Session 3

Climate resilient WASH & Circular Economy

Session 3 **Climate resilient WASH & Circular Economy**

Next Presentation:

Elise Mann – iDE



BUILDING SANITATION MARKETS THAT SURVIVE FLOODS: LESSONS FROM A STRESS TEST IN MOZAMBIQUE

KAPE KAPE

iDE Powering entrepreneurs to end poverty.

World Vision

GAZA PROVINCE, SOUTHERN MOZAMBIQUE

iDE

High exposure, low resilience , repeated cycles

Repeated climate shocks

Floods, cyclones and drought hit Mozambique year after year, with the greatest exposure in the first quarter.

Sanitation fails first

Emergency latrines are rebuilt each season by humanitarian actors and government, then washed away by the next event.

January 2026

Extreme rainfall flooded Gaza Province, destroying lowland crops and tightening household cash.

1. Flood or cyclone season arrives
2. Latrines collapse or wash away
3. Emergency funding rebuilds them
4. Temporary structures go back up

and it repeats

A YEAR LONG MARKETS FOR SANITATION PILOT

KAPE KAPE: WILL IT WITHSTAND THE FLOODS?

Entrepreneur led supply

Masons, sales agents and retailers sell durable latrines as a business, so replacement does not wait for the next grant cycle.

Design for the hazard

Lined pits, drainage and construction sequencing, judged against a real flood rather than a specification on paper.

Financing that fits

Build on how households already save, as the Xitique groups did, rather than introducing new credit products too early.

OVERALL

PILOT PERFORMANCE: Sales & Marketing

Apr 2025 - May 2026

260 Households Visits

239 Presentations

50* Total Sales

7 Masons Engaged

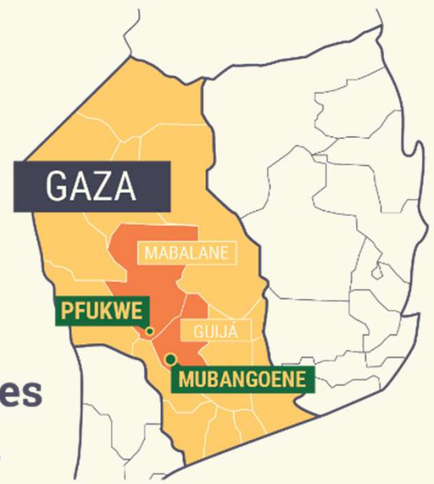
40 Sales Agents Trained

4 Retailers

Endline Assessment

May 2026

2 Communities Assessed



79 Households Interviewed

7 Masons Interviewed

10 Sales Agents Interviewed

2 Retailers Interviewed

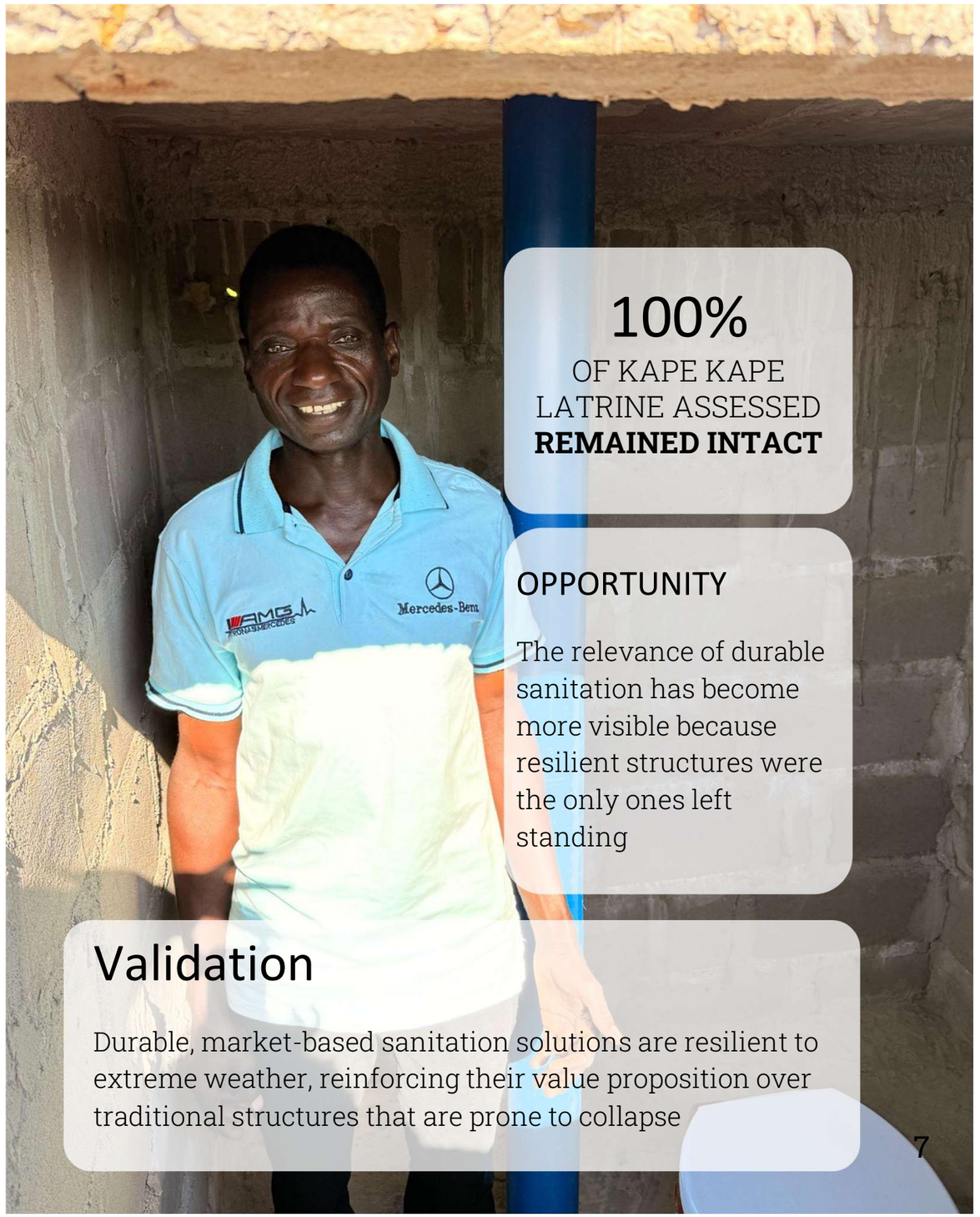
* As the pilot closed, 42 sales were confirmed with remaining stock reserved for the Xitique savings groups.

KAPE KAPE PASSED A TEST

Extreme rainfall and flooding in Gaza Province in January 2026 resulted in:

- Total crop destruction in lowland areas has caused a significant economic shock.
- Household liquidity is temporarily constrained as families prioritize food security and immediate survival.

Methodology[1]: A total of 28 latrines were assessed across Pfukwe and Chivongoene communities.



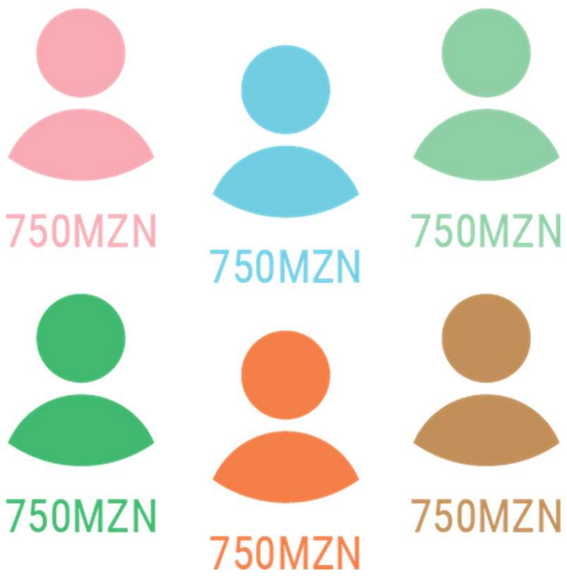
[1] Post Flooding Rapid Assessment Report



217% INCREASE IN SALES AFTER THE FLOODS

The surge in sales proved that rural households will actively invest their own capital during a crisis if the product delivers clear climate-resilient value (lined pits that do not collapse) and the price matches localized cash constraints.

Leveraging Existing Savings Practices: Xitique



Each month



4,500 MZN
Rotating pool

buys

1 latrine Installed



Per month

Promotion

375MZN biweekly payment	**6 members** Per Group	**6 Months** Full cycle	**4,500 MZN** Package prince

Takeaway: Households were more comfortable with **Xitique** than with new or formal financing products.



“What I witnessed during these floods made me say: enough of always rebuilding the latrine

Rosalina, Sales Agent, at her home in Chivongoene ”

iDE
Powering entrepreneurs to end poverty.

Elise Mann
iDE Global WASH Director
emann@ideglobal.org

Lina Henao
iDE Mozambique Programs and Impact Director
lhenao@ideglobal.org

The impact of climate change on WASH / Financial sustainability of sanitation systems / Engagement with the private sector

Presentation summary:

In January 2026, severe flooding struck Gaza Province in southern Mozambique. It had put a market-based sanitation pilot to an unplanned but revealing test. The KAPE KAPE pilot, implemented jointly by iDE and World Vision, had spent nine months building a community-level sanitation market across three rural communities in Mabalane and Guijá districts: training local masons and sales agents, engaging community retailers under a 70/30 risk-sharing model, and introducing a culturally adapted rotating savings mechanism, the "Xitique Sanitation", to tackle the affordability barrier that prevents most rural households from accessing improved sanitation.
When the floods came, 28 latrines were assessed across the two pilot communities. The results were instructive: structures built through the market model and completed to specification showed no structural damage. The most critical factor was not design standards on paper, but construction stage at the time of the flood, partially completed structures, with pits dug but slabs not yet installed, were consistently more vulnerable. This finding has direct implications for how MBS programmes sequence and incentivise construction completion.
This presentation will share practical lessons at the intersection of market systems development, climate resilience, and rural sanitation access, including how to design commission structures and financing mechanisms that accelerate construction completion, how simple drainage additions can be introduced as low-cost mason upsells, and what the xitique savings model offers as a replicable community financing tool for sanitation markets in flood-prone low-income contexts.

The session will be of interest to practitioners working on market-based WASH, climate-resilient infrastructure, and community financing in sub-Saharan Africa and beyond.



Climate Resilience Emerged as a Learning, Not the Starting Point

Climate resilience wasn't part of the original pilot design. The January floods changed that. The rapid assessment showed that lined pits and improved structures held up well, revealing what the product could do under pressure.

For future scale, this reframes the offer: durable sanitation is not just about improving household facilities, but about helping communities invest in structures that can withstand shocks.

THE PROBLEM WITH THE CURRENT RESPONSE

Why the cycle keeps repeating

> ***"After consultations with local authorities, one of the clearest messages was that emergency funding is being wasted year after year on the same temporary solutions."***
>
> Consultation with district authorities, Gaza Province

Relief spending replaces the same asset season after season. Households carry the risk in between.



GAZA PROVINCE, SOUTHERN MOZAMBIQUE

High exposure, low resilience

Repeated climate shocks

Floods, cyclones and drought hit Mozambique year after year, with the greatest exposure in the first quarter.

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Emergency latrines are rebuilt each season by humanitarian actors and government, then washed away by the next event.

January 2026

Extreme rainfall flooded Gaza Province, destroying lowland crops and tightening household cash.

WHY SANITATION IS THE BREAK POINT

From flood to outbreak: the chain to break

Flooding

Extreme rainfall and river flooding across low lying districts.

→

Sanitation damaged

Pits collapse, slabs shift, superstructures wash away, households displaced.

→

Contamination

Faecal matter spreads into standing water and shallow water sources.

→

Health burden

Annual cholera outbreaks reported since 2014, worst where WASH coverage is weakest.

The chain breaks at step two. Sanitation that survives the flood removes both the rebuild bill and the outbreak risk it feeds.

Session 3 **Climate resilient WASH & Circular Economy**

Next Presentation:

Digbijoy Dey – RIVA (formerly IRCWASH)

36th SuSanA MEETING · STOCKHOLM · 22 AUGUST · SESSION 2

Sanitation in Hard-to-Reach Areas

Experience from Bangladesh

Digbijoy Dey

RIVA (formerly IRCWASH)

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Next Presentation:

Susana Perez de Mora – GIZ Ecuador

Melting Glaciers, Resilient Wetlands:

Securing Water in the Andes

Susana Perez De Mora

22.08.2026

cooperación alemana DEUTSCHE ZUSAMMENARBEIT
Implementada por giz
EL NUEVO ECUADOR
Ministerio de Ambiente y Energía

1

Disappearing Ice

Tropical glaciers are among the most sensitive indicators of climate change



Photo: Anhalzer

Ecuador lost the Carihuairazo Glacier in 2024.



Photo: Anhalzer

Ecuadorian glaciers have lost more than 50% of their mass in recent decades.

2

The Real Foundation of Water Security

Water security does not depend on ice alone. It depends on living ecosystems.

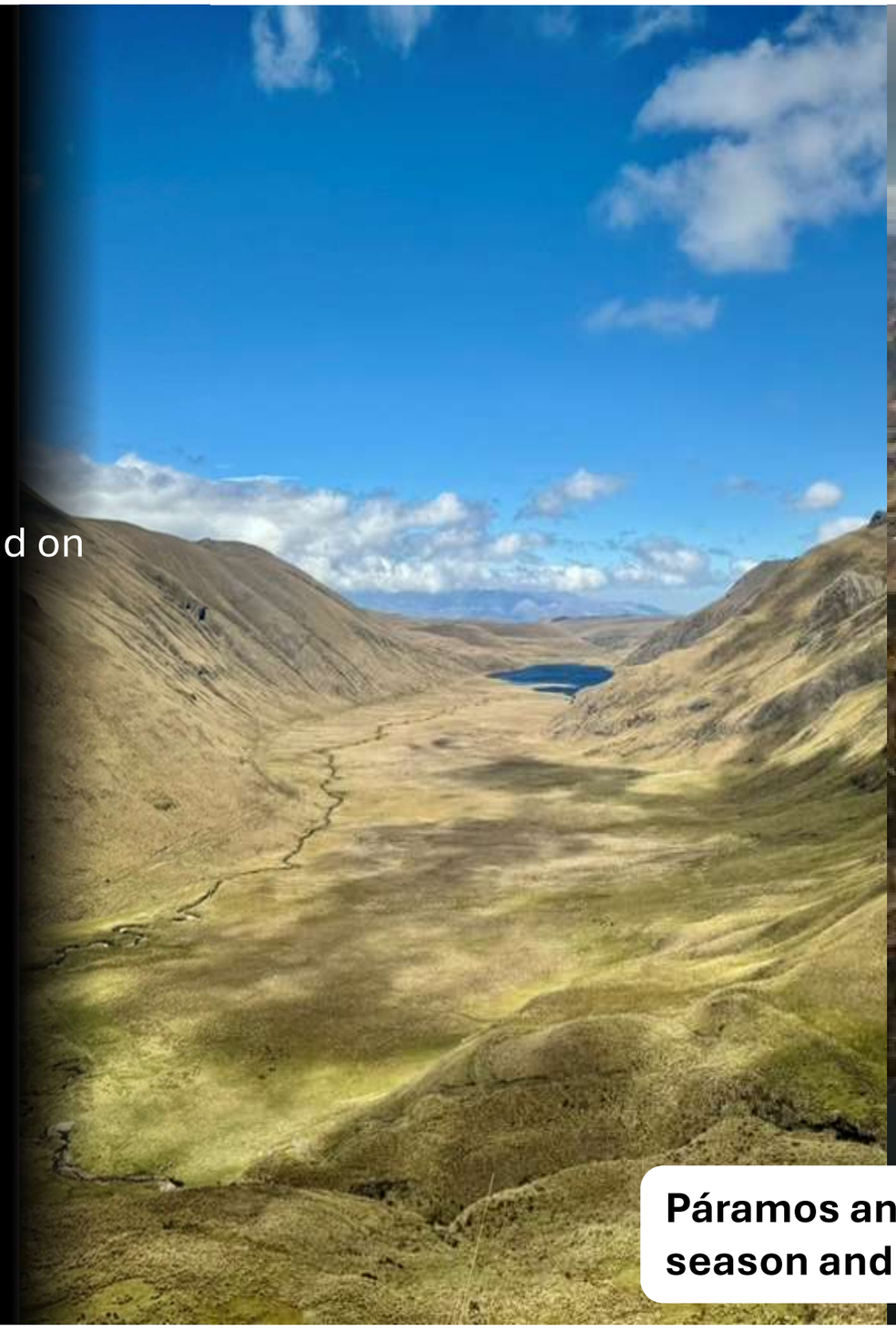




Photo: Anhalzer

Páramos and wetlands store water during the rainy season and release it slowly during dry periods.

3

Natural Water Infrastructure

Páramos function as a vast natural sponge.



Photo: Anhalzer

Rain and fog → Peatlands → Páramo → Lagoons → Rivers → Communities, agriculture and cities



Cities

Photo: Anhalzer

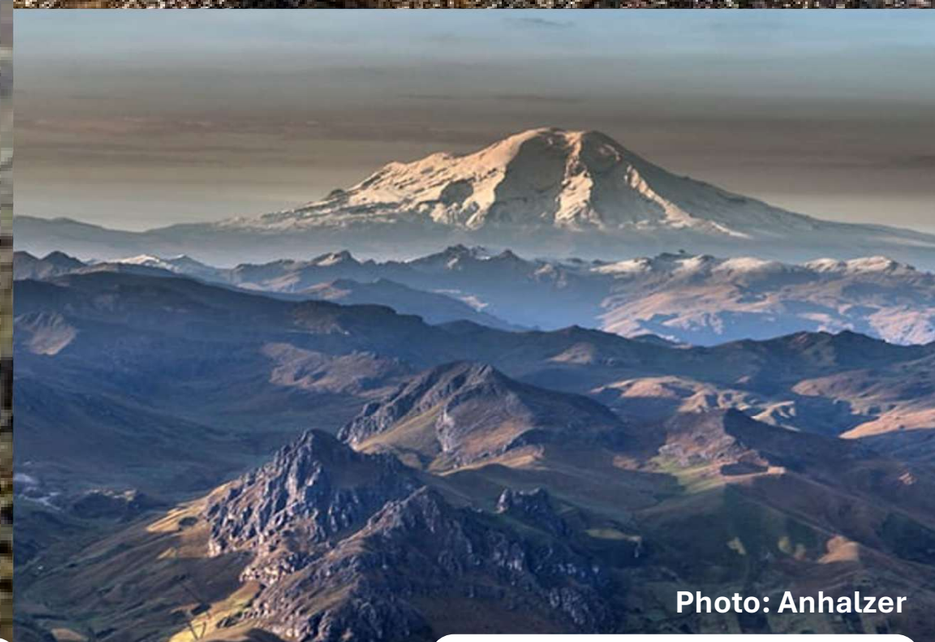


Photo: Anhalzer

Communities
Agriculture

4

What Is Being Lost

When a páramo is degraded, it loses its capacity to store water.



Photo: Anhalzer

Fires



Photo: Anhalzer

Overgrazing



Expansion of the agricultural frontier

5

The People Who Sustain Resilience

Resilience does not live only in ecosystems. It lives in the communities that protect them.





Photo: Rodrigo Buendía

6 million people living in Ecuador’s high-Andean region depend on water

6

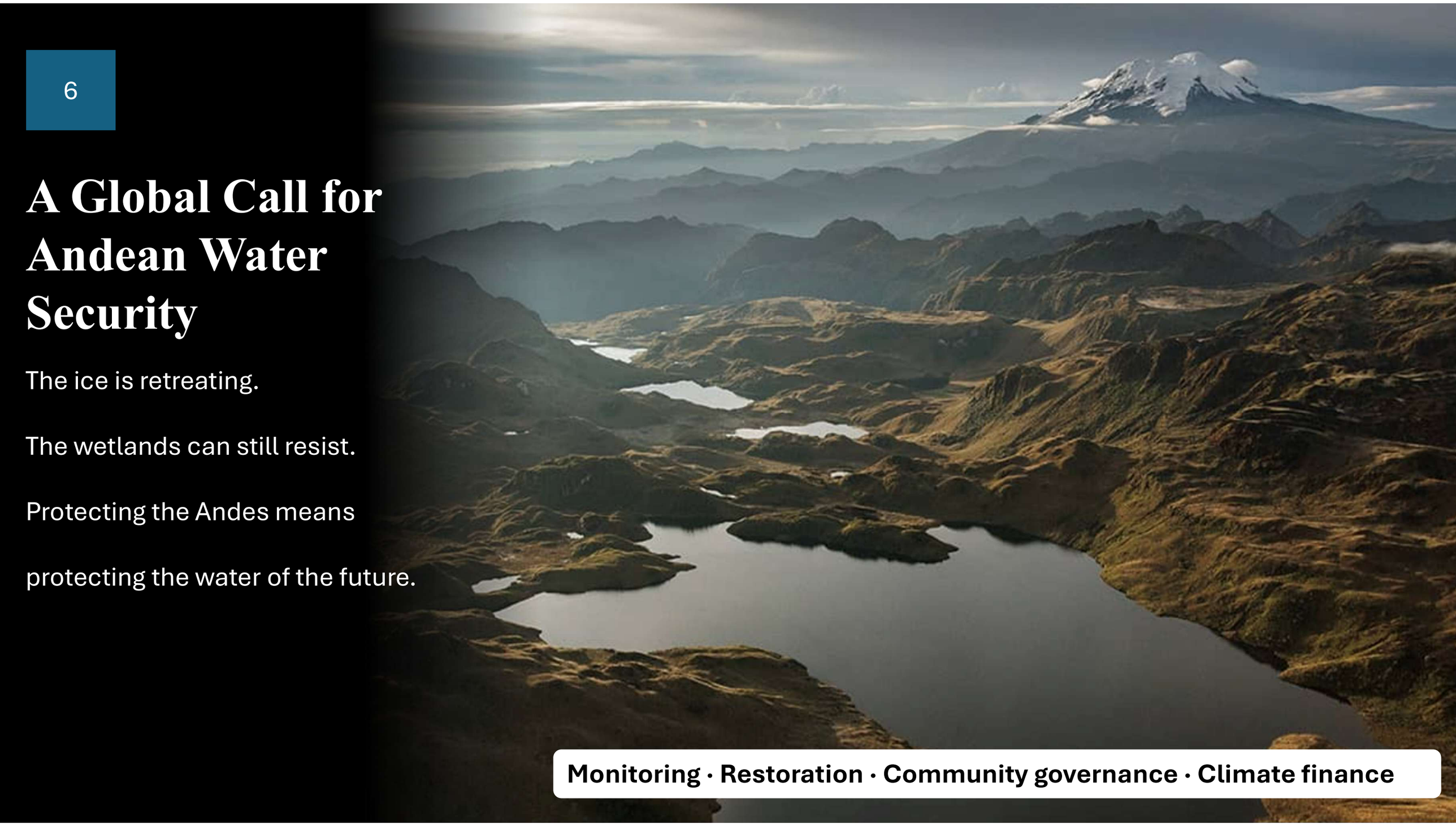
A Global Call for Andean Water Security

The ice is retreating.

The wetlands can still resist.

Protecting the Andes means

protecting the water of the future.



Monitoring · Restoration · Community governance · Climate finance

Como empresa federal, la GIZ apoya al Gobierno alemán en la consecución de sus objetivos en el ámbito de la cooperación internacional para el desarrollo sostenible.

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En cooperación con:

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Ministerio de Ambiente y Energía

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Next Presentation:

Linda Strande / Jess MacArthur– EAWAG-Sandec

Sandec Department of
Sanitation, Water and
Solid Waste for Development


Julian Fritzsche
Eawag-Sandec

Mythbusting: Estimating Greenhouse Gas Emissions from Sanitation

Linda Strande and Jess MacArthur
Eawag-Sandec

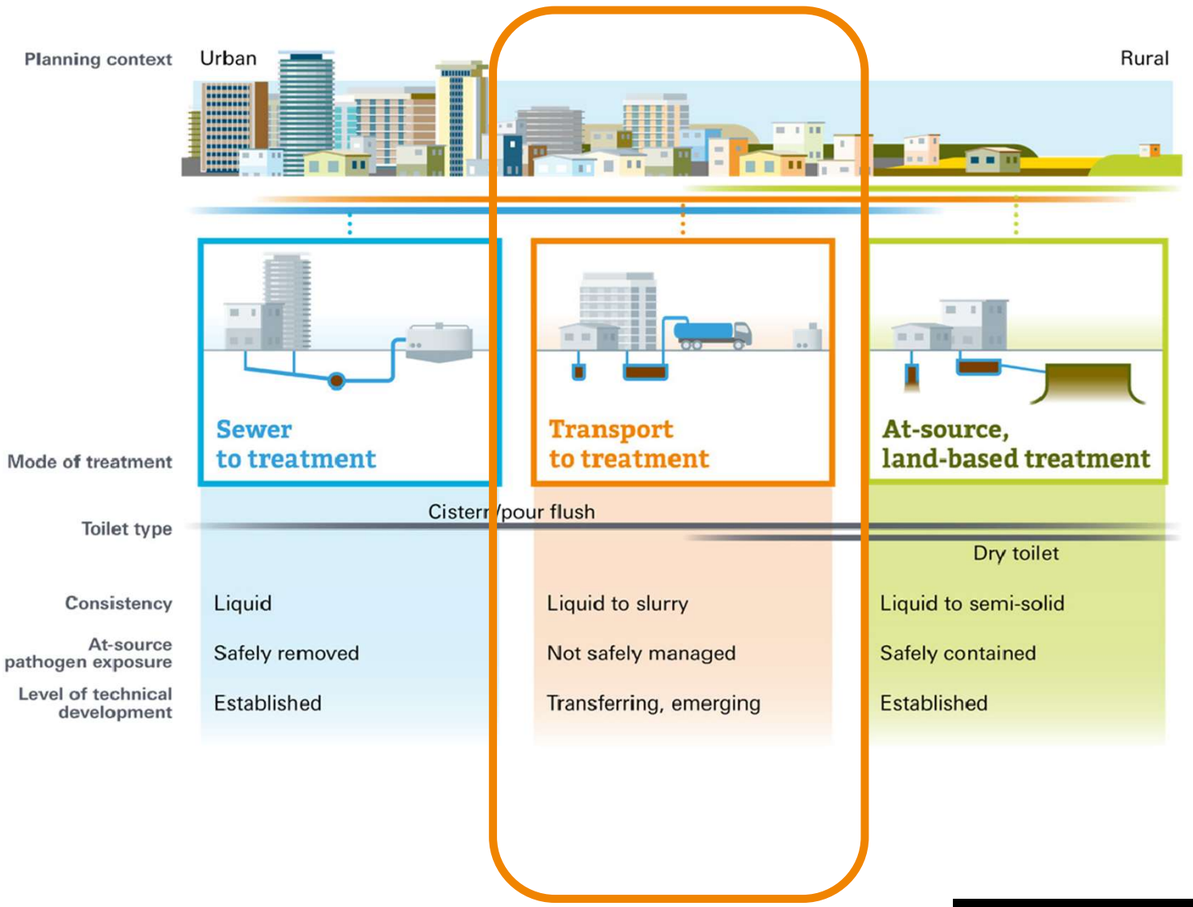
eawag
aquatic research

Myth 1: **Wastewater from urban non-sewered sanitation is the same as from sewers.**

Nope. Totally different.

We now have great evidence to show that what's in the wastewater is very different and this variability also impacts GHG emissions.

- **Quantities** - The **amounts** of different wastewater streams including urine, feces, flushwater, and greywater.
- **Qualities** - The **composition** and characteristics of wastewater.



Strande et al. 2023

Myth 2: **Pit latrines and septic tanks are actively treating wastewater.**

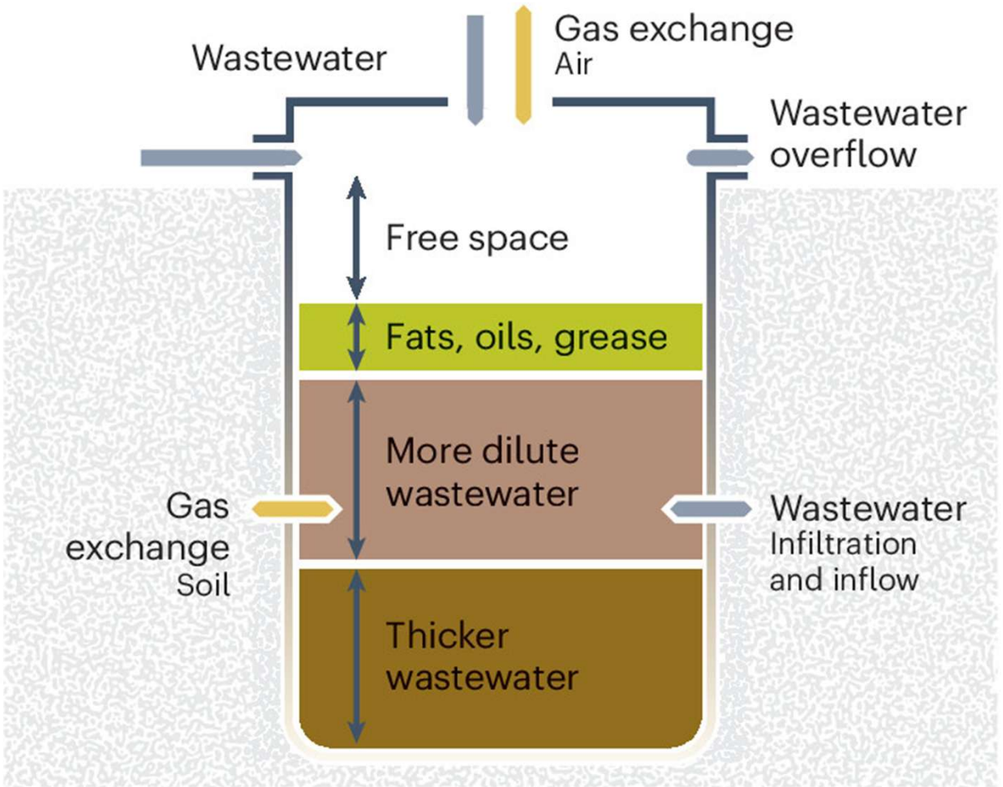
Nope. They mostly just store wastewater.

The processes of how organic matter in wastewater breaks down during storage are still relatively opaque.

In reality, only about 20% of the organic matter is actually degrading and transformed, and therefore producing methane.

True treatment must be strategically designed for:

- Solid-liquid separation
- Pathogen inactivation
- Stabilization
- Nutrient management



Strande 2024

Myth 3: **We can create excellent estimates of GHG emissions for non-sewered sanitation.**

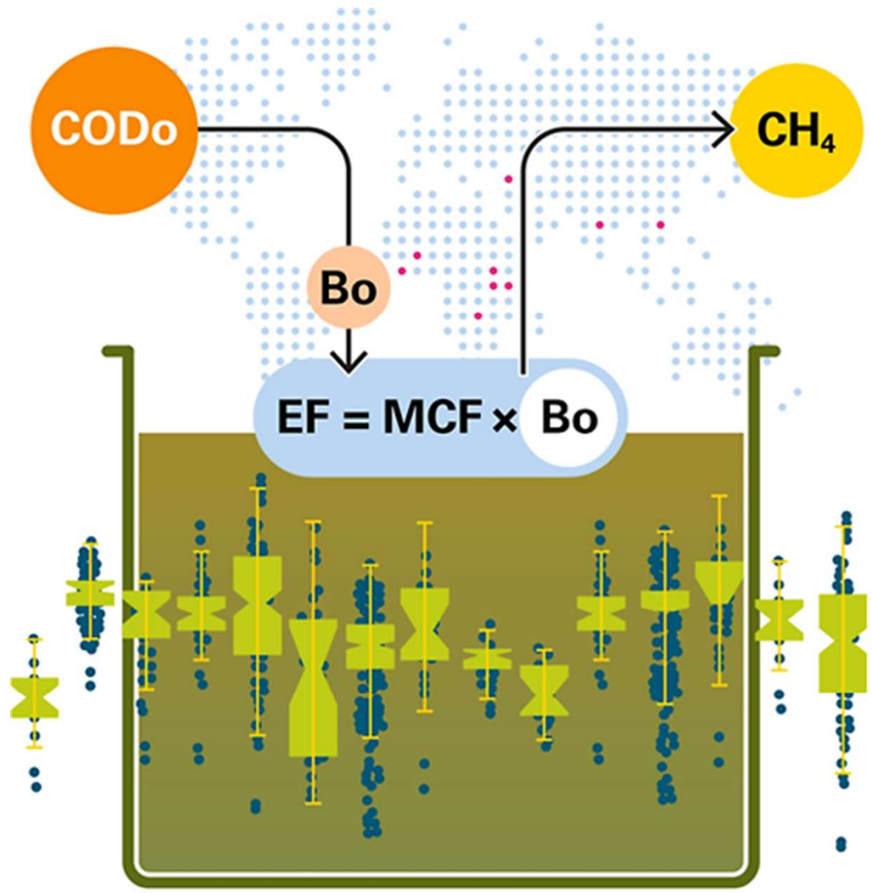
Nope. Our estimates are wobbly.

Current estimates rely on a lot of assumptions. And emerging science is showing that many of our assumptions and categories are incorrect.

The type of containment, is emerging as less important than the wastewater itself - which is highly variable.

Data mining from over 1349 datapoints in 11 cities from onsite storage of wastewater…

- Shows that accurate estimates are complicated by highly variable influent wastewater and storage conditions.
- Which means that GHG emissions are also highly variable.



Vogel & Strande 2026

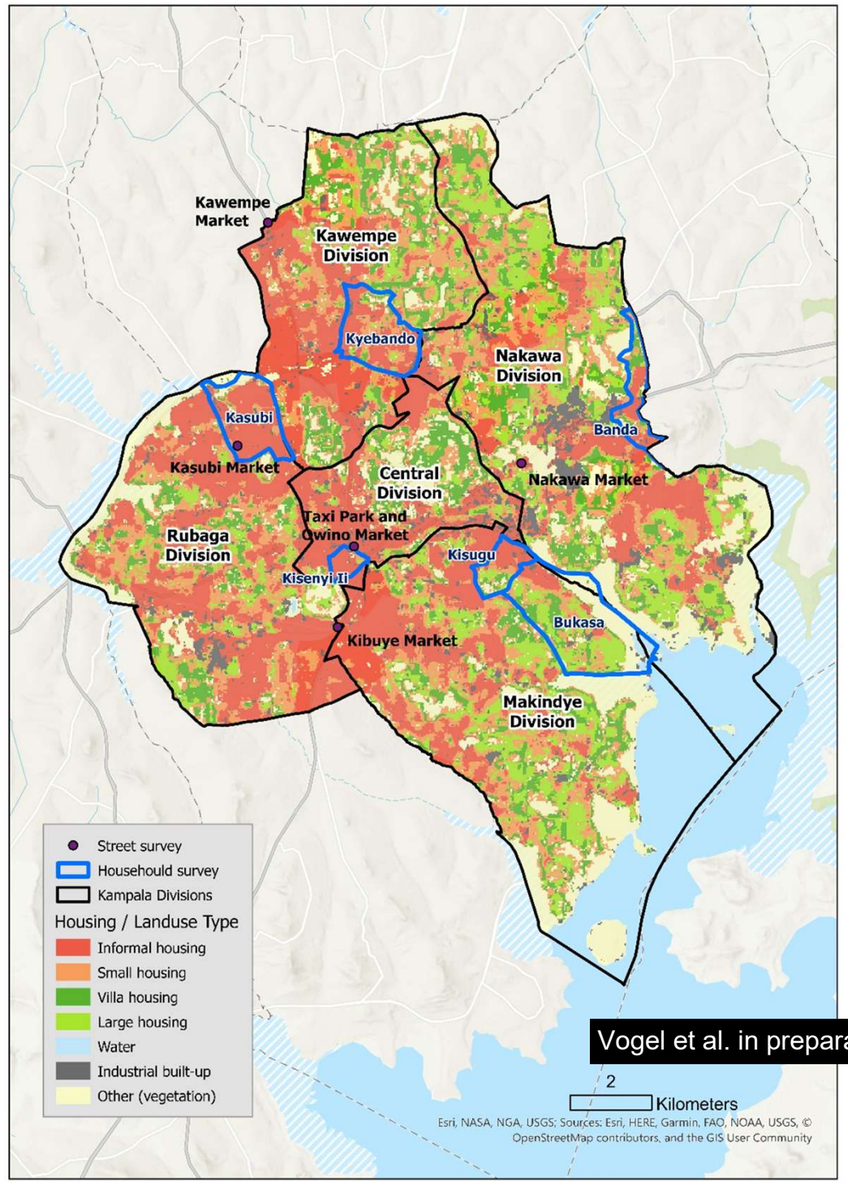
Myth 4: **We can accurately understand wastewater in non-sewered sanitation.**

Nope. Population equivalents used to design treatment plants don't work for non-sewered toilets

We did 700 surveys at households on the street across 5 divisions of Kampala. Preliminary insights:

- In very-low income households: 43% of feces outside the home (public and work toilets)
- In high-income households: 13% of feces outside the home (public and work toilets)
- 27% of respondents didn't even live in Kampala.

 Which is another reason that current GHG emissions estimates are also not correct.



Learn more

Are our GHG estimates accurate for nonsewered sanitation?

Improving methane emission estimates from nonsewered wastewater during storage in septic and holding tanks

[Shaw et al. 2026]

What is the state of knowledge in non-sewered urban sanitation?

Integrating recent scientific advances to enhance non-sewered sanitation in urban areas

Strande 2024





How do we get better GHG estimates?

Can data mining improve methane correction factors (MCFs) for urban non-sewered sanitation?

[Vogel & Strande 2026]

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GOAL

National University of Sciences & Technology Pakistan

an eco

The University of Zambia — Service and Excellence

National Water and Sewerage Corporation — Water is Life





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TU Delft Delft University of Technology

EPFL

Milton Margai Technical University — Skills Truth Wisdom

University of Victoria

IHE DELFT

ETH zürich

ETH4D

FNSNF Fonds national suisse Schweizerischer Nationalfonds Fondo nazionale svizzero Swiss National Science Foundation

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

REPIC Renewable Energy & Energy Efficiency Promotion in International Cooperation

NSERC CRSNG

UNIVERSITÉ DE GENÈVE

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Session 3 **Climate resilient WASH & Circular Economy**

Next Presentation:

Francesca Zanni – Stockholm Environmental Institute (SEI)



Treated Wastewater Reuse Under a Changing Climate

An ethnographic health risk assessment in the Chinchaya community in La Paz, Bolivia

Francesca Zanni,
Affiliate, Stockholm Environment Institute

SEI Stockholm Environment Institute

Context and methods





- **Peri-urban community:**
  - 87% of households are connected to potable water
  - 61% of households are connected to sanitation
  - Irrigation water is provided through the state program Mi Riego
- A **vermicomposting sewage treatment plant** was recently built by Sida
- SEI piloted the reuse of **treated wastewater for irrigation** of vegetables and flowers: the **health component** included **microbiological analysis** and **epidemiological analysis**
- However, **risk is a social phenomenon:** how do **social practices** around water use influence the health risks associated with reuse?
- Jan.–Mar. 2026, 1 participatory mapping workshop, 8 walking interviews, 14 semi-structured interviews, field observations

Findings



1. Water sources are used in a cumulative and interchangeable way
    - New sources of water that are introduced in the community **add to existing water infrastructure:** a formal network of piped potable water, an informal network of piped stream water, private rainwater harvesting tanks, wells, Mi Riego hydrants, and streams
    - New water sources **do not replace existing ones:** households use water sources **interchangeably** for domestic and agricultural purposes, depending on **economic** considerations, **maintenance** issues, **opportunity**, and **experience**

Treated water might be used differently from what is recommended by the project

Findings

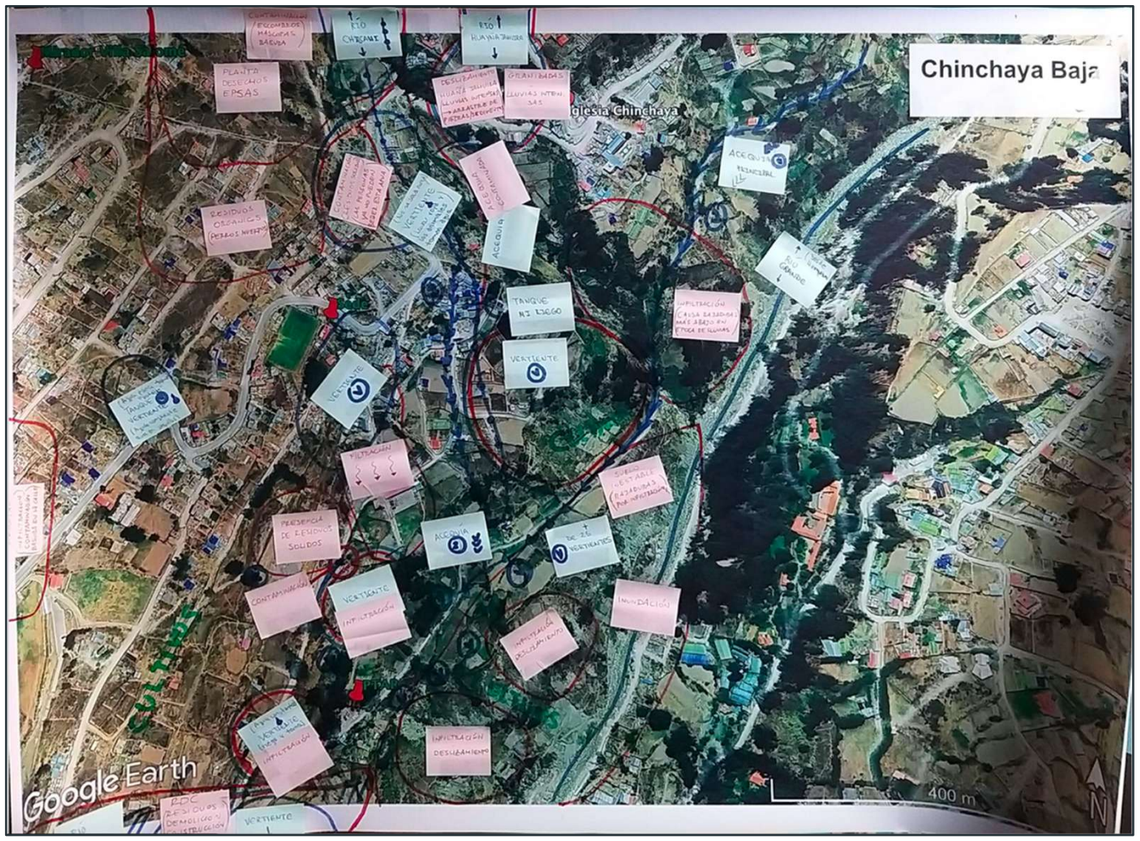


2. Prevalence of human-made reasons for water insecurity
   - The primary drivers of water insecurity are **human-made rather than natural factors:** clogging and unreliable maintenance of the community irrigation system Mi Riego, the destruction of traditional irrigation ditches, uneven access to the keys needed to open Mi Riego irrigation hydrants, leadership

Adding one more water source might not address water security if the social relations of water access are not addressed as well

SEI

Findings



3. Overlapping risks and the limits of single-hazard assessments
   - Water-related risks in Chinchaya **overlap significantly:** at least 25 surface water streams, environmental contamination, occasionally shared animal-human water sources, landslides, and surface runoff across cultivated plots

Substantial surface runoff across cultivated land suggests that treated wastewater may inadvertently be conveyed to food crops

High levels of environmental contamination in the area indicate that the laboratory profile of treated wastewater should not be assessed in isolation

SEI

Conclusions

1. The reuse pilot in Chinchaya is being **introduced into an existing, complex water system,** in which infrastructure, the use of multiple water sources, perceptions of water quality, community management, and social conflicts influence how water is accessed and used

2. Its outcomes will be shaped by **how treated water is incorporated into, and modifies, this existing configuration,** not by its microbiological properties alone

3. This study confirms that **technology fixes alone are insufficient** to address water insecurity - supporting calls to develop **integrated biological and social analyses** of WASH challenges - an ambition recognised for over a decade but still described as one of the great challenges facing engineering approaches to global water and sanitation

SEI

Thank you – Gracias – Yuspajara

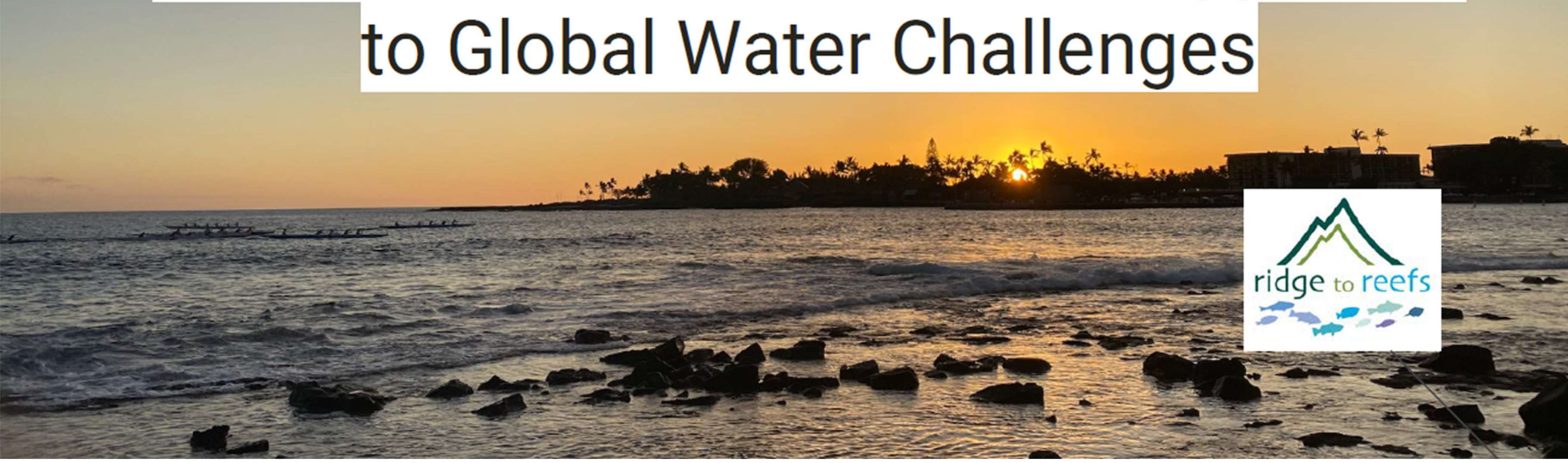


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Next Presentation:

Paul Sturm – Ridge to Reefs

Nature-Based Wastewater Treatment and Water Reuse: A Decentralized Approach to Global Water Challenges



Ridge to Reefs/ Nature Based Solutions : Organization Overview



Paul Sturm
Executive Director



Phal Mantha
Director of Agriculture & Sustainability



Kelly Harris
Ecological Engineer & Project Developer



Dr. Karen Herrero-Backe
Partnership Director

Mission: *We are a nonprofit catalyzing local capacity & develop nature-based solutions to create communities where connected human and natural systems thrive.*



John Astilla
Nature Based Restoration Coordinator (Hawai'i)



Leilua Willis Watson
Agricultural Technician (American Samoa)



Keith Ahsoon
Restoration Coordinator (American Samoa)



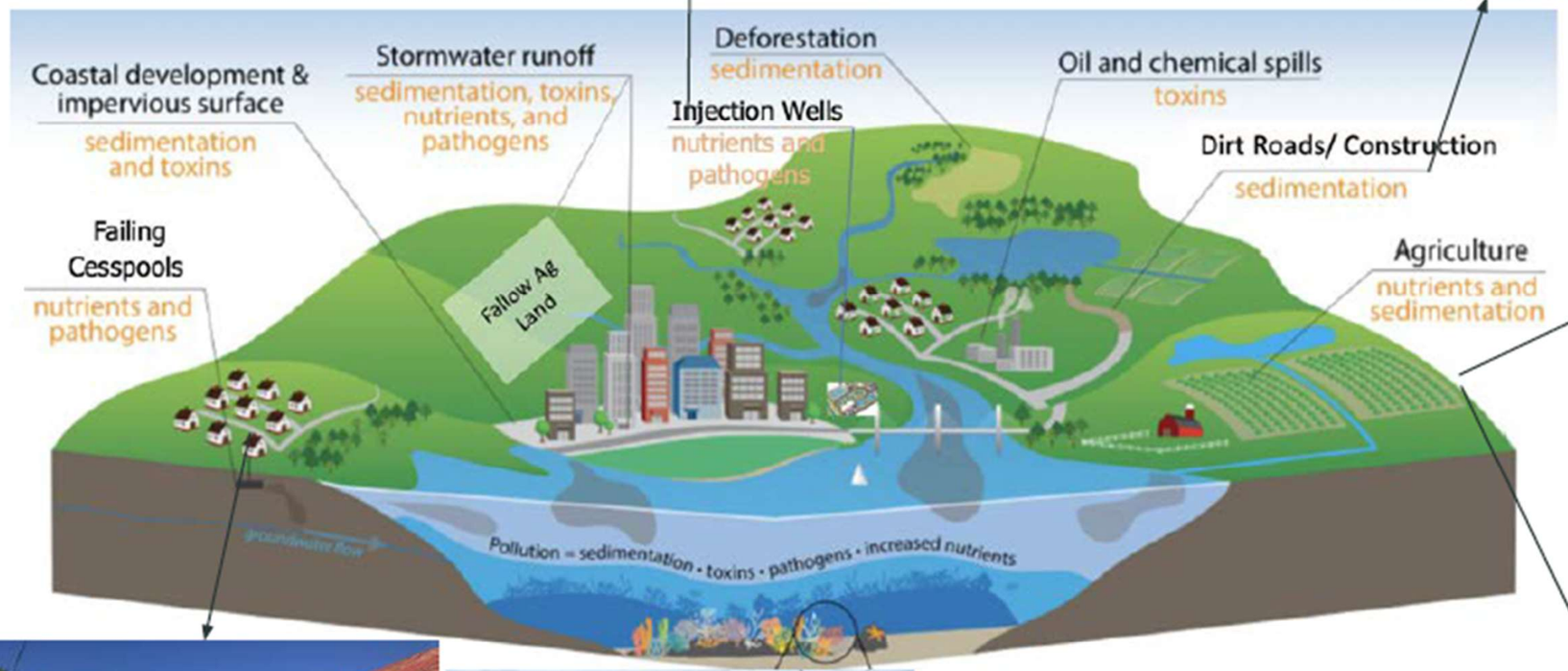
Ricardo Liquet-Gonzalez
Agronomist and Restoration Specialist (Puerto Rico and Caribbean)

Ridge to Reefs:

An applied "whole watershed" approach to mitigating land based sources of pollution.















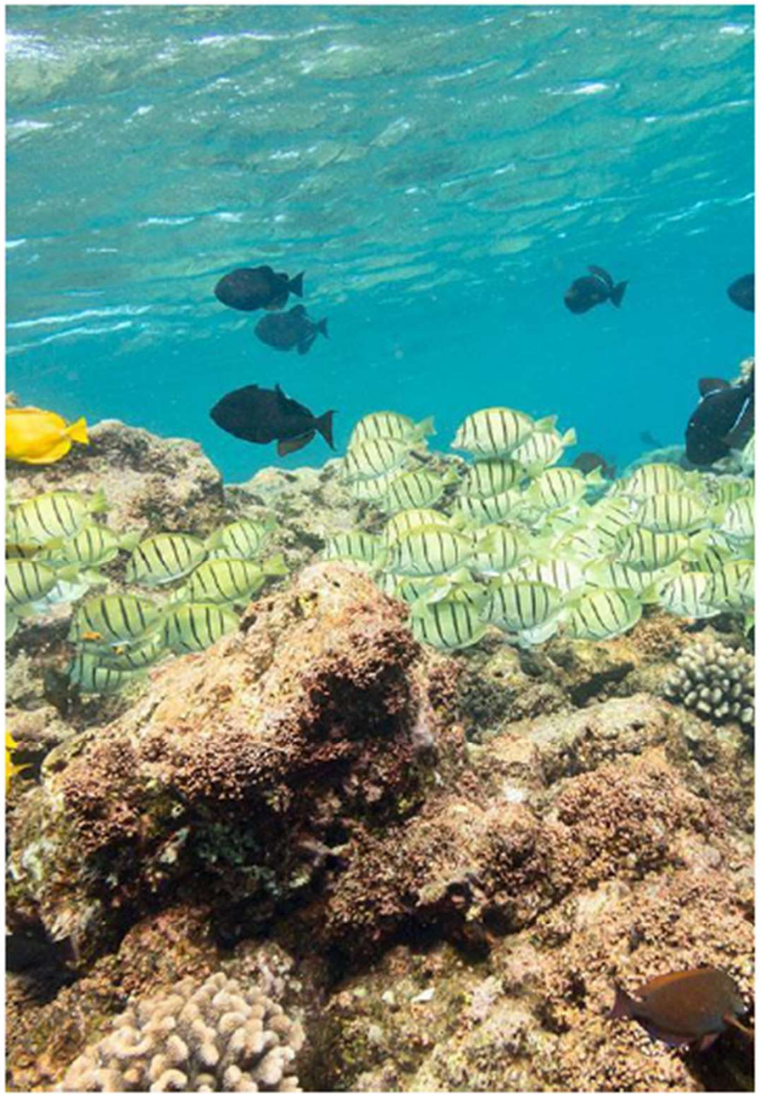




ridge to reefs

The Challenge

- **80% of wastewater is untreated or severely under treated**
- **Conventional wastewater treatment uses 1000 times more energy**
- **Conventional wastewater treatment relies on engineering principles and global distribution of materials** rather than nature based biomimicry achievable with existing waste streams and resources available locally



ridge to reefs

Our Vision

1. High quality treatment adopted at scale
2. **Circular economies** – woodchips from invasive species, sand made from local basalt
3. Reduced carbon and physical footprint
4. **Address pharmaceuticals and PCPPs**
5. Safe, low-cost for disposal challenges
6. **Allows for technological sovereignty**

Process

Denitrification (N_2 gas)

Evapotranspiration (water vapor)



Reduction of Pollutants

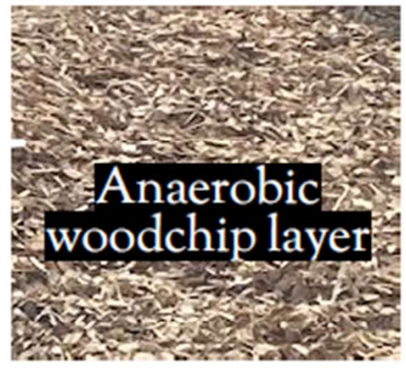
- ↓ 87% Total Nitrogen
- ↓ 83% Phosphorus
- ↓ 15-20% Water volume
- ↓ 95% TSS
- ↓ 94-99% antibiotics
- ↓ 60-99% other pharmaceuticals

System tested for NSF 40 and 245 compliance at a wastewater treatment plant by University of Hawaii



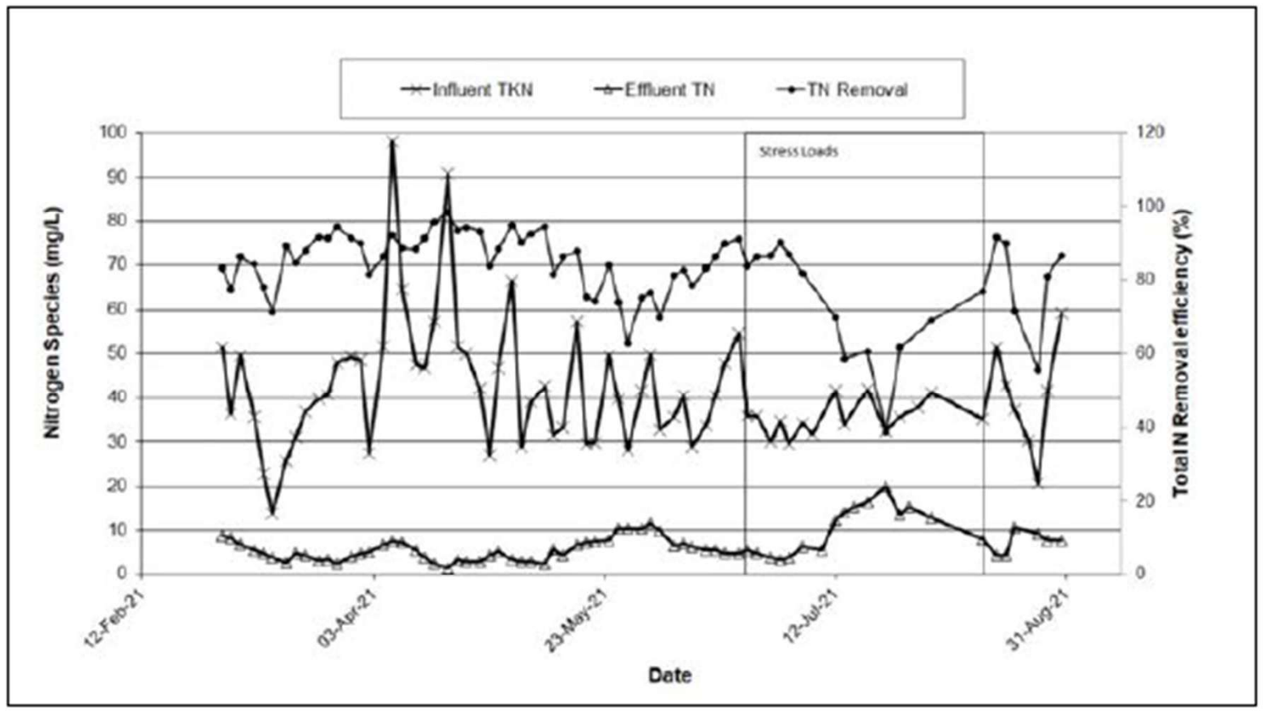
1. Nitrification (NH_4 > NO_2- > NO_3-)





2. Denitrification (NO_3- > N_2)

Water Quality Results - Bioreactor Garden

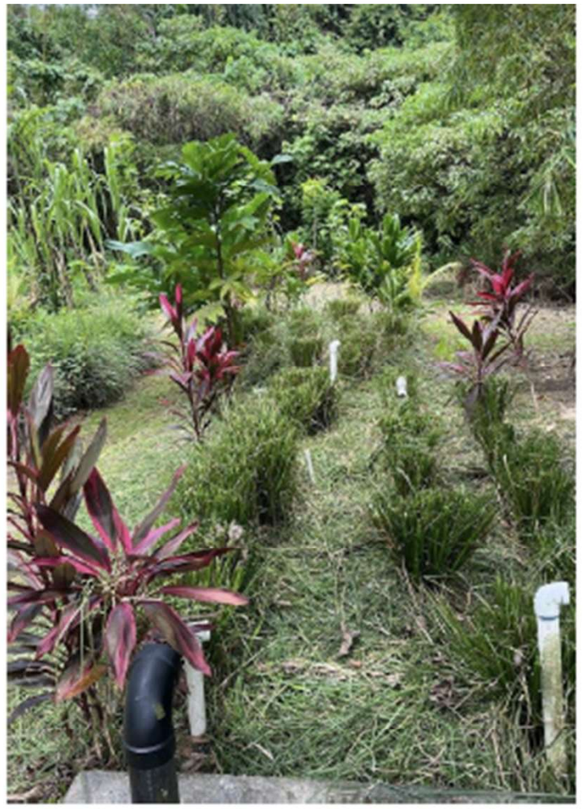


Reduction of Pollutants

↓ 87% Total Nitrogen
↓ 83% Phosphorus
↓ 15-20% Water volume
↓ 95% TSS
↓ 94-99% antibiotics
↓ 60-99% other pharmaceuticals

"Remember everything ultimately ends up in the Ocean"












Ridge to Reef's Bioreactor Garden

Stony Brook University

50 – 100% removal of two dozen drugs, pharmaceuticals, personal care products by NRBs in Suffolk County

Compound	Use	Removal (%)
Acetaminophen	NSAID	94 – 100
Caffeine	stimulant	99 – 100
Paraxanthine	human metabolite of caffeine	98 – 99
DEET	mosquito repellant	82 – 96
Nicotine	stimulant	92 – 97
Cotinine	human metabolite of nicotine	86 – 98
Sulfamethoxazole	antibiotic	85 – 97
Diphenhydramine	antihistamine	97 – 95
Trimethoprim	antibiotic	87 – 90
Ciprofloxacin	antibiotic	64 – 78
Atenolol	beta blocker	88 – 97
Metoprolol	beta blocker	85 – 90
Diltiazem	calcium channel blocker	76 – 90
Carbamazepine	anticonvulsant	51 -60
Ketoprofen	NSAID	68 – 74
TCEP	flame retardant	60 – 70
Salbutamol	bronchiodialator	50 – 78
Ranitidine	anti-acid	82 – 100
Diclofenac	NSAID	76
Propranolol	beta blocker	98 – 100
Venlafaxine	antibiotic	98
Fluoxetine	antidepressant (SSRI)	64 – 66
Lamotrigine	anticonvulsant	82
Primidone	anticonvulsant	58

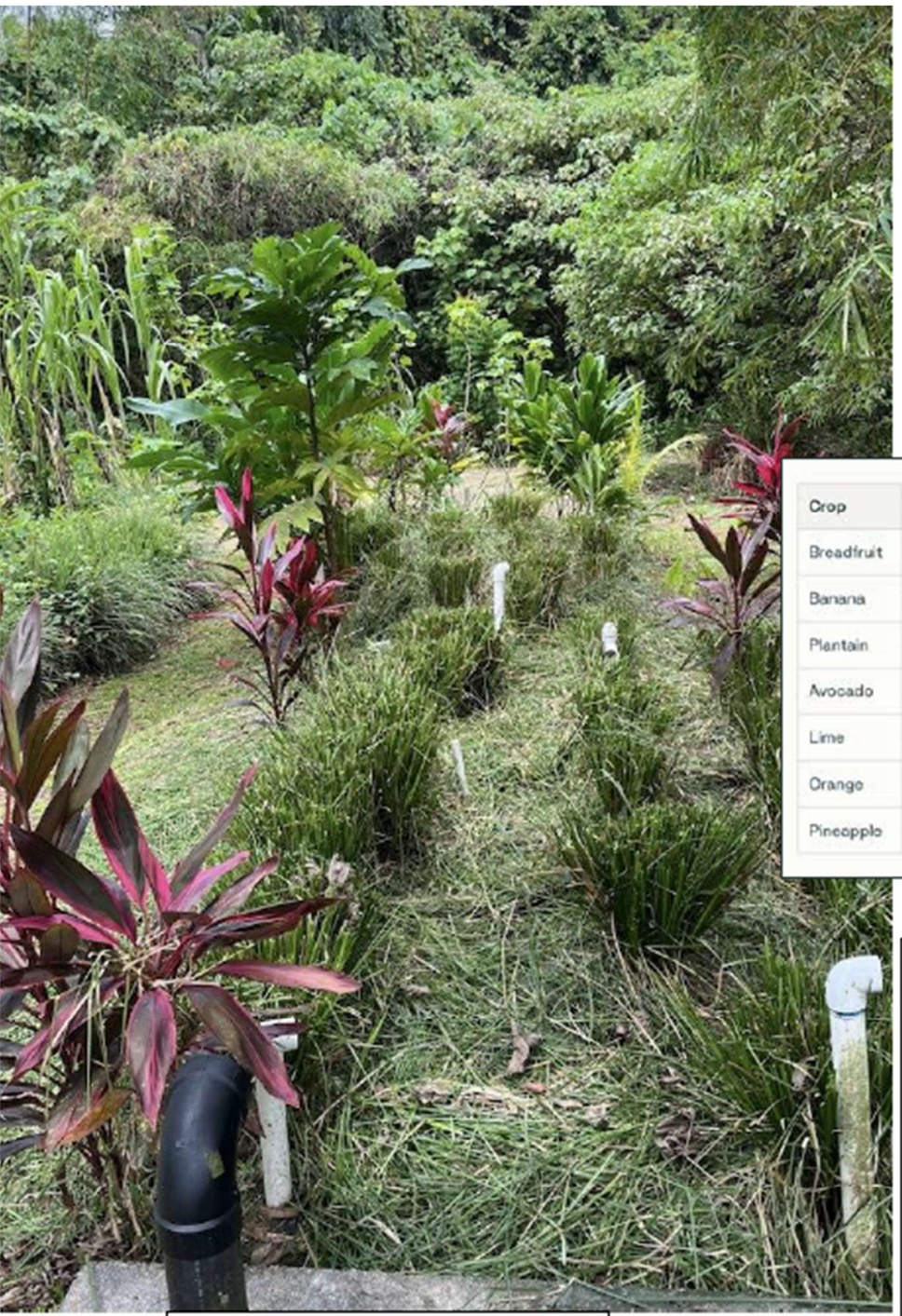
FAR BEYOND

Data courtesy of Dr. Tricia Clyde

Removal of Pharmaceuticals in these systems

Unique_id	Caffeine	Trimethoprim	Primidone	Sulfamethoxazole	Erythromycin	Carbamazepine	Fluoxetine
Kihei_A1	27.61	19.13	117.89	259.3	2.56	240.69	14.35
Kihei_F1	12.67	0	81.93	15.47	0	135.17	0
Kihei_F2	14.3	0	47.31	17.49	0	58.93	0
Removal Rate							
Bioreactor G	**54.11%**	**100.00%**	**30.50%**	**94.03%**	**100.00%**	**43.84%**	**100.00%**
BG + sand/biochar fil	**48.21%**	**100.00%**	**59.87%**	**93.25%**	**100.00%**	**75.52%**	**100.00%**
Notes							
Units in parts-per-trillion (ppt) or ng/L							
0 is not detectable							
	Caffeine	**Antibiotics**	**epileptic drug**	**Antibiotics**	**Antibiotics**	**Epilepsy**	**Antidepressent SSRI**

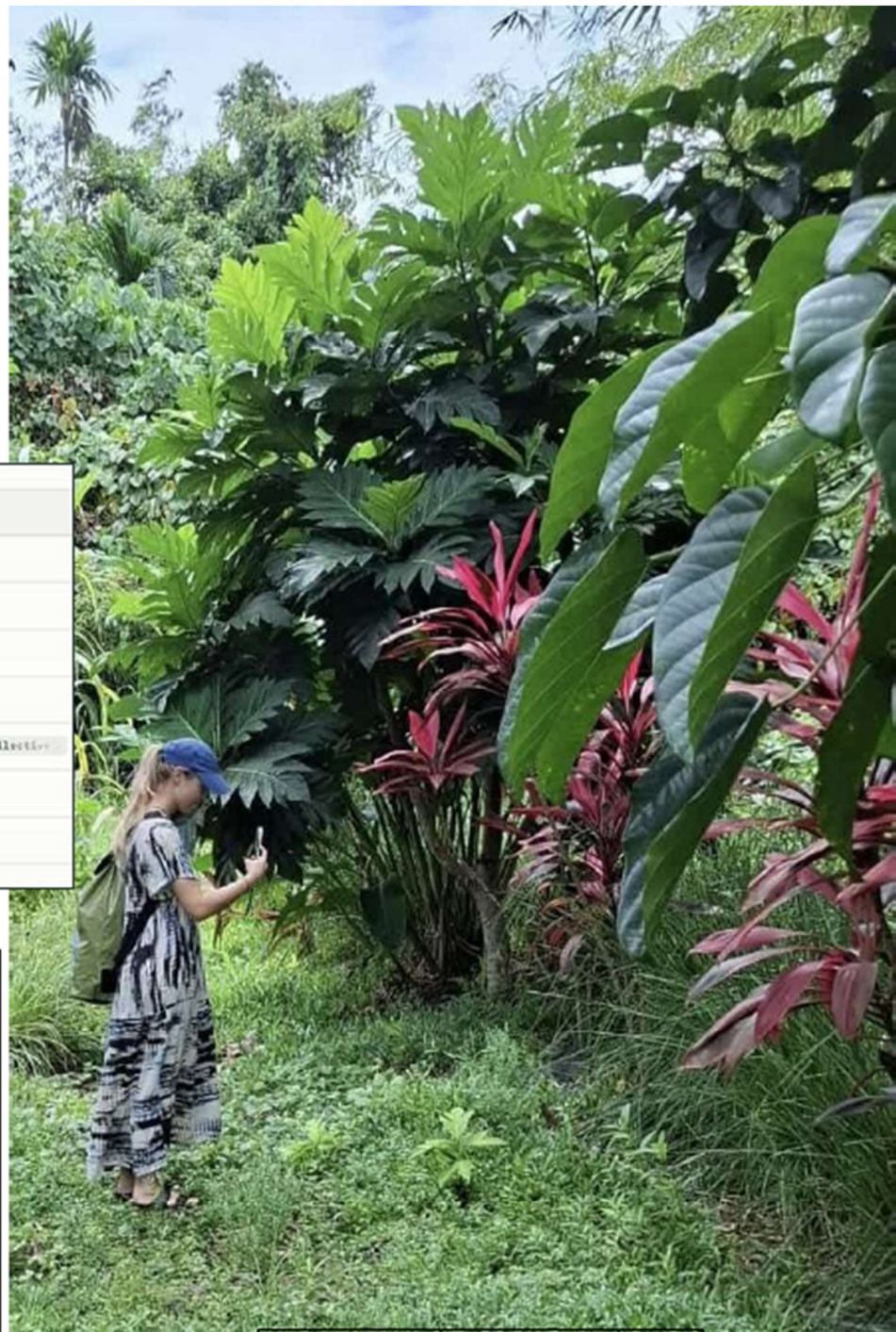
Ridge to Reefs Hawaii data analyzed at Texas A&M



Anticipated yields on a household system based on 2: breadfruit, Banana, Plantain, and Avocado trees; 1 Lime, orange and 4 pineapple plants)

Crop	Yield (kg)	Palau Low–High Value	Hawaii Low–High Value
Breadfruit	320–1,000	$627 – $5,880 dir.tridge	$2,816 – $13,200 ulu
Banana	15–45	$40 – $188 selinawamucii	$82 – $346 farmlinkhawaii
Plantain	20–60	$29 – $132 dir.tridge	$88 – $263 facebook
Avocado	45–320	$215 – $2,445 selinawamucii	$162 – $1,408 foodland +1
Lime	32–45	$14 – $223 dir.tridge	$240 – $338 ongaro-point-collecti…
Orange	75–120	$177 – $365 selinawamucii	$108 – $334 dir.tridge
Pineapple	6–8 (4 fruits)	$16 – $40 selinawamucii	$53 – $70 foodland

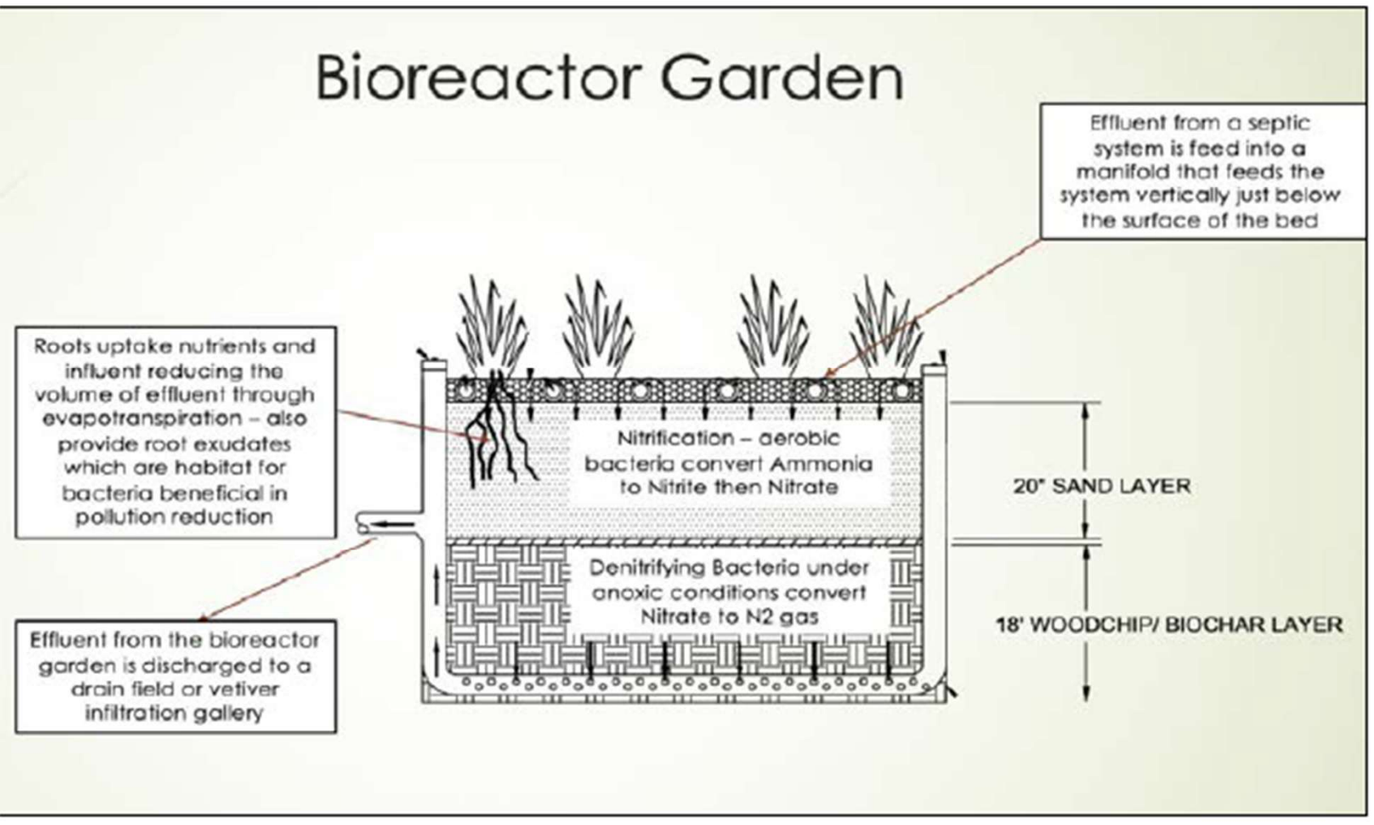
The most compelling models are for schools, health care centers, churches etc where additional space and volume could easily 10x these outputs
*breadfruit clearly is the star in terms of food security

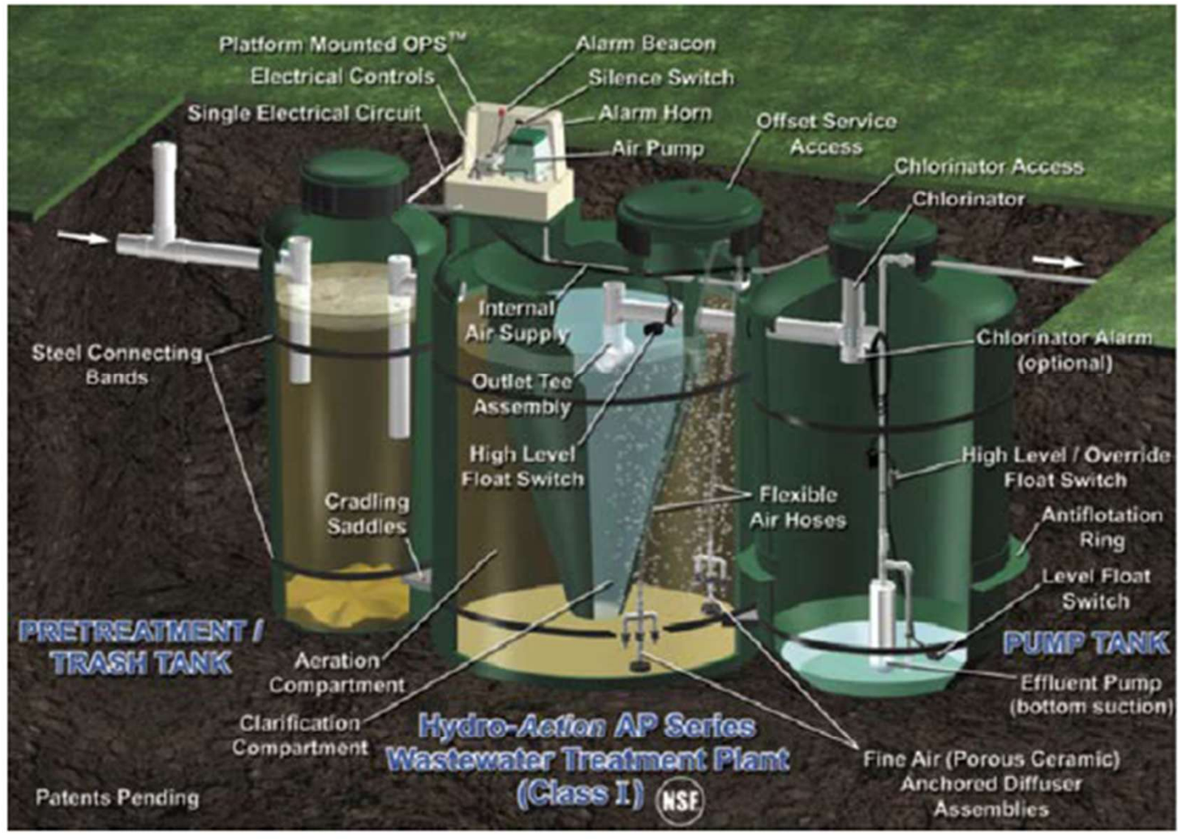


6 months

20 months

Natural Treatment Processes vs Conventional Engineering





Patent pending (2023)

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Ridge to Reefs Inc.

Session 3 **Climate resilient WASH & Circular Economy**

Next Presentation:

Dorothee Spuhler & Carla Liera – OST University

CO-CREATING SANITATION FUTURE(S)



C2S

CARLA LIERA & DOROTHEE SPUHLER

C2S
CO-CREATING CIRCULAR SANITATION SOLUTIONS

IMPLEMENTATION AND RESEARCH PROJECT THAT **BRINGS TOGETHER** RESEARCH, PRACTICES, COMMUNITIES, AUTHORITIES, AND THE PRIVATE SECTOR TO **CO-CREATE CIRCULAR SANITATION SYSTEM**S AND VIABLE SERVICE DELIVERY MODELS IN INFORMAL AREAS IN **SOUTH AFRICA AND MOZAMBIQUE.**



DECENTRALIZED RESOURCE RECOVERY SANITATION TECHNOLOGIES AND TREATMENT ALTERNATIVES

UDDT

BLACK SOLDIER FLY COMPOSTING

BIOGAS

TWIN-PIT LATRINE

VERMI COMPOSTI NG

SAVE WATER

SAVE ENERGY

RECOVER NUTRIENTS & ORGANIC MATTER



Food security



Adaptation to climate change



Health and wellbeing



Livelihoods

BUT WE KNOW THAT THE IMPLEMENTATION OF THESE SOLUTIONS IS COMPLEX

UNCERTAINTY IN PERFORMANCE OF TECHNOLOGIES

RISK AVERSION FROM UTILITIES & GOVERNMENTS

NEW MODES OF OPERATION

NEW SECTORS

NEW MARKETS

IMPLEMENTATION AND MAINTENANCE COSTS

WILLINGNESS TO USE THE TECHNOLOGIES BY USERS

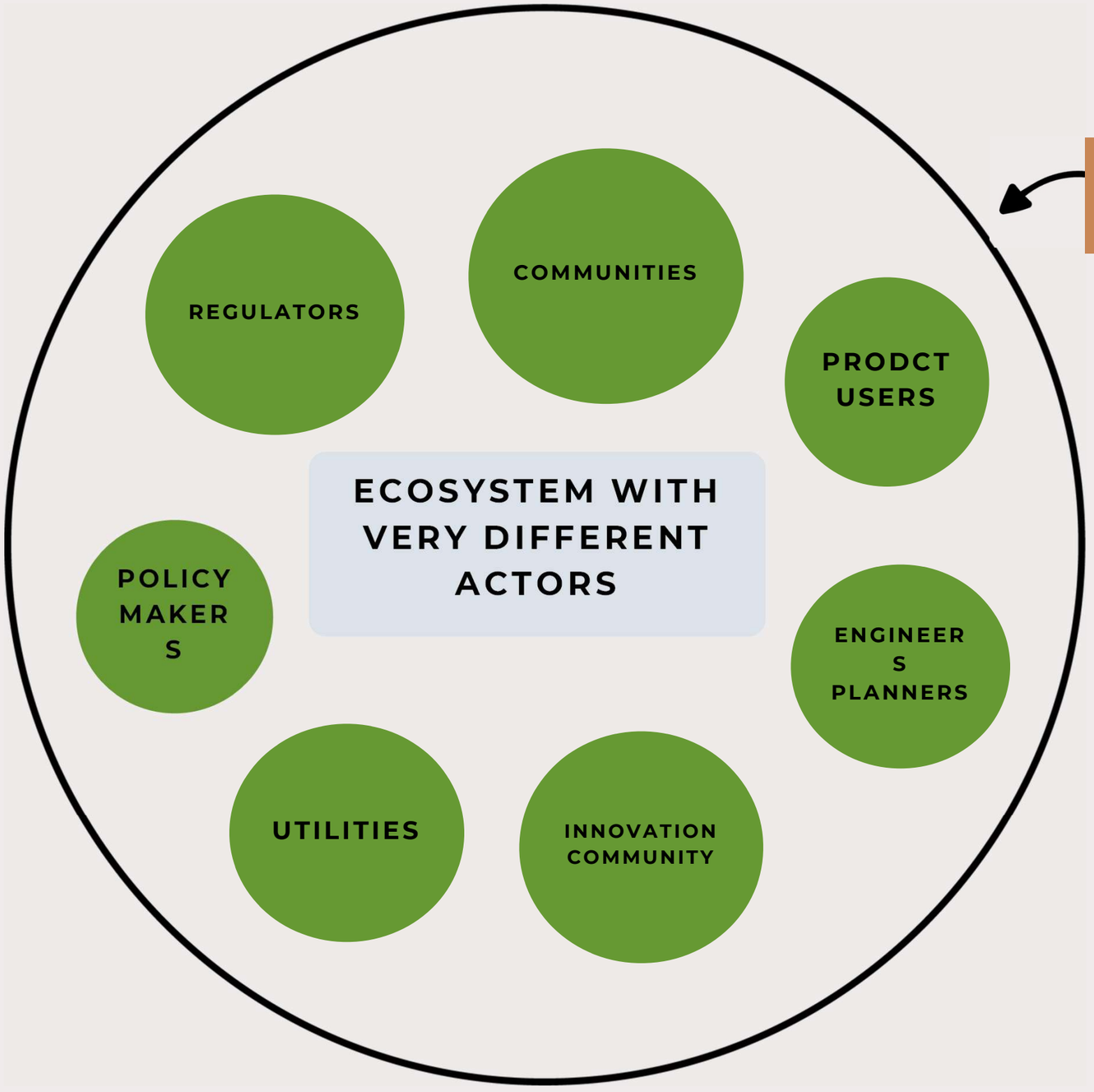
TRUST IN PRODUCTS

...

CLIMATE CHANGE

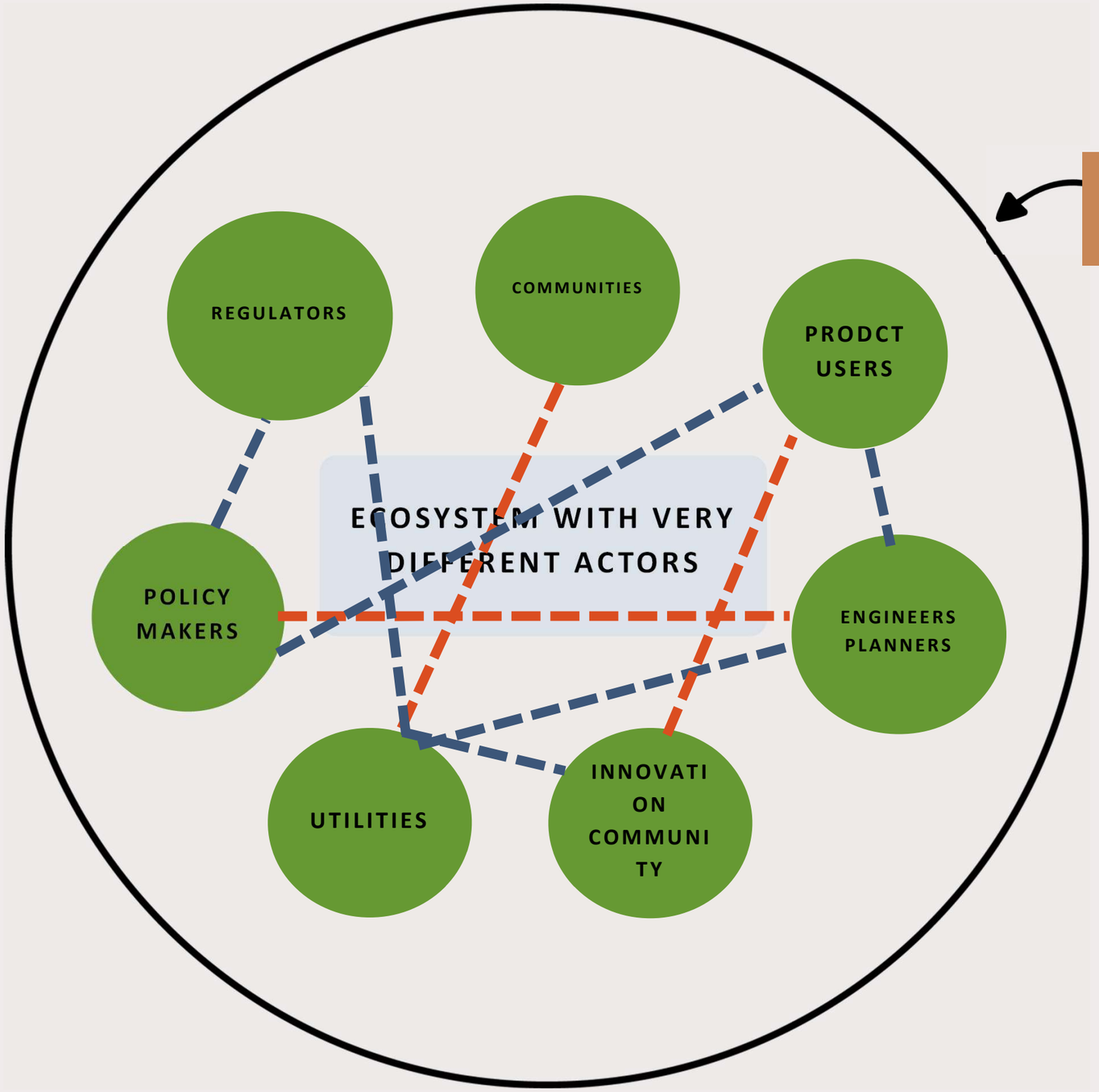
AI

MANY LAYERS OF COMPLEXITY ADDED TO THE ALREADY COMPLEX SANITATION DILEMA

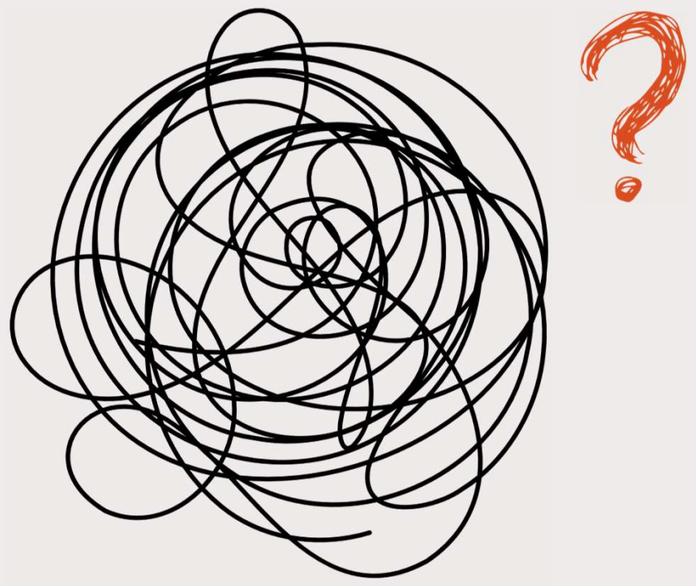


WHICH EXIST WITHIN A LARGER LIMITED ECOSYSTEM

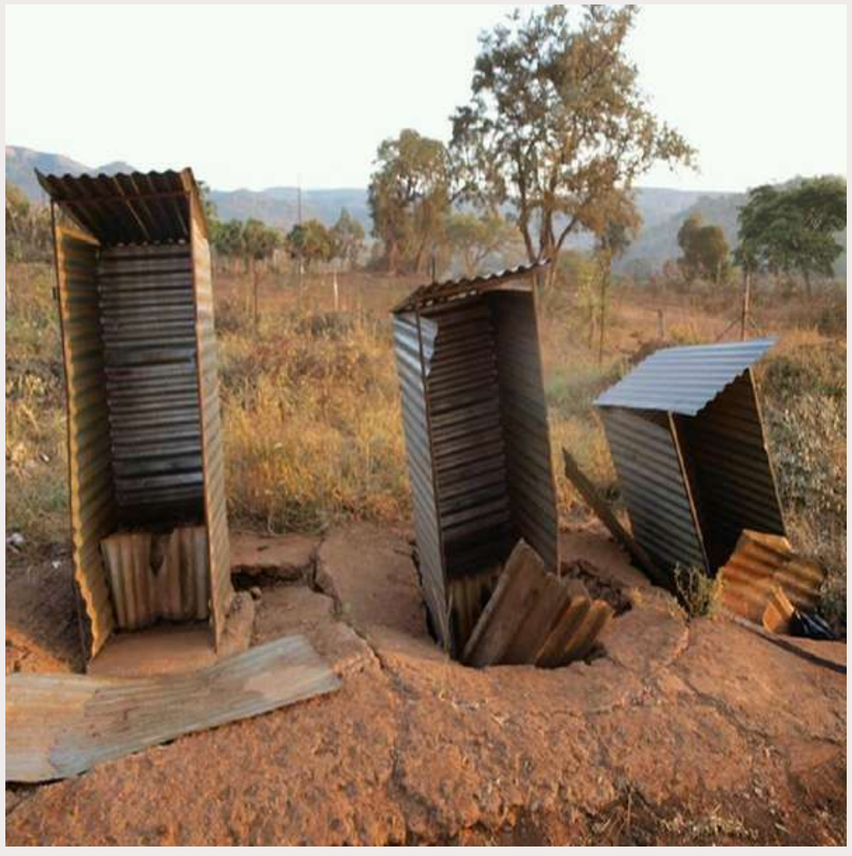
UNDERSTAND THE LOCAL ECOSYSTEM AND SYSTEM DYNAMICS



WHICH EXIST WITHIN A LARGER LIMITED ECOSYSTEM



HOW CAN WE CO-CREATE SANITATION FUTURE(S) WITH AN ECOSYSTEM OF DIVERSE ACTORS?





SOURCE: GUIDE TO SANITATION RESOURCE RECOVERY PRODUCTS & TECHNOLOGIES

FORESIGHT TOOLS AND METHODS

MAKE SENSE OF CHANGE

Horizon scanning

Used to identify important evidence needs and gaps and to integrate longer-term thinking into policymaking.

IMAGINE POSSIBLE FUTURES

Causal layered analysis

Used to explore the layers of change needed to truly transform and achieve the future(s) that we want.

TAKE ACTION

Backcasting

Used to develop pathways to that future (s), starting not from the present but from what we need to achieve.

FORESIGHT IS **NOT** ABOUT PREDICTING THE FUTURE. IT IS ABOUT **EXPLORING DIFFERENT POSSIBLE PATHS FOR FUTURE DEVELOPMENT AND IDENTIFYING THE OPPORTUNITIES AND CHALLENGES THEY MIGHT PRESENT**.

SOURCE: UN FUTURES LAB

COUNTRIES AND SECTORS ALREADY USE FORESIGHT

Foresight approaches for future health shocks: integration into policy making and accompanying research priorities

Futures Thinking and Foresight in the Development of Public Policy on Ageing

Integrating futures thinking and foresight into ageing policy is essential to proactively build equitable, innovative, and age-friendly societies.

Part I of the Government Report on the Future explores alternative paths of development, how they will impact Finland and how to prepare for them

Prime Minister's Office

Foresight and the Futures of India's Tech (and AI) Policy

SHIVRANJANA RATHORE



SO, IF WE LIVE IN A WORLD WHERE THEIR VISIONS THRIVE







WHY CAN WE NOT CO-CREATE A WORLD IN WHICH THEIR VISIONS THRIVE?

PHOTO:FRANCESCA ZANNI



THANK YOU!

FOR MORE INFO:
CARLA.LIERA@OST.CH
DOROTHEE.SPUHLER@OST.CH

Session 3 **Climate resilient WASH & Circular Economy**

Next Presentation:

Lakachew Yihunie Alemneh – Bahir Dar University

36th SUSANA MEETING

Sludge to Bricks

A Circular Economy Pathway for Textile Chemical Sludge through Compressed Stabilized Earth Blocks (CSEB) — the Bahir Dar Textile Share Company Case

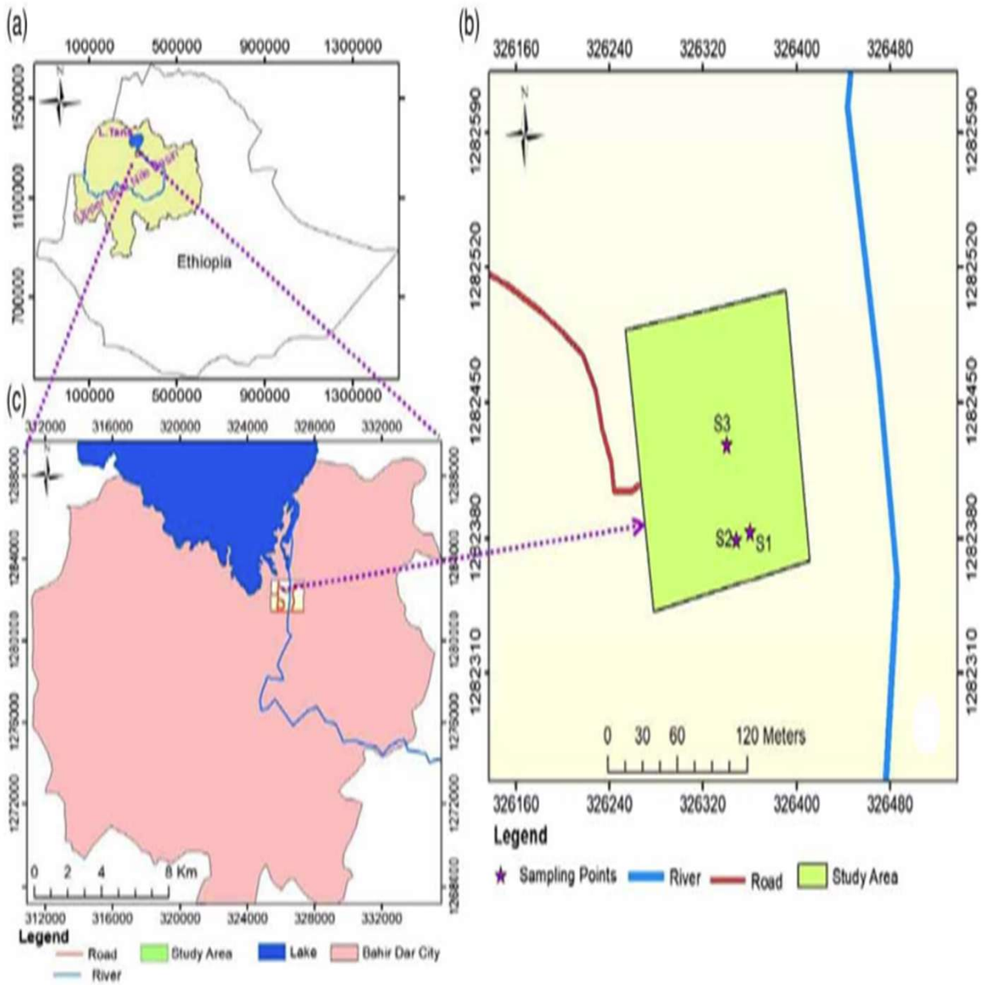
Lakachew Yihunie (Ph.D Candidate)
Bahir Dar Institute of Technology, Bahir Dar University, Ethiopia



Green-brick demonstration site, Bahir Dar

In partnership with NABU • Horticoop Ethiopia • BDU Soil & Water Laboratory

THE CONTEXT:





The Bahir Dar Textile sharing factory:

Location: Bahir Dar, Ethiopia, near the Blue Nile River, ~570 km northwest of Addis Ababa.

→ **Established: 1961 by the Italian Government as war compensation.**

Business: Supplier and manufacturer of 100% cotton textile products.

→ **Integrated mill: Spinning → Weaving → Dyeing/Finishing → Garment production.**

Rehabilitation: Spinning and weaving sections upgraded in 1989.

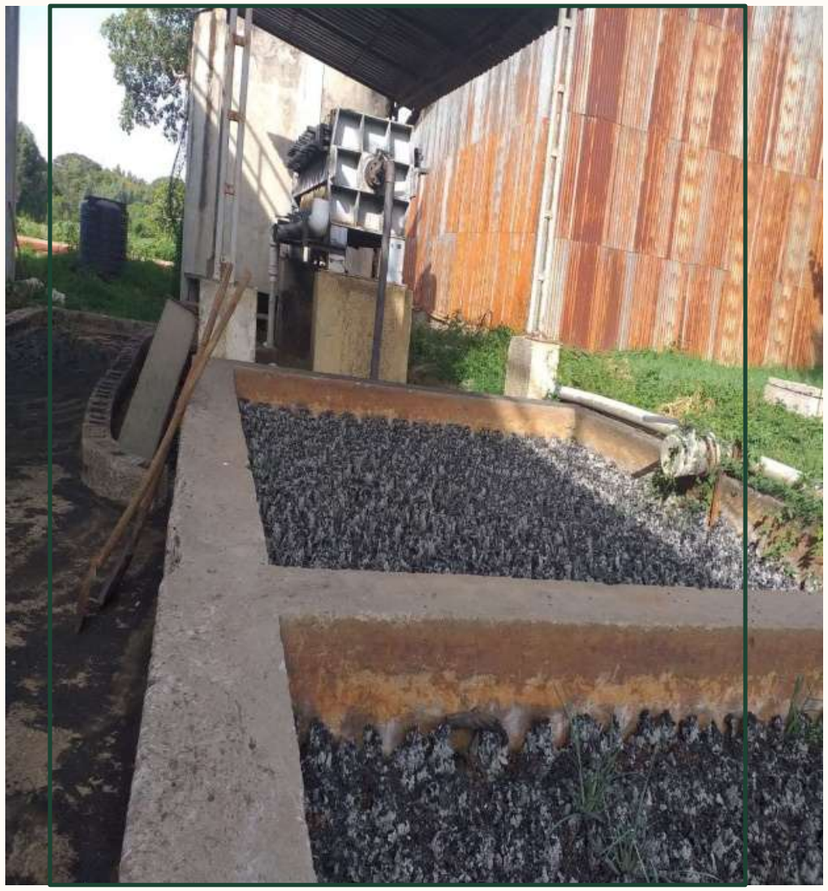
→ **Transformation: Converted from a public enterprise to a share company in 1999, with financial restructuring.**

Main markets: Domestic and international textile markets.

THE CHALLENGE

A Textile Sludge Stream Trapped in a Linear Model

- **Produce → Treat → Dump: 65 years of cotton processing has generated a chemical sludge stream with no engineered end-of-life route.**
- **The wastewater treatment plant processes ~400 m³/day, discharging treated effluent directly into the Blue Nile (Abay) river system.**
- **150–378 kg of dried chemical sludge accumulates daily, stockpiled in open warehouses on-site — a growing liability, not an asset.**
- **Left unmanaged, the sludge poses soil, odour and heavy-metal exposure risks — while representing untapped raw material value for construction.**



Sludge drying beds, Bahir Dar Textile Share Company

METHODOLOGY

Why Construction Materials? The Circular Economy Case for CSEB

Sludge characterization (26 parameters) + Life Cycle Assessment (ISO 14042) screened five candidate reuse routes against safety and environmental standards.

Agriculture & Composting	Excluded	Cd, Hg exceed food-chain-relevant soil limits
Incineration	Excluded	Heavy-metal air emission risk
Energy Recovery	Excluded	Contaminant carry-over into ash/emissions
Construction (CSEB)	Selected	Metals physically bound in the block matrix — no leaching pathway to soil, water or food chain

Only construction reuse fully immobilizes the sludge's cadmium and mercury content — turning a contamination risk into a locked-in, structurally useful material, with no dilution limit tied to food safety.



Raw sludge-clay-red ash blend, drying before mixing

FROM WASTE TO BLOCK

The CSEB Production Process, Step by Step

1



Dry & Source

Dewatered sludge is sun-dried on-site, ready to substitute virgin red-ash soil.

2



Blend & Sieve

Sludge, clay soil, red ash and cement are proportioned, screened and mixed uniformly.

3



Mix & Hydrate

The blend is pan-mixed with water to a uniform, compaction-ready consistency.

4



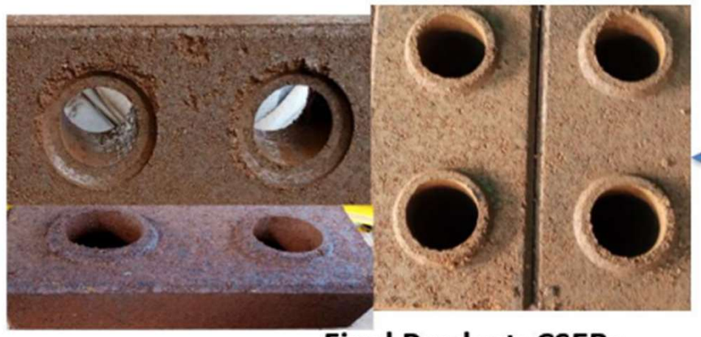
Press, Cure & Test

Blocks are compressed, cured, then verified for strength, absorption and finish.

Converting Textile Sludge into Sustainable Construction Materials



Initial stage:
Dewatered sludge from a textile wastewater plant is collected and characterized for eco-friendly construction blocks



Final Product: CSEBs
Engineered for durability, strength, and superior density offering sustainable solutions for eco-friendly housing and clean energy.



Processing stage:
Sludge is blended with cement and redash in a mixer, then shaped into blocks using a press

1 WASTE GENERATION
Textile wastewater sludge
→ Dewatered and characterized

2. RESOURCE RECOVERY
Sludge + Cement + Red Ash
→ Blended and compressed into blocks

3. VALUE CREATION
Eco-friendly CSEBs
→ Durable construction material

Waste → Resource → Product → Value

Closing the loop by converting textile sludge into value-added construction materials.

PERFORMANCE:

Sludge-Blended Blocks Meet Construction Standards

- **Sludge substitutes red-ash soil (up to 25%) alongside clay and cement in earth-block production, tested to BS EN 772-1:2000.**

Mix	Sludge share	28-day strength	Quality class
Control	0%	10 MPa	Class B
S10	10%	6 MPa	Class B
S15	15%	5 MPa	Class C
S20	20%	3 MPa	Class C



Compressive strength testing, ADSWE materials lab

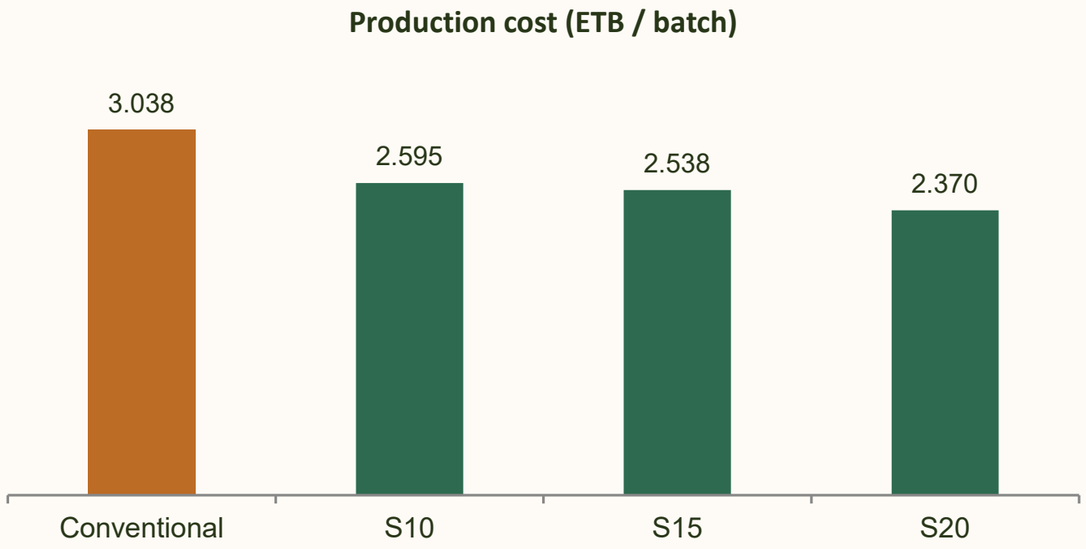
Circular economy takeaway

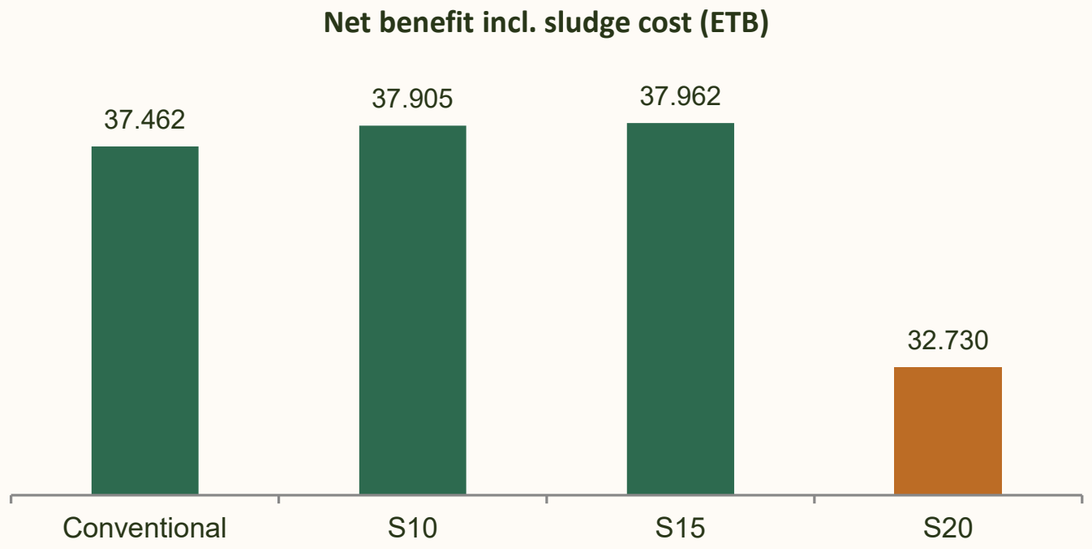
S10 (10% sludge) meets Class B structural standard and passes all seven visual-quality checks — **a genuine drop-in substitute for virgin red-ash soil,** with S15/S20 still usable at Class C for lower-load applications.

THE BUSINESS CASE

Circularity Pays: The Economics of Sludge-Blended Blocks

Partial budget analysis, CSEB production, including sludge transport cost (20 km radius).





S10 and S15 mixes cut input costs by up to 17% while matching or slightly beating conventional blocks on net benefit — turning a waste disposal cost into a cheaper, resource-efficient input stream. S20 shows the limit: too much sludge erodes structural quality and profitability.

CONCLUSIONS

From Sanitation Burden to Construction Resource

A verified circular pathway

CSEB safely diverts textile chemical sludge from open stockpiling into durable building material — a genuine closed loop, not a disposal workaround.

Safety by design

Heavy metals are physically locked into the compacted block matrix, removing the leaching pathway that rules out food-chain reuse routes.

Economically self-sustaining

10–15% sludge substitution lowers input costs by up to 17% without sacrificing Class B structural quality — no subsidy required.

A replicable model for SUSANA

A transferable protocol for textile- and industrial-sanitation hubs elsewhere to convert sludge liabilities into local construction material.

Thank you

— Lakachew Yihunie, Bahir Dar Institute of Technology, BDU • lakachew.yihunie@bdu.edu.et

Session 3 **Climate resilient WASH & Circular Economy**

Next Presentation:

Abishek Narayan – EAWAG



Eawag
Swiss Federal Institute of Aquatic Science and Technology

Decentralized Reuse for Circularity & Resilience:

Learnings from Bangalore & Beyond

Abishek S Narayan

Eawag-Sandec

SuSanA Meeting Nr 36
Stockholm, 2026

Defining Decentralisation

Sanitation system that collects and treats wastewater at or near its point of generation, using a sewerage network and a small-scale sewage treatment plant.

Scale:

- 10-1,000 households
- 50-5,000 person equivalents
- 5-700 KLD [=m3 /day] of wastewater

Based on the 4S Report



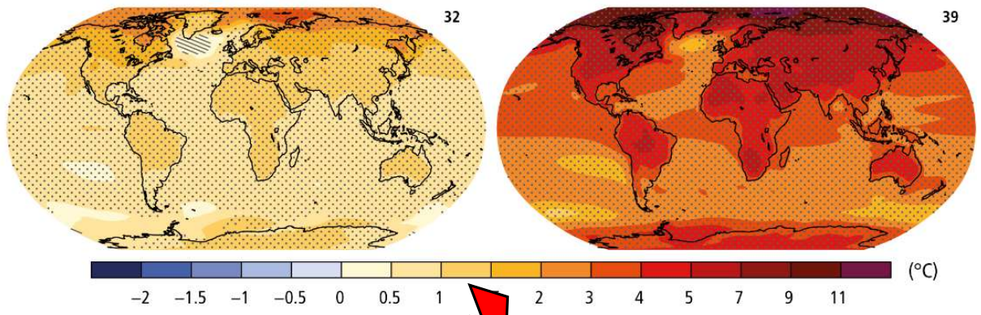
Lüthi and Narayan, 2019

Today’s urban water & sanitation system

rapid urbanization

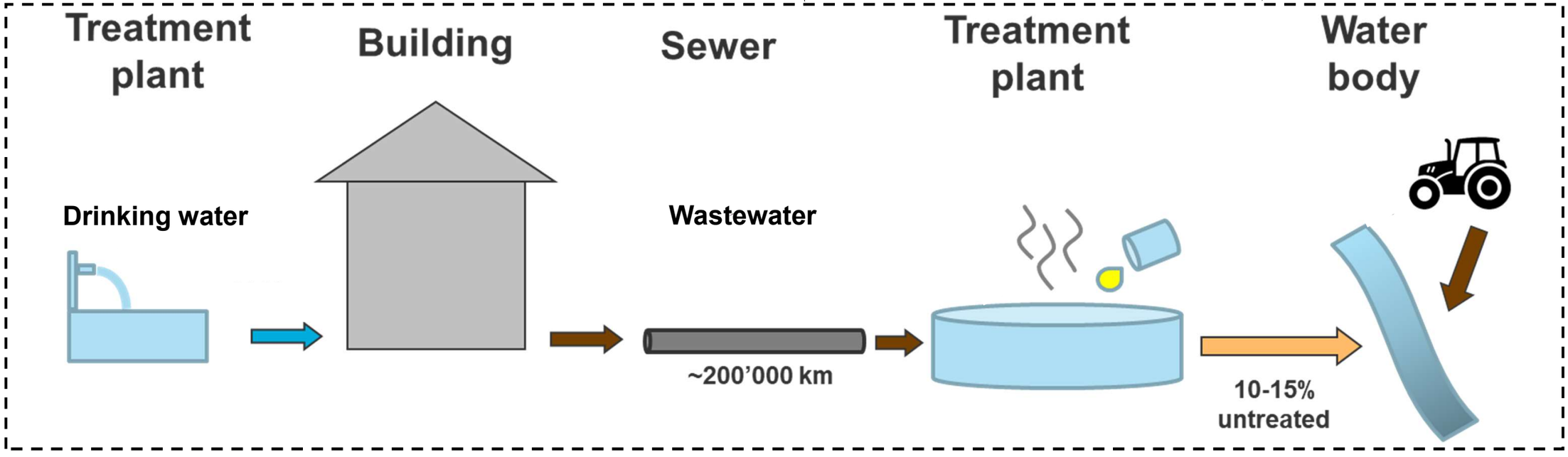


climate change



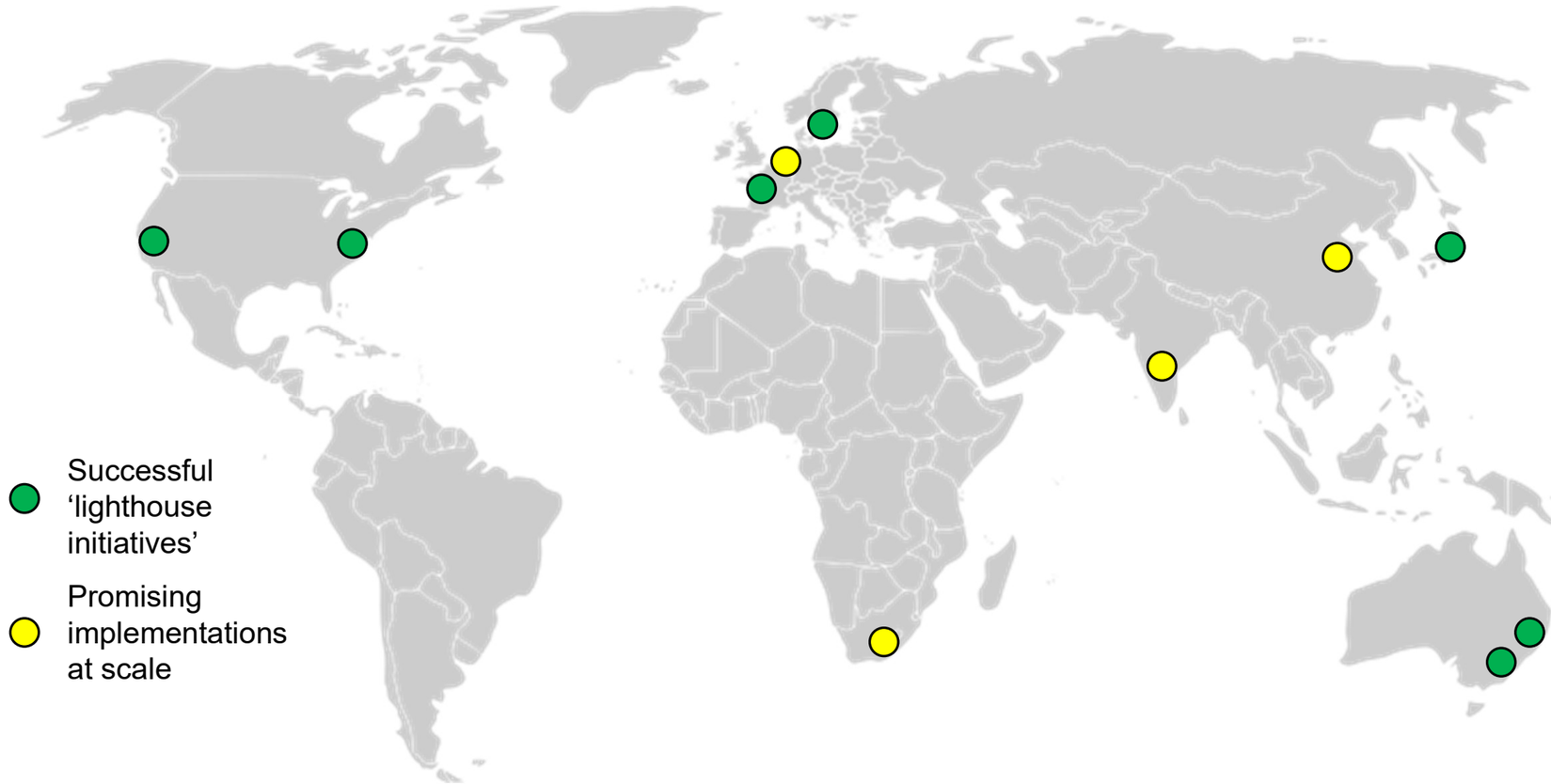
SDGs





Binz et al., 2024

Lighthouses of Decentralisation

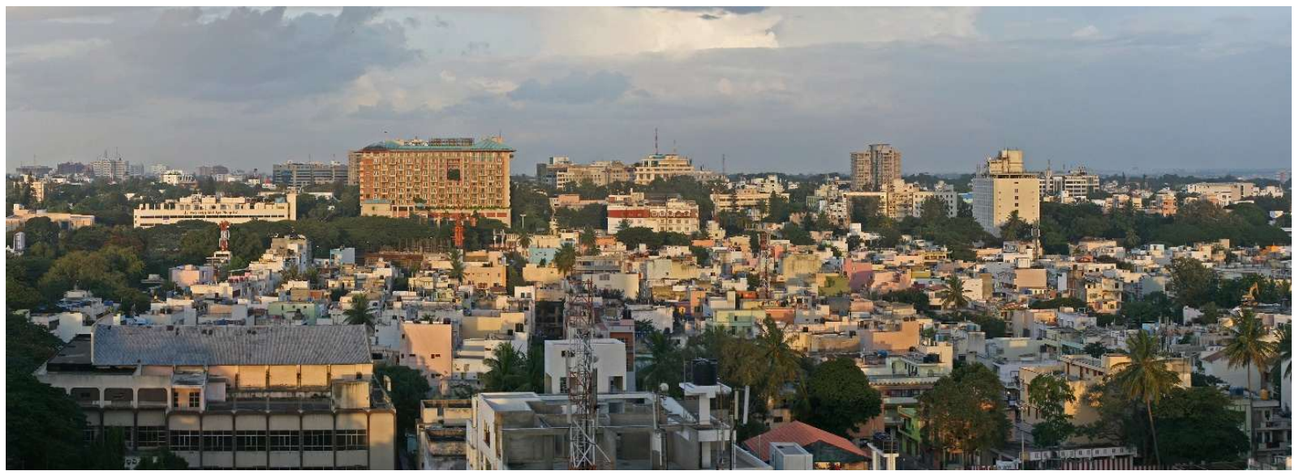


Binz et al., 2024

Introduction to Bangalore

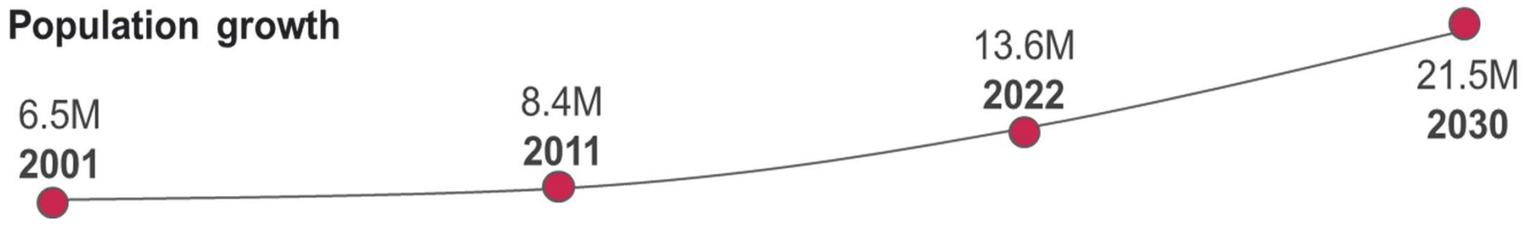
- Fastest growing megacity globally
- Tech hub of India
- 13 million inhabitants
- 60% safely managed sanitation
- 20% wastewater treated decentrally
- 3000 D-STPs





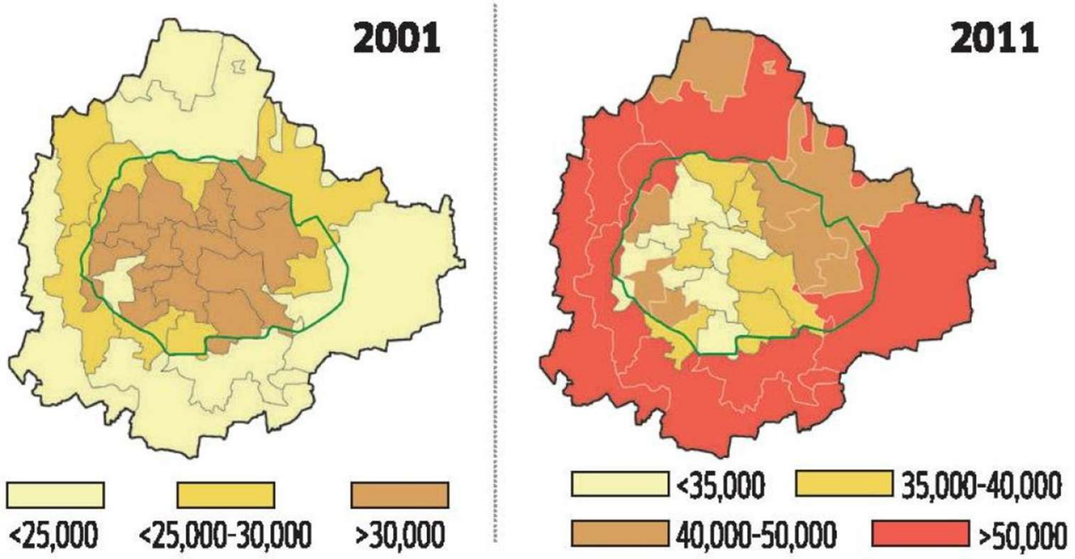
Narayan et al., 2020

Urban Pressures → Paradigm Shifts

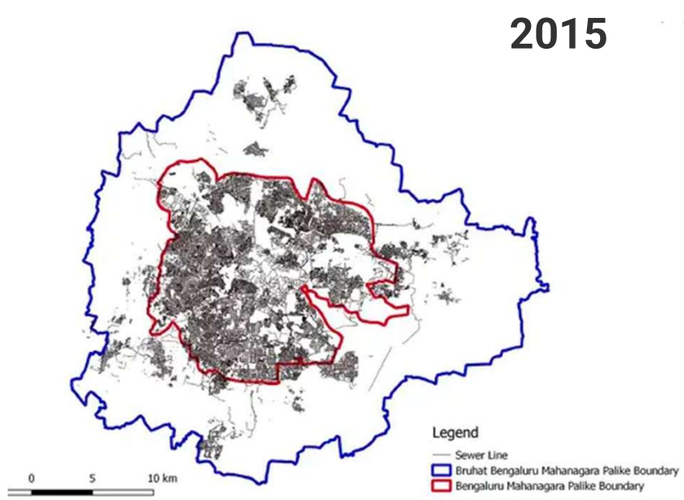




Bengaluru's population distribution *(inhabitants / assembly)*



Sewerage network





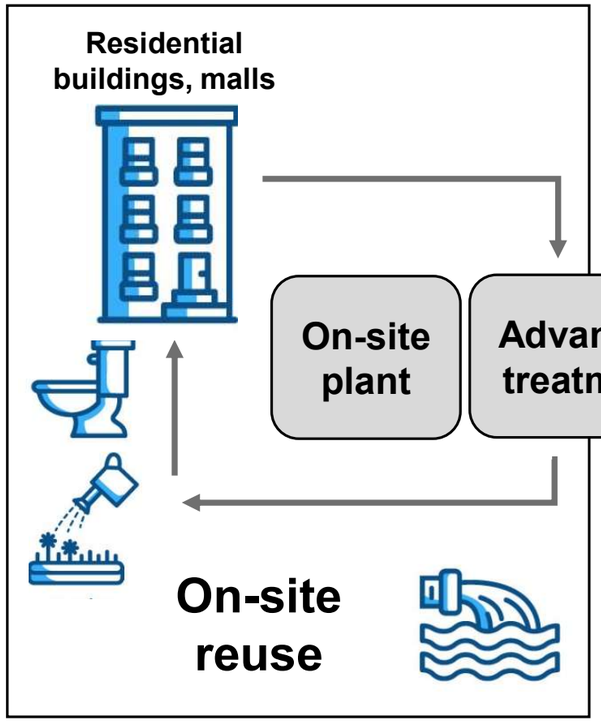
WELL Labs 2024

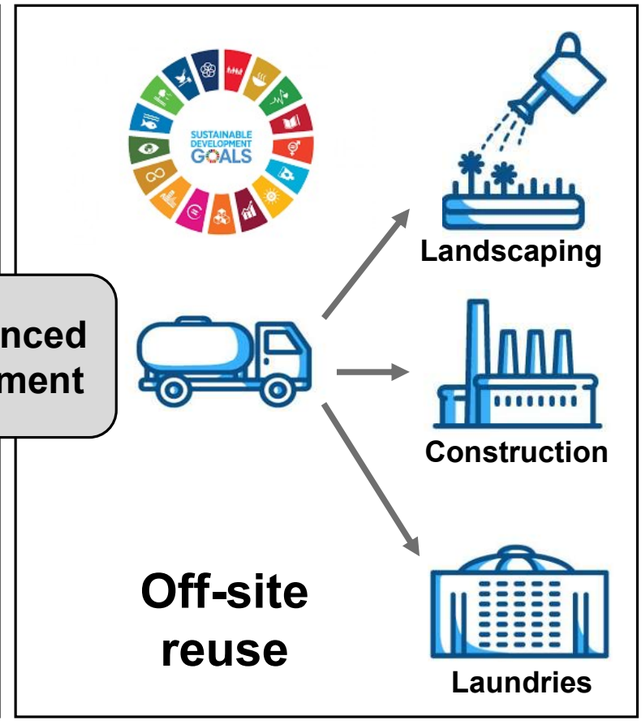
Bengaluru as globally unique lab for on-site water reuse

> 3’000 on-site wastewater treatment systems installed - and counting

Yet, only about 20% work well, many do not reach the water quality for save reuse





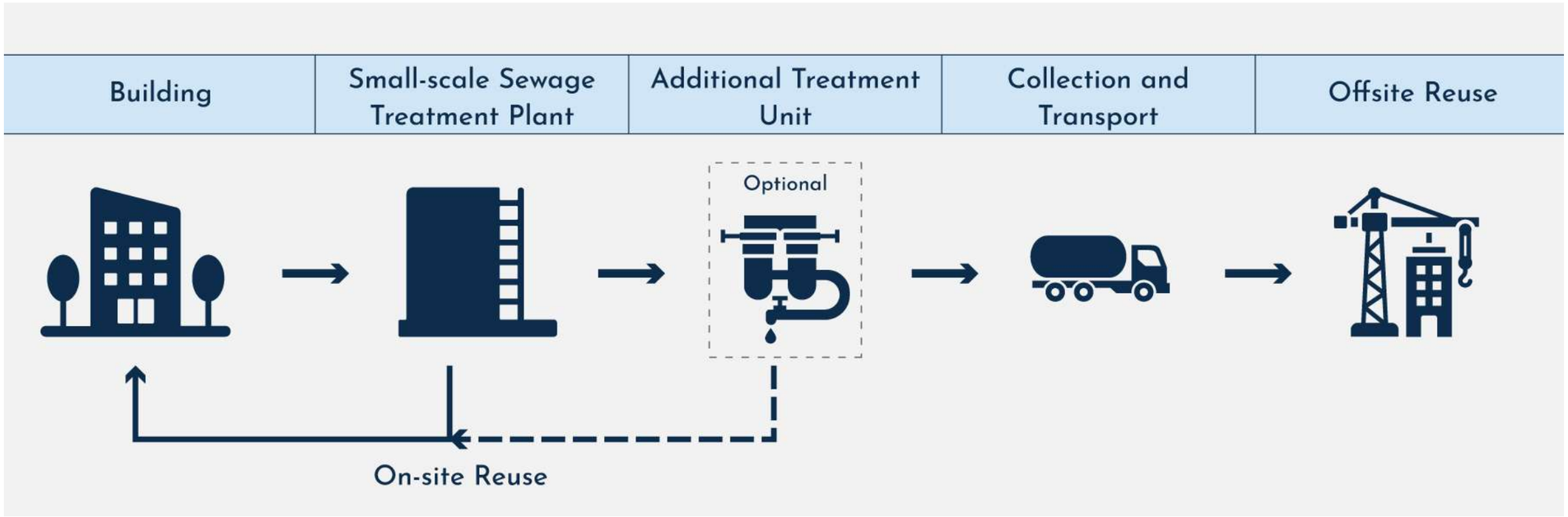




→ Integrated research on how to develop innovative on-site water reuse solutions that scale

Water Reuse Lab Project

Reuse Value Chain



van den Brandeler et al., 2024; Narayan et al., 2026

Evolution of Policies

- Promotion of DWTRS begain in 2006, with an EIA notification. Responsibility shifted from public to private for the 1st time.
- National policies are the first movers – often progressive and ambitious.
- State policies and city policies follow with an aprx. 2-3 year time lag.
- State polices are more stringent in terms of treatment, but refer to national standards.
- Lack of policies on transport and reuse.

Narayan et al., 2026



1974
CPCB Water (Prevention and Control of Pollution) Act Sets wastewater discharge standards for India

2006
MoEFCC EIA Notification Amendment
In unsewered areas, DSTPs to be installed for all buildings above 5000 sqm with on site reuse promoted

2012
MoJS, National Water Policy
Aimed at reducing water pollution & promotes DSTPs, recycling & reuse of treated water via tariff systems and subsidies for industries

2013
CPHEEO, Manual on Sewerage and Sewage Treatment Systems
Set reuse standards for non potable end uses; incentives for industrial water reuse

2014
Complaints about lake pollution from residents in Bengaluru resulting in **KSPCB notice of Directions under section 24/25 of Water Act, 1974** Prohibits discharge into water bodies & mandates monitoring

2015
Directions issued from CPCB to KSPCB in the matter of contamination of Bellandur and Varthur lake under under section 18 (1)(b) of Water (Prevention and Control of Pollution) Act, 1974
- BBMP and BWSSB to ensure stoppage of discharge of untreated sewage into water bodies and set up sewerage networks and STPs to cover the lake catchments and KSPCB to mandate reuse of the wastewater to prevent pollution
- KSPCB to direct all apartments with more than 50 units to treat in decentralized STPs

2016
FEE Secretariat Notification
Apartments > 20 units, residential/ commercial building of 2000 sq.m., educational institutes >5000 sq.m. must install STPs & ensure reuse

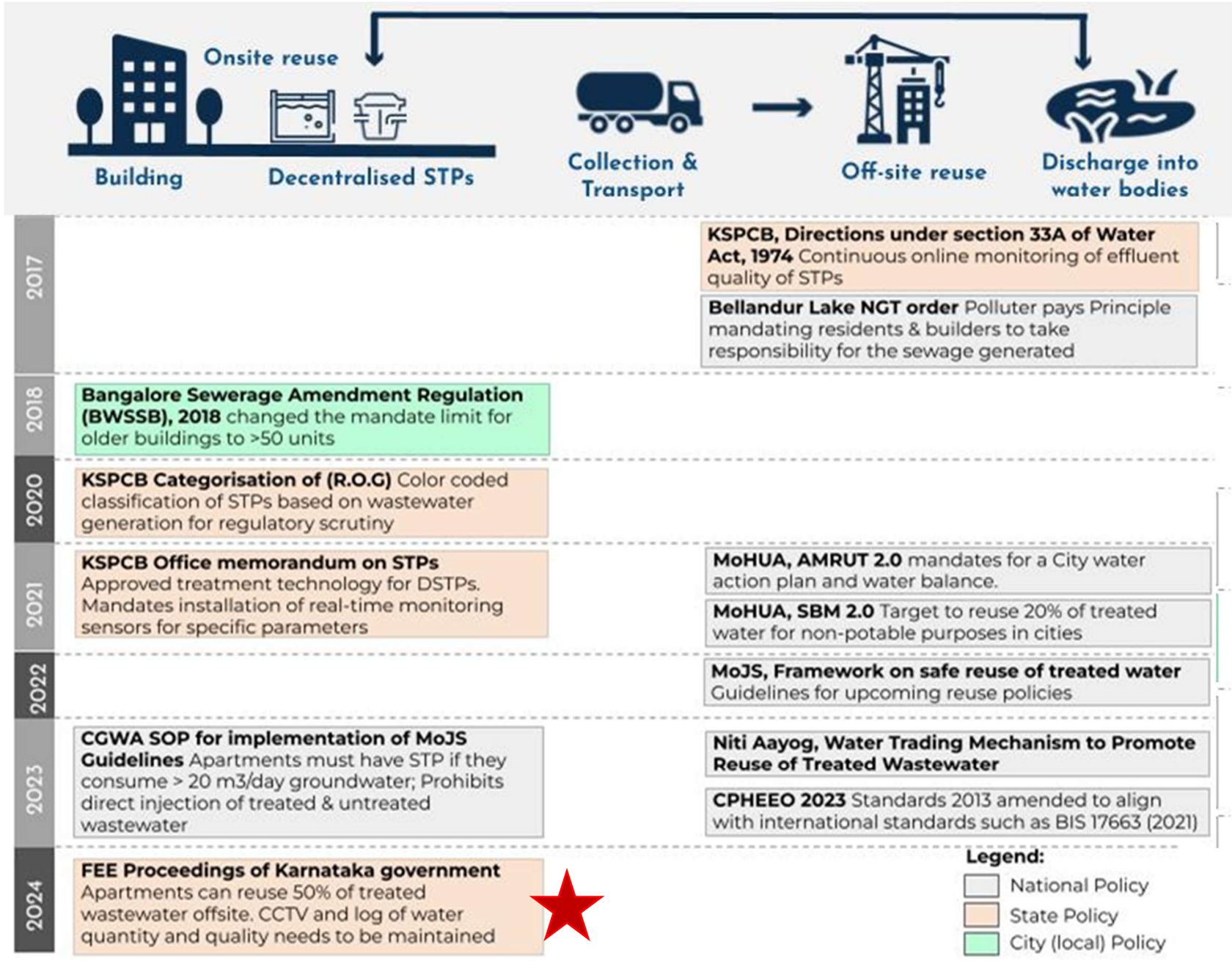
Bangalore Sewerage Amendment Regulation (BWSSB), 2015 All apartments > 20 units must install decentralised STPs & dual plumbing

MoP, National Tariff Policy
requires thermal power plants located within 50 km radius of a sewage treatment plant (STP) of a ULB to mandatorily use TUW

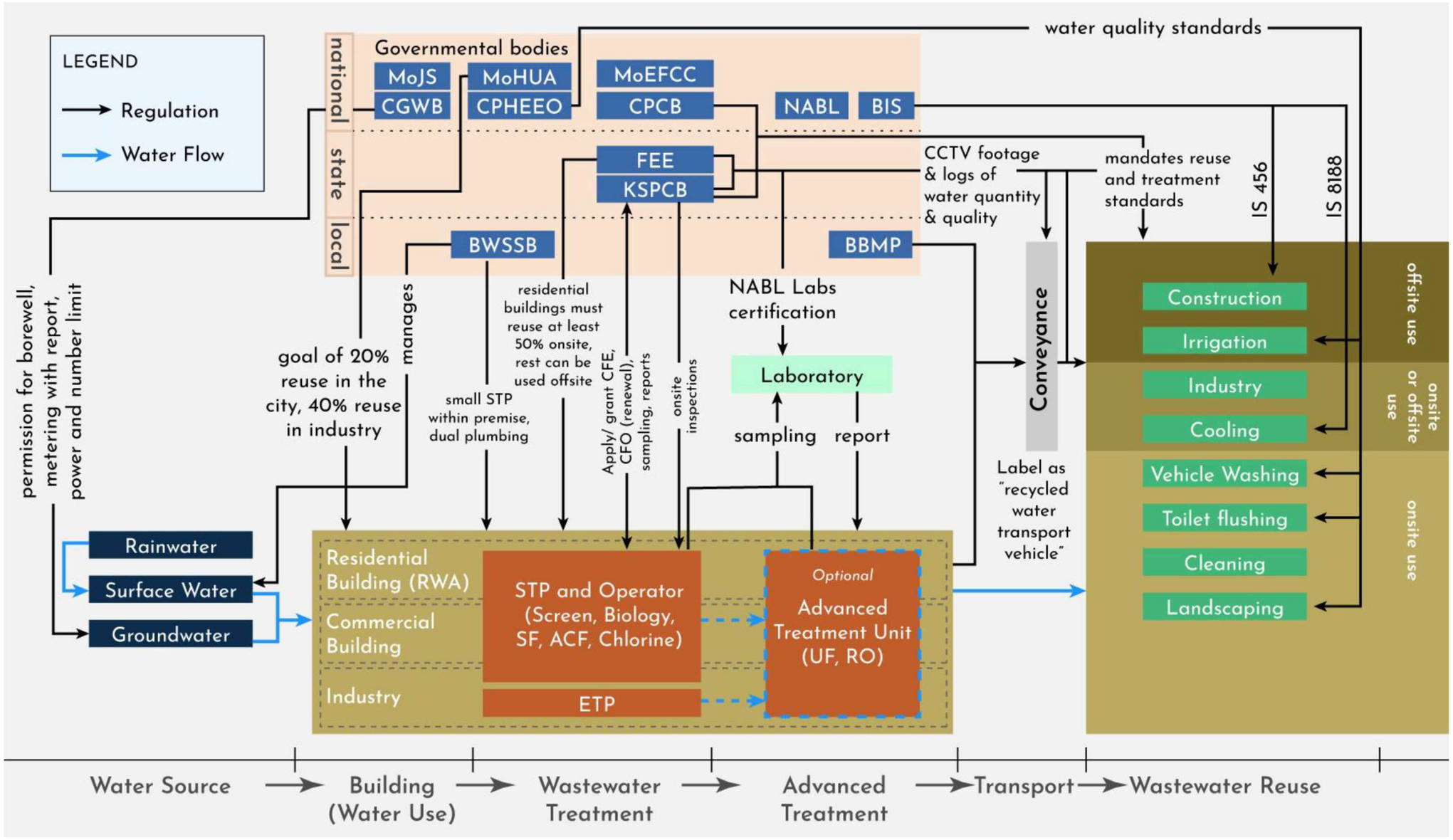
Evolution of Policies

- State polices are more stringent in terms of treatment, but refer to national standards.
- Visible environmental pollution events and water scarcity events prompted policy action.
- City level policies pressed unrealistic criteria that led to citizen activism led to policy change.
- NGT (environment court) played a crucial role in pushing more stringent requirements that led to policy change.

Narayan et al., 2026



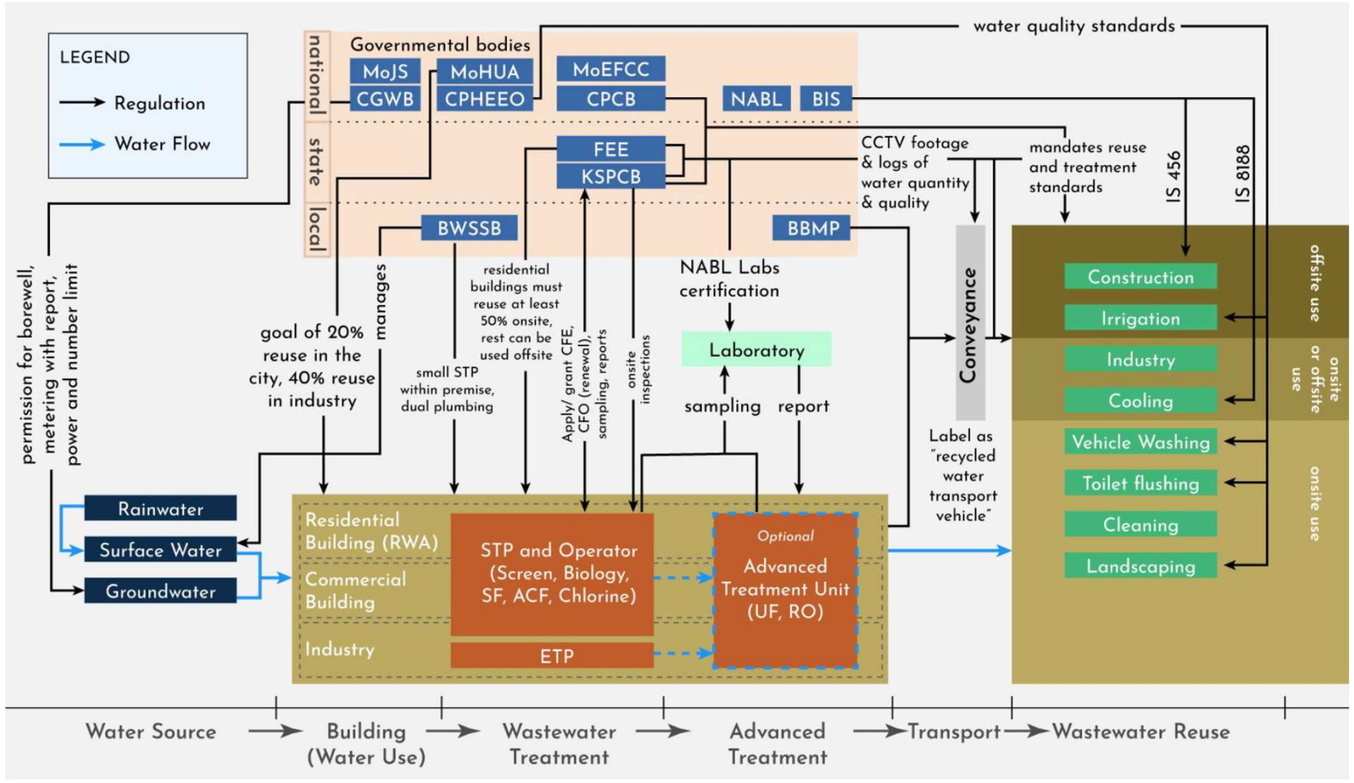
Governance landscape in Bangalore for Decentralised reuse



Narayan et al., 2026

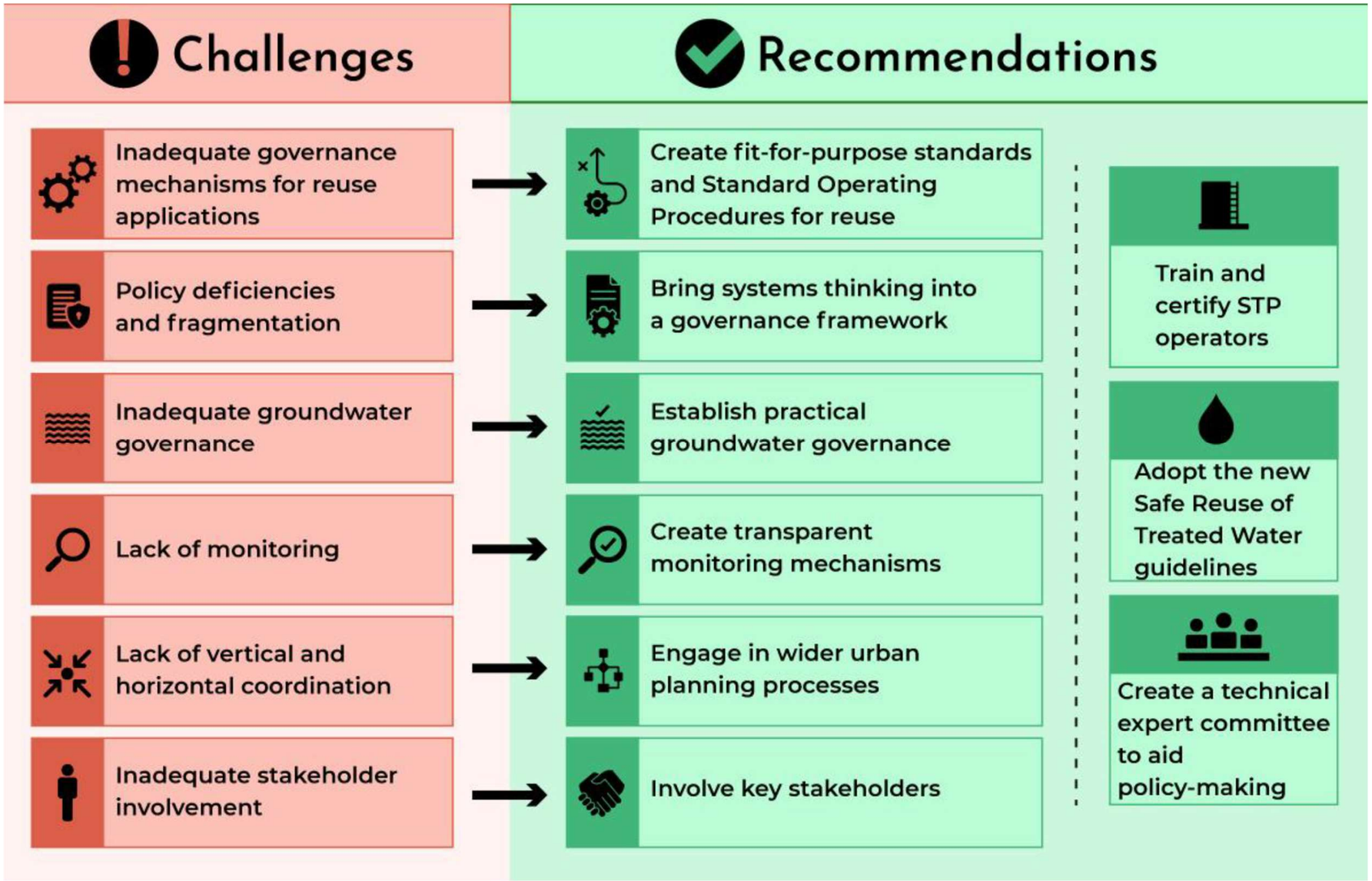
Governance landscape in Bangalore for Decentralised Reuse

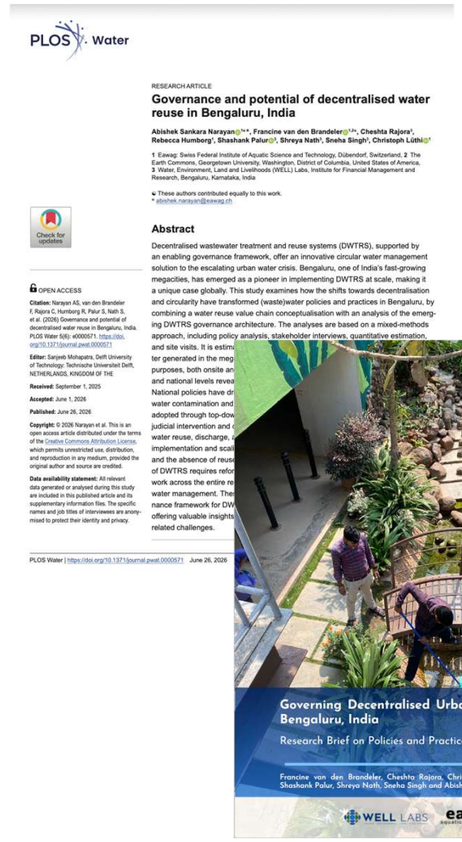
- A diverse set of governmental agencies at the city, state and national level are involved.
- Actor roles:
  - National bodies set policy visions and standards.
  - State bodies establish operational mandates and regulations.
  - City-level authorities implement regulations.
- Gap between policy and Practice:
  - Almost 80% of 22 STPs inspected did not reuse water as mandated (then 100% non potable reuse) and did not employ skilled personnel.
  - 70% discharged into stormwater / sewers.
  - 60% had unlicensed borewell for groundwater.



Narayan et al., 2026

Challenges and Reccomendations




PLOS Water

RESEARCH ARTICLE

Governance and potential of decentralised water reuse in Bengaluru, India

Abstract

Governing Decentralised Urban Water Reuse in Bengaluru, India

Research Brief on Policies and Practices

Francine van den Brandeler, Cheshta Rajora, Christoph Lüthi, Rebecca Humborg, Shashank Palur, Shreya Nath, Sneha Singh and Abishek S. Narayan.

WELL LABS eawag

Narayan et al., 2026
van den Brandeler et al., 2024

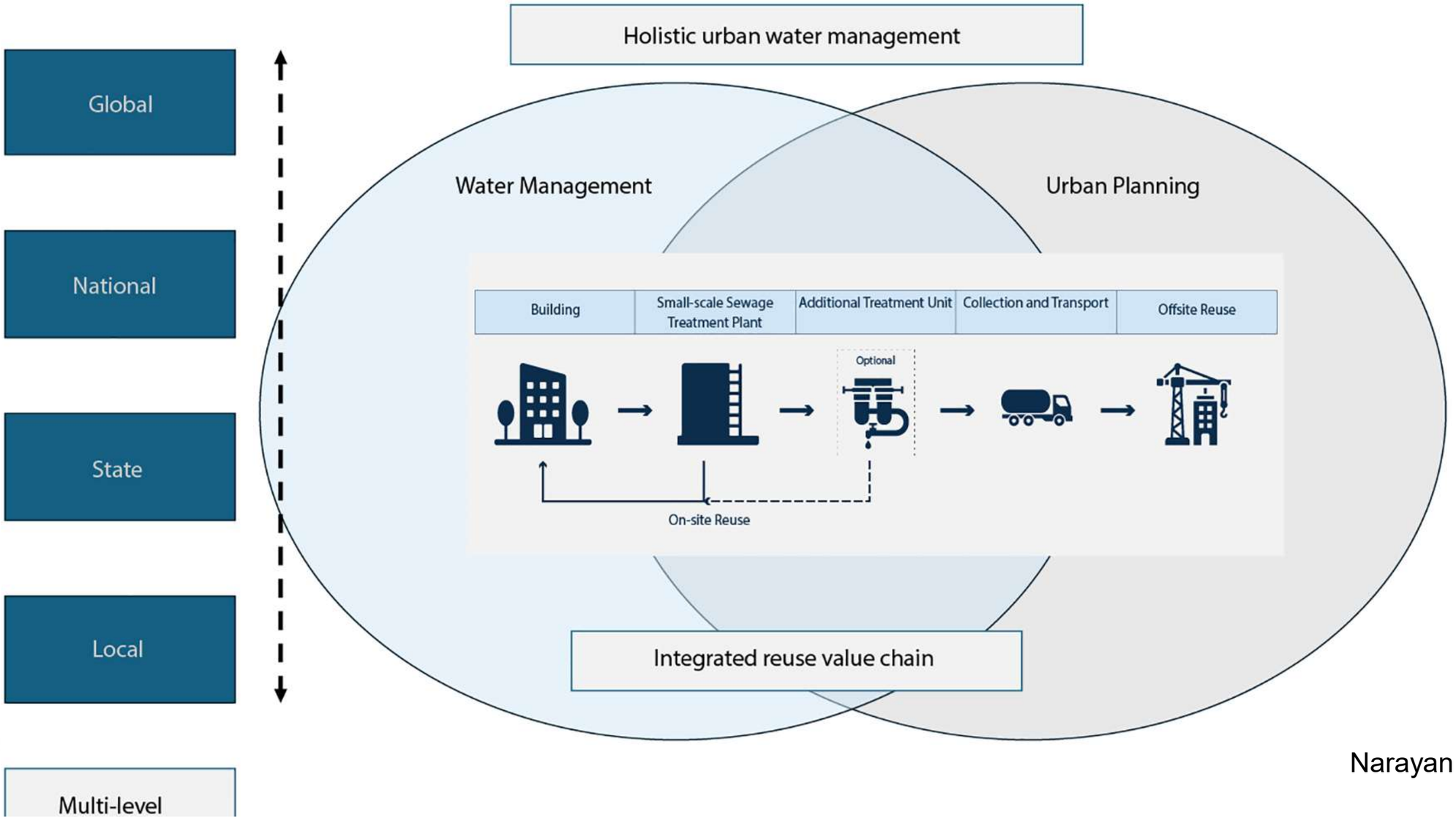
Challenges and Reccomendations

1. Lack of **Fit for Purpose Standards** + Standard Operating Procedures
2. Incoherent and incomplete **governance arrangements** – policies across the reuse value chain
3. **Disconnect** with the wider **urban development** efforts in the city

1. Create measurable Fit for Purpose Standards + practical Standard Operating Procedures for the prominent reuse cases. Align with the new national reuse guidelines.
2. Create holistic reuse policies and institutional coordination for governing reuse across the concerned departments at city and state levels.
3. Co-create urban reuse visions and integrate water reuse into urban planning processes with citizen participation.

Narayan et al., 2026

Where does reuse fit in urban water governance?



Narayan et al., 2026

Reuse Opportunities for Treated Water



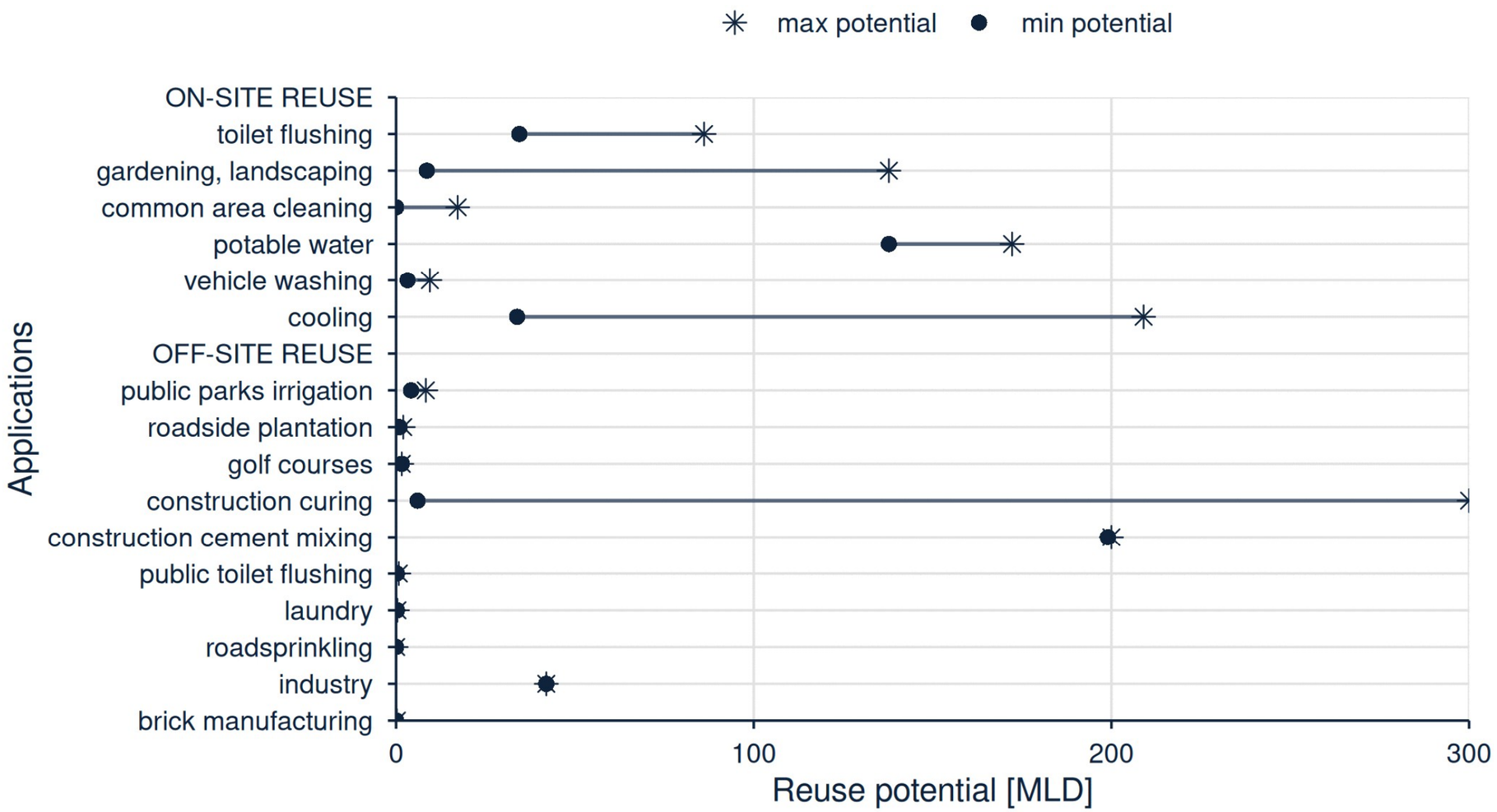






WELL Labs 2025

Estimated Potential for Onsite and Offsite Reuse

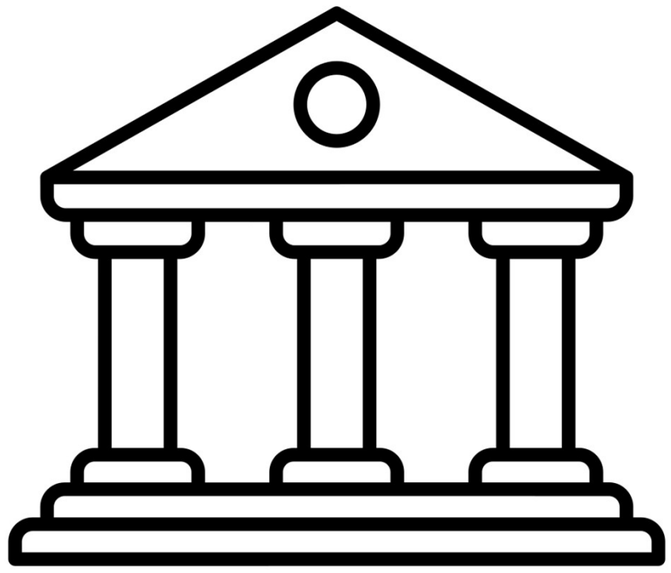


- Our calculations suggest, as of 2024:
  - installed capacity – 615 MLD
  - currently treating water – 250 MLD
  - current reuse - 47 MLD
  - potential reuse – 500 MLD
  - including centralized 1187 MLD

Overall, approx. 50% of the groundwater usage could be offset with treated water.

Narayan et al., 2026

eawag
aquatic research



Story of Policy Change

Policy Change 2024

- Policy of Bangalore and Karnataka on Water Reuse has officially been amended to include off-site water reuse.

- Several actors including WELL Labs, Bangalore Apartment Federation etc.

- New policy highlights:
  - Treated Wastewater can be sold (creation of wastewater market)
  - Reuse purposes can be construction, industrial, horticulture, mining etc.



Proceedings of Karnataka Govt

Content: 2024-25 Budget Speech 391 states that 'Treated waste water in private residential complexes will be encouraged Declaration by the as per pollution to be Board control norms. About made on recycling implementation.

Read: 1. Government Order No:Apajee 188 ENV 2003, 2.14.08.2003.
2. Proceedings of the meeting held by the Hon'ble Minister of Forest Ecology and Heritage dated: 06.03.2024,

Proposal:

In order (1) read above, in exercise of the power conferred on the State Government under Rule 5 of the Environment (Conservation) Act, 1986, for horticulture works, washing, servicing and cleaning of vehicles, including other intended uses of potable water such as gardens, resorts and golf courses, private in Bangalore city. All civil works activities of Developer, Government of Karnataka and Central Government like multi-storied building, commercial complex residential complex. To the Commissioner, Bangalore Municipal Corporation, Director, Horticulture Department, Chairman, Karnataka State Pollution Control Board, Secretary to Government, Public Works Department and Principal Secretary to Government, Transport Department to take all necessary steps to ensure that only purified water is used for the third stage of road and bridge construction works in Bangalore city. An order has been issued banning the use of potable water for other activities in Bangalore city.

In the meeting proceedings of (2) read above, the Hon'ble Minister of Forestry, Ecology and Heritage, in order to avoid the water crisis that may occur in the coming days, the Hon'ble Chief Minister in his budget speech for the year 2024-25- 391 'reuse treated waste water in private residential complexes as per the norms laid down by the Pollution Control Board. Informing that they will be encouraged to do this, necessary steps

substituted and read as follows:

Table - 2

Activities that need to install Sewerage Treatment Plants (STP) compulsorily and ensure reuse of treated water		
Sl. No.	**In sewered area where sewer line & STP of local bodies existing**	**In unsewered area where sewer line & STP of local bodies not existing**
1.	All the residential Group Housing Projects / Apartments with 120 Units and above or generating sewage of 80 KLD and above shall install STP	All the residential Group Housing Projects / Apartments with 20 Units and above or having a total built up area of 2,000 square meter including basement shall install STP
2.	Commercial constructions Projects (Commercials Complexes, office, IT rclated activities etc) with total built up area of 5,000 Square meter and above or generating sewage of 35 KLD or above shall install STP.	Commercial constructions Projects (Commercials Complexes, office, IT rclated activities etc) with total built up area of 2,000 Square meter and above shall install STP.
3.	Educational Institutions with or without Hostel facility having total built up area of 5,000 Square meter and above or generating sewage of 35 KLD or above shall install STP.	Educational Institutions with or without Hostel facility having total built up area of 5,000 Square meter and above shall install STP.
4.	Townships and Area Development Projects with an area of 10 acres and above shall install STP.	Townships and Area Development Projects with an area of 10 acres and above shall install STP.

NOTE:- Residential / Commercial Complexes / Educational Institutions / Townships / Area Development Projects which have already installed Sewage Treatment Plant Units prior to this Government Notification may continue to operate / Manage the Sewage Treatment Plant Units as per the Parameters Prescribed by Karnataka State Pollution Control Board and shall reuse / recycle or may discharge the sewage into the drainage system after obtaining the prior permission from the Bangalore Water Supply and Sewage Board and with intimation to the Karnataka state pollution control Board in writing.

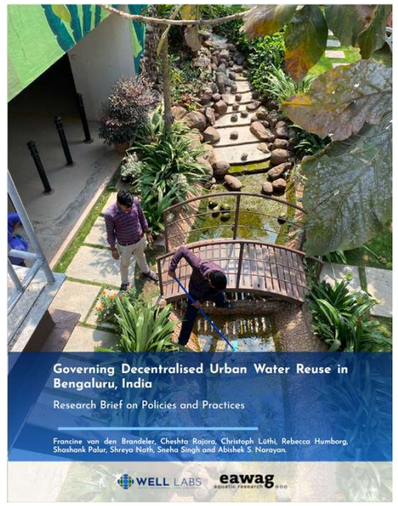
Rest of the contents in the aforesaid Government Notifications remain unaltered.

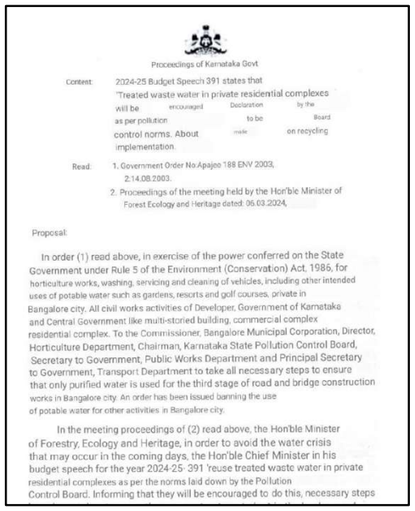
By order and in the name of the Governor of Karnataka,

(B.N.Praveen)
Under Secretary to Government,
(Ecology and Environment)
Forest, Ecology and Environment Department

To:
1. Additional Chief Secretaries / Principal Secretaries/ Secretaries to Government of Karnataka
2. The Chairman, Bangalore Water Supply and Sewerage Board (BWS&SB), Cauvery Bhavan, Bangalore – 560009.

Research to Policy




Proceedings of Karnataka Govt

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What led to policy change?

Opportunistic Timing:
Drought conditions in January to March 2024 and the upcoming election season at the national level.

Trust & Engagement:
Project members esp. from WELL labs constantly engaged with the regulators and built trust over time.

Strong partnership with key local actors:
Eawag's partnership with ext. stakeholders such as the Bangalore Apartment Federation was mutually beneficial.

Exchanges with Government officials:
Several data backed conversations with relevant government officers on these topics including at workshops.

Research translated into policy briefs:
Research from WRL, especially on the governance landscape and the policy gaps was available at timely manner.



For more information:

www.eawag.ch/waterreuselab

Session 3 **Climate resilient WASH & Circular Economy**

Next Presentation:

Celine Clemence Magneche Nde Sika – Affamir

INTERNATIONAL WEBINAR

Beyond the Binary

Integrating Reusable Menstrual Solutions into Climate-Resilient WASH Systems



Dr. Céline Magnéché Ndé Sika
Founder & Executive Director
AFFAMIR — Cameroon

THE PROBLEM

Climate Change is Driving Menstrual Poverty

Climate change Rising heat, extreme weather

Floods & drought More frequent, more severe

WASH systems collapse Water, sanitation, waste fail

Menstrual poverty No products, water or privacy

Girls miss school Up to a week every month

Greater gender inequality Lost education & income

The first systems climate change destroys

Water
Sources dry up or flood; safe water becomes scarce and costly

Sanitation
Latrines and washrooms are damaged first — privacy disappears

Waste management
Collection stops; disposable waste blocks drains and worsens floods

THE BLIND SPOT

The Hidden Environmental Cost of Disposable Pads

THE JOURNEY OF ONE DISPOSABLE PAD

Plastic-layered pad

Global transport

Poorly managed waste

Drains & rivers

Ocean pollution

Disposable pads depend on...

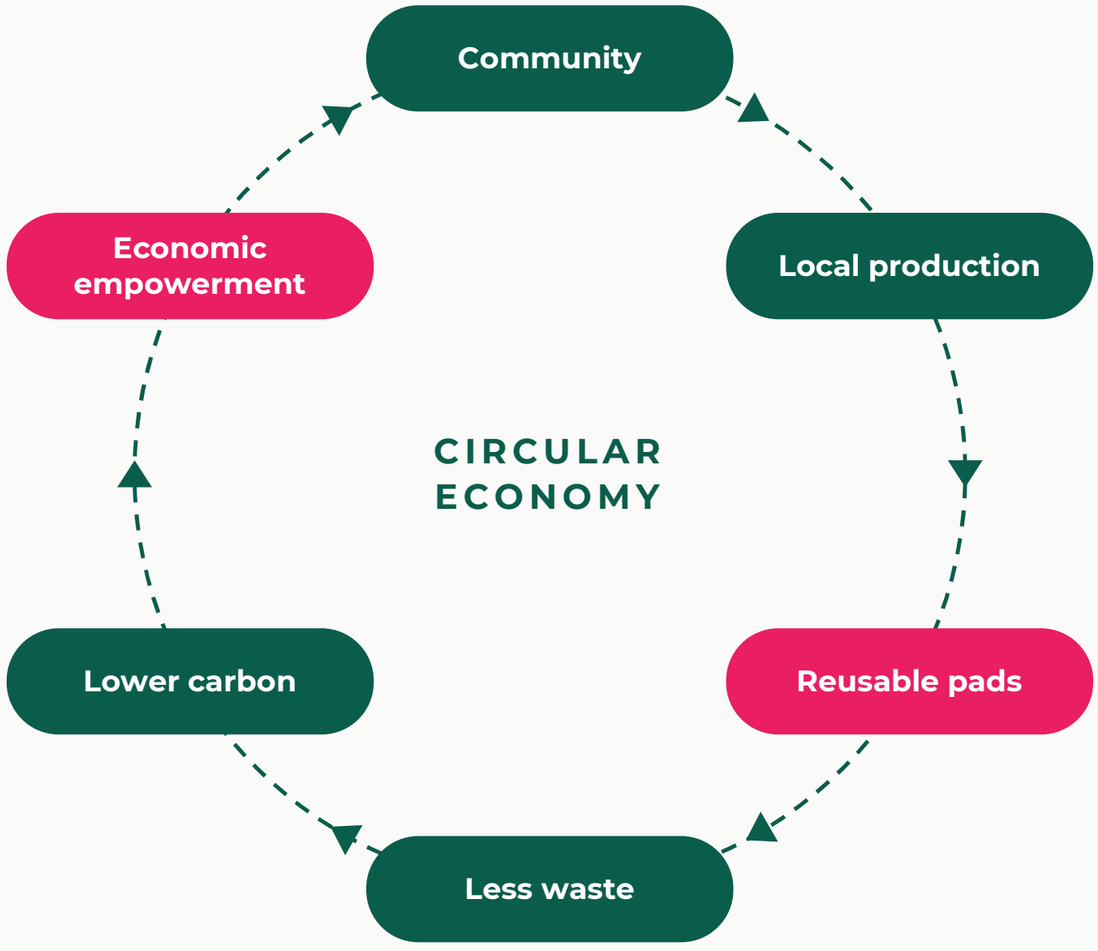
- Plastic — up to 90% of each pad is petroleum-based plastic
- Global transport — imported over thousands of kilometres
- Wood pulp — driving demand on forests
- Industrial water — intensive manufacturing footprint

And where waste management is weak...

- Discarded pads pollute soil and water
- Plastic waste blocks drainage channels
- Blocked drains increase urban flooding — a climate feedback loop

OUR SOLUTION

The Bansoa Model — From Linear Consumption to Circular Economy



FROM THE FIELD — AFFAMIR PHOTOGRAPHS







THE IMPACT OF ONE KIT

Why Reusable Menstrual Pads Matter

ONE OJEAPADS KIT REPLACES

600–800

disposable pads avoided over its lifetime

Plastic reduction

Hundreds of pads never reach landfill or rivers

Lower carbon emissions

Less manufacturing, less global transport

Household savings

Years of product costs freed for families

Girls stay in school

Reliable protection, every month

Lifecycle analyses show reusables consume considerably less water over time than manufacturing hundreds of disposables.

ONE MODEL, FIVE GLOBAL GOALS

Climate Action Through Local Manufacturing

Local manufacturing

Production in Bansoa — short supply chains, community ownership

Environmental protection

Less plastic, less waste, lower emissions

Women's employment

Skills, wages and enterprise for local women

Girls' education

Kits and education keep girls in class

The Bansoa Model contributes simultaneously to

- SDG 5 — Gender equality
- SDG 6 — Clean water & sanitation
- SDG 8 — Decent work
- SDG 12 — Responsible consumption
- SDG 13 — Climate action

OUR CALL TO ACTION

Stop treating menstrual hygiene as a welfare is
Start treating it as climate infrastructure.



Governments | **Donors** | **Engineers** | **Researchers** | **Private sector**

Invest in community-based reusable menstrual solutions — inside climate policy, National Adaptation Plans, WASH investments and the circular economy.

Because every reusable kit **reduces waste · reduces emissions · creates jobs · keeps girls in school · restores dignity**

> ***There can be no climate resilience without menstrual resilience.***

THANK YOU

Dr. Céline Magnéché Ndé Sika

Founder & Executive Director

AFFAMIR — Cameroon

Email: affamircam@yahoo.fr Website: www.affamir.com

Replace email and website with your actual contact details

Session 3

Climate resilient WASH & Circular Economy

Q&A and Discussion

Session 3

Climate resilient WASH & Circular Economy

Coffee & Tea Break