Contribution of Research and Innovation to Sustainable Water Development in Kenya

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1. BACKGROUND TO THE WATER RESOURCES DEVELOPMENT AND SECTOR REFORMS IN KENYA
   (A historical overview)
Kenya’s Water Resources Development: A brief history

1895 – Kenya declared the British East Africa Protectorate (BEAP)
1896 – Commencement of the Uganda Railway (reaching Nairobi in 1899 and Port Victoria/Kisumu in 1901)
  • The East Africa Railways and Harbours developed the first piped supplies to serve major towns
1902 - Hydraulics Branch (HB) of the Public Works Department (PWD) took over water development and supplies
1903 – HB opened offices in Kisumu
1910 – HB opened offices in the Rift Valley and Mt Kenya region
1914-1923: Private sector entry - Upper Nairobi Townships & Estate Co. Ltd supplied water to up-market areas of Nairobi.
1940s: Tetly, the Hydraulic Engineer, conducted several ground water explorations in Kenya (rift Valley, Eastern & northern Kenya)
1950s: Water dev in Northern Frontier Districts through construction of pans, dams and tanks.
Example: The Nile Treaty – What it actually said...

- The exchange of notes on 7 May 1929 between Her Majesty’s “Government in the United Kingdom and the Egyptian Government on the use of waters of the Nile for irrigation” is embodied in two related instruments that are literary referred to as the 1929 Nile Waters Agreement or the 1929 Nile Waters Agreements.

- **The 1929 Agreement** and is highly contested by the upper Nile riparian States is paragraph 4(b) of 7th May 1929 that states as follows:

  “Except with the prior consent of the Egyptian Government, no irrigation or power works or measures are to be constructed or taken on the River Nile or its branches, or on the lakes from which it flows so far as all these are in the Sudan or in countries under British administration, which would in such a manner as to entail prejudice to the interest of Egypt, either reduce the quantities of water arriving in Egypt, or modify the date of its arrival, or lower its level”. *See, Kenya was included*
Water Resources Development: A brief history contd...

1953-1955: The East Africa Royal Commission was established—administered in each territory (country) water supplies, apart from urban supplies.

1954-57: The “Swynnerton Plan” was developed under the Ministry of Agriculture. It also touched on rural water development.

1957: The HB was transferred to Department of Agriculture, and operated in small towns and rural areas. Large towns were under Local Authorities.

• This arrangement continued for 25 years (past independence).

1964: HB of the Ministry of Works (MoW) was merged with ALDEV of MoA and both put under the Ministry of Natural Resources (MoNR).

1972: the Water Development Division was elevated to a Department and the Director of Water Development in charge of the whole country.

• The Ministry of Local Government (MoLG) was in charge of water supplies in major municipalities.

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Sanitation, hygiene & pollution control: A brief history

1900-04: The bucket latrine system was introduced to Kenya especially in urban areas

1902 and 1907: Disease outbreaks and plague in Nairobi called for improvements in sanitation

1920s-30s: Bucket latrines dominated with the development of towns, labour camps, schools. Pit latrines were introduced in the rural areas

1934: About 3,350 buckets were used daily and ox-drawn carts used for collection

1950: Sewerage Department of PWD was created

1950s-60s: Enforcement of rural hygiene and digging of pit latrines

1960: Environmental Sanitation Programme commenced. It was concerned with waste disposal in schools, health centres, markets and public places

1969: Ministry of Health drafted the Natural Waters Pollution Control Act

1999: Environmental Management and Coordination Act (EMCA) was enacted.

2013: National Environment Policy was published under MEWNR
Water Policy and Legislation: A brief history

1929: The first Water Act in Kenya (Water Ordinance Act) was enacted
1935: Water Board was created –it gave permits for surface water (GW was free)
1951: Minister for Agriculture was given mandate to develop water policy
1952: Water Act Cap 372 was published (repealed the Water Ordinance Act)
1964-70: First Dev Plan - mainly a carry-over from the colonial period
1970: Government adopted the “water for all by 2000” programme
1974: A fully-fledged Ministry in Charge of Water affairs was created
1974: The First National Water Master Plan was developed
1983: District Focus for Rural Development was implemented
1992: MoWD released the 1st National Water Master Plan which set out long-term plans for reforms in the water sector
2002: The Water Act 2002 was published (it repealed Cap 372) with new institutions which ushered the “Water Sector Reforms of 2003”.
2013: National Water Master Plan 2030 was published.
2016: The Water Act 2016 was published.
2. CHALLENGES FACING THE WATER SECTOR IN KENYA

But Research & STI Could fix that!
• **Kenya is NOT Water Scarce** – It is failure to use Research, & STI

• Per capita water availability = (Total fresh water/total population)
  - It was 647 m³ in 2000, dropped to 502 m³ in 2012 and will be 235 m³ by 2025.

• Per capita storage is 102 m³/year (NWMP-2030) - compare with 4729 m³ for Australia

• The demand for water in Nairobi is 340,000 m³/day, and expected to reach over 1 million m³/day by 2030

• Mt. Kenya had 18 glaciers in 1900 but now it has only 7.

• Serious droughts since 1970s and effects of climate change

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The water crises affects large parts of Kenya

ASALs cover 84% of Kenya’s land

Areas prone to flooding in Kenya

The drier the area, the greater the flooding and hence water pollution (siltation)
Kenya is getting warmer: Climate Change is here! Sure can

- Within Kenya, climate change is already being experienced,
- Mean annual temperatures have risen by 1°C over the past 50 years
- A rise in temperature of 1.0-2.5°C is expected by 2030
- Many areas in Kenya have longer dry spells and heavier storms
- Between 200-2006, there were 60 weather related disasters
Even in urban areas, few households have tap water within their dwellings

Example: In Mombasa, where only about 15% of the people have access to piped water supply, more than 80% get their water from vendors
Flooding Problems in both rural and urban areas

- Flooding occurs in the same areas prone to droughts
- Flood occurrence is expected yet nothing is done as mitigation.
- Loss of life and property each year
- Flood management with innovative engineering infrastructure & catchment protection
- Flood control – an intervention for reduction of pollution – its do-able
Urban Stormwater = Wastewater in Kenya (wasted!)

• Rising urbanization in Kenya
• Water demand is increasing at a higher rate.
• Built up areas contributing more storm-water
• Most storm-water is polluted with wastewater
• The scant data on storm-water generation, use
• Most storm-water is mixed with Sewerage (goes to Ruai)
Pollution threats on Water Resources and Ecosystems

- Water pollution increasing with population growth.
- Increasing Nitrates ($\text{NO}_3$), sulphates ($\text{SO}_4$) heavy metals e.g. lead (Pb), chromium (Cr) and selenium (Si), and pesticides.
- Wastewater effluents from urban settlements polluting the environment & water resources
- Effluents from factories into shallow groundwater aquifers, and rivers (e.g. Nairobi River, Thika River).
Challenges Facing Lake Management in Kenya

• **Rising water levels** in all Rift Valley lakes since 2011, esp. Lakes Naivasha, Elementaita, Nakuru, Bogoria, Baringo, and Logipi.

• **Others affected include Lake Simbi in Homa Bay & Lake Chala at the Coast.**

• **Pollution** from agricultural activities (e.g. Lake Naivasha),

• **Solid waste** and waste water pollution (L. Victoria)

• **Over-fishing** (L. Turkana, L. Baringo, L. Victoria)

• **Transboundary** issues (L. Turkana, L. Victoria).
Deforestation - A cause for degradation of water sources

- The large-scale removal or partial removal of trees from forested areas.
- Forests shield the soil surface from heavy rainfall, reduce the rate of run-off by increasing infiltration.
- Forests decrease flooding, mitigate soil erosion and limit the sedimentation of rivers/dams.
Infrastructure failures = Design failures = STI gaps

**Examples**
- Breach of embankments
- Dams/pan silt too soon
- Pollution of water storages
- Dry boreholes
- Seepage problems
- Water deficits/inadequate design
3. DEFINITIONS OF RESEARCH, SCIENCE, TECHNOLOGY AND INNOVATION (RSTI)
What is Research

• **Research** is the creation of new knowledge and/or the use of existing knowledge in a new and creative way so as to generate new concepts, methodologies and understandings.

• **Research** is about the gathering of data, information and facts for the advancement of knowledge.

• **Applied research** is original investigation undertaken to acquire new knowledge but directed towards a specific, practical aim or objective (including a client-driven purpose).
What is Science

• **Science** is a systematic and logical approach to discovering how things work. It is derived from the Latin word “scientia,” which translates to knowledge.

• **Science** is the organized body of knowledge that is derived from such observations and that can be verified or tested by further investigation.

• Unlike the arts, **science** aims for measurable results through testing and analysis.

• **Science** is based on fact, not opinion or preferences.
What is Technology?

• **Technology** is the use of scientific knowledge for improving the way to do things. One would use scientific knowledge to invent machines or devices to make things easier to do.

• **Technology** includes the use of materials, tools, techniques, and sources of power to make life easier or more pleasant and work more productive. Whereas science is concerned with how and why things happen, technology focuses on making things happen.”
What is Innovation?

**Innovation** – Fresh/new/original or radical thinking/idea, or new ways of doing things, business processes that creates value, wealth or social welfare.

- Innovation deviates from “Business as Usual”
- Innovation is about *bringing ideas to life*,
- It improves efficiency, productivity, quality, competitive positioning and market share, performance and growth.

**Creativity** is about coming up with ideas... but it requires Action to become Innovation.

- Innovation does not occur in the mainstream but in the interaction of actors in the innovation system *(Source: Urama et al. 2010, The African Manifesto for STI)*
4. CONTRIBUTION OF RSTI IN KENYA’S WATER SECTOR DEVELOPMENT & MANAGEMENT
Research on Water is Conducted “Yes, but in silos”

- Most national universities conduct research on water esp at post-graduate levels e.g. JLUAT, KU, Moi, UoN, Egerton, TUK, TUM, MMUST, JOOUST, KEMU, etc
- Tertiary institutions also conduct water research e.g. KEWI
- Government Ministries – MWI, MoALF, MENR, MLHUD
- SAGAs e.g. WRMA, WSREB, NIB, KENGEN, NEMA have huge databases that constitute research findings
- NGOs/NSAs conduct research on water too, e.g. KEWASNET, KRA, NETWAS, Red Cross, WSUP, WV, etc
- International organizations in Kenya e.g. UNEP, FAO, UNDP, Habitat, WAC, WWF, World Bank, AfDB, TNC,
- External institutions such as overseas universities e.g. Oxford-UK, ITC-Netherlands,
- Water users themselves - these hold the largest research database which is un=documented & un-recognized
- The Water Research & Resource Center (WARREC) of JLUAT was created to bridge this gap....

WARREC is a Vision 2030 Flagship Programme under MTP-2
Vision 2030 Statements on Water promises...

Social Pillar

• “Water and Sanitation are available and accessible to all”
• Improving water resources management, storage and harvesting capability
• constructing multipurpose dams
• enhancing disaster preparedness
• improving the capacity for adaptation to global climatic change
• Increase irrigation from 140,000 to 1.2 million ha.
• Improve water harvesting and storage capacity as one of the Strategic Thrusts
• Construct 22 medium-sized multi-purpose dams of capacity 2 billion cu.m to supply water for domestic, livestock and irrigation (could surpass that target)

• Research & STI are needed to meet (even surpass) these Targets

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Design & Construction of Dams—requires RSTI

Dams are needed to store water for:
• Urban and rural water supplies
• Irrigation
• Generation of electricity
• Strategic water reserves
• Drought mitigation
• Flood control
Development of water services infrastructure

- Rural drinking water supplies
- Spring protection/water supplies
- Irrigation water supplies
- Pumped water supplies
Example: Design of water storages, pans & ponds

Many water pans/ponds pose safety and contamination concerns & high evaporation

A lined water pan with silt-trap inlet and net covering for safety and hygiene
Design of water conveyance infrastructure

Lined canals to reduce seepage losses

Conversion from canals to piped water systems
Change from installing toilets with wasteful flushing

Provide incentives e.g. to builders, to change from installing the 10 litre toilets (*they are cheaper*) to the dual 3-5 litre/flush toilets.
Example: Fit Low-Flow Aerators on Taps & Showerheads

Kitchen tap fitted with aerator

Simple flow regulators to fit various types of taps & uses

Water saving shower heads
Available in many designs,
Regulate water flow from 20 l/min to 9 litres/min or Less
Water Purification: Small gadgets & treatment works

**Water Purifying Bicycle:** A “Cycloclean,” is a water-purifying bike that harnesses kinetic energy to purify water. Users can ride the bike or simply cycle it at source.

*Source: Japan’s Nippon Basic Company*

Large water treatment works
*(Photo courtesy of MEWNR)*
Design of Sanitation with Water Saving/Recycling

e.g. Water and wastewater sink/urinal combo in an all-in-one grey water recycling system
Wastewater Recycling for flushing toilets

This "Eco Basin system" makes use of grey water after purifying it a bit, by simply mixing it with fresh water. The flush tank is connected to a freshwater source as well as a sink. When gray water enters the tank, it is mixed with the same amount of fresh water. This 50-50 consistency keeps the toilet drains unclogged and also ensures that 50% of fresh water is saved in the process. (Source: http://www.designswan.com)
Example: Research to improve water use efficiencies

- Centre Pivot Irrigation – going large scale
- How much water is used in irrigating crops
- Micro-sprinkler irrigation - scope for Kenya
- Greenhouse farming, Kenya – very efficient on water use
Examples of Constructed Wetland Systems

Wastewater treatment with constructed wetland from a large Estate in Delhi, India
(Photo: Bancy Mati)

A constructed wetland for a small estate at Agra, in India
(Photo: Bancy Mati)
Urban Stormwater harvesting
Example of missed opportunity for Nairobi

<table>
<thead>
<tr>
<th>Total area</th>
<th>684 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>3.6m (in 2009)</td>
</tr>
<tr>
<td>Population living in informal settlements</td>
<td>40%</td>
</tr>
<tr>
<td>Population with safe adequate water</td>
<td>65%</td>
</tr>
<tr>
<td>Water demand</td>
<td>690,000 m³/day</td>
</tr>
<tr>
<td>Water supply</td>
<td>525,000 m³/day</td>
</tr>
<tr>
<td>Water deficit</td>
<td>165,000 m³/day</td>
</tr>
<tr>
<td>Non-revenue water losses</td>
<td>40%</td>
</tr>
<tr>
<td>Mean Annual rainfall</td>
<td>1,062 mm</td>
</tr>
<tr>
<td>Potential for RWH (assuming 30% capture)</td>
<td>596,485 m³/day</td>
</tr>
<tr>
<td>Current RWH</td>
<td>Very low</td>
</tr>
</tbody>
</table>

Thus, Nairobi could meet 86% of its water demand from RWH, if 30% of rainfall were harnessed!

(Calculations by B. Mati)
RSTI for Watershed Protection & Management

• Conservation of existing forest cover
• Tree planting on catchment areas
• Road runoff harvesting
• Agroforestry
• Terracing sloping lands
• Vegetative buffers
• Irrigation and drainage

Photo by B. Mati
Reducing water-related diseases

♦ Limit faecal contamination
♦ Improve household water quality
♦ Improve water availability
♦ Reduce impact of insect vectors
♦ Disease treatment
♦ Focus on sanitation and wastewater and hygiene

Interventions

• In-home interventions
• Institution scale interventions
• Public water supply and sanitation
• Policy changes to promote better water and wastewater services
• Build the capacity of local people/organizations

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WAY FORWARD

Transformative Water Sector Development & Management
Take Part in the On-going Water Sector Transformation

• The Water Act 2016 is now law - It supports “institutional capacity for water research and technological development (article 10);
• Devolution of water services provision to the Counties – need for RSTI support counties improve their water services
• Vision 2030 projects – all of which require water (e.g. SGR, Expansion of irrigation)
• New projects on water e.g. Kalalu-Galana Irrigation scheme, Tana Grand Falls dam, construction of water pans.....
• Many universities now offer advanced degrees in the areas of water resources management, WASH, thus capacity is growing.
• Need to entrench “Water Education” at an early age starting from Primary school curriculum (example of Israel).
Upgrading Research, STI for the Water Sector

- Encourage water users to do simple experimentation with water (for their own knowledge & behavioural change)
- Empower Water Users Associations & Service Providers to conduct simple applied research (e.g. Installing meters)
- Upgrading the Water Research & Resource Center (WARREC) at JKUAT to be national research Center for water
- Bridge the research & gap between scientists/researchers with water users
- Support the strengthening of R, STI by allocating at least 2% of the budget allocated to water to be used on Research
- Government – include Researchers/scientists in planning and planning, implementation advisory services on water issues.
THANK YOU

For more information, contact
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http://www.jkuat.ac.ke/departments/warrec