WATER REUSE IN AFRICA

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  - Direct potable reuse of wastewater
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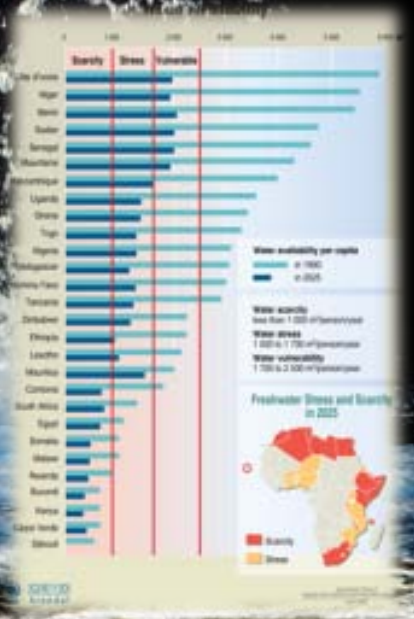
WATER AND SANITATION IN SUB-SAHARAN AFRICA

- 60% of the population use **improved sources** of drinking water
- Sanitation coverage is only 36%
- Chronic water stress is elevated for 25%



WATER REUSE IN AFRICA

- **Raw human waste used for centuries in both rural and urban areas**
  - Broad agriculture and aquaculture
  - Maintain the organic fraction of soil (conditioning and humus replenishment)
- **Untreated or only partially treated sludges are applied in the vast majority of cases**
- **Reuse extremes range from piped distribution of treated wastewater to illegal diversion of raw wastewater by farmers**

WASTEWATER REUSE

- **Agriculture accounts for major water use in developing countries (about 75 - 80% of total) followed by industry and domestic use**
- **In semi-arid African areas**
  - Wastewater may constitute 25 - 75% of available irrigation water (Angola, Namibia, Botswana and Zimbabwe)
  - In South Africa 15 - 20% of wastewater is reused in agriculture
  - In 1990 Morocco was using about 16% of its wastewater for irrigation

WASTEWATER REUSE

- data is sparse and often estimated or derived from models
- United Nations FAO Aquastat lists wastewater reuse data for only 5 African countries (F = FAO estimate)

Country	Treated Wastewater Reused ($10^9 m^3/yr$)
Egypt	2.971*(2000)*
Libyan Arab Jamahiriya	0.04F*(2000)*
Tunisia	0.021*(2001)*
Mauritania	0.0007F*(2000)*
Namibia	0.007F*(2000)*

WASTEWATER REUSE EXAMPLES

- **Tunisia**
  - Citrus, fodder
  - 24% of treated wastewater effluent used for irrigated agriculture
- **Morocco**
  - Vegetables, fodder
- **Ghana**
  - Vegetables, ornamental plants
  - Sludge from public toilets and septic tanks transported for decades to urban fringe farms in the North
- **Dakar**
  - Small scale horticulture (waste/groundwater mix)
- **Botswana**
  - Peri-urban farming around Gaborone

Tunisia

Ghana

Morocco

Dakar

- **Djibouti**
  - Plans for production of orchards and market gardening
- **Egypt**
  - Unofficial and uncontrolled wastewater reuse estimated between 2.8 and 4 km^3
- **Morocco**
  - In Ben Slimane, 5 600 m^3/day of treated wastewater effluent is used for golf course irrigation
- **Fish cultivation in sewage ponds (small scale)**
  - Kenya
  - Malawi
  - South Africa
  - Zimbabwe

Kenya fishery

WATER REUSE SPECIFIC CASES

- Indirect potable reuse of wastewater
  - South Africa, Mossel Bay WWTW
- Direct industrial reuse of wastewater
  - South Africa, Durban Water Recycling Plant
- Direct potable reuse of industrial (mine) water
  - South Africa, eMalahleni Water Reclamation Plant
- Direct potable reuse of wastewater
  - Namibia, Goreangab Water Reclamation Plant

Indirect potable reuse of wastewater

South Africa, Mossel Bay WWTW

(Picture: Wolwedans Dam, Source: Mossel Bay Municipality)

MOSSEL BAY WWTW

- Proposed indirect potable use of treated wastewater effluent to augment raw water supply
- Wastewater treatment works to provide 5 Ml/day of high quality treated effluent from the works
- To be introduced into the existing rising main from the Wolwedans Dam
- Construction to commence June 2010

- **Treatment process**
  - Pre-treatment (in-line strainers)
  - Ultrafiltration (UF)
  - Reverse osmosis (RO)
- **Portion of effluent desalinated in the RO plant and resulting permeate blended with UF filtrate**
- **Objective is to reduce the conductivity of the WWTW effluent to the same order of magnitude as the Wolwedans Dam water**

Wolwedans Dam – aerial view

WATER REUSE SPECIFIC CASES

Direct industrial reuse of wastewater

South Africa, Durban Water Recycling Plant

(Picture: DWRP, Source: VWS Envig)

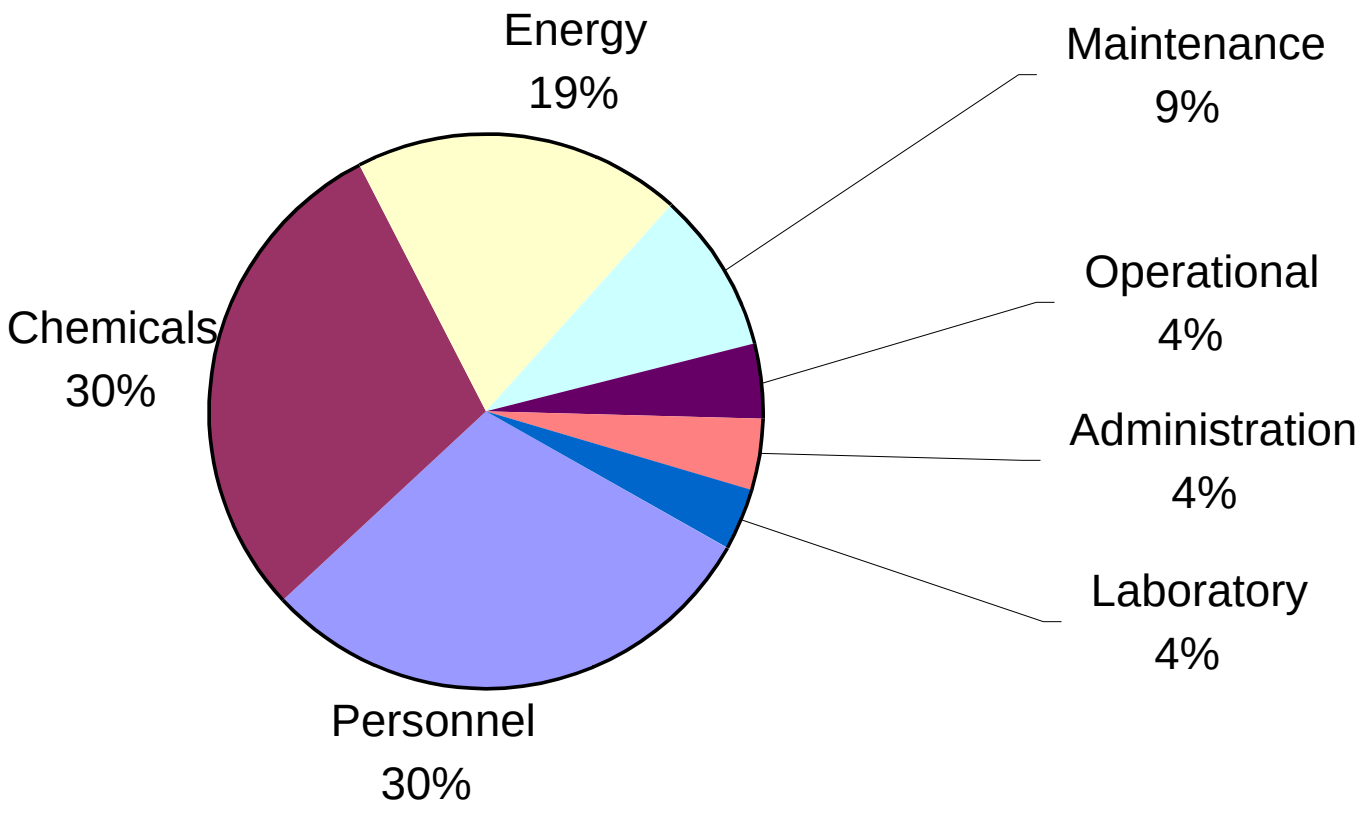
DURBAN WATER RECYCLING PLANT

- **Durban Water Recycling Plant**
  - Commissioned in 2001
  - Treats 47.5 Ml/day of domestic and industrial wastewater to a near potable standard
  - Sales to industrial consumers for direct use in their processes
- **Public Private Partnership**
  - eThekwini Water Services
  - Durban Water Recycling (Pty) Ltd

- **Wastewater source**
  - Predominantly domestic in nature
  - Industrial effluents comprise 10% by volume and 20% by pollution loading
- **Treatment Process**
  - Preliminary screening and primary settling
  - Activated sludge
  - Chemical dosing and lamella settling
  - Rapid dual media filtration
  - Ozonation
  - Granular activated carbon
  - Chlorination
  - Reticulation and storage before distribution to Mondi and Sapref

- **Water Quality**
  - Meets or exceeds the SANS241 South African Drinking Water Class I standard for 96% of the parameters
  - Typical non-compliances include sodium, conductivity and oil and grease
    - Relates to non-compliant feed water quality
- **Facility to augment the reclaimed water volume by potable water addition**
  - Ensure continuity of supply
  - Blending for quality control purposes

- Operational cost breakdown



- **Advantages for the metro council (EWS)**
  - Delayed capital investment (marine outfall and potable supply infrastructure)
  - No capital investment for recycling plant
  - Long term revenue stream from a recycled water levy
  - Reduced cost of water services to Durban's citizens
  - Reduces treated wastewater discharge by 10%

- **Advantages for the end-users (Mondi Paper and Sapref)**
  - 44% reduction in water tariff (2001) for Mondi
  - Likelihood that the price of recycled water will escalate at a lower rate than potable water
  - Enhanced security for water supply in times of drought

WATER REUSE SPECIFIC CASES

Direct potable reuse of industrial (mine) water

eMalahleni Water Reclamation Plant

(Picture: EWRP, Source: Keyplan)

eMALAHLENI WATER RECLAMATION PLANT

- **eMalahleni Water Reclamation Plant**
  - Joint initiative between mining companies (Anglo Coal and BHP Energy Coal)
  - Designed to recover potable water from acid mine drainage from several mines in the Witbank coalfields
  - 25 Ml/day plant was commissioned in 2007
- **Treatment Process**
  - Keyplan HiPRO in-house technology specifically developed for the treatment of acid mine drainage
  - Multistage sequential ultrafiltration and reverse osmosis membrane systems
  - Inter-stage precipitation of low solubility salts

- **Operations**
  - 99% water recovery with waste production at <1% brine
  - Low toxicity solid waste products (100 tons)
    - Impure gypsum cake (iron, manganese, aluminium, other metal contaminants)
    - Impure gypsum cake (magnesium contaminated)
    - High purity gypsum cake
  - 18 Ml/day supplied directly to the eMalahleni local municipality potable water reservoirs
    - Accounts for 20% of daily water requirements

- **Advantages**
  - Additional water for domestic use
  - Excess water for mining activities such as dust suppression have made such operations self-sufficient
  - Prevents polluted mine water decanting into the environment
  - Improves catchment water quality as excess treated water is discharged to the local river systems
  - Ultimate goal of zero waste facility may be realised

WATER REUSE SPECIFIC CASES

Direct potable reuse of wastewater

Namibia, Goreangab Water Reclamation Plant

(Picture: GWRP, Source: City of Windhoek)

GOREANGAB WATER RECLAMATION PLANT

- **1968**
  - Windhoek reliant on boreholes and catchment dams 65 to 200 km away
- **1969**
  - Goreangab Water Reclamation Plant with a capacity of 4 800 m^3/day commissioned
- **1992 and 1997**
  - Droughts lead to interim extension and then design of a new plant
- **2002**
  - New Goreangab Reclamation Plant with a capacity of 21 000 m^3/day commissioned

- **Multi-barrier approach to reclamation and treatment of wastewater to produce drinking water**
- **Minimise risks associated with direct reclamation**
  - A number of partial, full and multiple barriers for the most critical parameters
  - Six partial/complete barriers for resistant pathogenic protozoa
  - Five barriers for problematic organic compounds

- **Raw water sources for new plant**
  - **Goreangab Dam and/or secondary treated effluent from Gammams Wastewater Treatment Plant**
- **Currently 100% effluent is treated in the new plant as the Goereangab Dam quality and quantity has deteriorated**
- **Constitutes approximately 18% of the city's potable water supply**
- **Treated effluent from the first plant is used for irrigation of parks and recreation fields**
- **Since 1968, no outbreak of waterborne disease has been experienced**

- **Old Goreangab Plant Process**
  - Flocculation
  - Dissolved air flotation (upgraded unit process)
  - Settling
  - Rapid sand filtration (upgraded to dual-media)
  - GAC filtration
  - Breakpoint chlorination
  - Chemical stabilisation
  - Booster chlorination
  - Intermediate chlorination

- **New Goreangab Plant Process**
  - PAC (standby)
  - Pre-ozonation
  - Chemical dosing and coagulation
  - Dissolved air flotation
  - Rapid dual media filtration
  - Ozonation
  - Sequential BAC, GAC and ultra- filtration
  - Chlorination
  - Chemical stabilisation
  - Pumping, blending and distribution

- **New Goreangab Plant**
- **Capital costs approximately US$30 million**
- **Total operating costs US$0.76/m³**
  - Capital US$0.28/m³
  - Operation costs US$0.48/m³
- **Source: VA TECH WABAG**

PERCEPTIONS ON POTABLE WASTEWATER REUSE

- **Study on religious, philosophical and environmentalist perspectives conducted in Durban, South Africa found**
  - No fundamental religious objections to potable wastewater reuse
  - Concerns around the environment, global warming, water scarcity and pollution
  - People are willing to think creatively about sustainability
  - Key concerns are emotional and/or related to concerns about technical competency
  - Initiatives would be prone to politicization around equity/justice issues
- **In general, people are not comfortable with the idea of potable water recycling**
  - Reject potable water reuse on grounds that other interventions exist with superior equity implications
  - Consensus converged around potable reuse as a last resort

SUMMARY/CONCLUSIONS

- Apart from a few cases, formal and sophisticated wastewater reuse is still in its infancy in Africa
- Existing wastewater management systems hinder the advancement of water reuse
- Some innovative application of water reuse have emerged over the past few years
- Substantial potential exist for war reuse in Africa