German-African Partnership for Water and Sanitation - GAPWAS

ASK THE EXPERTS vol. 6

Valorising the end-products of domestic and industrial wastewater treatment

25.04.2023

Wastewater: A valuable resource

City of Windhoek
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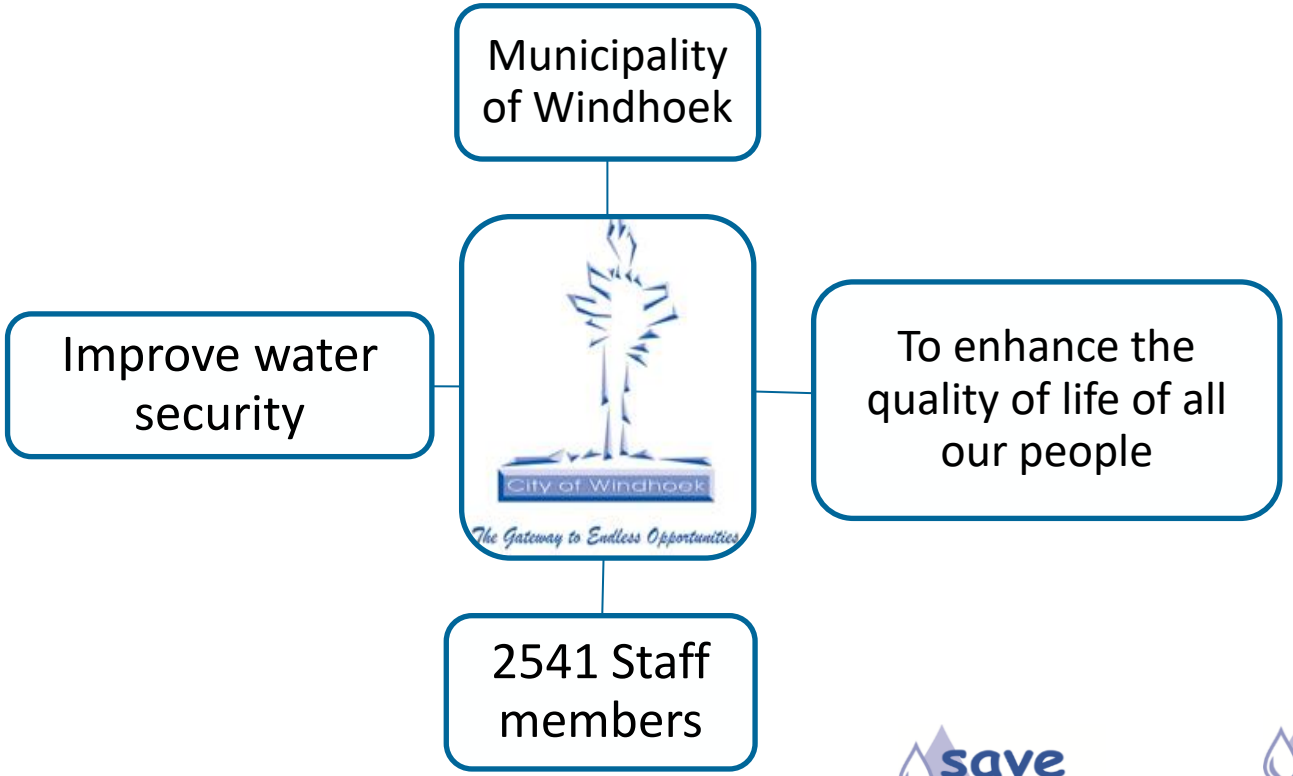
AfWASA / AAEA
African Water and Sanitation Association
Association Africaine de l'Eau et de l'Assainissement

German Water Partnership


Municipality of Windhoek
Improve water security
To enhance the quality of life of all our people
2541 Staff members
City of Windhoek
The Gateway to Endless Opportunities

Location: in the driest country in Sub-Saharan Africa

Annual water consumption: **27 Million m³/annum**

Windhoek

Population: **341,000** (2011 Census Survey)

431,700 (growth rate 4.3%)(current)

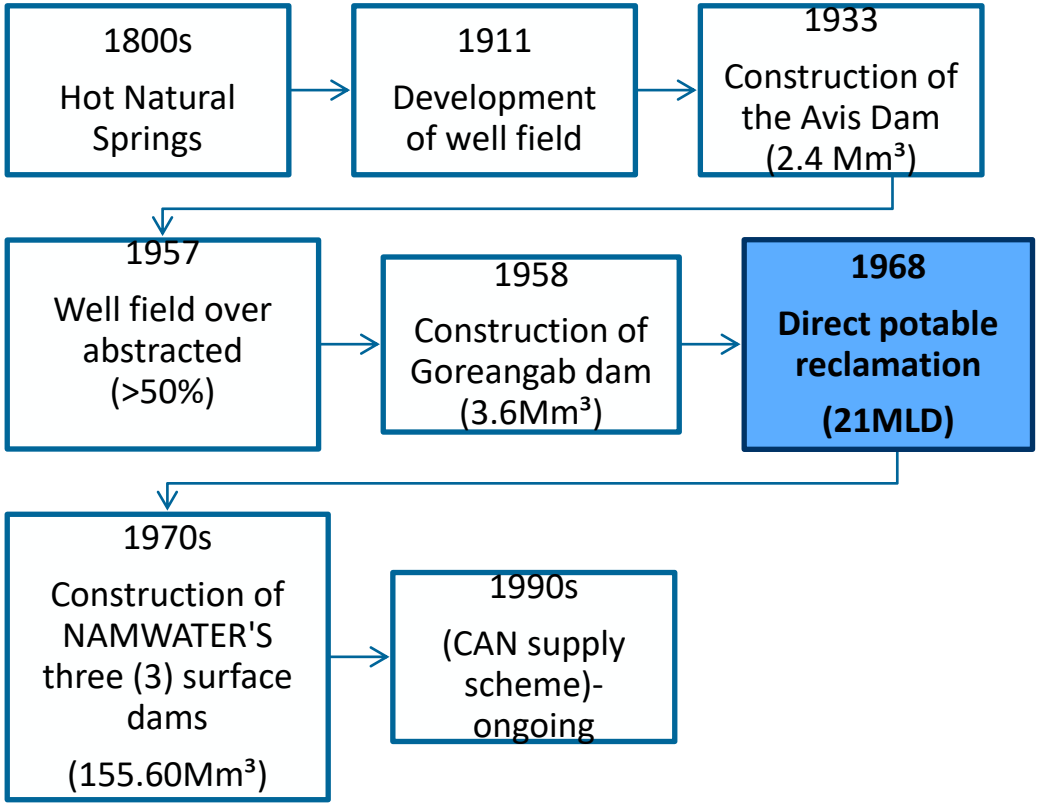
Economic hub

save water
Every Drop Counts

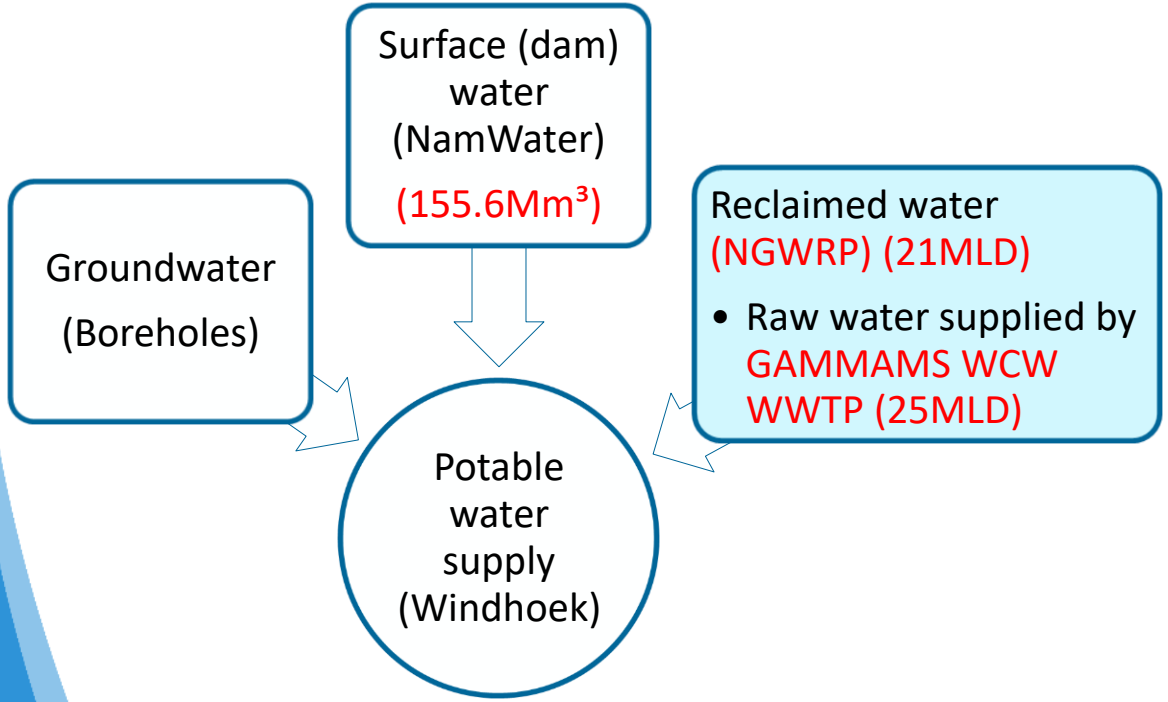
Water Security Uncertainty

- High population growth rates increasing the water demand
- Repeated Irregular rainfall patterns
- Annual rainfall: 300-400mm
- Annual Evaporation: 3000-3500mm
- Regular droughts
- Ephemeral rivers are fully harnessed
- Perennial sources are located too far away
- Perennial rivers are national borders
- Potable water sources within close proximity have been fully exploited

Windhoek: Timeline of the potable water supply scheme



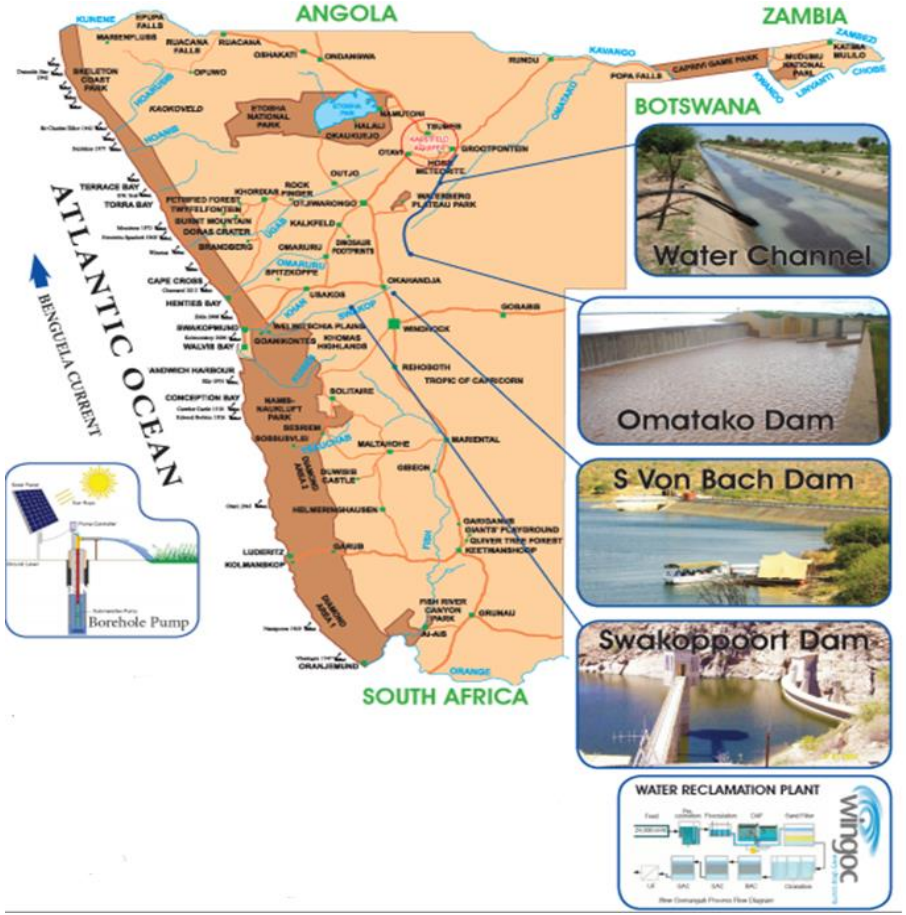
Windhoek: Current potable water supply scheme



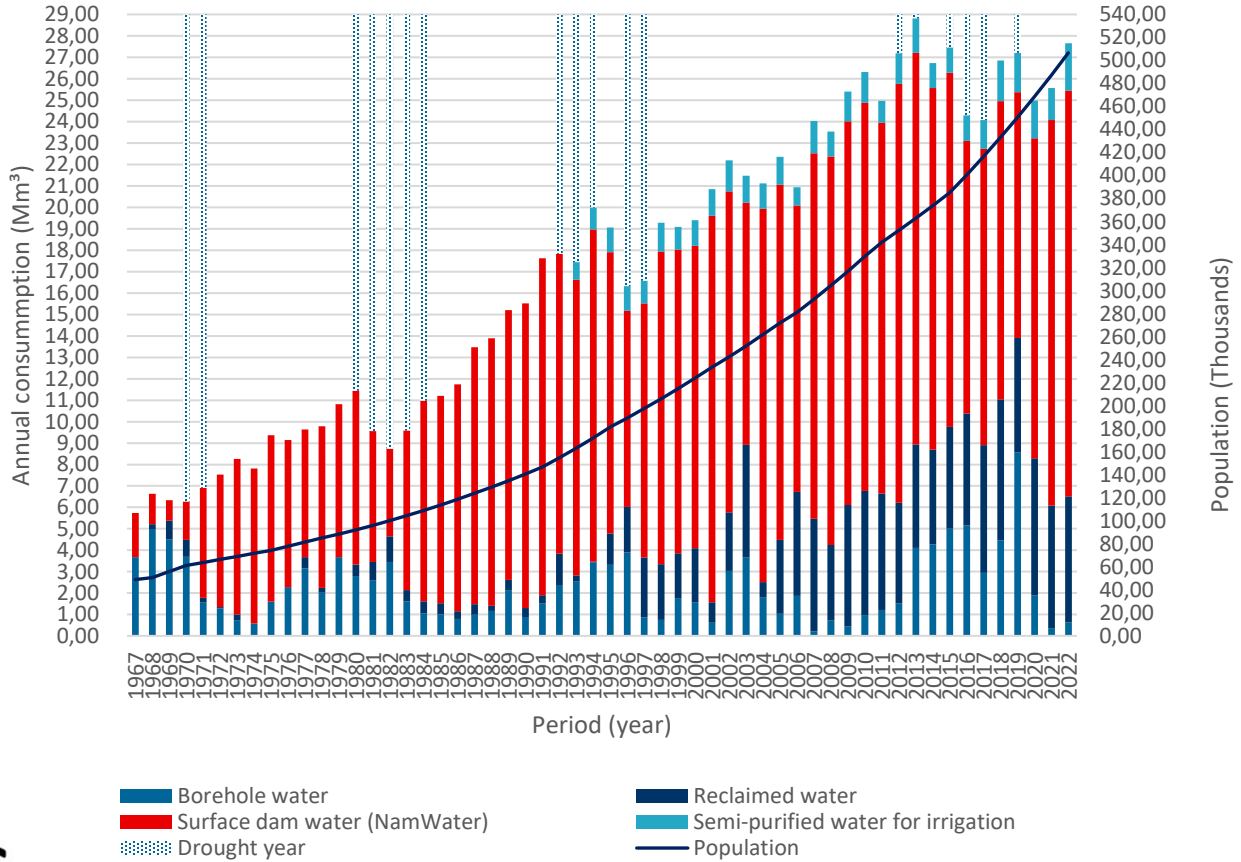
Semi-purified water for irrigation(OGWRP)
- Decrease water demand by 8%

save water
Every Drop Counts

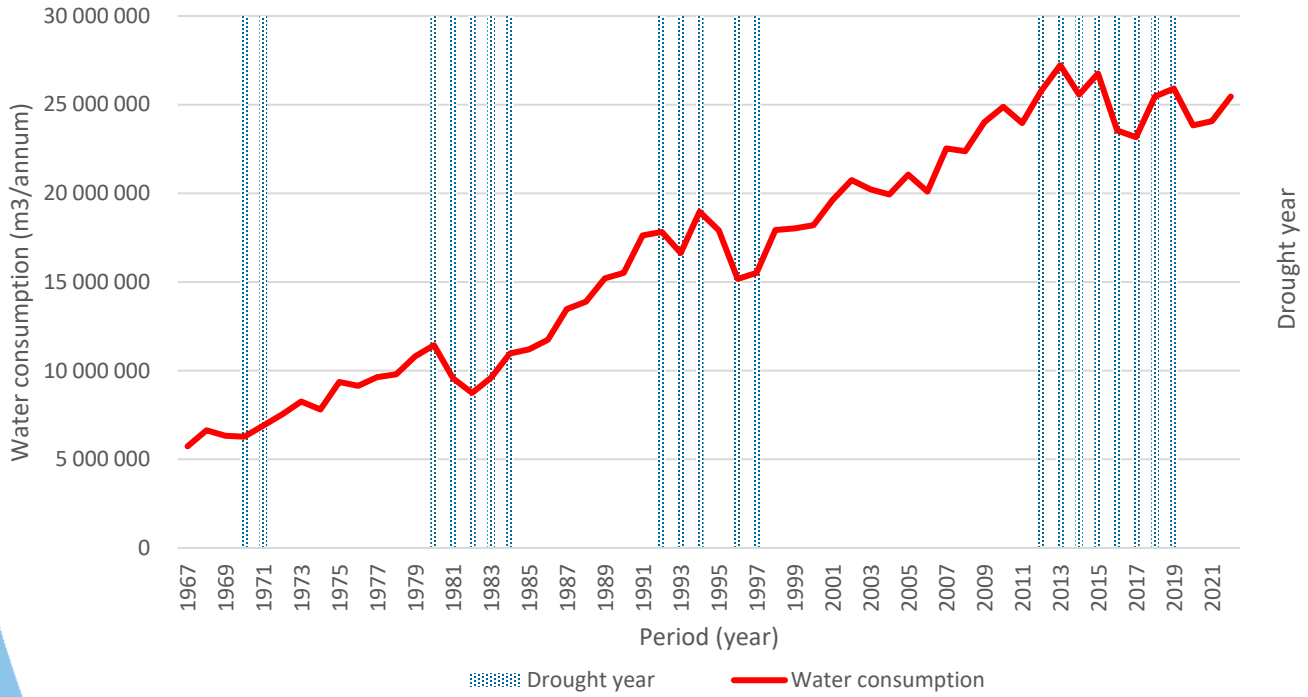
Windhoek: Current potable water supply scheme



Water demand/consumption by source



Water demand/Consumption



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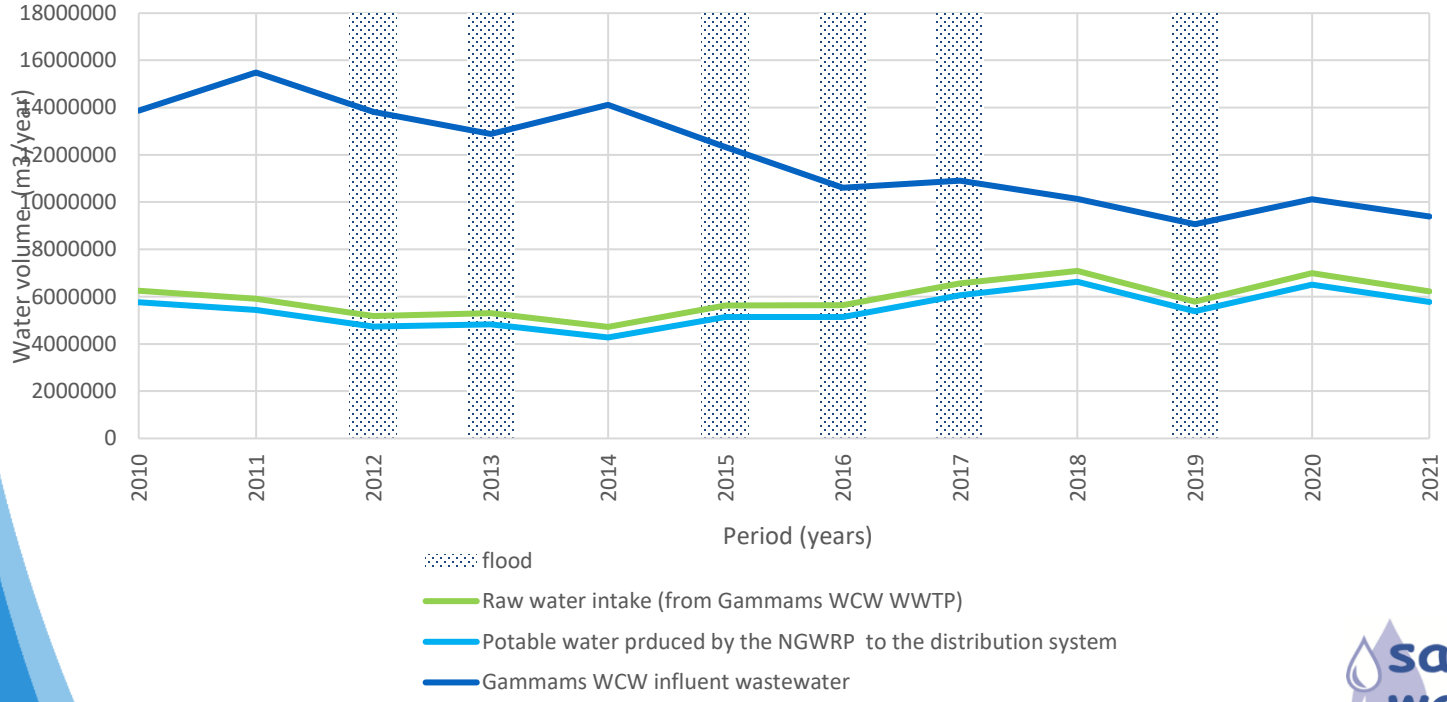
save water
Every Drop Counts

GAPWAS
German-African Partnership for Water and Sanitation

Gammams WCW WWTP

- An activate sludge/trickling filter plant
- Commissioned in 1963
- Capacity: 25MLD
- Treatment of domestic sewage
- The biggest WWTP in Windhoek/Namibia
- The effluent serves as raw water used to feed a DPR plant

Gammams WCW WWTP influent volume vs Raw and product water of NGWRP



The way forward: water security

Water reuse is well known as the main alternative to reduce water demand/consumption (Abdel-shafy, & Mansour, 2020).

- Increasing of the reuse potential
  - DPR2 project was identified as one of the medium-term interventions
- Additional upgrades are required at Gammams and Otjomuise WCW WWTP

Thank you for your attention!

Any Question?

Ms Justina Haihambo
Process Engineer

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Tel: +264 61 290 2778

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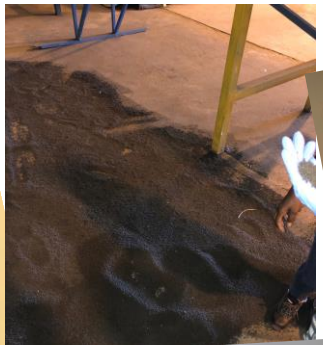
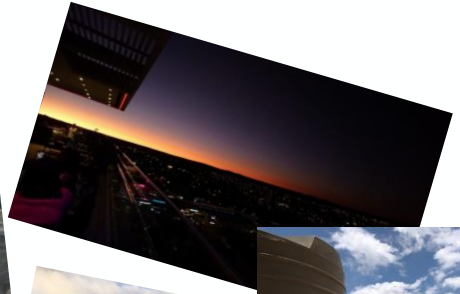
MORE THAN
8,000 KM
DISTANCE ...

... BUT A LOT OF
SIMILARITIES!

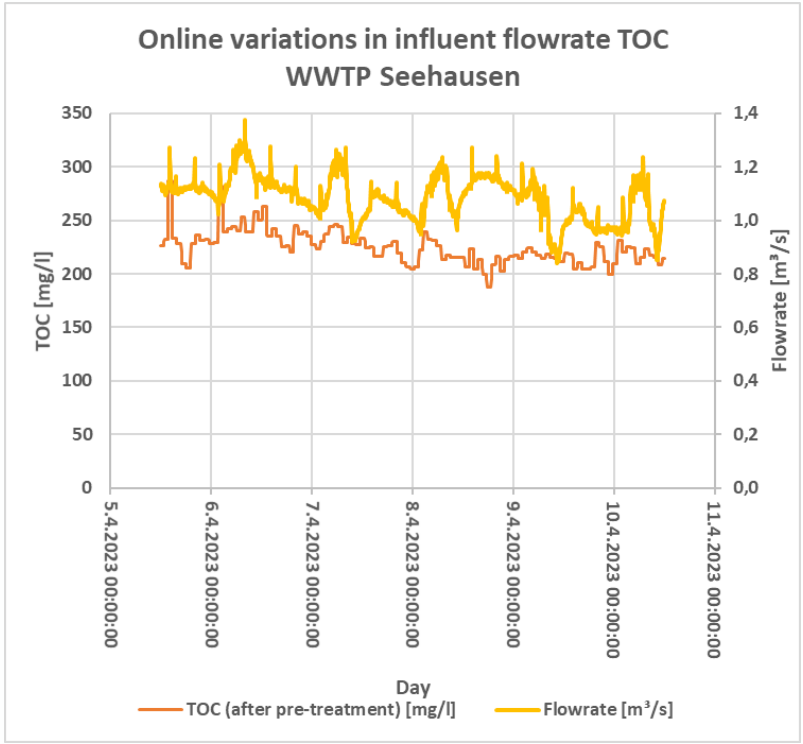

WHAT IF THIS WAS
YOUR LAST DROP?


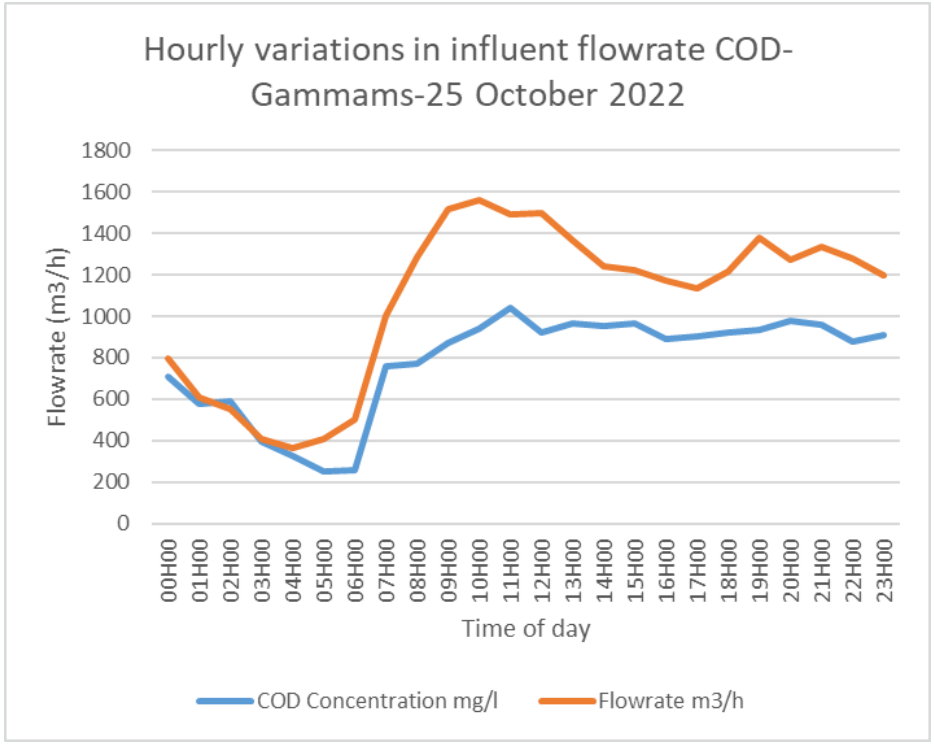



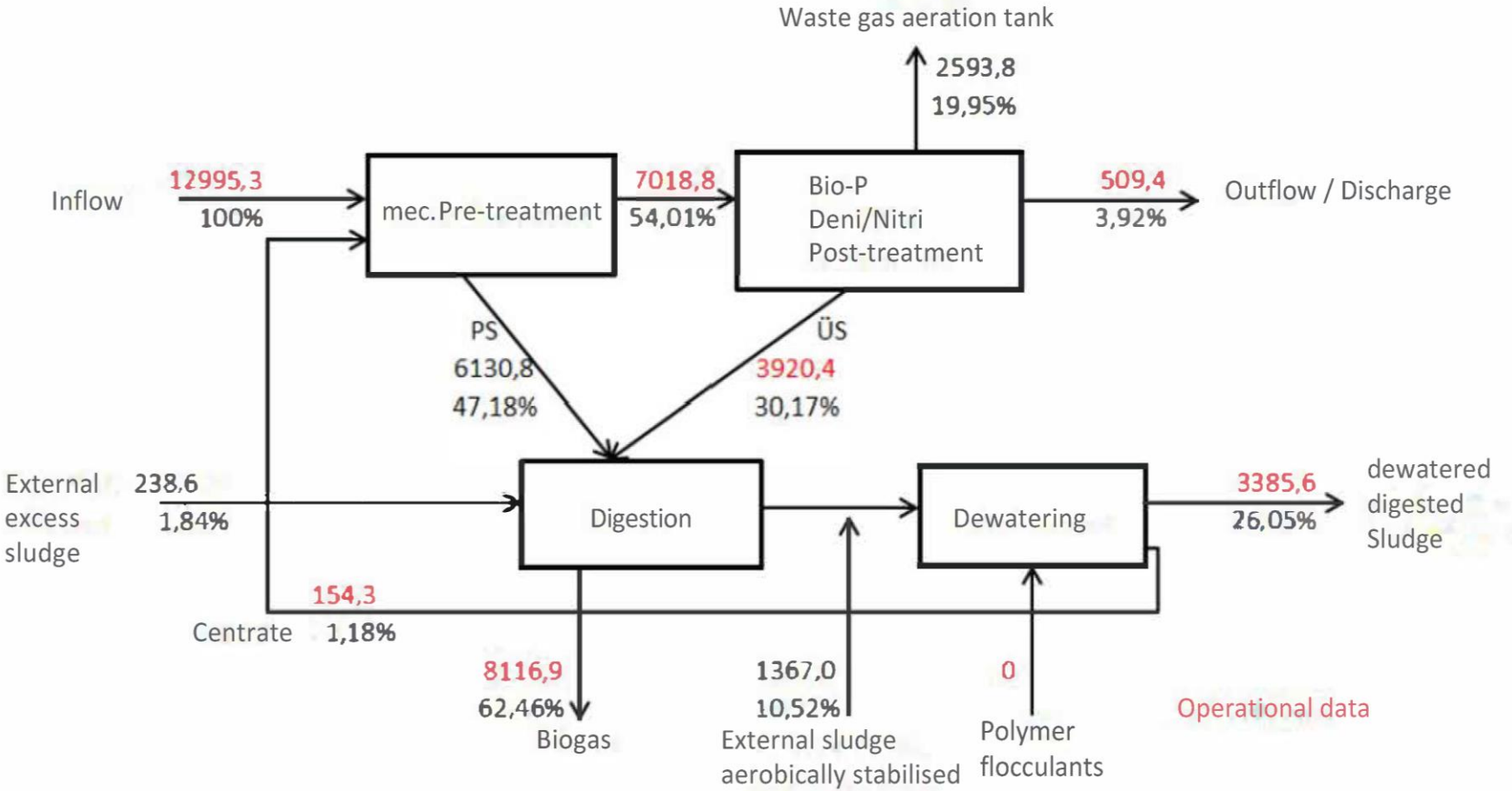








Online variations in influent flowrate TOC WWTP Seehausen
TOC [mg/l]
Flowrate [m³/s]
350
300
250
200
150
100
50
0
1,4
1,2
1,0
0,8
0,6
0,4
0,2
0,0
5.4.2023 00:00:00
6.4.2023 00:00:00
7.4.2023 00:00:00
8.4.2023 00:00:00
9.4.2023 00:00:00
10.4.2023 00:00:00
11.4.2023 00:00:00
Day
TOC (after pre-treatment) [mg/l]
Flowrate [m³/s]


Hourly variations in influent flowrate COD-Gammams-25 October 2022
Flowrate (m3/h)
1800
1600
1400
1200
1000
800
600
400
200
0
00H00
01H00
02H00
03H00
04H00
05H00
06H00
07H00
08H00
09H00
10H00
11H00
12H00
13H00
14H00
15H00
16H00
17H00
18H00
19H00
20H00
21H00
22H00
23H00
Time of day
COD Concentration mg/l
Flowrate m3/h


Waste gas aeration tank
2593,8
19,95%
Inflow
12995,3
100%
mec. Pre-treatment
7018,8
54,01%
Bio-P
Deni/Nitri
Post-treatment
509,4
3,92%
Outflow / Discharge
PS
6130,8
47,18%
ÜS
3920,4
30,17%
External excess sludge
238,6
1,84%
Digestion
Dewatering
3385,6
26,05%
dewatered digested Sludge
154,3
1,18%
Centrate
8116,9
62,46%
Biogas
1367,0
10,52%
External sludge aerobically stabilised
0
Polymer flocculants
Operational data

SIMILAR TASKS

Year 2020	WWTP Bremen-Seehausen	WWTP Gammams Watercare works	WWTP Bremen-Farge
Start of operation	1966	1963	1973
Inflow COD [ppm]	903	980	893
Inflow [m³/d]	118,645	26,000	15,595
Industrial sewage [%]	35	<10	<10
Effluent COD [ppm]	50	41	30
COD removal [%]	94.2	95.8	96.4

WWTP = Waste Water Treatment Plant

SPECIAL TASKS **WINDHOEK**

- Preparedness for rainfall events:
  - Use of buffer tanks to retain and temporarily store the stormwater to relief the waste-water treatment plants from extreme hydraulic overloads
  - Incorporate the Namibia meteorological Services for better preparedness
- Implementation of a better repair and maintenance management plan
- Setting up of a sewer training facility
- Awareness: education of the public (e.g. pre-school kids)
- General benchmarking (staffing structures)
- Increase the direct portable reclamation capacity

SPECIAL TASKS **BREMEN**

- Climate change adaption within the city of Bremen is needed in future to manage heavy rainfall events or extreme urban heat island effects. Thus, establishing a sponge city by decoupling of large sealed areas or roof greening, for instance.
  www.klimaanpassung.bremen.de
- Climate change will have a negative impact on the waterbodies of Bremen. Hence, the release of treated wastewater into the river Weser may have to be reconsidered.
- Possible options for the future:
  - Use of treated wastewater for industrial purposes (further treatment needed)
  - Groundwater recharge with treated wastewater
  - Producing drinking water from wastewater through establishing new treatment steps
- Currently, we are looking into further treatment processes to achieve higher WWTP effluent qualities (i.e. removal of micropollutants).

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The way of WWTP Bremen-Seehausen to an energy neutral plant

hanseWasser

African Water and Sanitation Association

Association Africaine de l'Eau et de l'Assainissement

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1 WWTP Farge


4 Pressure Pipe Findorff


2 Control Center Seehausen


5 Stormwater Basin MVA


2 WWTP Seehausen


6 Main Pumping Station Findorff


3 Headquarter


7 Sewer flow steering Stern

Sewer system
(Mixed- and separated Systems)

- → 2,200 km Sewer
- → 130 km pressure pipes
- → 200 pumping stations, Stormwater basins
- → Storage Volume for Stormwaterevents
  270,000 m³
- → 230 km Sewer-CCTV-Inspection per year
- → Sewer information system
- → 700 km sewer cleaning per year
- → Operational sewer information system

Treatment

WWTP Seehausen
1,000,000 Inh
WWTP Farge
160,000 Inh

hanseWasser
City of Windhoek
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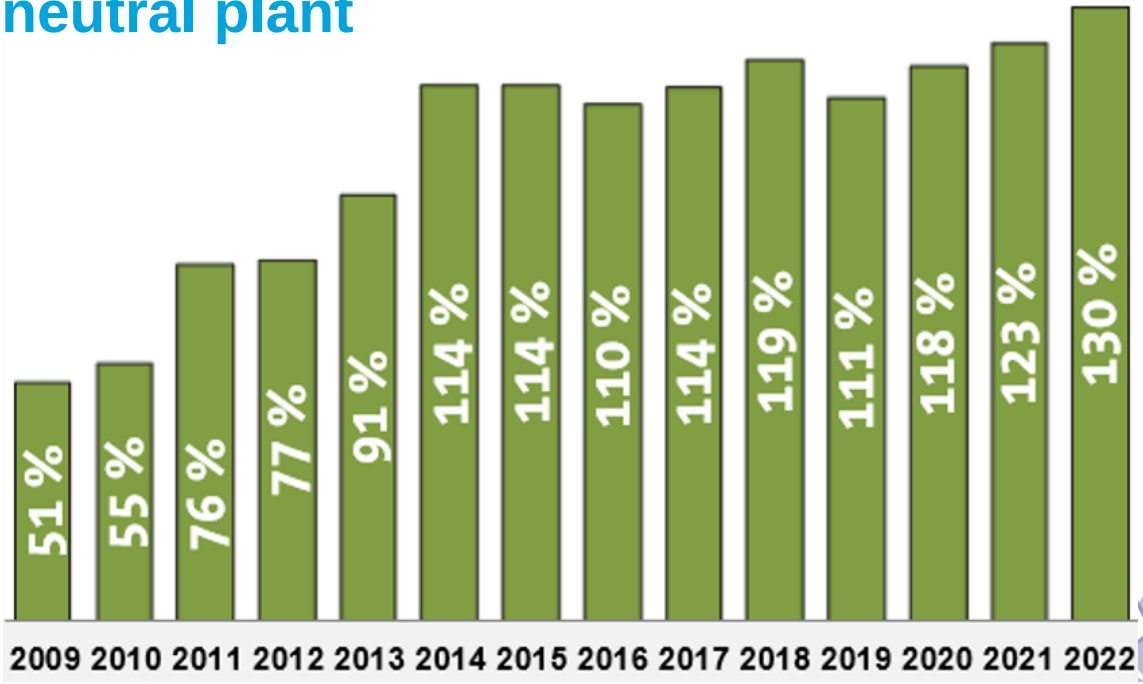
The way of WWTP Bremen-Seehausen to an energy neutral plant



save water

Development of energy self-production
(on site – gas, wind and sun)

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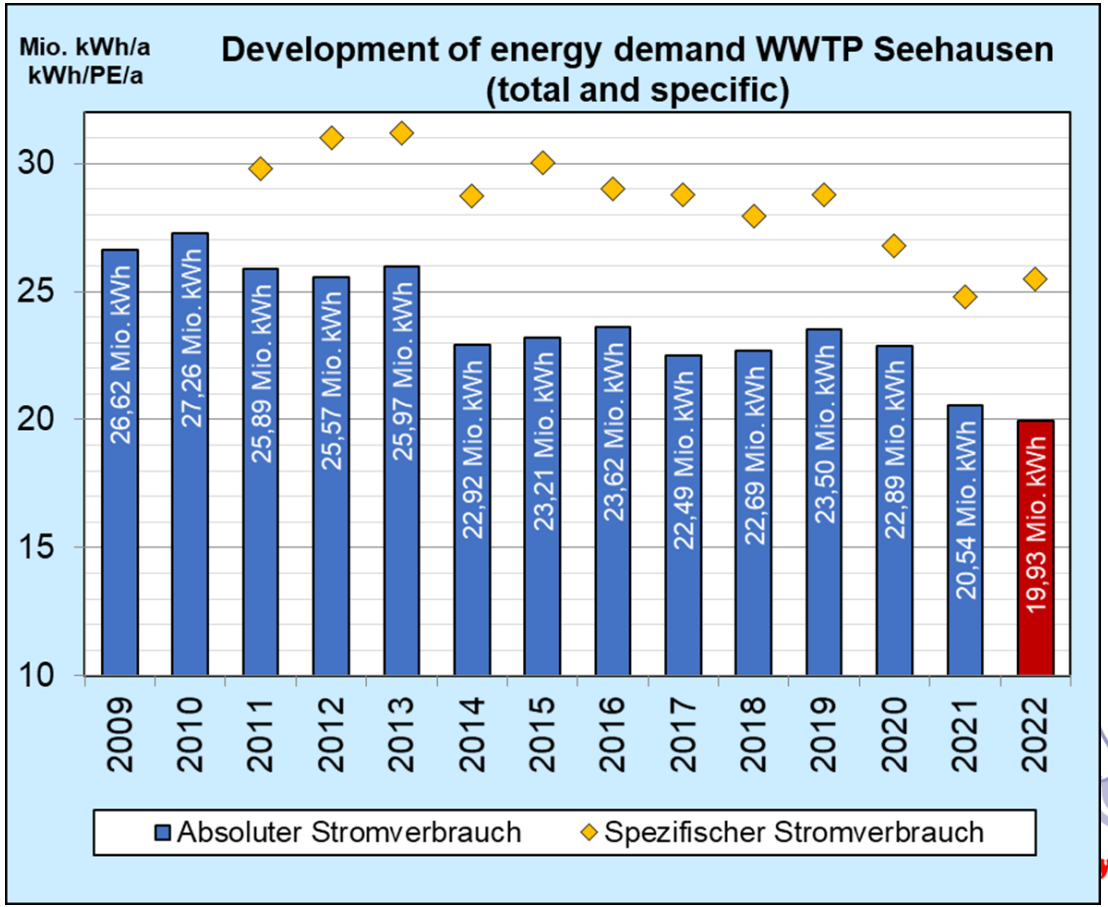

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save water
Every Drop Counts

Way to energy neutrality

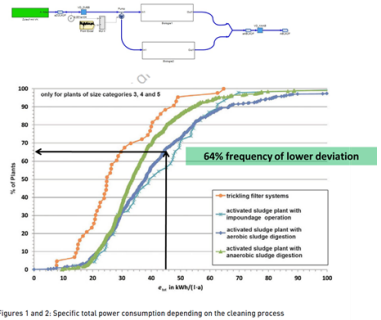
More efficient in energy-

Repowering
3 combined heat and power unit (1.4 MW el/unit) and a wind turbine (2 MW). Higher gas production.

production

Reinvestment
New (economically viable) aggregates with a lower specific demand (compressors, pumps, ...)

demand (technical)



Figures 1 and 2: Specific total power consumption depending on the cleaning process

Optimization
Digital twin of WWTP and focus on processes with high demand (aeration).

demand (process)

save water
Every Drop Counts

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Set of rules DWA A-216

What is the DWA Set of Rules?

Technical standards are an important factor in efficaciously and economically protecting the environment and material goods and in promoting quality assurance. The DWA therfore incorporates into its standards the most recent findings on time-tested procedures. The DWA Set of Rules consists of Standards and Guidelines and is prepared by more than 2400 specialists, who are engaged in the association in an honorary capacity and work in more than 340 specialist committees and working groups.

The DWA Set of Rules is viewed in Germany as the general basis for planning, construction and operation of plants in water, wastewater and waste management, as well as in soil conservation. It makes a considerable contribution to keeping the cost of environmental protection at a reasonable level. With this Set of Rules, the associations assume individual responsibility for their specific areas of expertise and unburden the state to a considerable extent: it should be noted that the DIN standards and the rules and standards of the DWA are of equal importance.

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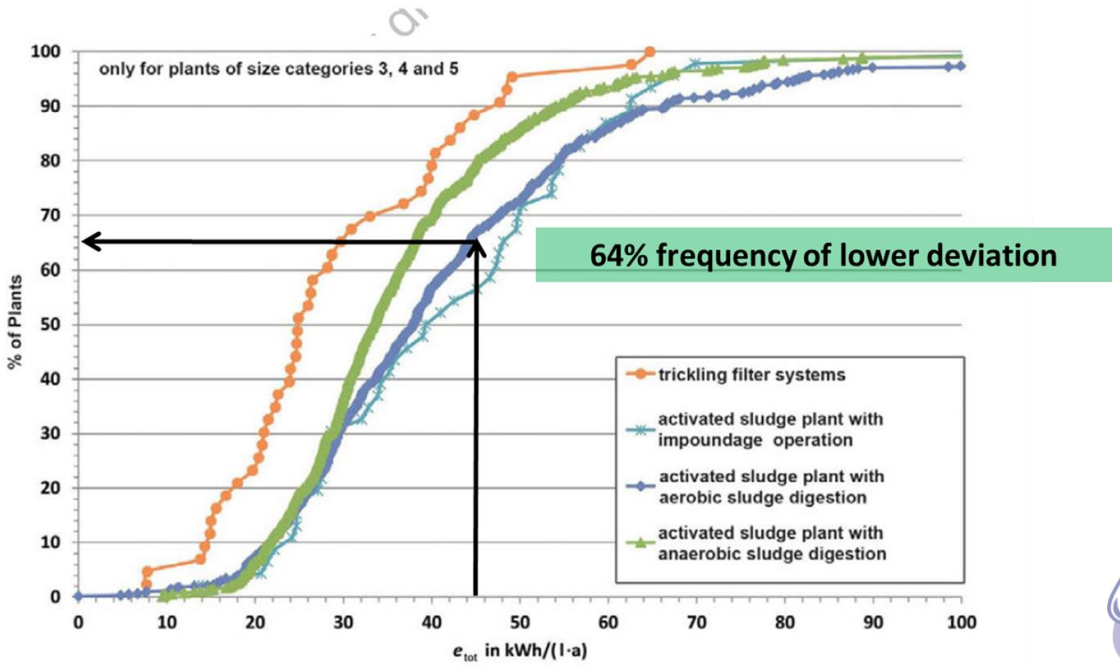
Energy Check



Figures 1 and 2: Specific total power consumption depending on the cleaning process

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German-African Partnership for Water and Sanitation

save water
Every Drop Counts

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City of Windhoek
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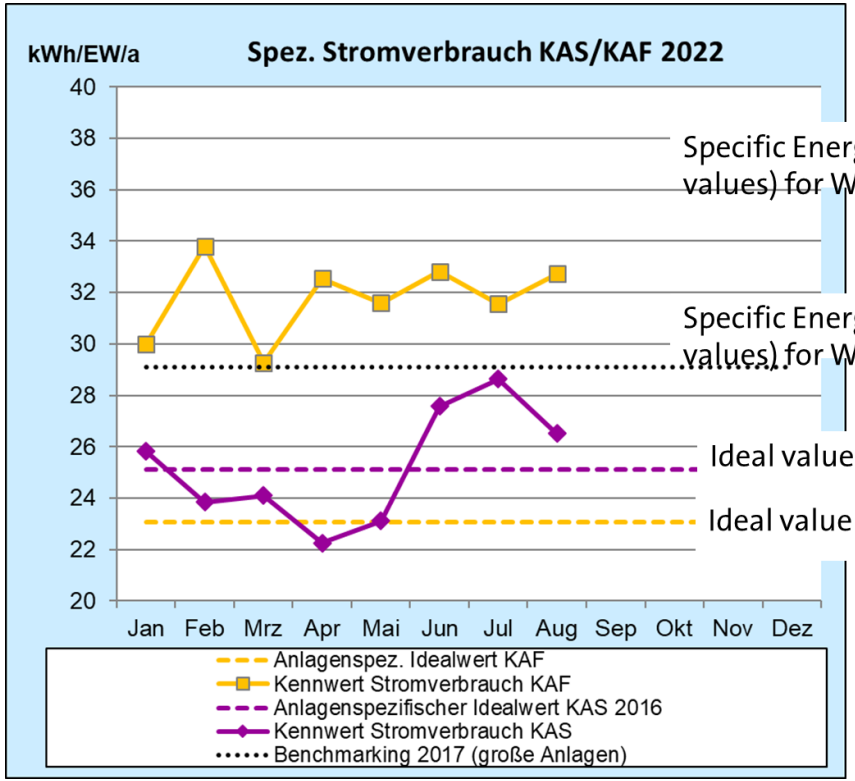
Energy Check



Specific Energy demand (based on monthly values) for WWTP Bremen-Farge

Specific Energy demand (based on monthly values) for WWTP Bremen-Seehausen

Ideal value for WWTP Bremen-Seehausen

Ideal value for WWTP Bremen-Farge

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City of Windhoek
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Summary

- We started at a good point because the main aggregates for energy production and demand had to be renewed.
- Energy neutrality was a main goal of the whole company and not a one-man-show.
- We reduced the specific demand of aggregates and the process and raised the efficiency of production.

Thank you for your attention!

Any Question?

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hanseWasser

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25.04.2023

Pilot project for wastewater treatment and reuse at
Uhuru Park, Nairobi / Kenya

aqua consult Baltic

SPACEDRIP

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German Water Partnership

aqua consult baltic OÜ

aqua consult Baltic

Technology Neutral Engineering & Consultancy Company

Municipal Wastewater treatment plants

Range 50 – 500 000 PE and Secondary waste handling

Industrial Wastewater treatment plants

Oil and Gas; Chemical;Food & Agriculture

Raw and Process water treatment plants

Drinking water; Process water Utility water

New Technology development

Biological carbon treatment; Nitrogen removal;Phosphorous removal

save water

Every Drop Counts

Since 1997

Tartu, Estonia

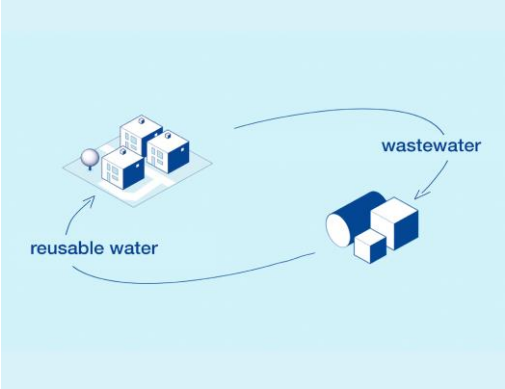
12 employees

GAPWAS
German-African Partnership for Water and Sanitation

SPACEDRIP

SPACEDRIP develops and manufactures automated wastewater treatment and reuse systems

- Wastewater & greywater reuse for non potable and potable application
- Treatment and reuse systems for 25-2000 people
- Provides systems to water companies, real estate developers and defense sector
- 40 systems commissioned by the end of 2023
- Estonian company founded in 2020 with 15 people in team



aqua consult Baltic

Pilot project for wastewater treatment and reuse at Uhuru Park Nairobi

Project

Project funded by The Estonian Environmental Investment Centre (EIC) and the Ministry of the Environment

ENVIRONMENTAL INVESTMENT CENTRE

Location: Uhuru Park, Nairobi, Kenya

Time (year): **2023**

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save water
Every Drop Counts

Challenges

President William Ruto:

"Government has resolved to not only reclaim Nairobi's reputation as Africa's green city but also live up to its ancestral identity as the river of cool and fresh water."

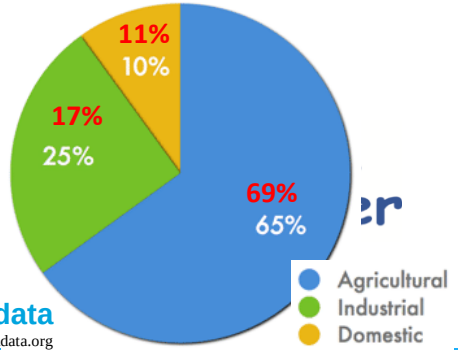
22-02-2023

Nairobi City Water production is approximately 500 000 m^3 per day.

However, 800 000 m^3 of water per day is needed to meet the existing demand.

Clean drinking water is currently wasted for flushing toilets, irrigation etc. for which technically safe recycled water could be used.

Water reuse systems can save more than 50% of water usage.



1992 / 2017 data

ourworldindata.org

aqua consult Baltic

Solution deployed

- Treatment of up to 50m^3/d
- Fitted into a 20ft. container
- Automated system with sensors
- Live overview with software
- Water reuse for park irrigation
- Average energy use of 80 kWh/day

save water
Every Drop Counts

Solution deployed

Sedimentation tank

Nitrogen removal

Membrane bioreactor with microfiltration membranes and sensors

Technical chamber with water reservoirs, pumps, blowers and automation

Solution deployed

WWTP inflow = stormwater drain

incl. septic tank overflow and industrial discharge

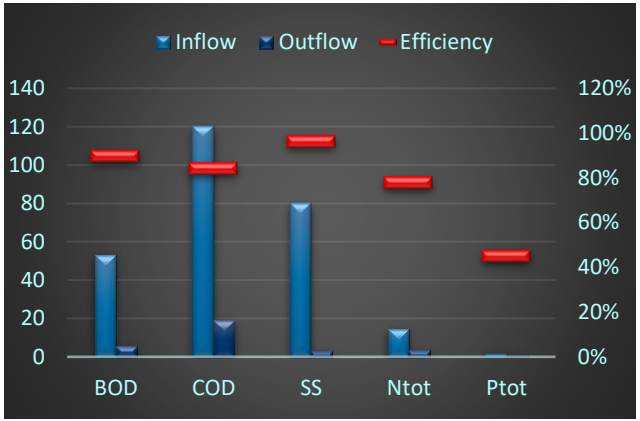
Sprinklers in the park

Treated effluent used for irrigation

Results obtained

Comissioning of the system

Input and output



Up to 25% of Uhuru Park irrigation water is now taken from treated wastewater (= “valorisation”)

Proof of compact automated plug and play technology

Conclusions

Technical water for toilet flushing, irrigation and other places could be used instead of clean drinking water

Treatment systems that are compact, fit in the small areas and allows to use the existing infrastructure

Operation of the system should be automated to cut maintenance and energy costs. Maintenance planning based on software data avoids system breakdowns

Thank you for your attention!

Any Questions?

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Pilot project for wastewater treatment and reuse at Uhuru Park, Nairobi / Kenya

Replication potential from Kenyan perspective

RUJI AFRICA LIMITED

African Water and Sanitation Association

Association Africaine de l'Eau et de l'Assainissement

AfWASA / AAEA

German Water Partnership

Ruji Africa Limited

… is a privately owned Kenyan Company specializing in Water and Sanitation engineering and Construction

Vision to be the Market leader in providing sustainable cost effective, innovative Water and Sanitation solutions maintaining highest standards.

Adopts strategies and practices that aim to meet the needs of today's society without compromising future human and natural resources.

Builds partnerships with other stakeholders to enable us to bring to the forefront ideas and innovations for responsible resource management.

Team comprises Specialist Engineers, Quality Assurance Technicians Water and Sanitation Specialists and Professionals.

Water and Wastewater Situation in Nairobi

Nairobi has an estimated population of about 5M people (city proper), the metropolitan area 10.8 M (projected population for 2022).

Current water production is 500 000 m^3/day against a demand of 800 000 m^3/day

Sewerage coverage is only about 50%.

The City encounters great challenges in collecting wastewater and faecal sludge. Sanitation facilities and sewage disposal points are inadequate. The rural-urban migration leading to accelerated population growth exacerbates the challenge.

Rivers are highly polluted by direct discharge of wastewater from non-sewered industries, households, and many other institutions.

Current wastewater treatment systems are stabilization ponds and aerated lagoons coupled with constructed wetlands as well as conventional treatment systems.

Stabilisation ponds require large areas which are hardly available.

River pollution in informal settlements

Initiative and leadership on highest political level

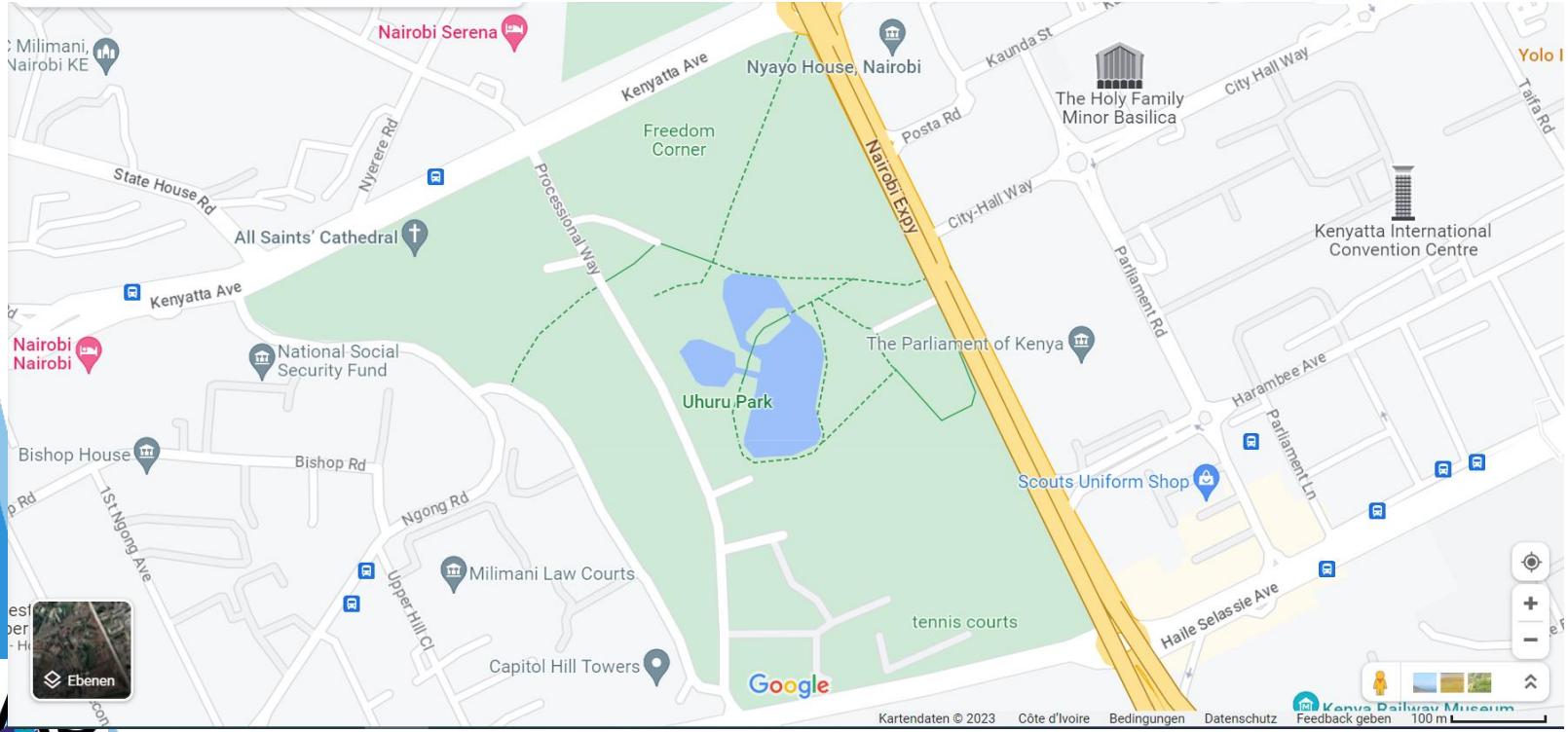
Kenyan and Estonian Presidents agreed on the pilot during meeting. Initiative embraced by President William Ruto 2022 for Uhuru Park's ongoing rehabilitation, supported by 'Nairobi Metropolitan Services' (under the Executive Office of the President).

Ruji Africa partnered with Spacedrip from Estonia in piloting an automated wastewater treatment and reuse system.

Aqua consult baltic designed the technology to connect with the Uhuru Park infrastructure and consulted during the commissioning and six-month operation of the plant – hand-over to Nairobi Water & Sewerage Company.

Environmental Impact Assessment – permit granted by Nairobi County Govt. based on planned system performance.

Uhuru Park, Nairobi, Kenya



Uhuru Park, Nairobi, Kenya

Benefits of the water reuse system

1. Small footprint – space availability no longer an issue
2. Treatment efficiency – no more pathogenic pollution and eutrophication
3. Inbuilt reuse capability – double value:
    - Valorising the treated effluent for flushing, irrigation, process water
    - reducing pressure on drinking water production (>50% savings!)

This technology can be implemented wherever there is no municipal sewer:

- Tourism and hospitality Industry
- Informal settlements
- Urban commercial and residential buildings
- Institutions
- Food processing and non-food industries

Way forward

Electricity demand is an issue – but can be addressed:

- Technically – by foreseeing control system autonomy by solar + battery
- Financially – saving bulk sewers = saving heavy cost and traffic chaos

The regulator is considering the development of bylaws requiring:

- Tourism and hospitality Industry
- Informal settlements
- Urban commercial and residential buildings
- Institutions
- Food processing and non-food industries

beyond a specific discharge quantity & quality and by a specific time to comply with treatment & reuse schemes *(…valorising the end-products!)*

Thank you for your attention!

Any Question?

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Vision to be the Market leader in providing sustainable cost effective, innovative Water and Sanitation solutions maintaining highest standards.

Adopts strategies and practices that aim to meet the needs of today's society without compromising future human and natural resources.

Builds partnerships with other stakeholders to enable us to bring to the forefront ideas and innovations for responsible resource management.

Team comprises Specialist Engineers, Quality Assurance Technicians Water and Sanitation Specialists and Professionals.

Water and Wastewater Situation in Nairobi

RUJI AFRICA LIMITED

Nairobi has an estimated population of about 5M people (city proper), the metropolitan area 10.8 M (projected population for 2022).

Current water production is 500 000 m^3/day against a demand of 800 000 m^3/day

Sewerage coverage is only about 50%.

The City encounters great challenges in collecting wastewater and faecal sludge. Sanitation facilities and sewage disposal points are inadequate. The rural-urban migration leading to accelerated population growth exacerbates the challenge.

Rivers are highly polluted by direct discharge of wastewater from non-sewered industries, households, and many other institutions.

Current wastewater treatment systems are stabilization ponds and aerated lagoons coupled with constructed wetlands as well as conventional treatment systems.

Stabilisation ponds require large areas which are hardly available.

River pollution in informal settlements

Initiative and leadership on highest political level

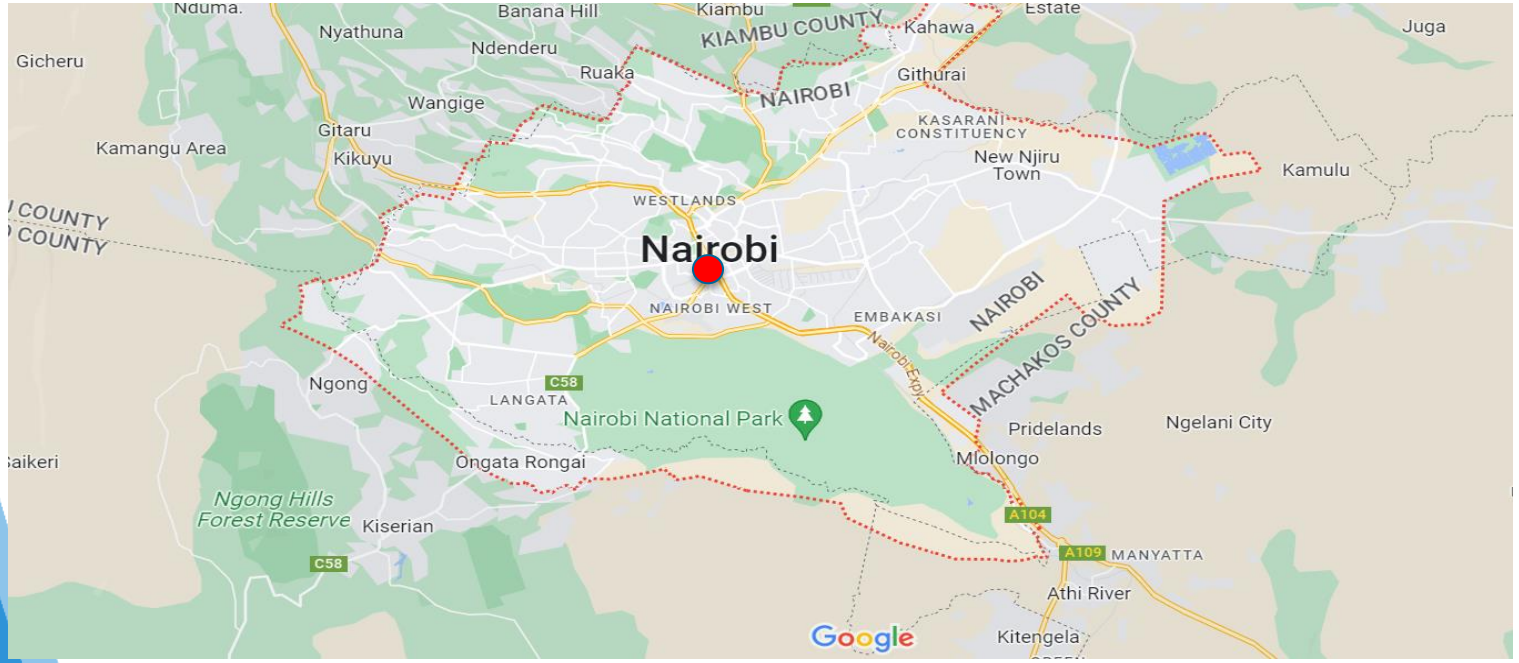
Kenyan and Estonian Presidents agreed on the pilot during a meeting. Initiative embraced by the President for Uhuru Park's ongoing rehabilitation, supported by 'Nairobi Metropolitan Services' (under the Executive Office of the President – currently by Nairobi City County Govt).

Ruji Africa partnered with Spacedrip from Estonia in piloting an automated wastewater treatment and reuse system.

Aqua consult baltic designed the technology to connect with the Uhuru Park infrastructure and consulted during the commissioning and six-month operation of the plant – hand-over to Nairobi Water & Sewerage Company.

Environmental Impact Assessment – permit granted by National Environment Management Authority based on planned system performance.

Uhuru Park, Nairobi, Kenya



Uhuru Park, Nairobi, Kenya

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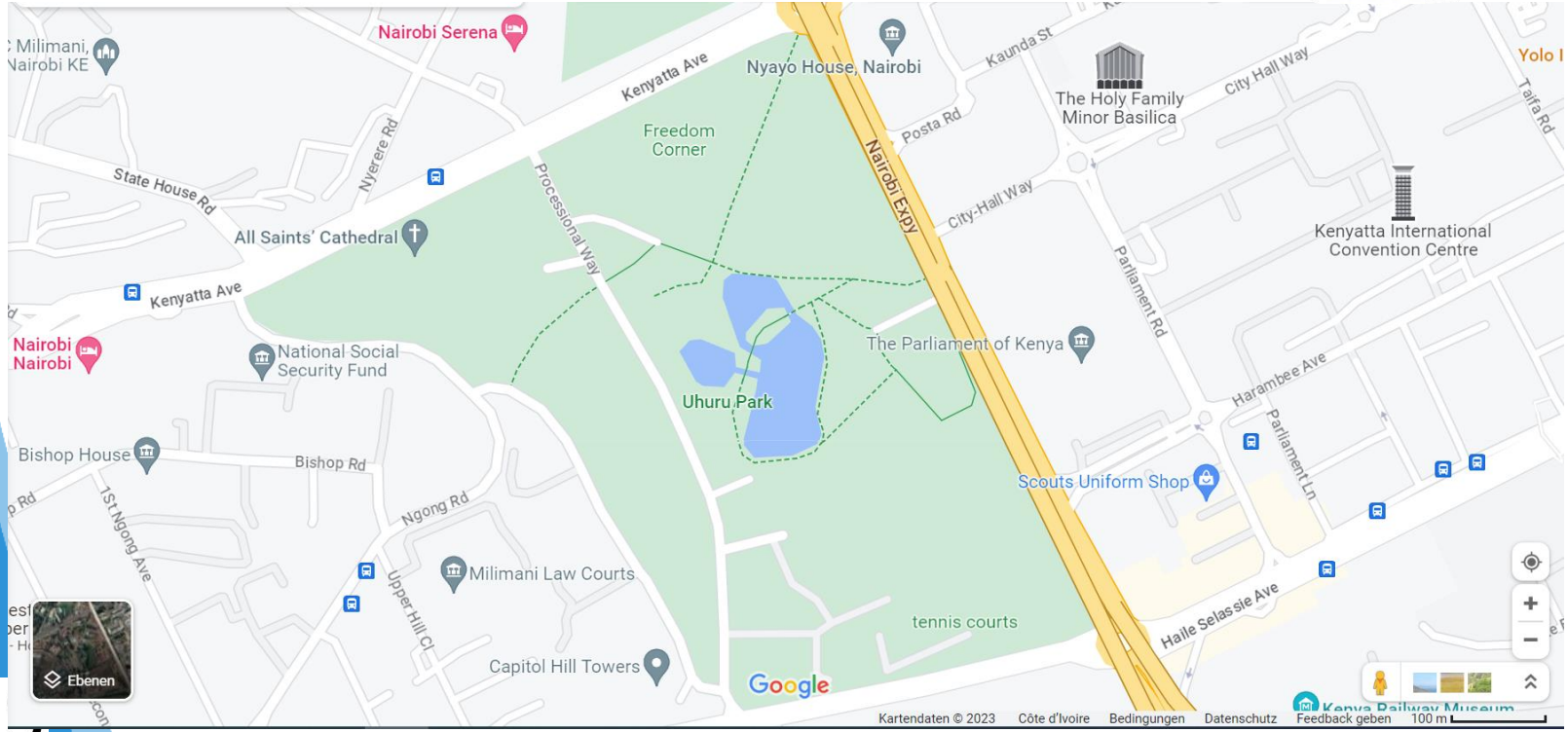

GAPWAS
German-African Partnership for Water and Sanitation

Uhuru Park, Nairobi, Kenya

RUJI AFRICA LIMITED

Benefits of the water reuse system

1. Small footprint – space availability no longer an issue
2. Treatment efficiency – no more pathogenic pollution and eutrophication
3. Inbuilt reuse capability – double value:
    - Valorising the treated effluent for flushing, irrigation, process water
    - reducing pressure on drinking water production (>50% savings!)

This technology can be implemented wherever there is no municipal sewer:

- Tourism and hospitality Industry
- Informal settlements
- Urban commercial and residential buildings
- Institutions
- Food processing and non-food industries

Way forward

Electricity demand is an issue – but can be addressed:

- Technically – by foreseeing control system autonomy by solar + battery
- Financially – saving bulk sewers = saving heavy cost and traffic chaos

This pilot is informing policy in the development of bylaws requiring:

- Tourism and Hospitality Industry
- Urban commercial and residential buildings
- Institutions
- Food processing and non-food industries

beyond a specific discharge quantity & quality and by a specific time to comply with treatment & reuse schemes *(…valorising the end-products!)*

Thank you for your attention!

Any Question?

Stephen Githinji
Senior Advisor

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RUJI AFRICA LIMITED

African Water and Sanitation Association
Association Africaine de l'Eau et de l'Assainissement
AfWASA / AAEA

German Water Partnership

German-African Partnership for Water and Sanitation - GAPWAS

ASK THE EXPERTS vol. 6

Valorising the end-products of domestic and industrial wastewater treatment

25.04.2023

Pilot project for wastewater treatment and reuse at Uhuru Park, Nairobi / Kenya

Replication potential from Kenyan perspective

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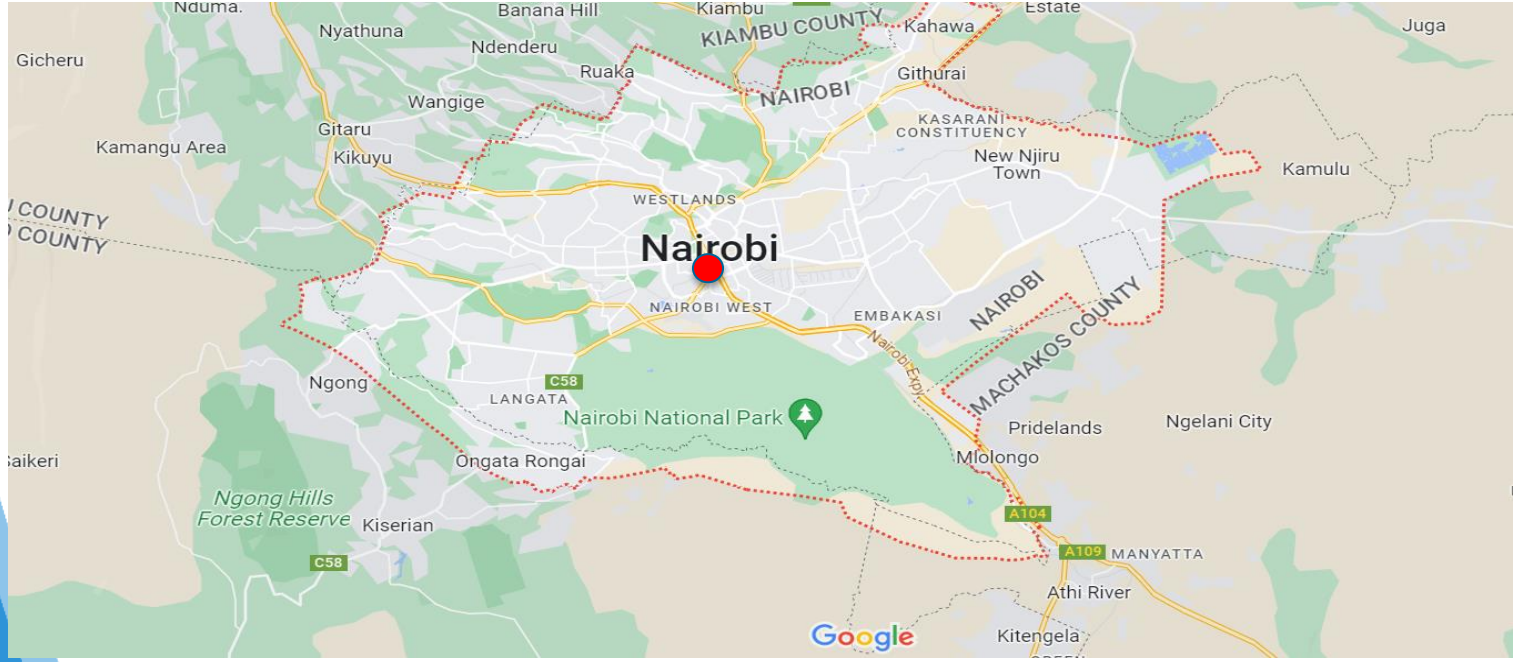

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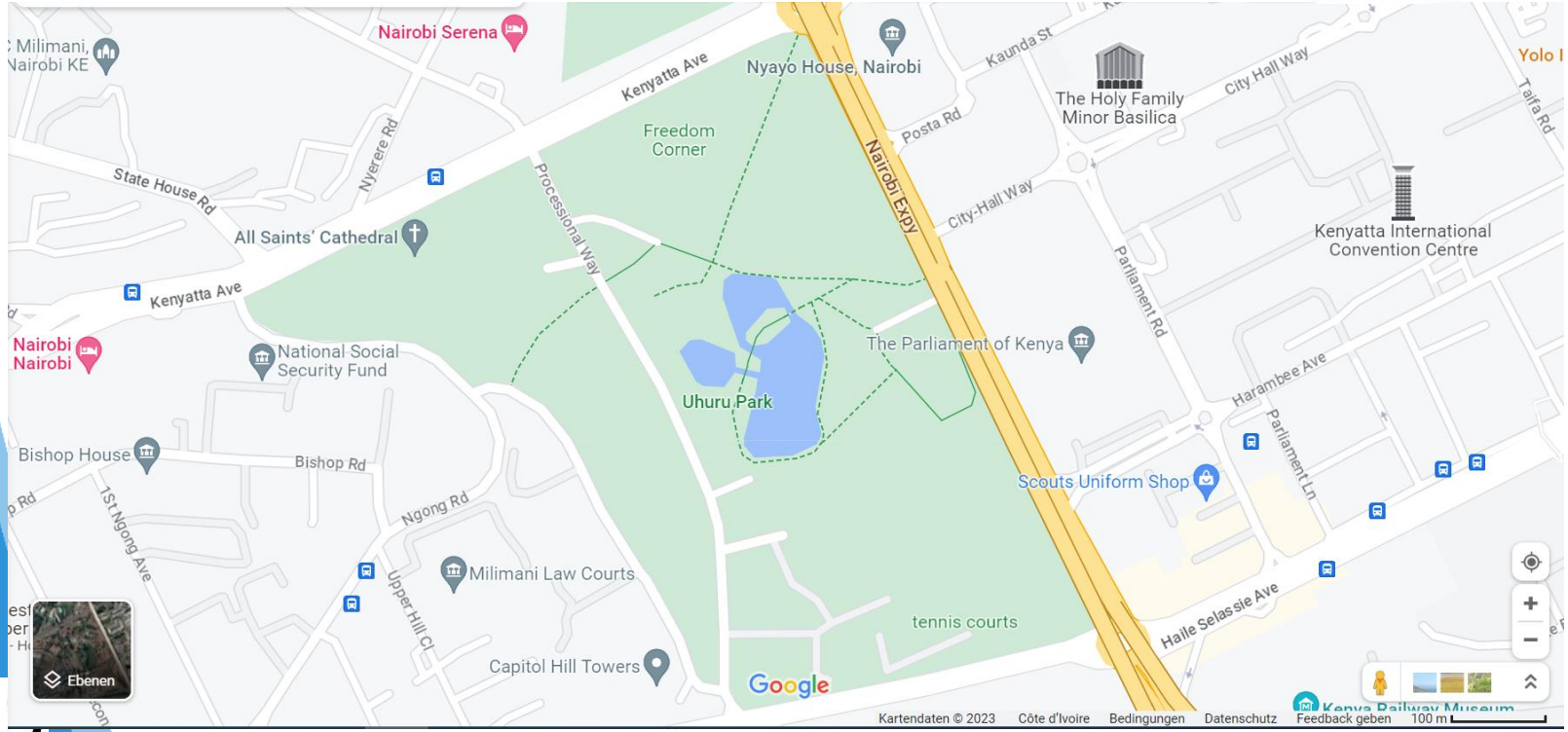

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