ECO-India

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Energy-efficient, community-based water- and wastewater-treatment systems for deployment in India

Agenda

- Project Overview
- Application of Geographical Information Systems for suitable site selection
- Community engagement and awareness
- Comparative analysis of roughing filter as pre-treatment for surface water
- Ecological surface water treatment
- Sustainable technology for removal of arsenic in rural areas
- Decentralized integrated approach for water and wastewater management
- Dissemination
- Research Outputs
- Cost-Benefit Analysis
- Conclusions

ECO-INDIA Research Team

Indian Consortium

- Jadavpur University Kolkata, School of Water Resources Engineering (JU)
- Indian Institute of Technology, Kharagpur (IIT)
- Super Technicians (ST)

European Consortium

- Tyndall National Institute (Tyndall-UCC)
- Trustwater Group (Trustwater)
- adelphi Research gGmbH (Adelphi)
- Danmarks Tekniske Universitet (DTU)
- Helmholtz-Zentrum fuer Umweltforschung GmbH (UFZ)
- Dryden Aqua Ltd (Dryden Aqua)
- AGM Communication & Control Ltd. (AGM)

Eco-India Objectives

Development of **community-managed** surface and groundwater based **sustainable water supply** system emphasizing water safety and security (Max. 165 m^3 per day).

Introduction of appropriate technology for **removal of contaminants** and up-gradation of surface and groundwater quality as well as evaluation of performance of **water purification system**.

Application of **off-line** as well as **online water quality monitoring** systems and their performance evaluation.

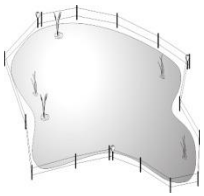
Conducting field based study for assessment of **technical feasibility, economic viability and social acceptability** of water management system introduced for the community.

Development of **low cost wastewater treatment** (Reed bed system) collected from dense populated rural cluster (Phase 3, awaiting completion)

Eco-India Schemes

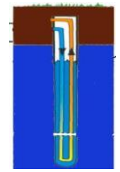
1 Water source protection

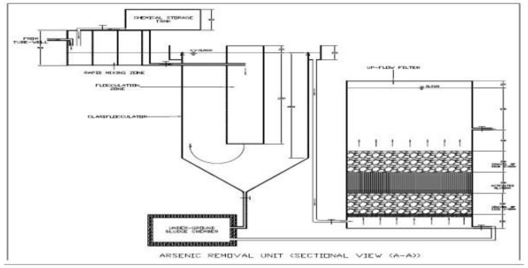
Ground-water aquifer



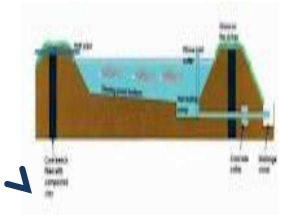
Surface-water sources

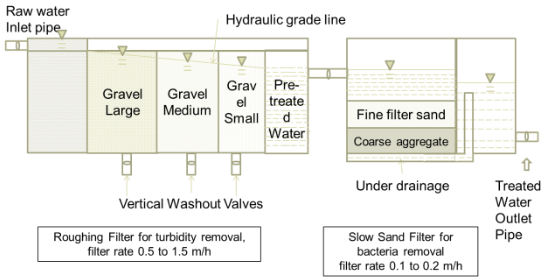
2 Ground Water Scheme



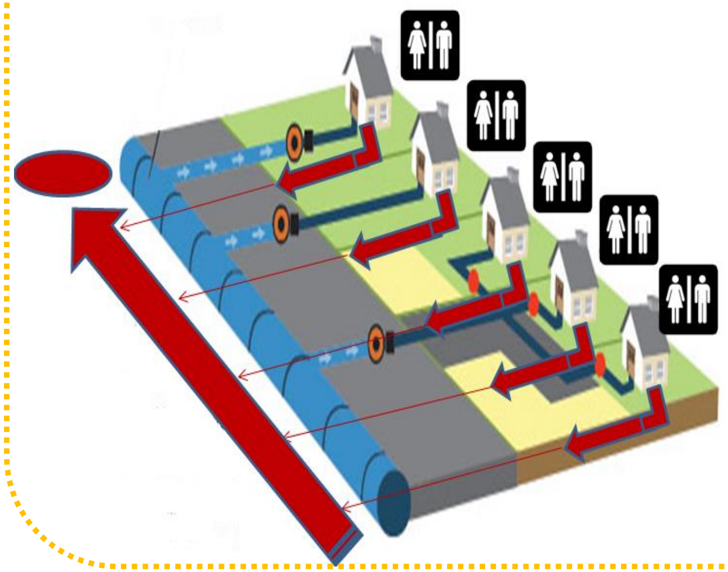


3 Surface Water Scheme

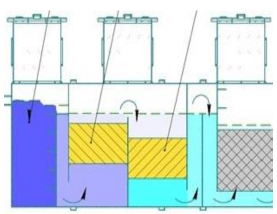


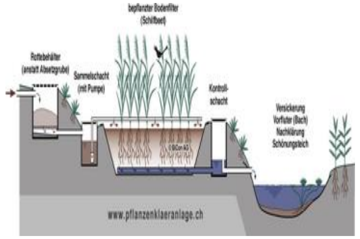


4 Integrated Scheme

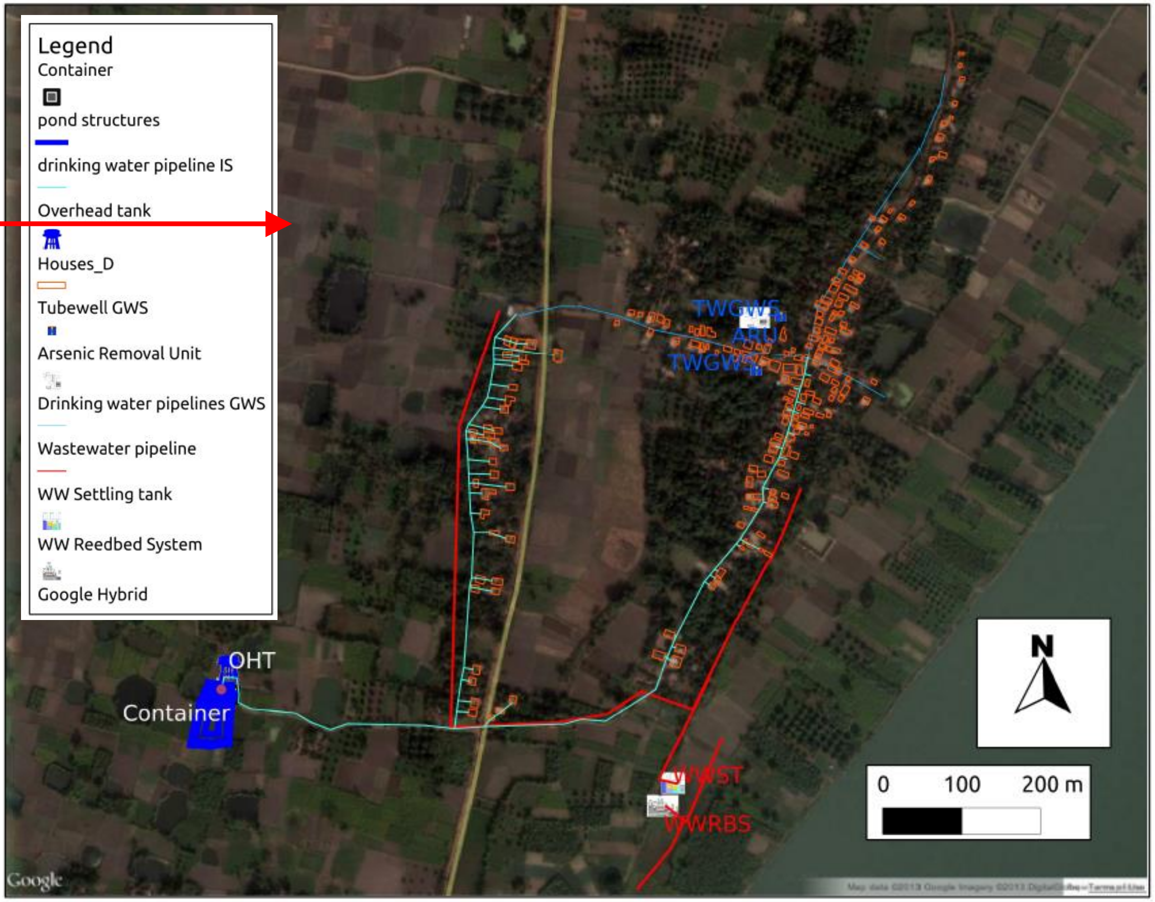


5 Waste water Treatment



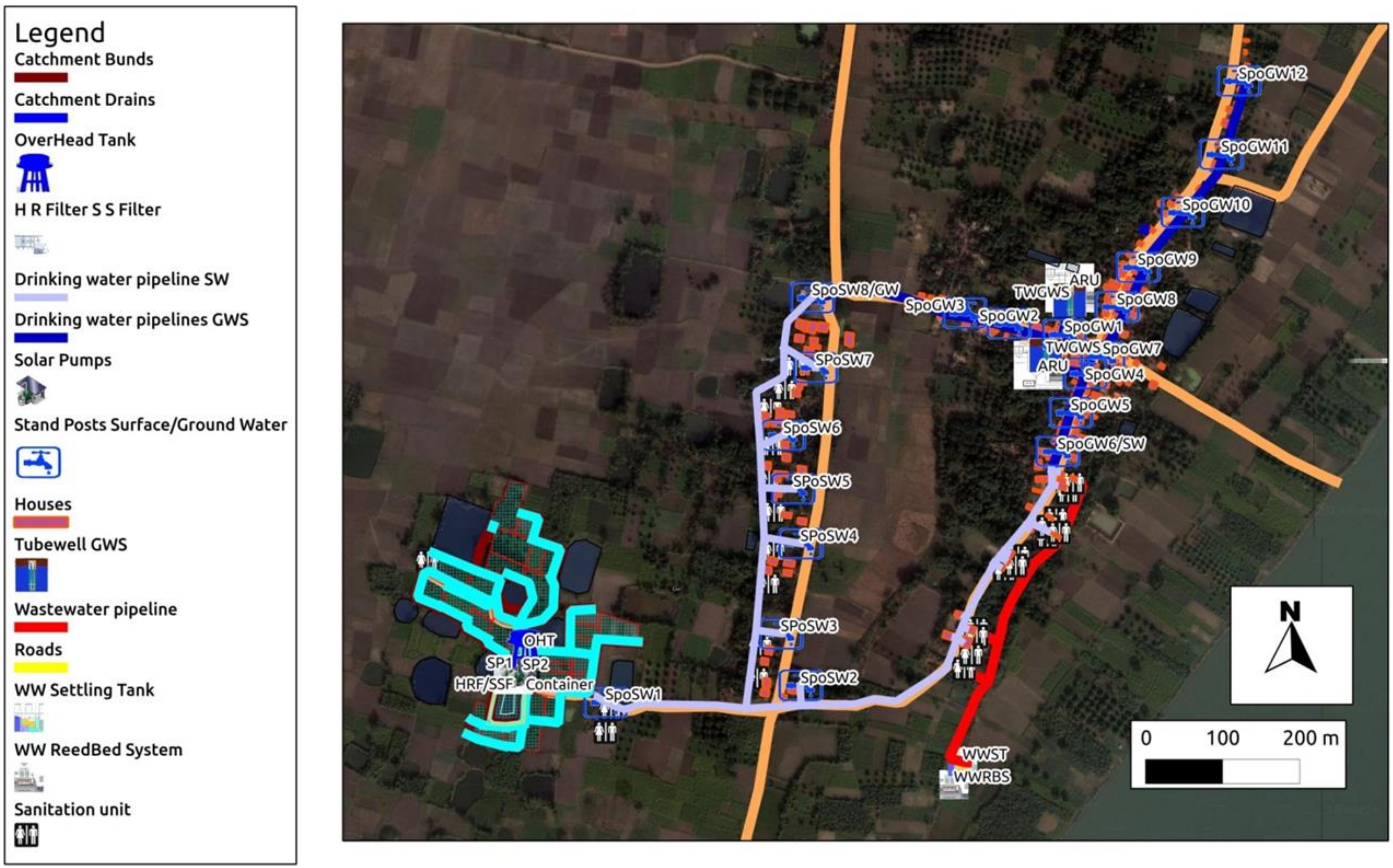


Study Area



Jyot Sujan, Murshidabad Region, West Bengal

Eco-India Pilot Site Plan

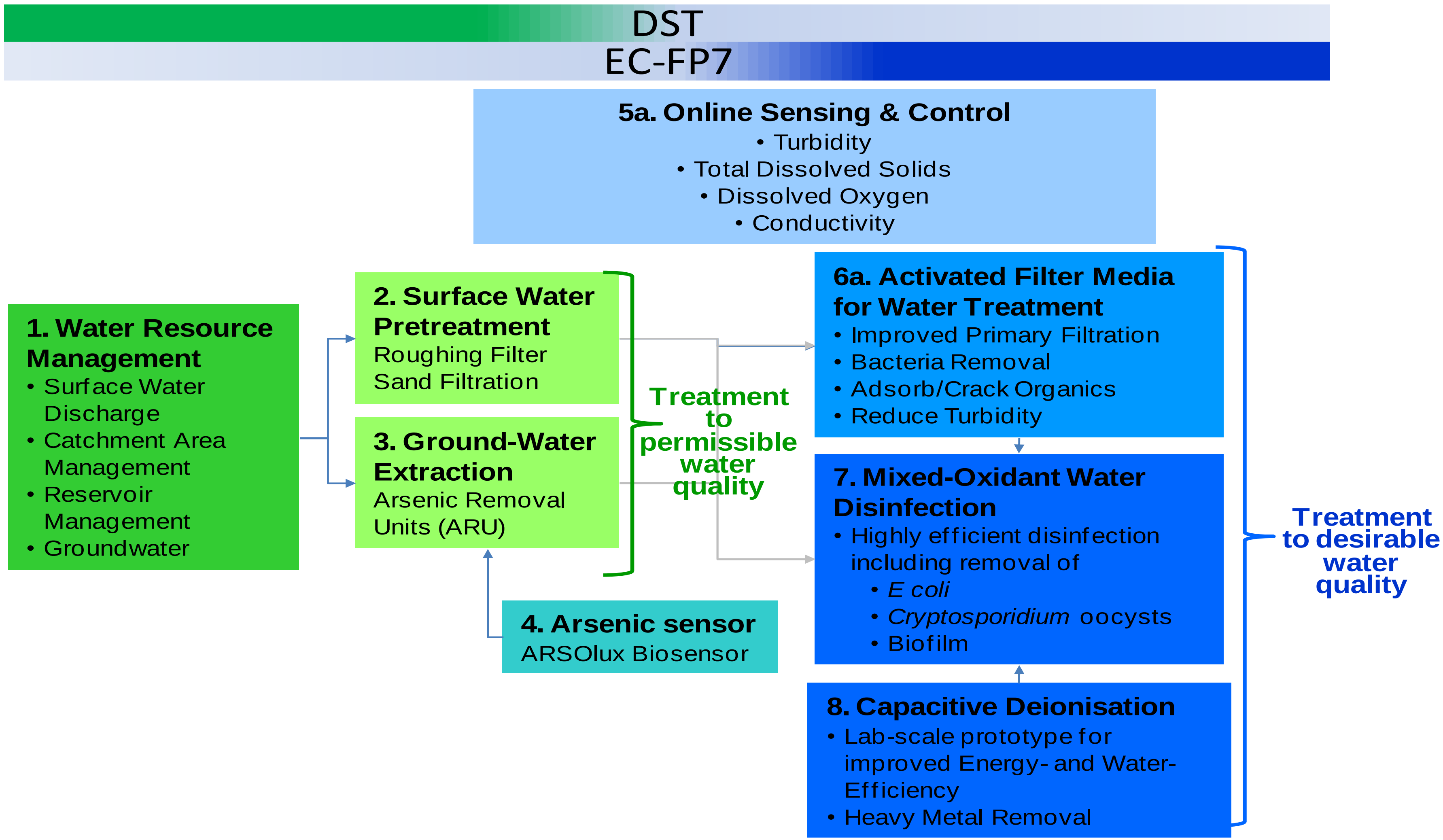


Need Assessment Water Committee Formation & workshop Organized

Participatory Rural Appraisal

Formation of Water committee

Overview


DST
EC-FP7
5a. Online Sensing & Control
• Turbidity
• Total Dissolved Solids
• Dissolved Oxygen
• Conductivity
1. Water Resource Management
• Surface Water Discharge
• Catchment Area Management
• Reservoir Management
• Groundwater
2. Surface Water Pretreatment
Roughing Filter
Sand Filtration
3. Ground-Water Extraction
Arsenic Removal Units (ARU)
4. Arsenic sensor
ARSOlux Biosensor
Treatment to permissible water quality
6a. Activated Filter Media for Water Treatment
• Improved Primary Filtration
• Bacteria Removal
• Adsorb/Crack Organics
• Reduce Turbidity
7. Mixed-Oxidant Water Disinfection
• Highly efficient disinfection including removal of
• E coli
• Cryptosporidium oocysts
• Biofilm
8. Capacitive Deionisation
• Lab-scale prototype for improved Energy- and Water-Efficiency
• Heavy Metal Removal
Treatment to desirable water quality

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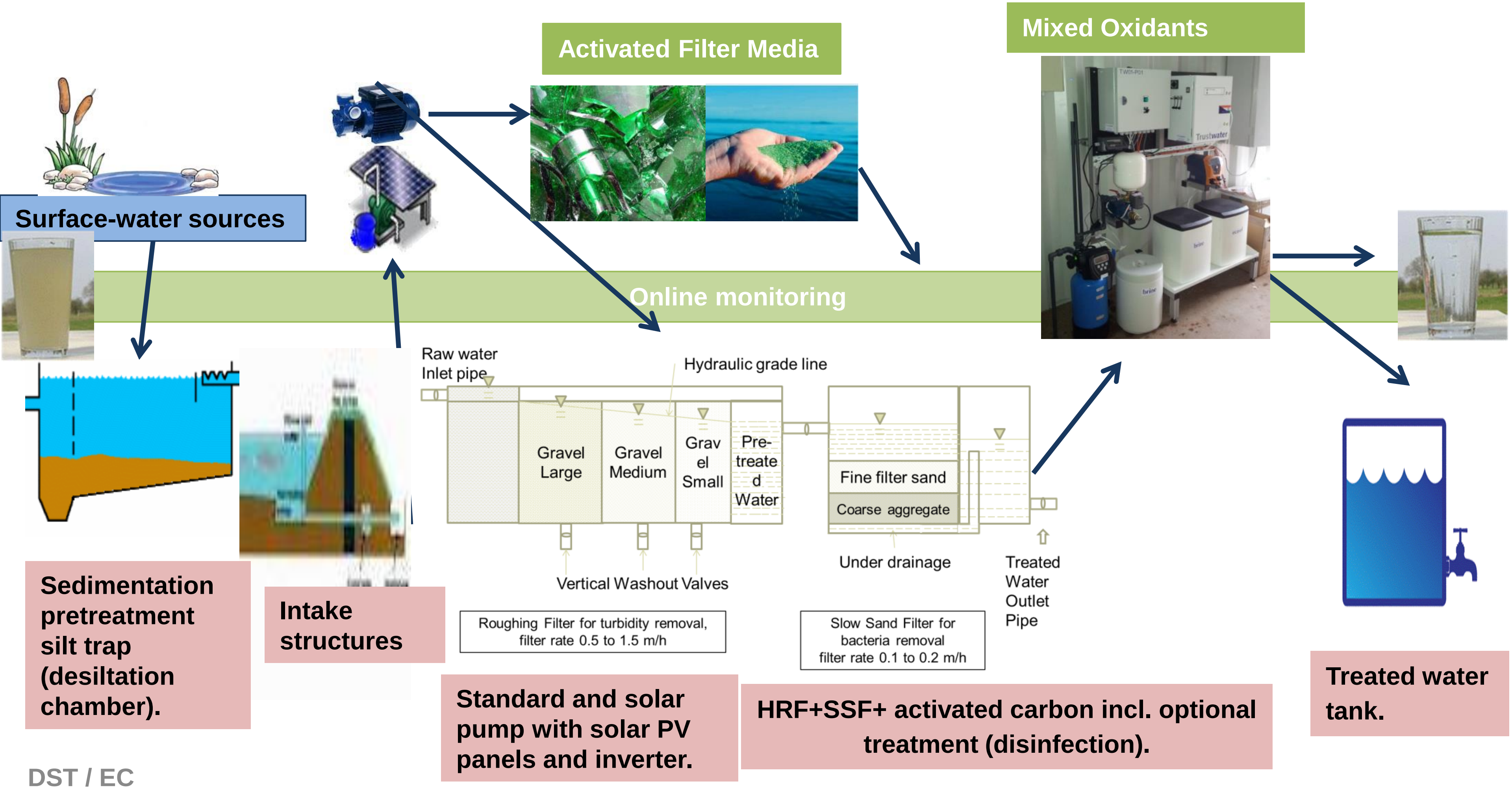
Schematic of surface water system
Maximum Capacity: 90 m³ per day



DST / EC

European Commission · Tyndall National Institute · Trustwater · adelphi · DTU · ARSOlux · DRYDEN AQUA · AGM

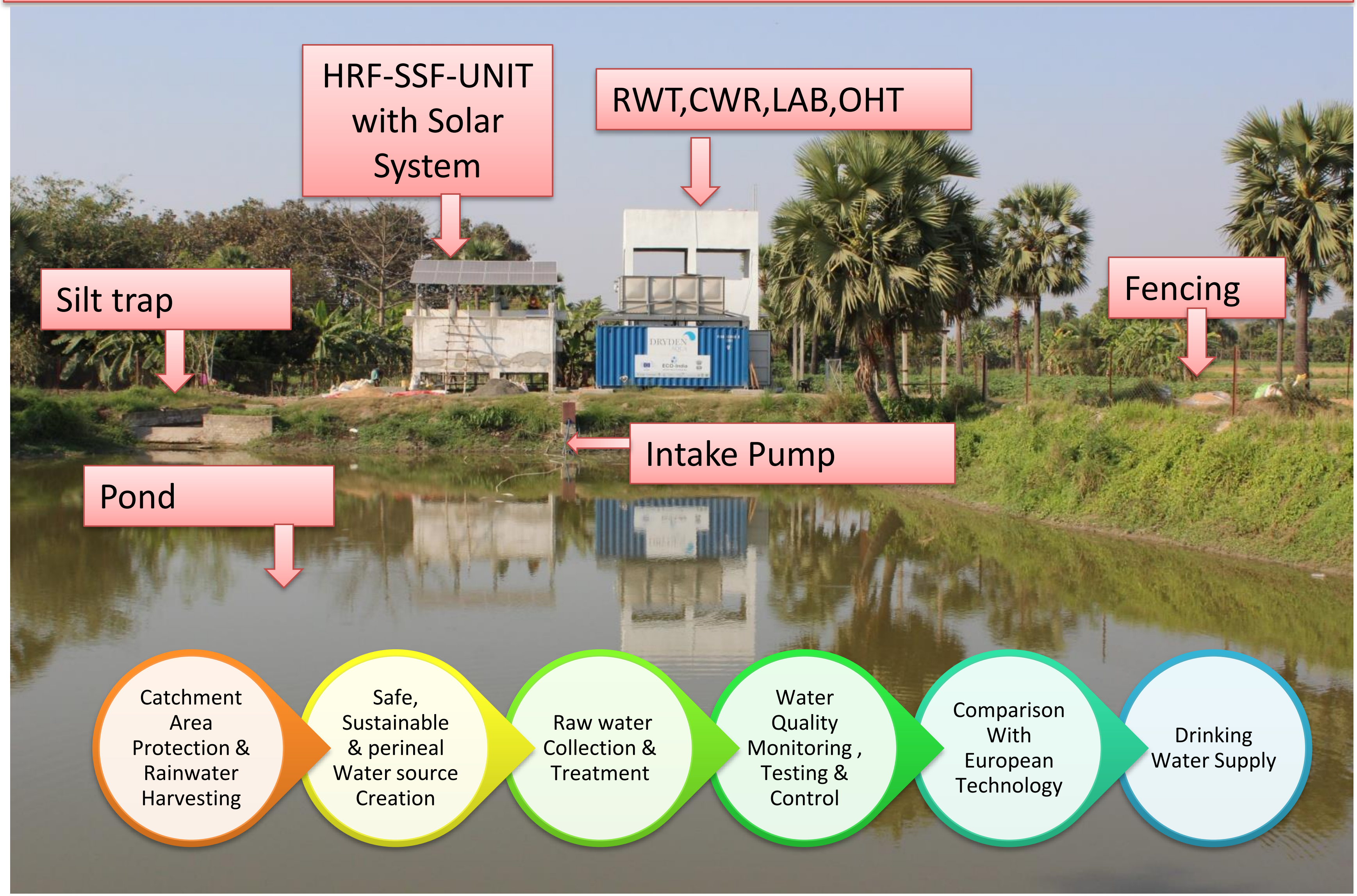






Surface Water Scheme Construction

Surface Water Scheme



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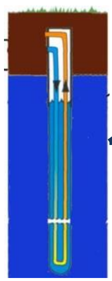
Ground water scheme. Maximum Capacity: 75 m^3 per day

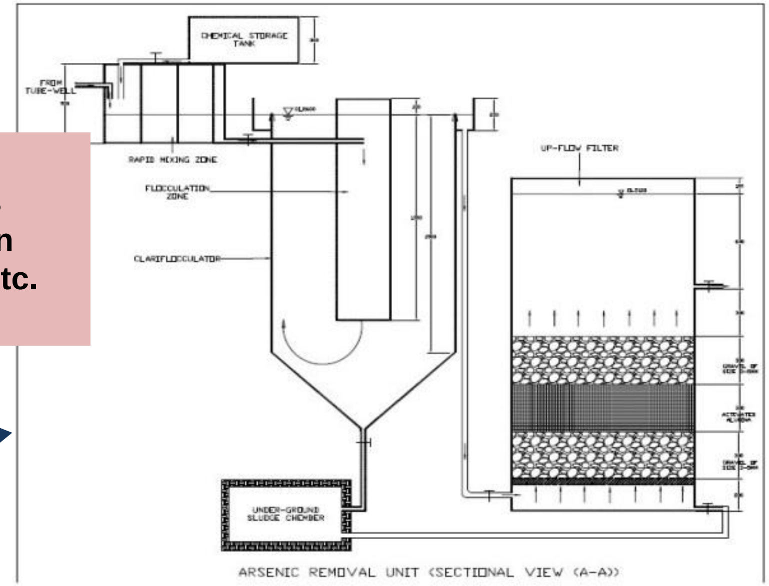
Arsenic Biosensor



Bore well rejuvenation and platform construction.

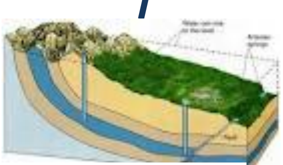
Standard pump.

Fabricated structure Items incl. installation and trial runs etc. for ARU.



AR sludge disposal unit, tclp testing (stabilization in anaerobic bioreactor).

Activated Filter Media



Ground-water aquifer

Treated water tank.

European Commission
Tyndall National Institute
Trustwater
adelphi
DTU
ARSOlux
DRYDEN AQUA
AGM

Groundwater Scheme Construction

Arsenic Removal Unit

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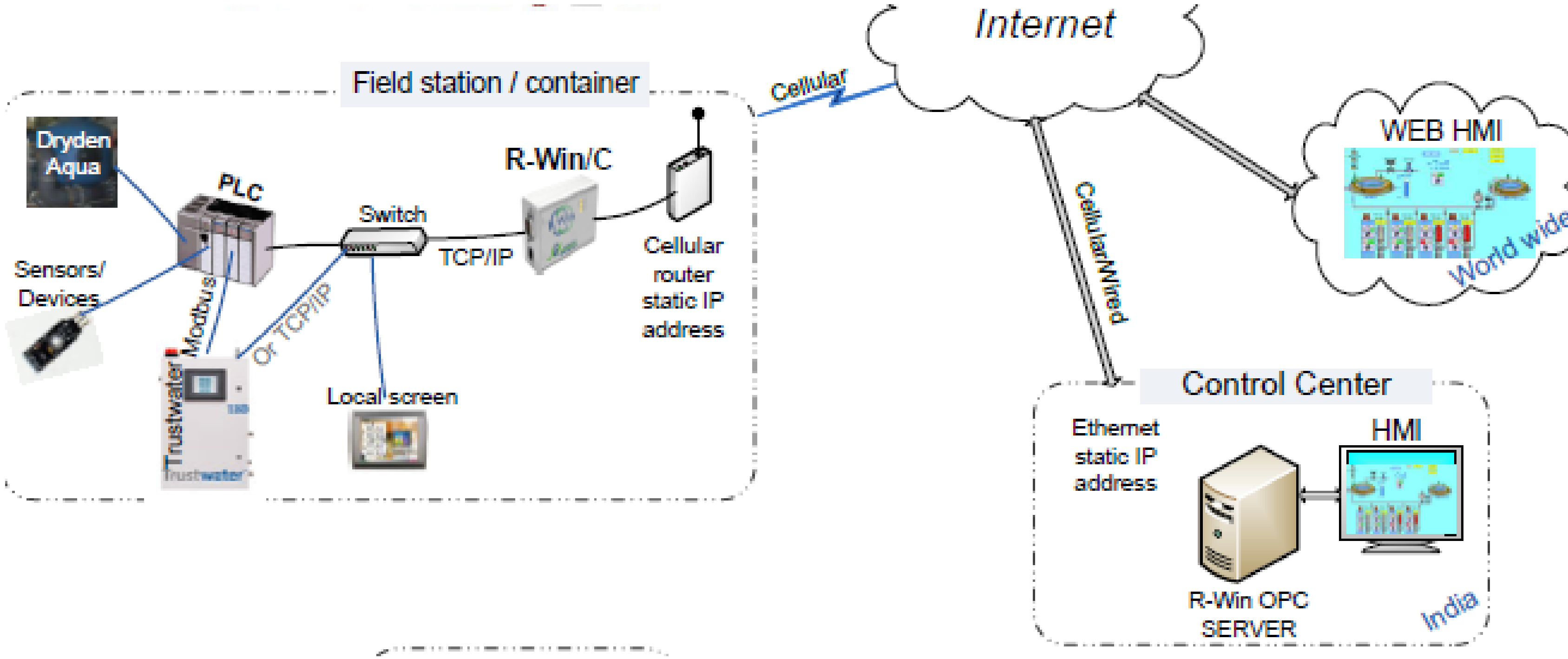
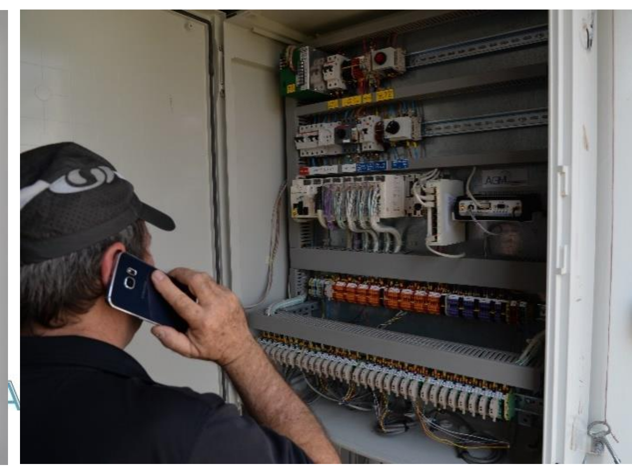
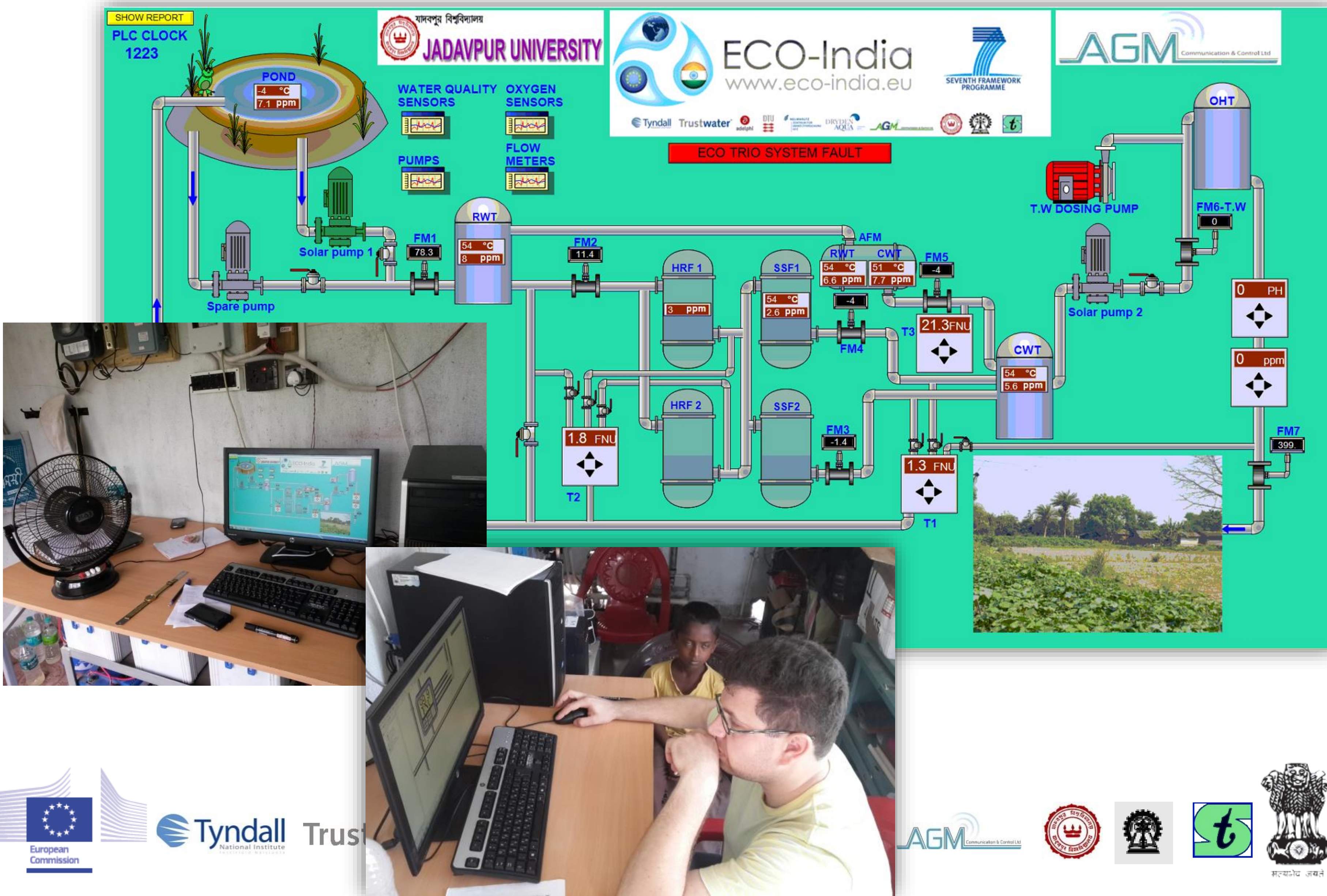
Online monitoring system





Online monitoring system

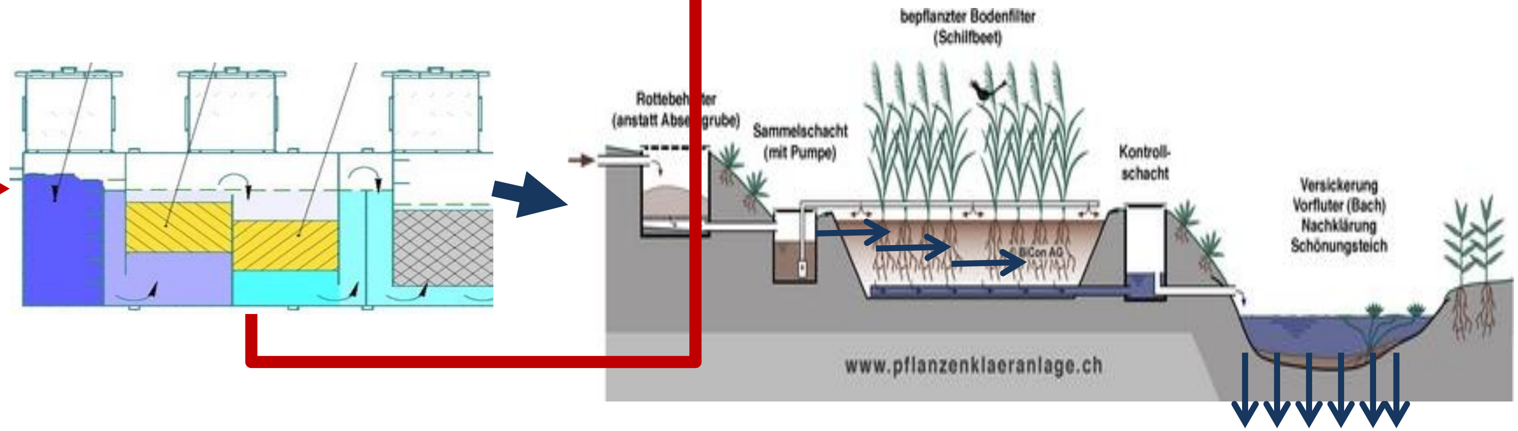


Wastewater treatment scheme

Collected waste water

Feasibility of energy harvesting through biogas production

Conceptualisation of Reed Bed Filter and exchange on German experience



Agricultural use / discharge

3 stage settling tank

Reed bed filter

[Eco-India Video]

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  Gourab Banerjee
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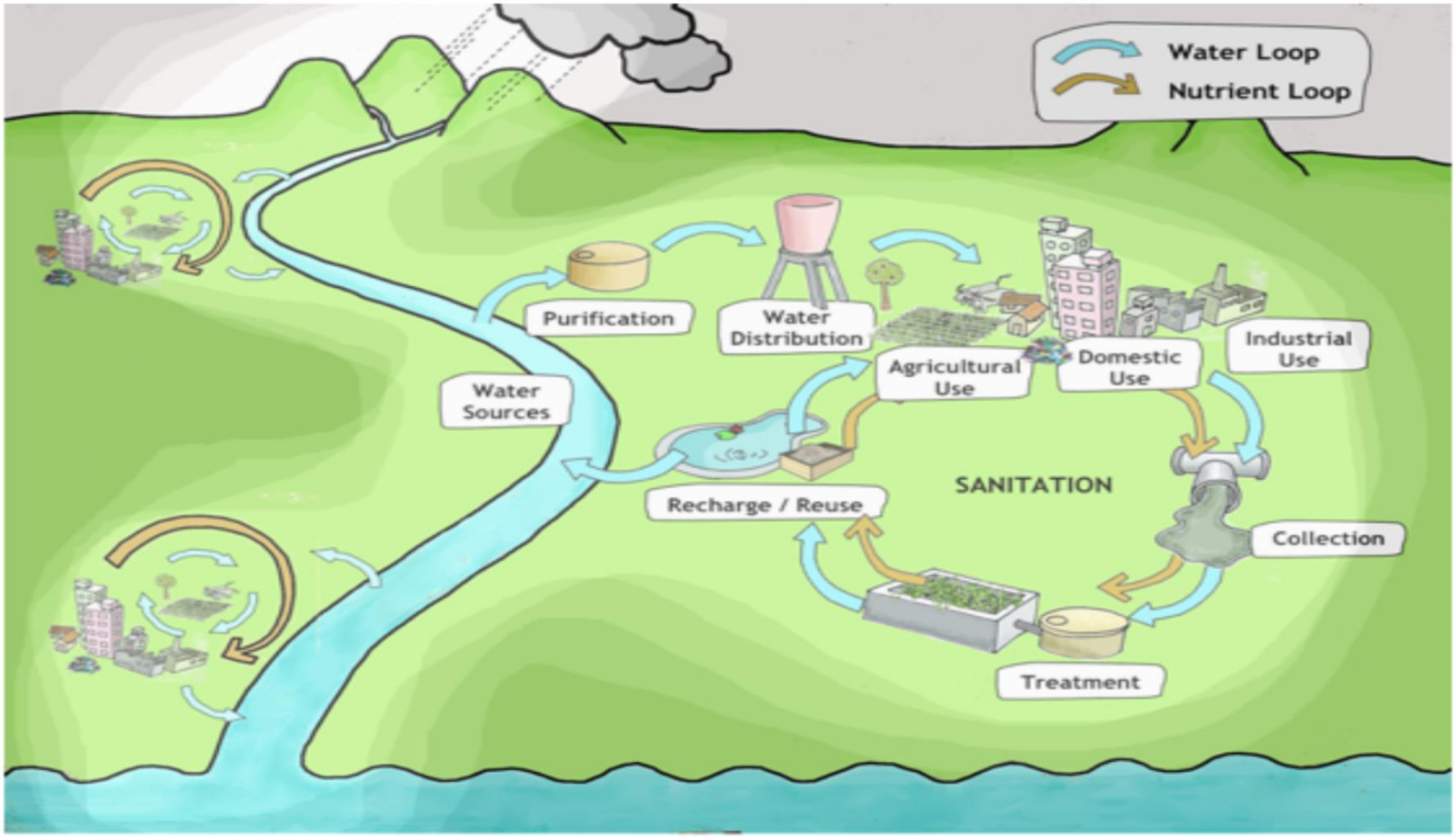
Key Features

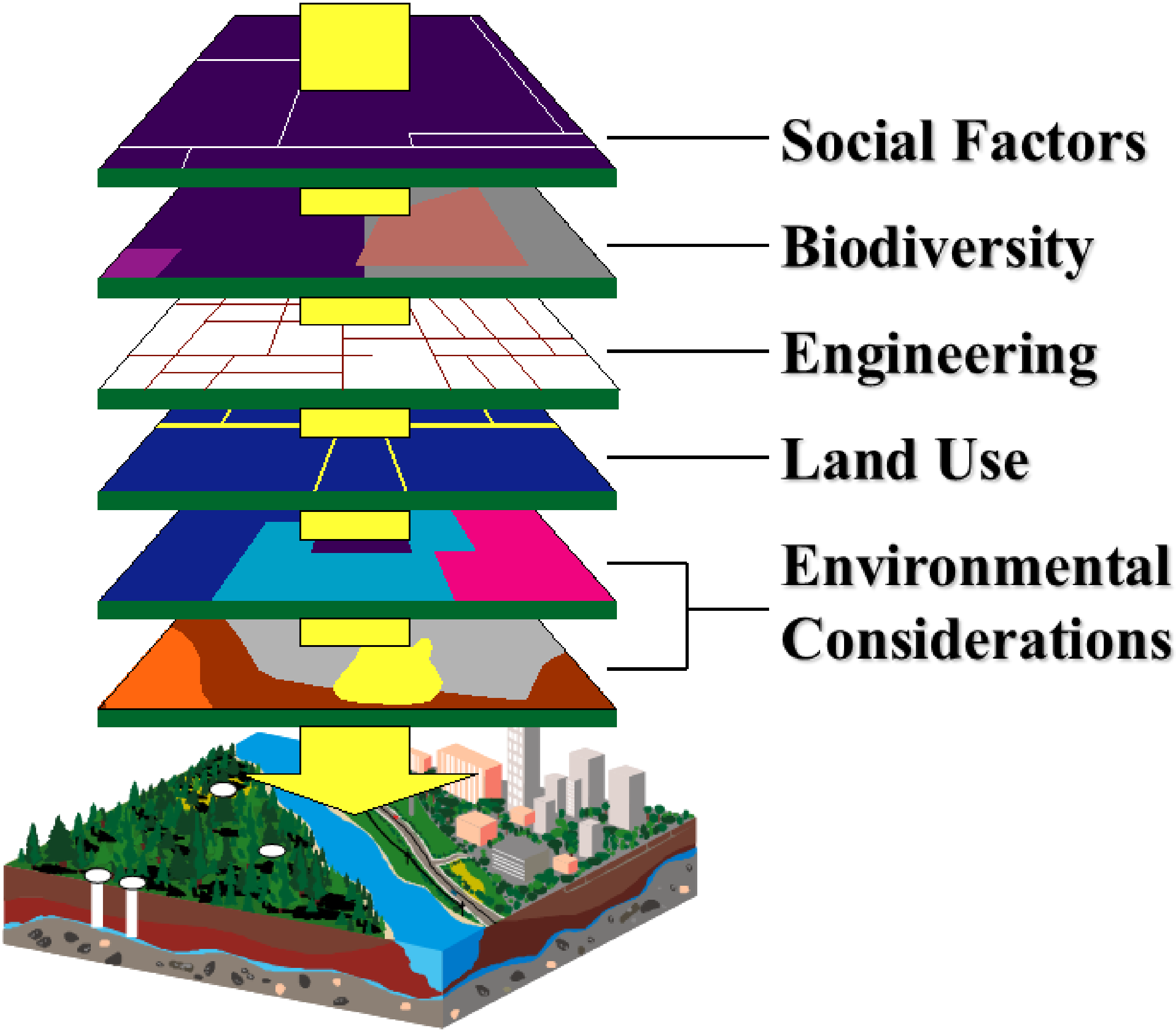
- Integrated Decentralized Water Treatment Plant.
- GIS & MCET
- Data collection & analysis
- Integration of Model
- Model development & Its application to ECO-India Project
- Output generation and prepare final planning
- Final Map with Selected Location & scheme.

INTEGRATED DECENTRALIZED WATER TREATMENT PLANTS



Could it be….?

Measuring and Integrating a multitude of attributes together to answer a common…



To Help See the Whole Picture

Key feature of GIS Application

Vision

- GIS Support for Right Decision at Right Time

Mission

- Providing the end users with the appropriate GIS services and tools to reduce cost, effort and time

Functions

- Maintain Data.
- Provide GIS Solutions.
- Elevate GIS awareness level.

- Adopt Latest GIS Technology.
- Manage GIS Database.
- Implement and Improve GIS Section's Procedures and Standards.

Selection of Initial Study Area

Basic Criteria

1. Environmental

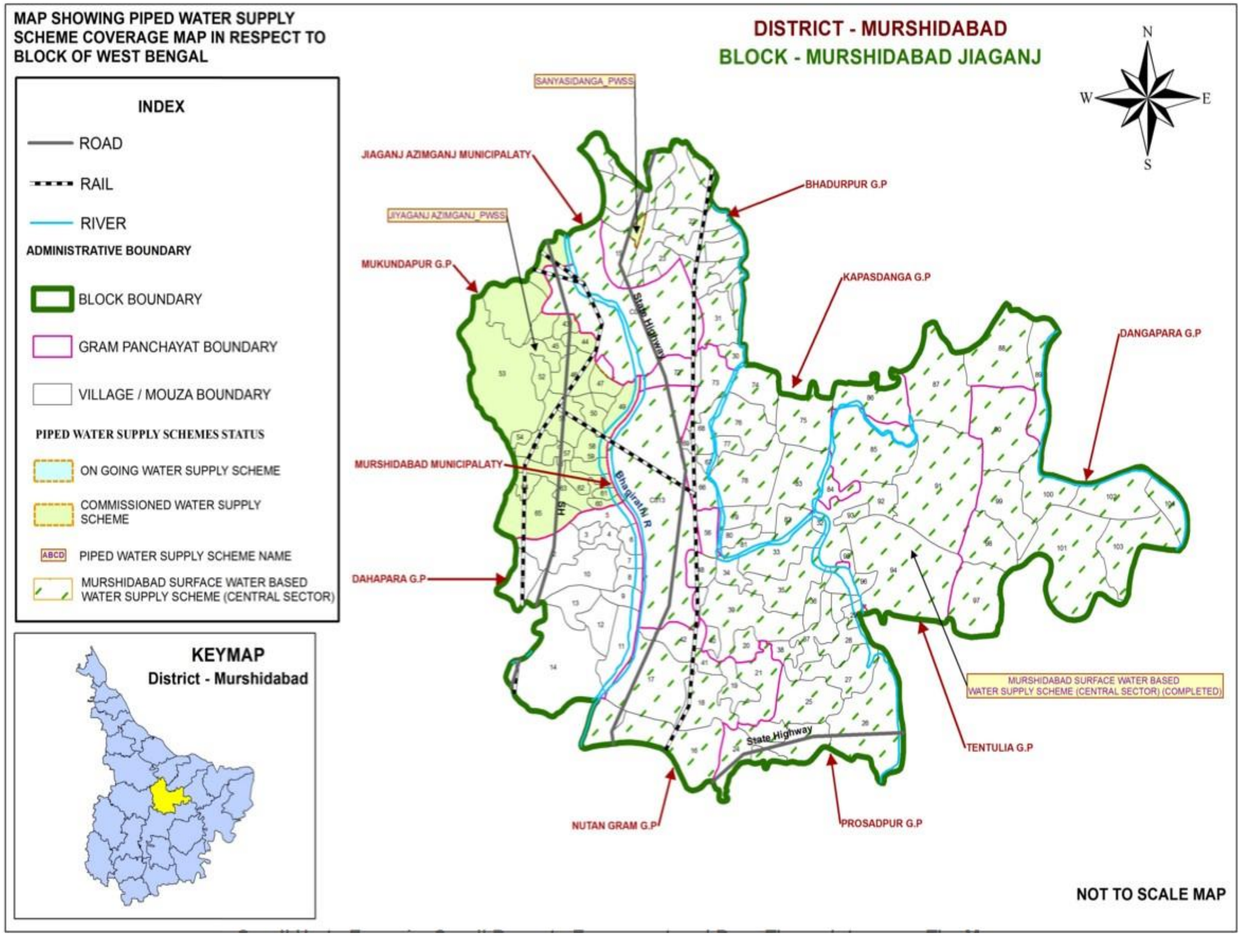
•Arsenic Contamination
•Population & their health condition of in contaminated area

2. Social & Administrative

•Absences of Institutional or public Water Supply Scheme
• Socio Economic

3. Technical & Physical Aspect

• Soil Characteristics
•Slope
•Hydrological & Hydro- geological
•Drainage pattern
•Land Use pattern
•Cost investment
• Technology option



Attribute Data Collection

Collection social Information

GPS Survey

Surface water Quality Survey

Groundwater Quality Survey

Contour survey

Hydro geological Survey

Infiltration Testing

Interaction with Villager

Technology Options

MCET(AHP)

MCET = Multi-criteria evaluation Technology is primarily concerned with how to combine the information from several criteria to form a single index of evaluation Technology

Decisions: a choice between alternatives

Criterion: some basis for a decision. Two main classes:

- **Factor**: *enhances* or *detracts* from the suitability of Location
- **Constraint**: *limits* the alternatives

Goal or target: some characteristic that the solution must possess (a positive constraint)

ANALYTIC HIERARCHY PROCESS (AHP)

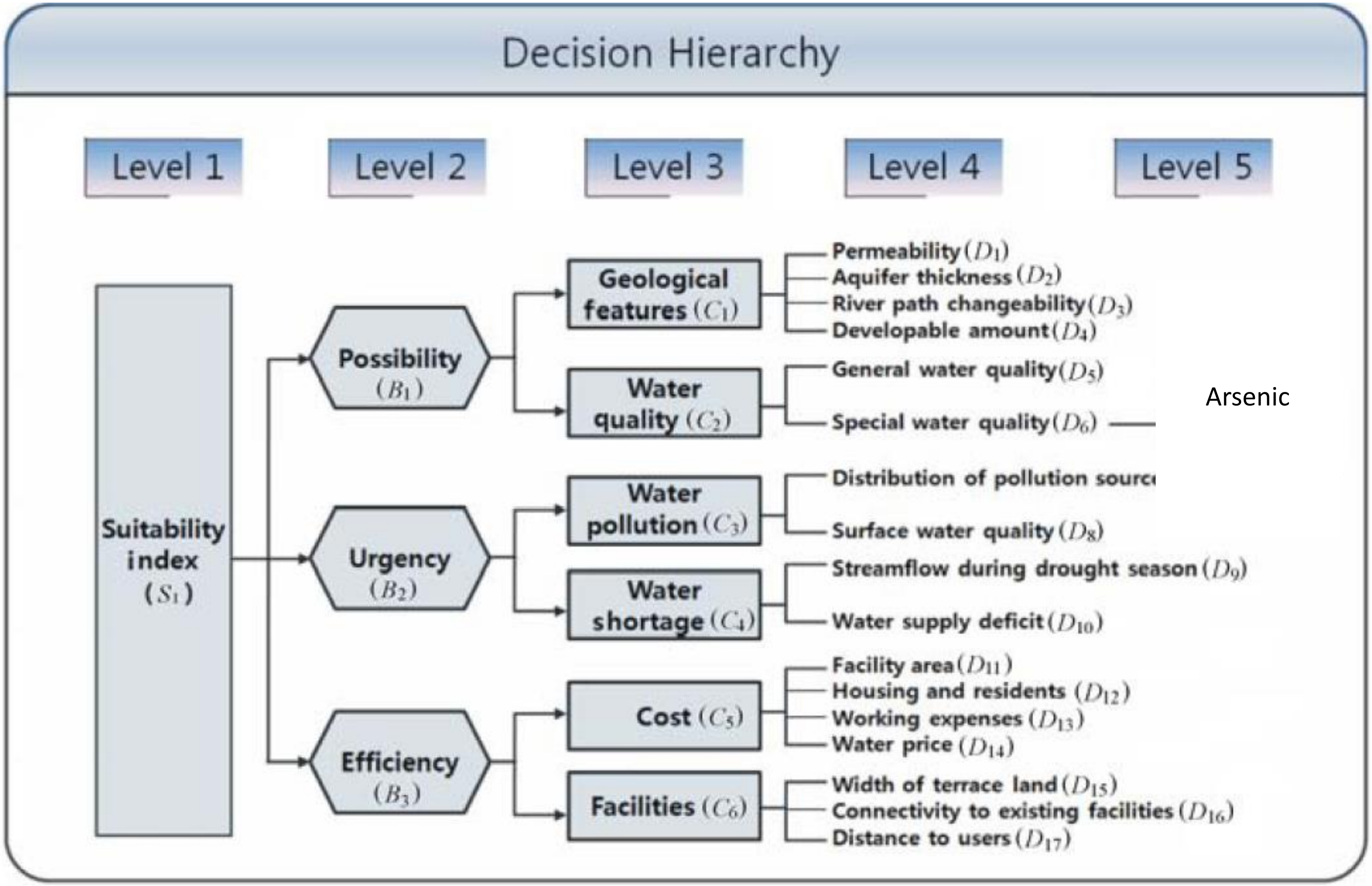
The analytic hierarchy process (AHP) was developed by Thomas L. Saaty.

Saaty, T.L., The Analytic Hierarchy Process, New York: McGraw-Hill, 1980

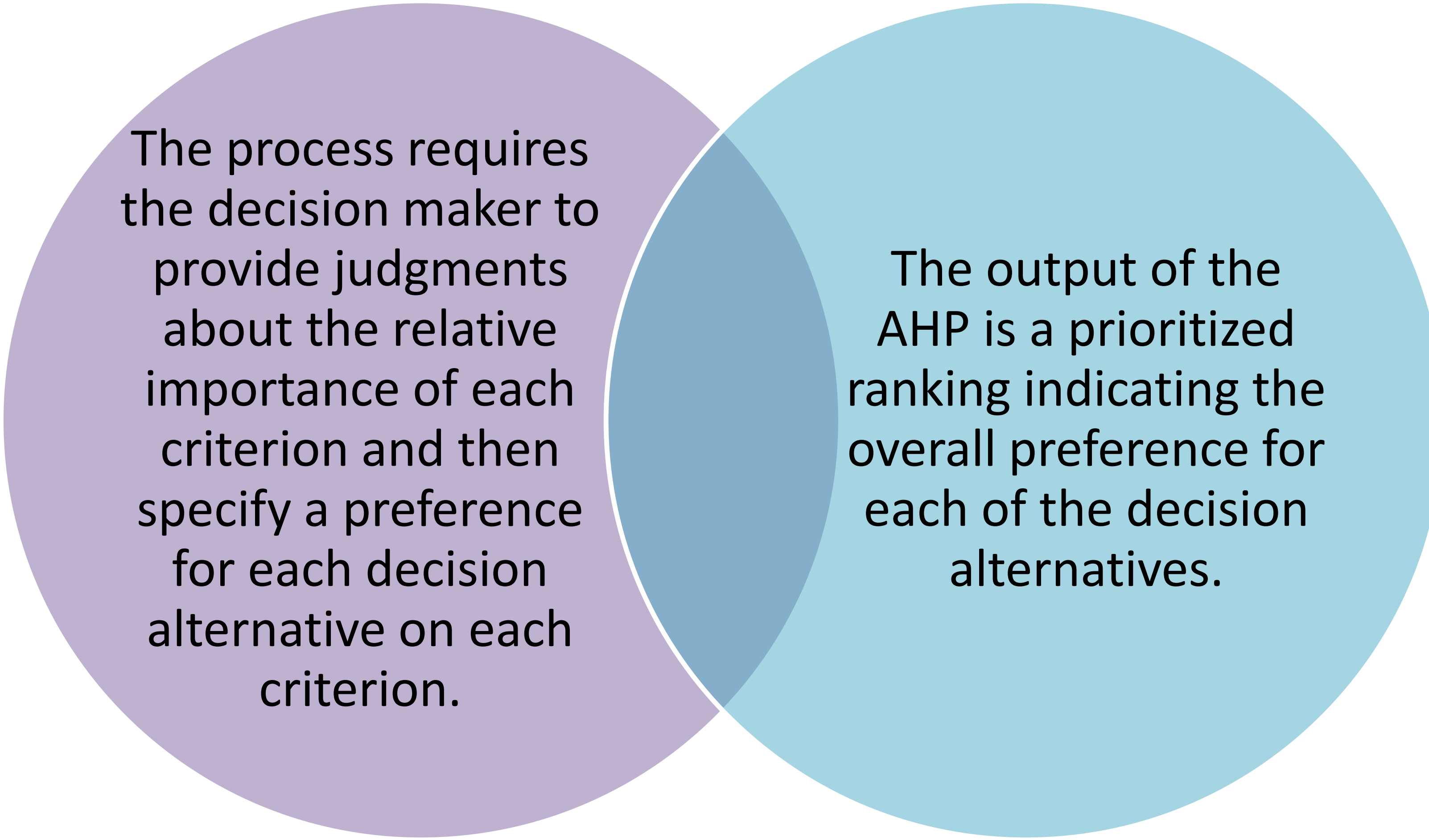
The AHP is designed to solve complex problems involving multiple criteria.

An advantage of the AHP is that it is designed to handle situations in which the subjective judgments of individuals constitute an important part of the decision process.

Elements Of Analysis of Site Suitability For INTEGRATED Decentralized Water Treatment Plants.



Process justification



Major Steps of AHP

1) To develop a graphical representation of the problem in terms of the overall goal, the criteria, and the decision alternatives. (i.e., the hierarchy of the problem)

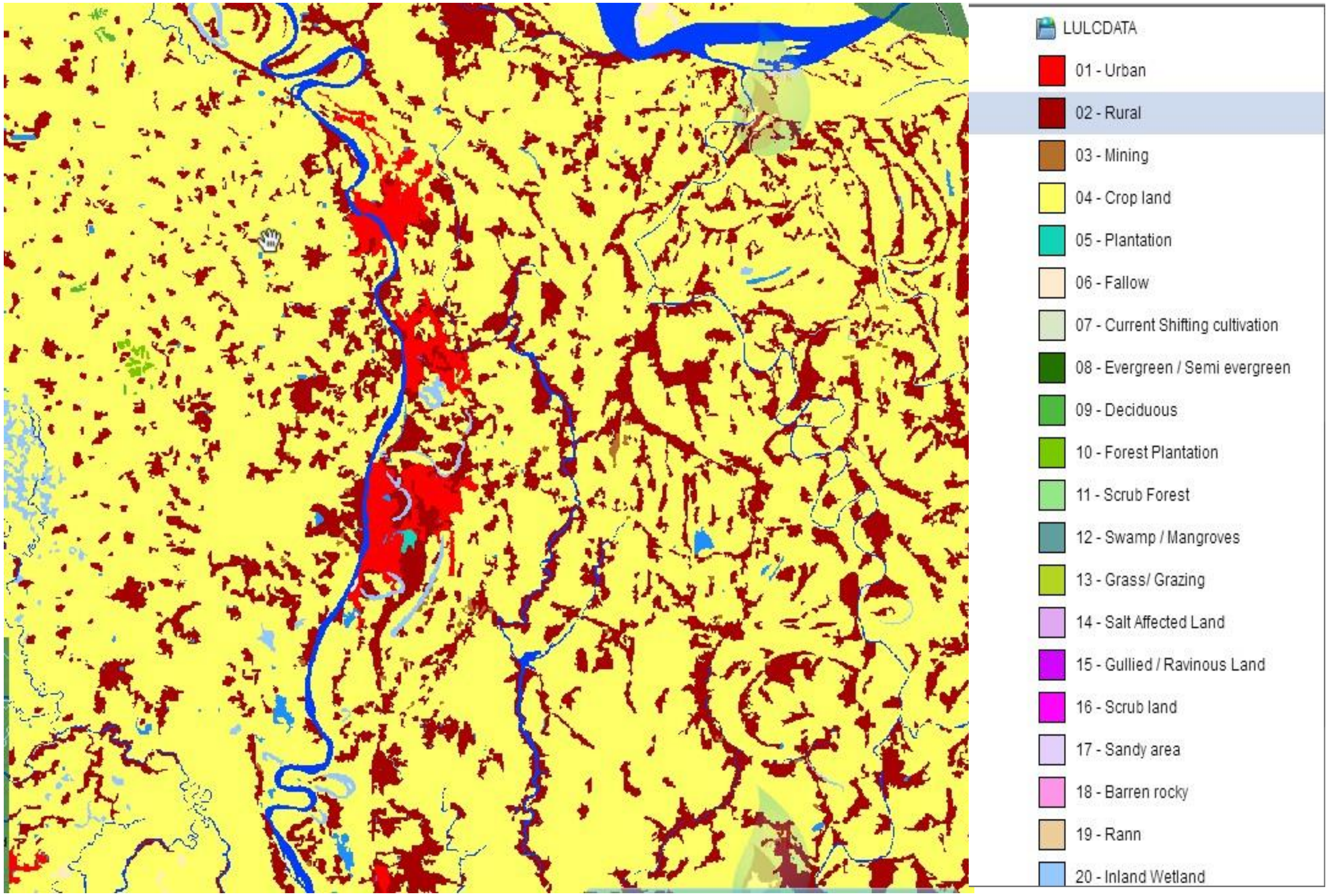
2) To specify his/her judgments about the relative importance of each criterion in terms of its contribution to the achievement of the overall goal.

3) To indicate a preference or priority for each decision alternative in terms of how it contributes to each criterion.

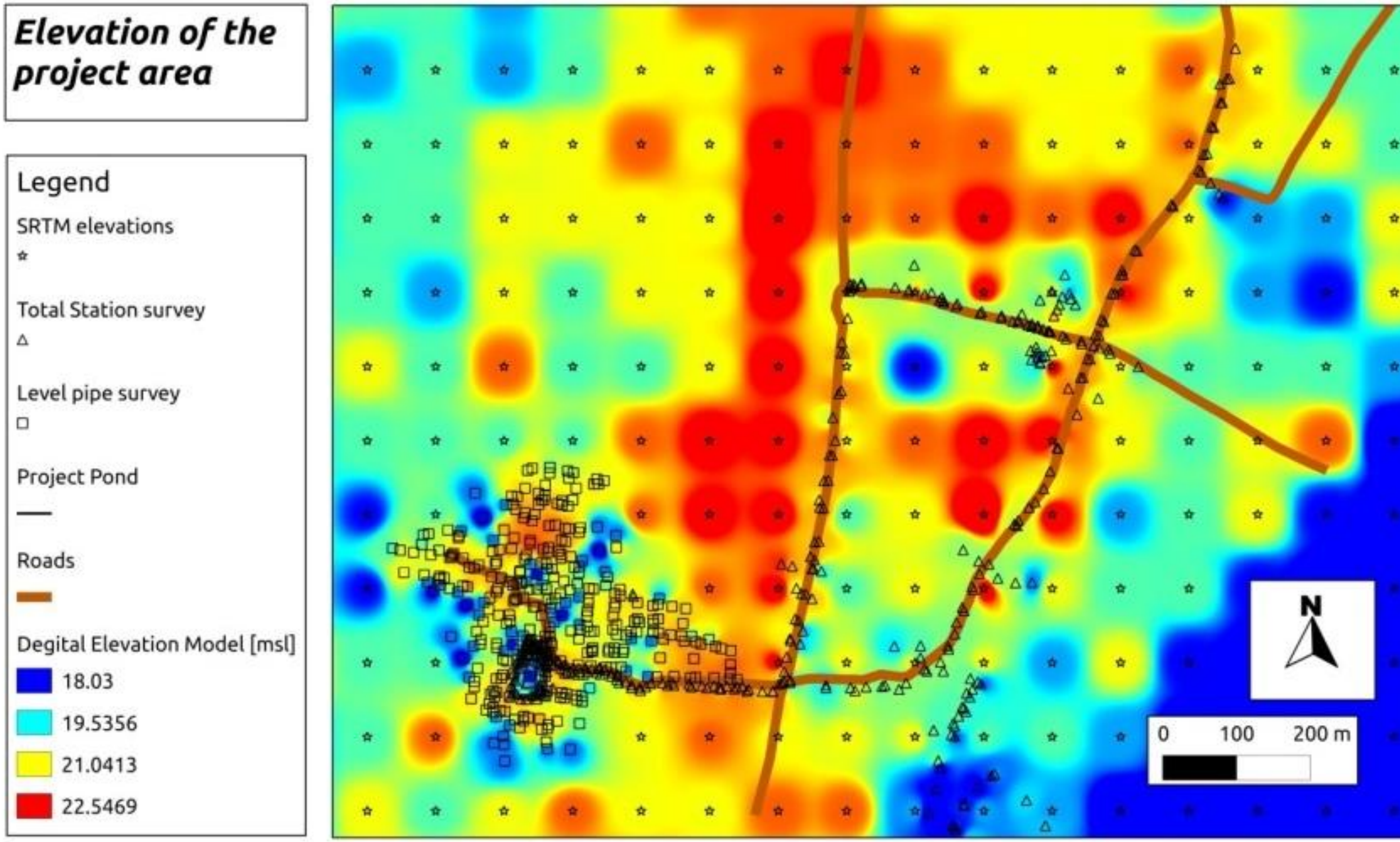
4) Given the information on relative importance and preferences, a mathematical process is used to synthesize the information (including consistency checking) and provide a priority ranking of all alternatives in terms of their overall preference.

DEM & Drainage Pattern Map

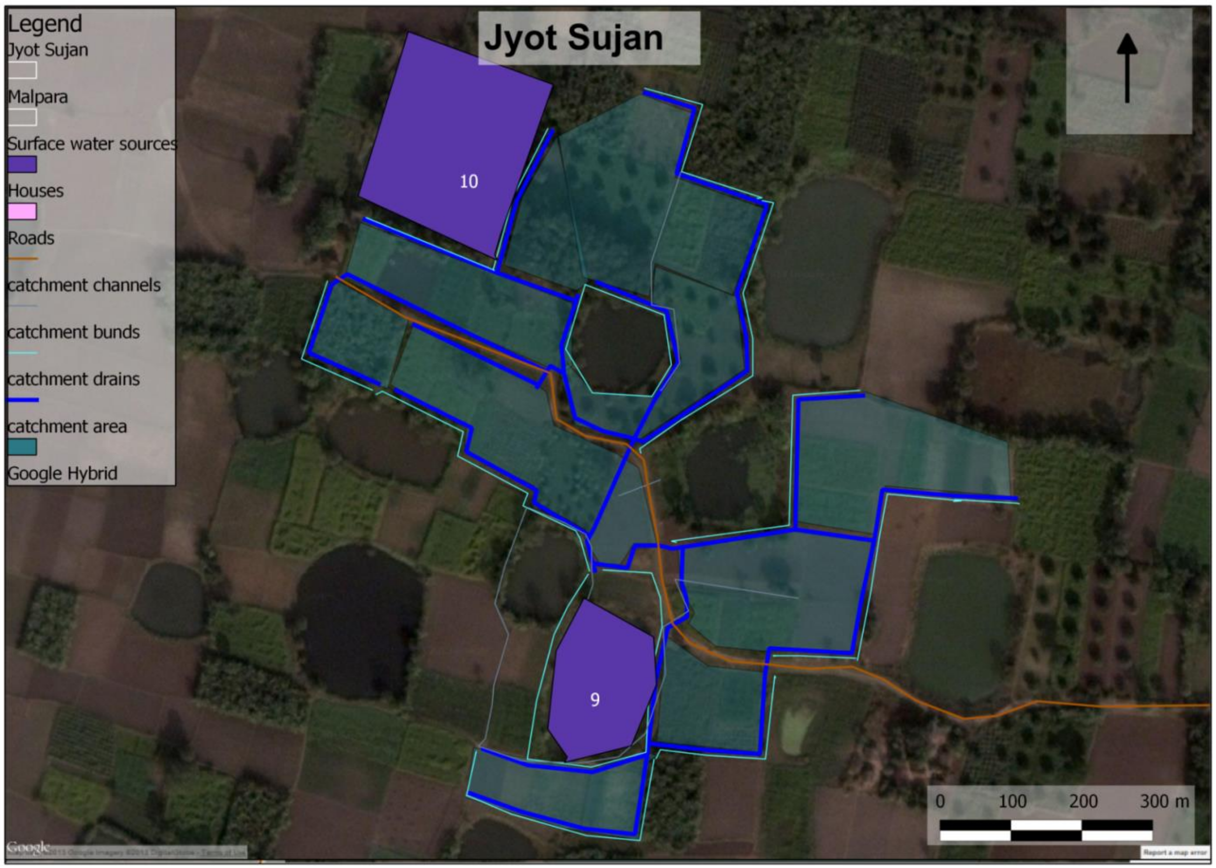
Land Use Pattern Map



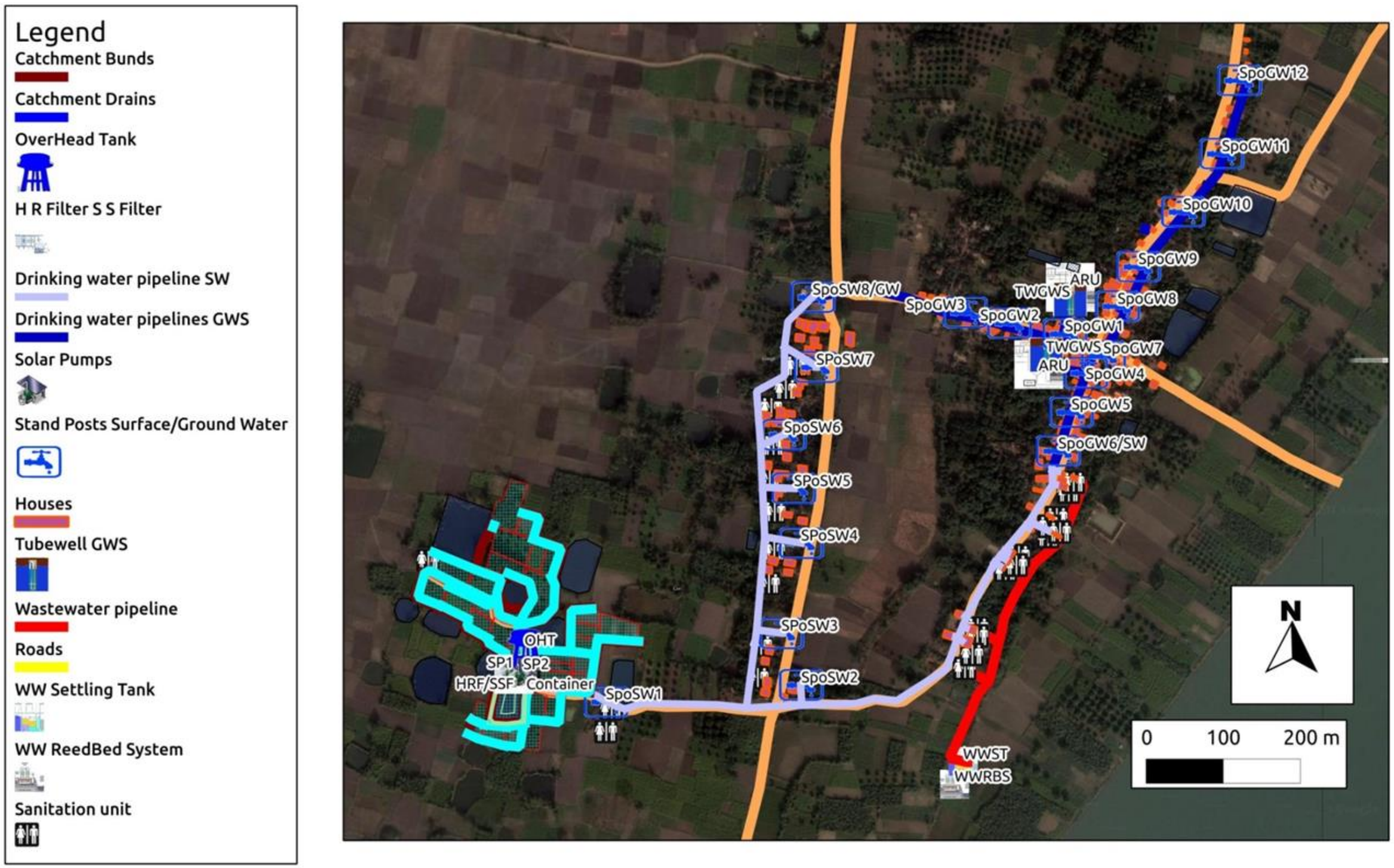
Elevation model with selected Project Component



Catchment Area



Final Scheme Map of Eco-India Proje



Outcome of GIS Applications

- **Integrated decentralized treatment plant is very much suitable for current scenario in rural India.**
- **Cluster of Integrated decentralized treatment system provide best water resource management option.**
- **The capital investment and operation and maintenance of this type of system will provide a better living environment and hygiene in rural areas. Combined application of AHP and GIS best decision for IDTP in best location.**
- **Majorly six criteria were selected Such as land use pattern, slope, population, soil, technology option and cost. A Paired comparison matrix were prepared for criteria clasess and individual classes and map score were evaluated.**
- **These weights were applied in linear summation to obtain overplayed weight map or priority base map.**
- **At the end all the weighted map were overlaid and modified to achieve the best potential site. In the current study along the murshida bad jiaganj block location selected for IDTP is JyotSujan Village.**

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  Ronjon Chakraborti & Gourab Banerjee
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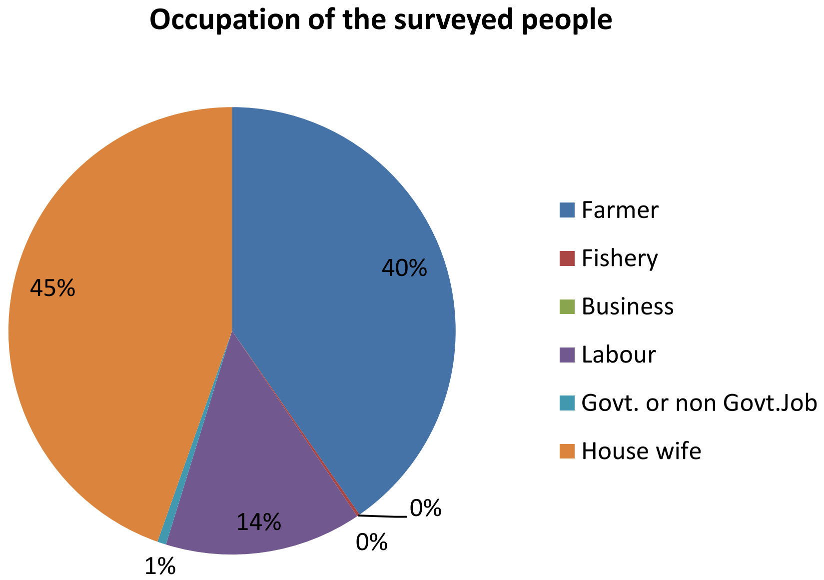
Creation of Water Committee

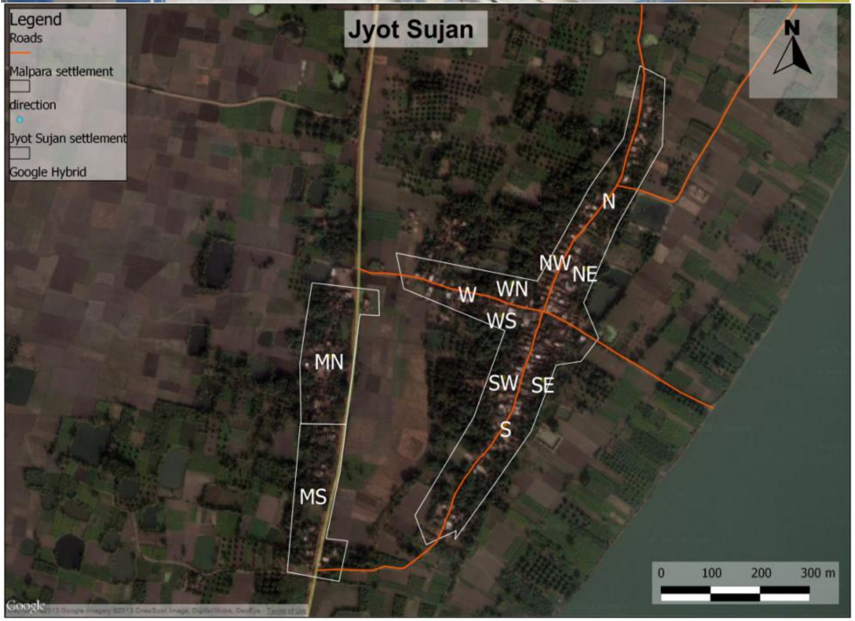
Criteria for the members of the Water Committee

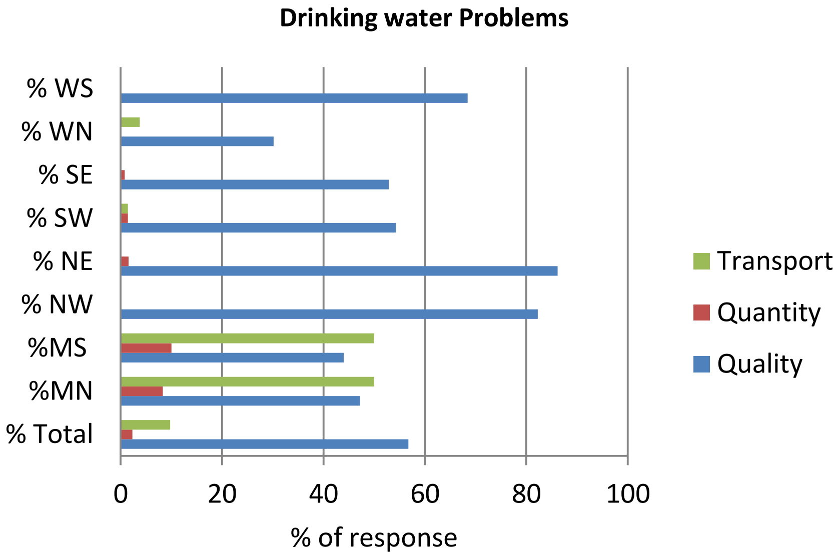
- Owners of ponds, tubewells and lands involved in the water supply scheme
- Elected representatives
- Representatives of each group of the community
- Proactive people of the community
- Technical experts
- Health centre and school representatives
- At least 50% of the members are women
- Eco-India project members

Water Committee Working Group Roles	
1	Documentation and taking of minutes (female).
2	Assessment and information collection .
3	Working out consents and approvals for the usage of land.
4	Regular communication with JU /adelphi.
5	Sample collection / water quality monitoring.
6	Working out WC budget, fee structure and collection of user fees.
7	Book keeping, opening and managing a bank account (female).
8	Catchment area protection, management and monitoring.
9	Technical operatorion in charge of technical planning, implementation and maintenance.

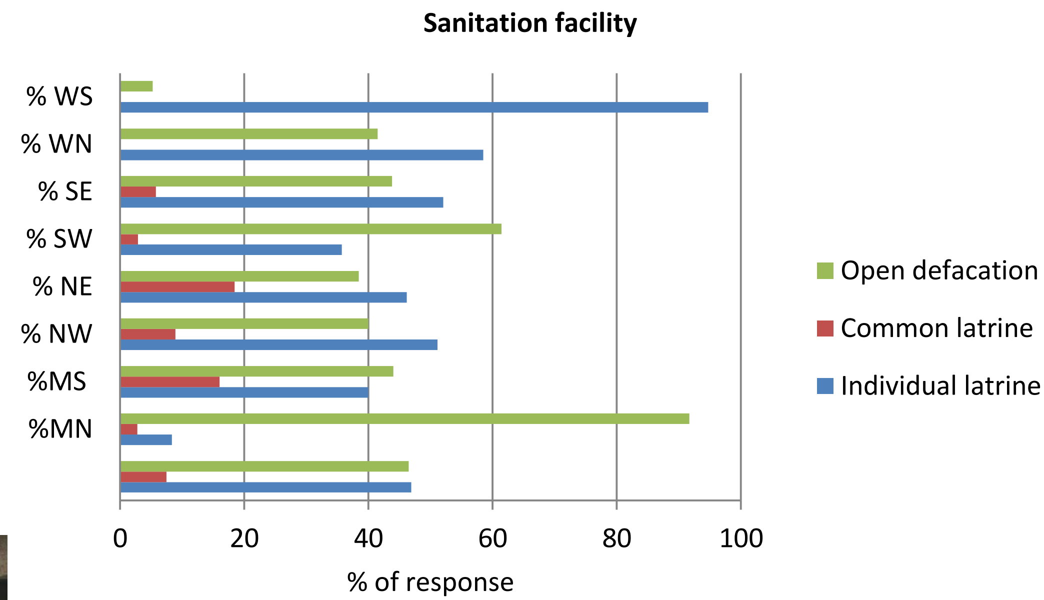
NA results: Occupation and drinking water problems

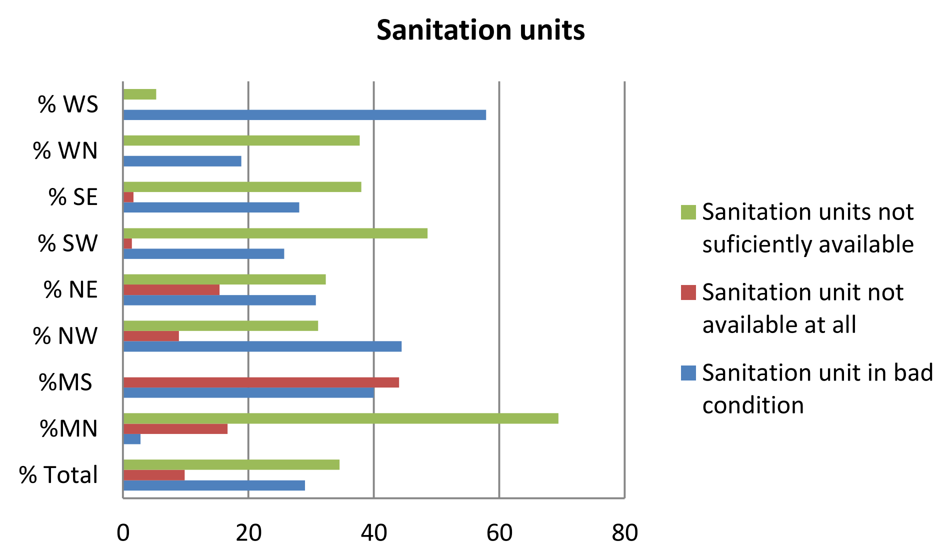




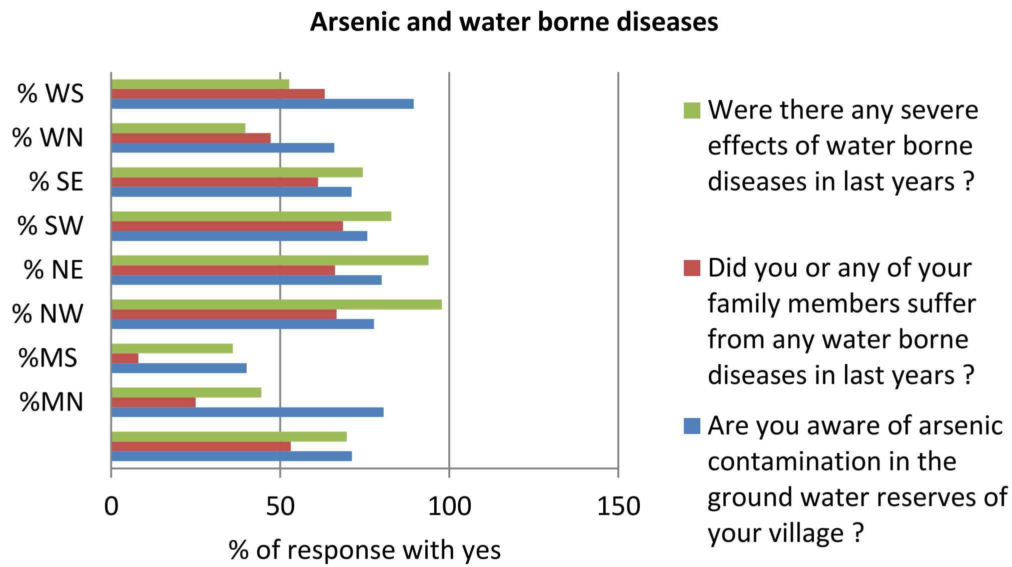


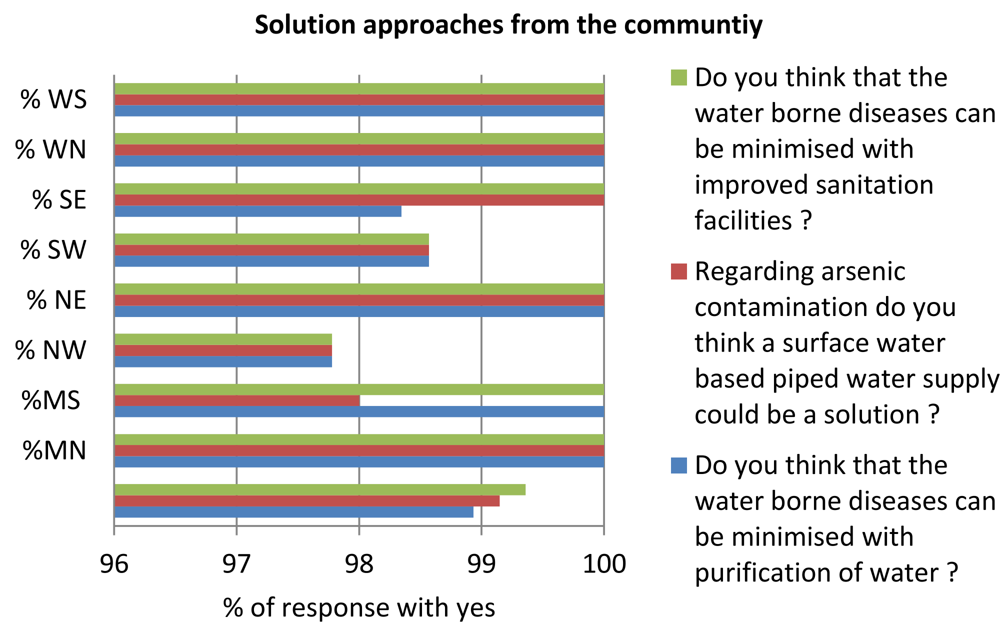
Situation of sanitary units





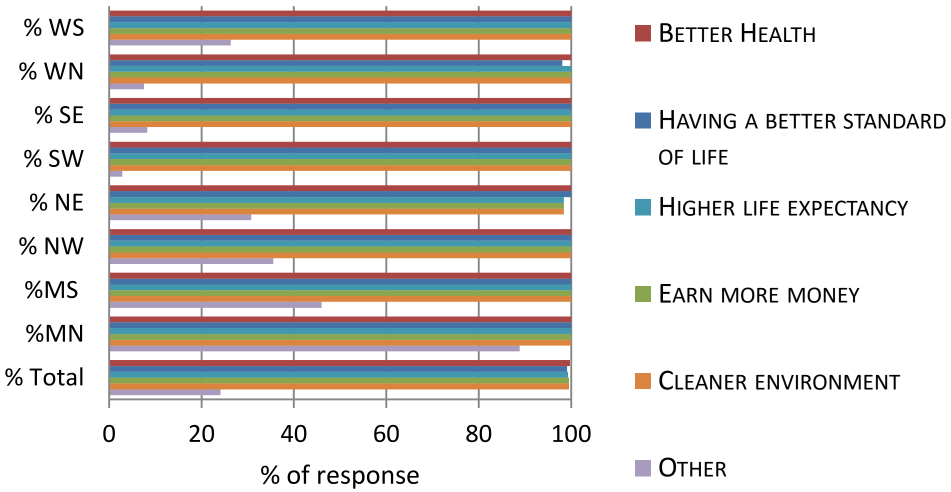
Water borne diseases, solution approaches



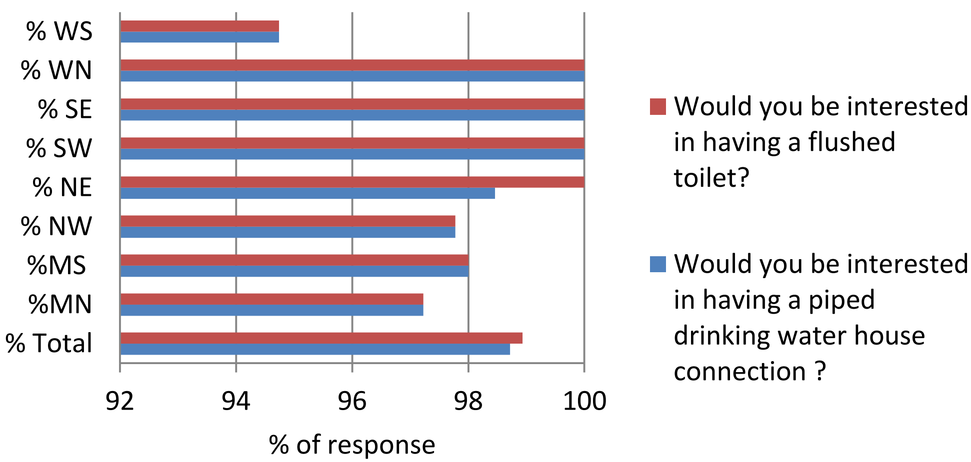


Awareness of the community and interest in participation

Benefits of safe drinking water supply and improved sanitation facilities



Interest to be covered under the integrated scheme



Tyndall
adelphi
Trustwater
DRYDEN AQUA
HELMHOLTZ ZENTRUM FÜR UMWELTFORSCHUNG UFZ
AGM
DTU

Technical information, baseline socioeconomic data collection & Topographical Survey of study area with Total station

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  Manisha Banik
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SCHEMATIC REPRESENTATION OF SURFACE WATER SYSTEM

1 – Catchment channels constructed so that max water enters and is stored in pond.

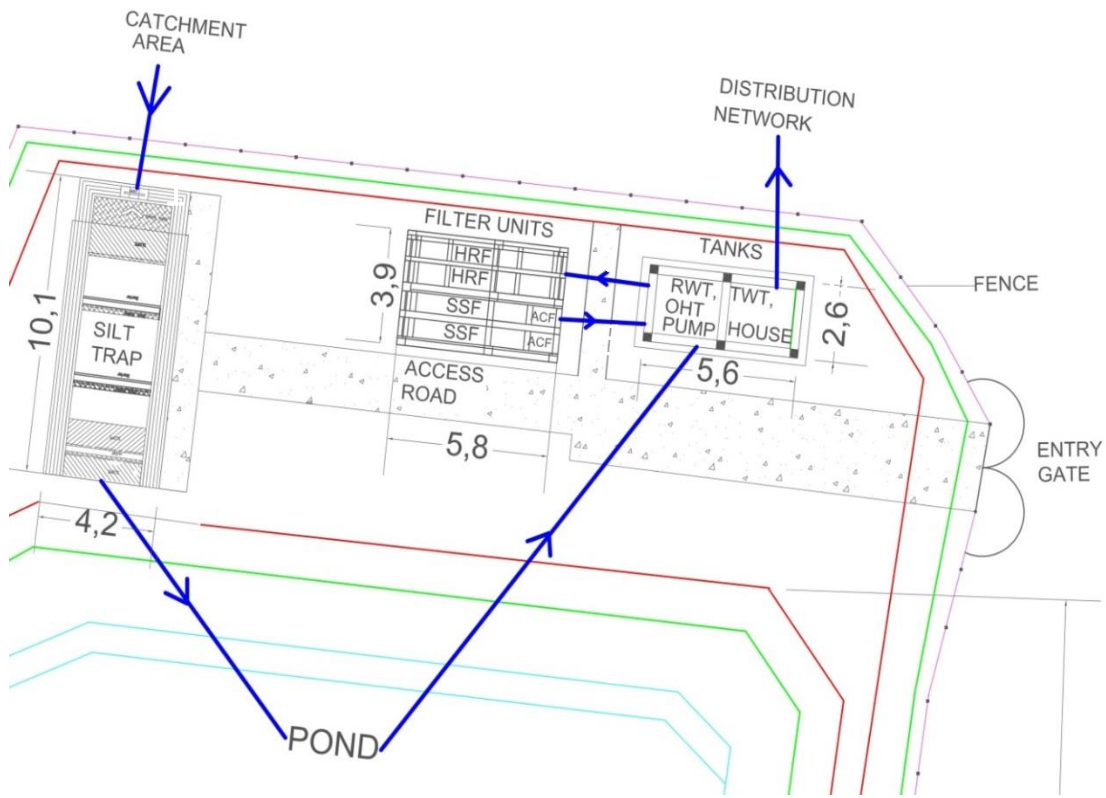
2 - Silt trap to control the inflow of sediments in pond.

3 - Pumping of Raw water to elevated RWT to provide pressure for the filtration system

4 - RWT to filter units for filtration through HRF, SSF and ACF

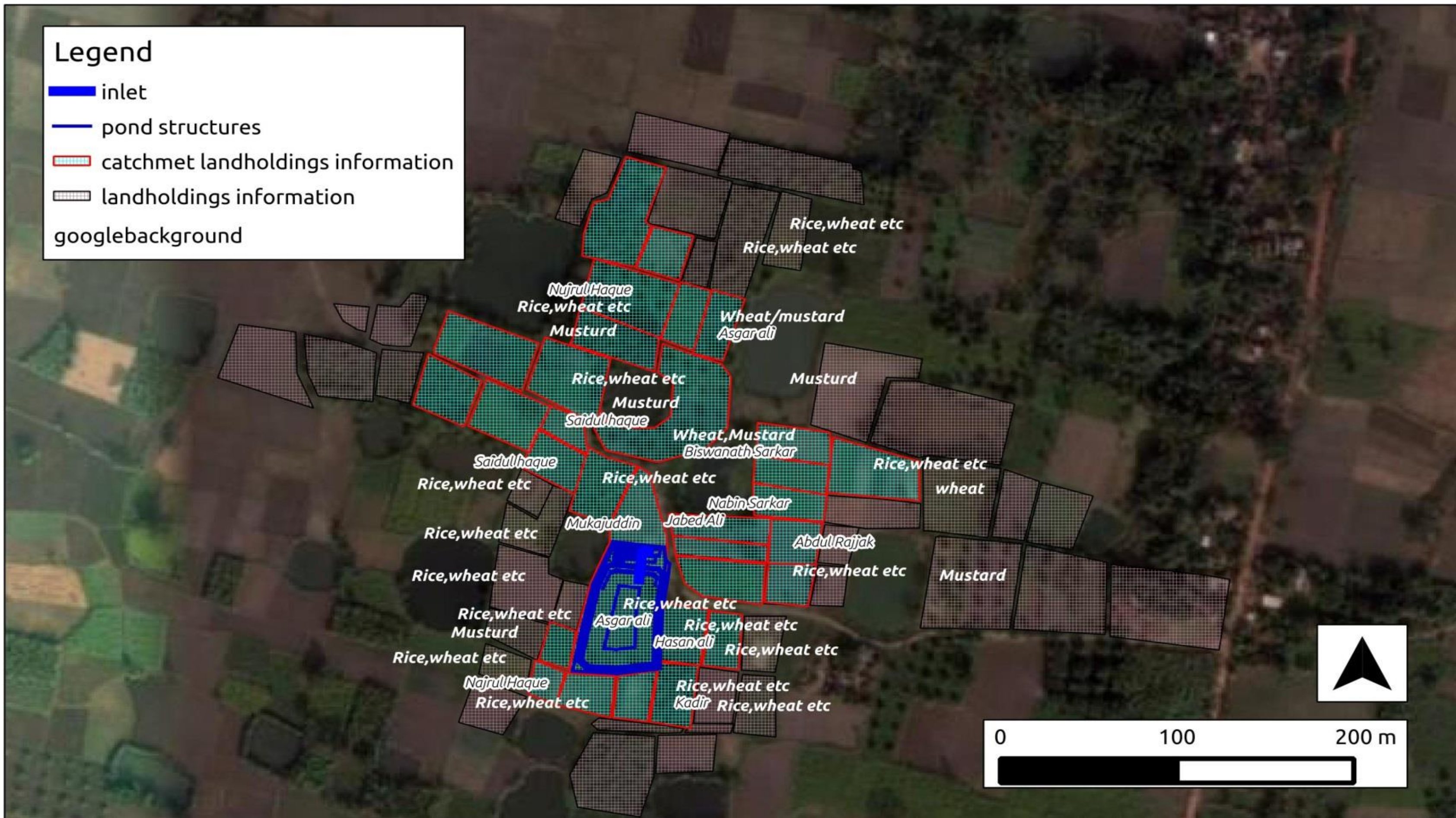
5 - Filtered water to CWT from where it is pumped to the OHT

6 - OHT to distribution to the village

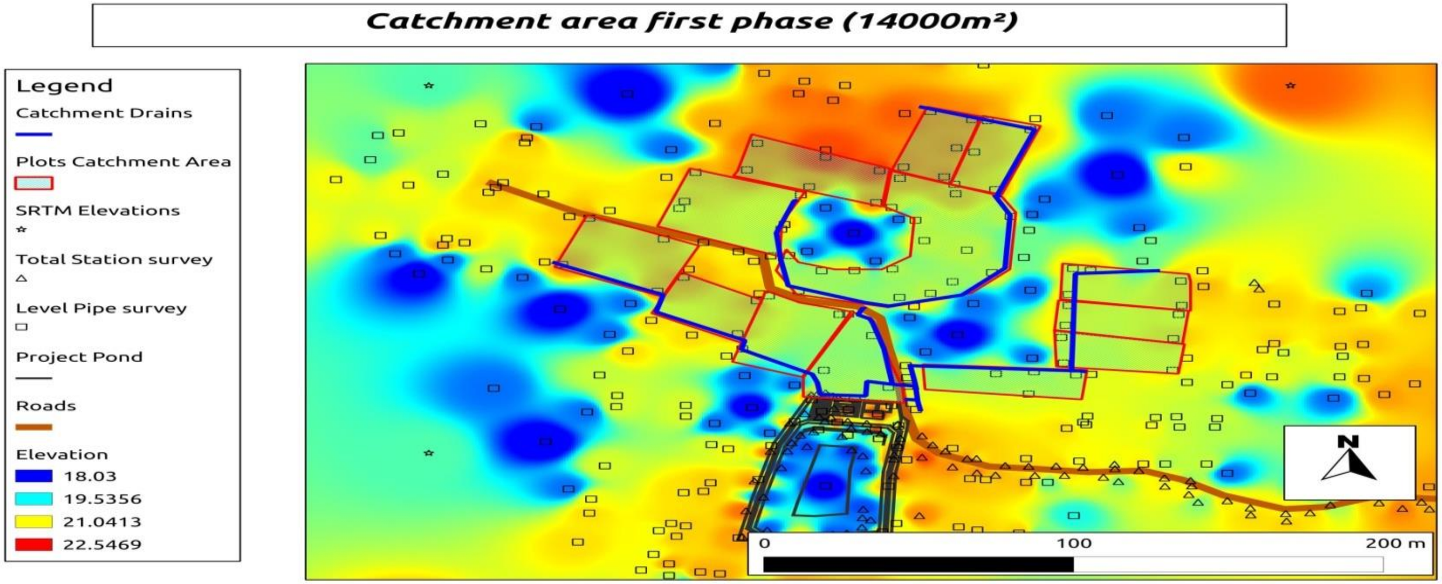


CONSTITUENTS OF STORED WATER SOURCE

Catchment area landholding owners and cropping pattern

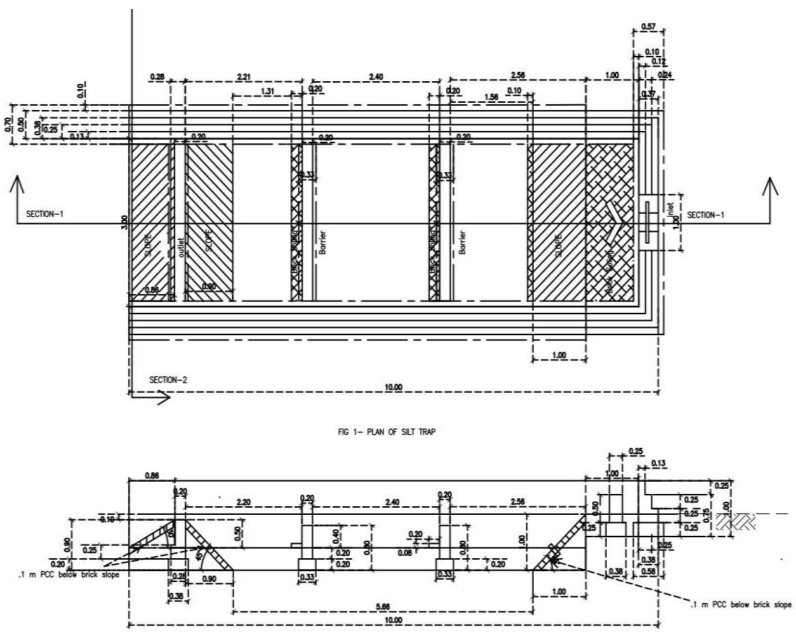


Catchment area development Activity



Silt trap construction

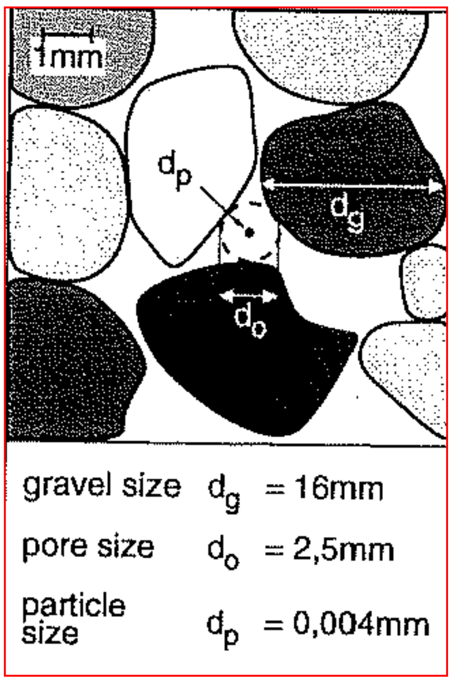
A 3m x10m silt trap with 1.5m height is setup to control the inflow of sediments into the pond



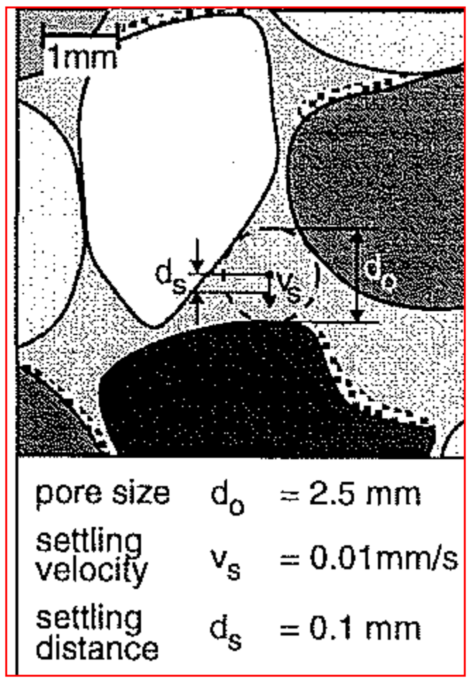
Surface water source Creation & Protection

Parameter	Dimensions
Length of the Pond	60 m
Breadth of the pond	32 m
Total pond area	2407 m^2
Catchment area	7.23 ha
Wetted pond area	920 m^2
Average depth of the pond	3.5 m

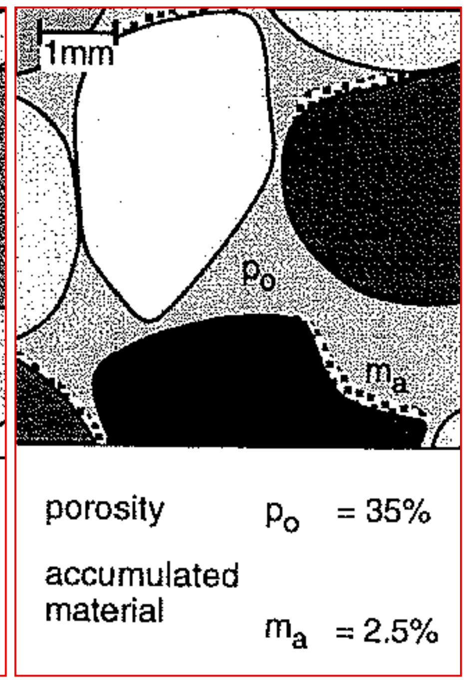
TRANSPORTATION MECHANISH IN HORIZONTAL ROUGHING FILTER



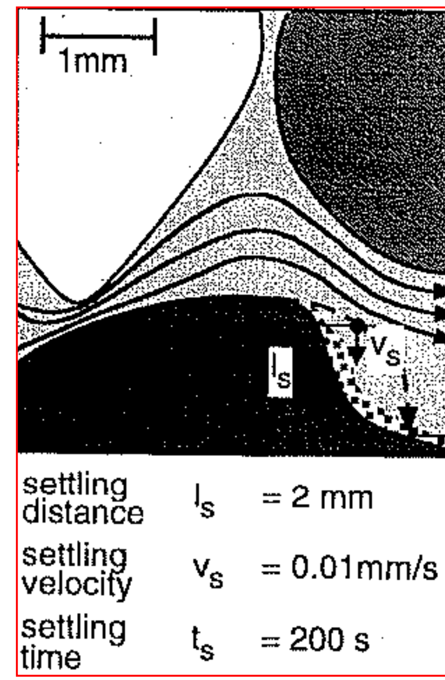
SCREENING



SEDIMENTATION



INTERCEPTION



HYDRODYNAMIC FORCES

CONSTRUCTION (CONCRETE STRUCTURE AND PIPING ARRANGEMENTS)

Sample point

Foundation work

Cross flush arrangement

Superstructure

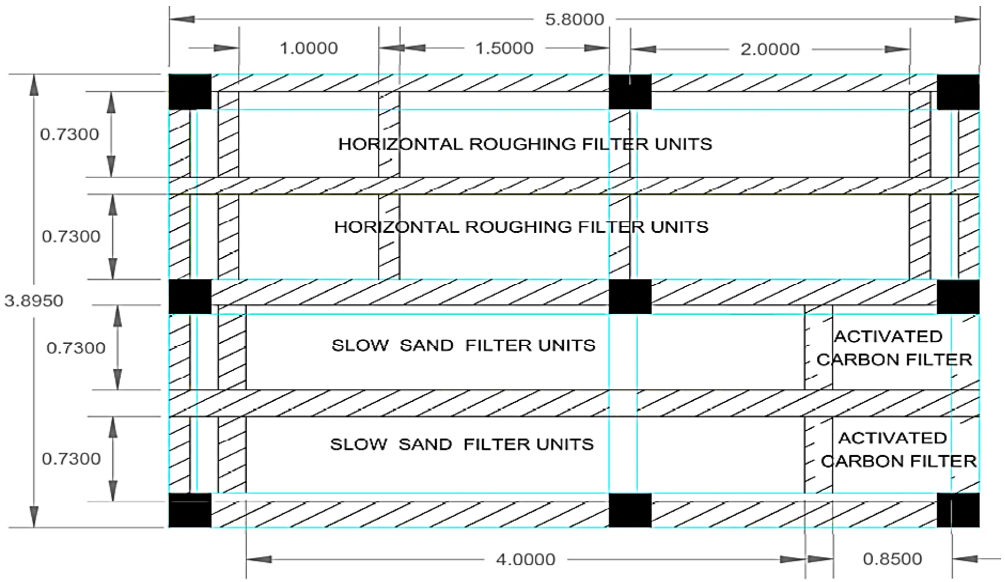
HORIZONTAL ROUGHING FILTERS(2 UNITS) WITH MEDIA

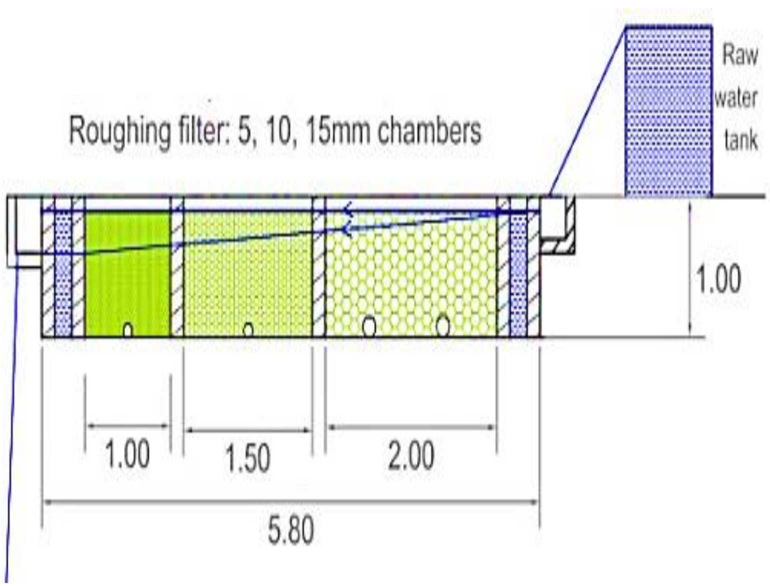
- flow rate of 0.5m/h in case of both filter units running and 1m/h in case of only one unit running.

Naming	Size of compartment(m)	Size of media (mm)	Material of media	Porosity in %
HRF 1(S)	2 x .73 x 1	15	Stone chips	28.6
	1.5 x .73 x 1	10	Stone chips	30.6
	1 x .73 x 1	5	Stone chips	32.4
HRF 2(G)	2 x .73 x 1	15	Gravel	25.3
	1.5 x .73 x 1	10	Gravel	26.5
	1 x .73 x 1	5	Gravel	28.6

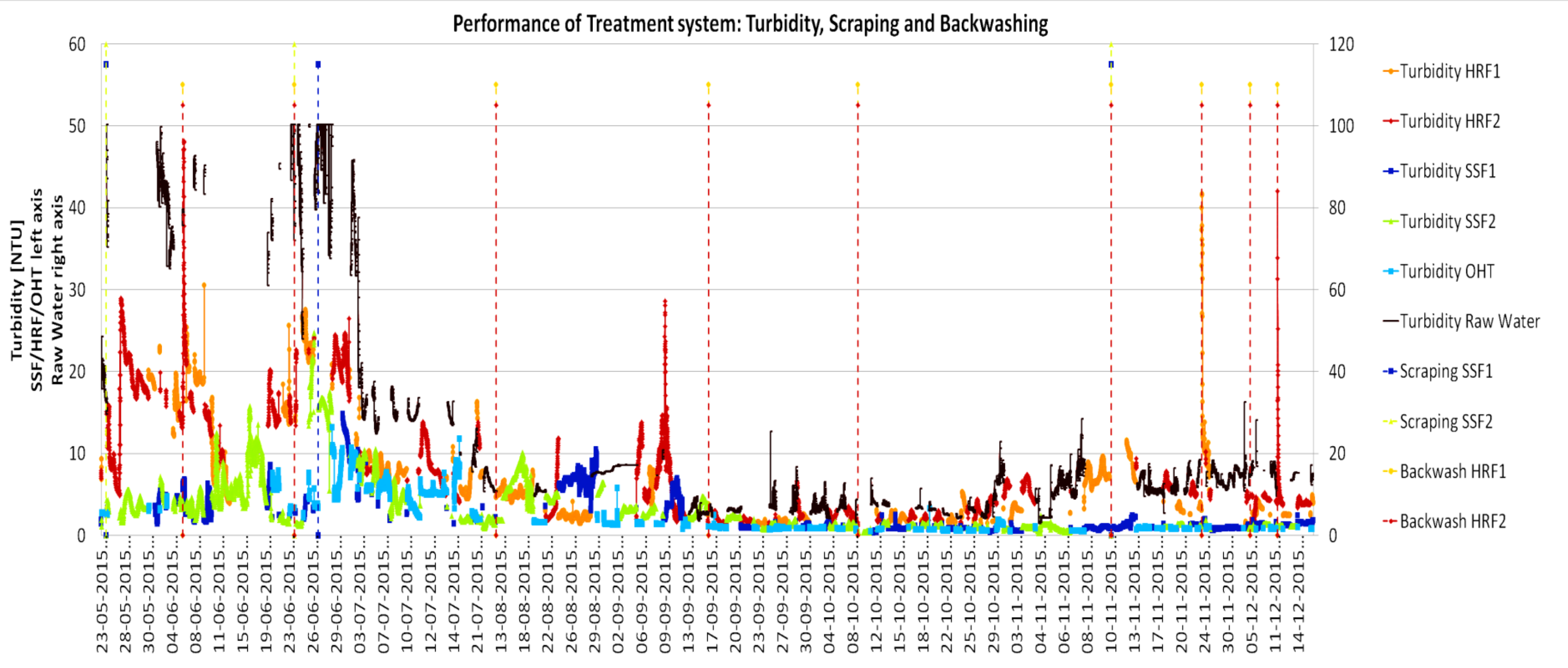
HRF1 HRF2

PATH OF FILTRATION

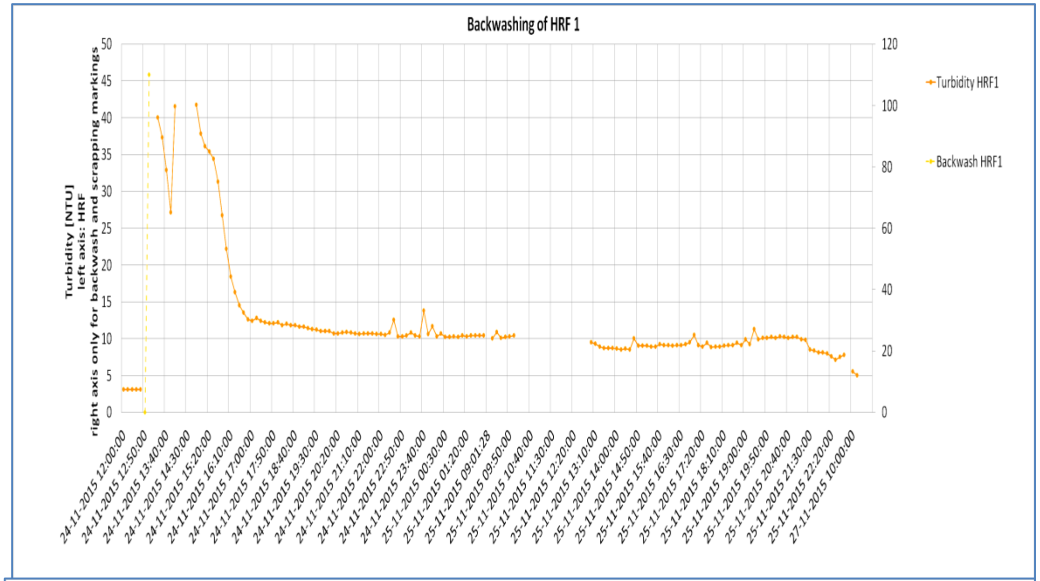




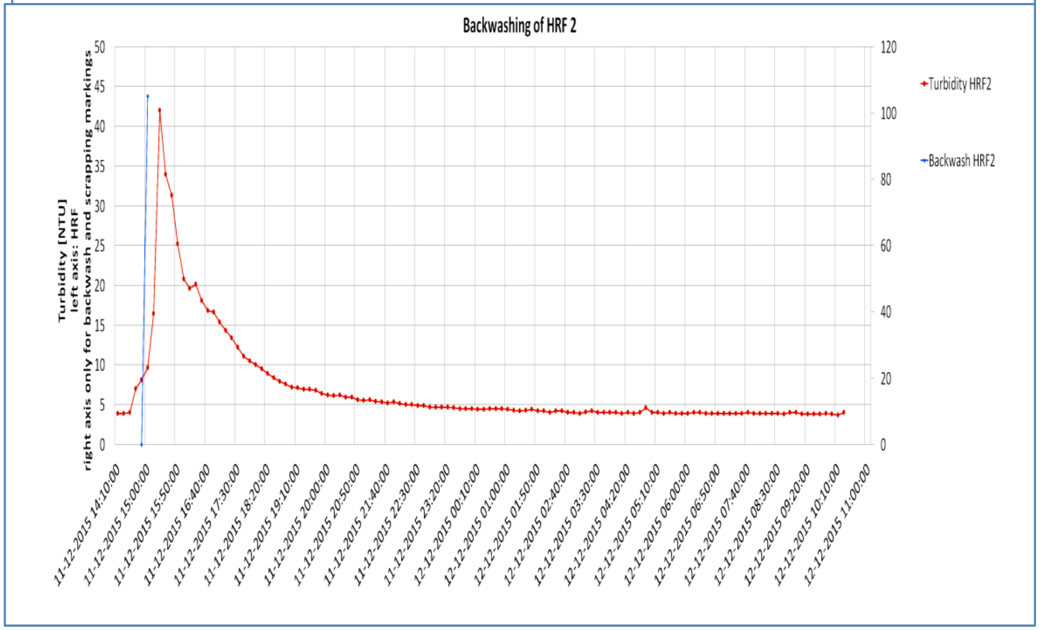
TURBIDITY PERFORMANCE OF THE TOTAL TREATMENT SYSTEM MEASURED ONLINE



STABILITY AFTER CROSSFLUSHING

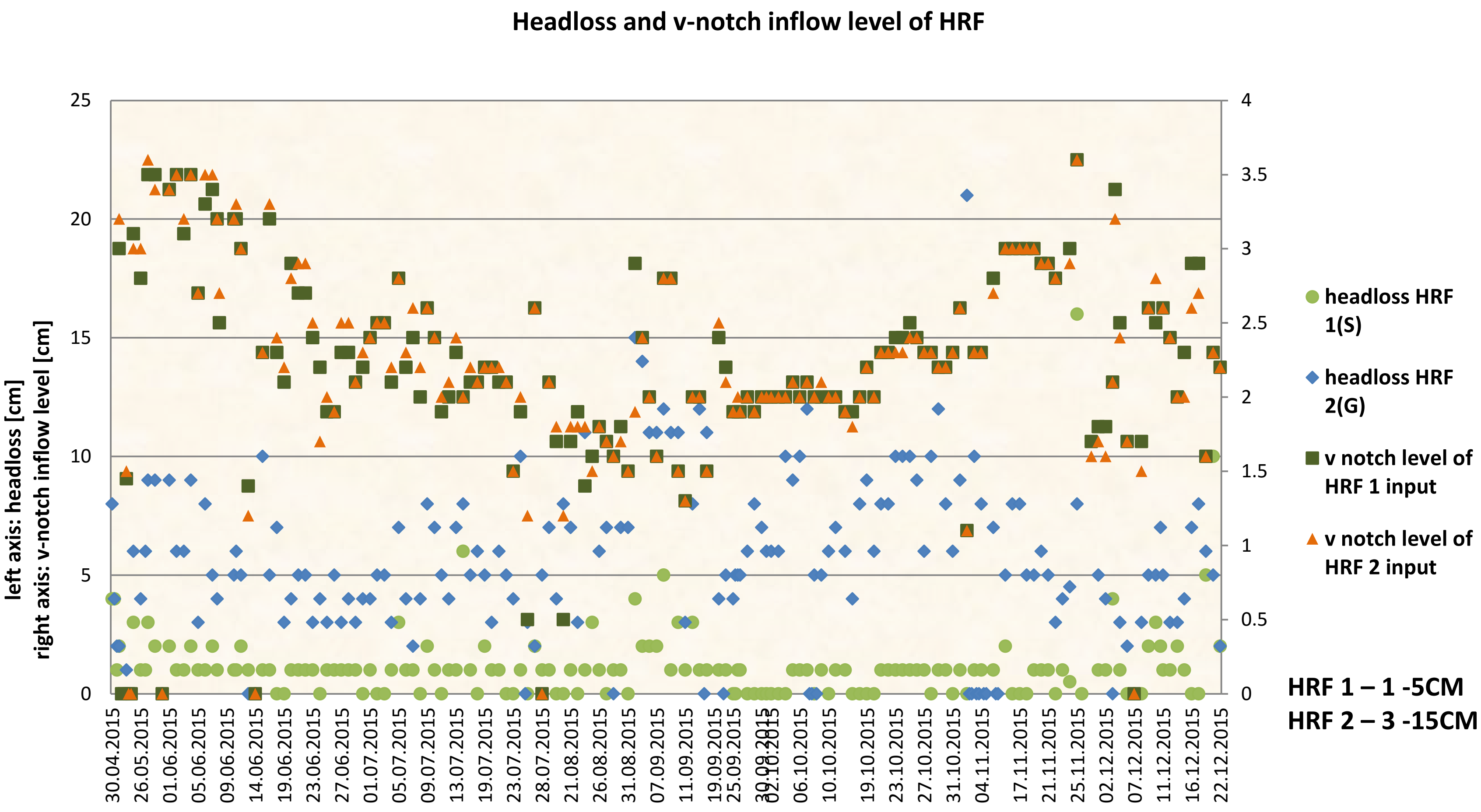


4 TO 8 HOURS with filtration rate .5m/hr to reach stable turbidity value of 10NTU



5 TO 10 hours with filtration rate .5m/hr to reach stable turbidity value of 5NTU

HEADLOSS COMPARISON OF HRF UNITS: Head loss of local stone chips (1-5 cm) < Gravel (3-15 cm)



HRF 1 – 1 -5CM
HRF 2 – 3 -15CM

TURBIDITY COMPARISON

THANK YOU

SAVE WATER.... NOT ALL ARE PREVILEDGED....

Agenda

- Project Overview
- Application of Geographical Information Systems for suitable site selection
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  Ronjon
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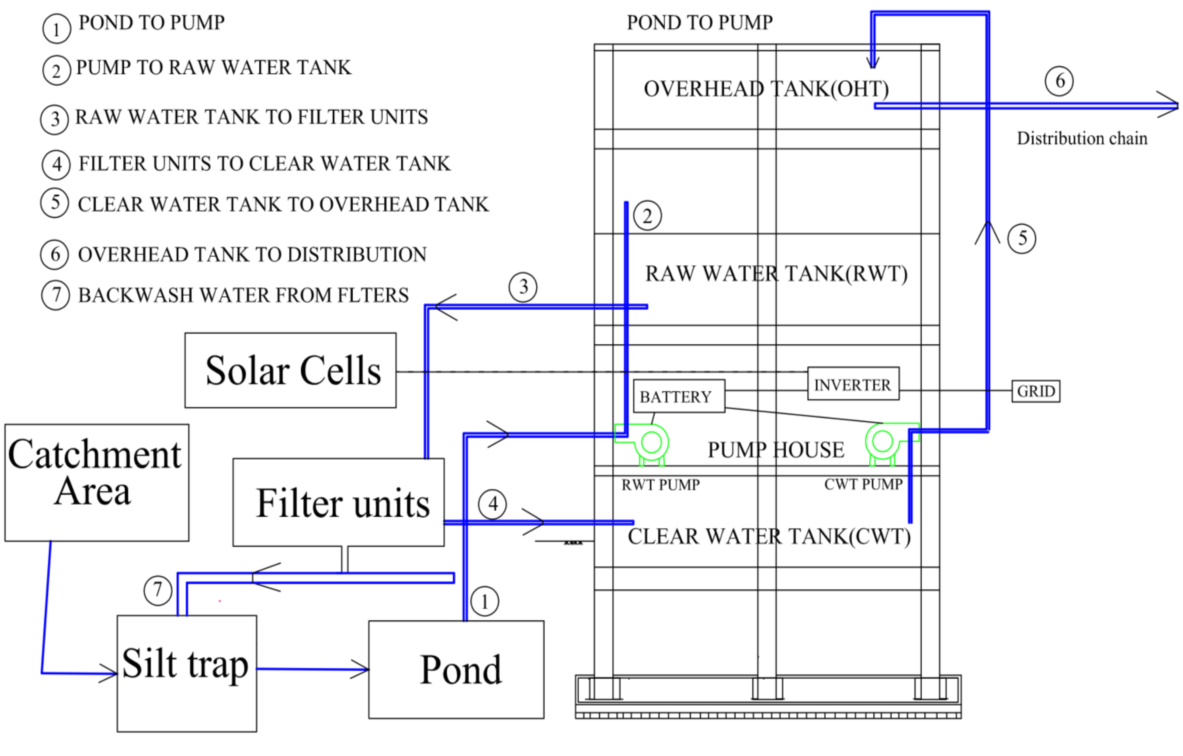
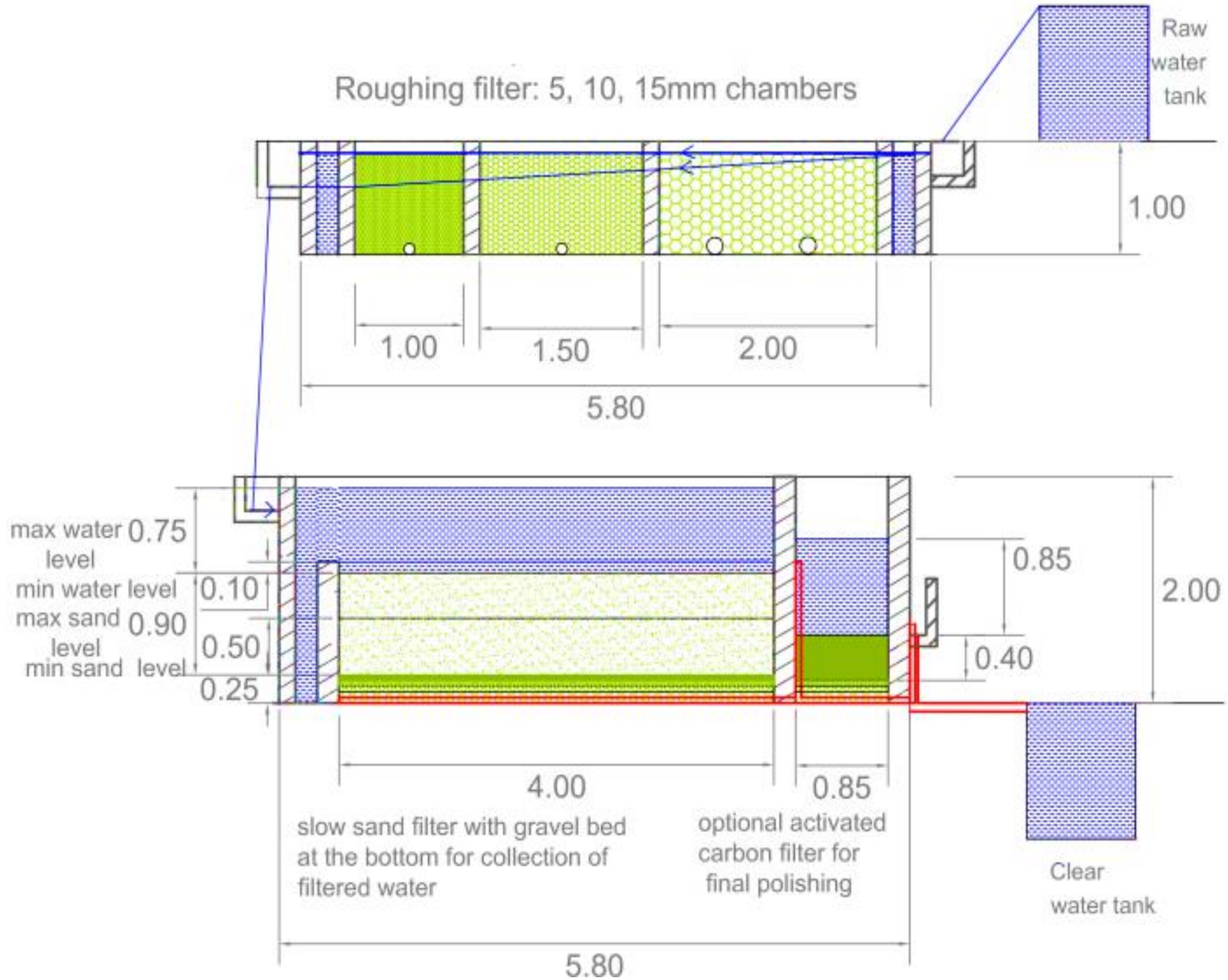
Multilayer treatment approach

- Rainwater harvesting
- Silt Trap
- Sedimentation pond
- Horizontal Roughing Filter
- Slow Sand Filtration
- Activated Carbon Filtration
- Disinfection.



Slow Sand Filtration System

- 2 chambers
  - 4 x 0.75
  - Total 6m²
- Flowrate
  - 0.05 to 0.2 m/hr
- Sandsize
  - 0.2mm
  - UC <3
- Headloss
  - ~ 10cm
  - max. 40cm



Daily treatment checklist

Since May 2015 daily (with interruptions)

- Equipment working status
- Monitoring setup working status
- Tank water levels
- Treatment process observations
- Filter unit observations
- Container (advanced system) observations
- Maintenance checklist

REGULAR CHECKLIST TREATMENT PROCESS						
INSIDE PUMPHOUSE						
Parameter	**IS**	**CHANGE / REMEDY**	**REMARKS**	**unit**	**criteria for ok**	**remarks**
Date				**DD/MM/YYYY**		
time of assessment				**HH/MM [24h format]**		
Name of Assesssor						
ofline monitoring of instrument check list						
all pumps are working ok				[yes(√)/no(X)]	both tanks have at least 50% water	
grid power				[yes(√)/no(X)]	on	meter has display, LED blinking (slowly)
Cumulative Active Energy				[kWh]		meter display: 5. kWh
Instant phase active power				[kW]		meter display: 13. PH: ..
solar inverter				[yes(√)/no(X)]	on	
solar inverter has grid power				[yes(√)/no(X)]	yes	inverter plug light, if off and grid on then check solar MCB
computer				[on/off]	on	
internet on				[on/off]	on	
online monitoring				[on/off]	on	
turbiditymeter				[on/off]	on	
flowmeter				[on/off]	on	
pump controller				[on/off]	on	
turbidity sensor measuring unit						
Turbidity Sensor 1 is measuring:				[SSF1/SSF2/OHT]	any	change after taking reading
WQ Turbidity				[FNU]		
Turbidity Sensor2 is measuring:				[RWT/HRF1/HRF2]	any	change after taking reading
WQ Turbidity				[FNU]		
tank status						
water level of RWT				[0,25,50,75,100%]	at least 50%	possibly turn pump controller off to save current
water level of CWT				[sump light on/off]	on	
water level of OHT				[0,25,50,75,100%]	at least 25%	possibly turn pump controller off to save current
treatment process observations						
Indicator RAW WQ in normal range				[FNU]	RWT < 60NTU	if above 50, reduce to low flow rate
Indicator HRF WQ in normal range				[FNU]	HRF < 20NTU	if above 18, reduce to low flow rate
Indicator SSF WQ in normal range				[FNU]	HRF < 5NTU	if above 3, reduce to low flowrate
all flowrates are in CORRECT! range				[yes/no]	as per below values	compare Turbidity values with flow rate (normal, low, max)
Flow time SSF 1				sec	normal: 12sec/L (5LPM,	normal 5lpm(12s), low 2lpm(30s), max up to 10lpm(6s),
Flow time SSF 2				sec	normal: 12sec/L (5LPM,	normal 5lpm(12s), low 2lpm(30s), max up to 10lpm(6s),
flow rate of ssf 1 IN CWT				l/hr		
flowrate of ssf 2 in CWT				l/hr		
total flow rate from ssf in cwt				l/hr		
time since last dosing				hr		
total flow of treated water since last dosing				l		
amount to be dosed per litre				ml		
type and amount of chlorine to be dosed				ml		

Online Monitoring

- **Treatment system online monitoring started March 2015**
- **Online Monitoring frequency:**

  Every 10 minutes

- **Online parameters:**
  - Pump Run
  - Flow Meter
  - Turbidity
  - pH
  - FAC
  - DO

Offline monitoring

Water source monitoring started in Nov 2012

Samples were taken during field visits on monthly basis

Treatment system offline monitoring started in June 2015

Offline Monitoring frequency:

1 month daily

22 weeks weekly

now monthly

Offline parameters:

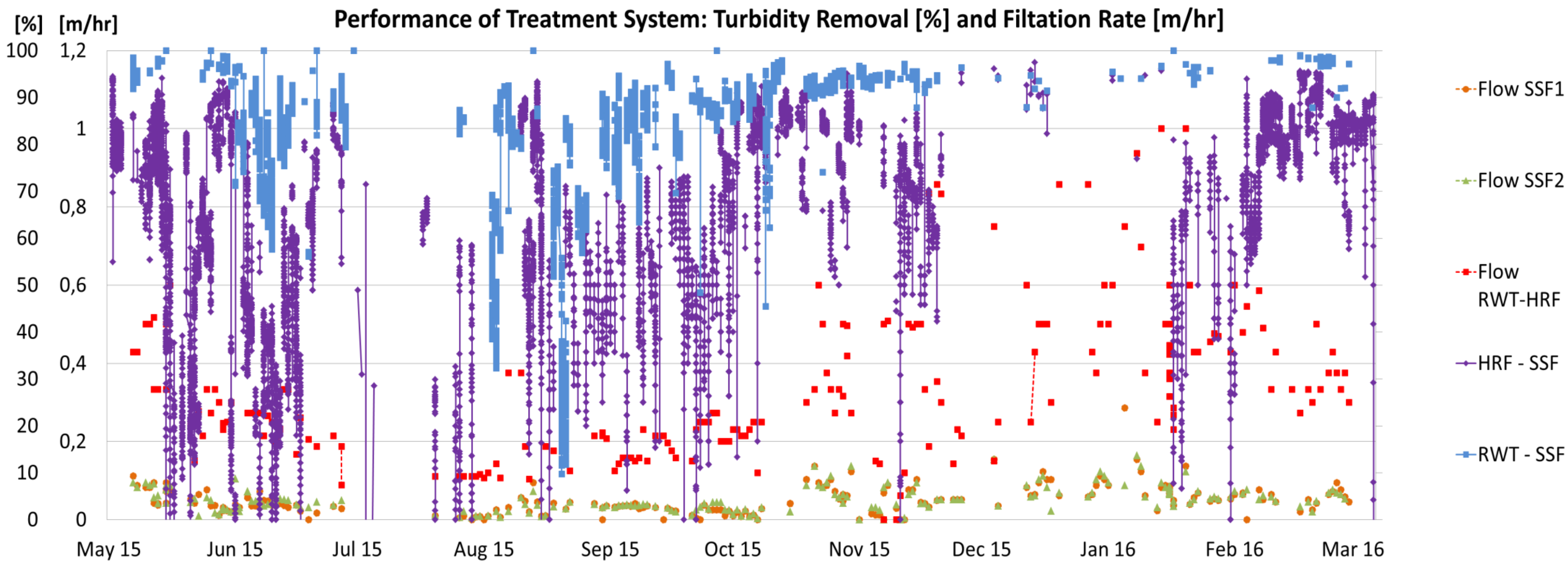
- pH
- Turbidity
- TDS
- Ammonia
- Iron
- Nitrate
- Chloride
- FAC
- Alkalinity
- Hardness
- Arsenic
- E.Coli
- Total Coliform
- DO
- Nitrite
- Phosphate
- Temp
- ORP

Removal Performance entire monitoring period

Removalafter pretreatment HRF – SSF around 50-95 %

Overal removal RW – SSF 60-98%

Filtration Rate of HRF 0.1 to 1 m/hr and SSF 0.05 to 0.2m/hr

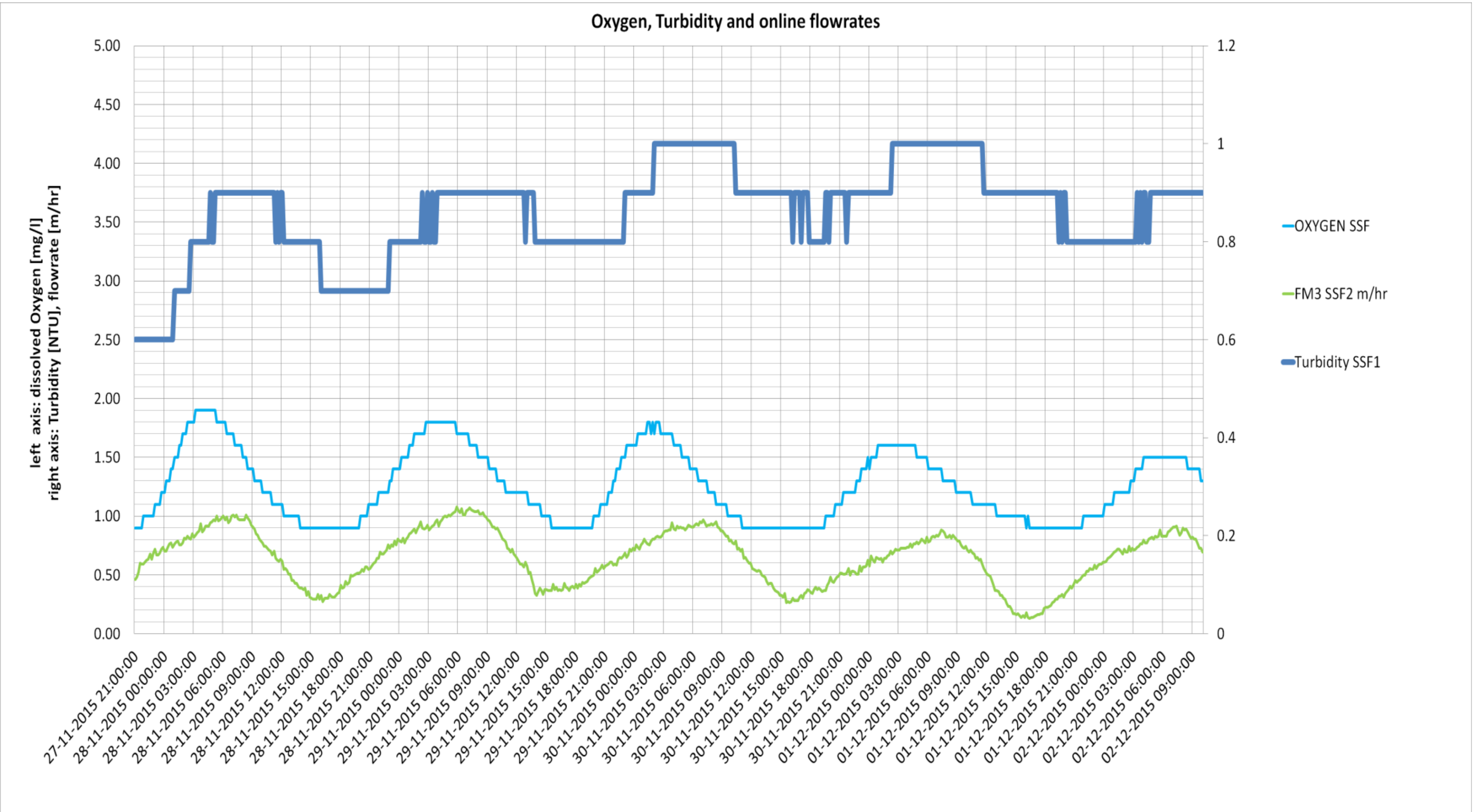


Turbidity Raw Water 5 to >100 NTU, HRF 3 to 25 NTU, SSF 0.3 to 0.8 NTU

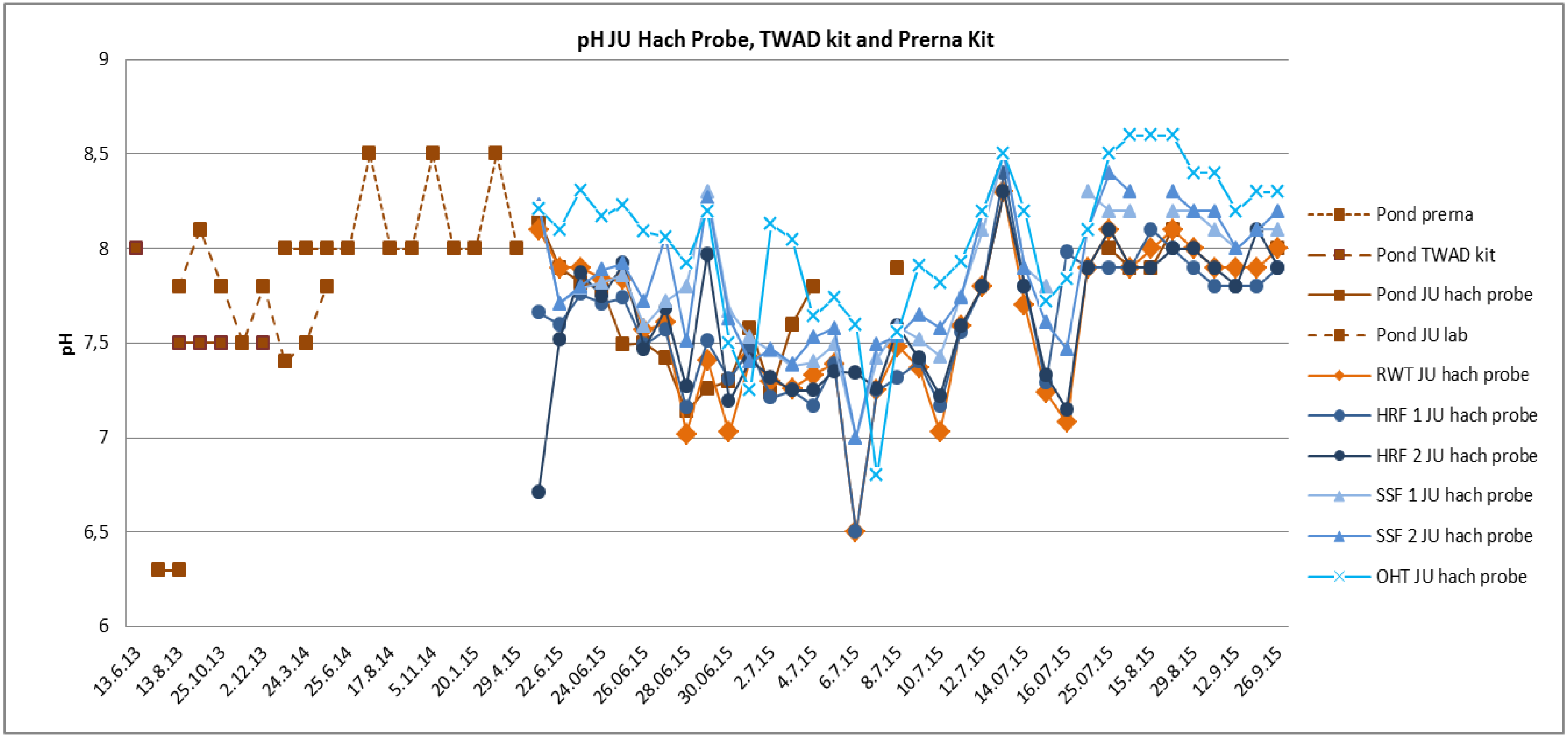
Scraping SSF 1 to 5 months, Cross-Flushing HRF, 1 week to 2 months

Comparing Oxygen, Turbidity and flowrates of SSF

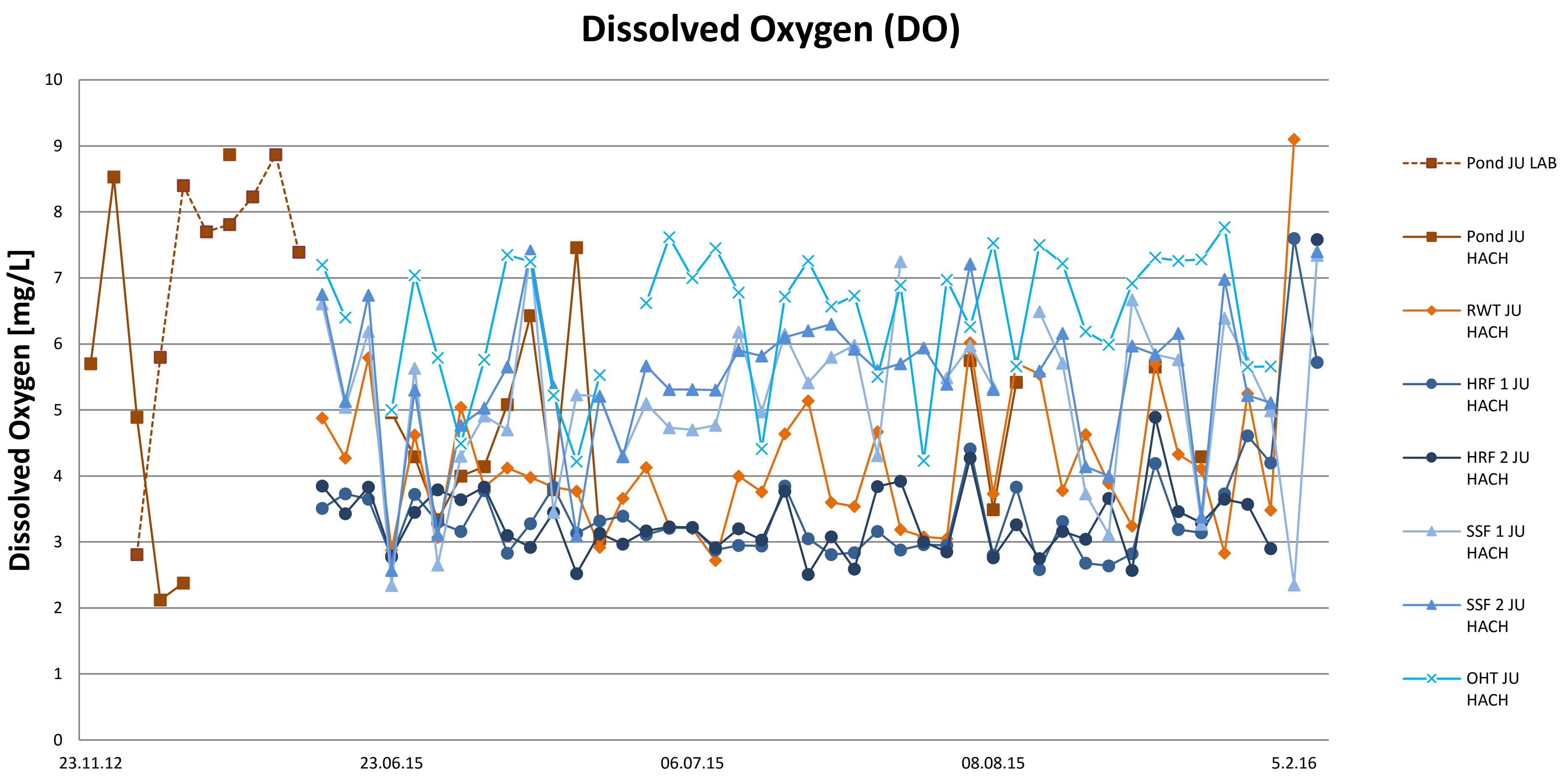
Turbidity removal better with higher flowrate and DO



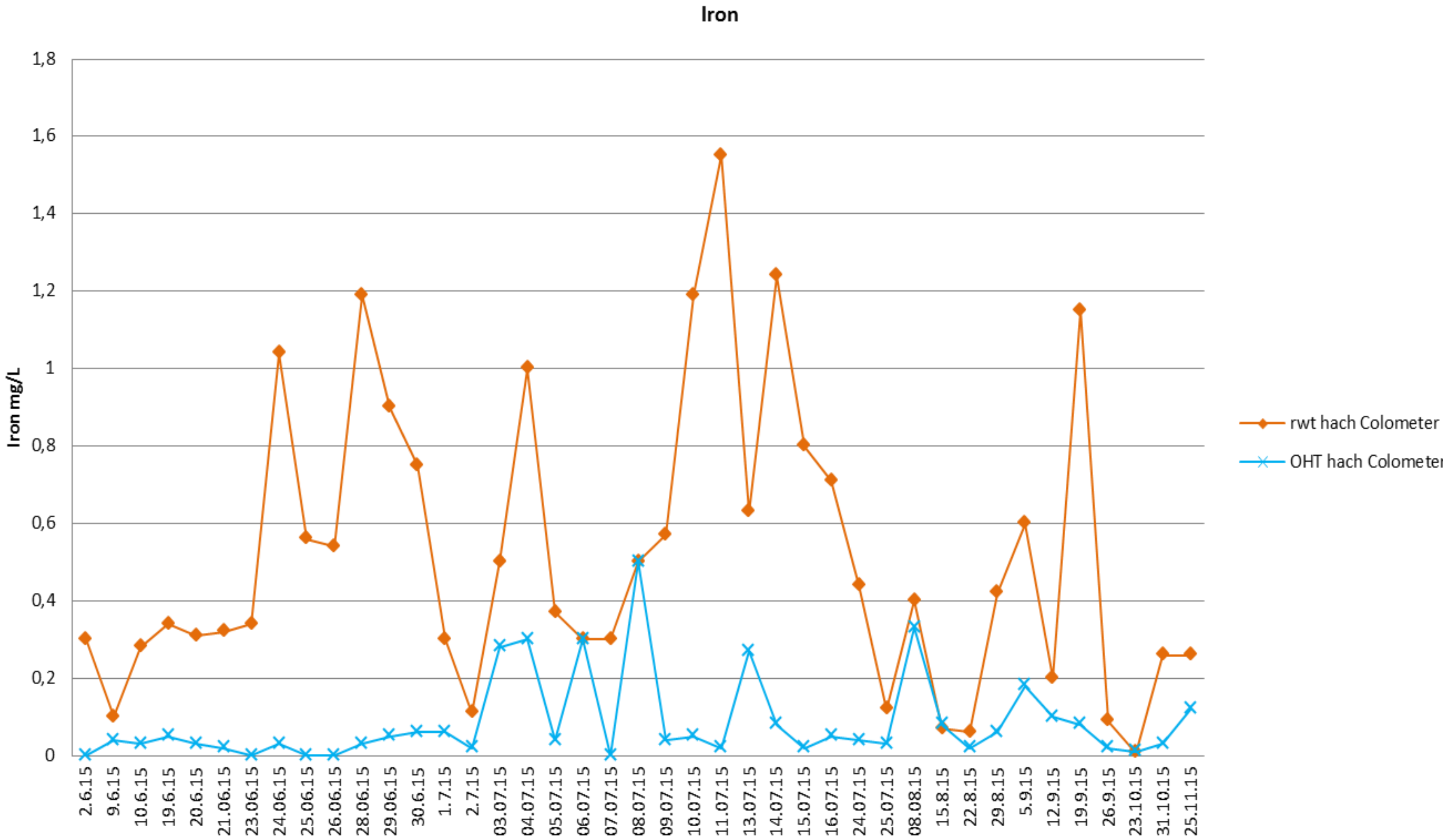
pH between 7 and 8.5



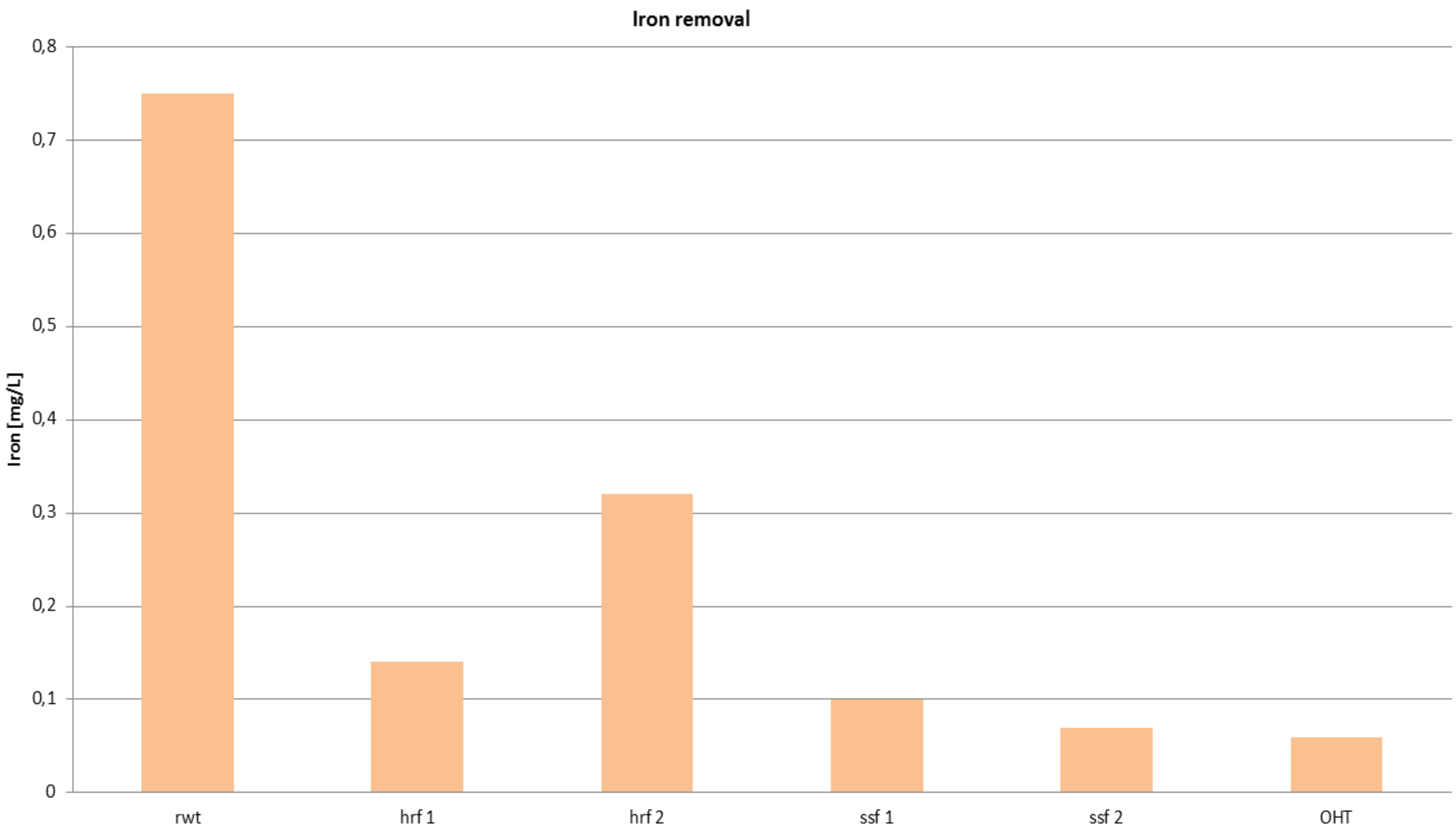
Dissolved Oxygen



Iron concentration in raw water and overhead tank



Iron removal along the treatment process on 30.06.2015



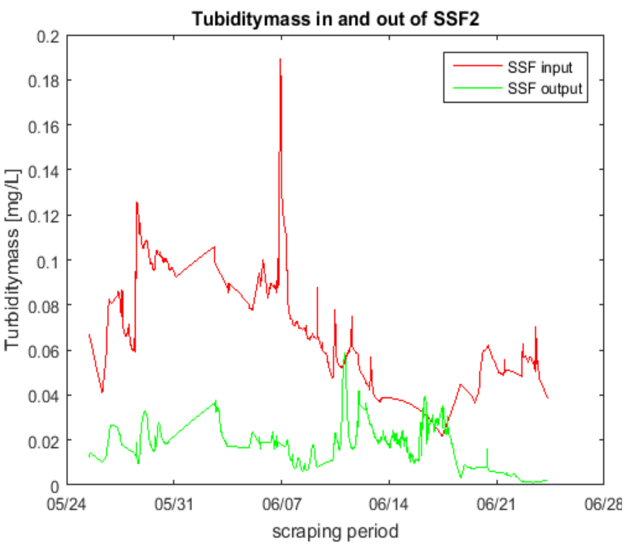
Parameters of concern

These parameters should be further monitored as they reach 80% of the desirable limit of IS10500

- pH
- turbidity
- ammonia
- free chlorine
- iron
- alkalinity
- arsenic
- bacteria

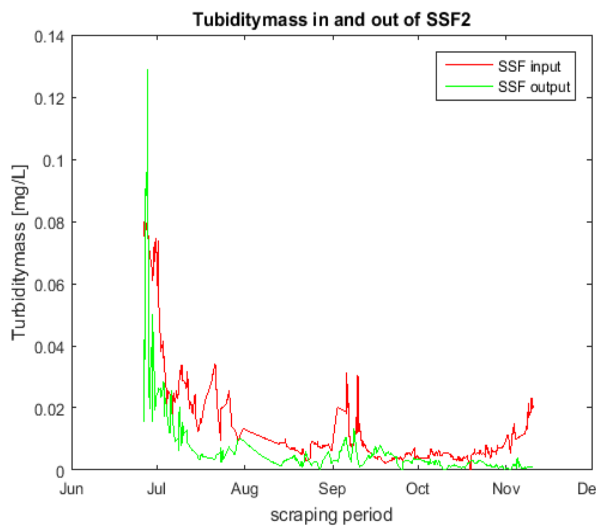
Total loading of SSFs in various scraping periods

1st



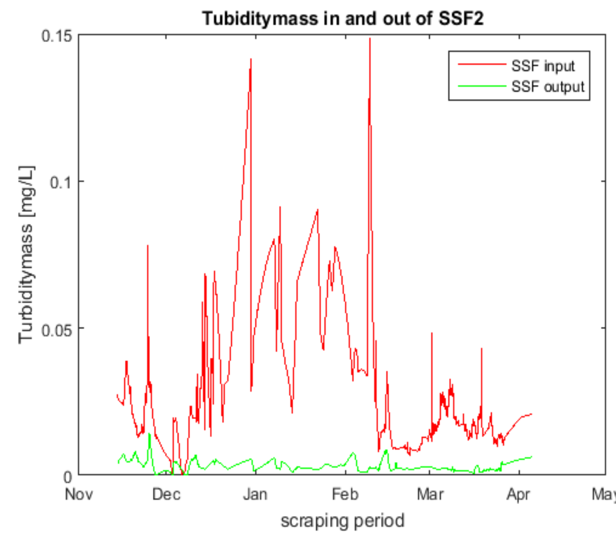
1 month, high turb.

2nd



5 months, low turb.

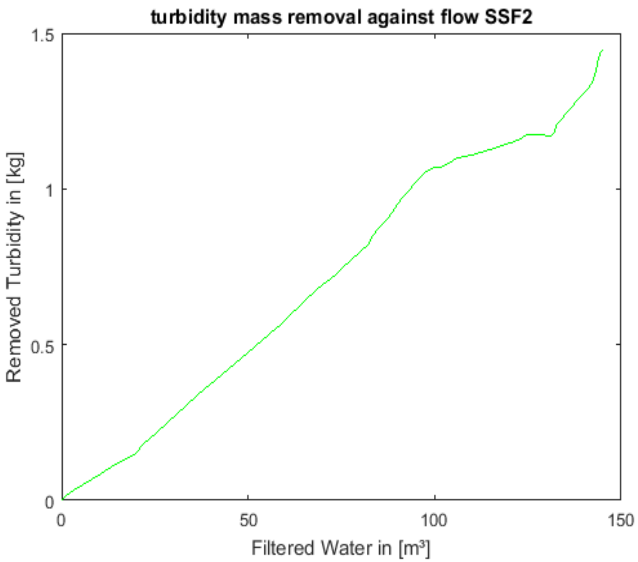
3rd scraping



4 months, high turb.

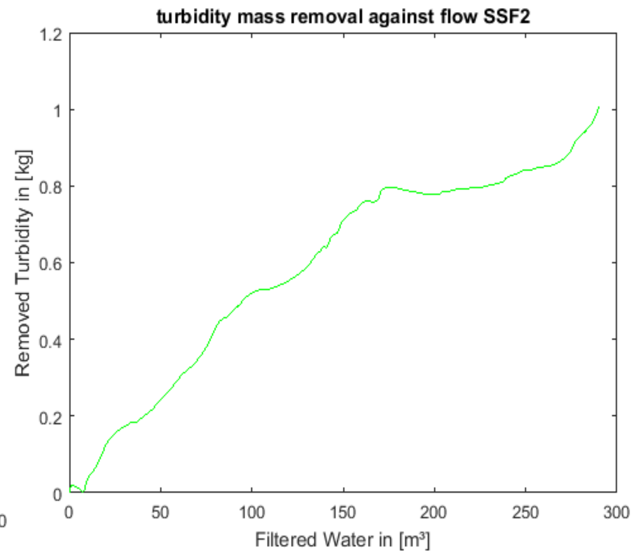
Total loading of SSFs in various scraping periods

1st



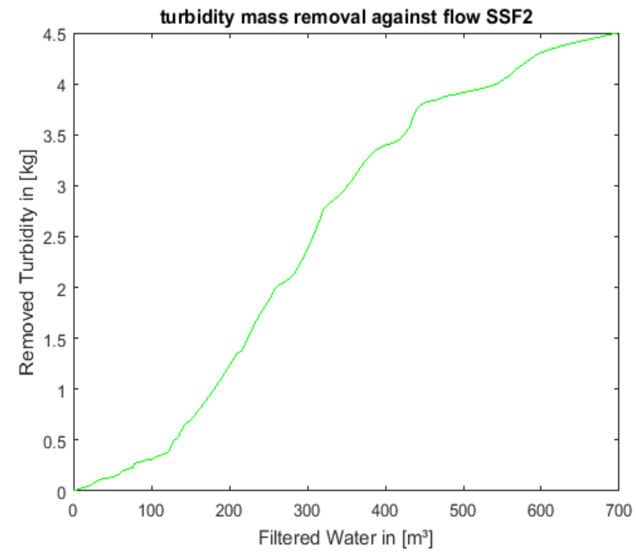
145 m³, 1.5kg in 1 month

2nd



280m³, 1.05kg in 5 months

3rd scraping



690m³, 4.5kg in 4 months

Economic figures

For the implemented R&D plant

incl. Catchment managment and complete treatment

not taking into account efficiency potentials of upscaling

• Total O&M approx. months	30.000 per
• Price per litre:	4 to 10 paise
• Monthly costs per household:	160 to 300 INR
• Benefit Cost Ratio:	12 to 23

* depending on 14 to 28 KLD supply

Conclusions and Optimization

- After shading of launders longer SSF filter runs could be observed
  - due to less clogging of the SSF surface

- Higher flowrates correlated with better removal
  - contrary to the mechanical filtration theory
  - supporting the ecological activity theory
  - **but: scraping intervalls are shorter with higher flowrates**

- Initial ripening period of filter longer than assumed (5 months)
- Pretreatment is very important
  - Lower input ~10 against ~20 lead to 3-4 times longer filter runs

Ongoing Evaluation and optimization

- Optimal flowrate
  - 0.05 to 0.3 m/hr for the SSF are currently being tested,
  - is the higher really the better?
  - Filtration speed against % of turb. removal
- Is DO level essential for removal efficiency?
  - DO of SSF inlet and outlet against % of turb. removal
- Seasonal effects, temperature dependency
  - Is warmer climate (summer) more preferably for treatment?
  - Temp against % of turb. removal
- More effective disinfection
  - how to lower pH so chlorine can better work?
  - more shading for less photosynthesis activity?
  - CO_2 gasing
- Which pre-treatment is the most suitable, stone chips or gravel?

Thanks for your attention!

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office@adelphi.de

Agenda

- Project Overview
- Application of Geographical Information Systems for suitable site selection
- Community engagement and awareness
- Comparative analysis of roughing filter as pre-treatment for surface water
- Activated Filter Media, Mixed oxidants & Capacitive Deionisation
  Aidan Quinn
- Sustainable technology for removal of arsenic in rural areas
- Decentralized integrated approach for water and wastewater management
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ECO-India
www.eco-india.eu

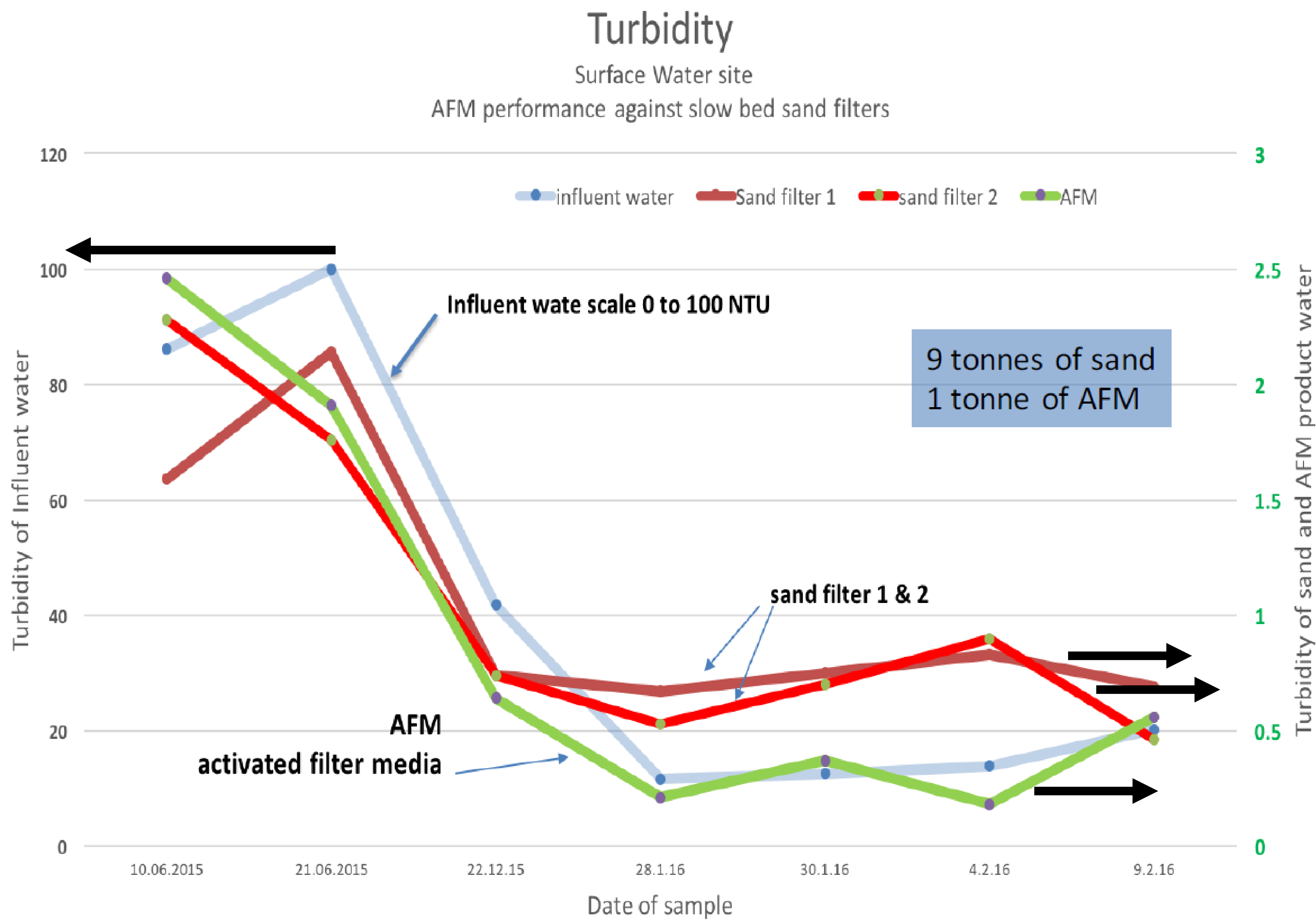
Activated Filter Media

- Manufactured from green **recycled** glass
- The large surface has a strong negative charge to **adsorb organics and small particles**.
- The surface also has metal oxide catalysts which produce free radicals and thus a **high redox potential.**
- AFM® is **self-disinfecting**. AFM® prevents bacteria from settling to make it a **unique, bio-resistant filter material**.
- Verified performance 99% filtration down to 3 microns with AFM grade 0, 97% to 5 microns with AFM grade 1.Sand achieved only 72% at 5 microns

AFM as an alternative water treatment system is examined via direct comparison to traditional roughing and sand filter

European Commission Tyndall National Institute Trustwater adelphi DTU ARSOlux DRYDEN AQUA AGM

Setup AFM System



Turbidity
Surface Water site
AFM performance against slow bed sand filters
influent water
Sand filter 1
sand filter 2
AFM
Influent wate scale 0 to 100 NTU
9 tonnes of sand
1 tonne of AFM
sand filter 1 & 2
AFM
activated filter media
Turbidity of Influent water
Turbidity of sand and AFM product water
Date of sample
120
100
80
60
40
20
0
3
2.5
2
1.5
1
0.5
0
10.06.2015
21.06.2015
22.12.15
28.1.16
30.1.16
4.2.16
9.2.16

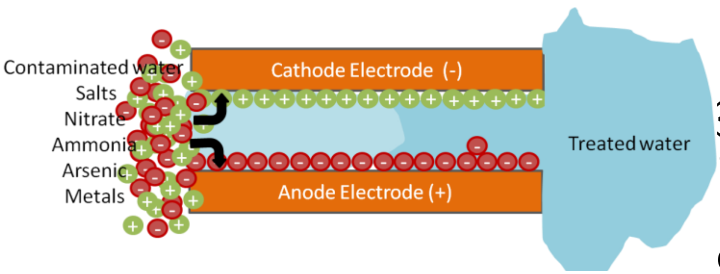
ECO-India
www.eco-india.eu

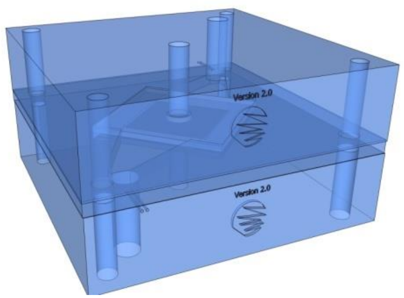
Electrochemical Disinfection

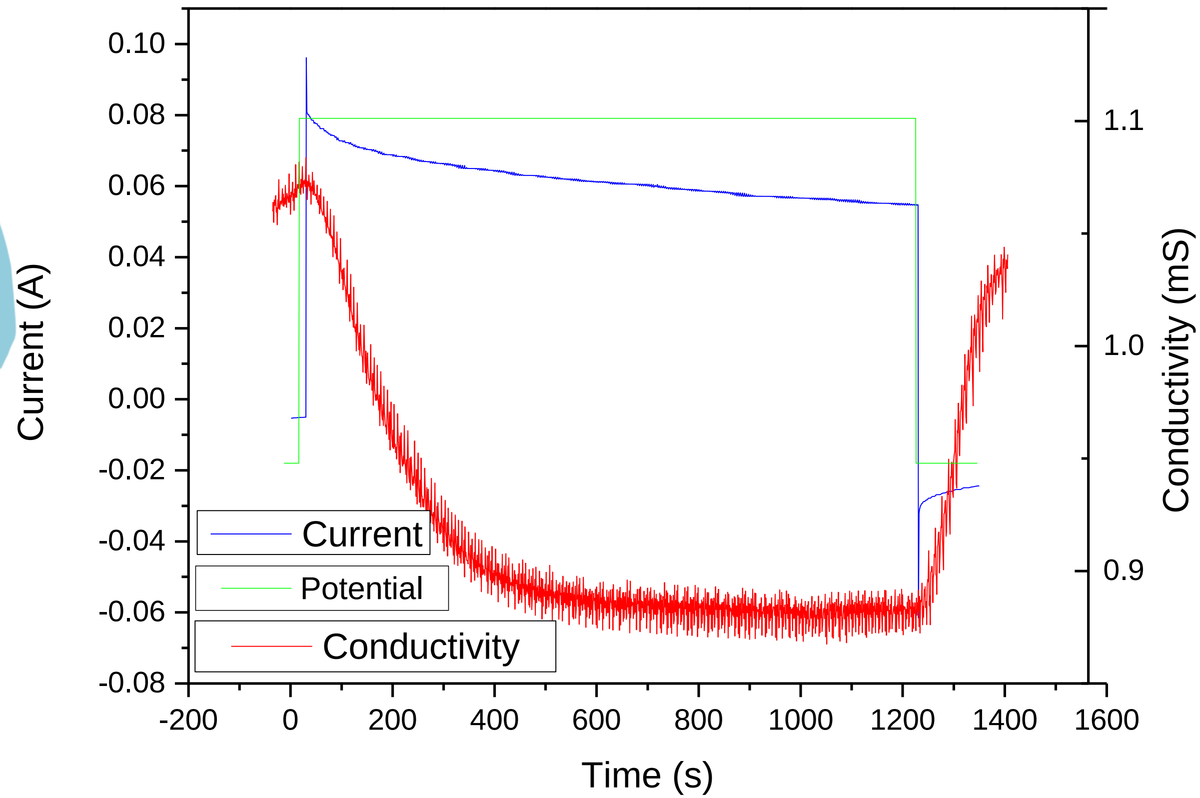
Specifications	Before Trustwater 110	After Eco Trio Device	% Improvement
Volume of water treated : m^3/day	84	100	19% ↑
Energy usage: kWhr per hr	0.17	0.1	41% ↓
Salt usage: g/hr	210	108	48% ↓
Waste output: Litres	12	Zero	100% ↓
Oxidant produced: g/hr	8.4	13.3	58% ↑

** device produces at 1,100 ppm but production quoted at 1,000 ppm (13.3 g vs. 12 g)

Capacitive Deionisation (Lab-scale)

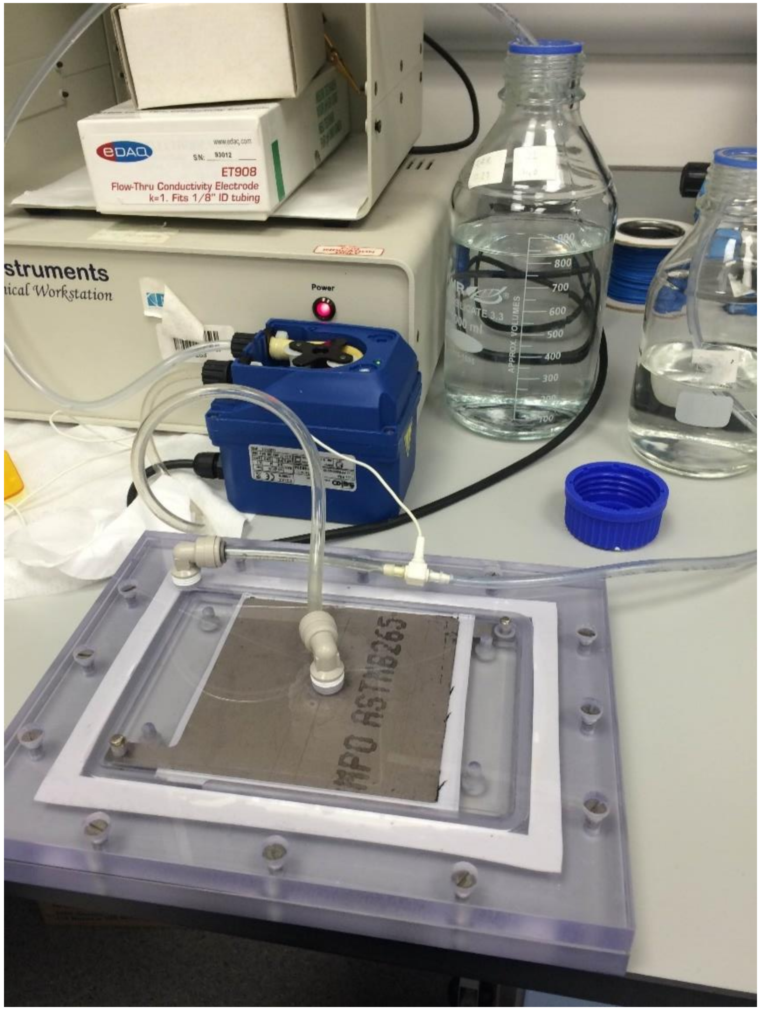


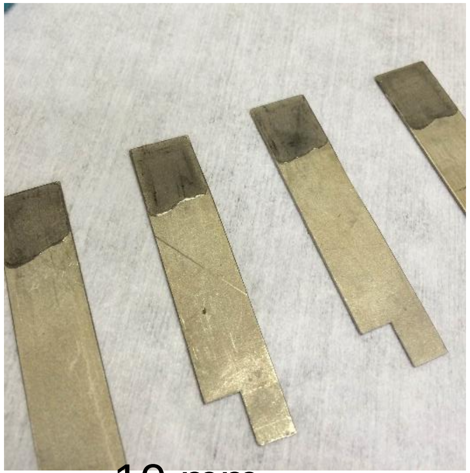




- High specific surface area of electrodes helps absorb more ions.
- Graphite/PVDF/Reduced graphene oxide electrodes developed
- Difficult to compete with activated carbon (cost)
- ɔecific binding/release a challenge for activated carbon electrodes

Capacitive Deionisation (Lab-scale)





Composite:

- Polymer
- Graphite
- Reduced Graphene Oxide

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  Somnath Pal
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Method	As > 10 µg/L%	As > 50µg/L%	As > 200 µg/L%
Arsolux	95	75	15
Arsenator	90	90	15

ARSOlux – Introducing Biosensor Technique for Testing Arsenic in Drinking Water in West Bengal

- Dr. Konrad Siegfried
- September 2013

ECO-India
www.eco-india.eu

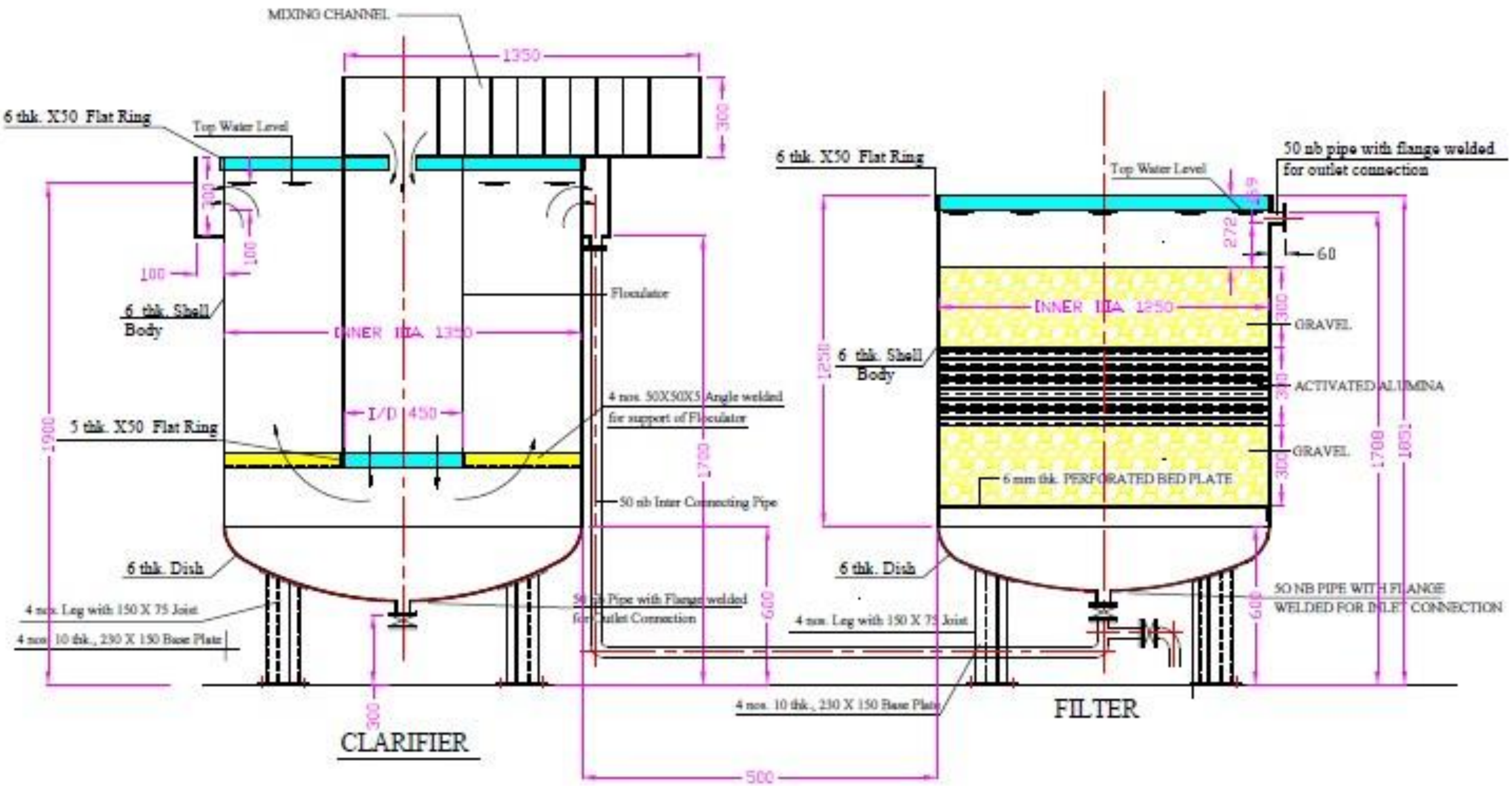
SEVENTH FRAMEWORK PROGRAMME

Tyndall Trustwater adelphi DTU DRYDEN AQUA AGM

Field Testing of UFZ Arsolux sensors for arsenic testing at the pilot site village in Jyot Sujan

HELMHOLTZ
CENTRE FOR
ENVIRONMENTAL
RESEARCH – UFZ

Arsenic Removal Unit (ARU)



Tyndall National Institute · Trustwater · adelphi · DTU · HELMHOLTZ ZENTRUM FÜR UMWELTFORSCHUNG UFZ · DRYDEN AQUA · AGM Communication & Control Ltd.

Groundwater Scheme Construction

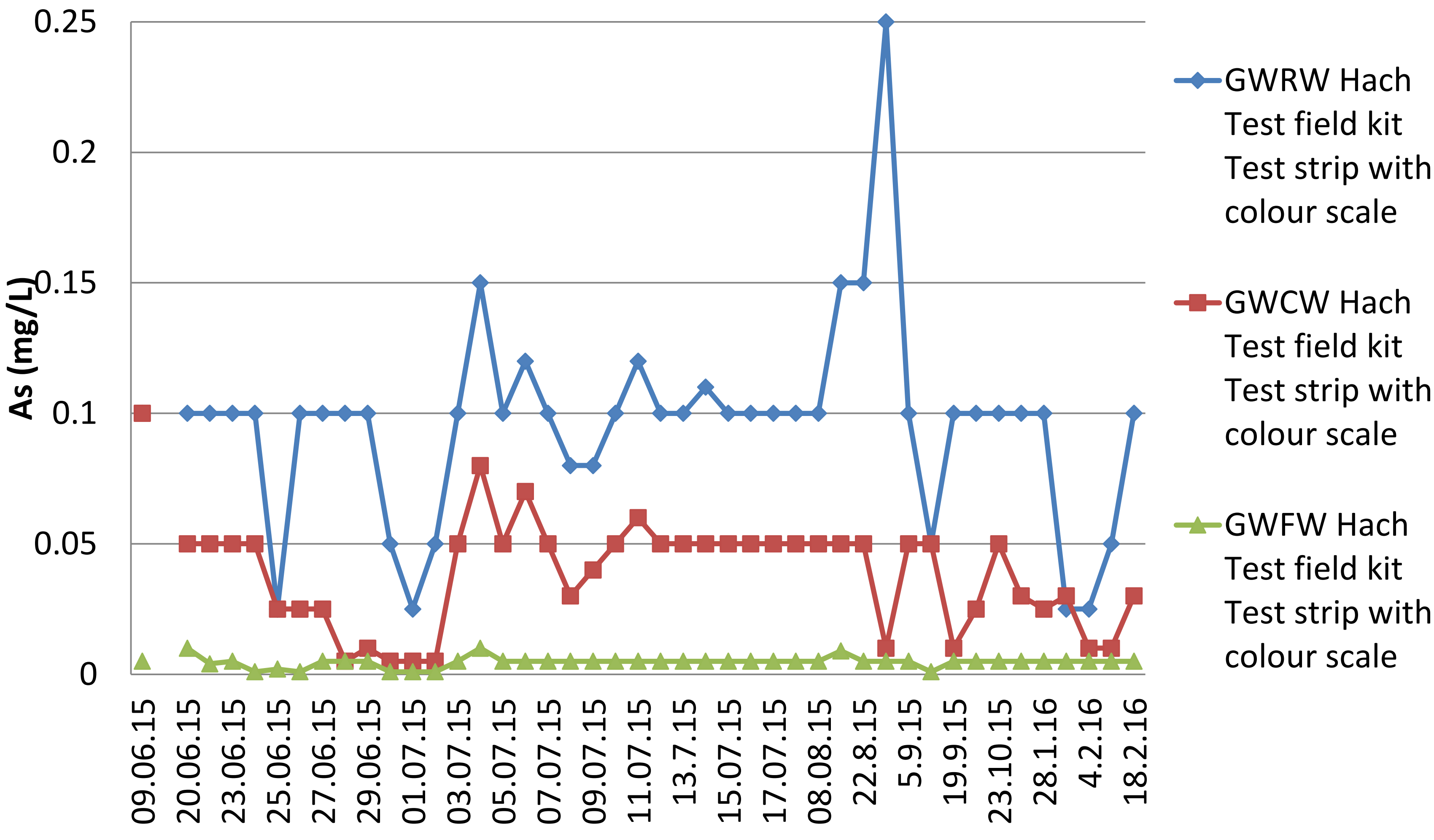
ARU at Project site

Tyndall National Institute | Trustwater | adelphi | DTU | HELMHOLTZ ZENTRUM FÜR UMWELTFORSCHUNG UFZ | DRYDEN AQUA | AGM Communication & Control Ltd.

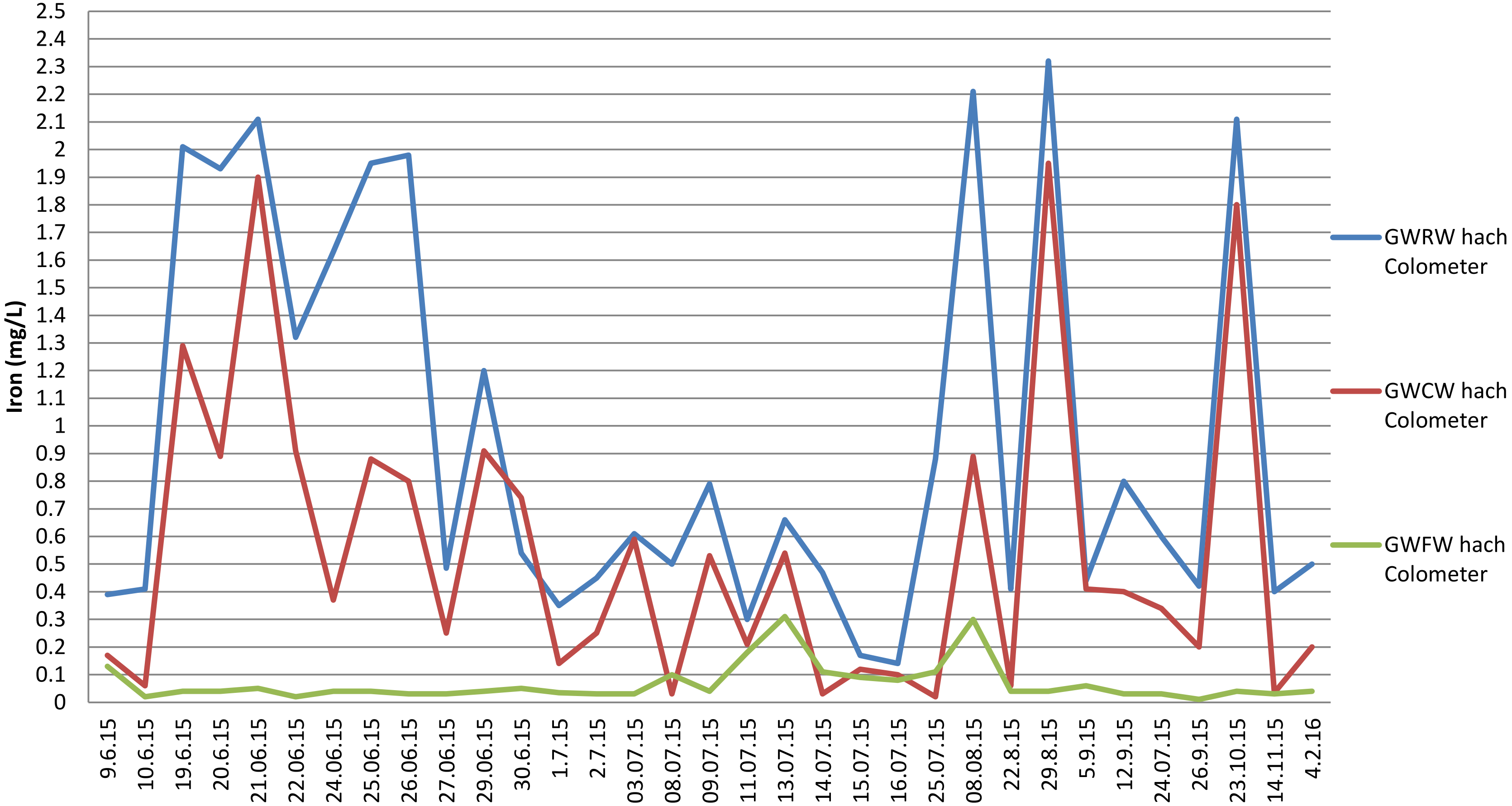
ARU Specification

Parameter Specification	Unit
Clarifier (Inner Diameter) Ht. of Clarifier (including Joist)	1350 mm 1900 mm
Floculator (Inner Diameter)	450 mm
Clarifier Thickness	6 mm
Mixing Channel	1350 mm (Length) 300 mm (Breadth)
Upflow Filter unit (Inner Diameter) Ht. of Upflow Filter Unit	1250 mm 1788 mm
Filter Media	300 mm (Gravel)
	300 mm (AA)
	300 mm (Gravel)
Max. Pumping rate of well	1.25 m3/hr

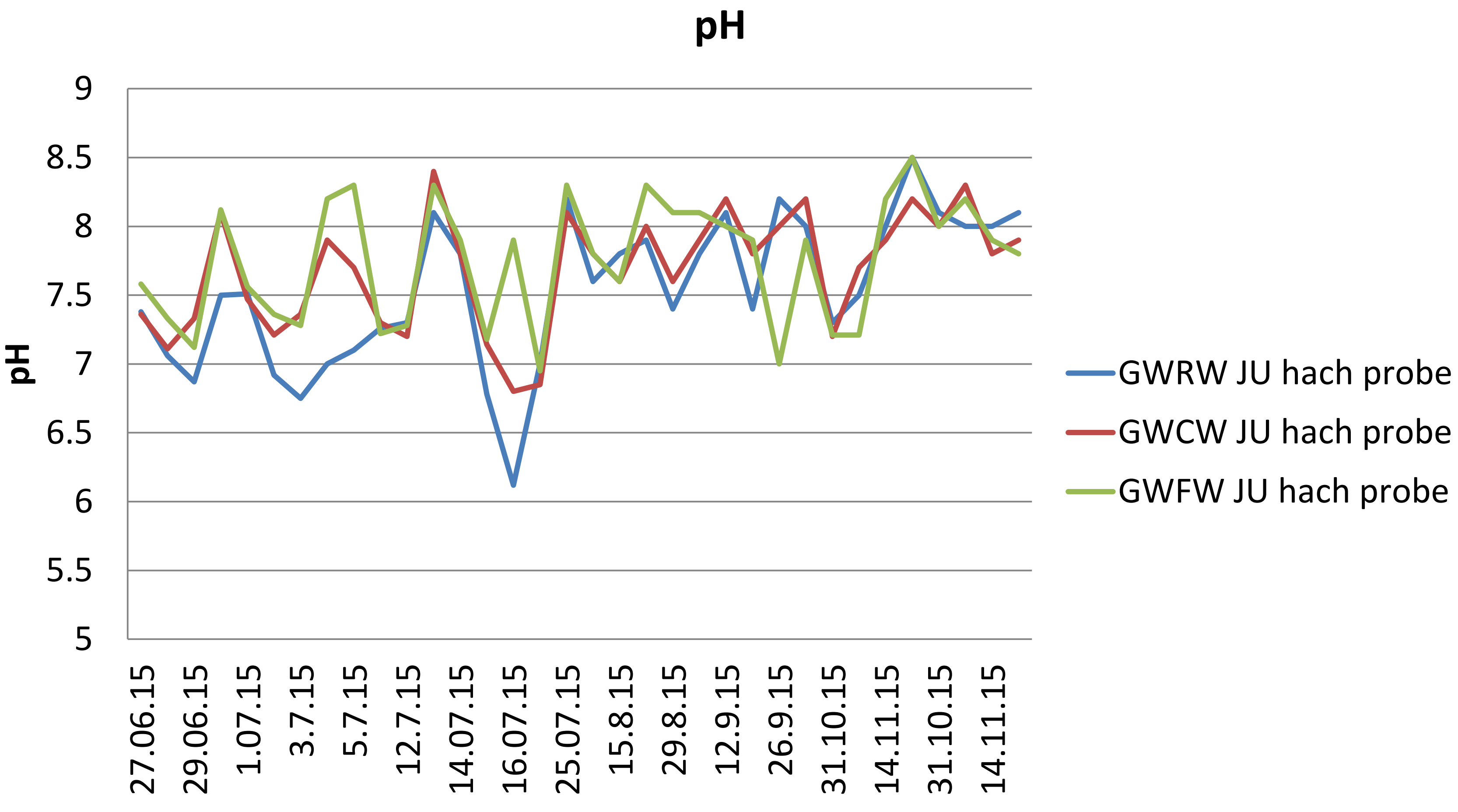
Arsenic Concentration (As) measurement at various points of the treatment process (source: offline monitoring)



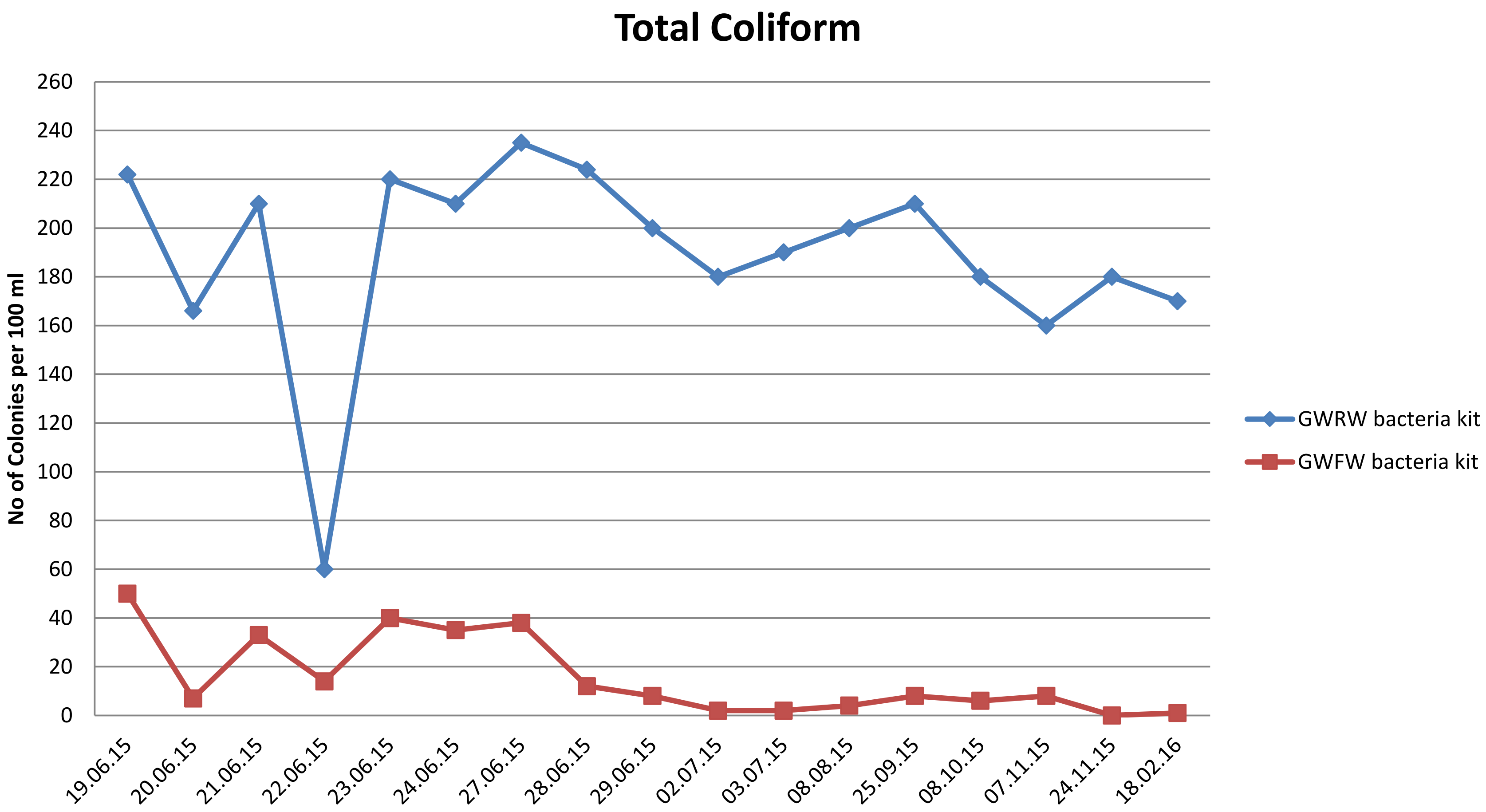
Offline Iron Concentration measurement at various points of the treatment process (source: offline monitoring)



pH at various points of the treatment process (source: offline monitoring)

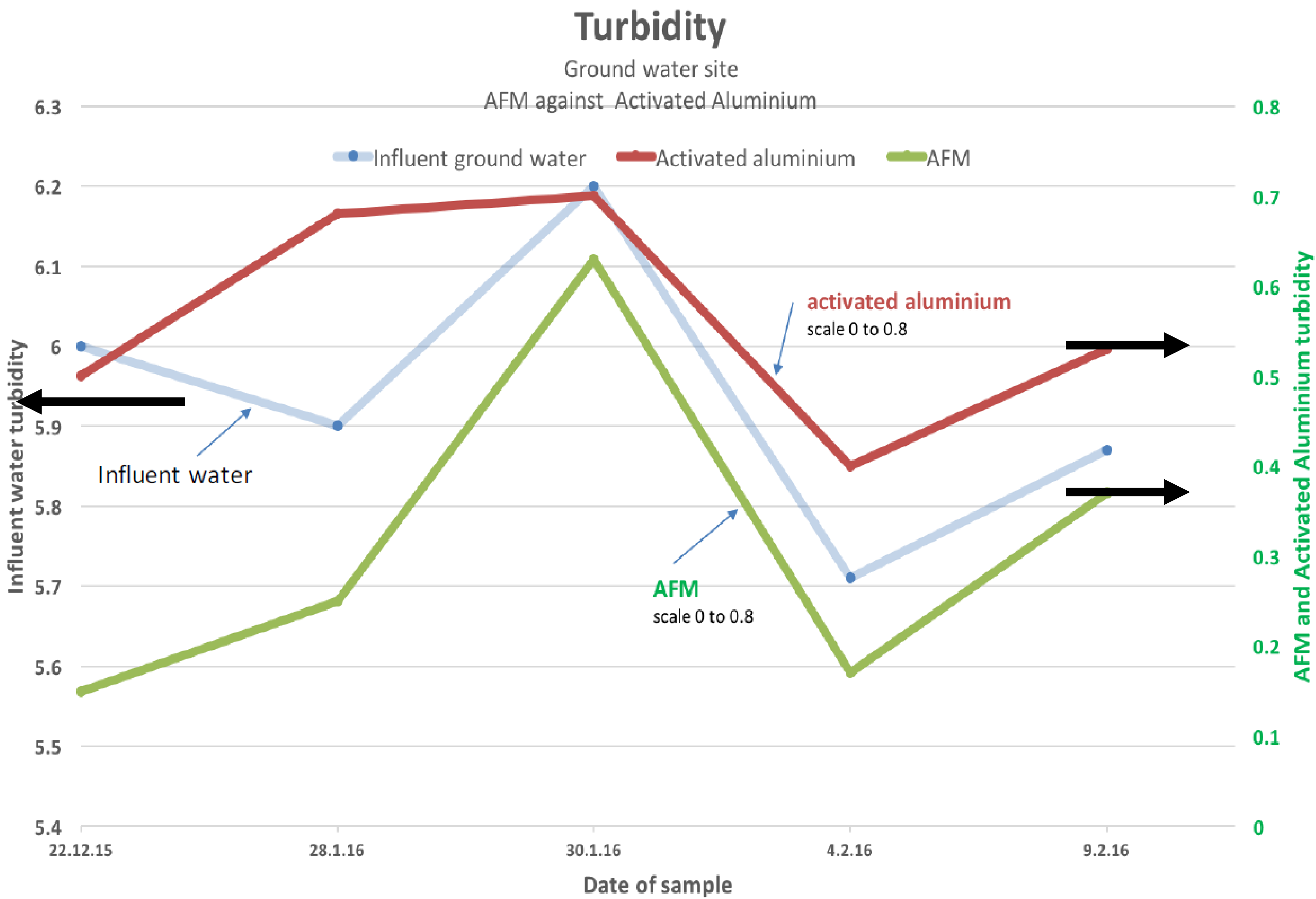


Total measurement at various points of the treatment process (source: offline monitoring)



Water Quality Result of Ground Water Treatment System

Parameters	Pre-treated Water	Post Treated Water
Turbidity (NTU)	4.46-16	0.42-1.7
Total Hardness (mg/L)	150-200	120-150
pH	7.2-8.1	7.9-8.0
TDS(mg/L)	301-351	280-371
As (mg/L)	0.2-0.1	0.007-0.005
Iron (mg/L)	0.37-2.11	0.06-0.74
E Coli (MPN/100 ml)	>20	Absent
Total Coliform (MPN/100 ml)	8	Absent



Turbidity
Ground water site
AFM against Activated Aluminium
Influent ground water
Activated aluminium
AFM
6.3
6.2
6.1
6
5.9
5.8
5.7
5.6
5.5
5.4
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Influent water turbidity
AFM and Activated Aluminium turbidity
activated aluminium
scale 0 to 0.8
Influent water
AFM
scale 0 to 0.8
22.12.15
28.1.16
30.1.16
4.2.16
9.2.16
Date of sample

Optimization

- Flow rate of Raw (Ground) Water, Sodium Hypochlorite , alum dozing tank
- Cleaning of Clarifier and Upflow Filter once in a month
- After cleaning of ARU sludge needs to store in a sludge tank

Conclusion

- low cost, sustainable, eco-friendly, technical feasible, socially acceptable simple treatment solution for removal of Arsenic, Iron more than 90% from contaminated ground water
- pre-chlorine dosing is not only used for oxidation of As^{+3} to As^{+5}, the liquid chlorine also removes bacteria very significantly from contaminated water
- Production cost (excluding capital cost) =Rs. 71.43 per 1000 L
- Production including capital cost =Rs. 464.43 per 1000 L
- **Net Arsenic rich sludge generated per year during the process is 102.20 Kg of which 146-219g is Arsenic (based on 4 m^3 water per day)**

Somnath Pal
Research Scholar
School of Water Resources Engineering
Jadavpur University
India

Agenda

- Project Overview
- Application of Geographical Information Systems for suitable site selection
- Community engagement and awareness
- Comparative analysis of roughing filter as pre-treatment for surface water
- Ecological surface water treatment
- Sustainable technology for removal of arsenic in rural areas
- Decentralized integrated approach for water and wastewater management
- Dissemination
- Research Outputs
  Dr Pankaj Roy
- Cost-Benefit Analysis
- Conclusions

Eco-India Team field visit During Workshop

Meeting in India and Europe

Meeting with DST Expert Committee & European Partner in presence of Honorable, Vice-chancellor of Jadavpur University

Meeting with European partner in Edinburgh

Eco-India Workshops & Meetings

Eco-India team Review Meeting at Brussels

Eco-India project meeting with water committee.

Participation in training & Workshop in Pune on March,2014.

DST-expert committee visit to Surface water Unit

DST Expert Committee Vistit at ARU Unit

DST Visit to European Technology

Eco-India Project Presentations

Eco-India Project Presentation at project review meeting in Brussels on June,2014

Eco India Partners participation in workshop organized by SWRE,JU

Poster Presentation at Indo-US summit (November-2014)

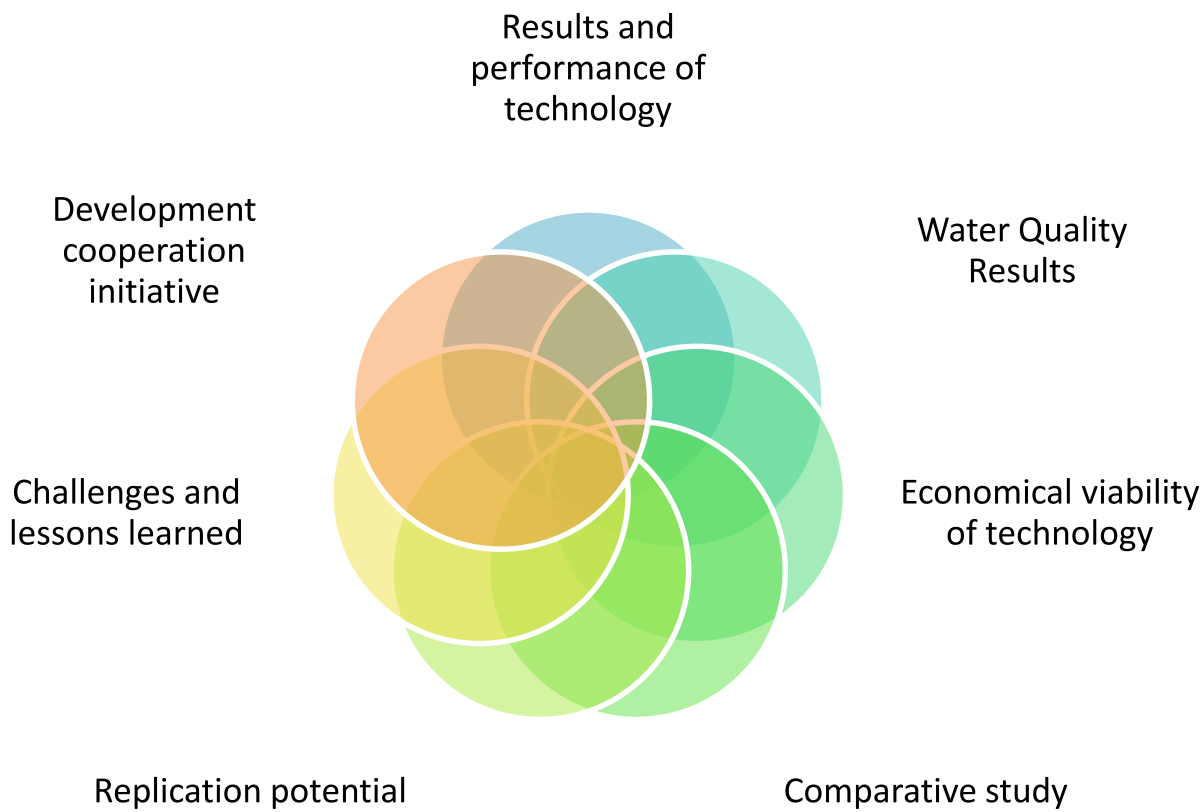
Field Workshop on 23rd November 2015

Promotional Workshop at Kolkata on 17th February,2016

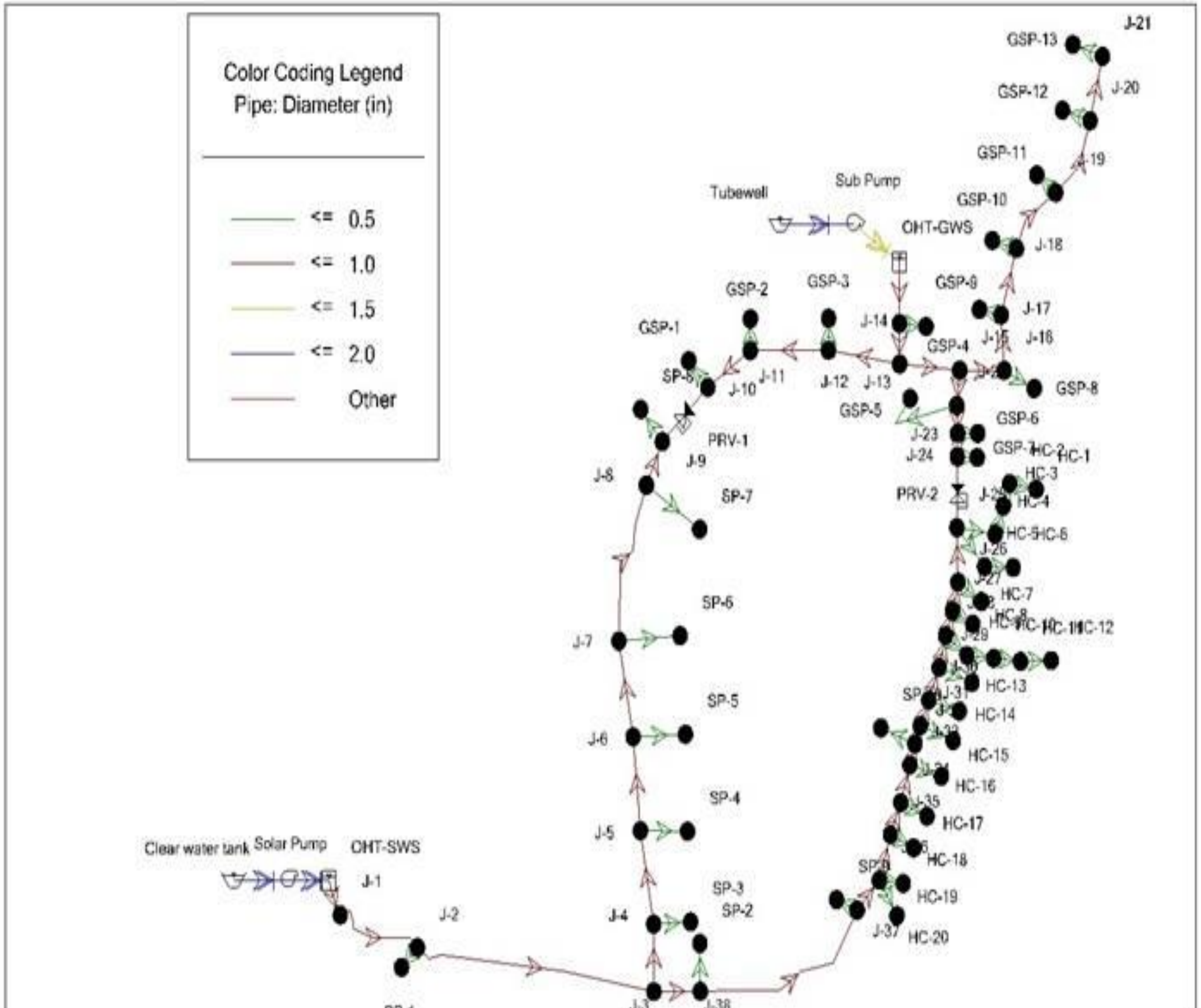
Project Outcomes

- 4 Ph.D. theses (Jadavpur University)
- 5 Master Thesis
- 2 Joint peer-reviewed publications
- 9 Joint Conference Presentations

Key feature of evaluation for Project Component



Integrated Drinking Water Distribution Network



24 x 7 Network ensures protection from post contamination

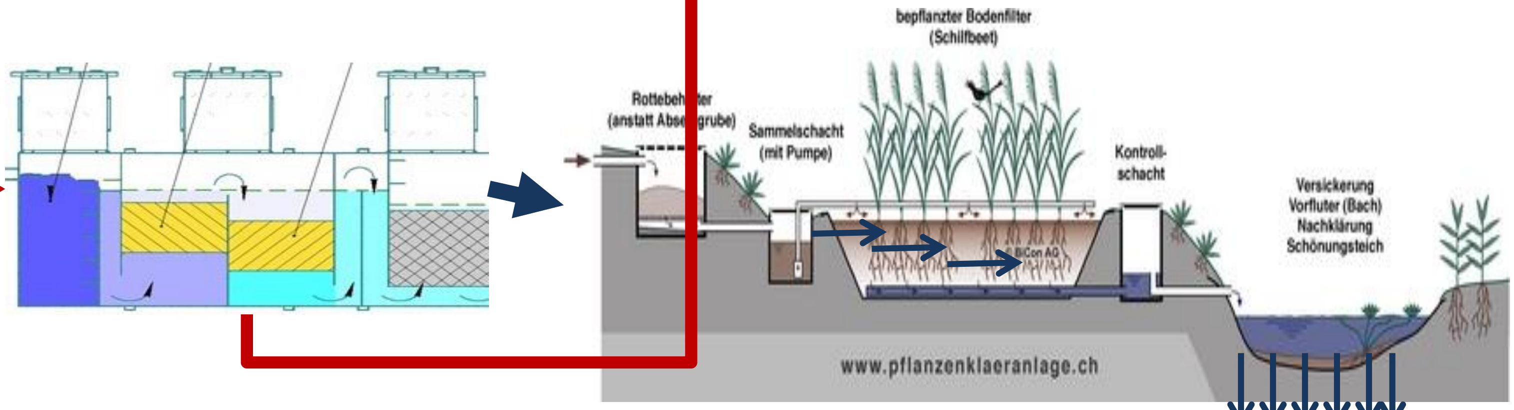
Sanitation Units

Wastewater treatment scheme

Collected waste water

Feasibility of energy harvesting through biogas production

Conceptualisation of Reed Bed Filter and exchange on German experience



Agricultural use / discharge

3 stage settling tank

Reed bed filter

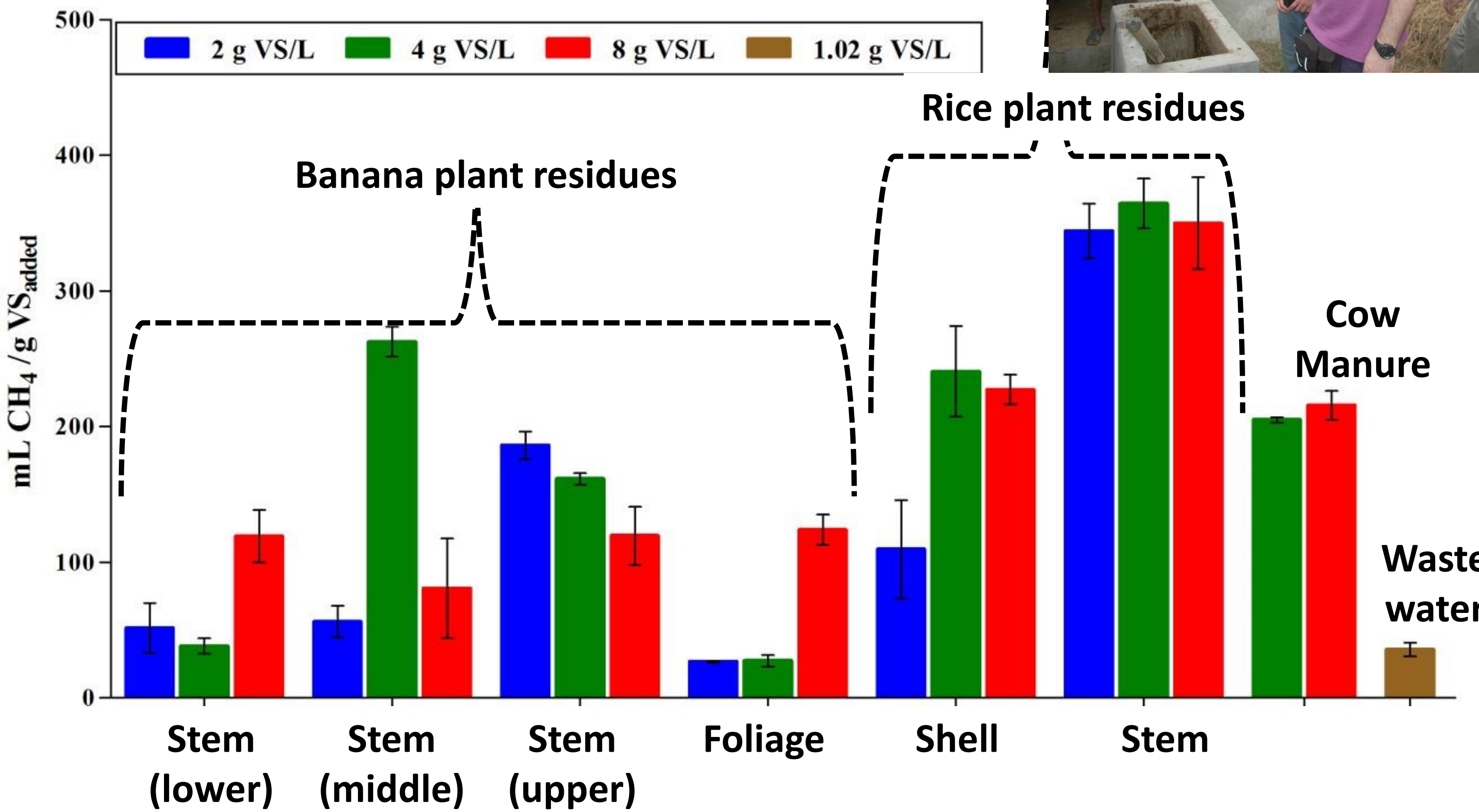
Design criteria of wastewater unit design

- Supply of drinking water 40 LPCD
- Total Population 30 persons
- Population for 1 unit 15 persons
- Black water generation 10 LPCD
- Grey water generation 22 LPCD
- Total grey water generation for 1 unit 330 L/day or 0.33 m3/day
- Avg. influent BOD (considered) 80 mg/L
- Expected Effluent BOD 10 mg/L
- Bed Area (A) 4

Biogas: Consultation with villagers on optimizing units for cooking




Biogas feasibility from plant residues and waste water



Conclusion

- Involvement of stakeholders at all levels ensures implementation improvement
- Overall integration of surface and groundwater leads to a higher sustainability
- House connections and 24x7 supply leads to higher level of water quality
- Waste water treatment is essential part of overall sustainability approach (catchment area protection)
- Setup has the potential for zero discharge of untreated wastewater
- Biogas feasibility study shows good potential for additional source of enregy (cooking and electricity)

Thank You

Dr. Pankaj Kumar Roy
Associate Professor
School of Water Resources Engineering
Jadavpur University
India

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  Prof. Asis Mazumdar & Dr. Aidan Quinn

Water Price of alternative setup

Number of households	Type of Setup	Lifetime (Estimated in months)	total O&M (per month)	Water fee only based on O&M costs (INR/Liter)	Water fee including investment cost (INR/Liter)	Water fee for one household based on O&M cost	Water fee for one household O&M and investment
140	Current Setup	120	59.833	0,14	0,24	427,38	719,63
280	Current Setup big	120	119.666	0,14	0,24	427,38	719,63
140	Conventional Setup	360	19.039	0,05	0,06	135,99	171,66
140	Alternative Setup incl. distr., sewerage, WWTP	360	48.834	0,12	0,17	348,81	502,98
140	Alternative Setup with catchment	360	29.353	0,07	0,09	209,67	265,12
140	A. Setup only water production	360	27.208	0,06	0,08	194,34	239,58
280	Alternative including all	360	51.783	0,06	0,09	184,94	262,03
280	Alternative Setup with catchment	360	32.303	0,04	0,05	115,37	143,09
280	A. Setup only water production	360	30.157	0,04	0,04	107,70	130,32

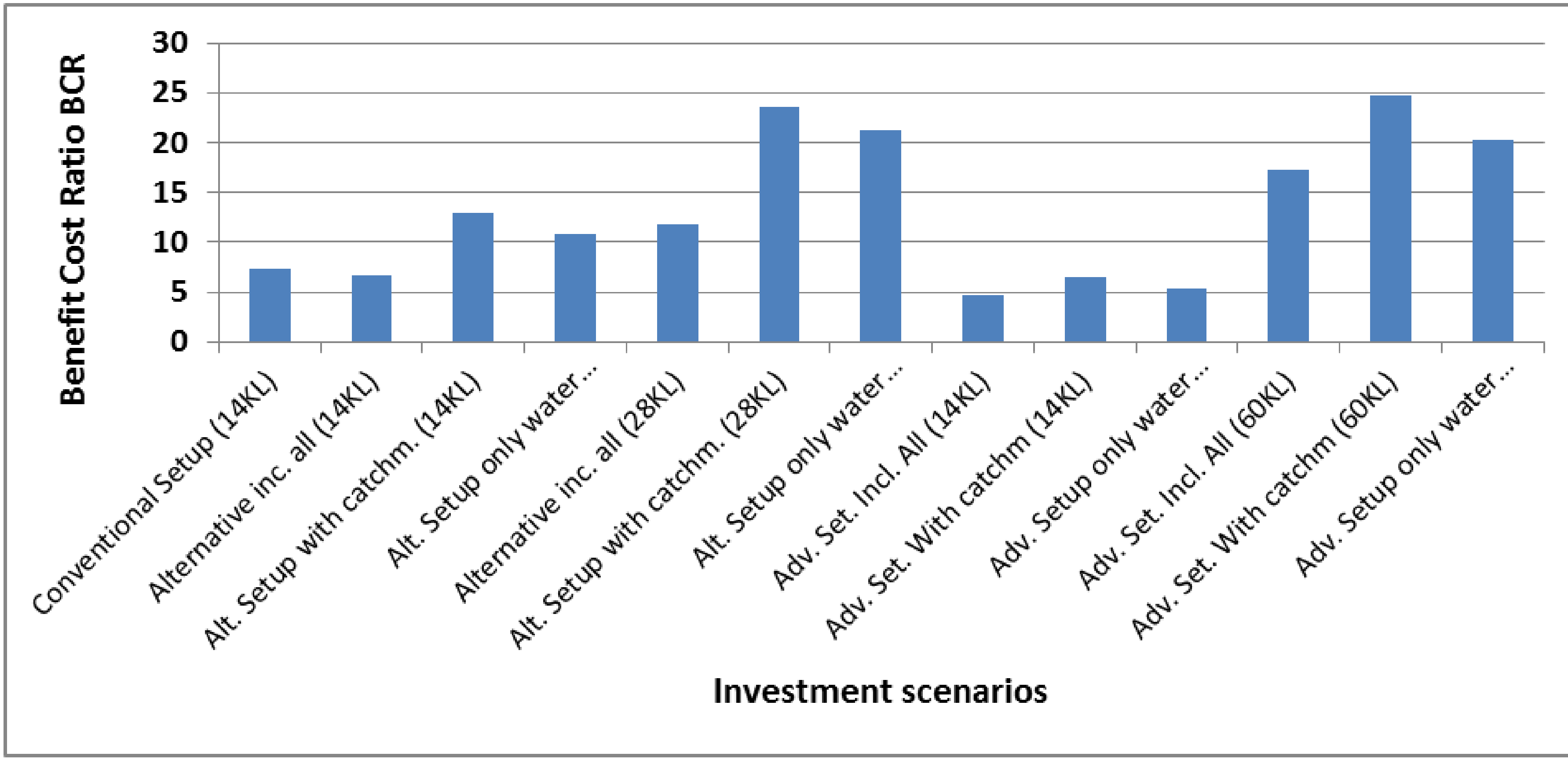
Benefits of Project

- Local Villagers are getting Arsenic free drinking water which will reduce the health problem.
- Creation of perennial drinking water source for sustainable water supply throughout the year
- Knowledge exchange and training of Young Researcher in field level.
- Online monitoring system and cost-effective treatment of surface water and groundwater to good quality by using Activated Glass Filter Media, Aerator system, Mixed Oxidants etc.
- Wastewater minimization and conversion of zero discharge as pilot scale model including pipeline design and feasibility study on the usage of wastewater for the generation of biogas.
- Integrated water and wastewater management
- Catering around 2000 population if not more with 20 L per capita per day for drinking and cooking purpose.

Benefit analysis (monetized)

- Time surplus for economic activities
- Health-related work productivity
- Reduced costs from purchasing bottled water
- Cost savings from reduced medicine purchases and hospital visits
- Employment of operators for distribution and waste water management
- Biodiversity in catchment area
- Increase in property value
- cost savings for leisure activities
- Improved environmental quality
- Independent Maintenance full system
- Better salaries for involved employees in construction of treatment system, distribution and waste water treatment system
- Increased organic fish production

Benefit Cost Ratio



Sustainability Aspect	Weightage (1-3, total 20)	Current	Conventional	Alternative (pilot)	Alternative (potential)	Advanced (pilot)	Advanced (potential)
Final Results (Water Quality as per IS10500)	2,4	7,2	16,8	19,2	21,6	21,6	24
Final Output (working status)	2,4	12	12	16,8	21,6	7,2	24
Construction and Installation, Material	1,2	12	9,6	9,6	10,8	1,2	6
Labour and time required for construction	1,4	7	4,2	1,4	4,2	7	14
Requirement to assure continuous operation (energy, consumables)	1,6	16	8	11,2	14,4	4,8	9,6
Operation and maintenance procedures (qualification of staff)	1,6	16	8	11,2	12,8	3,2	12,8
Socio-economic impacts	1,8	1,8	12,6	14,4	16,2	10,8	12,6
Environmental impacts	1,8	1,8	12,6	14,4	16,2	9	10,8
Adequacy of water price (O&M)	2,6	6,5	19,8	17,2	19,8	14,7	22,5
Adequacy of water price (investment +O&M)	1,8	4,8	14,9	13,3	15,1	10,5	15,9
Ratio of costs to benefits	1,4	1,4	4,1	8,2	9,6	7,4	11,6
Total Score	**20**	**87**	**123**	**137**	**162**	**97**	**164**

Conclusion

- A technical feasible, socially acceptable and low cost integrated solution has been elaborated with the treatment efficiency of ECO-India Project really applicable for arsenic affected areas in rural India.
- The main challenges of awareness and ownership by the community are overcome by involving all relevant groups of the community in the water committee and presently working out compromises which are supported by all water committee members.
- The developed concept promises an overall sustainable eco-friendly operation and maintenance regime.
- The performance efficiency also proved the scope of the pilot as a best practice model for communities in areas with non-potable groundwater sources.


ECO-INDIA CONSORTIUM MEETING,
AND FIELD VISIT TO PROJECT PILOT SITE
MAY 8th to 11th, 2014
Indian Consortium
Jadavpur University
Indian Institute of Technology
Super Technicians
ECO India
Organized by
School of Water Resources Engineering,
Jadavpur University
Training workshop on 8th May to 11th May,2014
European Consortium
Tyndall National Institute
Trustwater Ltd.
adelphi
Adelphi Research
Helmholtz-Zentrum fuer Umweltforschung GmbH
DRYDEN AQUA
Dryden Aqua Ltd
AGM Communication & Control Ltd

Thank You