Sustainable water

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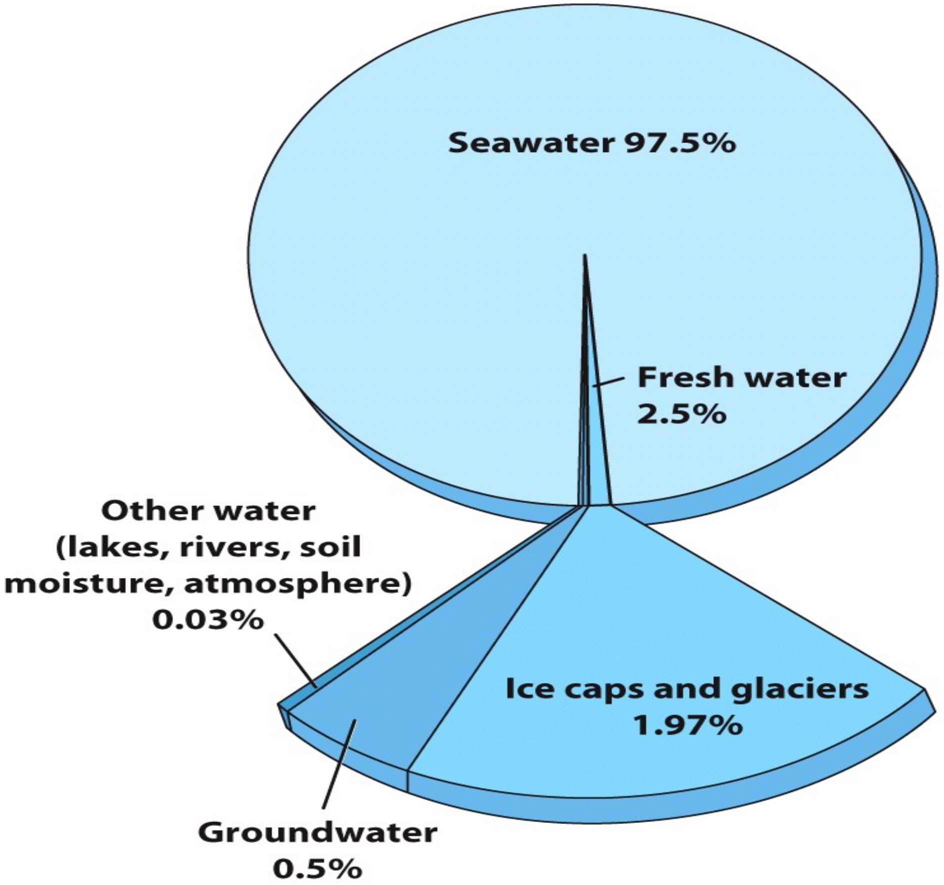
The Importance of Water

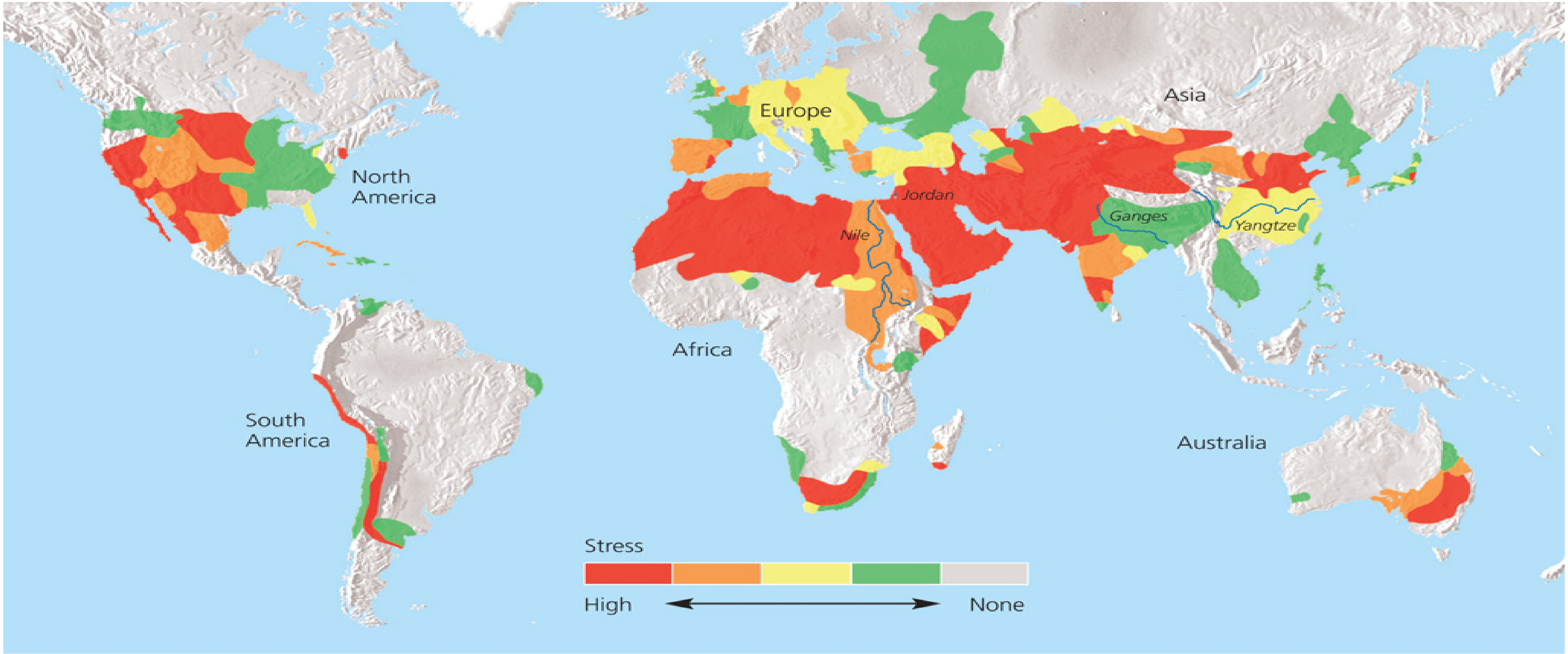
- Less than 3% of Earth's water is consumable (potable)
  - 97% is salty
  - Uneven distribution - serious regional supply issues across the globe
  - By 2025, more than 1/3 of humans will live in areas with inadequate supply of fresh water for drinking and irrigation



Distribution of Earth's water


2.1 billion people
globally lack safe water at home (2015)
Of those people...
263 million
spend more than 30 minutes per round trip collecting water
159 million
drink water directly from surface sources, such as streams or lakes
844 million
do not have basic drinking water services

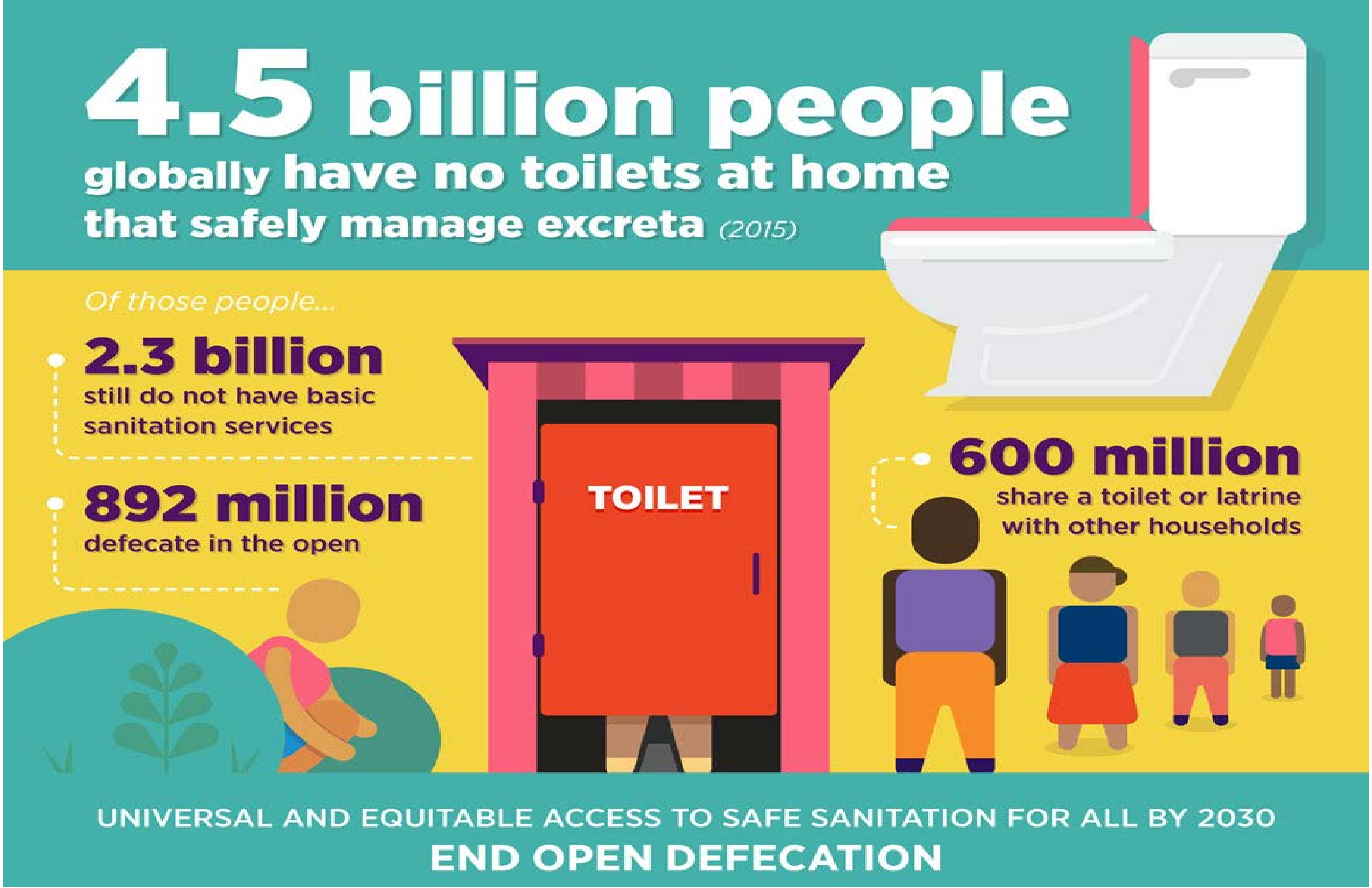
Freshwater Scarcity Stress



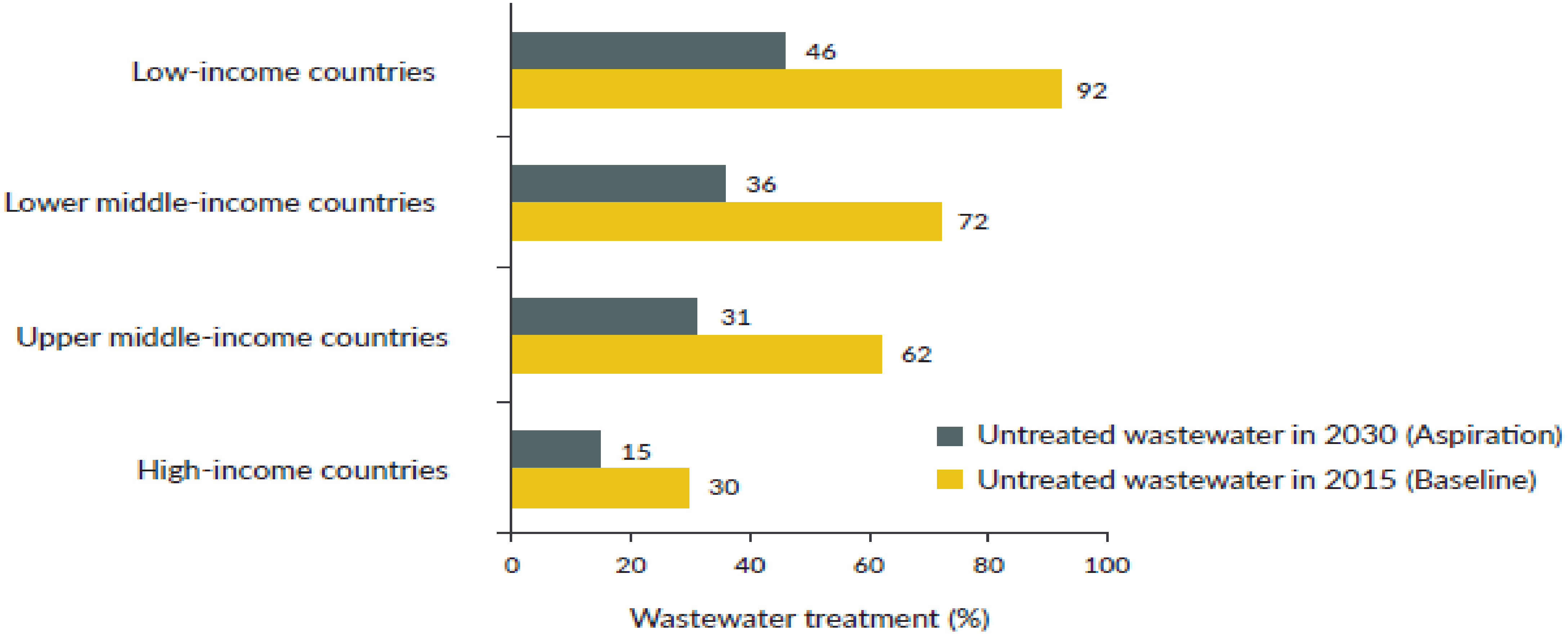
Compiled by the authors using data from World Commission on Water Use for the 21st Century, UN Food and Agriculture Organization, and World Water Council.

WATER SCARCITY

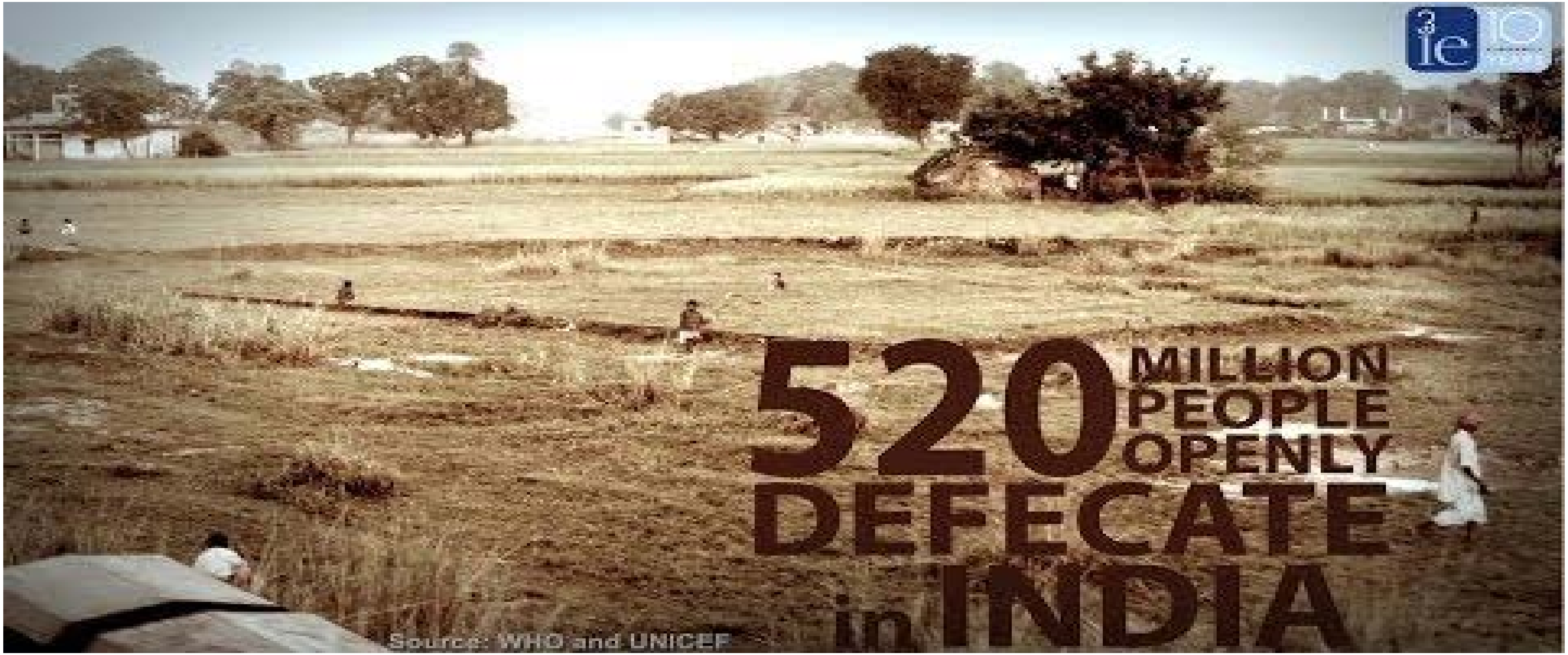
Given demographic and economic trends, it is estimated that the world will need 40% more water by 2025.


4.5 billion people
globally have no toilets at home
that safely manage excreta (2015)
Of those people...
2.3 billion
still do not have basic sanitation services
892 million
defecate in the open
TOILET
600 million
share a toilet or latrine with other households
UNIVERSAL AND EQUITABLE ACCESS TO SAFE SANITATION FOR ALL BY 2030
END OPEN DEFECATION

% of untreated wastewater in 2015
impact of income level and goal for 2030

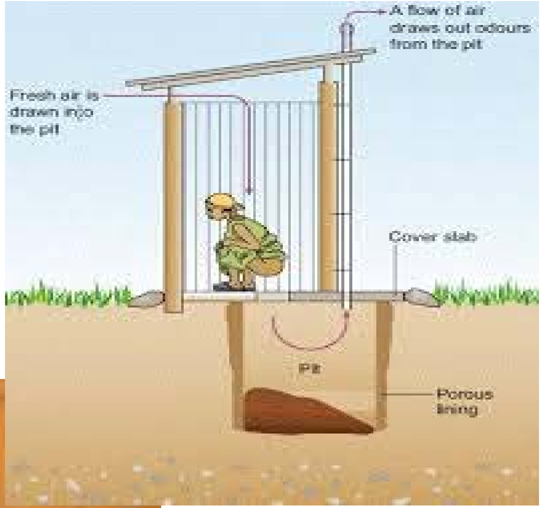


Source: Based on data from Sato et al. (2013).



520 MILLION PEOPLE OPENLY DEFECATE in INDIA
Source: WHO and UNICEF

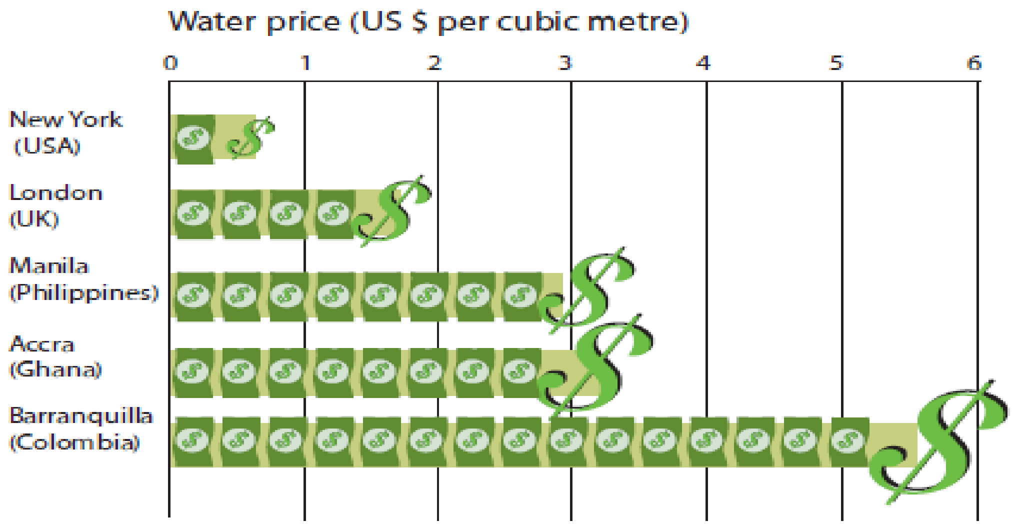
Latrine



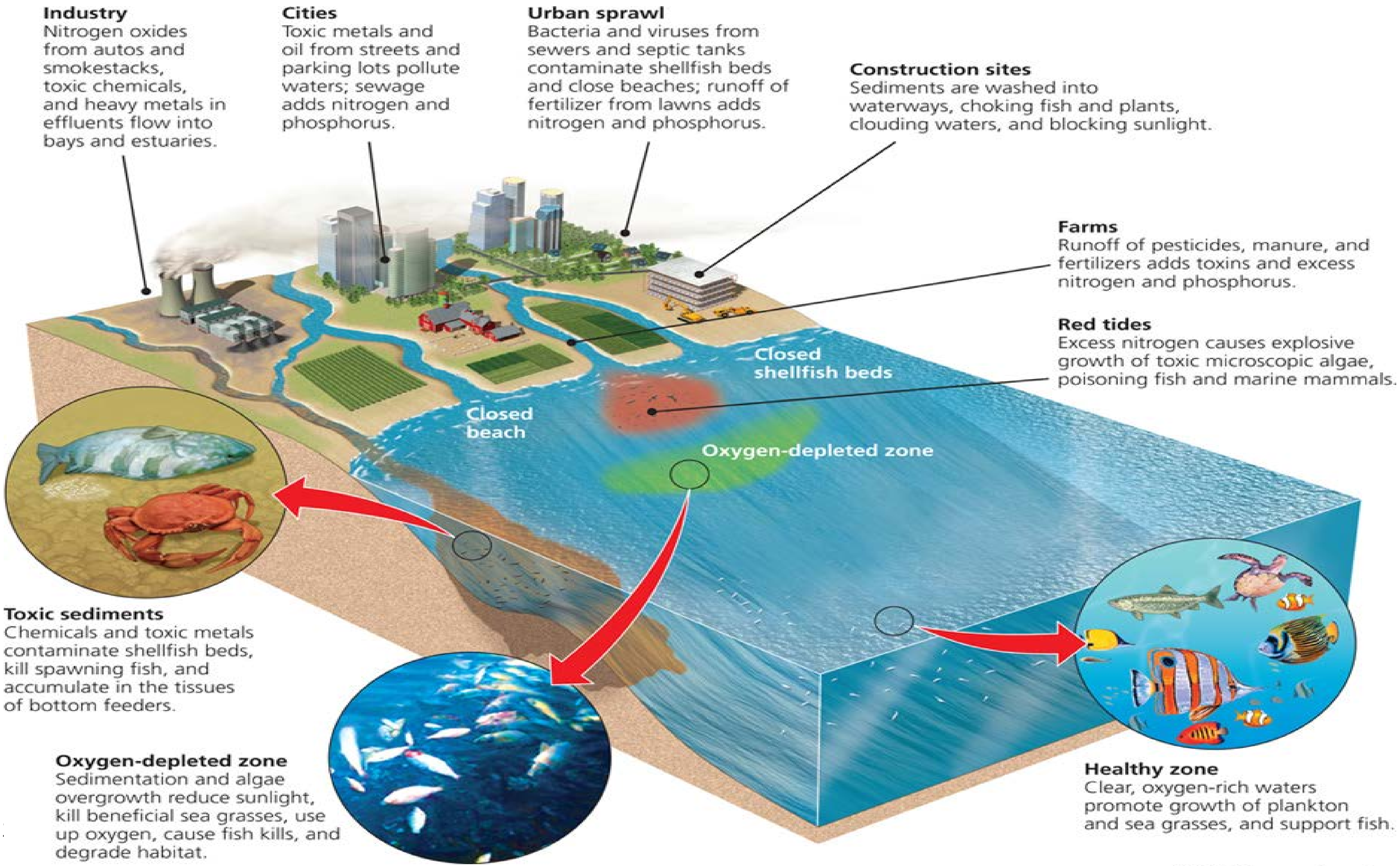
A flow of air draws out odours from the pit
Fresh air is drawn into the pit
Cover slab
Pit
Porous lining

Who pays the most

- Poor pay a lot of money for water, walk great distances, wait hours
- Woman and girls are responsible to collect water-lost opportunity to go to school and learn skills
- Water crisis threatens humanity
- Global climate change-higher temp, increased evaporation, changes in water cycle, more floods and draughts
- Can live only 5 days without water
- Water is a human right



http://www.unwater.org/downloads/water_rights_and_wrongs_en.pdf


Industry
Nitrogen oxides from autos and smokestacks, toxic chemicals, and heavy metals in effluents flow into bays and estuaries.
Cities
Toxic metals and oil from streets and parking lots pollute waters; sewage adds nitrogen and phosphorus.
Urban sprawl
Bacteria and viruses from sewers and septic tanks contaminate shellfish beds and close beaches; runoff of fertilizer from lawns adds nitrogen and phosphorus.
Construction sites
Sediments are washed into waterways, choking fish and plants, clouding waters, and blocking sunlight.
Farms
Runoff of pesticides, manure, and fertilizers adds toxins and excess nitrogen and phosphorus.
Red tides
Excess nitrogen causes explosive growth of toxic microscopic algae, poisoning fish and marine mammals.
Closed shellfish beds
Closed beach
Oxygen-depleted zone
Toxic sediments
Chemicals and toxic metals contaminate shellfish beds, kill spawning fish, and accumulate in the tissues of bottom feeders.
Oxygen-depleted zone
Sedimentation and algae overgrowth reduce sunlight, kill beneficial sea grasses, use up oxygen, cause fish kills, and degrade habitat.
Healthy zone
Clear, oxygen-rich waters promote growth of plankton and sea grasses, and support fish.

What are we doing on ***water sustainability*** at Tel Aviv University with Amrita in India?

Joint activities

Ram Fishman, Department of Public Policy
Hadas Mamane, Faculty of Engineering

Amrita-Tel Aviv Collaborative Center for Research in Water

- Multidisciplinary research in water resources and sanitation, engineering, management
- Development of tools for water sustainability and empowering the community to build a water-wise community
- Research work will be performed in selected areas where Amrita University is implementing the large scale project titled as "*Jivamritam – a Community Based Water Purification System*".

Main activities with Amrita in India

1. Innovation
2. Experimentation - Beta Sites
3. Implementation Sites
4. Research
5. Education

Innovation

- Stimulate the development of new approaches to provide safe drinking water to the target populations.
- Such innovation is needed for both the technological and behavioral aspects of the water challenge.
- Innovation ecosystem on water of both India and Israel - and work with promising ideas to help fine-tune them and adapt to local circumstances through a process of experimentation and learning in real field conditions

Experimentation - Beta Sites

1. The first set of field sites will consist of a small number of sites that represent different typologies of drinking water challenges.
2. In these sites, which will be our “labs in the field”, our faculty and students will conduct intensive monitoring of all aspects of the water situation and experimentation with various innovative technologies and behavioural approaches.

Implementation Sites

- Solutions that show promise based on learnings in the beta sites will be implemented at gradually increasing **scale in the thousands of sites** that Jivamitram will eventually reach.
- Most activities will be undertaken by field agents in a scalable manner.
- The process of innovation, piloting and testing will be a continual process occurring in annual cycles.
- New innovation and adaptation will be undertaken, leading to additional pilots and based on those, implementation.


Jivamritam: Clean Drinking Water Project
A joint project by
General of Israel to South India,
Vidyapee tham & Tel Aviv Un


Jivamritam: Clean Drinking Water Project
A joint project by
The Consulate General of Israel to South India,
Amrita Vishwa Vidyapeetham & Tel Aviv University
AMRITA
VISHWA VIDYAPEETHAM
TEL AVIV UNIVERSITY

Research

- All activities will be accompanied by mostly MSc, PhD and post-docs
- A rigorous applied research program that will be designed to support the goals of the initiative through a learning process that will adhere to the highest standards.
- This will ensure all implementation activities at scale are based on robust evidence of impact and enable us to share our learnings with the global community of researchers, implementers and policy makers through publications in top scientific journals.

Education

- Amrita university and TAU will jointly develop a novel, cross-disciplinary curriculum on the challenge of safe drinking water.
- Course will start next semester
- The educational resource will be made publicly available and include online training modules and the use of rich media from actual field sites.

Sirumugai Dyeing and Weaving Unit for Kovai Kora and Soft Silk

Dr. Ram, **Kumaraguru College of Technology, KCT**

Prof Bhaarathi Dhurai, Dr. Sukanya Devi, Prof. SathyamoorthyProf. Ramalingam, Dr. Geethakarthi

Prof Mamane, **Tel-Aviv University, TAU**

Prof Mohan, **Indian Institute of Technology Madras, IITM**

Background

- Sirumugai Magazhir Cotton & Silk Handloom Weavers Cooperative was established in 2003 and located at Sirumugai, Coimbatore, Tamil Nadu
- Products of the society are **Kora Cotton Sarees** and **Soft Silk Saree**
- Coimbatore is called the Manchester of India, due to the superior variety of cotton grown and spun on hand and power looms
- A superior quality cotton yarn is mixed with traditional silk to produce kora cotton.
- Dyeing soft silk and kovai kora cotton sarees are done at dyer's residential place

Silk material before and after dyeing

Dried silk material

Dyeing process of soft silk sarees

- Acid dye is used to dye the silk filament in a vessel
- Acid dye powder is dissolved in water followed by adding soap and washing soda (sodium bicarbonate) and then dye bath temperature is raised to **boil**.
- Dyeing is done on filament of silk
- Process is followed by additional baths including washing residual dye and fixation

Dyeing process

Fixation with acid

Acid wash bath

Wash water bath

Contamination

Dye adsorbed in soil

Direct discharge of all effluents to the ground or through channels to the river

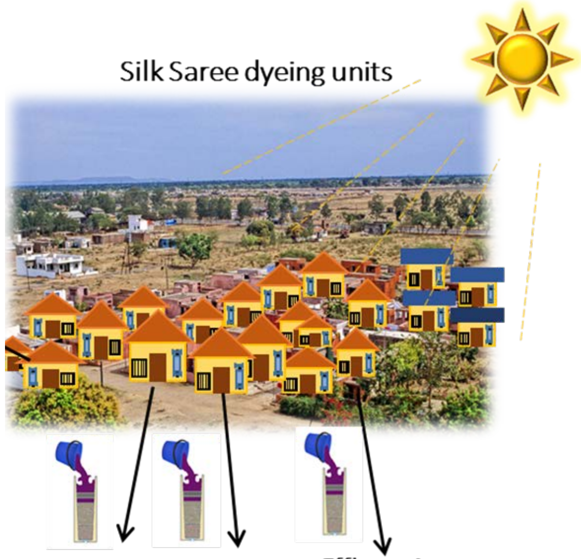
Discharge to channels along with sewage

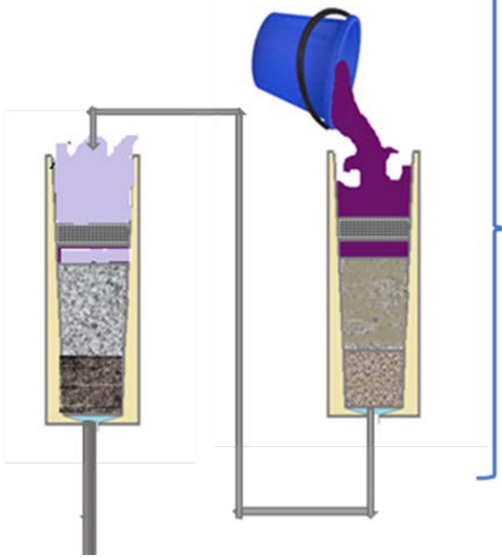
Outcome

Dyes can reach Bhavani river

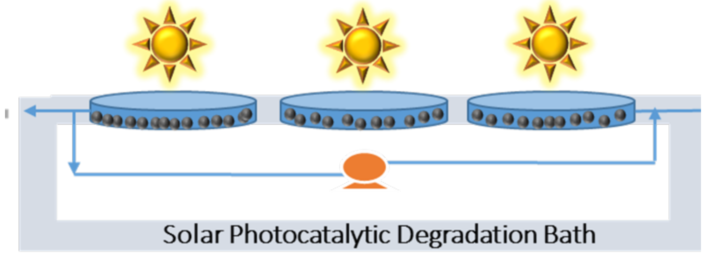
Dyes can reach food production

Process Flowchart





Will be designed as a water filtration/sorption unit

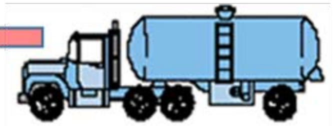


WasteWater stream per household → Filter → Sorption → Photocatalytic degradation bath → Clean Discharge

Sorption ↓ Hazardous storage & disposal

Filtration and sorption after use

Hazardous storage and disposal facility



Transportation

Electroplating wastewater

Open dump Chennai

Water drinking in slums

The impact

- Our goal is to make an impact on water sustainability
- By using data driven studies we can scale up
- We are approaching TAU faculty and students to support our initiative on water sustainability in India

What do we dream?

- Our dream is to immerse our adventurous students from Tel-Aviv University (TAU) to spend time in the villages in India, in development projects with local partners and identify new approaches and needs for understanding the complexity associated with achieving the Sustainable Development Goals (SGD) on water.

TAU students

- **Our students** seek for an environment that teaches them how to learn from experience and solve real problems and are driven by passion and innovation and we encourage them to think out of the box.

What do we wish

1. Support for these students will go very far in terms of the environmental impact it can generate on the water crisis.
2. Our collaboration with Amrita University in Kerala, India, is a remarkable opportunity to develop and adapt technologies and innovation at scale to provide safe drinking water to poverty stricken populations.

Main research activity

- Water-Tech Lab focus on technologies for treatment of contaminated water and wastewater and conversion of waste to fuels, by introducing solar and induced photons, free radicals and nanoparticles into the water.
- My current passion is to develop sustainable low cost and off the grid water and energy technologies for problems related to India
- Main research projects 2019:
  - Development of light emitting diodes (LED) reactors for water disinfection (Magneton, PI)
  - Combining nanoparticles with ozone for water treatment (ISF, PI)
  - Development of aerogels for sorption of contaminates (Sparc, PI)
  - Life cycle analysis of ethanol as transportation fuel (Ministry of Environmental Protection, co-PI)

Thank you

Shade darkening

- After dyeing, used dye bath is replenished with acid dye powder to dye another set of silk skeins for dark shade.
- This type of shade darkening/color changing of same dye bath will be continued for dyeing of skein for various color
- When the dye bath comes too viscous due to the serecin gum present in the raw silk – **it is discharged to the environment**
- **Including the wash water effluent and the acid wash effluent**

Quantities of wastewater per day

- 80 to 100 dyers (5 dyers / society and 18 such society exists in Sirumugai area)
- In total 1500 to 2000 weavers and 100 dyers
- The dyes are purchased from Surat, Gujarat, while sodium carbonate , soap etc are locally purchased.
- Health issues known - Lack of appetite, skin allergy
- The wastewater vary depending upon the quantity of material to be dyed per day.
- Dye liquor 70 to 100 litres, wash liquor 300 to 400 litres and acid wash liquor less than 75 litres.
- As an approximation 500 to 600 litres will be discharged to the environment/day/ household.
- 80 to 100 households in the entire area practice dyeing and discharge to the environment

Outcome

Total of 50,000 (50 m^3) to 60,000 (60 m^3) liters per day of dye wastewater is discharged to the environment in the area with no treatment.

Due to cost prohibitive and need for expensive treatment processes small scale industries are not able to treat waste generated

This unique industry of dyeing and hand-looming is of great value and must be maintained with proper treatment

Quantities per sari

1. How many silk skein (twisted silk yarn) are needed for one Saree?

A soft silk saree weighs ~ 500 to 600 gms; in one skein 3 sarees length can be taken and 4-5 such skeins will be required to match the width of the saree.

2. To obtain one shade they 3 to 4 dye stuffs in different colors, each of which will be 5 gms. Once the color is dyed, they will add sodium hydrosulphite to decolourize the previous shade and will add dyestuff for the next shade in the same bath. Similarly they will dye 10 to 15 shades in a dye bath starting from light shade to dark one. 50-75 grams of dye in 35L

If we calculate the waste water / saree (10 - 12 shades in a dyebath of 35 litres + wash liquor) approximately there will be around 20 to 30 litres of waste water generated per saree. This is only an approximate quantity.

All values are an approximation and reality may differ as there is not even studies / literature support for traditional dyeing practice.

Textile Effluents: The Problem

- Dyehouse wastewater contaminants include
  - ✓ Dyestuffs
  - ✓ Surfactants
  - ✓ Oily substances
  - ✓ Natural materials
  - ✓ Organic and inorganic salts
  - ✓ Solvents
  - ✓ Acids and alkalis
  - ✓ Suspended solids
- There is no proper effluent collection and treatment system available. The used dye solution is discharged in to the drainage which finally joins with River Bhavani or to groundwater or soil
- Hence a concrete process/technique should be developed or identified to treat the dye effluent solution from each house of dyers.

The challenge

- Totally remove color from the effluent
- Conventional treatment of wastewater is not efficient
- Advanced treatments (i.e. extended filtration, activated carbon & advanced oxidation processes) have limitations, including increased demand for energy, additional chemicals and generation of toxic solid waste.

The technology (suggestion)

The purification system may comprise of two sequential main modules, but other options are being examined:

- ✓ Filtration and sorption unit
- ✓ Solar photo-catalytic degradation bath

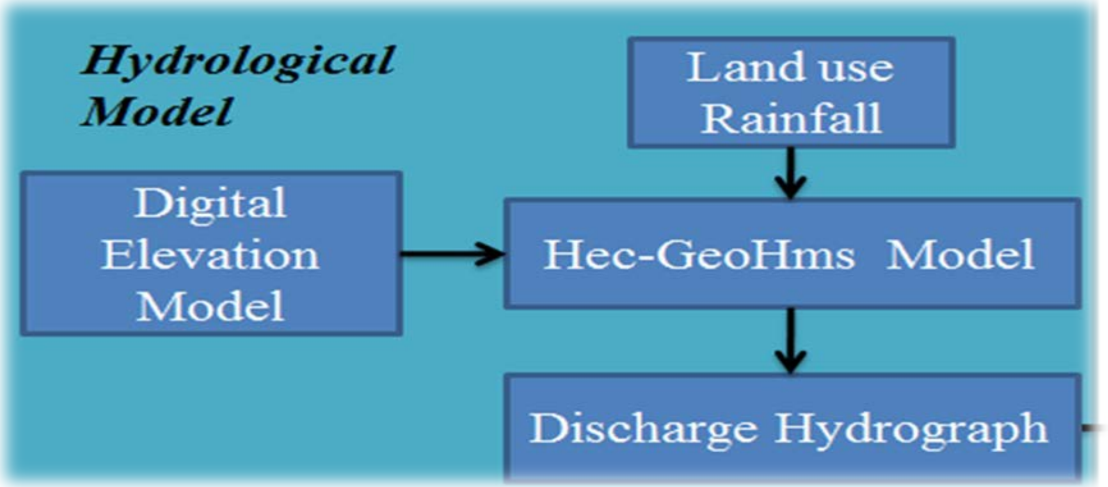
- ✓ Other options are viable as well
- ✓ Team up with a company that can design the filtration/sorption/photocatalytic unit
- ✓ **Faraday Ozone** located 4 km from KCT can design the unit once the cost-effective filtration/material and catalytic material and pilot budgeting is found (TATA)

Project needs

- Field study:
  - on line monitoring devices for water quality
  - Map the area for the households and location
  - Map the wastewater discharge quantities and dye conc.
  - Hydrological analysis combined with water quality models
  - Grab samples for detailed water analysis
  - Design treatment technology
- Recovery of the sericin protein
- Locate funds for pilot study
- Implement a treatment unit in the village in one or few dye units
- Once successful, disperse technology to other dye units
- Evaluate cost effectiveness
- Evaluate social acceptance of a treatment scheme

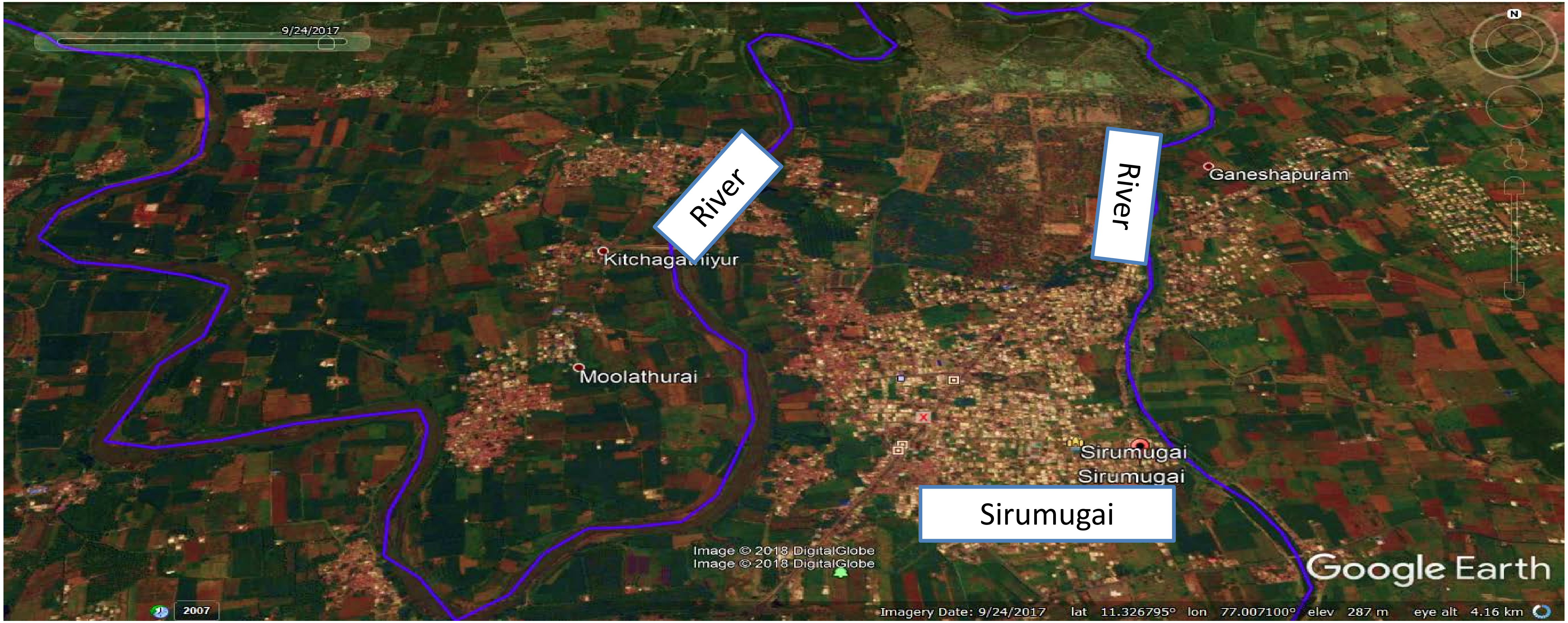
Hydrological Flow simulation combined with water quality models

- ✓ On the either side of the sirumagai river flows
- ✓ the left side river originates from western ghats
- ✓ The right side river originates from Belladhi lake
- ✓ Both the stream merges below sirumugai and drains into Bhavani sagar Reservoir



Proposed Hydrological model

Hydrological flow simulation



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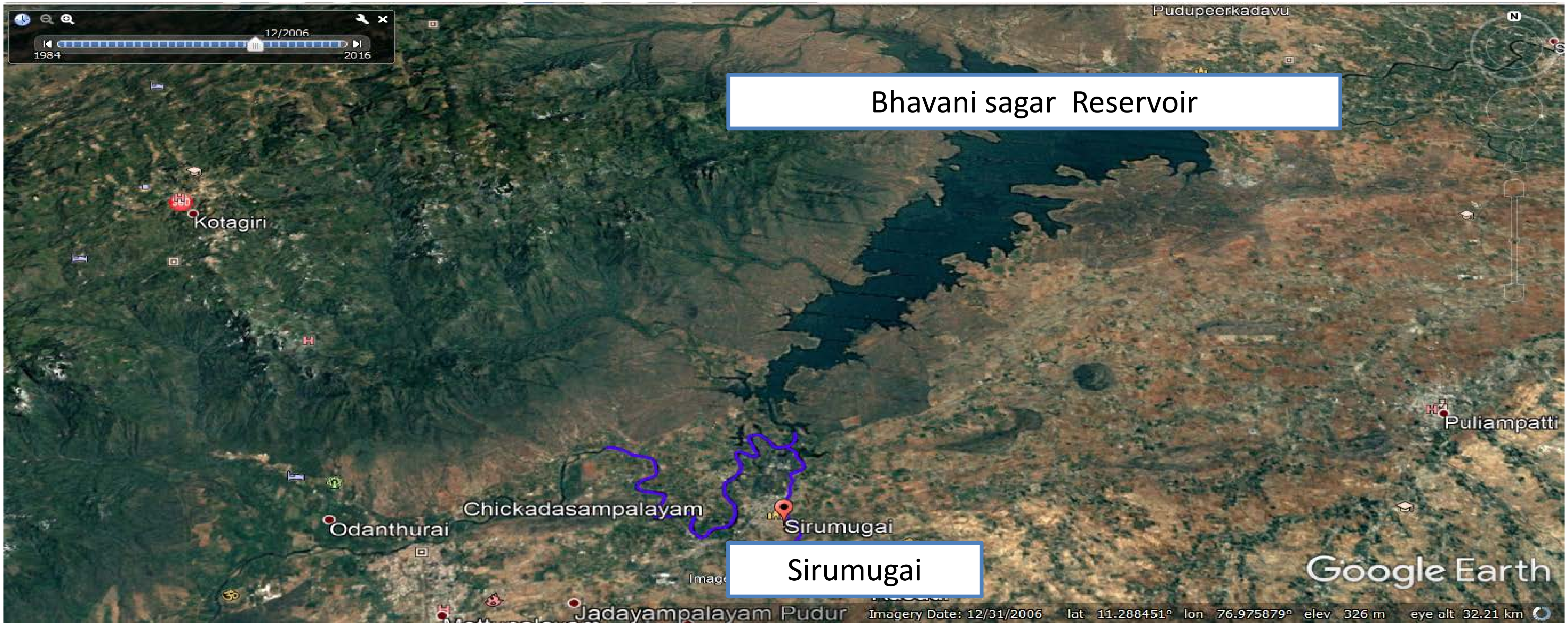
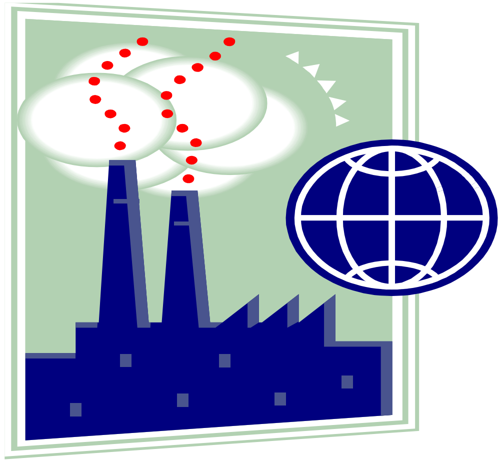


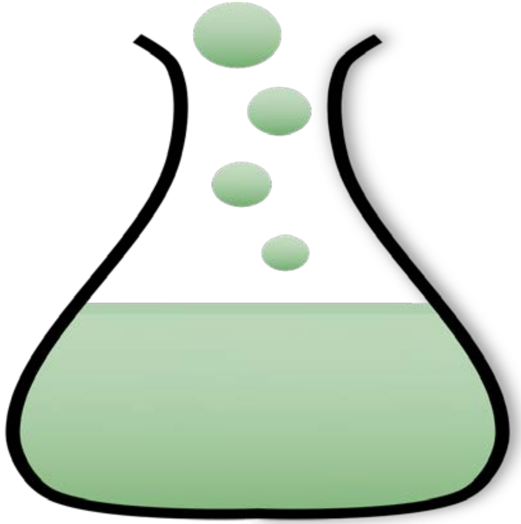
12/2006
1984
2016
Pudupeerkadavu
Bhavani sagar Reservoir
Kotagiri
Puliampatti
Chickadasampalayam
Odanthurai
Sirumugai
Sirumugai
Jadayampalayam Pudur
Imagery Date: 12/31/2006 lat 11.288451° lon 76.975879° elev 326 m eye alt 32.21 km
Google Earth

Future suggestions

- Dyeing soft silk and kovai kora cotton sarees are done at dyer's residential place as there is no special dyeing machineries or centralized dyeing units
- Hand operated dyeing machine should be designed and developed for dyers of Sirumugai through government funding agency.
- Collection of wastewater and treatment
- Develop less toxic materials

APPROPRIATE TECHNOLOGY





Industry

Pollutant

Treatment Technology

Type of industries that produce wastewater

- Food and beverages
- Coal mining
- Dairy
- Electrical and electronic components
- Inorganic chemical manufacturing
- Leather tanning
- Oil and gas extraction
- Nonferrous metal
- Plastics
- Pesticide chemicals
- Petroleum
- Pharmaceutical
- Pulp and paper
- Textile mills

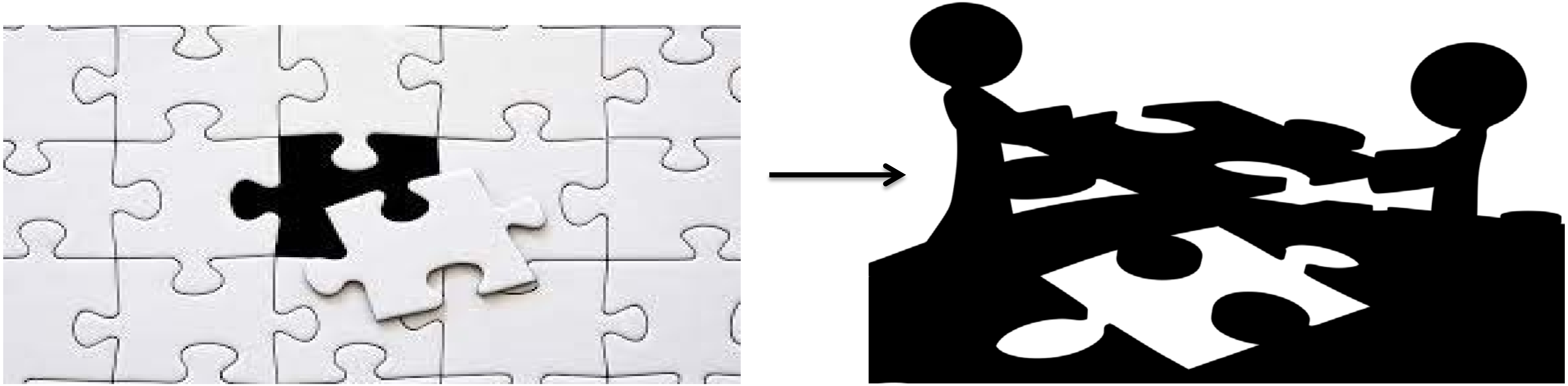
Types of contaminants

- Acetic acid
- Active pharmaceutical ingredients
- Absorbable organic halides
- Ammonium
- Arsenic
- BTEX
- Benzene
- BOD
- Cadmium
- Carbamazepine
- Cyanide
- Dichloromethane
- Fluoride
- Halogens
- Nickel
- Nitrate
- Oil and grease
- Perchlorate
- Phenol
- Silver
- Surfactants
- Toluene
- Vanadium

Treatment technologies

- Adsorptive media
- Advanced oxidation
- Aeration
- Aerobic/anaerobic biological treatment
- Biological nutrient removal
- Chemical precipitation
- Clarification
- Dissolved air floatation
- Distillation
- Granular media filtration
- Hydrolysis
- Ion exchange
- Liquid extraction
- Membrane bioreactor
- Membrane filtration

How to match industry-pollutant-treatment?



SYNERGIES

1 + 1 > 2

What is the industrial effluent target?

- Zero liquid discharge
- Discharge to municipal wastewater treatment plant
- Common effluent treatment plant (CETP)
- Storage until use
- Discharge/disposal to the environment
  - – Inland surface water
  - – Public sewers
  - – Land for irrigation
  - – Marine coastal areas
  - – Loading onto soil, according to soil type
- In the worst case without treatment

Examples for industry-pollutant-treatment

- To remove hexavalent chromium from electroplating effluent for reuse using adsorption and desorption processes.
- To remove oil sands Process Water by Chemical Precipitation, Dissolved Air Flotation (DAF), Micro- and Ultra-Membrane Filtration (MF) and Reverse Osmosis (RO)
- Removal of arsenic from non ferrous metals using Biologically Active Filters (BAC)
- Raw textile wastewater by ozone. With 70% color and 25% COD removal, and enhanced the biodegradability of the wastewater by a factor of up to 7-fold.