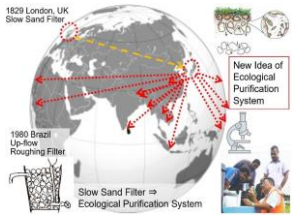


Chemical Free
Eco-friendly

Ecological Purification System (EPS)

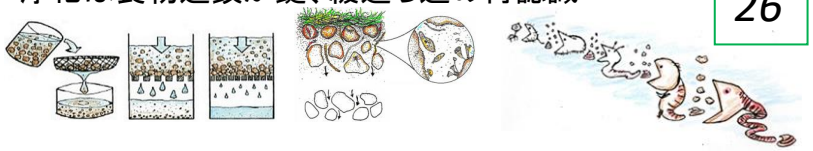
0. Introduction: Phytoplankton, Reservoir study, Meet Slow Sand Filter, Importance of Ecological point. JICA training
植物プランクトン、貯水池研究、緩速ろ過、生態学の視点、JICA研修へ

1-19 19

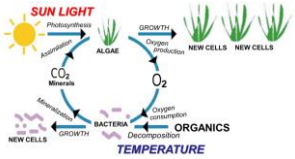
1. Water cycle, Safe water, Acceptable risk. *20-31* 12
水循環、安全な水、許容できるリスク

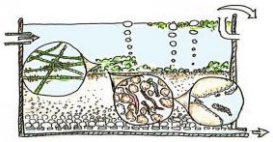


2. Key of purification in nature is food chain. Refocus to Slow Sand Filter. *32-57* 26
浄化は食物連鎖が鍵、緩速ろ過の再認識

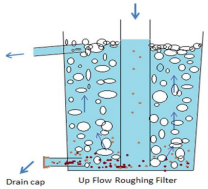


3. Algae and animals in Slow Sand Filter. *58-79* 22
緩速ろ過池の藻類と動物





4. Up-flow Roughing Filter to reduce SS *80-108* 29
濁り対策で上向き粗ろ過、モデルで解説



5. From JICA training in Miyako-jima, Okinawa to Samoa *109-124* 16
宮古島JICA研修からサモアへ



6. Safe water for rural people by EPS in Fiji *125-147* 23
フィジーの展開：生物浄化法で地方給水へ



7. Aerobic condition is essential for EPS. *148-157* 10
生物浄化法は酸素が必須



8. Confirm by yourself. Don't believe commercial. Trust your true sense. 自分で確かめよう。 *158-172* 15



JICA training in Hiroshima in July, 2024.

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

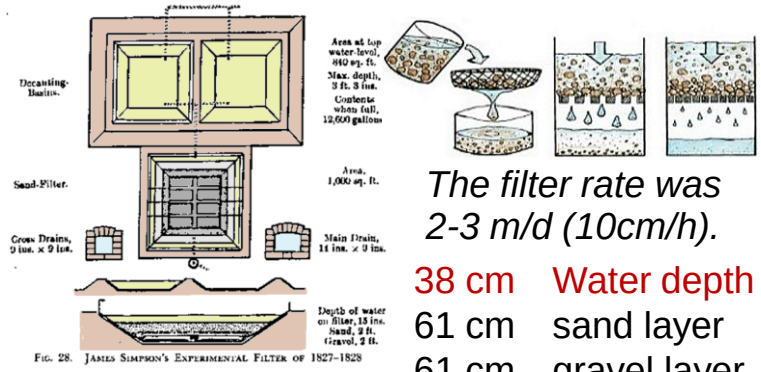


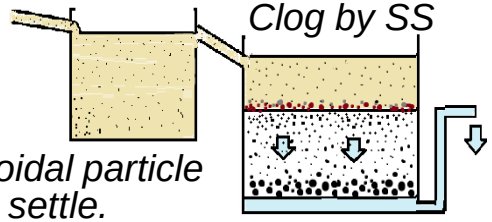
FIG. 28. JAMES SIMPSON'S EXPERIMENTAL FILTER OF 1827–1828

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

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

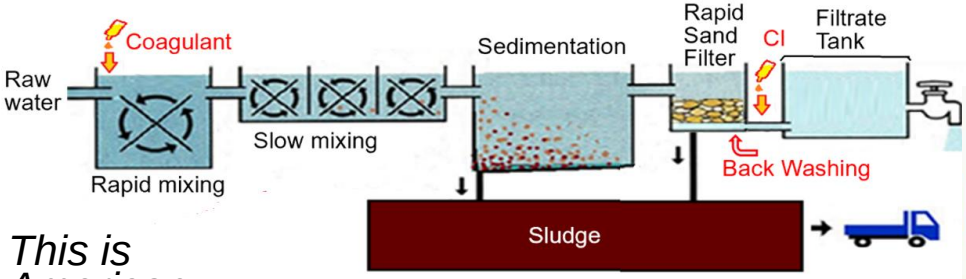
SSF spread to USA.

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



Fine colloidal particle does not settle.

*Biological **activity** is weak in winter.*

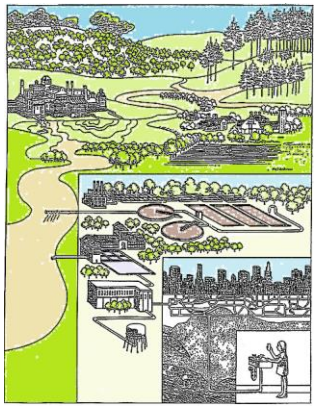


Odor and filter clog problem caused by algae in case of RSF.

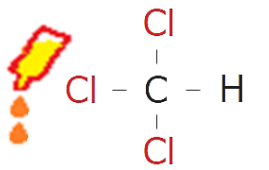
This is American Commercial Filter.

People loves new technology.

RSF spread to the world.



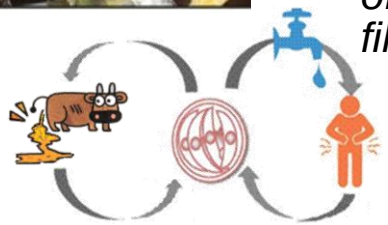
IS THE WATER SAFE TO DRINK?



That was Chlorine compound.

Cancer Risk

Back washing



The diarrhea-causing crypt parasites passed through the backwashing process of the rapid sand filtration.

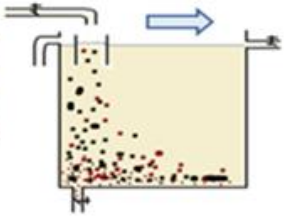
Refocus to SSF.

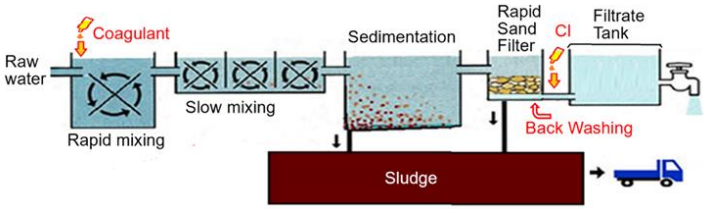
Turbidity mg/L

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

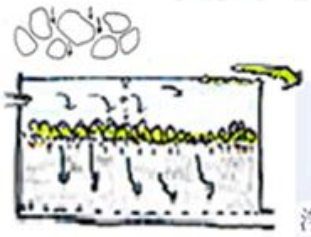
2 degrees
Jap. standard

After Crypto outbreak.

Recommended to 0.1 degrees

SS passes by backwash.

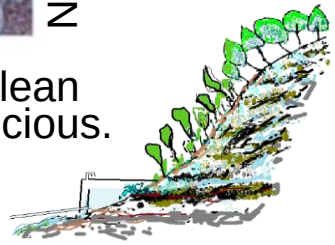
Chlorination is essential.



Purified by small organisms

Natural spring

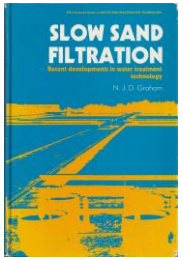
Super clean and delicious.



Artificial Natural spring water

Down flow and Up-flow Roughing Filter test (Master student report): Luiz Di Bernardo 1980, Univ. São Paulo, Brazil

1988

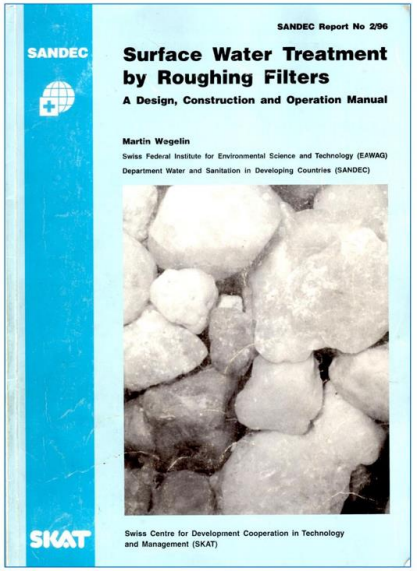


International pilot experiments in Columbia, (IRC：Holland), Peru, Brazil, UK, Switzerland etc.

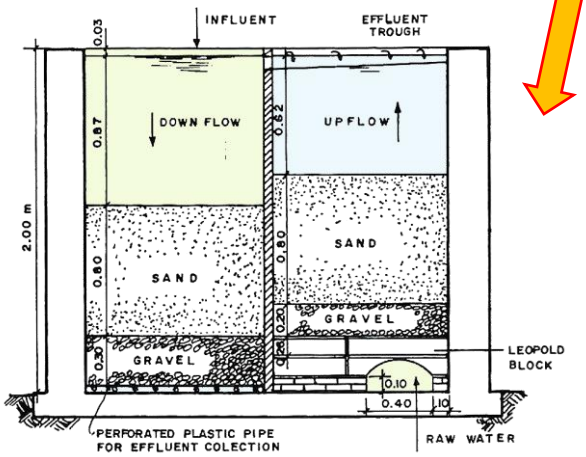
1996

Martin Wegelin

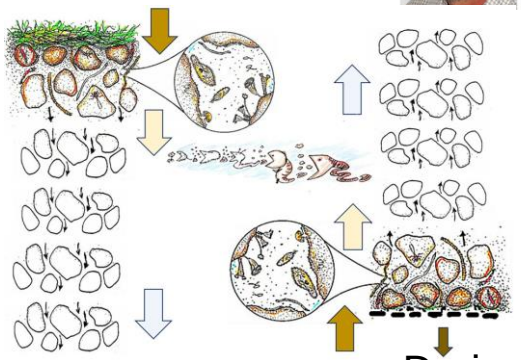
Swiss Federal Institute of Aquatic Science and Technology



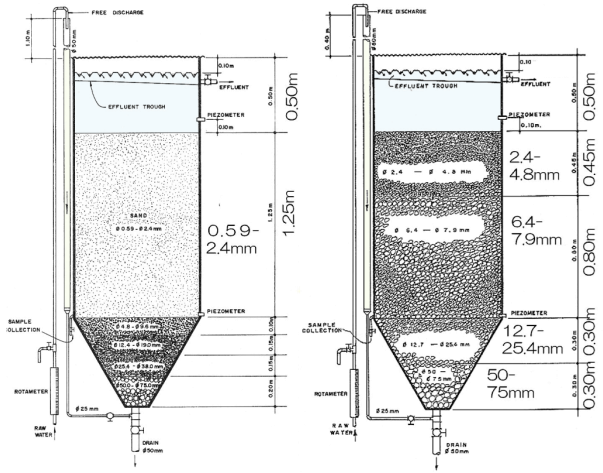
https://www.ircwash.org/sites/default/files/Wegelin-1996-Surface.pdf



Down-Flow and Up-Flow

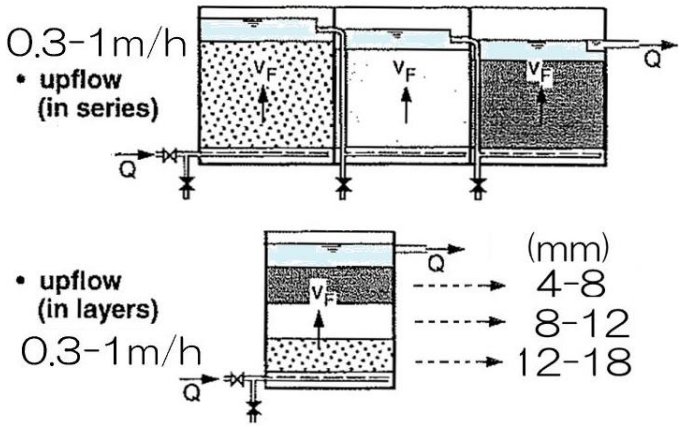


Down-Flow and Up-Flow



Sand URF and Gravel URF

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.

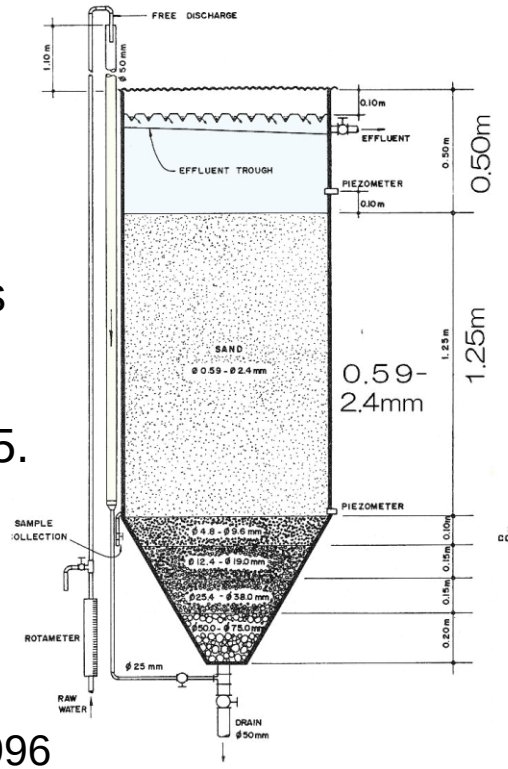


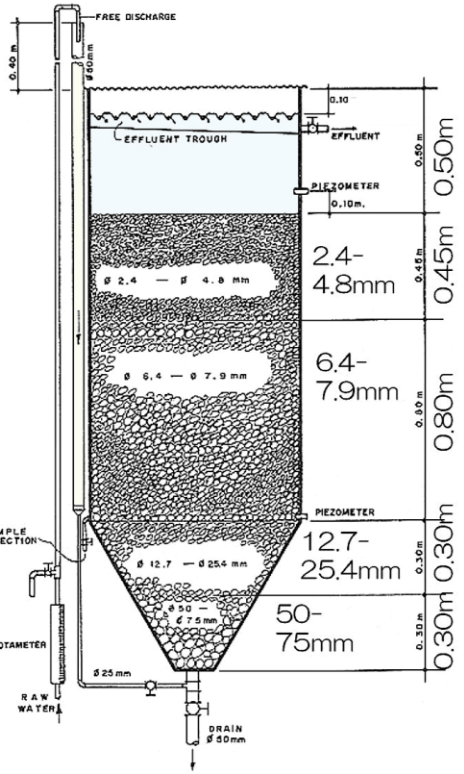
They believe the main action is based by mechanical reduction.

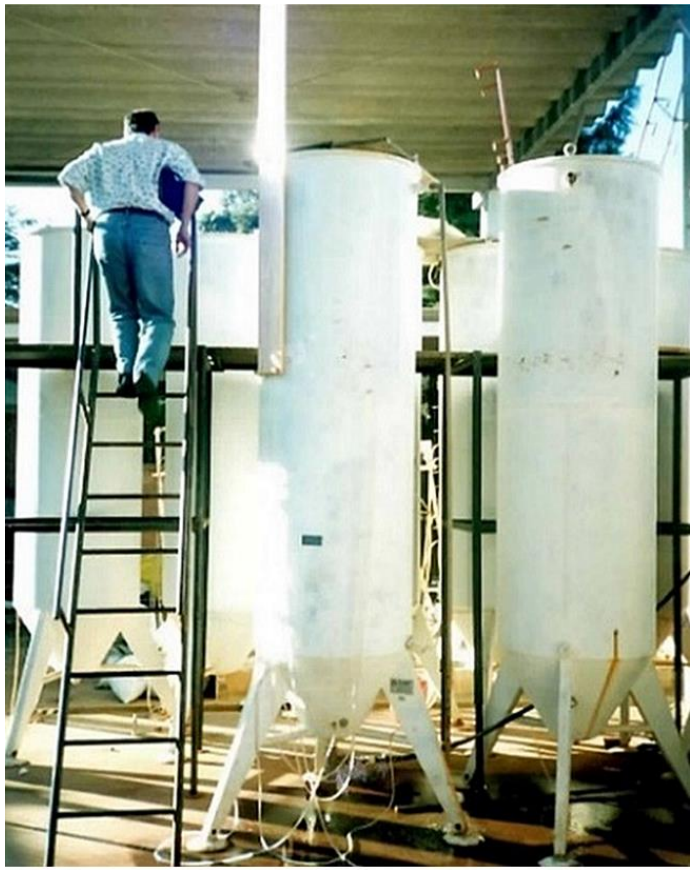
Luiz Di Bernardo examined chemical free roughing filter from 1980 in Brazil.

He reported the results in 1988, in London.

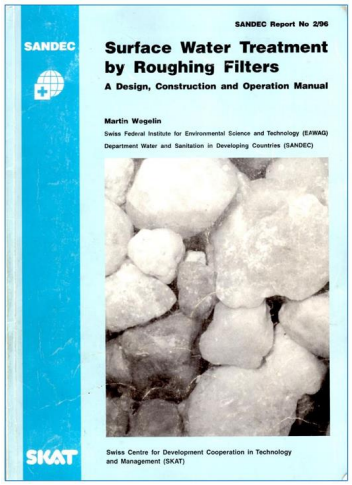
I visited São Carlos, Brazil in Aug. 1995.
He still examined URF.







1996



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

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

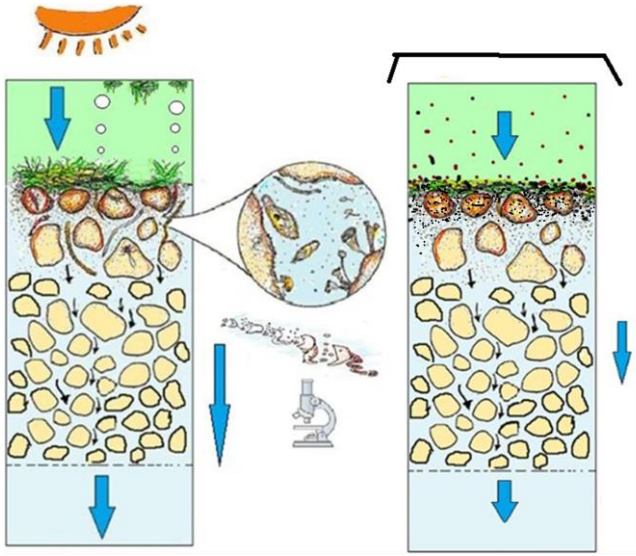
Effect of open filter and covered filter.

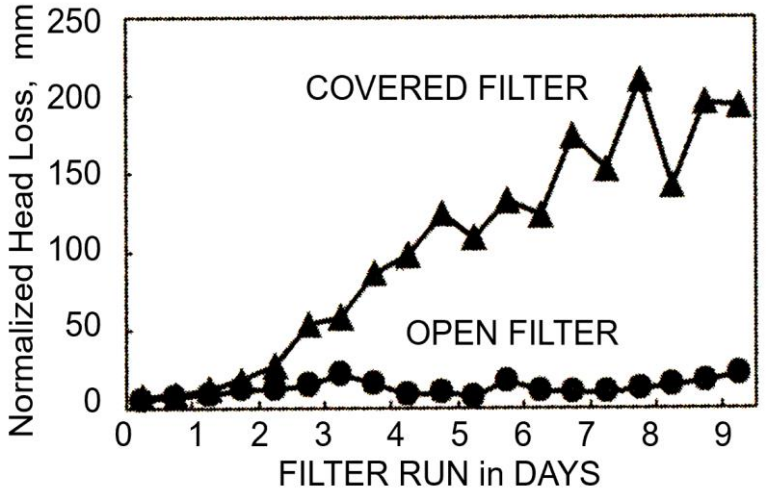
W. K. Burton **1894**
"The Water Supply of Towns and the Construction of Waterworks"

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

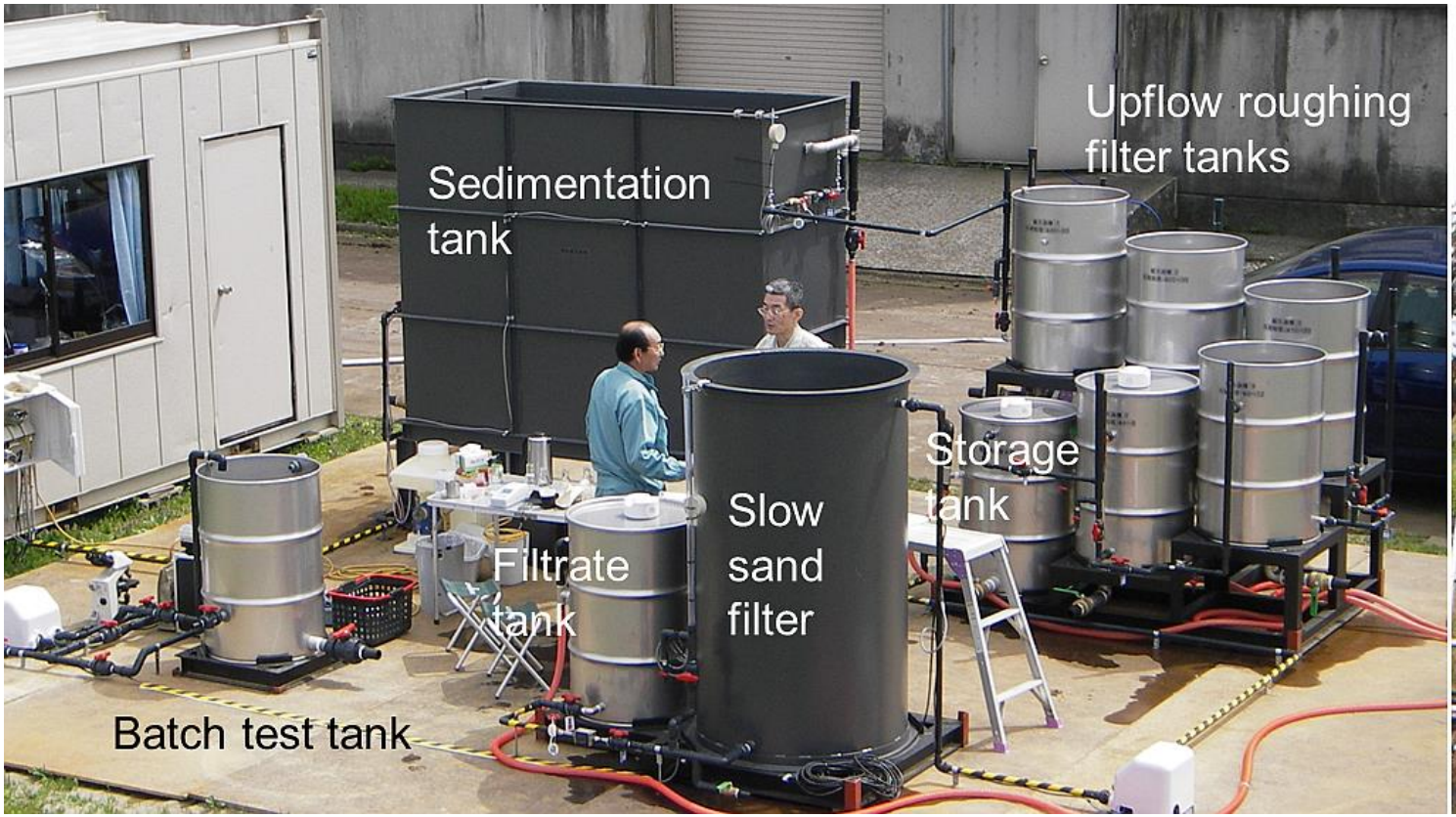
We confirmed the role of algae in EPS.

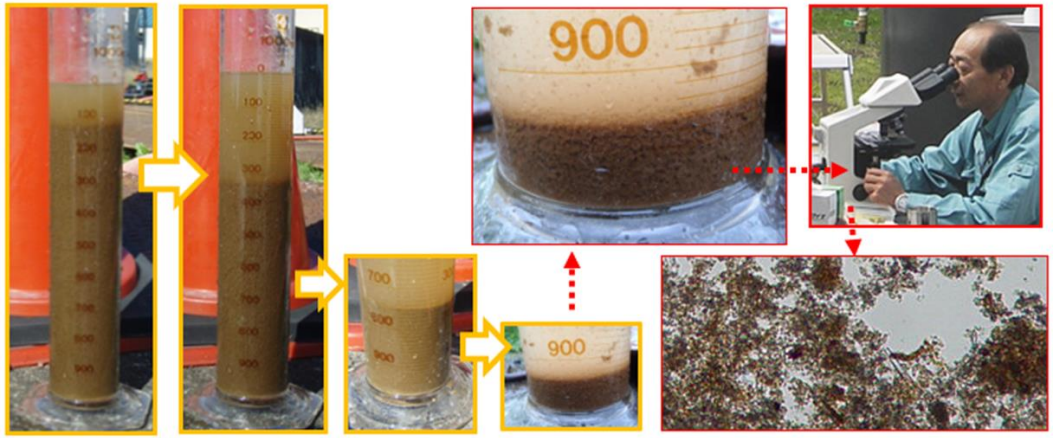
Filter resistance (NHL) of Open filter was almost constant.
But the resistance of Covered filter increased almost every day.





Algal growth under sunshine. ➡ Increase grazing animal. ➡ They search for food, make holes, and do not increase the resistance of the water.

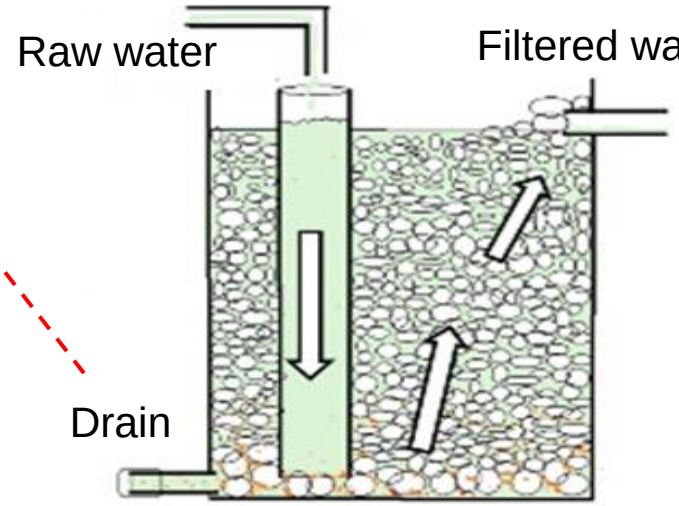




Drained sludge from URF settled Quickly.

Coagulated particles like a activated sludge.

Up-flow Roughing Filter (Gravel Filter)



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

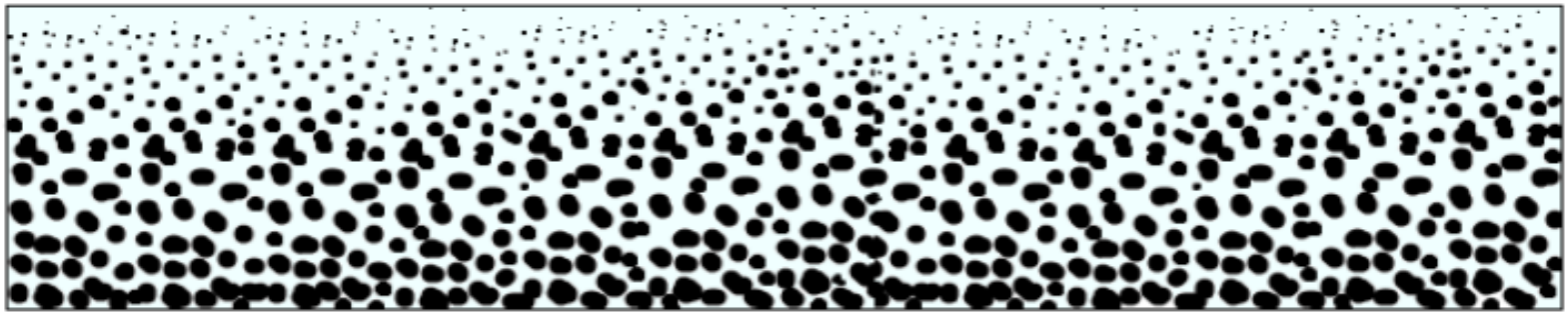
After heavy storm event, river water becomes dirty and rapidly increases.

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

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

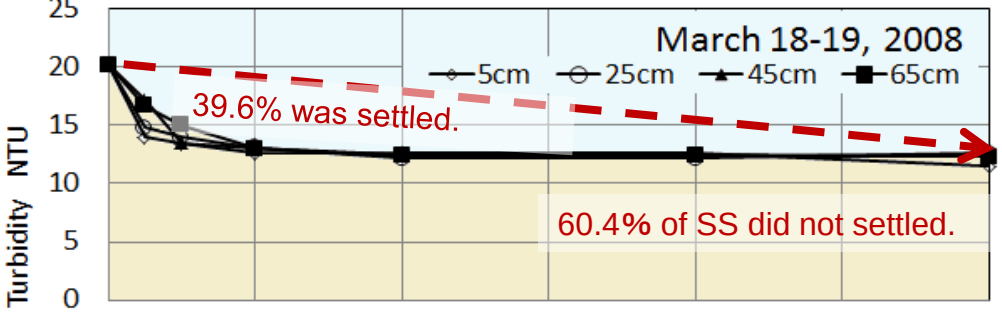
Light and small particle which is not easily settled.

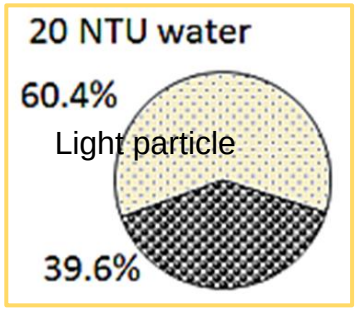
A large amount of heavy and large particles in a storm water.



*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.*

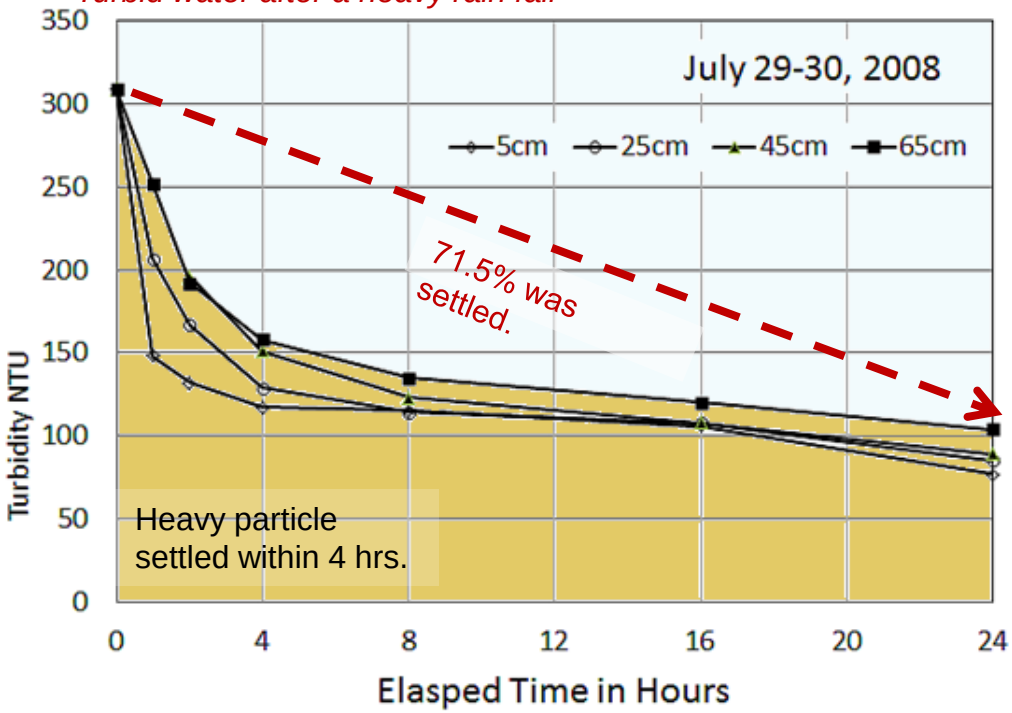
Light turbid water



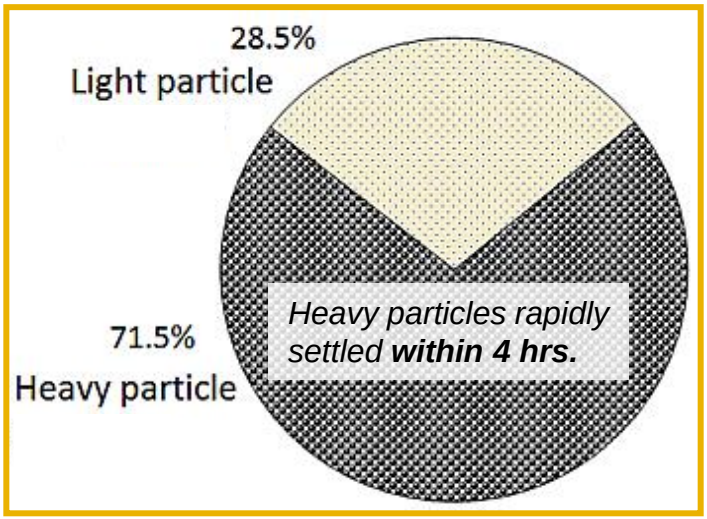


Light turbid water: small turbidity, a large portion of light particle.

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.

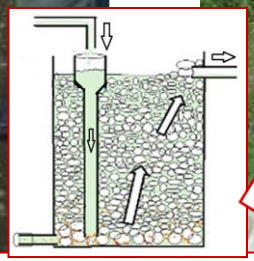
There are sedimentation tank, 4 gravel filters, and slow sand filter. Polluted water turns to safe and reliable water quality.

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

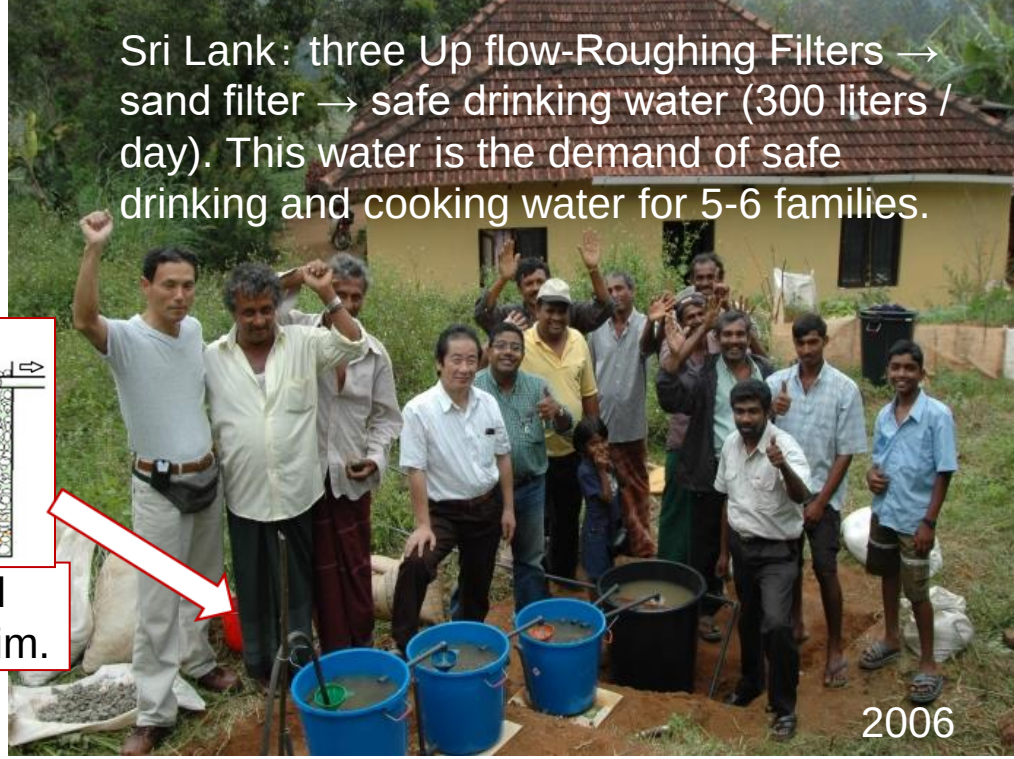
No detection of coli-form bacteria, lead, herbicides of Atrazine and Simazine. Nitrate N concentration : 2.0 mg/L, Nitrite N: 0 mg/L, pH8.5, total hardness: 250 mg/L and residual chlorine 0 mg/L.

OISCA Tokyo:
polluted water
→EPS
→ safe water

2005



I advised URF to him.



Sri Lank: three Up flow-Roughing Filters → sand filter → safe drinking water (300 liters / day). This water is the demand of safe drinking and cooking water for 5-6 families.

2006

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

2018

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

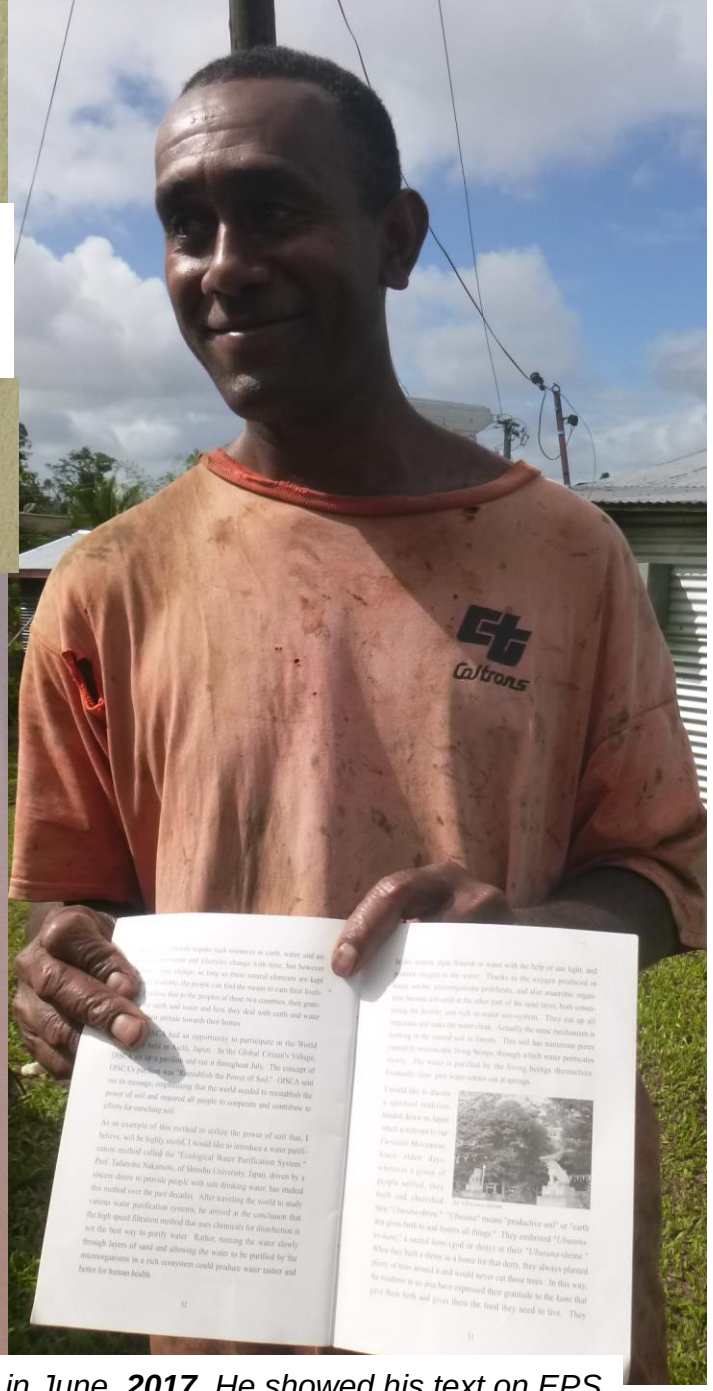
*Niko-San participated OISCA training in Fukuoka, Japan, in **2007** during 1 year. He remember my work on Ecological Purification System.*

Yoshiko Y. Nakano

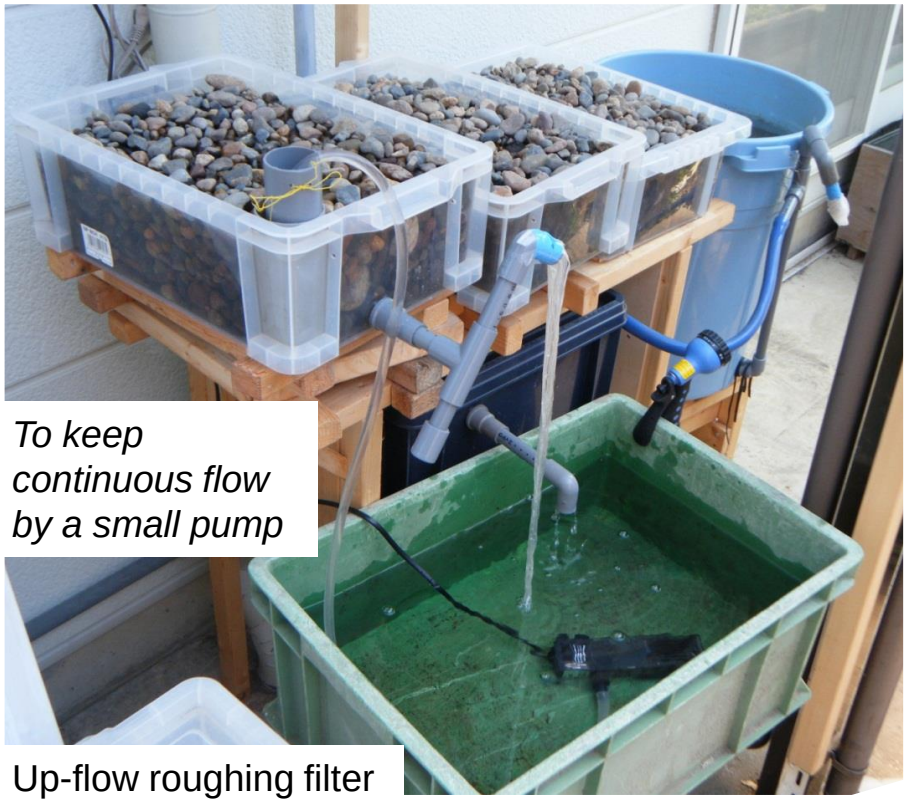
September 2006

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



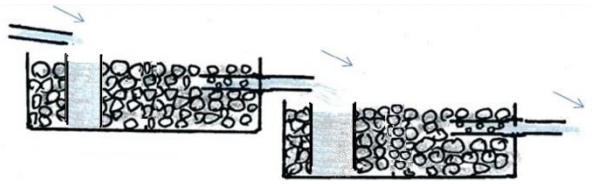
*I met Niko-San in Fiji, in June, **2017**. He showed his text on EPS.*



To keep continuous flow by a small pump

Up-flow roughing filter

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



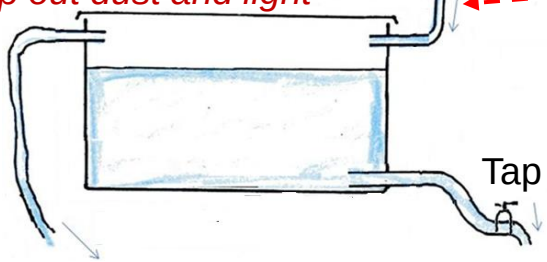
Filtrate storage tank

keep out dust and light

Filtrate

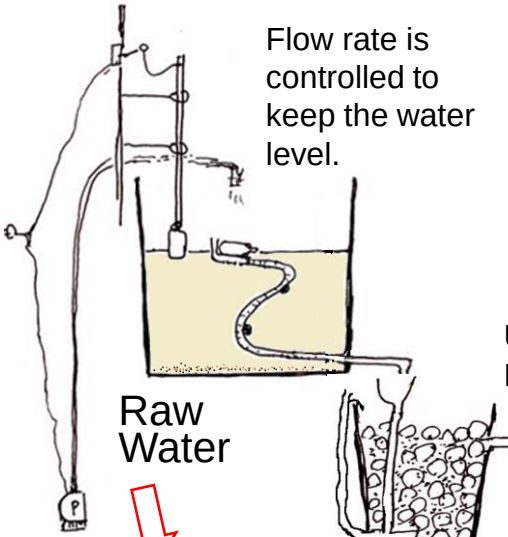
Over flow

Tap



keep out small animals

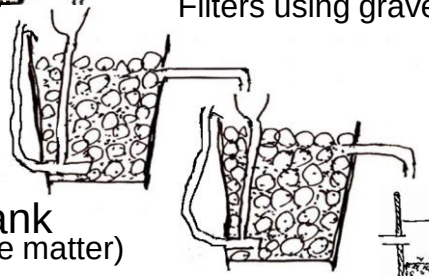
Under drainage porous pipe covered with mesh cloth.



Flow rate is controlled to keep the water level.

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

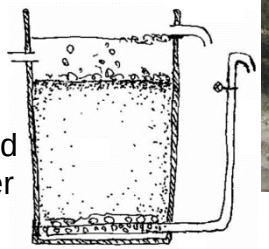
Raw Water



Up-flow Roughing Filters using gravel.

Sedimentation tank
(Reduce heavy particle matter)

(Settle Heavy matter)

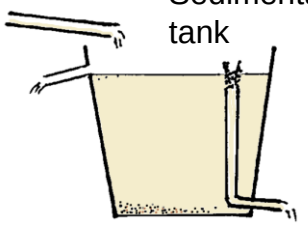


Sand Filter

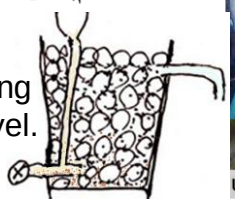
Up-flow Roughing Filter
(Reduce fine particles)

(Trap Colloid matter)

Sand Filter (Complete elimination of impurities by Ecological Purification System)



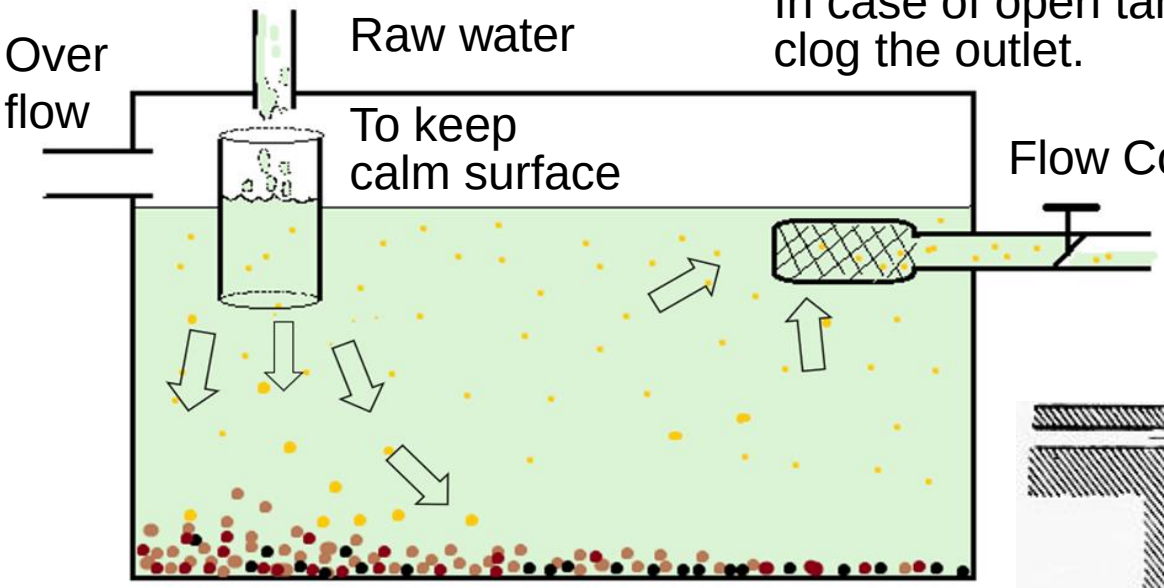
Sedimentation tank



Up-flow Roughing Filter using gravel.


Settling tank
沈殿槽
Up-flow Roughing Filter
上向き粗ろ過槽
Up-flow Roughing Filter
上向き粗ろ過槽
Sand Filter
砂ろ過槽
Storage tank 貯水槽
2016/ 8/24 9:01

Receiving Tank (Settling Tank)



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

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

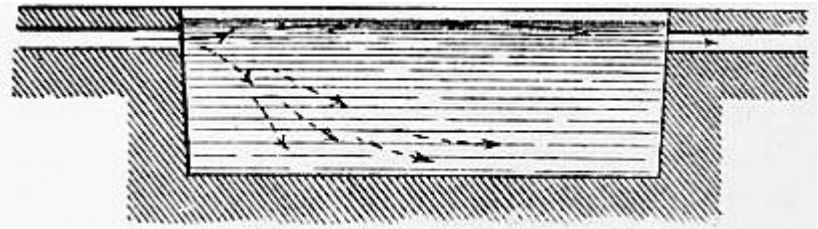
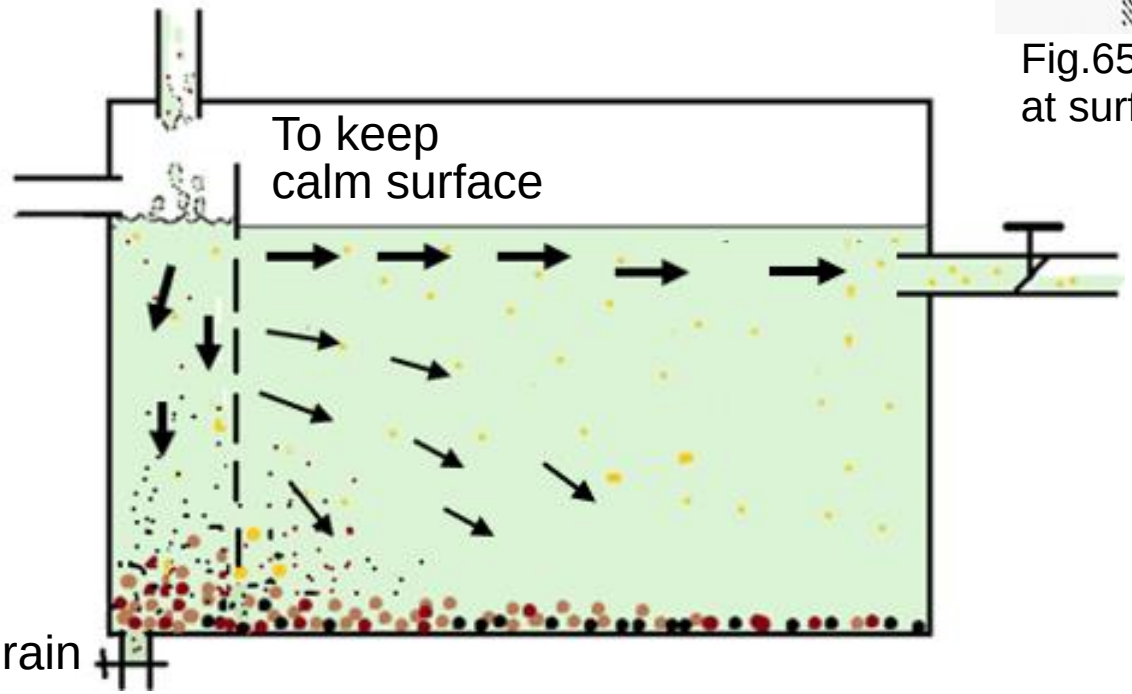


Fig.65. Settling reservoir: Inlet and outlet at surface level.

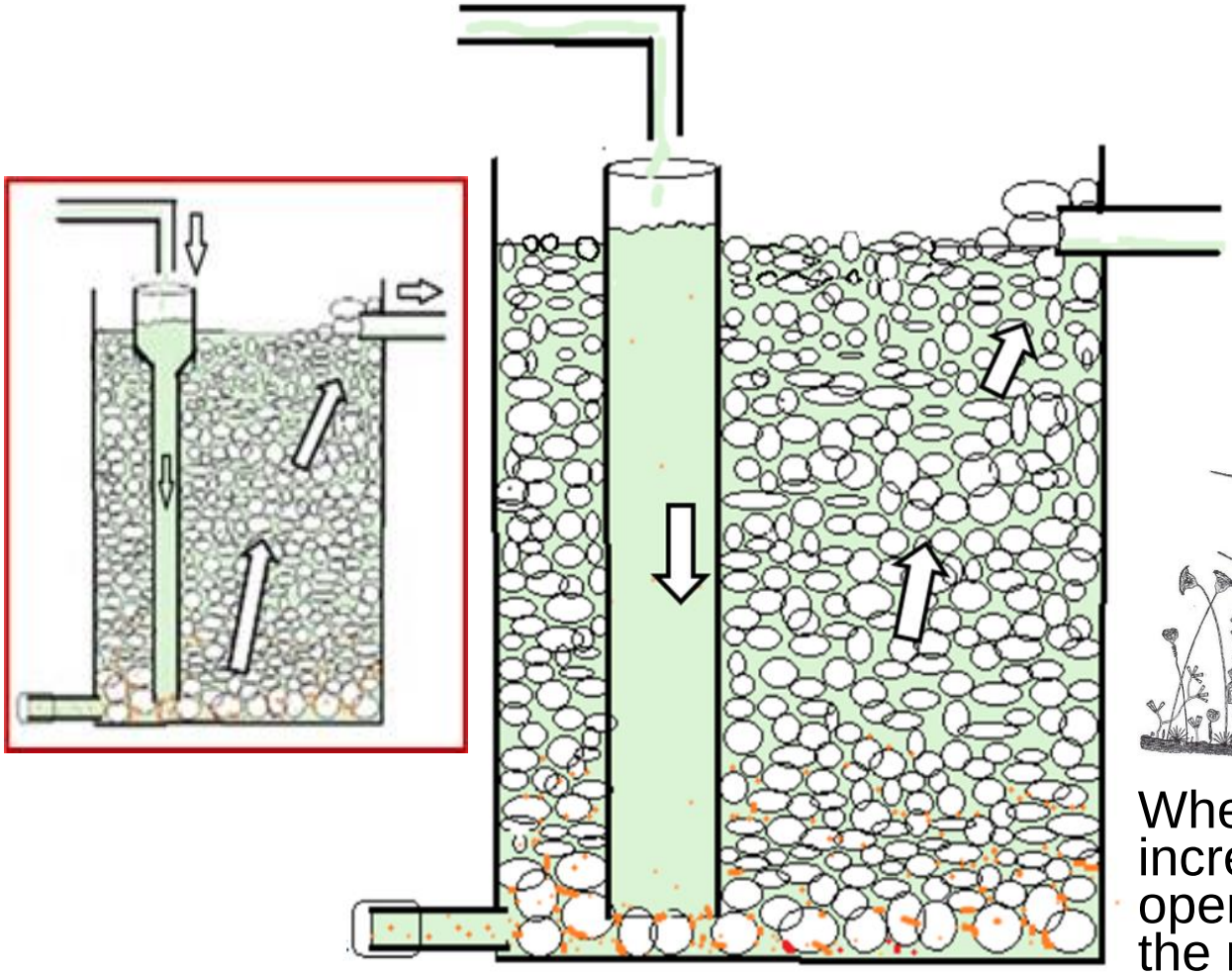


Heavy particulate matters are easily settled.

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

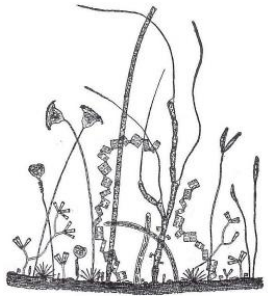
Up-Flow Roughing Filter (URF): Gravel Filter

Additional URF if necessary.



Drain cock for accumulated mud.

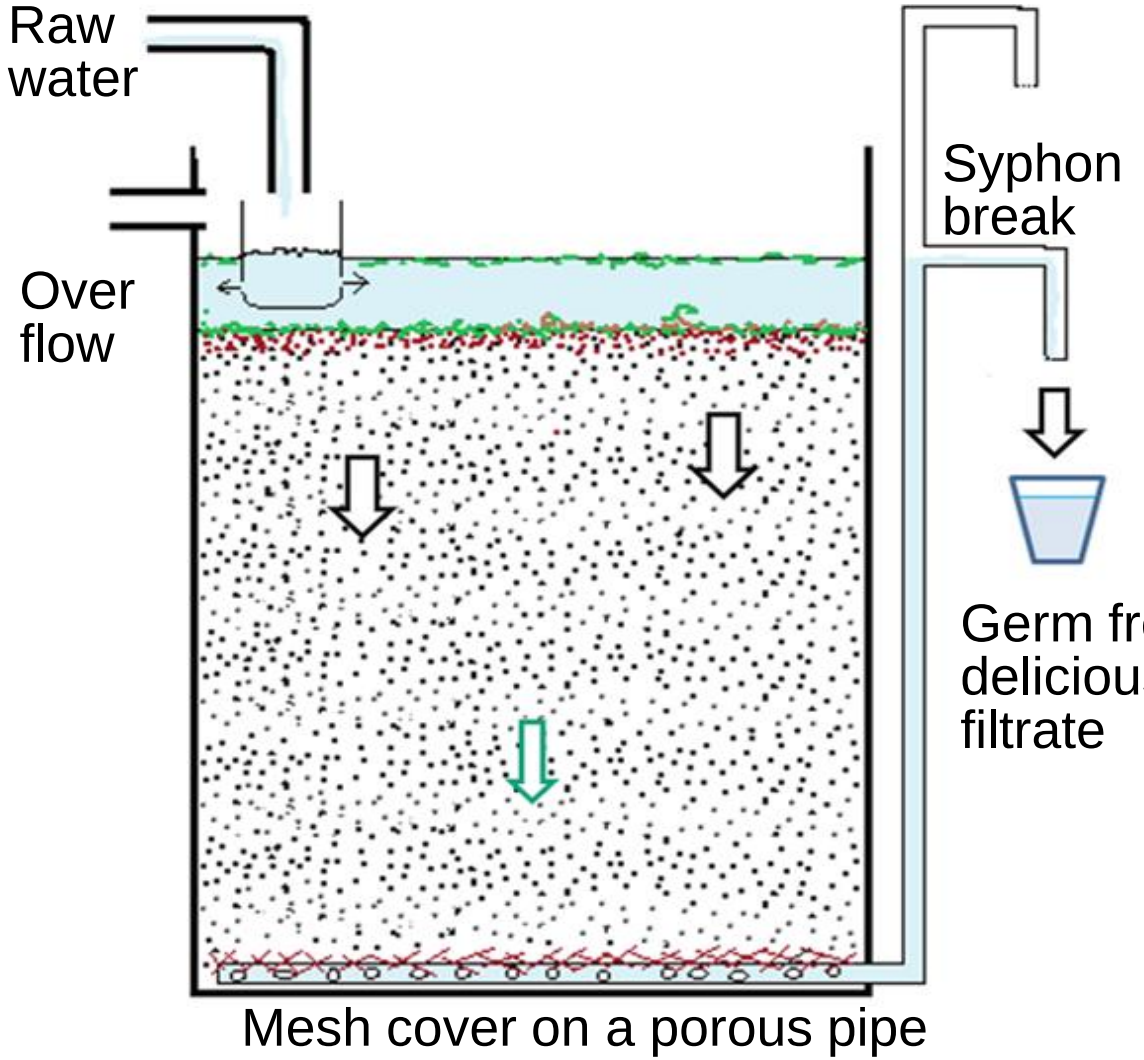
Colloidal fine particles adhesive to the surface of gravels. Small animals scrape them and produces fecal pellets. Fecal pellets accumulated to the bottom.



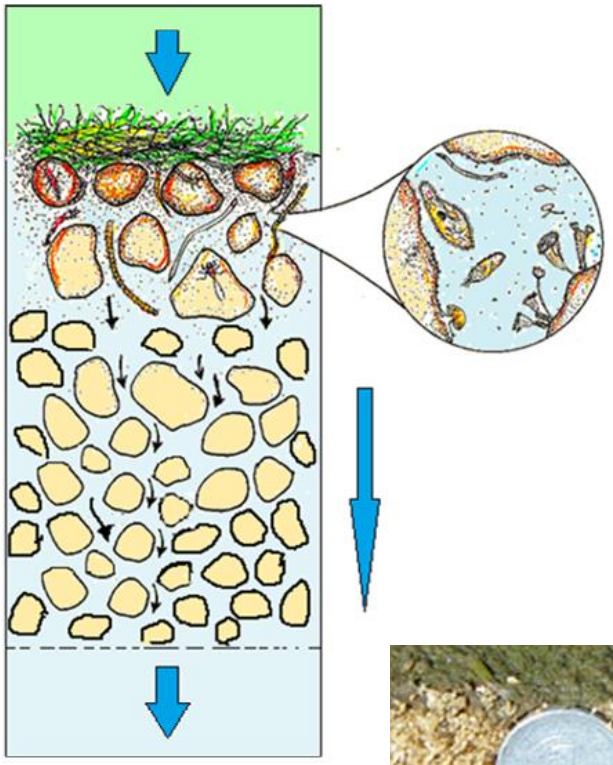
When the filter resistance increase, the drain cock is opened in short time to drain the mud (accumulated fecal pellets.)

EPS (Sand) Filter (Natural Down Flow)

Ecological Purification System

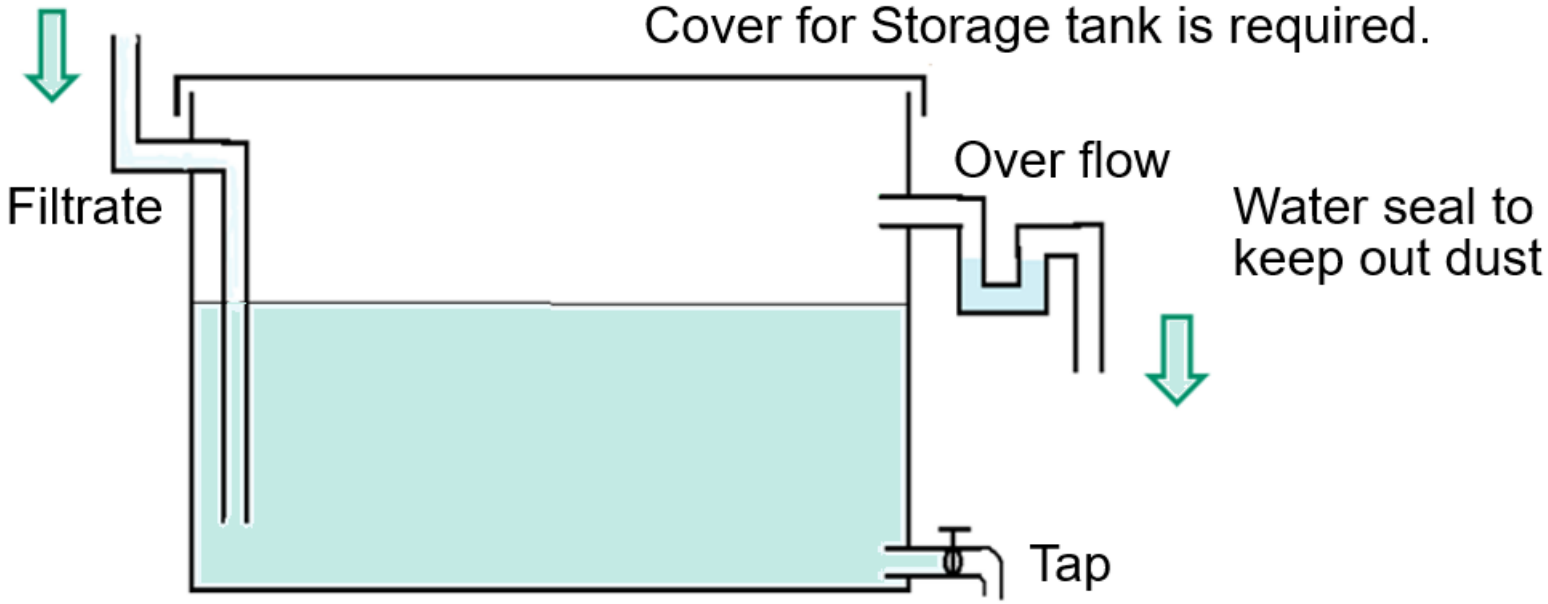


Biological active layer is only surface and thin layer beneath the surface.

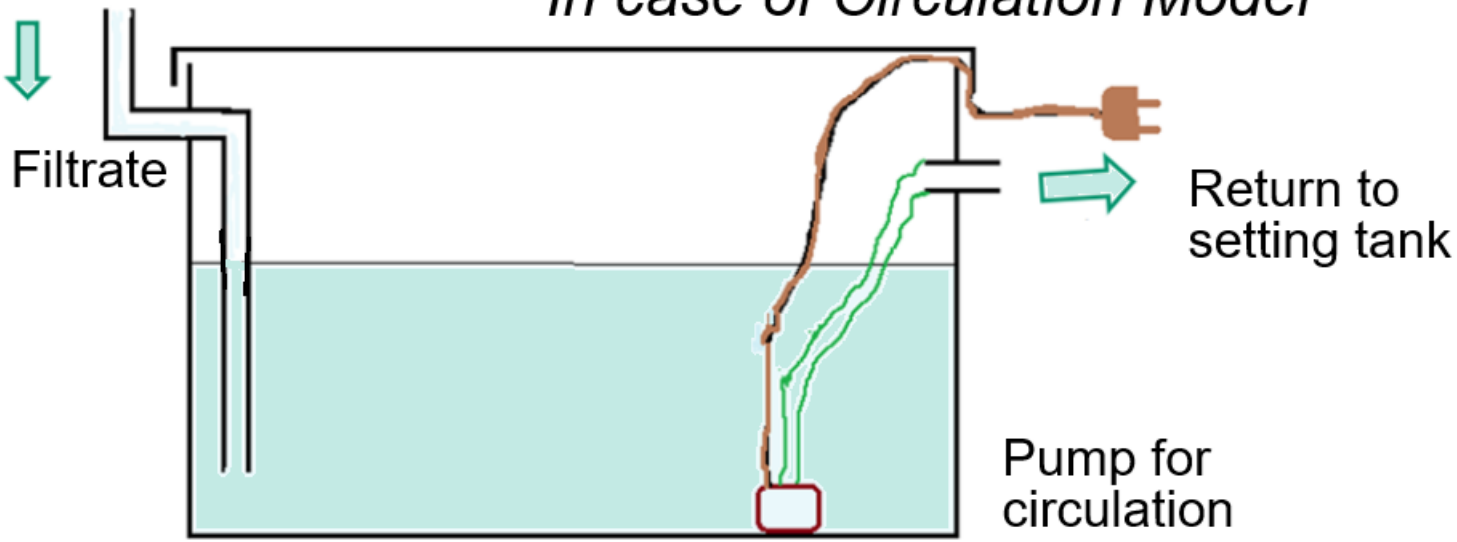


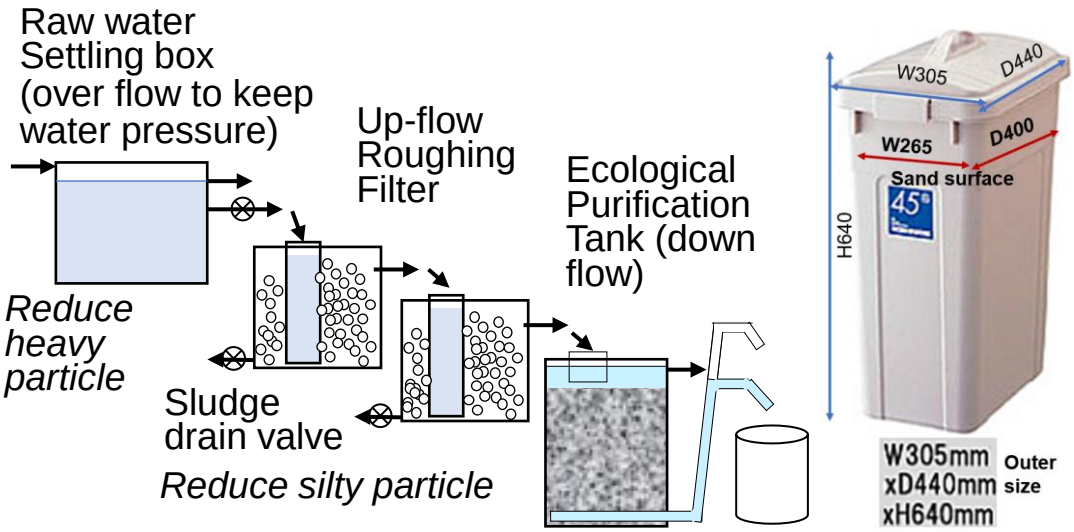
Algae and animals grow well on and beneath the sand surface.
Deep sand layer is a guarantee layer for emergency.

Storage (Filtrate) Tank



In case of Circulation Model





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

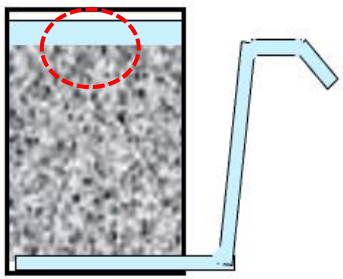
In case of Present Thames filter rate (40cm/h =9.6m/d)

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.

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

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

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

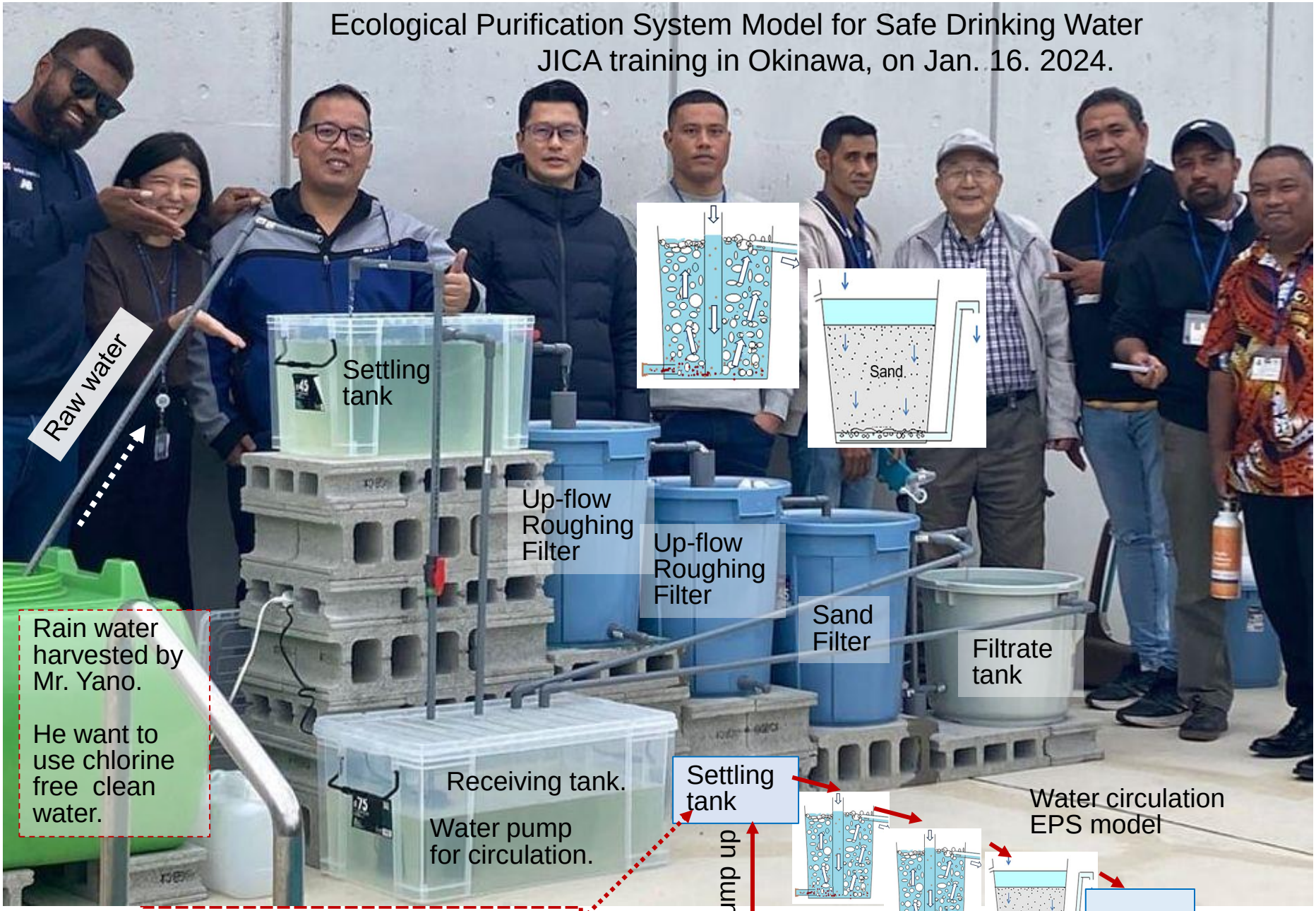
Un sistema ecológico, económico y replicable que puede ser utilizado por pequeñas, medianas y grandes comunidades. Este sistema fue desarrollado por el Doctor Nobutada Nakamoto

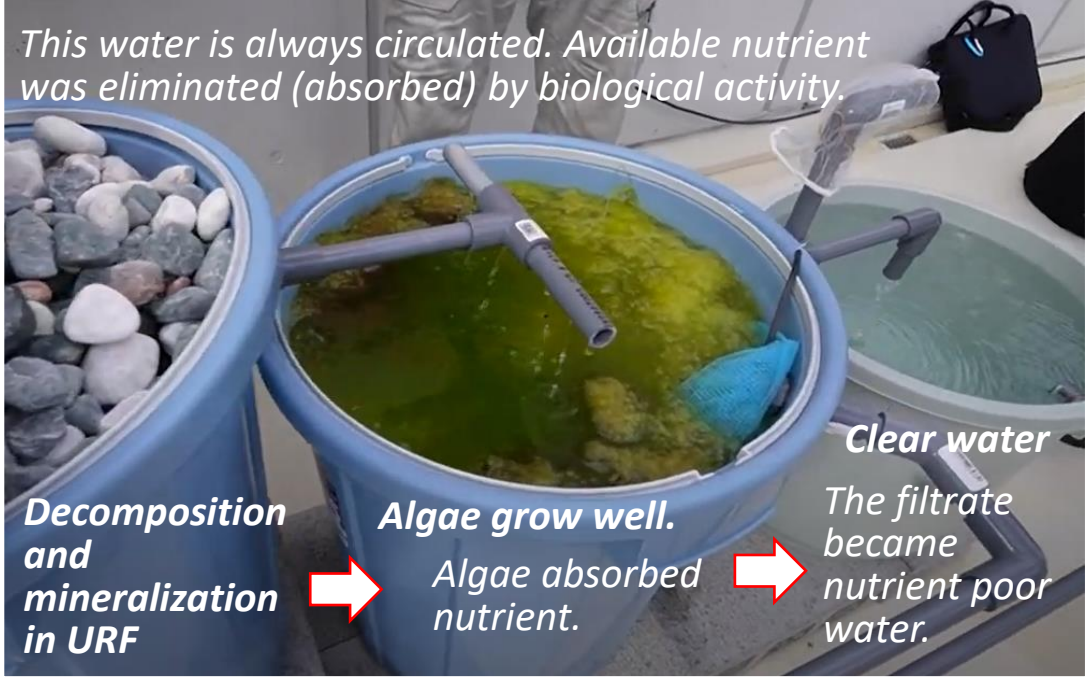
Ecological Purification System

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.



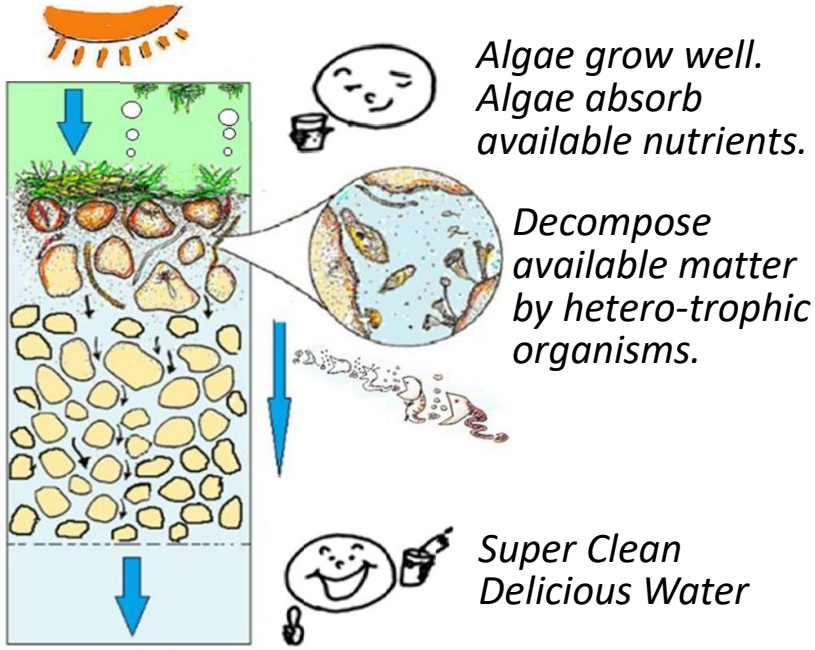


After 3 weeks, they enjoyed delicious super clean water.

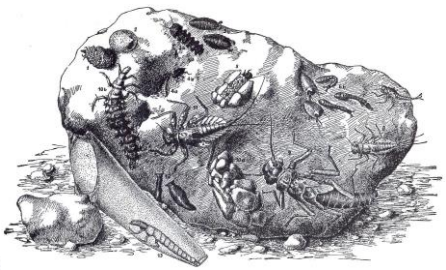
Filtrate Water that is free of substances that living things can react with.
It's water that tastes delicious and sweet.

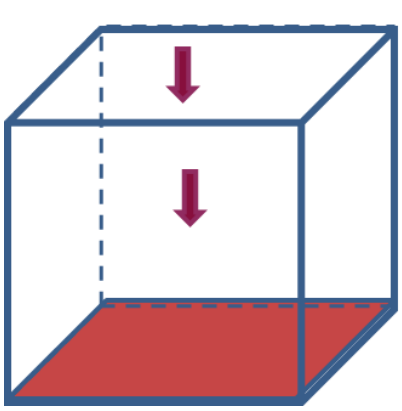
https://www.youtube.com/watch?v=RJLgf63s5Og

Sweet drop (honey dew)
Natural sweet and delicious water



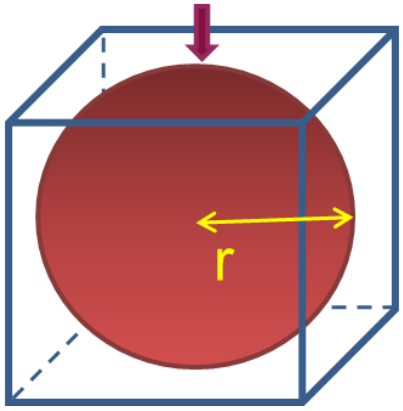
Most of small organisms live on the surface of substrata (sand particle) under slow current condition. They live at the top of sand layer where food comes. They are always waiting for food. They are hungry.



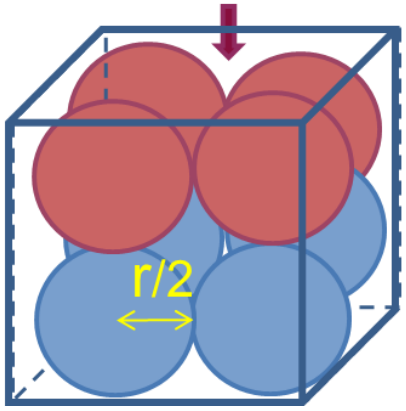


1

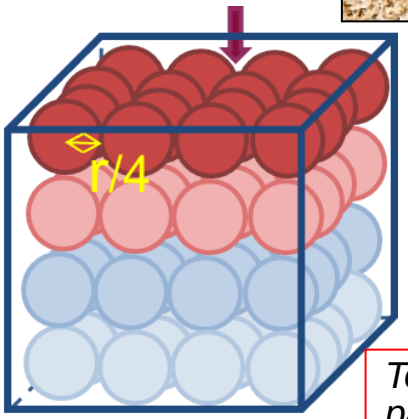
Bottom surface area



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***

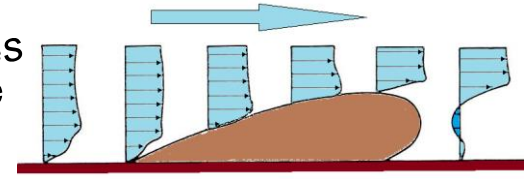
Surface area of a ball is 3.14 times than flat area.

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.

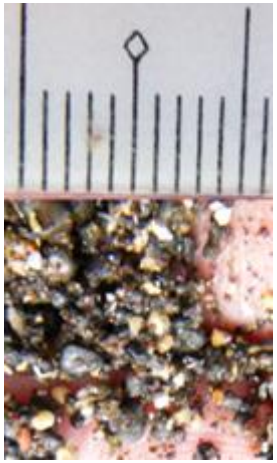
Filter resistance increases toward smaller size of particle.

Viscosity relates to temperature

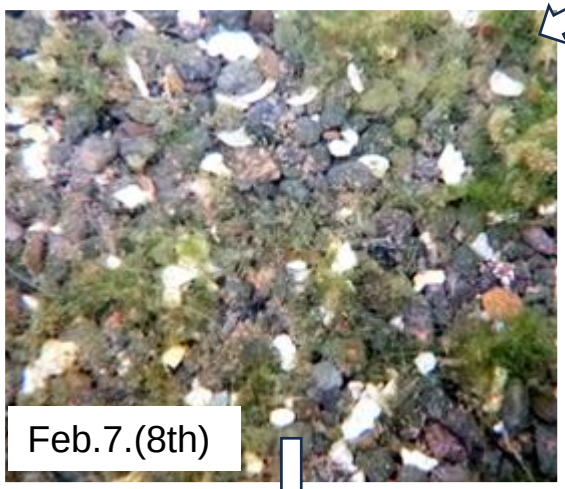


Points: shallow depth, enough radiation on the bottom, rapid growth, large size of sand.

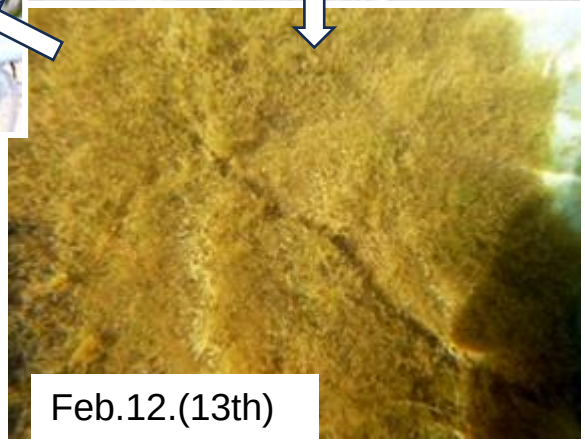
Sand separated with mosquito mesh (1-2 mm)



Feb.14.(15th)



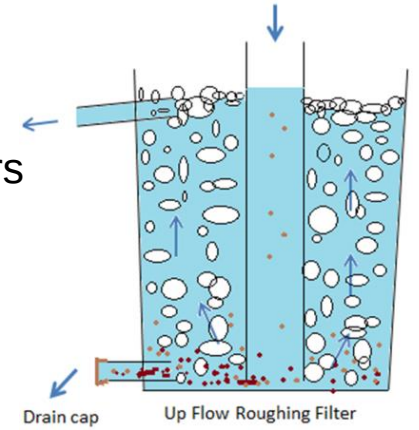
Feb.7.(8th)



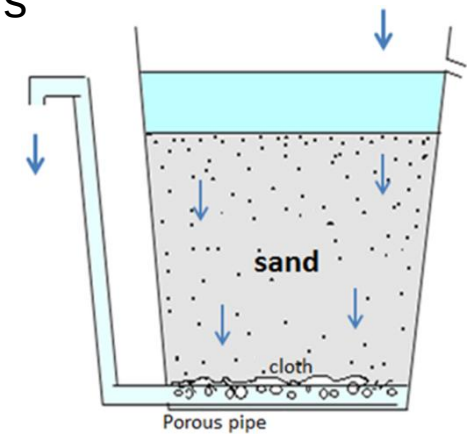
Feb.12.(13th)

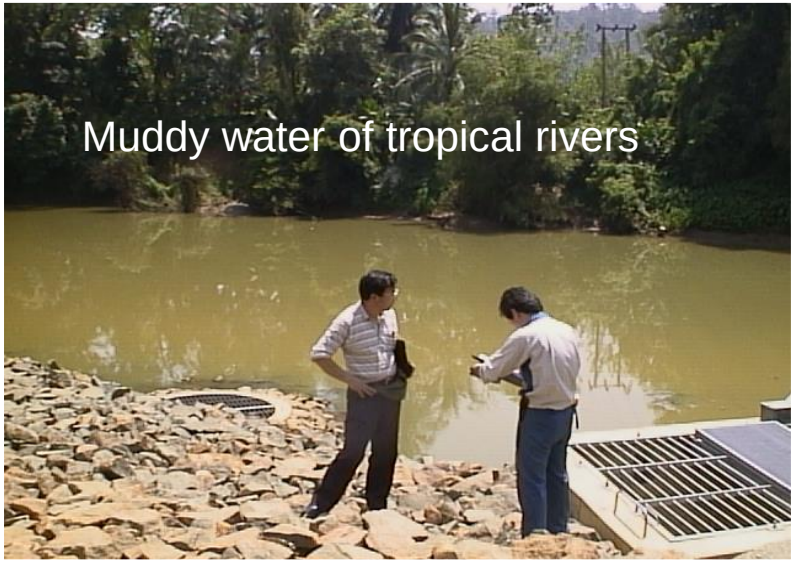
Shallow depth: Algae grow well

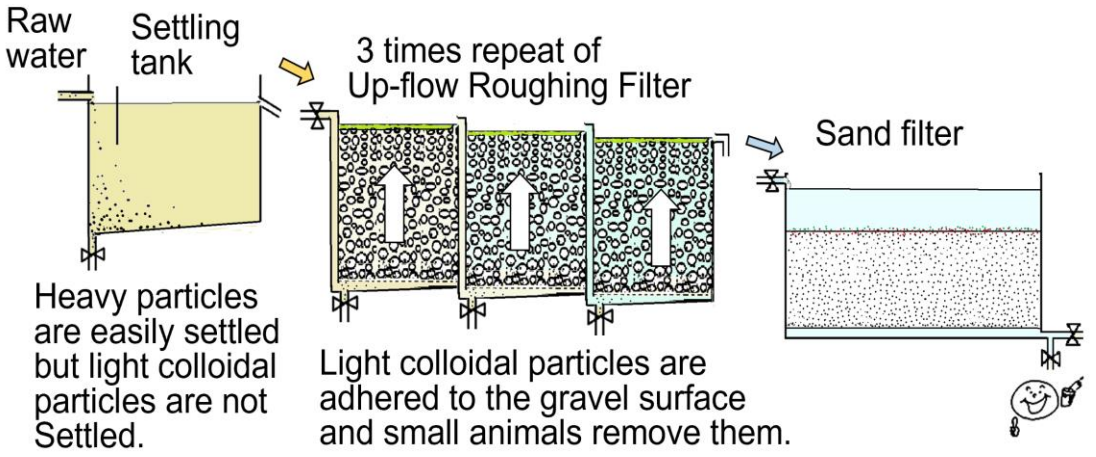
Two up-flow roughing filters



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

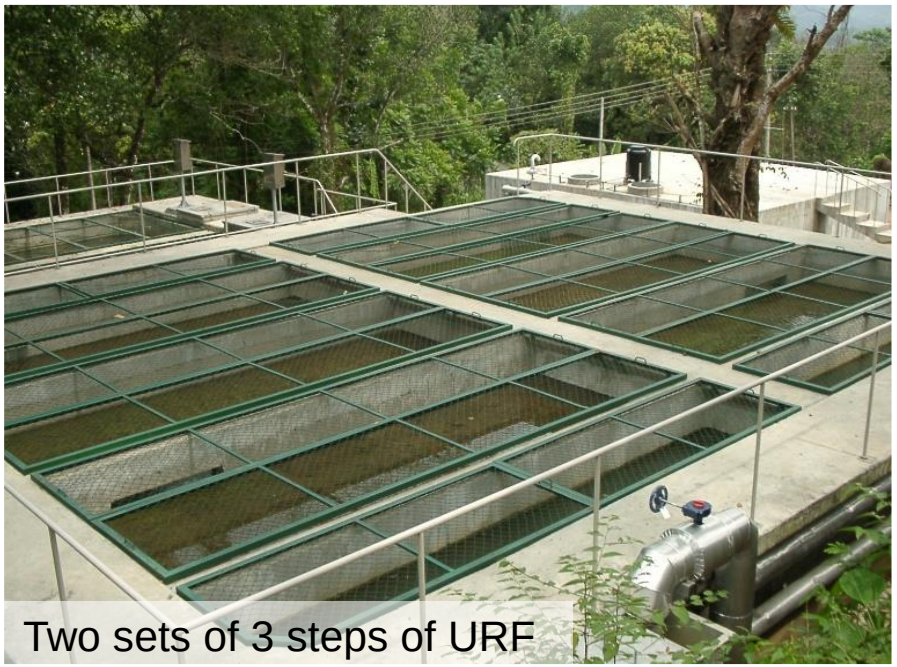






Settling tank and URF for turbidity reduction

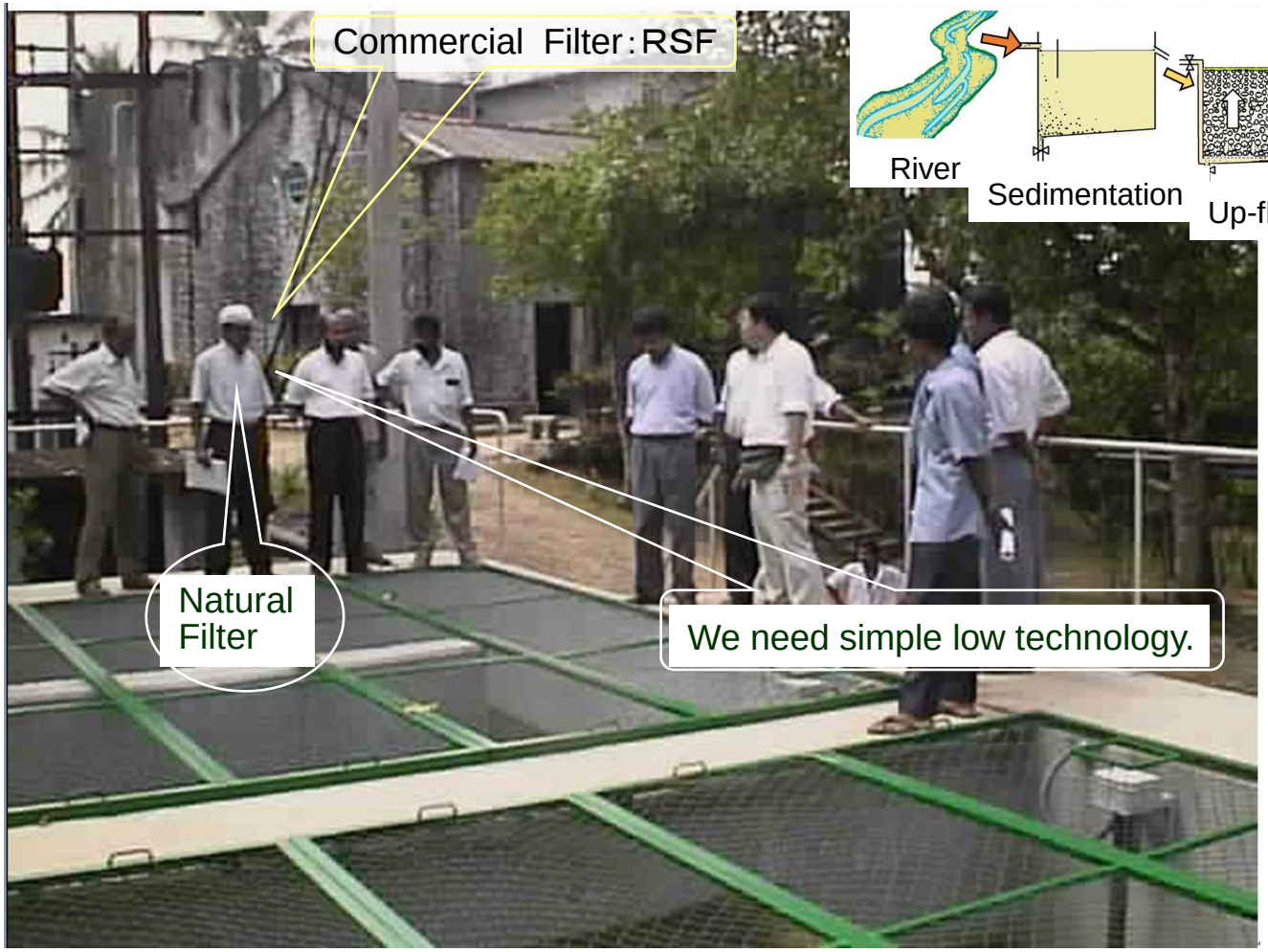
Water supply plant to the national Ratnapura hospital, Sri Lanka by EPS

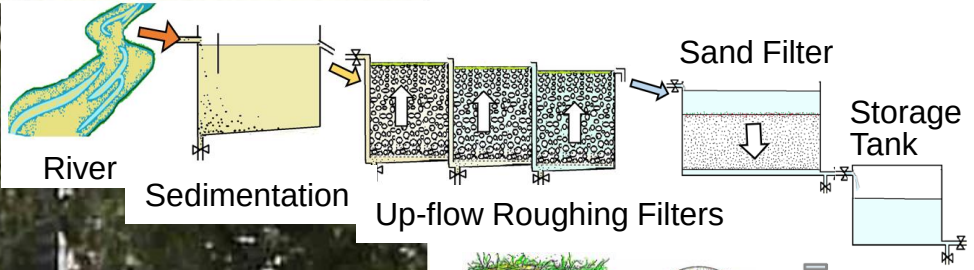


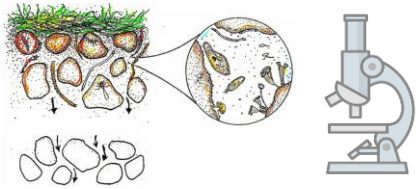
Explain the ecological purification mechanism of chemical free system.

Manager said "**Conventional is a commercial filter. This is a natural filter**".



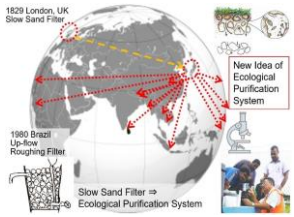








I explained the chemical free mechanism of EPS, the maintenance and management of EPS at the site to the engineers. This was wise use of natural system.
The manager understood the reason that we had commercial technology.

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



Chemical Free
Eco-friendly

Ecological Purification System (EPS)

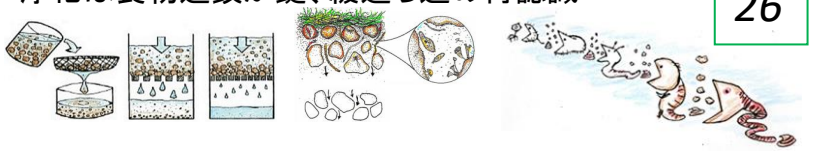
0. Introduction: Phytoplankton, Reservoir study, Meet Slow Sand Filter, Importance of Ecological point. JICA training
植物プランクトン、貯水池研究、緩速ろ過、生態学の視点、JICA研修へ

1-19 19

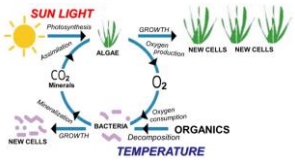
1. Water cycle, Safe water, Acceptable risk. *20-31* 12
水循環、安全な水、許容できるリスク

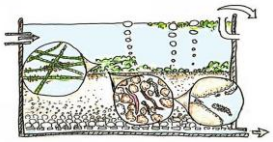


2. Key of purification in nature is food chain. Refocus to Slow Sand Filter. *32-57* 26
浄化は食物連鎖が鍵、緩速ろ過の再認識

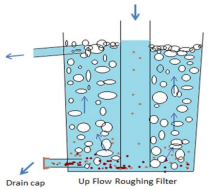


3. Algae and animals in Slow Sand Filter. *58-79* 22
緩速ろ過池の藻類と動物





4. Up-flow Roughing Filter to reduce SS *80-108* 29
濁り対策で上向き粗ろ過、モデルで解説



5. From JICA training in Miyako-jima, Okinawa to Samoa *109-124* 16
宮古島JICA研修からサモアへ



6. Safe water for rural people by EPS in Fiji *125-147* 23
フィジーの展開：生物浄化法で地方給水へ



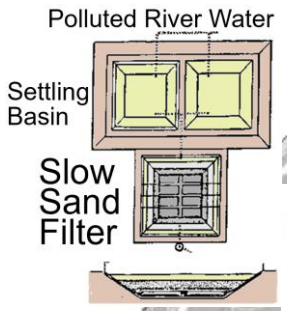
7. Aerobic condition is essential for EPS. *148-157* 10
生物浄化法は酸素が必須

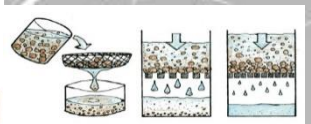


8. Confirm by yourself. Don't believe commercial. Trust your true sense. 自分で確かめよう。 *158-172* 15



JICA training in Hiroshima in July, 2024.





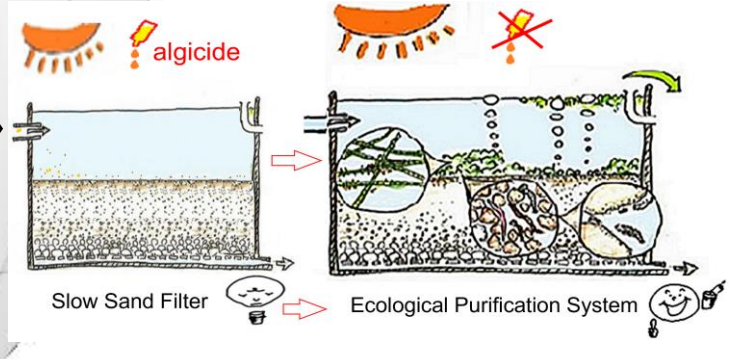
They believed mechanical reduction of polluted matter by fine sand under slow filtration.

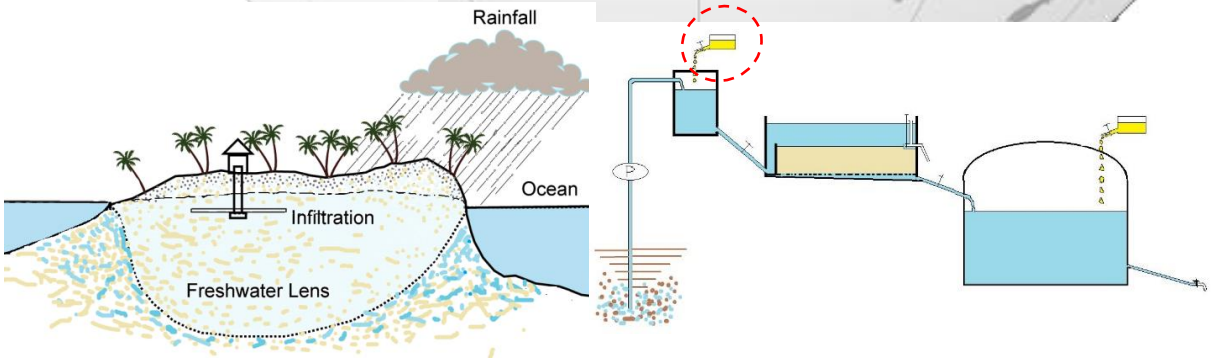
Miyako-jima island is a raised coral reef where is quit different environment compared with main part of Japan.

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-jima, visited to Nakamoto, Shinshu Univ. in July 8, 1997.

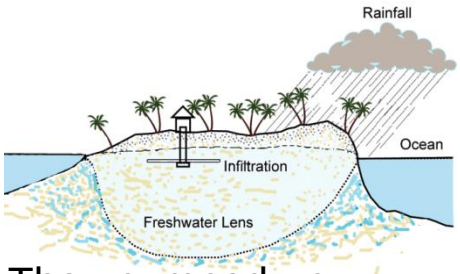
He stopped to injection of algaecide into receiving well in 1997.
As soon as the injection stop, the taste of tap water became delicious.
Biological communities started to work in SSF. Ecological Purification System functionated in this SSF.





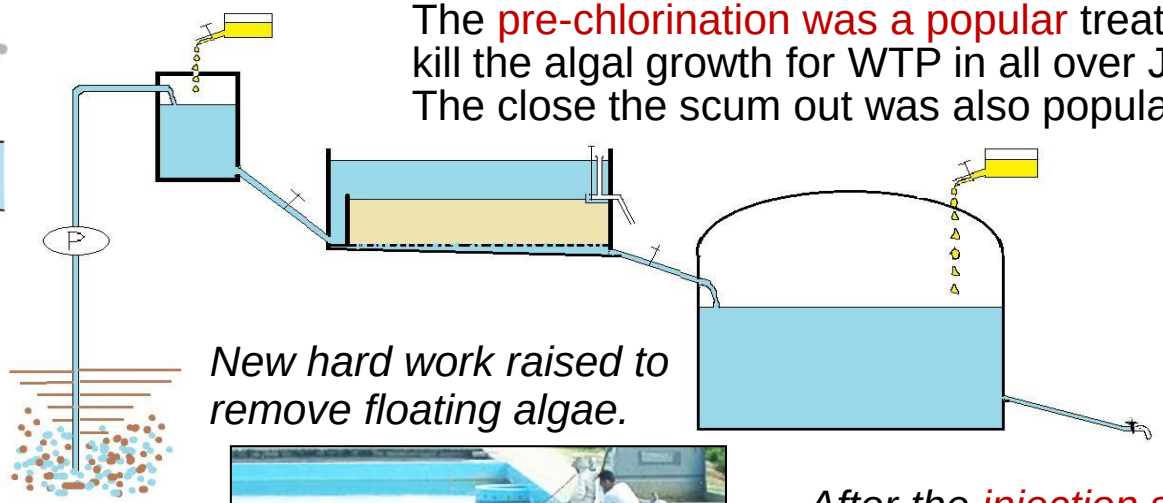
How to make delicious water

Nakamoto published Ecological Purification System text in 2005.



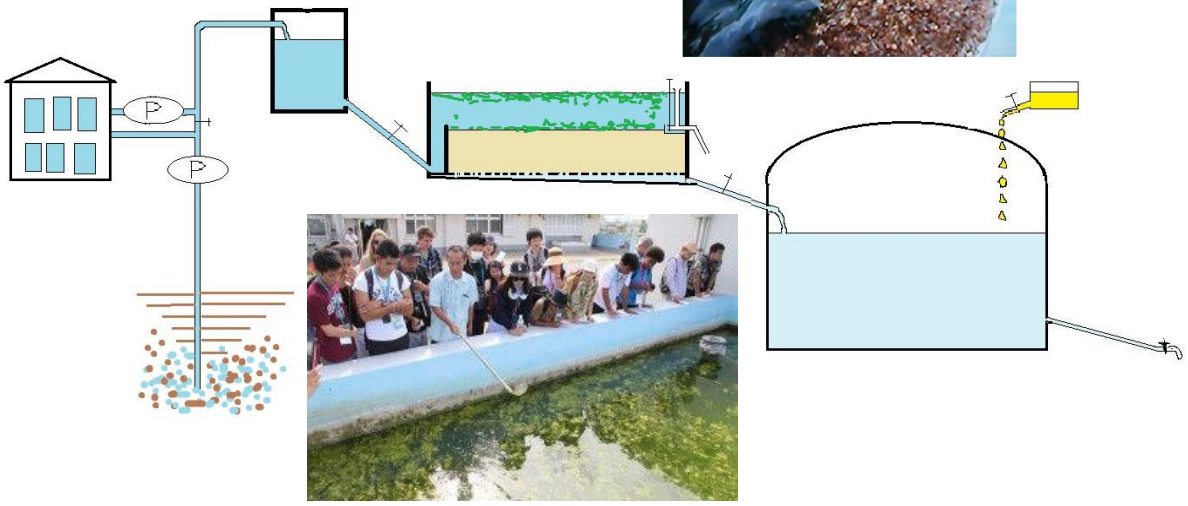
The pre-chlorination was a popular treatment to kill the algal growth for WTP in all over Japan. The close the scum out was also popular.

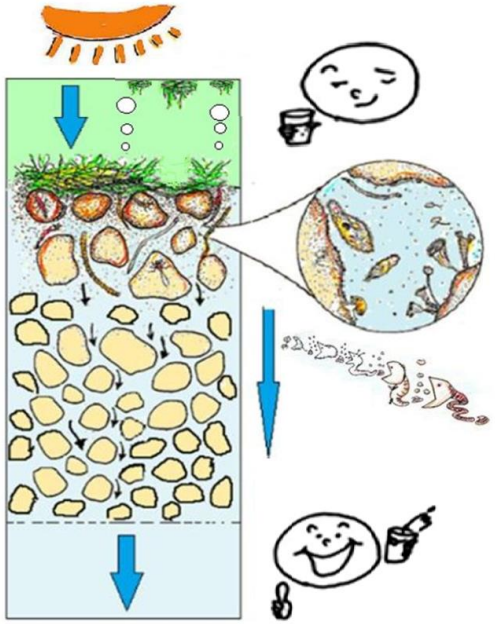
They pumped up the underground water as water source. They could not flow out from the scum out. In the pond, algal bloom was so severe. The pre-chlorination was introduced to kill the algal activity.



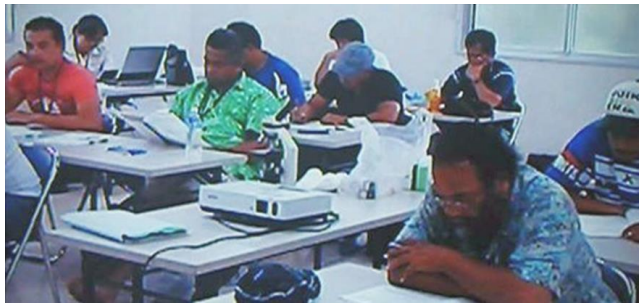
New hard work raised to remove floating algae.

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

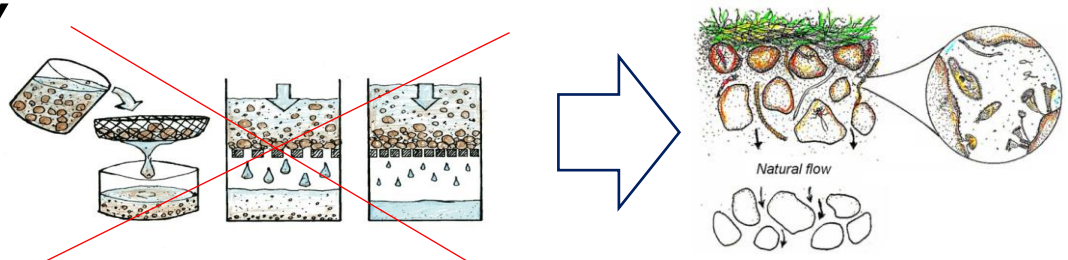
https://www.youtube.com/watch?v=c3mVIbmFPqA&t=138s

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

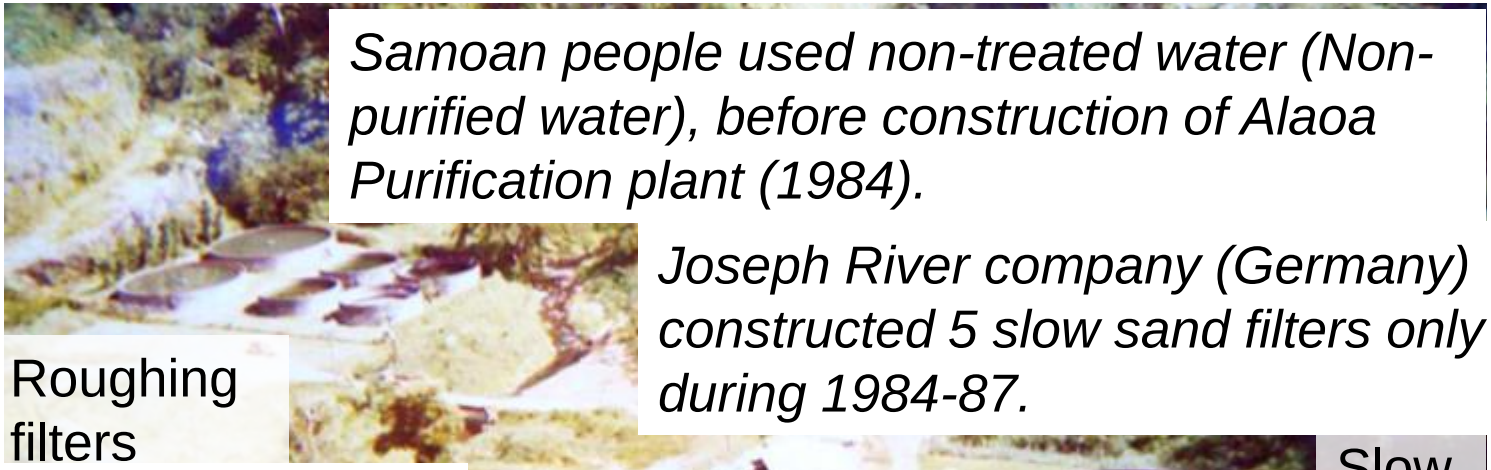
Slow sand filter problem in Samoa was solved by ecological point in 2010 – YouTube / 13:45

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.



Settling tanks



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

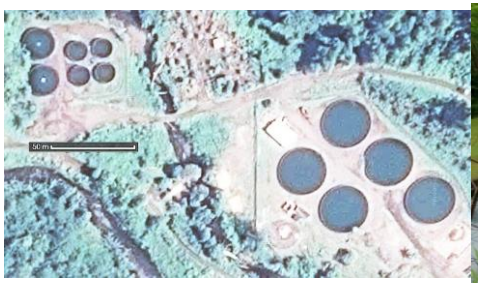
Joseph River company (Germany) constructed 5 slow sand filters only during 1984-87.

Roughing filters

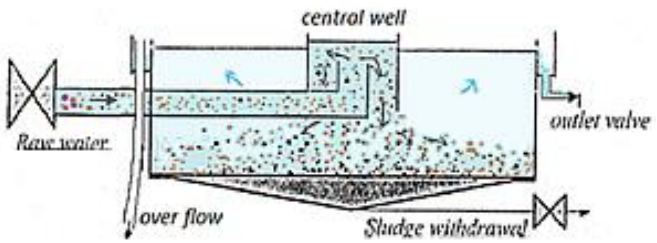
Slow sand filters

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.

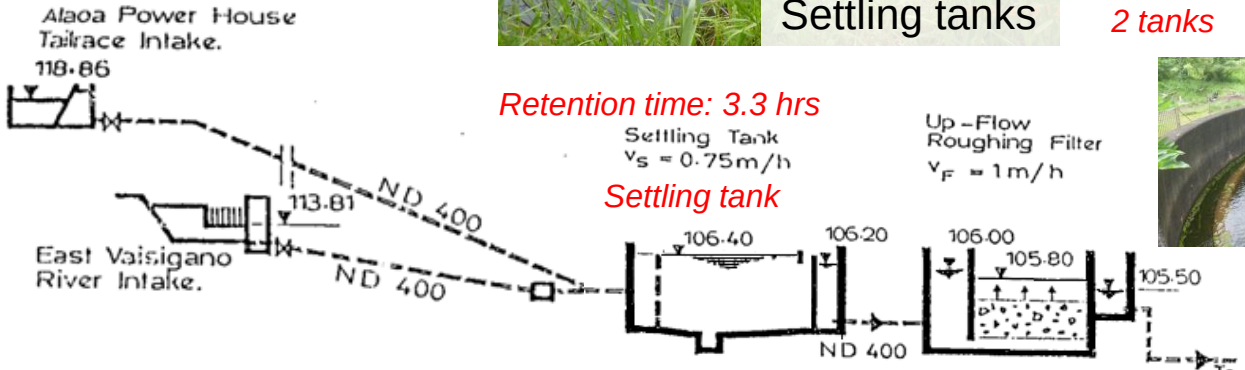
http://www.cwsc.or.jp/cwscpanel/wp-content/uploads/2022/10/AlaoaDurch-Manual.pdf



Settling tanks



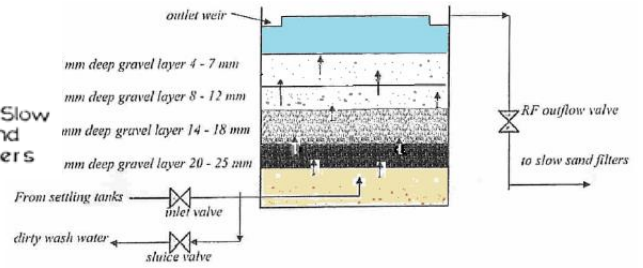
Diameter 17.8 m Area 248.8 m2
2 tanks Retention time: 3.3 hrs



Retention time: 3.3 hrs

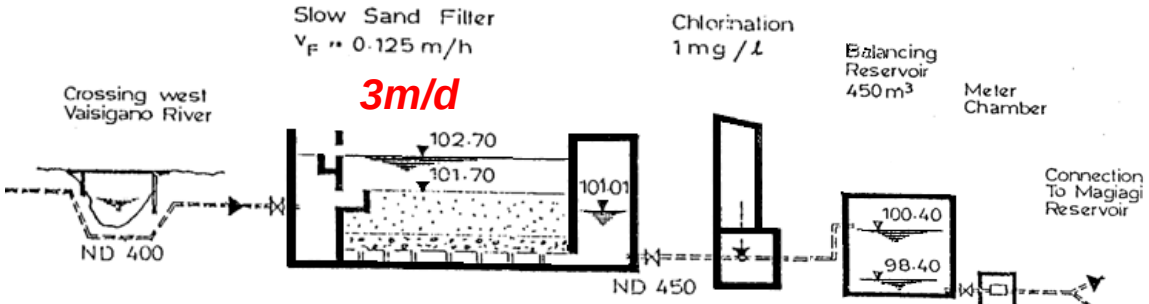
Settling tank

Up-flow Roughing filter:
Diameter 11.2 m
Area 98.5 m2
4 filters
Filter rate: 1m/h



Up-flow Roughing filter:
Fine, light particles cling to the gravel surface

Natural Down flow



3m/d

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

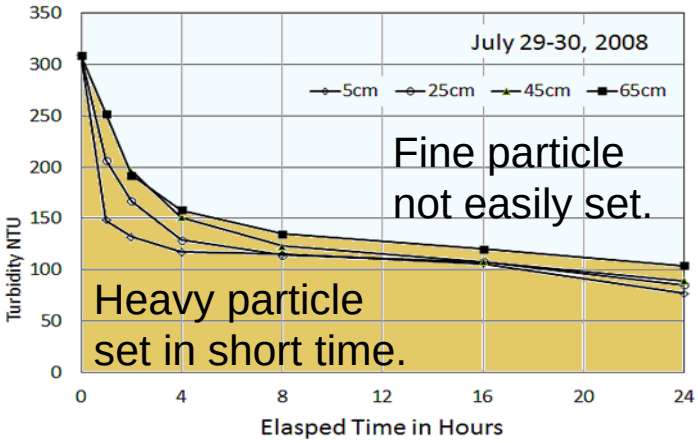
Slow Sand Filter⇒Ecological Purification System : Purification was done by the function of biological communities. It was the food chain.

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.

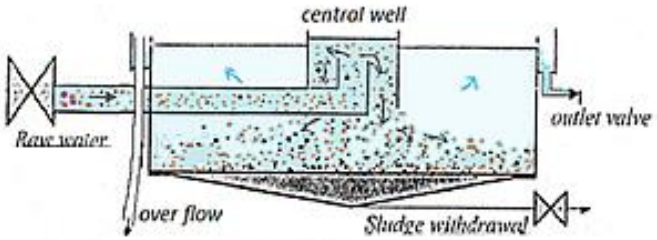
616 m2 x 3m/d = 1,848 m3/d x 5 filters =9,240 m3/d
5m/d なら 3,080 m3/d x 5 filters = 15,400 m3/d
10m/d なら 6,160 m3/d x 5 filters = 30,800 m3/d

One day demand: 0.1 to 0.3 m3/day person

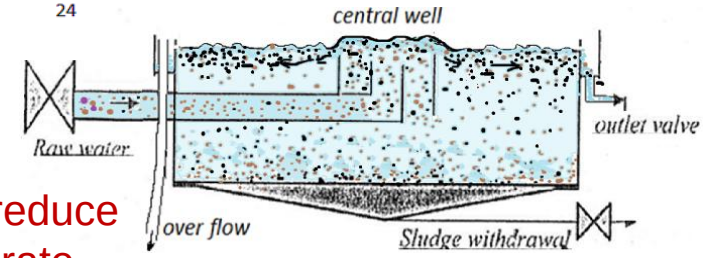
The ideal is a calm surface.

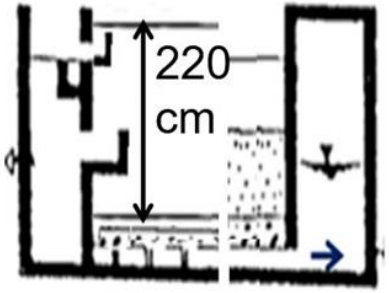


Retention time: 3.3 hrs (design)



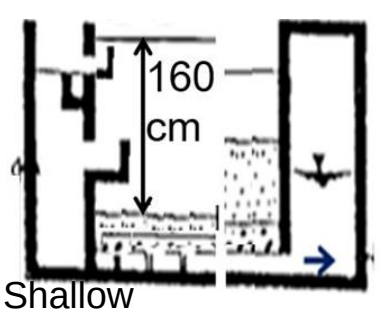
We reduce flow rate





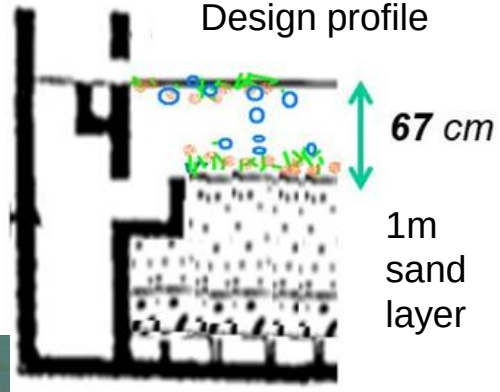
Deep

Almost no sand layer.



Shallow

Design profile



220 cm Deep

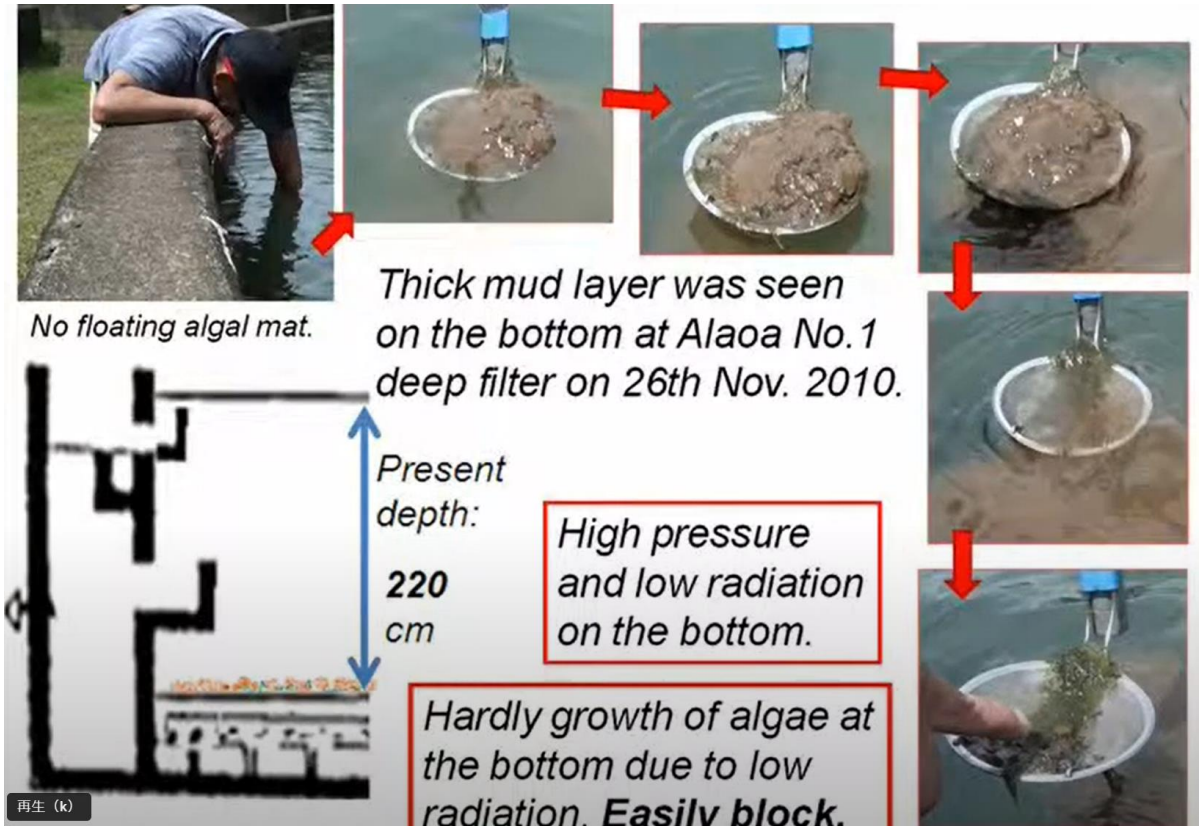
Lifted algal mat with mud.

Shallow depth: Active photosynthesis: much oxygen bubble formation.

Large mud on the bottom

We recommend: Put sand. Make shallow depth.

Shallow Water depth is the key for ecological purification system of slow sand filter pond.



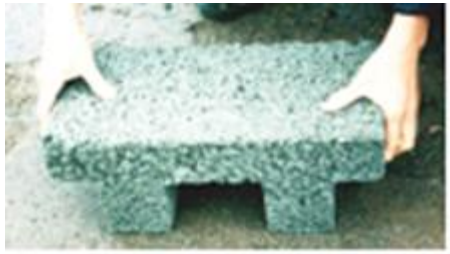
Hardly growth of algae on the deep bottom.

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

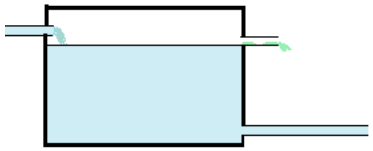
https://www.youtube.com/watch?v=ot-KAm6TuaY

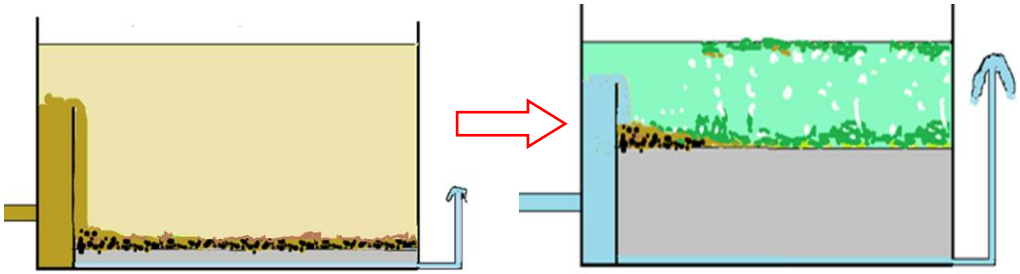
Beach sand near a river mouth was washed to make a shallow depth of slow sand filter pond.

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



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



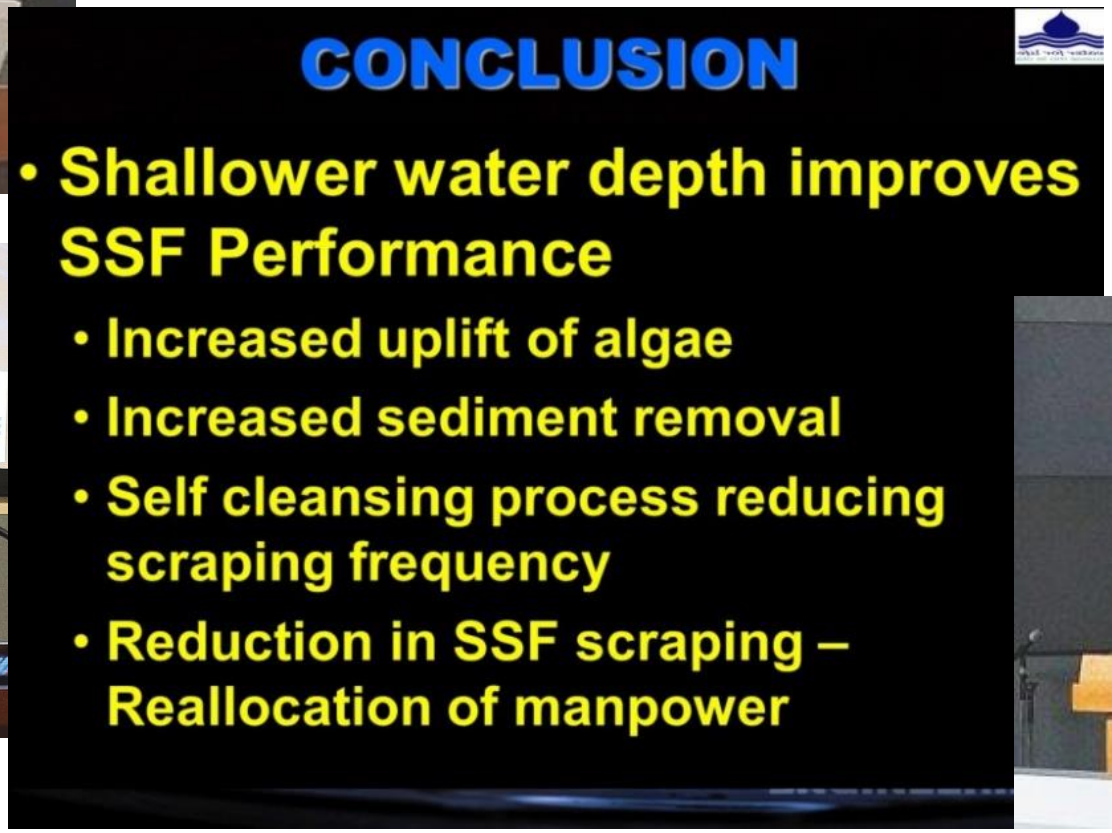


Deep to Shallow

Over-flow from the balance tank for filtrate water.

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

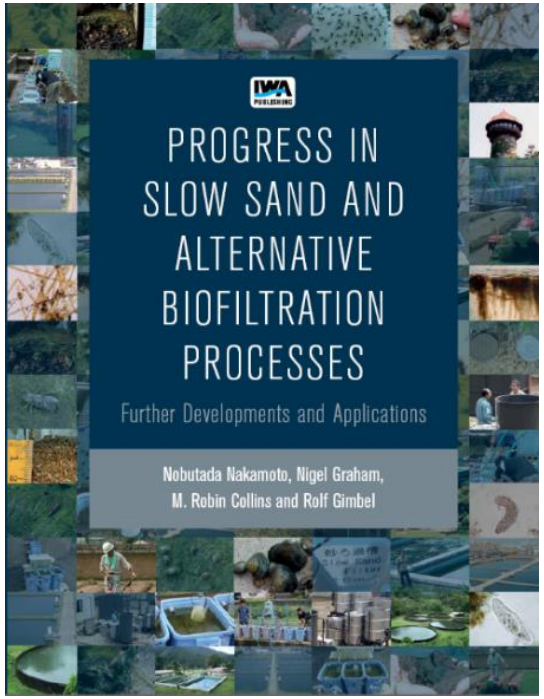
Professor
Nigel J.D. Graham
Imperial College London, UK
Chairman,
Program Committee

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

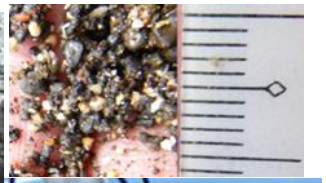
5SSABC - YouTube / 14:15

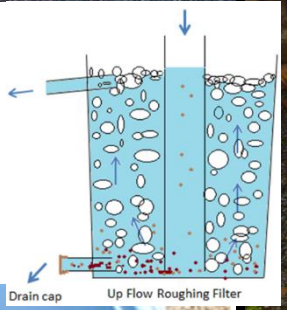


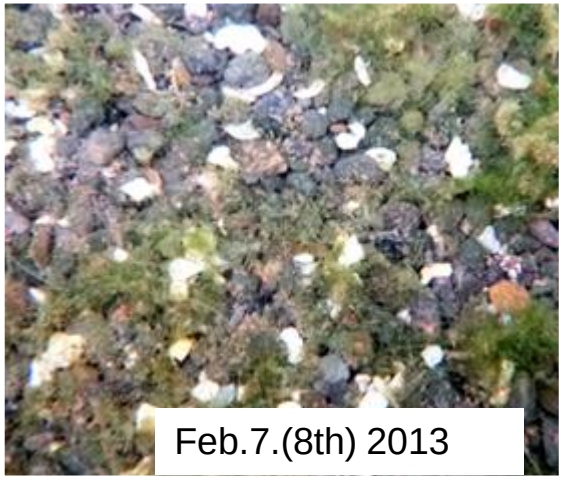
Biological activity is related with radiation and temperature.

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

Sand washed with mosquito mesh (1-2 mm)







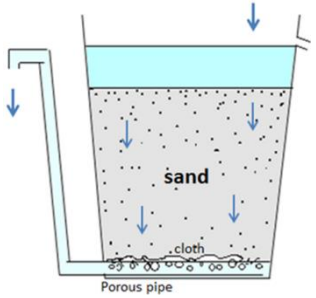
Feb.7.(8th) 2013

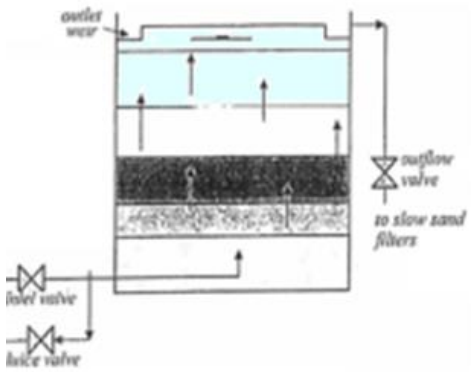
Feb.14.(15th)

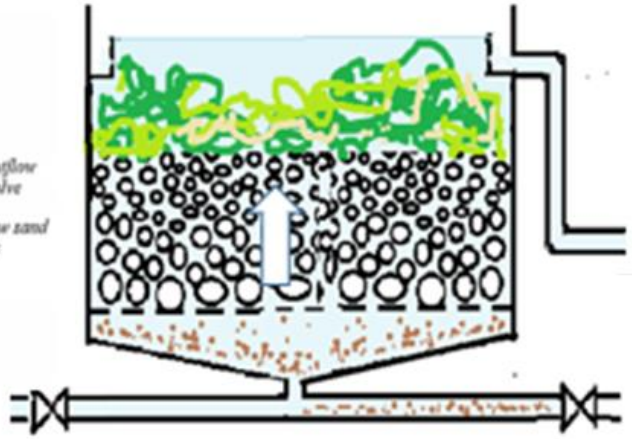
Shallow depth: Algae grow well

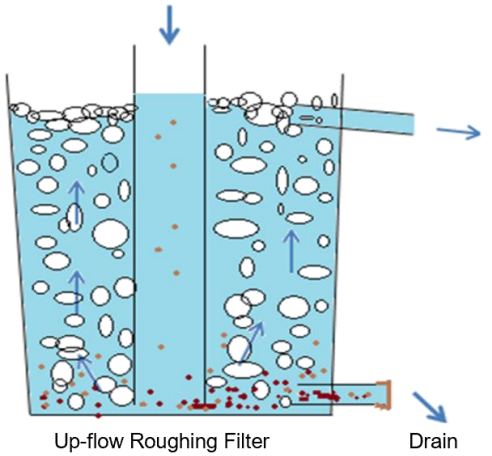
Different flow rate of sand filters (**5m/d, 10m/d, 20m/d**)
All good quality of filtrates.

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

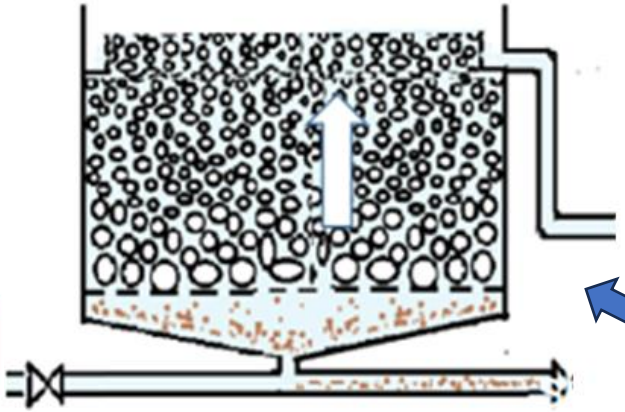








Active growth in URF



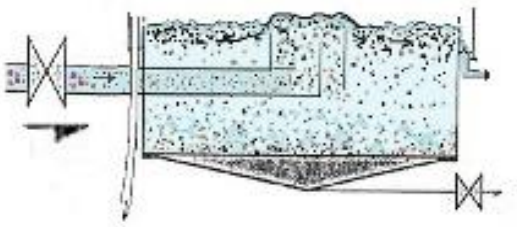
Large area of gravel surface is important to adhere suspended matter.

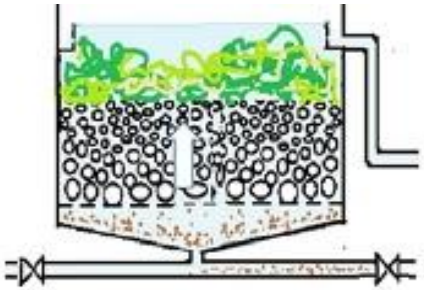
Clear water in river bed.

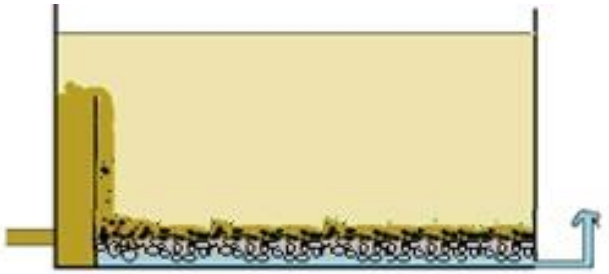
Full gravel with small crushed stones.

Advise for a better plant system to Samoa

Improvements to the Purification Function.



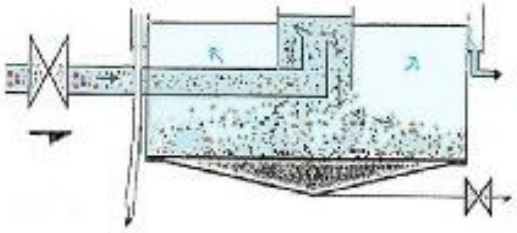


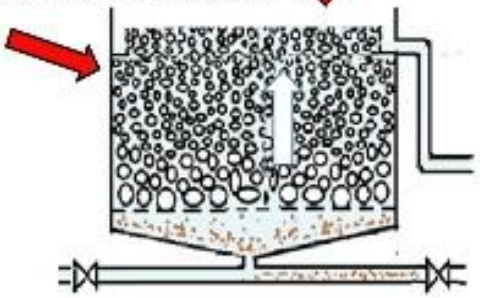


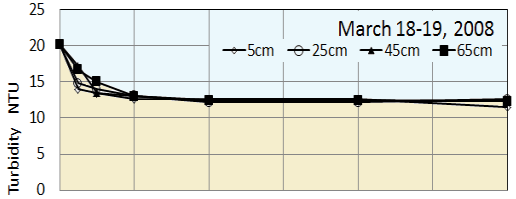
Reduce inflow
⇒Easy to settling

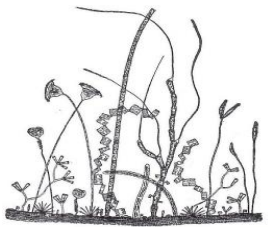
Thicker gravel media
⇒Expand active area

Make shallow depth
⇒ Activate algae

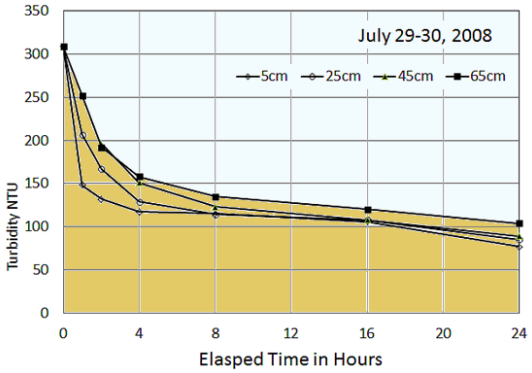








Shallow depth is better for algal activity.



Suitable residence time for settling

Small organisms active on the stone surface.