fluid Dynamics Laboratory transient, Princeton, NJ), MPI (Max Plank Institute, Hamburg, Germany), and CCC (Canadian Center for Climate, Victoria, Canada). The climate system can also be studied at the regional scale using Regional Climate Models (RCMs); e.g Mohamed et al. (2005) studied the hydroclimatology of the Nile using a regional climate model.

(1.2) Eastern Nile Region: Background about ENSAP/ENTRO

Eastern Nile Subsidiary Action Program (ENSAP) is designed under the umbrella of NBI and focuses on the Nile and its tributaries within the Eastern Nile countries of Egypt, Ethiopia and Sudan and encompasses the sub-basins of Baro-Akobo-Sobat, portions of the White Nile, Abay/Blue Nile, Tekezze-Settit-Atbara, and the Main Nile. The Eastern Nile Technical Regional Office (ENTRO), based in Addis Ababa, Ethiopia, is the implementing arm of ENSAP.

ENTRO works closely with Eastern Nile experts (groups and national multi sectors in environment, water, finance, socio-economic) regional focal points and national coordinators. ENSAP is engaged in the first set of identified investments referred to as the Integrated Development of Eastern Nile (IDEN) projects, which includes the Joint Multipurpose Program. IDEN consists of the fast track and multipurpose projects. IDEN "fast track" projects are planned to confer early mutual benefits and thus demonstrate tangible results of cooperation on the ground. Fast track projects are:

- Eastern Nile Planning Model
- Flood Preparedness and Early Warning
- ETHIOPIA-SUDAN Transmission Interconnection
- Irrigation and Drainage

- Watershed Management

The "multi-purpose track" includes jointly developed projects that serve multiple purposes in each of the three countries, In addition to the projects identified, the three EN countries have indicated their willingness to jointly identify and implement a major multipurpose investment project to cement regional cooperation in the basin.

Multi-purpose projects:

- Baro-Akobo Multi-Purpose Water Resources Development
- Eastern Nile Power Trade Investment Program Study
- Joint Multi-Purpose Program

ENTRO operates on the basis of agreed methodology, criteria, and tools for ensuring that the sub-projects contribute to a regional integrated development program and will continue on identifying consecutive rounds of investments.

(1.3) Literature Review

In this section we summarize a literature review on climate change in the Nile basin region and predicted changes in Nile flows. While nearly all studies agreed that temperatures will increase, precipitation predictions are less certain. Predictions of response by the Nile flow to the change in chemical composition of the global atmosphere vary widely; different studies give conflicting results. The summary of Yates (1998b) results shown in Figure 2 is an example of how widely results vary. The two numbers on ends of each line represent extreme discharges of six different GCM scenarios, whereas the boxed number is the historic long term average. Additional tick marks on each line are remaining GCM scenarios, which indicate range of climate change induced flows at different points in the Nile Basin. Five of the six GCMs showed increased flows at Aswan, with increases as much as 137%. (UKMO). Only one GCM showed a decline in annual discharge at Aswan (-15%). All numbers are in the units of cubic kilometers per year.

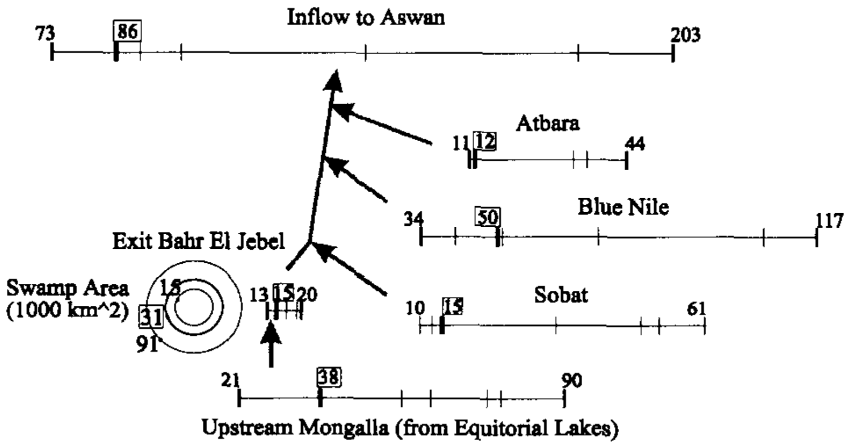


FIG. 9. Graphical Representation of Range of Discharges for Major Points along Nile (Two Numbers on Ends of Each Line Represent Extreme Discharges of Six GCM Scenarios, Whereas Boxed Number is Historic Average; Additional Tick Marks on Each Line are Remaining GCM Scenarios, which Indicate Range of Climate Change Induced Flows of Nile Basin)

Figure 2 – Range of discharges for major points along the Nile.

(Yates et al., 1998b)

To illustrate these differences further we review other similar studies. The predictions in Strzepek (1995) vary from 78% flow reduction in the GFDL simulation to a 30% increase in the GISS model. These results are confounded by Yates (1998a) predictions, which vary from 9% flow reduction for GFDL model to a 64% increase in the GISS model. Although most model results indicated that the Nile flow is quite sensitive to changes in precipitation. Hulme (1994) concludes Nile discharge will decline due to greater evaporation; specifically, he predicts reduced Blue Nile flows and constant or slightly increased White Nile flows. Similarly, Sene's (2001) results suggest a slight increase in White Nile flows. The impacts of global climate change on the water resources of the Nile River Basin were also evaluated by Strzepek et al. (1996) using simulation models. Four climate change scenarios were evaluated (baseline, GISS, GFDL, and UKMO). They concluded that "The complete impact of climatic changes in the Nile cannot be fully predicted with confidence, as some models forecast increased flows, while others project significant decreases." In summary, the collective results of these studies confirm that there is a lot of uncertainty in current predictions of future Nile flows.

At the country scale, the future availability of water in Egypt by 2050 has been studied by Conway et al. (1996). They predict that combined effects of global, regional, and basin-scale processes on future water availability in Egypt are quite uncertain ranging from a large water surplus to a large water deficit by the year 2050. This range of results arises from uncertainties in their integrated modeling approach and from the different ways Egypt may approach population growth, agricultural policy and human aspirations for greater water use in the future. In a more recent study, Conway (2005) concluded that analysis of climate change projections for the Nile basin region shows there is no clear indication of how Nile flows will be affected because of uncertainty about future rainfall patterns in the basin. In a recent study Elshamy et al. (2009) studied the impacts of climate change on Blue Nile flows using 17 bias-corrected GCM scenarios. They concluded that "There is no consensus among the GCMs on the direction of precipitation change. Changes in total annual precipitation range between −15% to +14% but more models report reductions (10) than those reporting increases (7)"

The climate change impacts on the White Nile system seem to be even more difficult to predict than the corresponding impacts on the Blue Nile. Sene at al (2001) studied the impact of climate change on the White Nile flows, using both observed and stochastic time series to drive the models. Example results are presented in this study using various assumed climate change scenarios and results from a GCM. They conclude that there are significant difficulties with the White Nile system due to the huge area of open water in the basin. Hence, "transient responses to short-lived events can occur over timescales comparable with those for which long term climate change impacts are being studied, and predicted changes in flows are extremely sensitive to estimates for the rainfall and evaporation at lake and swamp surfaces." In a more specific focus, Tate et al. (2004) studied the water balance of Lake Victoria including one climate change scenario up to 2100.

In comparing the Nile to other rivers, Aerts et al. (2006) studied the sensitivity of global river discharges under Holocene and future climate conditions. They concluded that "in some basins (Ganges, Mekong, Volta, Congo, Amazon, Murray-Darling, Rhine, Oder, Yukon) future discharges increase by 6-61%. These changes are of similar magnitude to changes over the last 9000 years. Some rivers (Nile, Syr Darya) experienced strong reductions in discharge over the last 9000 years (17-56%), but show much smaller responses to future warming."

At the scale of specific cities, Walsh et al (1994) studied the flooding frequency in Khartoum and the vulnerability of the city to future conditions. They concluded that "If the present dry conditions in the Sahel were to be replaced by the wetter climate of the late nineteenth century, Khartoum would face severe flooding problems."

Land use change and climate change are concurrent processes. Hence, their separate impacts on the Nile water are mixed, and can be difficult to detect accurately. The impact of changes in land use on the runoff from the sources the Nile in Ethiopian highlands has been the subject of two recent studies. Hurni et al. (2005) concluded that "there have been no significant trends over the long term in total annual rainfall in the highlands over the past 30-50 years. Nevertheless, test plot surface runoff rates were found to be clearly influenced by land use and soil degradation, and hence by population density and duration of agriculture. They reported a 5-30 times more surface runoff from cultivated or degraded test plots than from forested test plots." Their analysis and interpretation of data support the hypothesis that surface runoff and sediment yield from the Ethiopian and Eritrean highlands into the upper Nile Basin have most probably increased in the long term due to intensified land use and land degradation induced by population increase, when seen in a historical perspective. In a similar study, Bewket and Sterk (2005) analyzed changes in stream flow patterns with reference to dynamics in land cover/use in a typical watershed, the Chemoga, in northwestern highland Ethiopia. Their results show that, between 1960 and 1999, total annual stream flow decreased at a rate of 1.7 mm per year, whereas the annual rainfall decreased only at a rate of 0.29 mm per year. The decrease in the stream flow was more pronounced during the dry season (October to May), for which a statistically significant decline was observed while the corresponding rainfall showed no discernible trend. The wet season (June to September) rainfall and stream flow did not show any trends. Between 1960 and 1999, the monthly rainfall and stream flow amounts of February (month of lowest long-term mean flow) declined by 55% and 94% respectively. Similarly, minimum daily flows recorded during the three driest months (December to February) showed statistically highly significant declines over the same period. Bewket and Sterk (2005) concluded that "the observed adverse changes in the stream flow have partly resulted from changes in land cover/use and/or degradation of the watershed that involved destruction of natural vegetative covers, expansion of croplands, overgrazing and increased area under eucalypt plantations." The conclusions from these two studies, which are based on field data, seem contradictory which highlights the complexity of the response of land surface hydrology to changes in land use. This response is highly dependent on local conditions and the exact nature of the change in land use. The stated conclusions are important to keep in mind while conducting any effort that would try to isolate the impact of climate change on the flow of the Nile based on empirical data. Observed flow would mix signals from natural variability of the process, anthropogenic effects due to land use change, in addition to any climate change signal. Isolation of the climate change signal would then require understanding of both natural variability of the Nile flow, as well as some assessment of the impact on the Nile flow due to changes in land use.

The impact of sea level rise due to climate change on the Nile delta has been the subject of several studies. Nicholls and Hoozemans (1996) stress the need for coastal management plans along the Mediterranean coast and especially on the deltaic area to explicitly address long-term issues, including climate change, and integrate this planning with short-term issues. A study of the Rosetta city and the estuary of the river Nile (Rosetta branch), has been carried out by El-Raey et al. (1997) for assessment of the impact of sea level rise. Analysis of data has been carried out to assess vulnerability of various land use and land cover classes. An assessment of the impact of sea level rise on the city of Port Said, Egypt has also been carried out by El-Raey (1999) using remote sensing and GIS techniques. Results indicate serious physical and socio-economic impacts. They suggested that protection measures must be carried out with emphasis on building breakwaters along the most vulnerable shoreline area.

The impact of climate change on the Nile water availability is likely to have significant economic implications. Strzepek (2000) used an equilibrium model to study the impact of climate change on the Egyptian economy. He concluded that “Under "wet" climate scenarios, surplus water beyond 75 billion cubic meters (BCM) remained unused, as the marginal value of water dropped to zero and other resource constraints limited agricultural growth. For drier scenarios (below 75 BCM), water was a constraint to agricultural production into the 21(st) century, as resources were diverted to less water demanding crops and the livestock and non-agricultural sectors. The reduced water scenarios showed agriculture declining in its total share of GDP, burdening the agricultural wage earner.” Further studies will be needed to address the impacts on the other economies of the Eastern Nile countries.

A recent study conducted in my research group at MIT demonstrated that hydropower generation in the Blue Nile and the main Nile are likely to be more sensitive to changes in the low flow regime. Changes during the flooding season are less

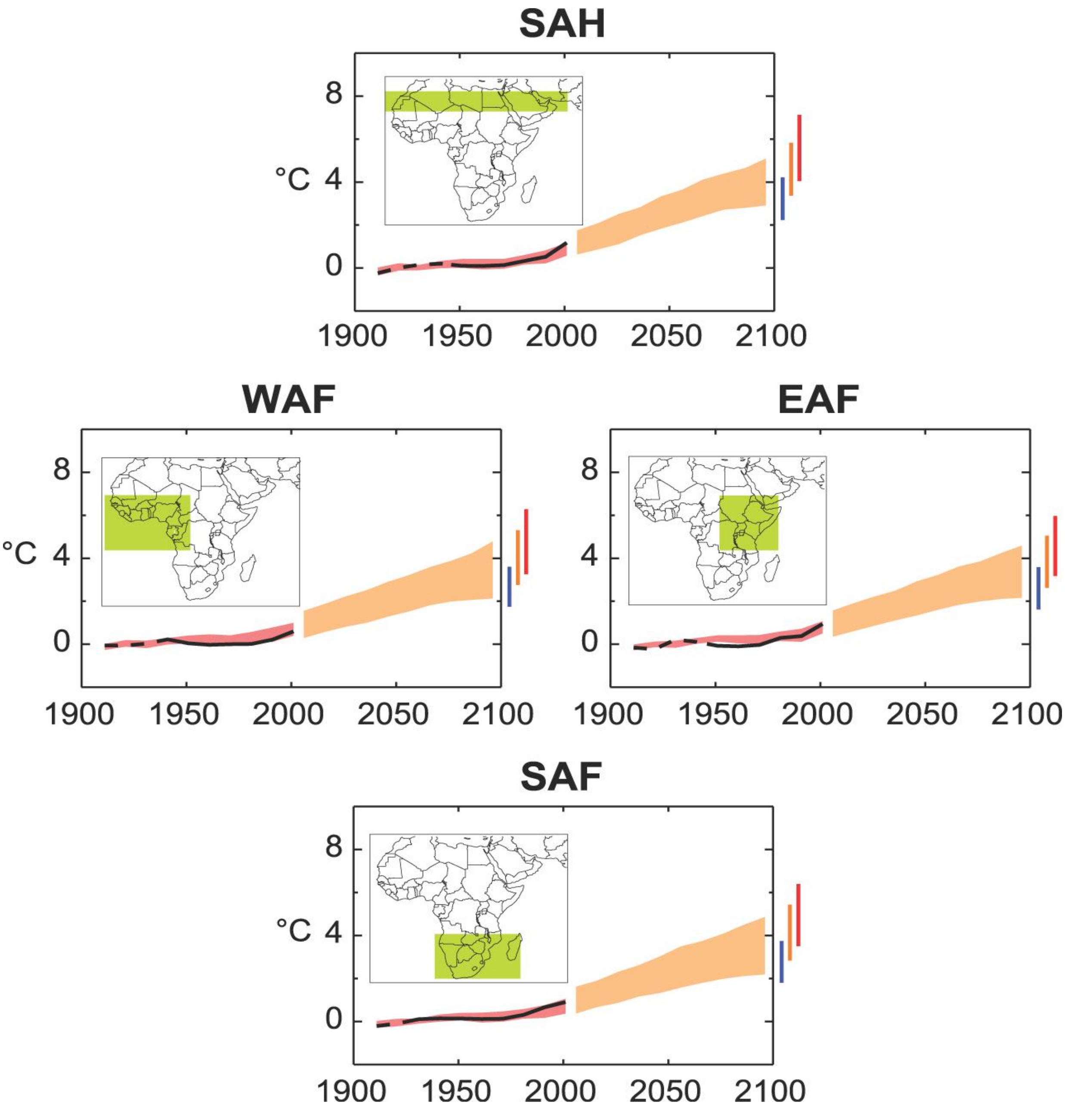


Figure 3: GCM predictions of surface temperature over African regions, (Boko et al, 2007).

significant. Hence, predicting the seasonality of the impact of climate change on the Nile flow is as important as predicting changes in the mean annual flow.

In the 1980s, a global body of climate scientists, the Intergovernmental Panel on Climate Change (IPCC), was formed to provide scientific advice to growing international political negotiations over how to respond to climatic change. In their 2001 report, the IPCC notes that because the Nile and other major rivers in Africa "originate within the tropics, where temperatures are high, evaporative losses also are high in comparison to rivers in temperate regions. Elevated temperatures will enhance evaporative losses; unless they are compensated by increased precipitation, runoff is likely to be further reduced" (IPCC, 2001a).

The most recent IPCC report relevant to Africa was issued in 2007 (Boko et al, 2007). Figure 3 is based on the results presented in this recent report. It shows the range of predictions made by different GCMs for the surface temperature over Africa up to the year 2100. The different colors (red, orange, and blue) denote the different emissions scenarios. The blue set of predictions corresponds to the most optimistic scenario assuming significant action to mitigate climate change. The red set of predictions corresponds to "business as usual", or continuation of the current trends in emissions of greenhouse gases. The orange set assumes limited mitigation efforts. While these different assumptions result in slightly different magnitudes of the predicted warming over East Africa, all the models simulations and under different emissions assumptions agree in the prediction of a warmer future with annual temperature in 2100 rising by 4 degrees C (+ or – 1 degree C). It is also important to note that for current conditions the magnitude of the observed warming of order 1 degree C over East Africa is consistent with the models simulations.

Figure 4 shows the distribution of the predicted warming in surface temperature. The same figure shows the distribution of the predicted change in precipitation over Africa. Although, on average models seem to predict an increase in precipitation over the Nile basin, the results presented in the same figure indicate that about half of the models

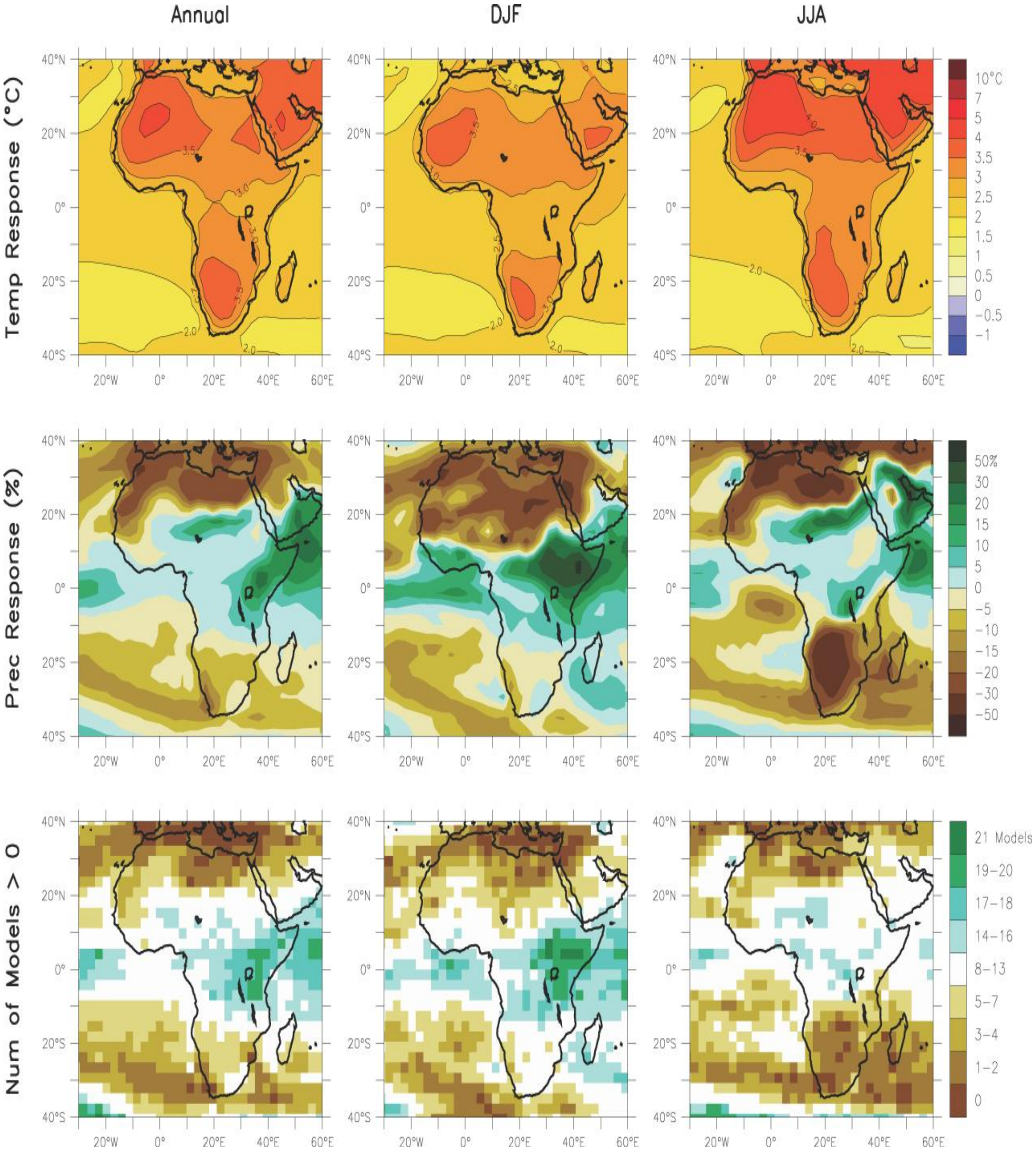


Figure 4: GCM predictions of surface temperature change (Temp Response); precipitation change (Prec Response (%); and number of models that predict an increase in precipitation (Number of Models >0). All results correspond to 2100. IPCC report (Boko et al, 2007).

considered seem to predict an increase in precipitation while the other half predict a decrease in precipitation. This last conclusion is significant. It points to the high level of uncertainty about the sign of the predicted change in precipitation. While global models seem to agree in predicting warming of surface temperature over this region, the same models disagree on even the sign of the predicted changes in rainfall and river flow.

When it comes to the future of Nile water availability, our best answer would remain uncertain for years to come.

2. Strategies to Address Climate Change

So how can we approach the issue of climate change given this uncertainty? We need an approach that is *flexible* since it needs to evolve as climate change predictions become more certain. The same approach has to be *comprehensive* since a wide range of potential impacts will need to be considered. *Low cost* approaches should always be desirable, and more so given the level of uncertainty. Approaches that have multiple objectives, beyond the issue of climate change, would offer attractive alternatives under these conditions.

The issue of climate change can be approached differently depending on the nature and mandate of the institution considering this important issue. Local, national, and regional institutions may share the same vision, but have different roles to play. The recommended approach to the issue of climate change is tailored to suit ENTRO: a regional organization, with a limited mandate focusing on the Nile water resources, and guided by the NBI vision.

Before we describe the proposed strategy we need to define a general framework to discuss the issue of climate change. Figure 5, taken form the IPCC, 2007 report outlines the main set of climate change processes (prediction, adaptation, mitigation, etc) taking place, within the Earth system, within the Human system, and as two way interactions between the two systems. This Figure serves as a general framework to define climate change processes.

Here, we recommend a proactive approach that addresses:

- Prediction,
- Adaptation,
- Mitigation,
- Potential opportunities, and
- Education

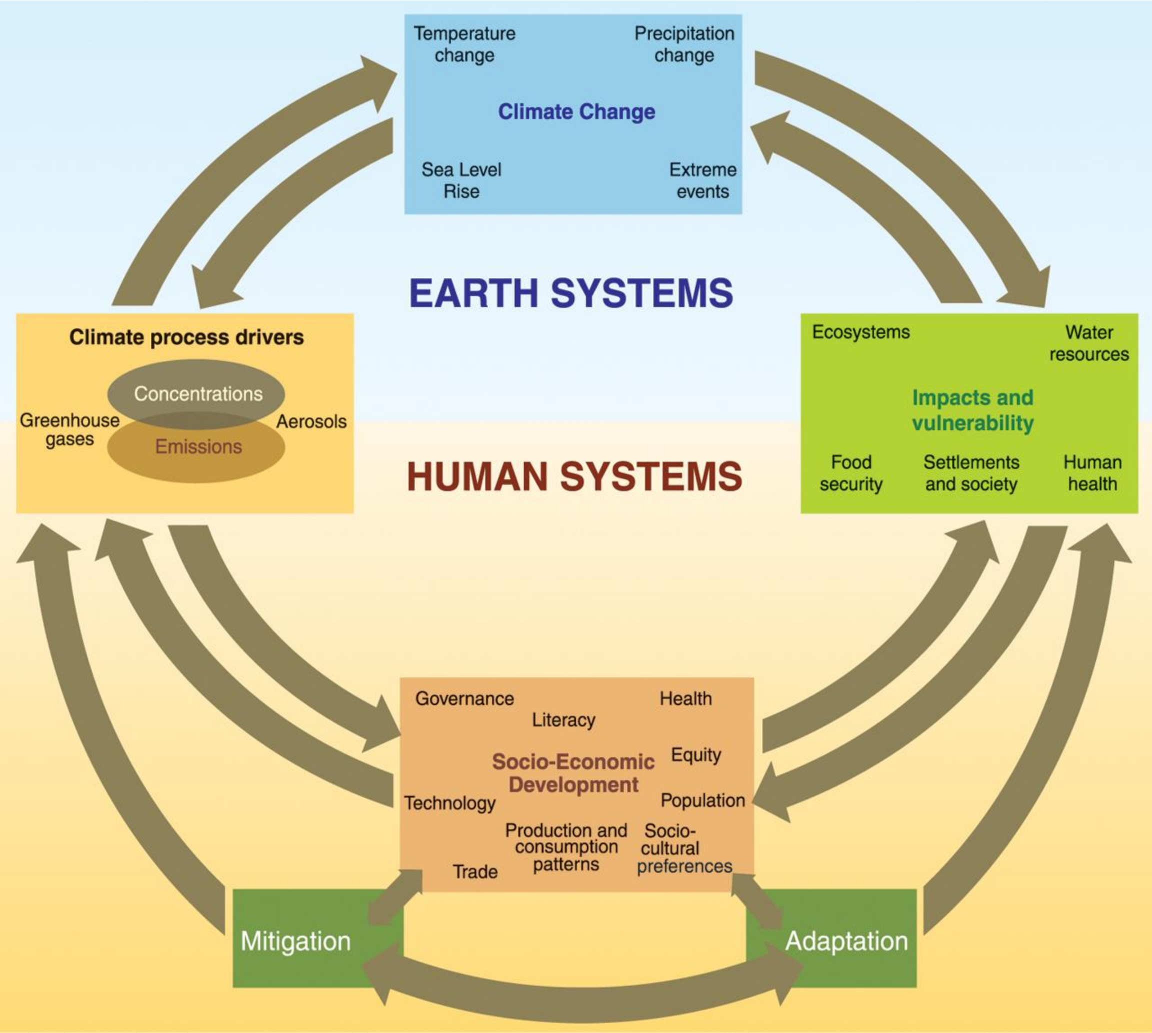


Figure 5: Climate Change and the Earth-Human System, IPCC report 2007

In recommending a *proactive* approach we seek a strategy that would consciously serve to avoid any future surprises, relative to climate change, in the Eastern Nile basin. The recommended approach is tailored to suit ENTRO: a regional organization, with a limited mandate, aligned with NBI vision

Here, we propose a *comprehensive, flexible, and low cost* strategy that has five pillars:

(2.1) Prediction of Climate Change

We need new research tools to develop:

- more relevant (e.g. how hydropower generation will be impacted?);
- more specific (e.g. what would happen to base flow?); and
- more accurate predictions that would narrow the range of uncertainty about the impact of climate change on water resources in the Nile basin

Some of the limitation of climate change predictions in Africa stem from the fact that the upper air observations network in Africa has a relatively poor density. There is an urgent need for enhancement of upper atmospheric observations network.

Due to their relatively coarse resolutions GCMs are more suited for studies that are carried at the global scale. They provide adequate accuracy in simulations of globally averaged climate variables. In order to address regional climate issues, regional climate models offer better tools that can be tailored to study the impact of climate change in specific regions such as the Nile Basin. Regional climate models have finer resolutions and can be calibrated to reproduce details of the regional climate considered. Regional climate models can also be used to drive fine resolution hydrologic models for detailed impact assessment. **Here we recommend "improvement of regional <u>predictions</u> through local development and use of the new class of regional climate models"**

(2.2) Adaptation to Climate Change

Based on paleo-climatic evidence, migration towards (from) the Nile valley has been the main adaptation mechanism for past climate change in this region. However, with the development of modern irrigation and hydropower projects on the Nile valley, mobility of the population is increasingly constrained since these projects are located along the Nile valley.

In the short term, we propose two specific adaptation mechanisms

1. New projects planned under the umbrella of NBI/ENSAP (e.g. JMP) should incorporate the uncertainty/risk associated with climate change at early design stages. This is the best approach to avoid costly surprises later.
2. The operation and management of existing water resources projects should be revised as new knowledge about climate change becomes available.

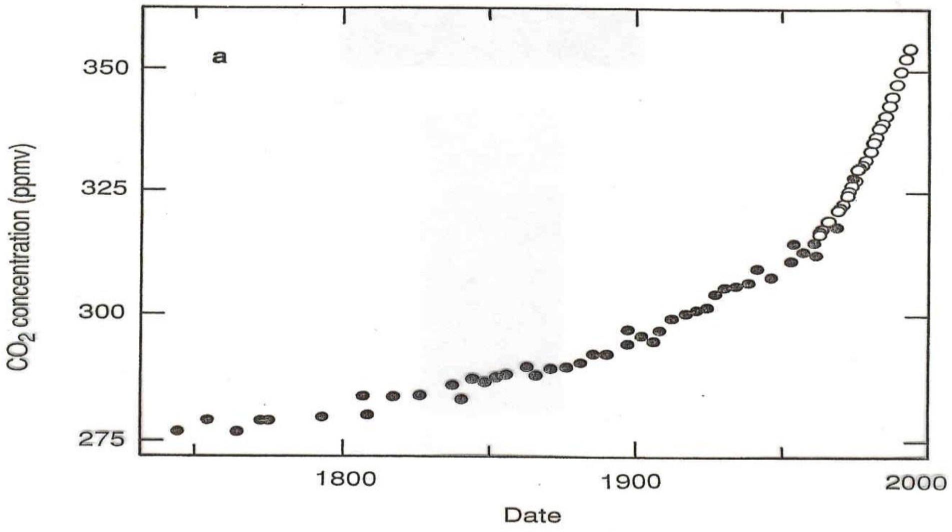
However, in the long term, there is significant uncertainty about how the Nile river flow will respond to climate change. Both outcomes of decreased flow or increased flow are possible. Hence, we propose a *flexible* approach that addresses the two possibilities. In the event of a decreased flow, the most efficient adaptation mechanism would be to target comparable reductions in water demand. Since the agricultural sector is the main consumer of the Nile water, this demand management approach has to target reduction of water use for irrigation. Given the trends in population and economic development in the region, the objective of improving the efficiency of water use in irrigation is a desirable objective irrespective of the issue of climate change.

In order to enhance the regional capacity for adaptation to climate change, we propose development of an Eastern Nile Irrigation Management Information System (ENIMIS). The proposed system consists of two components: a network of monitoring stations (~10) distributed over the basin to monitor rainfall and other variables that can be used to estimate potential evaporation; and a web based information system that links together the stations through the web and makes their data available in real time to potential users. The proposed information system should also provide recommended methodologies on how to estimate irrigation requirements based on the observed local climate and crop type. This information should be available regularly to irrigation engineers in the basin countries to assist in their efforts to minimize wasted water in irrigation schemes. The proposed system is modeled after the California Irrigation Management Information System (CIMIS). The technology used as well as the experience gained in water conservation efforts in California can be quite valuable if transferred to the Nile basin.

In the event of increased flow in the Nile, this would be a good outcome that offers opportunities for additional water use in the Nile basin. However, in order to make optimal use of this new resource, creation of additional reservoir storage capacity could be of great value for efficient management of this new source. We are not recommending building of new reservoirs in adaptation to climate change, not yet. However, there has been recently renewed interest in development of new dam projects on the Nile valley for hydropower generation and expanded irrigation. These projects will add significant storage capacity to the overall system. This added storage capacity will be of even greater value in the event of increased flow due to climate change. We are suggesting climate change as an additional reason for investment in building these new reservoirs.

Any new identified set of proposed reservoirs, and their sequencing, should be analyzed using simulation models to determine their relative performance under different future climate scenarios. The capacity of the proposed design to manage water under a wetter climate should be one of several factors that are used to guide the planning process.

Here we recommend "development of the regional capacity for adaptation through: (i) minimization of irrigation water losses which should help to alleviate water shortages in the event of decreased flow, and (ii) addition of new reservoir storage capacity that can be used to manage water better in the event of increased flow; "



ATMOSPHERIC CHANGE
An Earth System Perspective
T. E. GRAEDEL • PAUL J. CRUTZEN

Figure 6: Global concentration of Carbon dioxide 1725-2000

(2.3) Mitigation of Climate Change:

Most of the emissions of greenhouse gases that cause climate change occur outside the Nile basin and Africa. Hence, Africa and the Nile basin countries would have only limited role to play in mitigation of climate change. However, it has been estimated that about 10% to 30% of the global emissions of carbon dioxide are associated with changes in land cover. Since the vegetated land surface plays a significant role in the global carbon cycle by emitting and absorbing carbon dioxide, any anthropogenic degradation of land cover should be associated with effective release of carbon dioxide into the atmosphere. Figure 6 shows the global concentration of carbon dioxide in the last three centuries. There has been significant increase in carbon dioxide concentration even before the industrial revolution, mostly due to changes in land cover over Europe and North America. This figure presents a clear evidence that changes in land cover contribute significantly to the climate change problem.

Sustainable development of the Nile basin should aim at restoration and protection of vegetation cover**. Here we recommend “limited good faith efforts in <u>mitigation</u> of climate change by combating anthropogenic deforestation and desertification in the region”**

(2.4) Potential Opportunities

Most water resources development projects on the Nile valley involve adding new capacity for hydropower generation. Hydropower is a clean technology with almost zero emissions. Carbon emission trading is well established in Europe. Recently, this mechanism is gaining grounds even in the US. At the international level, the Clean Development Mechanism (CDM) was established under the Kyoto Protocol. The CDM allows approved projects in developing countries to earn Certified Emission Reductions credits measured in tonnes of CO2. These CERs can then be sold to industrialized countries for use in accounting of their emission reduction targets.

A project participating in the CDM has to first be approved by a designated national authority as contributing to their sustainable development before formal registration by the Executive Board of the CDM. The project has to establish a baseline scenario to determine emissions levels assuming that the project is not developed, and has to meet the additionality requirement which establishes that the planned reductions would not occur without the additional incentive provided by the CERs credits. Then the project has to be monitored over a pre-specified accounting period to determine the difference between actual emissions and the corresponding emissions under the baseline assumptions. This difference is then credited to the project as a CER. The CDM offers an opportunity for all the new hydropower projects on the Nile to obtain CERs. This process should be engaged at the early stages in the planning of such projects.

The role of ENTRO should focus on facilitation and capacity building at national and regional levels for:

(i) using the existing CDM structure more efficiently;

(ii) negotiation of better mechanism structure for CDM that enables better African participation in the future

In a recent development, a report commissioned by the WWF, UK environmental group, suggested that the world already had compensation deals for accidents from nuclear power, oil spills, or even objects launched into space. But there were no U.N. schemes for damage from climate change. "The likelihood of legal action against major-emitting countries is increasing". This was the conclusion of to a study of options written by two climate lawyers. Among options were an international compensation fund set up by some future U.N. treaty to compensate victims, according to the report, released on the sidelines of December 2008 U.N. talks in Poland on fighting climate change. In the long term, countries of the Nile basin should advocate and prepare to participate in any such compensation fund.

Here we recommend “vigorous pursuit of the <u>opportunities</u> available: (i) through the Clean Development Mechanism (CDM) of the Kyoto Protocol to get Certified

Emission Reductions (CERs) for any new hydropower project on the Nile, and (ii) through new international compensation schemes that may be developed in the future"

(2.5) Education

The review of section 2 concluded that there is a high level of uncertainty in predictions of future climate over the Nile basin which presents tremendous opportunity for young researchers in the region. There is urgent need to motivate and inspire young minds to consider a career in research and/or policy in global change science. There is also a need to invest in training programs, and before that careful analysis to determine critical training needs. NBI training programs are positioned to play a significant role in offering education about climate change to a broad constituency of stakeholders. ENTRO can be play an enhanced role by sponsoring seminars and lecture series on the topics of sustainable development and climate change targeting young scientists, researchers, and engineers. **Here we recommend "enhanced efforts in education, research, and outreach to prepare the next generation of scientists, engineers, and policy makers who will deal with the issue of climate change as impacts become more evident and models become more accurate."**

All five pillars of the proposed strategy represent objectives that would be of great benefit to society and should be pursued under all circumstances. Their relevance to climate change adds to their, otherwise sound, rational.

3.0 Potential New Initiatives by ENTRO

Here, we recommend new initiatives by ENTRO, in relation to climate change, in the following five areas:

- Capacity building in regional climate modeling, in coordination with ongoing efforts in the area of floods.
- Consideration of climate change impacts within the JMP1 identification studies, for purposes of both mitigation and adaptation.
- Development and application of the ENIMIS concept.
- Engagement of the CDM process.
- A sponsorship of a regional seminar series on climate change and sustainable development.

The proposed initiatives, especially those related to regional climate modeling and CDM, should be pursued in coordination with other NBI organizations. Egypt seems to have significant experience in dealing with the CDM process. Some of that experience can be shared with other countries to help build capacity in this important area.

The proposed strategy should be implemented in coordination with ongoing international programs, especially those addressing climate issues at the regional level of Africa. For example, synergies should be developed with the ongoing AUC-ECA-ADB Joint Programme on Climate and Development in Africa (ClimDev-Africa).

4.0 Connections to ENSAP/ENTRO Projects

The proposed strategy and initiatives should be implemented within the context of ongoing projects at ENTRO.

The focus on regional climate modeling should build on the ongoing efforts within the Flood Preparedness and Early Warning Project. The latter invested in capacity building at the three Eastern Nile countries in the area of numerical model predictions of floods. Any new efforts in capacity building in the area of regional climate modeling should be designed in coordination with ongoing efforts in the Flood Project.

The proposed initiative in the area of water conservation (ENIMIS) should be developed further in coordination with ongoing efforts in Irrigation and Drainage Project. ENIMIS complements ongoing efforts since it takes a different approach that focuses on developing a new region-wide information system.

The proposed strategy that calls for a limited effort in mitigation of climate change, through prevention of land cover degradation, could best be implemented through the ongoing activities in the Watershed Management Project.

Finally, the proposed initiative regarding incorporation of considerations regarding climate change in the JMP1 identification studies demonstrates how the proposed strategy can be implemented within the context of the Joint Multi-Purpose Program.

5.0 Relevant Literature (not necessarily quoted within the text)

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