Project MaWaSU 4th International Seminar 16-18 November 2016 Savannakhet, Lao PDR

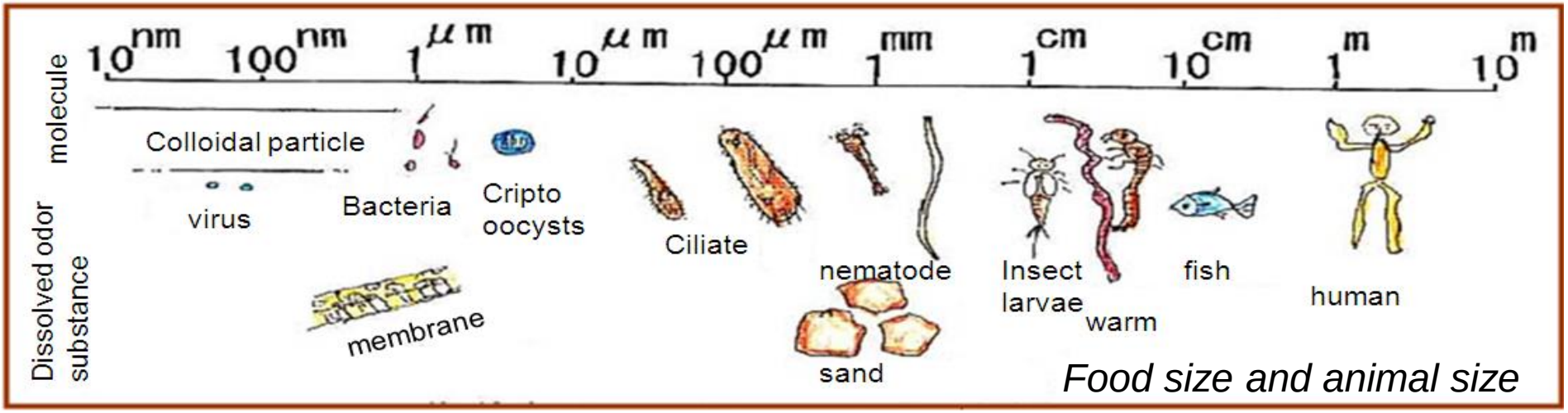
Invitation to Ecological Purification System

New treatment concept to make safe drinking water

We can make safe drinkable water from muddy water without chemicals by Wise Use of Ecological Purification Process in Nature.

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

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



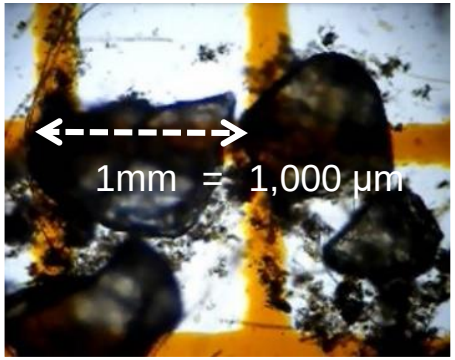
Short time work

Passing time of food in body is also very short.

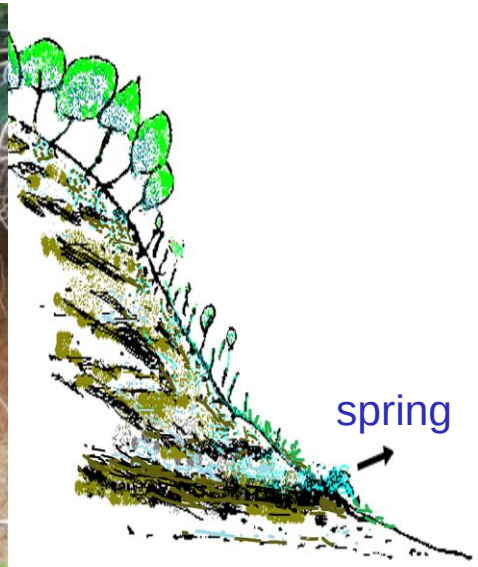
Long term action

Complete decomposition (mineralization) in the faecal pellet.

Anaerobic condition inside of fecal pellet.

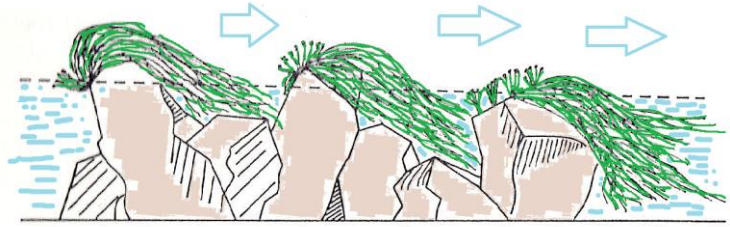


Hungry animals are important to trap any particles under gentle condition.

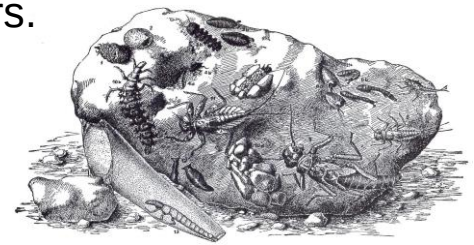


Spring water is always clean and delicious. This water is purified by natural EPS .

People loves and trusts natural spring water as a safe water.



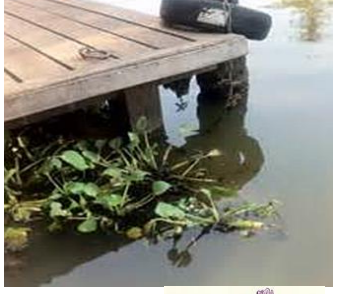
When plants and animals do not flush out, water is always clear. Small animals on the surface of rocks collect turbid matters.

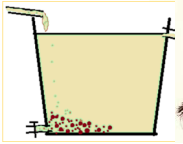


Soil is easily flushed out from a land and flows into a river after a heavy rain.

Gravel, stone and sand are easily rolled during storm event. Small organisms on and among rocks were flushed out.

Light colloid particle is not easily settled.





Water in paddy field is clear water. Many small animals eliminate fine particles in water.

Clear seepage water

shallow water depth

In shallow water depth, Algae and small animals grow well.

Image of Ecological Purification System

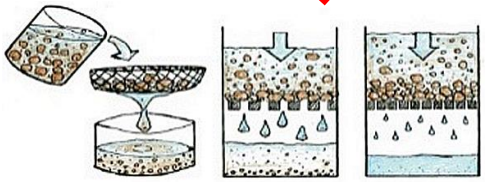
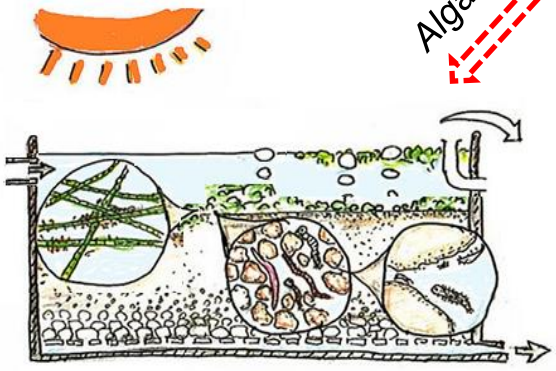
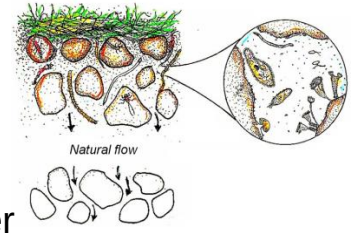


Image of Slow Sand Filter





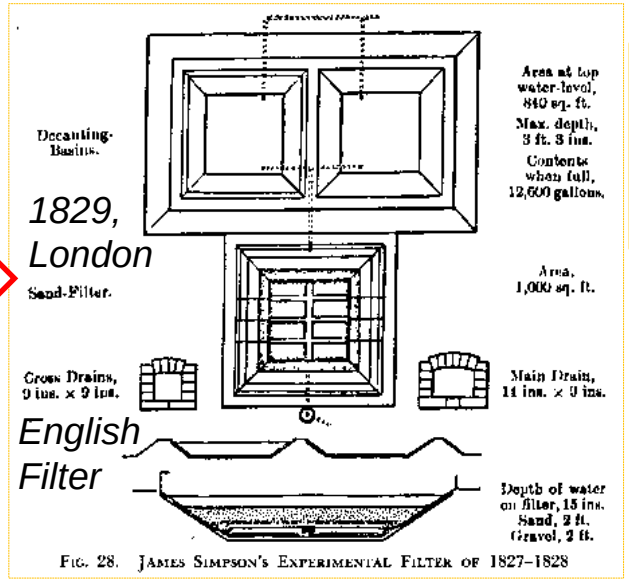
Slow gentle down flow through sand layer and shallow water depth

Clean drinkable water

Artificial clear seepage water

Origin of Slow Sand Filter

Artificial seepage water in a flood plain

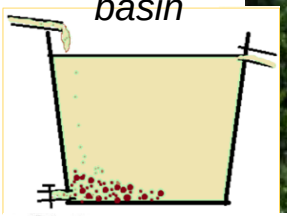


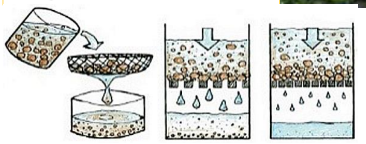
1829, London

English Filter

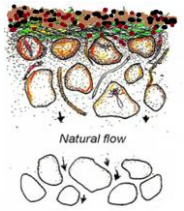
FIG. 28. JAMES SIMPSON'S EXPERIMENTAL FILTER OF 1827–1828

Settling basin

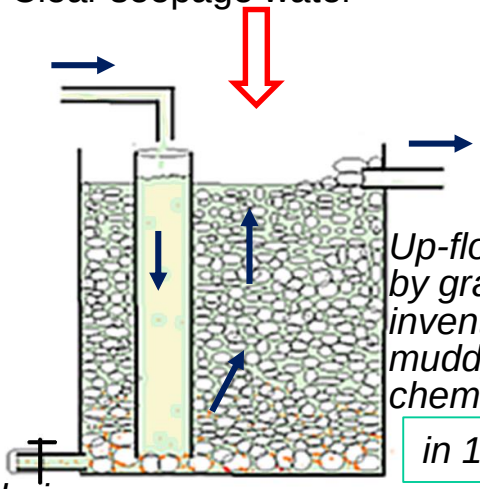




Sand filter



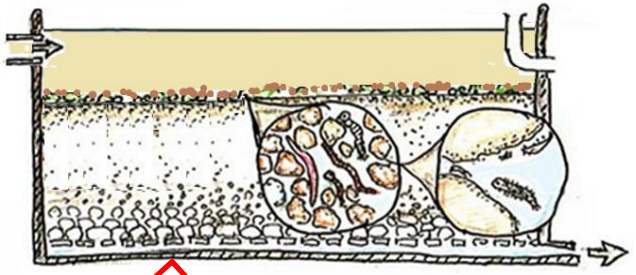
Clear seepage water



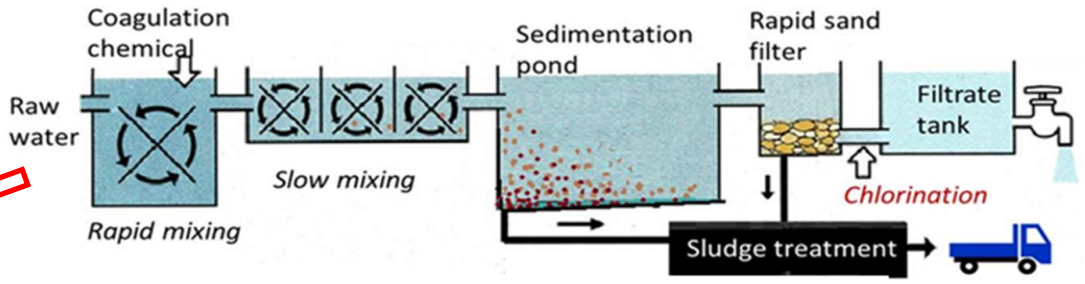
Up-flow Roughing Filter by gravel layer was invented to eliminate muddy matter without chemicals.

in 1980s

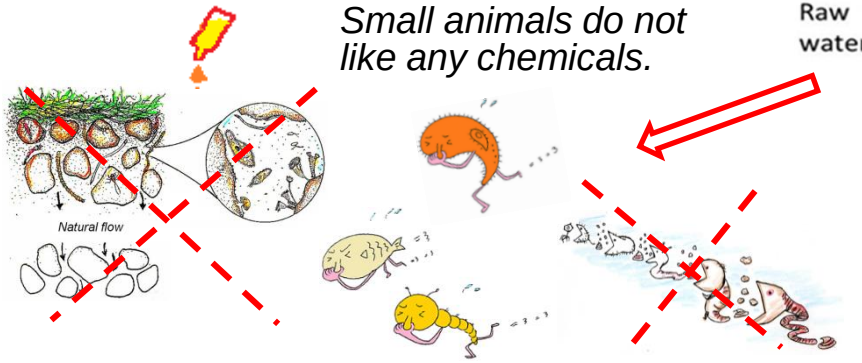
drain



Sand filter was easily covered and was clogged by muddy matter during storm event.



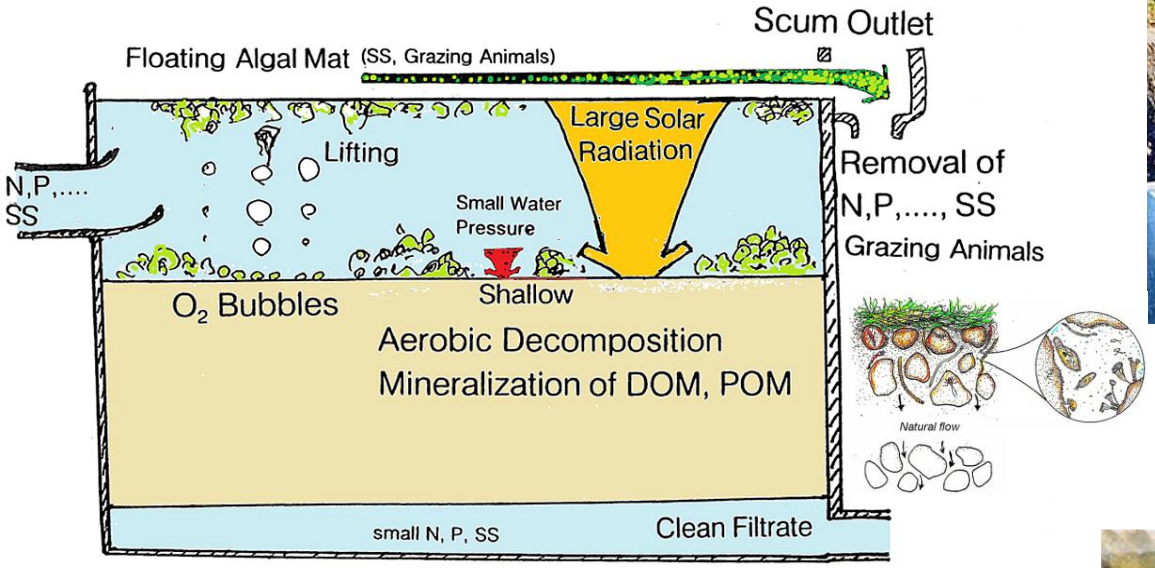
Small animals do not like any chemicals.



Coagulation treatment (Rapid sand filter technique) was invented to reduce the over load of muddy water to the filter.

1910 USA: American Filter

Shallow depth promotes the biological activities.

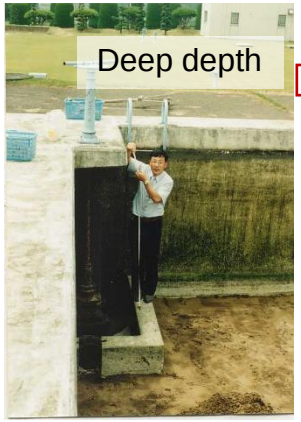


When no growth of algae was observed on the filter bed in cold winter in Ueda, Japan, an active growth of filamentous diatom was observed in a shallow model.

$$106CO_2 + 16HNO_3 + H_3PO_4 + 122H_2O + \text{Minerals} \rightleftarrows (CH_2O)106(NH_3)16H_3PO_4 + 138O_2$$

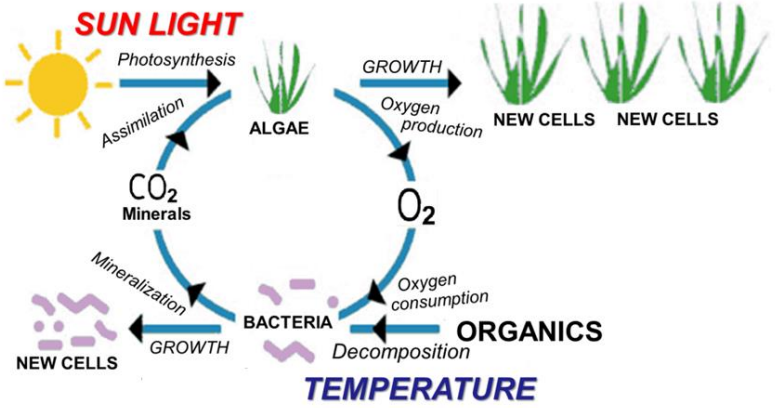
Algae produce oxygen by photosynthesis. Algal growth promotes heterotrophic activity (bacteria, animal), removal of nutrient and suspended matter and prevention of filter clog.

Active growth of filamentous diatom was observed in a pool in flood plain in cold winter where the grazing activity by animal was weak in cold water.



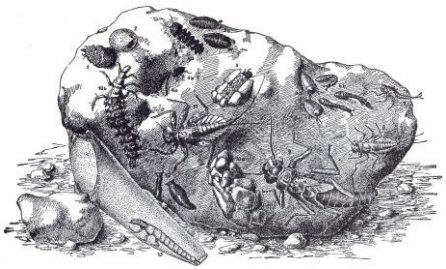
Shallow depth

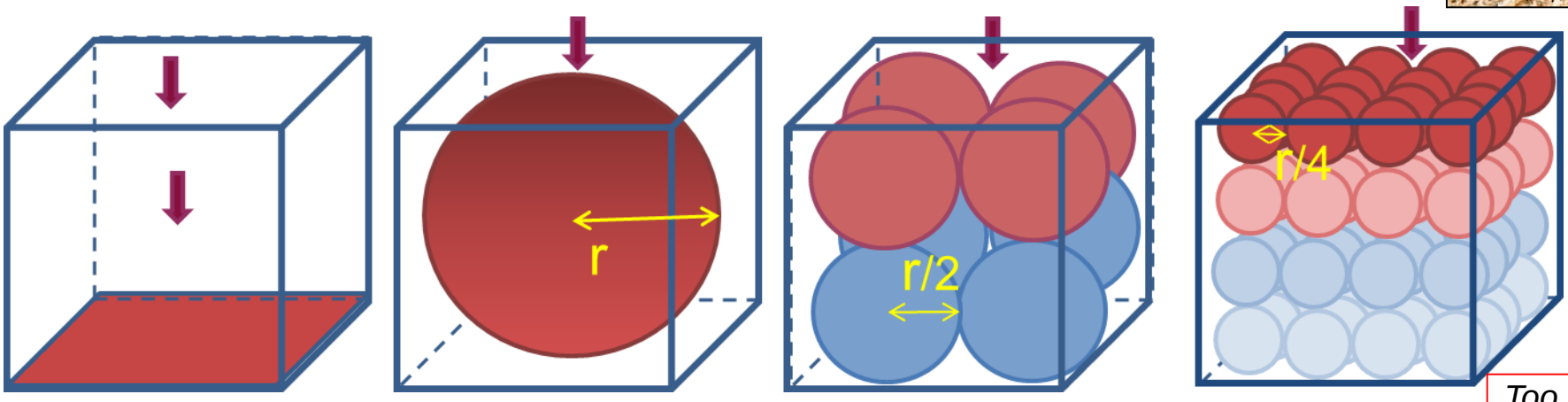
From deep depth to shallow depth.



Bubble formation is remarkable in shallow depth.

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

1

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

= 3.14

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

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

= 3.14

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

= 3.14

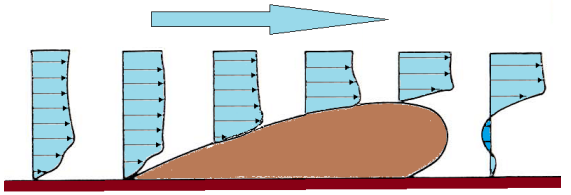
Too small particle becomes a flat surface.

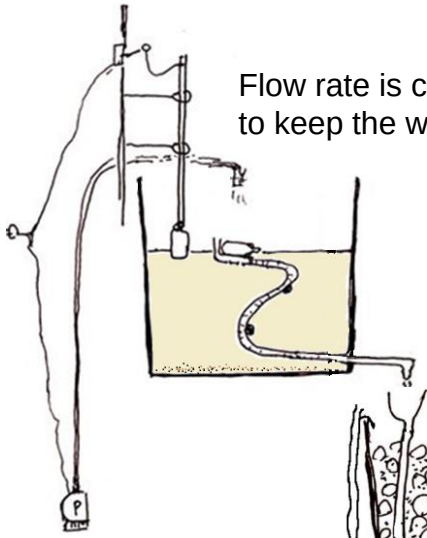
Total surface area of top layer of balls is always same of 3.14 times than flat area. Smaller ball makes larger area.

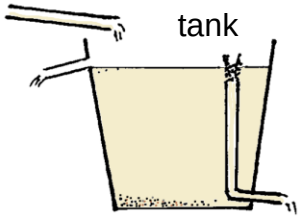
And, total volume of balls is always same of 52 % (porosity : 48%) in a box.

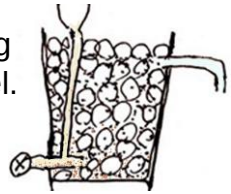
Filter resistance increases toward smaller size of particle.

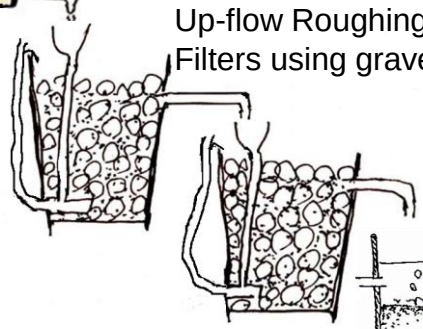
Viscosity :
temperature

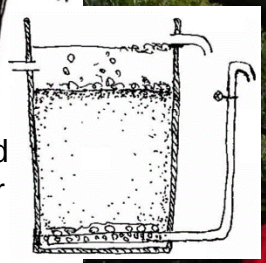












Raw Water

Sedimentation tank
(Reduce heavy particle matter)

(Settle Heavy matter)

Up-flow Roughing Filter
(Reduce fine particles)

(Trap Colloid matter)

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

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

Public tap system

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

Delivery service to other village.

Villager maintains over 10 years by themselves.

Application of the mechanism how to turn clean water in a paddy field.

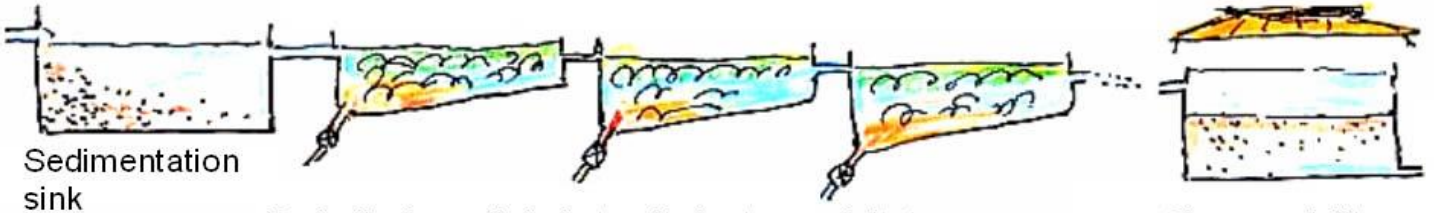
Two bottles of 20liters per 1 family. This water is used for drinking and cooking only. This water is not used for bath and washing hands. Diarrhea and eye sickness are disappeared. →Health village →sanitary sense and its level are distributed among the villagers. →This acts to protect against sickness.

New biological pre-treatment for SSF

Active growth of algae : holding stick (code) for filamentous algae

O2↑ →bubbles →keep aerobic condition

pH↑ → precipitate oxide and hydroxide complexes.



Periodical small drain to eliminate precipitate material and unhealthy organisms.

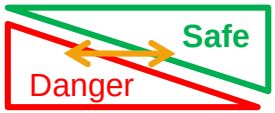
Slow sand filter

Metal-OH ↓ Oxide complexes can react with anions and precipitate.

Slow velocity of water for microbe to eliminate bacteria.

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

Acceptable Risk



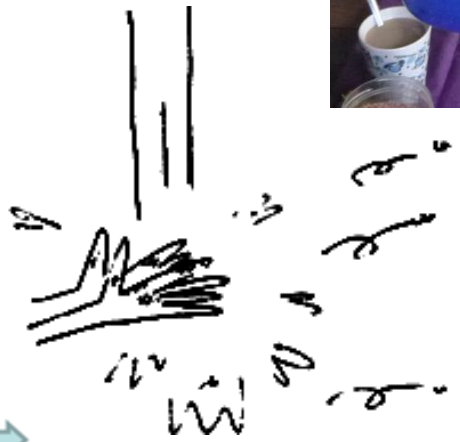
General bacteria: many in the natural environment

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

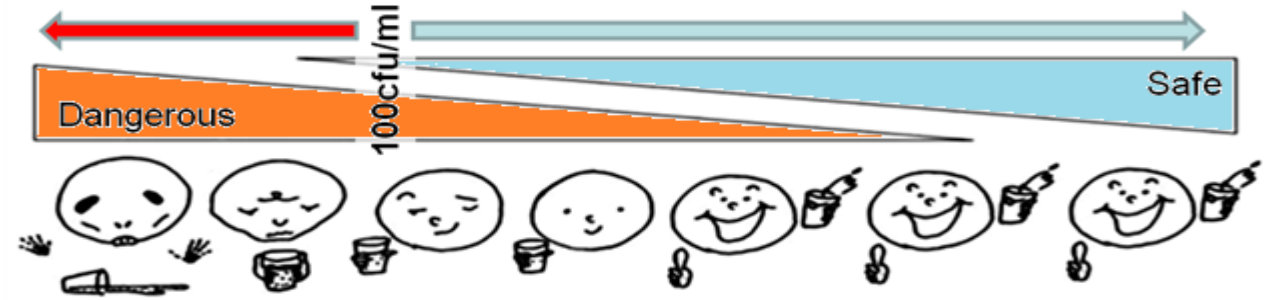
Escherichia coli : indication of intestinal bacteria.

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

Pathogenic bacteria



Reduce the risk



We must think about acceptable risk.

Which level of water quality, we need?

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


















Is this, safe or not?

We have to think about acceptable risk and treatment.

Which level of treatment, we need?

http://www.suncoli.com/02_1-2.html

http://sibata.co.jp/english/product01.html
E-mail:overseas@sibata.co.jp

Test Paper for General Bacteria/Coliform Group

Suncoli bacteria test paper
Viable number of coliform group bacteria test paper and general bacteria paper in water are easily counted by this pater.

general bacteria paper

サンコリー般細菌数用簡易検出紙

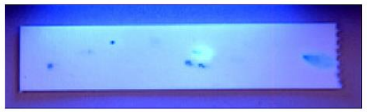
入数:1箱100枚入
細菌に対する反応色:赤
培養時間:35～37℃24時間

After one day incubation, pink colonies develop. These colonies are general (total) bacteria

サンコリ改変大腸菌群簡易検出紙

入数:1箱100枚入
細菌に対する反応色:大腸菌群:青
大腸菌:紫外線照射でライトブルー蛍光
培養時間:35～37℃24時間

coliform group bacteria and coliform bacteria by UV irradiation

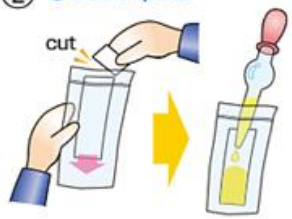


After one day incubation, blue colonies develop. These colonies are Coliform group bacteria. And under UV radiation, luminescence colonies are Coliform bacteria.

① 

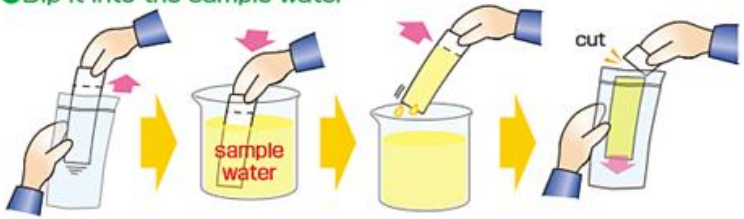
Open the polyethylene pouch, pinch the top of test paper ant take it out.

② ●Use Pipets



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

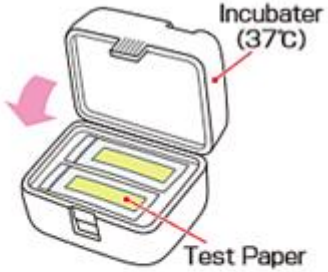
●Dip it into the sample water



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

③ 

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

④ 

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

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

You can incubate at room temperature. Development speed (bacteria growth rater) relates with temperature.

⑤ 

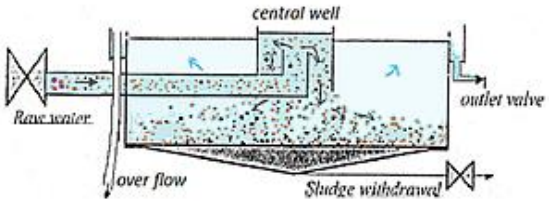
Count the number of spots(colonies).

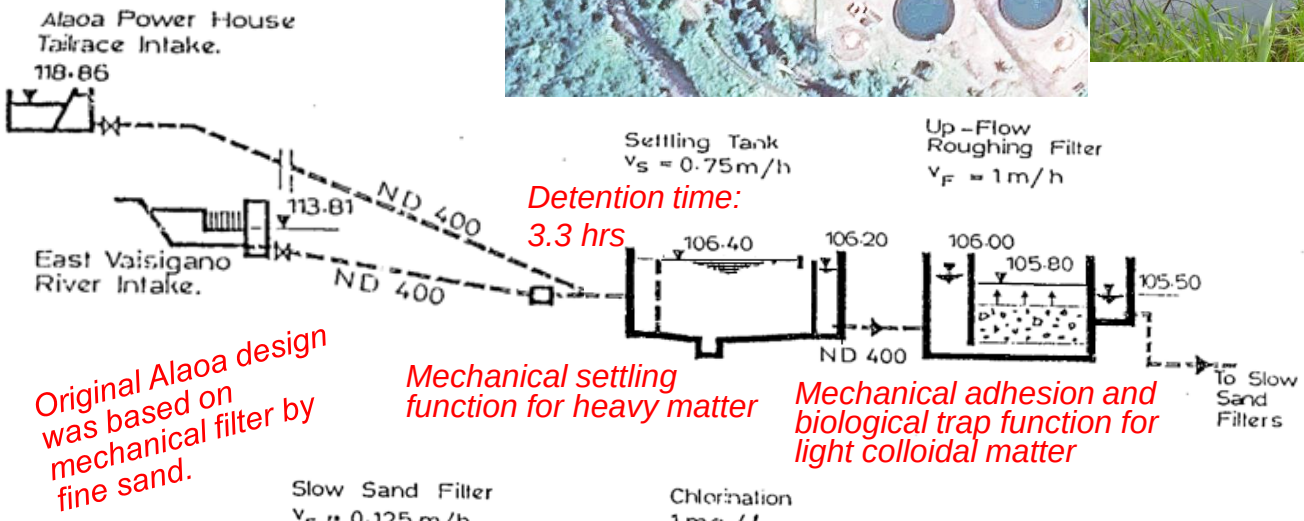
We can use this cheap UV light (Magic light pen). 100yen+tax

There is ideal water treatment plant in Samoa.

Alaoa WTP was built during 1984-'88 in Samoa.

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





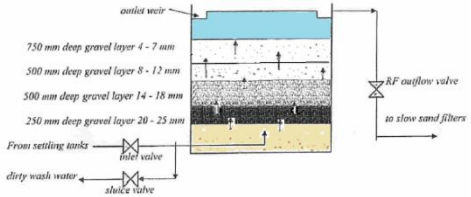
Detention time: 3.3 hrs

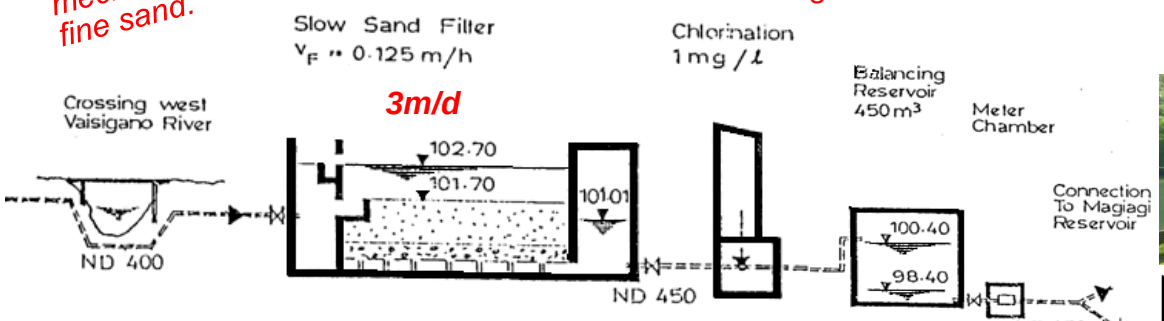
Diameter 11.2 m
Area 98.5 m2
4 URFs
Flow rate: 1m/h

Original Alaoa design was based on mechanical filter by fine sand.

Mechanical settling function for heavy matter

Mechanical adhesion and biological trap function for light colloidal matter





Diameter 28 m
Area 616 m2 5 Filters
Design rate: 3m/d

Ecological function: Shallow depth and temperature are the key for biological activity.

English filter rate: 5m/d (0.2m/h) Present Thames rate: **10m/d(0.4m/h)**
Our experiment in 2013: 5m/d, 10m/d and 20m/d =all good performance.

Water demand 100 liters /person/day in Fiji
Japanese demand 300 liters /person/day

Capacity of treatment

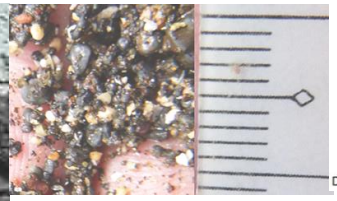
616 m2 x 3m/d = 1,848 m3/d	x 5 filters =	9,240 m3/d
In case 5m/d = 3,080 m3/d	x 5 filters =	15,400 m3/d
In case 10m/d = 6,160 m3/d	x 5 filters =	30,800 m3/d

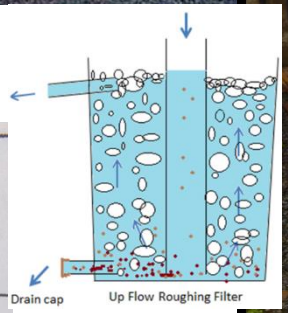
100 liters /person/day	300 liters /person/day
92,400 persons/day	30,800 persons/day
154,000 persons/day	51,333 persons/day
308,000 persons/day	102,666 persons/day

Biological activity is related with radiation and temperature.

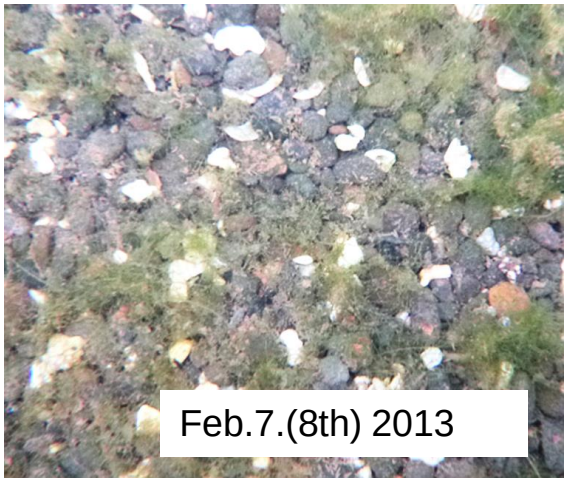
High flow rate experiment for the performance of slow sand filter was done in Samoa (tropical region) from Dec. 2012 to Feb. 2013.

Sand washed with mosquito mesh (1-2 mm)

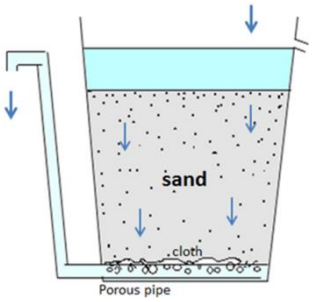




Different flow rate of sand filters (5m/d, 10m/d, 20m/d)
All good quality of filtrates.



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



Shallow depth: Algae grow well

Water source

After JICA training, he confirmed the EPS performance in Fiji.

Fiji EPS plan started for rural people from 2013.

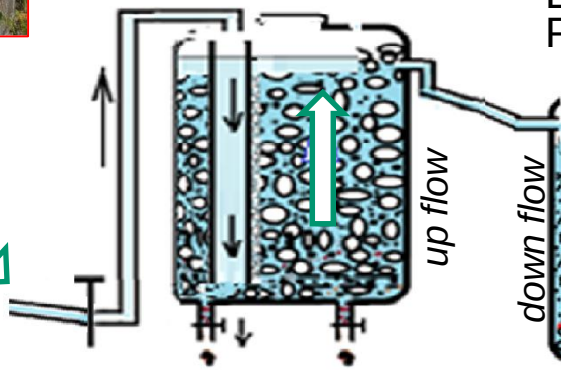
2013.1.

Receiving tank

Settle heavy muddy matter

URF : Up-flow Roughing Filter

EPS : Ecological Purification System



Adhere suspended matters on the gravel surface. And small animals trap suspended matter. Accumulated mud is drained off when filter is clogged.

Purified by natural community at the top of sand layer under natural down flow.

Store the germ free safe drinking water

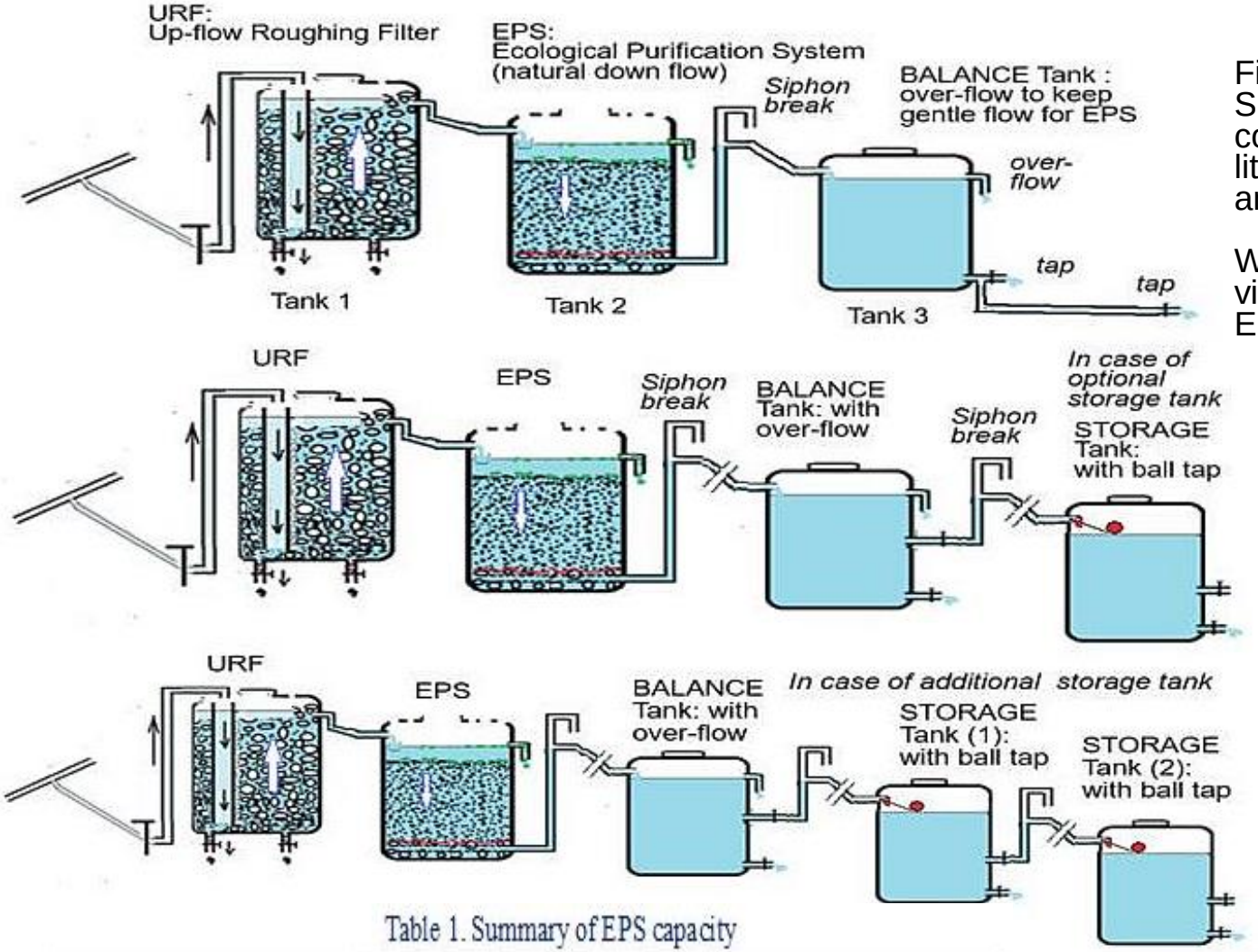
BALANCE (Storage)

Tap in a village

6 liters /person/d for drink and cooking.

Existing system in a village

EPS project for safe drinking water in a village



Fiji Safe Drinking Water Supply Project for rural community is to provide 6 liters/person/day for drink and cooking.

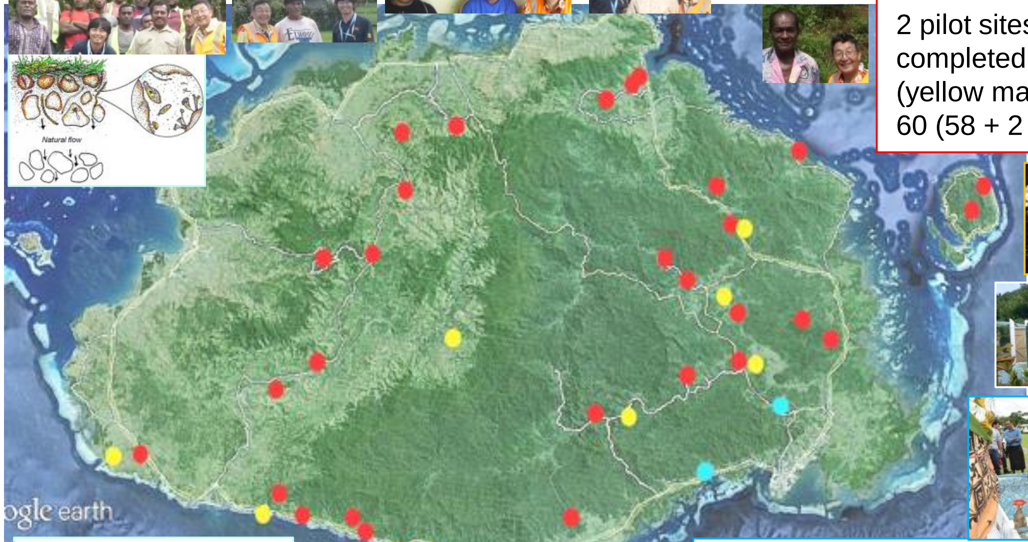
Water Committee in a village takes care of the EPS plants.

Table 1. Summary of EPS capacity

EPS Capacity of Tank (2,700 liter tank)									
Radius of tank (r):0.7m = Filter area (pxrxr), 1.54 m2									
Flow rate			Filtrate rate			Suppy capacity for person			remarks
m/d	cm/h	m3/d	liter/d	liter/h	liter/m	2 liter/d	6 liter/d	100 liter/d	
2	8	3.1	3,080	128	2.1	1,540	513	31	Original filter rate in UK, in 1829
5	20	7.4	7,392	308	5.1	3,696	1,232	74	Traditional English standard
10	42	15.4	15,400	642	10.7	7,700	2,567	154	Present Thames rate
15	63	23.1	23,100	963	16.0	11,550	3,850	231	Acceptable rate in warm region
20	83	30.8	30,800	1,283	21.4	15,400	5,133	308	Acceptable rate in warm region

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

2 pilot sites (blue): Kalokolevu and Navatuvule of 2013 project. EPS project completed 2015 fiscal year : 46 villages (red mark). Another 12 villages (yellow mark) were completed until May 2016. Total village sites are completed 60 (58 + 2 pilot sites) until June 2016.



EPS Engineer Meeting 2015

EPS project started from Kolokolevu and Navatuvula in 2013

Food Chain is the Key

Jica staff
K. OHARA

Jica Volunteer
Hide EGUCHI

Jica Expert
N. NAKAMOTO

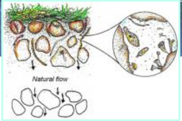
Cleaner Water Project by EPS (Ecological Purification System: Wise Use of Natural Phenomena) for Rural People in Fiji

2 pilot sites :Kalokolevu and Navatuvule of 2013 project. EPS project completed 2015 fiscal year : 46 villages . Another 12 villages were completed until May 2016. Total village sites were completed 60 (58 + 2 pilot sites) until June 2016. 98 villages were completed until Jan. 2018.

EPS project started from Kalokolevu and Navatuvula in 2013

EPS Engineer Meeting 2015

JICA president visited Kalokolevu on April 7. 2018



Food Chain is the Key

Jica staff K. OHARA

Jica Volunteer Hide EGUCHI 2015-16

Jica staff A. KANI

Jica Volunteer Iamu SHIOIRI 2017-18

Jica Expert N. NAKAMOTO

98 EPS plants were completed until Jan. 2018. Project was supported by Fijian government and JICA assisted only advice.

http://www.cwsc.or.jp/index-e.html

Community Water Supply Support Center of Japan
地域水道支援センター

"Community Water Supply Support Center of Japan (CWSC)" supports a reasonable, safe and high quality of water as a public supply system for communities.

- Organization
- Outline
- Declaration
- Greeting words
- Documents

http://www.cwsc.or.jp/index-e.html

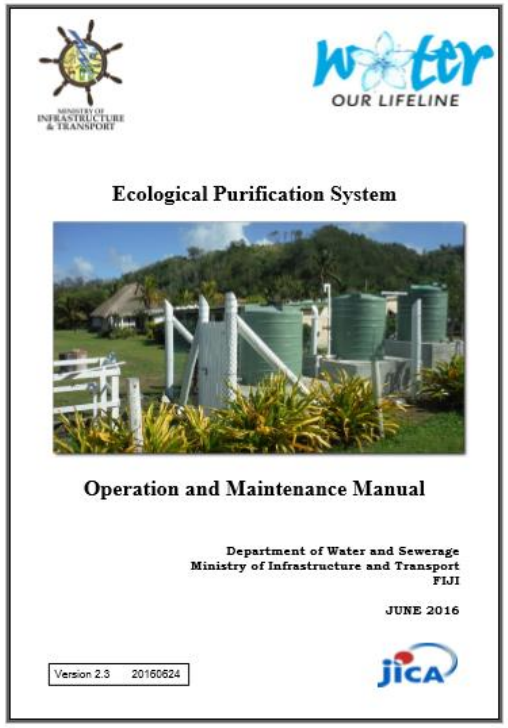
■ Reference Documents

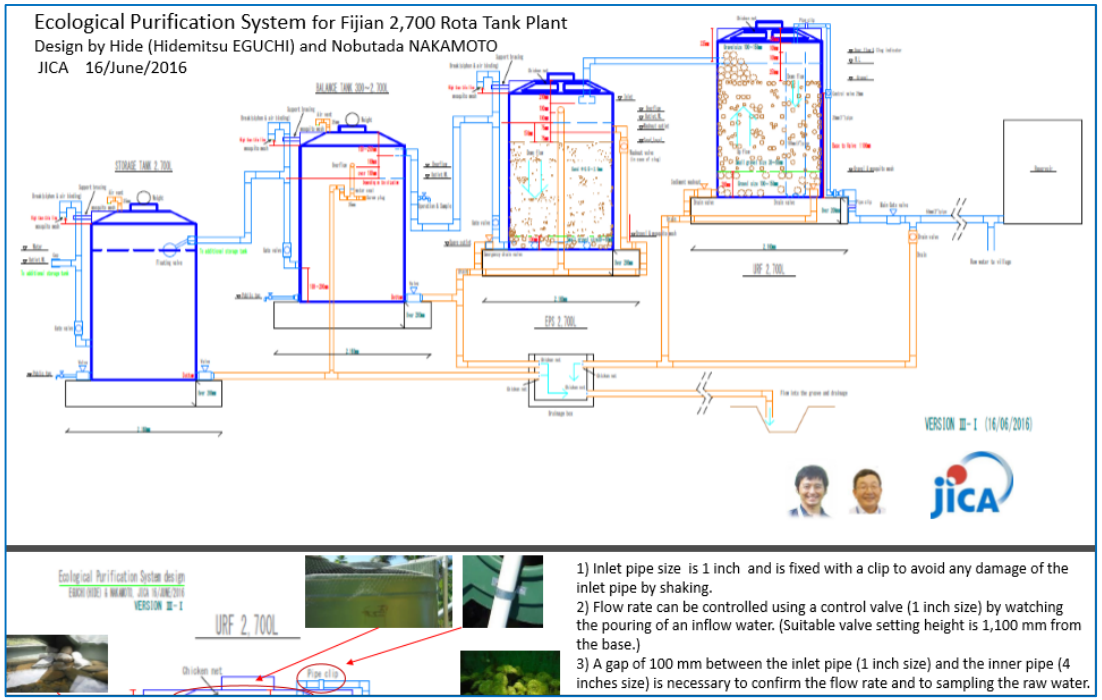
Please hit Documents

No.	Materials	Content	Language
01	Speech Material June, 2008	Speech Material by Nakamoto(JICA:Nagano)(1)(2)	English
02	Speech Material 2007.11	Speech Material by Nakamoto(JICA:Miyako-island in Okinawa)(1)(2)(3)(4)(5)(6)	English
03	Speech Material 2008.2		English
04	Speech Material March, 2009	Speech Material by Nakamoto(JICA:Brasil)(1),(2)	English
05	Tasty Water -Brasil-	Tasty Water by Nakamoto in Portuguese -Brasil-	Portuguese
06	Manual of Ecological Purification System	Manual, Drawings	English

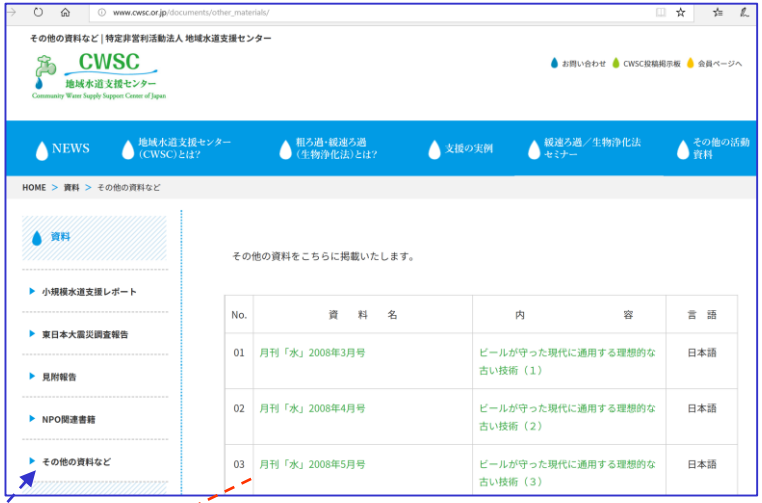
Please hit Manual or Drawings

You can download the files.

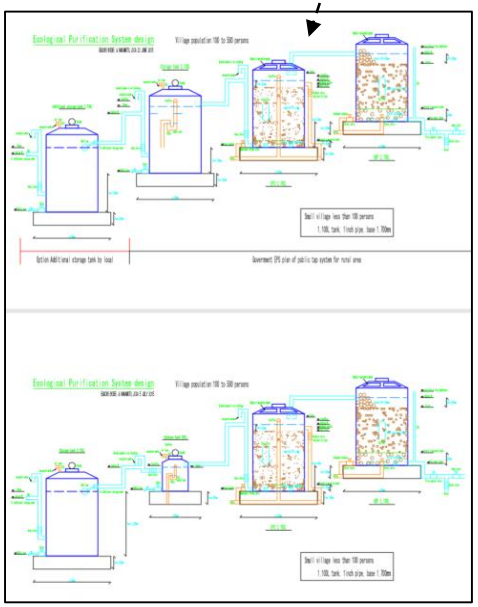




1) Inlet pipe size is 1 inch and is fixed with a clip to avoid any damage of the inlet pipe by shaking.
2) Flow rate can be controlled using a control valve (1 inch size) by watching the pouring of an inflow water. (Suitable valve setting height is 1,100 mm from the base.)
3) A gap of 100 mm between the inlet pipe (1 inch size) and the inner pipe (4 inches size) is necessary to confirm the flow rate and to sampling the raw water.



15	2015年度JICA沖縄研修資料	2015年沖縄で開催されたJICA研修の資料	日本語・英語併記
16	小規模生物浄化プラント　システムフロー図	2種類の生物浄化システムフロー図	英語
17	フィジー小規模生物浄化プラント　マニュアル（日本語）及び図面	マニュアル、図面	日本語
18	フィジー小規模生物浄化プラント　マニュアル（英語）及び図面	マニュアル、図面	英語



15	2015年度JICA沖縄研修資料	2015年沖縄で開催されたJICA研修の資料	日本語・英語併記
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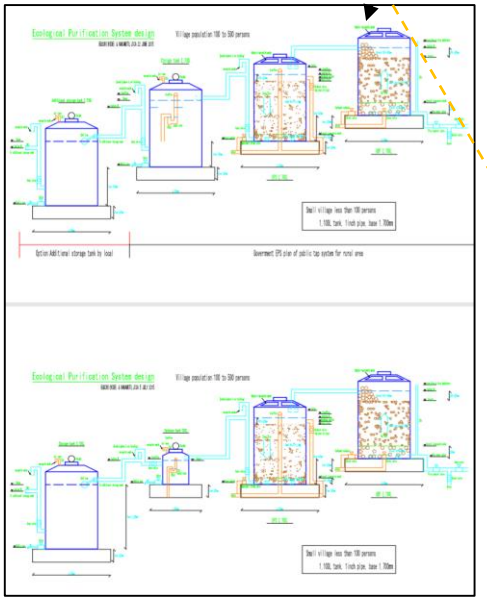
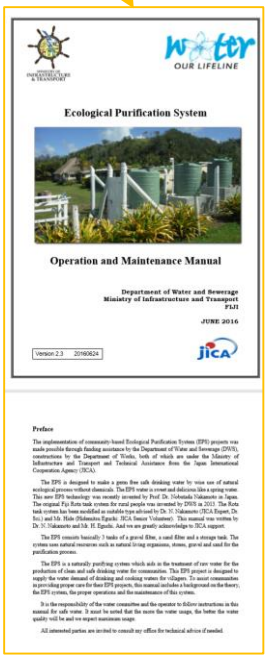
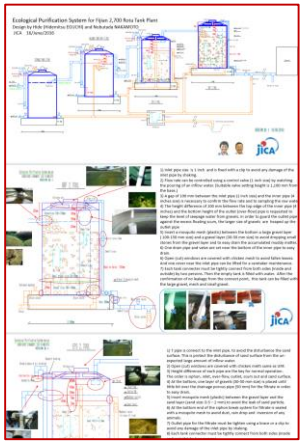
18	フィジー小規模生物浄化プラント　マニュアル（英語）及び図面	マニュアル、図面	英語



2 pages



14 pages

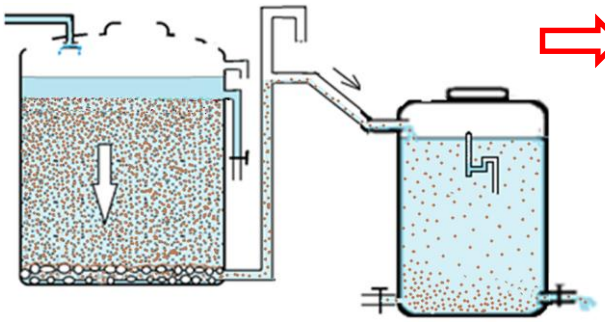


18 pages

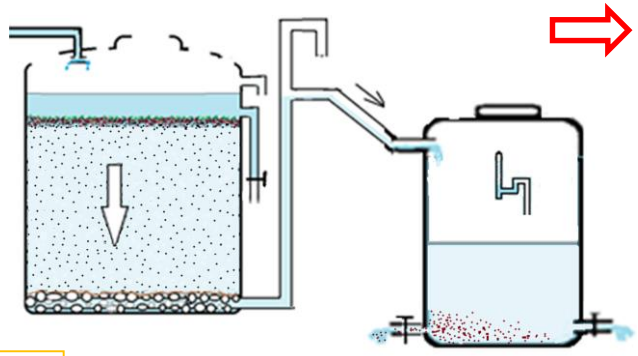
14 pages

18 pages

Ecological Purification System is wise use of biological activity.
EPS development: it takes time for mature to get sufficient filtrate.

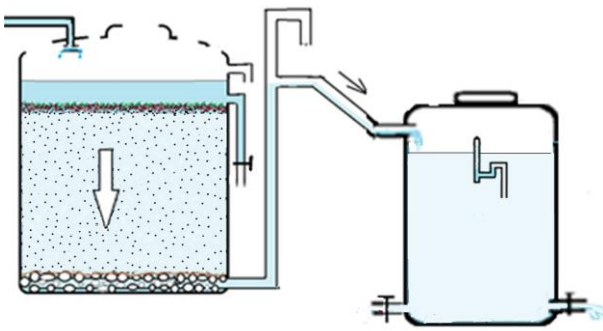


Dirty particles on new sand are drained and are scraped out by small organisms under gentle down flow.



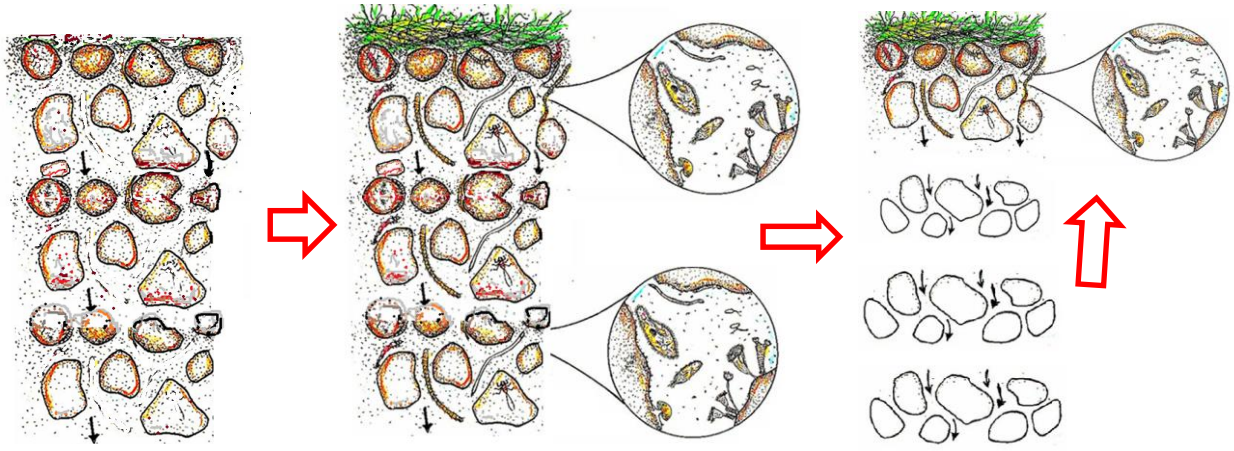
Initial filtrate is dirty. It takes days to get clean filtrate.

It takes days to get clean filtrate. This dirty filtrate must drain off.



Then we can get clean, safe and delicious filtrate.

Mechanism and principal of ecological purification.

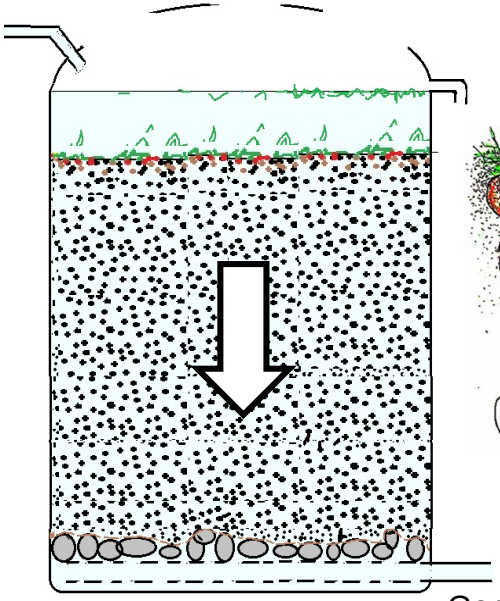


It takes days to scrape surface dirty on the surface of sand by small organisms. It takes time to growth and to develop for small organisms in the sand layer under gentle down ward current condition.

Matured ecosystem.

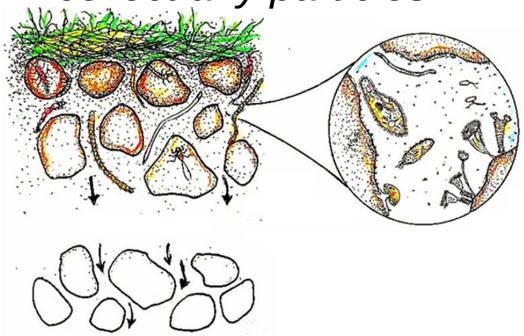
Hungry small organisms are always waiting for food near the surface in case of matured ecosystem.

All the food on the surface of sand are grazed up in deep layer. Then there is no food in deep layer. Small organisms become hungry and move to near the surface where food comes.



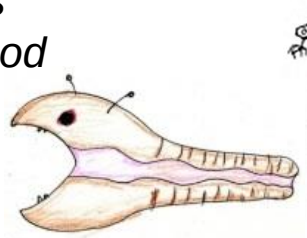
Germ free safe water to drink

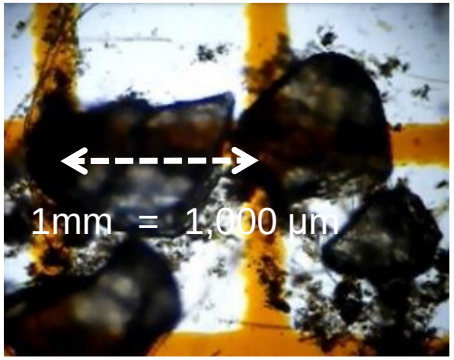
Food comes from the top. Small organisms collect any particles.



Trap and collection time of particle by small organisms is very short. Passing time of food in a body is also very short.

Food Chain is the Key.

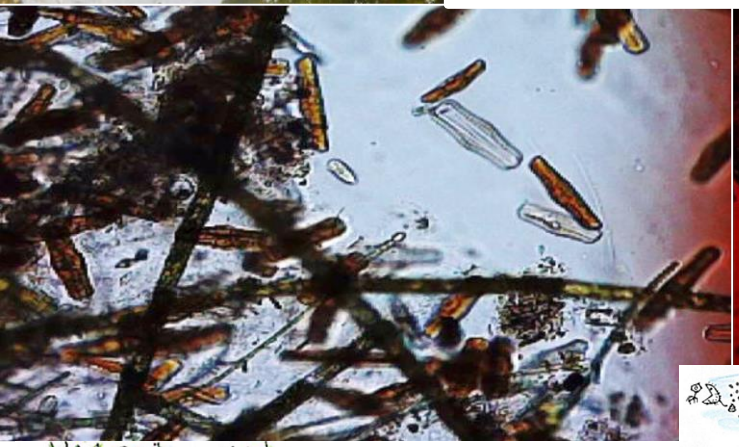


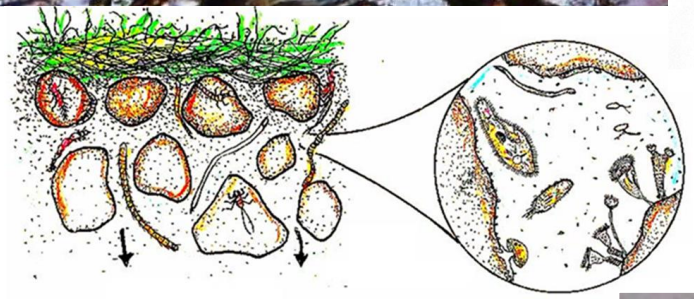


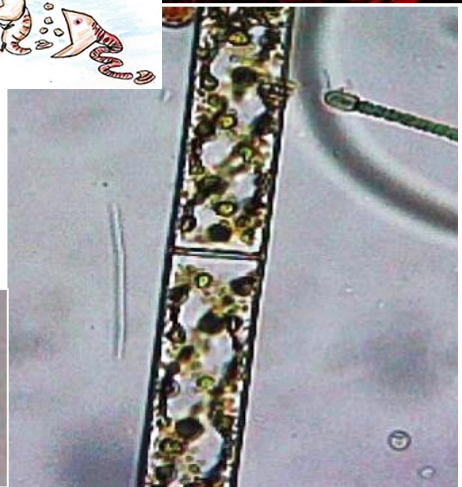
Food chain by small animals is the key for purification system.

Healthy and hungry condition of animals are important to collect any particles under gentle condition.

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

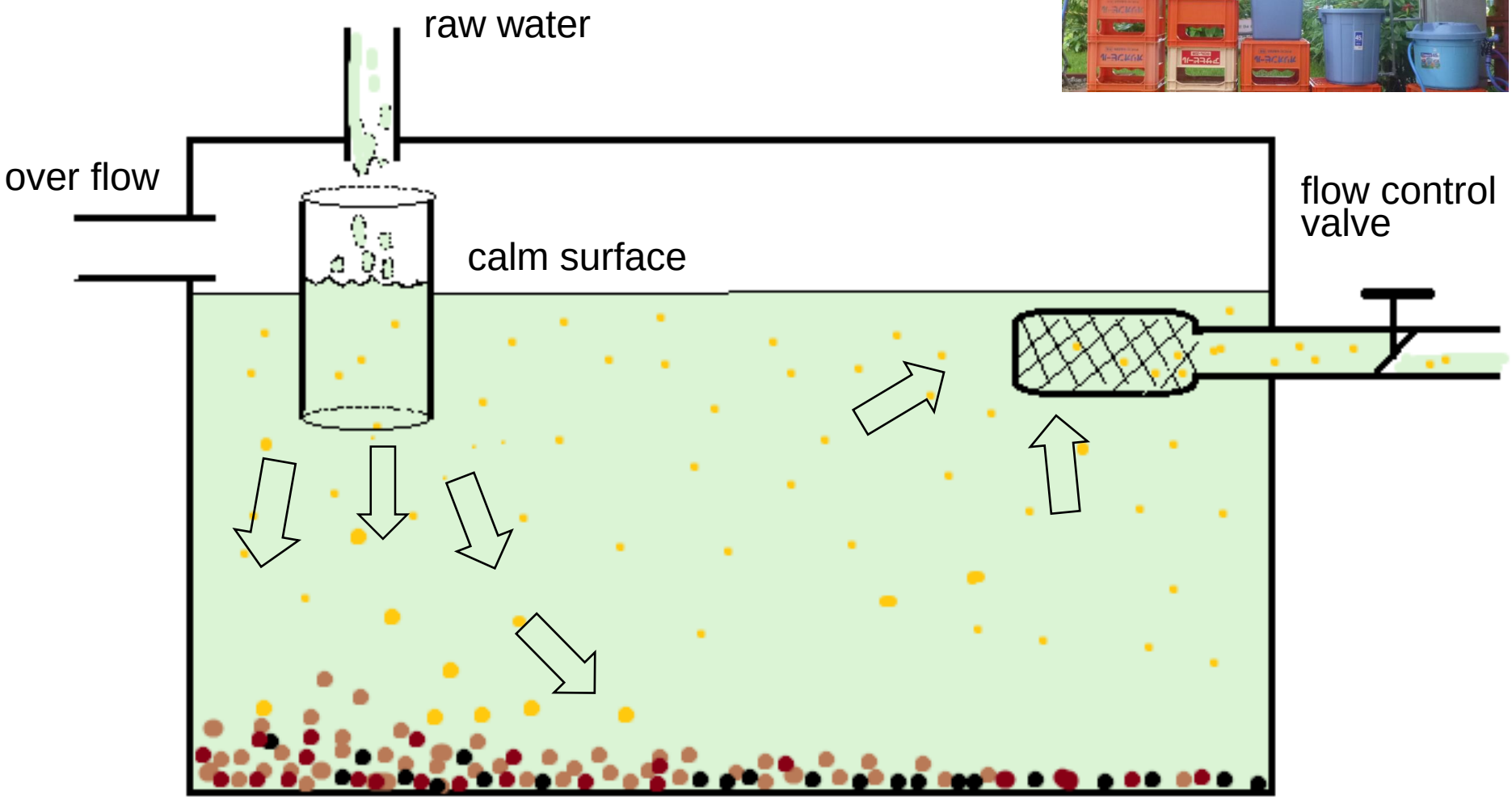






JICA training in Okinawa, in Aug. 2016

Receiving tank (Settling tank)



Heavy particulate matters are easily settled. *However, colloidal fine particles are not settled in this settling tank.*

Up-Flow Roughing Filter (URF : gravel filter)

Additional URF if necessary

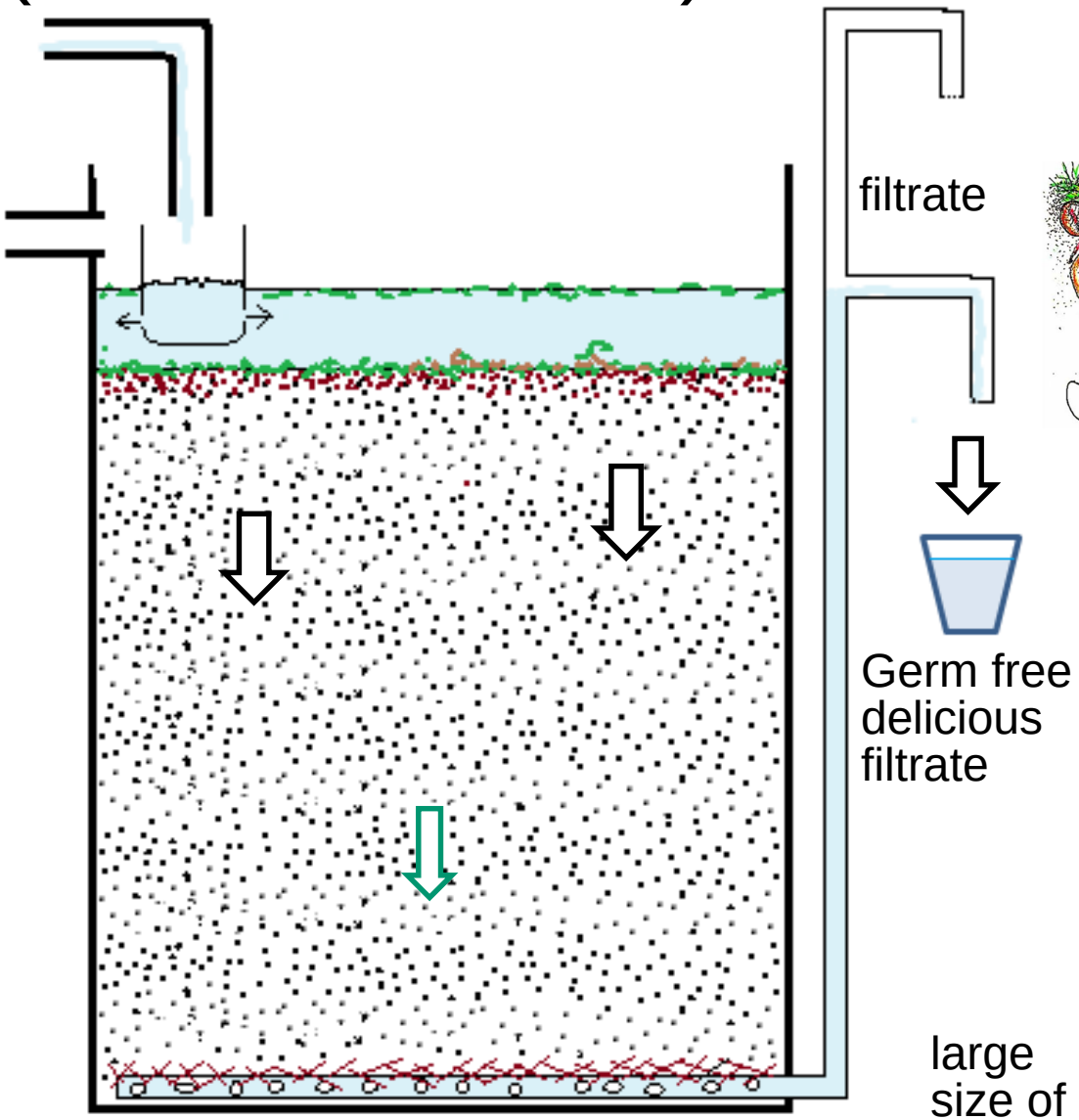
Colloidal fine particles adhesive to the surface of gravels. Small animals scrap them and produce fecal pellets. Fecal pellets accumulated to the bottom.

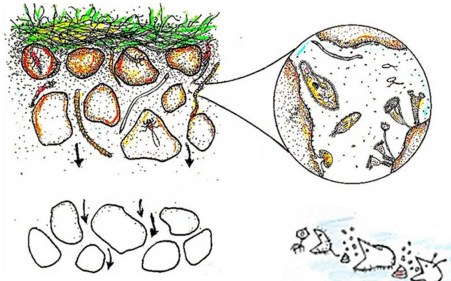
drain cock for accumulate mud

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

EPS (sand) tank (natural down flow)

Ecological Purification System



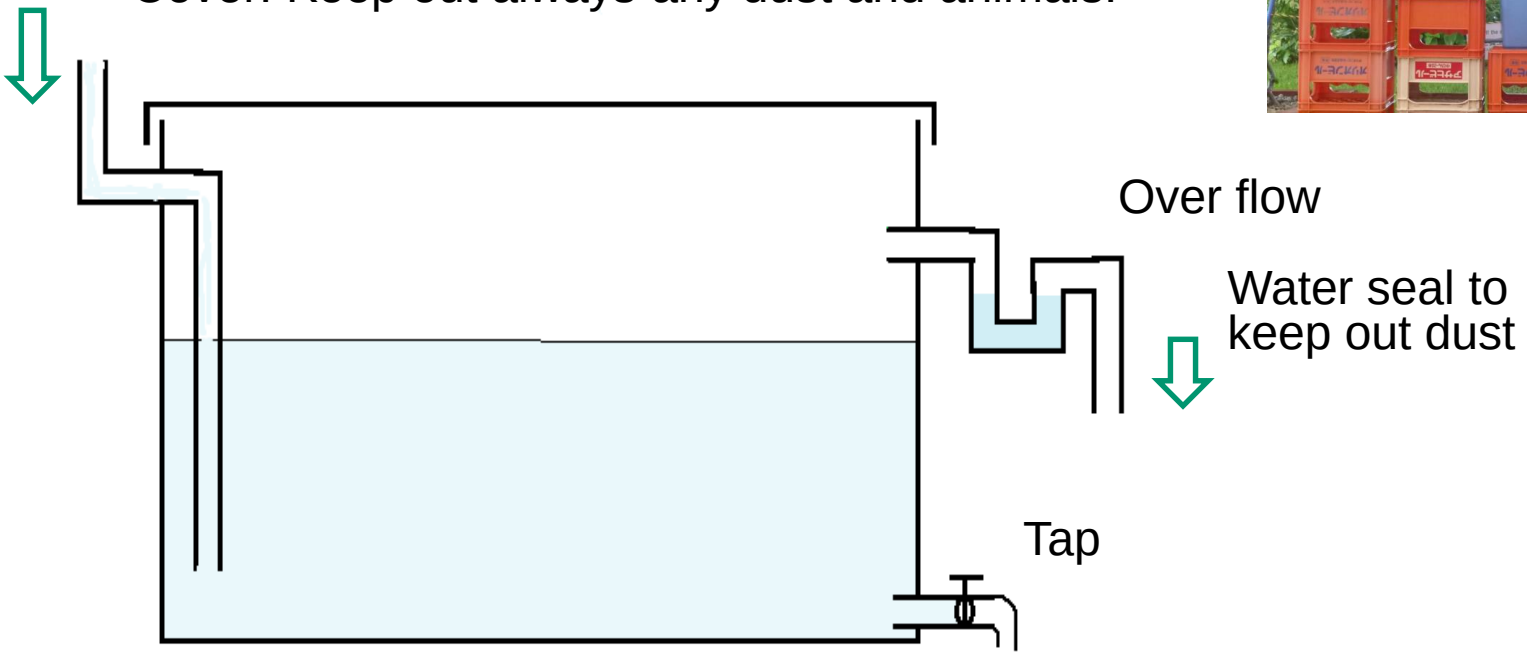


Food comes from the top.

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

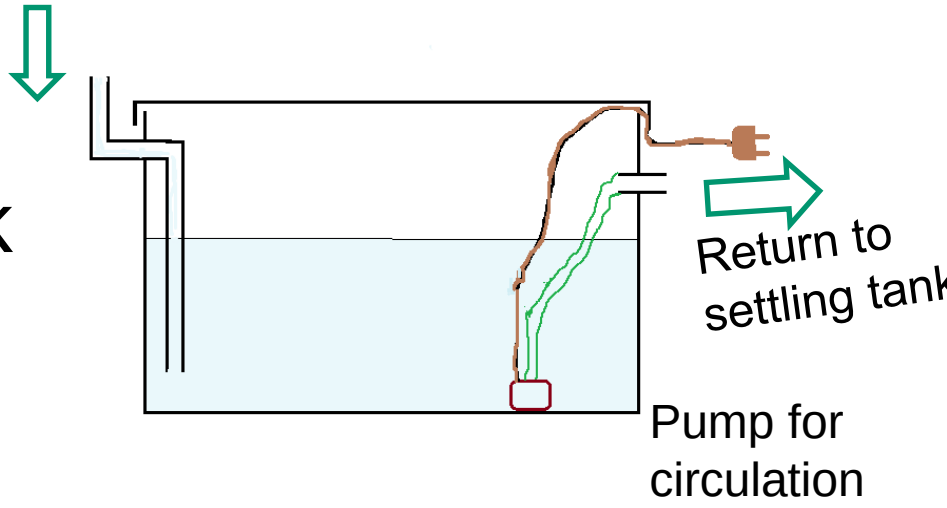
Storage Tank

Cover: Keep out always any dust and animals.



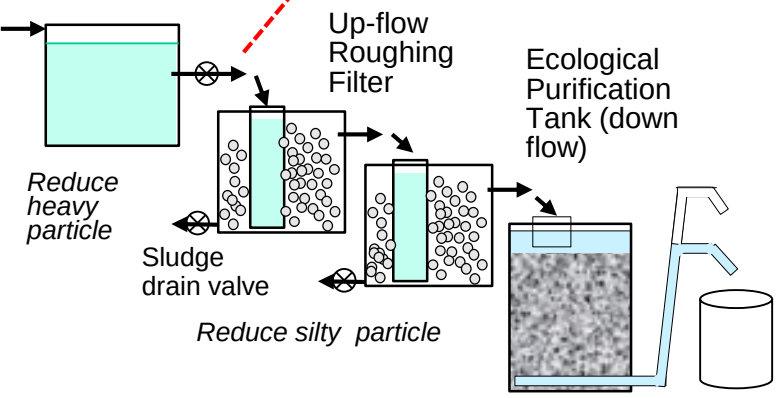
Storage Tank

（Circulation Model）



Calculation of the performance of a EPS model

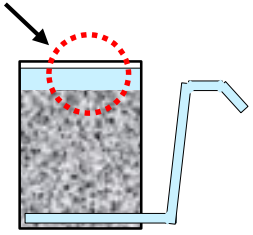
Filter rate can be measured using a cup and is regulated by a cock.



Filter area（π x r x r) = 3.14 x 22.9 cm x 22.9 cm =1,640 cm2

In case of Present Thames filter rate
= (40cm/h = 9.6m/d = 0.67 cm/min)

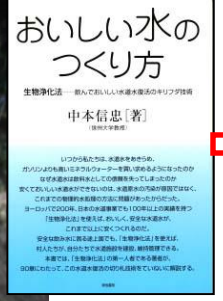
Filtrate/min = 1,640 cm2 x 40 cm/h/ 60 (min) =1,093 cm3(ml)/min
Filtrate/h = 1,640 cm2 x 40 cm/h = 65,600 cm3/h =65.6 liter/h
Filtrate/d = 65.6 liter x 24 hrs = 1.57 m3/d



	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

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.

Almost all impurities are eliminated and are decomposed by Ecological Purification process in this biological active layer.

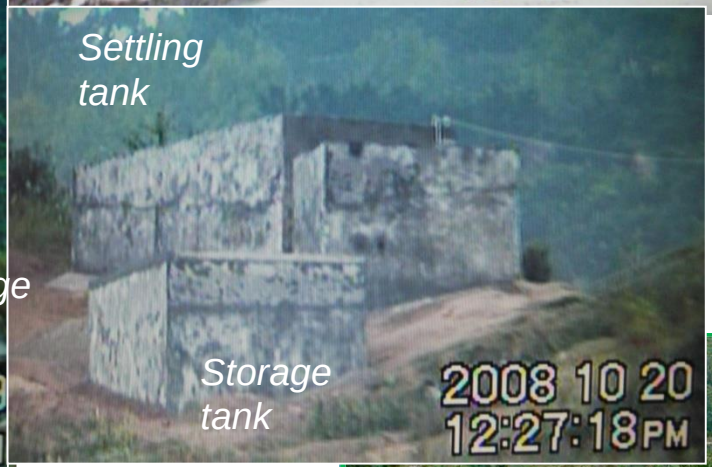


Aug. 2005.

May, 2009.

Japanese EPS Text

Mr. Jin sheng zhe, translator of Chinese version, made 3 EPS plants in China after the great Sichuan earthquake (May 12. 2008).

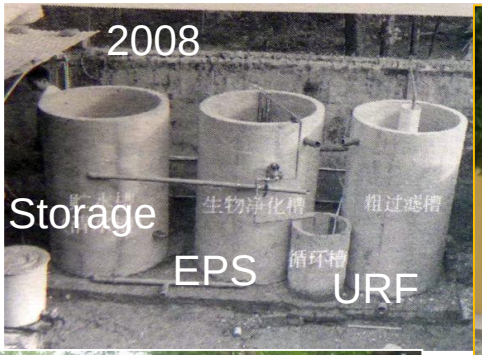


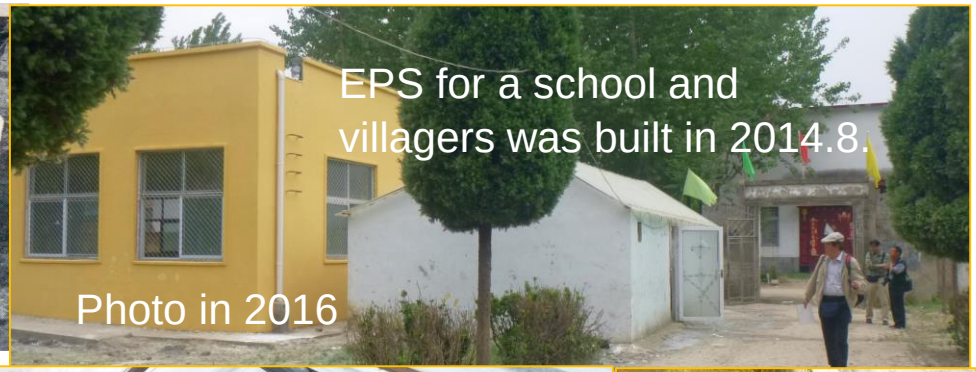
This is 30 m3 per day.

Settling tank → up-flow roughing filter → EPS → Storage tank

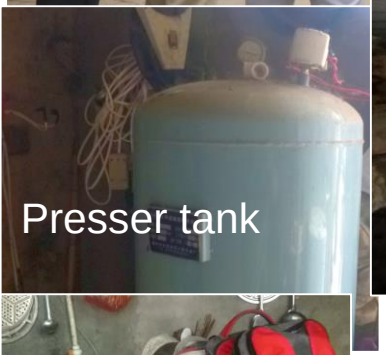
This is 3.7 m3 per day.

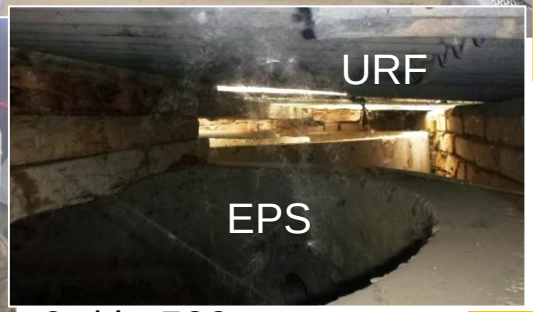
China: Mr Huo Daishan and his sons built EPS to made safe drinking water. (helped by Mr Jin sheng zhe)





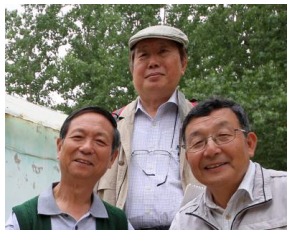
70-80 t/d, 4,600 villagers
(246 students) 16 liter/person/d
Filter(2 m x 4 m) x 2 set of filters
(URF+EPS)



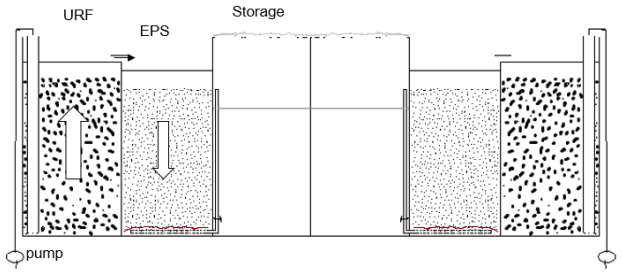


6 t/d, 500 persons.
12 liter/person/d

Supply to owner's kitchen.



Public tap system for villagers



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

1910: Kenzaki WTP, Japan.

Introduced

1829: J. Simpson, London, UK

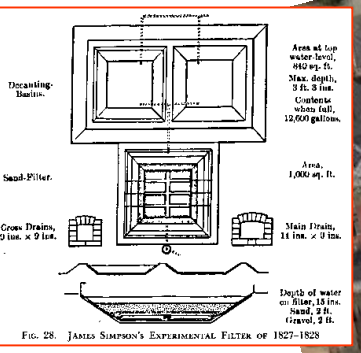
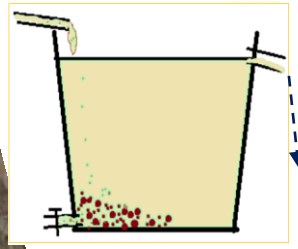


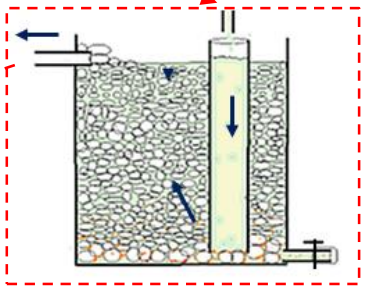
Fig. 28. James Simpson's Experimental Filter of 1827–1828

Raw water intake of surface water of a river

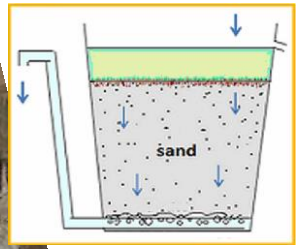
Heavy particulate matter is settled. Light colloid matter is not easily settled.

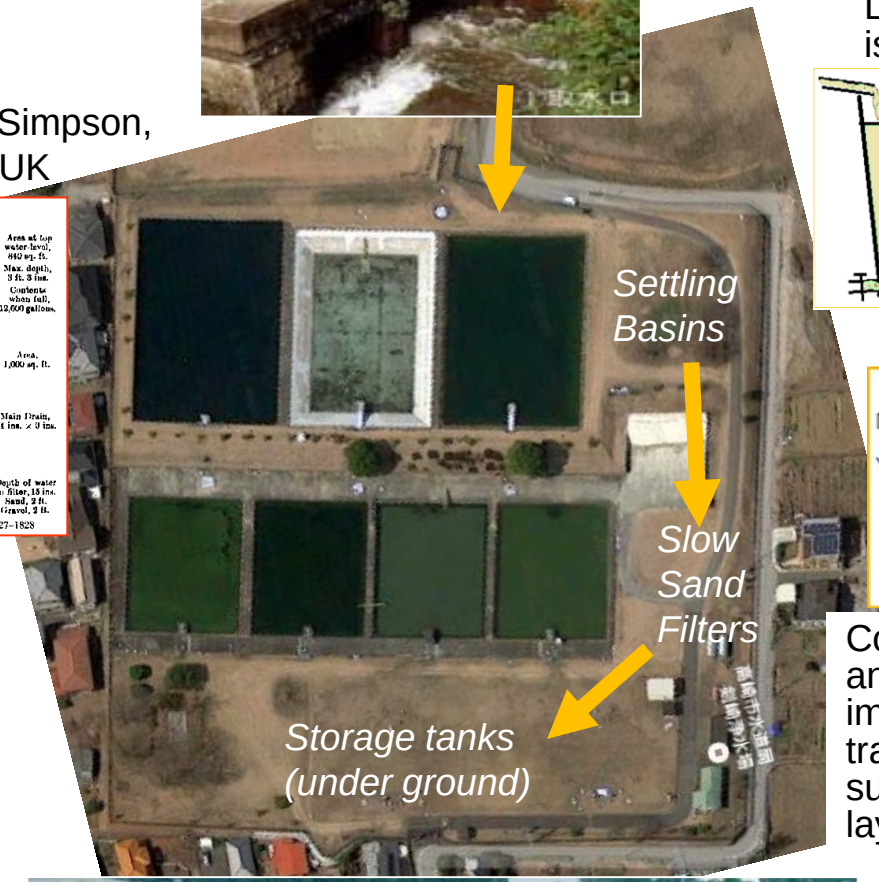


Ideal new modification: Insert Up-flow Roughing Filter and make shallow depth.

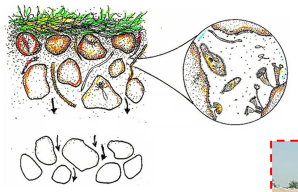


Up-flow Roughing Filter





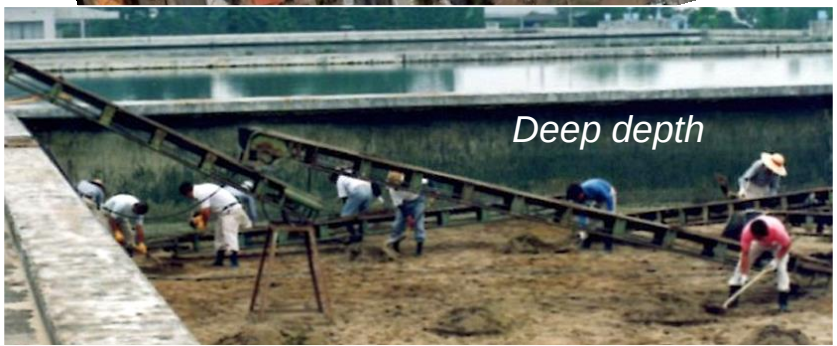
Colloid matter and other impurities are trapped on the surface of sand layer.



Promote biological activity

Shallow water depth

When the filter resistance increased with accumulated muddy matter, the surface of sand layer had been scraped off to recover the filter resistance.



Filter resistance does not increase.

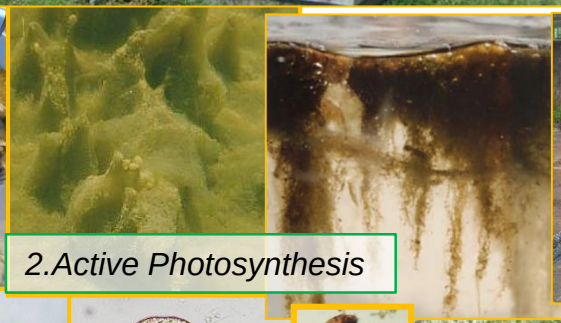
Removal of the surface (scrape) is not necessary.

This is Ecological Purification System.

Gentle for small organisms

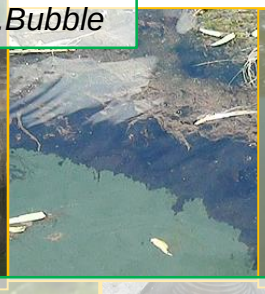
Change the Image of Slow Sand Filter to Ecological Purification System.

1.Shallow depth



2.Active Photosynthesis

3.Bubble

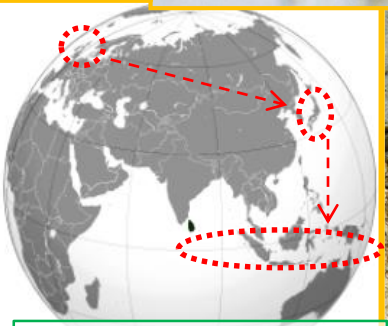


4.Lift up

5.Microbe to animal

6.Collect, graze and decompose

7.Food chain is the key for purification.



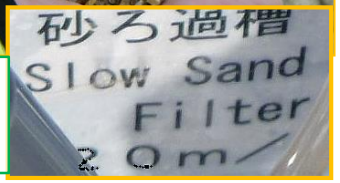
10.Activety relates with Temp and Radiation.

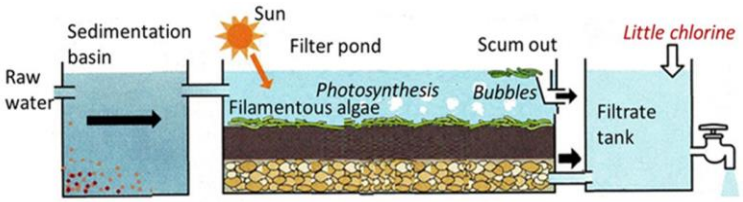
11.Pass time is 1 or 2 minutes.

8.Sand is habitat.

9.Large Sand

12.High flow rate keeps aerobic condition.



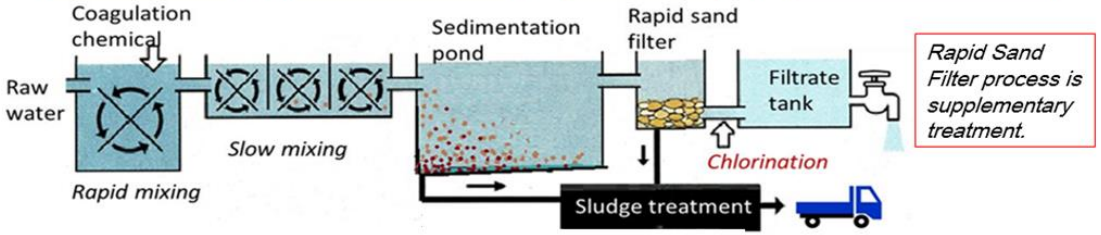


Slow Sand Filter(1829): Natural Purification System without chemical

Slow Sand Filter was misunderstood due to the image of mechanical filter in the world.

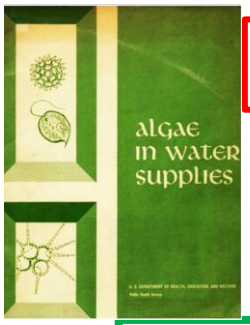
Rapid Sand Filter : Turbid Water⇒Coagulant(1885)+ Chlorine (1910) : **Water Industry**

Un-fair name = Rapid Sand Filter ⇨ *Main process is Chemical Treatment* ⇨ *Finally Rapid Sand Filter* ⇨ Chemically Coagulation Sedimentation Treatment



Nakamoto started to study on the role of algae in the slow sand filter pond, in Ueda, Japan from April, 1984.

Thames Wks research and American SSF Survey from 1994 by Nakamoto.



Algaecide (CuSO4) treatment was necessary for RSF. ⇨ Odor problem ⇨ Activated Carbon, Ozone

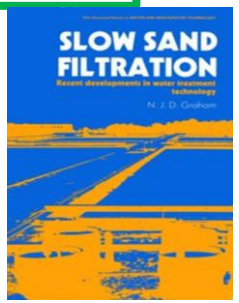
Recognized RSF as risky treatment

Tri-halo-methane: cancer risk 1974 ⇨ Crypt-outbreak, Milwaukie, USA 1993 ⇨ Advance treatment / Membrane

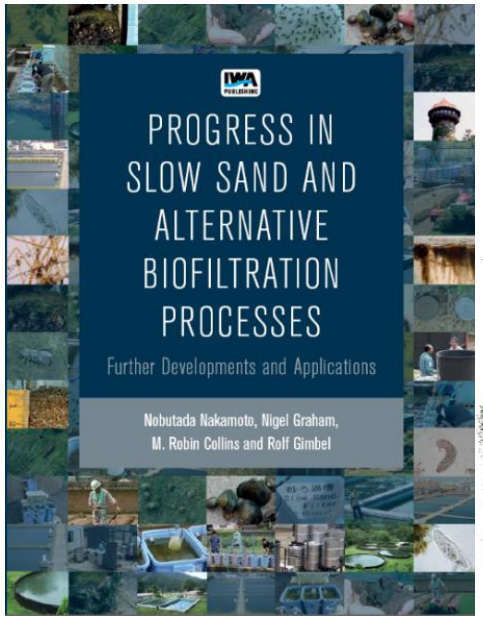
New tech.

Refocus to SSF as safe treatment

1974 WHO text
Slow Sand Filtration
Huisman and Wood

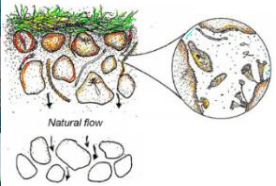


First International Conf. on SSF, 1988, London



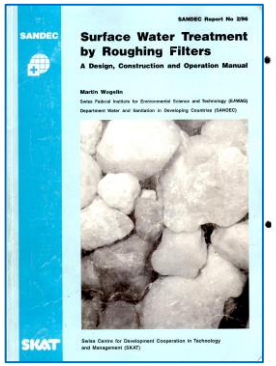
5th SSF Conf. June, 2014, in Nagoya, Japan

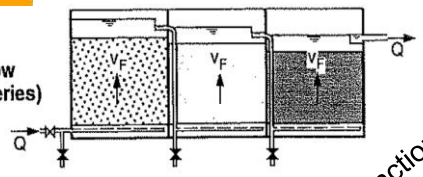
Ecological process was highlighted in this conference.

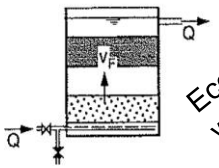


Up-flow Roughing Filter (URF) was focused for turbid water instead of coagulation chemicals.

Wegelin 1996. Surface Water Treatment by Roughing Filters







Ecological function was recognized by Nakamoto, in 2000s.

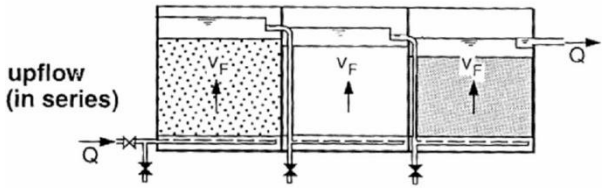
SANDEC 25.8.95

In Bangladesh, surface water is contaminated by germ bacteria.
バングラデッシュでは表面水は病原菌で汚染されているのが普通。

Underground water must be oxidized.
地下水は必ず酸化処理する。

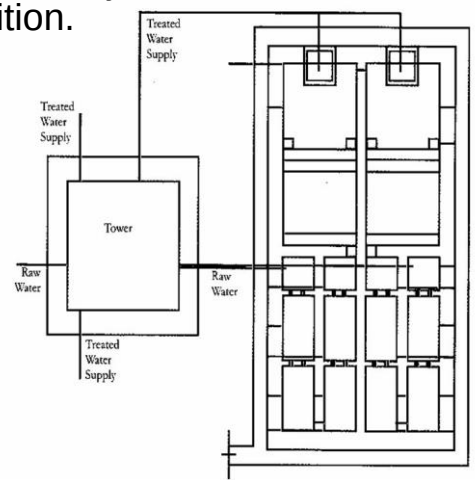
Underground water contaminated with arsenate.
地下水は砒素に汚染されていた。

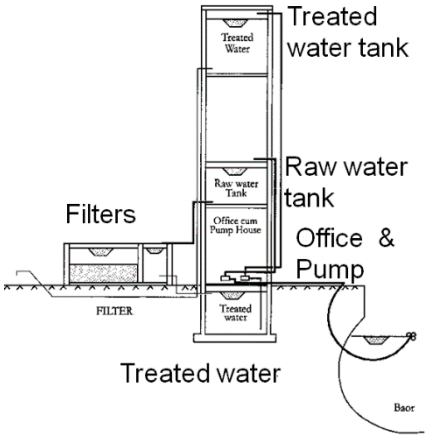
Mechanical SSF was used.
機械的緩速砂ろ過が行われていた。



I recommended use of EPS using up-flow roughing filter for contaminated shallow lagoon water. I tried to eliminate herbicide and insecticide.
汚染された三日月湖の水を処理するために、上向き粗ろ過を何度も通し、農薬除去も考えたEPSを勧めた。

Faster flow rate is necessary to keep aerobic condition.
速いろ過速度は好気的状態を保つ。





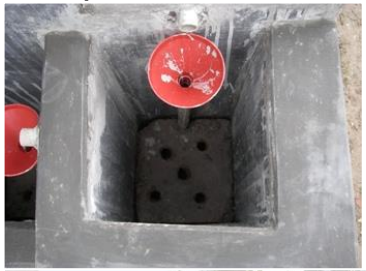






Small Ecological Purification system was set up at Jessore in Bangladesh, in December, 2006. One day capacity is 0.5 m3. In Bangladesh, one person demand for drink and cook is 10 liter per day. This capacity corresponds to 50 persons (10 families) using public tap system. Two times of pumping up is required in one day.

My student rebuilt concrete one. Plastic bottle was very expensive than brick price. This was cheaper than plastic one. Handy pump was used to fill up raw water.



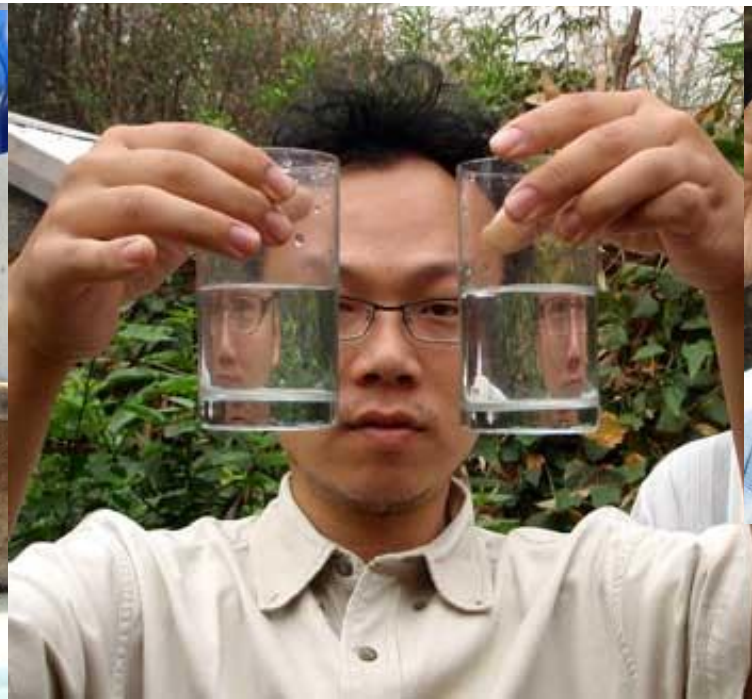

Storage tank capacity=1.2t/d,

Up-flow roughing filters (3 steps: 30X30cm2 gravel),

40x82cm2:sandfilter, 50cm depth.


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

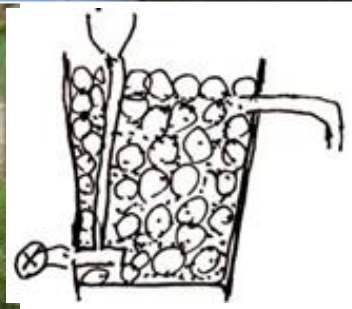
岩田さんはコルカタ郊外でEPSで飲用可の水を



OISCA in Tokyo (The Organization for Industrial Spiritual and Cultural Advancement International):

polluted water (Kanda river) → gravel filter → gravel filter → sand filter (down flow) → safe drinkable water

Sri Lank: pond water → 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.



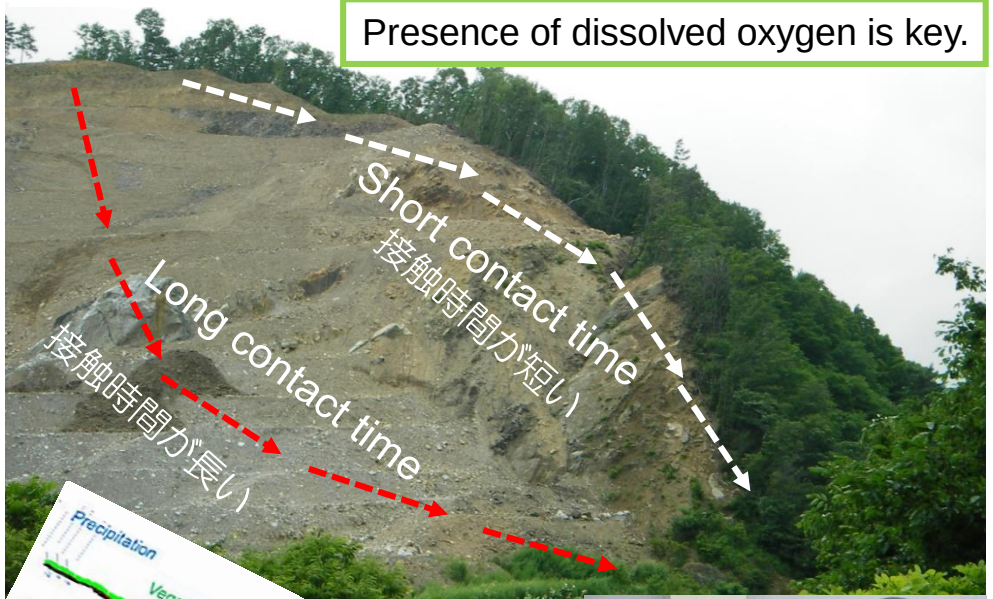
Wise use of natural phenomena.

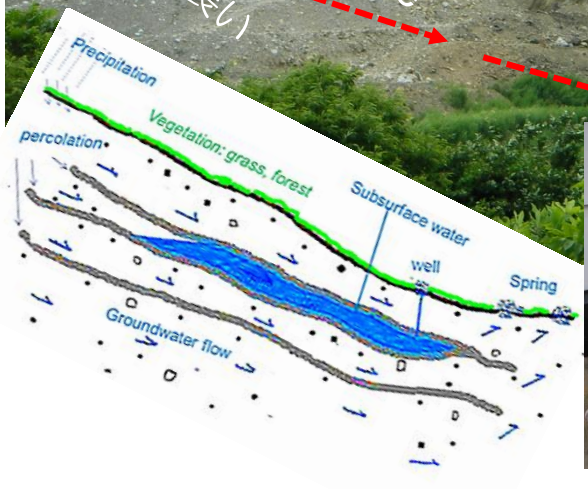
We can easily get safe drinking water by ourselves.

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

自然界のおいしい湧水には酸素が十分あり、普通は安全。

Presence of dissolved oxygen is key.

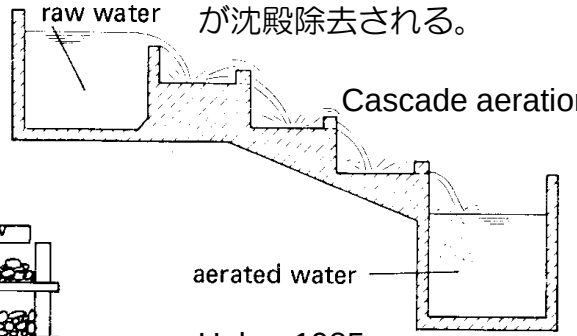




Addition of oxygen:

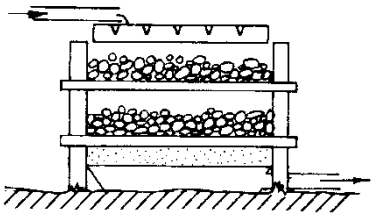
Aeration is frequently used for treatment of groundwater (reduction of unpleasant tastes and odors, discoloration, precipitation of iron and manganese).

酸素の負荷：地下水の処理には普通は曝気（エアレーション）が使われる。曝気で美味しくなり臭いや色、鉄やマンガンが沈殿除去される。



Heber 1985

Aeration filter



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

酸素不足の環境で溶存していた鉄やマンガンは酸化され不溶性の水酸化物沈殿になる。それは沈殿槽や粗ろ過で除去できる。

Non-chlorinated water

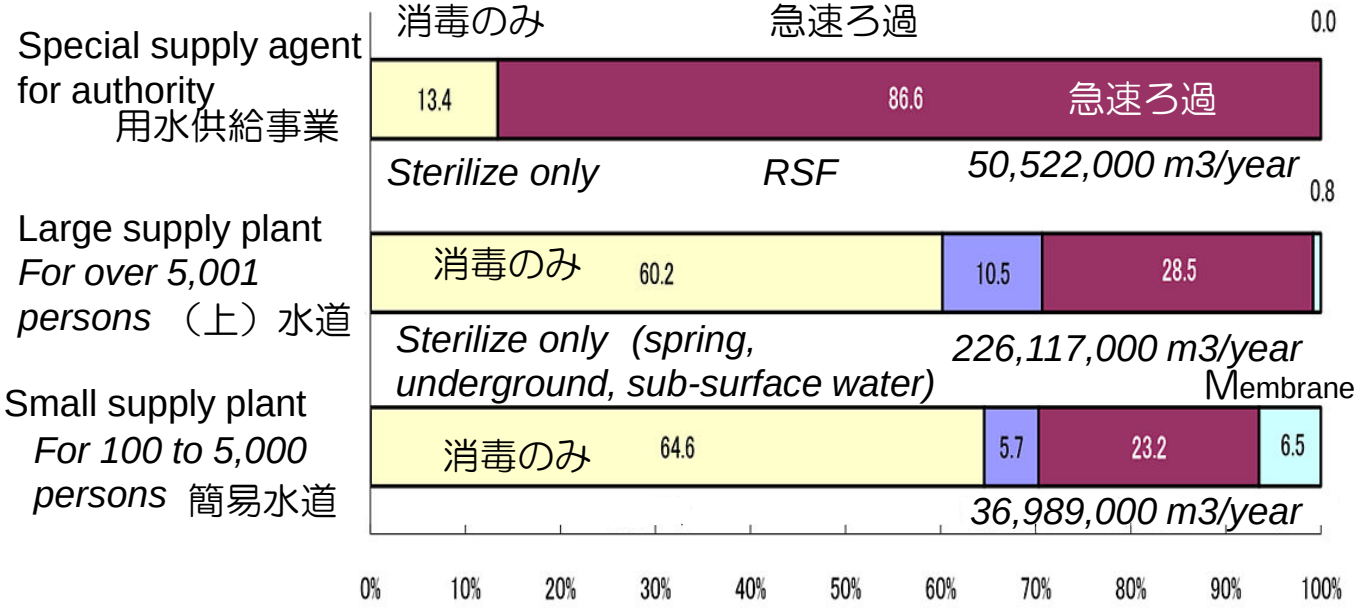
This water is purified by Natural Ecological Purified System.
この水は天然の生物浄化法の水

Sterilize only (spring, underground, sub-surface water)

Statics of water supply in Nagano (2012) *Nagano (mountain region)*

Ratio(%) of water supply by different system.

山地の長野県の水道統計（2012）



浄水処理方法別、浄水量の割合（%）