① Ecological Purification System

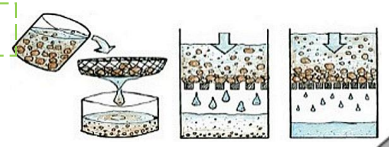
Slow Sand Filtration (SSF) to make **Safe Drinking Water** was developed in London, UK.

July 9 (Wed.) am 10- pm 16. 2025

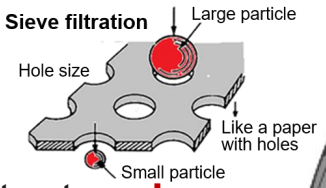
NAKAMOTO Nobutada,
Professor Emeritus of Shinshu University,
Dr. Science cwscnkmt@yahoo.co.jp
https://eps.watervision.jp

Slow Sand Filtration

Image of
Slow Sand Filter

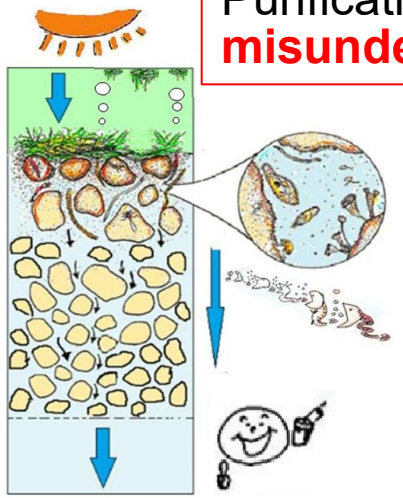


Only **200 years** have passed, since SSF was developed to supply clean water to **urban** areas in **London, UK**.



SSF is to make artificial spring water.

Purification mechanism of **SSF** was **misunderstood by the name**.



Food Chain is Key.

I proposed **new name** of **EPS** instead of **SSF.**

Idea of **Ecological Purification System** was born from this plant, in Ueda, Nagano, Japan.


Someya Water Purification Plant

Hiroshima City Waterworks Bureau（広島市水道局）
JICA-Hiroshima training on: Operation and Maintenance of **Urban Water Supply System** (Water Distribution and Service) from July to Aug., 2025
JICA広島：都市上水道維持管理（給・配水）

Participants for JICA Hiroshima training in July 2025.

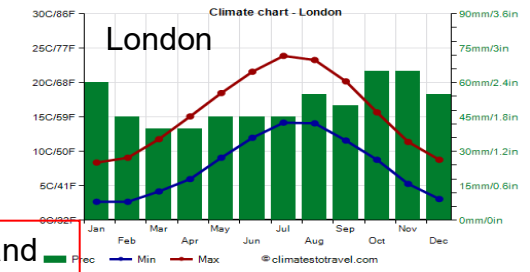
Operation and Maintenance of **Urban Water Supply System** (Water Distribution and Service)

There is seasonal variation in different regions.

Nakamoto will explain how to get clean safe water by EPS.

Temperature, precipitation and radiation are key.

Participants come from different climate regions.



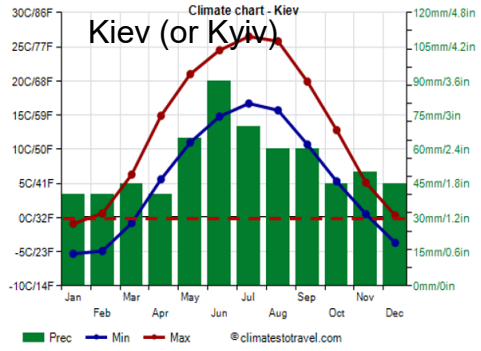
Small rain and no dry period.

690mm/year

Ukraine

Severe winter

No Dry Period

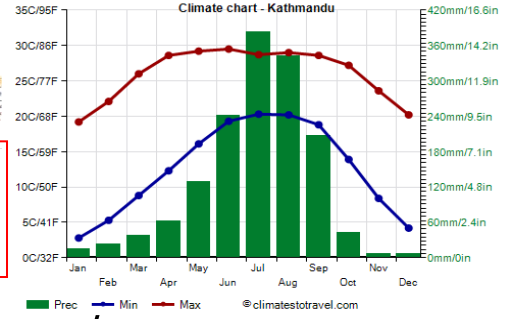


677mm/year

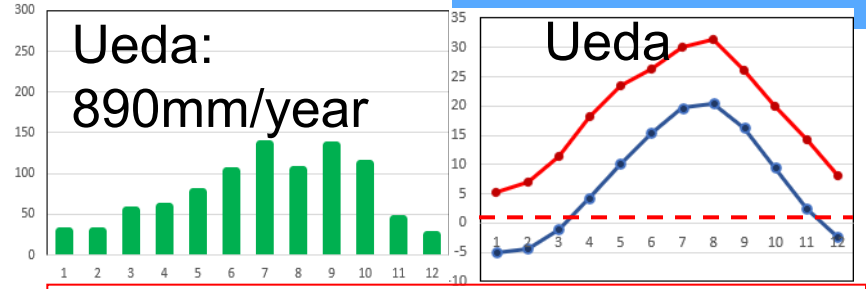
Nepal

Cold winter and Dry winter

Kathmandu



1600mm/year

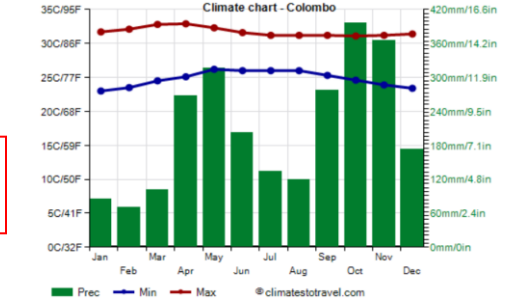


Always dry. Small rain. Cold in winter and hot summer.

Sri Lanka

Always hot

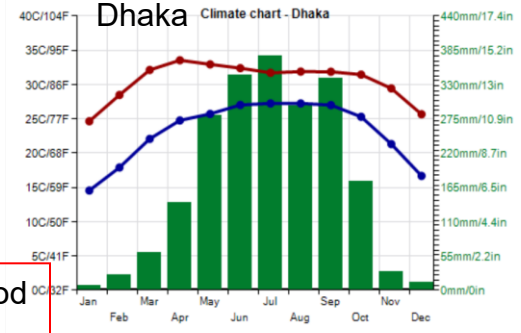
Colombo



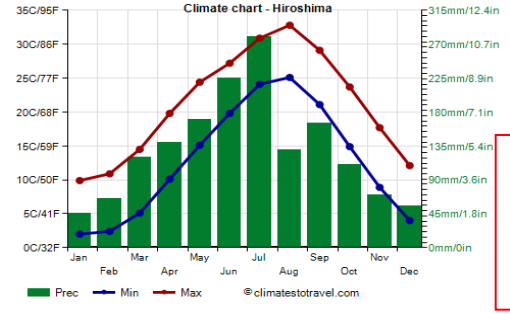
2387mm/year

Bangladesh

Lond hot period and long wet. Winter is dry.



2055mm/year



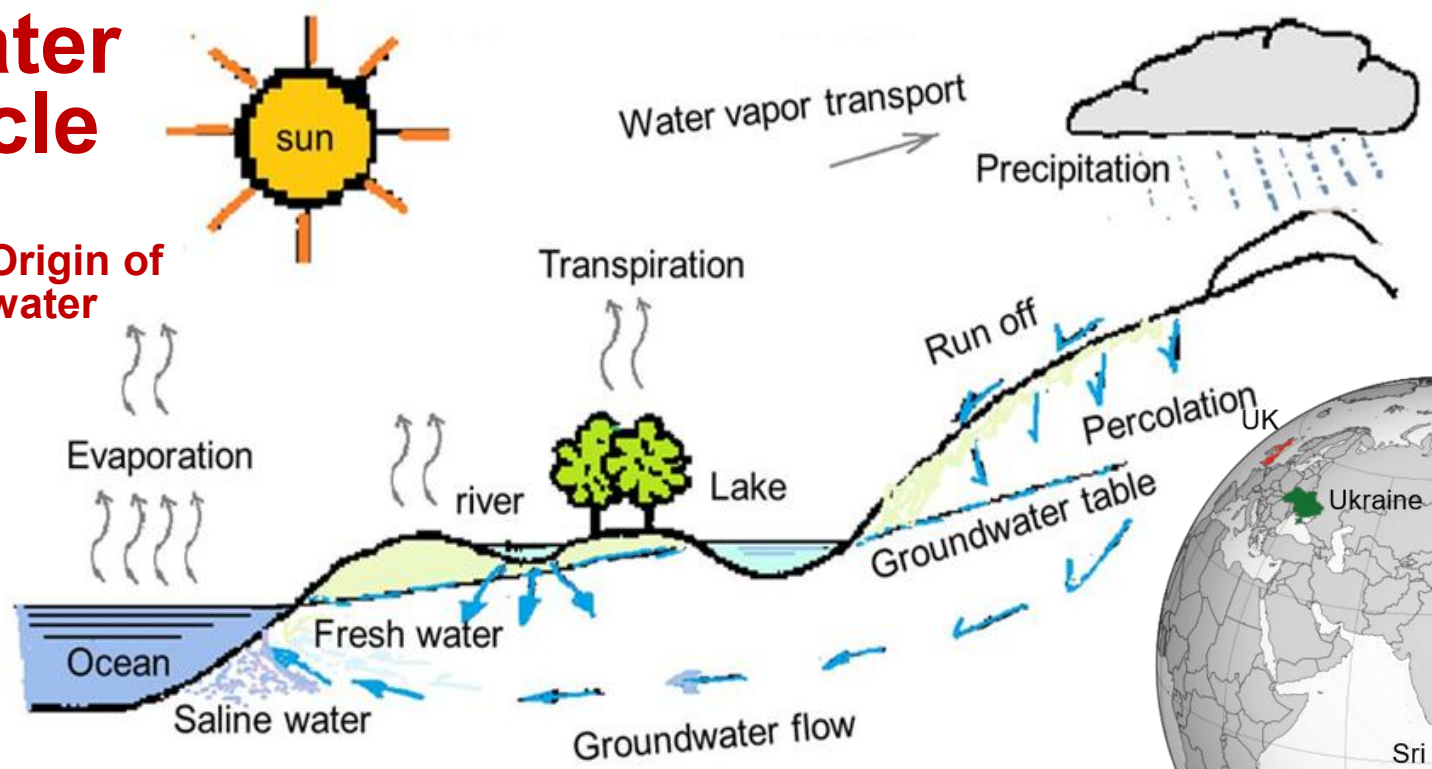
1517mm/year

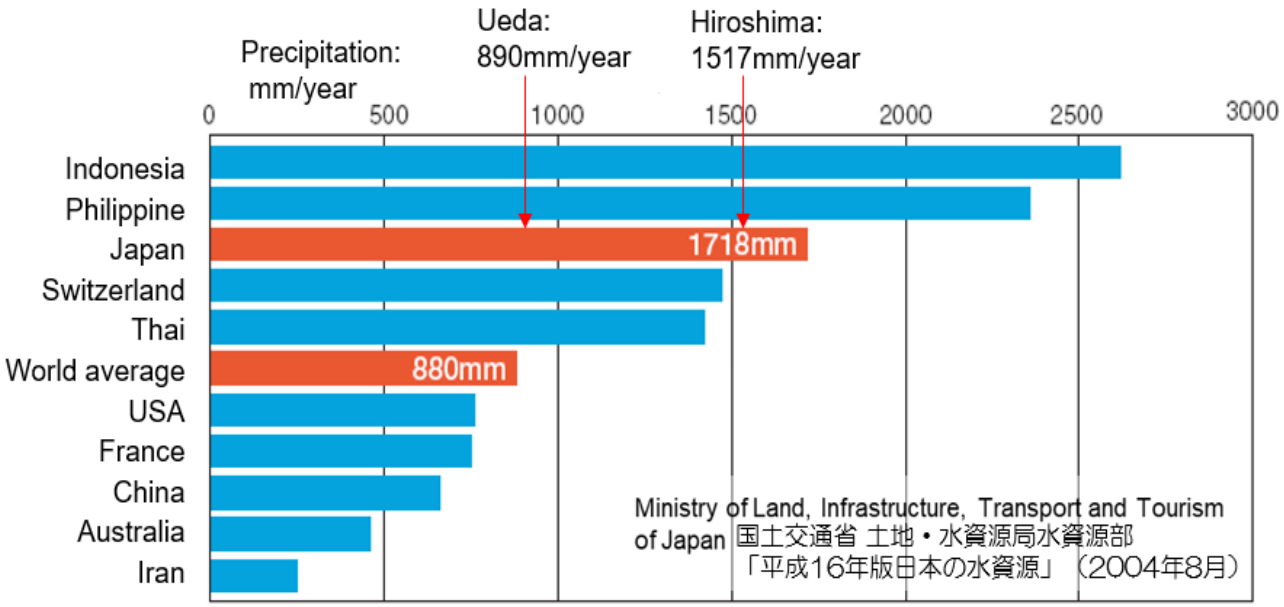
Hiroshima

Cool winter and hot summer.
Wet in summer and dry in winter.

https://www.climatestotravel.com/

Water cycle





Where is available water.

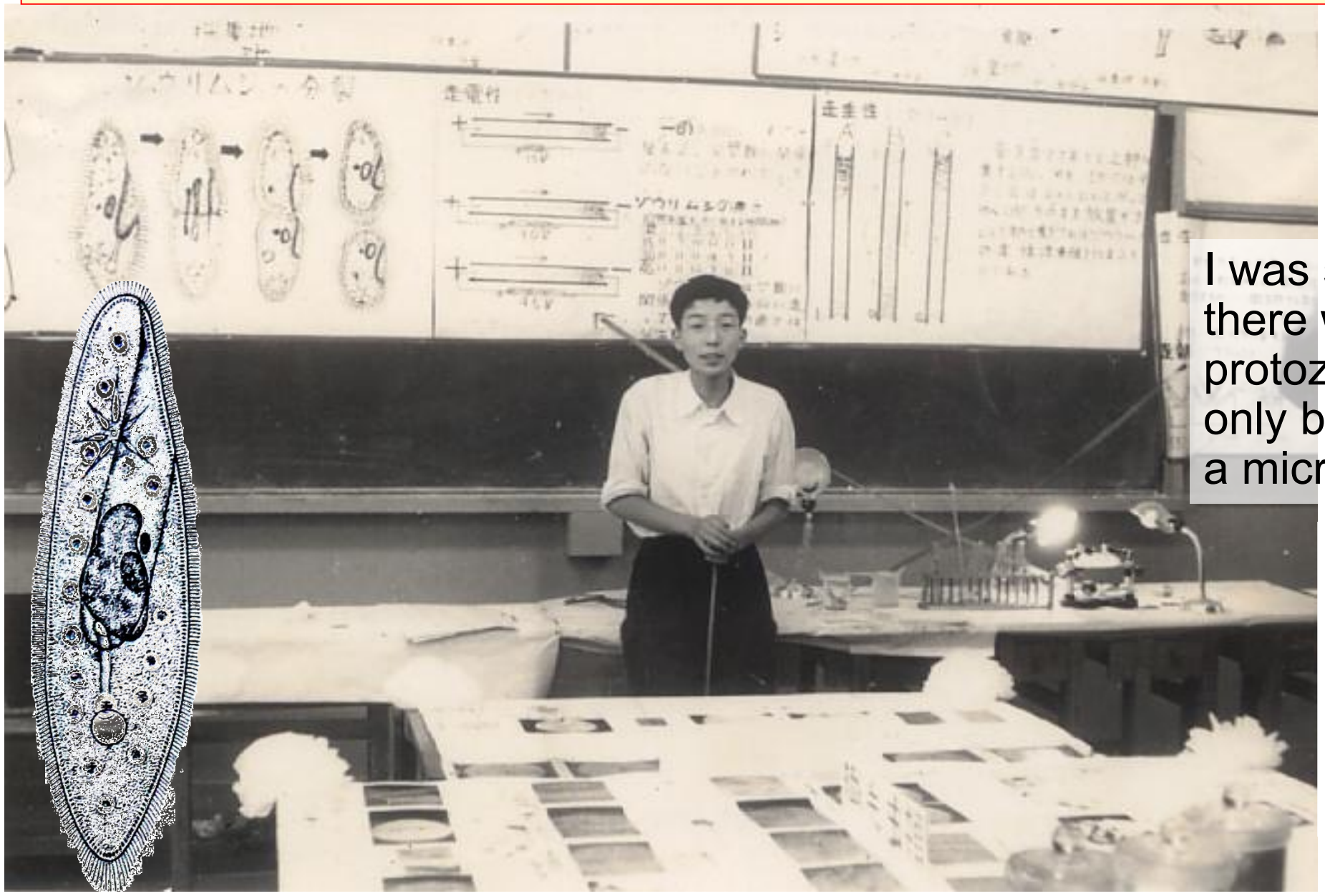
Mountain: much precipitation

Spring water

Average annual precipitation varies by location.

Areas close to the equator, with a lot of sunlight and the influence of the ocean, experience a lot of precipitation. Even in areas close to the equator, inland areas experience less precipitation. High latitude areas with less sunlight experience less precipitation.

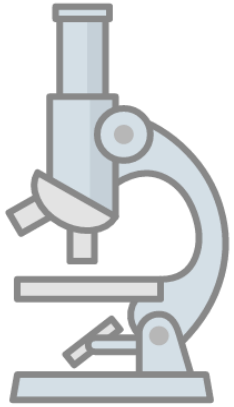
Introduction: My background: Phytoplankton, Reservoir study, Meet Slow Sand Filter, Importance of Ecological point.



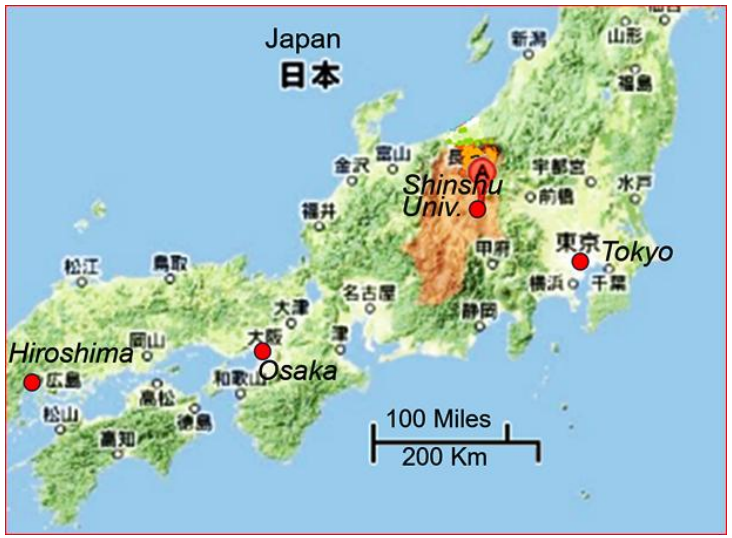
I was born in May, 1942 in Tokyo.

It all started with the biology club in my high school.

I was supplied with there was a world of protozoa that could only be seen using a microscope.



I presented the microbial world of protozoa to our school mates at our high school festival in 1960 (65 years ago).



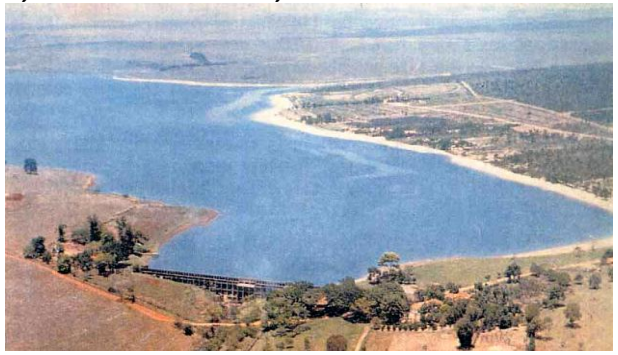
I entered Tokyo Metropolitan University to study biological science.
I studied phytoplankton ecology in graduate school.

1969, Tahiti, South Pacific

Marine surveys were also conducted in the Pacific and Atlantic Oceans.

I also studied plankton in reservoirs in Japan and in Brazil.

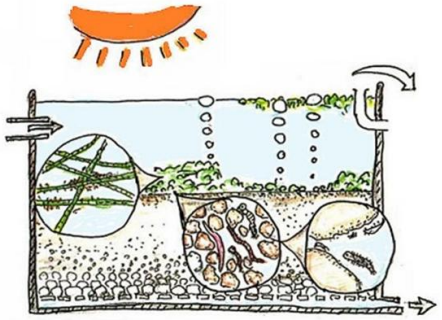
JICA Expert to Fed. Univ. São Carlos and Univ. São Paulo, Brazil in 1974, 1976.



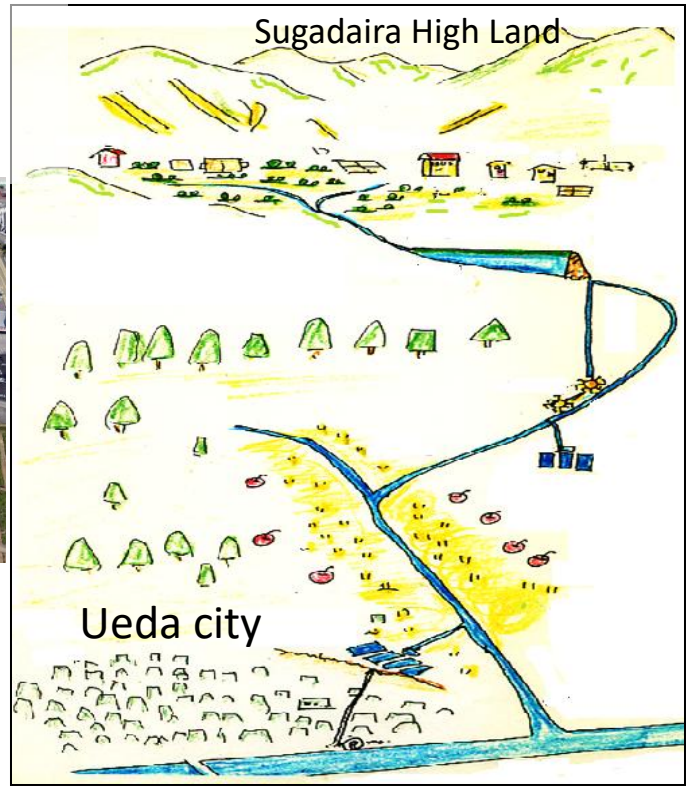
1970, Miami, USA

I found that any plankton in all regions in the ocean and in the fresh water was same species and under **hungry condition**.

From 1975, I worked as a teaching staff of Shinshu University at Ueda Campus.



Heavy Algal bloom in a slow sand filter pond.



Dam was constructed in 1964.

Algal bloom in reservoir

→Eutrophication study on Sugadaira Reservoir from 1975.

Odor problem in tap water

They stopped algicide.

Delicious tap water

Plant manager said Good Algae in filter pond but Bad Algae in the reservoir.

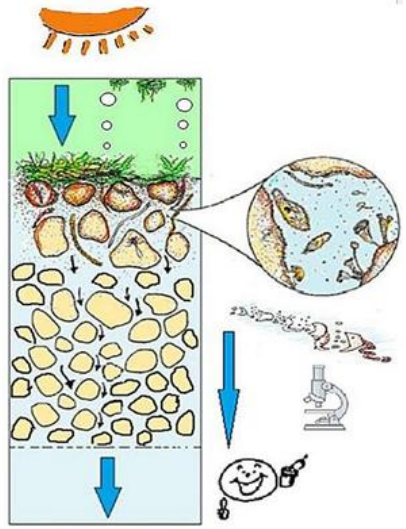
I started to study **Role of algae** in a slow sand filter pond in 1984.

→**Wise Use of Biological Phenomena**

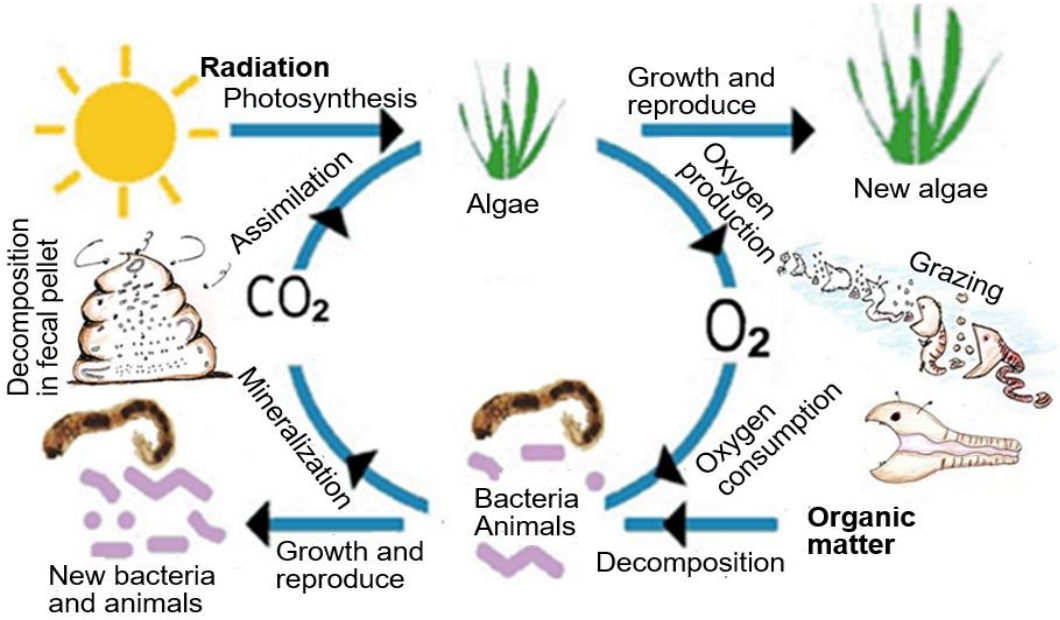
https://www.youtube.com/watch?v=b7wPQIKVIMY

My first visit to Thames Water Company was on August 19th in 1992. I explained my study on the role of algae in SSF system in Ueda.

Ashford Common WTP



The sand does not move even when the flow rate changes.



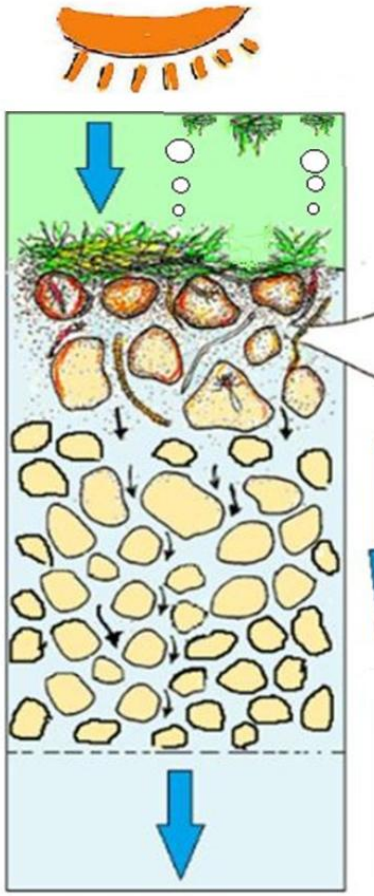
About higher flow rate from N. Nakamoto
Michael Chipps Principal Research Scientist
2025/03/18

Thames Water's asset standard says we can operate up to 0.5 m/h, but in reality, we are usually in region of 0.25 to 0.35 m/h, but we can reach 0.4 m/h occasionally if we have to. We do have keep a careful eye on dissolved oxygen (DO).
Since your visit (Aug. 19th 1992) we have added DO and turbidity monitoring on the outlet of all SSFs.

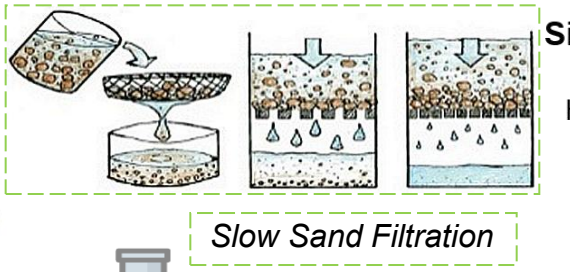
Slow sand filtration is a purification process that relies on the efforts of a biological community. Algae produce oxygen through photosynthesis, and the presence of dissolved oxygen creates an environment in which heterotrophic organisms can thrive without worry. Slow does not refer to speed, but to being gentle to the organisms.

Idea of EPS spreads from Japan to the world.

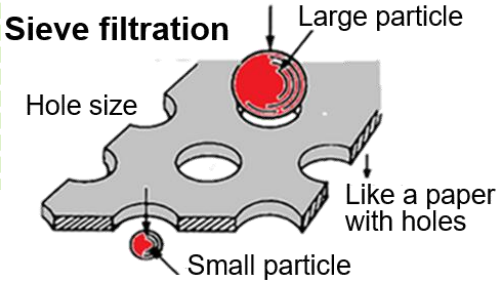
*Slow Sand Filter is Wise Use of Natural Purification System to **make artificial spring water**.*



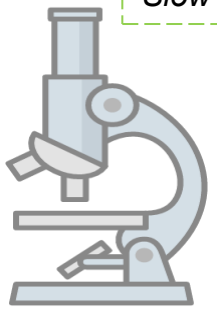
Microorganisms trap and decompose dirt in water near the surface of the sand layer of slow sand filter (SSF).



Slow Sand Filtration



I noticed that Slow Sand Filter has been **misunderstood** by the name in the world.



I proposed **Ecological Purification System (EPS) in 2004** instead of the name of Slow Sand Filter.

The filtrate is clean and delicious water.

I, applied biologist, taught to the students that purification in nature and its application is called **slow sand filtration**.
However, I pointed out that the name of **SSF** gave rise to a misunderstanding of how purification works.
I have been teaching this **EPS** at JICA training **since 2006**.

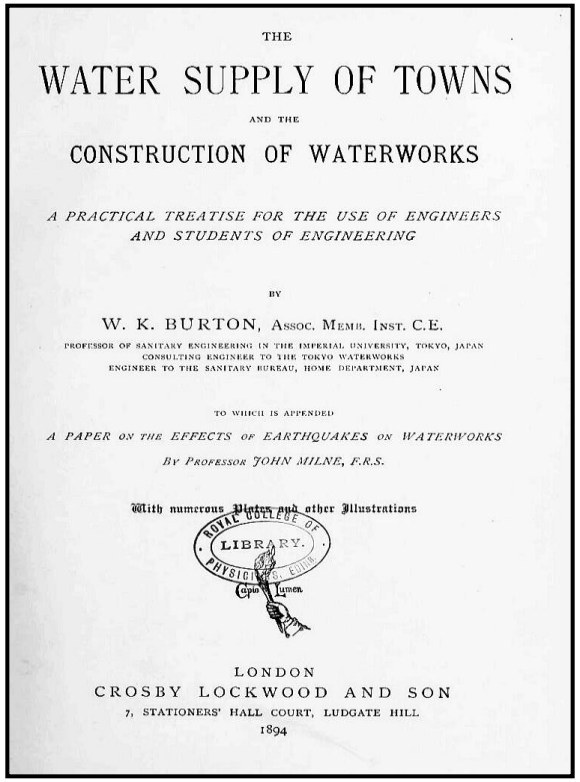
Modern Water Supply System was developed **in Towns.**

People in the city struggled to get clean water.

William Kinnimond Burton was a Scottish engineer, born on 11 May 1856 in, Scotland.
He passed away on 5 August **1899 at the age of 43**, Tokyo.

He (**31 years old**) was invited in **May 1887** by the Meiji government to assume the post of first unofficial professor of sanitary engineering at Tokyo Imperial University. He advised to **major important tows (cities)** in all over Japan **during 12 years** (from 1887 to1899).

Burton published "**The Water Supply of Towns and the Construction of Waterworks**" in **1894** in London.



THE

WATER SUPPLY OF TOWNS

AND THE

CONSTRUCTION OF WATERWORKS

A PRACTICAL TREATISE FOR THE USE OF ENGINEERS AND STUDENTS OF ENGINEERING

BY

W. K. BURTON, Assoc. Memb. Inst. C.E.

PROFESSOR OF SANITARY ENGINEERING IN THE IMPERIAL UNIVERSITY, TOKYO, JAPAN
CONSULTING ENGINEER TO THE TOKYO WATERWORKS
ENGINEER TO THE SANITARY BUREAU, HOME DEPARTMENT, JAPAN

TO WHICH IS APPENDED

A PAPER ON THE EFFECTS OF EARTHQUAKES ON WATERWORKS

By Professor JOHN MILNE, F.R.S.

With numerous Plates and other Illustrations

LONDON
CROSBY LOCKWOOD AND SON
7, STATIONERS' HALL COURT, LUDGATE HILL
1894

In April 1894 (Meiji 27), Hiroshima City asked Burton for guidance and advice to design a water supply system.
He visited Hiroshima from September 16 to 18, 1894 (Meiji 27).
He submitted a plan to Hiroshima City in December of the same year. He submitted a plan to Hiroshima City in December of the same year (1894). Ushita Plant was completed in 25. Aug. 1889 (Meiji 31).

https://wellcomecollection.org/works/da2p35kj/items

Photo 1974

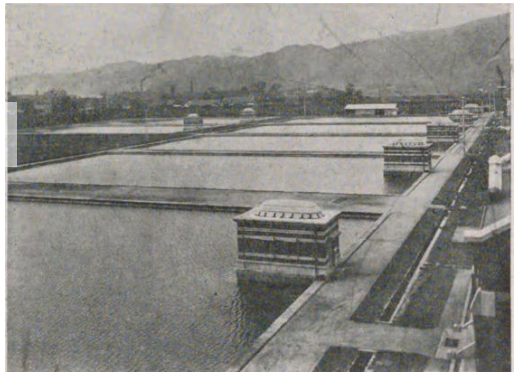


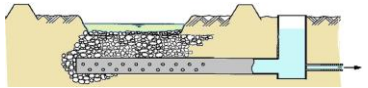
Photo 1930

Urban water supply services expanded with the **development of cities**.

Ecological Purification System (EPS) : This is Wise Use of Natural Phenomena.
This is Chemical Free System to make Artificial Delicious Spring Water.
This is a Smart and Eco-friendly technique.


Surface water of river

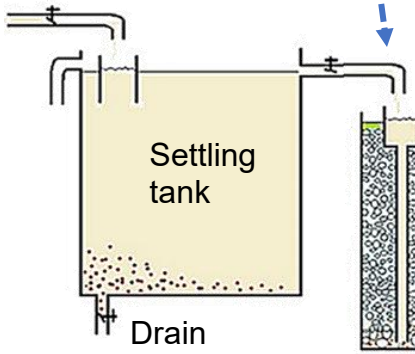

Reservoir, lake


Subsurface water of the flood plain

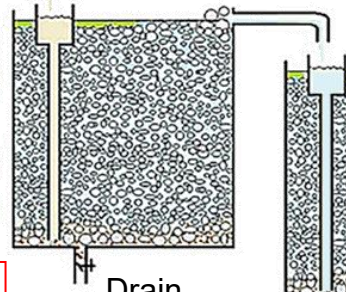

Clear spring water

Underground water

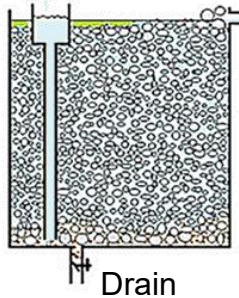
Raw water



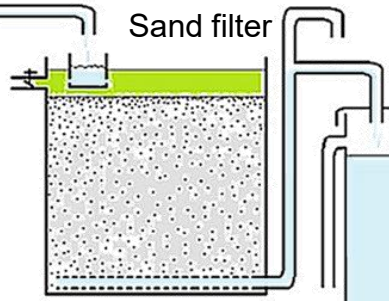
Up-flow Roughing Filter



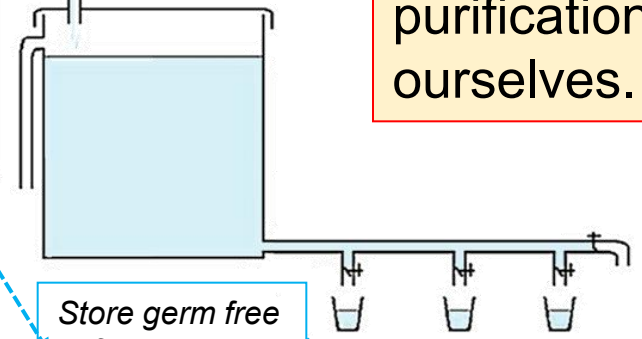
Up-flow Roughing Filter

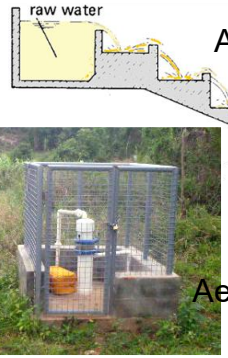


Slow Sand filter



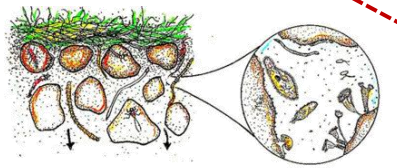
Storage tank





Aeration

Sink suspended solid



Trap and reduce fine matter

Complete purification

Store germ free safe and delicious filtrate.

Supply to houses.

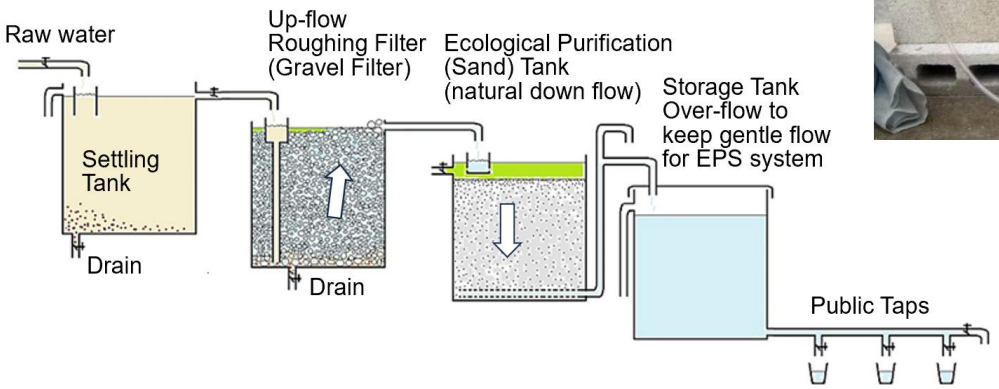

Tap

Key is Gentle for small organisms.

We can make EPS purification device ourselves.

Microscopic organisms

EPS mini model



11th Pacific Water and Waste water conference, Noumea, New Caledonia, August, 2018

This is a concise English manual on EPS. You can down load from the following address.

11th Pacific Water and Waste water conference, Nouméa, New Caledonia, August, 2018.

Ecological Purification System for Safe Drinking Water

- Application of Natural Process -

Eco-friendly technique to make artificial spring water

NAKAMOTO Nobutada, Dr. Science
Prof. Emeritus of Shinshu University, Japan

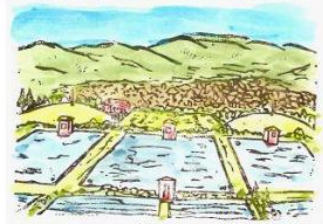
Fig.0. Fijian EPS using rain harvest tanks in a village.

August 2018

Ecological Purification System for Safe Drinking Water

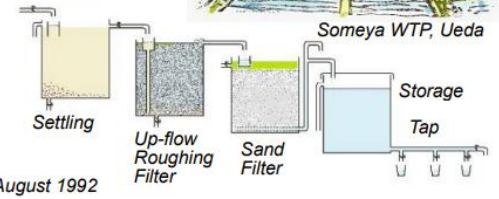
Contents

Cast off skins of midge larvae



Someya WTP, Ueda

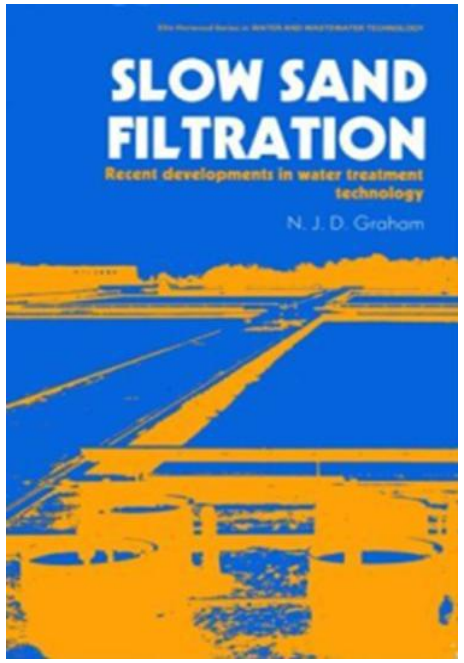
August 1992



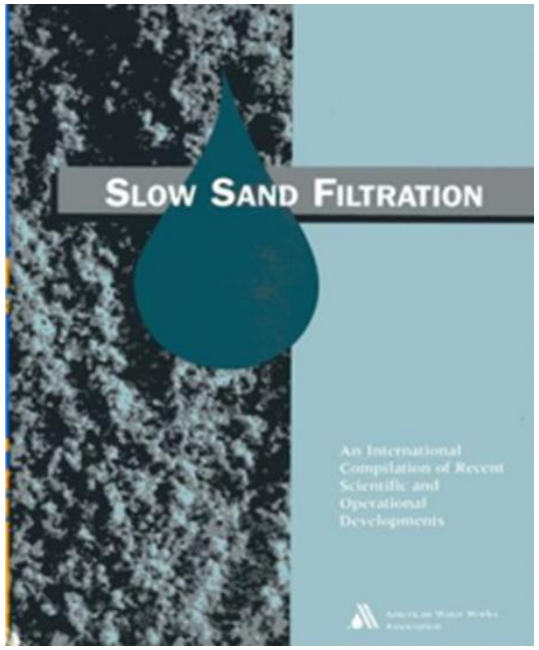
2

https://eps.watervision.jp/wp-content/uploads/2025/04/EPStext-NC-2019.pdf

Focus to Slow Sand Filter from Chemical treatment of Rapid Sand Filter in the world.



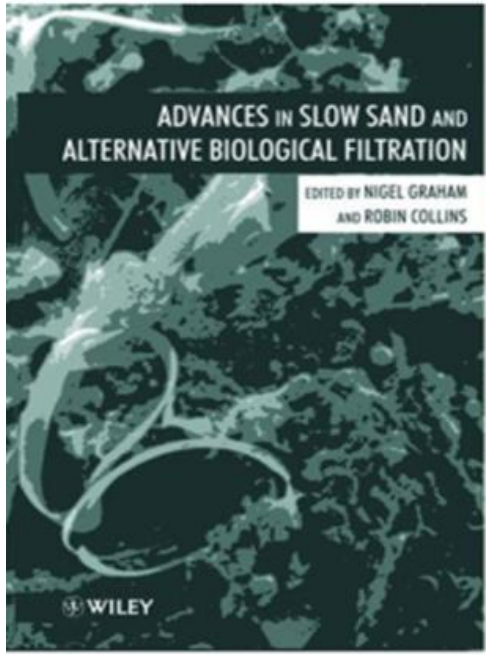
1988, Nov. 1st. SSF Conf. in London, UK



1991,Oct. 2nd. SSF Conf. in New Hampshire, USA

My first visit to Thames Filter was Aug. 1992.

I could study on Thames Filters during 1994 to 1996.

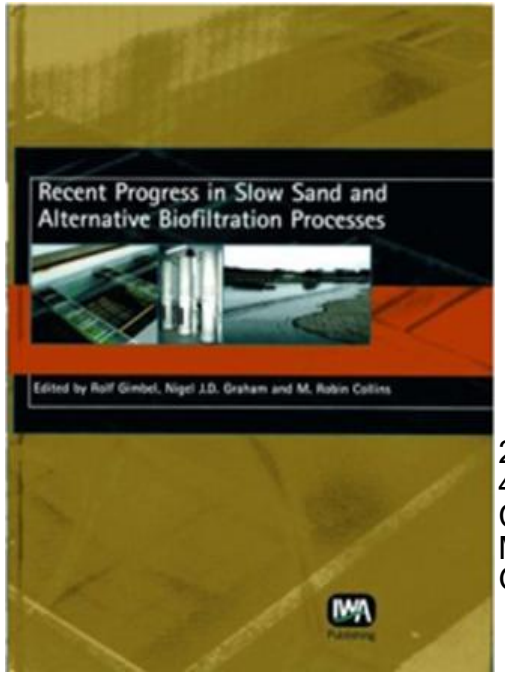


1996 April, 3rd SSF Conf. in London, UK

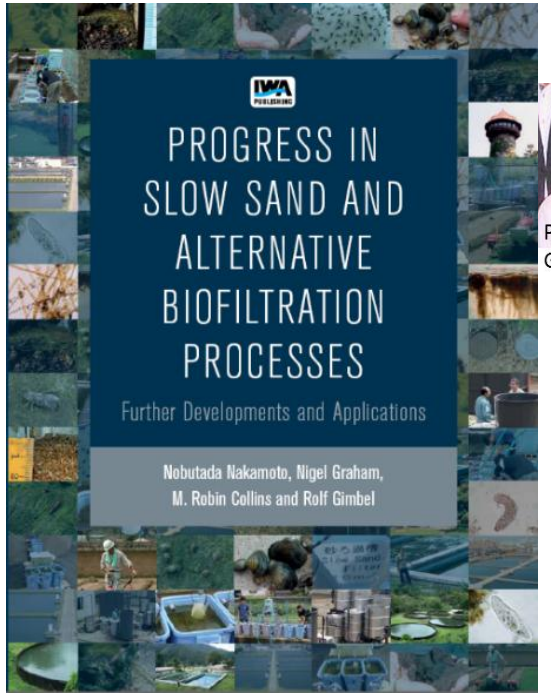
Key speech of Global 100 Eco-Tech Awards Ceremony, 2005 World Expo. Aichi, Japan.

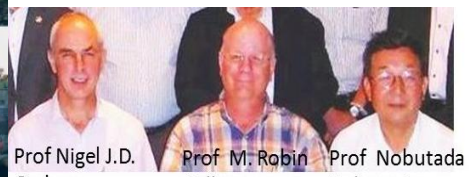
Slow Sand Filtration Technology Focusing on Algal Production

https://www.youtube.com/watch?v=Xf2HOJ7y7c8&t=21s 8 min 32 seconds



2006 May, 4th SSF Conf. in Mulheim, Germany





2014 June, 5th SSF Conf. in Nagoya, Japan

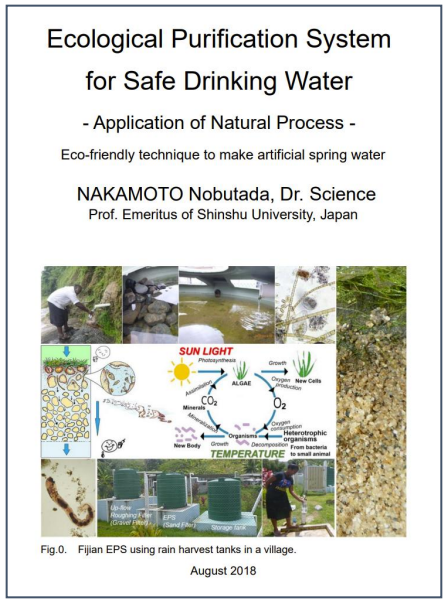
https://www.youtube.com/results?search_query=5ssabc

Ecological Purification System was focused and recognized.

JICA supports EPS as Japanese innovation for the people.

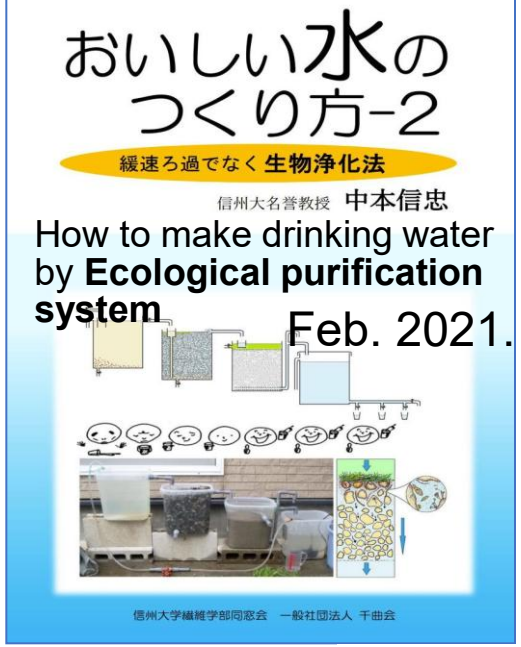
How to make drinking water by **Ecological purification system**

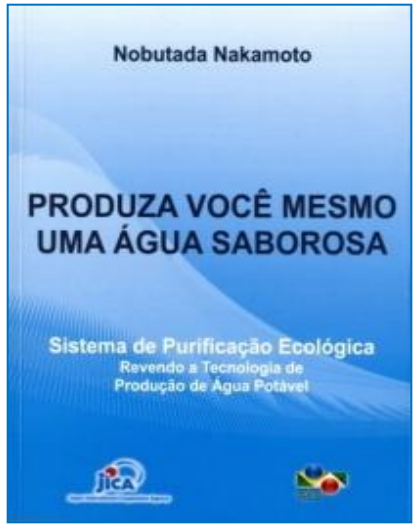
Aug. 2005.



August, 2018

https://eps.watervision.jp/wp-content/uploads/2025/04/EPStext-NC-2019.pdf





July 2010.

Portuguese, Brazil

https://eps.watervision.jp/wp-content/uploads/2025/04/TratamentoEcologicoTexto.pdf

March, 2009.

Internet text by JICA

Slow sand filtration: creating clean, safe water

(26 min Full)

https://www.youtube.com/watch?v=V6_uDZE_l8E&t=423s

(3 min Digest)

https://www.youtube.com/watch?v=QAH1SoAgfL0&t=27s

International Contribution Award of the 21st Japan Water Awards, 25. June, 2019

Safe Drinking Water by Ecological Purification System

Chemical free purification system focused on food chain as a new treatment system from Japan.

https://eps.watervision.jp/wp-content/uploads/2025/05/Document_Int.Contribution_Award_21stJapan_Water_Awards_EN.pdf

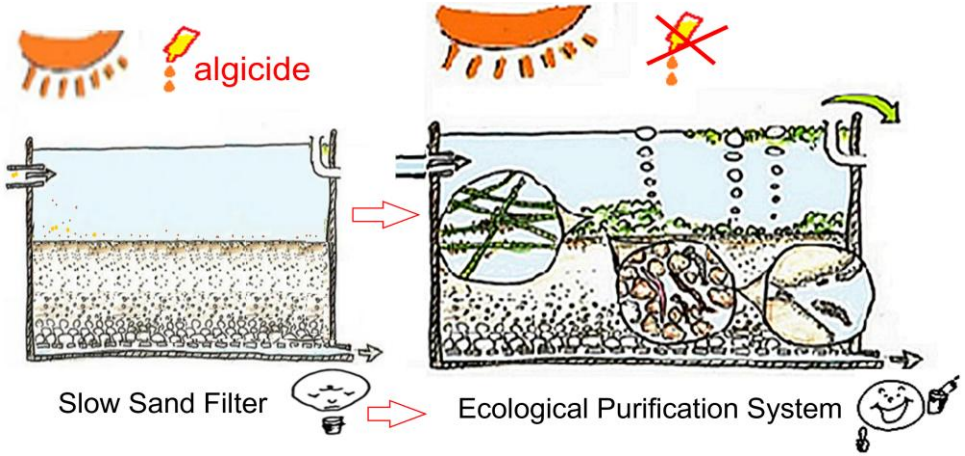


Fig. 1. Delicious water by stopping the algicide

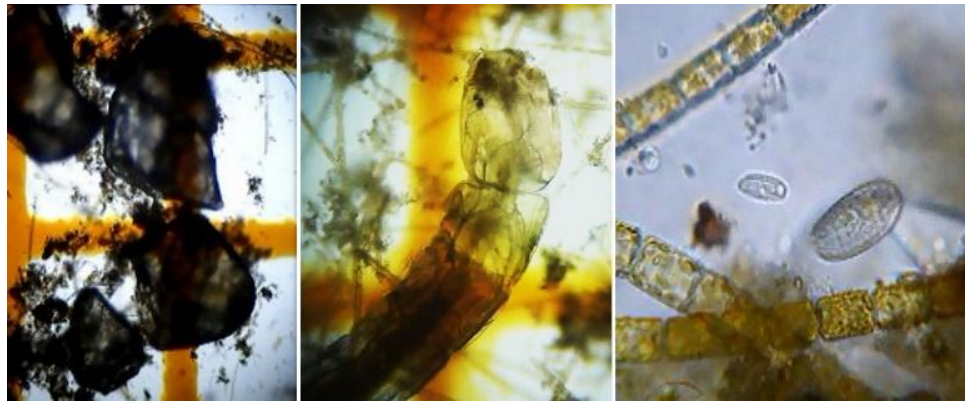


Fig. 2. Attention to the role of algae and micro-animals

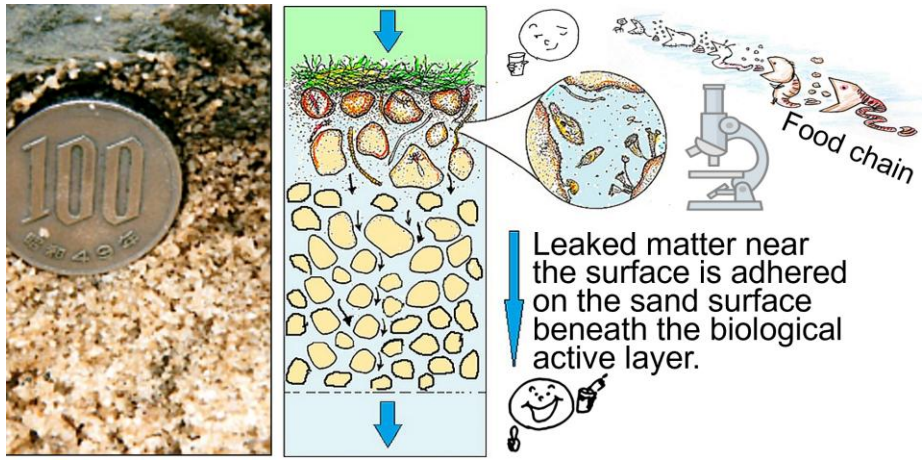


Fig. 3. Algae and small animals are active at the top

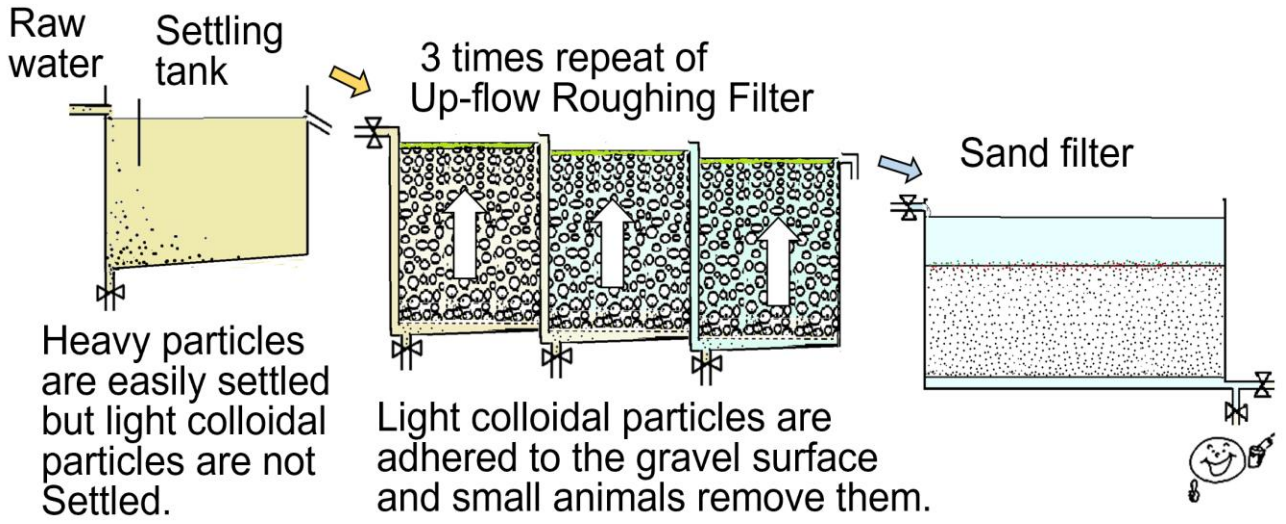


Fig. 4. Settling tank and URF for turbid reduction

Web Japan Ministry of Foreign Affairs of Japan

Japan Video Topics

Feb. 2021.

Clean drinking water is essential for life, but expensive water filtration systems are out of reach for many communities around the world. Japanese scientist NAKAMOTO Nobutada is unlocking the water-cleaning power of algae and microorganisms to bring down costs!

日本語
世界の水を
きれいに

英語
Clean Water
for All

ポルトガル語
Água Limpa
para Todos

中国語
创造洁净水源—
日本的净水技术

フランス語
De l'eau propre
pour tout le monde

スペイン語
Agua limpia
para todos

アラビア語
المياه النظيفة للجميع

https://www.youtube.com/watch?v=ki8Qyb2lZ10

JAPANGOV THE GOVERNMENT OF JAPAN https://www.japan.go.jp/kizuna/2023/07/utilizing_microorganisms_to_purify_water.html

KIZUNA Linking Japan and the World

Health & Welfare

Utilizing Microorganisms to Purify Water and Enhance Public Health

07/07/2023

A Japanese researcher has been promoting a method called the ecological purification system to purify water utilizing the activities of small organisms. **What is this low-tech but smart solution that produces safe and affordable drinking water to help protect people's health?**

"In places without safe access to this vital resource, slight improvements to water for drinking and cooking can reduce instances of diarrhea or dermatological diseases. You'll then see a change in people's health awareness. **The key is promoting sustainable, do-it-yourself technologies and fostering awareness.**"

② Quest for Pure Water from SSF to EPS.

YouYube: 21 slides (①—㉑) and movie of microscopic organisms.

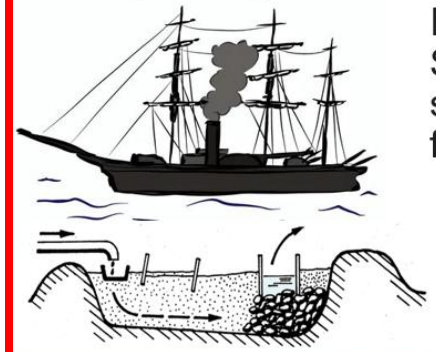
From SSF to EPS

https://youtu.be/CJ-WvvOo9b0

8 min 39 seconds

Quest for Pure Water, Origin of Public Water Supply

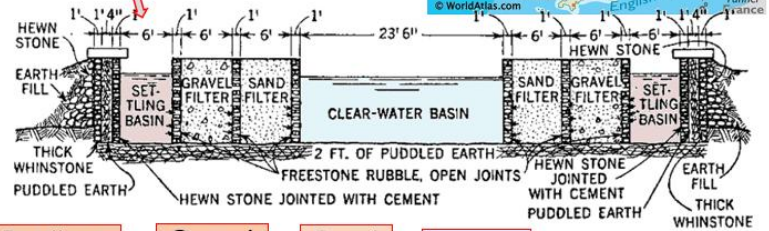
During the Age of Discovery, the textile industry developed.



In 1804, in Paisley, a suburb of Glasgow, Scotland, John Gibb created an artificial spring in a riverbed to wash away dye from dyed fabric.

By mimicking the spring water that flows along the riverbank, he artificially created clear, pure water from the river's surface water.

Surface water from the Clyde river.



Settling Basin → Gravel Filter → Sand Filter → Clear-Water Basin

Horizontal flow

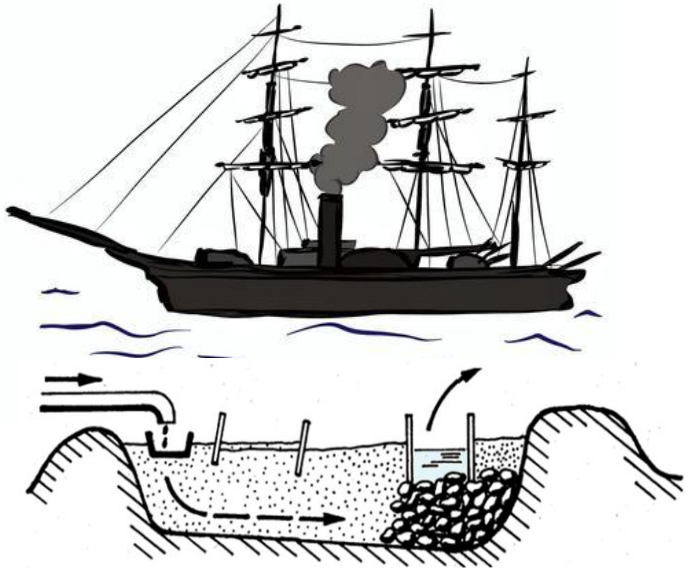
This is said to be the beginning of public water supply systems.

Gibb had water left over from his factory work, so he put it in barrels and sold it around the city by horse-drawn cart.

①

Quest for Pure Water, Origin of Public Water Supply

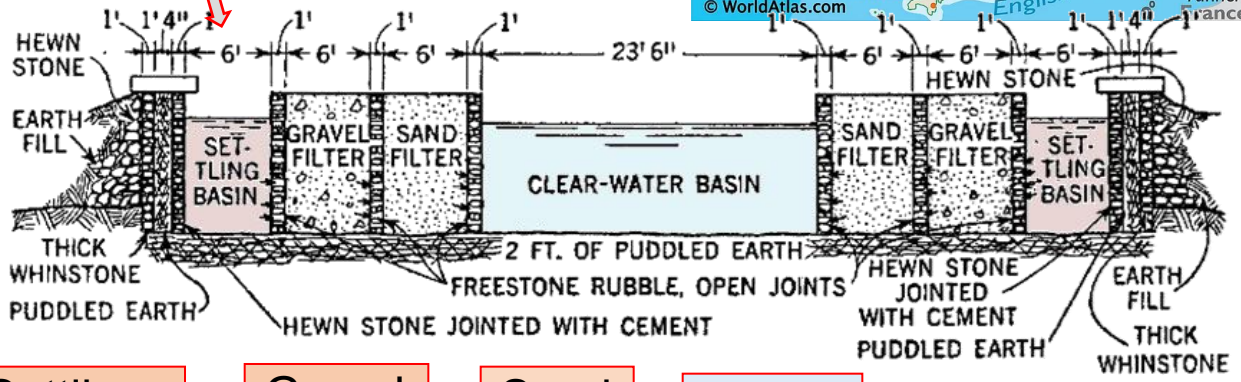
During the Age of Discovery, the textile industry developed.



In 1804, in Paisley, a suburb of Glasgow, Scotland, John Gibb created an artificial spring in a riverbed to wash away dye from dyed f

By mimicking the spring water that flows along the riverbank, he artificially created clear, pure water from the river's surface water.

Surface water from the Clyde river.



Settling Basin → Gravel Filter → Sand Filter → Clear-Water Basin

Horizontal flow

Gibb had water left over from his factory work, so he put it in barrels and sold it around the city by horse-drawn cart.

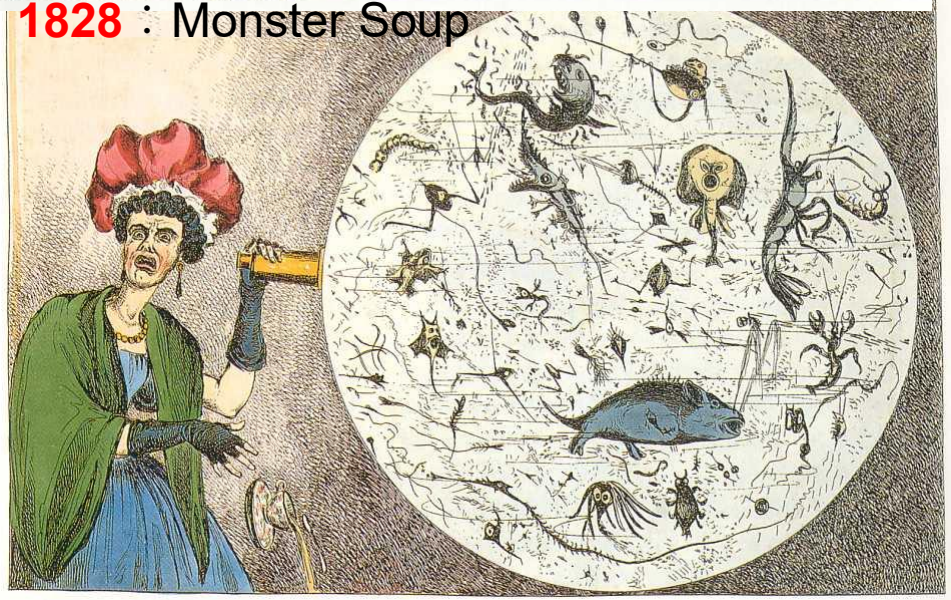
This is said to be the beginning of public water supply systems.

During the Industrial Revolution, many people concentrated in cities, and urban rivers became polluted.

The River Thames in London during the Industrial Revolution

1832: Sewage was spilling into the Thames.

1828：Monster Soup

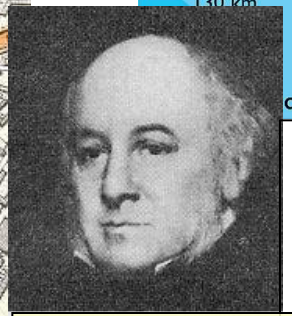


In search of clean water, citizens relied on springs and water vendors.

Hyde park

Chelsea water company

London 1843



James Simpson surveyed various parts of the UK for clean water.

James Simpson (1799-1869) was 24 years old (1823) when he joined his father's Chelsea Water Company and made a "2,000 miles tour of inspection" around England. This became known as the **Quest for Pure Water.**

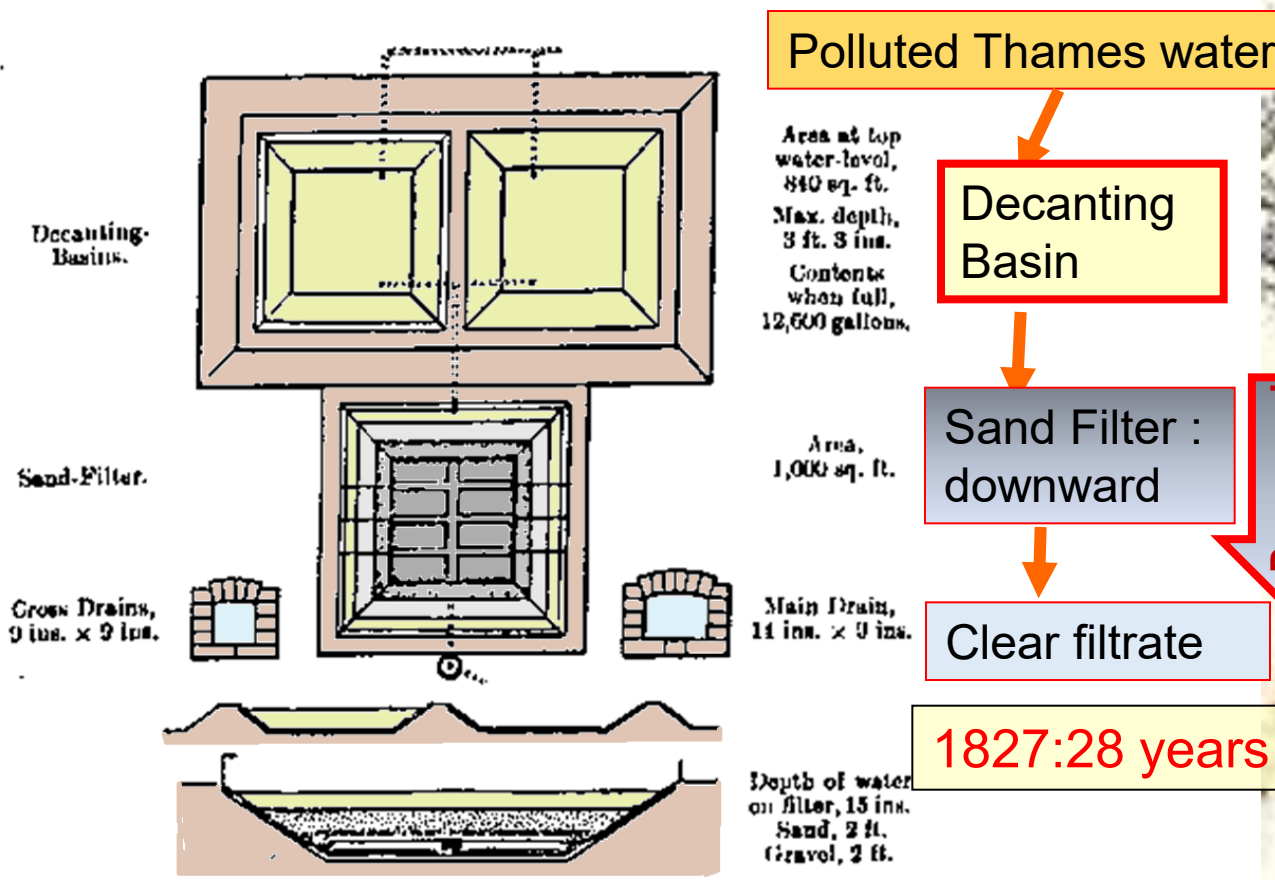


FIG. 28. JAMES SIMPSON'S EXPERIMENTAL FILTER OF 1827–1828

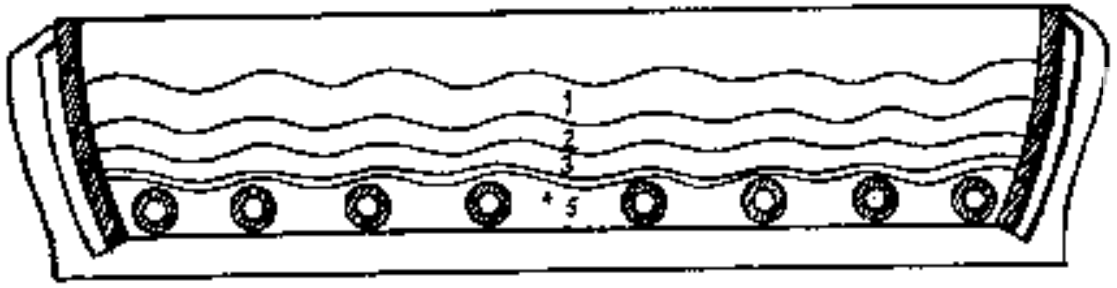


FIG. 29. CROSS SECTION OF SIMPSON'S ONE-ACRE FILTER FOR CHELSEA WATER WORKS CO., 1829

No detailed drawings of practical filtration ponds remain.

Polluted Thames water

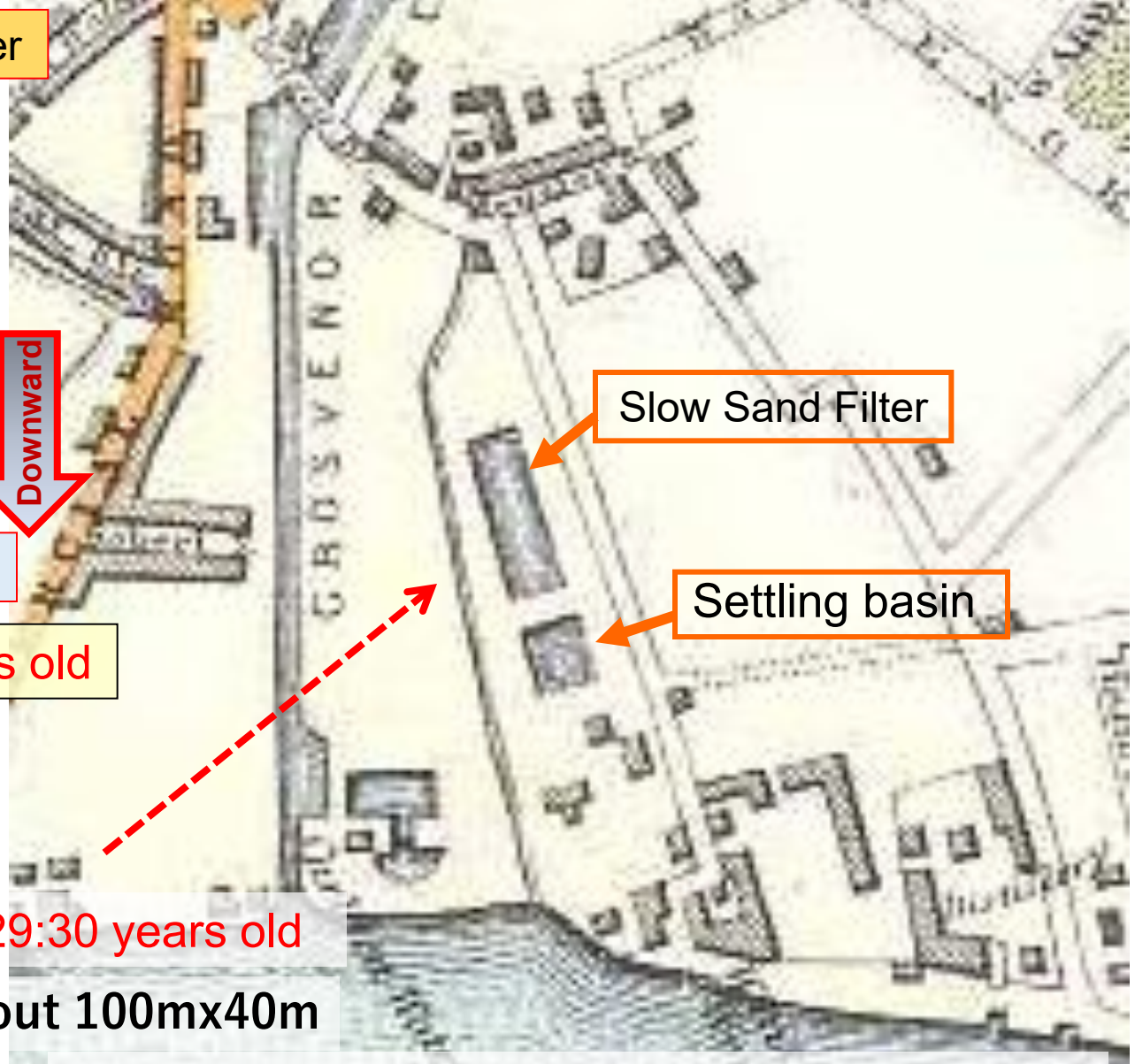
Decanting Basin

Sand Filter : downward

Downward

Clear filtrate

1827:28 years old



1829:30 years old

About 100mx40m

The Chelsea Waterworks' working filters were in use from 1829 to 1856. When the railway was built the water company moved and began filtering water upstream at Surbiton.

FARADAY GIVING HIS CARD TO FATHER THAMES;

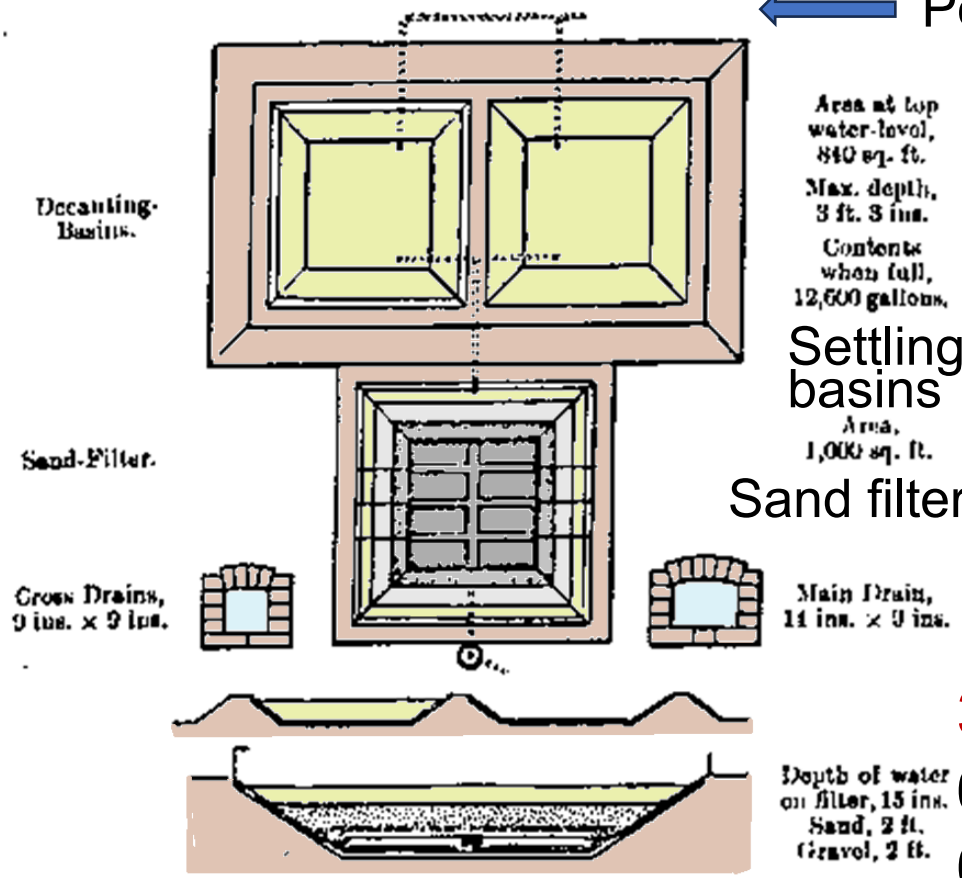
And we hope the Dirty Fellow will consult the learned Professor.

It was said that even the polluted water of the River Thames could be made free of pathogens by using slow sand filtration. After that, slow sand filtration spread around the world as **English filter**.

1829-1856

London 1843

Polluted Thames water



Settling basins

Sand filter

FIG. 28. JAMES SIMPSON'S EXPERIMENTAL FILTER OF 1827–1828

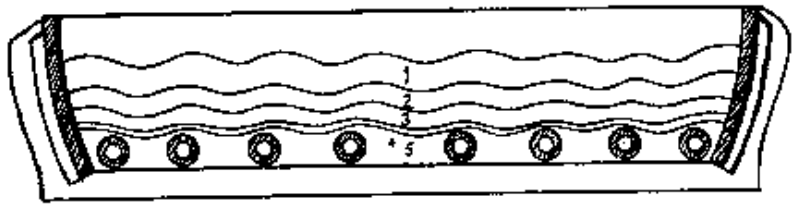
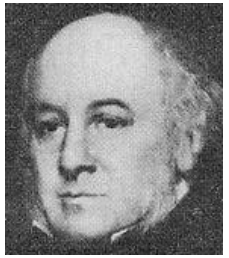


FIG. 29. CROSS SECTION OF SIMPSON'S ONE-ACRE FILTER FOR CHELSEA WATER WORKS CO., 1829



James Simpson

Experiment filter 1827-1829

28 years old

Filter rate

2-3 m/d (10cm/h)

38 cm **Water depth**

61 cm **Sand depth**

61 cm **Gravel depth**

The practical filter was completed in 1829.

30 years old

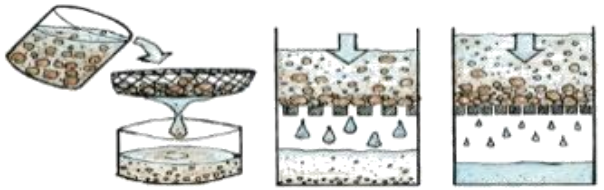
Downward

The sand doesn't move.

In 1838, James Simpson pointed out that slow sand filtration had greater removal capacity than mechanical filtration.

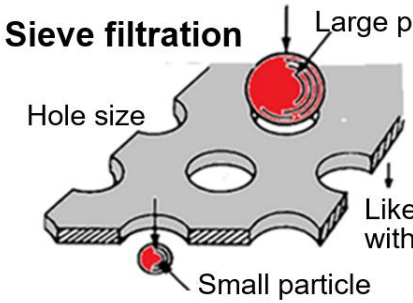
39 years old

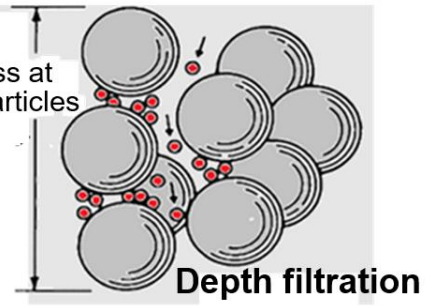
Did Simpson feel that biological activity was involved?



The image of Slow Sand Filter

Slow Sand Filtration through fine sand

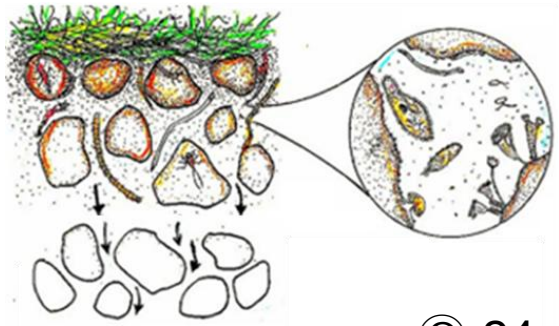




The mechanism of slow sand filtration that was able to remove fine particles at that time

The world's most widely used English filtration rate

4.8 m/d (20cm/h).

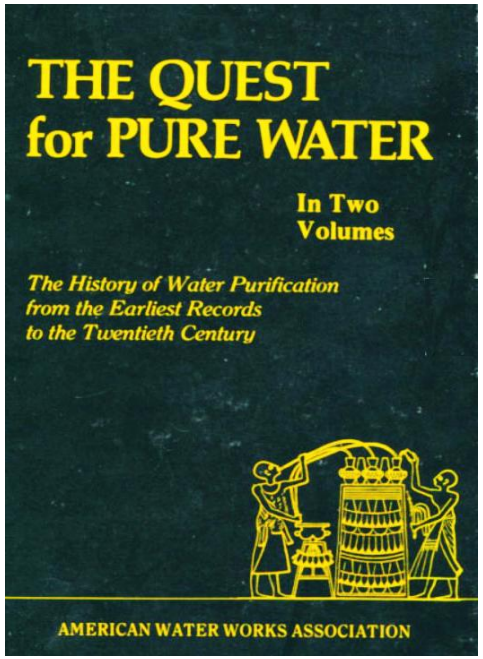


James Simpson and the Chelsea Water Works Company

Best known of all the filtration pioneers is James Simpson. He was born July 25, 1799, at the official residence of his father, who was Inspector General (engineer) of the Chelsea Water Works Co. The house was on the north bank of the Thames, near the pumping station and near what was to become the site of the filter that was copied the world over. At the early age of 24, James Simpson was appointed Inspector (engineer) of the water company at a salary of £300 a year, after having acted in that capacity for a year and a half during the illness of his father. At 26, he was elected to the recently created Institution of Civil Engineers. At 28, he made his 2,000-mile inspection trip to Manchester, Glasgow and other towns in the North, after designing the model for a working-scale filter to be executed in his absence. On January 14, 1829, when Simpson was in his thirtieth year, the one-acre filter at Chelsea, commonly known as the first English slow sand filter, was put into operation.

Of the eight water companies supplying Metropolitan London in the 1820's, five, including the Chelsea until early in 1829, served raw water from the always polluted and sometimes turbid Thames, taken within the tidal reach of the stream into which numerous sewers discharged. The Chelsea Water Works Co., probably led by James Simpson, was the first to give official attention to this deplorable con-

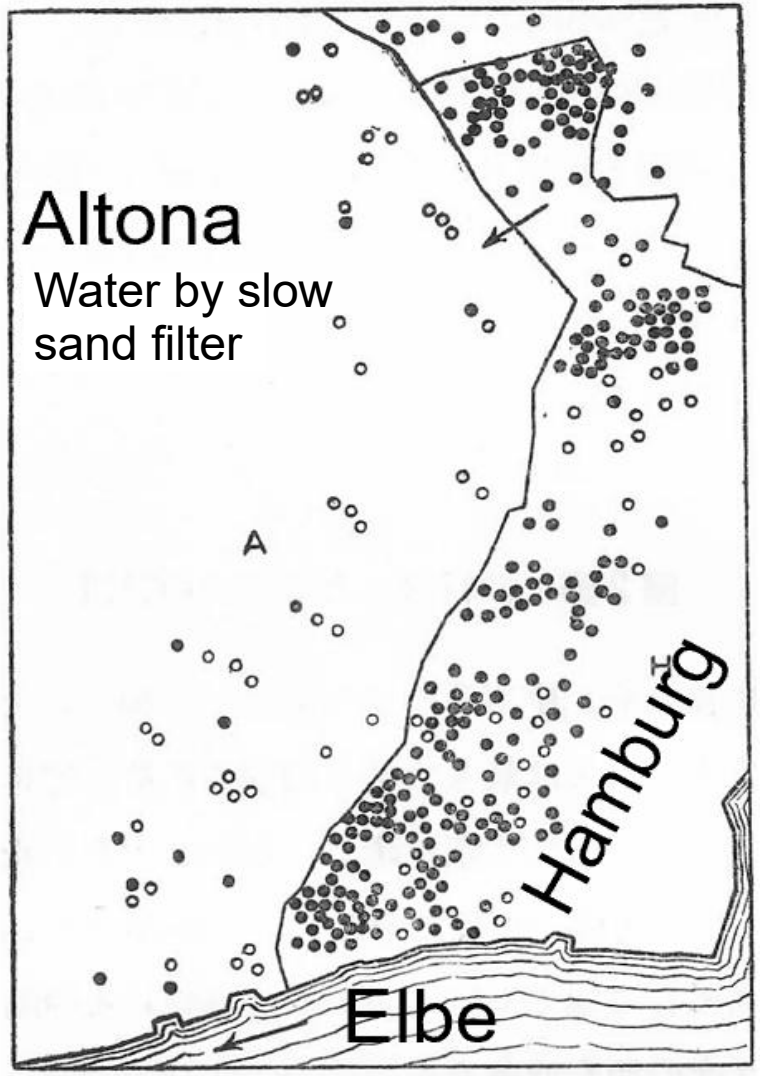
M. N. Baker 1949.
The Quest for Pure Water



https://babel.hathitrust.org/cgi/pt?id=mdp.39015007372272&seq=10

Unfortunately, this drawing does not remain.

Clear evidence of the effectiveness of slow sand filtration came in 1892: a cholera epidemic broke out in Hamburg, killing 7,500 people. However, in the neighbor city of Altona, which was supplied with water that had been filtered by slow sand, there were almost no deaths.



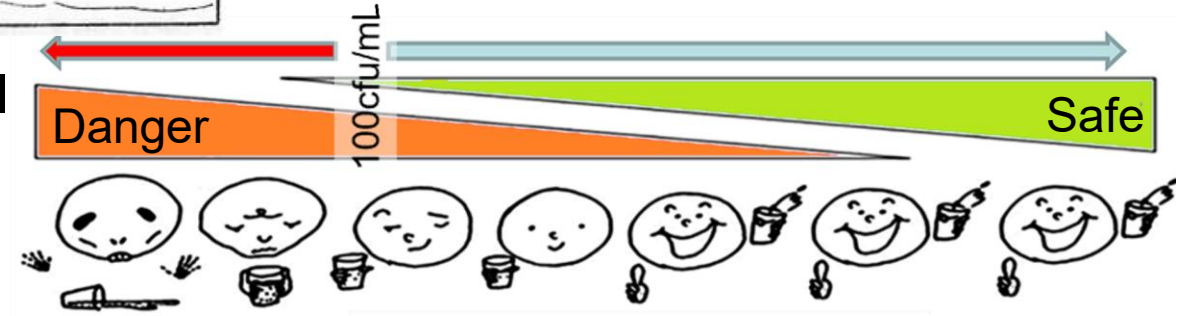
Robert Koch investigated bacteria in tap water and reported that water is safe for preventing cholera and typhoid if the general bacterial count is less than 100 per mL.

This idea and values are carried over to the current WHO drinking water standards.

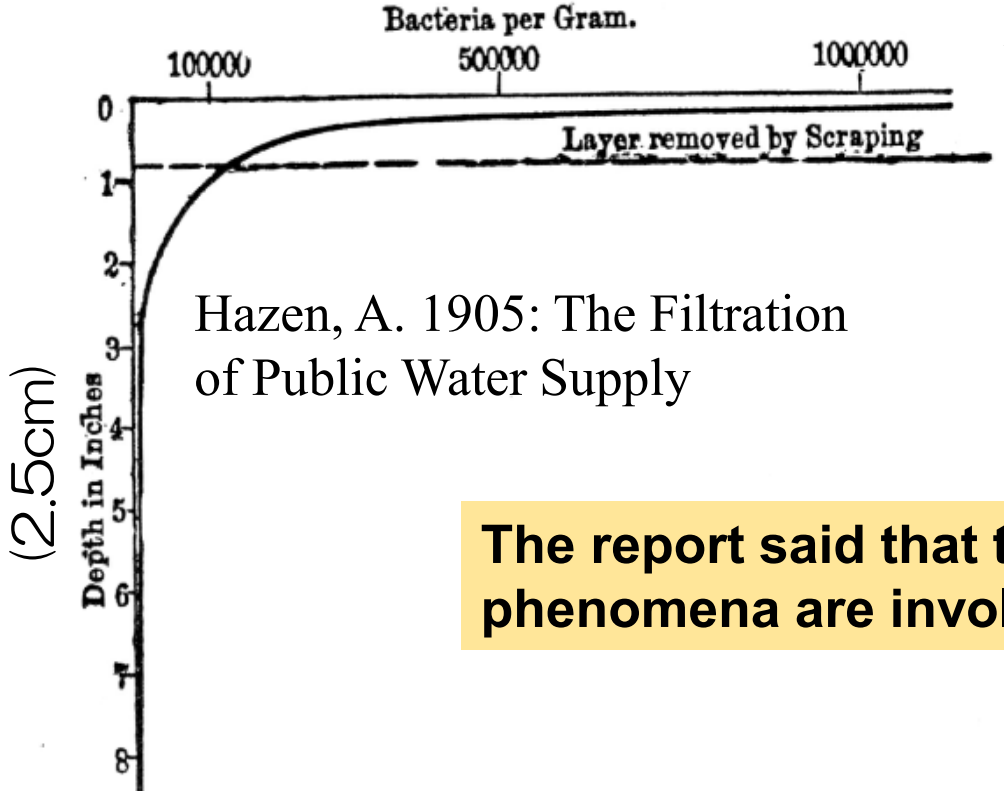
This idea does not require complete sterilization.

This is an acceptable risk.

Normally, even if we are exposed to small number of pathogens, humans have a strong immune system and are fine.
Reduce the risk of danger, dilute it, or make it an **acceptable level**.



In 1838, James Simpson pointed out that slow sand filtration had greater removal capacity than mechanical filtration.



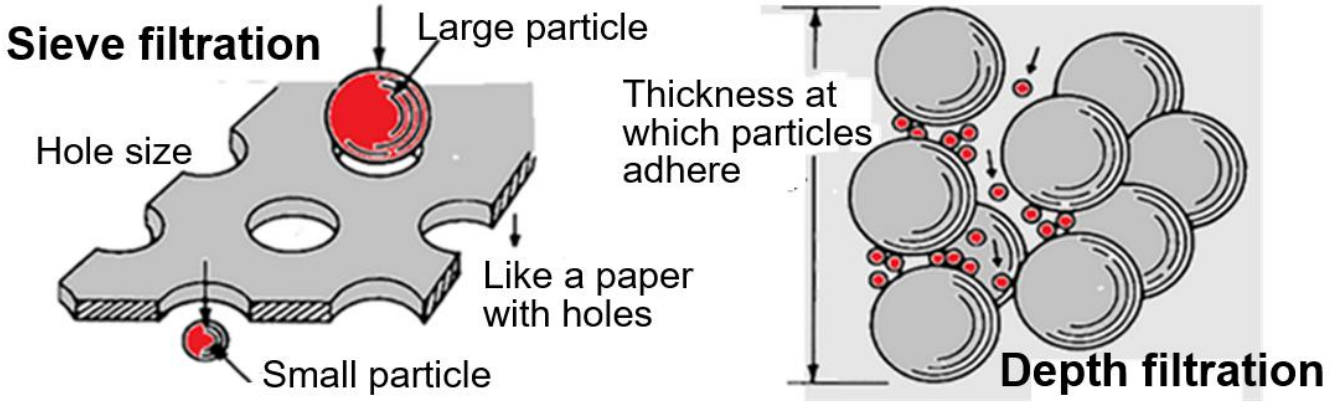
(2.5cm)

Hazen, A. 1905: The Filtration of Public Water Supply

55 years after Simpson's findings, in 1893, a report from a water purification plant in Berlin stated that only the upper part of the sand layer was polluted. The erosion was deep in winter and shallow in summer. However, algae were in bloom in summer. When comparing open and covered filtration ponds and investigating bacterial removal for 20 years, the open filtration ponds had a better removal rate. The report said that this may have been something special.

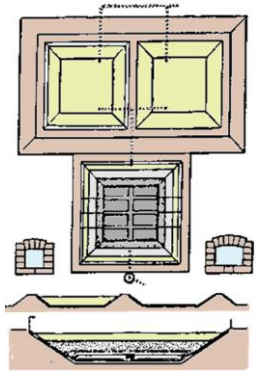
The report said that temperature and solar radiation are related, that biological phenomena are involved, but that mechanical removal is the greater factor.

He can't get over the image of the name slow sand filtration that Simpson first mentioned.



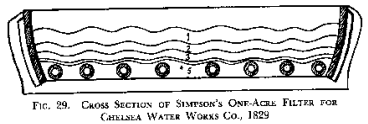
Considering the size of the pathogens, their removal cannot be explained by the size or gaps in the sand, nor by mechanical sieving or filtering through the sand.

Experiment filter
1827-1829



Open Filtrate Basin

Practical Filter
1829



1832:
Richmond,
Virginia,
USA

Germ free filtrate

From 1872: Poughkeepsie Filter plant, NY

Sand filter

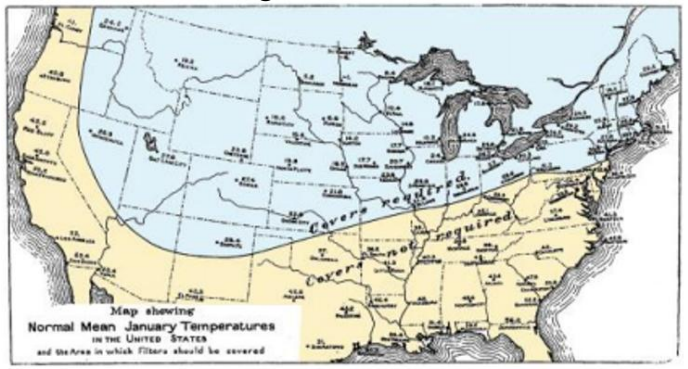
Filtrate basin

1891: Ilion, NY.

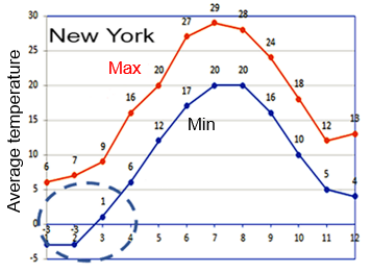
Slow sand filtration removed pathogens from the polluted water of the Thames, making it safe to drink.

The filtered basin was open because the pathogens had already been removed.

The average temperature in January is below 0 degrees.

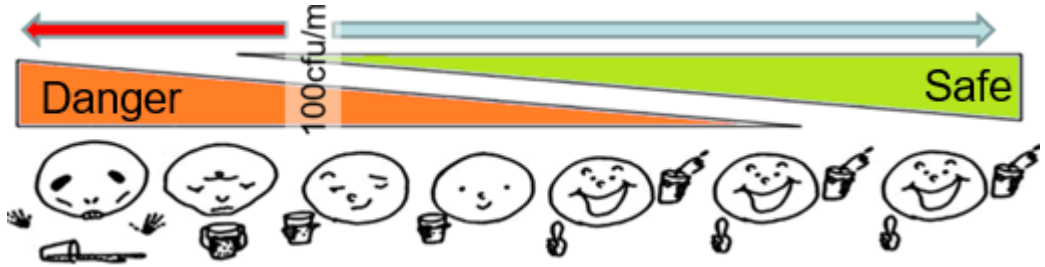


In the United States, it is recommended to cover filter ponds and filtrate basins to prevent freezing.



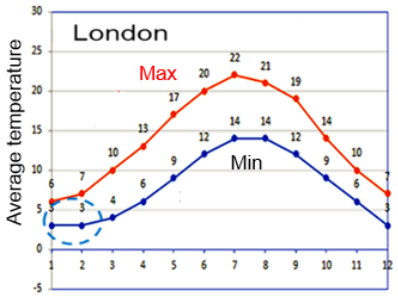
New York gets very cold in the winter and hot in the summer.

Normally, even if we are exposed to small number of pathogens, humans have a strong immune system and are fine.

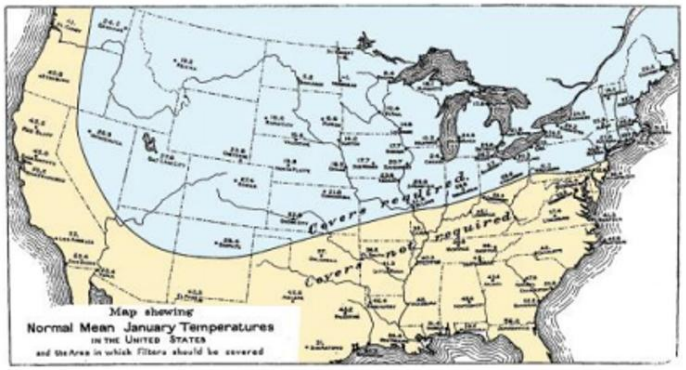


Vartry Water works, Dublin, Irlanda, from 1860s.

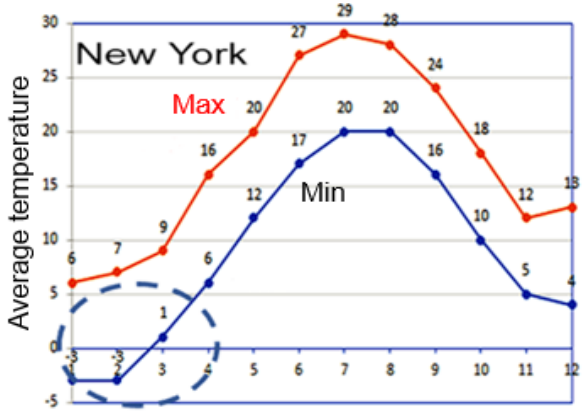
Clear water basin is open in 1998.



London doesn't get very cold even in winter.

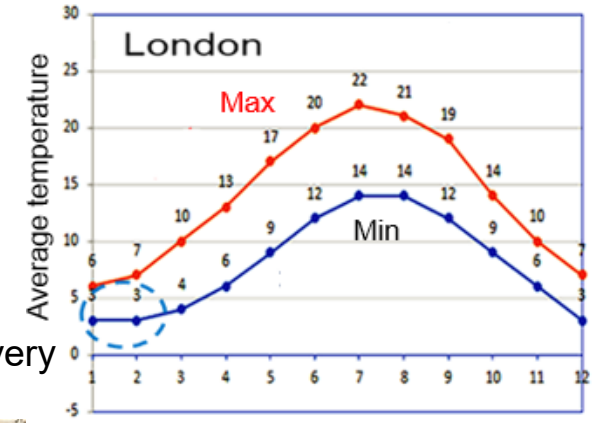


The inland of North America is extremely cold in winter.



New York gets very cold in the winter and hot in the summer.

The warm Gulf Stream and the westerly winds keep Europe from suffering severe winters.

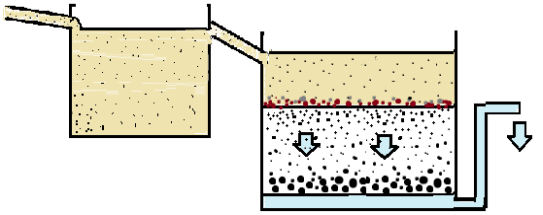


London doesn't get very cold even in winter.

Covered filter, Albany, NY, US

Development of rapid sand filtration with coagulation and chemical sedimentation treatment to combat turbid water.

Winters in North America are extremely cold, so the water is very viscous.



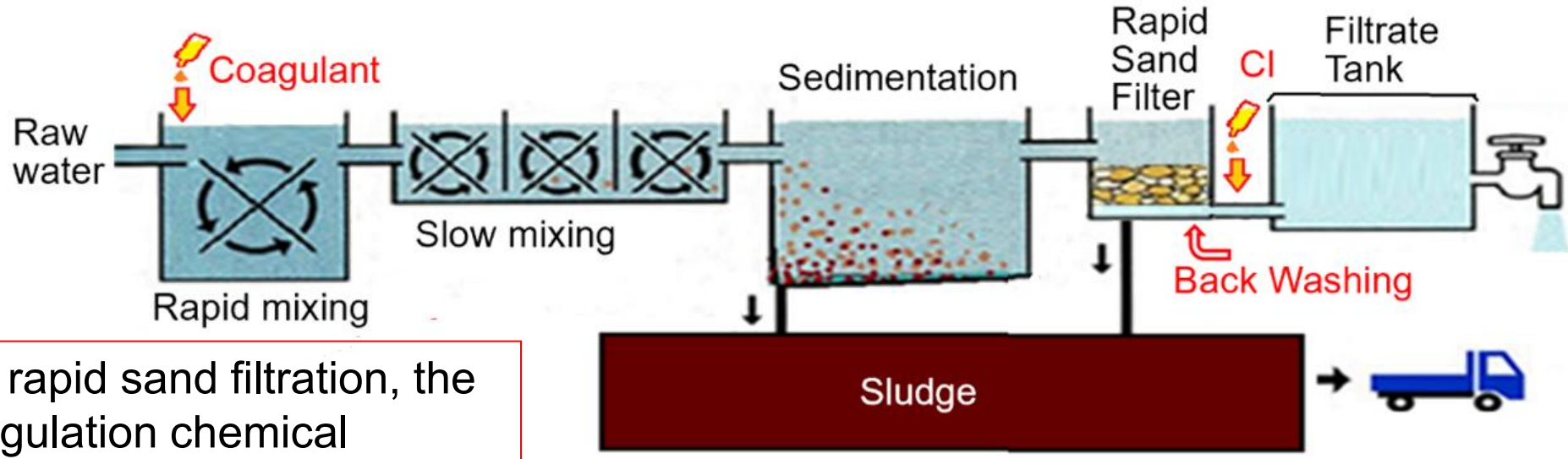
The muddy water in continental plain rivers is fine and does not sink.

The rivers of the New World were less polluted by farmland and cities.
⇒There was little food for living things.
⇒Biological activity was poor.

During extreme cold, the organisms were unable to active and the filtration ponds became clogged.

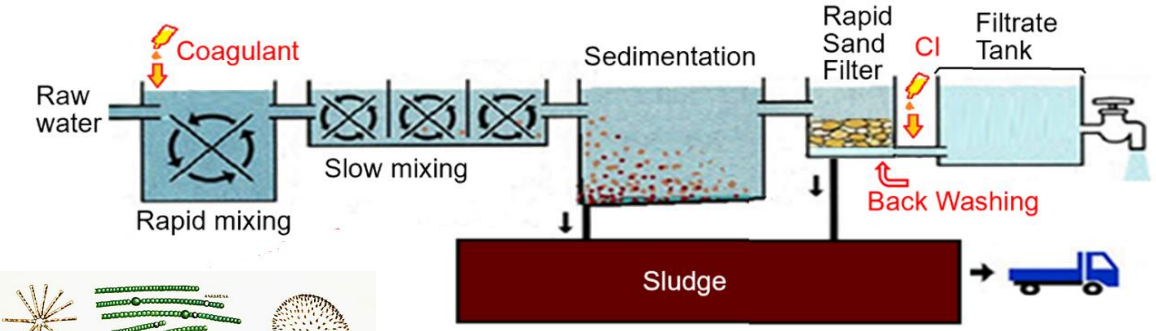
1882: New Jersey, USA: Coagulants used to combat turbidity: Origin of rapid sand filtration
1910: Safe water made safe by chlorine disinfection: Origin of American filtration
⇒ Spreads throughout the United States ⇒ Worldwide

People love new things.



Although it is called rapid sand filtration, the correct name is coagulation chemical sedimentation and filtration processing.

From Rapid Sand Filter to a Safe Purification Method **without chemicals**: Rediscovery of Slow Sand Filter.

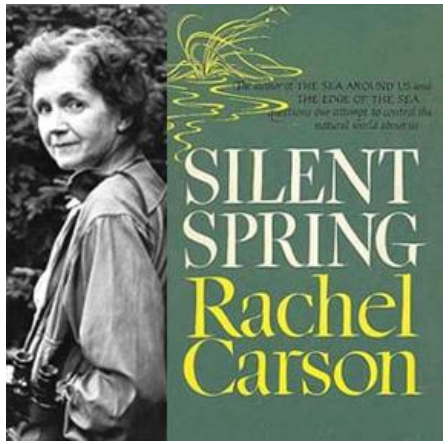


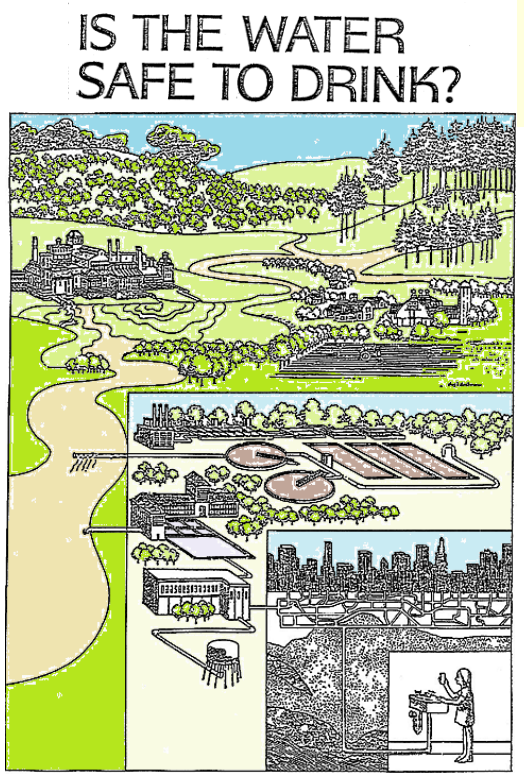
Tast, Odor algae

Filter clog algae

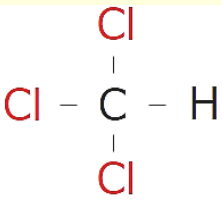
Algaecide is common practice in rapid sand filtration.

In 1962, R. Carson published Silent Spring. It warned that the pesticide DDT was causing biological condensation, killing not only insects but also other unexpected organisms. It warned of the dangers of chlorinated compounds.





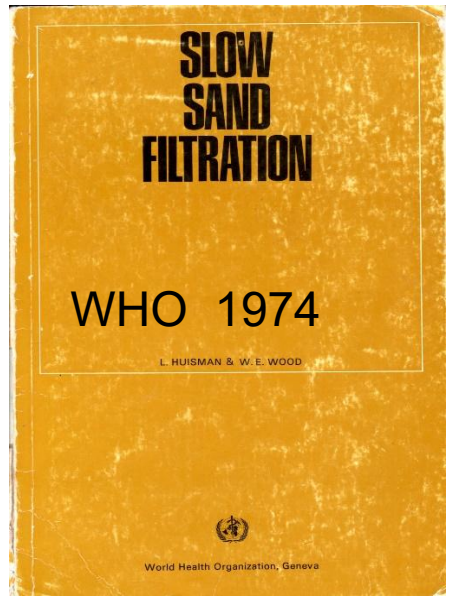
Robert H. Harris and others
Consumer Report, June, 1974.



Tri-halo methane

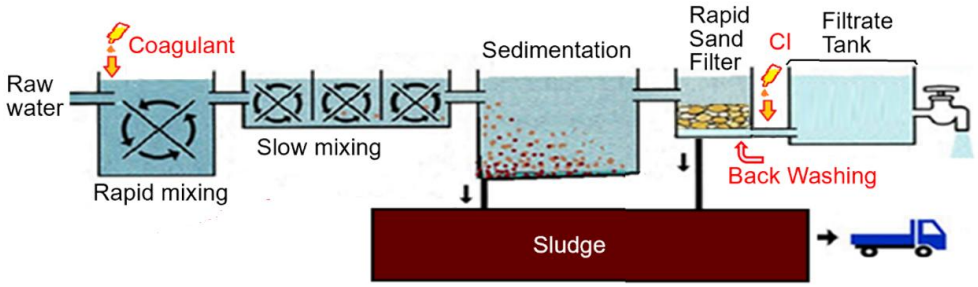
They point out the risk of carcinogens in chemically treated tap water, the risk of asbestos pipes, etc.

Slow Sand Filtration: a safe chemical-free purification method, by Huisman and Wood, 1974



A large-scale outbreak of diarrhea caused by Crypto zoa that had passed through rapid sand filtration.

Rediscovery of slow sand filtration without backwashing



In April 1993, an outbreak of diarrhea caused by Cryptozoa occurred in Milwaukee, USA, affecting 400,000 people. Rapid sand filtration was carried out through the backwash process.

Backwashing lets everything pass through.

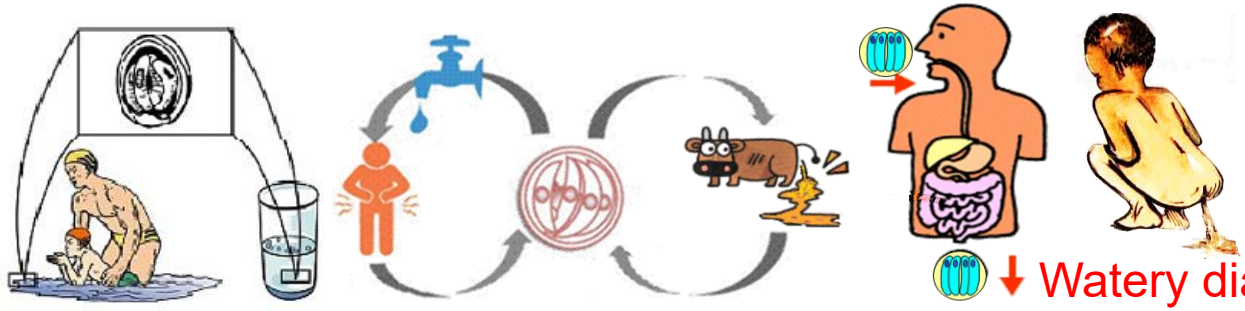
The dormant protozoa have a thick shell and cannot be killed by chlorine, so they pass through the rapid sand filter.

Rapid sand filtration is recognized as a completely defective process.

In September 1994, the American Water Works Association held a workshop on slow sand filtration in Salem, Oregon.

Refocus, Rediscovery, Timeless Technology for Modern Application.

However, people loves New Technology.



Watery diarrhea

Only mammals with long intestines get diarrhea.

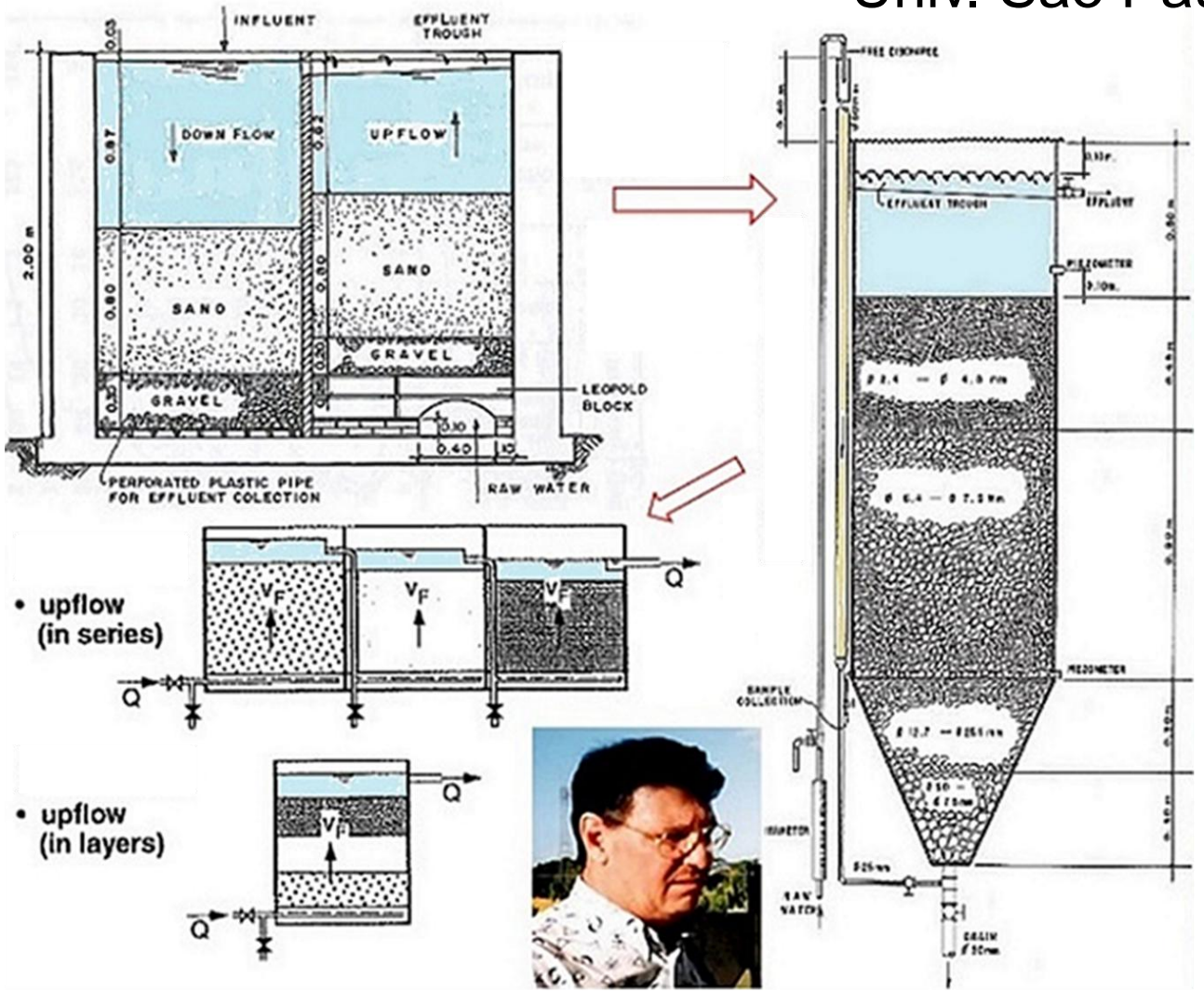
June 1996: Mass diarrhea in Ogose, Saitama Prefecture

Japan recommended membrane treatment.

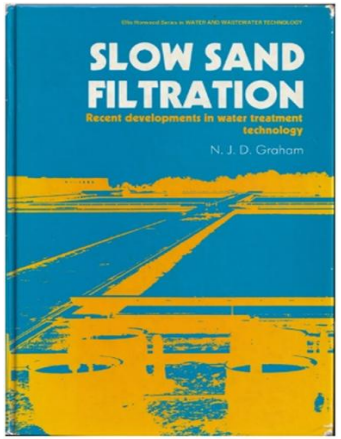
Development of Eco-friendly and Chemical-free turbidity countermeasures: **Up-flow Roughing Filter.**

Down Flow and Up-Flow

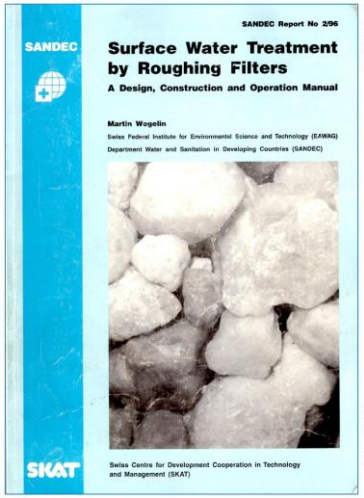
Luiz Di Bernardo 1980
Univ. São Paulo, Brazil



Up-flow Roughing Filter: presented at the International Conference on Slow Sand Filtration, London, 1988



At the international conference in 1988, Martin Wegelin from Switzerland reviewed past roughing filters
⇒International joint experiment
⇒In 1996, a roughing filter manual was published by Switzerland.

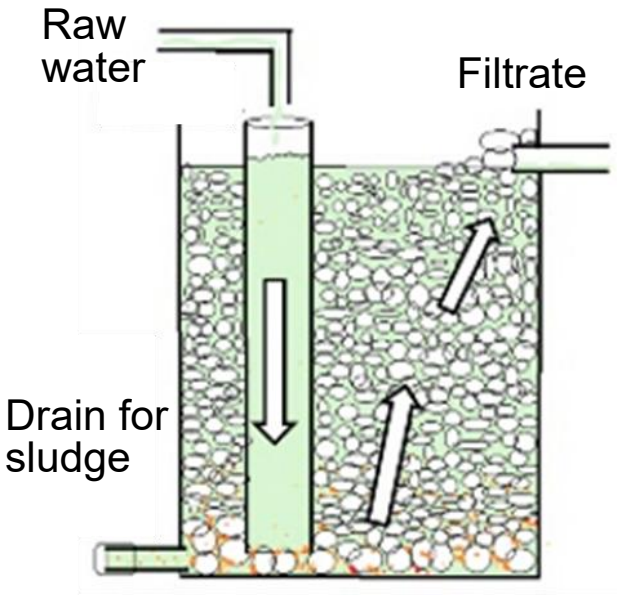


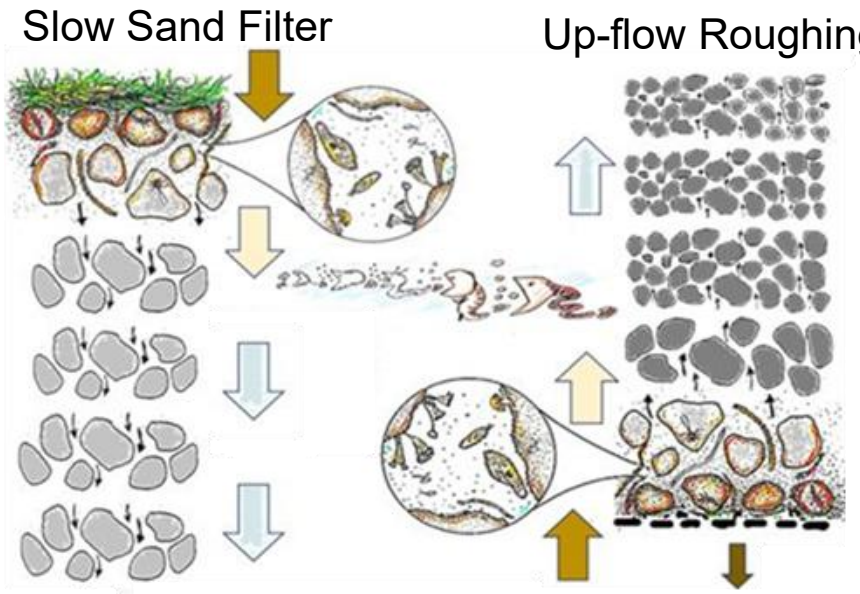
https://www.ircwash.org/sites/default/files/Wegelin-1996-Surface.pdf

Martin Wegelin
Swiss Federal Institute of Aquatic Science and Technology

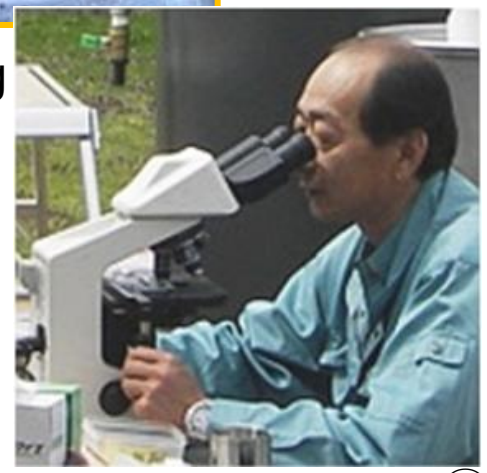
The role of the biological community was also key in Up-flow Roughing Filter.

Up-flow Roughing Filter

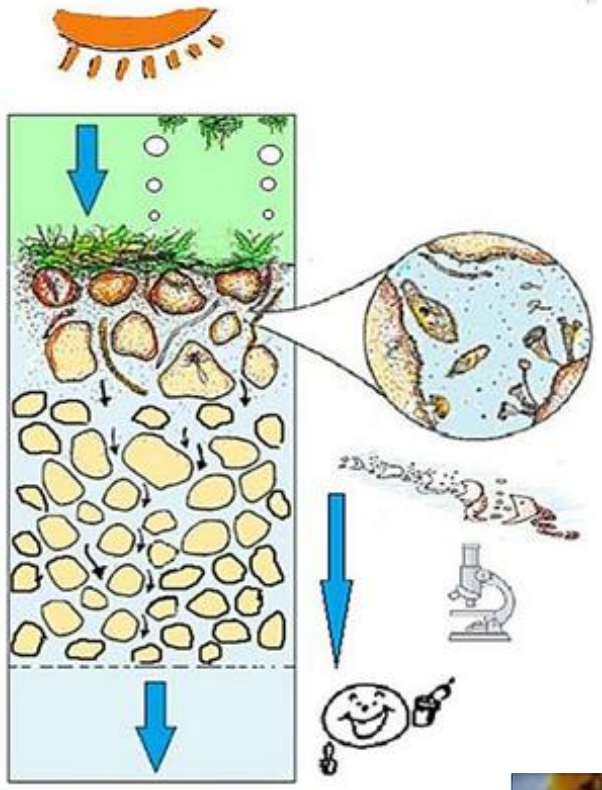




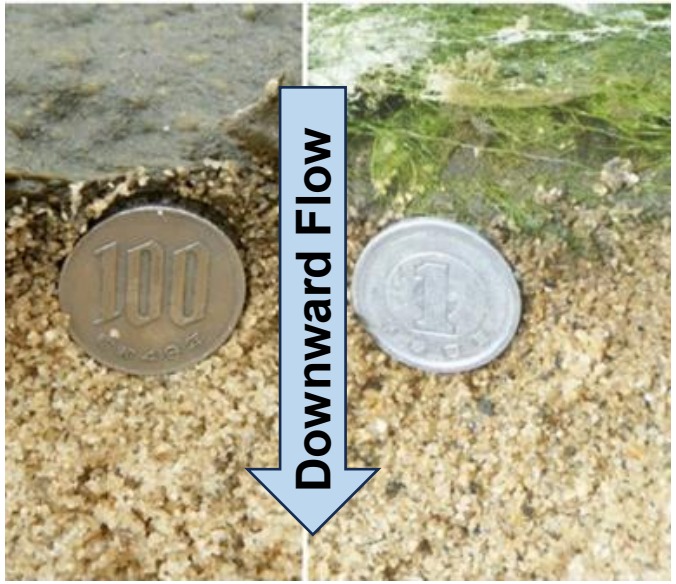
It has good settling properties and is similar to activated sludge in sewage treatment, where the biological community is active.



The activity of biological communities is key.

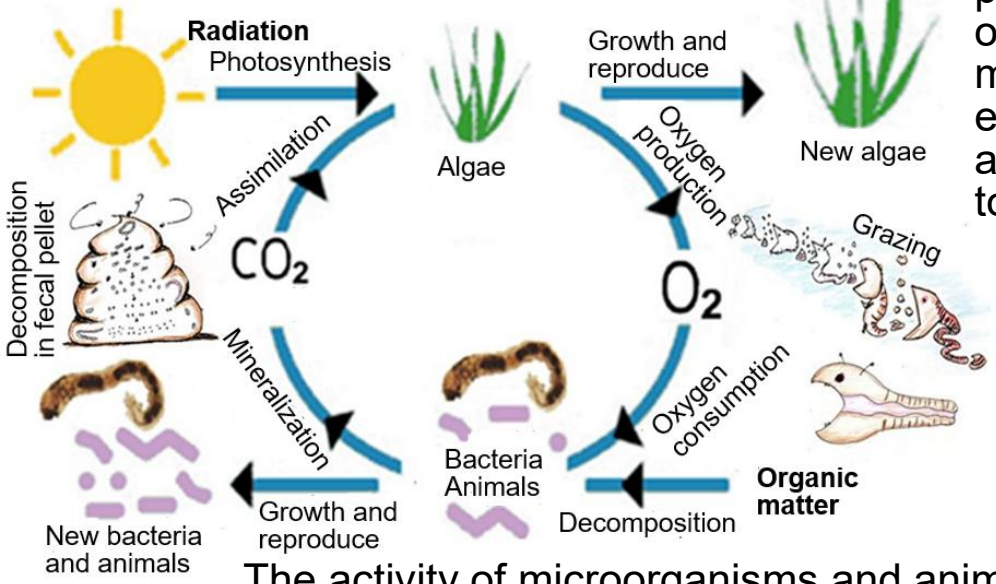


Artificial delicious spring water



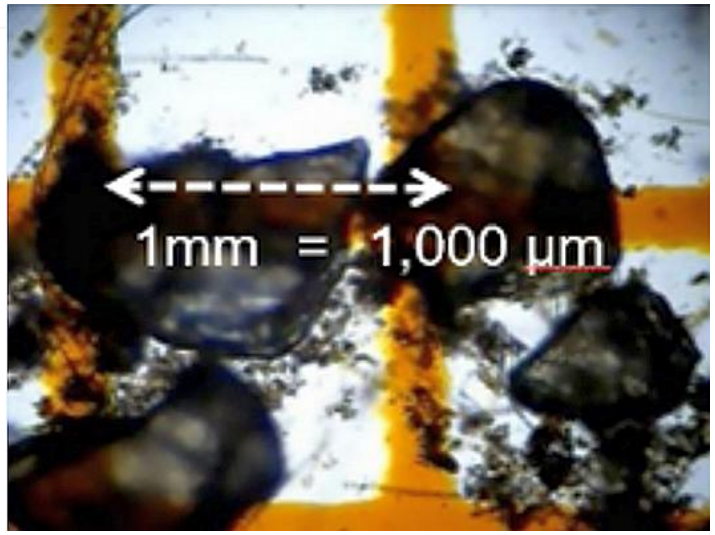
Gentle for small organisms.
The sand does not move even when the flow rate changes.

Photosynthesis is dependent on the amount of **solar radiation**.

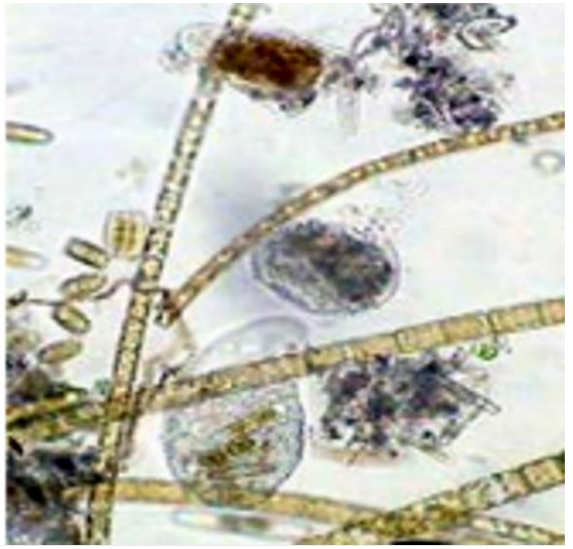


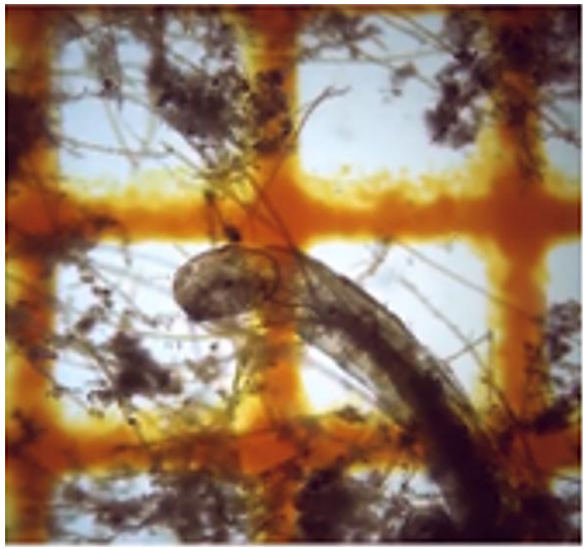
Algae produce oxygen, making it easier for animals to thrive.

The activity of microorganisms and animals is related to **temperature**.



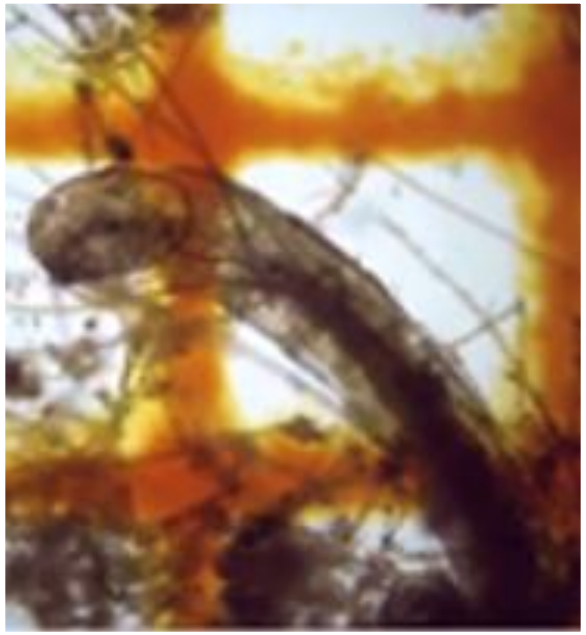
Organisms smaller than the size of sand are active here.





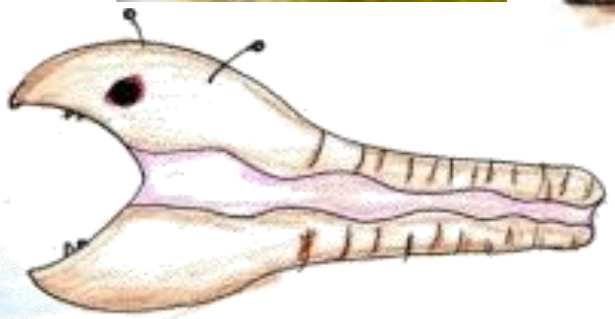
Hungry microscopic animals will eat anything.

Hungry animals move around in search of food and will eat anything they can.



Short time work.

It only takes a split second for the microscopic organisms to capture food and turbidity.

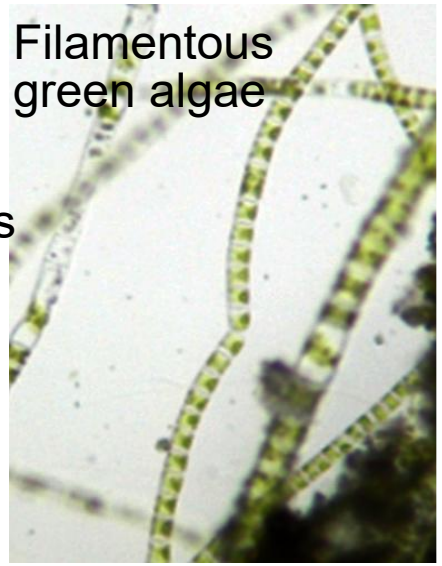


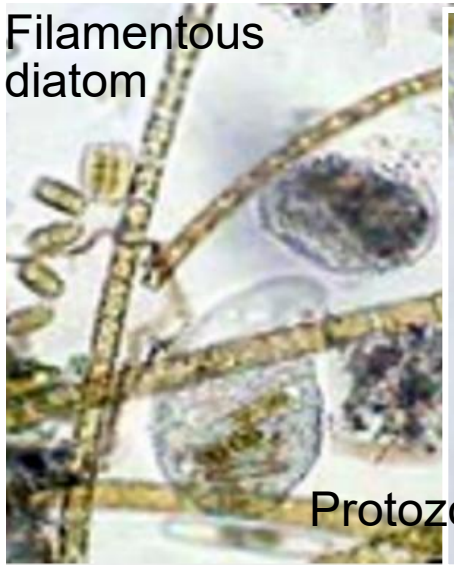
The food that is eaten passes through the intestinal tract in a short time and is immediately excreted as feces.

Long-term action.

Decomposition takes place over a long period of time within the feces. Fermentation progresses in the anaerobic environment with a lack of oxygen, breaking down polymers into smaller molecules.

When observed under a microscope, algae and other tiny organisms are at work.





Nematoda

Rotifer

Chironomid
larvae

Carnivorous dragonfly nymph

The snail eats
green algae.

There are clams in
the sand layer.

In slow sand filters, the **food chain** is the key to purification - eating and being eaten.

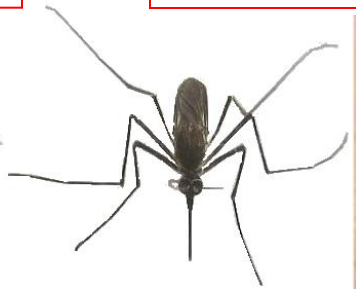
Chironomid is not same as **Mosquito**.

Chironomid

Non-biting Mosquito

Mosquito

Biting Mosquito (Female)



Both Midges of Chironomid and Mosquito swarm for mating.

Midge swarming

Mosquito larvae live in stagnant environments.

Troublesome Nuisance Insects

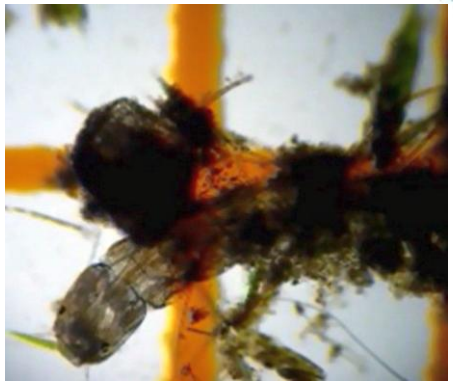
Vending Machine

Lake and Pond

Roughing filter

Ecological System under slow water current

Chironomid larvae are active on the muddy surface, sandy surface, and upper part of the sand layer. These environments with currents have dissolved oxygen.

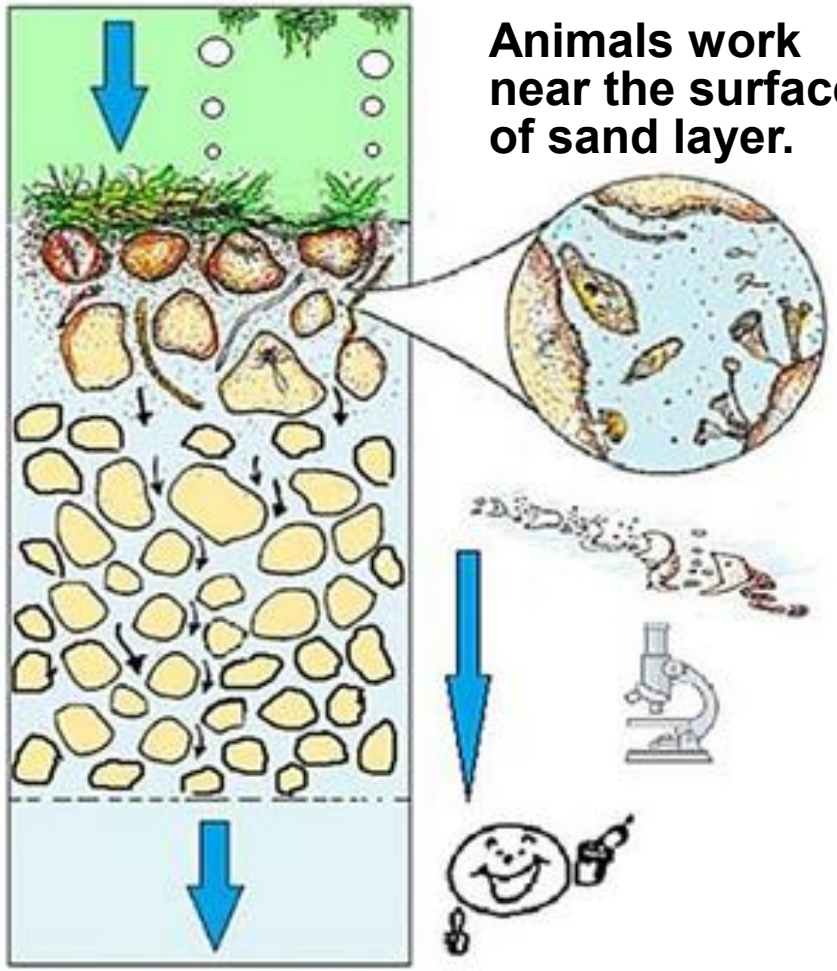


Chironomid larvae:
making nest at the bottom

The mosquito larvae float on the water surface, drifting with their tails up. Their tails act as respiratory organs, and they bring them to the surface to breathe.

Algae grow on the sand surface.

Animals work near the surface of sand layer.



Hungry organisms works in this EPS.

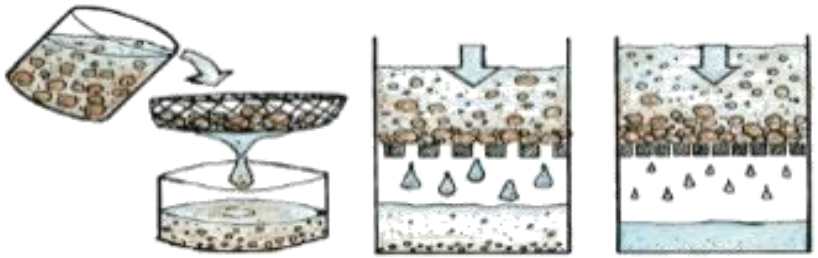
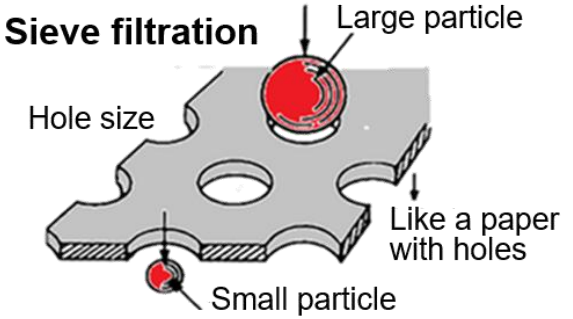
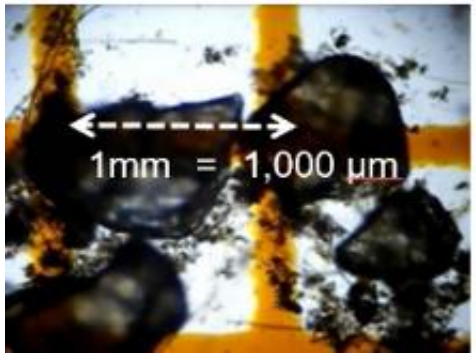
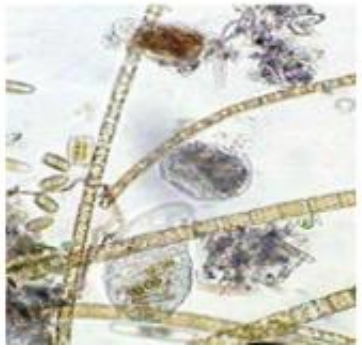
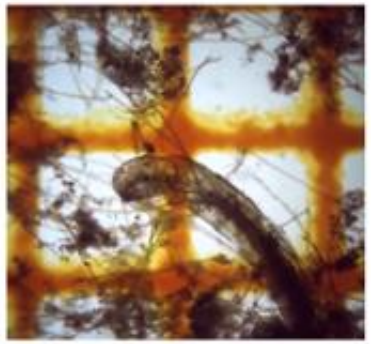


Image of Slow Sand Filter.









Food chain is the Key.

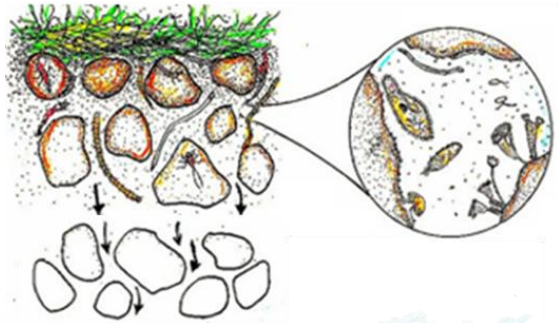
Slow Filtration with fine sand under slow current.

Slow Sand Filter → **Ecological Purification System**

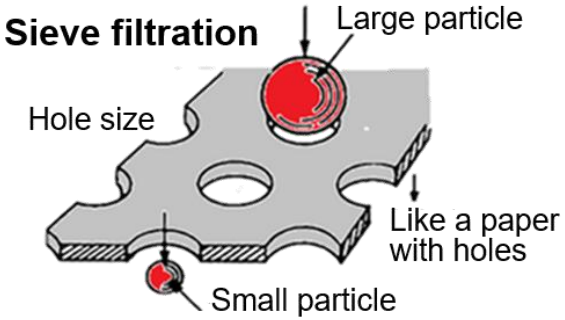
slow → **gentle**

Slow Sand Filter

Purification mechanism of SSF was misunderstood by the name.



Mechanical filtration with fine sand under slow current



Nigeria

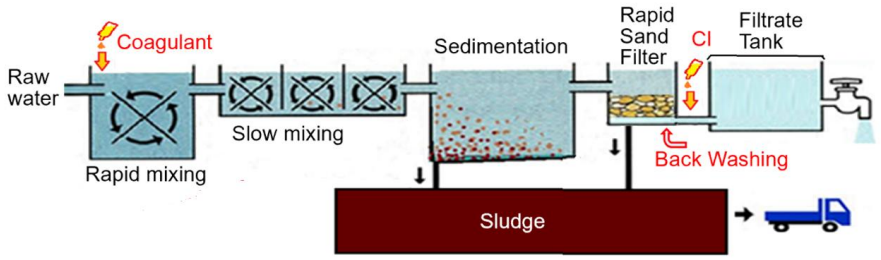
Slow sand filtration, which originated in the UK 200 years ago, was reborn in Japan as the Ecological Purification System (EPS). From Japan, EPS began to spread throughout the world.

Ecological Purification System from Japan to the world

Super clean delicious water

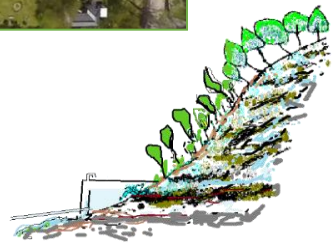
Trust Our Sense !

A large-scale outbreak of diarrhea caused by Crypto zoa that had passed through rapid sand filtration in April 1993.



Backwashing lets everything pass through.

Refocus to Slow Sand Filtration after the large-scale outbreak of diarrhea caused by Crypto zoa.

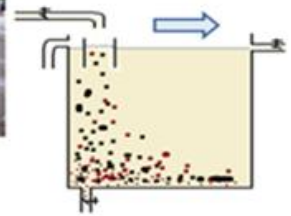


Turbidity mg/L

500
200
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0.0005
0.0002
0.0001

Storm event

Major turbid matter in mountain stream is easily set within several hours.



Coagulant＋Chlorine Rapid Sand Filter

SS passes by backwash.

2 degrees Jap. standard

After Crypto outbreak.

Recommended to 0.1 degrees

Chlorination is essential.

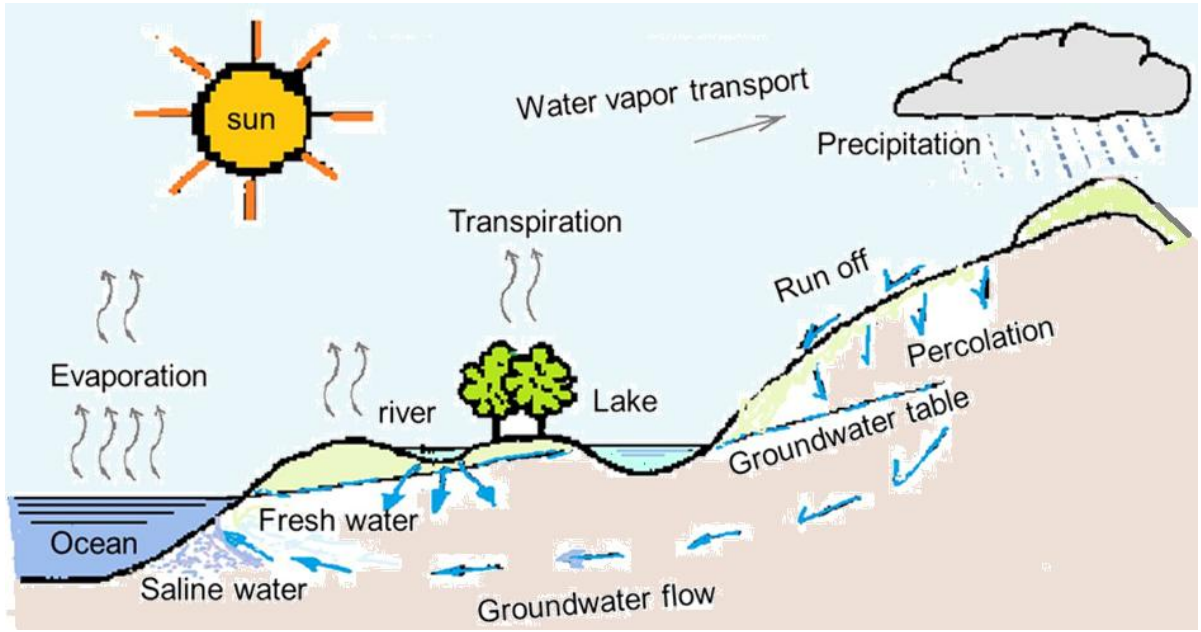
Purified by small organisms

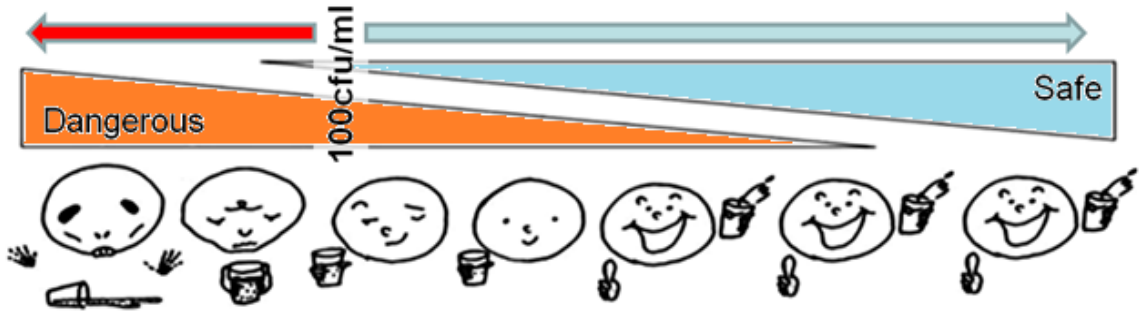
Natural spring

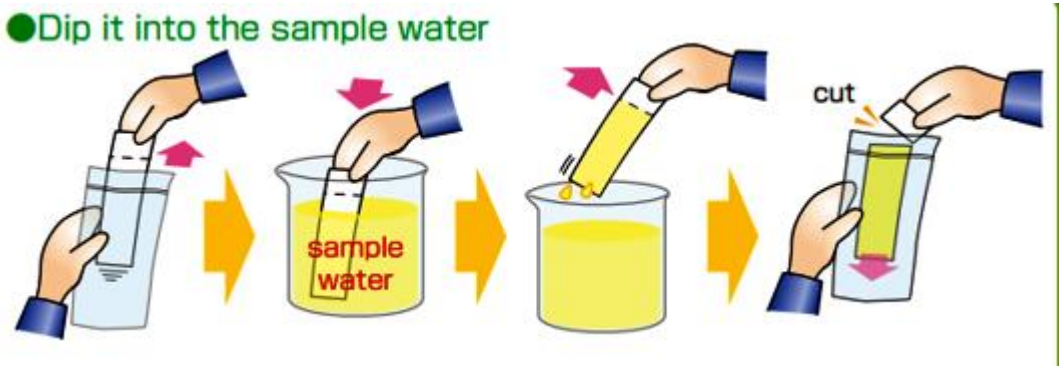
Super clean and delicious.

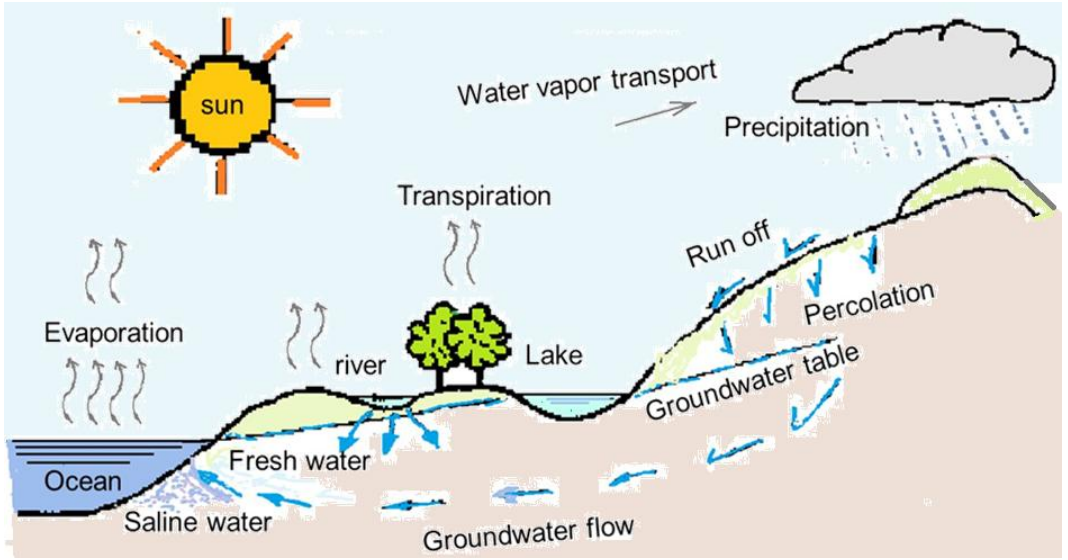
Artificial Natural spring water

③ Water Cycle, Safe and Acceptable Risk.

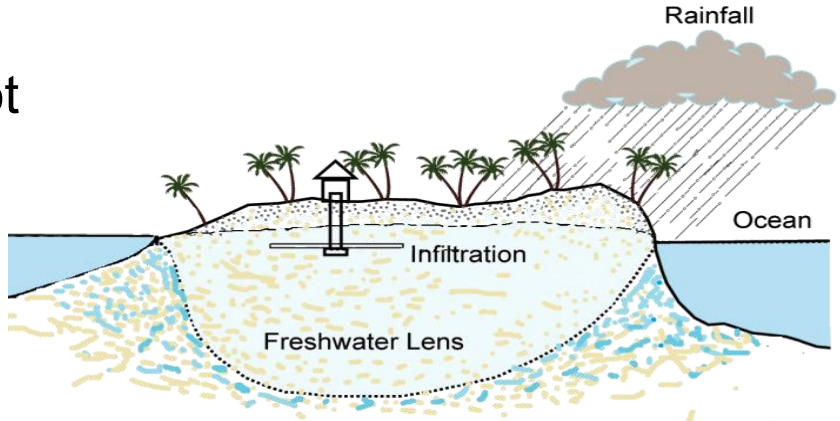


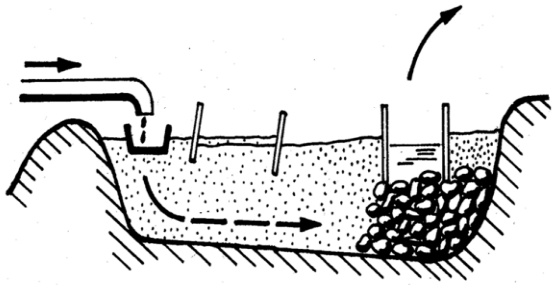


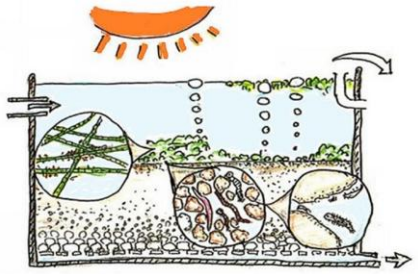




Rain falls on mountains and islands. There is a lot of sunlight, clouds form, and rain falls. Rainwater seeps underground and comes to the surface as spring water. It is purified in the soil and becomes clean water.

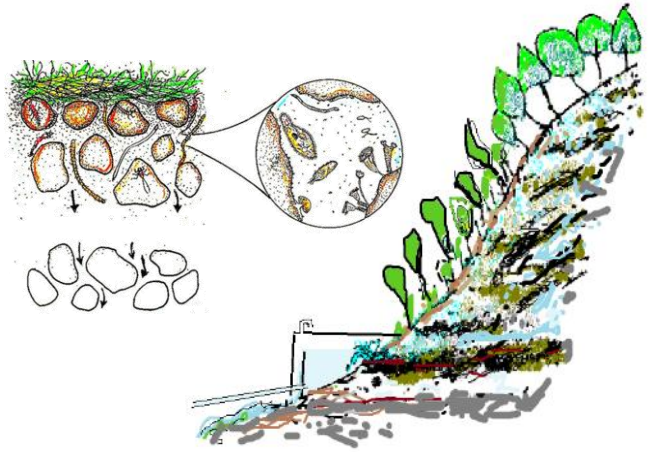






Artificial clean subsurface water in a flood plain.

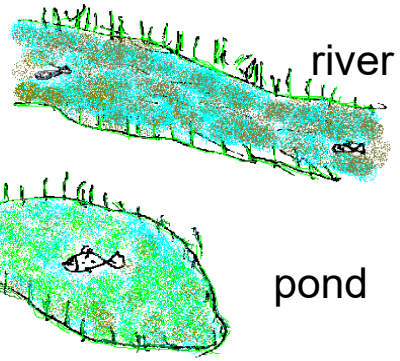
Image of Slow Sand Filter as Ecological Purification System (EPS).



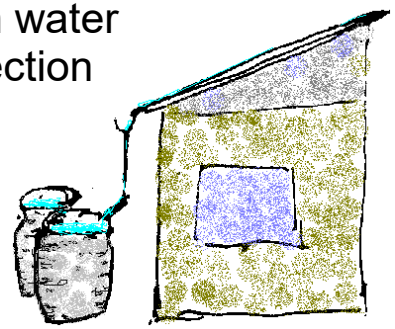
We have been used natural safe water which is natural spring water. This water is purified in nature without any chemical.

EPS is a new purification system to make artificial spring water. This is wise use of natural phenomena.

Familiar surface waters are not always safe. How to get safe water.

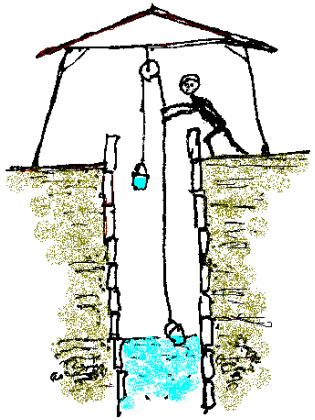


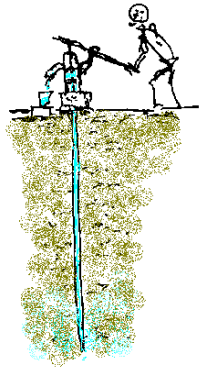
Rain water collection



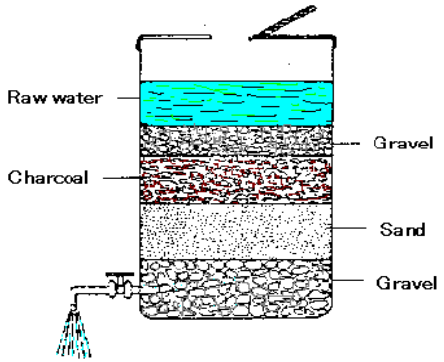
Surface water is easily contaminated by pathogens and other dangerous worms. It is not always safe to drink directly.

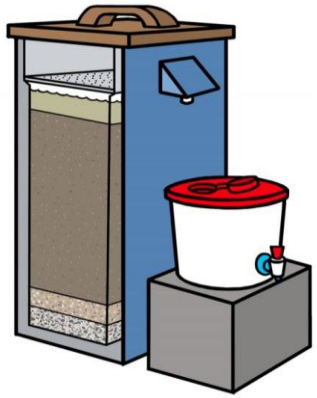
Fish is one of the indicator.



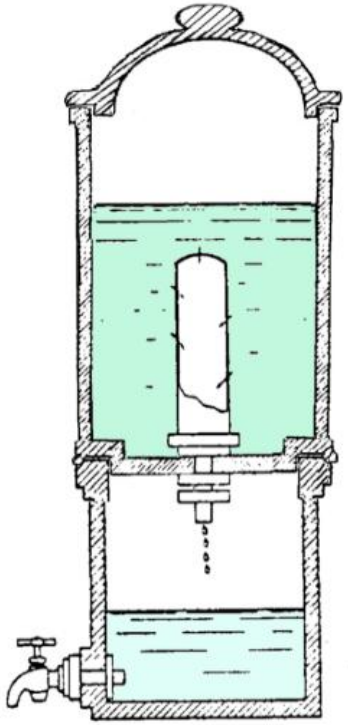


Heavy metals are easily dissolved in underground water. This water does not contain **enough amount of dissolved oxygen**.





Multiple layer filter, Bio-Sand Filter and Ceramic candle filter do not perform completely at removing pathogens. These can be reduced the risk.



Boiling is the best way against pathogens.

Almost all pathogens may be removed by ceramic filter. The pore size is smaller than 1.5 micron.

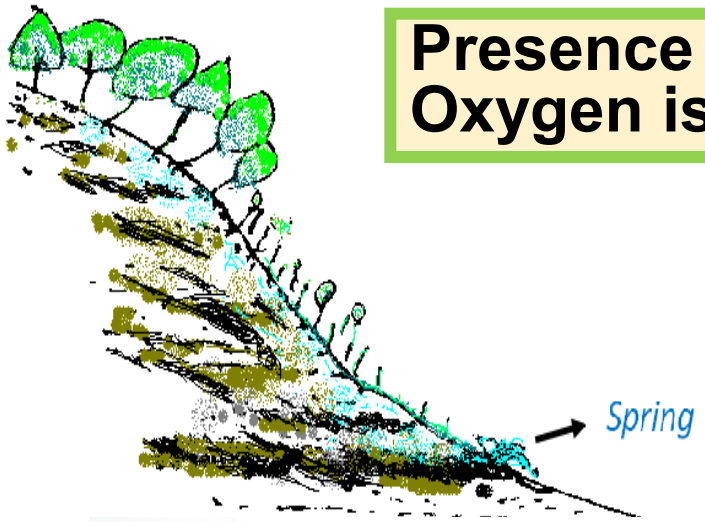
All the contaminated particulate matter can be removed by a membrane filter. But the running cost is so big.

Sweet drop (honey dew) Natural sweet and delicious water

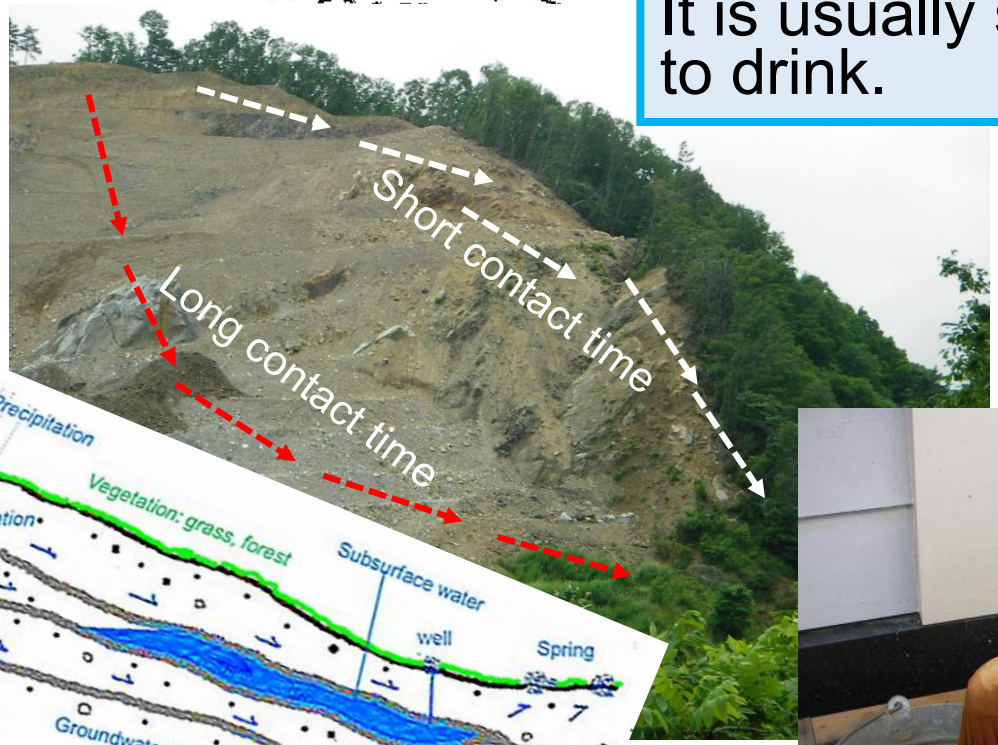
Natural spring water and rain water are usually sweet and delicious.

Rain harvesting

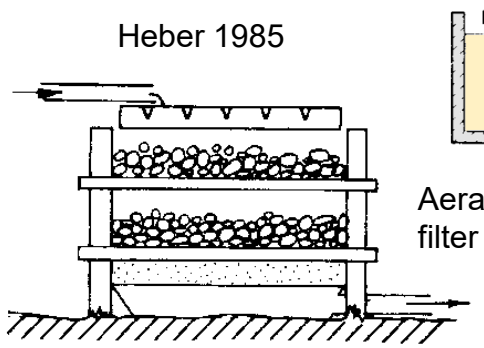
Presence of Dissolved Oxygen is Key.

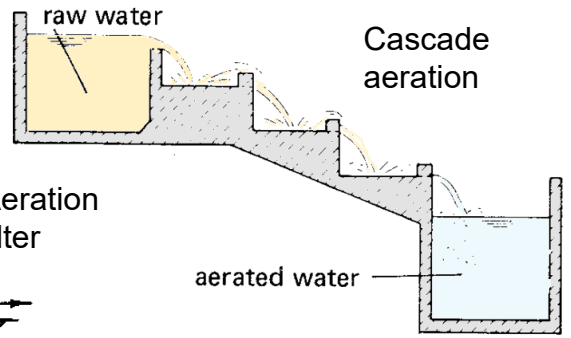


Natural delicious spring water contains enough amount of dissolved oxygen. It is usually safe to drink.



Addition of oxygen:
Aeration is frequently used for treatment of groundwater (reduction of unpleasant tastes and odors, discoloration, precipitation of iron and manganese).

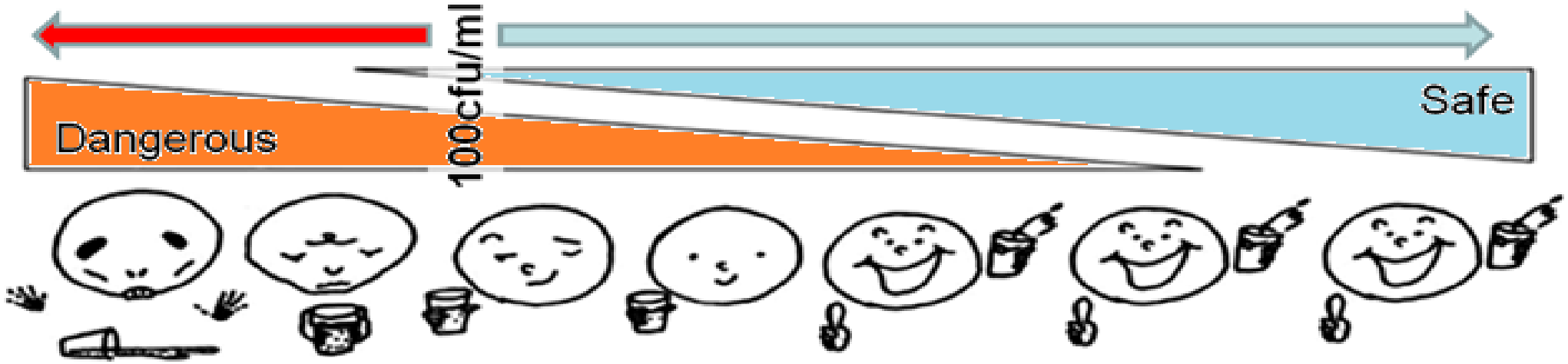




Iron and manganese are oxidized and form nearly insoluble hydroxide sludge. They can be removed in a settling tank (a coarse filter).

We have to think about acceptable risk and treatment.

Is this, safe or not?



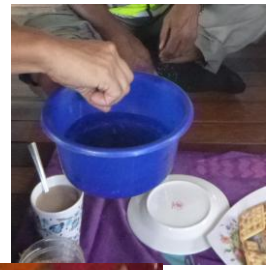
Which level of treatment, we need?











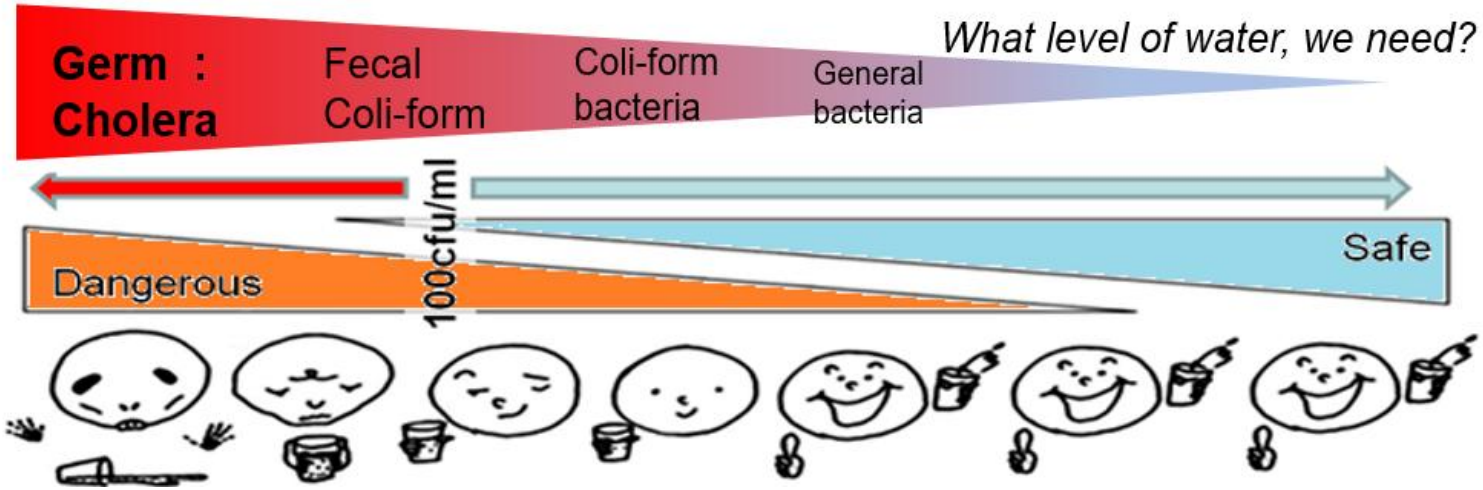






We have to think about acceptable risk and treatment.

I could not say that bacteria free water is safe.

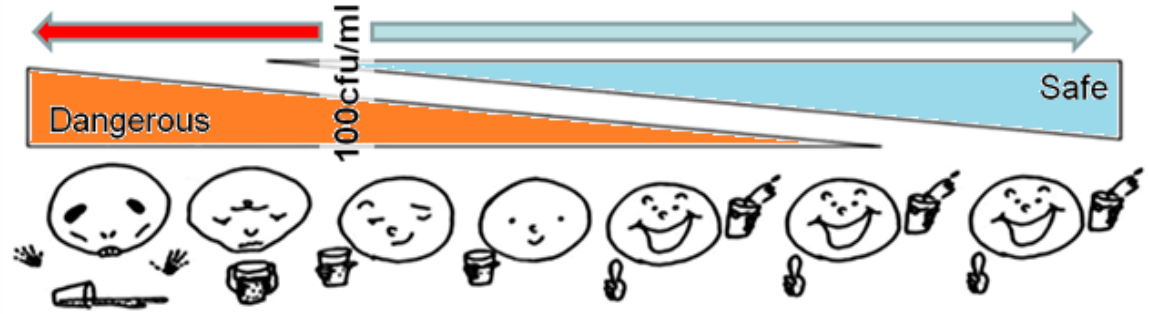


Kava ceremony in a village in Fiji.

https://www.youtube.com/watch?v=vQxpxhUVkM8

49 seconds

There are many kinds of bacteria in nature (in water and in the soil).



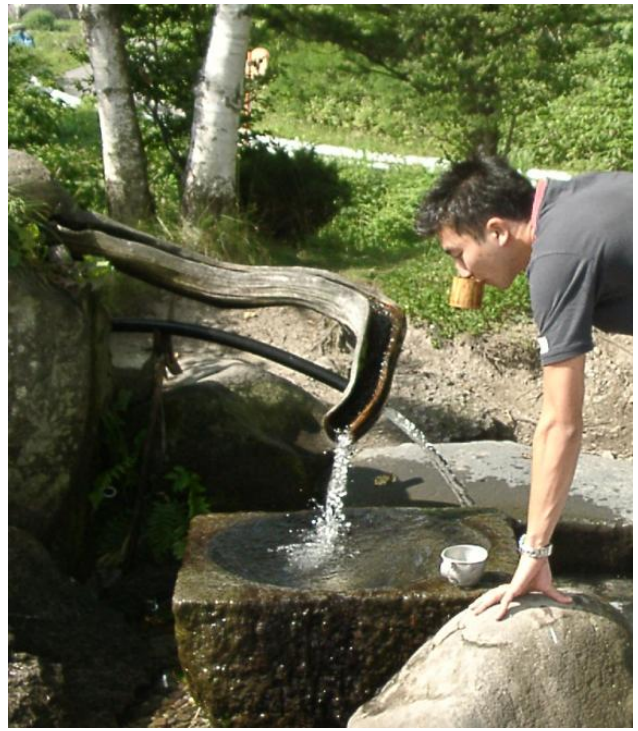
General bacteria: many in the natural environment

Group of coli-form bacteria : an indicator of pollution: many in the natural environment

Escherichia coli : indication of intestinal bacteria.

Fecal *Escherichia coli* : an indicator of fecal contamination of mammals.

Pathogenic bacteria

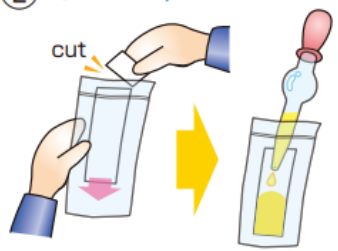


Wash hand!
Reduce the risk.

Easy bacteria test paper of SUNCOLI paper
https://www.sibata.co.jp/wpcms/wp-content/themes/sibata/en/pdf/test_paper.pdf

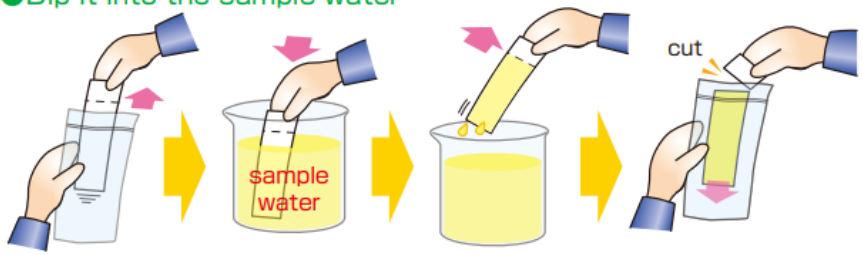
① Open the polyethylene pouch, pinch the top of test paper ant take it out.

② ●Use Pipets



Drop 1mL of the sample water on the test paper.

●Dip it into the sample water

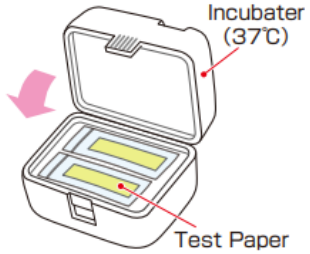


Dip it into the sample water, pull it out and shake off the extra water.
Put the sample test paper into the polyethylene pouch, cut the perforation line and throw away the top.

③

Push the air out of the pouch. Then seal the fastener.

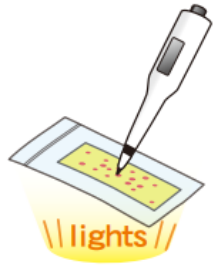
④



Put It In a thermostat and incubate it at 35-37°C.

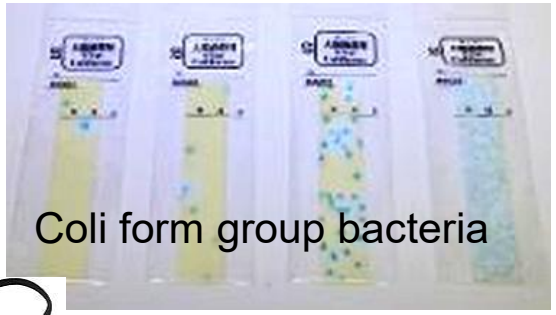
Coli form Group・・・15 hours
General Bacteria・・・24 hours

⑤



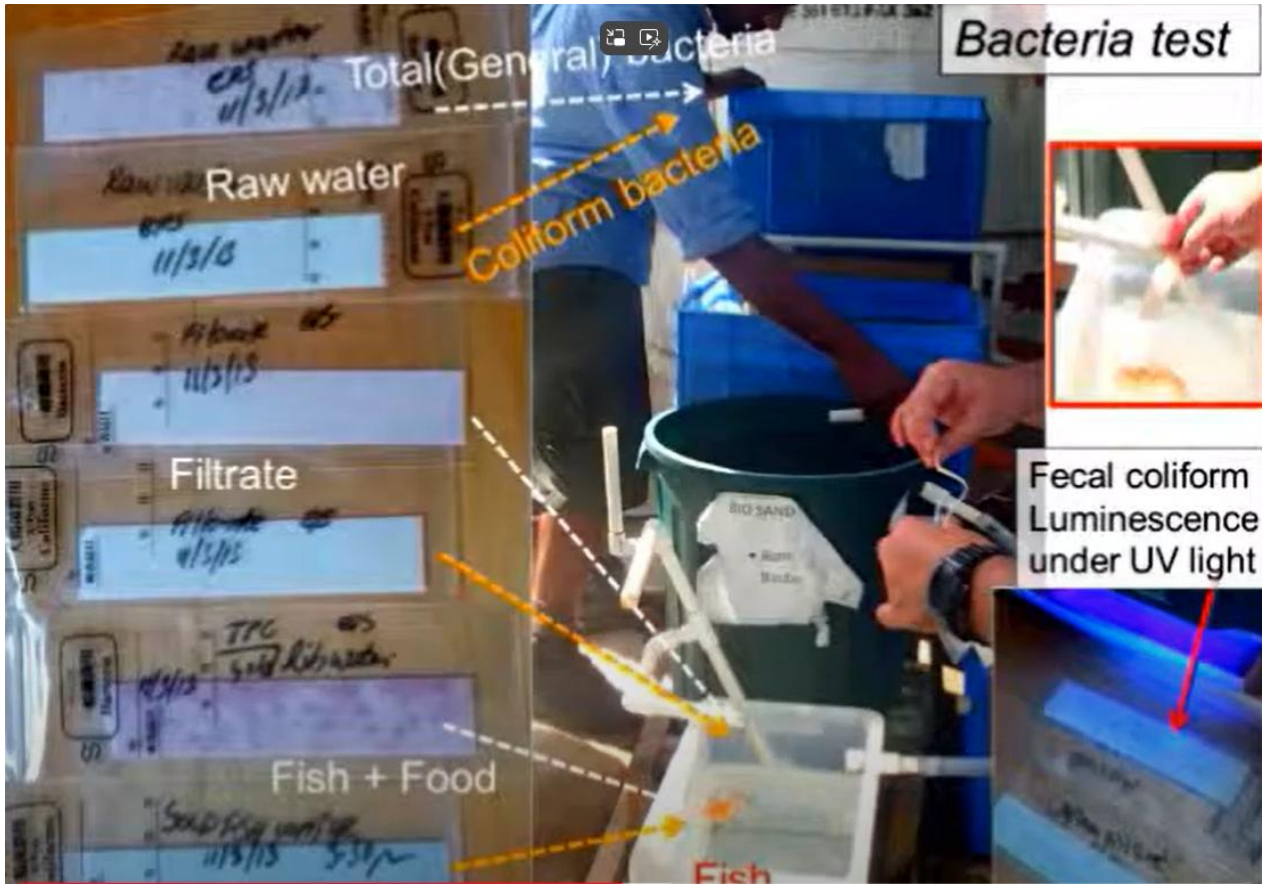
Count the number of spots(colonies).

Incubate at 35-37 C.
Coli form bacteria: 15 hrs.
General bacteria: 24 hrs.



Fluorescence emitted when exposed to ultraviolet rays in case of Coli form bacteria paper.

At the opening ceremony of Safe Drinking water for rural people in Fiji, January 13th. 2013.

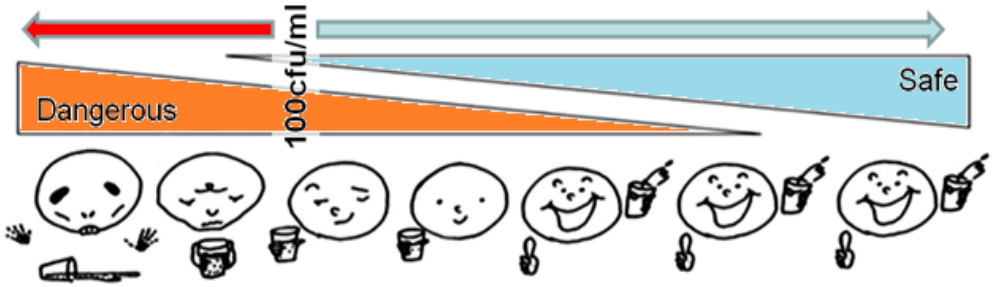


Bacteria Test by SUNCOLI test in Fiji
Watch 3:21- 4:22

Total length **7:43**

https://www.youtube.com/watch?v=Vrr2EOS1PMA&t=49s

There are so many bacteria.
→Medical doctor touches with patients.
Medical Doctor is safe.



Logarithmic bacteria number in 1 ml

100,000,000 10,000,000 1,000,000 100,000 10,000 1,000 100 10 1 0.1 0.01 0.001 0.0001 0.00001

10^8 10^7 10^6 10^5 10^4 10^3 10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3} 10^{-4} 10^{-5}

General bacteria — soil — Coli-form bacteria — Fecal Coli-form — Germ : Cholera

Coli-form bacteria are abundant in soil and are not germ bacteria.

Wash hand

General bacteria — water — Coli-form bacteria — Fecal Coli-form — Germ : Cholera

Please compare the numbers of Cryptosporidium with bacteria in water. Risk?

Risk of germ bacteria in water.

Elimination **by chemical** — General bacteria — RSF — Coli-form bacteria — Fecal Coli-form — Germ : Cholera

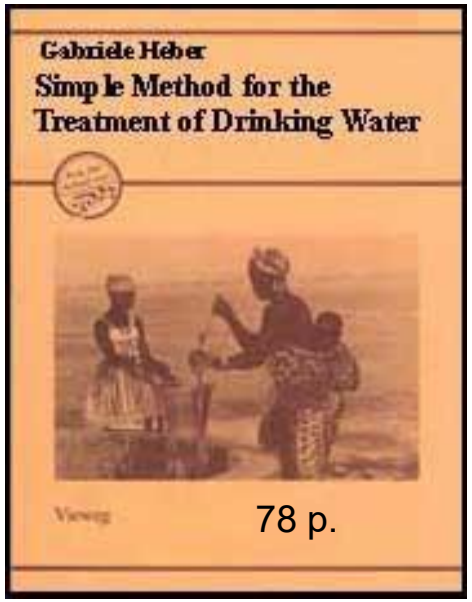
Sterilize by chlorine

Toxicity of chlorine?

Elimination **by biological community** — General bacteria — EPS (SSF) — Coli-form bacteria — Fecal Coli-form — Germ : Cholera

We have to think about acceptable risk.

Gabriele Heber 1985: Simple Methods for the Treatment of Drinking Water



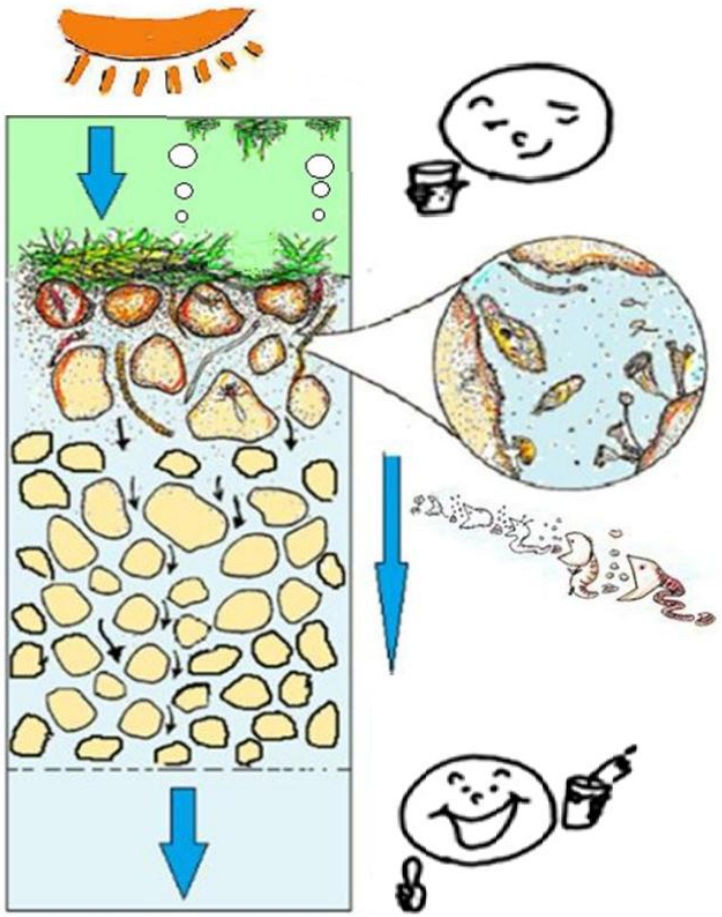
https://www.nzdl.org/cgi-bin/library.cgi?e=d-00000-00---off-0hdl--00-0----0-10-0---0---0direct-10---4-------0-0l--11-en-50---20-about---00-0-1-00-0-0-11-1-0utfZz-8-10&cl=CL3.21&d=HASH175e57dd8f453120fc2d5d&gt=2

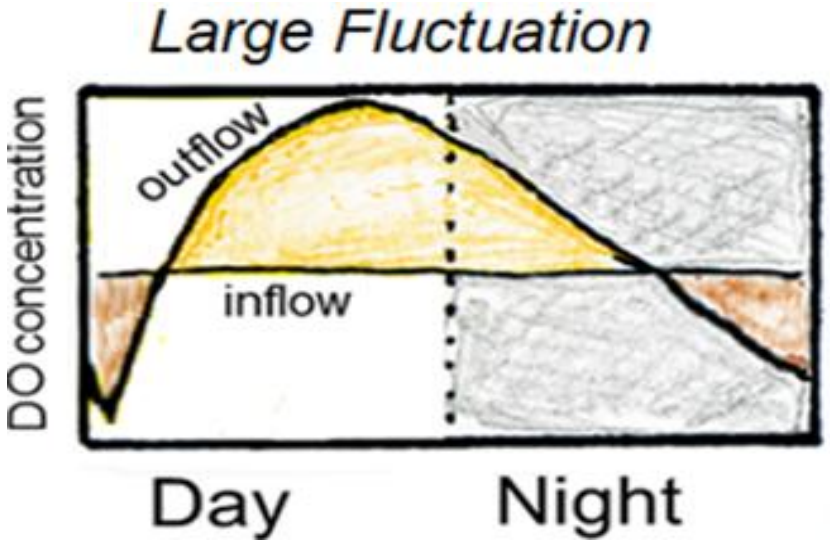
Turbidity, Average Values (NTU)	E. Coli (MPN/100 ml)	Processes and Combinations
Up to 10	10	No treatment necessary
10	100	Only disinfection
100	1,000	Slow sand filtration
250	1,000	Pretreatment + Slow sand filtration
250	10,000	Pretreatment + Slow sand filtration + Disinfection
1,000	100,000	Two pretreatment methods: e.g. sedimentation + coarse filtration or coagulation/fluctuation + sedimentation Subsequently: slow sand filtration + disinfection
100	2,000	Rapid filtration + disinfection
1,000	3,000	Pretreatment + rapid filtration + disinfection

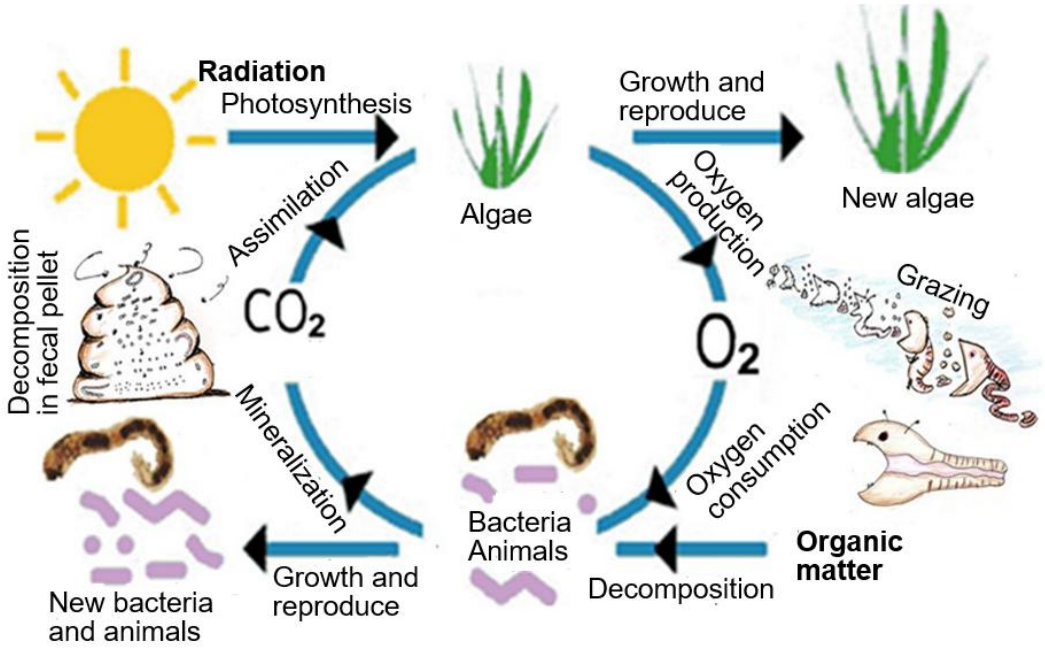
Table 4: Treatment processes and combinations as a function of turbidity and E. Coli count in the raw water. Additional aeration generally helps to increase oxygen content in water. The turbidity values refer to the contents of settleable and non-settleable substances. The choice of pretreatment method thus depends on the type and composition of turbidity.

It is popular in the world to eat with our bare hands. We have to remove the contaminated small stones in food. This is a reasonable way.

④ Food Chain is Key.







https://www.youtube.com/watch?v=pBmHoxOqi1U&t=3s

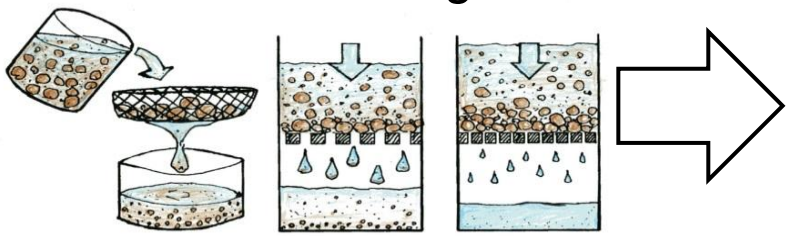
THIS is FOOD CHAIN.

This is a summary of the open lecture at UCL and Univ. Glasgow, in May, 2011.

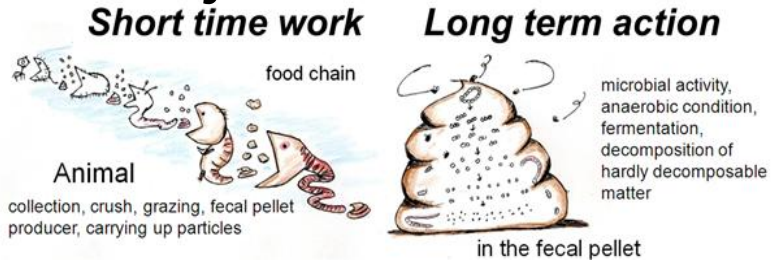
The first use of slow sand filter for the public supply of drinking water began in 1804 in Paisley, Scotland. The present vertical type of slow sand filter was devised by James Simpson in 1829 after his 2,000 miles inspection trip all over the Britain. This filter provided safe drinking water, free of pathogens to residents in London. This **vertical** type of filter spread round the world and was known as the "English Filter". Slow sand filter has been believed that it was a **mechanical filter with fine sand under slow current**. However, the major contribution of the purification of the impurities is the **food chain** in this system. The word of "**slow**" was "**gentle for organisms**". Recently, the English filter of "**Slow Sand Filter**" has been recognized as "**Ecological Purification System**" in Japan.

Slow Sand Filter → Biological Filter → ***Ecological Purification System***

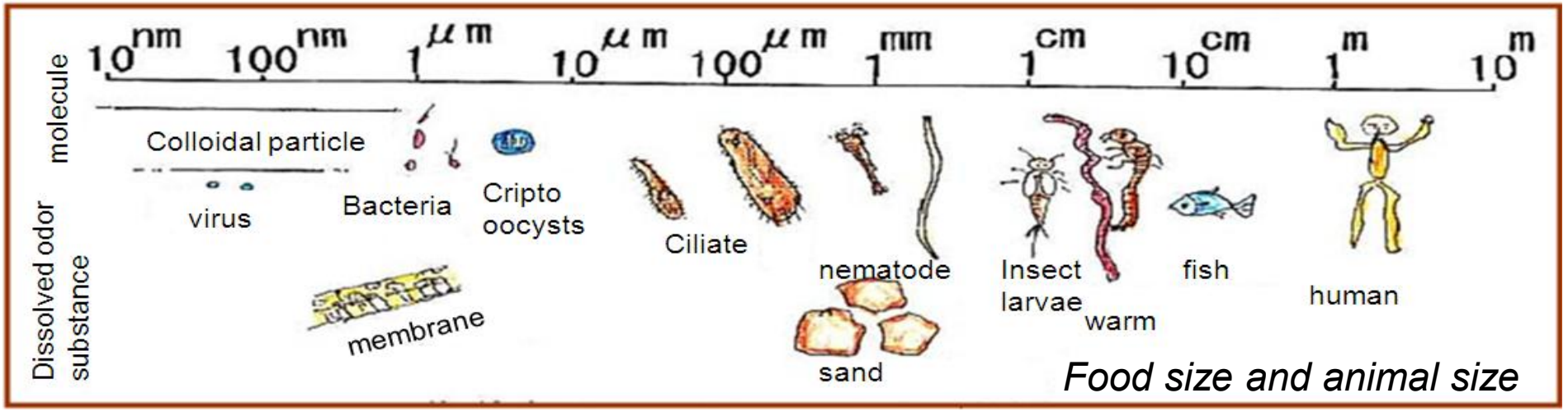
English Filter :
Mechanical filter



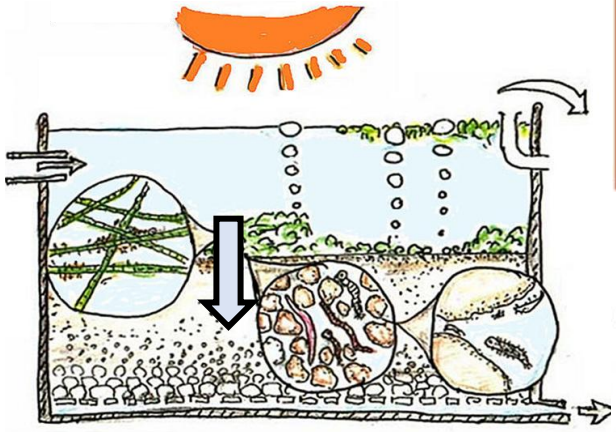
New Concept and New Name



Food chain among small animals is the key for purification system.



Food size and animal size



Short time work

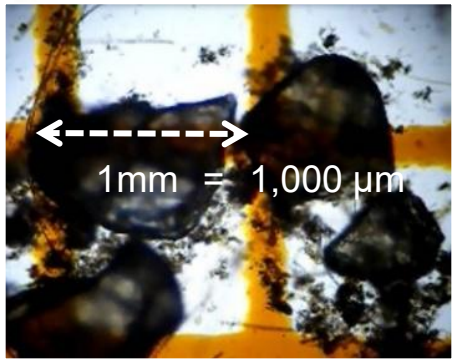
Passing time of food in body is also very short.

Trap and collection time of particle by small organisms is very short.

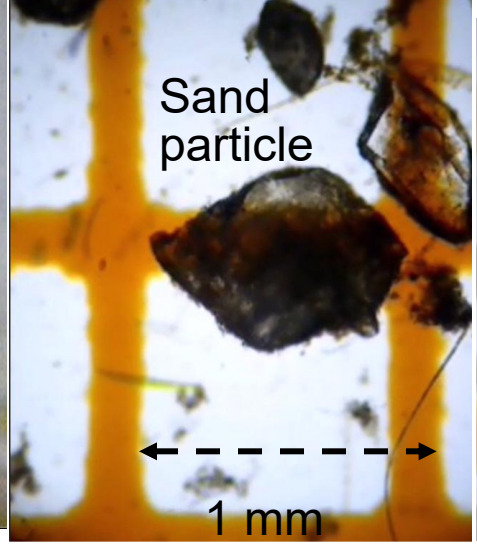
Long term action

Complete decomposition (mineralization) in the faecal pellet.

Anaerobic condition inside of fecal pellet.



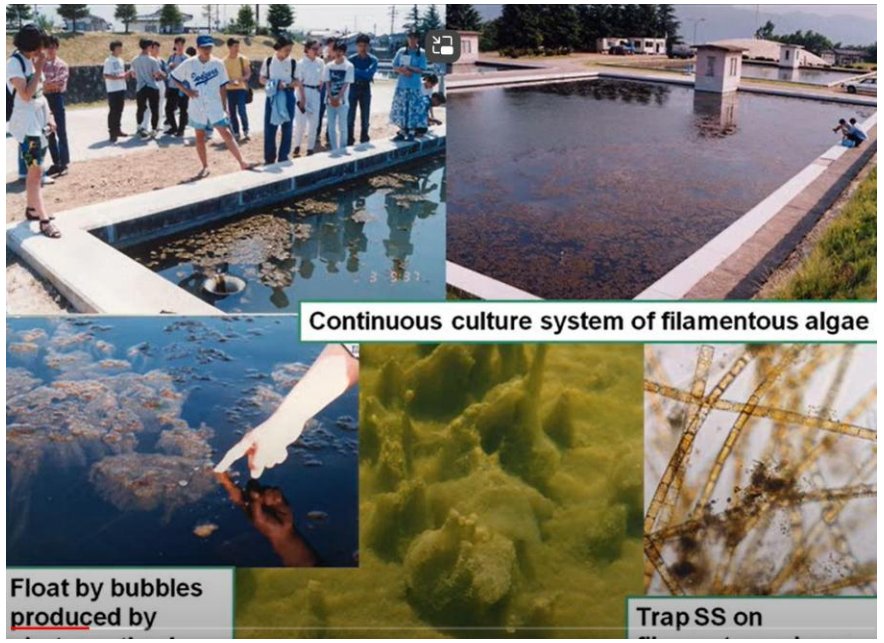
Hungry animals are important to trap any particles under gentle condition.



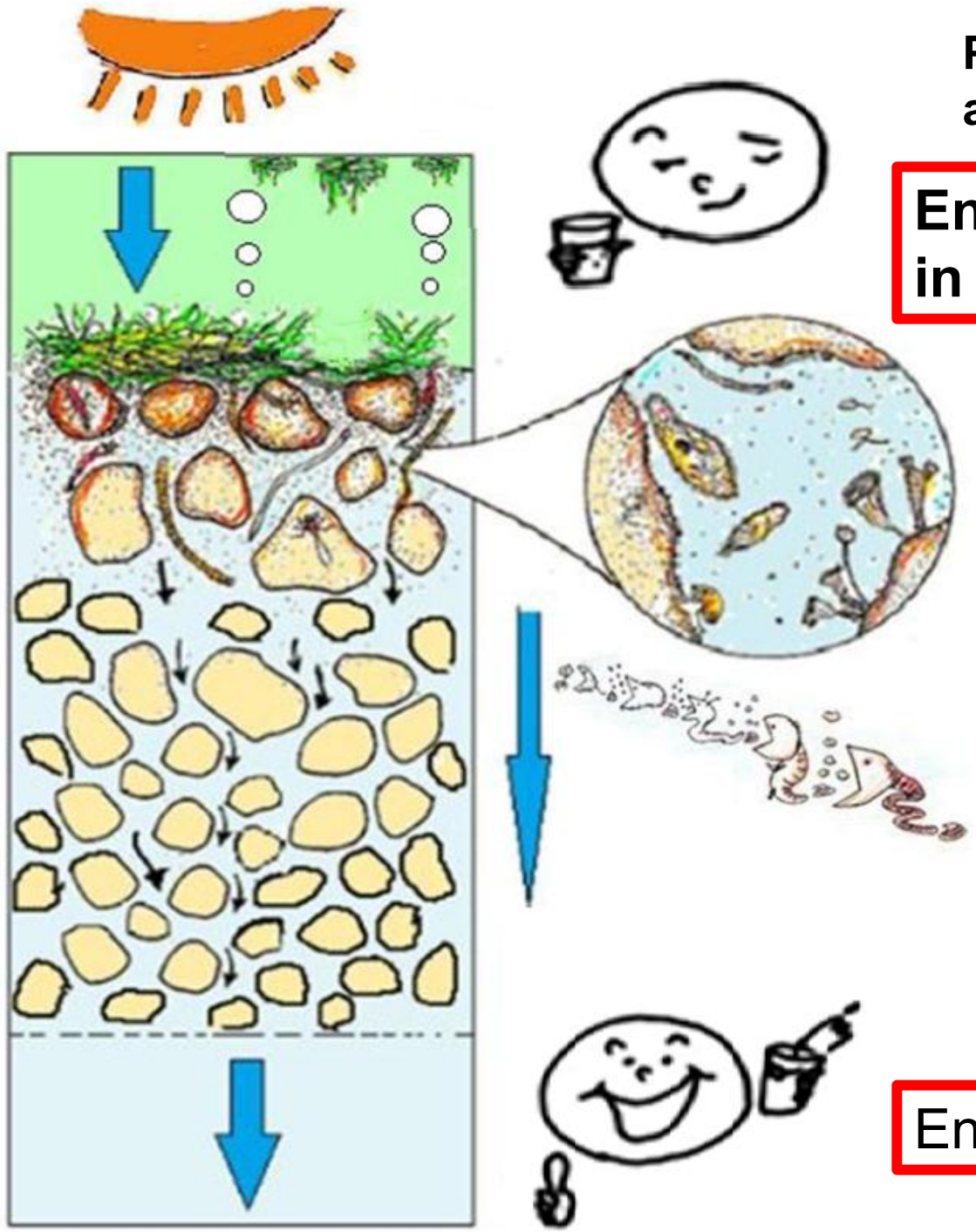
Slow sand filter is real ecological purification system. Food chain is the key. It's an ecological purification system. / 5:22

https://www.youtube.com/watch?v=pBmHoxOqi1U&t=3s

Detail of Ecological Purification System for safe drinking water / 6:23



https://www.youtube.com/watch?v=Pk_JNC6RTyo



Passing time during biological active layer is very short.

English standard filter rate 4.8m/d (20 cm/h) in supernatant water.

Purification is done during the passing time of **1 to 2 minutes** through biological active layer.

Purification time is very short near the surface.

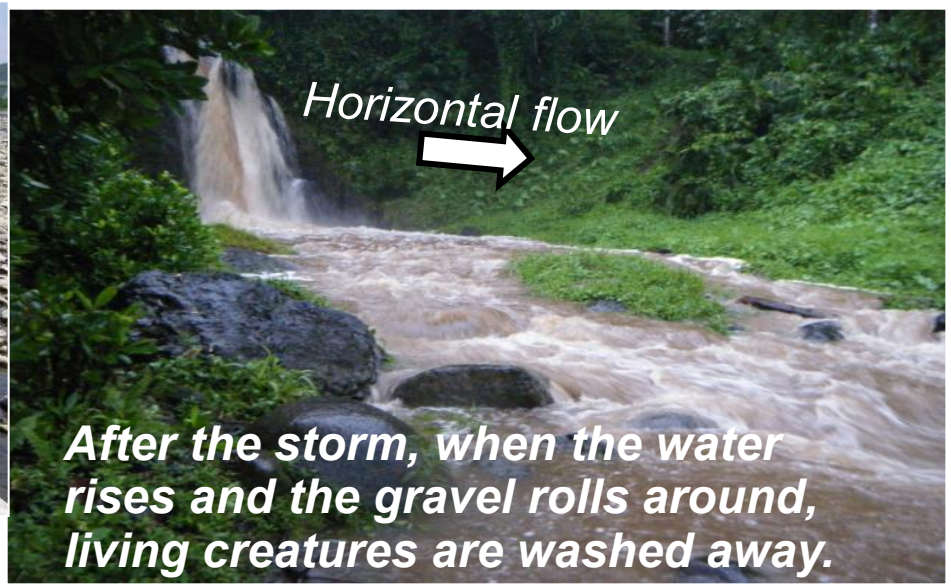
Guarantee and insurance layer for emergency

When the porosity is 50% in sand layer, filter rate becomes double. 9.6m/d (40 cm/h)

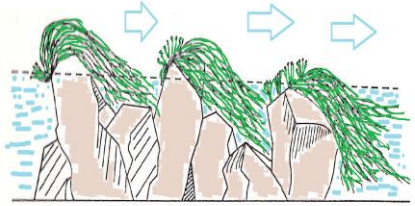
English standard filter rate 4.8m/d (20 cm/h)

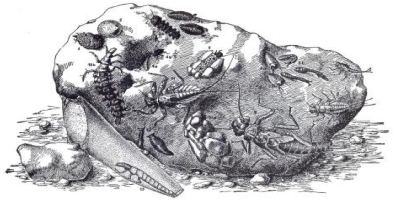
Where is clear water?

Sand, stone and soil are not moved.



After the storm, when the water rises and the gravel rolls around, living creatures are washed away.

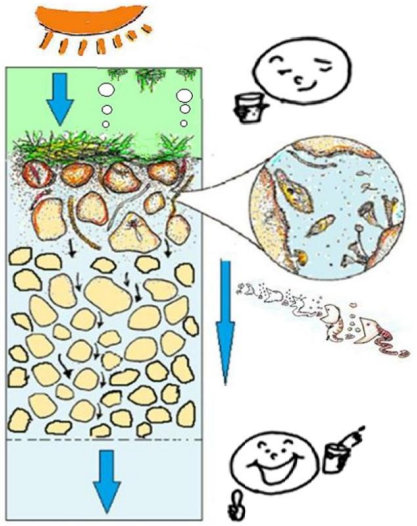




Small animals on the surface of rocks collect turbid matters.

Sand and stone are not moved.

Spring water is always clear.



vertical current.

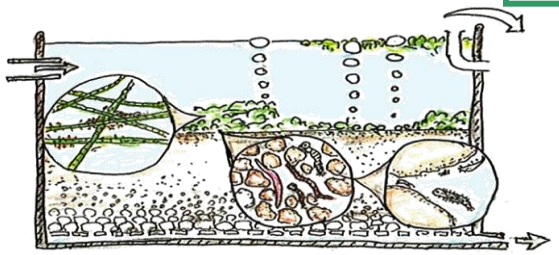
Gentle for small organisms is the key to make **clean water**.

Capacity of one filter pond:
780 m2 x 5 m/d ＝ 3,900m3/d

One day demand per person: 0.3 m3/d
3,900 m3/d ÷ 0.3 m3/d
＝ 13,000 persons/d

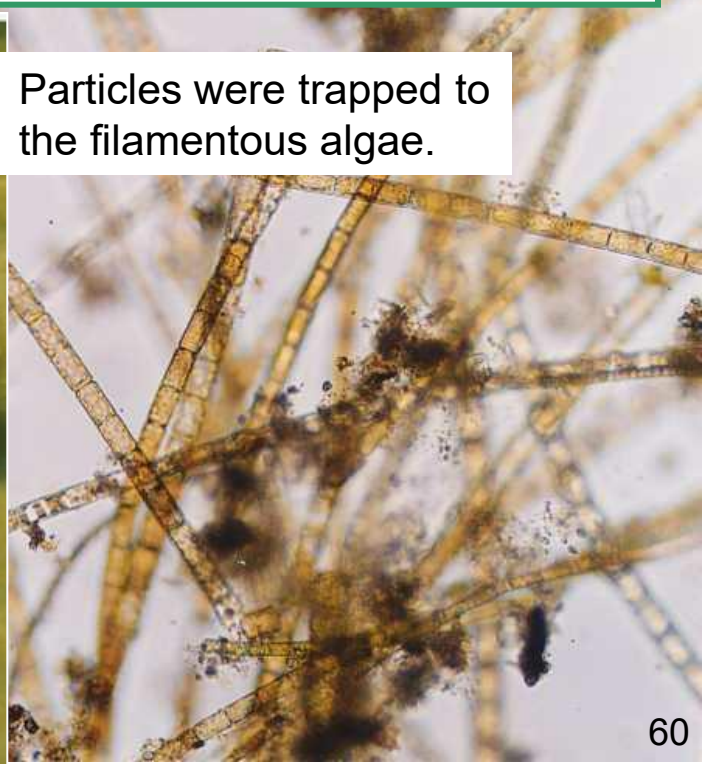
SSF Capacity to make safe drinking water is so large.

I noticed the Continuous Culture system of filamentous diatom

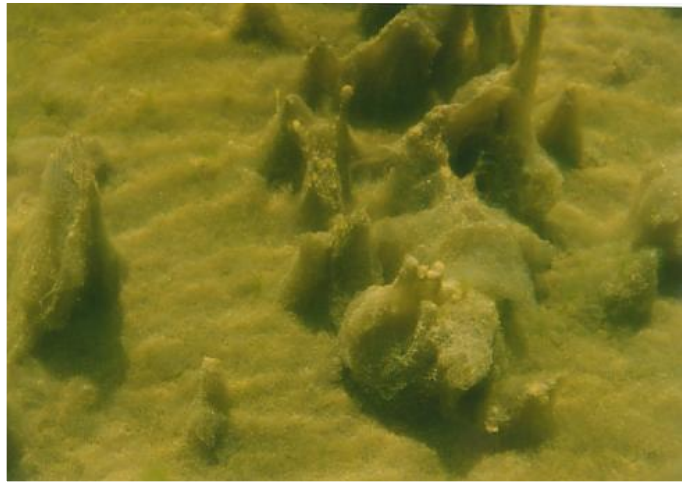


Algal mat lifts by oxygen bubbles produced by photosynthesis.

Particles were trapped to the filamentous algae.

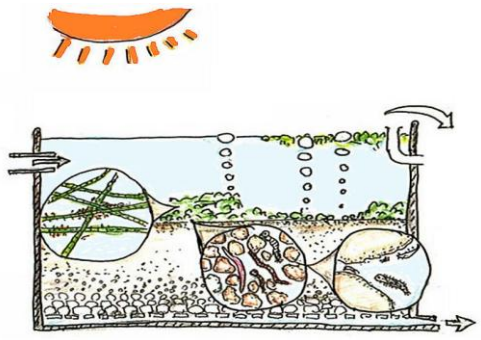


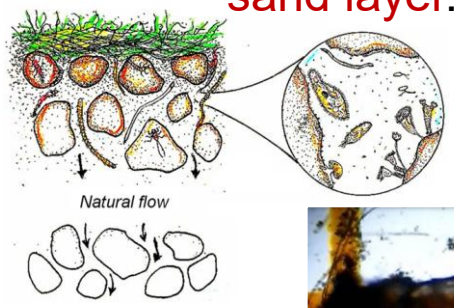
There is a thin **slimy (gelatinous) mat** known as the *Schmutzdecke*, or filter skin on the surface of the sand layer in many textbooks. *This explanation is not correct.*



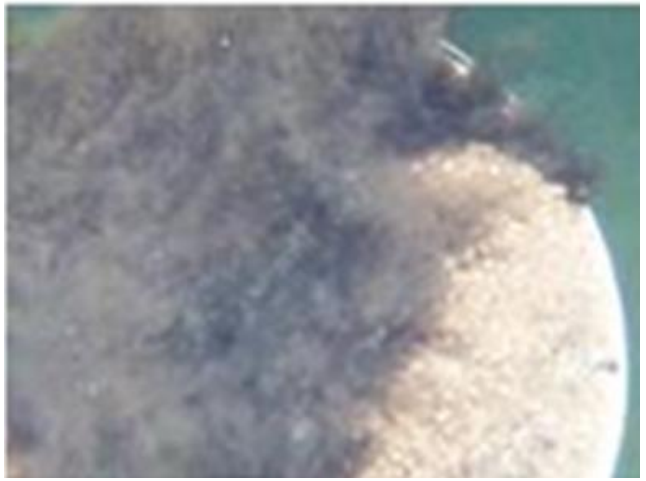
On the surface of sand layer, there is a **soft mat like light feather** mat. Filamentous algal mat is just lay down.

On the shallow bottom, filamentous algae grow well.



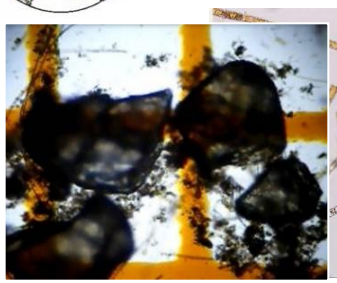


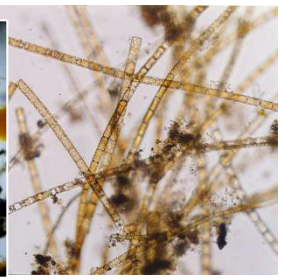
Filamentous diatom is a **pioneer plant in cold water**.

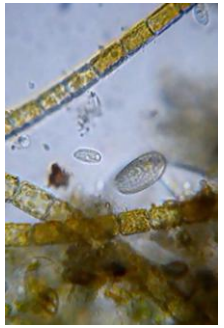


Sand is clear at the site **in water**. When we pull up this mat from the bottom to surface and in air, sand turns dirty color. A large amount of trapped SS among filamentous algal mat drops into sand layer.

Algae are the best food for animal.







Opflow
ISSN 0149-8029 Vol. 19 No. 7 July 1993
A monthly publication of the American Water Works Association

Opflow: American Water Works Association 1993.7.

I made algal mat sampler without any damage of sand filter during the filter run.

Schmutzdecke Sampler Reduces Filter Bed Damage

Nobutada Nakamoto
Department of Applied Biological Science
Shinshu University
Ueda, Japan

A schmutzdecke is a sticky algal mat cultivated on the fine sand surface of a slow sand filter. The schmutzdecke is valuable because it acts to remove turbidity without chemical coagulation. The algae prevents the filter from becoming clogged by trapping suspended matter and producing oxygen to promote decomposition activity on the surface sand. When a schmutzdecke is properly maintained, it acts as an "automatic purifier." For a schmutzdecke to form, flow rates must be kept very low.

Operators frequently have difficulty checking the condition of the schmutzdecke while the slow sand filter is being operated. The device described in this article allows samples to be drawn so that the schmutzdecke can be easily analyzed without any damage to the sand surface during operation of the filter.

Sampler Components

The schmutzdecke sampler shown in Figure 1 was assembled from the parts listed in the box below. Figure 2 (page 4) shows a schematic view of the sampler.

The total costs of all components was estimated to be about $100, primarily for the hand pump and acrylic tube. Several hours were required to construct the sampler.

Building the Sampler

The schmutzdecke sampler can be constructed by following the steps listed below.

1. To construct the ring weight, drill an inner hole 1.4 in. (35.7 mm) in diameter in the 2.75-in. × 2-in. (70-mm × 50-mm) brass rod. Drill two holes through the ring weight for screws to secure the acrylic tube. Form the 0.3-in. (8-mm) edge on the bottom of the ring weight.

Figure 1 The schmutzdecke sampler

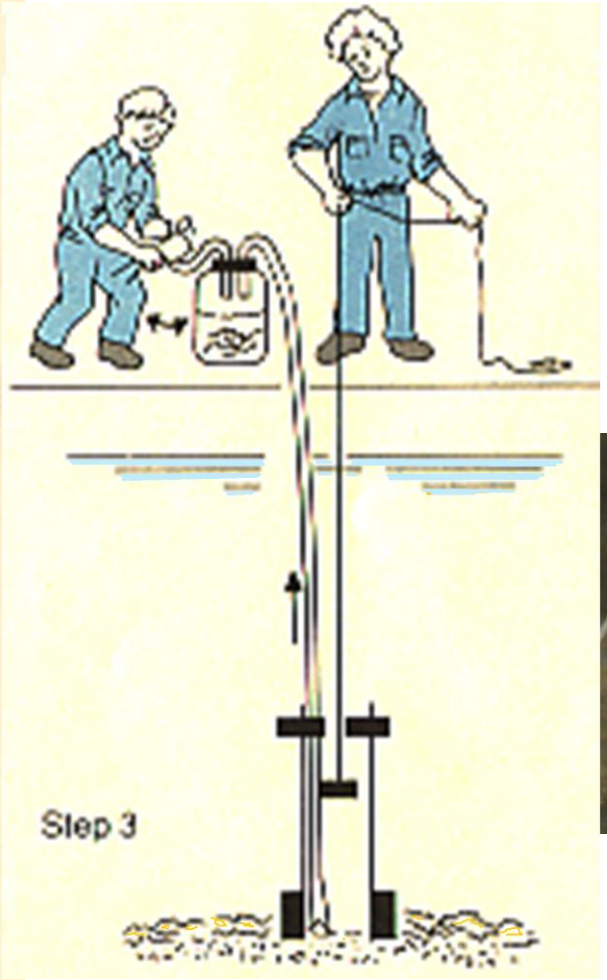
2. Drill a hole in the inner hammer rod for the hanger string.

3. In the stopper rod, drill 0.18-in. (4.5-mm) diameter holes in the center for

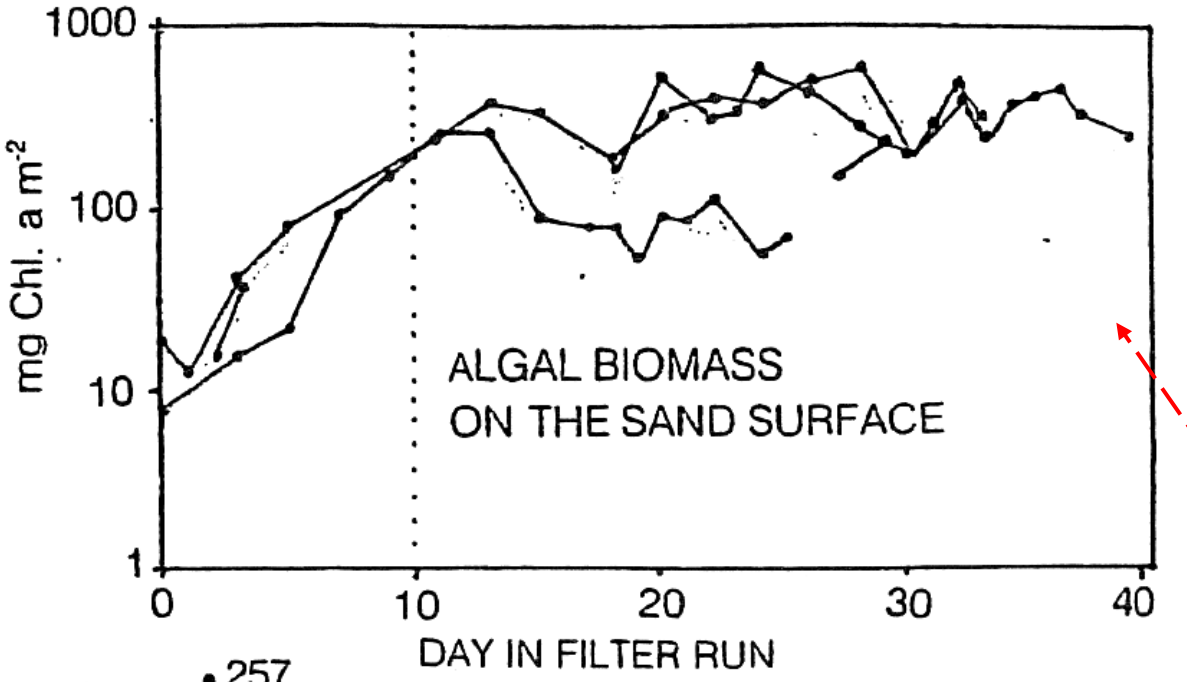
(continued on page 4)

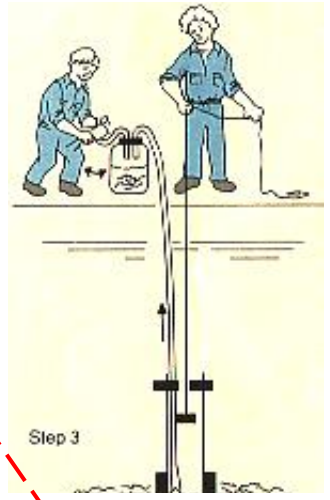
Materials and Costs of the Schmutzdecke Sampler

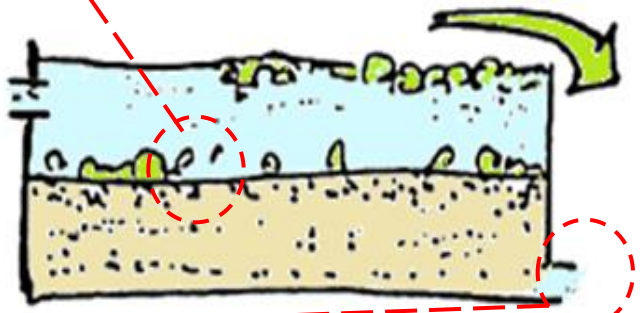
Item	Purpose	Cost
one brass rod, 2.75 in. × 2 in. (70 mm × 50 mm)	ring weight	$ 1.50
one brass rod, 0.6 in. × 0.9 in. (15 mm × 22 mm)	inner hammer rod	15

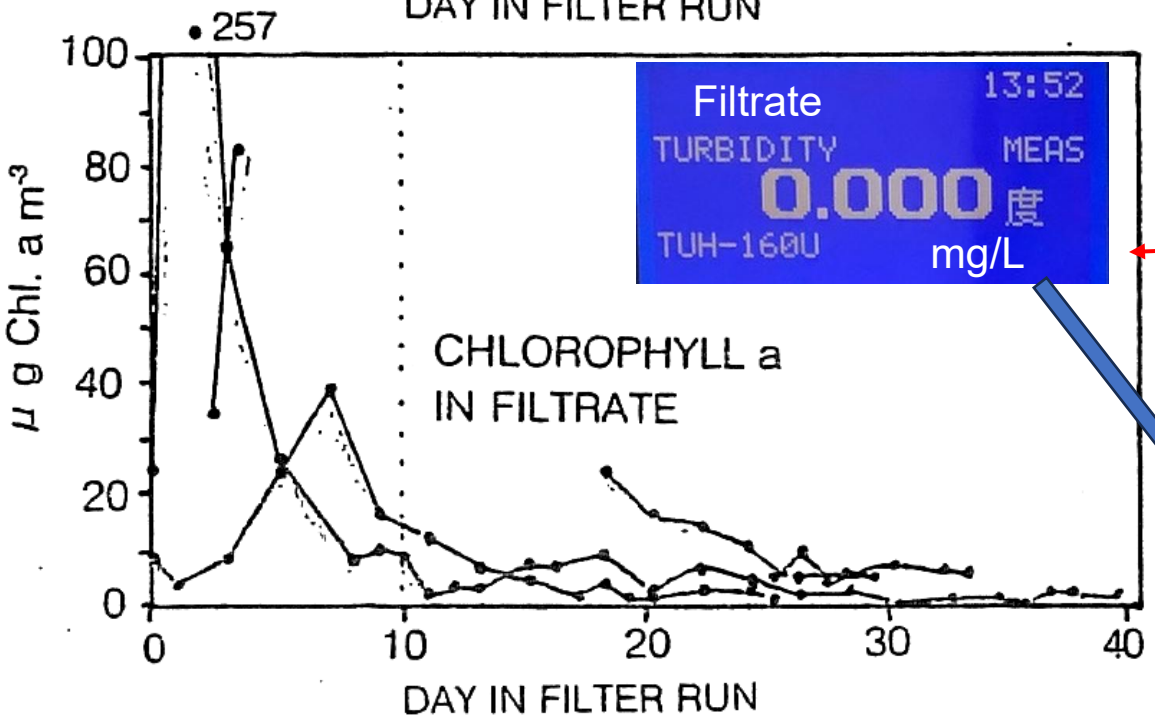


Algae grow well in summer. Continuous culture system of filamentous algae becomes after 10 days.









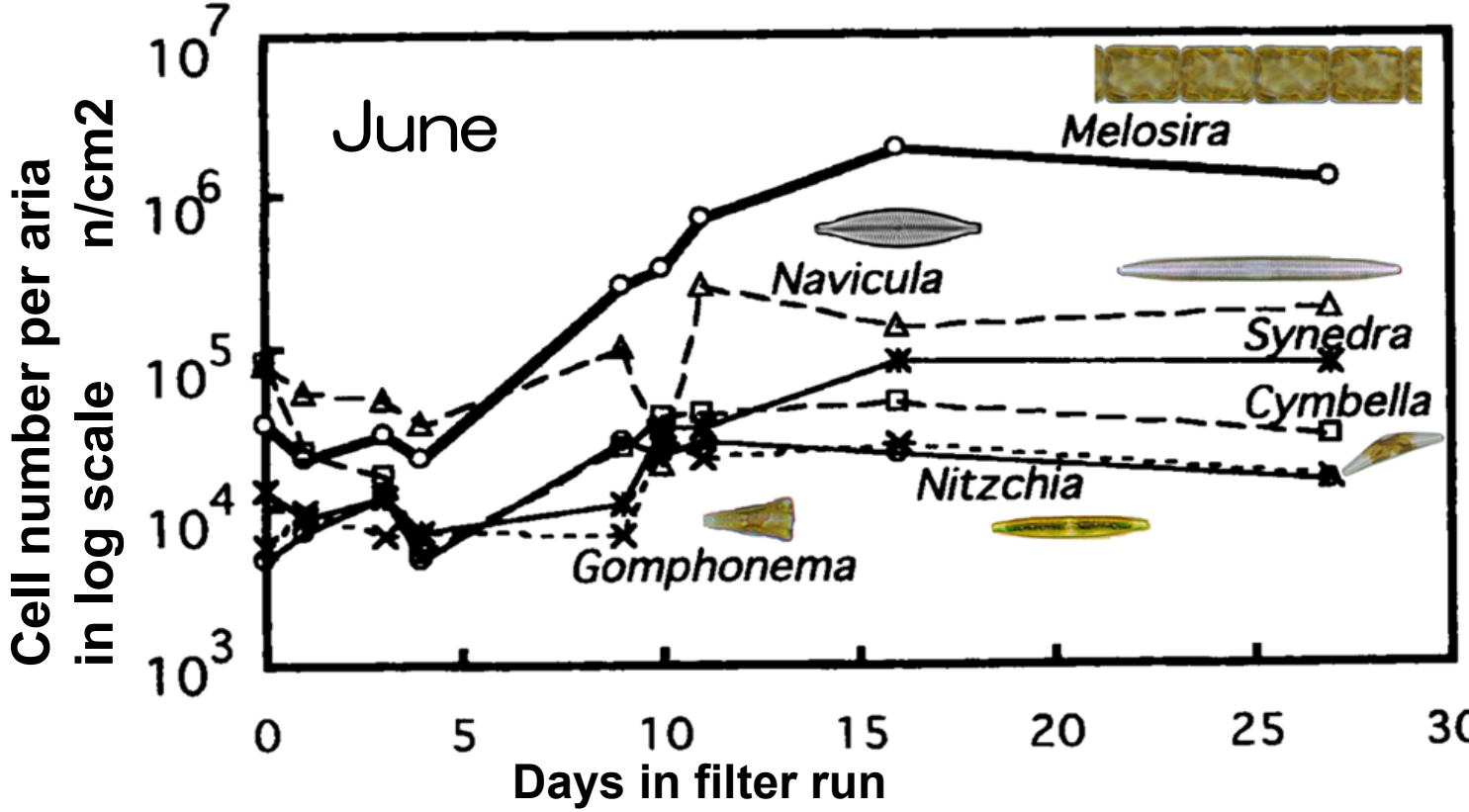
Filtrate water became clear water in 10 days. Grazing animal community grew well within 10 days.

*Japanese standard of filtrate is **2 degrees (mg/L).***

Super clean filtrate.

In summer, scrapping of surface mud is not necessary.

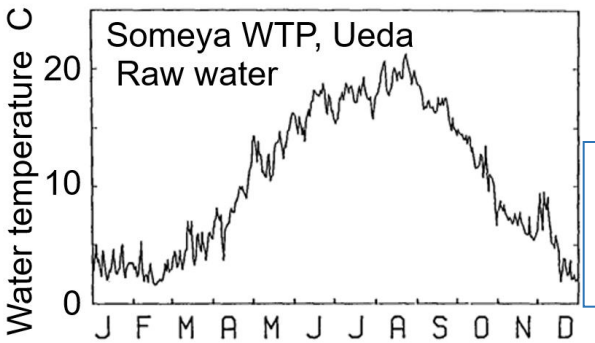
Development of algae on the sand bed during filter run in June in Ueda, Japan.



Filamentous algae grow well on the sand filter bed.

From a river

In June, algae first appear on the sand are the same as attached algae (periphyton) on the rock of riverbeds.

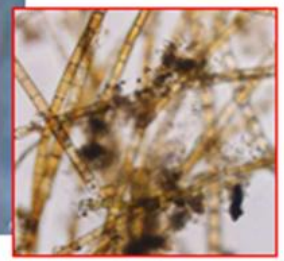


Seasonal change of temperature

My city (Ueda, Nagano, Japan) is located in cool region in Japan.

When the filtration continued, filamentous diatom of *Melosira* became dominant.

Melosira became dominates in cool water where grazing activity of animals is weak.



Algal mat on the sand surface in water.

Lift up in air.

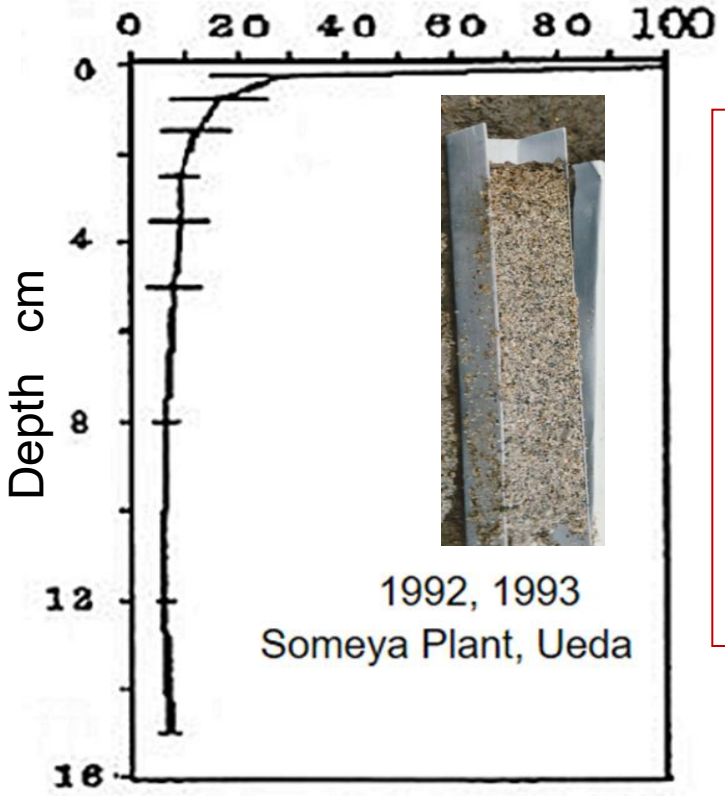
Suspended Solid in washed sand.

At scraping time, we took sand sample.

Sand beneath the surface in water is clean.
When the supernatant water drain off, the trapped SS releases and drops into sand layer.

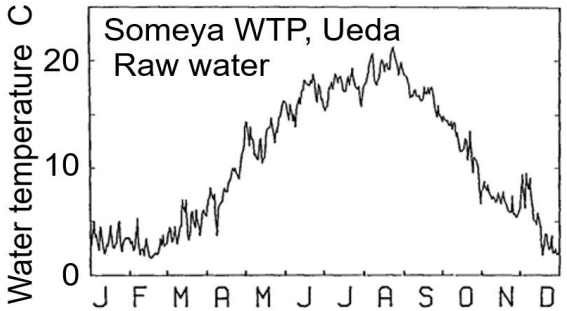
Dirty Suspended matter is only near the surface.

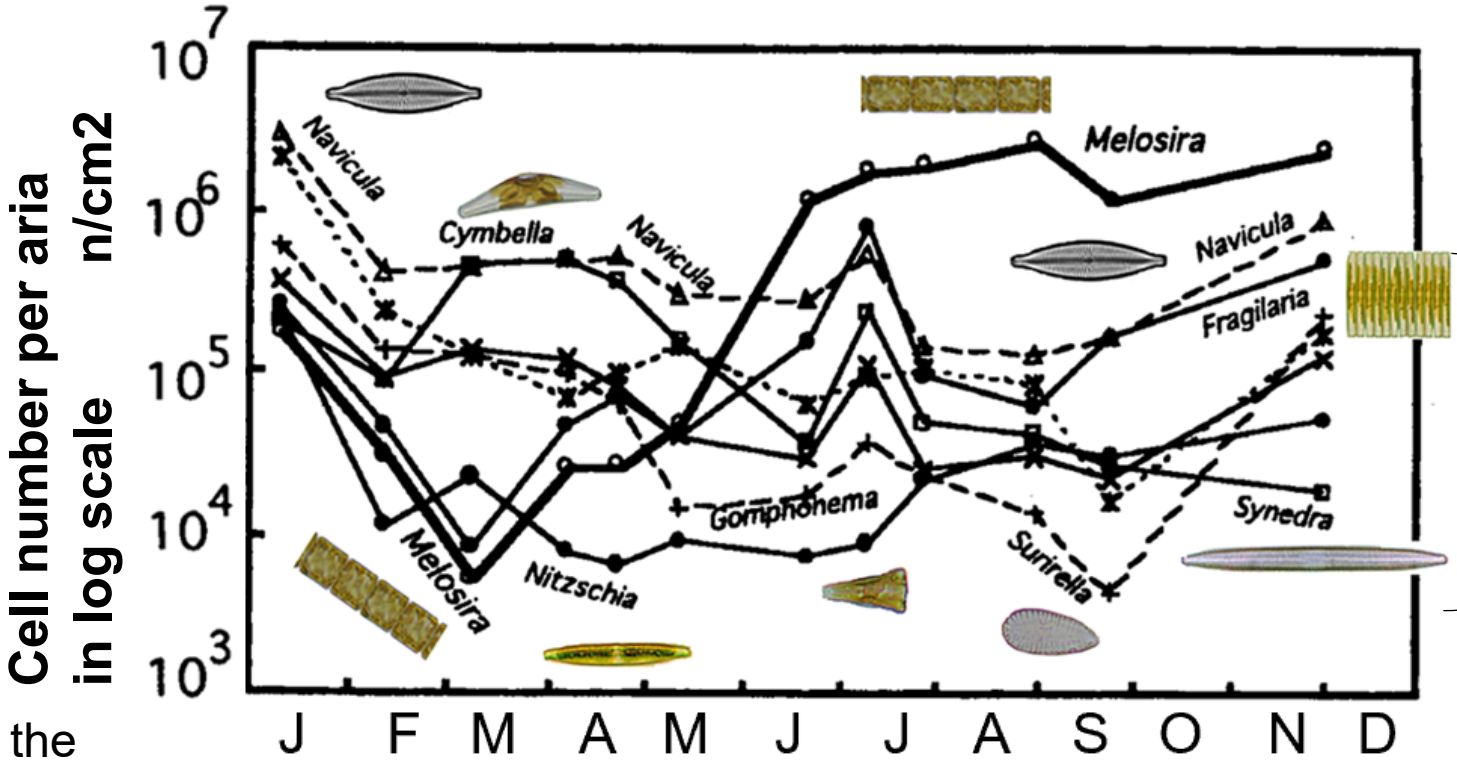
SS mg/ g of sand



Dirty matter in sand layer is only near the surface where biological activity is high. Deeper sand layer is clear.

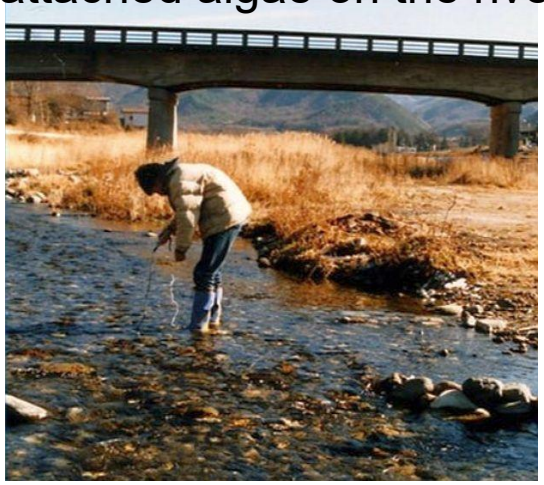
Seasonal changes of the algal mat after 10 days of filtration run.





From a river

In winter, it was the same as the attached algae on the riverbed.



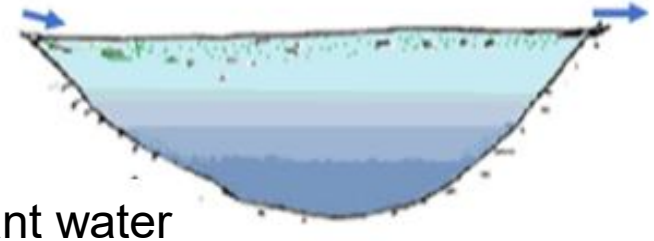
Weak biological activity in cold water.

When the amount of solar radiation increased and the water temperature increased, the filamentous diatom of *Melosira* became dominant until December.

Different type of algae grow in different environment.

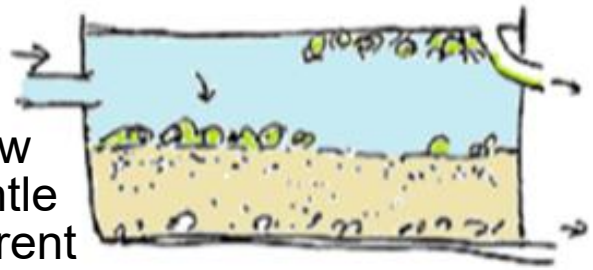
In Slow Sand Filter pond, there is down ward current from surface.
Filamentous form of algae can grow on the sand bed.

Pond, lake and ocean

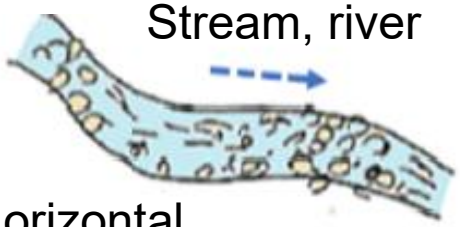


Stagnant water

Slow gentle current

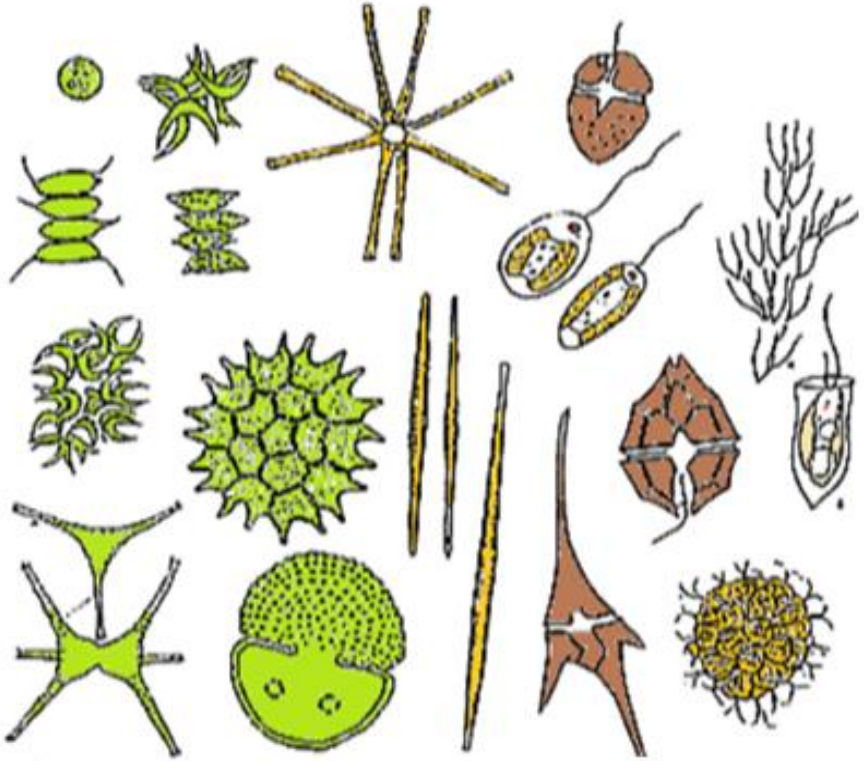


Stream, river



Horizontal running water

Occasional storms and rapid currents.



Float and drift algae

Phytoplankton

Flagellated algae

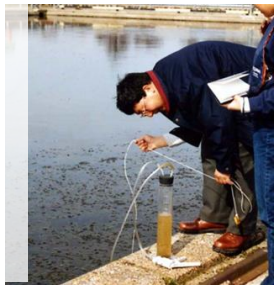
Filamentous algae

Periphyton
Attached algae

Try to accelerate algal growth in winter.

Algal growth made delicious tap water.

I thought that the nutrient concentration in rivers in Ueda city was poor than in London.



Even in winter, the diatom *Melosira grew* well in London, UK.

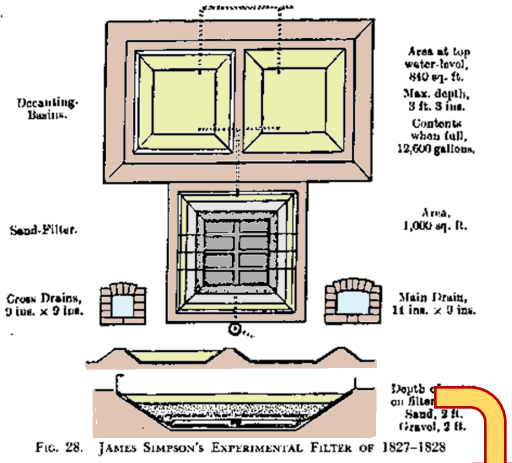


Fig. 28. James Simpson's Experimental Filter of 1827–1828

I thought the nutrient concentration was too low.

38 cm Water
61 cm Sand
61 cm Gravel

I put nutrient to the filter pond in cold winter.

But no growth of algae in the filter pond.

When I put nutrient to the floating bottle in winter, algae grew even in cold condition in Ueda.

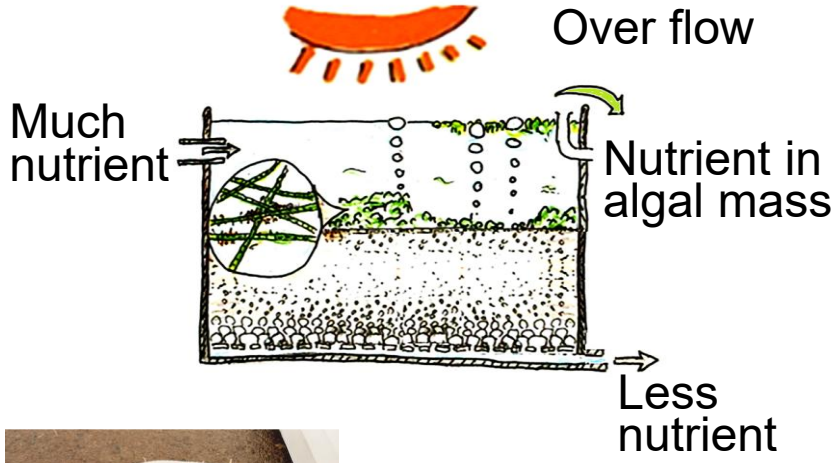
In March when snow melt period, algae did not grow in the filter pond.

Algae grew well in shallow water in the flood plain.

Algae grew well in a shallow model.

I found **shallow depth** was the key of growth of algae than nutrient.

Continuous algal culture system is a nutrient reducing system.

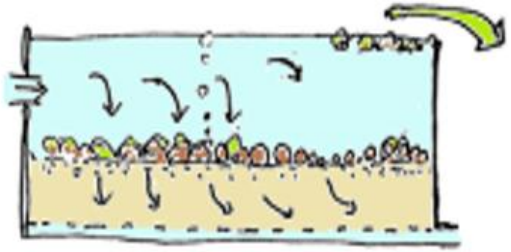


Harvest experiment was done.

Average daily harvest during 11 days in July

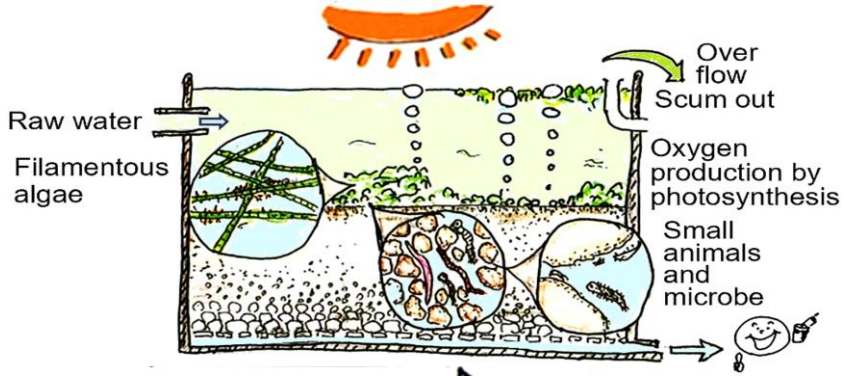
Wet matter	173 g/m2
Dry matter	25.9 g/m2
Organic matter	7.81 g/m2
Nitrogen	373 mg/m2
Phosphorous	32 mg/m2

Nutrient reduction from inflow water to filtrate by algal growth.



Nutrient removal as
Nitrogen 4.6 %
Phosphorous 27%

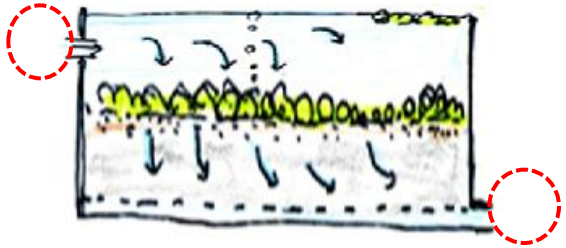
Aerobic condition is essential for biological activity.



$$CO_2 + H_2O \rightleftharpoons CH_2O + O_2$$

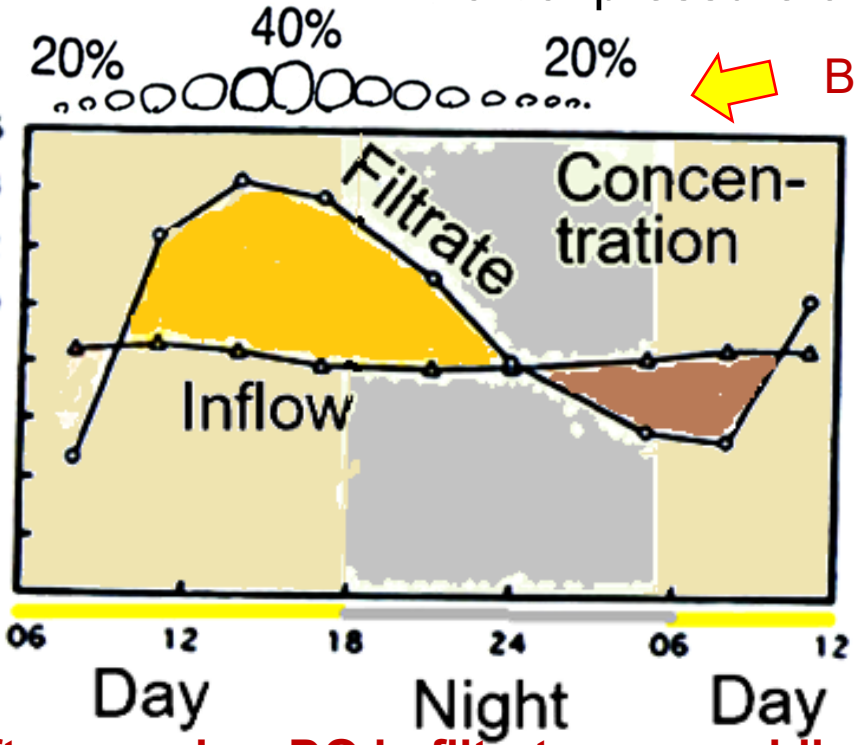
Algal photosynthesis accelerates purification process.

There is down ward current.

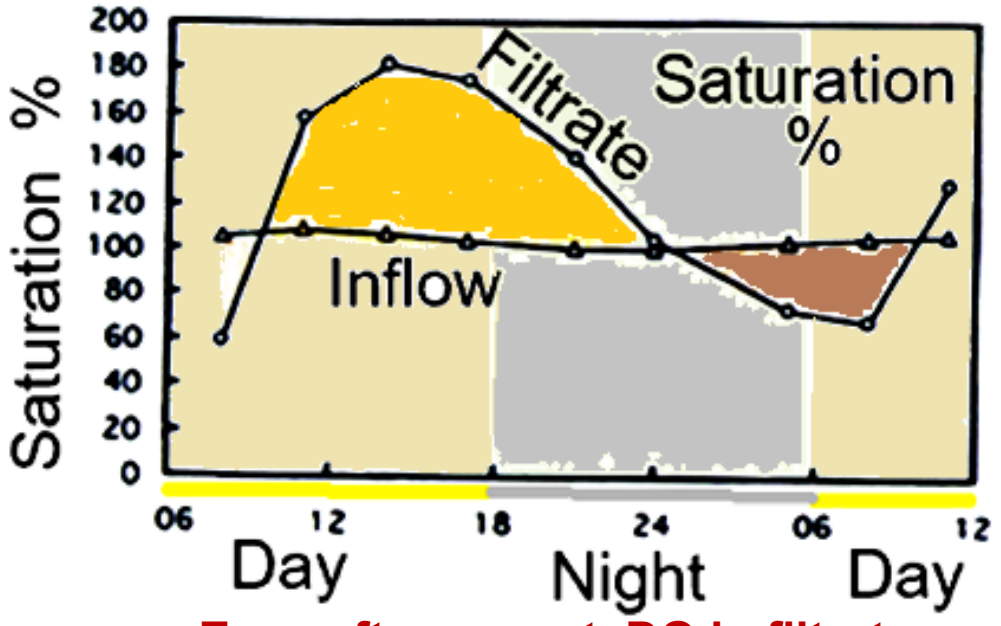


Diurnal change of dissolved oxygen (DO) was measured.

Partial pressure of oxygen in bubbles was also measured.



Bubbles keep aerobic condition after sunset.



After sun rise, DO in filtrate was rapidly increased.

Even after sunset, DO in filtrate was super saturated condition.

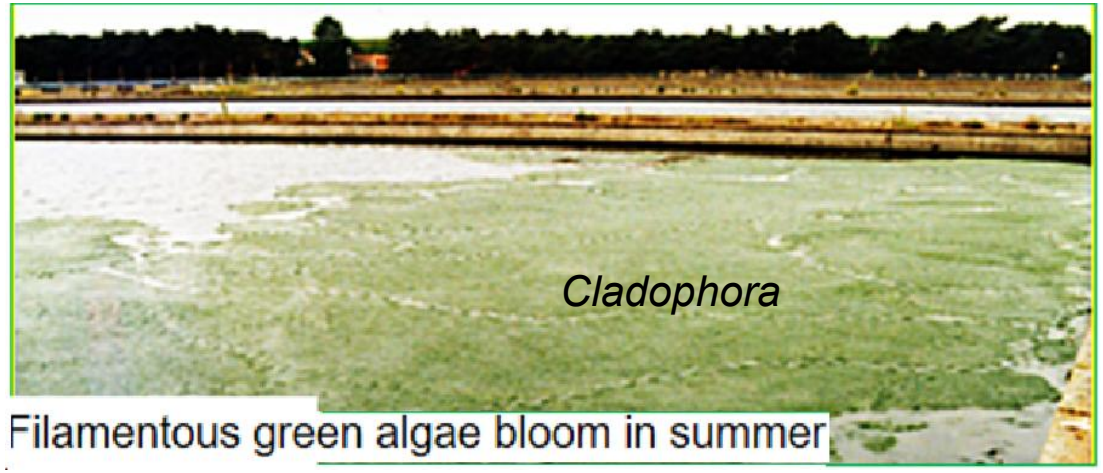
I investigated the seasonal change of algae in Thames filters in London from 1994 to 1996, **30 years ago**.

Nutrient rich water

Biological roughing filter without chemical.

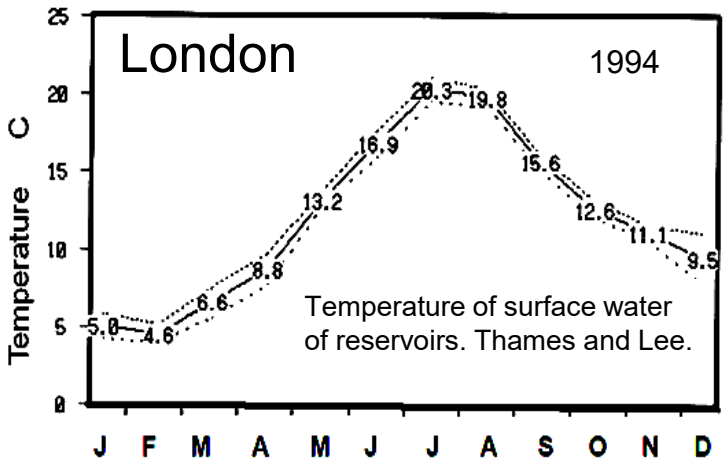
100mx35m
32 Filters

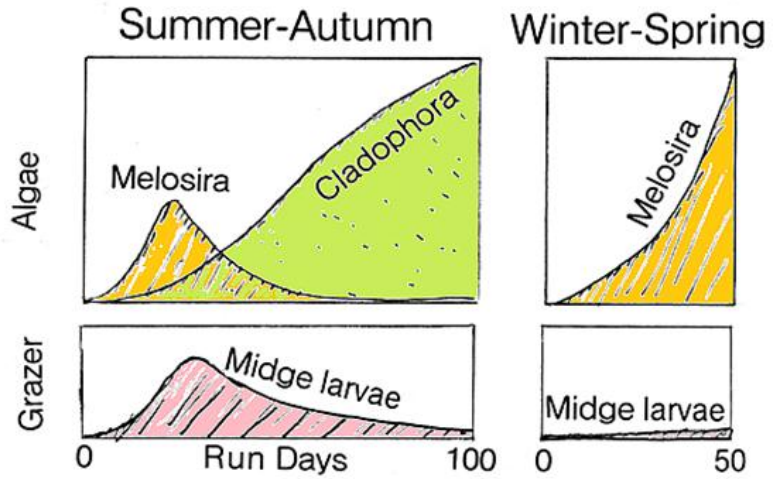
Ashford Common WTP, Thames Water



Filamentous green algae bloom in summer

Filamentous diatom in winter





Diatom to Green algae in summer is due to grazing activity.

Aerobic condition is essential for hetero-tropic organisms in the sand layer.

Faster flow rate was better for small organisms in the filter.

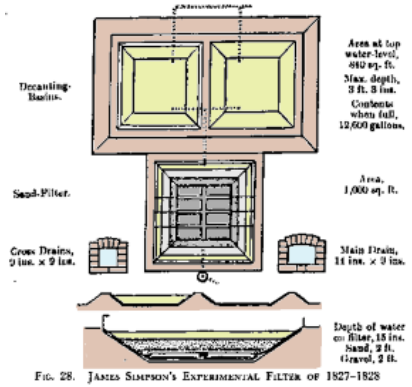
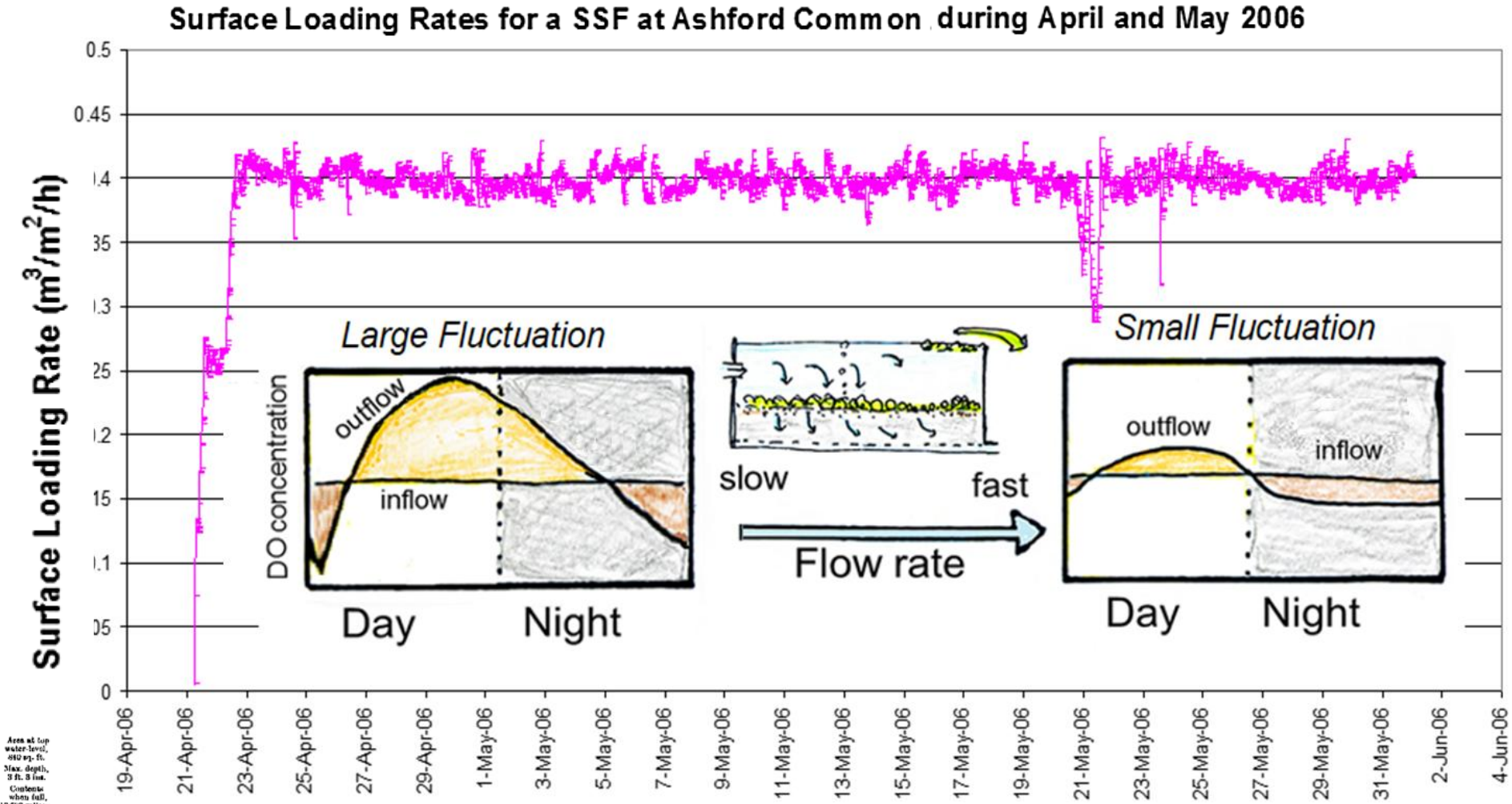


Fig. 28. James Simpson's Experimental Filter of 1827–1828



The filter rate was 2-3 m/d (10cm/h).

38cm water depth

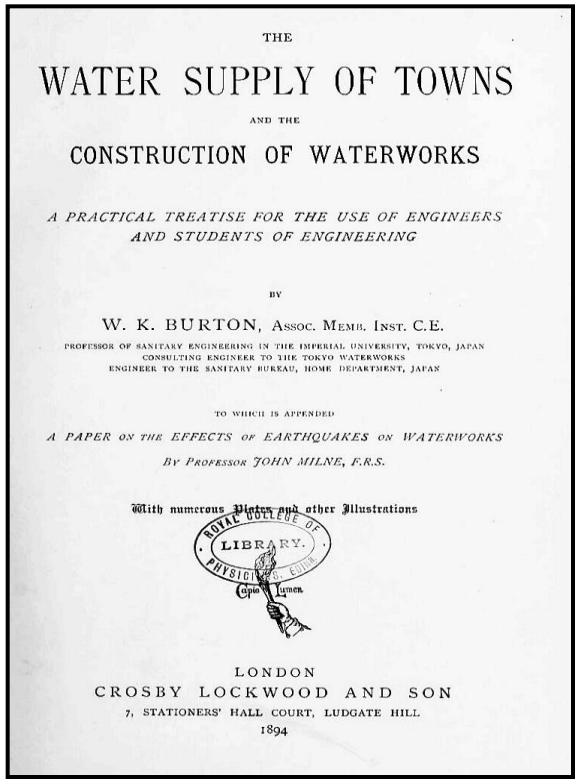
200yrs ago

4.8 m/d (20 cm/h)
World wide English Standard Filter rate

The filter rate of 0.4 m/h (9.6 m/d) is adopted in Thames filter plants in London to escape oxygen drop in filtrate during the night time.

W. K. Burton published "**The Water Supply of Towns and the Construction of Waterworks**" in **1894** in London.

https://wellcomecollection.org/works/da2p35kj/items



THE

WATER SUPPLY OF TOWNS

AND THE

CONSTRUCTION OF WATERWORKS

A PRACTICAL TREATISE FOR THE USE OF ENGINEERS AND STUDENTS OF ENGINEERING

BY

W. K. BURTON, Assoc. Memb. Inst. C.E.

PROFESSOR OF SANITARY ENGINEERING IN THE IMPERIAL UNIVERSITY, TOKYO, JAPAN
CONSULTING ENGINEER TO THE TOKYO WATERWORKS
ENGINEER TO THE SANITARY BUREAU, HOME DEPARTMENT, JAPAN

TO WHICH IS APPENDED

A PAPER ON THE EFFECTS OF EARTHQUAKES ON WATERWORKS

By Professor JOHN MILNE, F.R.S.

With numerous Plates and other Illustrations

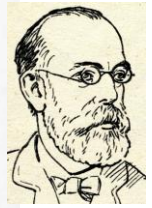
LONDON
CROSBY LOCKWOOD AND SON
7, STATIONERS' HALL COURT, LUDGATE HILL
1894

On p94

practice. Dr. Koch, the eminent bacteriologist, has (the writer understands) come to the conclusion that a filtering speed should never exceed $7\frac{3}{4}$ feet in twenty-four hours. It seems unlikely that any such hard-and-fast rule can hold good for all cases,* for there can be no doubt that the efficiency of filtration varies with many circumstances—with the purity or the reverse of the water, for example; with the nature of the sand; and with the temperature.

* A series of experiments, both biological and chemical, carried on in connection with the Osaka (Japan) waterworks, gave very different results from this.

It has recently been discovered, at the Berlin waterworks, that covered filters are much less efficient than open.



Dr. R. Koch
neve exceed 7 ¾ feet in 24 hrs.
= **2.27 m/d**

Osaka(Japan) wks gave very different results from this.
➪**faster rate?**

Berlin wks discovered that covered filters are much less efficient than open.
➪**Open is better.**

On p95

On the other hand, the much higher velocities—16 feet in twenty-four hours or even more—adopted by some English engineers, are undoubtedly too high.

It is with some diffidence that the writer states the conclusion he has come to—namely, that a *maximum filtering speed of* 10 *feet in twenty-four hours is quite permissible* in the case of water already fairly good. That is to say, with arrangements properly

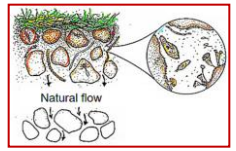
English engineers adopted more 16 feet in 24 hrs.
= **over 4.88 m/d**

Burton : max 10 feet in 24 hrs. = **max 3 m/d**

At that time in 1894, he believed that purification was done by slow speed with fine sand.

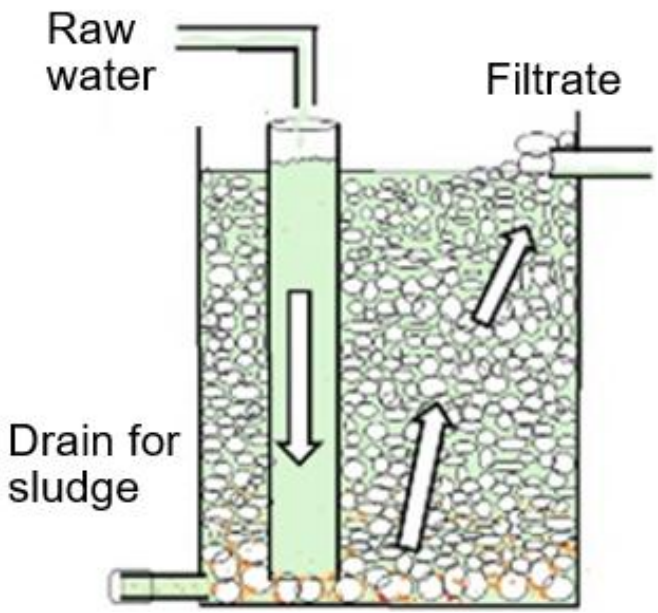
This means **mechanical filtration**.

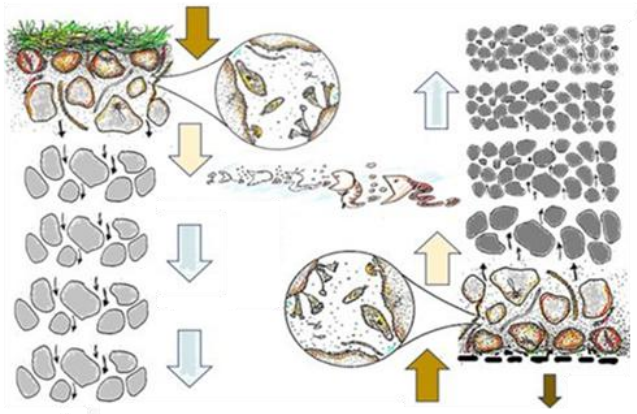
Present Thames wks adopts **9.6 m/d.**



This means **Ecological Purification System**.

⑤ URF and EPS Model.





https://www.youtube.com/watch?v=Ye-POV6qBU0&t=39s

The name of **Slow Sand Filter** caused a **misunderstand** of real mechanism.

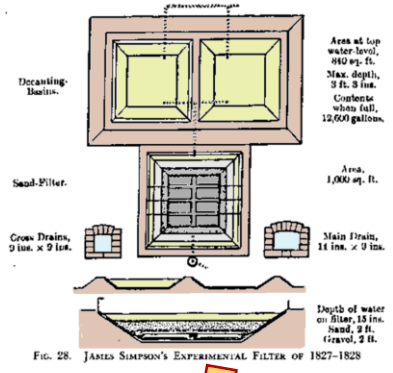
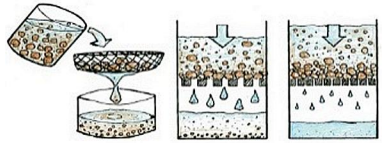


Fig. 28. James Simpson's Experimental Filter of 1827–1828

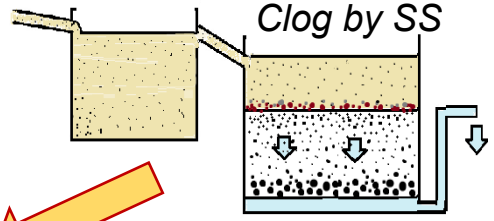


The filter rate was 2-3 m/d (10cm/h).

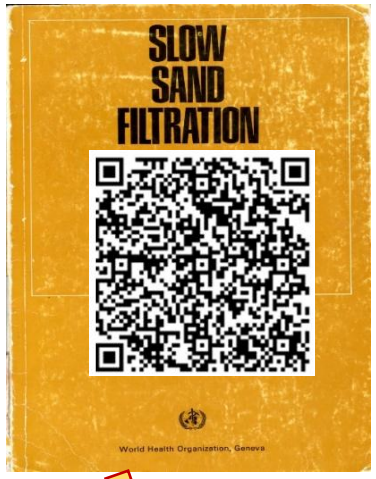
38 cm	Water depth
61 cm	sand layer
61 cm	gravel layer

They believed **mechanical reduction** by **slow** filtration with **fine sand** in 200 years ago. They called **Slow Sand Filter**.

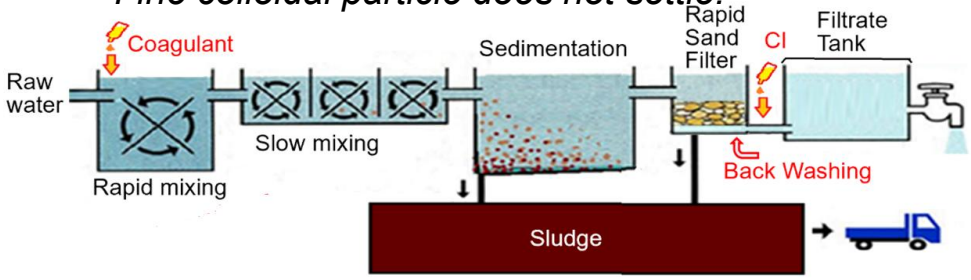
SSF spread to USA.



Refocus to SSF of chemical free system.



Fine colloidal particle does not settle.

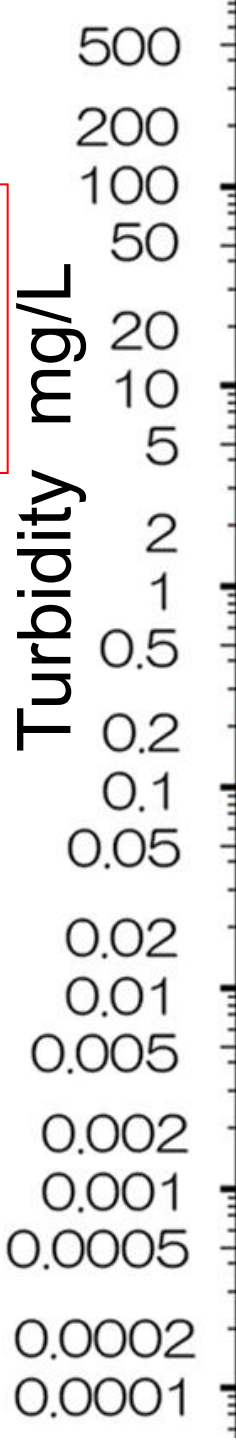


This is American Commercial Filter.

Back washing

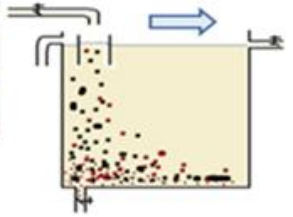
RSF spread to the world.

I proposed Ecological Purification System instead of Slow Sand Filter in Japan.



Storm event

Major turbid matter in mountain stream is easily set within several hours.



Coagulant＋Chlorine Rapid Sand Filter

SS passes by backwash.

2 degrees Jap. standard

After Crypto outbreak.

Recommended to 0.1 degrees

Chlorination is essential.

Purified by small organisms

Natural spring

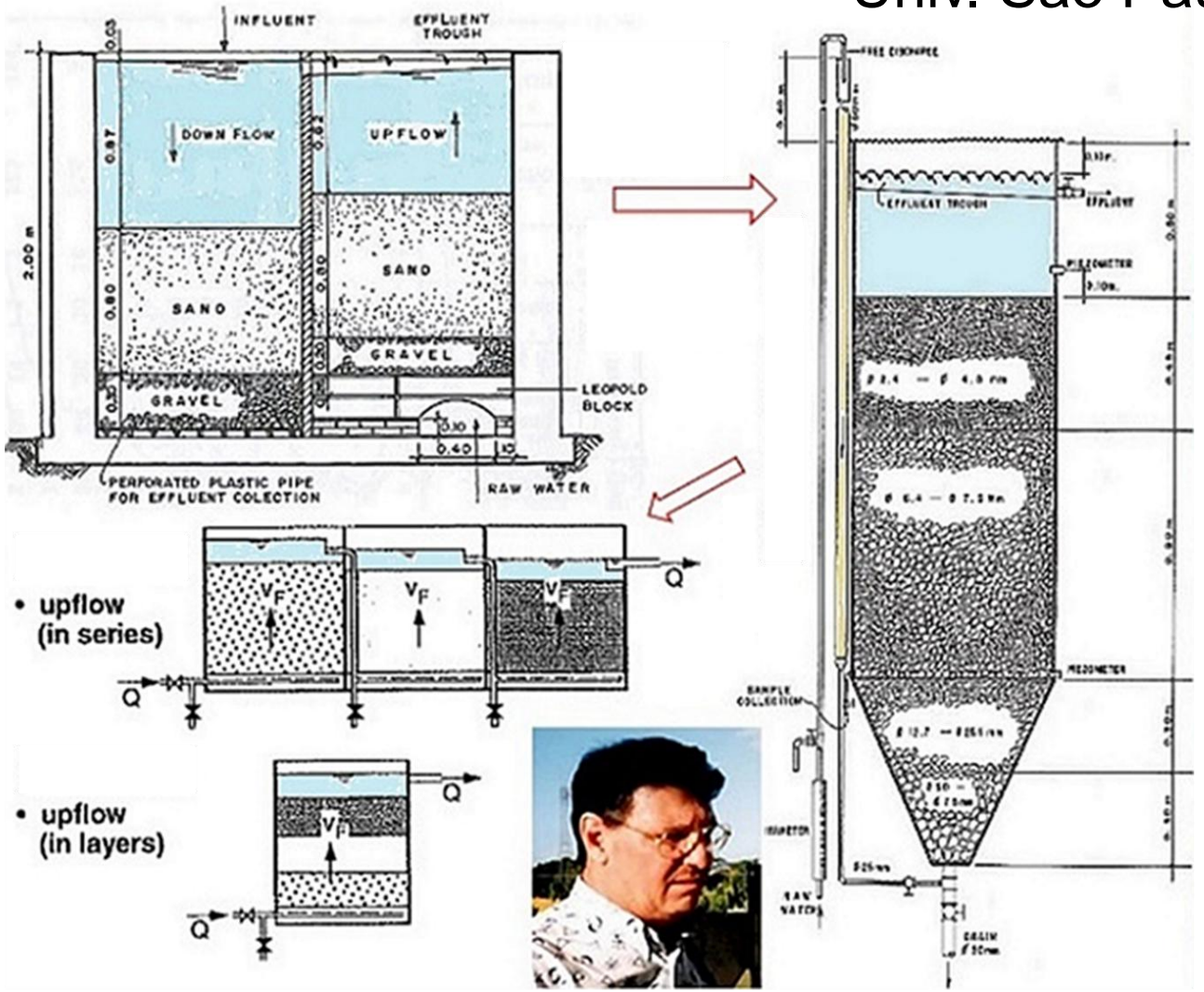
Super clean and delicious.

Artificial Natural spring water

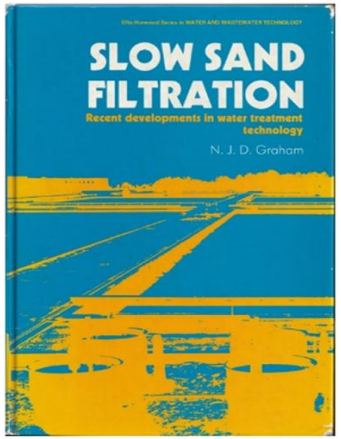
Development of Eco-friendly and Chemical-free turbidity countermeasures: **Up-flow Roughing Filter.**

Down Flow and Up-Flow

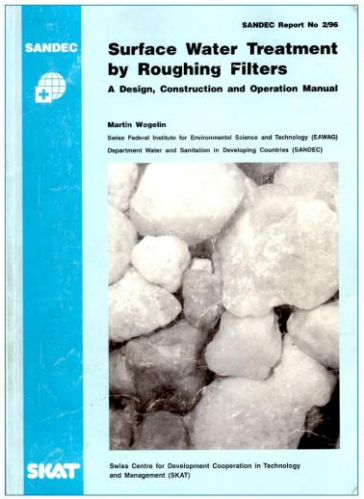
Luiz Di Bernardo 1980
Univ. São Paulo, Brazil



Up-flow Roughing Filter: presented at the International Conference on Slow Sand Filtration, London, 1988



At the international conference in 1988, Martin Wegelin from Switzerland reviewed past roughing filters
⇒International joint experiment
⇒In 1996, a roughing filter manual was published by Switzerland.

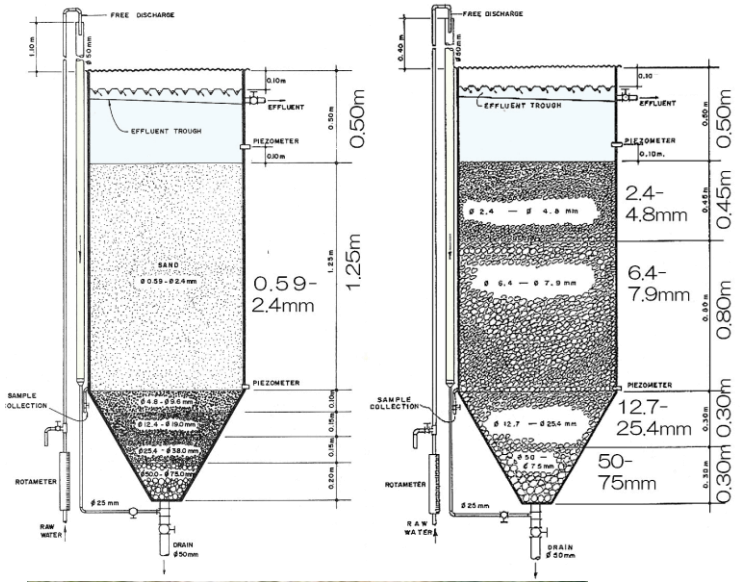


https://www.ircwash.org/sites/default/files/Wegelin-1996-Surface.pdf

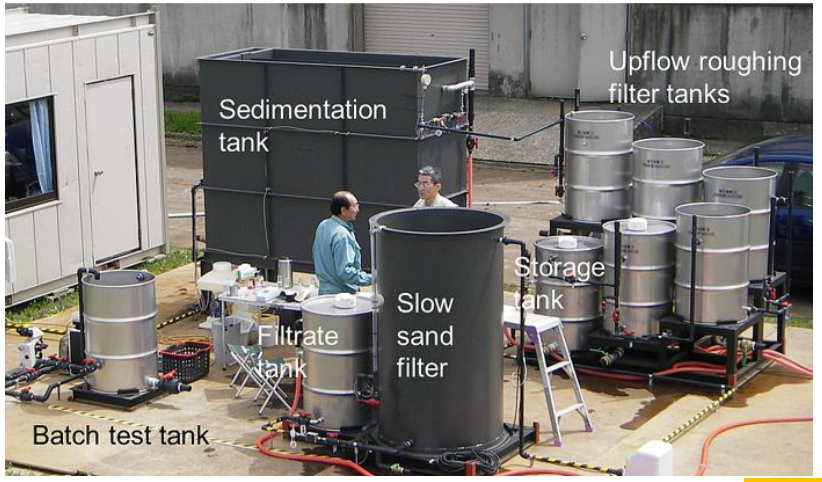
Martin Wegelin
Swiss Federal Institute of Aquatic Science and Technology

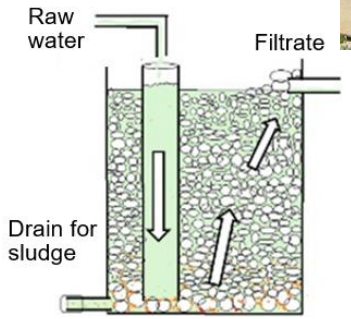
The role of the biological community was also key in Up-flow Roughing Filter.

Up-flow Roughing Filter

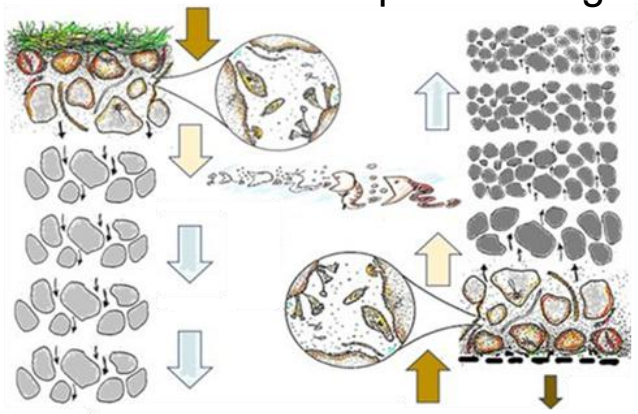


Nakamoto was a JICA advisor of the control of a reservoir ecosystem to São Paulo Univ. and Federal Univ. of São Carlos in 1974 and 1976.

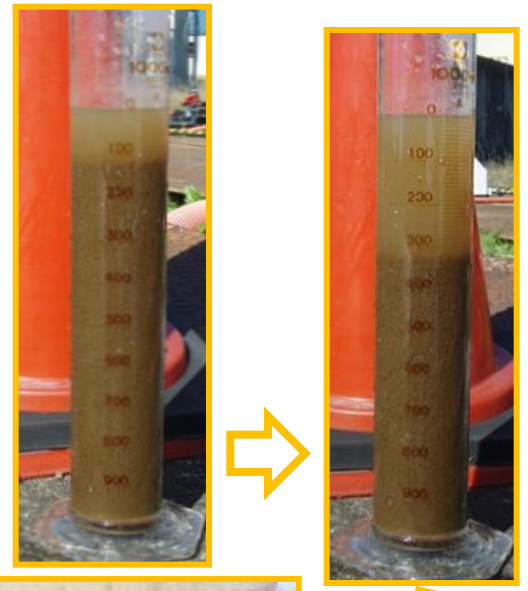




Slow Sand Filter

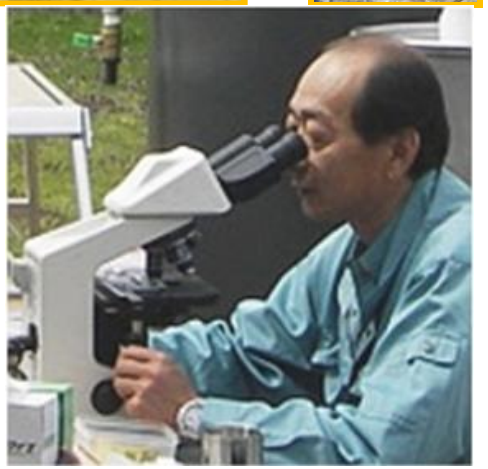


Up-flow Roughing Filter



I examined URF from 1996, and I noticed a large contribution of biological action in URF.

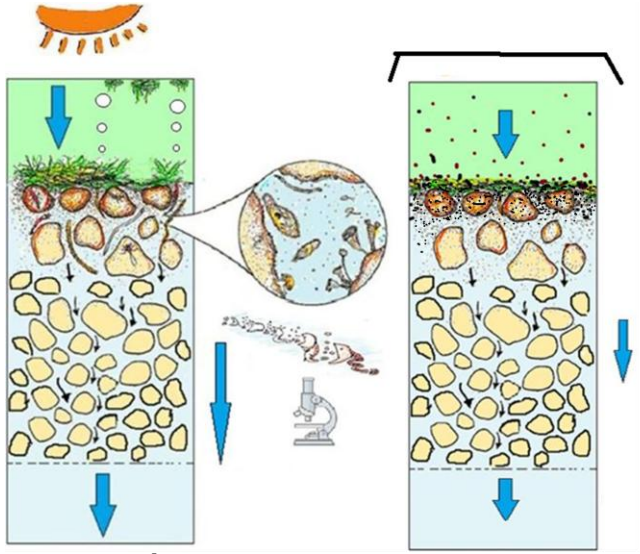
It has good settling properties and is similar to activated sludge in sewage treatment, where the biological community is active.



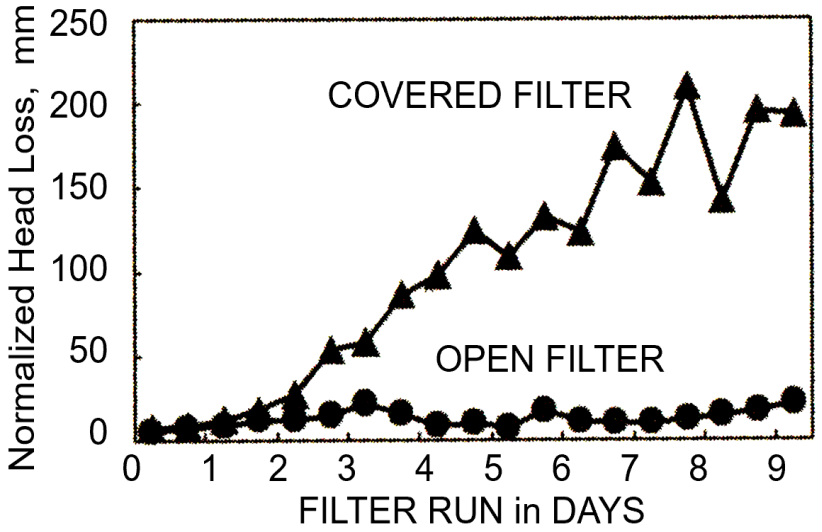
The activity of biological communities is key.

Multiple Roughing Filters to eliminate SS from an irrigation canal water.

Effect of open filter and covered filter.



Filter resistance (NHL) of Open filter was almost constant.
But the resistance of Covered filter increased almost every day.



Algal growth under sunshine.

⇩

Increase grazing activity by animal.

⇩

These animals search for food, make holes, and do not increase the resistance of the water.

W. K. Burton **1894** "**The Water Supply of Towns and the Construction of Waterworks**"

Berlin wks discovered that covered filters are much less efficient than open.
➪**Open is better.**

We confirmed the role of algae in EPS.

After heavy storm event, river water becomes dirty and rapidly increases.

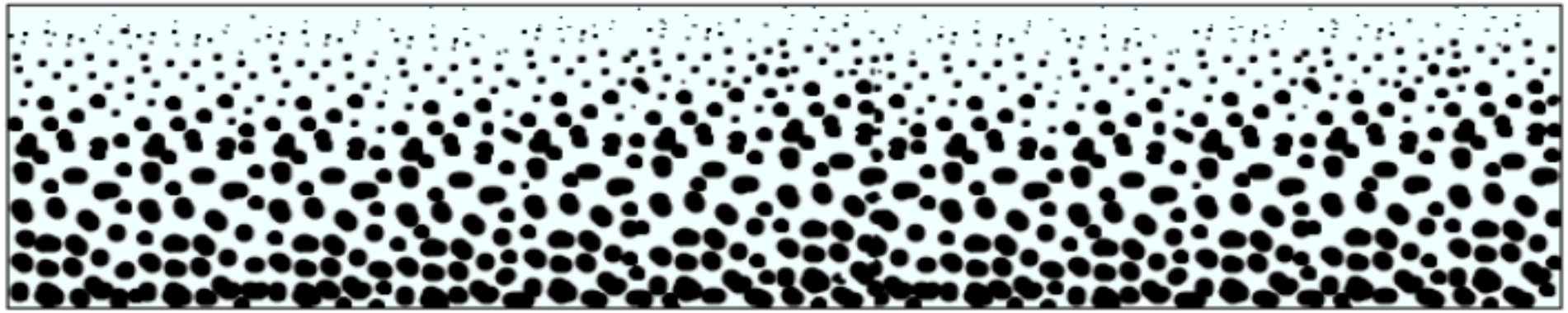
In Japan, river water is usually clear and small amount of water.

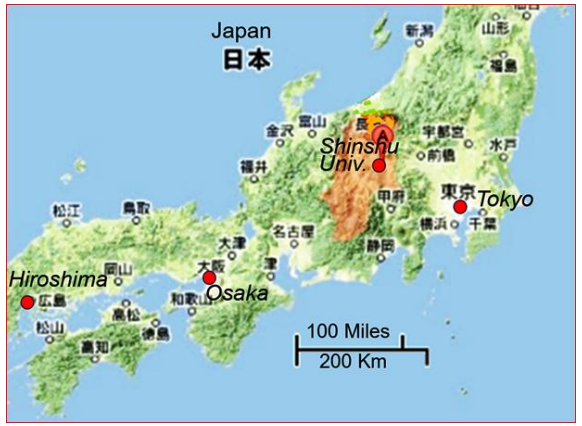
Clear and suspended free water from spring is found in a flood plain.

Light and small particle which is not easily settled.

A large amount of heavy and large particles in a storm water.

Flood water is dirty. There is huge amount of soil matter from land surface.

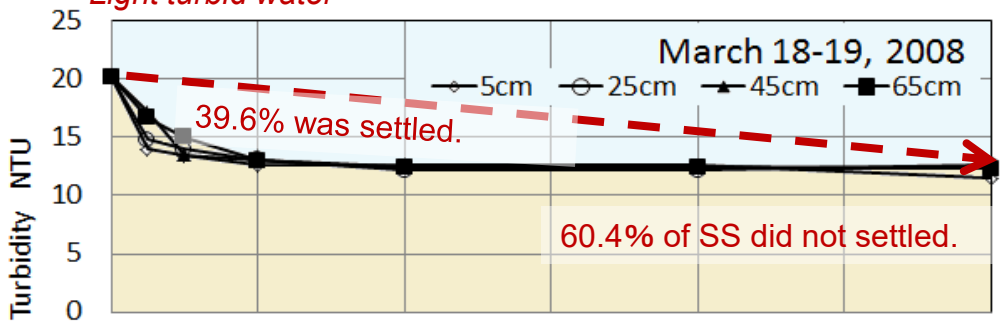


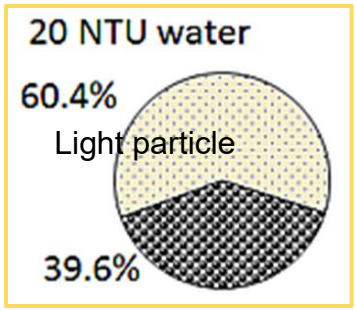


This result is for mountainous country.

*There were extremely small particles like as colloidal particles in case of small turbidity, like as less than 20 NTU. The rapid settling of turbid matters was observed **within 4 hrs**. However, a large portion of turbidity did not decrease.*

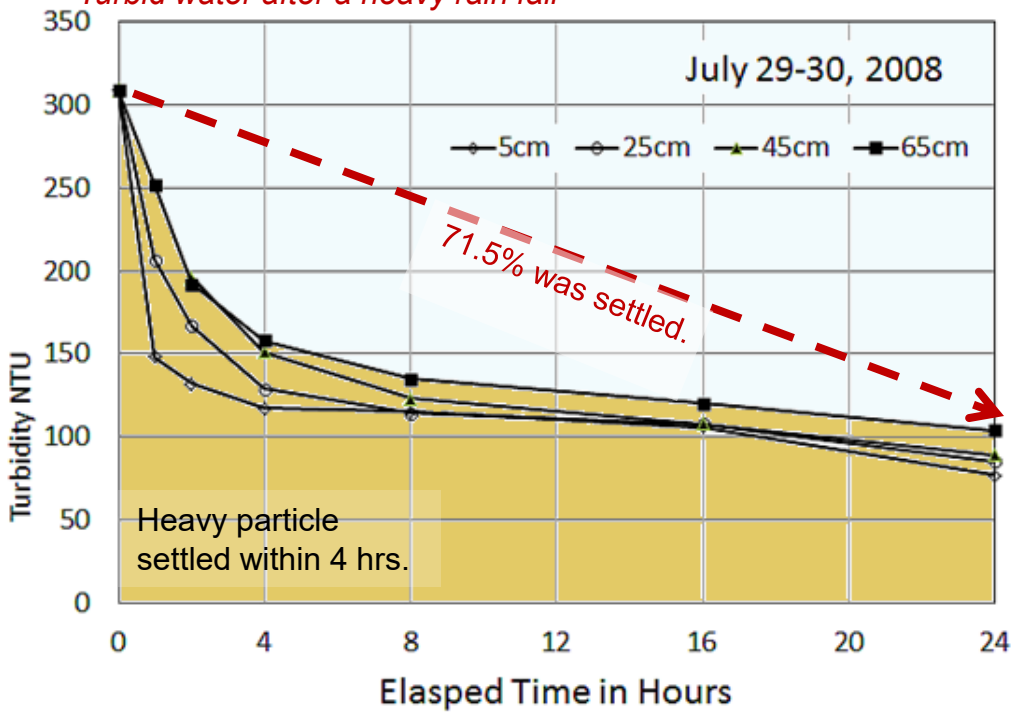
Light turbid water



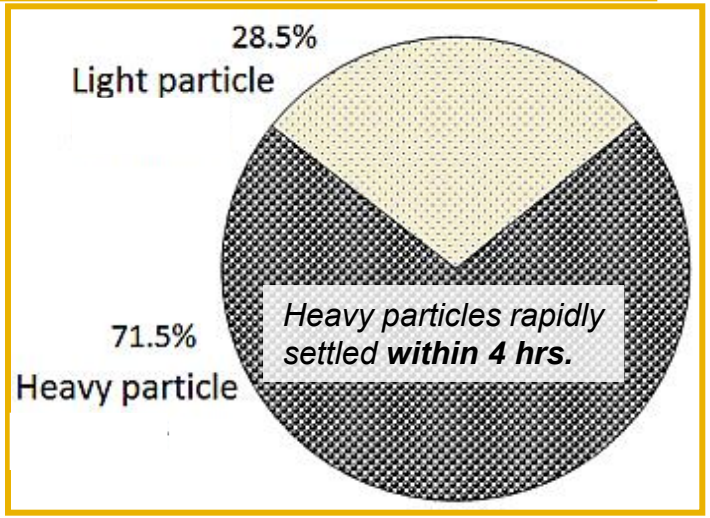


Light turbid water: small turbidity, a large portion of light particle.

Turbid water after a heavy rain fall



In case of turbid water, a large portion was heavy particles.



4 hrs. settling is enough.

OISCA (The Organization for Industrial, Spiritual and Cultural Advancement-International)

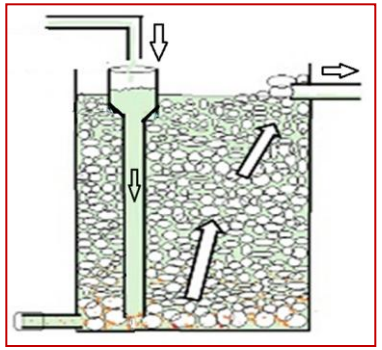
OISCA has started working on the idea that EPS, which applies natural mechanisms, can produce safe drinking water without relying on others.

There are sedimentation tank, 4 gravel filters, and slow sand filter. Polluted water turns to safe and reliable water quality.

Polluted water from River Kanda, Tokyo is pumped up in 2005.

No detection of coli-form bacteria, lead, herbicides of Atrazine and Simazine. Nitrate N concentration : 2.0 mg/L, Nitrite N: 0 mg/L, pH8.5, total hardness: 250 mg/L and residual chlorine 0 mg/L.

OISCA Tokyo:
polluted water
→EPS
→ safe water



I advised URF to him.

Mandalay, Myanmar: Pond → settling tank → 3 Up-flow Roughing Filters → Sand Filter → safe drinking water.

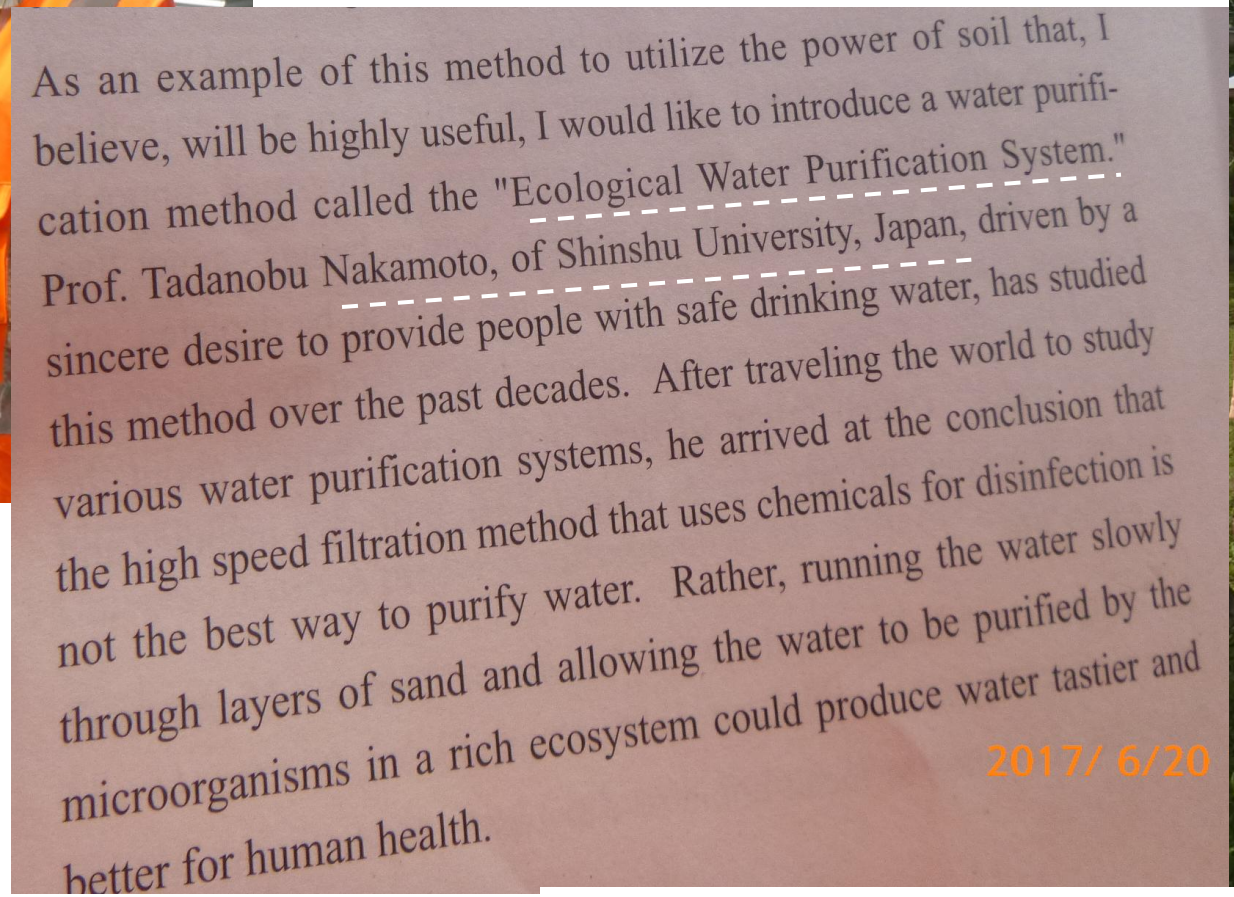
Try it !
First, check it yourself without getting any subsidies.

Three points worth to remember

1. Knowing is NOT enough, we must APPLY it to something useful.
2. Willingness is NOT enough, we must PUT it into the PLAN and ACTION.
3. Putting the PLAN into action is NOT enough, we must ACCOMPLISH the goals.

OISCA International

*Niko-San participated OISCA training in Fukuoka, Japan, in **2007** during 1 year. He remember my work on Ecological Purification System.*

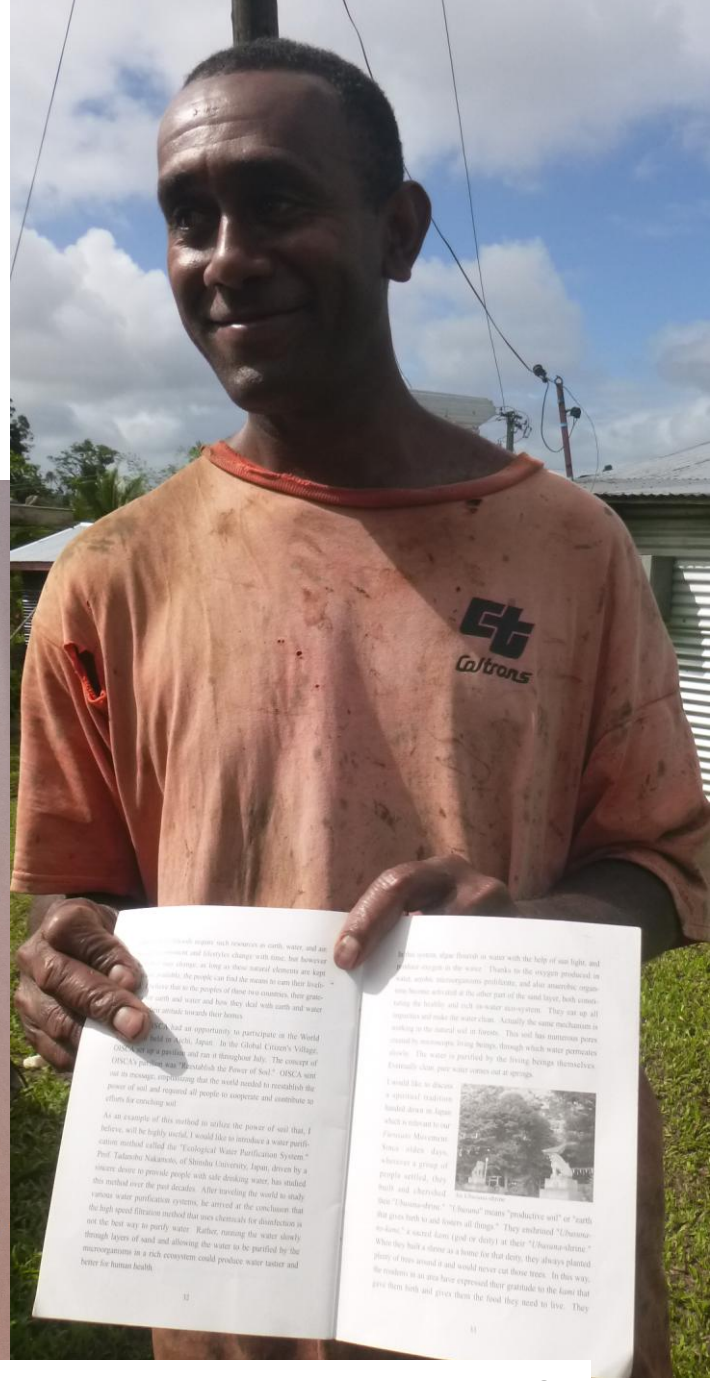


As an example of this method to utilize the power of soil that, I believe, will be highly useful, I would like to introduce a water purification method called the "Ecological Water Purification System." Prof. Tadanobu Nakamoto, of Shinshu University, Japan, driven by a sincere desire to provide people with safe drinking water, has studied this method over the past decades. After traveling the world to study various water purification systems, he arrived at the conclusion that the high speed filtration method that uses chemicals for disinfection is not the best way to purify water. Rather, running the water slowly through layers of sand and allowing the water to be purified by the microorganisms in a rich ecosystem could produce water tastier and better for human health.

2017/ 6/20

Yoshiko Y. Nakano

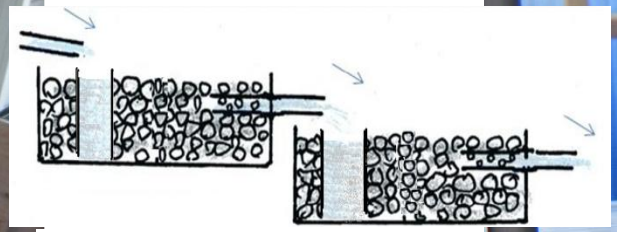
September 2006



*I met Niko-San in Fiji, in June, **2017**. He showed his text on EPS.*

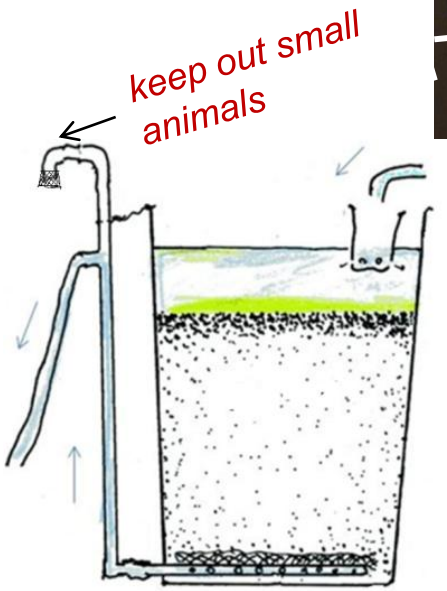
To make subsurface suspension free clean water in the flood plain.

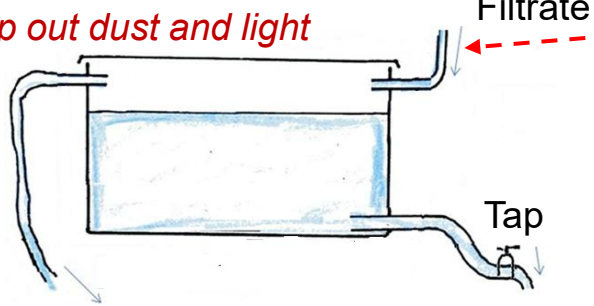
Filtrate storage tank



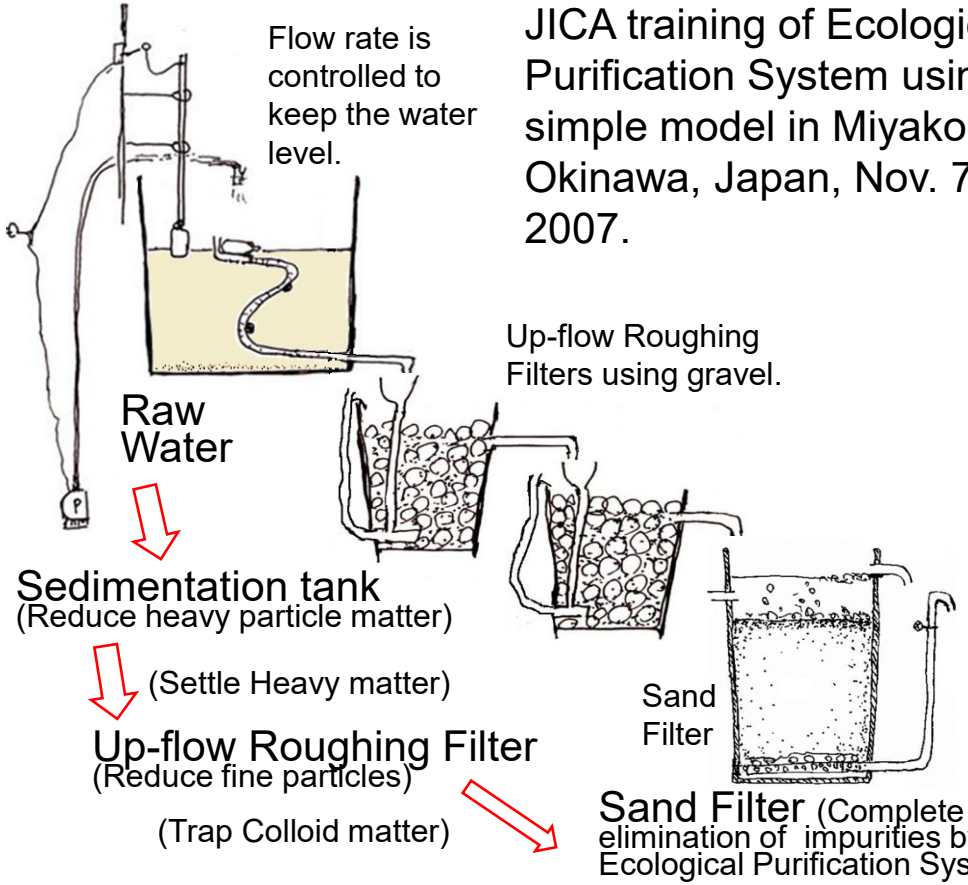
Up-flow roughing filter

To keep continuous flow by a small pump

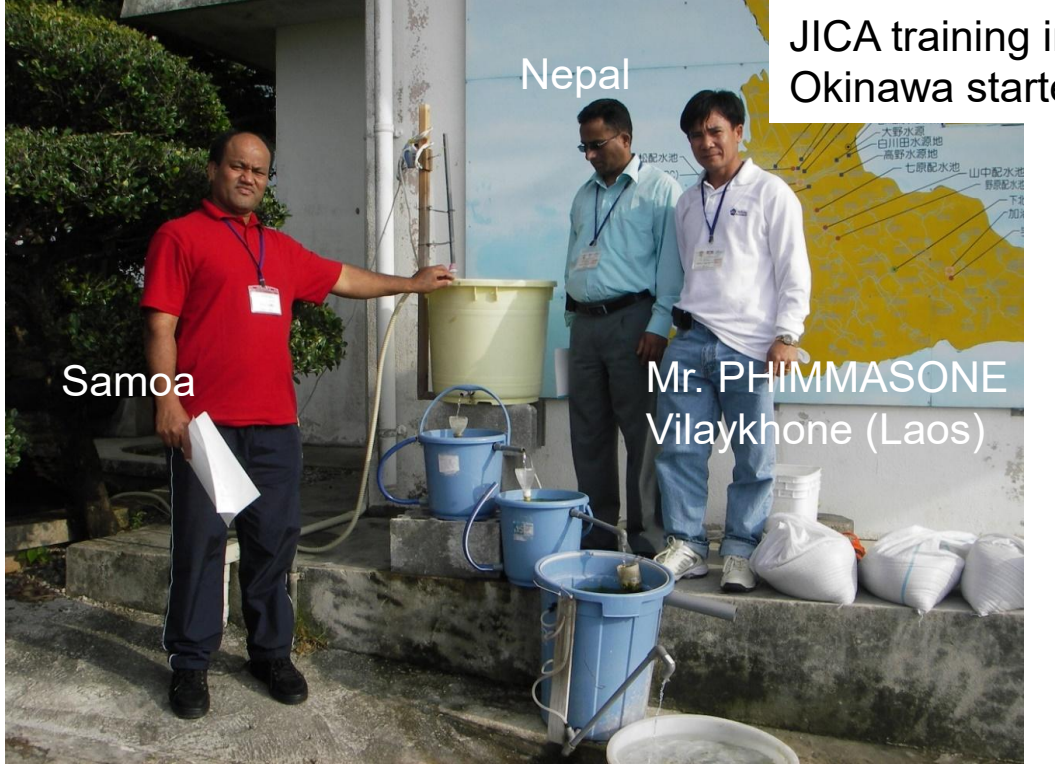




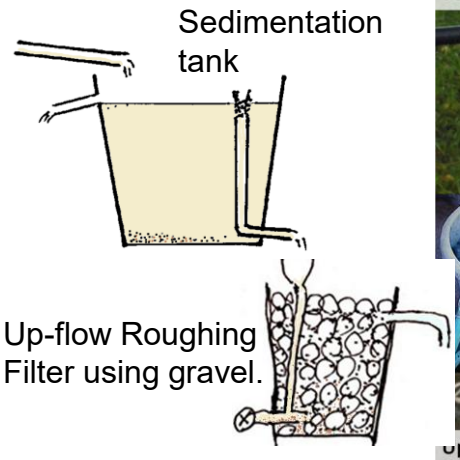
Under drainage porous pipe covered with mesh cloth.



JICA training of Ecological Purification System using a simple model in Miyako-jima, Okinawa, Japan, Nov. 7th. 2007.

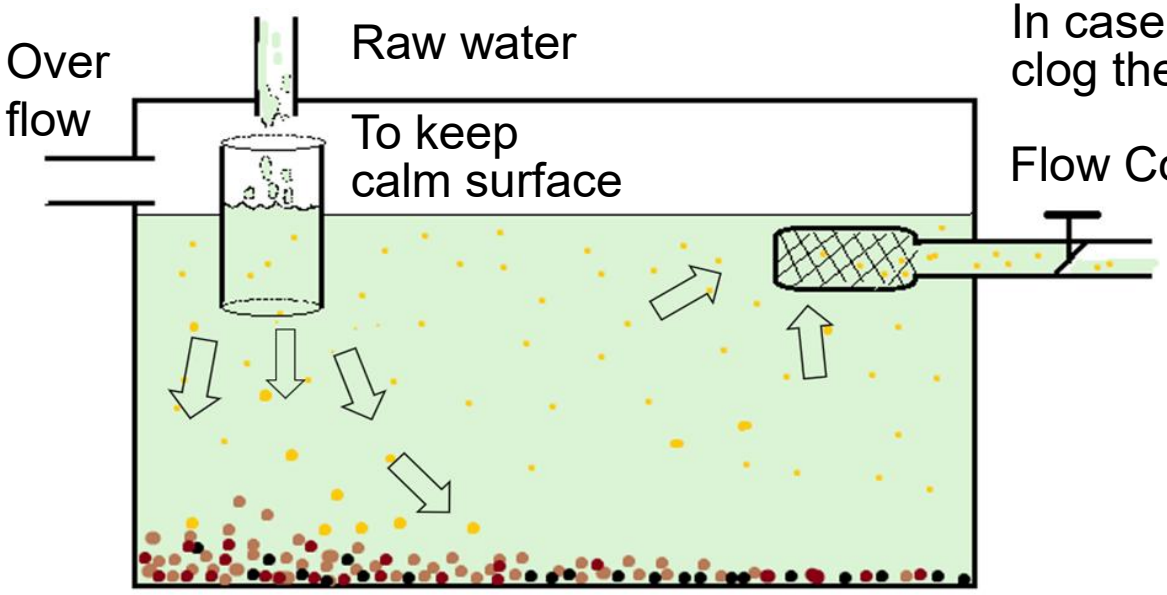


JICA training in Miyako-jima, Okinawa started from 2006.



JICA training in Okinawa, in Feb. 2025.

Receiving Tank (Settling Tank)



In case of open tank, filamentous algae clog the outlet.

The Water Supply of Towns
by W. K. Burton **1894**.

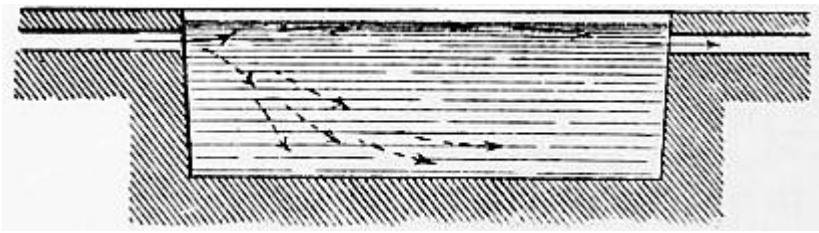
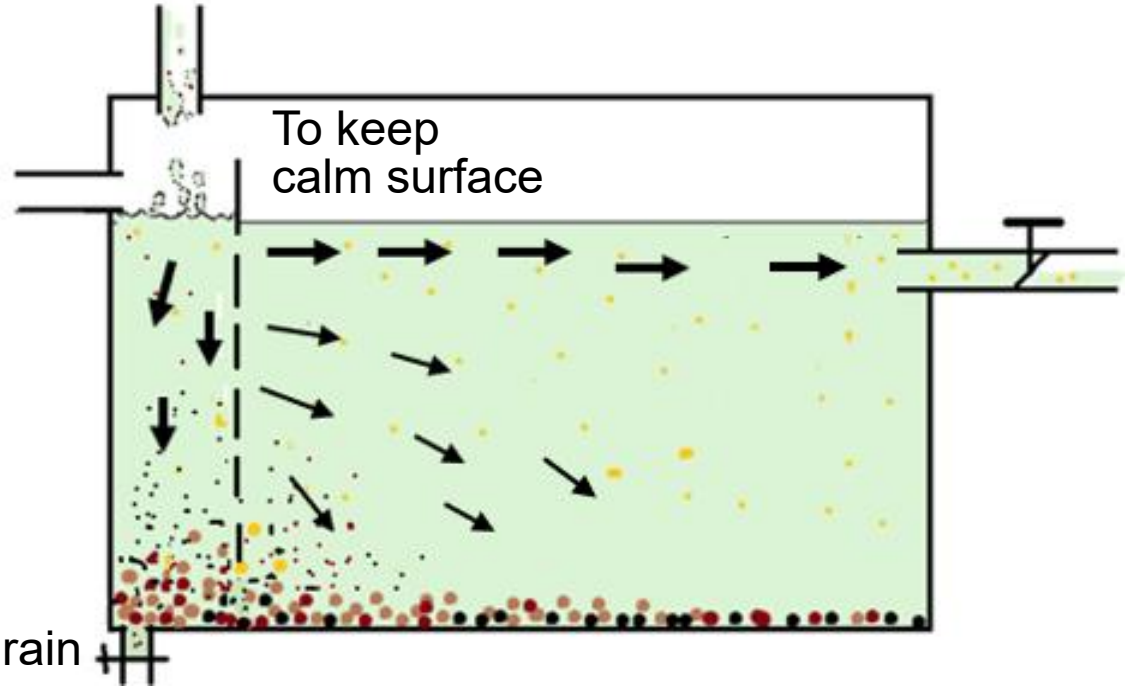


Fig.65. Settling reservoir: Inlet and outlet at surface level.

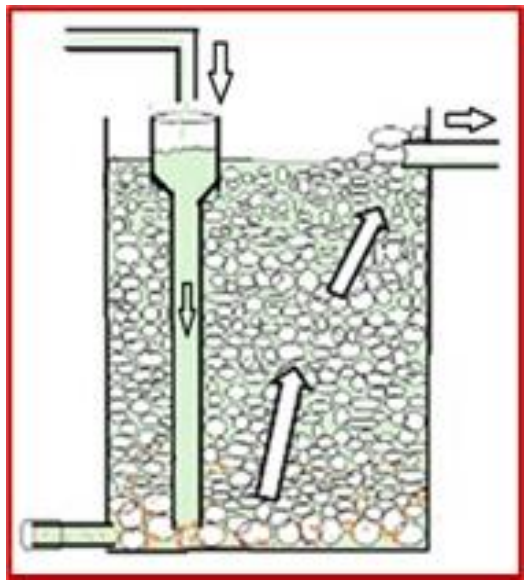


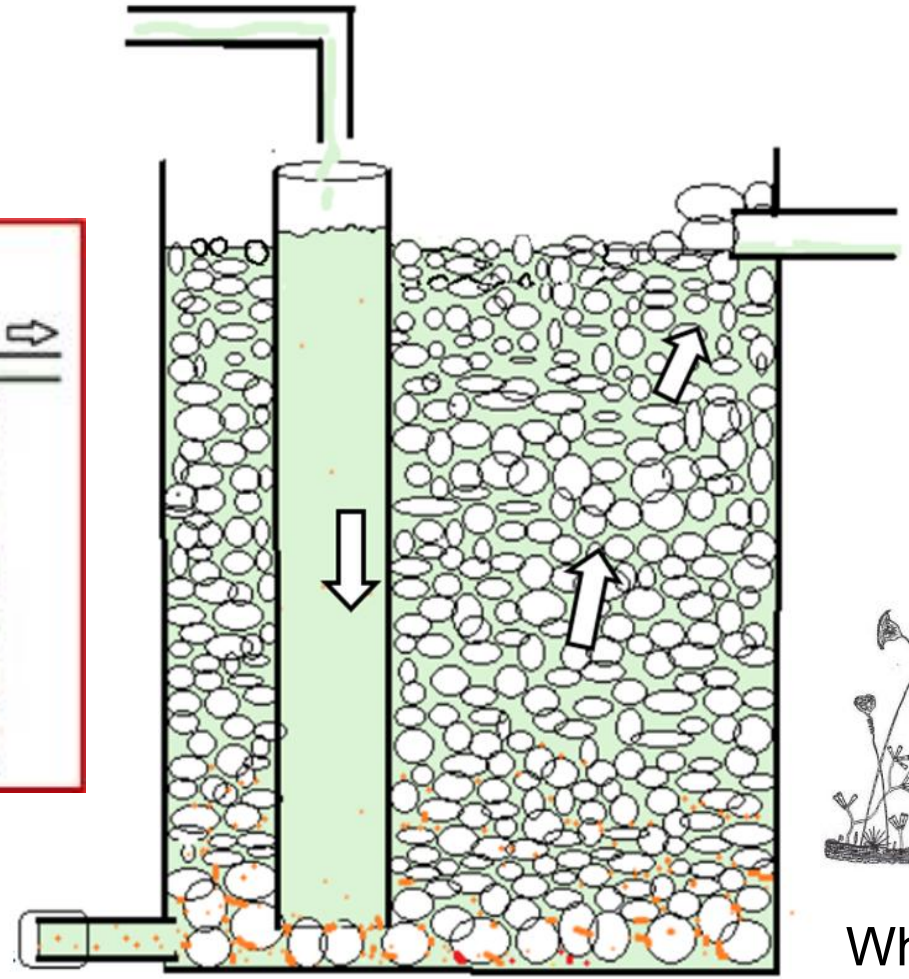
Heavy particulate matters are easily settled.

However, colloidal light particles like silt material are not settled in this settling tank.

Up-Flow Roughing Filter (URF): Gravel Filter

Additional URF if necessary.





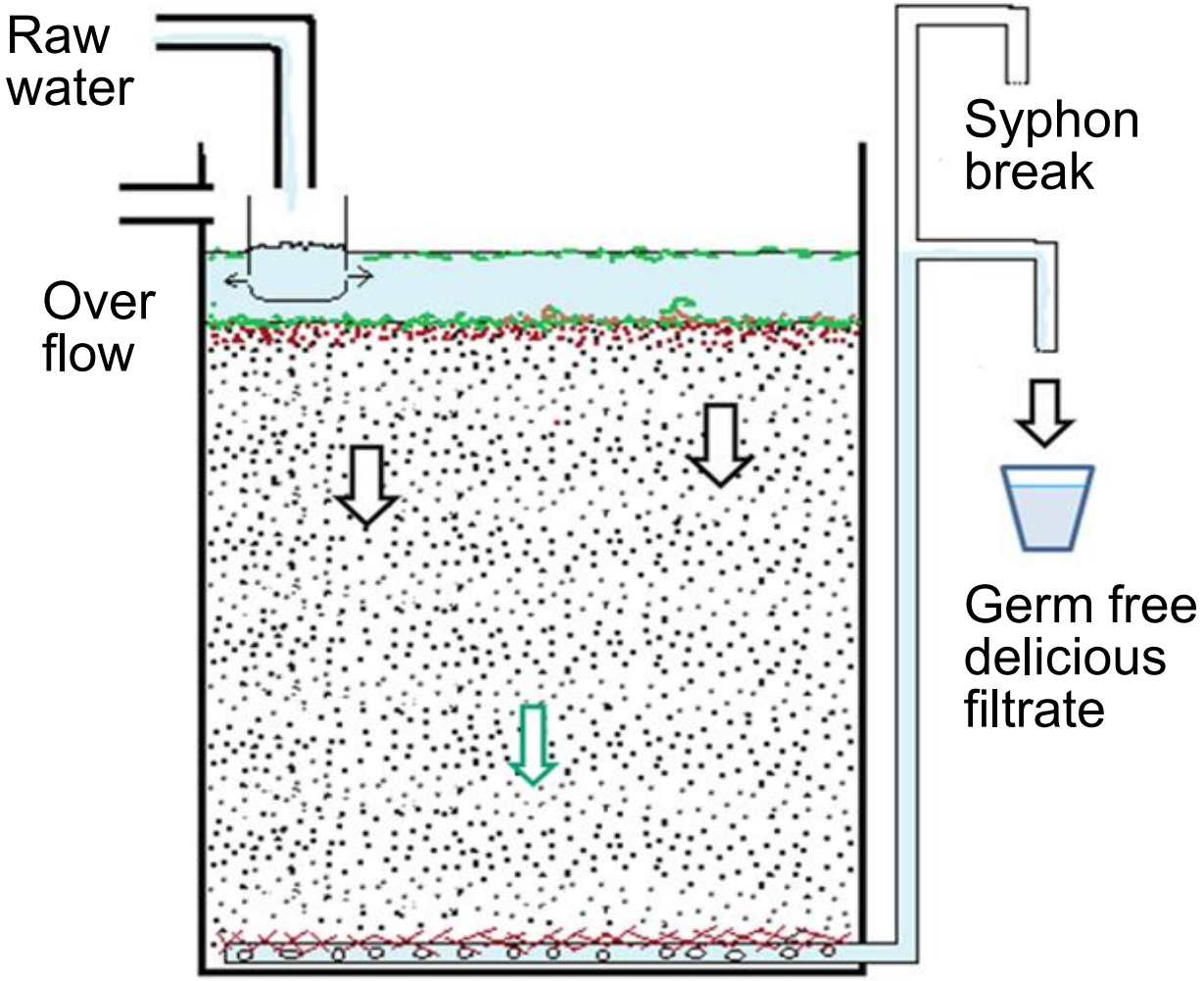
Drain cock for accumulated mud.

Colloidal fine particles adhesive to the surface of gravels. Small animals scrape them and produces fecal pellets. Fecal pellets accumulated to the bottom.

When the filter resistance increase, the drain cock is opened in short time to drain the mud (accumulated fecal pellets.)

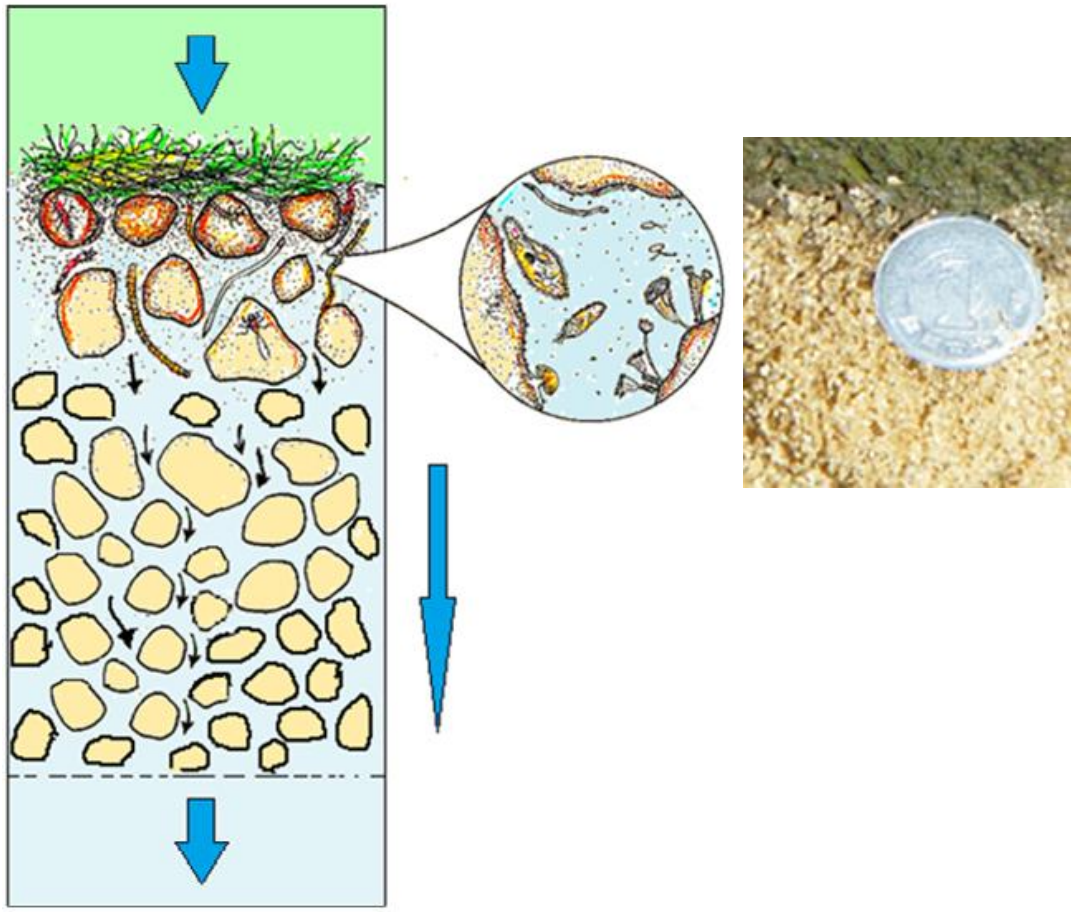
EPS (Sand) Filter (Natural Down Flow)

Ecological Purification System



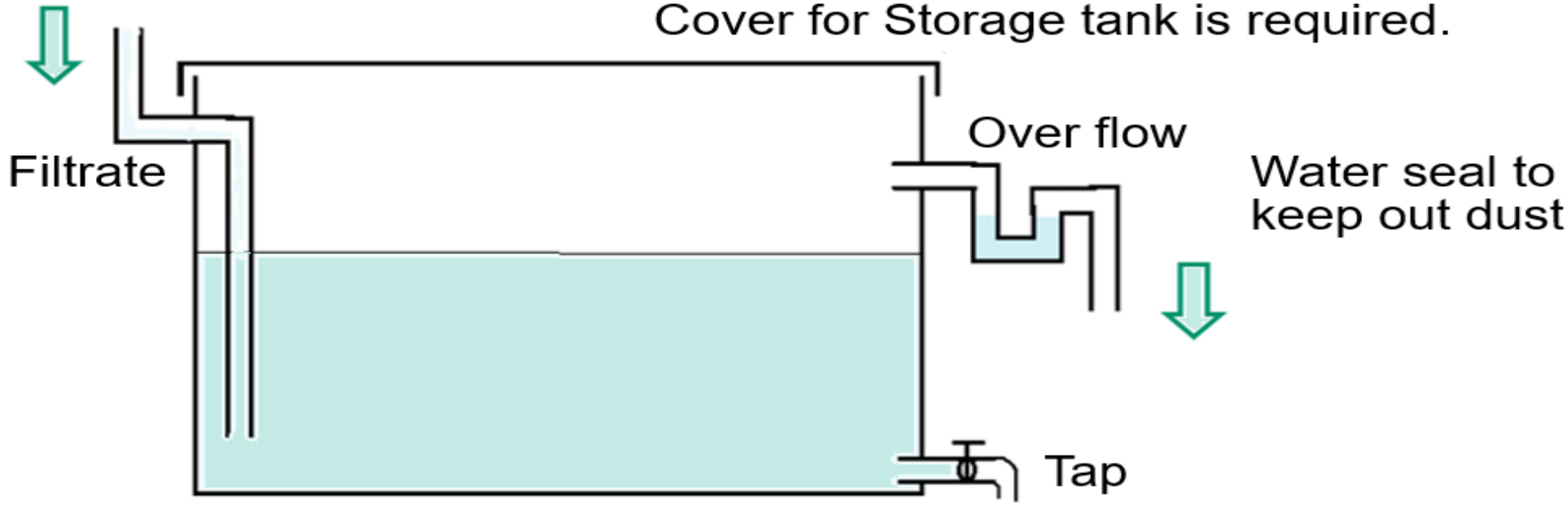
Mesh cover on a porous pipe

Biological active layer is only surface and thin layer beneath the surface.

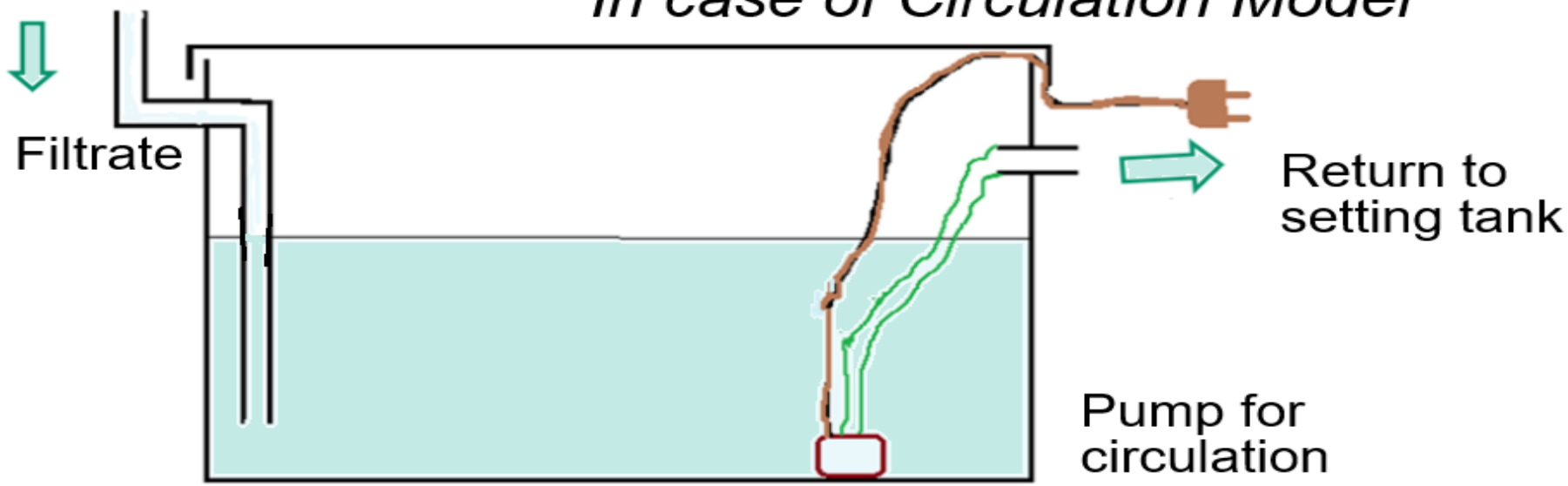


Algae and animals grow well on and beneath the sand surface.
Deep sand layer is a guarantee layer for emergency.

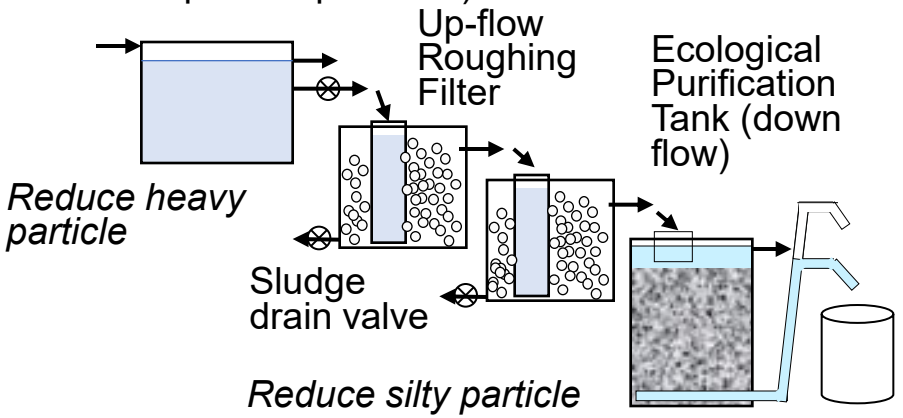
Storage (Filtrate) Tank



In case of Circulation Model



Raw water Settling box
(over flow to keep water pressure)



Filter area = 26.5 cm x 40 cm = 1,060 cm2

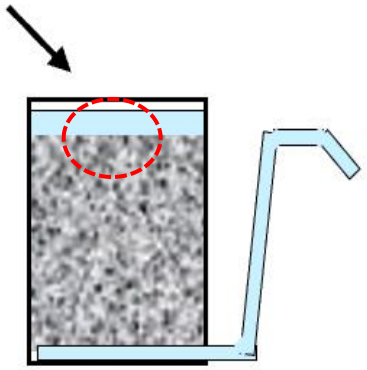
In case of Present Thames filter rate (40cm/h =9.6m/d)

Filtrate/min = 1,060 cm2 x 40 cm/h/ 60 (min) =707 cm3(ml)/min

Filtrate/h = 1,060 cm2 x 40 cm/h = 42,400 cm3/h =42.4 liter/h

Filtrate/d = 42.4 liter x 24 hrs = **1.02 m3/d**

Filter rate can be measured using a cup and is regulated by a cock.



Shallow water depth over sand is important to keep aerobic condition.

Passing time of water is shorter in shallower depth.
And higher flow rate is also better to keep aerobic condition.

	unit	Simpson 1829	English Filter	Present Thames Filter	Experiment in Samoa
Flow rate	m/d	2	4.8	9.6	20
	cm/h	8.3	20	40	83
Flow rate in sand layer (50% porosity)	cm/h	16.7	40	80	167
Passing time of 1 m sand layer	hr	6	2.5	1.25	0.6
Passing time of upper active 1 cm	min	3.6	1.5	0.75	0.36

I studied on ecological function of Miyako-jima wks. I made a video on EPS function of Miyako wks in March 2004 and published a book in August 2005.

JICA training started in 2006.

JICA made Video in 2008

Slow sand filtration: creating clean, safe water(Full ver) in 2020

https://www.youtube.com/watch?v=V6_uDZE_l8E&t=1218s

Quest for Safe and Delicious Tap Water, Miyako-jima, Island in March 2004. /15:22
With English subtitle version in Oct. 2007.

https://www.youtube.com/watch?v=r1LlPuQliu0&t=16s

Ecological Purification System : JICA training for SIWA, April 18, 2013

https://www.youtube.com/watch?v=NCI9oeNM0aI

Slow sand filtration: (Digest ver) in 2021/3:26

https://www.youtube.com/watch?v=QAH1SoAgfL0&t=37s

JICA Training on Ecological Purification System (EPS) in Okinawa, Japan in 2022

DIY EPS bucket model making 2022 - YouTube / 38:01

https://www.youtube.com/watch?v=jz94KFkLL3E

NGO Okinawa Blue Water

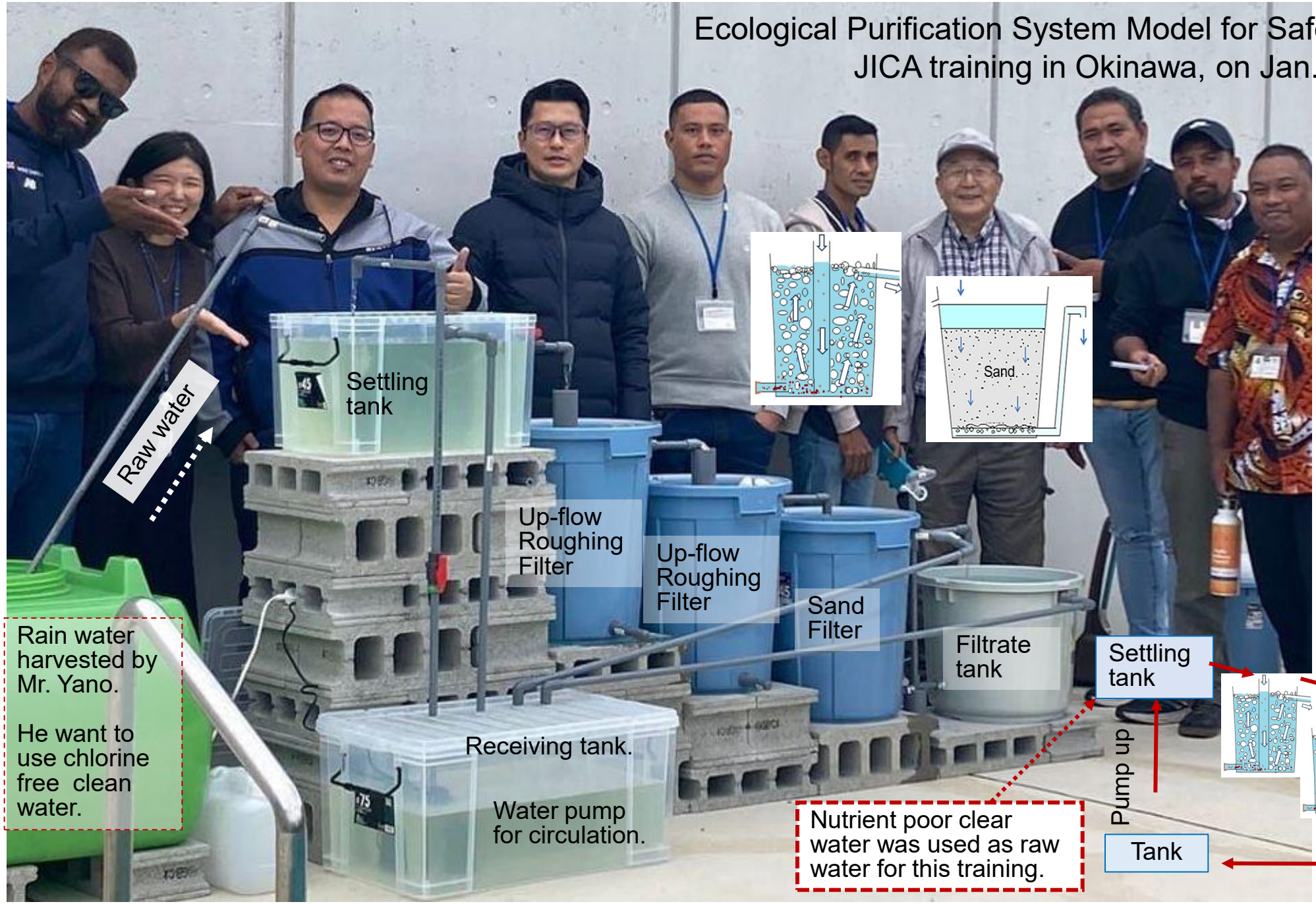
Un sistema ecológico, económico y replicable que puede ser utilizado por pequeñas, medianas y grandes comunidades. Este sistema fue desarrollado por el Doctor Nobutada Nakamoto

Ecological Purification System

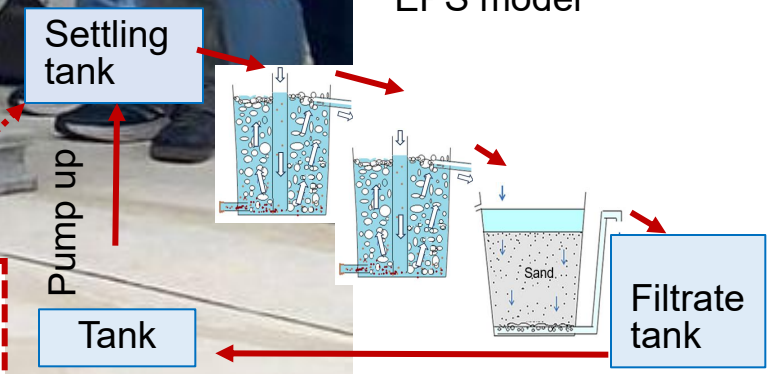
Daniel Castro
2017/07/20 に公開

https://www.youtube.com/watch?v=Ye-POV6qBU0&t=39s

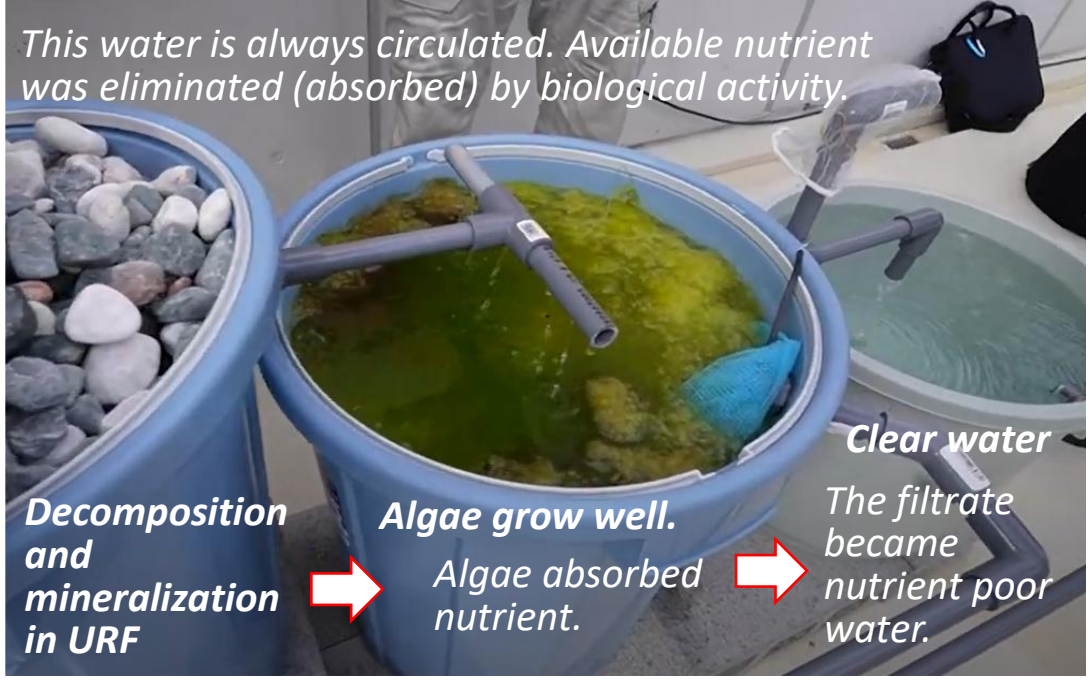
Ecological Purification System Model for Safe Drinking Water
JICA training in Okinawa, on Jan. 16. 2024.



Water circulation EPS model



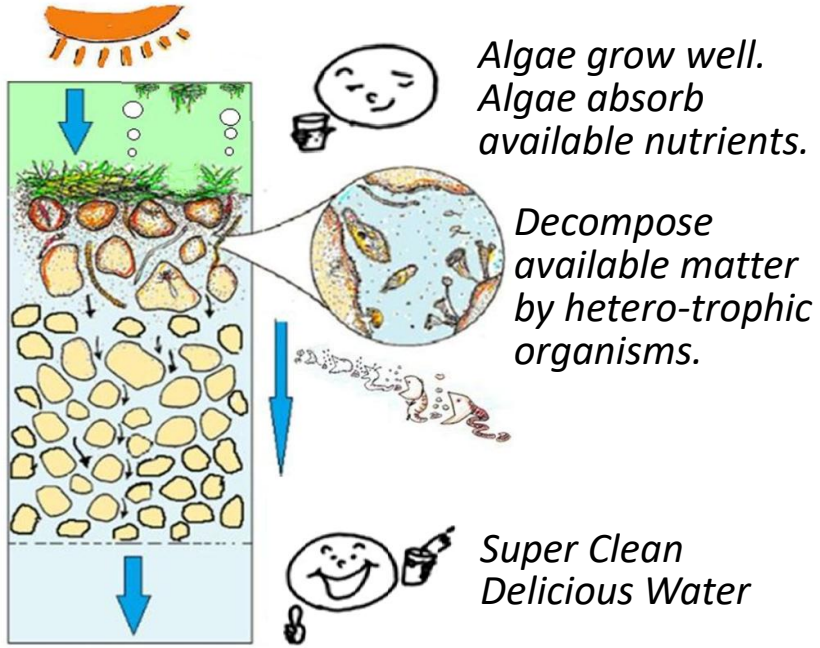
After 3 weeks, they enjoyed delicious super clean water.



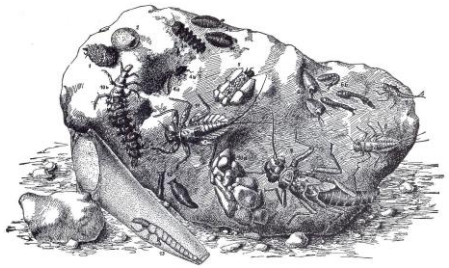
Filtrate Water that is free of substances that living things can react with.
It's water that tastes delicious and sweet.

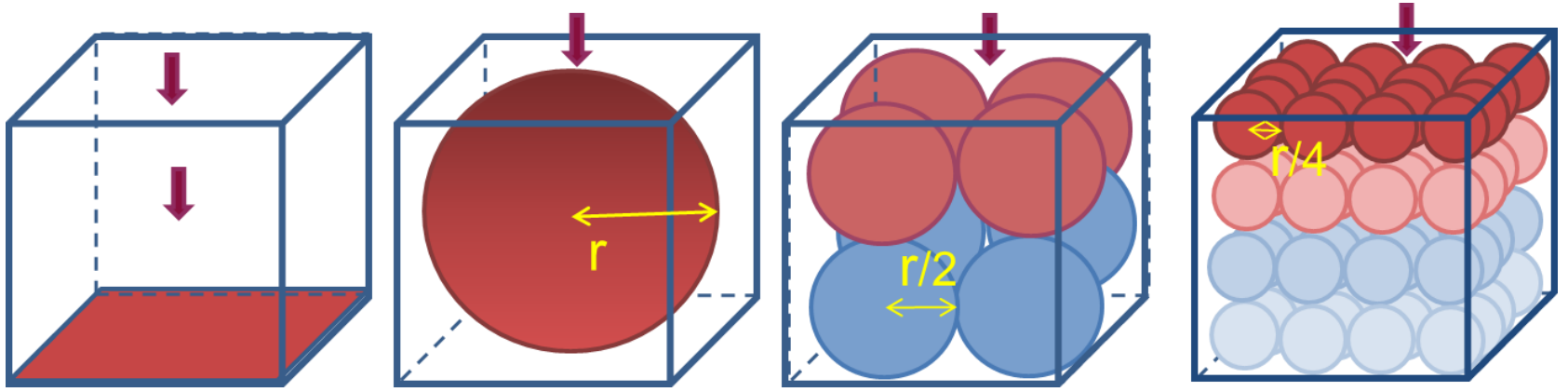
https://www.youtube.com/watch?v=RJLgf63s5Og

Sweet drop (honey dew)
Natural sweet and delicious water



Most of small organisms live on the surface of substrata (sand particle) under slow current condition. They live at the top of sand layer where food comes. They are always waiting for food. They are hungry.





1
Bottom surface area

radius = 0.5
Surface area
= 4 x π x r x r

radius = 0.25
Surface area of one ball
= 0.785
8 balls in box = ***6.28***
Total area of top 4 balls

radius= 0.125
One ball area
= 0.196
64 balls in box =***12.56***
Total area of top 16 balls

Too small particle becomes a flat surface.

1 → ***= 3.14*** → ***= 3.14*** → ***= 3.14***

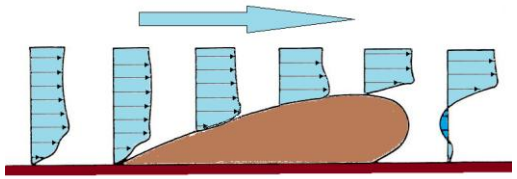
Surface area of a ball is 3.14 times than flat area.

Total surface area of top layer of balls is always same of 3.14 times than flat area.
Smaller ball makes larger area.

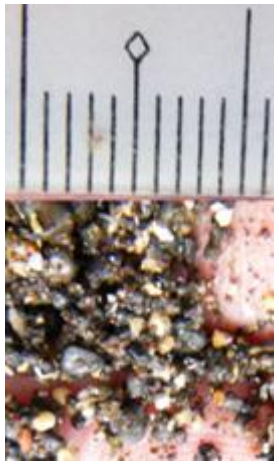
And, total volume of balls is always same of 52 % (porosity : 48%) in a box.

Filter resistance increases toward smaller size of particle.

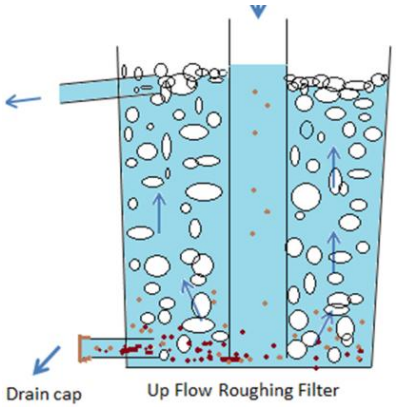
Viscosity relates to temperature



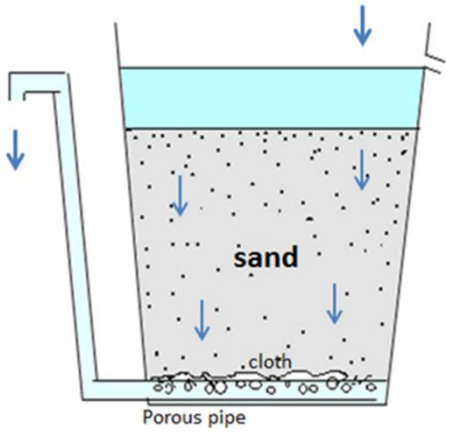
Points: shallow depth, enough radiation on the bottom, rapid growth, large size of sand.

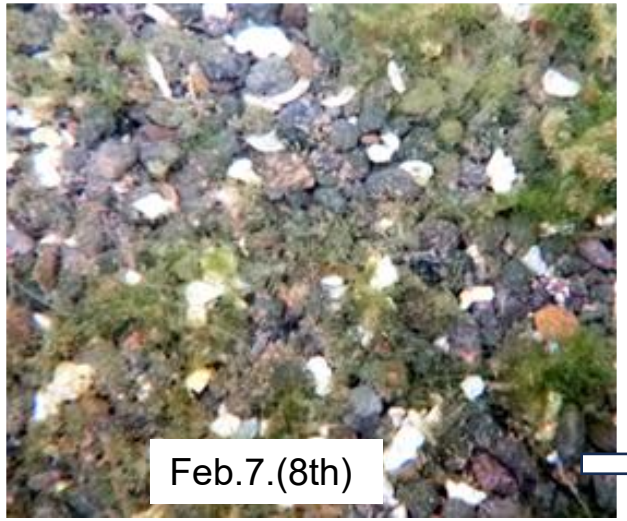


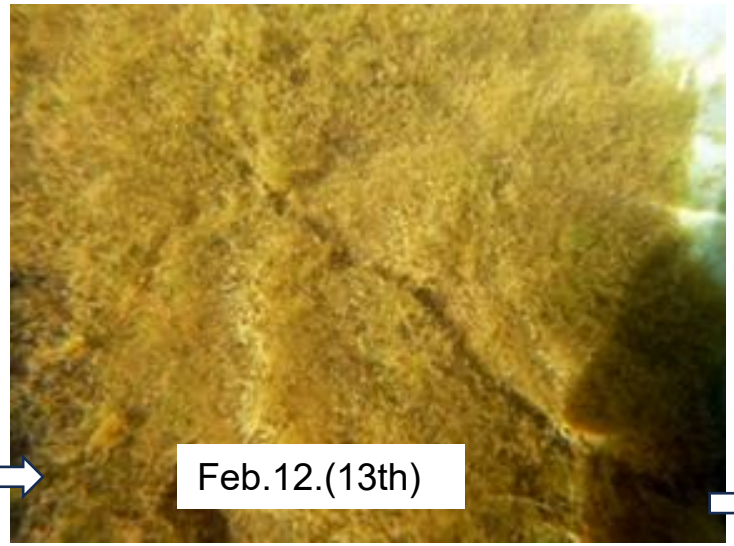
Sand separated with mosquito mesh (1-2 mm)



Two up-flow roughing filters

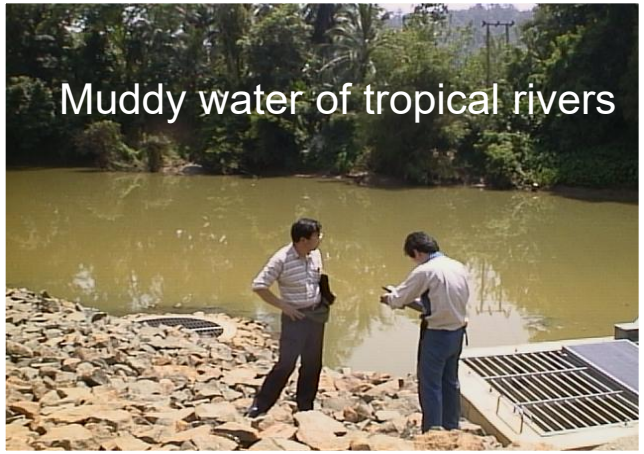






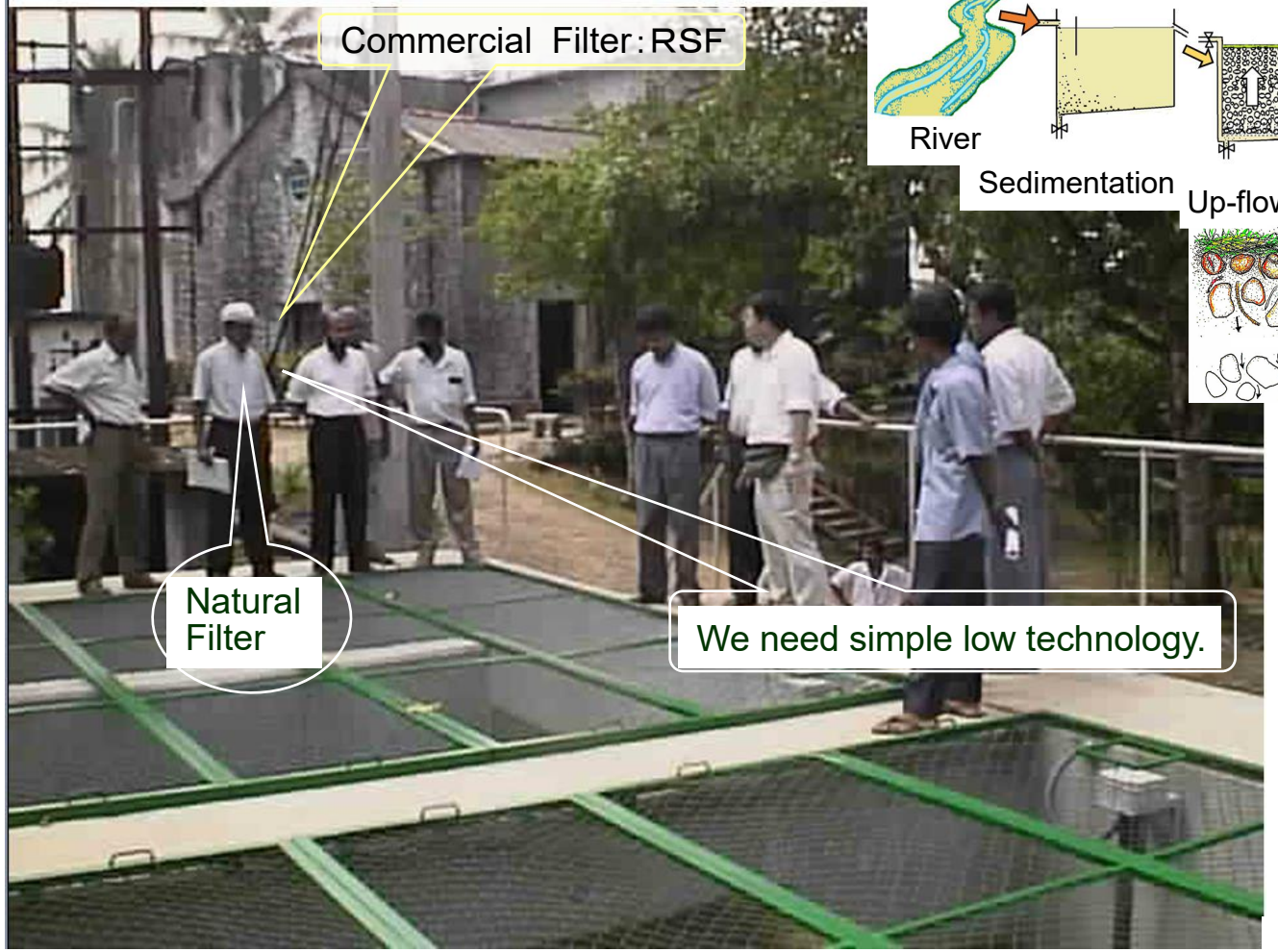
Sand filters (5m/d, 10m/d, 20m/d) All good filtrates.

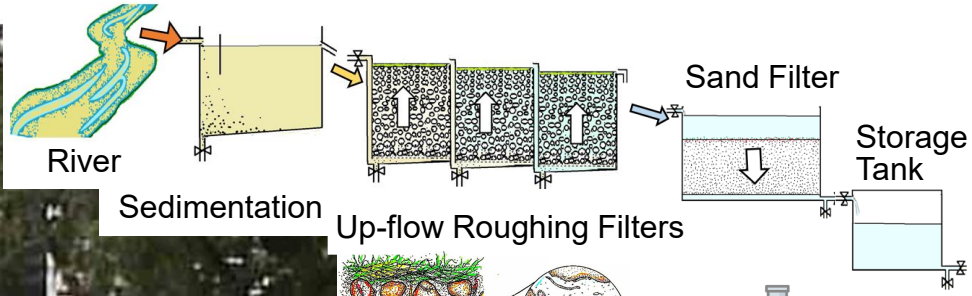
Shallow depth: Algae grow well.

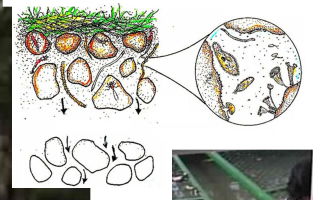


Water supply plant to the national Ratnapura hospital, Sri Lanka by EPS

I explained the chemical free mechanism of EPS, the maintenance and management of EPS at the site to the engineers. This was wise use of natural system.
The manager understood the reason that we had commercial technology.



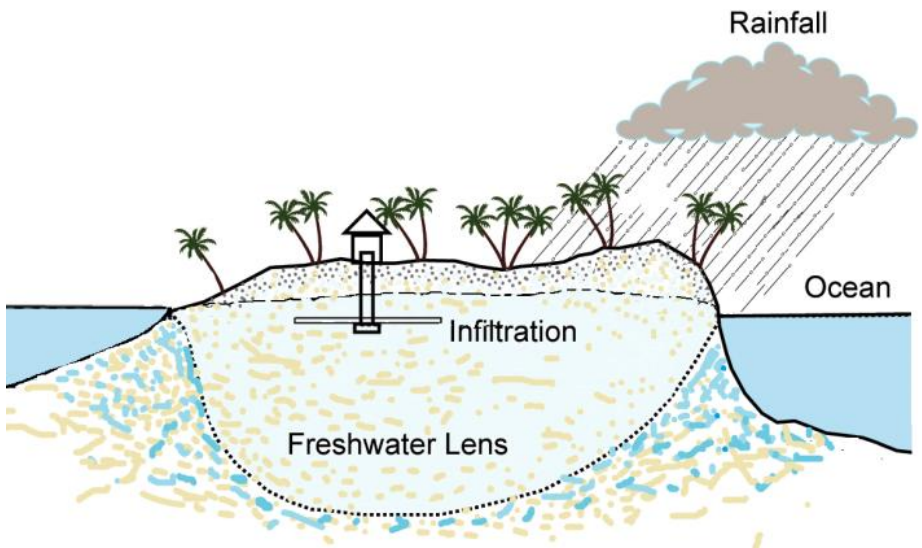




Up-flow Roughing Filters

I visited again this site after construction in 10 years later. **The hospital director said there was no problem.**

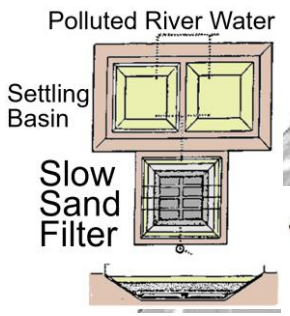
⑥ From Miyako Island to Samoa

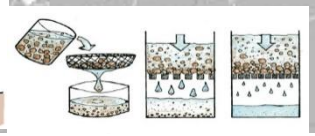


It is also worth appreciating the Ecological Purification System as taught by you, Dr. Nakamoto; a simple, natural and yet an effective water purification technology, we can all agree to as the most relevant technology for the Islands.

It is cheap to construct, operate and maintain which makes it even more attractive. We are grateful to your pioneering research on this technology and for generously impart this to us, so that the people of the pacific may in the very near future will have access to the high quality and delicious taste that this technology provides.

From JICA training in Miyako-island, Okinawa to Samoa





They believed mechanical reduction of polluted matter by fine sand under slow filtration.

Pre-chlorination was a popular water treatment to kill the algae in all over Japan and in the world. This treatment was for Rapid sand filtration.

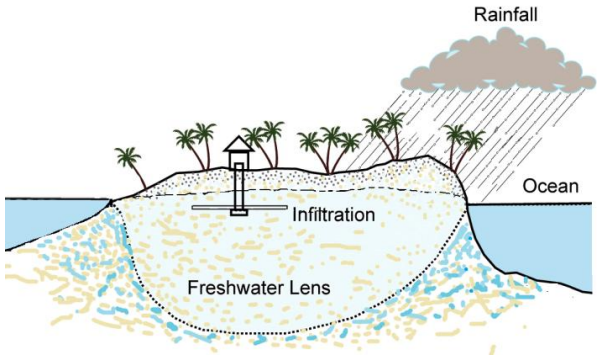
Mr. Mitsutoshi **Tomari**, managing director of Sodeyama WTP, Miyako-island, visited to Nakamoto, Shinshu Univ. in July 8, 1997.

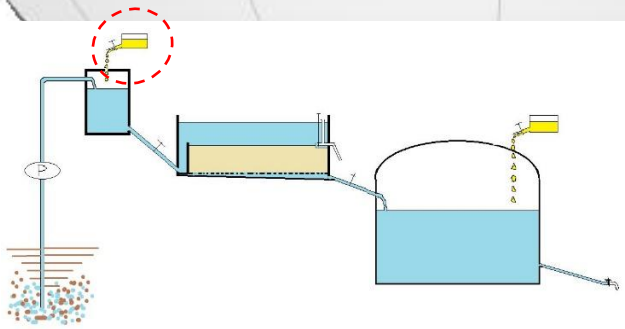
He stopped to injection of algaecide into receiving well in 1997. As soon as the injection stop, the taste of tap water became delicious. Biological communities started to work in SSF. Ecological Purification System functionated in this SSF.

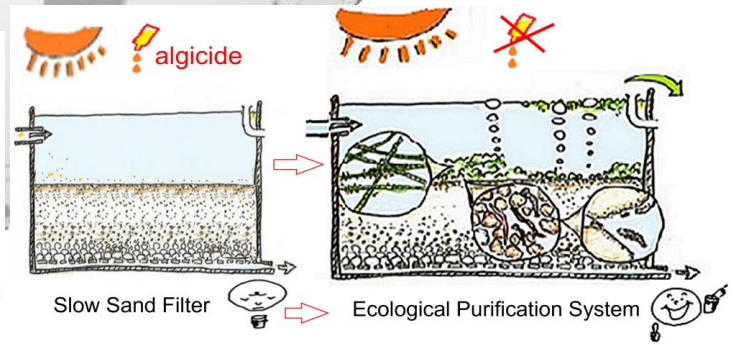
Miyako-island island is a raised coral reef where is quit different environment compared with main part of Japan.

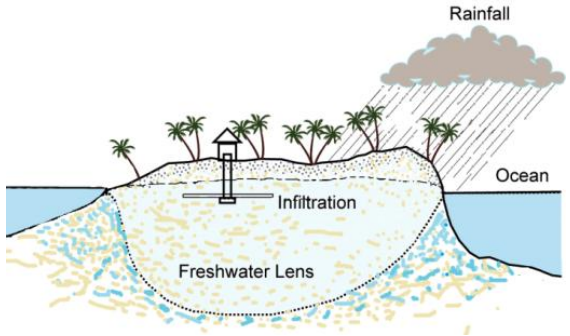
How to make delicious water

Nakamoto published Ecological Purification System text in 2005.

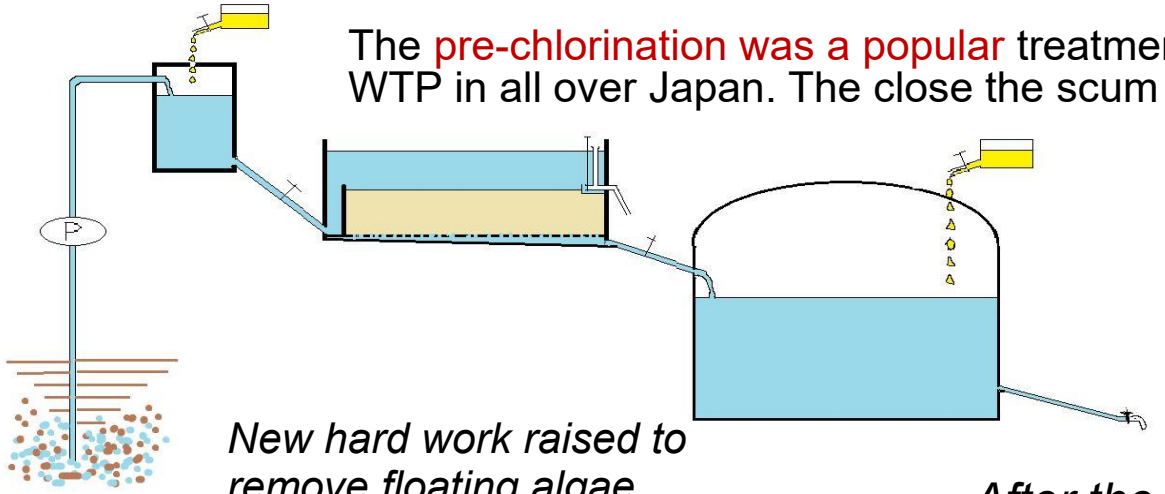








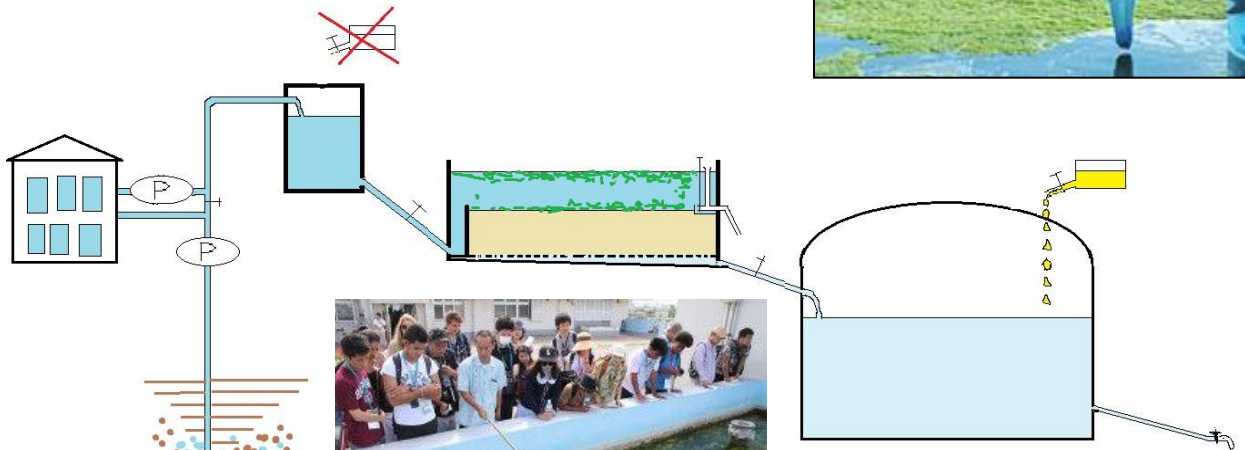
They pumped up the underground water as water source. They could not flow out from the scum out. In the pond, algal bloom was so severe. The pre-chlorination was introduced to kill the algal activity.

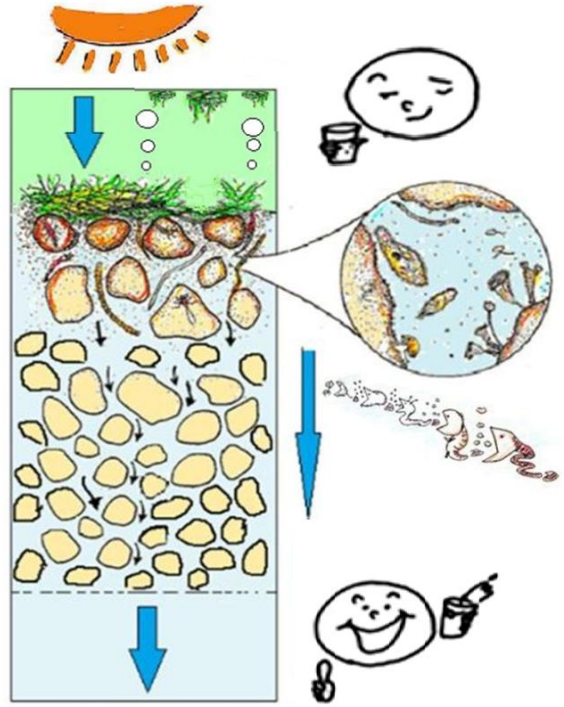


The pre-chlorination was a popular treatment to kill the algal growth for WTP in all over Japan. The close the scum out was also popular.

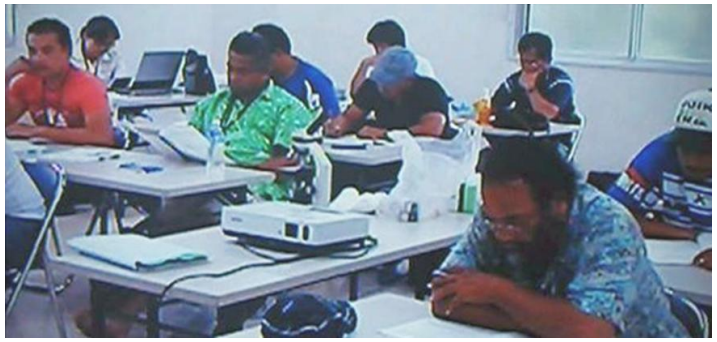
New hard work raised to remove floating algae.

After the injection stopped in 1997, the algae grew well in filter ponds. ***The taste of tap water became delicious.***





I started JICA training on EPS in Okinawa from 2006.




At the end of the six-week JICA training in Okinawa (September 1, 2010), Ms. Marista from the Solomon Islands, gave a speech of thanks on behalf of the trainees.

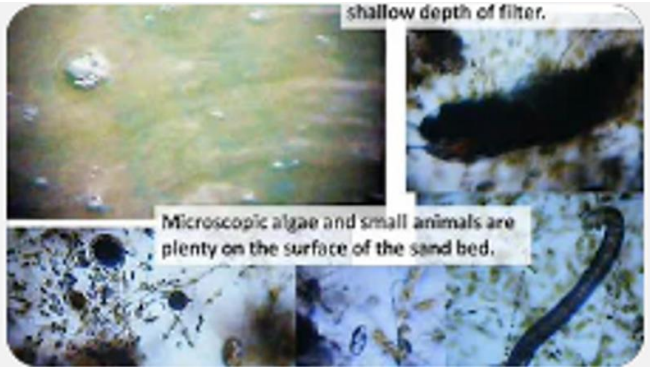
It is also worth appreciating the Ecological Purification System as taught by you, Dr. Nakamoto; a simple, natural and yet an effective water purification technology, we can all agree to as the most relevant technology for the Islands.

It is cheap to construct, operate and maintain which makes it even more attractive. We are grateful to your pioneering research on this technology and for generously impart this to us, so that the people of the pacific may in the very near future will have access to the high quality and delicious taste that this technology provides.

International Course on Slow Sand Filter in Okinawa, in 2010 by JICA

YouTube / 6:08

https://www.youtube.com/watch?v=c3mVIbmFPqA&t=138s

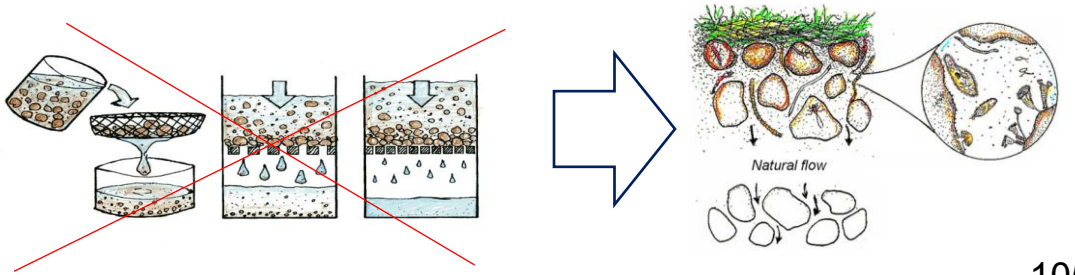


You can deepen your understanding through outdoor experience rather than classroom lectures.

Slow sand filter problem in Samoa was solved by ecological point in 2010 – YouTube / 13:45

https://www.youtube.com/watch?v=Kkk-wdlHui4

This problem was happened by the misunderstand of the real mechanism. Slow sand filter system is not simple mechanical filter. This is a real Ecological Purification System.



Samoan people used non-treated water (Non-purified water), before construction of Alaoa Purification plant (1984).

Joseph River company (Germany) constructed 5 slow sand filters only during 1984-87.

Filters were blocked with turbid matters by storm event.

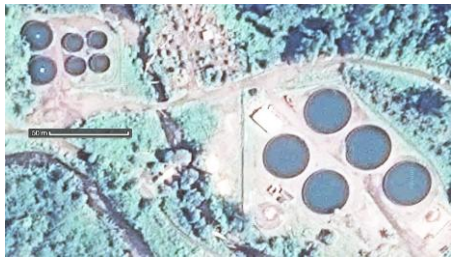
*Dorsch consult (Germany) constructed Settling tanks and **Up-flow roughing filters** in order to reduce the extraordinary load of surface run off by storm event in **2000**.*

5 Slow sand filters 1984-'87

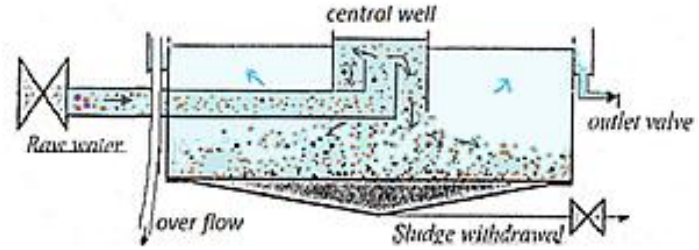
https://eps.watervision.jp/wp-content/uploads/2025/04/AlaoaDurch-Manual.pdf

Slow Sand Filter ⇒ Ecological Purification System :

Purification was done by the function of biological communities. It was the food chain.



Settling tanks

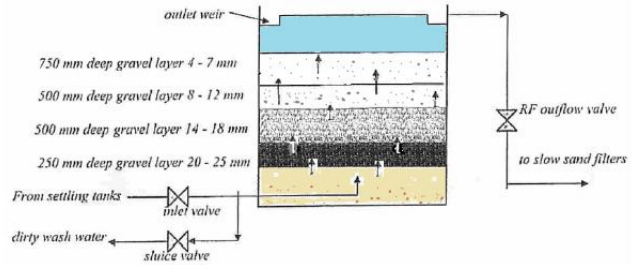


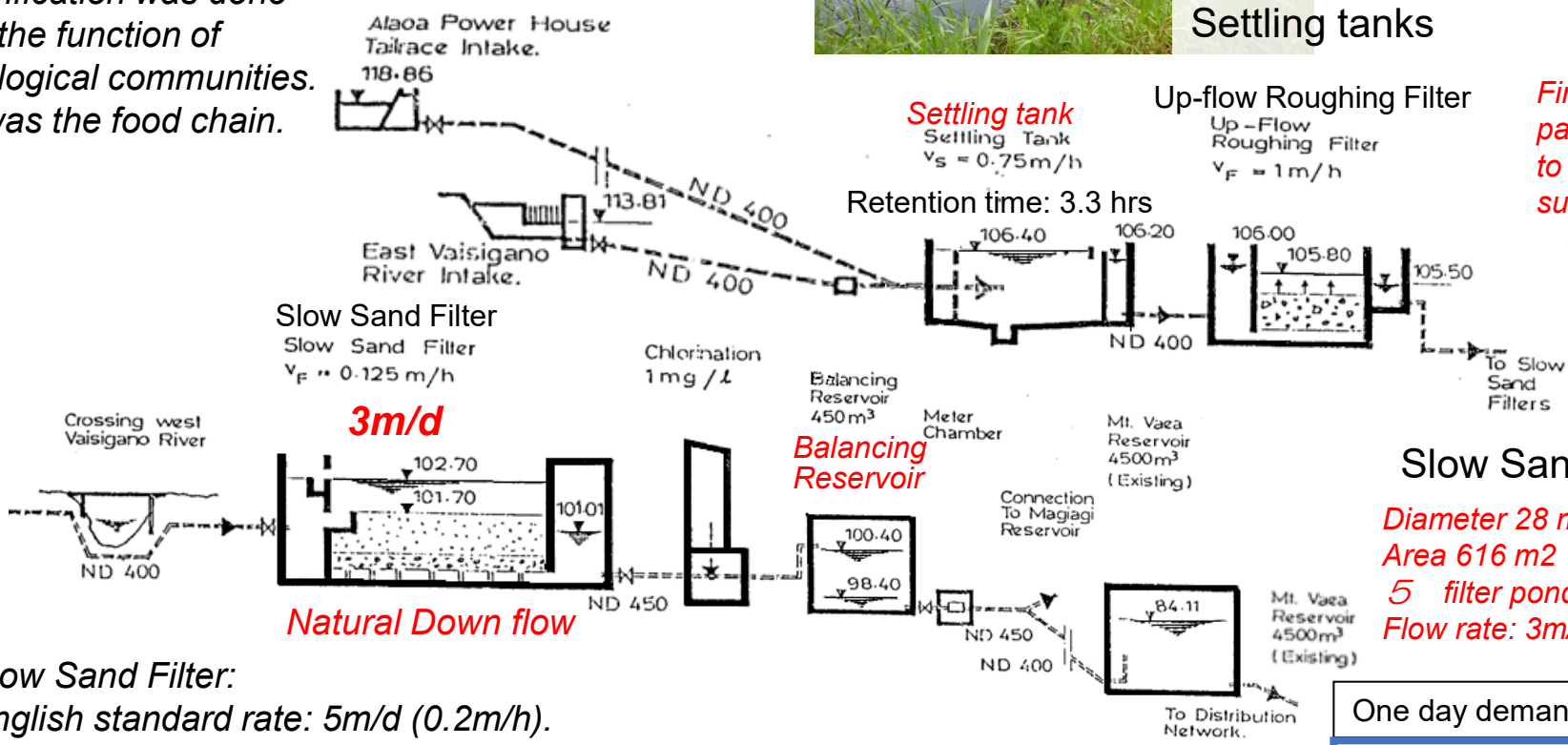
Diameter 17.8 m
Area 248.8 m2
2 tanks
Retention time: 3.3 hrs

Up-flow Roughing Filter:

Fine, light particles cling to the gravel surface

Diameter 11.2 m
Area 98.5 m2
4 filters
Filter rate: 1m/h





Slow Sand Filter

Diameter 28 m
Area 616 m2
5 filter ponds
Flow rate: 3m/d

Slow Sand Filter:
English standard rate: 5m/d (0.2m/h).
Present Thames rater: 10m/d(0.4m/h)
Our experiment in Samoa :2013: 5m/d、10m/d 、20m/d
= Any rate is good results.
Samoa is located in warm region.
Biological Activity is always good.

One day demand: 0.1 to 0.3 m3/day person (Japan)

IF: One day demand: 0.2 m3/day person (Samoa)

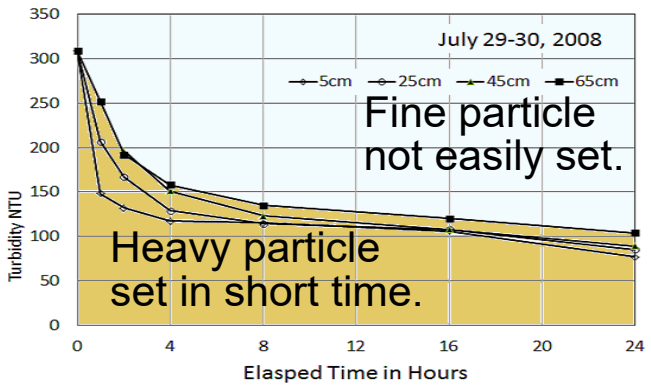
616 m2 x 3m/d = 1,848 m3/d x 5 filters = 9,240 m3/d
5m/d : 3,080 m3/d x 5 filters = 15,400 m3/d
10m/d : 6,160 m3/d x 5 filters = 30,800 m3/d

⇒ 0.2 m3/d = *46,200 persons*
⇒ 0.2 m3/d = *77,000 persons*
⇒ 0.2 m3/d = *154,000 persons*

Heavy rains during the rainy season cause filter blocks, which are a major problem. Water leakage from water supply pipes is also a problem.

Samoa 217,000 persons (2023)
Apia 36,000 persons (2021)

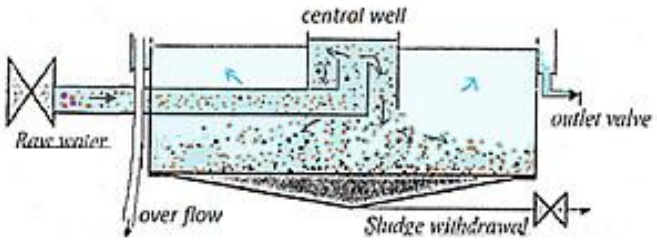
We advised: Reduce inflow water for set turbid matter.

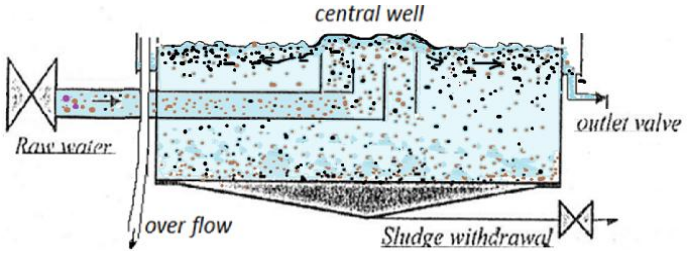


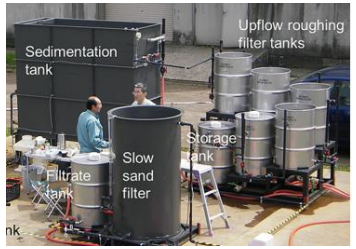
Result of pilot plant in Japan.

The ideal is a calm surface.

Retention time: 3.3 hrs (design)







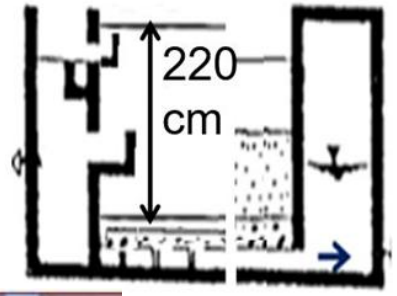
We reduced the inflow rate.

We advised: Put more sand to make shallow depth.

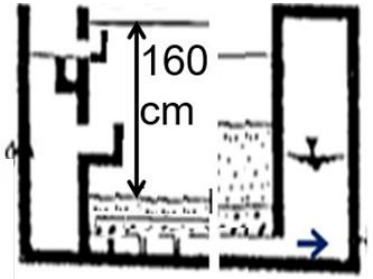
Large mud on the bottom

Deep

220 cm Deep



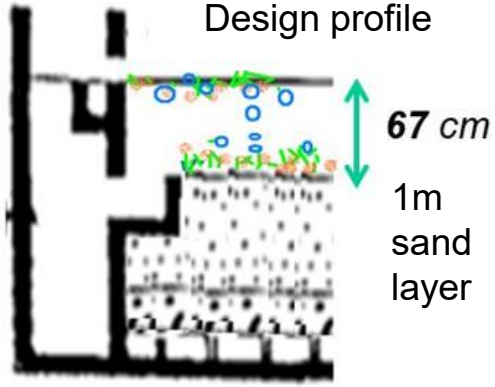
Almost no sand layer.



Shallower depth

Lifted algal mat with mud.

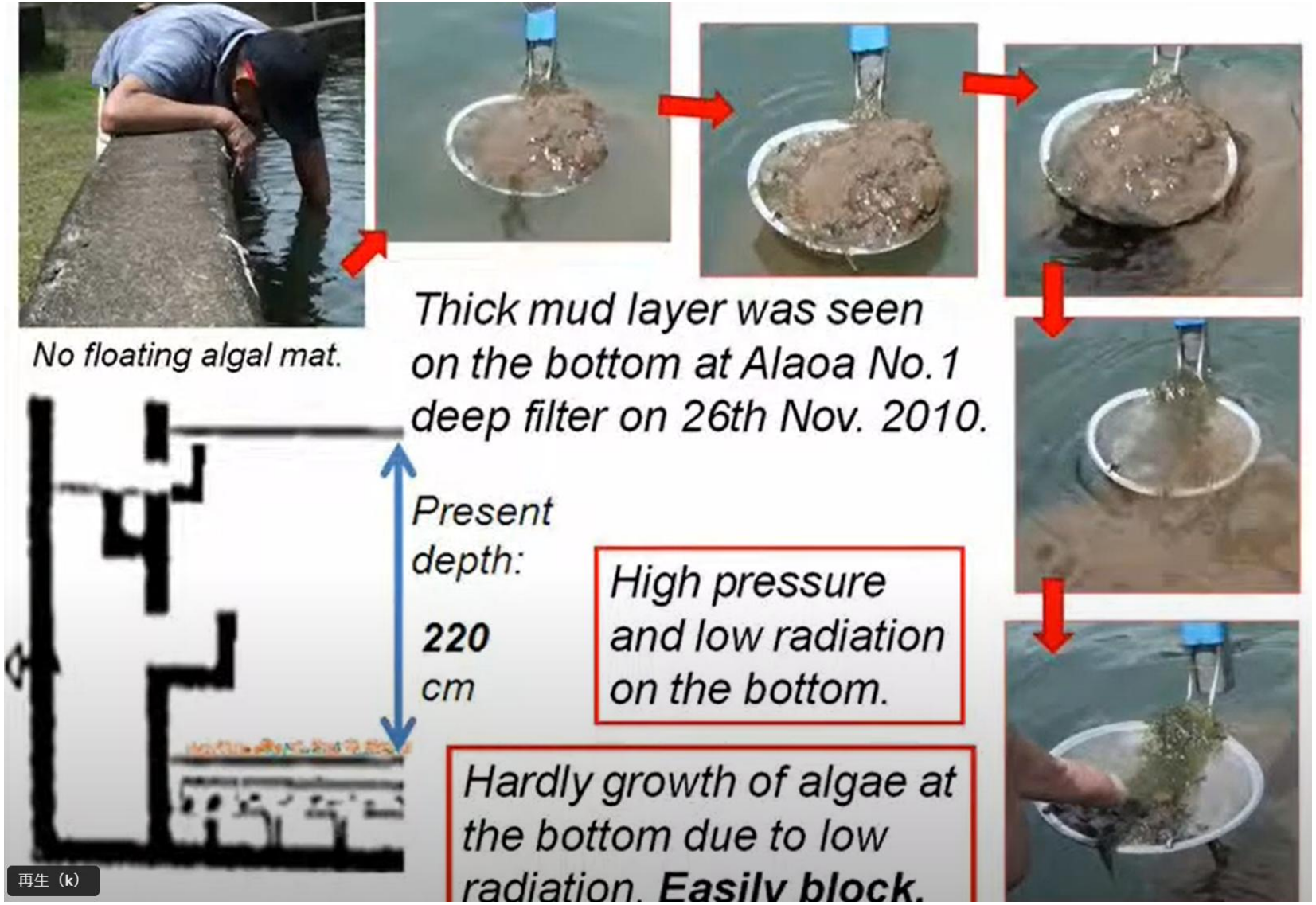
Design profile



1m sand layer

Shallow depth: Active photosynthesis: much oxygen bubble formation.

Shallow Water Depth is the Key for Ecological Purification System of a Filter Pond.



Hardly growth of algae on the deep bottom.

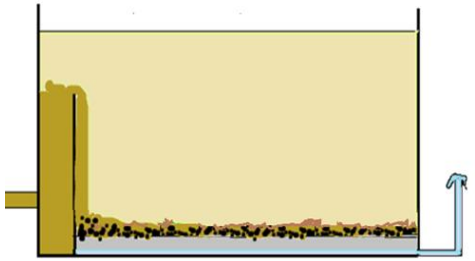
In shallower pond, algal mat lifts up by photosynthetic bubbles.

Role of algal mat in slow sand filter, shallow depth is key: experience in Samoa - YouTube/ 5:05

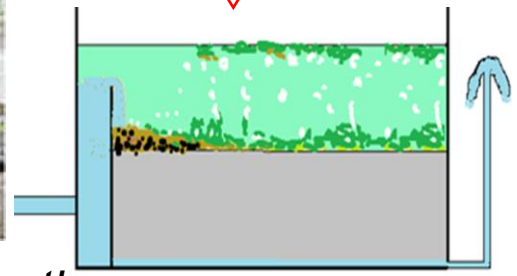
https://www.youtube.com/watch?v=ot-KAm6TuaY

I advised to use beach sand and easy way to wash.

Beach sand *near a river mouth was washed to make a shallow depth of slow sand filter pond.*



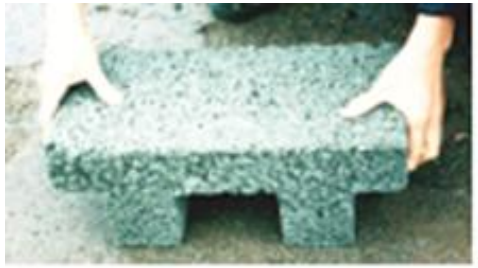
From Deep to Shallow

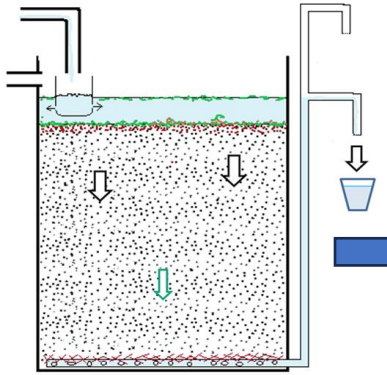


Put sand to make shallow depth.

I advised easy way to put the sand using a cloth seat.

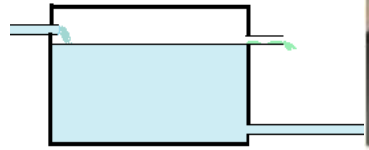
I knew there was only sand layer on bottom porous brick in slow sand filter pond in UK.



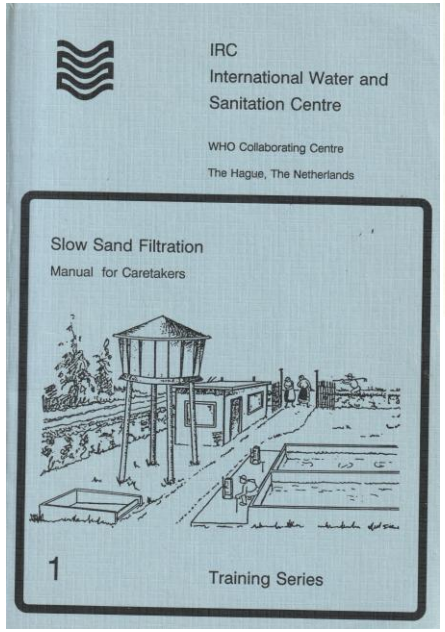


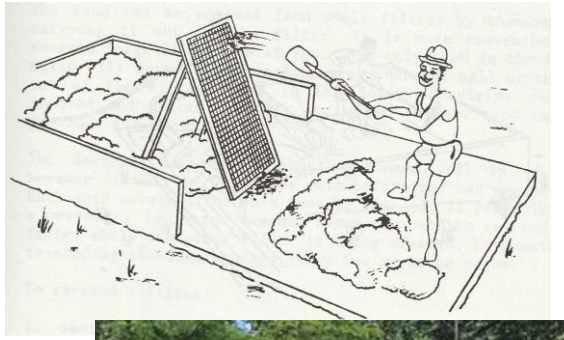
Mesh cover on a porous pipe

Only the sand was put on the gravel layer using a cloth to separate them.



Over-flow from the balance tank for filtrate water.





From the video photo of friend of Samoa Water Authority.

https://www.ircwash.org/sites/default/files/255.1-85SL-1994.pdf

IRC Slow Sand Filtration
Manual for caretakers

How to wash the sand.
How to set the gravel layer and sand layer.

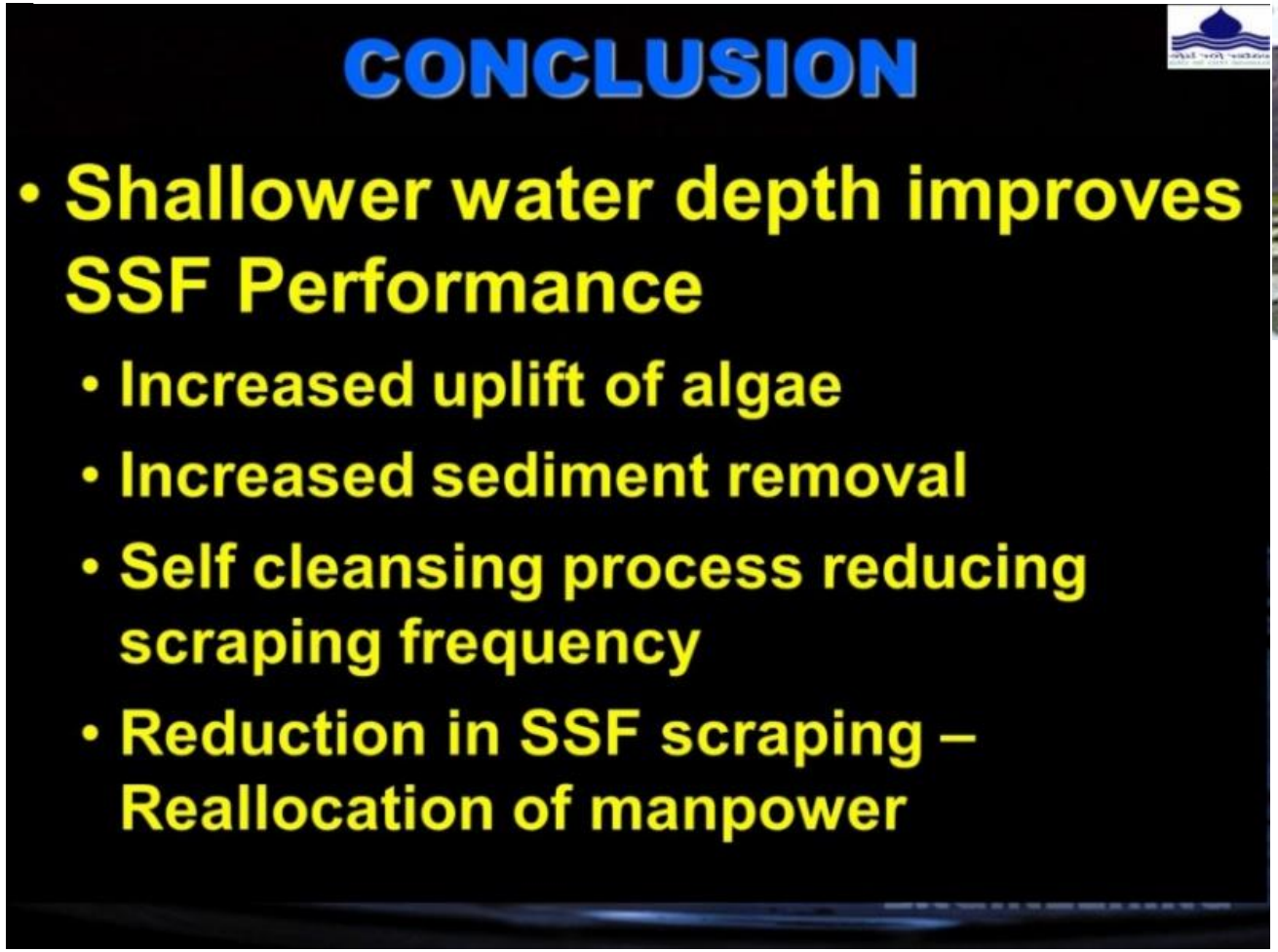
https://youtu.be/IfoI8D3tAAc

4 min:12”

June, 2025

Stuffs of Samoa Water Authority presented their activity at the **5th Conference at Nagoya, Japan in 2014**.

They made shallow water depth of 0.5 - 1m.



名古屋市上下水道100周年

The 100th Anniversary of
Waterworks & Sewerage of Nagoya

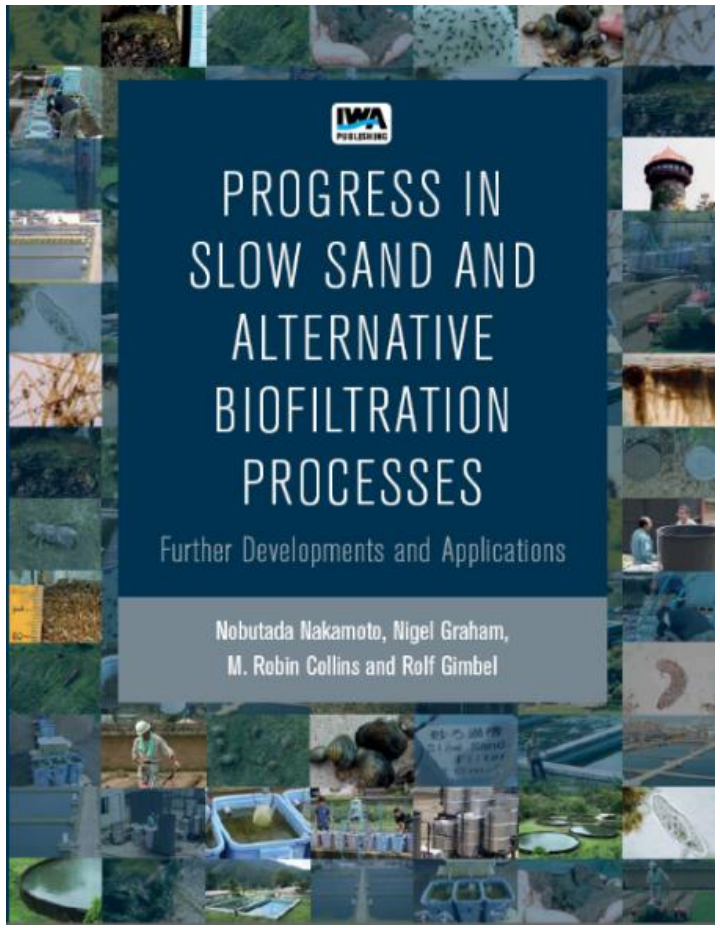
5SSABC

第5回　緩速・生物ろ過国際会議　19th(Thu) June - 21st(Sat) June 2014
The 5th International Slow Sand and Alternative Biological Filtration Conference

Professor
Nigel J.D. Graham
Imperial College London, UK
Chairman,
Program Committee

Professor
M. Robin Collins, Ph.D., P.E.
University of New Hampshire
Vice-chairman,
Program Committee

Professor (Emeritus)
Nobutada Nakamoto
Shinshu University, Japan
Vice-chairman,
Program Committee

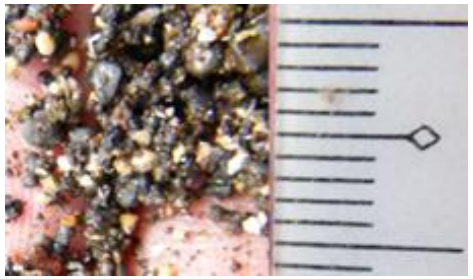


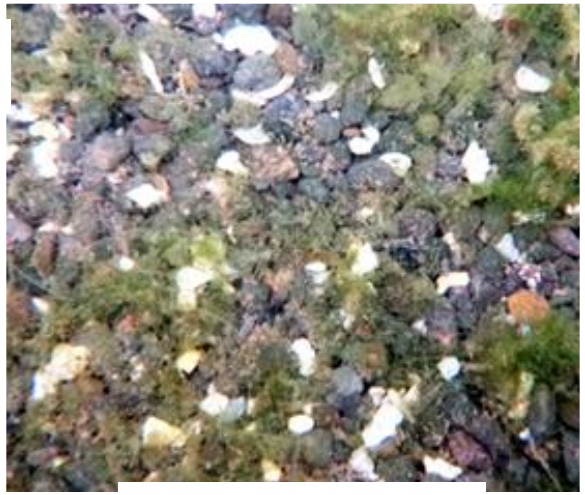
https://www.youtube.com/watch?v=Wv1FxTkDfsM&t=2s

5SSABC - YouTube / 14:15

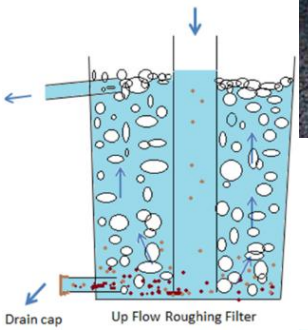
Biological activity is related with radiation and temperature.

Sand washed with mosquito mesh (1-2 mm)





Feb.7.(8th) 2013



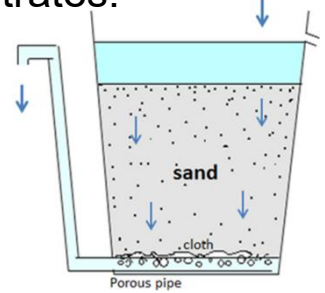
Feb.14.(15th)

Shallow depth: Algae grow well

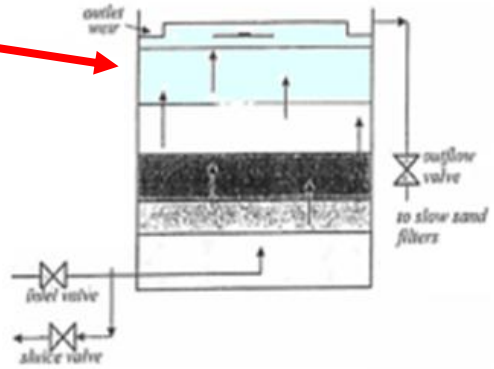
High flow rate experiment for the performance of slow sand filter was done in Samoa (tropical region) from Dec. 2012 to Feb. 2013.

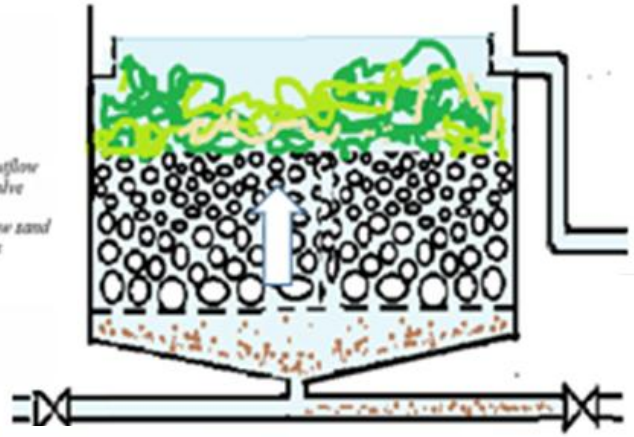
Different flow rate of sand filters (**5m/d, 10m/d, 20m/d**)
All good quality of filtrates.

Points:
shallow depth,
enough radiation
on the bottom,
rapid growth,
large size of sand.

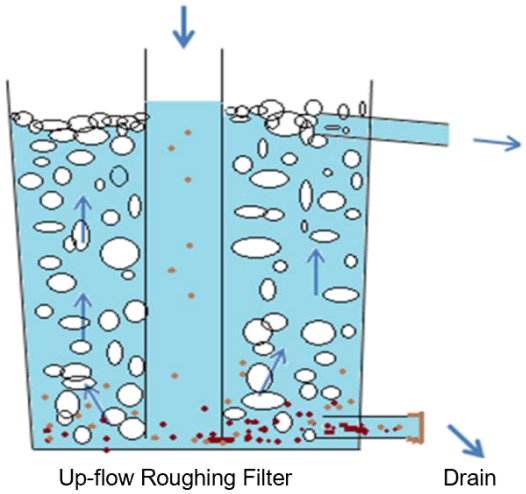


Dorsch 1 m

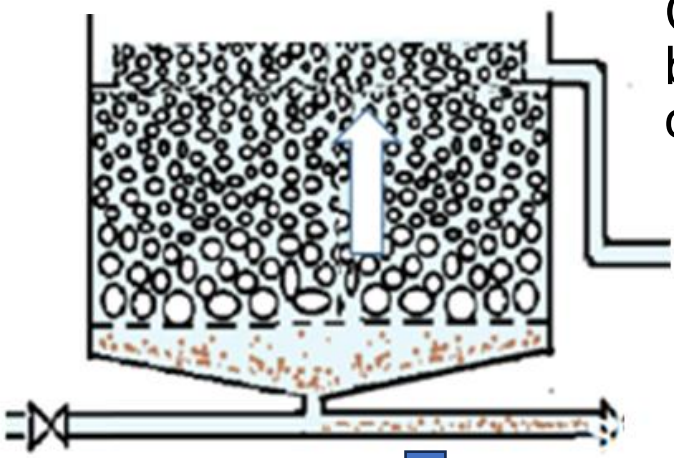




Clear water in river bed in enough area of gravel surface.



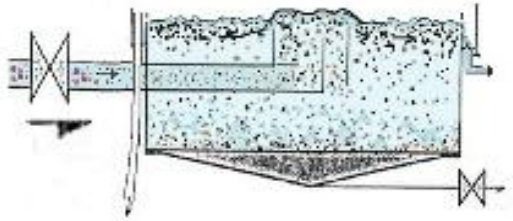
Active growth in URF

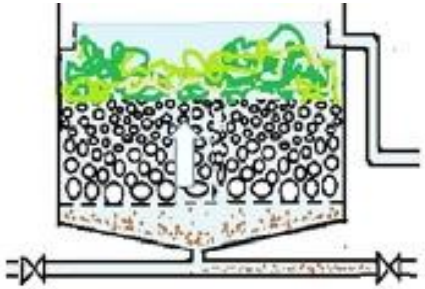


Large area of gravel surface is important to adhere suspended matter.

Full gravel with small crushed stones.

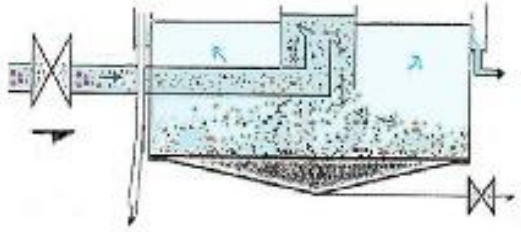
Advise for a better plant system to Samoa

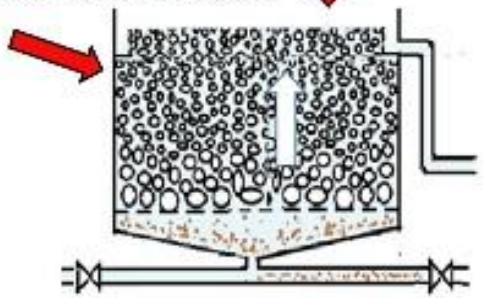




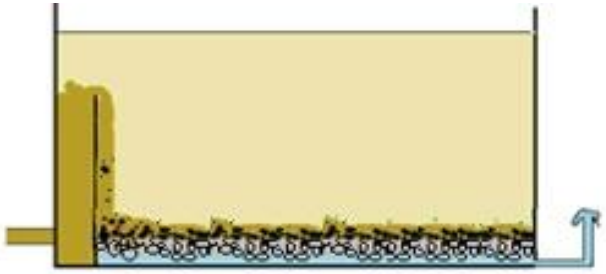
Reduce inflow
⇒Easy to settling

Thicker gravel media
⇒Expand active area

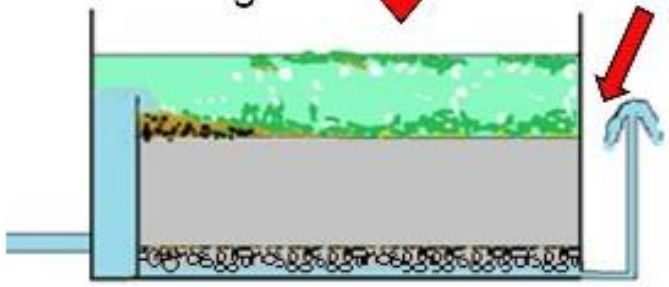


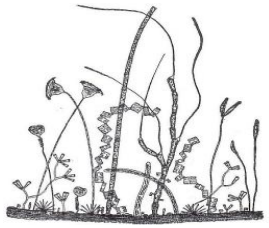


Improvements to the Purification Function.

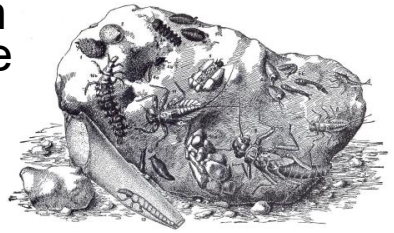


Make shallow depth
⇒ Activate algae

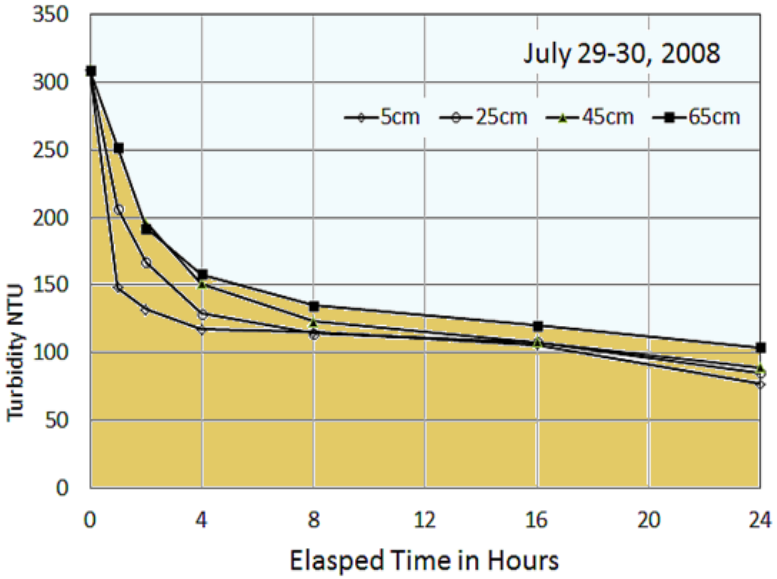




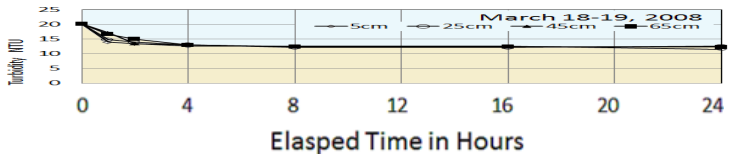
Small organisms active on the stone surface.



Suitable residence time for settling



Clear water



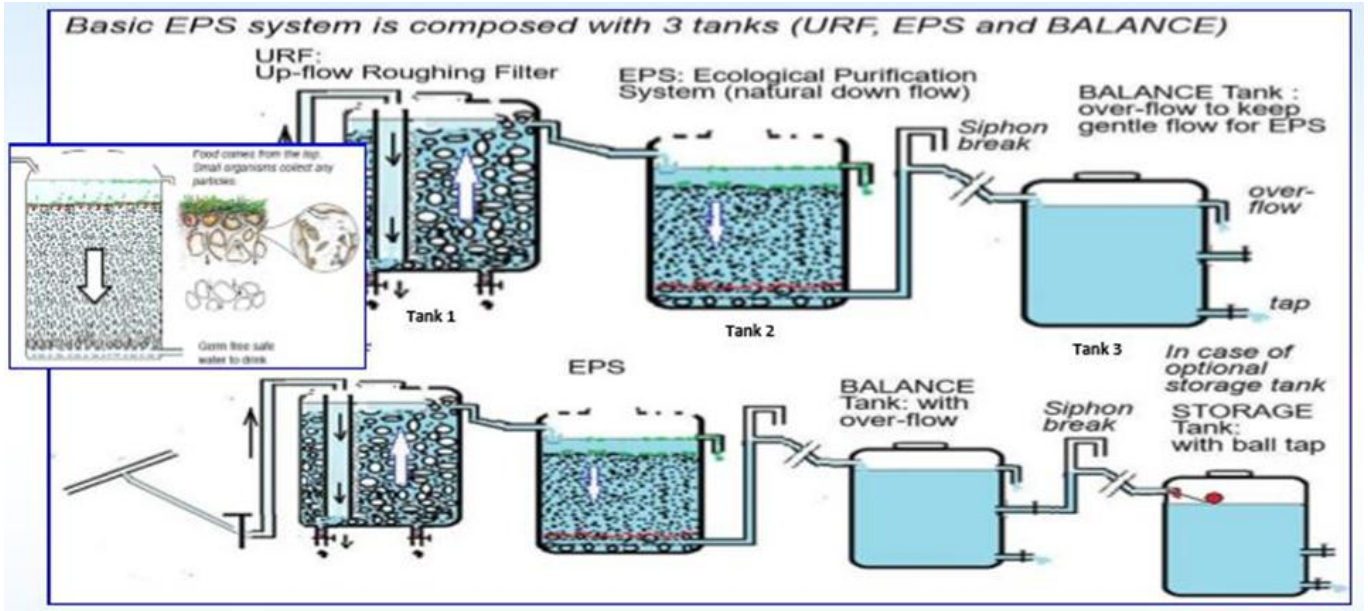
Shallow depth is better for algal activity.

⑦ From Okinawa to Fiji

CONSTITUTION
OF
THE REPUBLIC OF FIJI

New plans for cleaner water

https://www.youtube.com/watch?v=wxAGhjx7e40



Hungry is Normal.

JICA training in Miyako Jima, in Aug. 2011.

Mr. Vishwa Jeet from Fiji asked me many questions during the training in 2011.

New Constitution of Fiji shall come on 7 September 2013. p24, No.36.

https://laws.gov.fj/ResourceFile/Get/?fileName=2013%20Constitution%20of%20Fiji%20(English).pdf

CONSTITUTION
OF
THE REPUBLIC OF FIJI

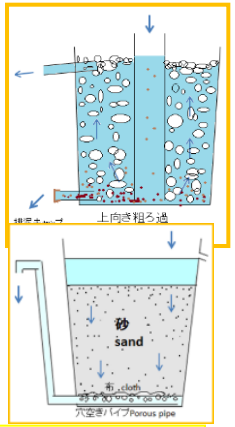
36. Right to adequate food and water

36.—(1) The State must take reasonable measures within its available resources to achieve the progressive realisation of the right of every person to be free from hunger, to have adequate food of acceptable quality and to clean and safe water in adequate quantities.

Remember Three Steps *He remember these words.*

1. Knowing is NOT enough, we must APPLY it to something useful.
2. Willingness is NOT enough, we must PUT it into the PLAN and ACTION.
3. Putting the PLAN into action is NOT enough, we must ACCOMPLISH the goals.


JICA Training at Okinawa, in **August, 2011**



Mr. Vishwa Jeet from Fiji gave many questions to me.

He returned back to Fiji, he made a model to make safe drinking water by EPS technology at the yard of Department of Sewage and Water. Water source was rain harvest tank.

The PM had attention for EPS display during the World Marine Time Day **on Sept. 28, 2012.** Our Director informed the PM on the functions of the EPS and reference to JICA was made.

Kick off Workshop on **Jan. 16. 2013**. at Holiday Inn. Commander Francis B. Kean, Permanent Secretary, Ministry of Works, Transport, Public Utilities.

Holiday Inn: Jan.16.2013


NATIONAL NEWS

New plans for cleaner water

https://www.youtube.com/watch?v=wxAGhjx7e40

The Fiji Times ONLINE

Quality water for all

Priya Chand
Thursday, January 17, 2013

WITH the new Ecological Purification System (EPS) in the pipeline, water quality enjoyed by urban people can now also be made available in rural villages and communities.

A workshop on a new water treatment system, hosted by the Department for Water and in collaboration with the Japan International Cooperation Agency (JICA) in Suva yesterday, revealed that EPS was an economical and ecological way of purifying water.

Works permanent secretary Commander Francis Kean said the vision to provide safe adequate water and efficient sanitation to the whole population in Fiji was in government's roadmap.

"About 70 per cent of our rural population drink water directly from creeks and river sources which are most

+ Enlarge this image

Water treatment expert Dr Nakamoto Nobutada speaking at the Holiday Inn.
Picture: ELIKI NUKUTABU


Jan. 17. 2013.,
Dept. Sewage and Water


Rain harvest tank of 2.7 tons for this project.

THE FIJIAN GOVERNMENT

EPS technology is our technology for ours. We can make it by ourselves.

KALOKOLEVU VILLAGERS WELCOME ACCESS TO CLEAN DRINKING WATER

7/17/2013

More than 270 villagers in Lami now have access to clean and safe drinking water through an ecological purification system (EPS), thanks to the partnership between the Department of Water and Sewerage, the Water Authority of Fiji (WAF) and the Japan International Cooperation Agency (JICA).

The EPS, which is the first of its kind to be installed in a local rural setting, was commissioned by the Ministry of Works, Transport and Public Utilities permanent secretary Commander Francis Kean in Kalokolevu village, Lami yesterday.

Commander Kean said the pilot project was aimed at improving accessibility to clean water and sanitation to people living in rural areas.

He said this is a major milestone for the country and the Government in particular in its desire to lift the living standards of people in the rural and maritime areas.

"Improving the living standards of the rural citizens through better accessibility to clean water and sanitation is one of the key priorities of this Government as enshrined in the Peoples Charter for Change, Peace and Progress and the Government Roadmap to Sustainable Development in the medium term," Commander Kean said.

Ecological Purification System in Fiji, 2013 for Safe Drinking Water - YouTube/ 3:05

https://www.youtube.com/watch?v=kbCaSAACQZ0

Beginning of Ecological Purification System (EPS) to make safe drinking water in Fiji / 1:45

https://www.youtube.com/watch?v=wxAGhjx7e40

EPS technology is our technology for ours. We can make it by ourselves.

THE FIJIAN GOVERNMENT

Opening ceremony of public tap on September 11, 2013. at 2nd Eps.

Clean, safe water brings joy to village

NAVATUVULA VILLAGERS GET ACCESS TO CLEAN DRINKING WATER

9/12/2013

Improving the living standards of the rural communities through better accessibility to c safe drinking water and sanitation is one of the key priorities of the Fijian Government.

This was highlighted today by the Ministry for Works, Transport and Public Utilities perm secretary, Mr Francis Kean at the commissioning of the second ecological water purificat (EPS) at Navatuvula village in Sawani, Naitasiri.

The first EPS was commissioned at Kalokolevu village in Lami about two months ago.

Mr Kean said his ministry's aim is to install EPS into rural water supply systems to ensu removal of contaminants before water is consumed.

"The incorporation of the EPS into rural water projects will take place after further moni the results of the pilot projects by the Water Authority of Fiji (WAF)," Mr Kean added.

Villagers of Navatuvula, Naitasiri have a reason to smile, thanks to the governments of Fiji and Japan. From yesterday the villagers started drinking safe and clean water, commissioned by the Permanent Secretary for Works, Commander Francis Kean. The water is supplied through an ecological purification system (EPS) – similar to traditional mineral water production.

Quality Water for All : Safe and Clean Water Project in Fiji, 2013 - YouTube/ 7:43

https://www.youtube.com/watch?v=Vrr2EOS1PMA

EPS was settled between the existing distribution pipes of non-treated water supply. A public tap system of water supply for germ free safe water was proposed.

Water source

Settling storage tank

Sediment heavy muddy matter

EPS can provide 6 liters per person of water for drink and cooking.

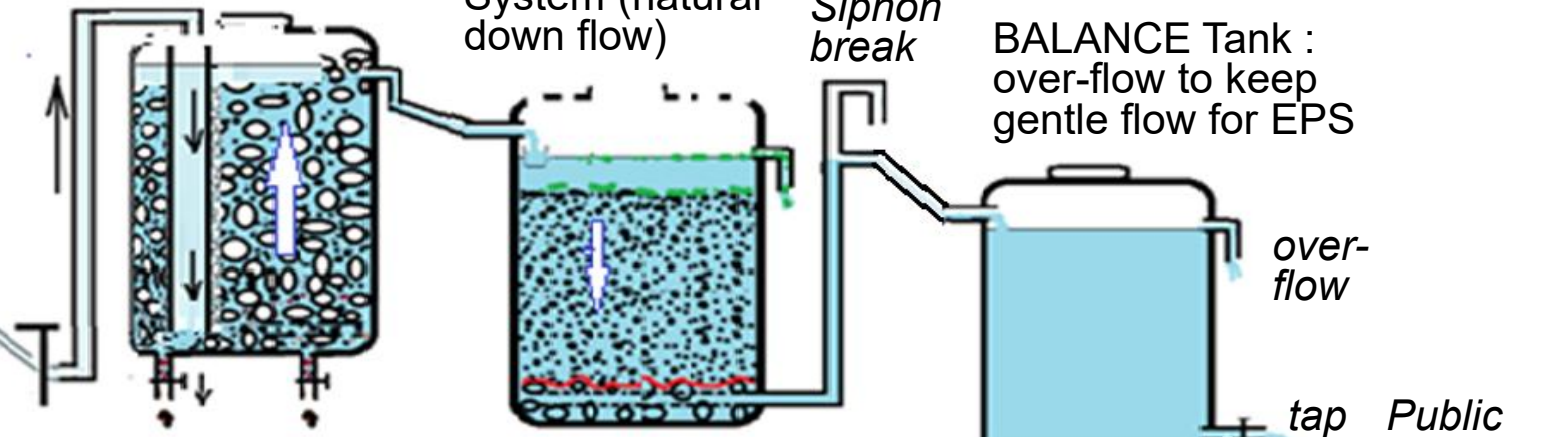
Tap in Village

URF: Up-flow Roughing Filter

EPS: Ecological Purification System (natural down flow)

Siphon break

BALANCE Tank : over-flow to keep gentle flow for EPS



Trap and reduce muddy matter by gravel tank

Complete purification by sand tank

Store the germ free, safe and delicious drinking water

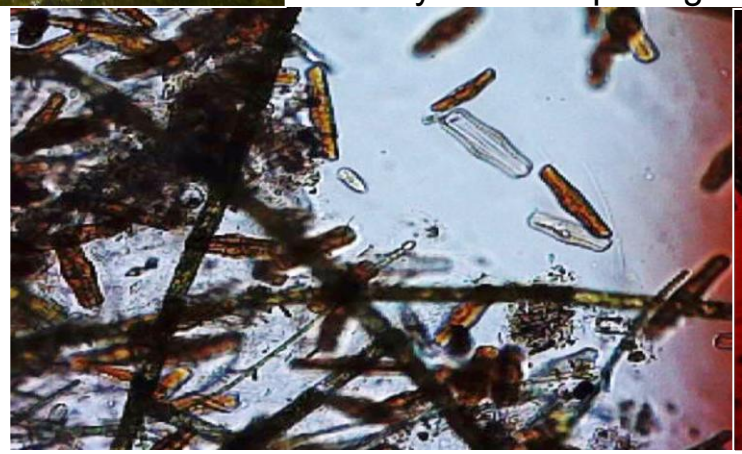
Existing system in village

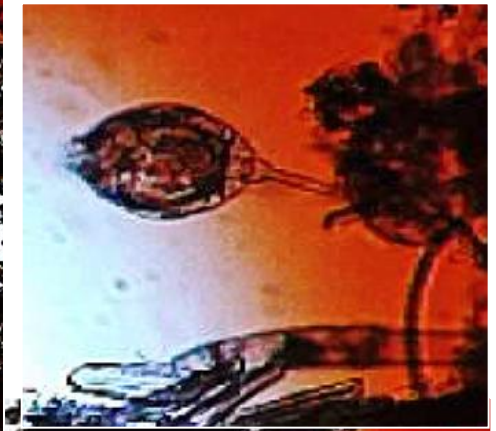
Non treated water

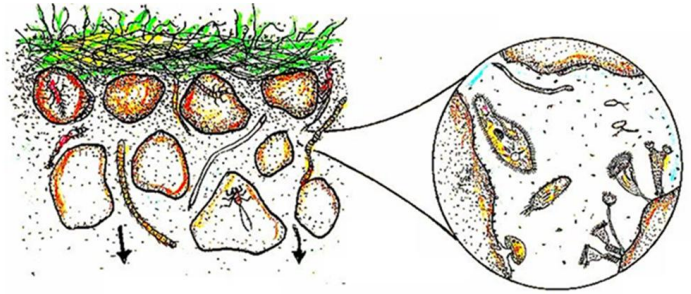
EPS (Ecological Purification System) for germ free drinking water

Look like dirty mud. There are so many microscopic organisms.

I showed microscopic organisms using portable microscope to villagers at the site.







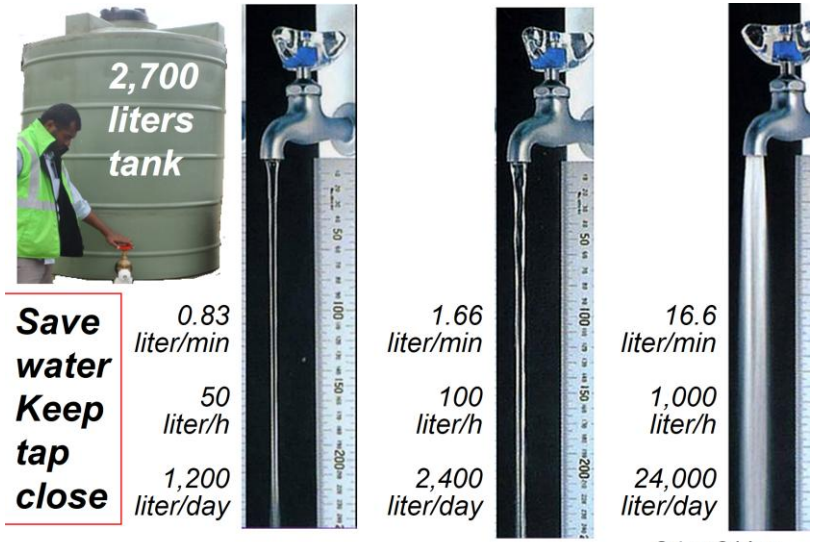
Trap and decompose layer by microscopic and small organisms

Insurance layer for adhesion of leak matters from biological active layer.

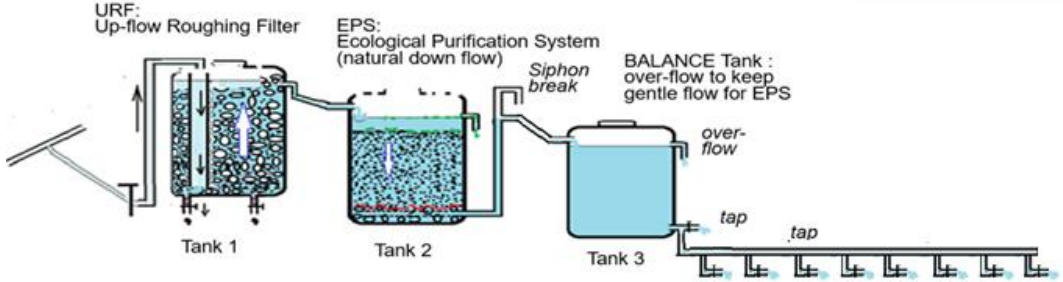
Comment on more use of EPS water in a village

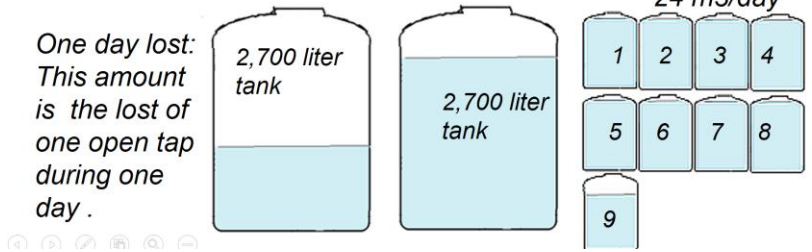
EPS capacity of 2,700 liters tank									
radius（r）=0.7m、（π x r x r）=1.54m2									
flow rate			filtrate			Available persons			remarks
m/d	cm/h	m3/d	liter/d	liter/h	liter/min	2 liter/d	6 liter/d	100 liter/d	
2	8	3.1	3,080	128	2.1	1,540	513	31	Original flow rate in UK, 1829
5	20	7.4	7,392	308	5.1	3,696	1,232	74	English standard rate
10	42	15.4	15,400	642	10.7	7,700	2,567	154	Present Thames Water rate
15	63	23.1	23,100	963	16.0	11,550	3,850	231	Possible rate in warm region
20	83	30.8	30,800	1,283	21.4	15,400	5,133	308	Possible rate in warm region

Drink　　Drink Cook　　Drink Cook Shower



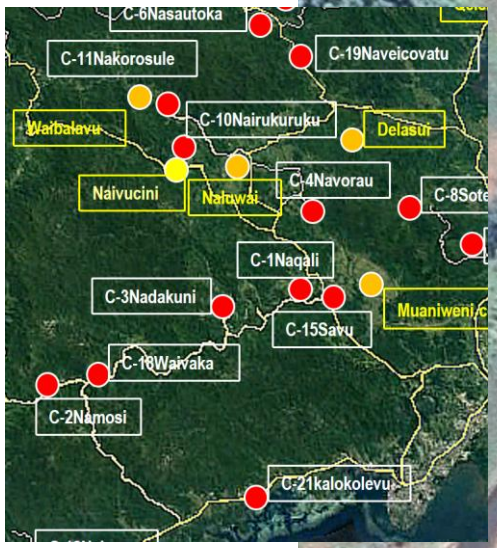
1. Block distribution system for EPS water is recommended.
2. Install more public taps for villagers.
3. Training for the save the limited amount of EPS water.





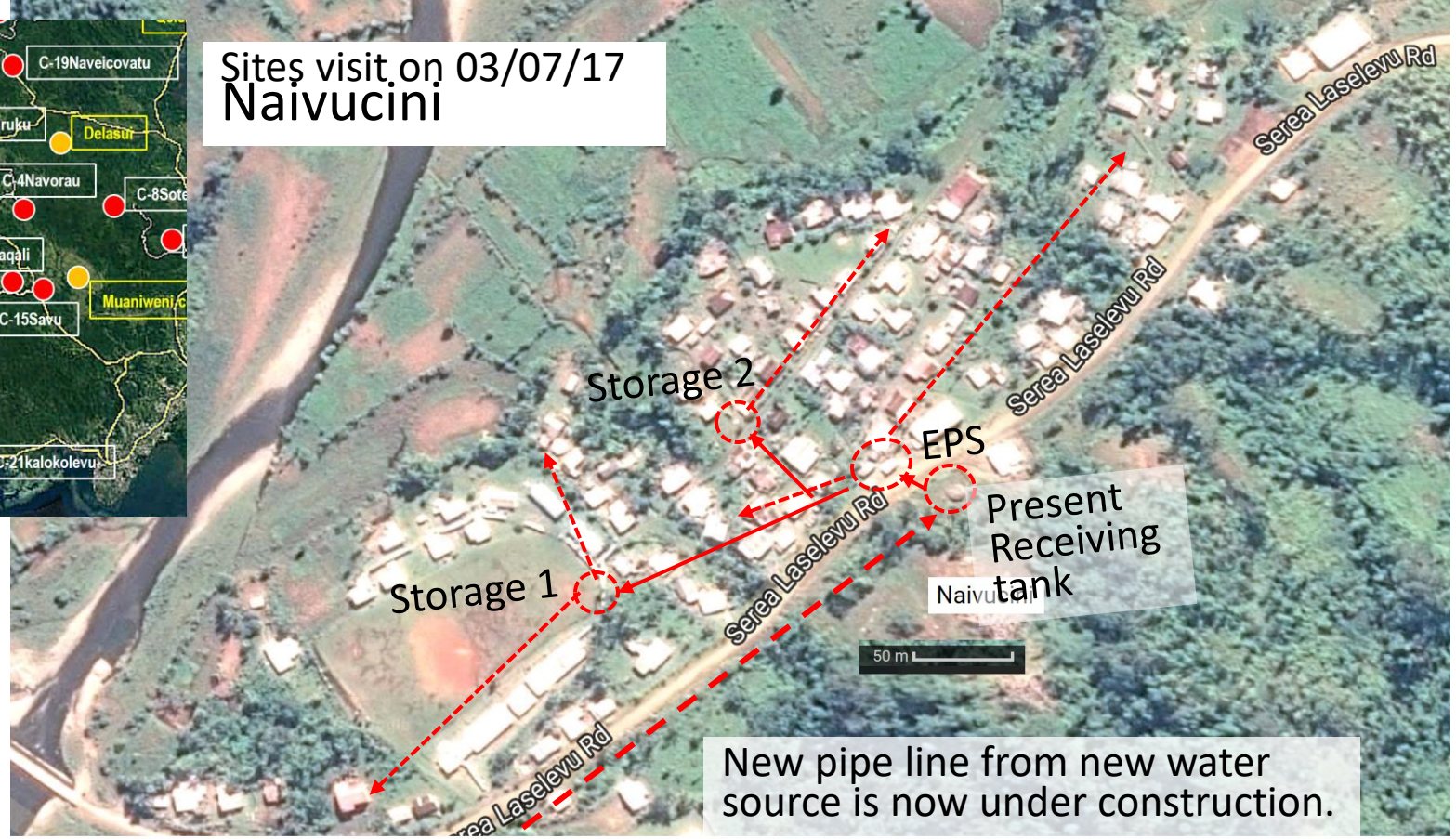
There is non-detected leak, therefore we have to install EPS pipe with may public taps in a small village (even up to 200 persons).

If there is absolutely no leak problem, we may connect to present distribution pipe in case of a small village. But this is risky. I cannot recommend this connection.



Sites visit on 03/07/17

Naivucini



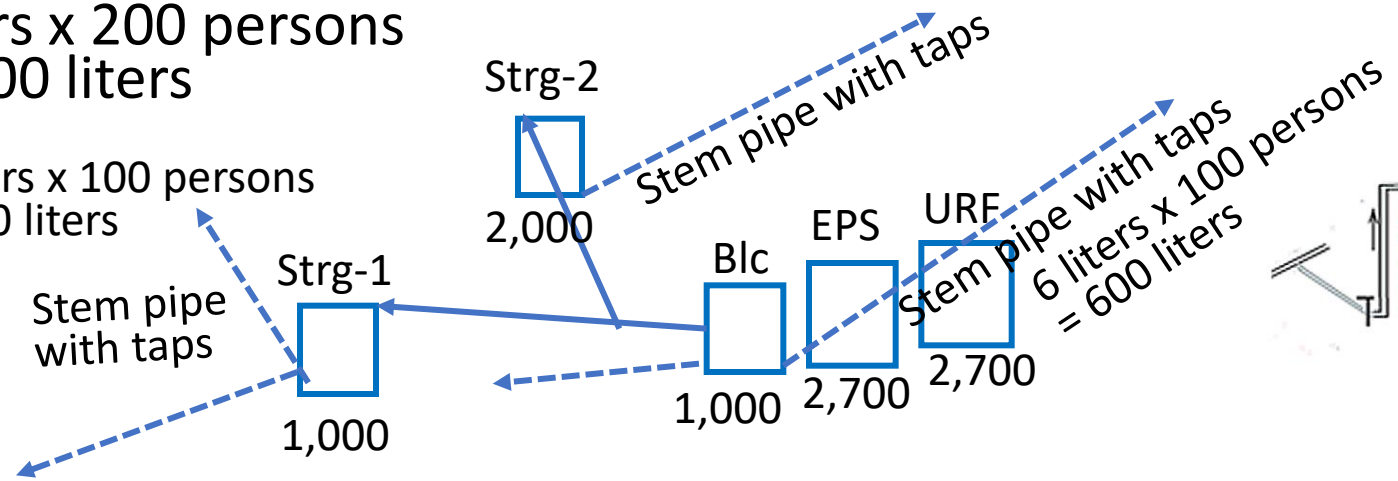
New pipe line from new water source is now under construction.

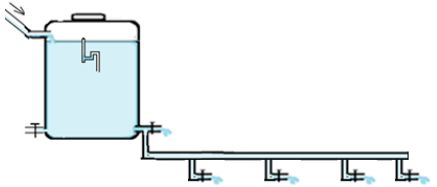
Present Receiving tank.
Water shortage problem.

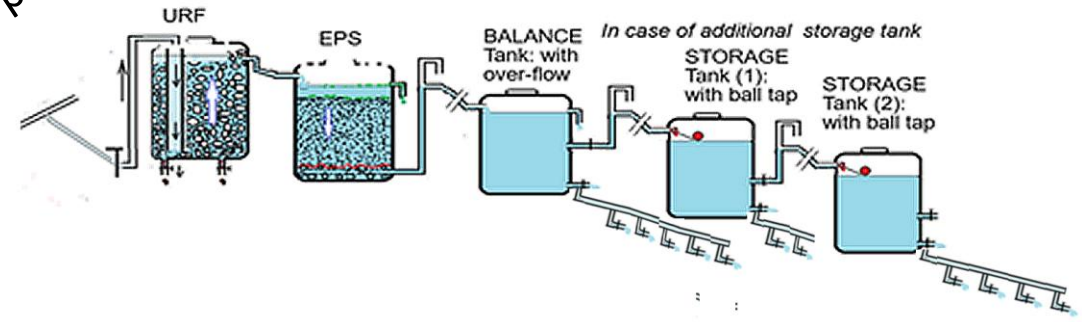
NEMANI TG 9501657
500 persons 120 houses

More use of EPS water is key to be better quality.

6 liters x 200 persons
= 1,200 liters





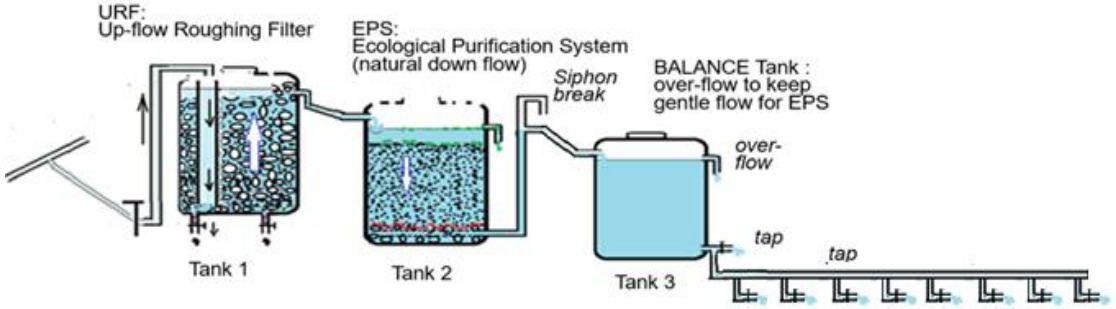


Comment on more use of EPS water in a village

There is non-detected leak, therefore we have to install EPS pipe with may public taps in a small village.

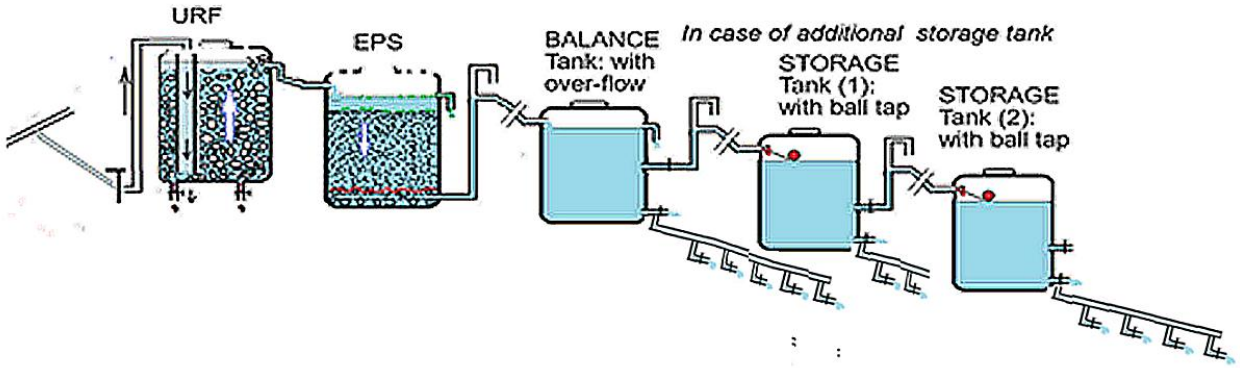
Up to 200 persons in a village

If there is no leak problem, we may connect to present distribution pipe in case of a small village. But this is risky. I cannot recommend this connection.

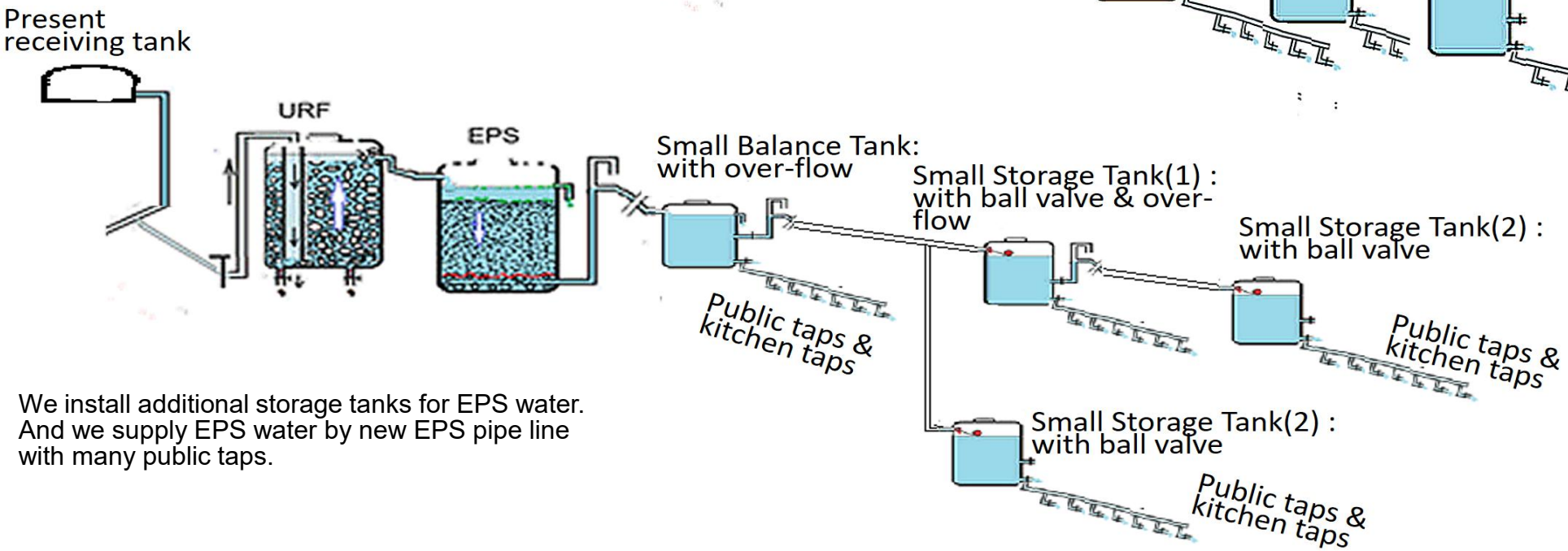


200 to 500 persons in a village

We supply EPS water by new EPS pipe line with many public taps. Or we install additional storage tanks for EPS water. And we supply EPS water by new EPS pipe line with many public taps.

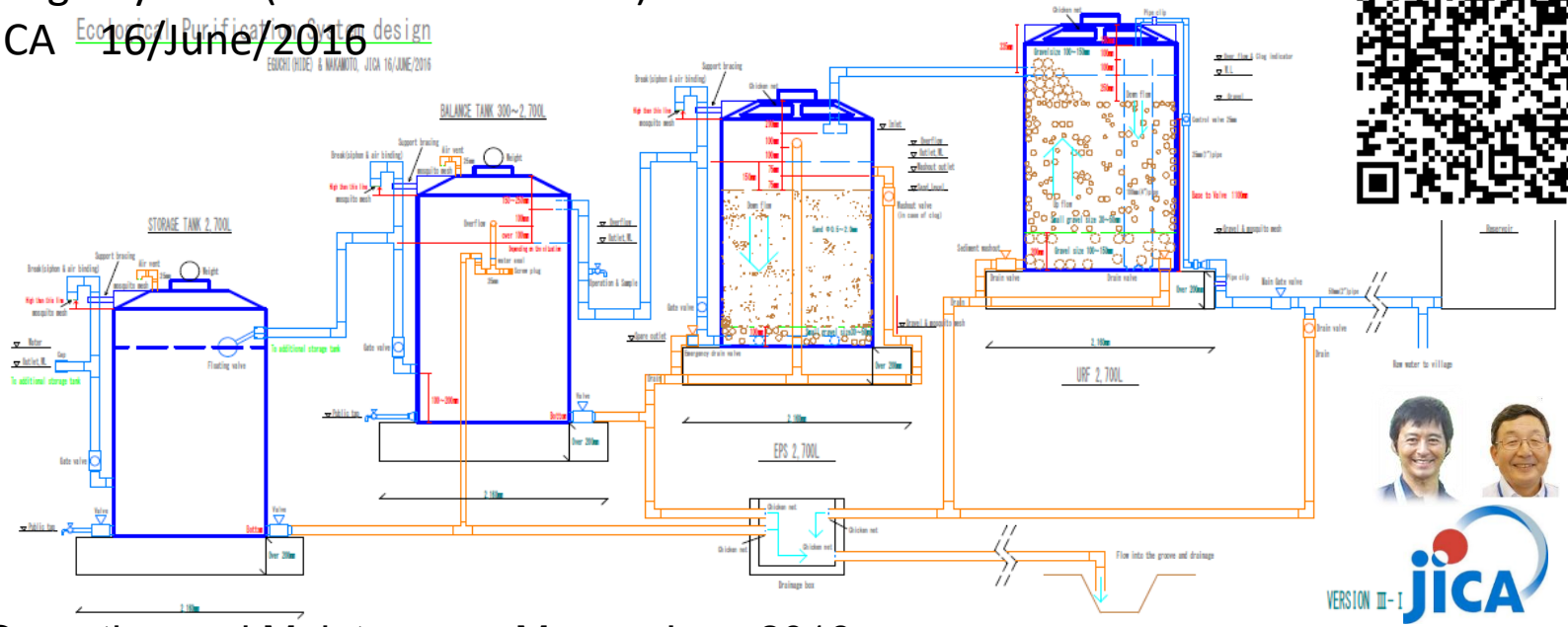


More 500 persons in a village



We install additional storage tanks for EPS water. And we supply EPS water by new EPS pipe line with many public taps.

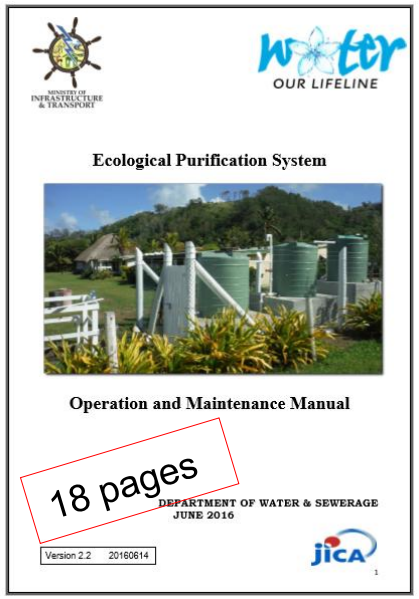
Ecological Purification System for Fijian 2,700 Rota Tank Plant Design by Hide (Hidemitsu EGUCHI) and Nobutada NAKAMOTO JICA 16/June/2016



https://eps.watervision.jp/wp-content/uploads/2025/04/EPS_design.pdf

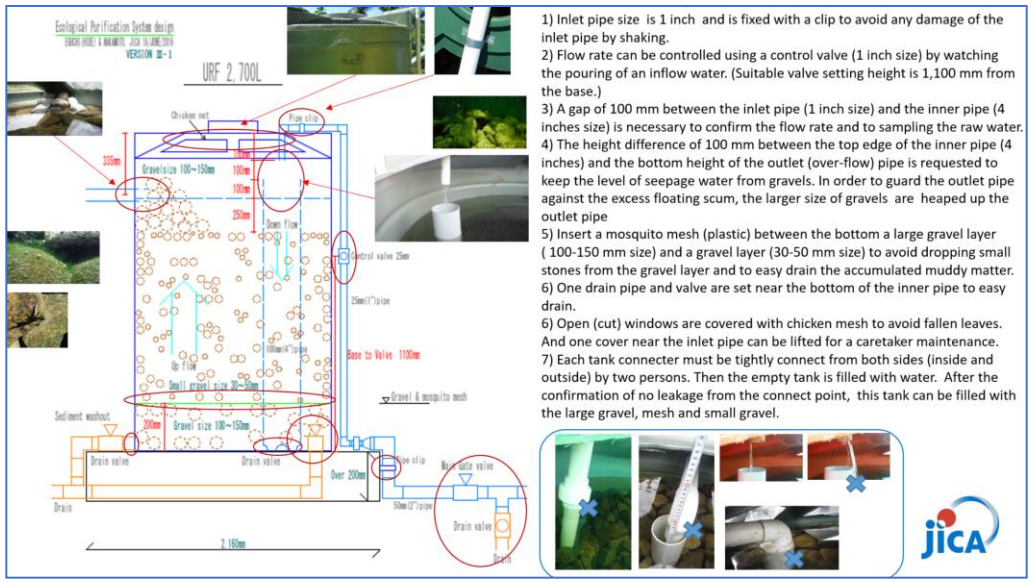
https://eps.watervision.jp/wp-content/uploads/2025/04/Fiji-EPS-2016-tank300-2700CAD-Design.pdf

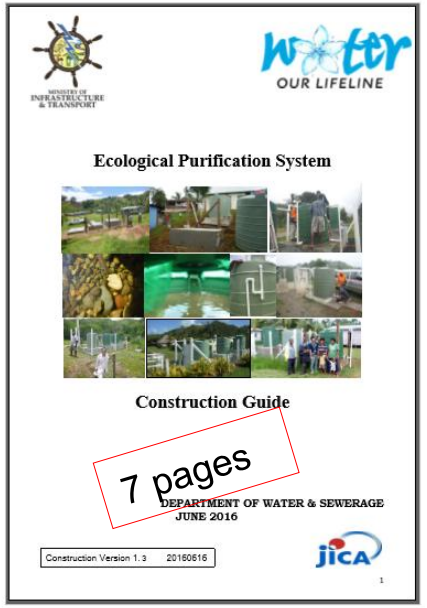
Operation and Maintenance Manua June 2016



https://eps.watervision.jp/wp-content/uploads/2025/04/160614-Eng-Fiji-EPS-Manual_Eng.pdf

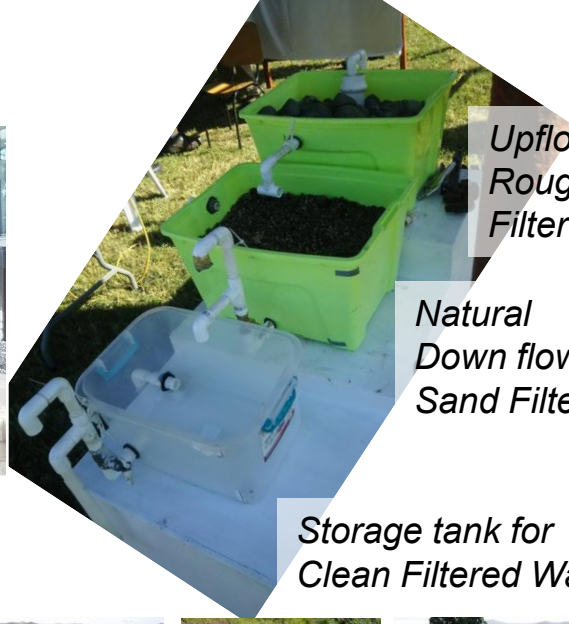
Construction Guide June 2016





World Water Day 2018. March 22/23 Lautoka, Fiji

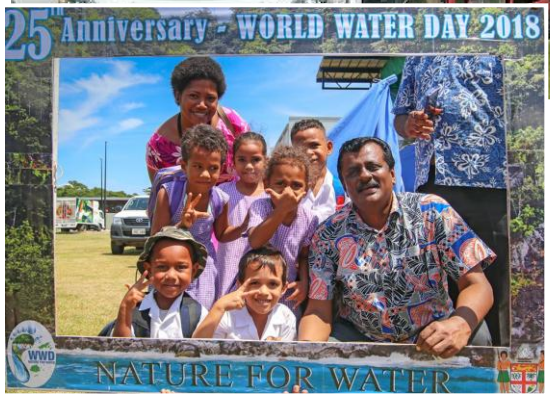
Receiving tank
Sedimentation



Upflow
Roughing
Filter

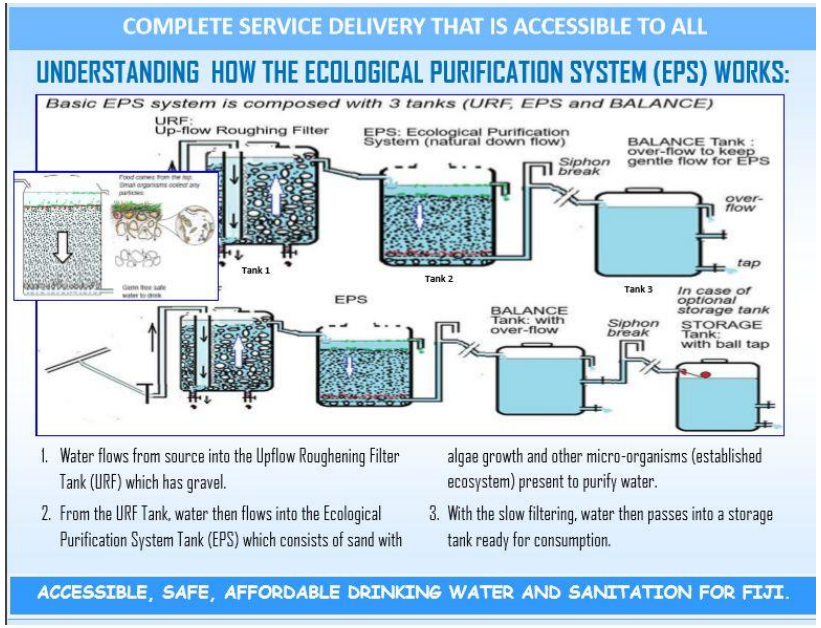
Natural
Down flow
Sand Filter

Storage tank for
Clean Filtered Water

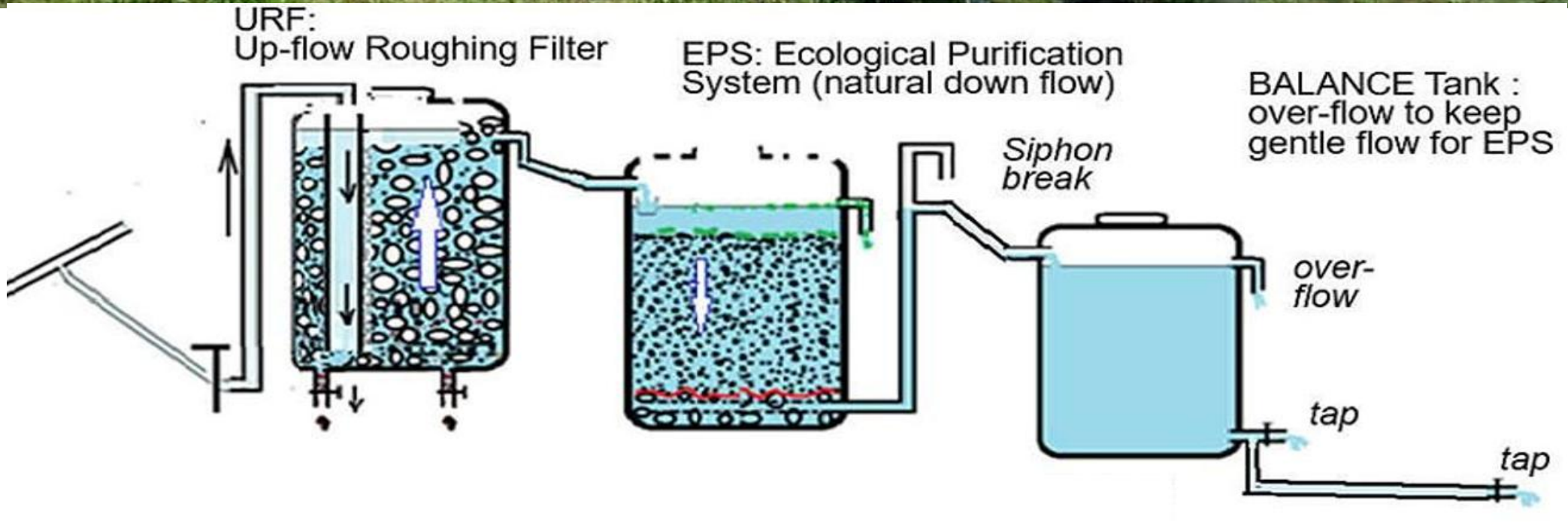


Nature for Water

DWS actively promoted EPS when it had the chance.



New movement to make more large scale EPS plant arises by own activities of a rural village in March, 2018.

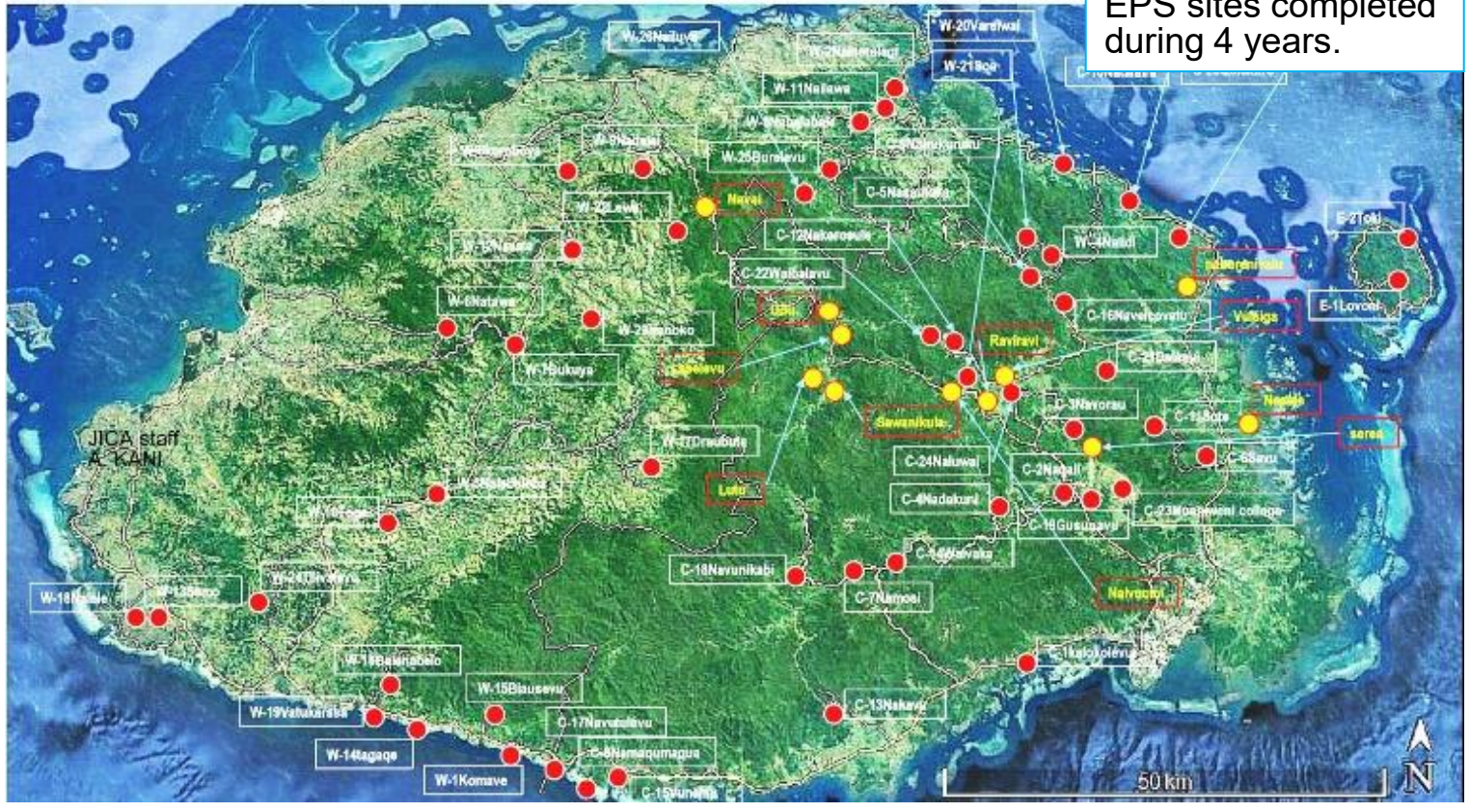

URF:
Up-flow Roughing Filter
EPS: Ecological Purification System (natural down flow)
BALANCE Tank : over-flow to keep gentle flow for EPS
Siphon break
over-flow
tap
tap

Nakamoto：Short term expert
2014.10.~2018.11.

8 times of a month visit during 4 years.

Hidemitsu Eguchi
Volunteer
2015~2016

Isamu Shioiri
Volunteer
2017~2018



EPS sites completed during 4 years.

Cleaner Water Project by EPS (Ecological Purification System: Wise Use of Natural Phenomena) for Rural People in Fiji

EPS project started from Kalokolevu and Navatuvula in 2013

The project was implemented under the initiative of the Fiji government, and construction of around 30 plants was covered by the government budget every year, and JICA only provided technical cooperation by dispatching Nakamoto and volunteers. EPS technology has been transmitted from Japan to Fiji as a technology that can be done by themselves.

https://www.youtube.com/watch?v=vji0ay-7GA8

EPS Fiji Wksp 2019 for safe water/ 7:08

This seminar was held at the end of 4 years EPS JICA contribution (Nov.2014 to Dec.2018) in Fiji by Nakamoto.

People loved the latest advanced technology. However, there is suitable technology for each country. That can be maintained and managed by local people. That is EPS.

EPS Seminar/ Wksp at USP, Suva, Fiji March 2019/ 4:32

https://www.youtube.com/watch?v=fEl5ghBzfMw&t=23s

Fijian Minister for Infrastructure opens the Ecological Purification System Project at USP (The University of South Pacific)

https://www.youtube.com/watch?v=iBcjbocOleQ&t=2s

11 min 21 sec

Fiji Government

The implementation of community based Ecological Purification System was made possible through the funding of government.

The Fijian Minister for Infrastructure, Transport, Disaster Management and Meteorological Services Hon. Jone Usamate, in saying this, officiated as Chief Guest at the opening of the Ecological Purification System (EPS) Workshop which was held at The University of the South Pacific.

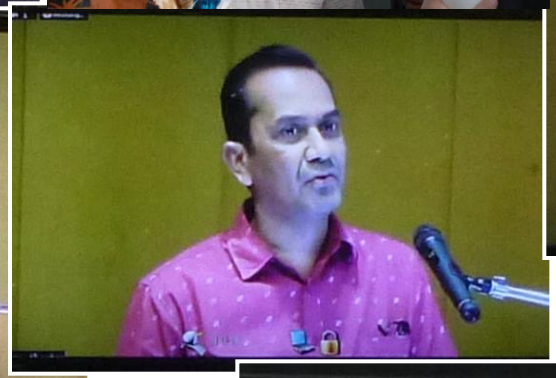
The EPS is a chemical-free and energy-free water purification technology which was initiated by Dr. Nobutada Nakamoto, Professor Emeritus of Shinshu University in Japan.

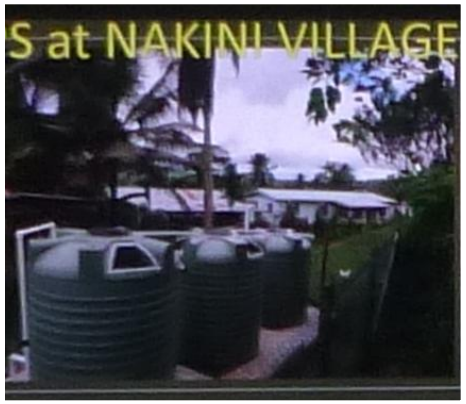
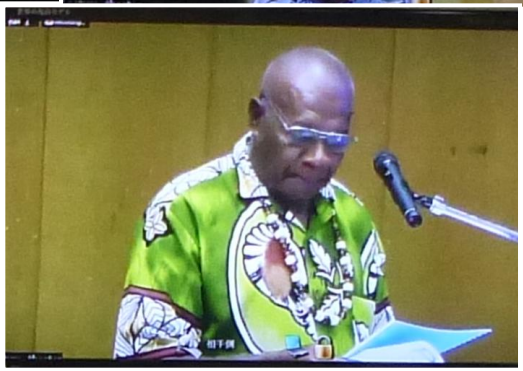
Also present at the opening event was special guest was Deputy Vice Chancellor of USP Mr. Derrick Armstrong.

The workshop is a two-day event hosted by JICA from 12-13 March, 2019 at The University of the South Pacific ICT Centre in Suva, Fiji.





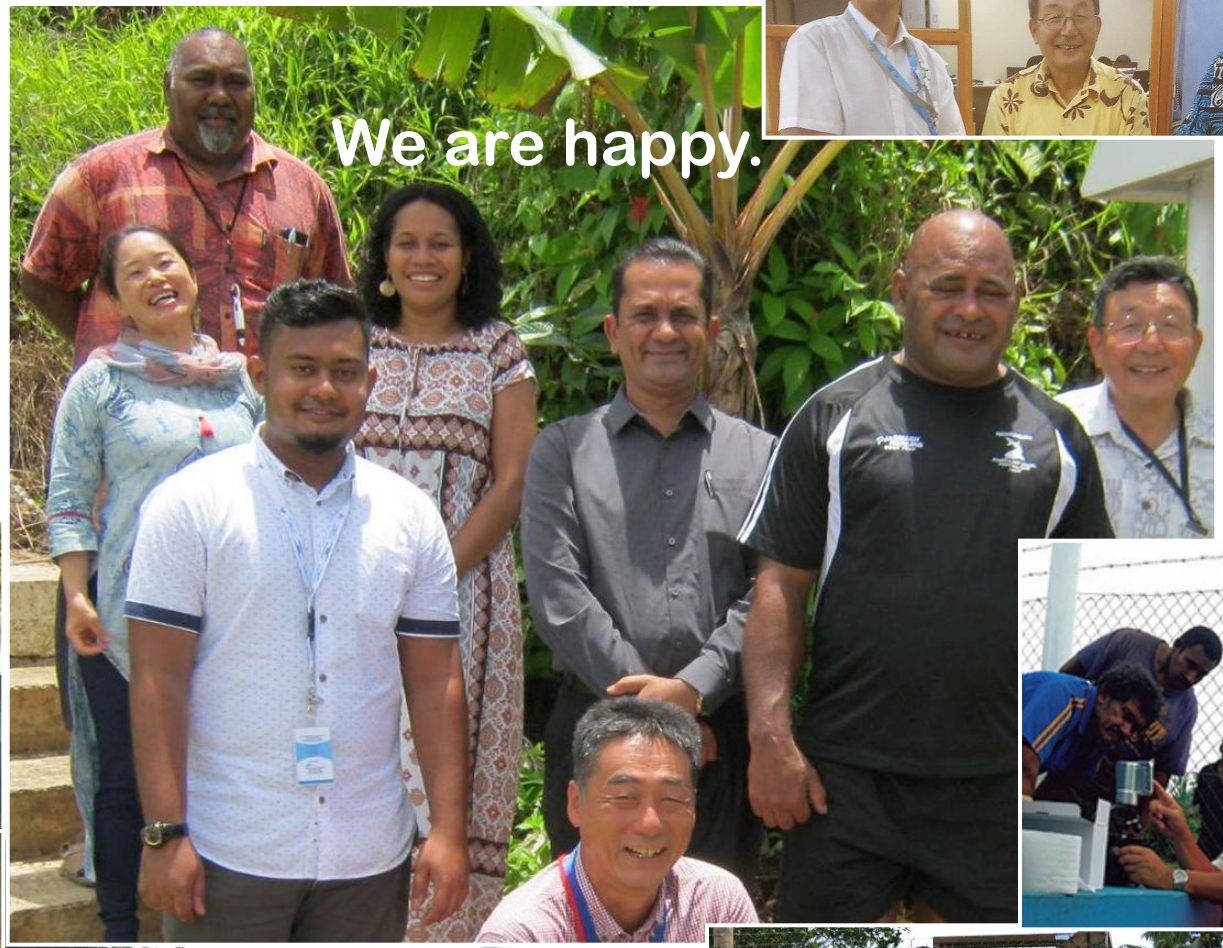


S at NAKINI VILLAGE



We are all happy!!


2018/ 8/27

17:30-18:30 Wrap-up

We are happy.



Fijian people made EPS plants by themselves.

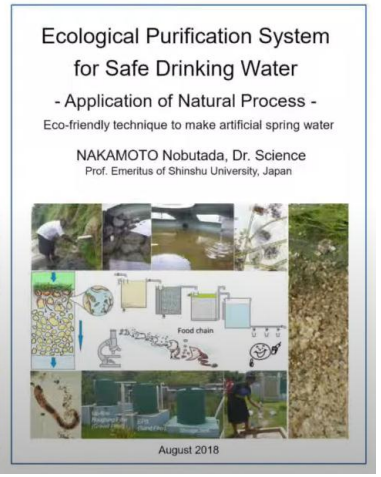
EPS Public Seminar/Workshop 11:30-12:30 Principle of EPS, Q&A

Ecological Purification System for Safe Drinking Water

- Application of Natural Process -

NAKAMOTO Nobutada, Dr. Scinece
Prof. Emeritus of Shinshu University

Eco-friendly technique to make artificial spring water



https://www.youtube.com/watch?v=fEl5ghBzfMw&t=62s

4min 32 sec

EPS to make safe drinking water is real our technology.

https://www.youtube.com/watch?v=vji0ay-7GA8&t=254s

7min 08 sec

Remember Three Steps

1. Knowing is NOT enough, we must APPLY it to something useful.
2. Willingness is NOT enough, we must PUT it into the PLAN and ACTION.
3. Putting the PLAN into action is NOT enough, we must ACCOMPLISH the goals.

CONSTITUTION OF THE REPUBLIC OF FIJI

This Constitution issued on 7 September **2013**.

36: Right to adequate food and water

the right of every person to have adequate food of acceptable quality and to **clean and safe water in adequate Quantities**.

SSF was recognized as Ecological Purification System in Ueda, Japan.

JICA training began in Okinawa, from 2006.

Fijian people made a big effort for the people.

EPS spread to Pacific countries.

This is Fijian EPS project.
Fijian people made EPS by themselves.

JICA short term Expert
N. NAKAMOTO
Oct. 2014-Nov.2018
8 times:
Each about one month

JICA Volunteer
Hide EGUCHI
2015-2016

JICA Volunteer
Isamu SHIOIRI
2017-2018

We assisted a little for this project.

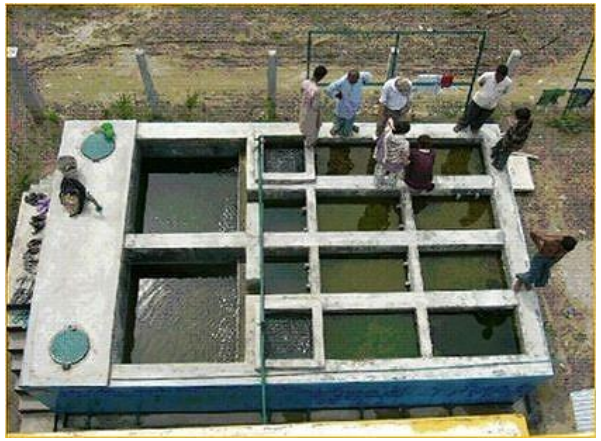
The contribution of short-term expert by Nakamoto was from Oct. **2014** to Nov. 2018.

This Fijian EPS project for rural people **still continues** until now by Fijian government in **2024**.

This is a real technical transfer from JICA training.

EPS is Our Smart Treatment System. Fijian people realized and certified. We can have safe and delicious water.

⑧ From Japan to the world by the social contribution.



Ecological Purification System for Safe Drinking Water

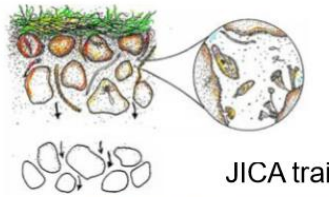
- Application of Natural Process -

Eco-friendly technique to make artificial spring water

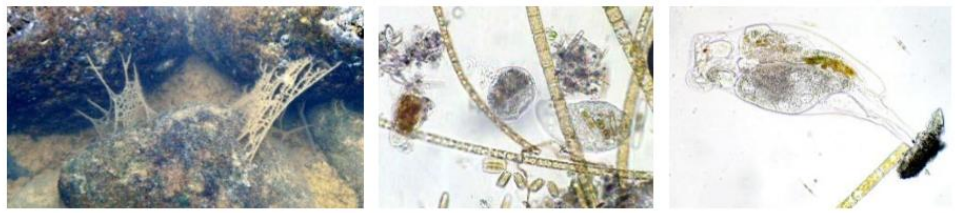
NAKAMOTO Nobutada, Dr. Science
Prof. Emeritus of Shinshu University, Japan

August 2018

This is our technology.



JICA training



Microscopic organism is the key of EPS.

Biological activity was evaluated by the diurnal change of dissolved oxygen.

Ecological Purification System NAKAMOTO 2018

Toward Zero Waste World by Chemical-free System

Smart Treatment System to make artificial spring water by Eco-friendly technique.

https://eps.watervision.jp/wp-content/uploads/2025/04/EPStext-NC-2019.pdf

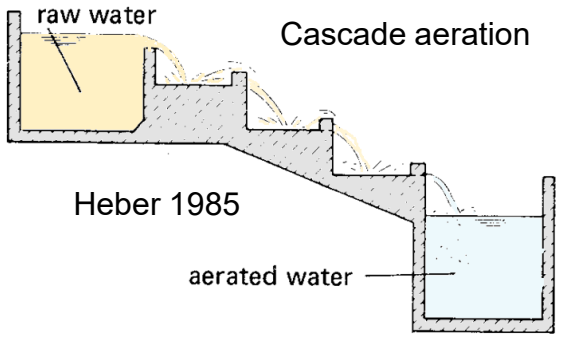
I cooperated with Yamaha Motor's social contribution activities by EPS technology.

There was a factory in Jakarta, Indonesia that manufactured engines for outboard motors, boats, motorcycles, and other automobiles.
Since it was related to water, they also manufactured water purifiers.

YAMAHA motor company in Indonesia made a purifier for clean and safe water in 1991.

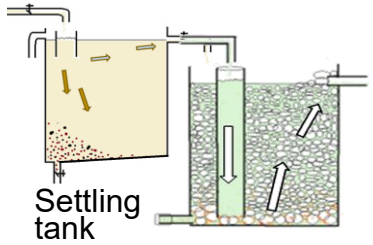
Mr. Yagi came to Shinshu Univ. He asked how to make safe drinkable water without chemical from unsuitable source of water.

Underground water contains iron and manganese in Jakarta plain. Well water was clear. But the brown colloidal particle was formed soon. They could make clear water using cascade aeration system without any chemical reagent.



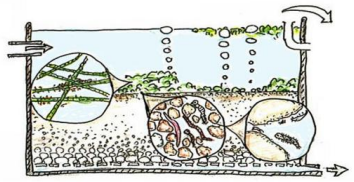
I advised we can make safe water by ecological purification system of wise use of natural phenomena.

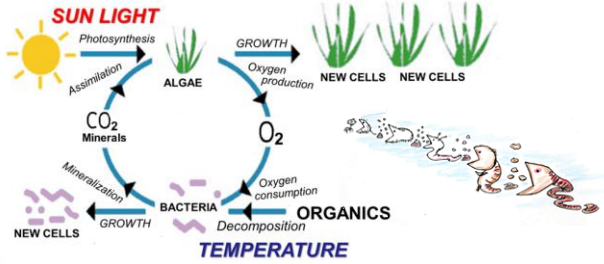
Iron and manganese are oxidized and form nearly insoluble hydroxide sludge. They can be removed in a settling tank (a coarse filter).



Raw water

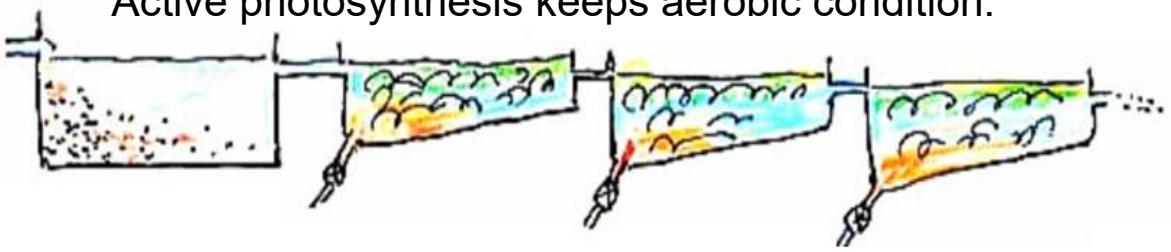
Final water of cascade aeration steps.





Small animals collect silt and colloid particles in dirty water by the food chain. Then water becomes clear.

Active growth of algae and grazing animals grow well in the channel.
Active photosynthesis keeps aerobic condition.



Slow sand filter

Sedimentation tank

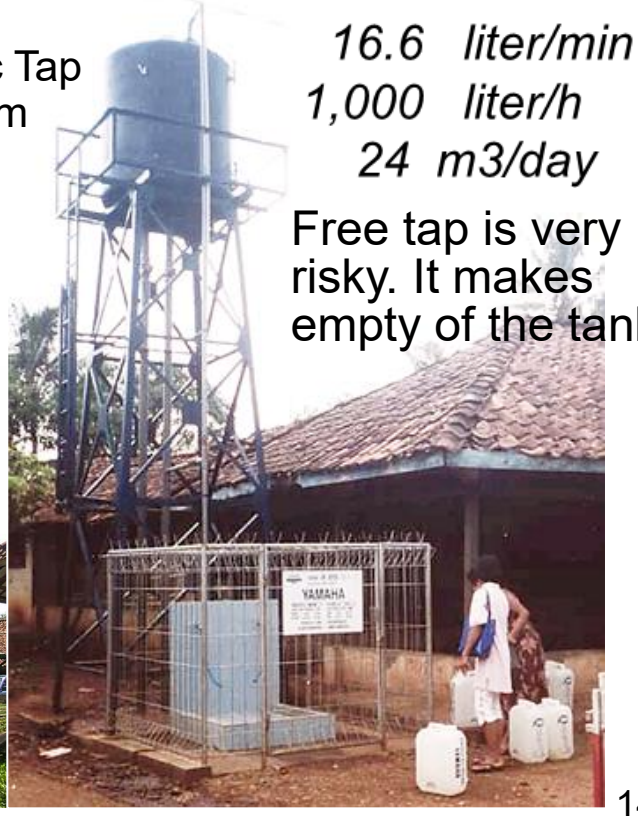
Animals grazed particulate matter (living and non-living).

Periodical small drain to eliminate precipitate material and unhealthy organisms.

Public Tap System

16.6 liter/min
1,000 liter/h
24 m3/day

Free tap is very risky. It makes empty of the tank.



This is new idea of ecological pretreatment system without chemical to reduce silt and colloidal particle for sand filter instead of URF.

Tap keeper collects money of filling the bottle for the maintenance cost of the plant.

Tap control is key. Lady collects the money for the amount of water.
Free water is not good. It is necessary to collect money for the maintenance of the plant.

Two bottles of 20 liters per 1 family.

This water is used for drinking and cooking only. This water is not used for bathing and washing hands.

The good quality of Yamaha clean water was also transmitted to neighboring villages. Delivery service has also started.

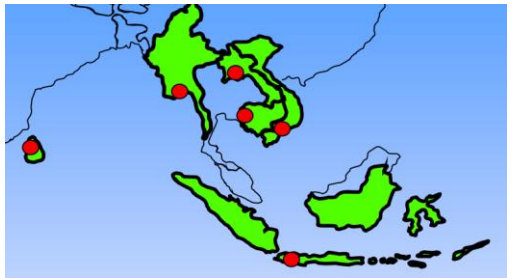
Diarrhea and eye sickness are disappeared. →Health village
→sanitary sense and its level are distributed among the villagers.
→This acts to protect naturally against sickness.

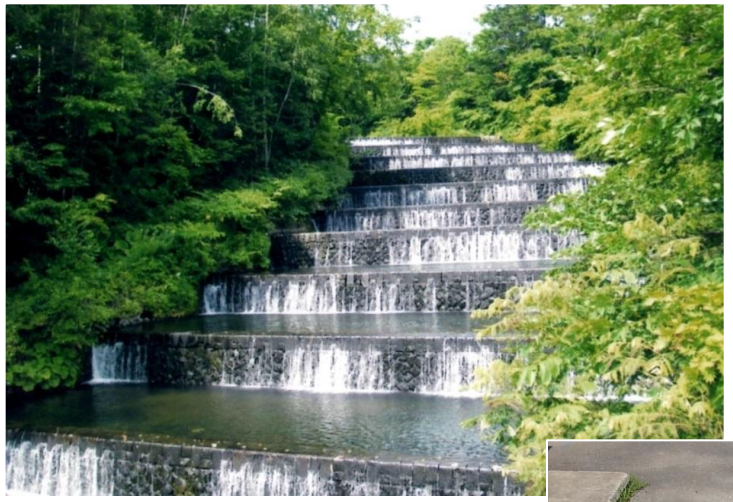
Acceptable Risk

1. Safe drinking water system which can maintain by local villagers as a **Social Contribution** of **Yamaha Motor Company**.
2. Pilot test plant with several public taps was donated from Yamaha Company to Kagawong village near Jakarta, Indonesia.
3. **Villagers discussed how to maintain this plant by villagers**.
4. Villagers decided to **collect money** from the users in order to stock for maintenance.
5. Water committee started a **delivery service** to other villages.
6. Water committee maintains more than **15 years without any trouble**.

This pilot plant developed to new Yamaha Clean Water Indonesia to Asia and Africa.

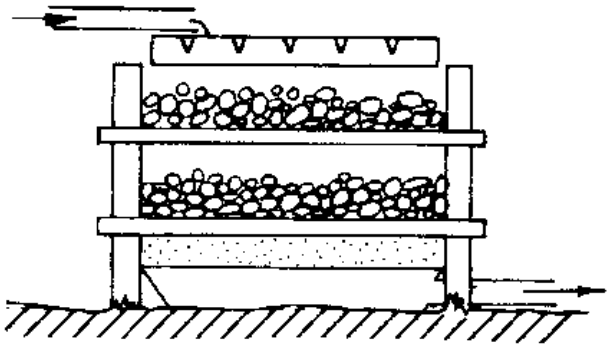
System in 2010 and distribute from Indonesia, Vietnam, Cambodia, Laos, Myanmar, Sri Lanka Senegal, etc.



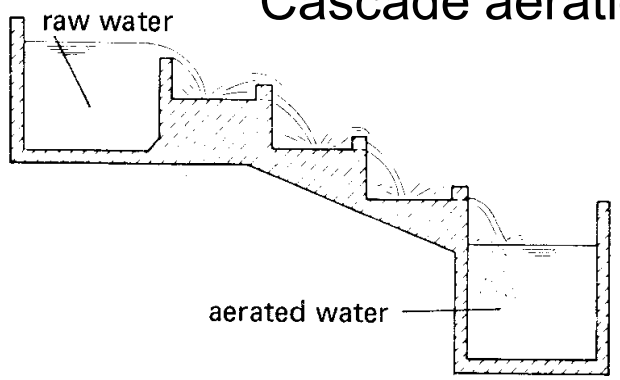


Wise use of natural phenomena for small organisms.

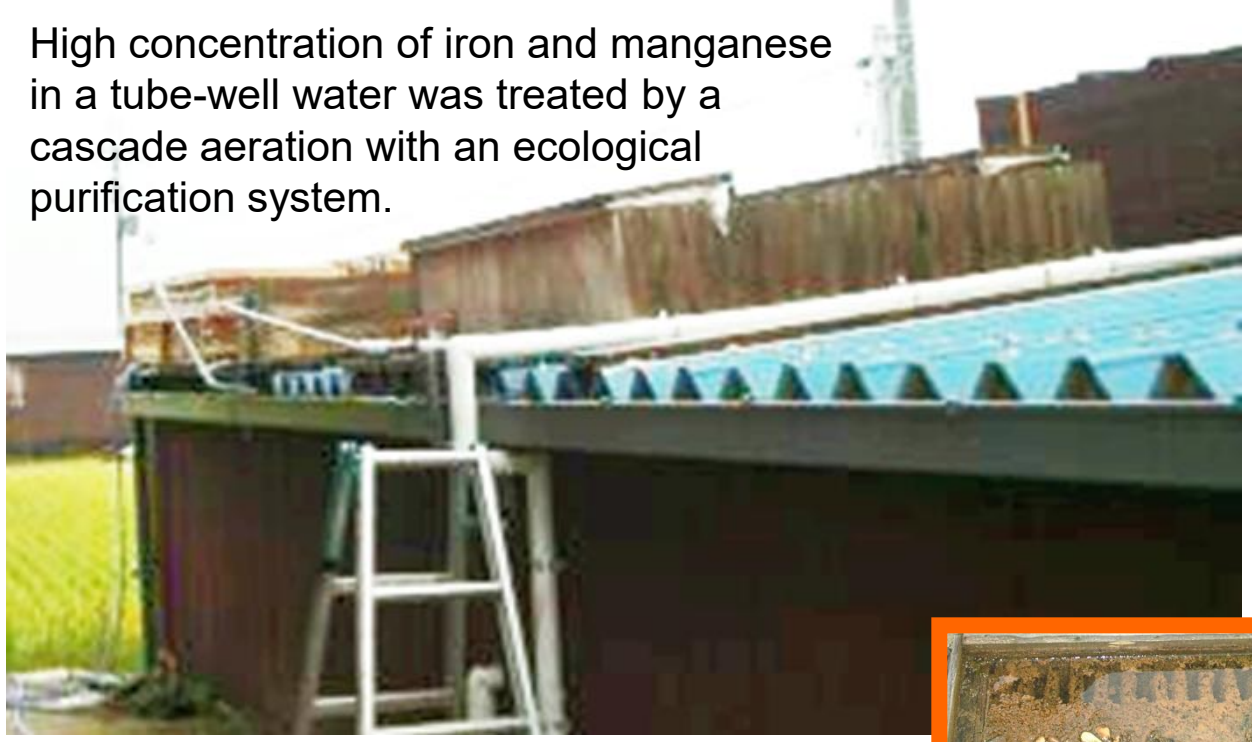
Aeration filter



Cascade aeration



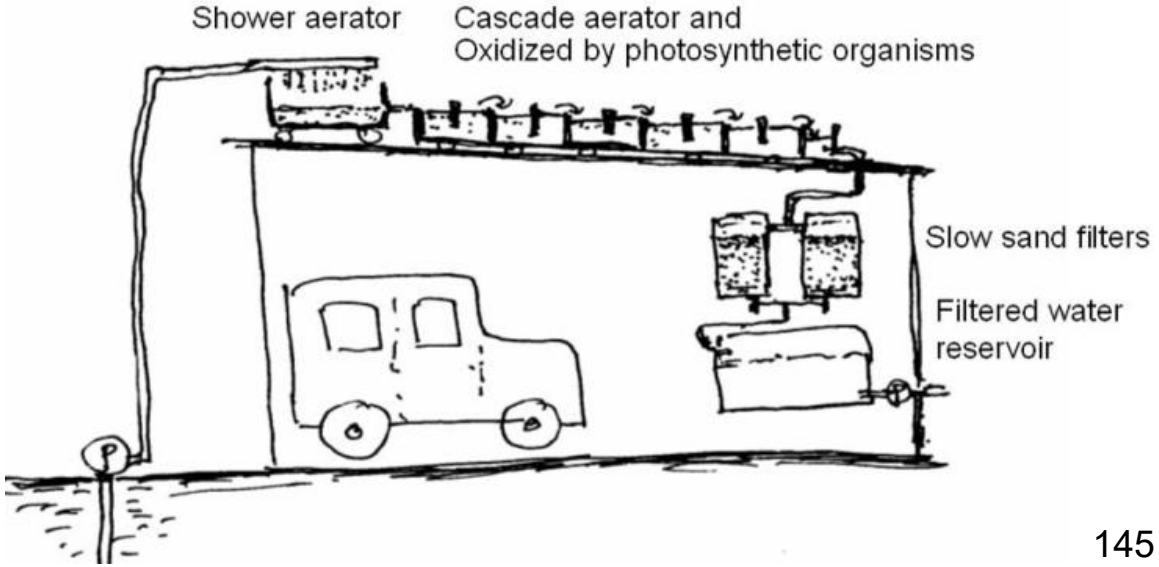
High concentration of iron and manganese in a tube-well water was treated by a cascade aeration with an ecological purification system.



Pre-treatment of cascade aerator using biological activity of bacteria, algae and animals.

Final treatment of slow sand filter.

Mr. Jun Kinoshita



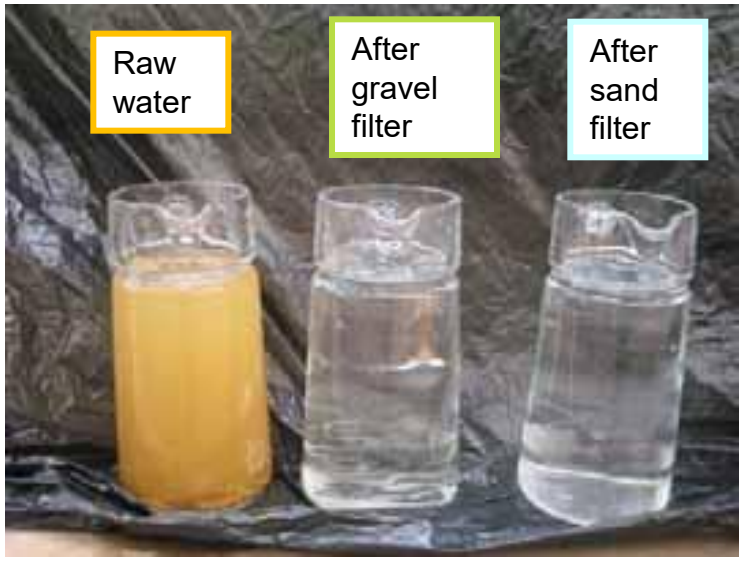
Use of natural slope, drinking water could be made by EPS, Bolivia, 2008

Volunteer JICA's report, Horie, T. 2009

Pump for groundwater and source water tank

3 gravel filters

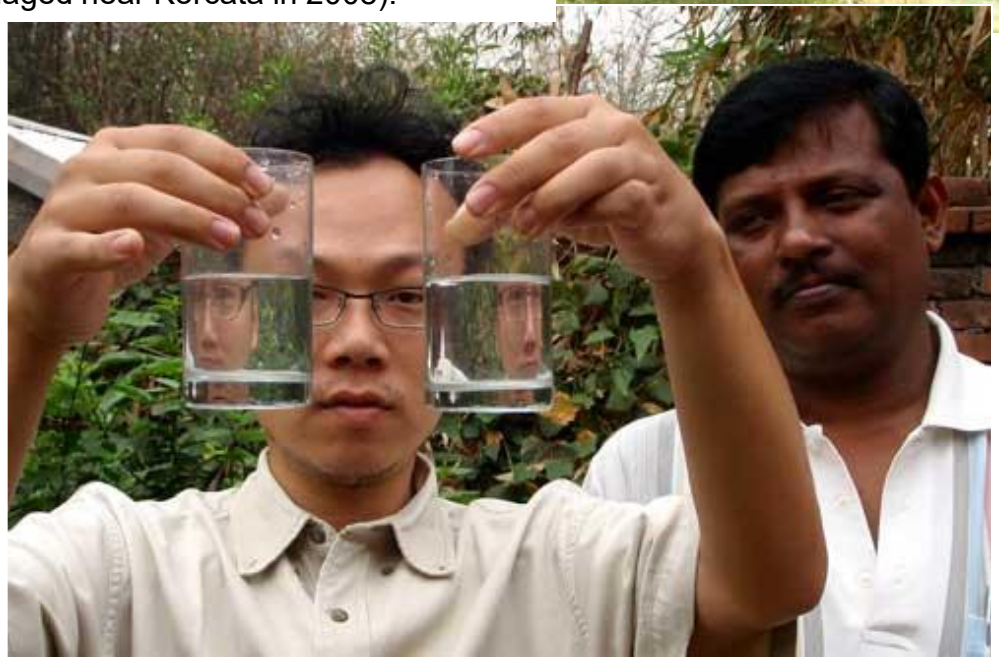
Use of natural slope, pour in sand filter



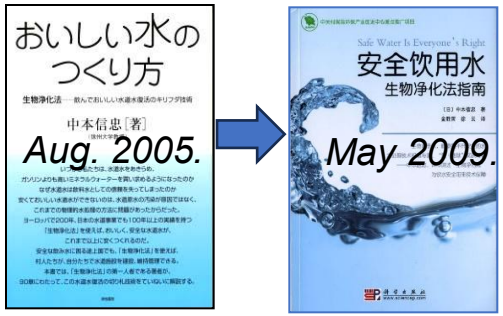
Filtered water tank

After 4 days, filtered water became clear. After one month, the water became drinkable water, in which coli-form bacteria form was not detected.

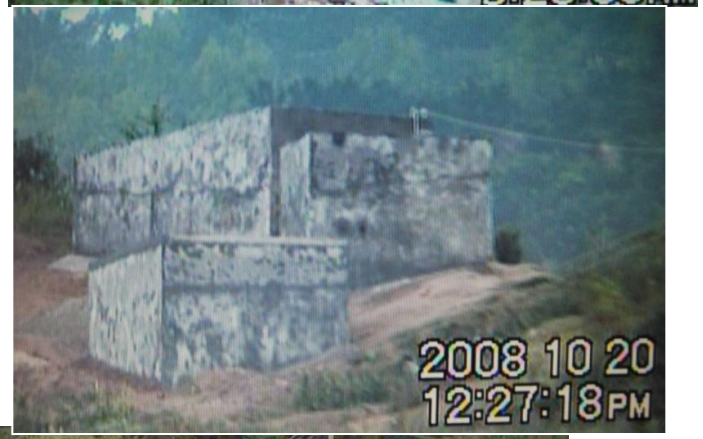
ApamNapat Art Project (Mr. Sohei Iwata managed near Korcata in 2008).

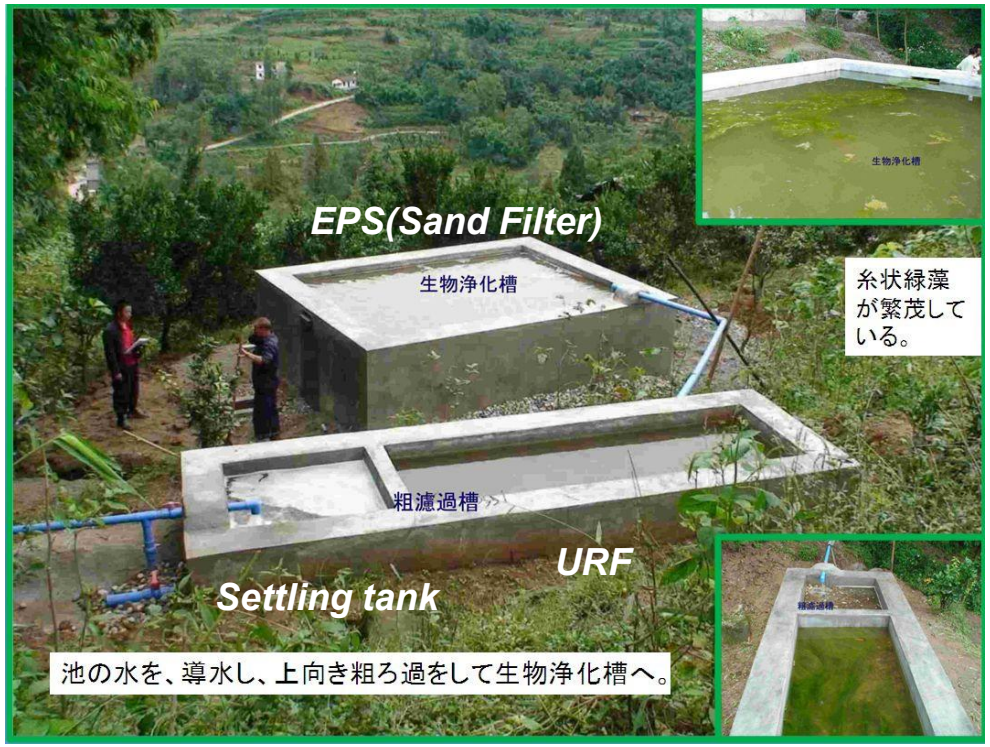


Mr. Jin Shengzhe, translator of Chinese version, made several water plants in China in 2008 after the Sichuan great earthquake, May 12. 2008.



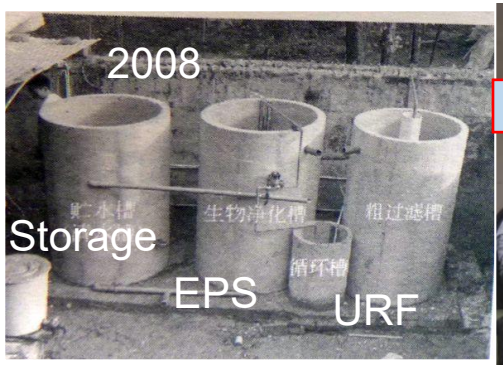
This is 30 tons per day.





金胜哲

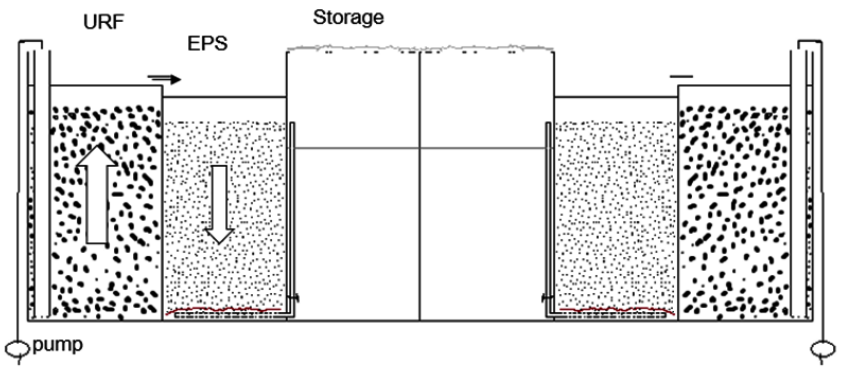
China: Mr. Huo Daishan 霍岱珊 and his sons built EPS to made safe drinking water. (helped by Mr. Jin Shengzhe 金胜哲)



70-80 t/d, 4,600 villagers (246 students)
16 liter/person/d
Filter(2 m x 4 m) x 2 set of filters (URF+EPS)

6 t/d, 500 persons.
12 liter/person/d

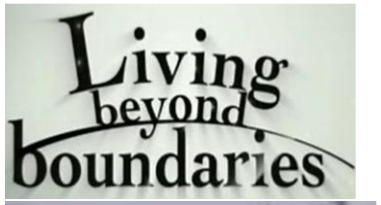
Supply to owner's kitchen.

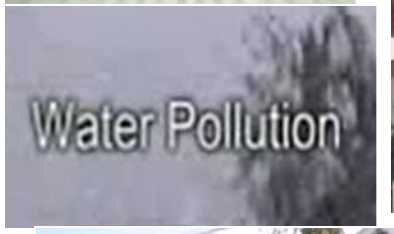


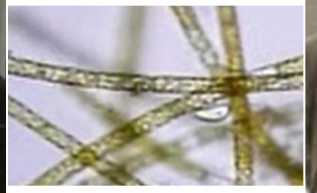
Public tap system for villagers

Mr. Huo and his sons made 40 plants of EPS by themselves.

NHK World　Living beyond boundaries　Dec. 13. 2014.







EPS, which originated in Japan, has also begun to spread in China.

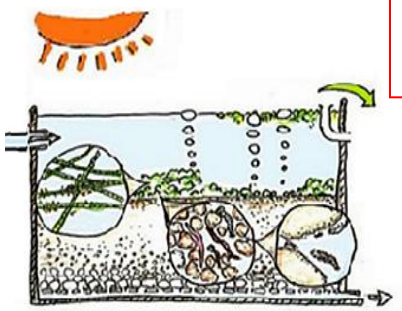
Since 2002, I have cooperated with the Asian Arsenic Network (AAN, NGO) activity in Bangladesh.

Surface water is polluted. The people use underground water. However, this water was contaminated Arsenic. AAN checked the Arsenate contamination.

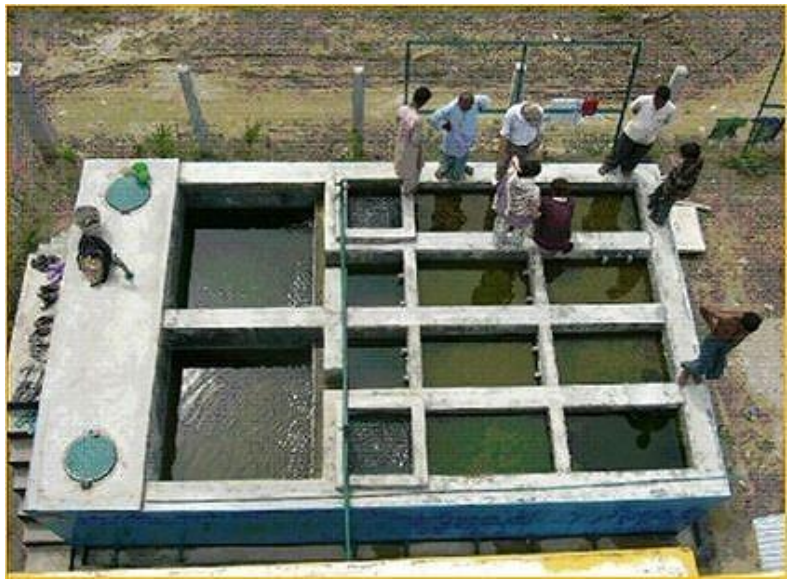
Wells contaminated with arsenic were painted red.

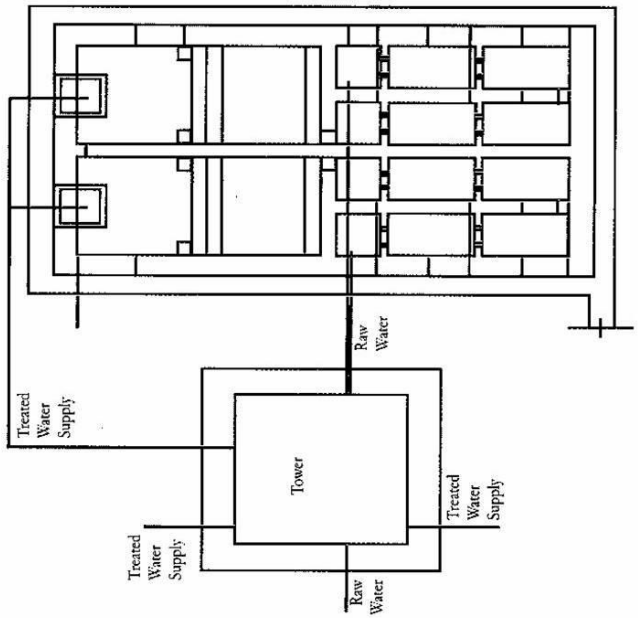
AAN made Slow Sand Filtration system for safe water. I advised better SSF system using biological activity to AAN.

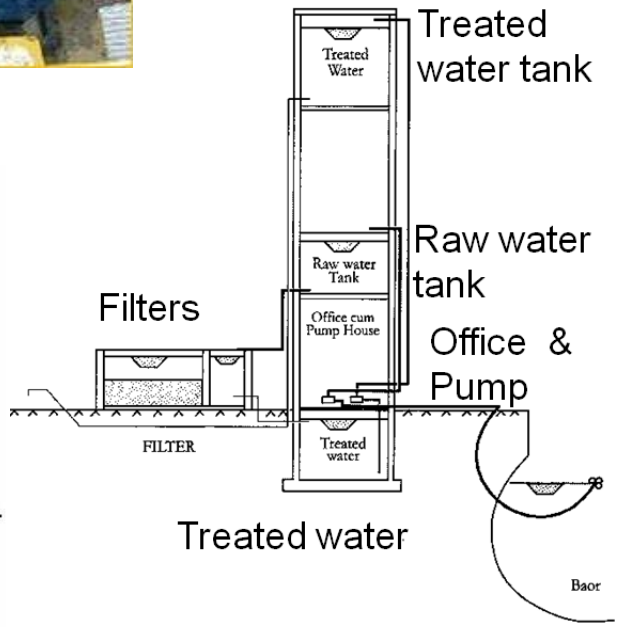
Then, I was asked to consider a mechanism that can **decompose pesticides without using chemicals**.



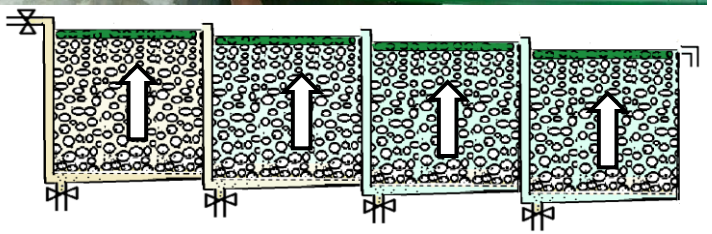
Repeated growth of algae and decomposition by grazing animals, and real decomposition of pesticides and herbicides under anerobic condition in fecal pellets.







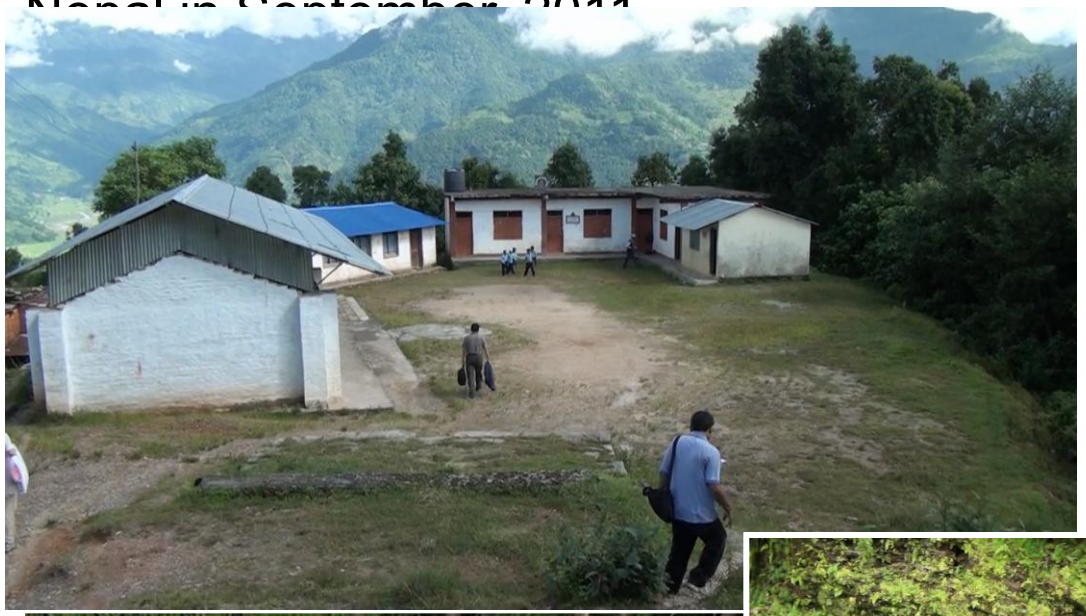
AAN made new construction with UNICEF funding in 2019.



Repeated URF process of **algal growth and decomposition by animals in 4 times**. DO in water is necessary for animal activity in this system.

Mr. Kawahara said to me "This is not SSF". Then I proposed " This is Ecological Purification System" in Bangladesh in 2004.

In mountainous country like Nepal, many houses are scattered on the slope. They use natural spring on the slope. I visited Nepal in September 2011.



These waters by natural purified process are always clear and safe to use.

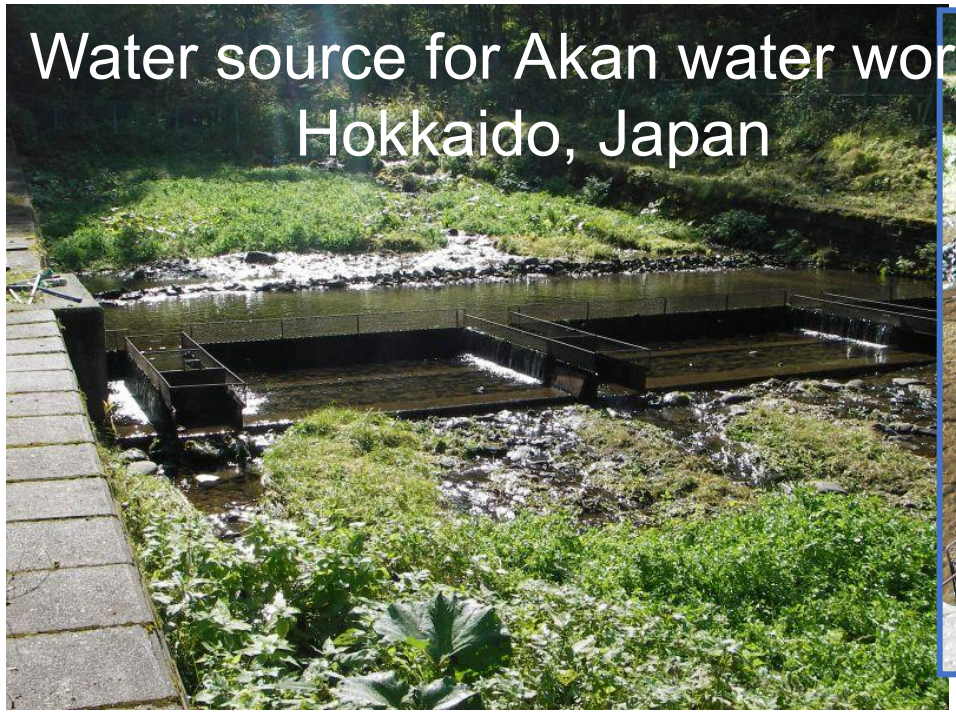
Nepal is a mountainous country with a lot of precipitation. They also used rainwater. Spring water is abundant, and it is drawn through pipes and used carefully. Because of the large difference in elevation, it is difficult to adjust the water pressure with large diameter water pipes. In a mountainous country like Nepal, it seems that using spring water is a good way.

I gave a talk on water purification to students at this university. I found a wonderful slogan in Professor Shiba Kumar Rai's room.

Professor & Research Director at Nepal Medical College
Prof. Dr. Shiba Kumar Rai

Three points worth to remember

1. **Knowing is NOT enough, we must APPLY it to something useful** *(von Geothe)*
2. **Willingness is NOT enough, we must PUT it into the *PLAN* and *ACTION*** (von Geothe)
3. **Putting the PLAN into action is NOT enough, we must ACCOMPLISH the goals** (Nakamura)



Porous pipes were placed under the gravel bed in a river. Almost suspended free water is taken for a slow sand filter plant. This is an intake of an artificial subsurface water.

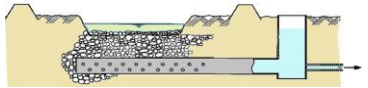
In case of mountain area, we can find a good quality of spring water.

Wise use of natural purified water is the best.

Ecological Purification System (EPS) : This is Wise Use of Natural Phenomena. This is Chemical Free System to make Artificial Delicious Spring Water. This is a Smart and Eco-friendly technique.

Surface water of river

Reservoir, lake

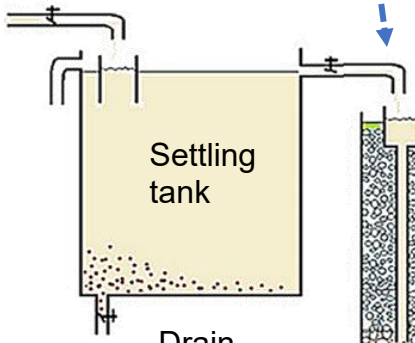


Subsurface water of the flood plain

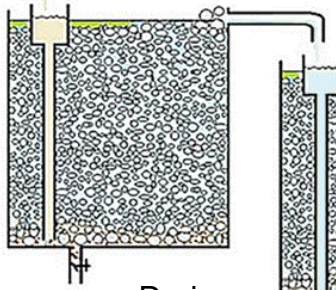
Clear spring water

Underground water

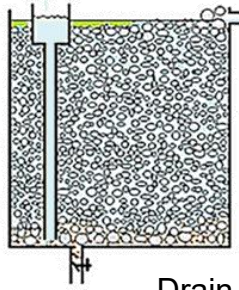
Raw water



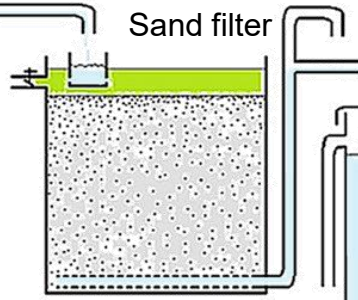
Up-flow Roughing Filter



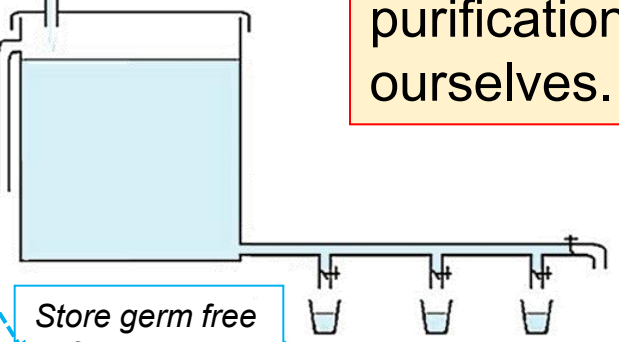
Up-flow Roughing Filter



Slow Sand filter

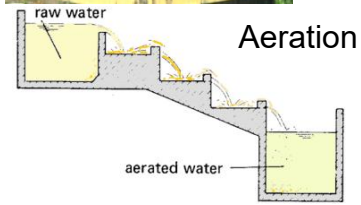


Storage tank



Underground water

Aeration



Sink suspended solid

Trap and reduce fine matter

Complete purification

Store germ free safe and delicious filtrate.

Supply to houses.

We can make EPS purification device ourselves.

Key is presence of dissolved oxygen.

Ecological Purification System Model for Safe Drinking Water

JICA training in Okinawa, on Jan. 16. 2024.

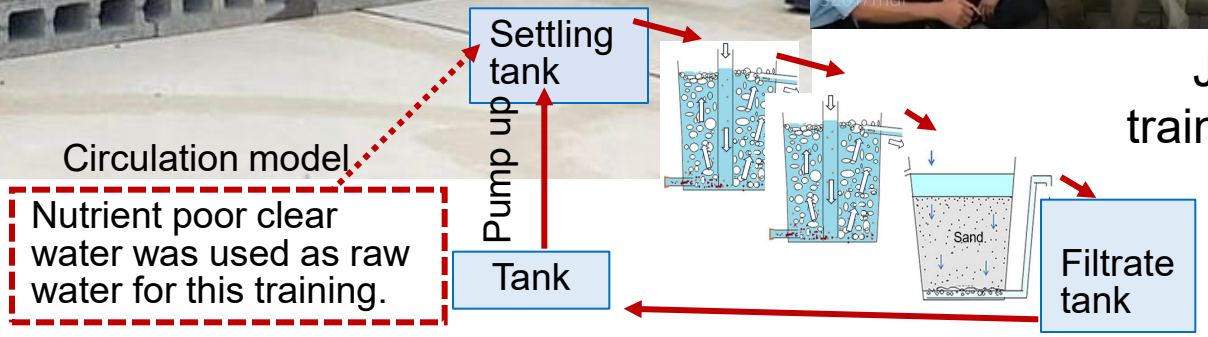
Rain water harvested by Mr. Yano.

He want to use chlorine free clean water.

https://www.youtube.com/watch?v=Ye-POV6qBU0&t=39s

Daniel Castro
2017/07/20 に公開

JICA Hiroshima training, in July. 2017.



Circulation model

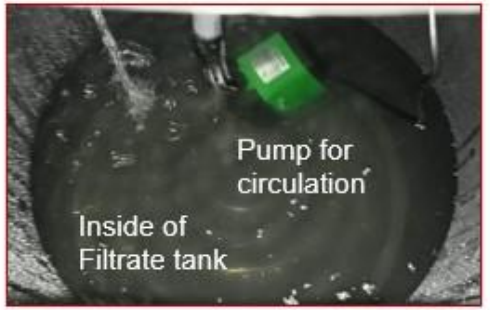
Nutrient poor clear water was used as raw water for this training.

Mr. Mhd Zairi, trainee of JICA Okinawa returned back to Malaysia after JICA EPS training in Okinawa from January to February 2024.

He applied EPS knowledge at his brother in law's house in April, 2024.

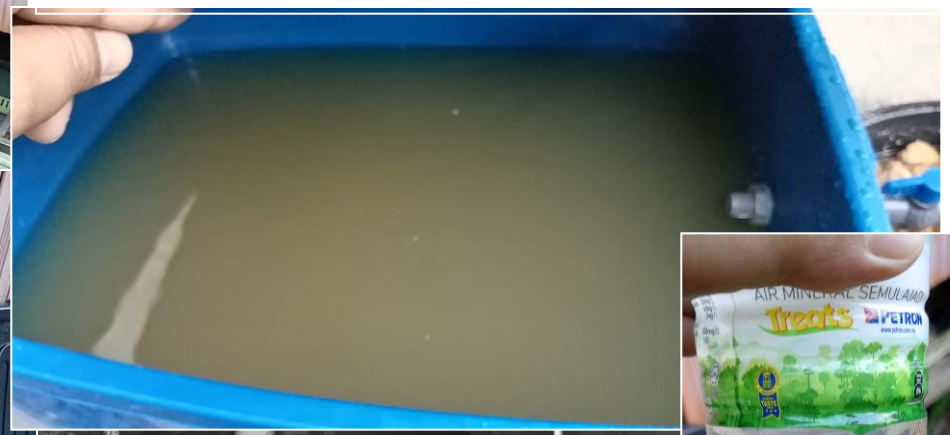
On April 6, he washed the sand.

And EPS model was completed on April 11 2024.

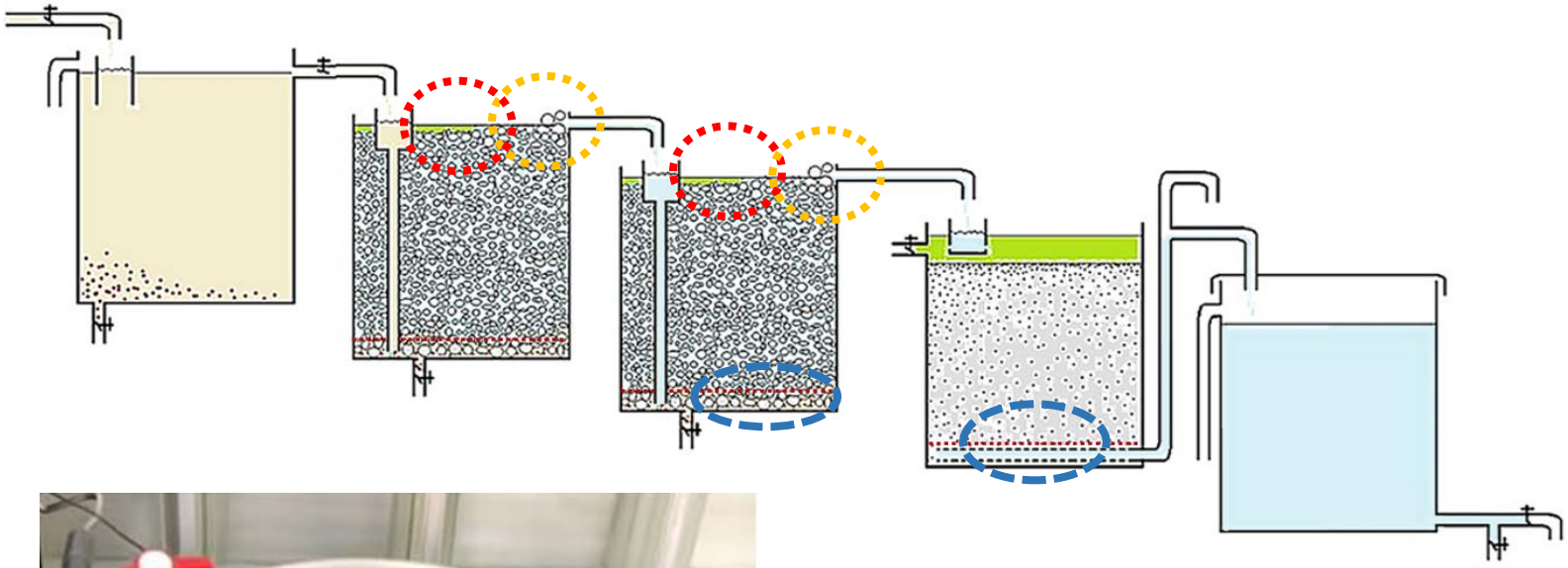


April 11. 2024.
Finally, his first EPS bucket model launching with production purification rate of 7.2m/d.
He mentioned the volume of storage (filtrate) tank was 56 liters.

He mailed that hoping after few weeks, and the algae start growing, the quality and production rate may improve.



56 liters storage



We can easily confirm the clear water which is out.

Covet the over flow with gravel.

On April 11. 2024. Nakamoto:
Thank you for your effort to make EPS model. I suggest that it is better to remove some gravel in URF. We can confirm the condition of URF which produce clear spring water. However, please cover the overflow pipe with gravel.

Mr. Mhd Zairi :
Yes, I agree with you, round tank is the best shape as the water tend to force the square wall to become round. I just found it when I see the URF tank maintain the shape. It's a lesson learn to me on how to design the tank. I take note your advise, sir.

Please watch this video how to set sand and gravel in URF and Sand Filter.

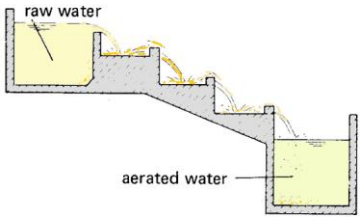
https://www.youtube.com/watch?v=Ye-POV6qBU0&t=39s

Daniel Castro
2017/07/20 に公開

On April 11, 2024, Nakamoto advised:

Well water (underground water: tubewell water) often contains iron and manganese.

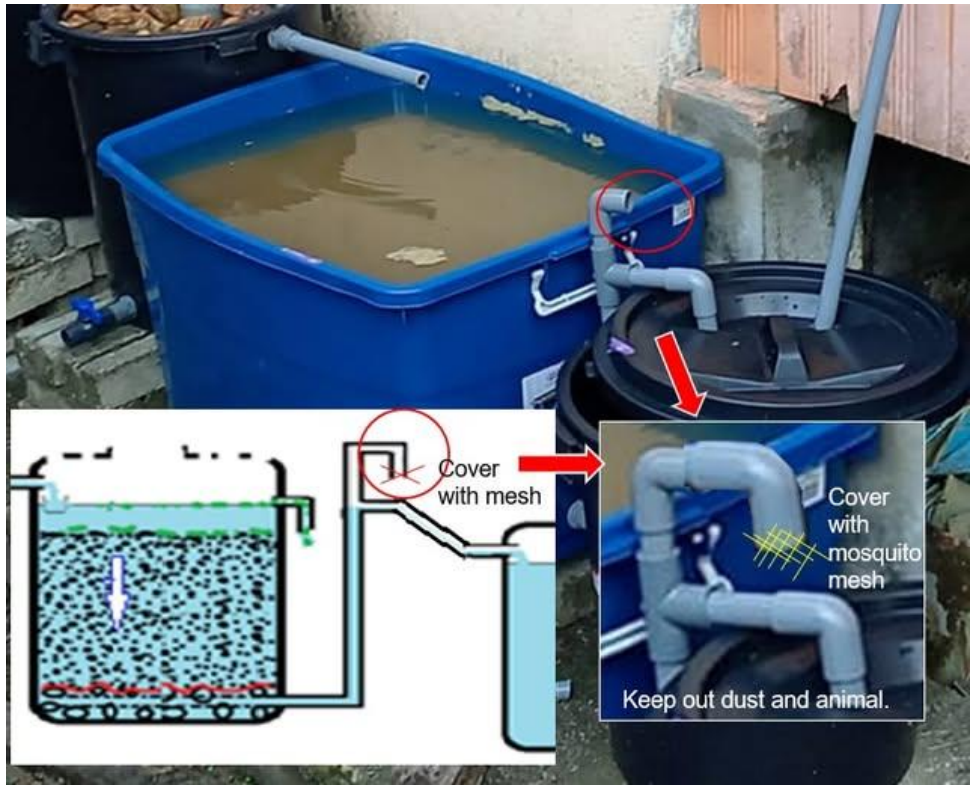
Since there is sufficient dissolved oxygen in URF, these metal ions are removed by oxidation and precipitation.



Precipitated iron and manganese accumulate on the gravel surface and at the bottom of URF.

If the size of the URF gravel is too small, it will be difficult to remove the material that has hardly accumulated on the gravel surface over a long period of time even with mud removal operations at the bottom.

Therefore, in the case of well water, it is better to use large URF gravel of about 1 to 3 cm. It could be bigger.



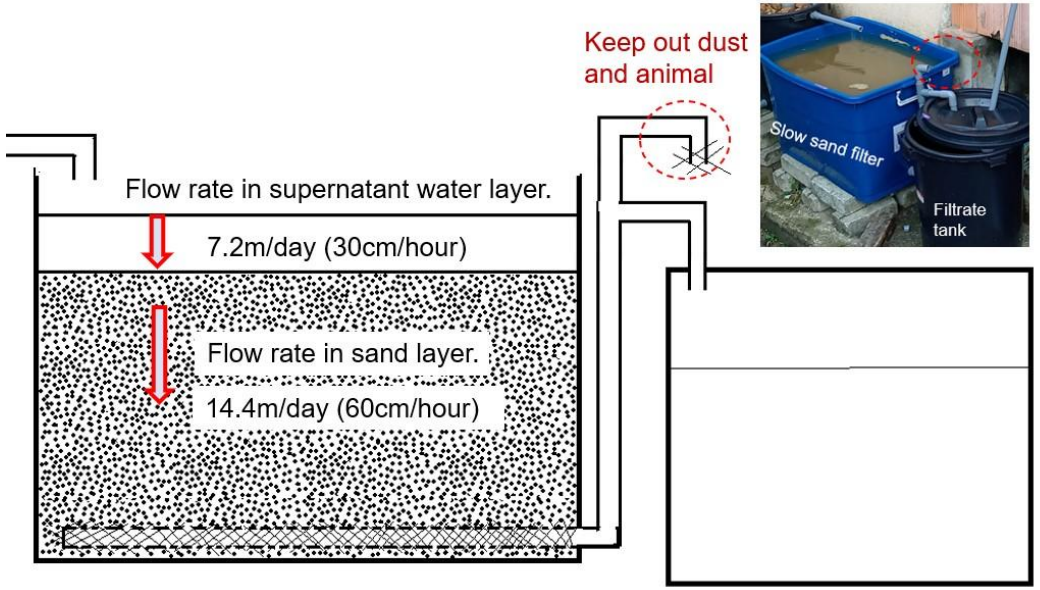
Nakamoto April 11. 2024:

Round tank is better for the model. Round tank is gentle for small organisms. If the sand filter tank is square, when sand or water enters the tank, the tank will try to become round and expand.

The actual facility is made of concrete, which is good.

Nakamoto April 12. 2024:

I suggest you that please put L cap and cover with mesh to keep out dust and animal contamination to filtrate water.
We call the flow rate is in the supernatant water over the sand layer. The real flow rate in the sand layer becomes about double.



Nakamoto April 12. 2024:

The filtration speed of the sand filter tank is 7.2m/day (water layer above the sand), or 30cm per hour. In the sand layer, water passes through the gaps between the sand. The space per volume is about half. The speed will be approximately doubled. Therefore, the flow rate of water in the sand layer is 60 cm per hour. Slow filtration is said to take time. However, when we calculated the actual flow velocity ourselves, we found that it was faster than we imagined.

Mr. Mhd Zairi : Sept. 15. 2024: Just come back to home town in Kelantan after 5 months installing the EPS.
Thank you for the knowledge you share and benefits the people in rural area to enjoy crystals clear, clean and delicious water.

I feel proud & thank full for the knowledge I gain from JICA Program.
In addition, I want to share to all of you, up-flow filtration method is super value for money, maintenance & stress free as to compare to normal downflow filtration.

Non stop producing
crystal clear spring water

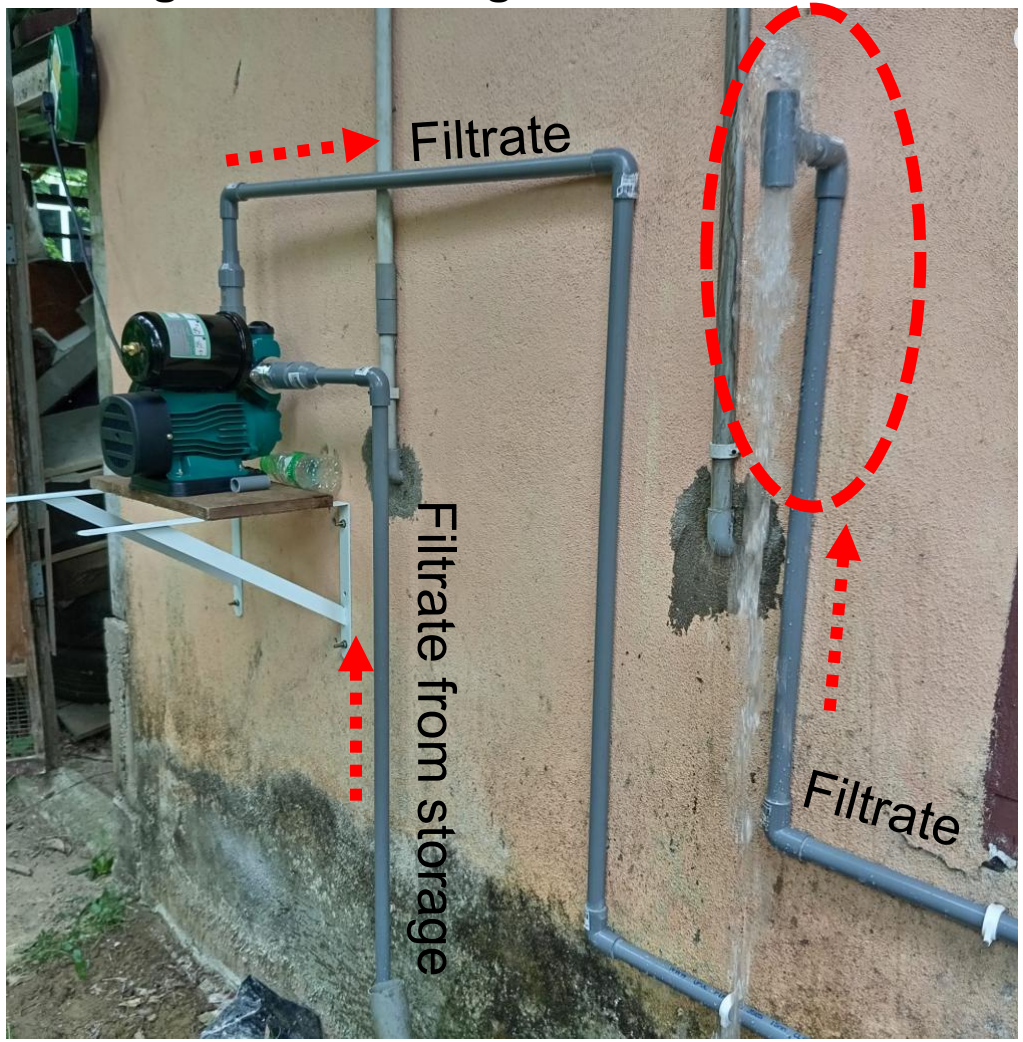
Algae growth :
URF

Sept. 15. 2024
1st backwash after 5 months

Backwashing up-flow roughing filter

June 9, 2025: I asked to Mhd Zairi that this was **under construction photo** or not?

Mhd Zairi: Yes, this picture is before I connect the **filtrate pipe to kitchen tap behind the wall.** While the black storage tank after sand filter only store about **180liters** and **balance storage at the ceiling inside the house**.



Filtrate pipe to new pump.

Mhd Zairi : Sept. 21. 2024:
Done upgrading reticulation system from **56 liters** storage to **454 liters** for my village house.
Thank you for the support I have received all this time and I can describe EPS as "Old Is Gold".

Mhd Zairi : Sept. 21. 2024:
Floating valve help me to maintain the water level that self filling water (underground water) into the sedimentation tank.

On Jan. 25. 2025. Mr. Mhd Zairi :
I take this Chinese New Year holidays to review my EPS filtration after 8 months commissioned. The result still produce the same, fresh, cool and refreshing water.

This is Super clean delicious water.

On June 6. 2025. Mr. Mhd Zairi :
Comparison between 1st URF and 2nd URF. It shows 1st URF works well in filtration for underground water.

Nakamoto:
You mentioned that water source is underground water. The 1st drain is brown. This means oxidized iron and another metal ions. The 2nd is clear. This means that only one URF is very effective to remove dissolved metal ions in the underground water. I would like to set 2 URFs for safe system. I will introduce next this result for next JICA training. Thank you for this information.

Mr. Mhd Zairi :
Yes, 1st URF is enough but for safety purpose 2nd URF is a must. Exactly and I found actually 1URF is sufficient to filter the well water but having 2 sets of URF is highly recommended for safety reasons.

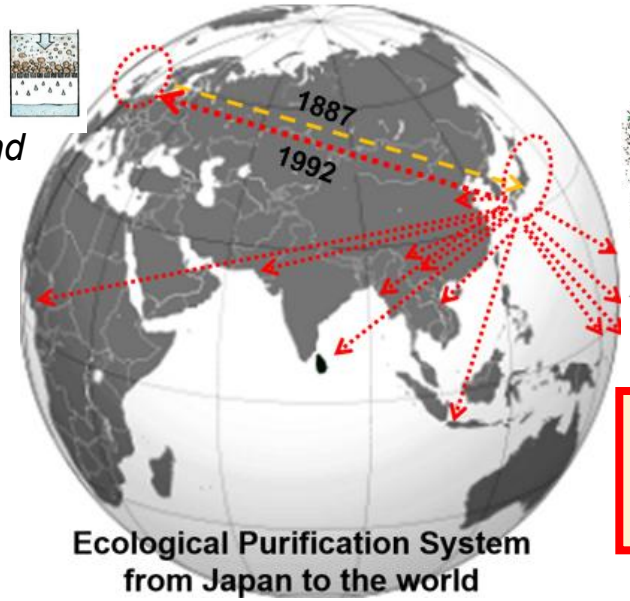
Don’t afraid Failures.

Recommending the Study of Failures

People always make mistakes.

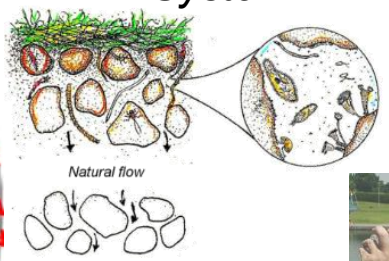
We think we are lucky if we fail.

Slow Sand Filter



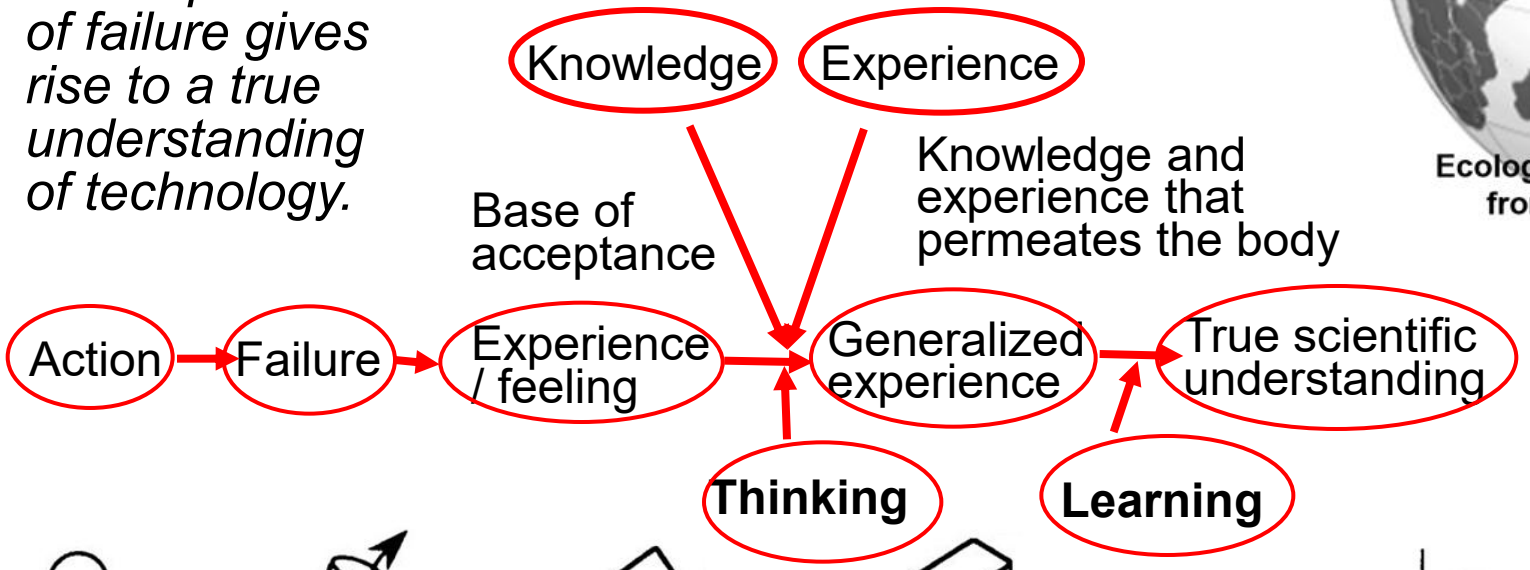
Ecological Purification System from Japan to the world

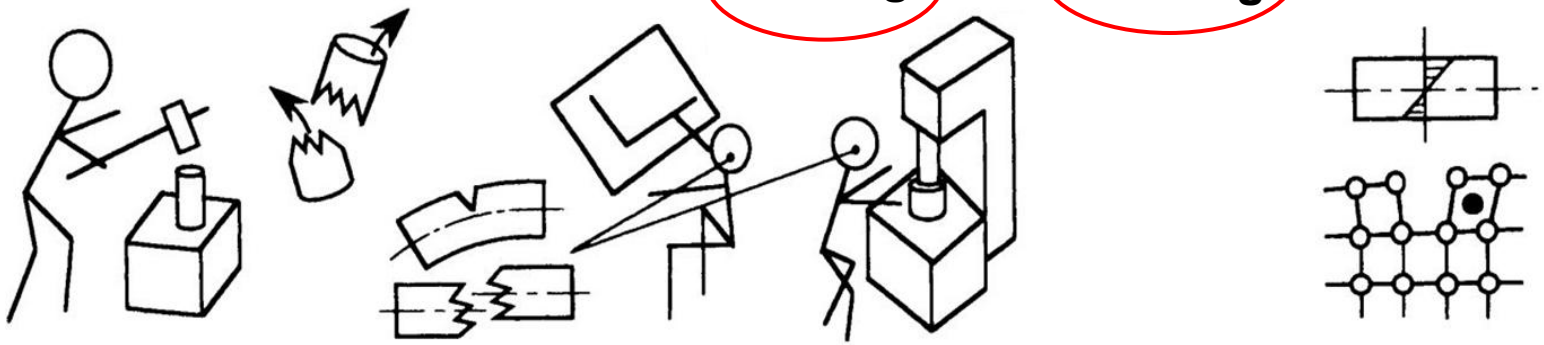
Ecological Purification System



Trust Our Sense !

The experience of failure gives rise to a true understanding of technology.





Learning from the mistakes.

Responding to unexpected events.

from Yotaro HATAMURA 2002

Prof. Dr. Shiba Kumar Rai
Professor & Research Director at Nepal Medical College

Three Points worth to Remember

1. Knowing is NOT enough, we must APPLY it to something useful.

2. Willingness is NOT enough, we must PUT it into the PLAN and ACTION.

3. Putting the PLAN into action is NOT enough, we must ACCOMPLISH the goals.

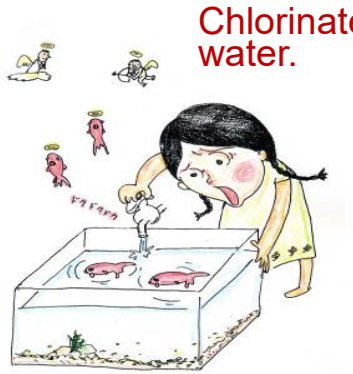
⑨ EPS: Trust Our Sense.

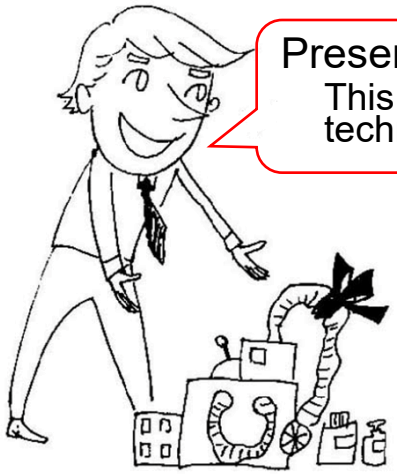
Super clean delicious water

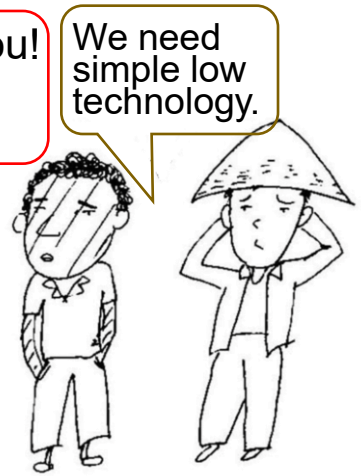
Remember Three Steps

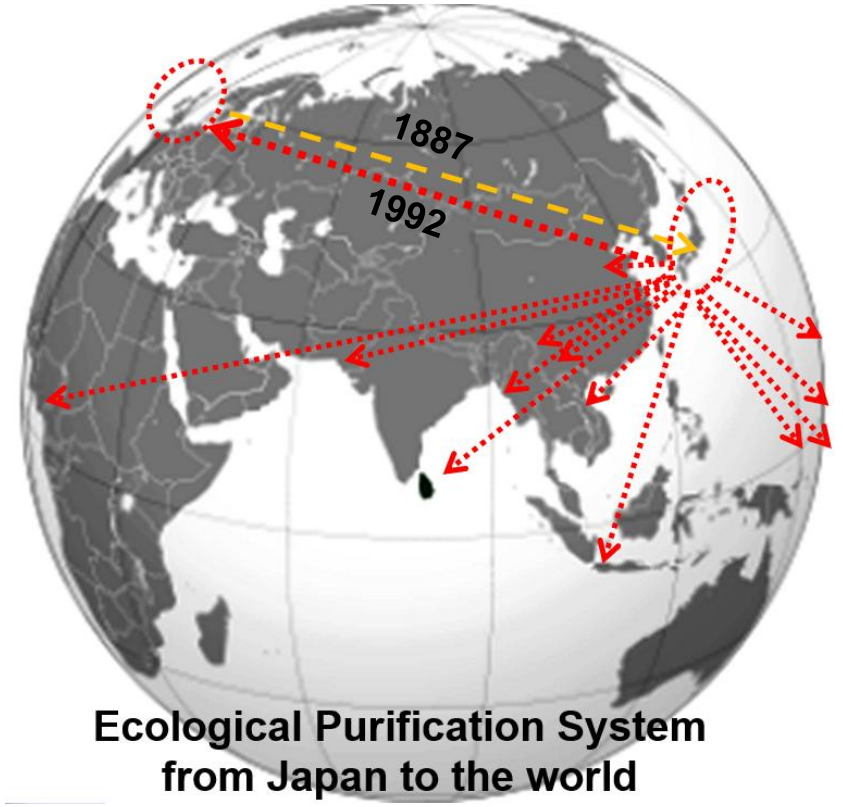
1. Knowing is NOT enough, we must APPLY it to something useful.
2. Willingness is NOT enough, we must PUT it into the PLAN and ACTION.
3. Putting the PLAN into action is NOT enough, we must ACCOMPLISH the goals.

Trust Our Sense !









Ecological Purification System from Japan to the world

Confirm by yourself.
Don't believe commercial.

Trust your true sense.

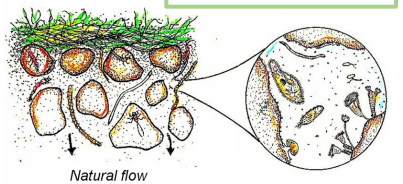
I, applied biologist, began the role of algae in slow sand filter pond.

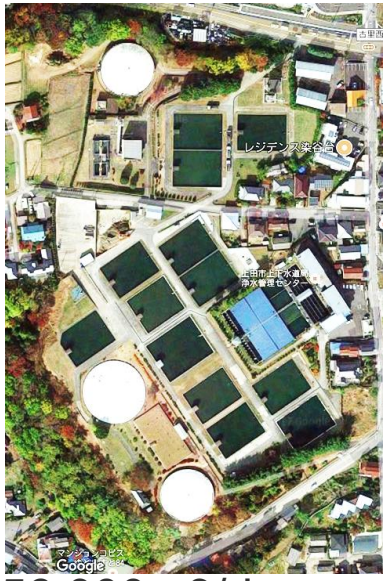
I noticed SSF has been misunderstood by the name.
This is Ecological purification system.

This system is wise application of natural system to make an artificial spring water.

Slow Sand Filter

Ecological Purification System





1923
Someya WPT

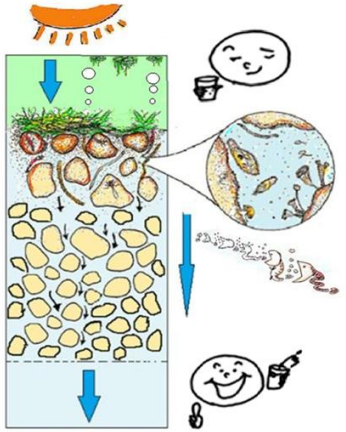
56,000m3/day capacity

Settling pond

Main Process

Slow Sand Filter

Ecological Purification System



Chlorination

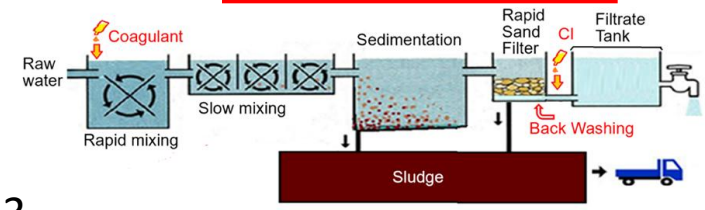
Natural Filter

Filtrate tank

Rapid Sand Filter

1964
Suwagata

Chemical Physical Treatment

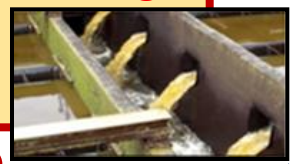


48,000m3/day capacity

Activated carbon

Main Process

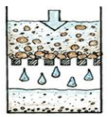
Pretreatment (coagulation/ mixing/ settling)



Sludge treatment

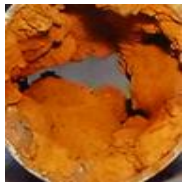
Sludge

Rapid Sand Filter



Chlorination

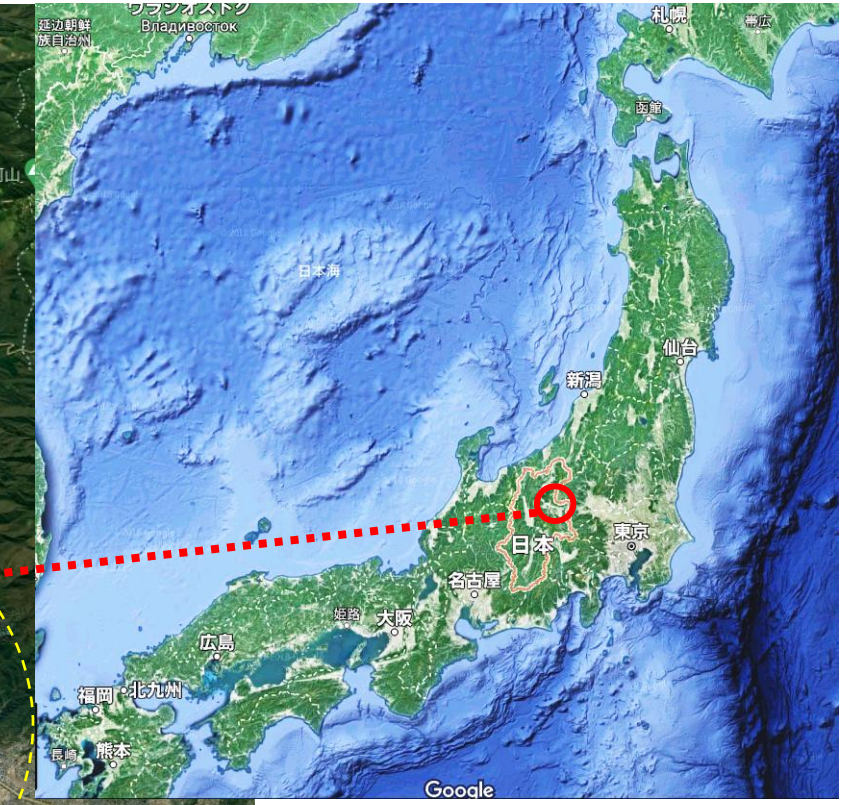
Commercial Filter



Back Washing process is essential.

Nagano prefecture

Ueda city

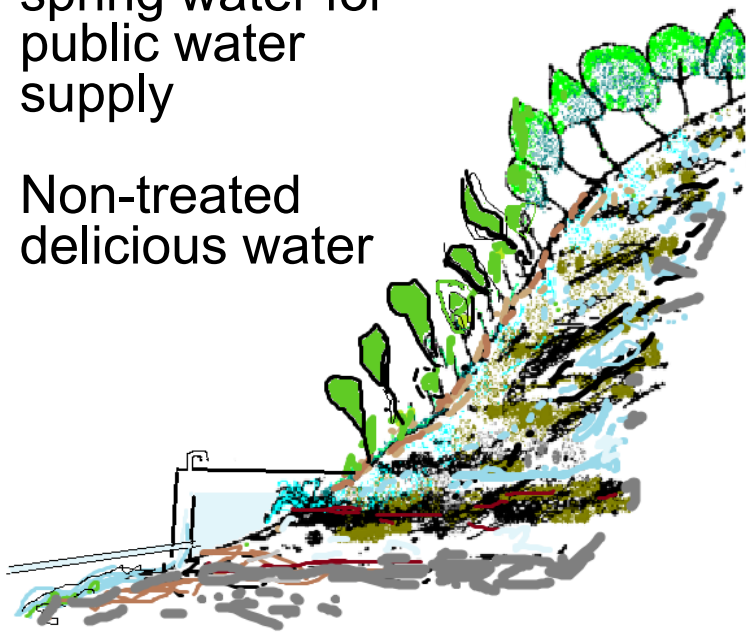


Suwagata WTP

Someya WTP

Collect natural spring water for public water supply

Non-treated delicious water



There are many plants of non-treated supply systems in rural area in Japan.

Surface water of River Ohta

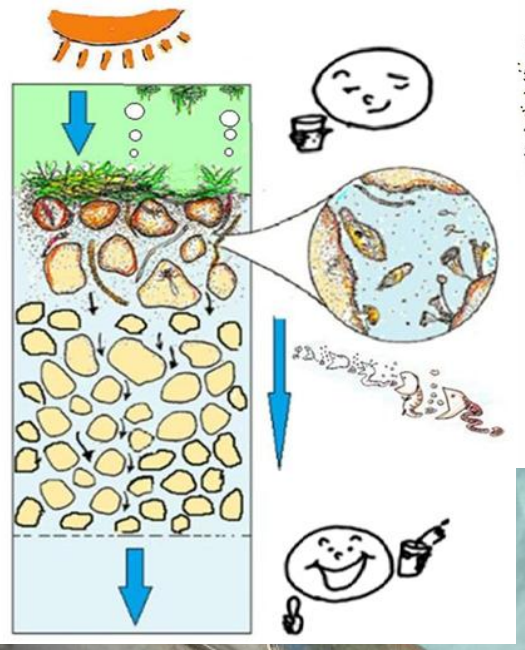
Settling + Sedimentation

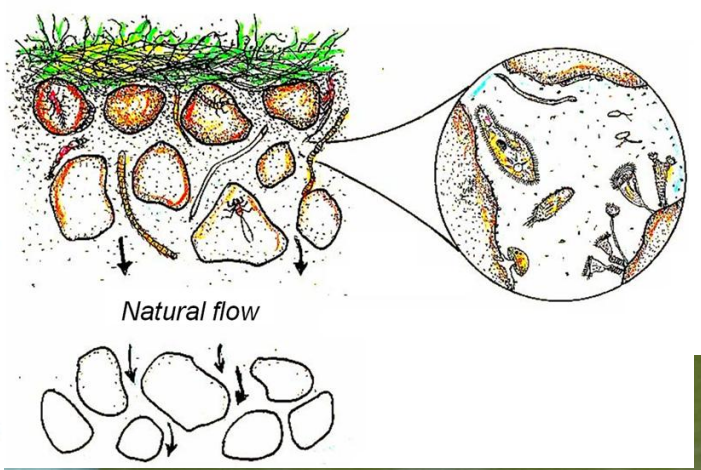
Toita Intake
+Settling

Fuchu WTP (Slow sand filter)：From May 6, 1965, capacity 27,000m³/day

In July, 2017, at that time, Fuchu WTP was working.

Present view by Google map in 2025





Microscopic organisms actively work on the sand layer and purify the water.

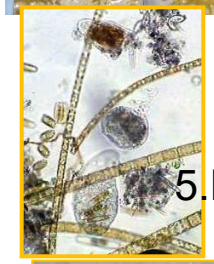
When we can understand EPS, we can make the plant for our life by ourselves.


1.Shallow depth


2.Photosynthesis


3.Bubbles


4.Lift up



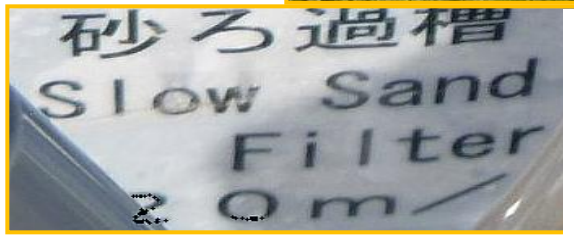

5.Microscopic organisms


6.Trap & decomposition

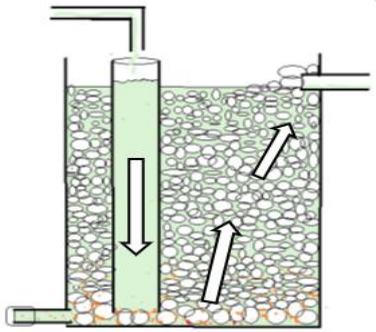

8.Sand is habitat

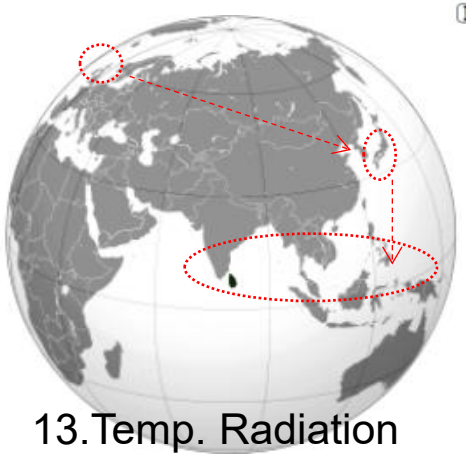

9.Large size of sand


10.Short passing time through active layer.



11.Fast flow rate


12. URF for turbidity reduction


13.Temp. Radiation

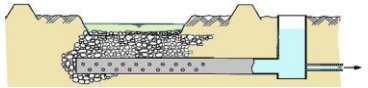
Gentle: chemical free

EPS is Eco-Friendly Smart Technology.

Ecological Purification System (EPS) : This is Wise Use of Natural Phenomena. This is Chemical Free System to make Artificial Delicious Spring Water. This is a Smart and Eco-friendly technique.

Surface water of river

Reservoir, lake

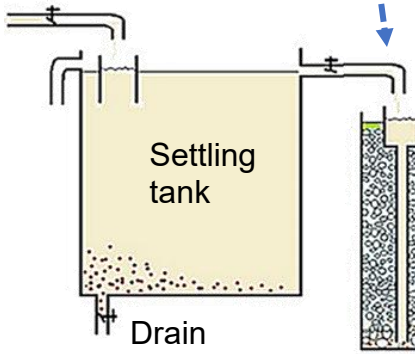


Subsurface water of the flood plain

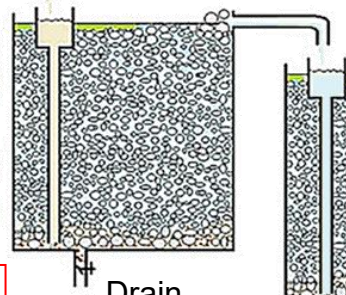
Clear spring water

Underground water

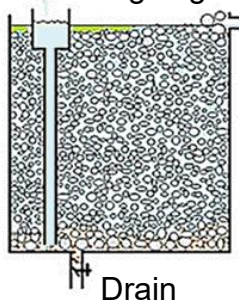
Raw water



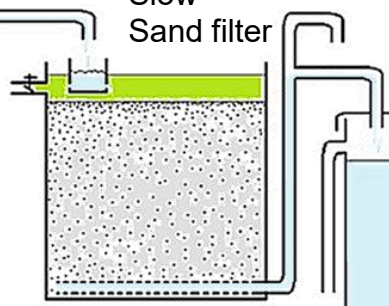
Up-flow Roughing Filter



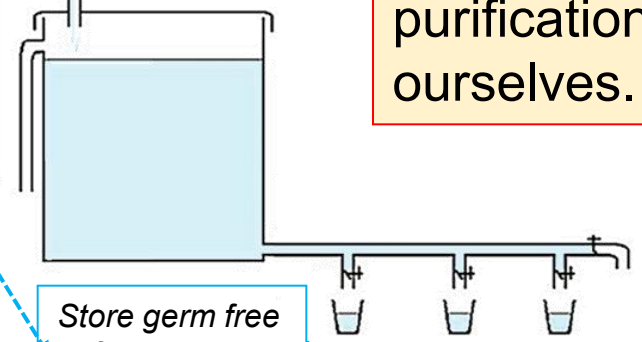
Up-flow Roughing Filter

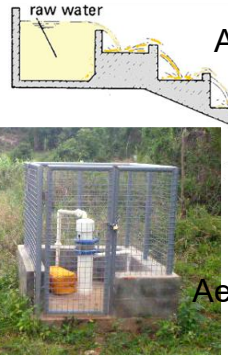


Slow Sand filter



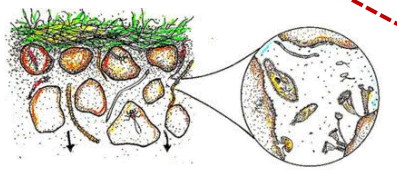
Storage tank

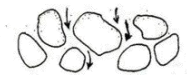




Aeration

Sink suspended solid





Trap and reduce fine matter

Complete purification

Store germ free safe and delicious filtrate.

Supply to houses.

Key is Gentle for small organisms.

We can make EPS purification device ourselves.

The name of **Slow Sand Filter** caused a **misunderstand** of real mechanism.

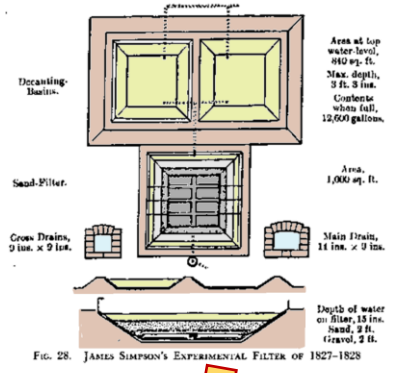
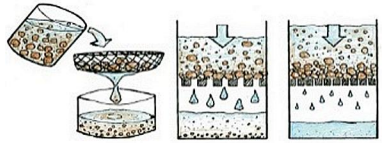


Fig. 28. James Simpson's Experimental Filter of 1827–1828

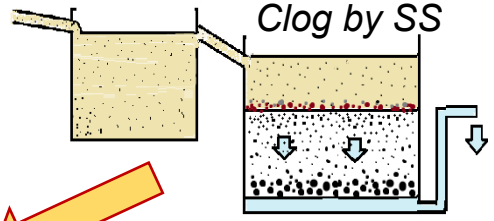


The filter rate was 2-3 m/d (10cm/h).

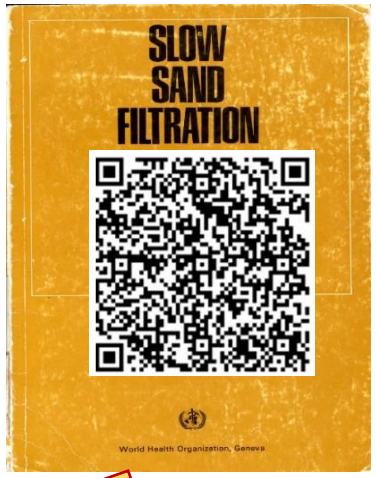
38 cm	Water depth
61 cm	sand layer
61 cm	gravel layer

They believed **mechanical reduction** by **slow** filtration with **fine sand** in 200 years ago. They called **Slow Sand Filter**.

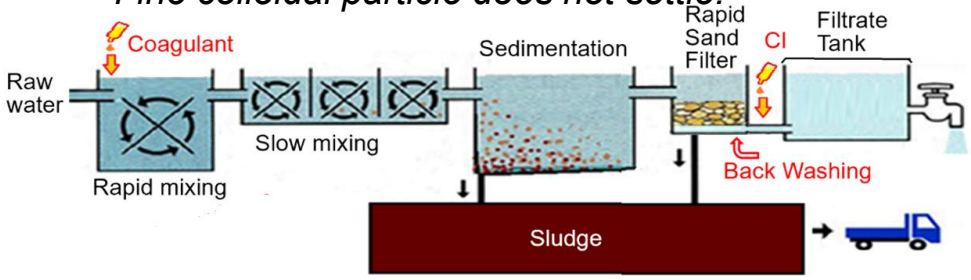
SSF spread to USA.



Refocus to SSF of chemical free system.



Fine colloidal particle does not settle.

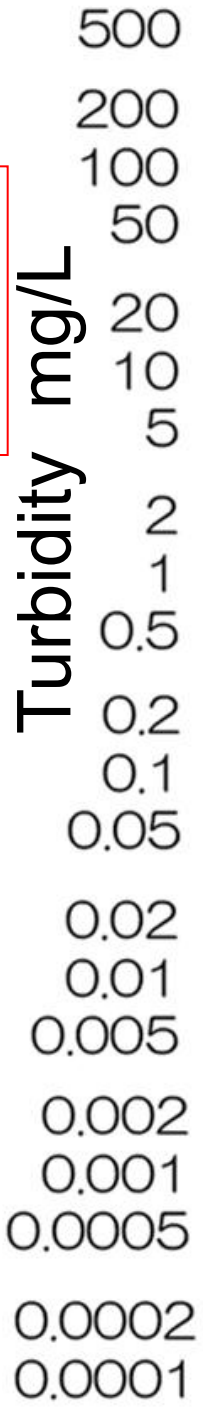


This is American Commercial Filter.

Back washing

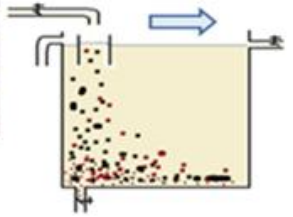
RSF spread to the world.

I proposed Ecological Purification System instead of Slow Sand Filter in Japan.



Storm event

Major turbid matter in mountain stream is easily set within several hours.



Coagulant＋Chlorine Rapid Sand Filter

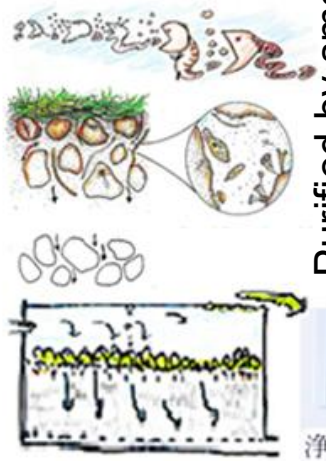
SS passes by backwash.

2 degrees Jap. standard

After Crypto outbreak.

Recommended to 0.1 degrees

Chlorination is essential.



Purified by small organisms

Natural spring

Super clean and delicious.

Artificial Natural spring water

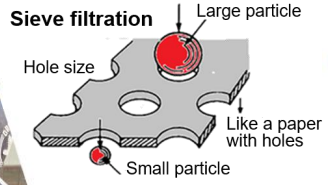
75⇒175

EPS from Japan to the World

Wise Use of Natural Phenomena for Human Life.
Safe and Delicious Water by EPS, Our Technology.

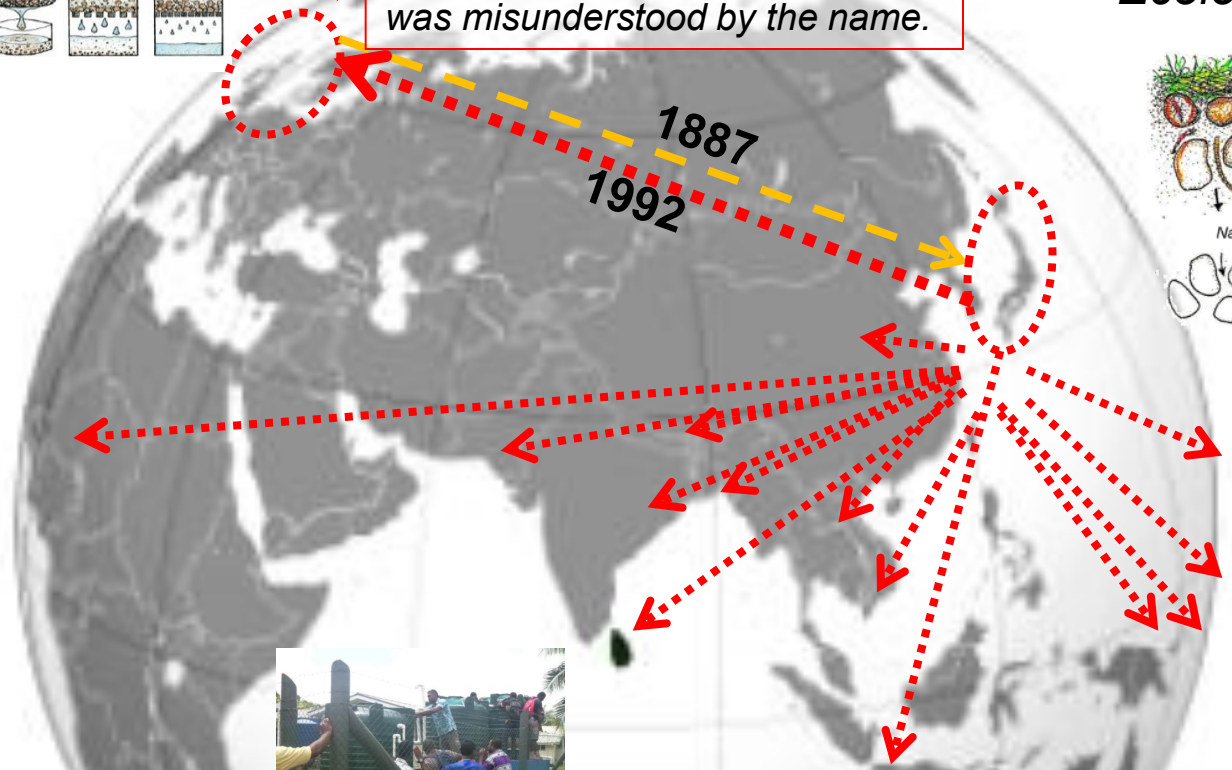
Trust Our Sense !

Super clean delicious water

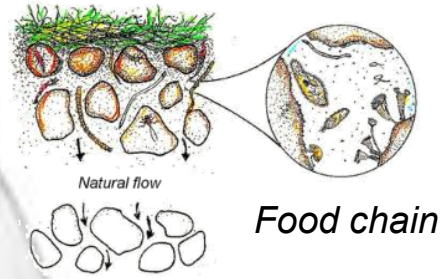


Slow Sand Filter

Purification mechanism of SSF was misunderstood by the name.



Ecological Purification System



Food chain

Gentle for small organisms

Nigeria

Remember Three Steps

1. Knowing is NOT enough, we must APPLY it to something useful.

2. Willingness is NOT enough, we must PUT it into the PLAN and ACTION.

3. Putting the PLAN into action is NOT enough, we must ACCOMPLISH the goals.