Joint ICTP-IAEA Workshop on Vulnerability of Energy Systems to Climate Change and Extreme Events

19 - 23 April 2010

Vulnerability of the Tanzanian hydropower production to extreme weather events

Saiguran Loisulie
Sokoine University of Agriculture
Morogoro
Tanzania
Vulnerability of the Tanzanian Hydropower Production to Extreme Weather Events

Saiguran Loisulie

Sokoine University of Agriculture
Faculty of Science
Department of Physical Sciences
P.O.BOX 3038
Morogoro
Tanzania

Email: saiguran@suanet.ac.tz
Mobile: +255 757 876603
Introduction

- Energy sources in Tanzania are solar, wind, biogas, coal reserves, natural gas, hydropower, biofuel, wood fuel, and geothermal power.
- The most exploited is wood fuel because it is both cheap and accessible to the majority in rural and urban areas.
- Petroleum, hydropower and coal are the major source of commercial energy in the country.
- Fuel-wood and charcoal from both natural forest and plantations, accounts for 93 per cent of total energy consumption.
- Tanzania depends mainly on rainfall to recharge the hydropower plants which are the major source of electricity.
Introduction cont ...

- The spatiotemporal variability of rainfall over Tanzania and its impacts on hydropower production is investigated.
- Extremely dry years are defined as those whose rainfall per day is more than 1 and 0.5 mm below average for OND and MAM respectively.
- Extremely wet years are defined as those whose rainfall per day is more than 1 and 0.5 mm above average for OND and MAM respectively.
- Monthly means of rainfall (mm/day) from combined satellite/station data given at 2.5 degree latitude by 2.5 degree longitude from January 1979 to June 2009 were used.
Introduction cont ...

- Data were obtained from the Global Precipitation Climatology Project (GPCP), provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their Web site at http://www.esrl.noaa.gov/psd/
- River basins that are used for hydropower production are the Pangani and Ruaha Basins
- Nyumba ya Mungu, Hale and Pangani hydropower plants are in the Pangani River Basin
- Mtera, Kihansi and Kidatu hydropower plants are in the Ruaha River Basin
- Pangani river originates from Mount Meru and Kilimanjaro and flows into the Indian Ocean
- The Ruaha tributaries originates from southern highlands and flows into the Indian Ocean
Spatiotemporal distribution of rainfall

- Northeastern and northern Tanzania have two rainfall seasons, OND and MAM.
- Southern and western Tanzania have one rainfall season, October to May.
- Extremely wet years during OND and October to May from 1979 to 2008 were 1982, 1986, 1997 and 2006.
Spatiotemporal distribution of rainfall cont ...

- There is a general decrease of the amount of annual rainfall
- The frequency of below average rainfall is generally going up
- It is also evident that the severity of extreme weather events like dry and wet spells is intensifying
- The ENSO episodes impacts are also becoming more evident and severe
- The predictability of seasonal weather patterns is becoming more challenging
Annual rainfall cycle over Tanzania for 1979 - 2008
Spatial distribution of rainfall (MAM) 1979 - 2009
Temporal variability of rainfall (MAM) 1979 -2009
Spatial distribution of rainfall anomalies - MAM/2005
Spatial distribution of rainfall anomalies–MAM/2006
Spatial distribution of rainfall (OND) 1979 - 2008

[Image of a map showing the spatial distribution of rainfall]
Temporal variability of rainfall (OND) 1979-2008
Spatial distribution of rainfall anomalies – OND/2005
Spatial distribution of rainfall anomalies – OND/2006
Hydropower production

- Tanzania installed Hydropower generation capacity is about 561 MW
- Ruaha Basin is the major source of hydropower, producing about 82% of the total hydropower generation
- Mtera hydropower station generates 80MW
- Kidatu has power generating capacity of 204MW
- Kihansi has a power generating capacity of 180MW, likely to increase to 300MW in the future.
- The Pangani river basin has three power generation plants at Nyumba ya Mungu (8MW), Hale (21MW) and New Pangani Falls (68MW)
Vulnerability of the hydropower production to rainfall variability

- Due to drought, the highest water levels in most of the hydropower stations have progressively been declining in recent years.
- **Mtera Dam**

<table>
<thead>
<tr>
<th>Year</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>695.8m</td>
<td>690.5m</td>
<td>689.5m</td>
<td>688m</td>
</tr>
</tbody>
</table>

- **Nyumba ya Mungu Dam**

<table>
<thead>
<tr>
<th>Year</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>686.2m</td>
<td>683.8m</td>
<td>683m</td>
<td>680m</td>
</tr>
</tbody>
</table>

- These affected hydropower production...
In February, 2006 load shedding started in Tanzania due to insufficient hydropower generation into the national grid to meet the country’s maximum demand. While the country's demand stood at about 540 MW, the contribution by hydropower plants was as low as 140 MW (from the installed capacity of 561 MW).

In March, 2006 TANESCO announced that drought has affected all the six hydropower stations. The six stations was then yielding a paltry 50 megawatts, which necessitated the day-long power shedding.

Floods during wet years lead to erosion on the highlands leading to siltation of the dams.
Conclusions and recommendations

- Use thermal power, natural gas and coal in Kinyerezi, on the outskirts of Dar es Salaam, and Kiwira coal mines to generate 500 MW that would completely end power outages.
- Set up small hydropower plants that are environment friendly, like the Kinko one in Lushoto area, producing 27 kW.
- Popularise the adoption of solar panels for the rural majority left out of the national power grid.
- Use biogas from animal waste.
- Invest in wind energy to generate electricity.
- Engage in Interconnector Power project.
- Suspend tax on imported generators and related equipment during power rationing episodes.
References

- Daniel Mshana, 2007: Great Ruaha power project crucial: (http://216.69.164.44/ipp/guardian/2007/03/02/85459.html)
THANK YOU FOR YOUR ATTENTION