SLIDES: Environmental Flow Case Studies: Southern and Eastern Africa

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Water Management in Tanzania and Kenya

Tanzania

National Water Policy 2002
“water for basic human needs will receive highest priority, water for the environment to protect the ecosystems that underpin our water resources will attain second priority and will be reserved”

Water Resources Management Act (WRMA) No. 11 of 2009
“take into account and give effect to the requirements of the reserve”

Kenya

Water Resources Management Rules 2007
“establish the reserve based on water resource records and reserve water demand or ecological vulnerability, human vulnerability, local observations of historic drought flows, maintenance of perennial flows and consultations with WUAs”

The Water Bill 2014
"reserve, in relation to a water resource, means that quantity and quality of water required (a) to satisfy basic human needs for all people who are or may be supplied from the water resource; and (b) to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the water resource ”
Tanzania
Rufiji Basin Environmental Flow Assessment

To provide support for balanced use and protection of water resources by determining recommendations for the Reserve, with special attention devoted to protecting ecological functions that also provide services to neighboring human communities.
Main stages and tasks in holistic e-flows assessment for Kilombero to build flow regime for 5 sites and 2 flow scenarios

Stakeholders engaged at each stage of process
Kilombero Socioeconomic Surveys

To assess dependencies of communities on ecosystem services and the suitable flows to sustain them

Two-phase method to collect socio-economic information

1. Participatory Rural Appraisal (PRA) supported with key informants interviews (village extension officers, traditional healers, school children, fishermen)

2. Questionnaire survey for quantification of Phase 1 results

16 villages
436 households

- 45% female - 55% male
- 59% young - 31% middle - 10% elderly
- 82% primary education

* Ecohydrological surveys also conducted
<table>
<thead>
<tr>
<th>Kilombero Riverine Resource Services</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rivers</strong></td>
</tr>
<tr>
<td>Supply of domestic water</td>
</tr>
<tr>
<td>Fishing</td>
</tr>
<tr>
<td>Recession agriculture</td>
</tr>
<tr>
<td>Navigation</td>
</tr>
<tr>
<td>Rituals (floodplains)</td>
</tr>
<tr>
<td><strong>Oxbow lakes/ponds</strong></td>
</tr>
<tr>
<td>• Fish spawning areas</td>
</tr>
<tr>
<td>• Fishing</td>
</tr>
<tr>
<td>• Cultivated and wild vegetables</td>
</tr>
<tr>
<td><strong>Valleys</strong></td>
</tr>
<tr>
<td>• Rice farming during rainy seasons</td>
</tr>
<tr>
<td>• Maize and cultivated vegetables during dry seasons</td>
</tr>
<tr>
<td>• Grazing livestock during dry seasons</td>
</tr>
<tr>
<td><strong>Fish</strong></td>
</tr>
<tr>
<td>• Important food source</td>
</tr>
<tr>
<td>• Cash generation for subsistence</td>
</tr>
<tr>
<td>• Culturally important for rituals</td>
</tr>
</tbody>
</table>
### Ecological and Social Importance and Sensitivity

#### Present Ecological State

#### Environmental Management Class

<table>
<thead>
<tr>
<th>Component</th>
<th>EIS</th>
<th>SIS</th>
<th>PES</th>
<th>Trajectory</th>
<th>EMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrology</td>
<td>Medium</td>
<td>N/A</td>
<td>A/B</td>
<td>Negative</td>
<td>B</td>
</tr>
<tr>
<td>Geomorphology</td>
<td>N/A</td>
<td>N/A</td>
<td>B/C</td>
<td>Negative</td>
<td>B</td>
</tr>
<tr>
<td>Water Quality</td>
<td>High</td>
<td>High</td>
<td>A/B</td>
<td>Negative</td>
<td>A/B</td>
</tr>
<tr>
<td>Vegetation</td>
<td>Moderate</td>
<td>High</td>
<td>B</td>
<td>Negative</td>
<td>B</td>
</tr>
<tr>
<td>Fish</td>
<td>High</td>
<td>High</td>
<td>B</td>
<td>Negative</td>
<td>B</td>
</tr>
<tr>
<td>Macroinvertebrates</td>
<td>High</td>
<td>High</td>
<td>C</td>
<td>Negative</td>
<td>B</td>
</tr>
<tr>
<td>Social</td>
<td>N/A</td>
<td>Very High</td>
<td>C</td>
<td>Negative</td>
<td>B</td>
</tr>
<tr>
<td>Overall</td>
<td>Moderate</td>
<td>High</td>
<td>B</td>
<td>Negative</td>
<td>B</td>
</tr>
</tbody>
</table>
Kilombero River-floodplain System
Conceptual model of social and ecological relationships with flow regime

**Human Communities**
- High fishing season
- Rice cultivation
- Increased dependence on water from floodplain ponds
- Increased collection of wild fruits
- Maize cultivation

**Riparian Vegetation**
- Rains trigger plant germination away from rivers, which continues until March
- Intense floodplain wetland plant growth, including trees, grasses, shrubs, and aquatic species
- Rains trigger plant germination
- Existing riparian vegetation provides feeding and breeding sites for fish and macroinvertebrates
- Fires on the floodplain

**Fish Community**
- Adult fish, which have already spawned, migrate downstream
- Wetland becomes a nursery during this period
- Large number of fish begin downstream migration to wetland
- Secondary peak of spawning for a few species
- Great proportion of fish are feeding in wetland (fry, juveniles, adults)
- Fish leave the wetland and drift downstream to their dry season low flow habitats in a particular sequence of species
- Start of the upstream migration
- Spawning takes place, especially in the lower reaches of mountain rivers
- Spawning of quiet water species starts

**Graph**
- Discharge (m³ s⁻¹)
- Late rains rise, short rains transition, long rains rise, long rains recession, early dry season
- October, November, December, January, February, March, April, May, June, July, August, September

Photo: F. Mombo
Photo: R. Tamatamah
Recommended Environmental Flow Regime
Lwipa River, Kilombero Sub-basin
Scenarios of E-flow results for Lwipa River with Irrigation Demand Kisegese Blocks 1 & 2

No Irrigation

With Irrigation

Flow is at times below the Drought E-flow recommendations without irrigation – natural and expected

Percentage of time spent below drought flow recommendation increases

Increase greatest during dry periods (e.g. Sep-Oct)

Amount of time flow exceeds Maintenance E-flow recommendations decreases, even during wetter periods (e.g. Mar)
Mara River Basin Environmental Flows
Kenya and Tanzania

EFA 2006-2012

Legend
- Perennial River
- Seasonal River
- Mau Forest
- Protected Areas
- Mara Wetland
- Gauging Stations
- Sampling Sites
- Tenwek Dam

EFA 2015-2016

Legend
- MRB-EFA sampling sites
- WAP Rivers
- WAP Sub-basins
- Land use
  - Forest
  - Plantation
  - Grass
  - Savanna
  - Shrub
  - Wetland
  - Urban
  - Bare
  - Mining
  - Pasture
  - Agriculture
  - Tea
Mara River Basin Environmental Flow Timeline

2006 Project Transboundary Water for Biodiversity and Human Health in the Mara River Basin (TWB-MRB)
2008 NBI Legal and Institutional Cooperative Framework for water management in the MRB
2010 LVBC and WWF-ESARPO Biodiversity Strategy and Action Plan for Sustainable Management of the MRB
2010-2012 Mara River Basin Management Initiative (MRBMI) Environmental Flow
2007-2012 Assessment using Building Block Methodology (BBM)
2013 LVBC Initiation of Mara River basin-wide Water Allocation Plan
2015 Signature of MoU between Kenya and Tanzania as agreement for transboundary water management in MRB
2015-2016 E-flow Assessment using PROBFLO and BBM (ongoing)
Water Resource Classification System
Lake Victoria South Catchment
Management Units, Kenya

**Upper Mara:** high ecological importance (E1), high livelihoods value (L1) low commercial (C3) value

**Lower Mara:** high ecological importance (E1), livelihoods value reduces to medium (L2) and commercial (C2) value increases from a low to medium importance

(WRMA 2014)
# Resource Use and Flow-related Social Impacts at Low and High Flows

Based on separate studies for Mara River Basin Kenya and Tanzania

<table>
<thead>
<tr>
<th>Resource</th>
<th>Use</th>
<th>Flow-related impact on livelihoods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Low flow (dry season)</strong></td>
<td><strong>High flow (wet season)</strong></td>
</tr>
<tr>
<td>Water</td>
<td>Domestic consumption</td>
<td>Increased proximity with wildlife</td>
</tr>
<tr>
<td></td>
<td>Livestock consumption</td>
<td>Bank degradation</td>
</tr>
<tr>
<td></td>
<td>Irrigation</td>
<td>Risk of availability &lt; demand</td>
</tr>
<tr>
<td>Recreation</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Industrial use, e.g. water mills, mines</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Generation of hydroelectric power</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cultural/religious practices, e.g. baptism</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Transportation</td>
<td>River crossing, harvest of opposite banks</td>
<td>-</td>
</tr>
<tr>
<td>Fish</td>
<td>Consumption and sale</td>
<td>Easier catch</td>
</tr>
<tr>
<td>Reeds</td>
<td>Habitats for wildlife</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Making mats and baskets</td>
<td>-</td>
</tr>
<tr>
<td>Trees</td>
<td>Construction material, furnitures and utensils, medicine, charcoal, fuel wood</td>
<td>Harvest and drying of the wood</td>
</tr>
<tr>
<td></td>
<td>Water retention</td>
<td>Less water infiltration</td>
</tr>
<tr>
<td>Herbs</td>
<td>Medicine</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Cultural/traditional artifacts</td>
<td>Riparian zones under pressure if levels are too low</td>
</tr>
<tr>
<td>Soil sediments</td>
<td>Construction, sale and art work</td>
<td>Sediments more accessible</td>
</tr>
<tr>
<td>Land</td>
<td>Cultivation</td>
<td>More land to harvest</td>
</tr>
<tr>
<td>Wildlife</td>
<td>Tourist attraction</td>
<td>Wildlife watering points and habitat under pressure</td>
</tr>
</tbody>
</table>
Probflo Bayesian Network for E-flows
Recommendations for Mara River

**Phase 1: Preparation**  
Preparation of monitoring protocol, incl. indicator species, methodology and site selection

**Phase 2: EFR workshop**  
Finalization of the monitoring protocol

**Phase 3: Reserve recommendations and post-workshop integration of the reserve into WAP**

**Phase 4: Reserve implementation**

**Phase 5: Reserve evaluation**

**Phase 6: Adaptive management (Protocol)**

<table>
<thead>
<tr>
<th>Indicators \Groups</th>
<th>Trigger points (TPCs)</th>
<th>Frequency</th>
<th># Sites</th>
</tr>
</thead>
</table>
| Fish species (Rheophilic) | Enough fish to eat or sell  
Both adults and juveniles present  
Each sample > 3 adults, > 5 juveniles | seasonal  
6 months  
Yearly | All 7 Sites  
All 7 sites  
Key sites; 3/7 |
| Macroinvertebrates | High abundance  
Sensitive taxa present  
Index Score < value X | Yearly  
3,5 years  
3,5 years | All 7 sites  
All 7 sites  
All 7 sites |