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## Tailor-Made Socio Economic Approaches for Integrated Water Management in Rural to Urban Driven Mutations SoWat

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Africa-EU Innovation Alliance for Water and Climate



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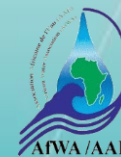


# Tailor-Made Socio Economic Approaches for Integrated Water Management in Rural to Urban Driven Mutations

## SoWat

Ranya AMER, Tarek HOSNY, Eslam SALAMA, Dina IHAB, Sherif ABU EL-MAGD, Harrison PIENAAR, Fhumulani RAMUKHWATHO, Pascal BREIL, Philippe NAMOUR

Water Resources Dialogue: China-Africa Water Forum Series No. 7,  
Windhoek, Namibia 22-27 July 2019



# Outline

- AfriAlliance call
- SoWat AfriAlliance Action group
  - French case
  - Egyptian case
  - South Africa case
- Concluding remarks (web site, first advancements)

# AfriAlliance Projects

- **Funded** by the European Commissions Horizon 2020 programme
- **Main objectives:**
  - Stimulate cooperation between African and EU stakeholders in the areas of water innovation, research, policy, and capacity development to prepare Africa for future Climate Change challenges.
  - Drive Africa-EU cooperation in these fields to a practical level by sharing innovation for local challenges and boosting sustainable market and investment opportunities
  - Reinforce Water & Climate Change research and (social) innovation (R&I) cooperation between Africa and EU through a mix of forward-looking and bottom-up innovations
- **SoWat Action Group** has been chosen from more than 80 applications.

# SoWat AfriAlliance Action group

## Organisation and synergies

- **SoWat** action group gathers of 6 partners from 3 countries: Egypt (EG), South Africa (SA) and France (FR)
- Multidisciplinary is the main strength of **SoWat** to meet climate change challenges and adaptation to increased hydrological variability
- Indeed, **SoWat**'s partners brings complementary skills in: wastewater treatment, water use efficiency, decontamination, water conservation, nature based solutions (NBS), water management techniques, socioeconomic studies
- **SoWat**'s partners develop operational demonstration sites (demo-sites) in a gradient of rural to urban contexts, assess solutions dealing with water stresses related to land use change

# SoWat AfriAlliance Action group

## Theme # 1: Human development and capacity development needs in water and climate actions:

- Proposes to assess various NBSs on demo-sites, by means of case studies. Afin de donner aux utilisateurs locaux (les communautés les plus touchées) les moyens de gérer facilement les BNS par une gestion participative indispensable.
- Focusses on the capacity building and public awareness for wastewater recycling

## SoWat aims

1: Propose new NBSs to water scarcity due to climate change, in EG, SA and FR

Show low-cost NBSs for water decontamination and purification.

2: Build capacity and empower local communities with knowhow on sustainable water management practices to promote SMEs

Promote water management best practices (domestic water reuse, irrigation and feed stock production).

# SoWat AfriAlliance Action group

3: Close the gap between science, technology and policy focusing on community needs and demands

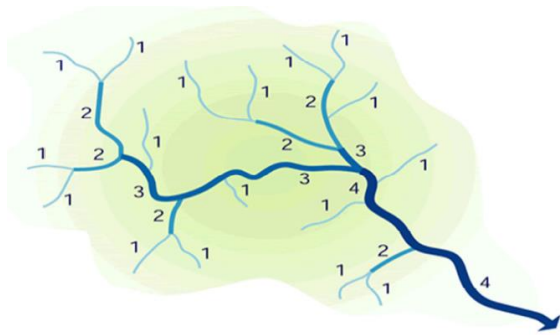
4: Support the economies of EG and SA by protecting human health and creating more sustainable job opportunities

## Communication Strategy

- Improve societal awareness by interaction with the local community on NBS implementation.
- Assist capacity development by interaction, training and communication of project outputs.
- Address policy and decision-makers to adopt projects outputs.

# French case

## What are headwaters ?



Strahler classification (EPA, 2009)

- Natural drains of order 1-2, from less than 1 meter to 2-3 m wide
- Watershed from 0,01 to 1 km<sup>2</sup>
- Easy to disturb by mechanical means
- Almost never gauged
- 70 to 90% of the drainage network length in French Mediterranean coast



## EcoHydrological role of headwaters

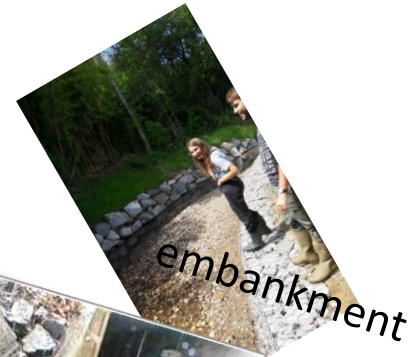
- Headwaters can have permanent or seasonal or intermittent flow regimes
- Often connected to upstream wetlands
  - *Contribute biodiversity dissemination*
  - *Ensure low flow regulation*
  - *Provide a variety of physical-chemical processes (oxic – anoxic)*
  - *Fed downstream systems with minerals and organic matter*
  - *Limit water temperature fluctuation*
  - *Dissipate hydraulic energy.....*



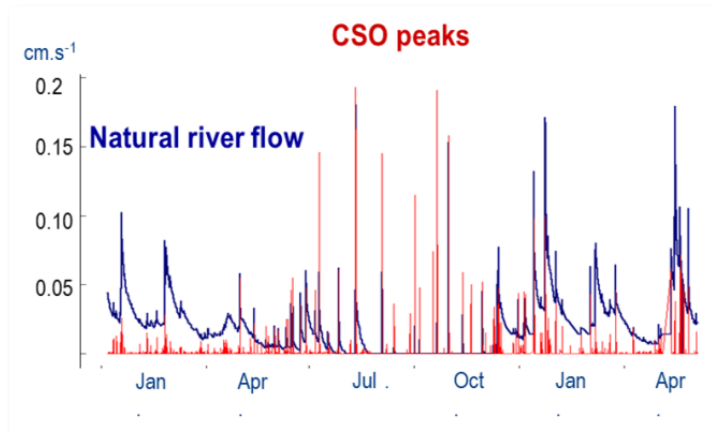
# How and Why headwaters are so degraded ?

Cropland

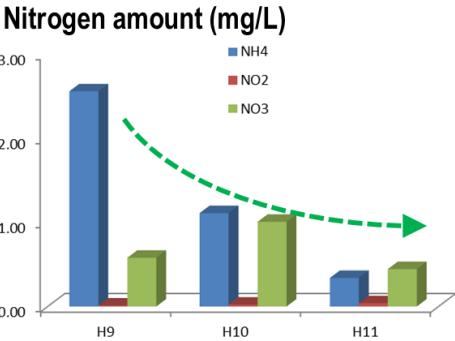
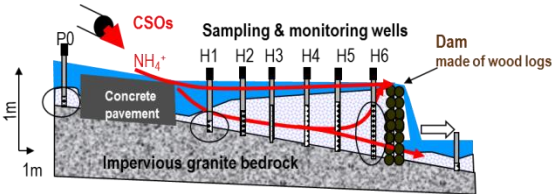
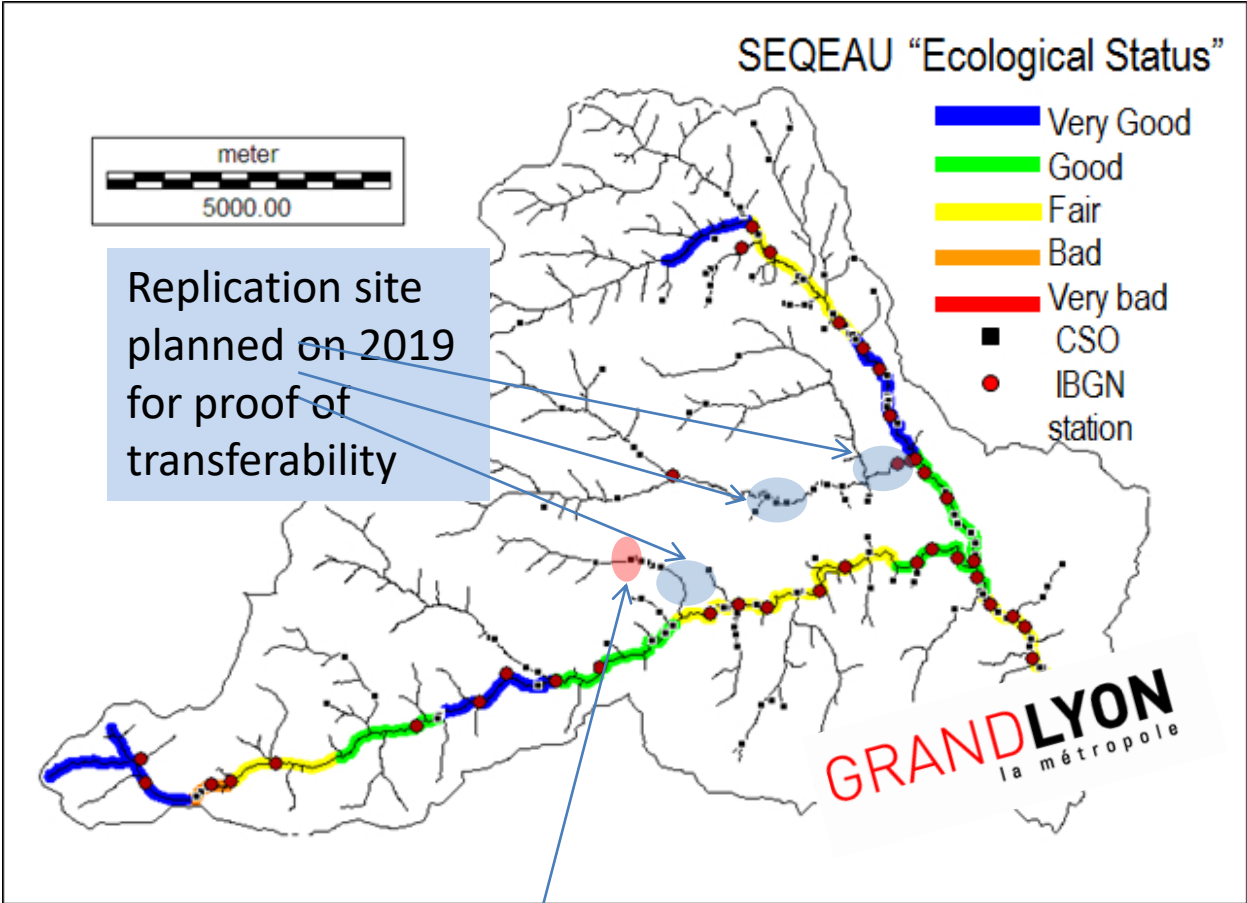
Urbanization



- Economical impact of headwater degradation :
  - Increasing cost of remediation efforts for downstream rivers belonging to EU referenced water bodies (EWFD)
  - Increasing cost of flooding damages for near downstream urbanized riversides

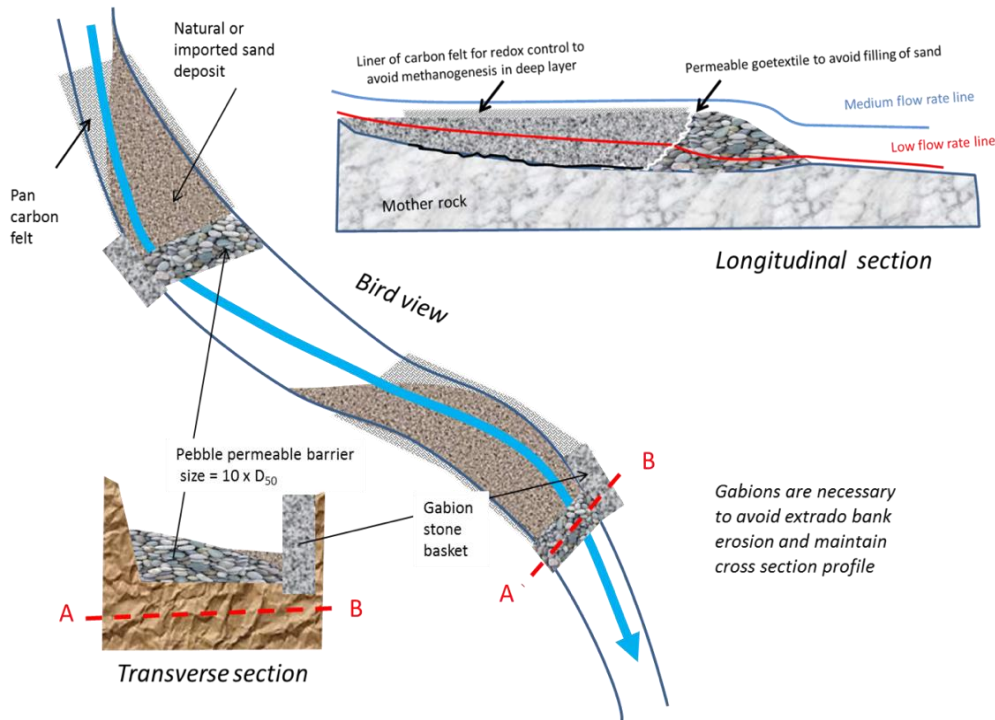


# French case



# Prospective design of constructed porous ramps to trap organic matter during low flows and process during medium to high flow periods.

*Principle of constructed porous ramps (P. Breil & Ph. Namour)*

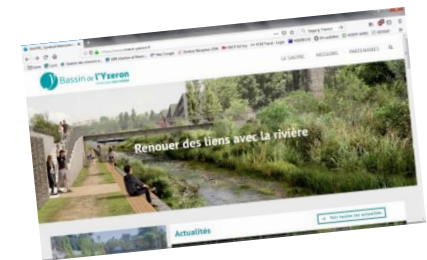
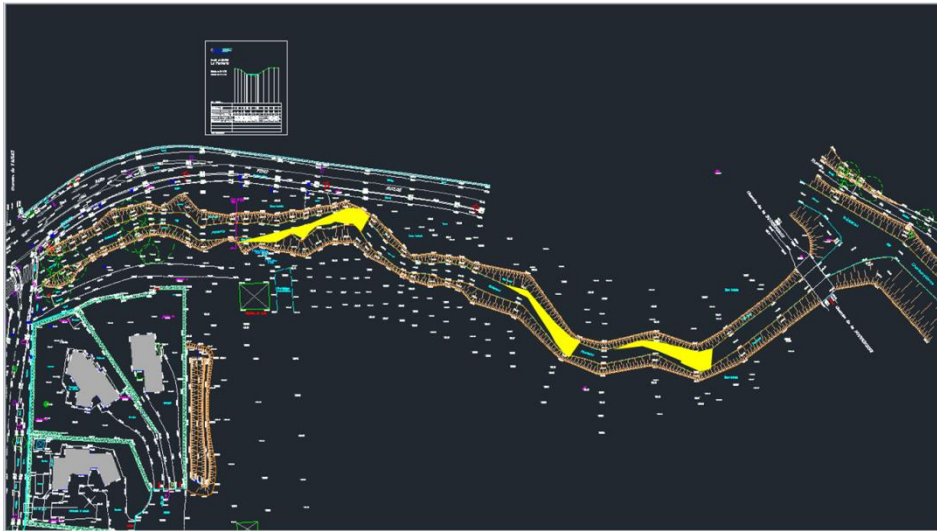


*Gabions are necessary to avoid extrado bank erosion and maintain cross section profile*



# Field implementation & partnerships

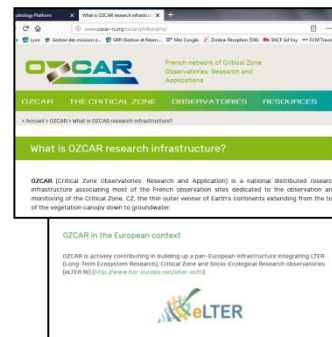
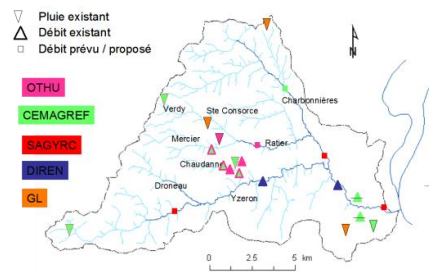
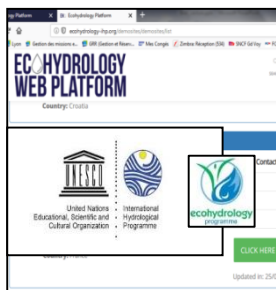
Implementation during July 2019



Missions since 2000:  
Flood, Drought, river resource management  
WFD objectives / good ecological status...



Missions since 1974:  
Sewer and waste water system planning and management.



# Egyptian case



Rural area  
(Diab Village)



High salt concentration of the ground water and canal irrigation



Deterioration of soil quality and limited cultivation



No wastewater treatment system





**Samples were collected from available water sources**



## **Public participation**

- **Community entering through “Future Protectors” NGO**
- Deciding after Listening
- Sharing decisions
- The output can be start-ups

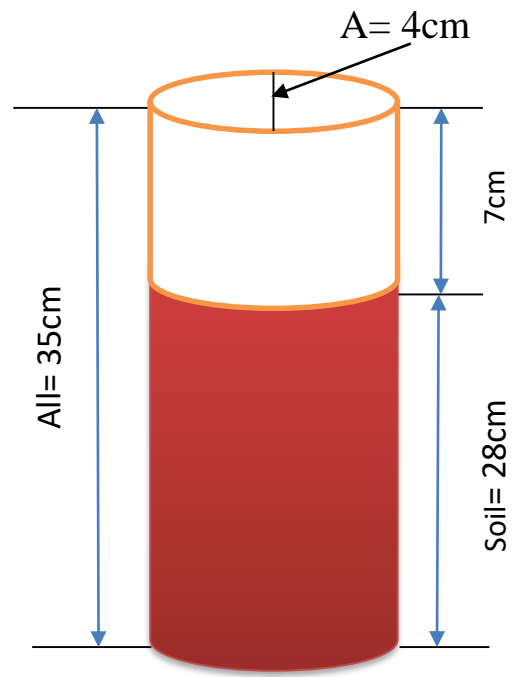


# Table 1: Chemical analysis of water samples collected from Diab village

(ND= Not Detected)

Parameter	Unit	Canal water	Ground water	Tap water
pH		6.55	7.15	6.63
EC	mS <sup>-1</sup>	4.43	6.52	0.841
TDS	mg/L	3020	4280	564
Salt	mg/L	0.24	0.34	0.05
Li	mg/L	ND*	ND	
Na	mg/L	242	816.08	
NH <sub>4</sub>	mg/L	ND	ND	
K	mg/L	22.516	43.0	
Mg	mg/L	62.722	180.42	
Ca	mg/L	179.387	554.646	
F	mg/L	6.0191	5.8120	
Cl	mg/L	298.66	231.793	
NO <sub>2</sub>	mg/L	ND	ND	
Br	mg/L	ND	ND	
NO <sub>3</sub>	mg/L	0.863	0.856	
PO <sub>4</sub>	mg/L	90.208	75.187	
SO <sub>4</sub>	mg/L	1218.409	1185.331	
Zn	mg/L	0.7571	1.3179	
Ni	mg/L	ND	ND	
Pb	mg/L	ND	ND	
Cu	mg/L	ND	ND	
Co	mg/L	ND	ND	
Total Coliform	MPN	>1000	>1000	

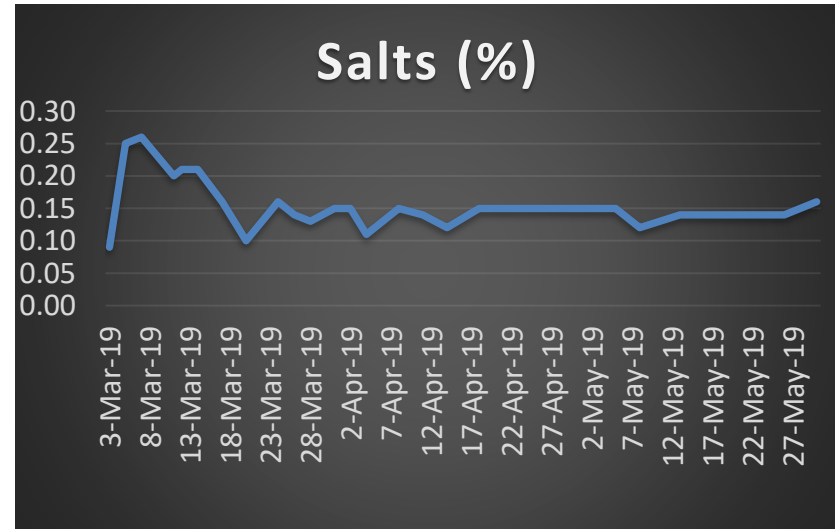
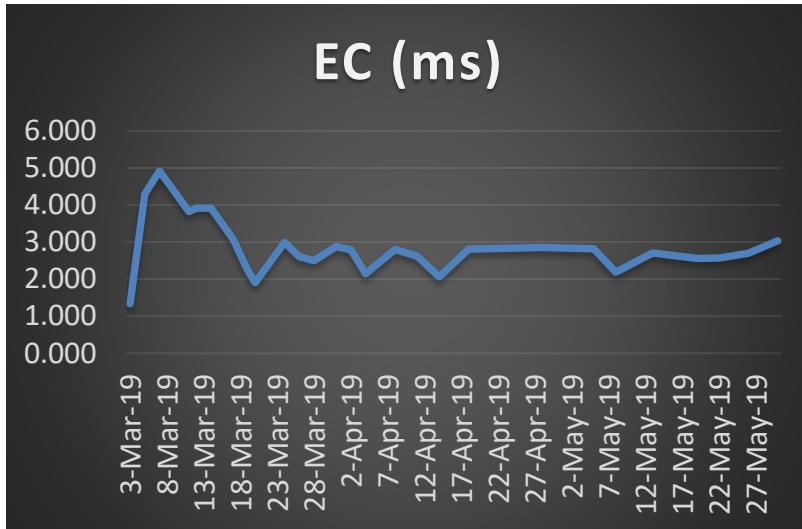
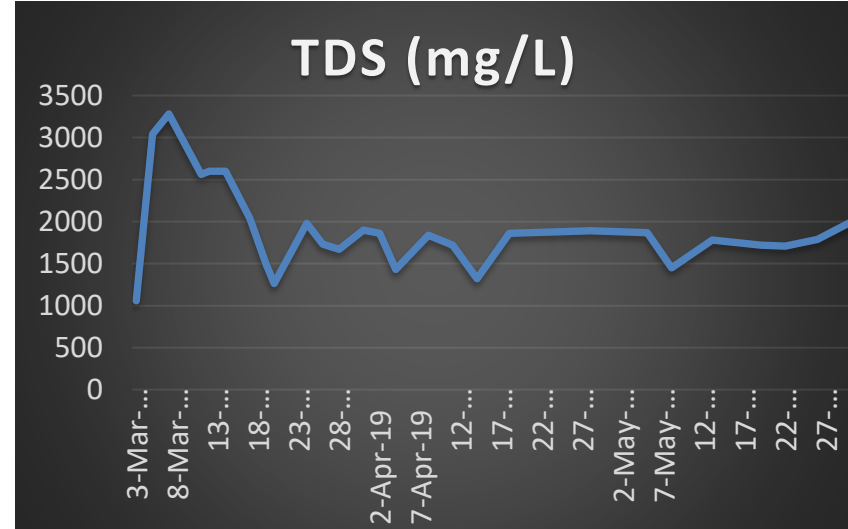
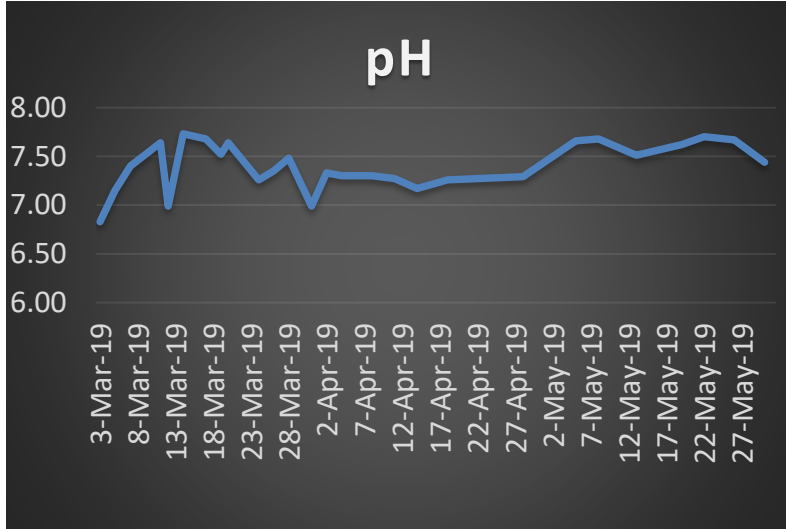
# Soil Wash



The flow rate is 15 cm water in 24 hours  
The volume of soil in the cylinder is 352 cm<sup>3</sup>



# Water Quality



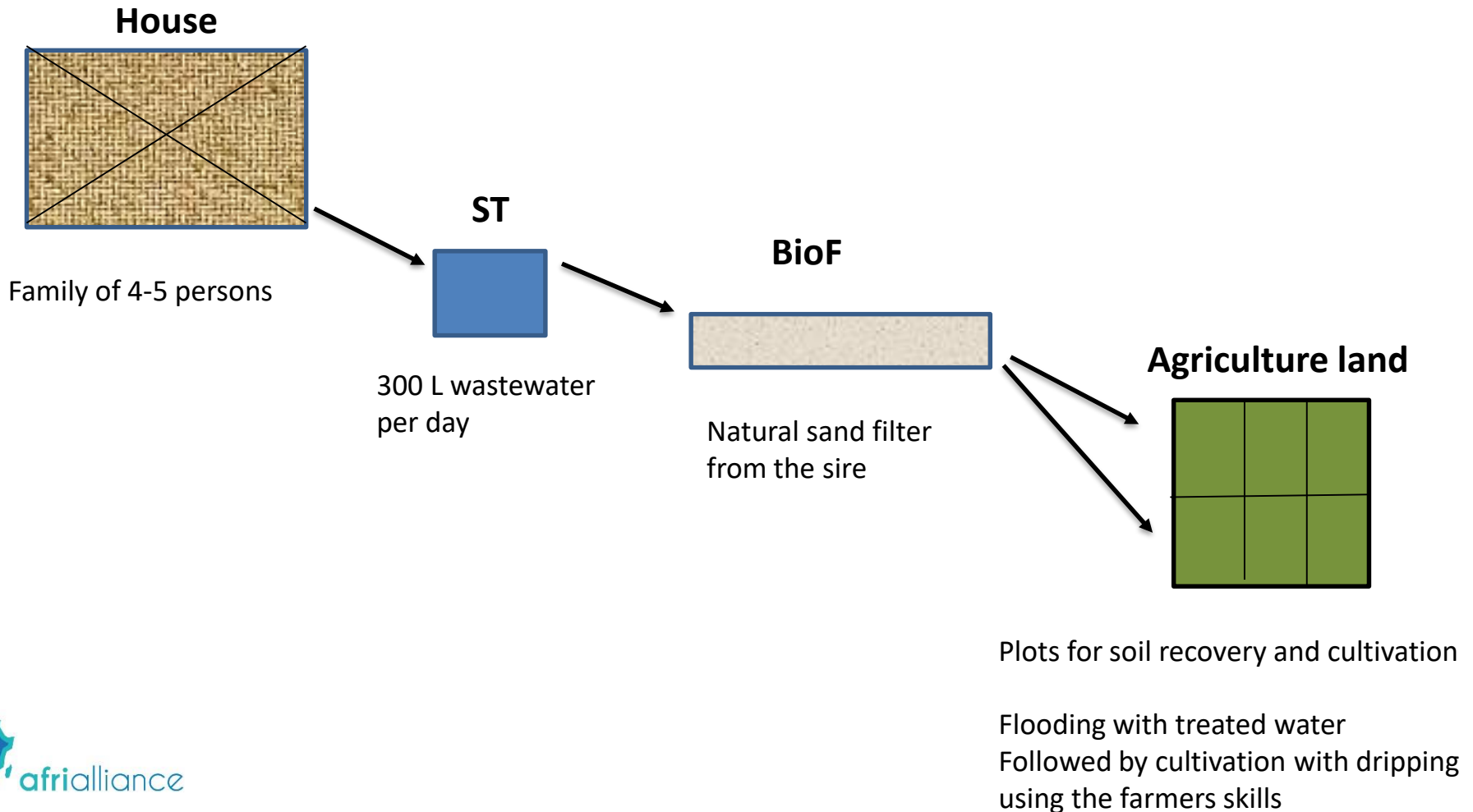
# Soil Analysis

- After 3 month soil wash using 15

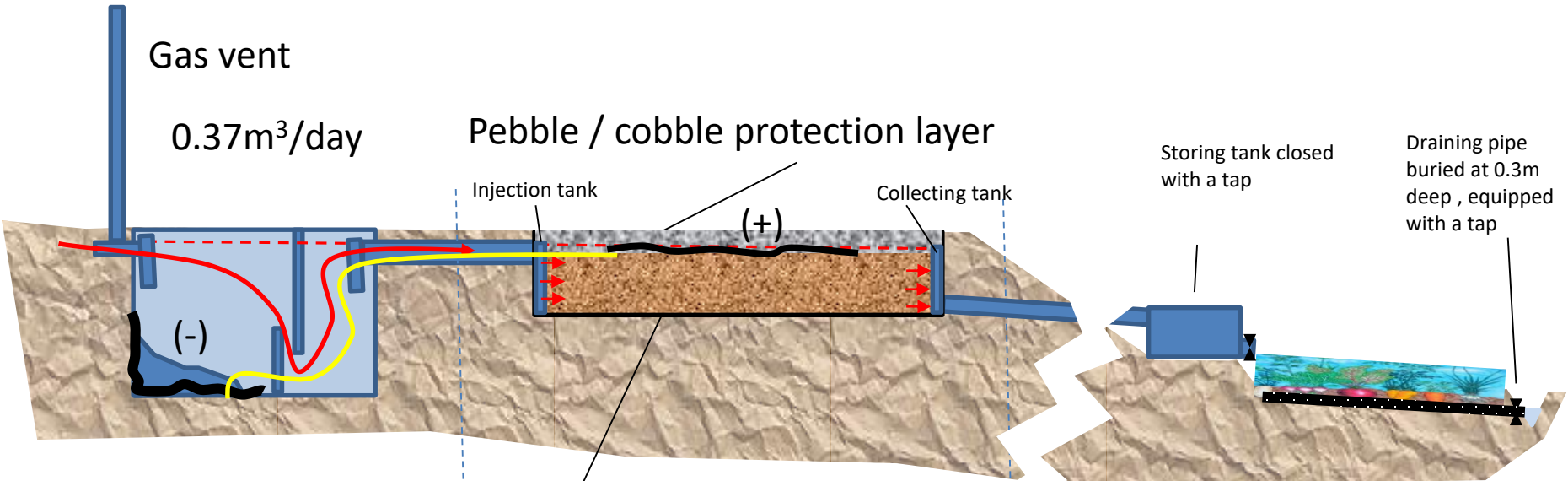
	EC (mS/cm)	pH	TDS (ppm)	Carbonate (%)
<b>Before</b>	5.82	7.3	4200	46.71
<b>After</b>	2.22	7.5	1500	46.35

Cations(mg/L)	Before	After
Li	0.94	0.352
Na	9050.34	779.32
NH4	14.57	26.47
K	424.57	166.22
Mg	2054.02	513.5
Ca	5694.08	6370.48
Anions (mg/L)	Before	After
F	23.33	23.3
Cl	10604.43	558.18
NO <sub>2</sub>	48.5353	nd
Br	23.636	5.2
NO <sub>3</sub>	532.98	25.81
PO4	nd	nd
SO4	20864.2	16740.41

# Schematic diagram for the treatment unit



# Anaerobic biodegradation



## Sceptic tank principle

### Anoxic biodegradation phase

Design  
3-4 m<sup>3</sup> for 5 persons

Must be cleaned every  
3 years

Medium to coarse sand  
(0.25 <math>\phi</math> <math><1\text{mm}</math>)

### Oxic mineralization phase

Design assuming  
Hydraulic conductivity of  $10^{-4}$  m/s  
Sand Volume of 0.5 m X 2.0 m X 12.0 m  
Hydraulic gradient of 0.5 m

Which gives:  
A flux of 0.36 m<sup>3</sup>/day  
Residence time of 10 days  
Storage capacity of 3.7 m<sup>3</sup>

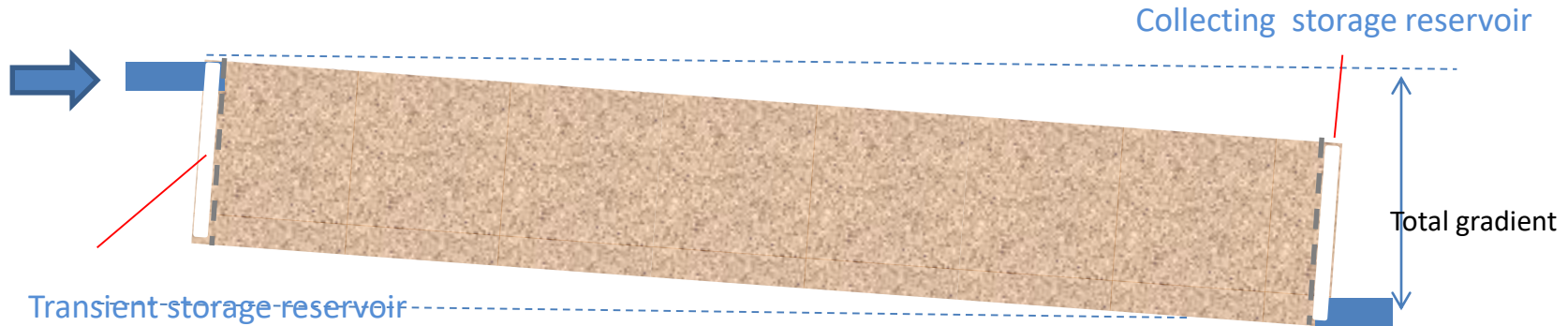
Phase 1 : washing soil by flooding irrigation (as it is practice by local people). Duration is 40 days for a plot of 5m<sup>2</sup> flooded each night under 0.07 m of treated WW.

Phase 2 : drip irrigation with 0.007 m / day (0.7 cm) required for vegetable growing in arid zone (FAO data).

# Sand treatment tank

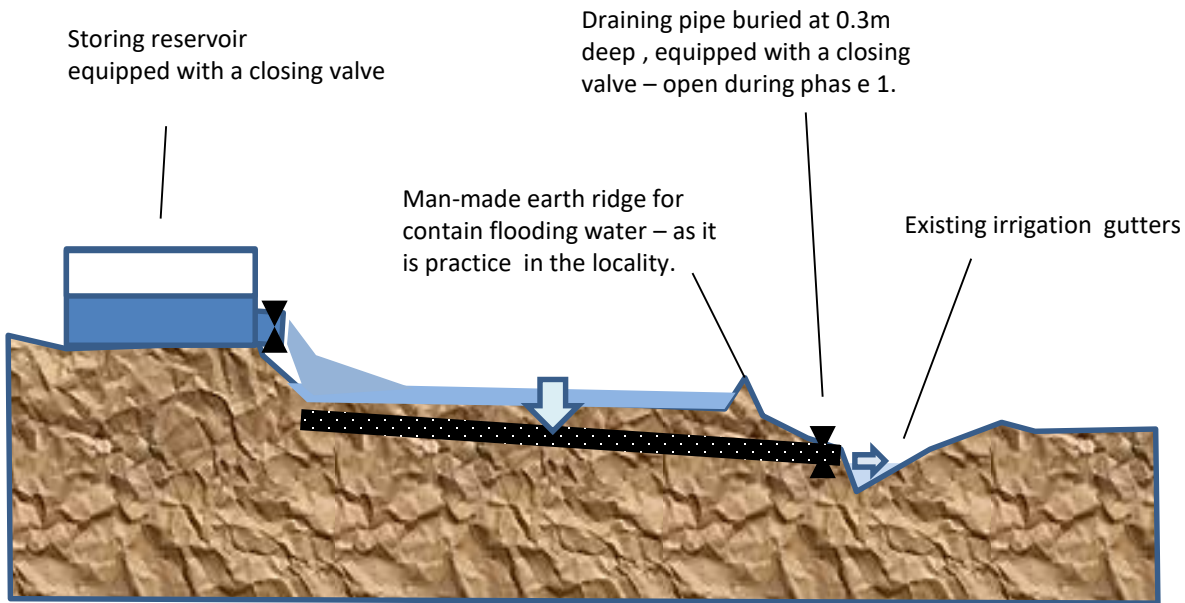
## Biofilter profile design

- height x width x length = 3.7 m<sup>3</sup>
- long shape required to use the energy of gravity in the direction of the slope. (eg 0.5 x 2 x 12m)



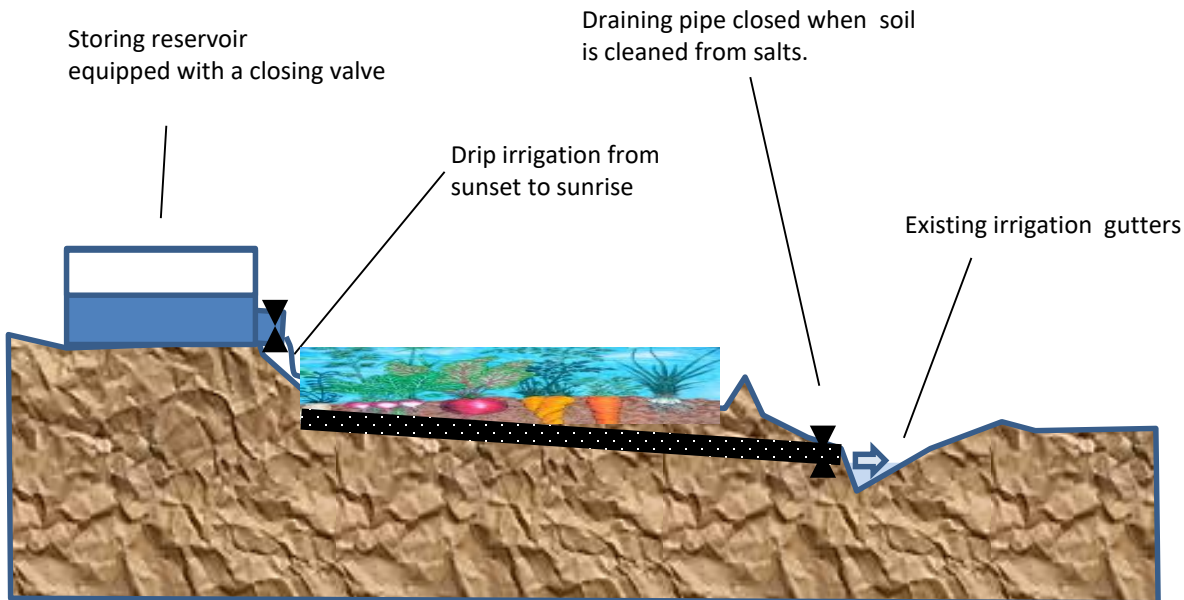
Calculation spreadsheet

Initial requirements	(i) Septic tank (ST) of 3 to 4 m <sup>3</sup> with input flow of 0.37 m <sup>3</sup> /day; (ii) biofilter with residence time of about 10 days
6 Waste Water (WW)	
7 WW daily flow production (eg for 5 persons)	0.37 m <sup>3</sup> /day
8 sand volume for 30 days	12.2 m <sup>3</sup> /day
9	
10 Biofilter characteristics	unit
11 Slope data	
12 material coarse sand (<2 mm) is 30% porous	0.30
13 width	4.52 m
14 depth	0.38 m
15 target (computer optimization)	9.44 m
16 Section	1.29 m <sup>2</sup>
17 total water content	3.85 m <sup>3</sup>
18 Transient storage reservoir width	0.03 m
19	10% peak flow hypothesis
20	as WW outflow is not constant during a day, water is delivered to the bio-filter through a transient storage reservoir of a same section (B16)
21	
22 Hydrodynamic data	
23 field slope	0.002 m/m
24 coarse sand hydraulic conductivity	1.0E-05 m/s
25 vertical distance between inlet and outlet	0.33 m
26 hydraulic gradient	0.033 m/m
27 mean hydraulic flow velocity	0.28 m/day
28 true hydraulic flow velocity	0.94 m/day
29 hydraulic residence time (computer optimize)	10.00 day
30 Maximum acceptable daily flow input	0.37 m <sup>3</sup> /day
31	
32 Optimization criteria "input flux = infiltration"	0.00
33	
34	
35	
36	
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43	



Phase 1: Soil cleaning duration (from lab. experiment data) is 40 days over a plot of 5m<sup>2</sup>. Plot must be flat and horizontal as possible to be completely flooded by the complete release of the storing reservoir just after the sunset to limit evaporation. Drains must have been buried at 0.3m depth before the flooding operation. A recommended inter-drain distance is 0.6 m for drain of 0.08m in diameter.

## Implementation phases



Phase 2: Drip irrigation must be installed. Drain outflow must be closed to avoid water drainage. Irrigation is 0.7 cm / day over a plot of 5m<sup>2</sup>, while 7cm / day are delivered by the storing reservoir, allowing to irrigate 50m<sup>2</sup> after this area soil has been washed. A calendar is proposed to progressively shift from phase 1 to phase 2. It is possible to complete 30m<sup>2</sup> of irrigated cleaned soil after 1 year. 2.7 years to complete the maximum area of 50 m<sup>2</sup>.

# South African case

In South Africa, 56% of waste water treatment works do not work properly; same applies for 44% of water treatment in general.

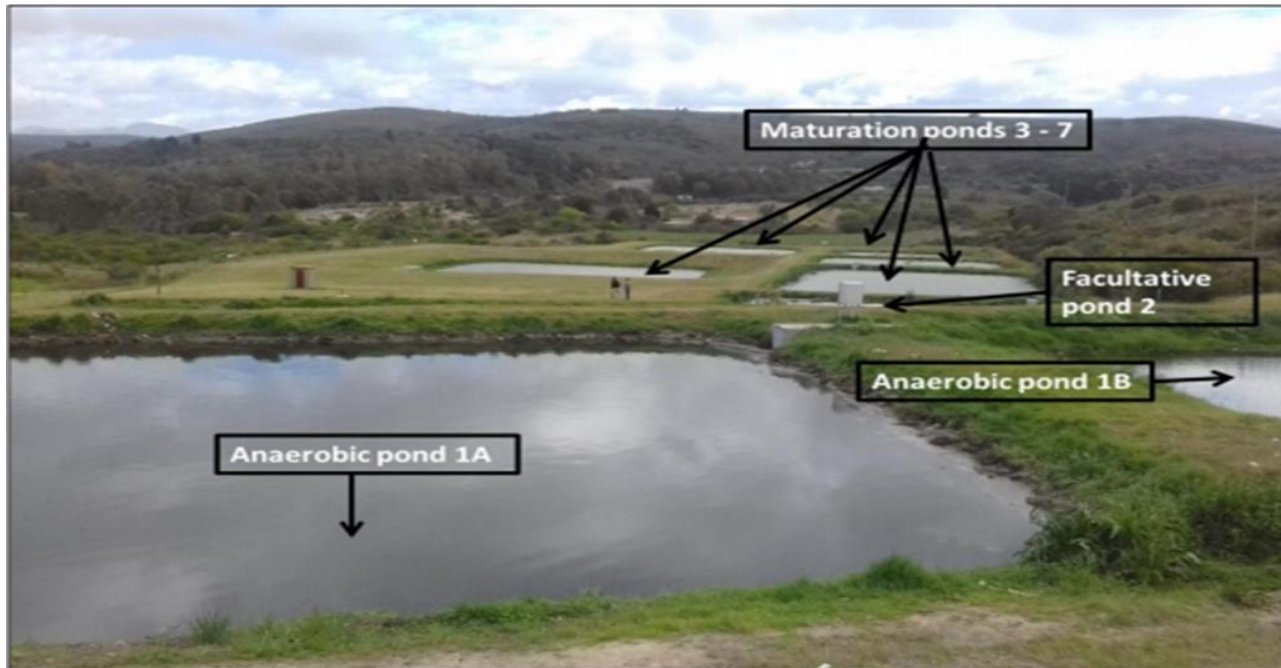
More than 80 % of municipal WWTWs in SA treat less than 10 ML/d and more than 50% of all WWTWs are micro sized (<0.5 ML/d), which make green passive treatment technology ideal for smaller rural WWTP.

Local municipal officials are dealing with aging infrastructure, insufficient technical skills and limited resources.

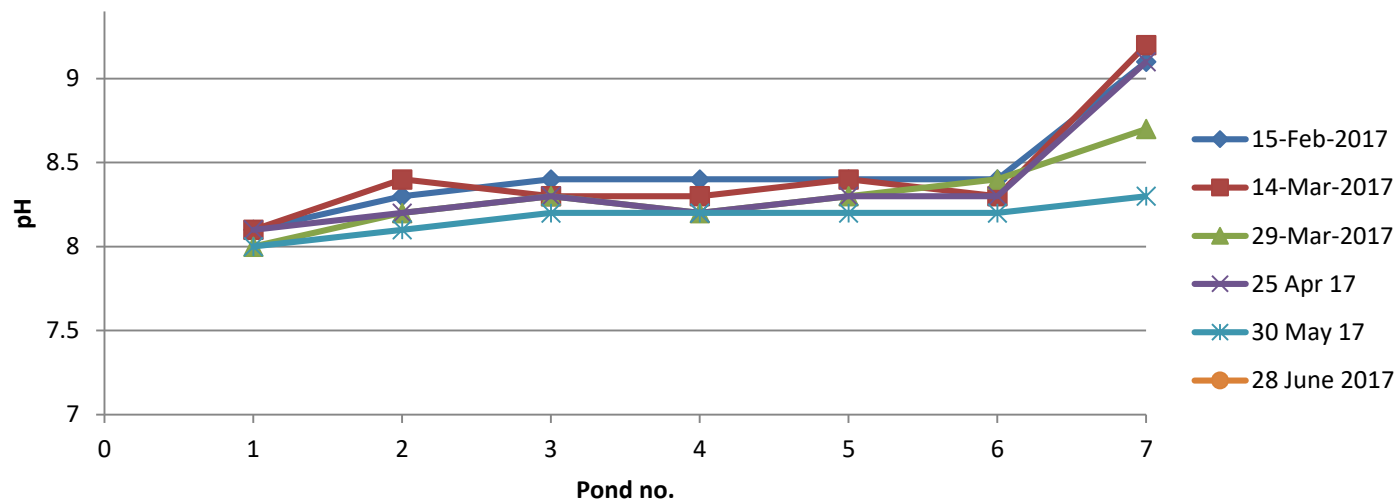
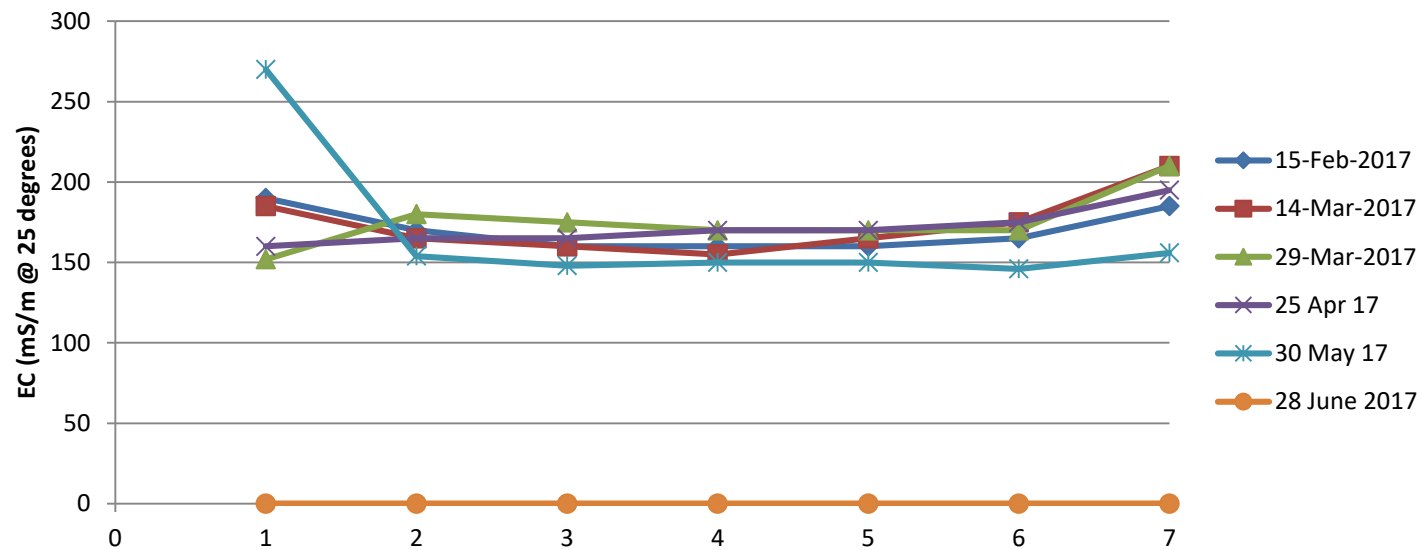


# Site selection

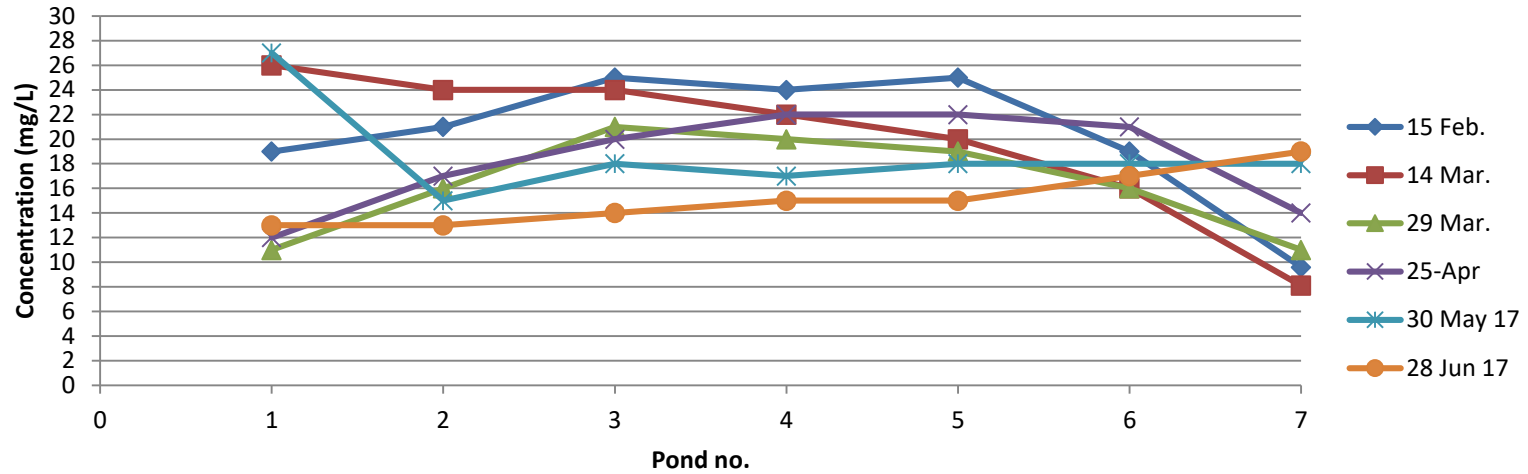
- Mosselbay municipality - population is rapidly growing, placing strain on service delivery at municipal level.
- Sequence of 7 active pond-system was built in 90s mainly for improving wastewater treatment in semi-urban areas.
- Municipality focusing mainly on water quality data from Pond 7 only.
- SA research team have monitored Pond 1 – Pond 7 over couple of months – with focus on inflow data for microbiological.
- Pond 1 - Outflow microbiological and chemistry data.



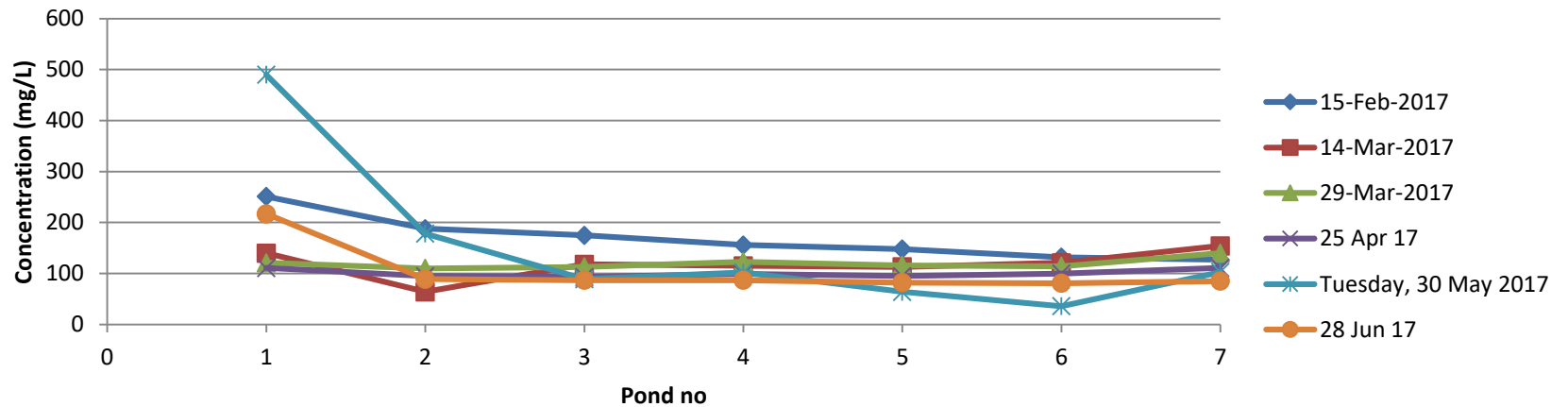




## Total Phosphorus (unfiltered)



## COD monitoring (after filtering)



# Municipality objectives

- Facilitate the effective & efficient removal of nutrients and pathogens in WWTWs effluent; by using a combination of specific algal species which has been isolated and cultured in the laboratory to remove nutrients and create conditions for effective reduction of pathogens and *E coli*.
- Test the feasibility of an aquaculture venture.
- Implement a self-sustaining system that is independent of electricity or expensive chemicals and can be effectively maintained by a semi-skilled workforce.
- Use existing infrastructure.
- Apply a Quantitative Microbial Risk Assessment (QMRA) to confirm the reduction of health risks.
- Improve community awareness, knowledge sharing and capacity development through an associated community and stakeholder programme.



# SoWat NBS intervention – technical aspects

- SoWat action group relates the Mosselbay municipality experience on the design, maintenance and adaptation of this NBS in a growing population context.
- Request to municipality for data i.e. flow (rate) or retention time for each pond.
- Intention – to assist local municipality to enhance wastewater quality treatment - to try and do hydrological modeling of Brandwacht WWT plant – in order to conduct systems optimization for algae growth and resultant algae production for bio-energy.
- Municipality do not have inflow water quality data (nor volume data for inflow) all, only monitors the effluent.

*SoWat members inspecting the Eden district water treatment plant in Mosselbay – treating 0.5ML/day.*

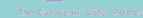


# Concluding remarks

- A multidisciplinary research approach - main strength and key focus of SoWat action group - to address climate change, water quality and associated increased hydrological variability challenges through proposed adaptation interventions.
- SoWat partners developed operational demonstration sites (demo-sites) in a gradient of rural to urban contexts, to assess solutions dealing with water security and related land-use changes.
- To close the gap between water demand and supply (water scarcity context), SoWat proposes to assess various nature-based solutions (NBSs) on demo-sites, by means of case studies.
- For NBSs to be easily managed by local users (affected communities), a participatory management approach is required.
- SoWat focusses on capacity building and public awareness in wastewater recycling.
- A key focus is also close collaboration with local residents, stakeholders and authorities to guarantee the sustainability of proposed NBSs.



# Thank you



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 689162.

# More information



[www.afrialliance.org](http://www.afrialliance.org)



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<https://rsr.akvo.org/en/project/7677/>





# Septic tank design

--height x width x length = 4 m<sup>3</sup> for 4 to 5 connected persons

- compact design preferred to limit space requirements

