Impacts of Climate change on water resources in Africa

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Introduction (1/5)

• Life on earth is critically dependent upon the water cycle between oceans, continents and atmosphere through a complex and dynamic hydrological cycle
• Climate is changing and Africa is most vulnerable
• Climate parameters determine availability and renewability of natural resources such as water, vegetation, forests, biodiversity etc
• This in turn determines the livelihood of most of societies.
• There is presently much concern that anthropogenic increases in greenhouse gases is inducing rapid surface warming of the Earth.
The Greenhouse Effect

1. Solar radiation passes through the clear atmosphere. 
   - **Incoming solar radiation:** 343 Watt per m²

2. Net incoming solar radiation: 240 Watt per m²

3. Some solar radiation is reflected by the atmosphere and earth's surface. 
   - **Outgoing solar radiation:** 103 Watt per m²

4. Solar energy is absorbed by the earth's surface and warms it... 
   - **168 Watt per m²**

5. Some of the infrared radiation is absorbed and re-emitted by the greenhouse gas molecules. 
   - The direct effect is the warming of the earth's surface and the troposphere.
   - **Surface gains more heat and infrared radiation is emitted again**

6. Some of the infrared radiation passes through the atmosphere and is lost in space.
   - **Net outgoing infrared radiation:** 240 Watt per m²

Source: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington, Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.
Introduction (3/5)

CO₂ Emissions for Selected Countries in 1997

Per capita metric tonnes

- United States
- Australia
- Japan
- United Kingdom
- France
- India
- China
- Algeria
- Tunisia
- Morocco
- South Africa
- Gabon
- Botswana
- Zambia
- Zimbabwe
- Côte d’Ivoire
- Djibouti
- Niger
- Kenya
- Senegal
- Mauritania
- Morocco
- Egypt
- Libya

In many situations, efforts to adapt to climate change and mitigate greenhouse-gas emissions are comparable with efforts to tackle the associated threats of habitat destruction, fragmentation and degradation.
Indicators

Mean temperature anomaly in °C

the past 100 years in Africa

Direct temperatures
Indicators

Water Availability

- Scarcity
- Stress
- Vulnerable

Vulnerability of water resources

- IPCC predicts that rainfall will decrease in the already arid areas of the Horn of Africa,
- Drought and desertification will become more widespread
- Due to increasing scarcity of surface freshwater, groundwater aquifers will increasingly be mined
- Wetlands areas are also being used to obtain water for humans and livestock, and for additional cultivation and grazing land.
- This alters hydrological cycles, leaving the surrounding area more prone to flooding.
Vulnerability of water resources (1/2)

• As water resource stresses become acute in future water-deficit areas of Africa due to climate impacts and escalating human demand, the conflict between human and environmental demands on water resources will intensify

• Catchment degradation is a major problem, which is undermining the limited sustainable water resources base especially in the region
Vulnerability of water resources (2/2)

• It results increased runoff, flash flooding, reduced infiltration, erosion and siltation.

• The main causes of catchment degradation are poor farming methods, population pressure, overgrazing and deforestation.

• The major threat resulting to catchments degradation are
  – the forest excision for resettlement
  – dependence on wood fuel
  – illegal logging and encroachment into forests and marginal land.
1. There are no trees to soak up water, so more water flows into the rivers.

2. There are no trees to bind the soil together, therefore soil erosion takes place. Large amounts of soil are washed by rain into the rivers.

3. Because of silting, the riverbed
Mau Forest: large scale destruction of forest cover
Water resources vulnerability in EA (1/4)

- Eastern Africa, on the whole, is fairly well endowed with freshwater, with total average renewable freshwater resources amounting to 187 km$^3$/yr.

- Uganda has the largest share of this, with 39 km$^3$/yr while Eritrea has the least, with 2.8 km$^3$/yr.

- The amount and distribution of rainfall varies across Eastern Africa, with annual averages ranging from 147 mm for Djibouti to more than 1 000 mm for Uganda, Rwanda and Burundi.
Water resources vulnerability in EA (2/4)

- Intra-annual variations are also high, ranging from: 50–300 mm for Djibouti; 250–700 mm for Somalia; 750–2000 mm for Uganda; and 100–2400 mm for Ethiopia
- These intra-annual variations determine, to some extent, water availability.
- The mean annual rainfall over the region varies considerably from very high to very low annual rainfall amounts.
Water resources vulnerability in EA (3/4)

• The highest values are observed over the Ethiopian and East African Highlands as well as the western and northern shores of Lake Victoria.

• The rainfall in the Eastern African region is strongly seasonal.

• Most of the northern parts of the region receive rainfall mainly during the northern summer period (July to September-JAS).

• Central parts of the region (Southern Sudan, Southern Ethiopia, Southern Somali, Kenya, Uganda, Rwanda, Burundi, and central and northern Tanzania) have two main seasons.
Seasonal rainfall distribution

DJF
MAM
JJA
SON
Water resources vulnerability in EA (4/4)

- Changes in precipitation
- Evaporation and transpiration
- Changes in soil moisture
- Changes in snowfall and snowmelt
- Changes in storm frequency and intensity
- Changes in runoff, floods and droughts
Factors affecting water availability

- A broad range of internal and external factors have influenced the availability and quality of water sources.
- **Population pressure and conflict** - population growth has forced people to settle in ecologically sensitive areas such as hilltops and wetlands, leading to loss of water sources.
- Population pressure may lead to conflicts within communities over water resources.
Factors affecting water availability

• Major threat resulting to catchments degradation are the forest excision for resettlement, dependence on wood fuel, illegal logging and encroachment into forests and marginal land.

• Privatization & changing land tenure arrangements -this may force people to pay to regain the right of access or seek alternative sources.

• Poverty and social differentiation –poverty is a major contributing factor to the prevailing poor water situation.

• Environmental change and degradation – e.g. the draining of wetlands for agriculture
IMPACTS OF CLIMATE EXTREMES IN THE EA

- Failure in Agricultural Production
- Failure in hydro-power based industries.
- Destruction of infrastructure
- Loss of life & property
- Disease outbreak & epidemics
Impact of droughts and dam operations on L. Victoria levels, USDA (2005)
Time series of glacier surface areas on Kilimanjaro, Rwenzori Range and on Mount Kenya
The Disappearance of Lake Chad in Africa

1963
- Niger
- Chad
- Cameroon

1973
- Niger
- Chad
- Nigeria
- Cameroon

1987
- Niger
- Chad
- Nigeria
- Cameroon

1997
- Niger
- Chad
- Nigeria
- Cameroon

2001
- Niger
- Chad
- Nigeria
- Cameroon

Source: This collection of maps has been drawn after a series of satellite images provided by NASA Goddard Space Flight Center, available at: http://www.gsfc.nasa.gov/gsfc/earth/environ/lakechad/chad.htm
Floods in Budalangi, Nzoia River in Lake Victoria basin Kenya.
Floods: deaths, destruction and disruption of normal life
Human-livestock Conflicts - Droughts
......impacts

disruption of normal life
Severe shortage of water for domestic use
Reduction in dam levels affecting hydropower production
Drought: Livestock death and loss of livelihood
CLIMATE DATA / INFORMATION NEEDS FOR SUSTAINABLE MANAGEMENT

• We need up to date information (Evaporation, Water Level, Discharge, Precipitation, Humidity etc) describing hydro-meteorological conditions of a basin to anticipate and mitigate the associated impacts.

• Available ground-based measurements of stream flow and rainfall are inadequate to provide comprehensive monitoring of regional flooding.
CONCLUSIONS

• Need to harmonise catchment Disaster management policy and environmental protection for the EA region.

• We can do little to control the timing and intensity of floods & droughts in the short term.

• What we need to do, and can, is increase our capacity to cope with the extreme climate events
THANK YOU FOR LISTENING