Water-Energy Nexus in Bangalore City and Improved Water Services: Building Urban Resilience

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Wageningen University and Research, the Netherlands

Reba Paul
Doctoral researcher and research assistant, Institute for Sustainable future, UTS
Water and Energy Linkages/ Water-Energy Nexus

- Water Extraction/Collection and Transport
- Water Treatment
- Energy for Water
- Water Distribution
- Wastewater Collection
- Wastewater Treatment and disposal/transport
- Thermoelectric Cooling (80% power plants need cooling)
- Fuel Production (Ethanol, Hydrogen)
- Fuel extraction and refining such as coal, gas, and oil
- Hydropower Development (20% energy production)
- Fuel processing and Transport
- Energy for Water
Globally, 2.8 billion people live in water-stressed areas. About 748 million of the world’s population have no access to improved water and 2.5 billion have no access to basic sanitation (UNWWDR 2012).

The urban population will increase by 70% (6.5 billion out of estimated 9.3 billion) by 2050, with most of this increase taking place in Asia, Africa and China (United Nations 2014).
World primary energy demand will increase by nearly 60% (about double) by 2050. This will increase associated water consumption by 85%.

1.3 billion people have no access to electricity and 1.2 billion have unreliable access. 700 million people in Asia lack access to electricity.

Blackouts are a frequent phenomenon in many cities in developing countries.
Old Paradigm - Centralised Water and Wastewater Management – a cause of water-energy nexus

- Requires substantial energy due to huge pump and piping infrastructure
- High system loss and difficult to replace due to Huge and ageing infrastructure
- Single high quality water for all purposes and 80% supplied water goes to drain
- Linear management of water and little or no scope of recycling and pollute surface and ground water
- Less involvement of community
Energy Expenditure of Urban Water Services

- Urban Water utility pays 30-40% of their annual operating budget for energy (Copeland 2014) in developing countries but some pay as much as 80% (ICLEI 2008).
- In developed country it is 15-20% but can be as high as 40%.
- Energy cost of water utilities will increase further due to more dependence on remote water sources and stringent regulation of water quality in the face of pollution.
Challenges for Urban Water Utilities

- Increased Energy Production
- Increased GHGs
- Increased Energy Price $$
- Increased water supply
- Increased energy supply
- Long Distance Pumping/deep Aquifer/desalination
- Increased Water Services
- Increased Water Price $$
- Increased GHGs

Slow progress in SDGs
- Water as human right & also economic good

- Population Growth
- Urbanisation
- Industrialisation
- Improved life style of people
- Climate Change
Total city area  800 sq. km
Population  8.5 million
Third largest city in India
Rainfall  850 mm
No perennial river
Groundwater Problem in Bangalore City

Only 30% ground water is potable
(Mining and Geology Department 2011)

Ground water overdraft = 142%
(Hedge and Subhash 2011)

Contaminated due to pollution from untreated wastewater and industrial effluent
Current Water Supply in Bangalore city

- **Surface Water Supply**: 800 MLD
- **Ground Water Supply**: 400 MLD
- **Rainwater Harvesting**: 18 MLD
- **Centralised wastewater Reuse**: 10 MLD
- **Decentralised Wastewater Reuse**: 42 MLD

**Type of water source**
Current Water Demand Supply Gap = 642 MLD ~ 650 MLD

People meet the gap from tubewells / groundwater and private tankers.
Access to Water Supply and Sanitation in Bangalore city

Water Supply

- Indian Standard: 150 lpcd
- BWSSB: 100-110 lpcd avg
- End users receive: roughly 70-75 lpcd
- Supply: 4-5 hours alternate day
- Inequity distribution: 26-330 lpcd
- Poor or slum people: little or no water

Sewerage service

- The city produce 1200 MLD sewage but can treat only 800 MLD
- 40% people have sewerage coverage
Water-Energy Nexus and Its Implications in Bangalore city

**Population growth**

- Increased demand for water
- Reduced water flow and conflicts between riparian states in sharing water for other purposes such as agriculture and hydropower production

**Climate Change**

- Water reservoir
- Over extraction of groundwater and depletion of ground water table
- The Cauvery River shared by many riparian states

**Wastewater Treatment Plants**

- Long piping network to collect wastewater
- Effluent disposal to lakes and water bodies

**Water Distribution**

- Long water supply pipe network, overhead tanks and numerous booster pumps
- High system loss (50%)

**Users**

- New regulation for small scale decentralised Sewage Treatment Plants (STPs) and 100% recycling
- Rainwater Harvesting by users as mandated by BWSSB

**Water Pollution**

- High O&M Cost due to high energy involvement and financially burden to residents
- Poor operation and maintenance and slow expansion of water services

**DWSSD pays 50-60% of their annual operating budget for energy to BESCOM**

**Subsidy for energy by Government of Karnataka**

- More investment to produce energy for increased water supply and other purposes
- Increased water price
- Increased energy price
- More carbon emission

**Implications on organisations**

- Slow progress in achieving SDGs
- Inadequate Systems failure.
- Poor Economy
- Slow progress in achieving SDGs

**Social, economic and environmental impacts**

- Institute for Sustainable Futures
Need a new paradigm of resources management/ circular and integrated management of resources

Kenway, 2011
System Thinking/Basin approach of water management

Whole Cycle of Urban Water and Wastewater System

Centralised Water and Wastewater System

- Water Extraction and transport
- Water Treatment
- Water Distribution
- Wastewater Collection
- Wastewater Treatment
- Wastewater Disposal

End Users (Residential, Commercial, Industrial, Agriculture and others)

Recycled wastewater treatment

Recycled water

Recycled water Distribution

Source

Rainwater/Storm water

Decentralised water and wastewater systems

Aquifer/ground water, rainwater, treated decentralised recycled water

Water Sources (Rivers, Aquifers, Ocean, other storages)
Decentralised system–stand alone system

Distributed System – mid scale systems that are connected or can be connected to existing sewerage network – so follows a system/basin approach of water management
Concept of Distributed Recycled Water System to reduce energy consumption

- **Inflow of raw water**
  - Water supply from remote source/long distance or deep GW aquifer

- **City boundary/bigger catchment boundary**

- **Centralised Water Supply system**

- **Wastewater Flow**

- **Centralised Wastewater treatment system**

- **Effluent**
  - Outflow of wastewater/recovery of nutrients and generation of energy

- **End Users**
  - End users
  - End Users
  - End Users

- **Distributed recycled water system**

- **D**
Energy Intensity is the energy use to process a unit volume of water such as water pumping, treatment or for the whole process or system. Measured in kWh/MG (kL).
‘One Water’/Integrated Water Management Framework for Paradigm Shift to distributed recycled water system

Source: Mukheibir et al. 2015
Thank you

Email: reba.paul@uts.edu.au