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

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SoWat

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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.

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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

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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).

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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.

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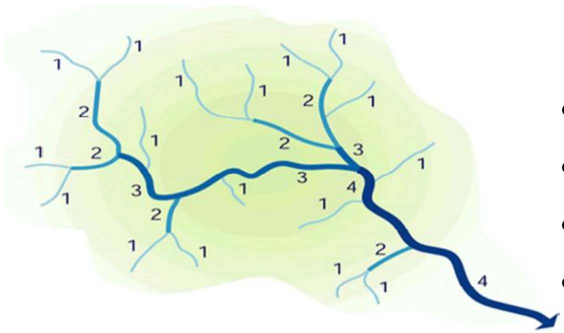
French case

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^2
- 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……*

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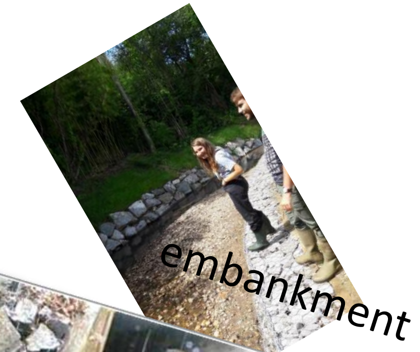
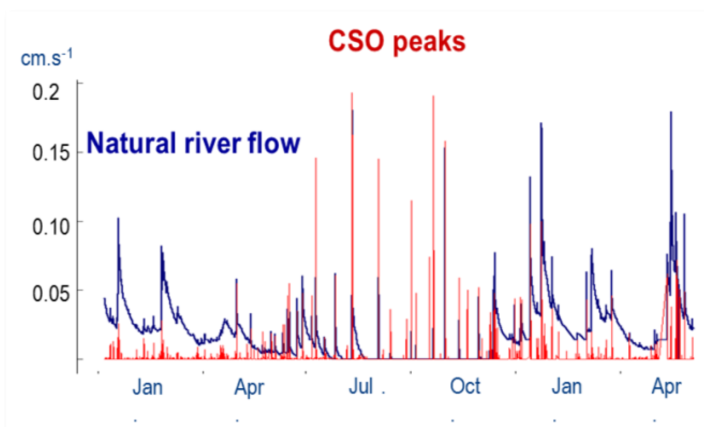
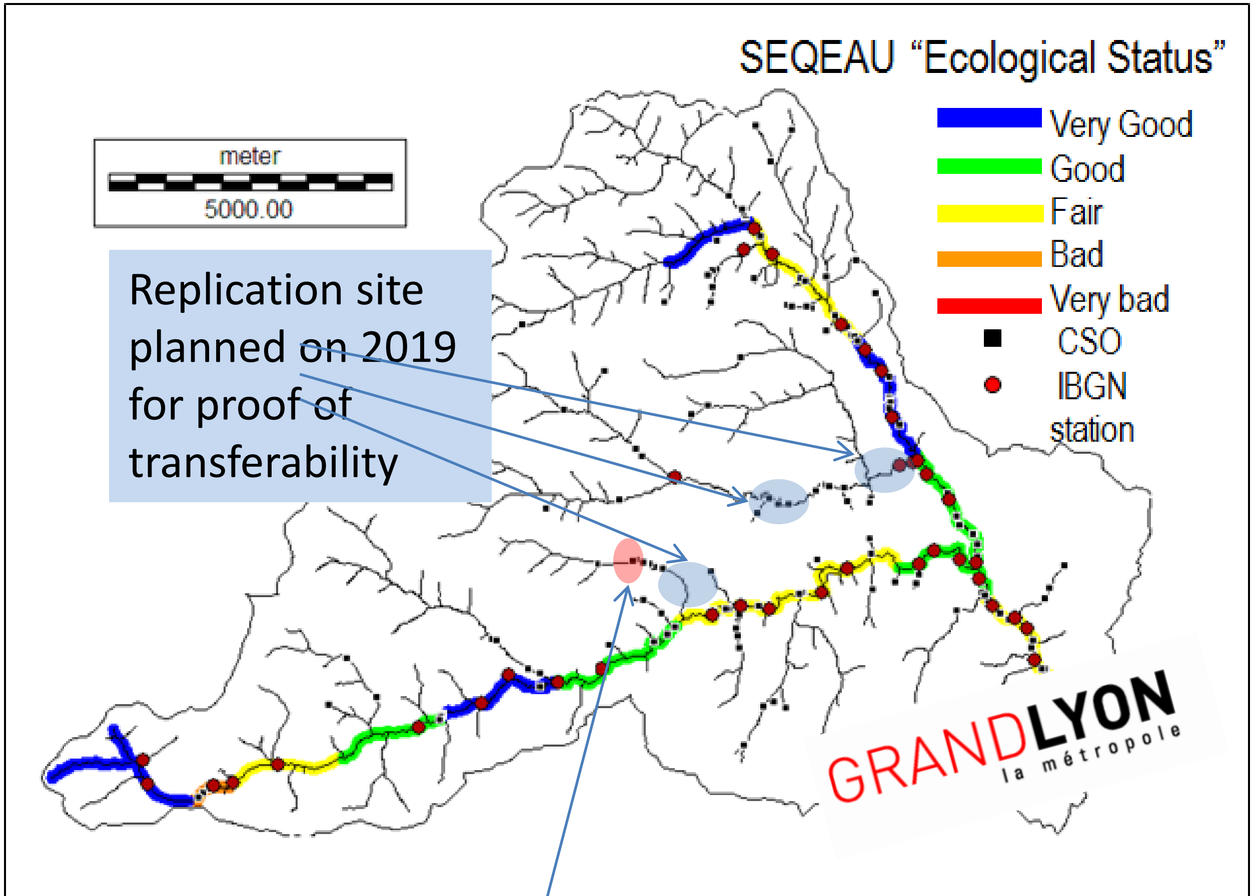
How and Why headwaters are so degraded ?

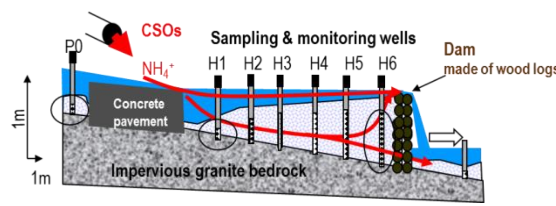


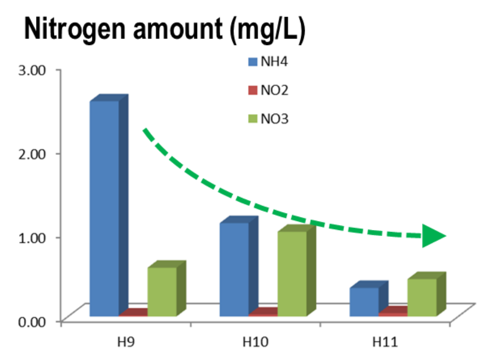
- Economical impact of headwater degradation :
  - *Increasing cost of remediation efforts for downstream rivers belonging to EU referenced water bodies (EWFD)*
  - *Increasing cost of flooding damages for near downstream urbanized riversides*



French case



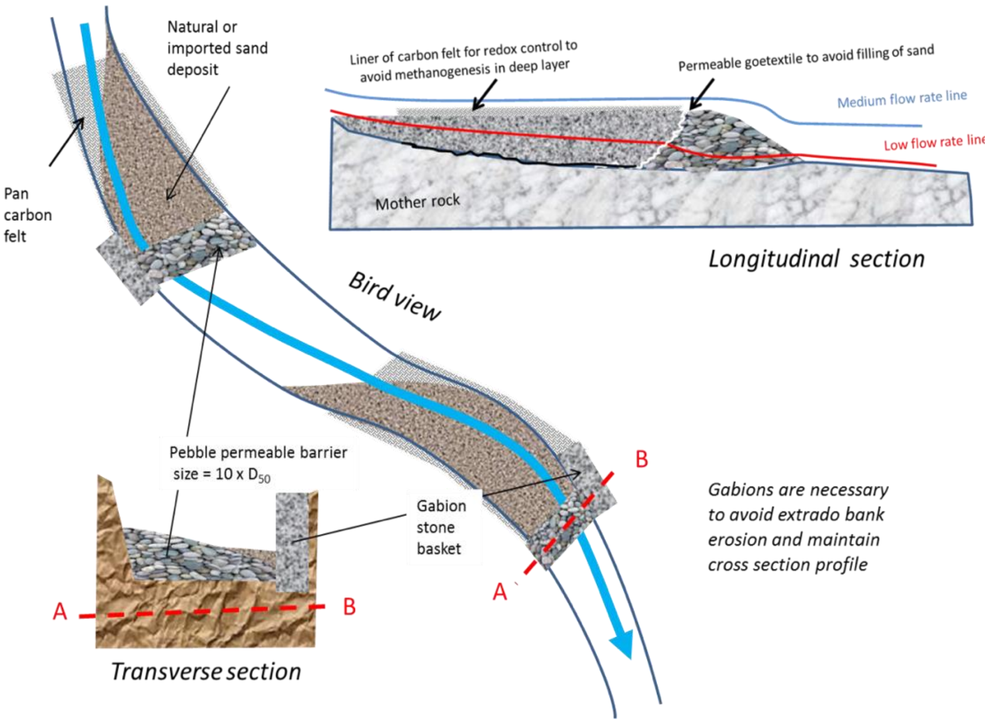




Field pilote – proof of concept running since 2006

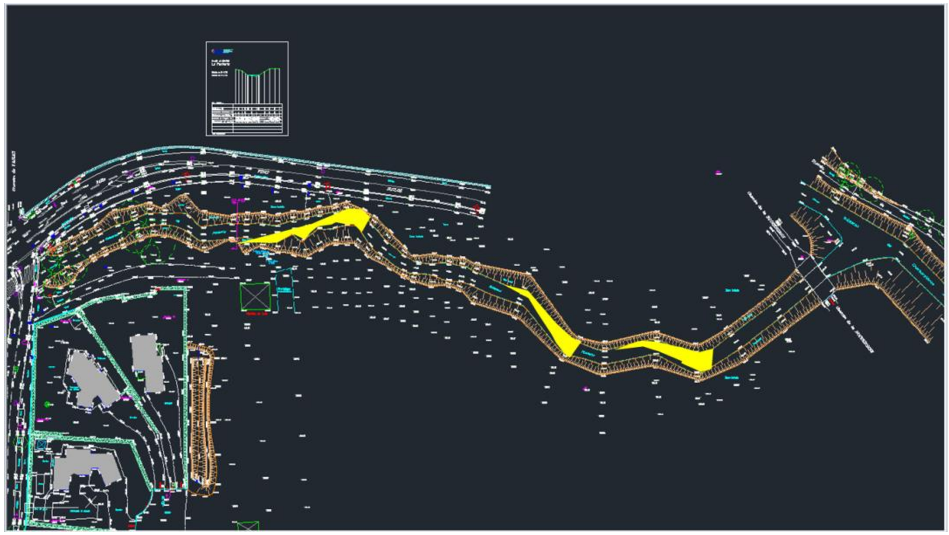
Prospective design of constructed porous ramps to trap organic matter during low flows and process during medium to high flow periods.

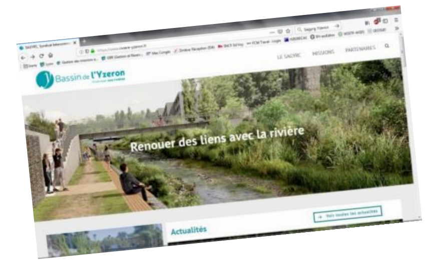
Principle of constructed porous ramps (P. Breil & Ph. Namour)



Field implementation & partnerships

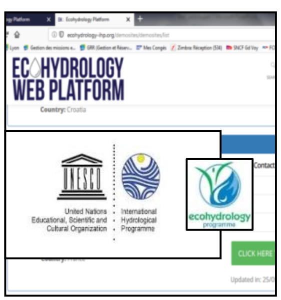
Implementation during July 2019

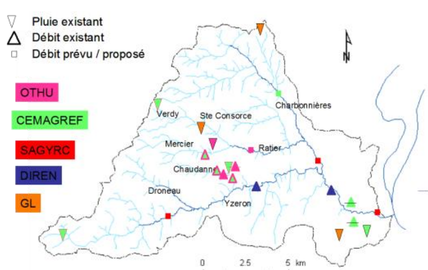


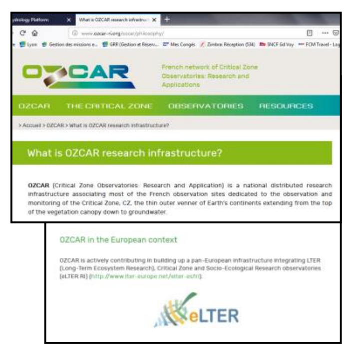


Missions since 2000:
Flood, Drought, river resource management
WFD objectives / good ecological status…

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

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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

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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^{-1}	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_4	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_2	mg/L	ND	ND	
Br	mg/L	ND	ND	
NO_3	mg/L	0.863	0.856	
PO_4	mg/L	90.208	75.187	
SO_4	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	

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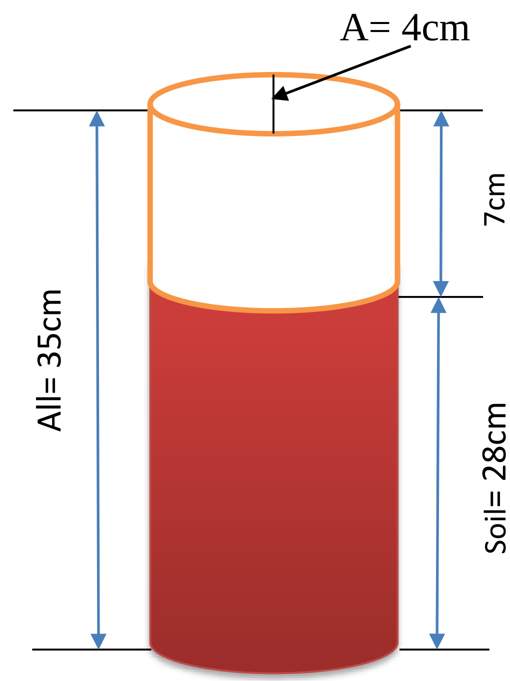
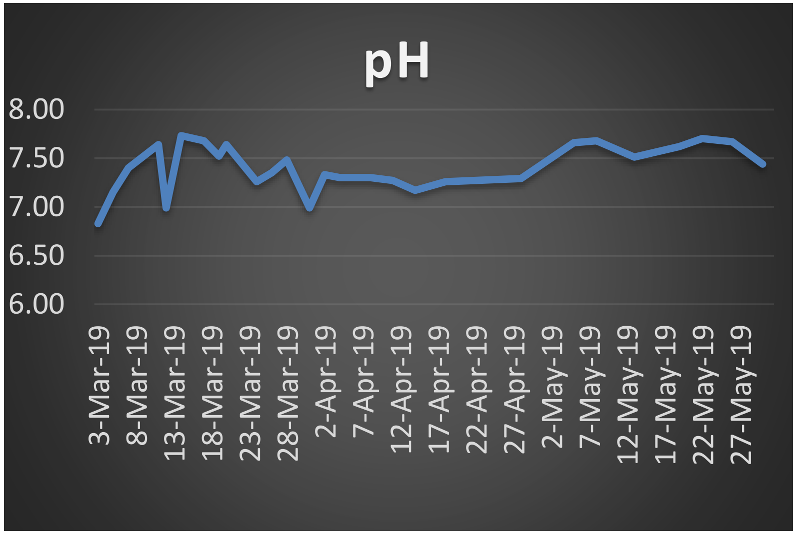
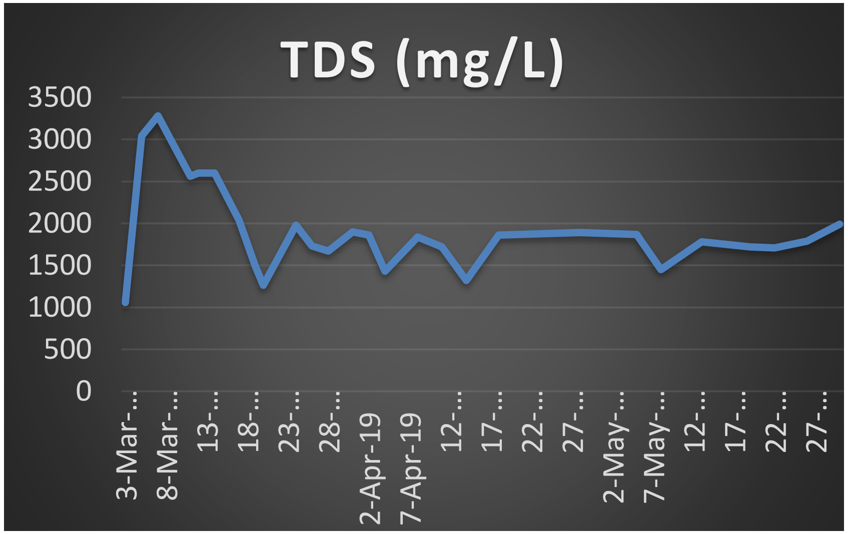
Soil Wash

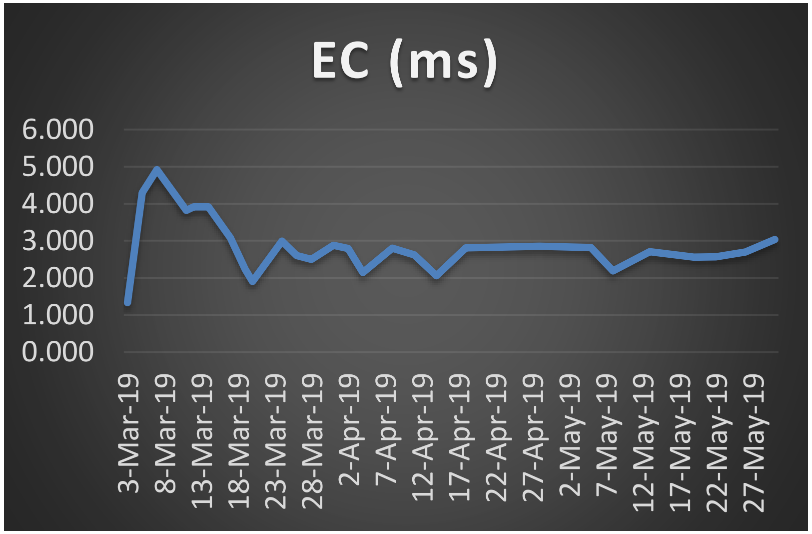


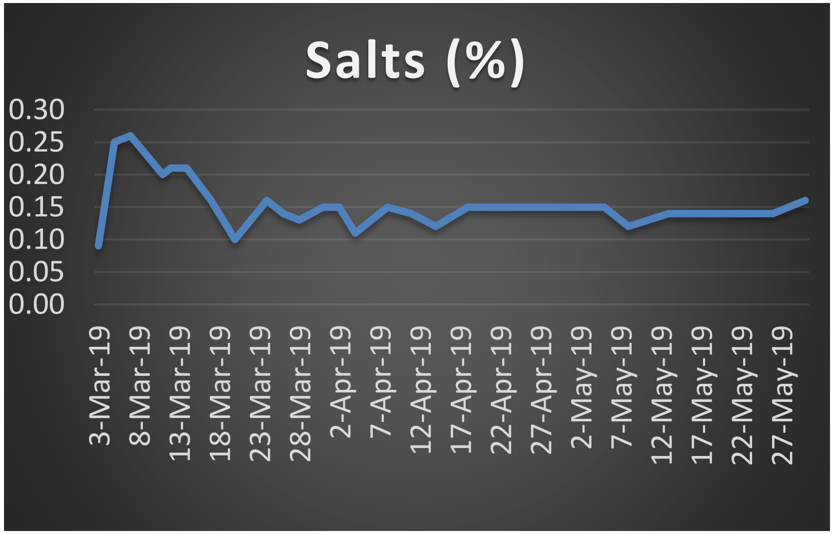
The flow rate is 15 cm water in 24 hours
The volume of soil in the cylinder is 352 cm3

Water Quality









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Soil Analysis

- **After 3 month soil wash using 15**

	EC (mS/cm)	pH	TDS (ppm)	Carbonate (%)
Before	5.82	7.3	4200	46.71
After	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_2	48.5353	nd
Br	23.636	5.2
NO_3	532.98	25.81
PO4	nd	nd
SO4	20864.2	16740.41

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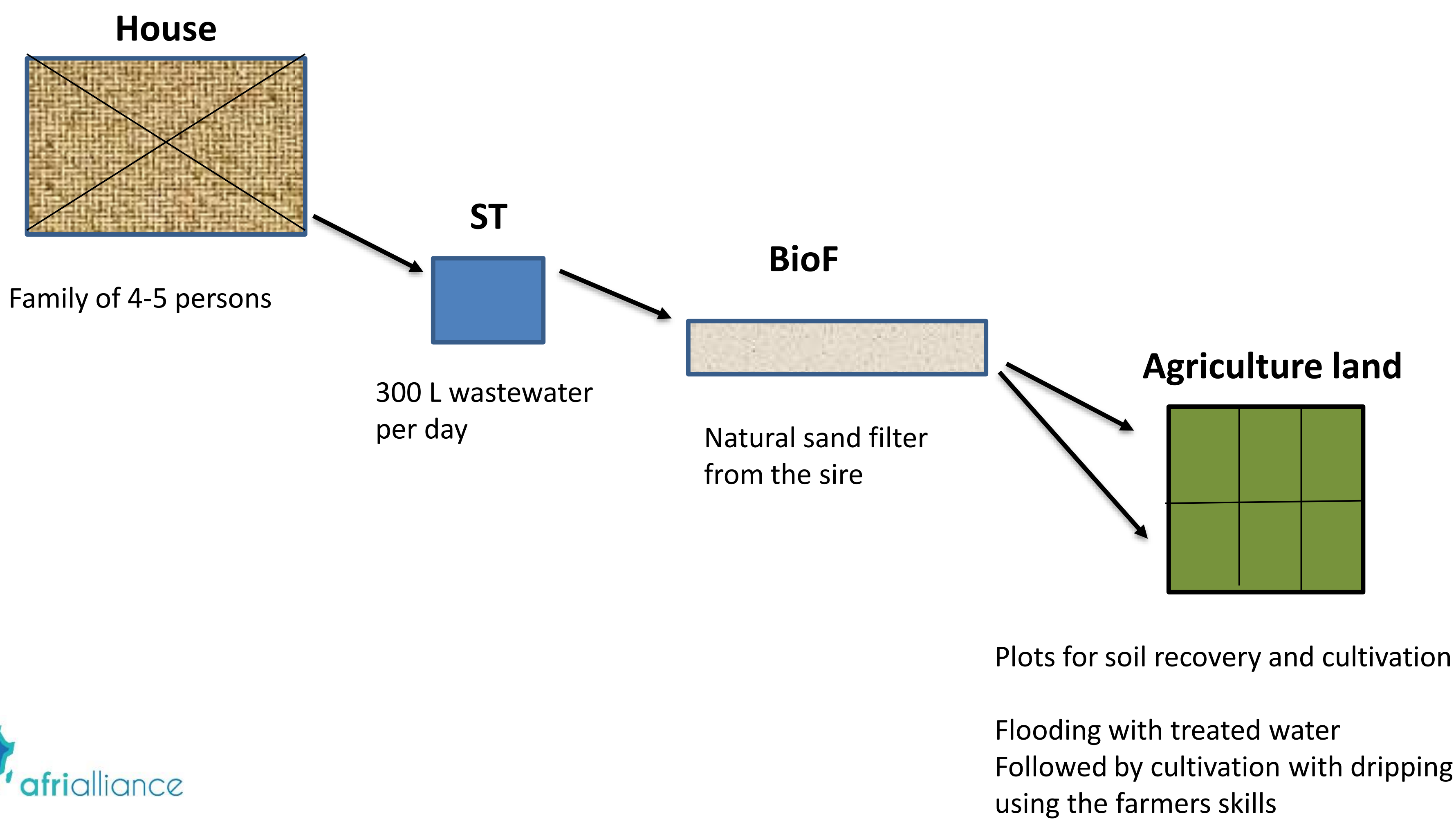
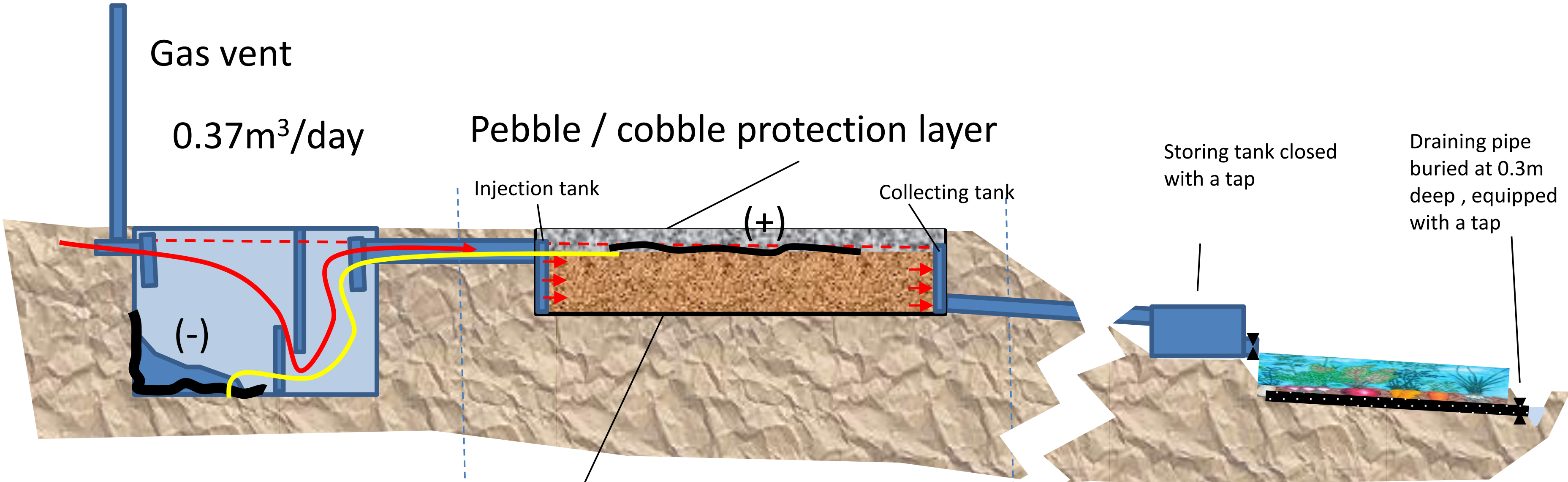
Schematic diagram for the treatment unit



Anaerobic biodegradation



Sceptic tank principle

Medium to coarse sand (0.25<∅<1mm)

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^3/day
Residence time of 10 days
Storage capacity of 3.7 m^3

Anoxic biodegradation phase

Design
3-4 m^3 for 5 persons

Must be cleaned every 3 years

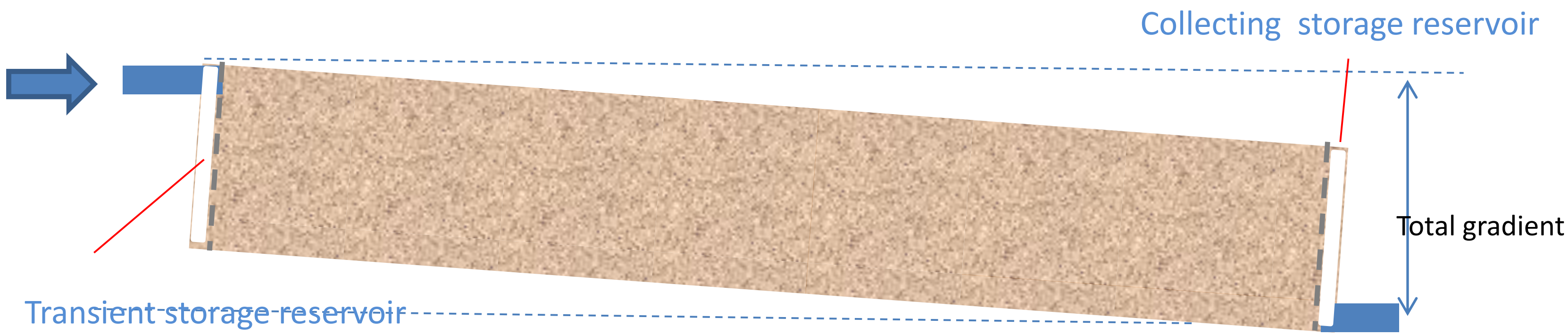
Phase 1 : washing soil by flooding irrigation (as it is practice by local people). Duration is 40 days for a plot of 5m2 flooded each night under 0.07 m of treated WW.

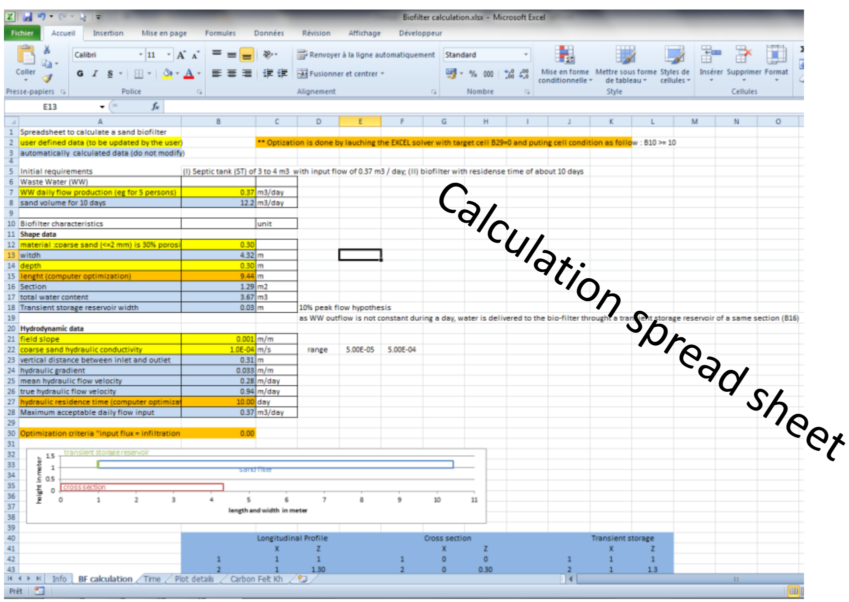
Phase 2 : drip irrigation with 0.007 m / day (0.7 cm) required for vegetable growing in arid zone (FAO data).

Sand treatment tank

Biofilter profile design

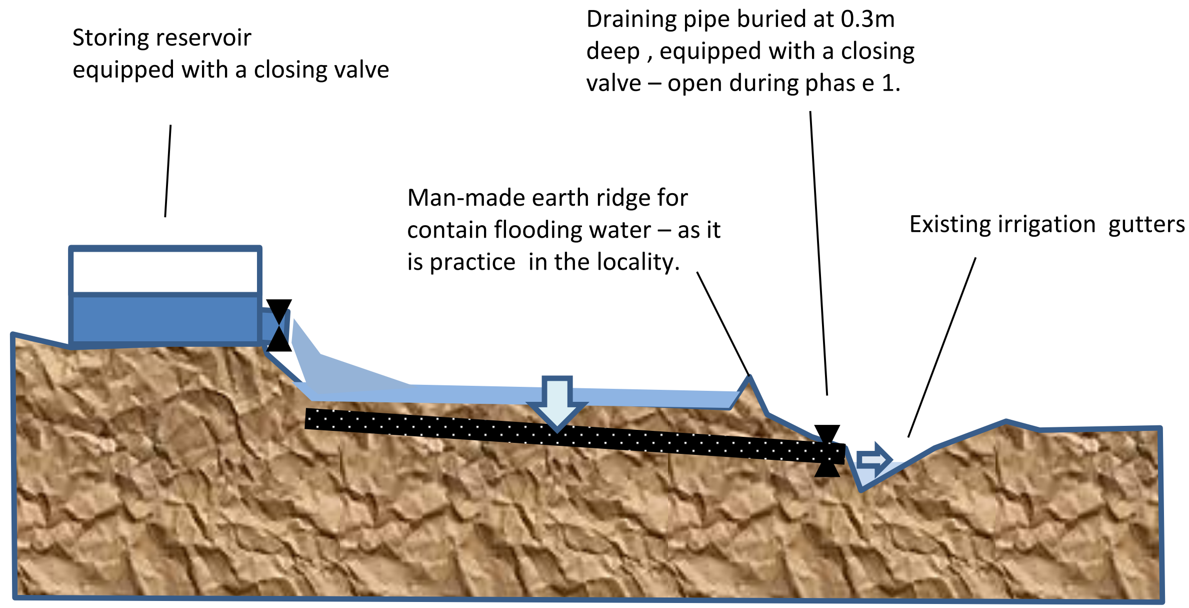
- height x width x length = 3.7 m^3
- long shape required to use the energy of gravity in the direction of the slope. (eg 0.5 x 2 x 12m)



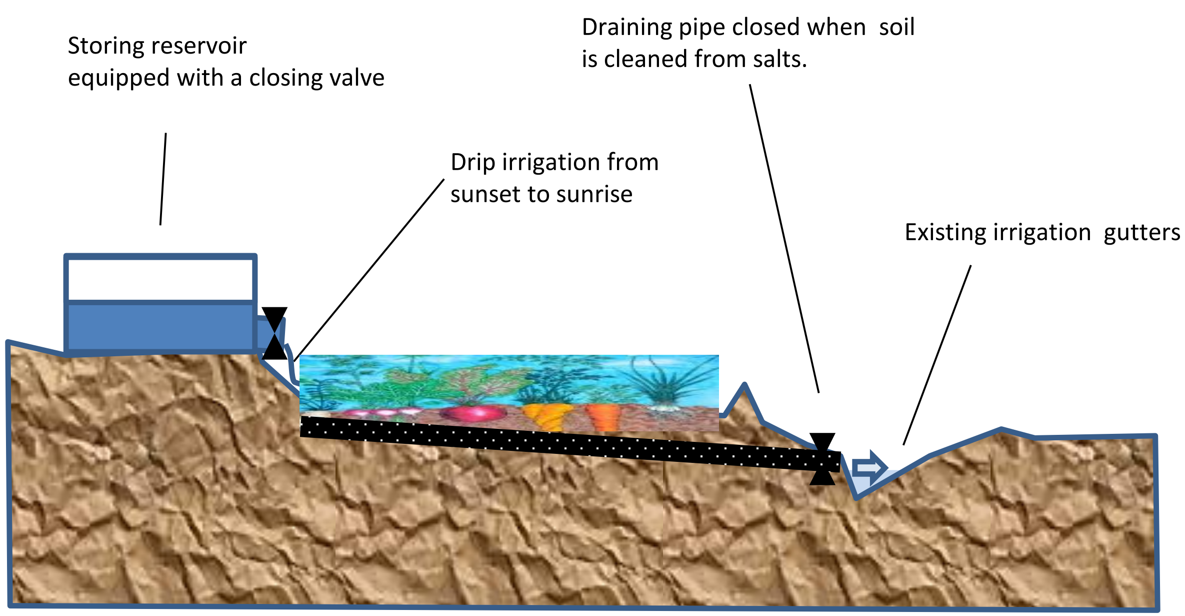


	A	B	C	D
1	Spreadsheet to calculate a sand biofilter			
2	user defined data (to be updated by the user)		** Optization is done by lauching the EXCEL solver with target cell B29=0 and puting cell condition as follow : B10 >= 10	
3	automatically calculated data (do not modify)			
5	Initial requirements	(I) Septic tank (ST) of 3 to 4 m3 with input flow of 0.37 m3 / day; (II) biofilter with residense time of about 10 days		
6	Waste Water (WW)			
7	WW daily flow production (eg for 5 persons)	0.37	m3/day	
8	sand volume for 10 days	12.2	m3/day	
10	Biofilter characteristics		unit	
11	Shape data			
12	material :coarse sand (<=2 mm) is 30% porosi	0.30		
13	witdh	4.32	m	
14	depth	0.30	m	
15	lenght (computer optimization)	9.44	m	
16	Section	1.29	m2	
17	total water content	3.67	m3	
18	Transient storage reservoir width	0.03	m	10% peak flow hypothesis
19				as WW outflow is not constant during a day, water is delivered to the bio-filter throught a transient storage reservoir of a same section (B16)
20	Hydrodynamic data			
21	field slope	0.001	m/m	
22	coarse sand hydraulic conductivity	1.0E-04	m/s	range 5.00E-05 5.00E-04
23	vertical distance between inlet and outlet	0.31	m	
24	hydraulic gradient	0.033	m/m	
25	mean hydraulic flow velocity	0.28	m/day	
26	true hydraulic flow velocity	0.94	m/day	
27	hydraulic residence time (computer optimizat	10.00	day	
28	Maximum acceptable daily flow input	0.37	m3/day	
30	Optimization criteria "input flux = infiltration	0.00		

Implementation phases



Phase 1:Soil cleaning
duration (from lab. experiment data) is 40 days over a plot of 5m2.
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.



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 5m2, while 7cm / day are delivered by the storing reservoir, allowing to irrigate 50m2 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 30m2 of irrigated cleaned soil after 1 year.
2.7 years to complete the maximum area of 50 m2.

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.

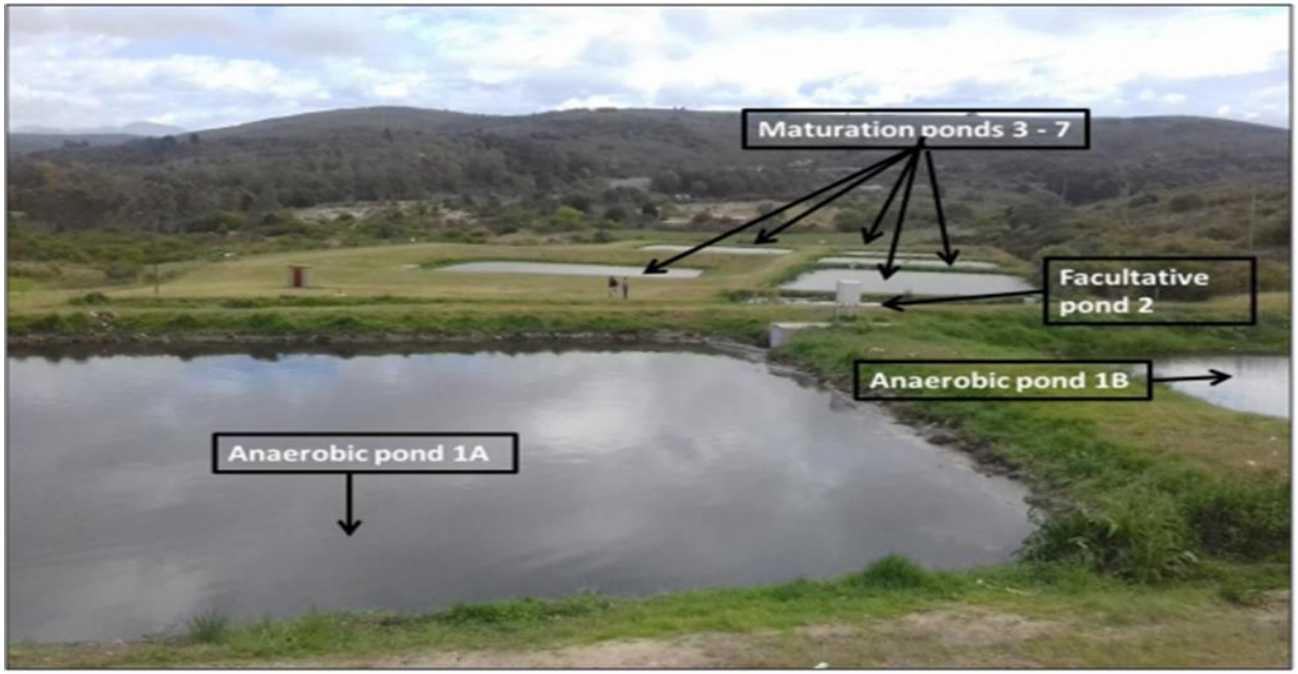
More than 80 % of municipal WWTWs in SA treat less than 10 ML/d and more than 50% of all WWTWs are micro sized (<0.5 ML/d), which make green passive treatment technology ideal for smaller rural WWTP.

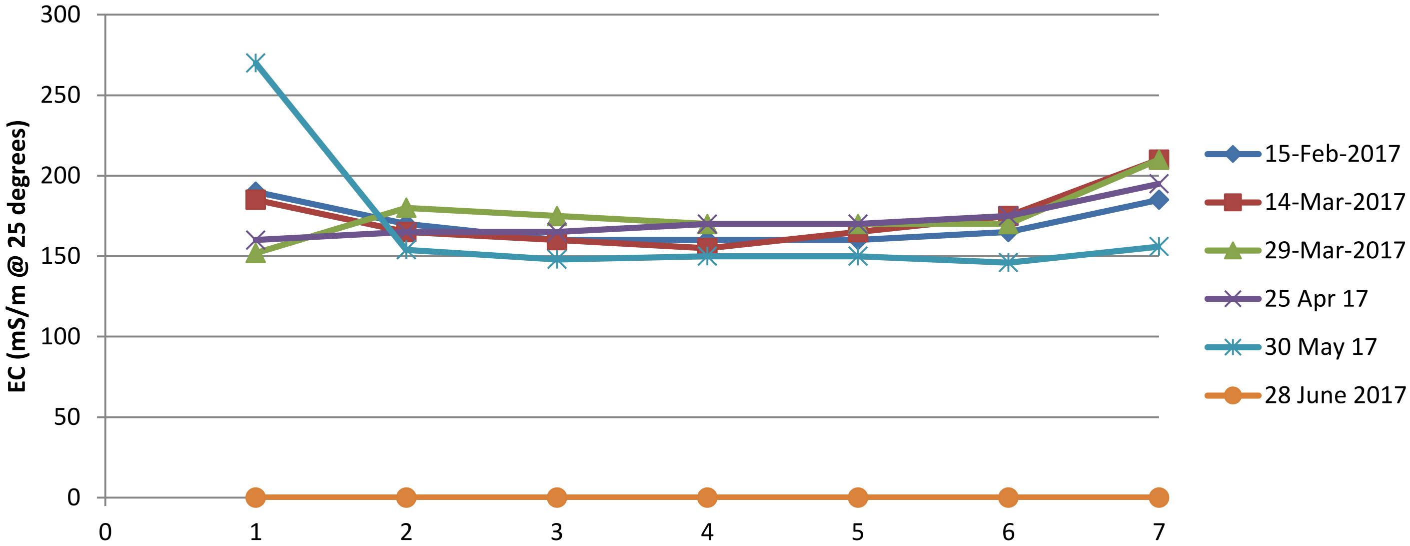
Local municipal officials are dealing with aging infrastructure, insufficient technical skills and limited resources.

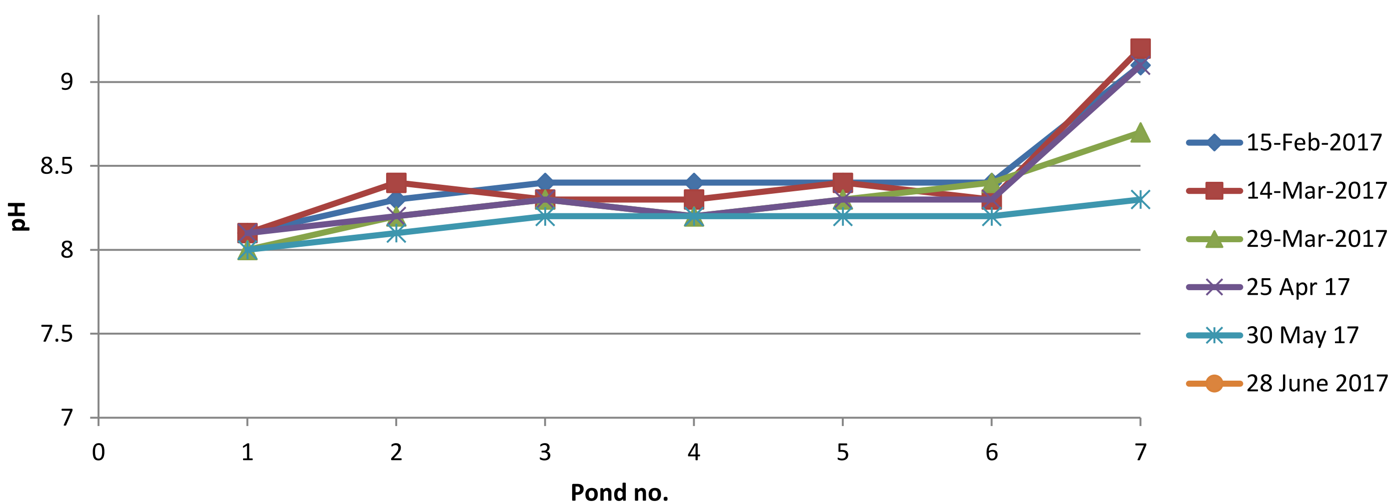
Site selection

- 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.

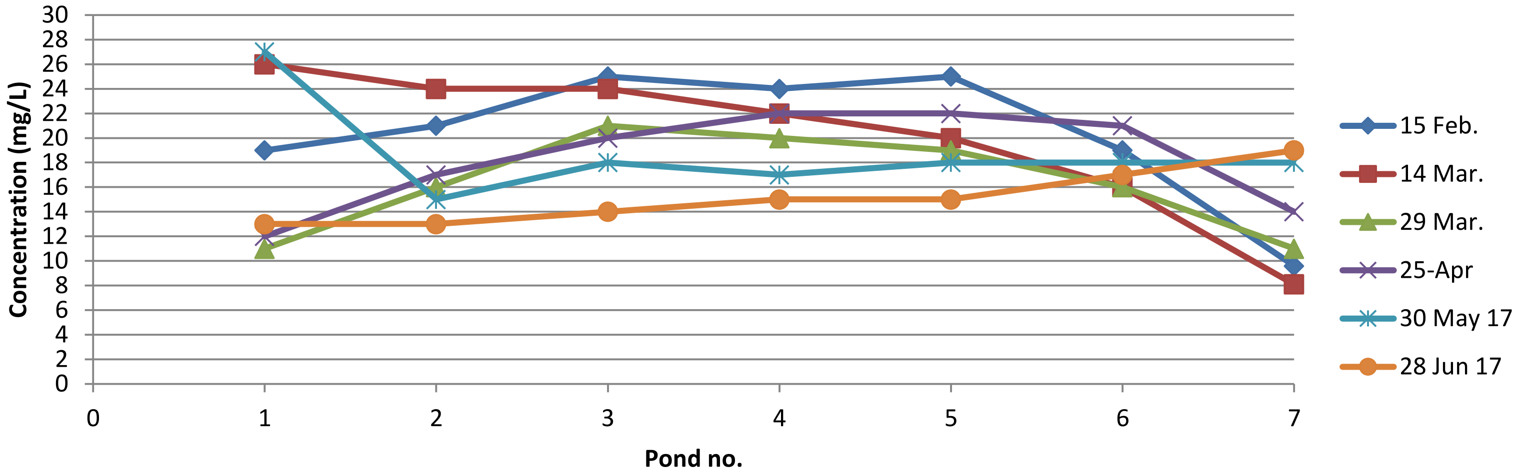
- Municipality focusing mainly on water quality data from Pond 7 only.
- SA research team have monitored Pond 1 – Pond 7 over couple of months – with focus on inflow data for microbiological.
- Pond 1 - Outflow microbiological and chemistry data.



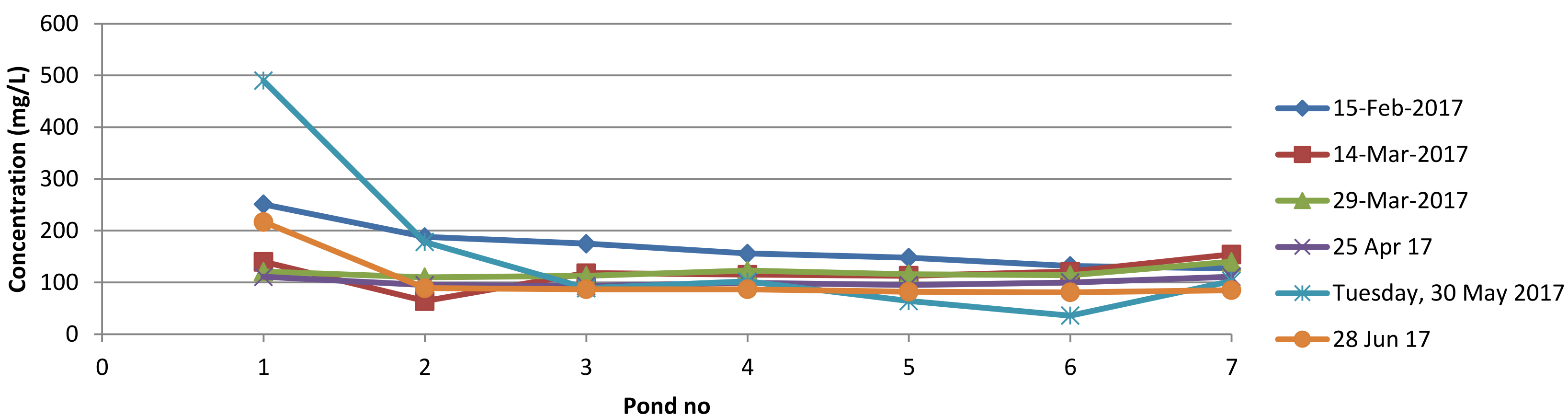

EC (mS/m @ 25 degrees)
300
250
200
150
100
50
0
0
1
2
3
4
5
6
7
15-Feb-2017
14-Mar-2017
29-Mar-2017
25 Apr 17
30 May 17
28 June 2017


pH
9
8.5
8
7.5
7
0
1
2
3
4
5
6
7
Pond no.
15-Feb-2017
14-Mar-2017
29-Mar-2017
25 Apr 17
30 May 17
28 June 2017

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 ito. 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 no 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.

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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

CSIR
irstea
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Office International de l'Eau
WATER RESEARCH COMMISSION
UNIVERSITY OF TWENTE. ITC FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION
WE & B Water, Environment and Business for Development
INTERNATIONAL NETWORK OF BASIN ORGANIZATIONS
WATERnet
Both ENDS Connecting people for change
akvo.org
2iE
WASCAL West African Science Service Center on Climate Change and Adapted Land Use
ICLEI Local Governments for Sustainability
Global Water Partnership
CSIR
WssTP
AfWA / AAE

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More information

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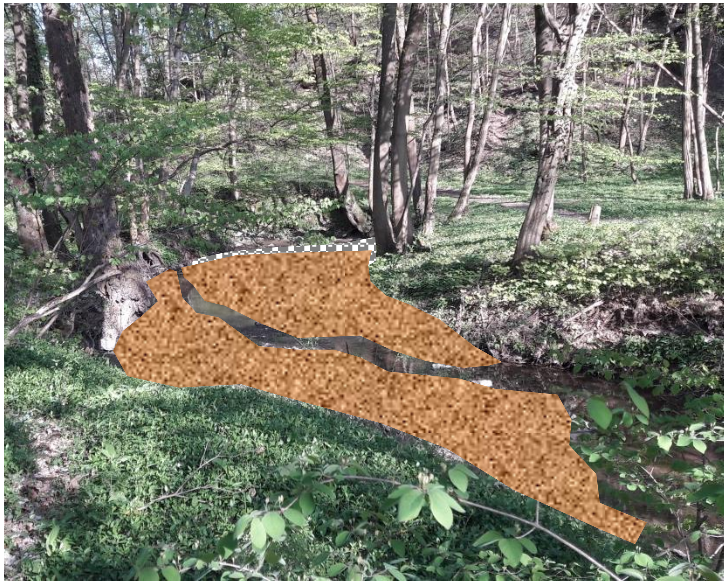
https://rsr.akvo.org/en/project/7677/



Septic tank design

--height x width x length = 4 m3 for 4 to 5 connected persons

- compact design preferred to limit space requirements