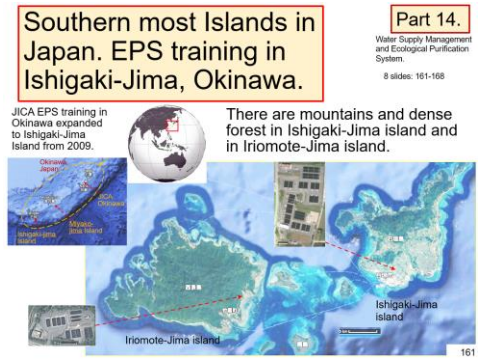
EPS4 Part 13. Miyako-Jima to Samoa

https://youtu.be/SkKZm5aL9Tk

EPS4 Part 14. Ishigaki-Jima, warm region

https://youtu.be/ZQbd7_VZOZg



EPS4 Part 15. DO is key. Smart Technology.

https://youtu.be/m9dPcAJAfg4

JICA EPS Training started from Miyako-Jima, Okinawa. EPS is Wise Use of Natural Purification System.

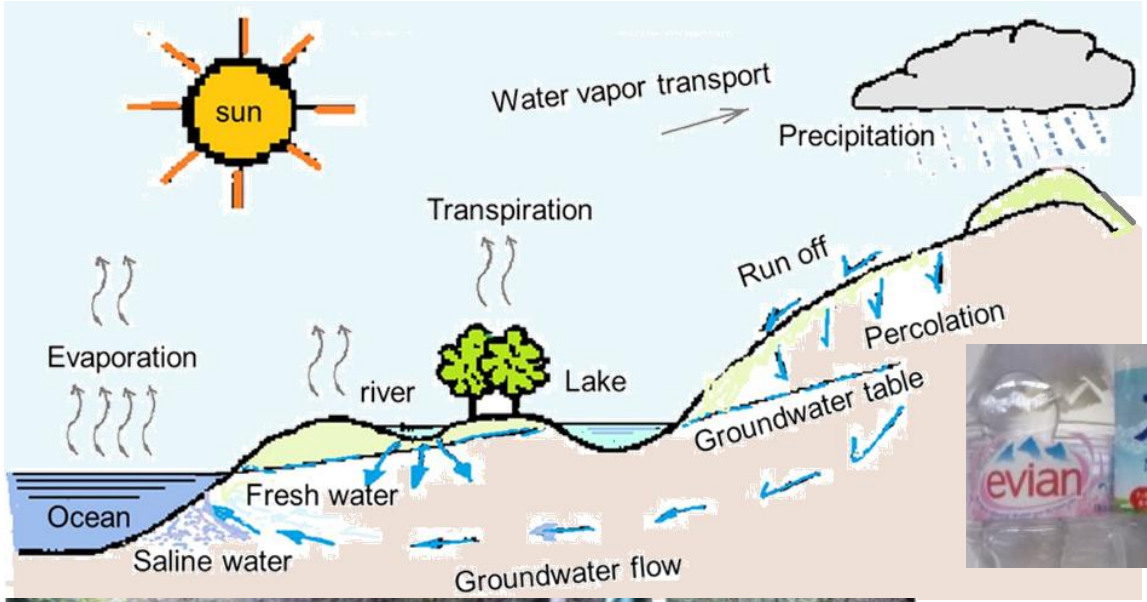
Part 13.

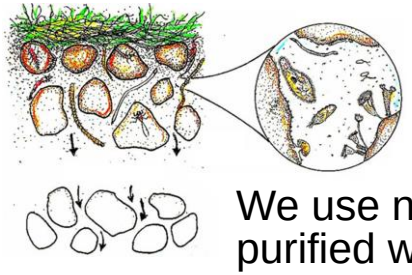
Water Supply Management and Ecological Purification System.

20 slides: 141-160

2021(4 yrs) Refresh

JICA EPS training started in 2006 in Miyako-Jima.

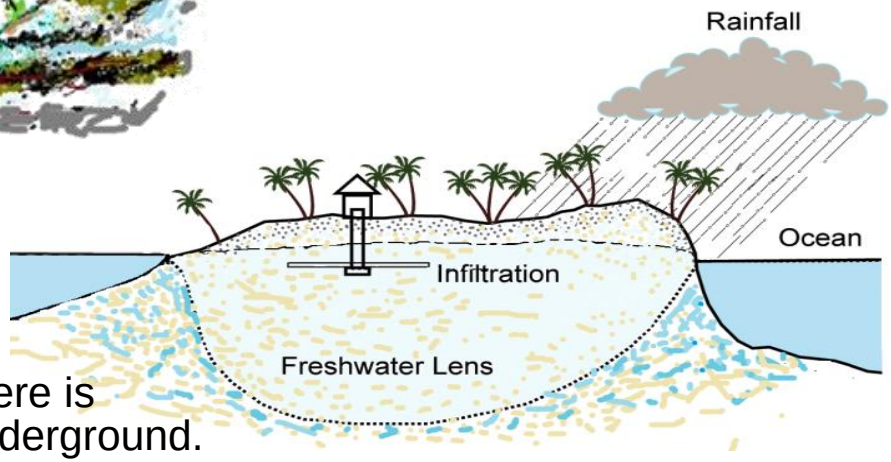




We use natural purified water.

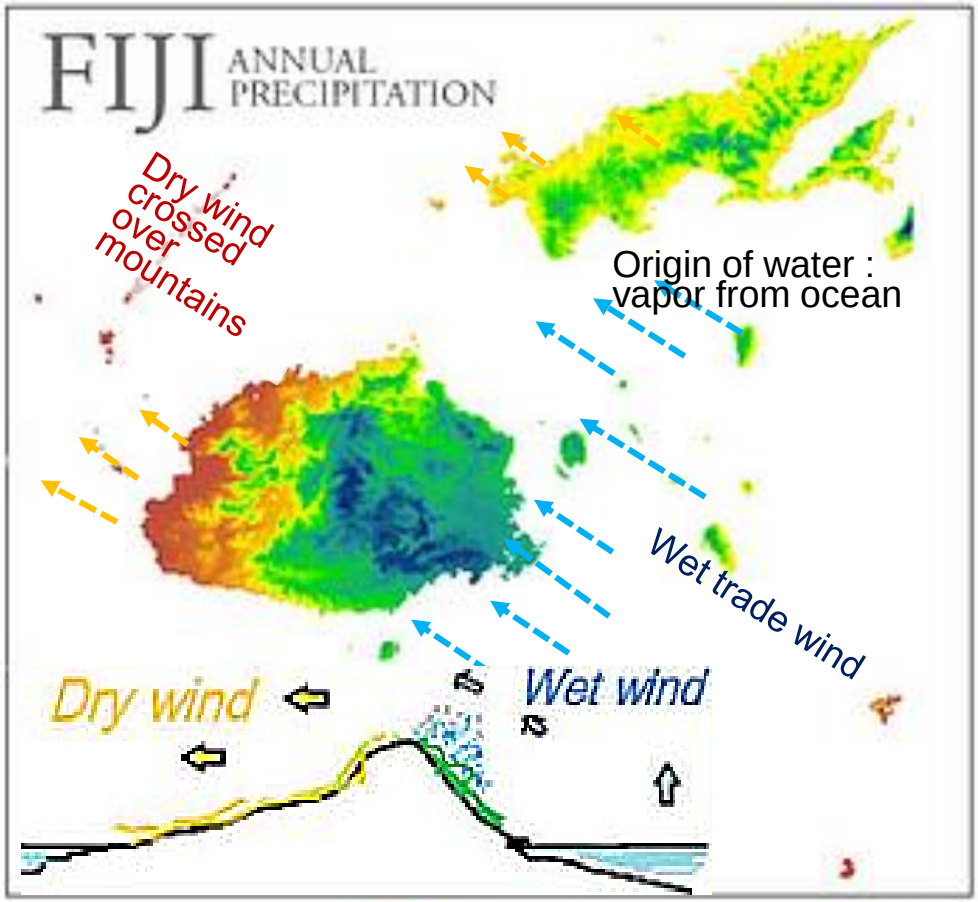
In case of mountain area, we can find a good quality of spring water.

We store the natural spring water and use for water supply system.

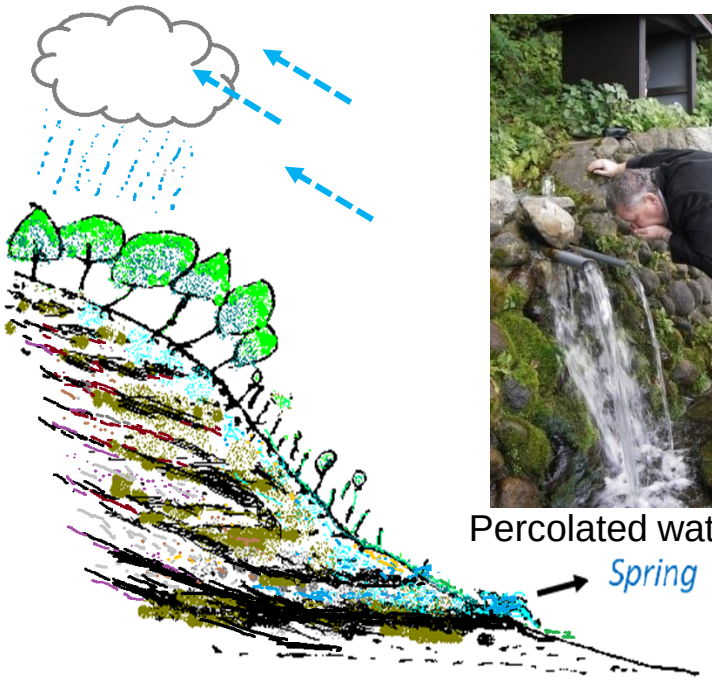


In case of island, there is freshwater in the underground. We can use this water.

Where can we find Clean and Safe Water in Nature?



Vapor:
distilled water



In mountainous country, many houses are scattered on the slope. They use natural spring on the slope.

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

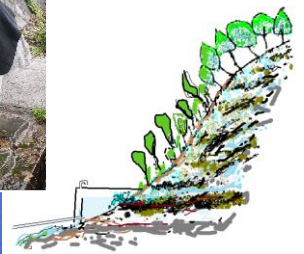
Water source for Akan water works, Hokkaido, Japan

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.

Japan is an island country **surrounded by the sea** and has many **mountains**. It rains on the mountains. There are many forests and many **springs**. Its water is always flowing into the river from the mountain.

Ueda city is about 200 km far from Tokyo and in mountain area.

JICA EPS training started in Okinawa from 2006.



Okinawa district is islands country in south west in main land of Japan where is about more than 2,000 km far from Tokyo.

Okinawa, Japan

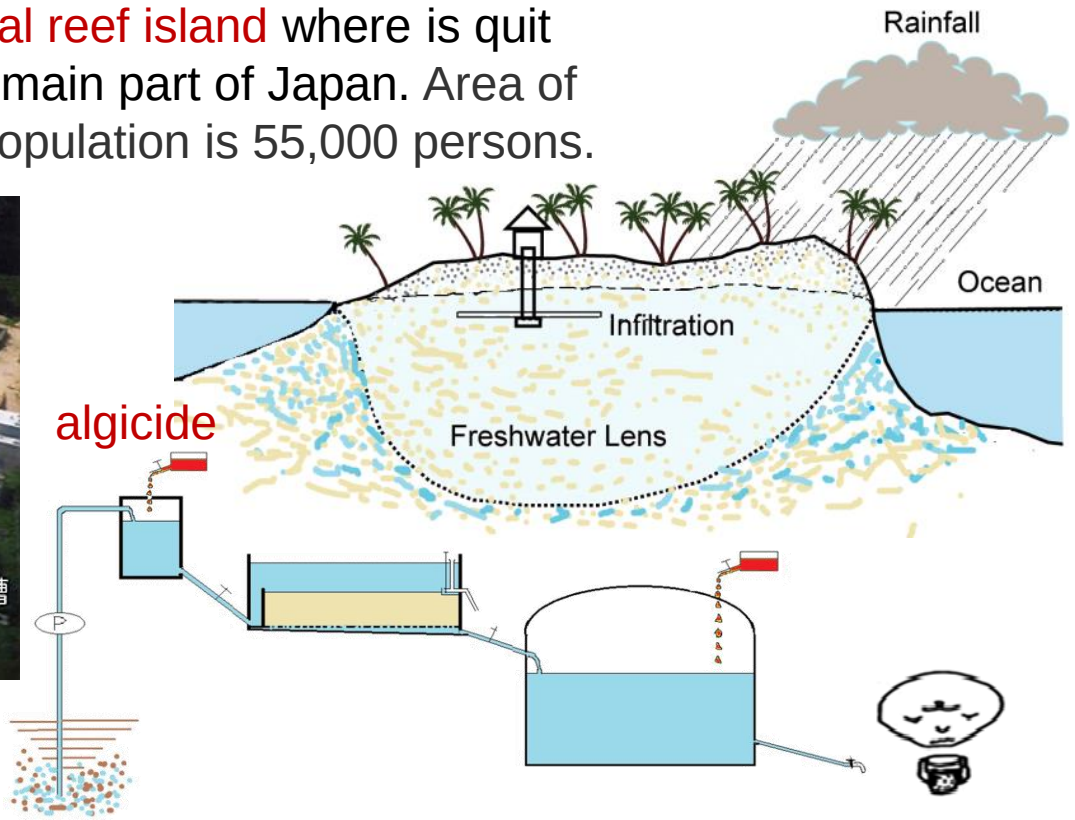
JICA Okinawa

Miyako-jima Island

Ishigaki-jima Island

Okinawa countries are surrounded by **coral reefs** and warm currents. The climate is similar to tropical islands. In Okinawa, there are no large rivers, and most of the **groundwater** was **hard water**, so it is difficult to obtain good quality water that is soft water. Until several decades ago, it also used rain harvest water.

Miyako-Jima island is an uplifted coral reef island where is quit different environment compared with main part of Japan. Area of islands of Miyako-Jima is 204 km2, population is 55,000 persons.



Before 1997, pre-chlorination as algicide to receiving well was a popular to **kill** the algae and to **stop** the algal growth in all over Japan. This is **popular for Rapid Sand Filter**.

Mr. Mitsutoshi Tomari, managing director of Sodeyama WTP, Miyako-Jima, visited to Nakamoto, Shinshu Univ. in July 8, **1997**. Nakamoto explained about the ecological purification system of slow sand filter.

He **stopped to injection** of algicide into receiving well. As soon as the injection stop, the taste of tap water became delicious.

Sode-yama Purification plant

Miyako-Jima, Okinawa

17.25m x 27.6m(x2.6m) x7 filter ponds (17.25m x 27.6m=476.1m2)

23.7m x 20.0m(x2.6m) x 1 filter pond (23.7m x 20.0m=474m2)

Designed capacity (7 filters, 1 filter is spare : 8(new)+1(old)=9 filters)

475m2 x 7m/d= 3,325 m3/d x 7 filters= 23,275 m3/d

Water demand 400 liter per day per person

= 58,000 persons

1997

Receiving well

Hardness reduction plant

1999 to 2021

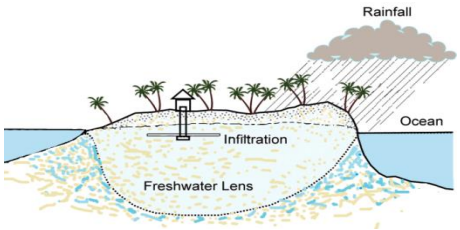
2021-2025 (4 yrs)
Refresh Hardness plant

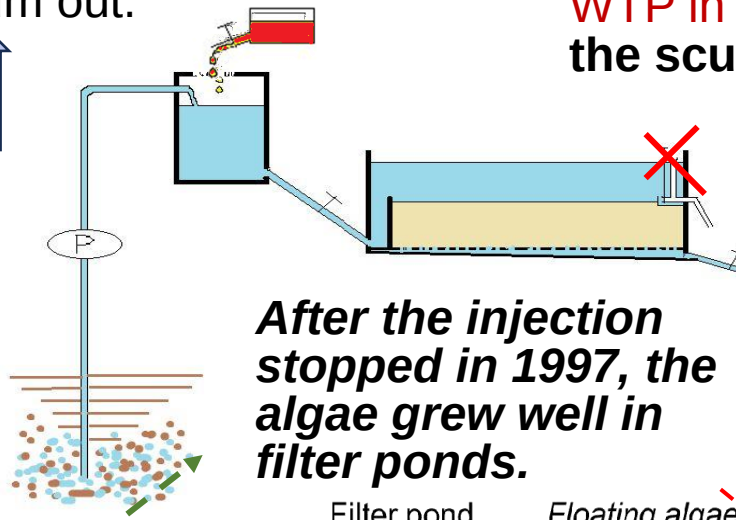
And an additional one filter was built.

In the filter pond, algal bloom was so severe. They could not flow out from the scum out.

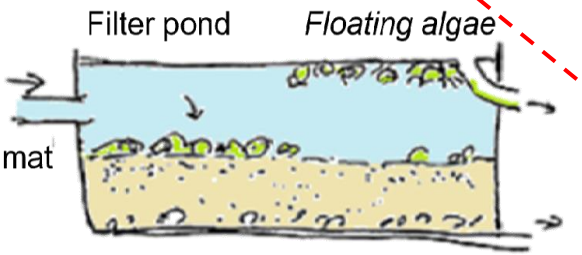
The **pre-chlorination** was a popular treatment to stop the algal growth for WTP in all over Japan. The **close the scum** out was also popular.

They pumped up the underground water as water source.



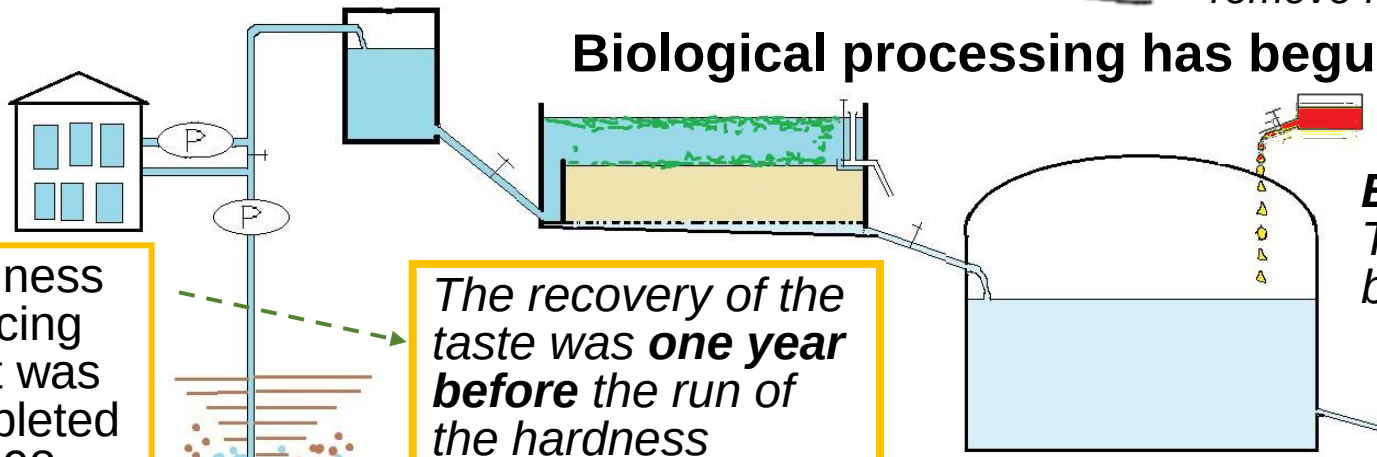


After the injection stopped in 1997, the algae grew well in filter ponds.



New hard work raised to remove floating algae.

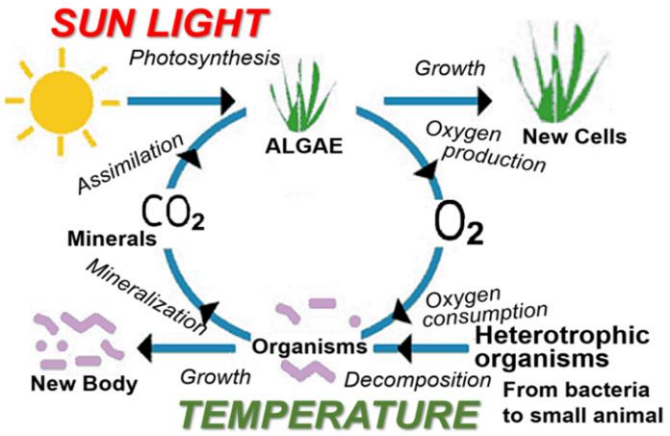
Biological processing has begun to work.



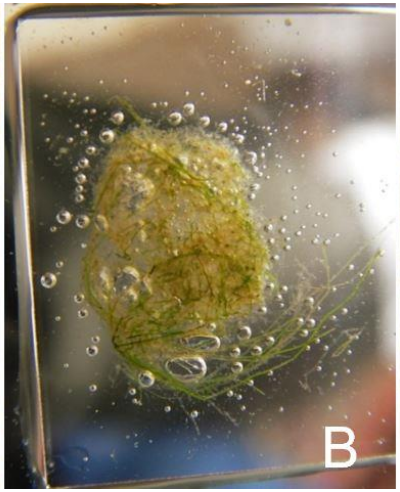
EPS functioned. *The tap water became **delicious.***

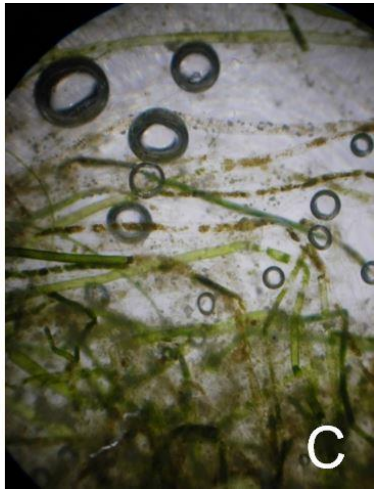
Hardness reducing plant was completed in 1998.

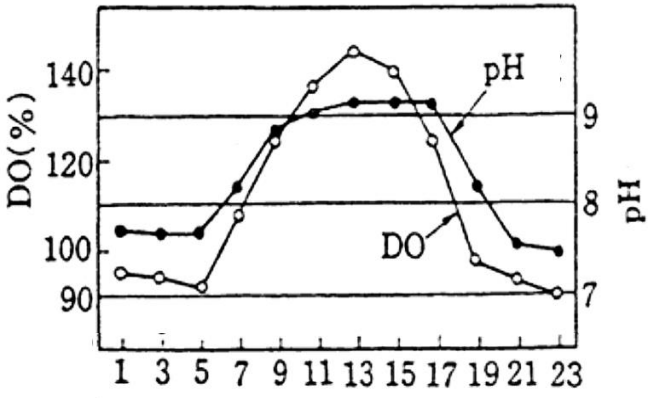
*The recovery of the taste was **one year before** the run of the hardness reducing plant.*



Due to active photosynthesis, water shifted to high pH.





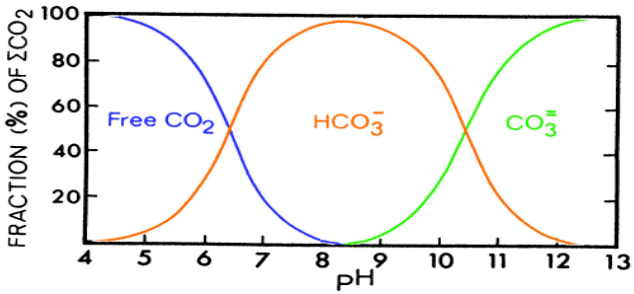


合山幹二、水環境指標(1979)

limestone:CaCO3

$$CO_{2(g)} + H_2O \rightarrow \underset{\text{carbonic acid}}{H_2CO_3} \leftrightarrow H^+ + \underset{\text{bicarbonate}}{HCO_3^-} \leftrightarrow H^+ + \underset{\text{carbonate}}{CO_3^{2-}}$$

$$\underset{\text{carbon dioxide}}{6CO_2} + \underset{\text{water}}{6H_2O} \xrightarrow[\text{Respiration}]{\text{Photosynthesis}} \underset{\text{glucose}}{C_6H_{12}O_6} + \underset{\text{oxygen}}{6O_2}$$



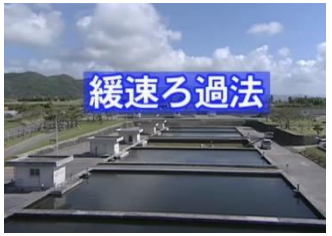
Biological softening happened in active slow sand filter.

JICA EPS Training started from 2006 in Miyako-Jima Island, Okinawa to Pacific Islands and Asian Countries.

Nakamoto published a manual in Japanese with English summary in 2005.

Quest for Safe and Delicious Water
Oct. 2007

JICA also made YouTube file.



26min. 2019

3min. 2020

JICA training in Okinawa expanded to Ishigaki Island from 2009.

Running model

Lecture

Sand surface was taken.

Sand is clear. Algal mat is just laid on the sand surface.

Thread-like algae were observed on and between the sand. The size of algae is much smaller than the size of sand.

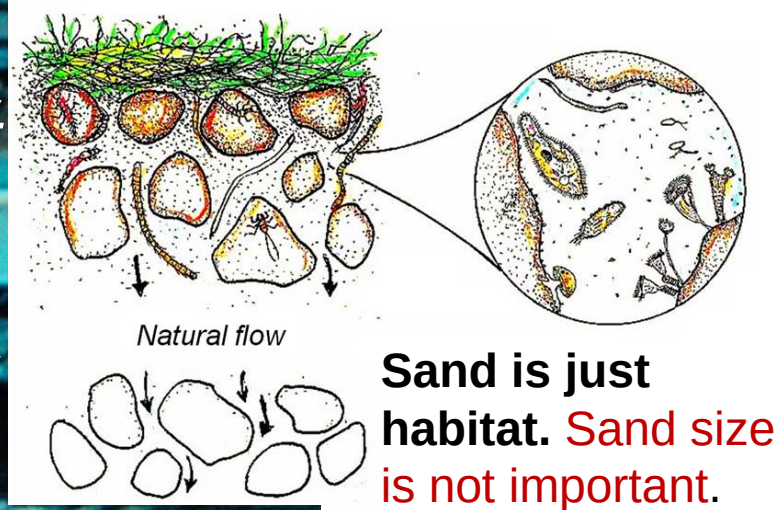
Fine sand. But this size is too large to separate the small organisms from the sand.

1 mm

Sand size and microscopic organisms

Aerobic condition for small animals is the key.

Sand is just habitat.
Small sand and uniformity of sand size is not important. Large size of sand and higher flow rate are better for organisms.

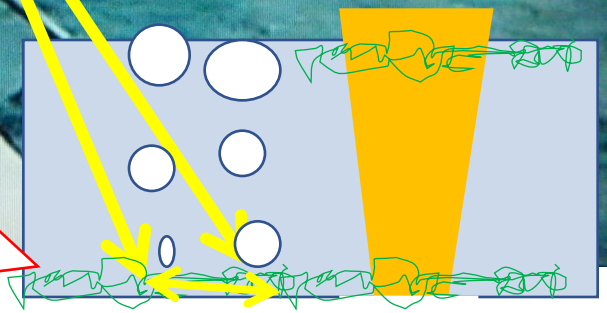


Sand is just habitat. Sand size is not important. Large size of sand and higher flow rate are better for organisms.

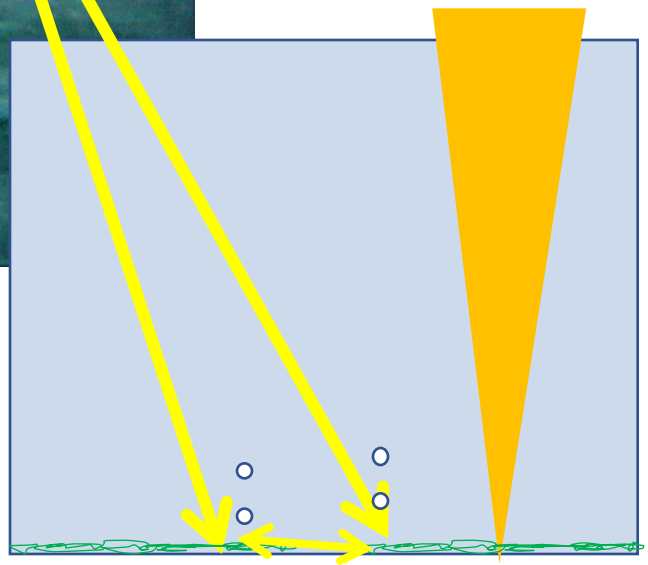
Shallow depth is better.

Touch the bottom by stick.

Super saturated dissolved oxygen at the bottom.

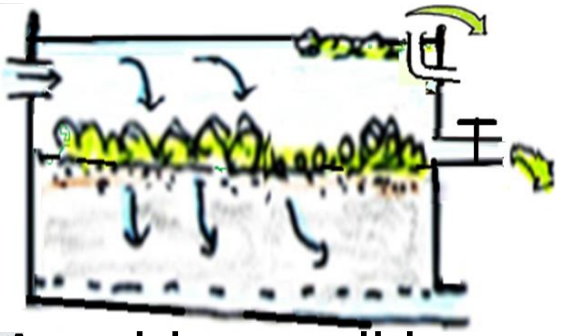


Shallow depth



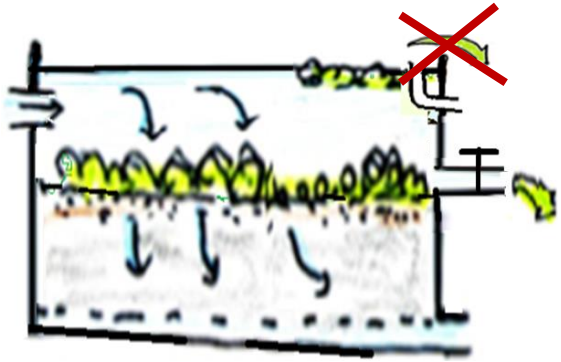
Deep depth

Active photosynthesis by algae and aerobic condition for small animals are the key.

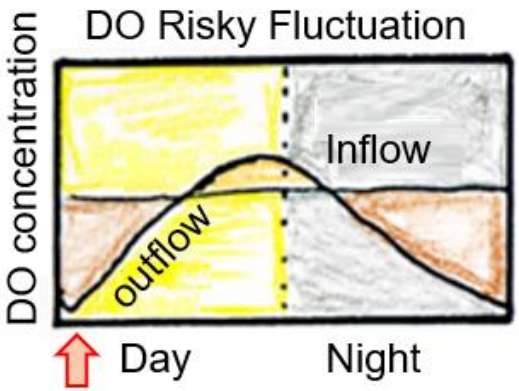


Aerobic condition in the sand layer

No scum out



Heavy algal growth

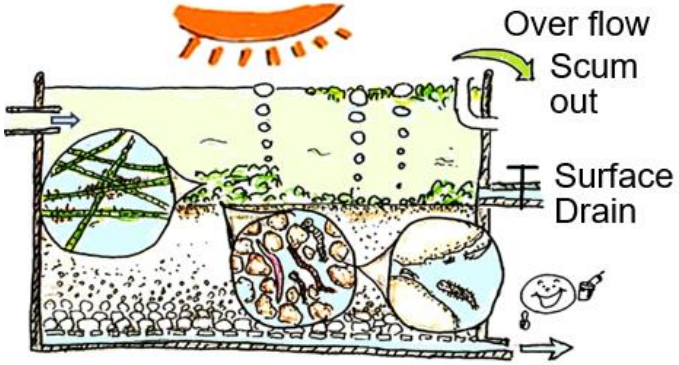


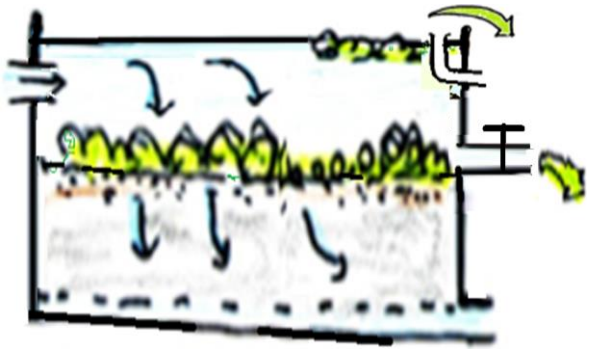
Slow flow rate

Consume up DO

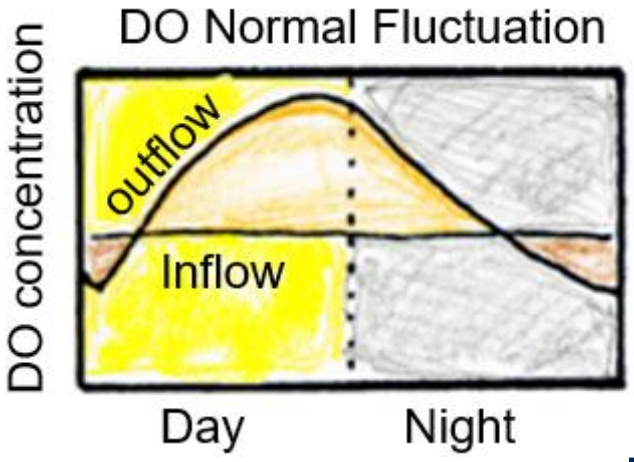
Anaerobic condition → Bad smell

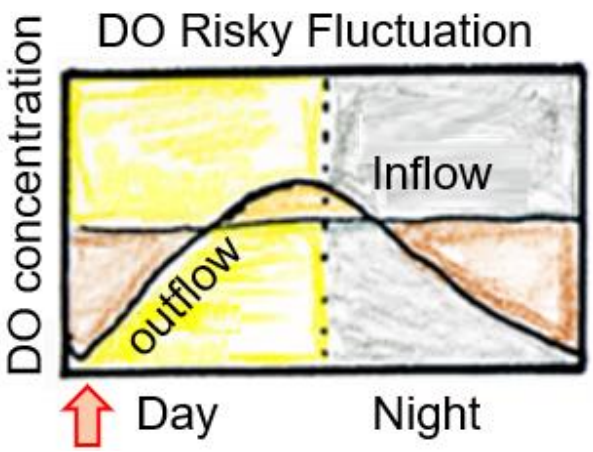
Aerobic condition is essential for biological activity.

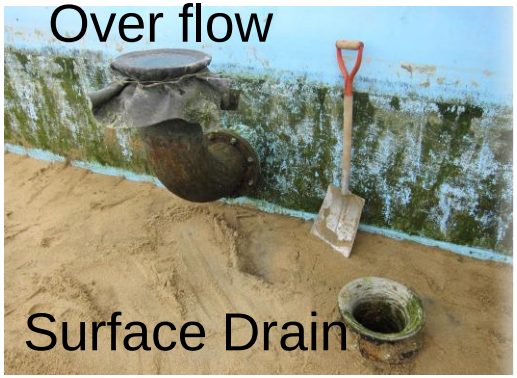


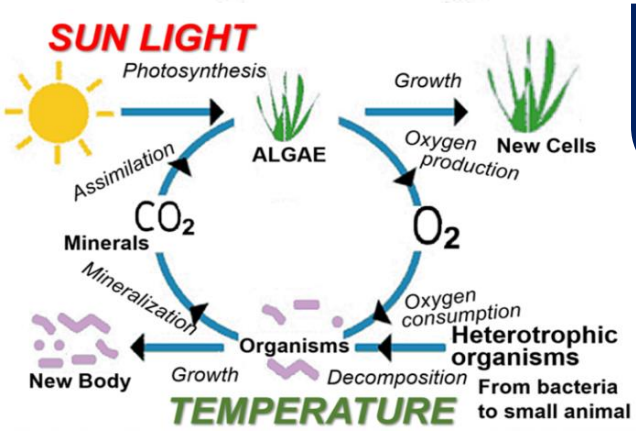


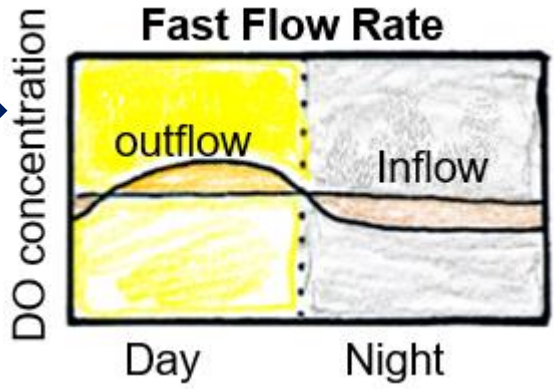
Surface Drain before scrape the surface.







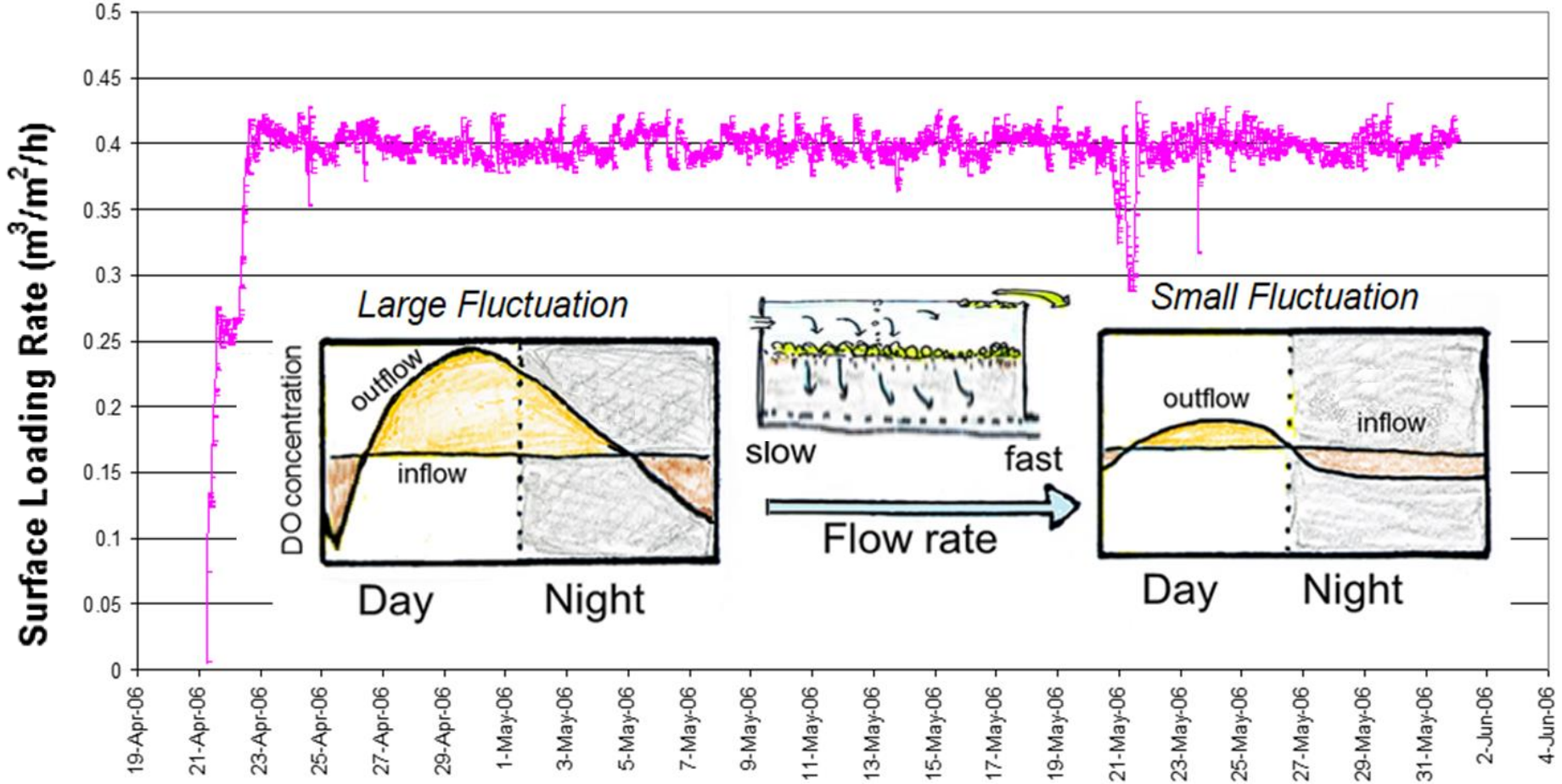




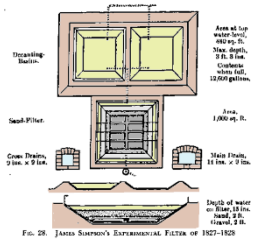
Over flow: scum out
Fast flow

Delicious filtrate

Surface Loading Rates for a SSF at Ashford Common during April and May 2006



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



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

38cm water depth

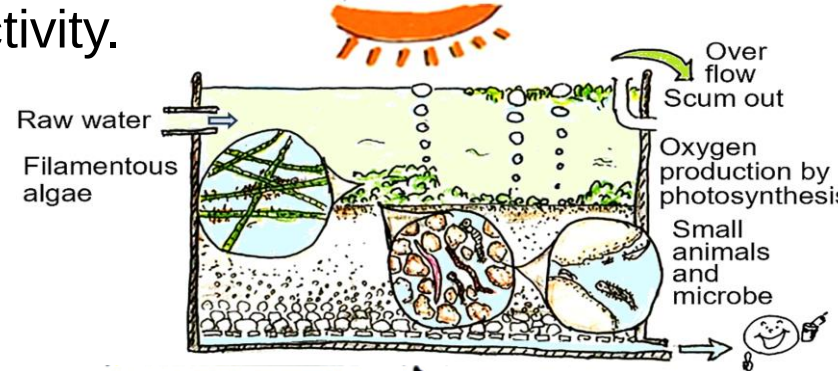
200yrs ago

→ *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.

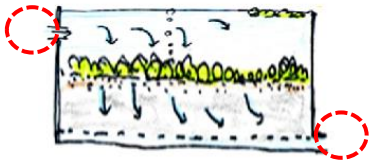
Faster flow rate is better for small organisms in the filter.

Aerobic condition is essential for biological activity.

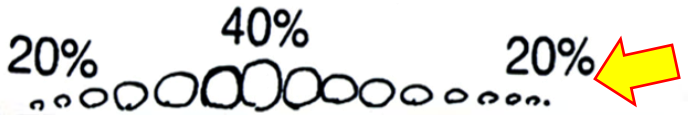


$$CO_2 + H_2O \rightleftharpoons CH_2O + O_2$$

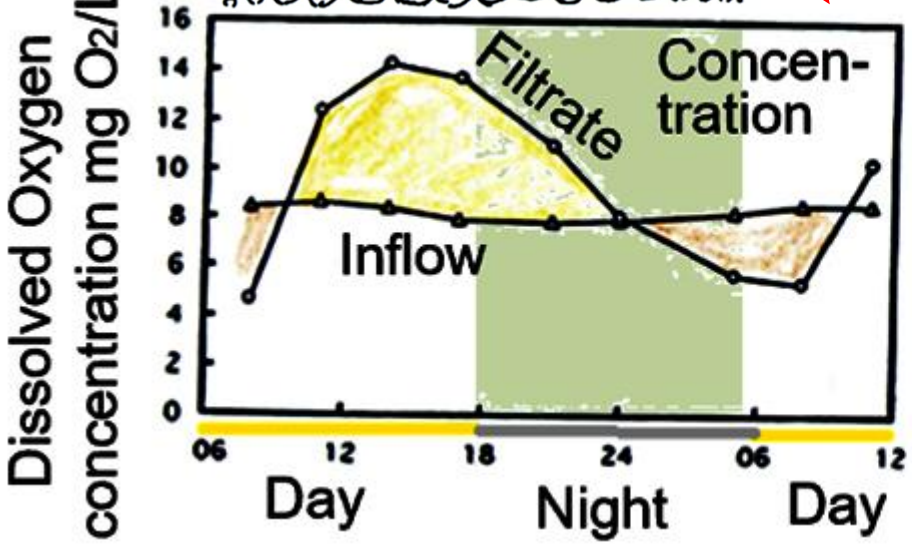
There is down ward current.



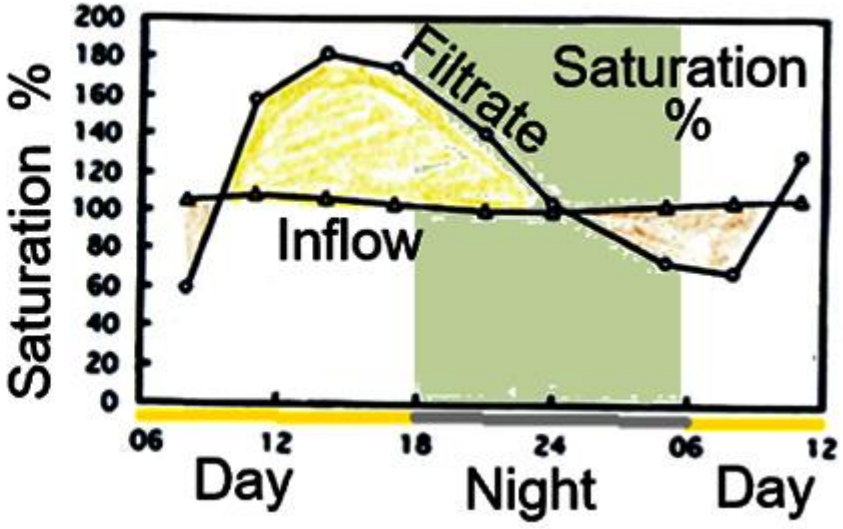
Diurnal change of dissolved oxygen (DO) was measured.



Partial pressure of oxygen in bubbles was also measured.

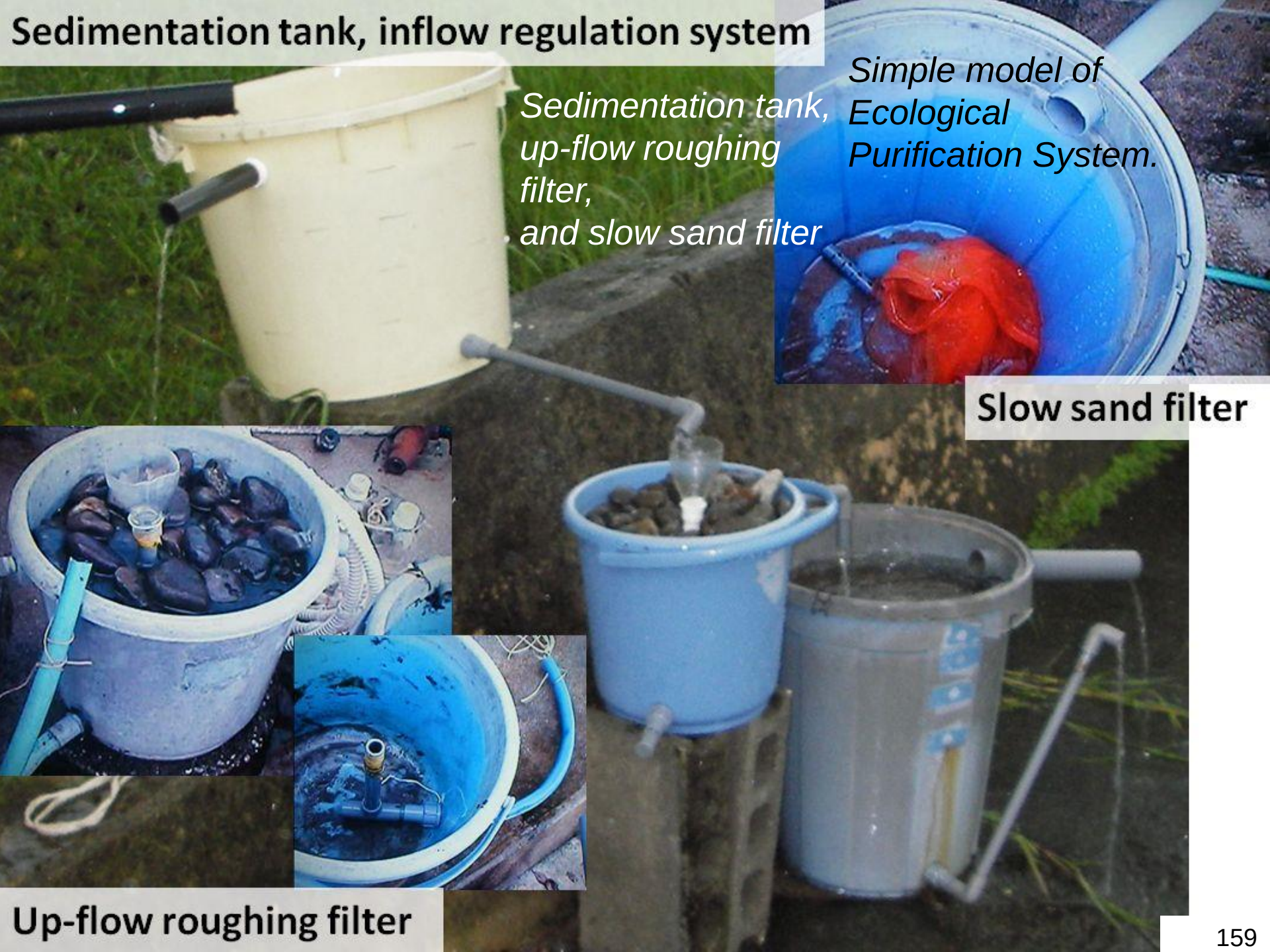


Soon after sun rise, DO in filtrate was rapidly increased.

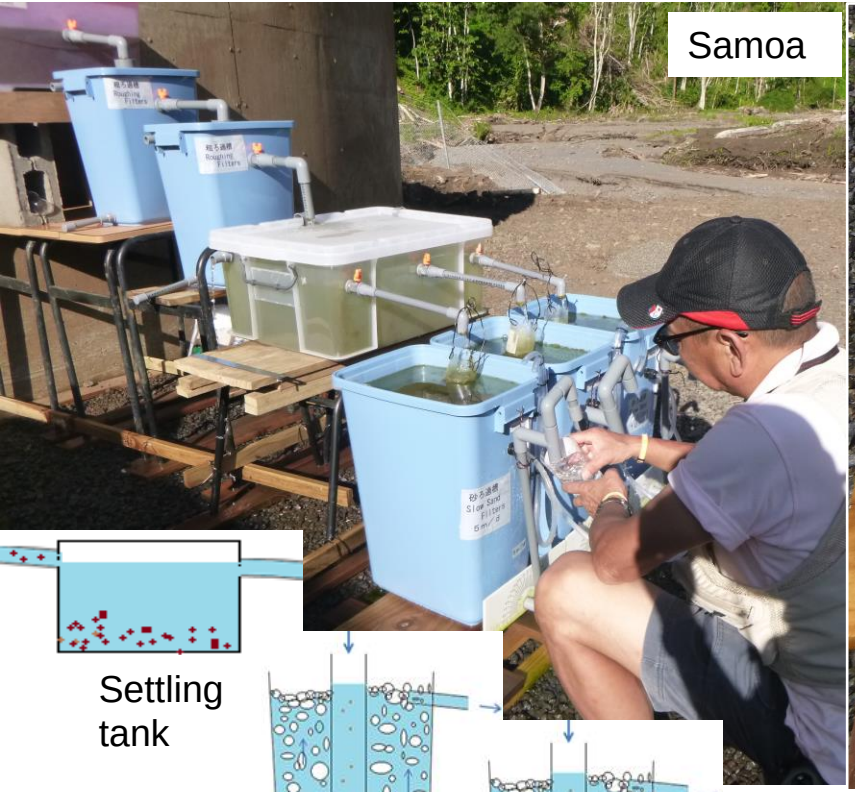


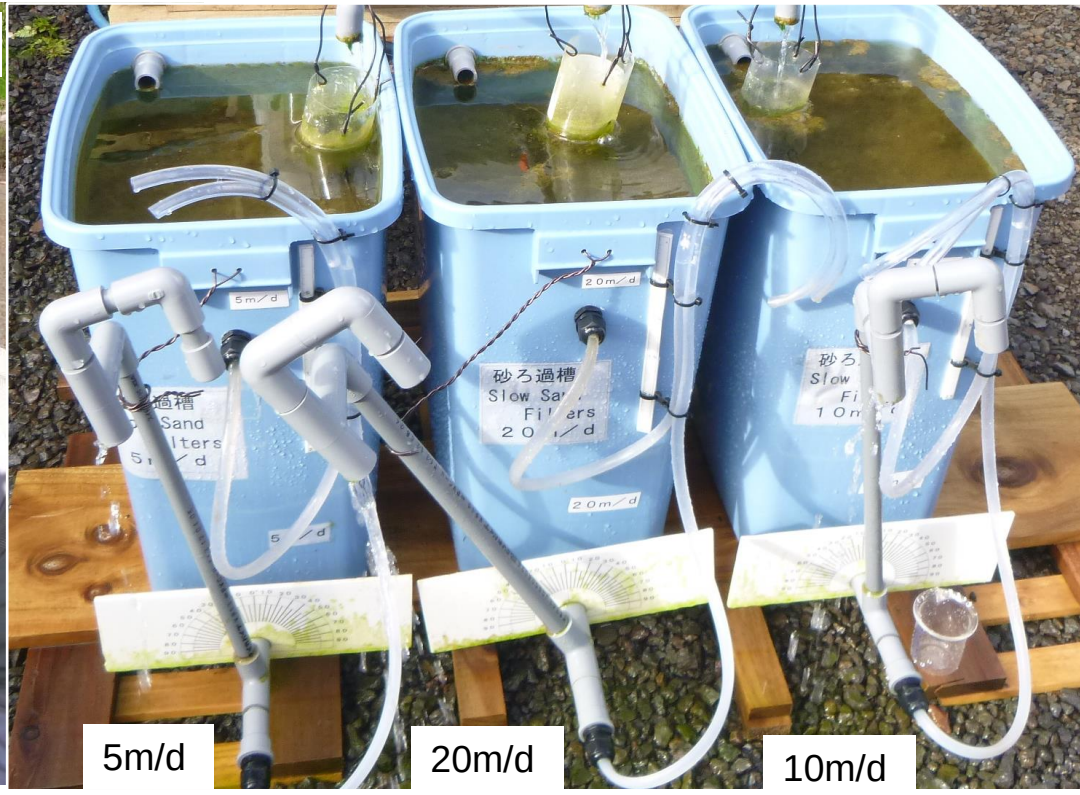
Even after sunset, DO in filtrate was super saturated condition.

Algal photosynthesis accelerates purification process.


Sedimentation tank, inflow regulation system
Sedimentation tank, up-flow roughing filter, and slow sand filter
Simple model of Ecological Purification System.
Slow sand filter
Up-flow roughing filter

Samoa

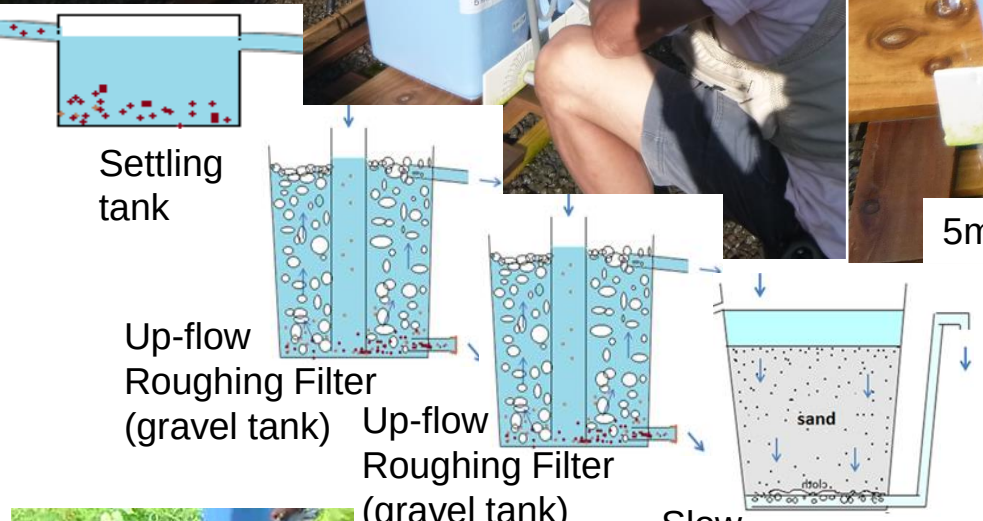




5m/d

20m/d

10m/d



Settling tank

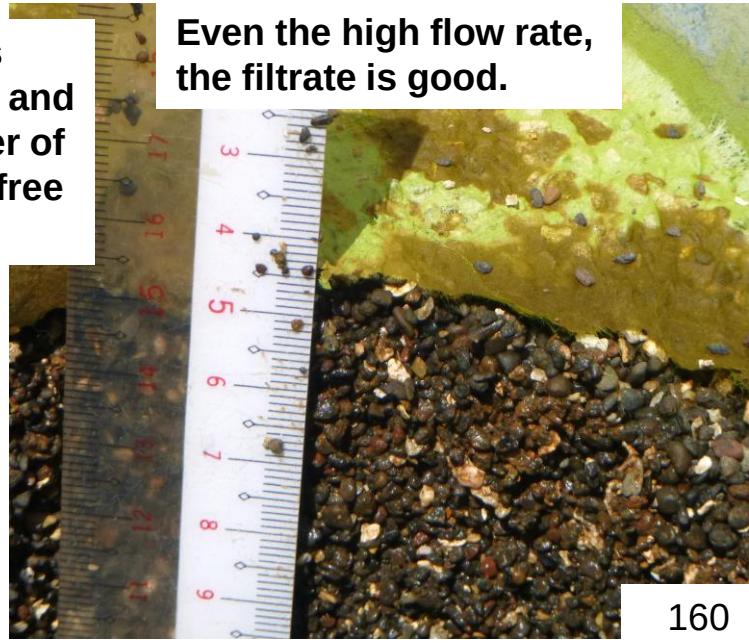
Up-flow Roughing Filter (gravel tank)

Up-flow Roughing Filter (gravel tank)

Slow Sand Filter

Filtrate is delicious and safe water of Bacteria free water.

Even the high flow rate, the filtrate is good.



Washing beach sand using mosquito net

Southern most Islands in Japan. EPS training in Ishigaki-Jima, Okinawa.

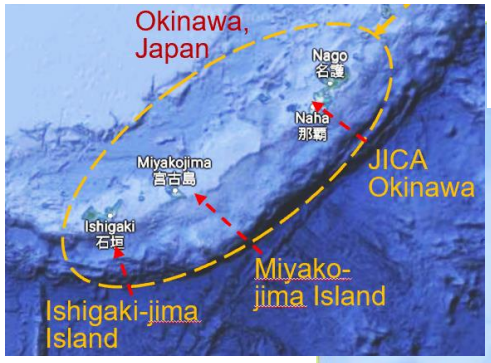
Part 14.

Water Supply Management and Ecological Purification System.

20 slides: 161-168

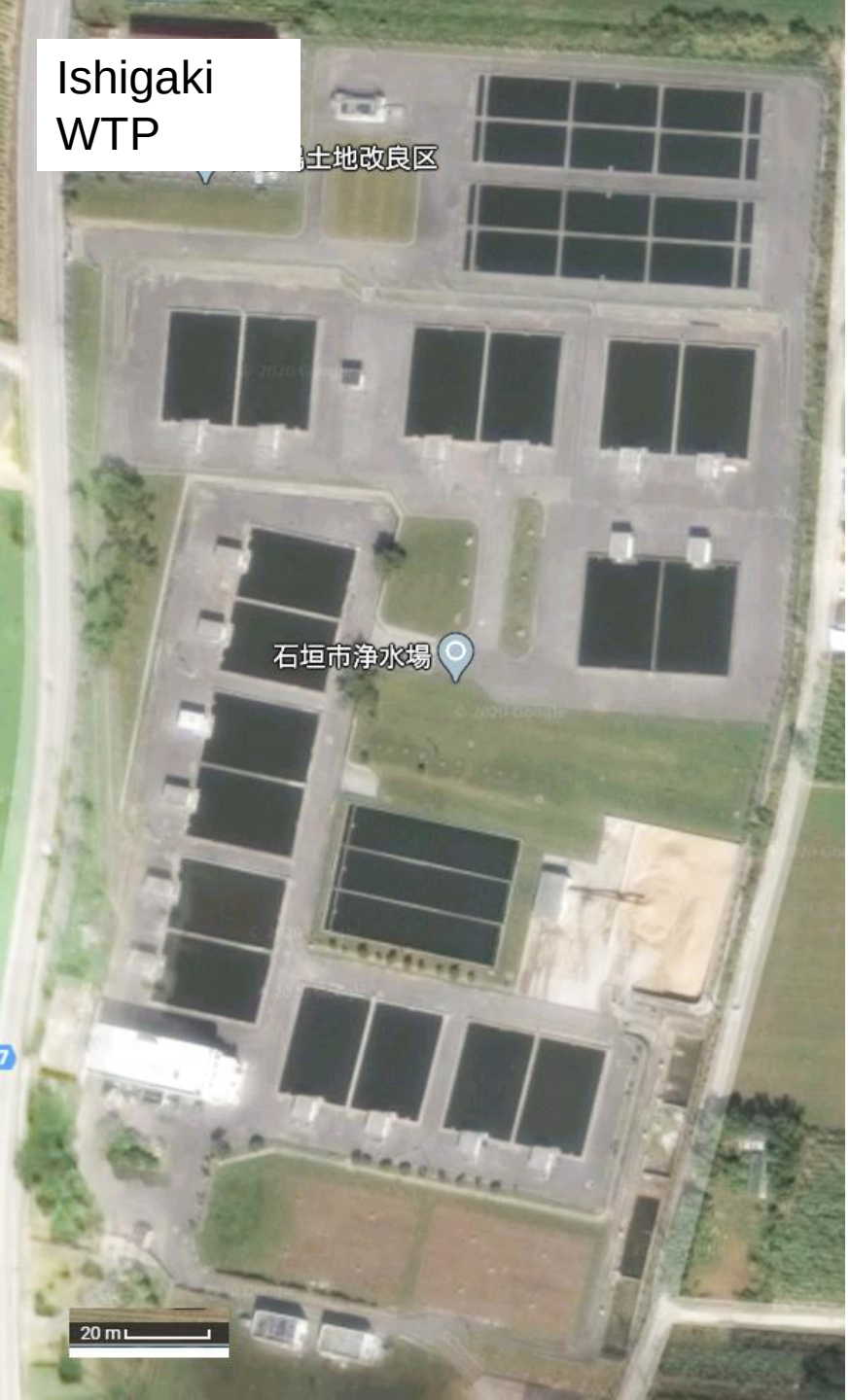
JICA EPS training in Okinawa expanded to Ishigaki-Jima Island from 2009.

There are mountains and dense forest in Ishigaki-Jima island and in Iriomote-Jima island.



Ishigaki-Jima island

Iriomote-Jima island



Receiving well

4 Sedimentation ponds

10.5mx65mx3.15mx 4 ponds

18 Filters:

Each 27mx17.6mx4.08m

Sedimentation ponds

3 Sedimentation ponds

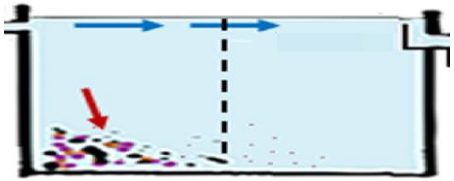
10mx40mx3.15mx3ponds

Sand wash yard

Control building

Filtrate tank

Residence time of sedimentation ponds: 0.4 day＝10 hrs. in manual.



Heavy suspended matters sink down to the bottom. But fine particles do not sink. And surface water drifts near the surface and passes the sediment pond. This means residence time of near surface water is shorter time than the manual.

Ishigaki plant capacity:

Design capacity:30,160m3/d
in manual.

Slow sand filter:

4m/d : Design filter rate in manual.

Each filter: 27m x 17.6m = 475.2m2

475.2m2 x **4m/d** = 1,901m3/d

1,901m3/d x 16filters = 30,413m3/d

2 filters are spare use.

Water supply per person

0.3m3/person/d⇒100,000persons.

0.5m3/person/d⇒ 60,000persons.

Big capacity

Shallow depth is the key for algal growth.

I explain importance of depth and flow.

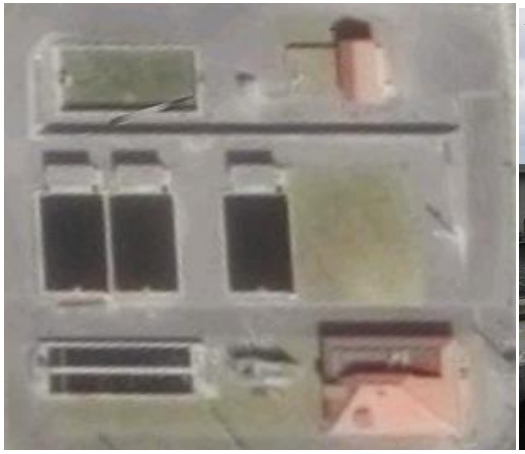
How to reduce the suspended matter without chemicals.

Mountain stream.
Shiramizu intake

Ma’e sato reservoir

Pump station for
underground water

Omoto intake

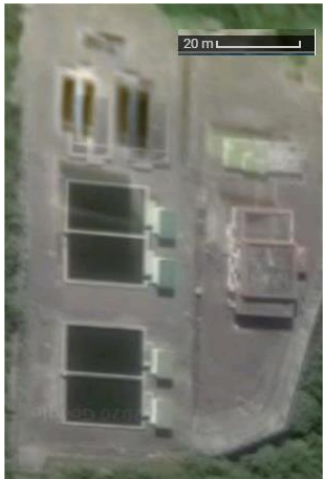


Yoshihara plant

Designed capacity 1,040m3/d
(2 filters and 1 spare)

Sedimentation pond:
3.2mx18.2mx3.0mx2ponds

Slow sand filter
9.4mx14.1m(x4.0m)x3filter(2+1)
9.4x14.1=132.54m2(1 filter)
132.54m2x4m/d=530.2m3/d

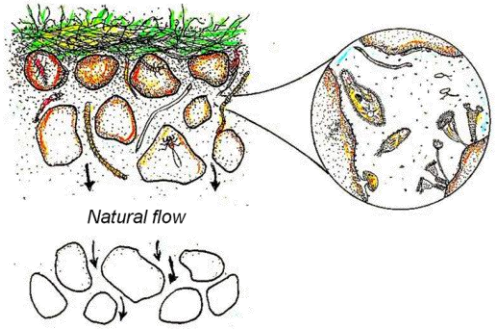


Nosoko plant

Designed capacity 1,066m3/d
(3 filters and 1 spare)

Sedimentation pond:
3.0x11.2x3.0x4ponds

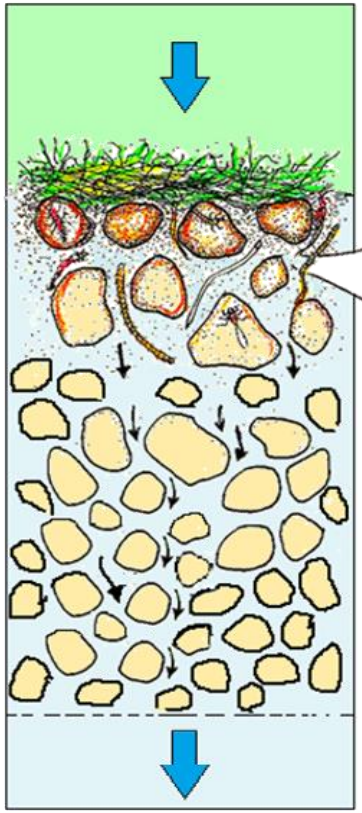
Slow sand filter
11.0x13.5(x2.4)x4filter(3+1)
11.0x13.5=148.5m2(1 filter)
148.5m2x4m/d=594m3/d



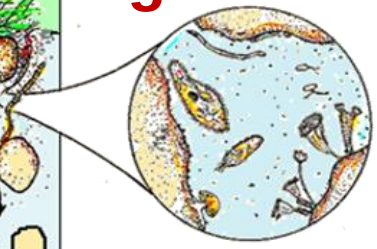
I explained role of small organisms.

Scraping the surface at Ishigaki plant.

In case of surface water intake, muddy materials are easily accumulated at the surface of sand filter. *Sand is clear. We need not remove all of the biological active layer.*



Biological activity is high in warm region.



Muddy materials are trapped at the surface. **Sand is always clear.** Biological community works near the surface. There is food for them near the surface.



Drain off filter for scraping. Many fishes and mollusks are remarkable.

This is just natural ecosystem.

Inflow mud does not enter the sand layer. Sand is clear.



Grazing Activity is high in warm region.

EPS is Wise Application of Natural Ecosystem. Key is Dissolved Oxygen.

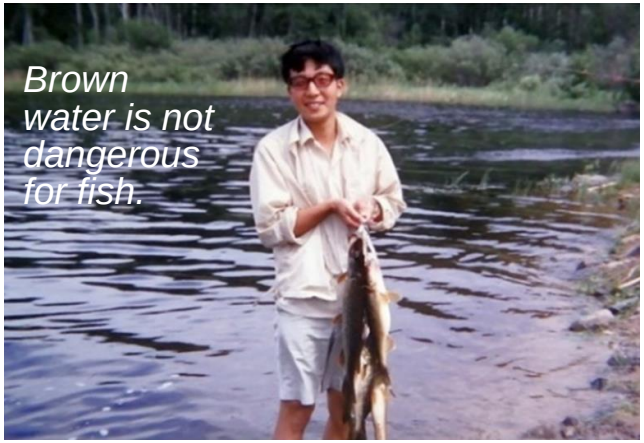
Part 15.

Water Supply Management and Ecological Purification System.

14 slides: 169-182

Almost no change in dissolved oxygen.
Gentle condition for small organisms.

https://www.cwsc.or.jp/files/pdf/EPStext-NC-2019.pdf



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

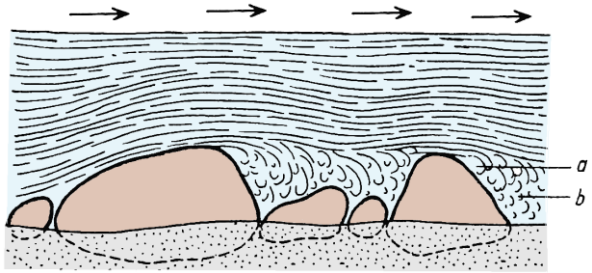
Fig.0. Fijian EPS using rain harvest tanks in a village.

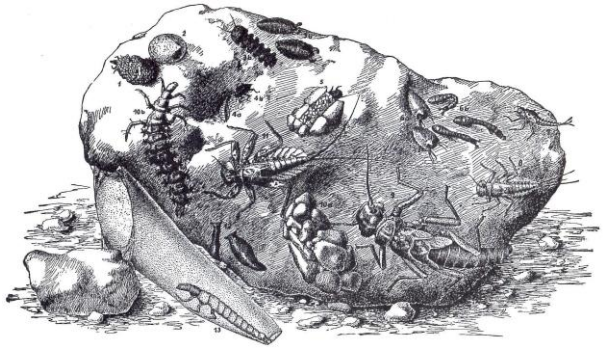
August 2018

Presence of Oxygen
is the key for
delicious water.

Running water, but unexpected flush out by storm event

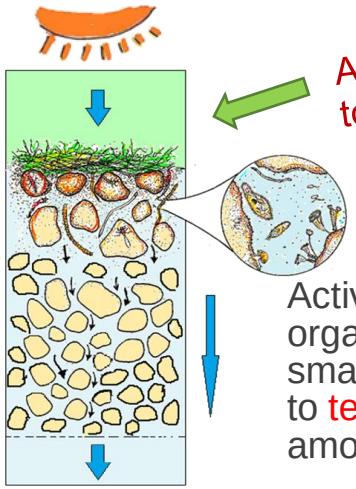
When plants and animals do not flush out, water is always clear.

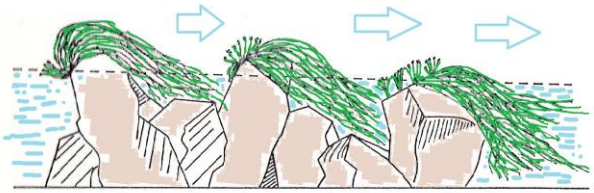




"**slow**" means "**gentle for organisms**"

Vertical current is gentle for small animals on the surface of sand and soil particle.



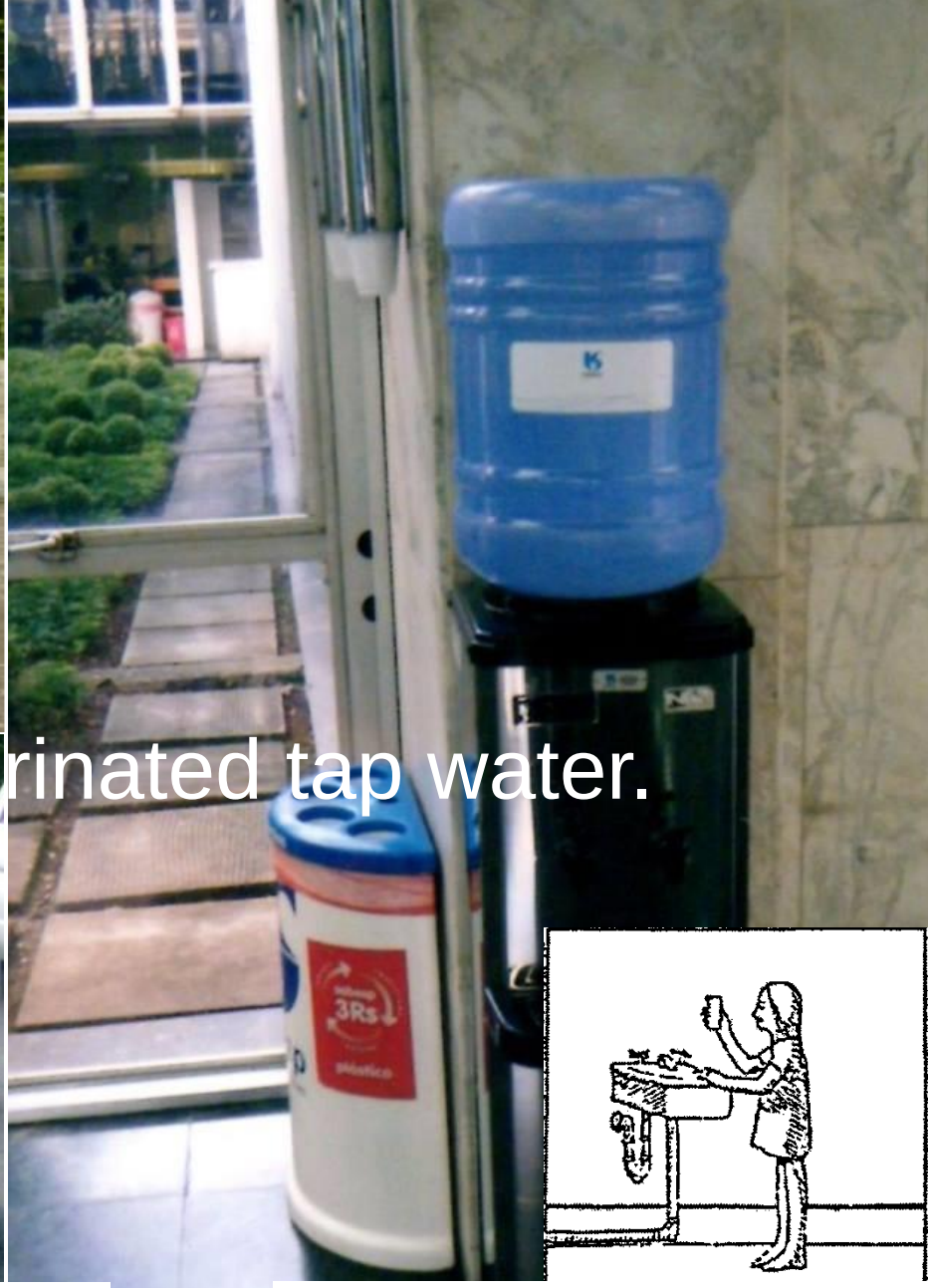


Small animals on the surface of rocks collect turbid matters.

*Sand, stone and rocks **don't role and move** in a small creak among dense forest.*

People prefer to drink natural spring water.

People does not like chlorinated tap water.



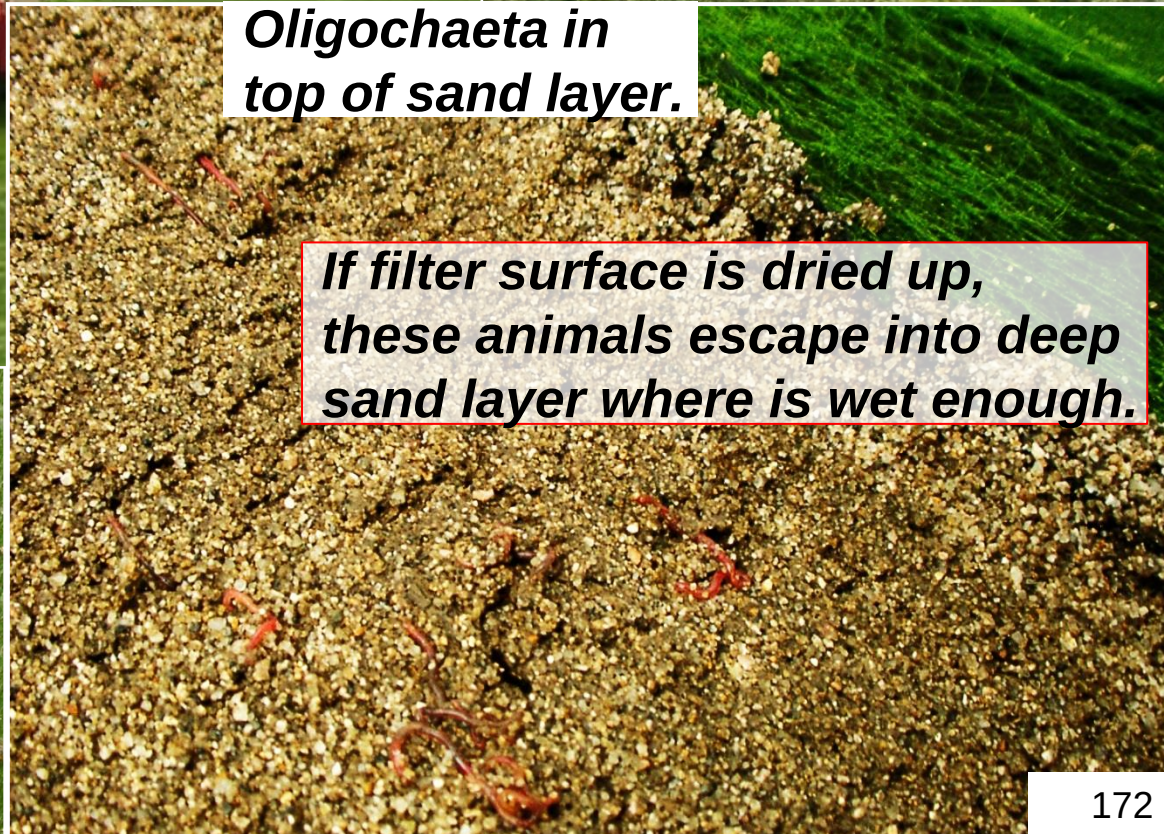
Is this water is safe? Harris 1974

This water is not guarantied by the authority.
However, people trusts this water.

It is better to scrape during wet condition and short time.

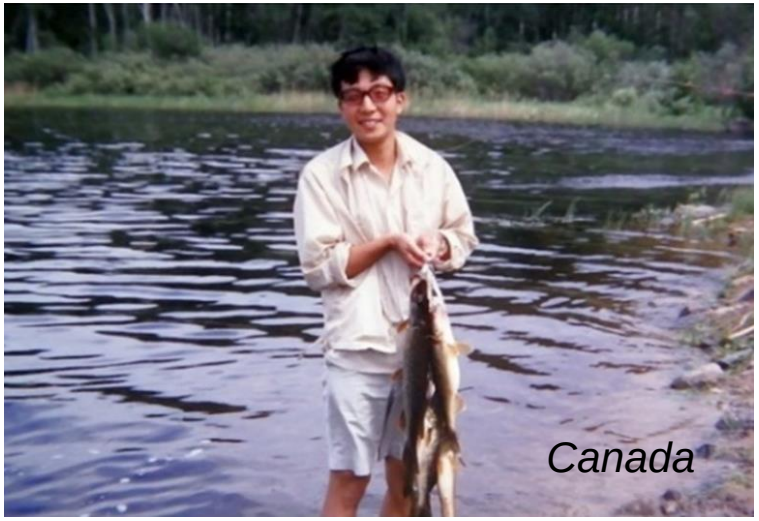
Mollusk is grazing animal of green algae. Long filter run.

Clean sand means that dirty matter does not enter in deep.



Oligochaeta in top of sand layer.

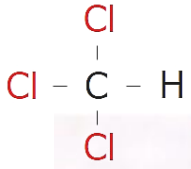
If filter surface is dried up, these animals escape into deep sand layer where is wet enough.

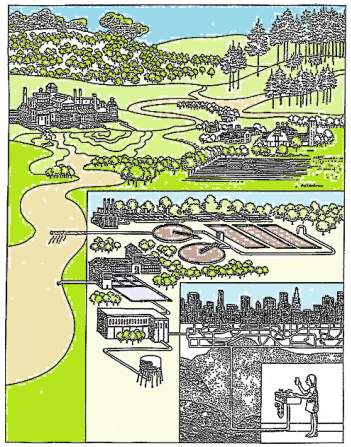


Water color is brown in the filter pond in Edinburgh in Scotland. Raw water comes from peat land.

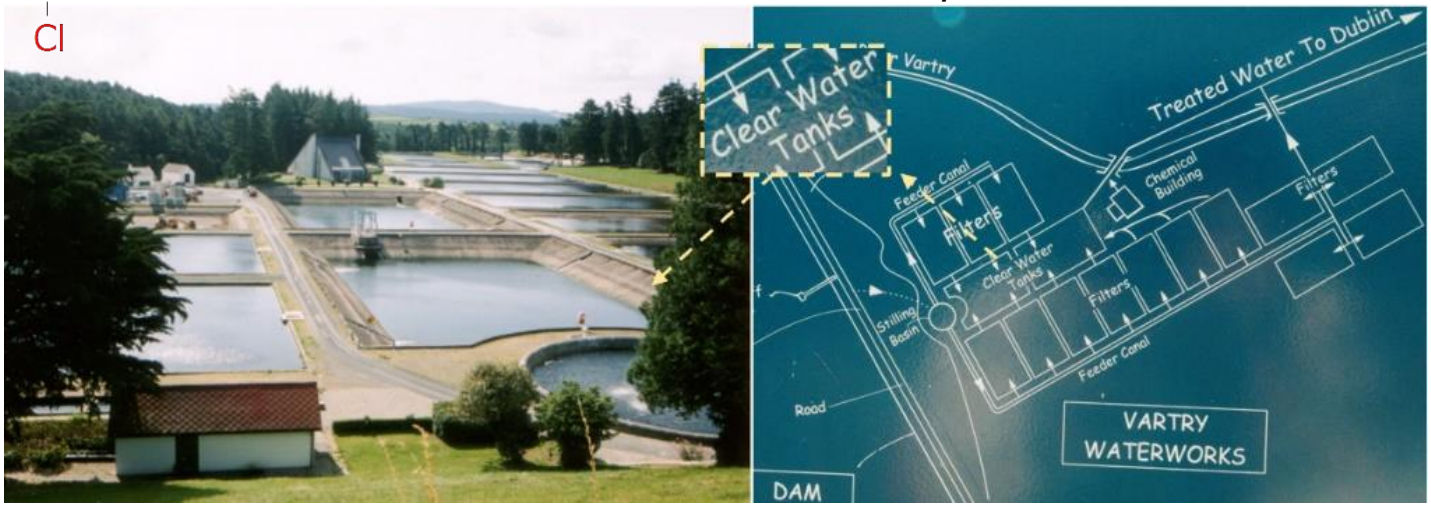
IS THE WATER SAFE TO DRINK?

Harris Report 1974





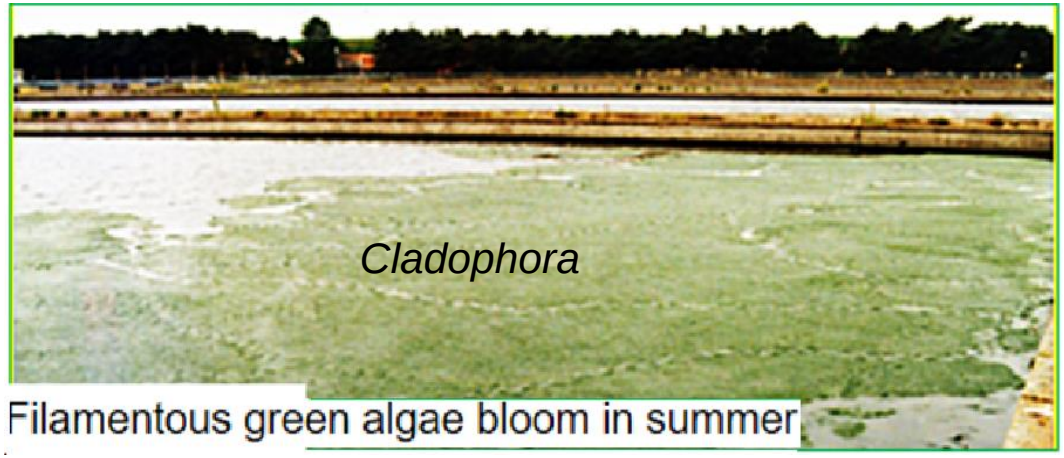
Robert H. Harris and others 1974 pointed out the risk of formation of tri-halo-methane by chemical addition of chlorine.



Vartry Waterworks, Dublin, Ireland. I could see brown water in open clear water tank (filtrate water tank). They have served from 1860s.

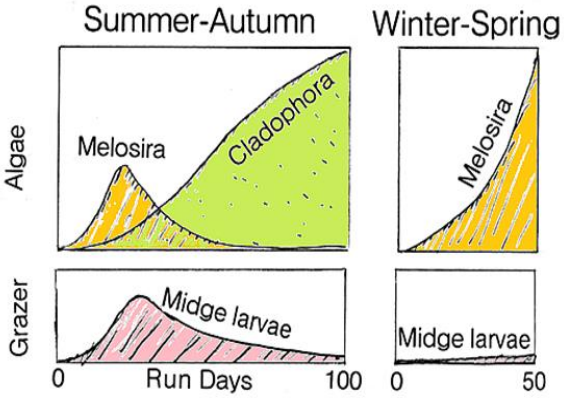
Brown water is not good. This idea came from chemical treatment. Rapid Sand Filter produces Cancer Risk by chlorine addition.

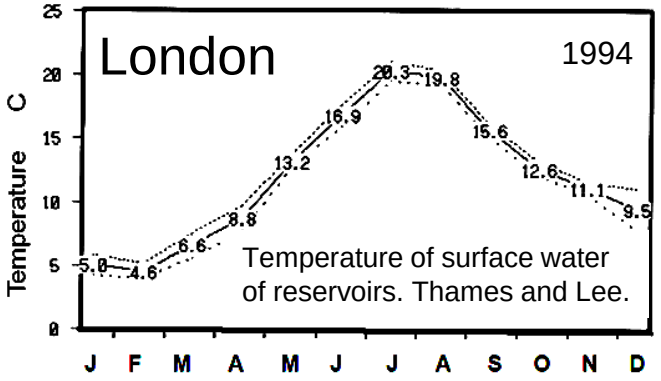
I investigated the seasonal change of algae in Thames filters in London from 1994 to 1996, more than 30 years ago.



Filamentous green algae bloom in summer

Filamentous diatom in winter





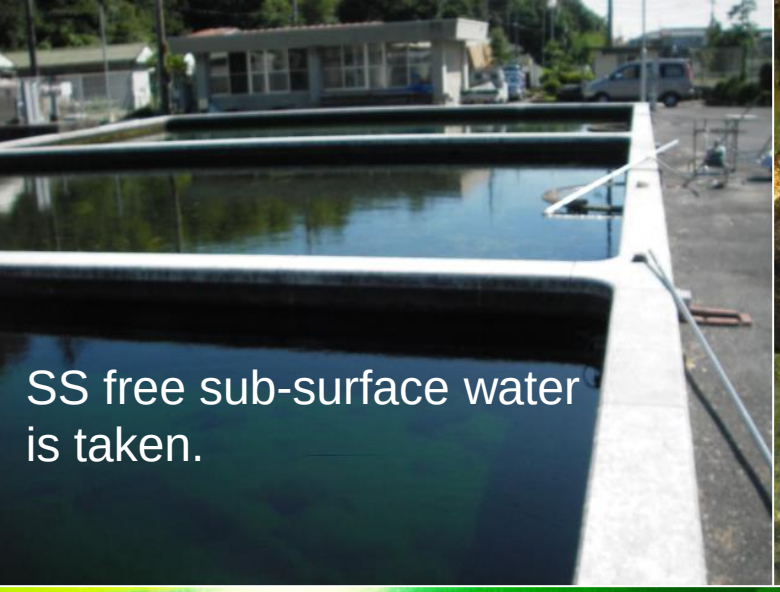
Diatom to Green algae in summer is due to grazing activity.

Water temperature is low in Ueda, Nagano, Japan and short filter run.

Diatom

In summer, green alga was observed.

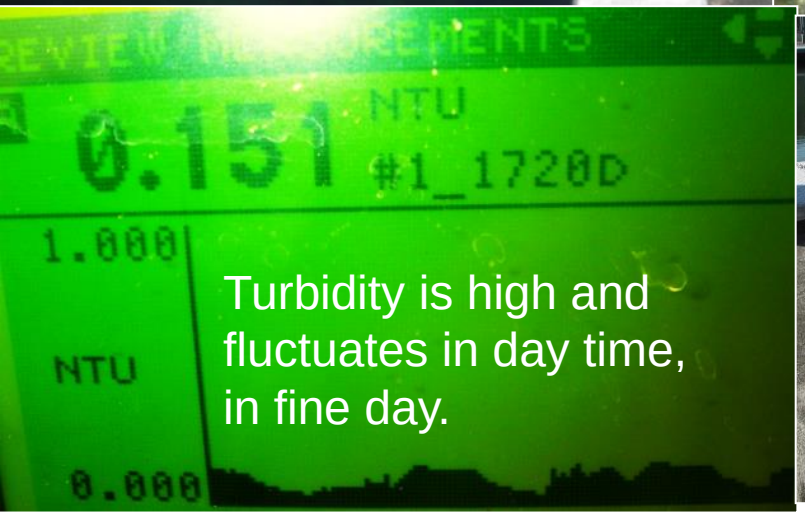
I noticed that this change from diatom to green algae is due to grazing activity. I confirmed also this change in Ueda.



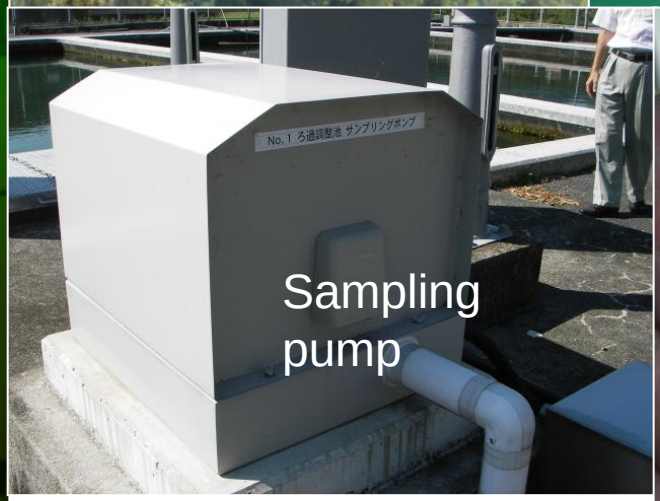
SS free sub-surface water is taken.

Long filter run

Good filter condition

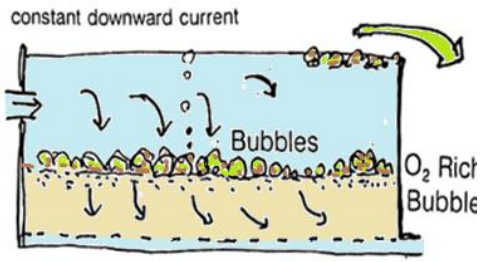


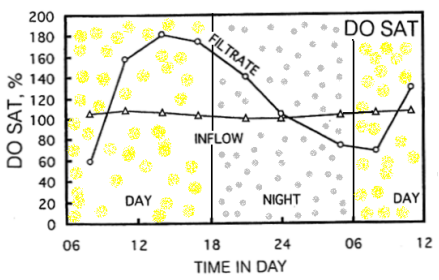
Turbidity is high and fluctuates in day time, in fine day.



Sampling pump

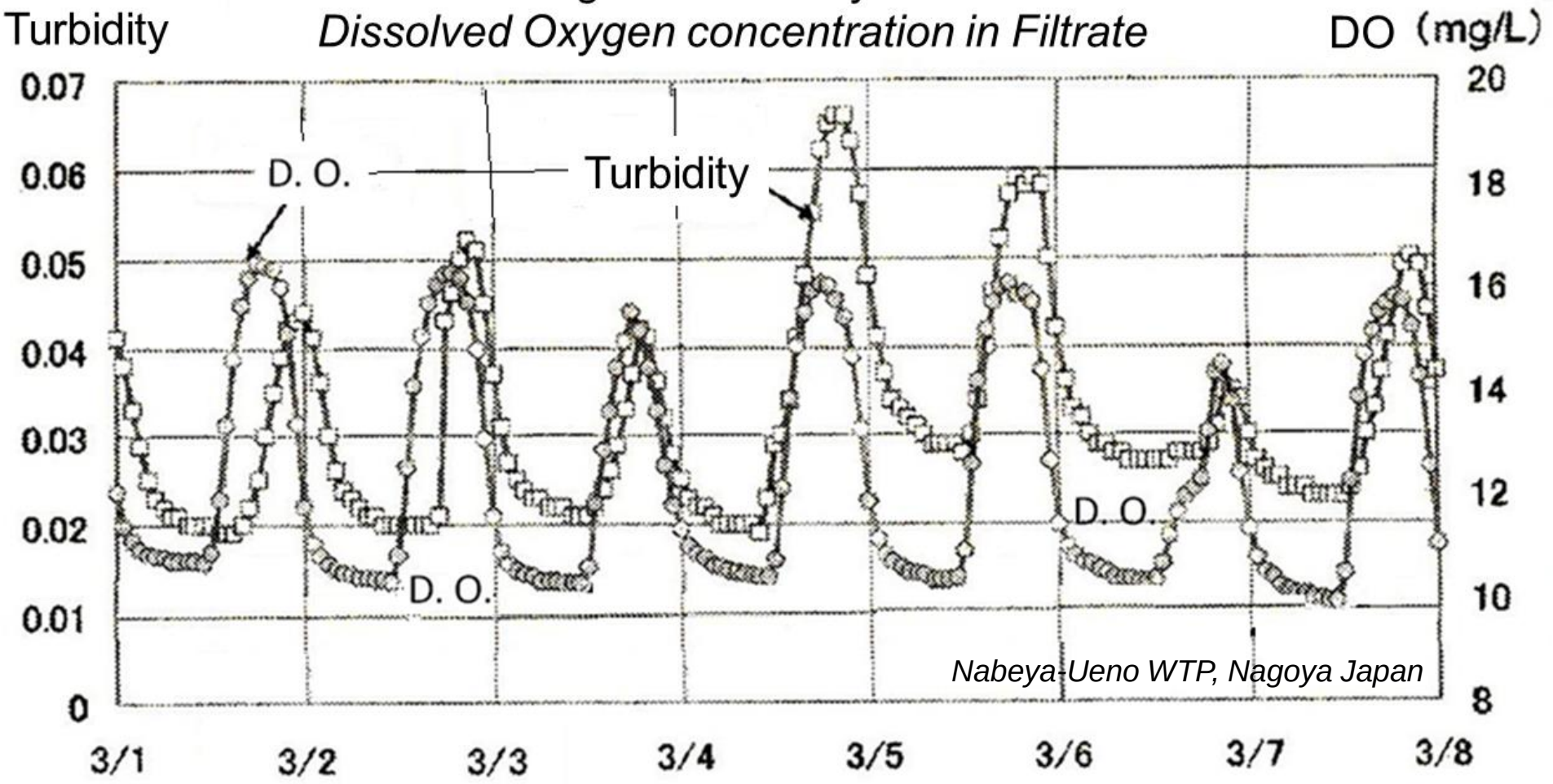
Micro bubbles are observed.





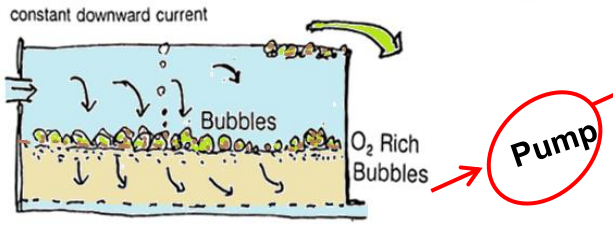
Photosynthetic activity is high in day time. DO concentration becomes super-saturation. After the sampling pump, oxygen bubbles form in water. Turbidity is due to bubbles.

Diurnal Changes in Turbidity Meter Value and Dissolved Oxygen concentration in Filtrate

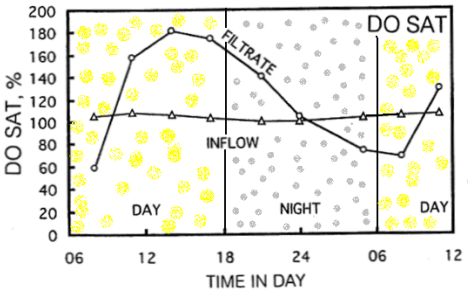


Nabeya-Ueno WTP, Nagoya Japan

Bubbles are not formed in filtrate under the high pressure and gentle condition.



Bubbles are easily formed under super-saturate condition.



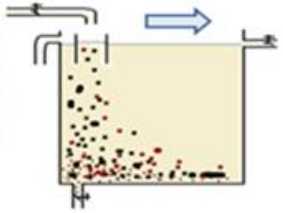
Turbidity meter value is not equal to real suspended matter. This particulate by the meter is micro-bubble.

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 + Activated Carbon
Raw Water
Mixing
Settling Basin
Storage tank
Back Washing
Chlorine
Coagulation, Sedimentation and Rapid filtration Treatment
Sludge

Coagulant＋Chlorine Rapid Sand Filter

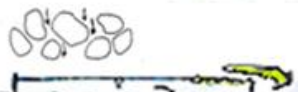
2 degrees Jap. standard

After Crypto outbreak.

Recommended to 0.1 degrees

SS passes by backwash.

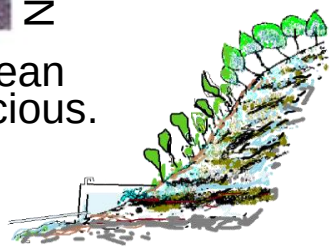
Chlorination is essential.



Purified by small organisms

Natural spring

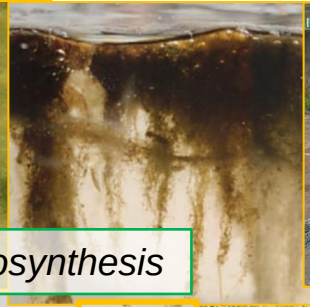
Super clean and delicious.



Artificial Natural spring water

1.Shallow depth

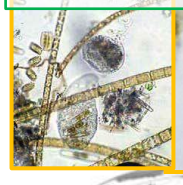
2.Active Photosynthesis

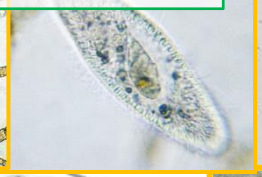


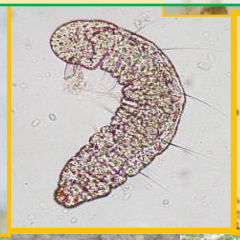
3.Bubble

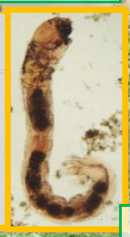
4.Lift up

5.Microbe to animal









6.Collect, graze and decompose

7.Food chain is the key for purification.

8.Sand is habitat.

9.Large Sand

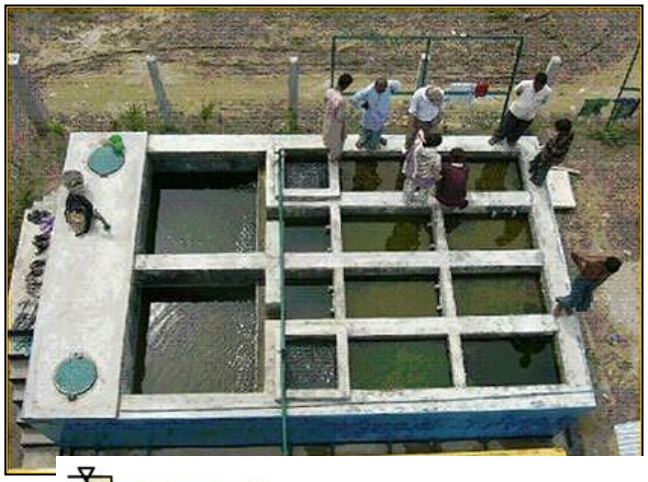
10.Activety depend on Temp & Radiation.

11.Pass time is 1 or 2 minutes.

This is Smart Treatment System to make Artificial Spring Water by Eco-friendly Technique of Ecological Purification System.

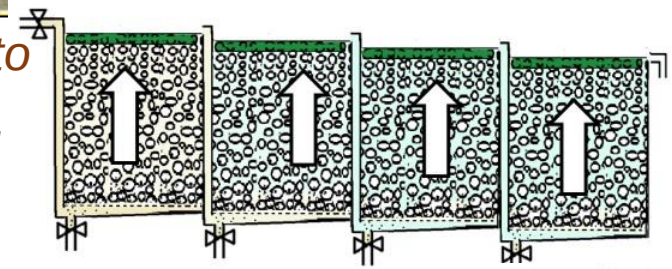
EPS for safe drinking water in arsenate contaminated Bangladesh in 2004.

Surface water is polluted by herbicides and insecticides.

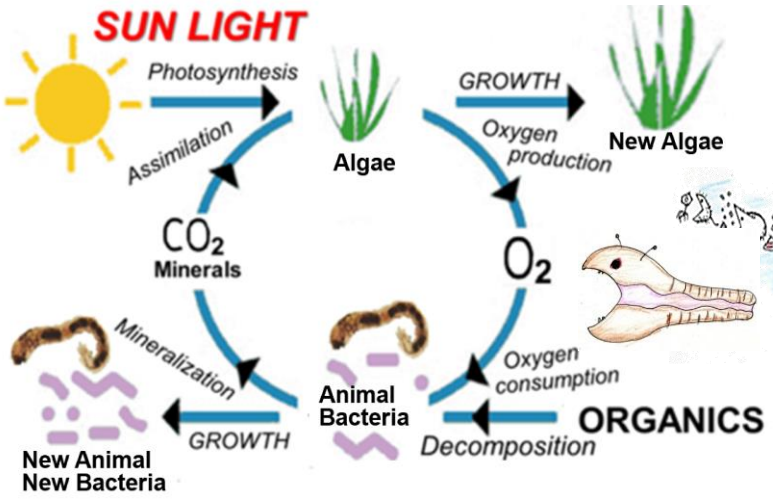


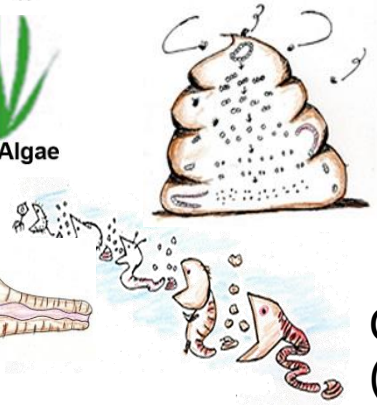
Algal growth

Repeat URF to decompose herbicide and pesticide.



Mr. Kawahara asked me to teach him a method to decompose herbicides and insecticides that are difficult to decompose in nature. Therefore, I taught a method of repeating decomposition through fermentation in the lack of oxygen inside the fecal pellets of the biological community. I thought that one time was not enough, so I recommended repeating it four times.



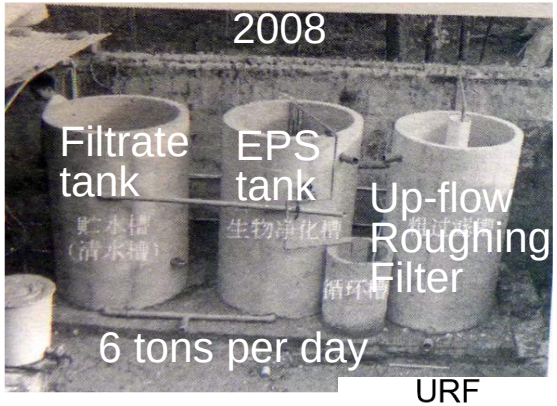


Complete decomposition (mineralization) in the faecal pellet.

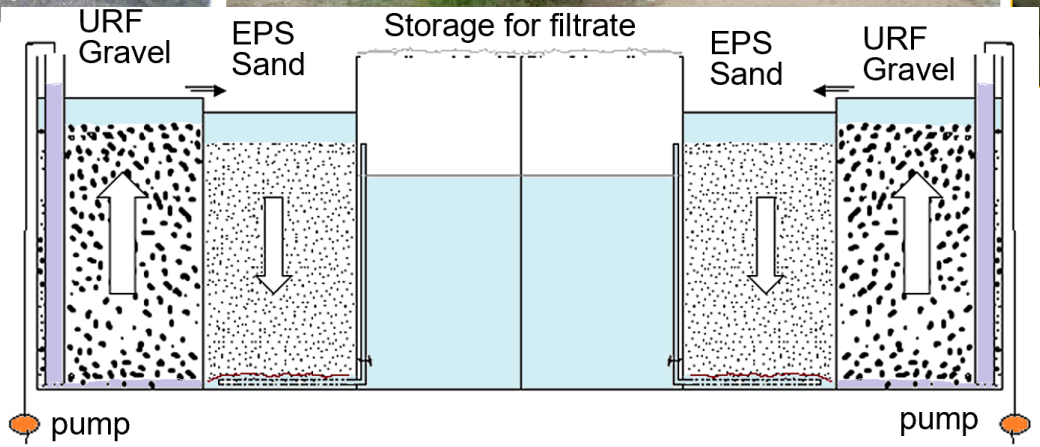
Anaerobic condition in fecal pellet.

In 2008, Mr. Huo Dai Shan, Shenqiu county, Henan province, made safe drinking water from contaminated groundwater under the guidance of Jin Shengzhe. Since then, water purification systems have been constructed in over 40 locations.

They used EPS to produce drinkable water from groundwater contaminated with industrial wastewater.



Covered EPS was constructed at a school for students and villagers in August, 2014.



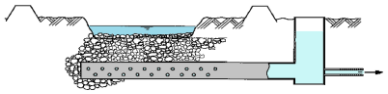
May 2016.

EPS-Use of Natural Process-**Chemical Free** : **Gentle for small organisms**

Surface stream water

Reservoir

Clean spring water



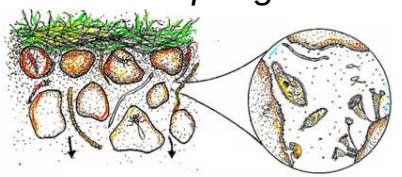
Subsurface water

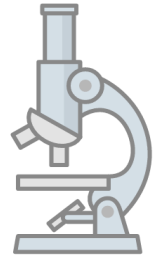
Raw water

Up-flow
Roughing Filter
(Gravel Filter)

Ecological Purification
(Sand) Tank
(natural down flow)

Storage Tank
Over-flow to
keep gentle flow
for EPS system





Settling
Tank

Drain

Drain

Public Taps

Borehole

Sediment heavy
muddy matter

Trap & reduce
colloidal matter

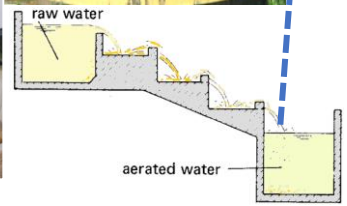
Complete
purification

Store the germ
free safe &
delicious water

Project in Fiji provides
6 litters/person/day
For drink & cook

Aeration

Tubewell



Food chain

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

THIS is FOOD CHAIN

①The 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.

② 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”.

③ Slow sand filter has been believed that it was a mechanical filter with fine sand under slow current.

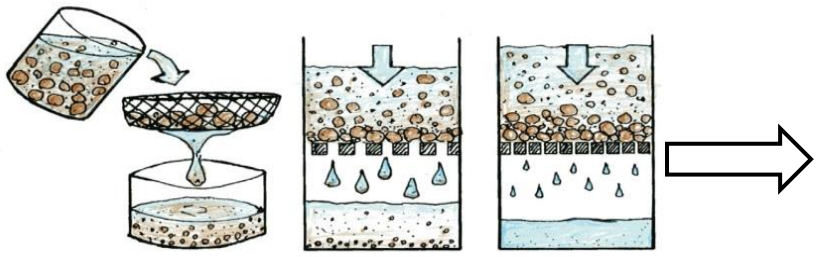
④ However, the major contribution of the purification of the impurities is the food chain in this system.

⑤ The word of “**slow**” was “**gentle for organisms**”.

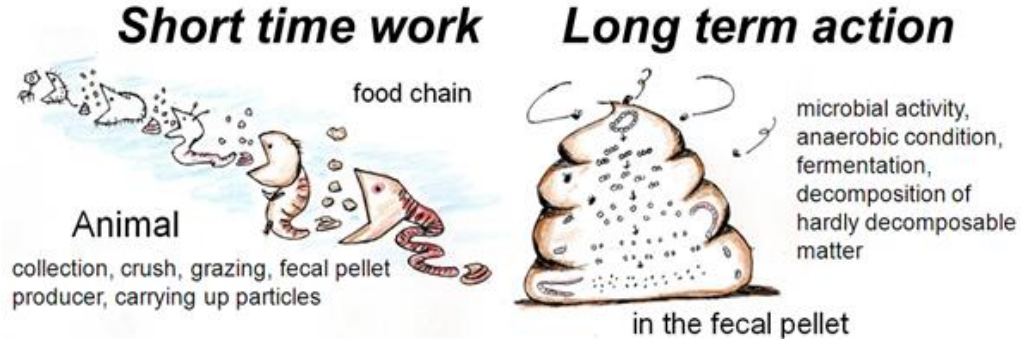
⑥ Recently, the English filter of “Slow Sand Filter” has been recognized as “**Ecological Purification System**” in Japan.

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

English Filter : Mechanical filter



New Concept and New Name

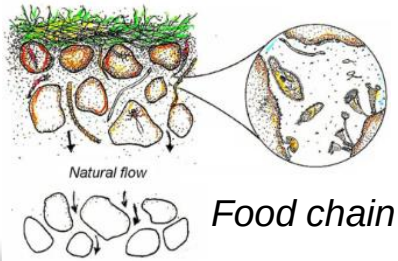


EPS from Japan to the World

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

Slow Sand Filter

Ecological Purification System



Food chain

Gentle for small organisms

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.