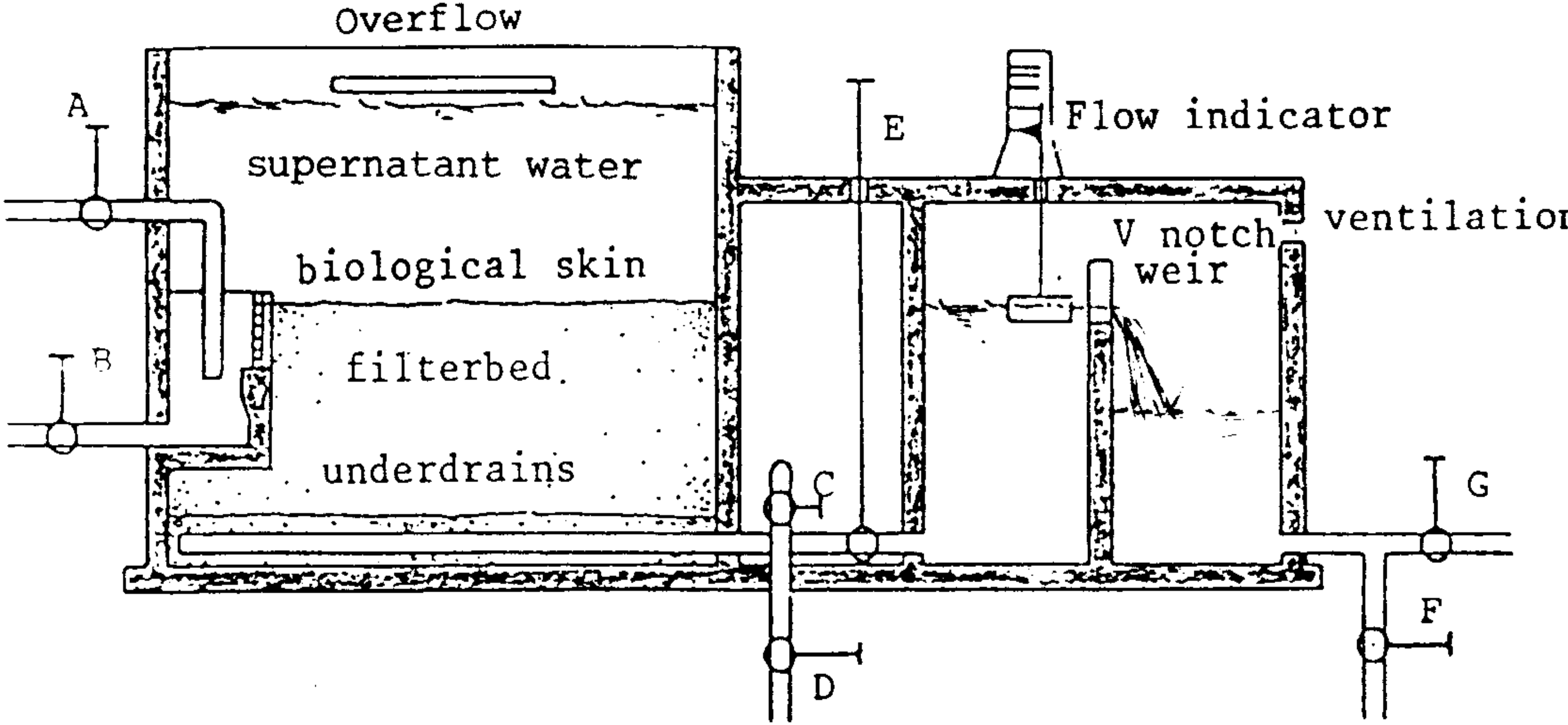
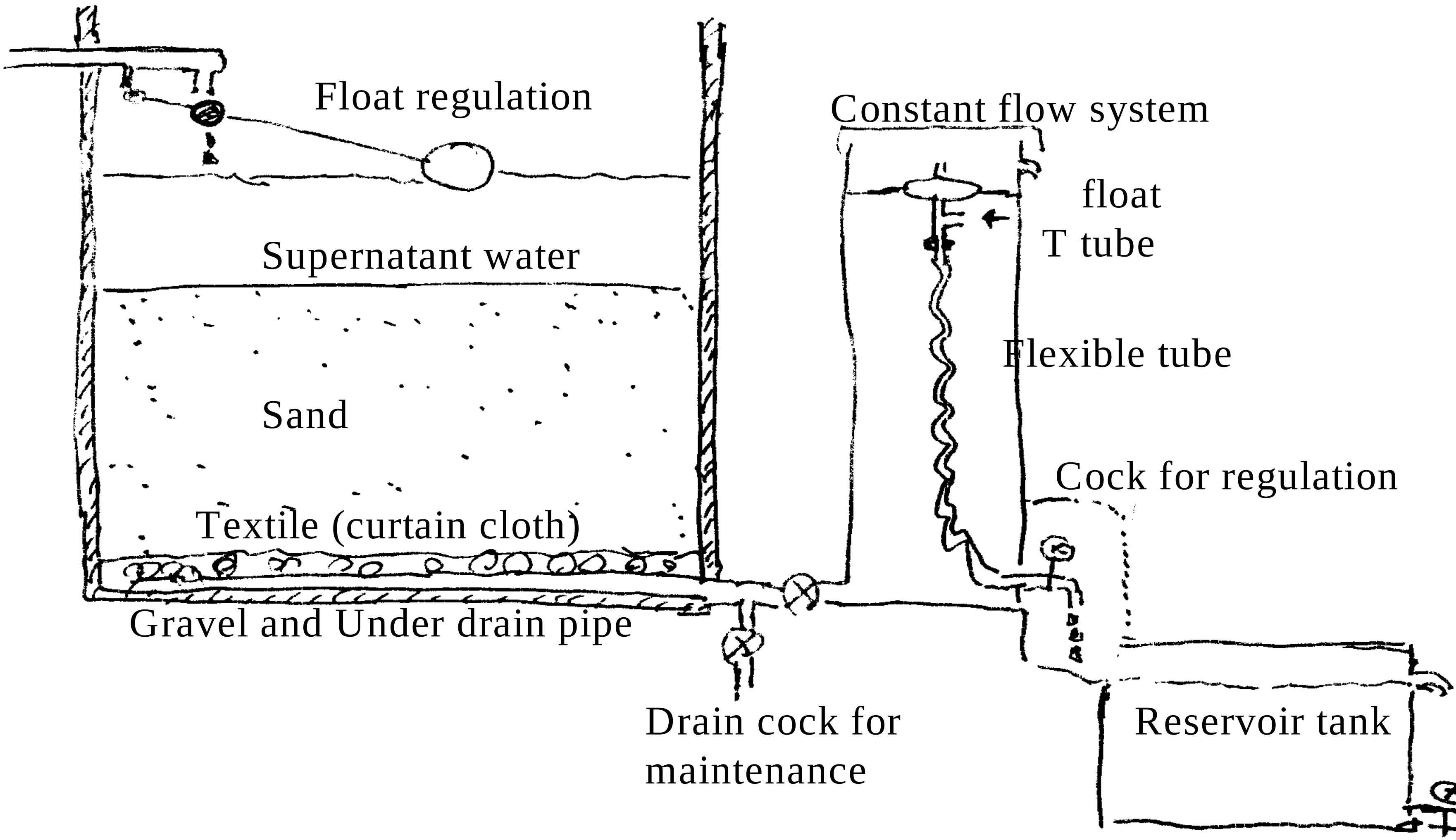


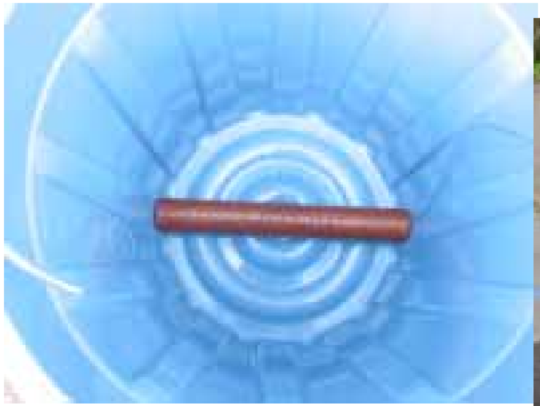
Outline of slow sand filter: Slow sand filter system composes a sand filter box and flow regulation system.

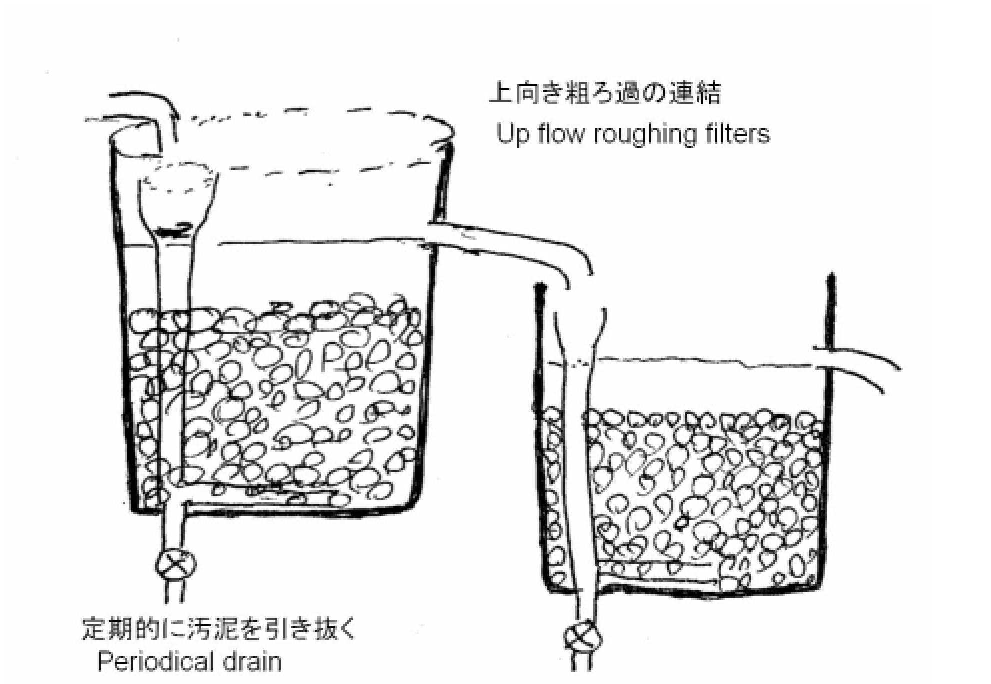
Visscher 1985



It is necessary to keep some water level of supernatant on the sand filter. This is one of the idea to keep the water level by an float and flexible pipe. Almost constant flow is important in this system.

Surface water of a river＋sub-surface water (low oxygen concentration)






Roughing filter to eliminate SS
SSF experiment ,
Open and covered



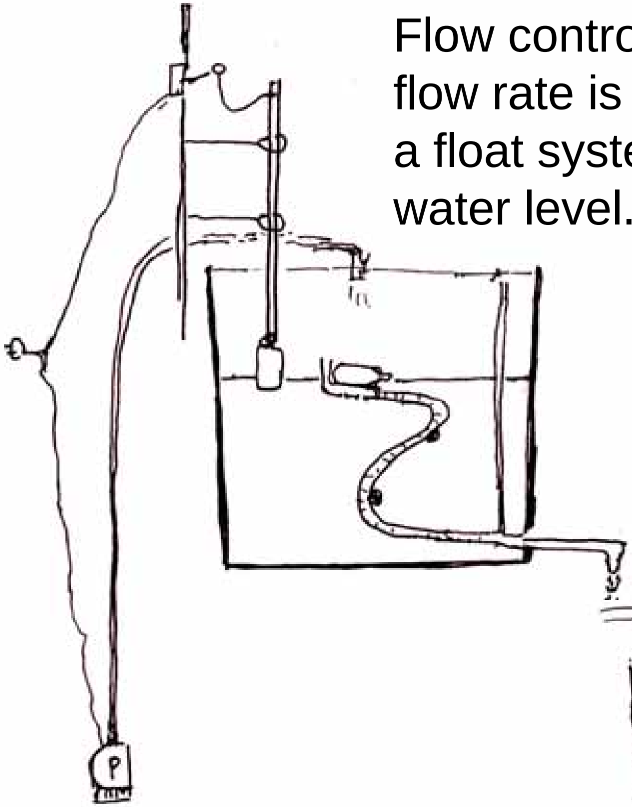
OISCA (The Organization for Industrial, Spiritual and Cultural Advancement-International)

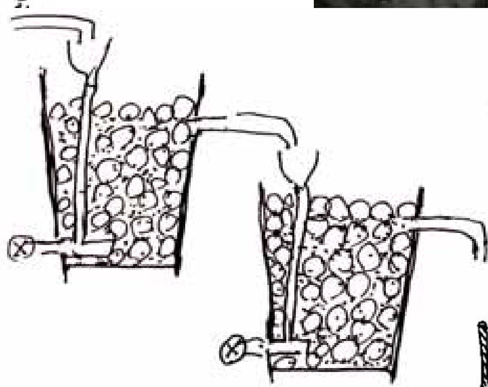
Polluted water of River Kanda, Tokyo is pumped up. There are sedimentation tank, several gravel filter, and slow sand filter. Polluted water turns to safe and reliable water quality (no detection of coli-form bacteria, lead, hervicides of Atrazine and simazine. Nitrate N concentration : 2.0 mg/l, Nitrite N: 0 mg/l, pH8.5, total hardnes: 250 mg/l and residual chlorine 0 mg/l).

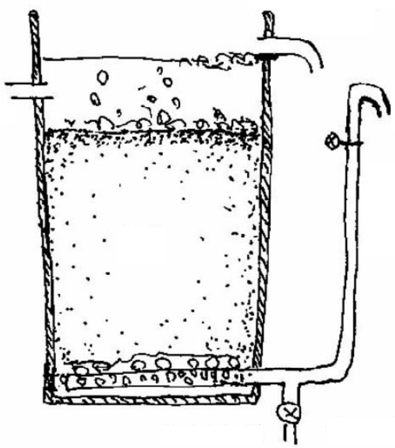
OISCA Tokyo: polluted water (Kanda river)→gravel→gravel→small sand→safe water

Sri Lank：three Up flow roughing filters→sand filter→safe drinking water (300 liters / day). This water is the demand of 5-6 family.

Flow control: Constant flow rate is kept using a float system at any water level.







Rough sand

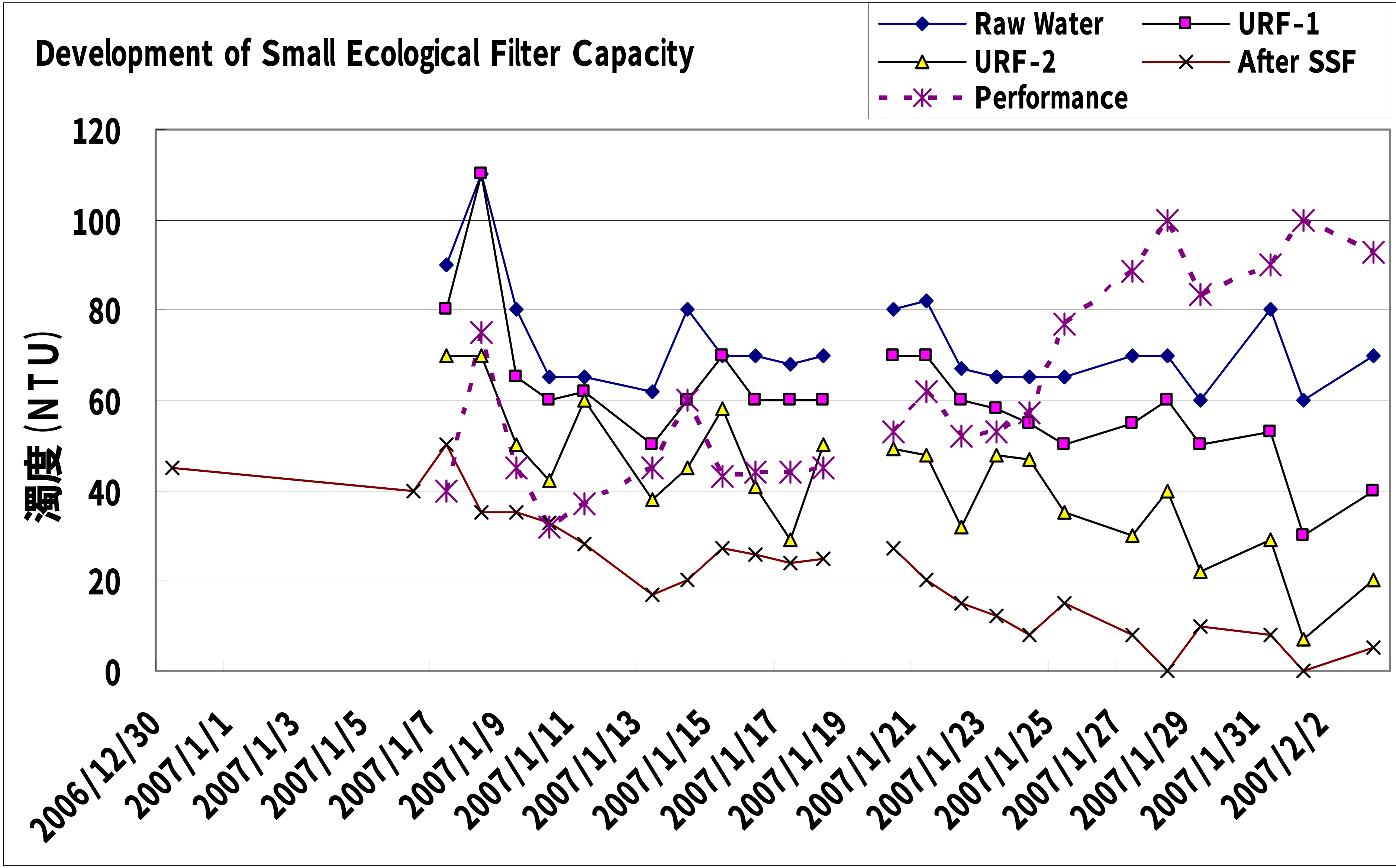

Ceramic candle filter
For drink
For washing







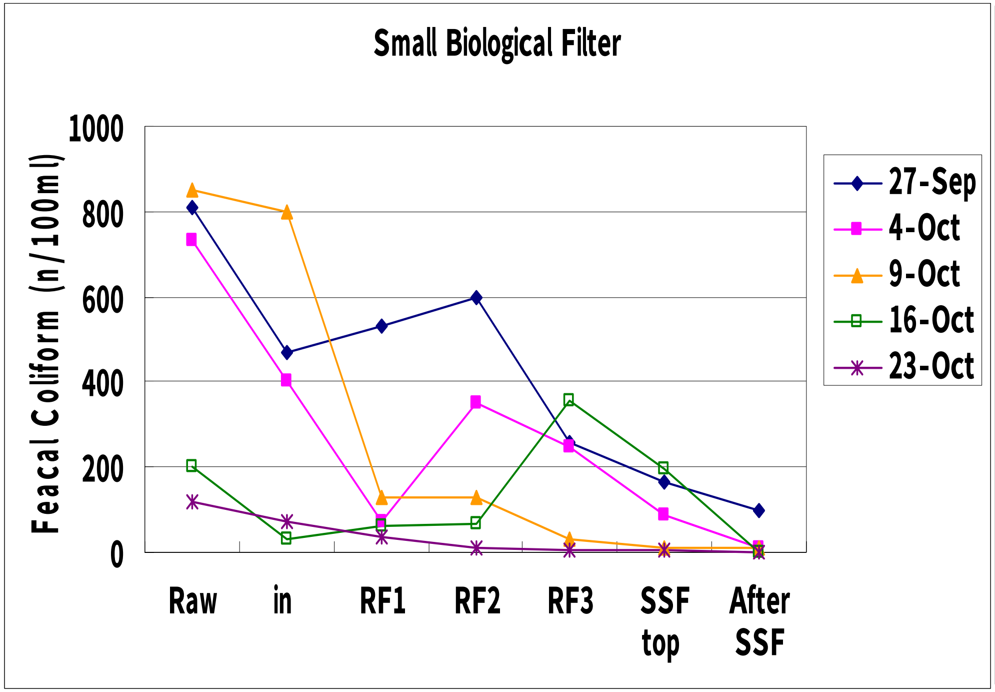
Small Ecological Purification system was set up at Jessore, in Bangladesh, in December, 2006. One day capacity is 0.5 m3. In Bangladesh, one person demand is 10 liter per day. This capacity corresponds to 50 persons (10 families). Two times of pumping up is required in one day.

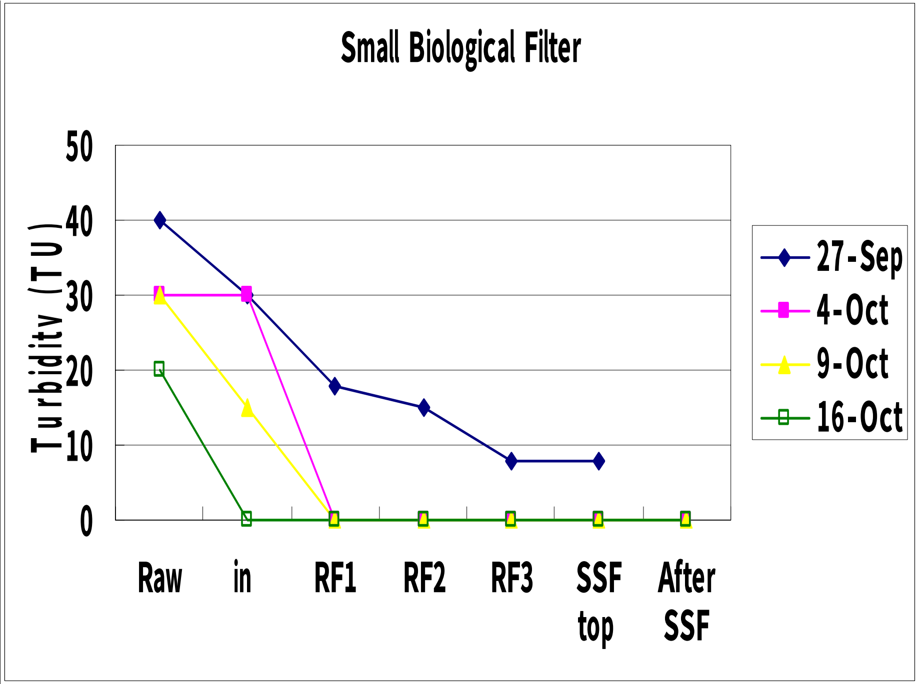


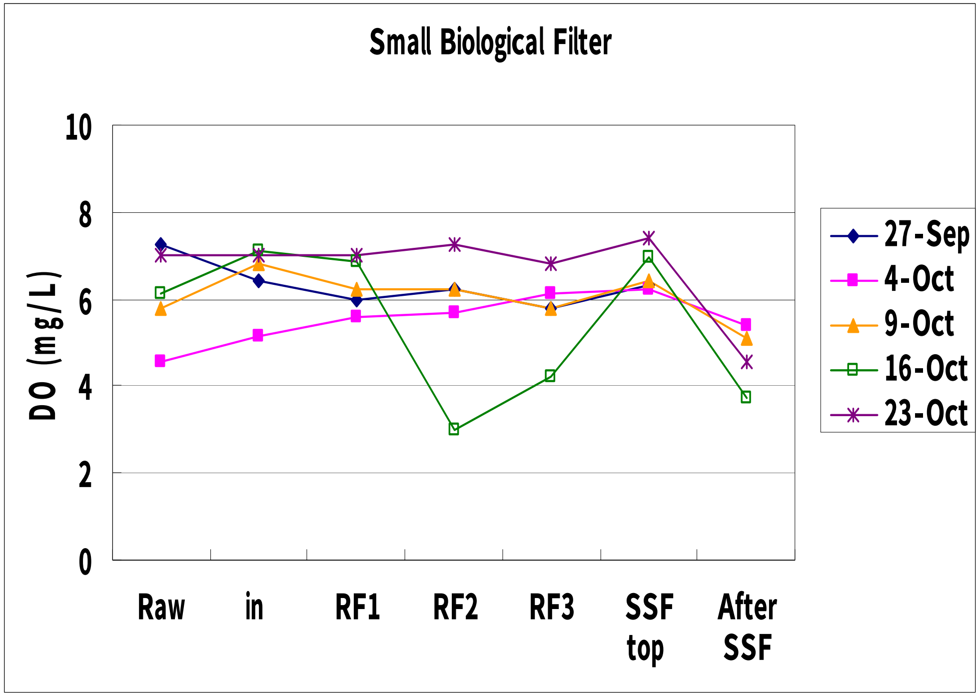
In case of New sand and gravel, it needs about one month to get sufficient quality of final water.

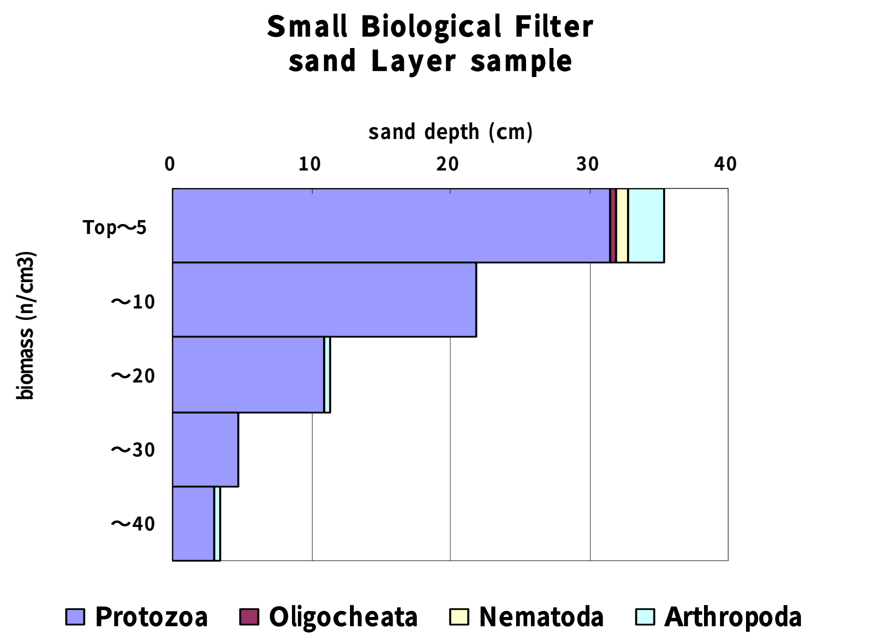
This means that it takes one month to grow up suitable biological community among the sand and gravel layer.

Storage tank capacity=1.2t/d, Up-flow roughing filters (3 steps: 30X30cm2 gravel), 40x82cm2:sandfilter, 50cm depth.

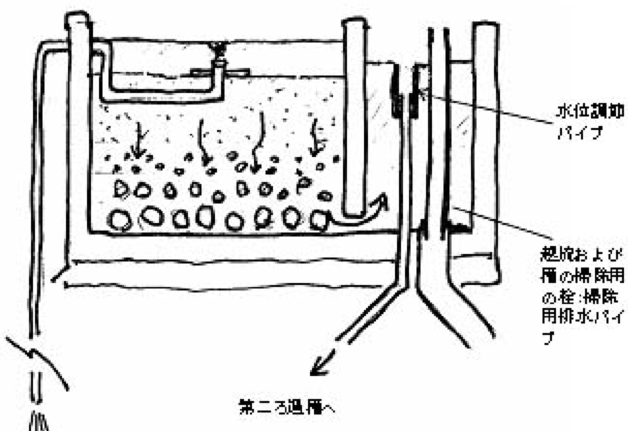

Small Biological Filter
Feacal Coliform (n/100ml)
1000
800
600
400
200
0
Raw
in
RF1
RF2
RF3
SSF top
After SSF
27-Sep
4-Oct
9-Oct
16-Oct
23-Oct


Small Biological Filter
Turbidity (TU)
50
40
30
20
10
0
Raw
in
RF1
RF2
RF3
SSF top
After SSF
27-Sep
4-Oct
9-Oct
16-Oct

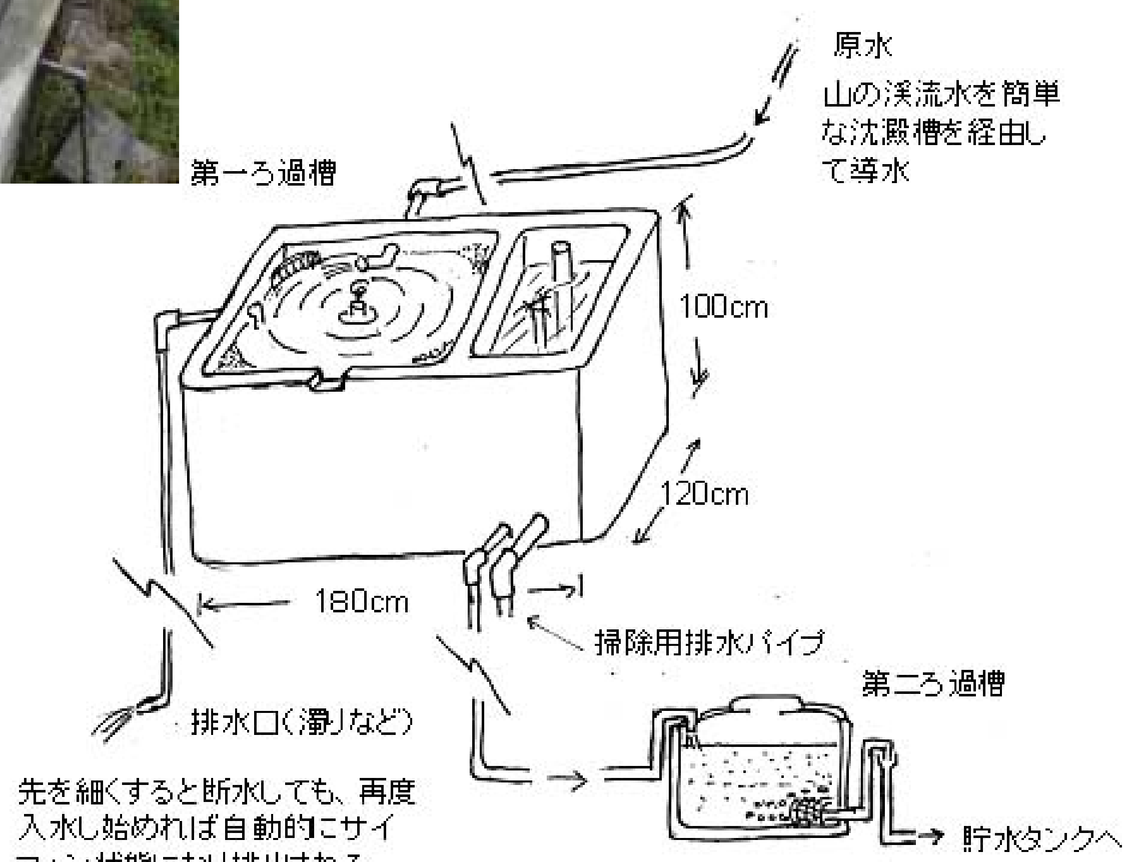

Small Biological Filter
DO (mg/L)
10
8
6
4
2
0
Raw
in
RF1
RF2
RF3
SSF top
After SSF
27-Sep
4-Oct
9-Oct
16-Oct
23-Oct


Small Biological Filter
sand Layer sample
sand depth (cm)
0
10
20
30
40
biomass (n/cm3)
Top～5
～10
～20
～30
～40
Protozoa
Oligocheata
Nematoda
Arthropoda

Remove large matter like leaf using mesh screen



水位調節パイプ
越流および層の掃除用の栓:掃除用排水パイプ
第二ろ過槽へ



原水
山の渓流水を簡単な沈澱槽を経由して導水
第一ろ過槽
100cm
120cm
180cm
掃除用排水パイプ
第二ろ過槽
排水口(濁りなど)
先を細くすると断水しても、再度入水し始めれば自動的にサイフォン状態になり排出される
貯水タンクへ

Ojouchi water works(Nagano city)

Water source: Togakushi Reservoir

Accumulation of Dead Plankton on the bed

(Effect of Algaecide of $CuSO_4$)

Nishihara water works(Suzaka city)

Water source: subsurface stream water

Bloom of filamentous algae

Ishifune water works (Ueda city)

Sugadaira High Land (Agricultural field)

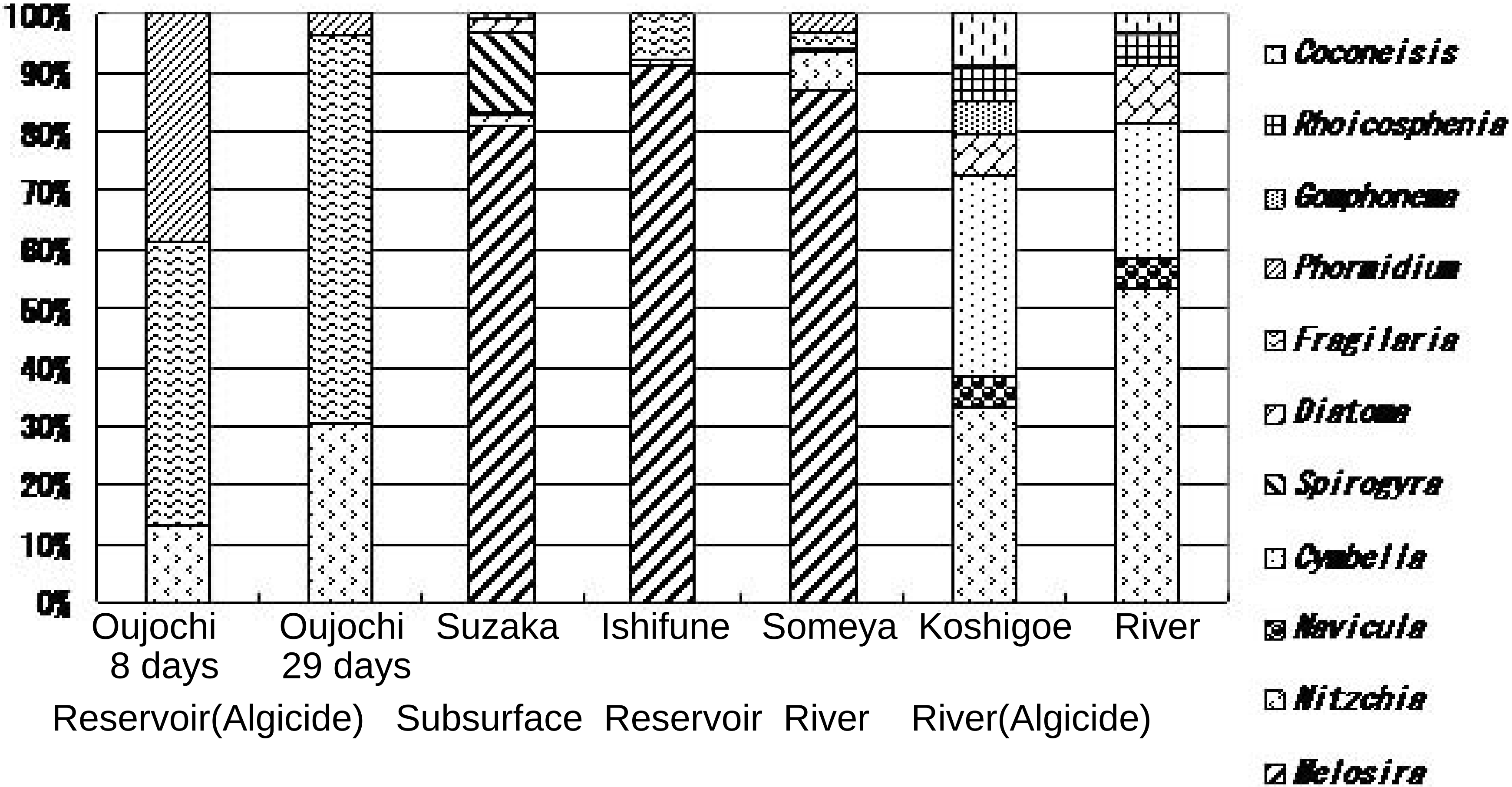
Sewerage treatment and Reservoir

Someya water works (Ueda city)

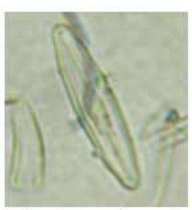
Surface stream water: sometimes add coagulant

Koshigoe water works (Maruko, Ueda city)

Surface stream water: sometimes add coagulant

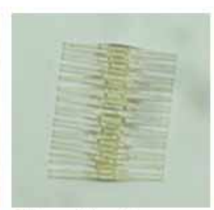


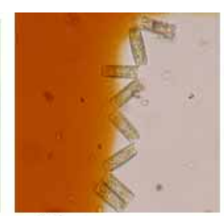

Coconeisis

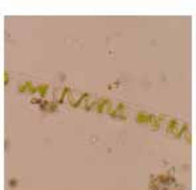

Rhoicosphenia


Gomphonema

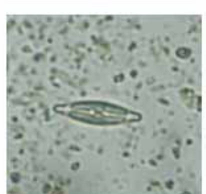

Phormidium


Fragilaria


Diatoma

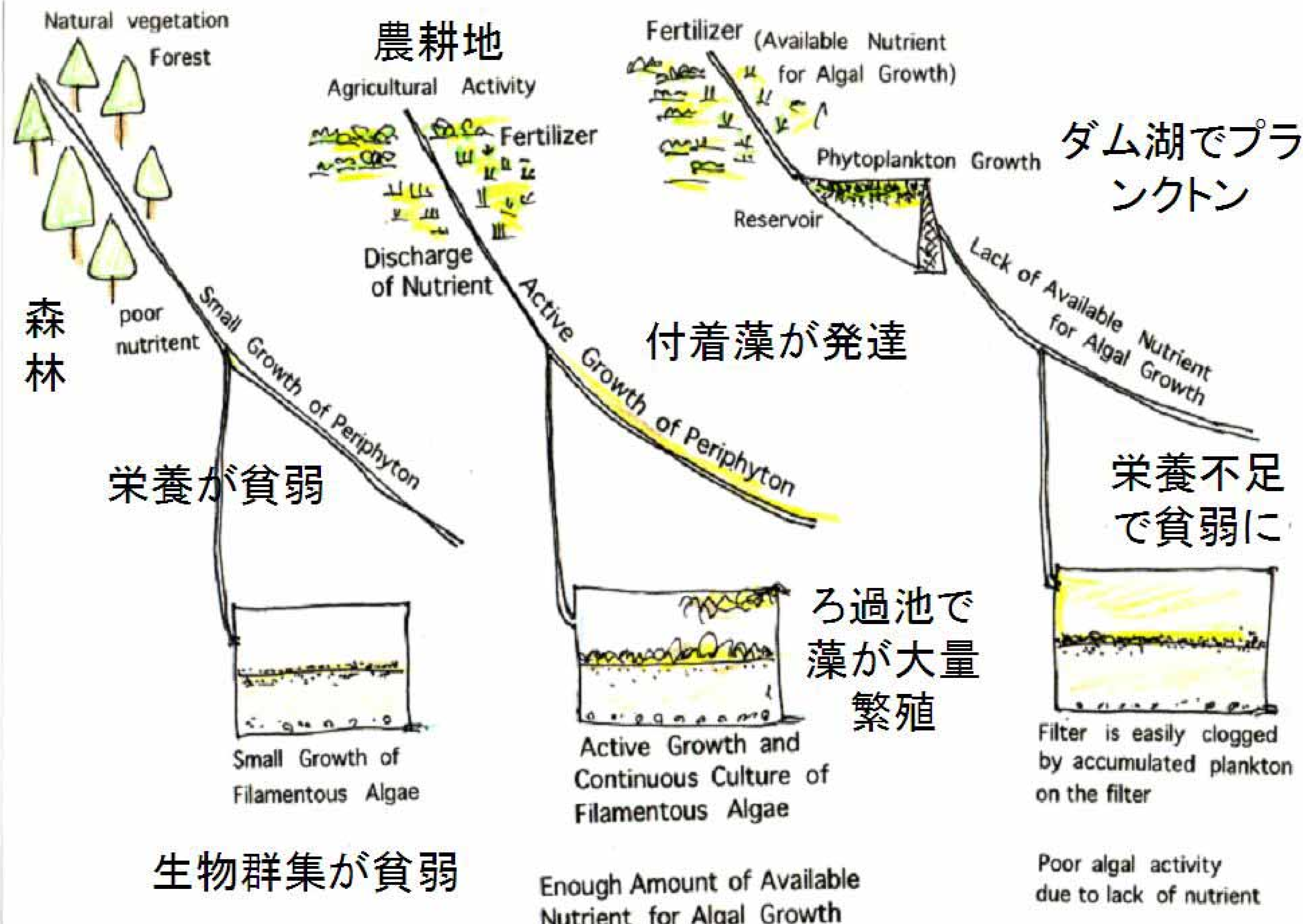

Spirogyra


Cymbella


Navicula

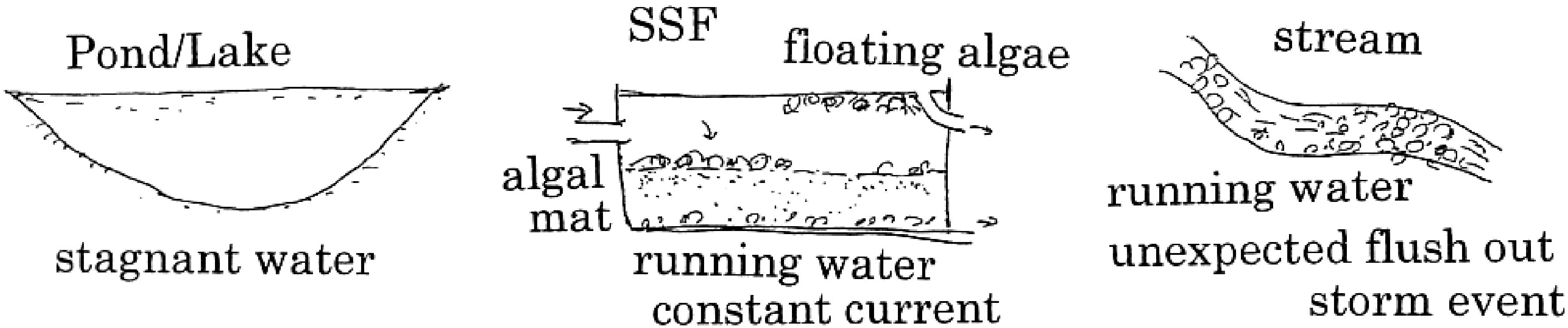

Nitzchia

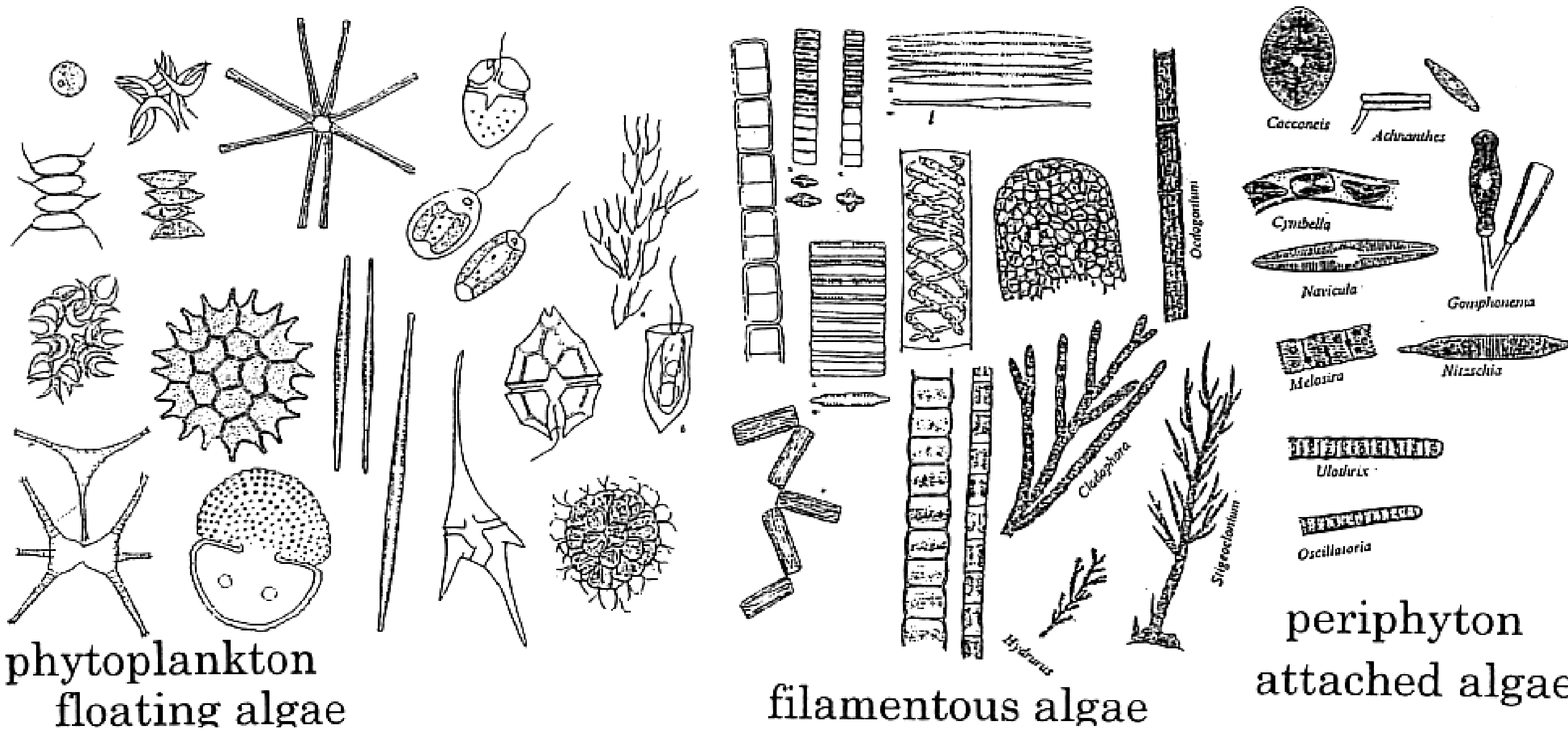

Melosira



Natural vegetation
Forest
森林
poor nutritent
Small Growth of Periphyton
栄養が貧弱
Small Growth of Filamentous Algae
生物群集が貧弱
農耕地
Agricultural Activity
Fertilizer
Discharge of Nutrient
Active Growth of Periphyton
付着藻が発達
ろ過池で藻が大量繁殖
Active Growth and Continuous Culture of Filamentous Algae
Enough Amount of Available Nutrient for Algal Growth
Fertilizer (Available Nutrient for Algal Growth)
Phytoplankton Growth
ダム湖でプランクトン
Reservoir
Lack of Available Nutrient for Algal Growth
栄養不足で貧弱に
Filter is easily clogged by accumulated plankton on the filter
Poor algal activity due to lack of nutrient

SSF(Ecological Purification System) is the suitable environment for filamentous algae.





Oh-joh-chi waterworks, Nagano since 1915.

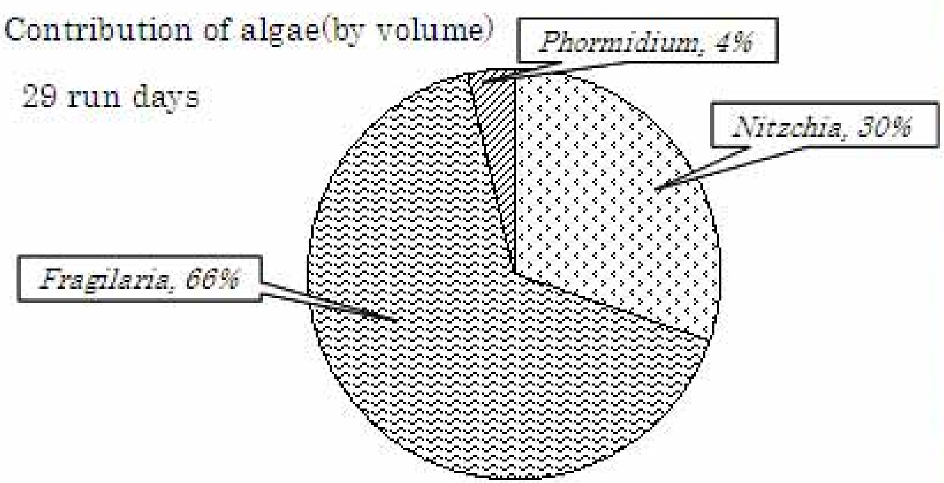
One filter area is 860m2 (x 3 ponds = total 2,580 m2). storage tank : 8,760 m3

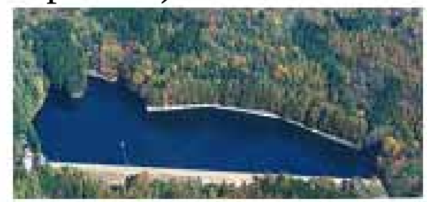
Original plan for 60,000 persons demand in 1915.

If filter rate of 5m/d is adopted, 12,900 m3/d of filtered water can be made. This capacity is equal to the demand of 43,000 persons (0.3m3/d/person).

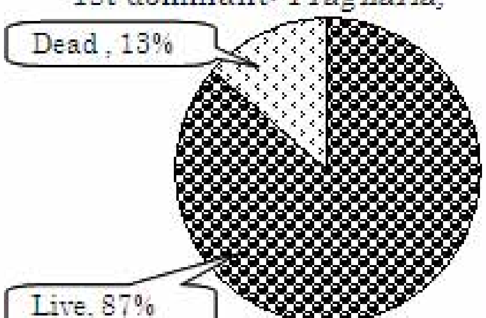
Sometimes, *cupper sulfate* is added to regulate the algal bloom in a reservoir (Togakushi). This treatment is for the chemical treatment of RSF. In case of SSF, this treatment is sometimes caused the short filter run.

Oujouji (Nagano)

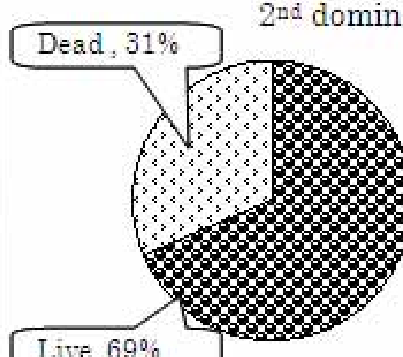




1st dominant: *Fragilaria,*



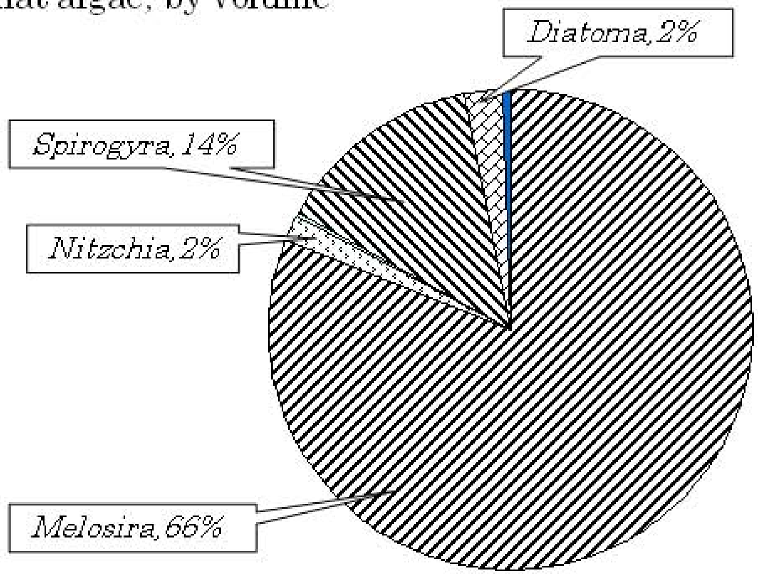
2nd dominant: *Nitzchia*



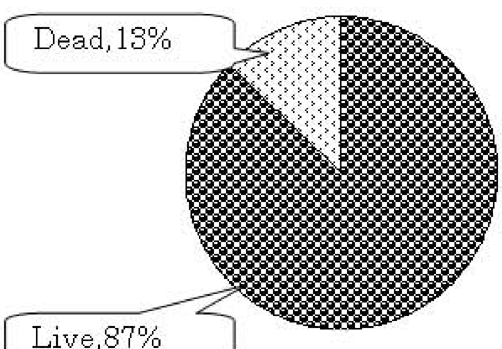
Nishihara waterworks, Suzaka city, Nagano. Raw water: SS free of subsurface water. Over one year, there is no scrapping. This is almost no work to maintenance. One filter area: 6.8mx13.5m=91.8m2 One filter capacity : 459m3/d. One filter can supply for 1500 persons demand (0.3m3/d).

At the foot of mountain, there is a reed plant where underground water leaks out. Porous pipes were set to take the subsurface water which is suspension free water.

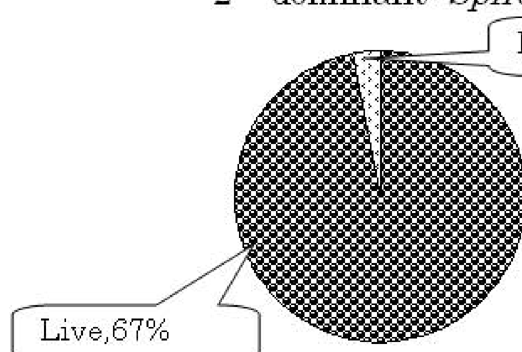
Dominat algae, by volume



Fist dominant: *Melosira*

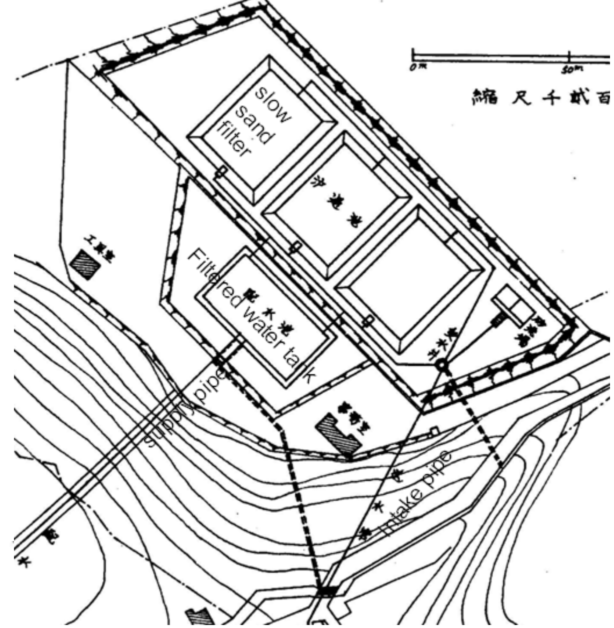


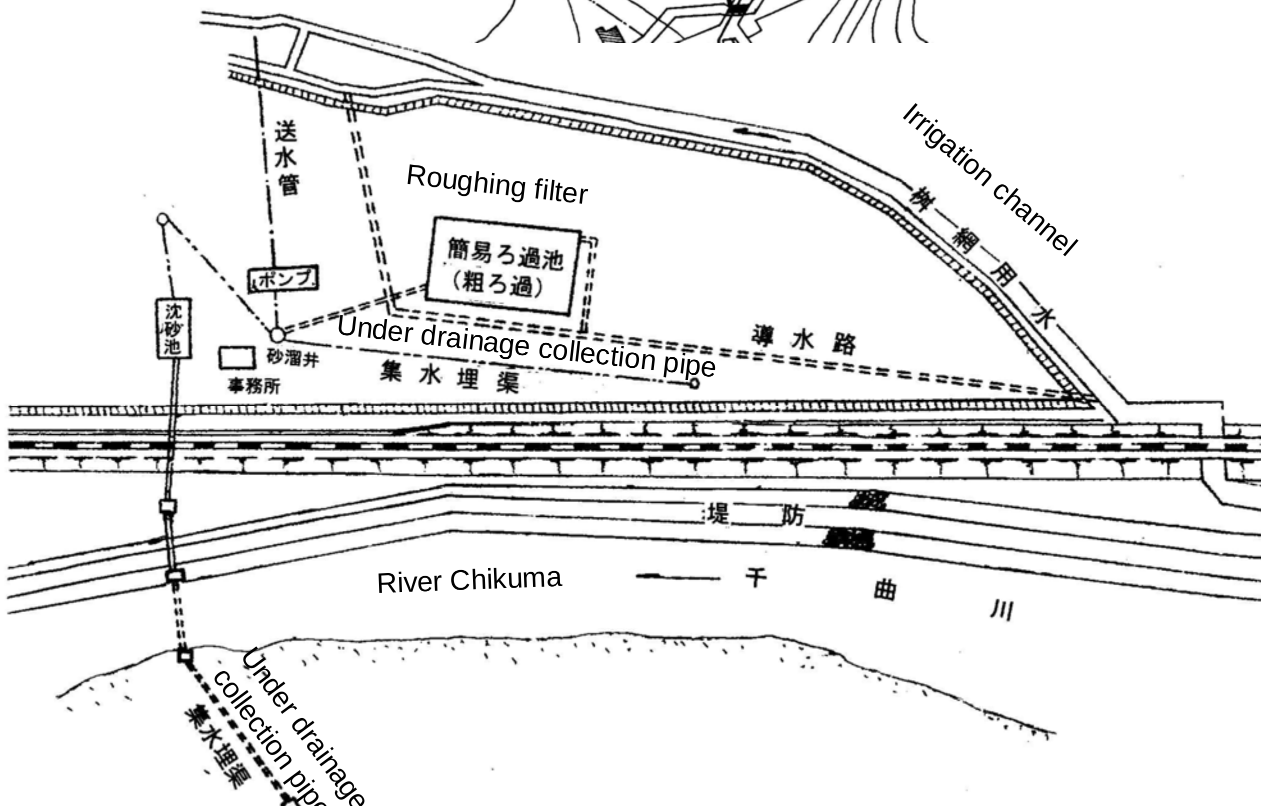
2nd dominant: *Spirogyra*

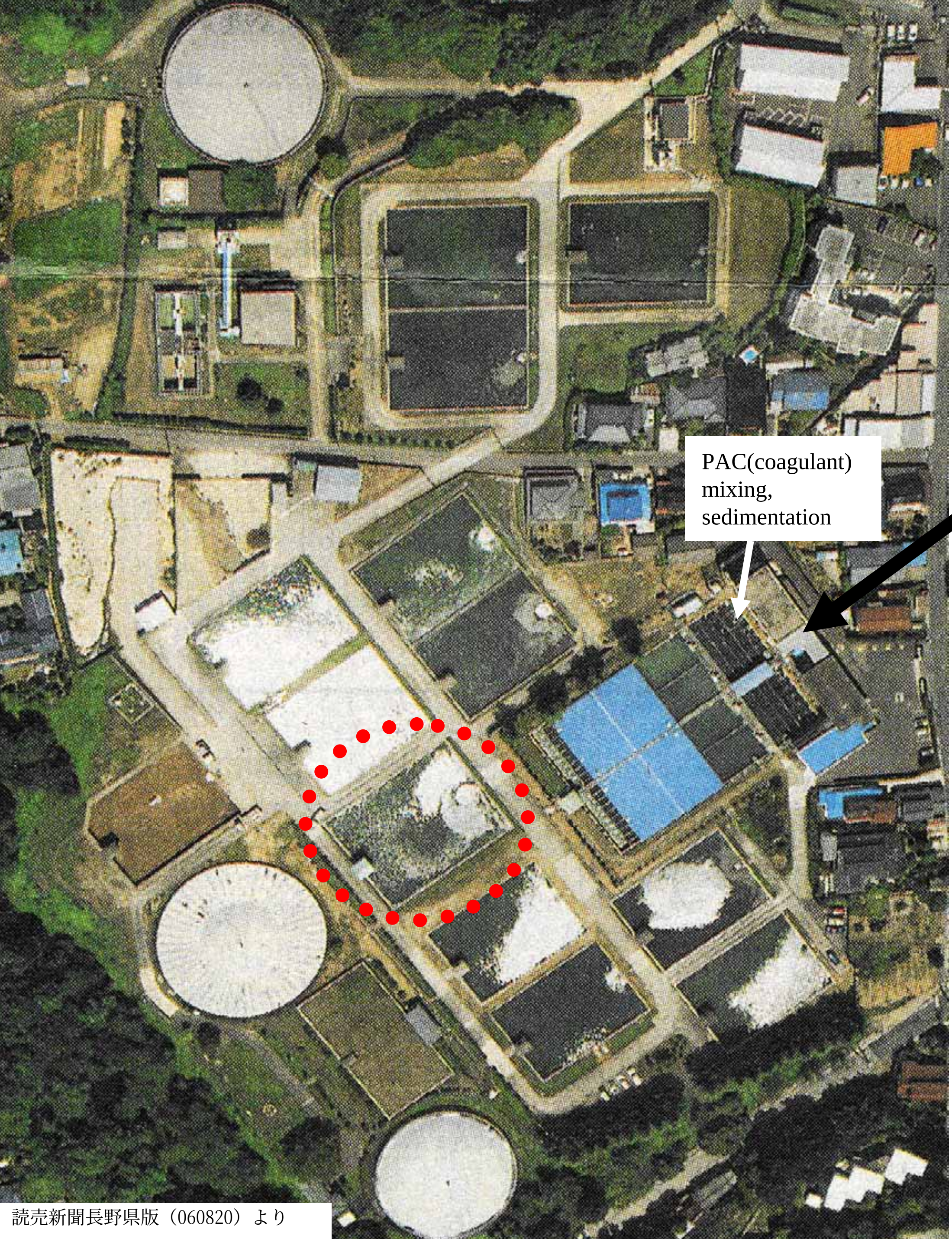


Someya waterworks, Ueda city, Nagano was completed in 1923.
Subsurface underground water of River Chikuma was taken and was pumped up to the filter plant.

Original waterworks has 3 filters and storage tank.







読売新聞長野県版（060820）より

In 1964, Sugadaira reservoir was completed at about 15 km up from the waterworks. This water flows to Kangawa river and flows to the waterworks.

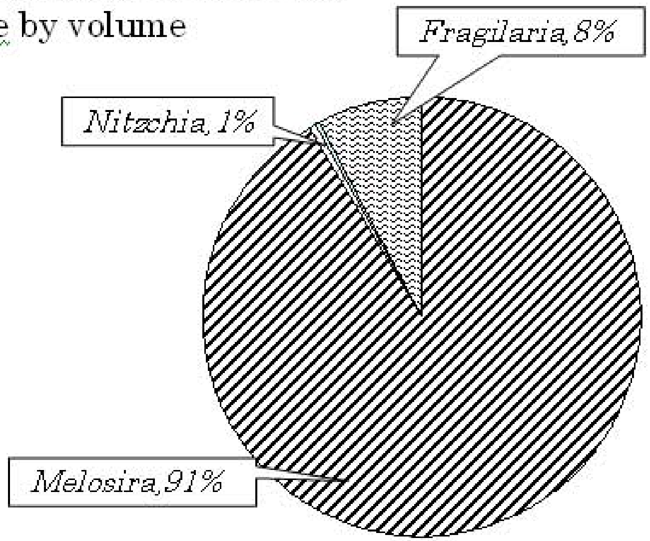
Present waterworks has 13 filters. Only one original slow sand filter pond is remained. The side wall of the original filter pond is slant wall like a natural pond. In case of other new filter pond, the wall are all vertical wall.

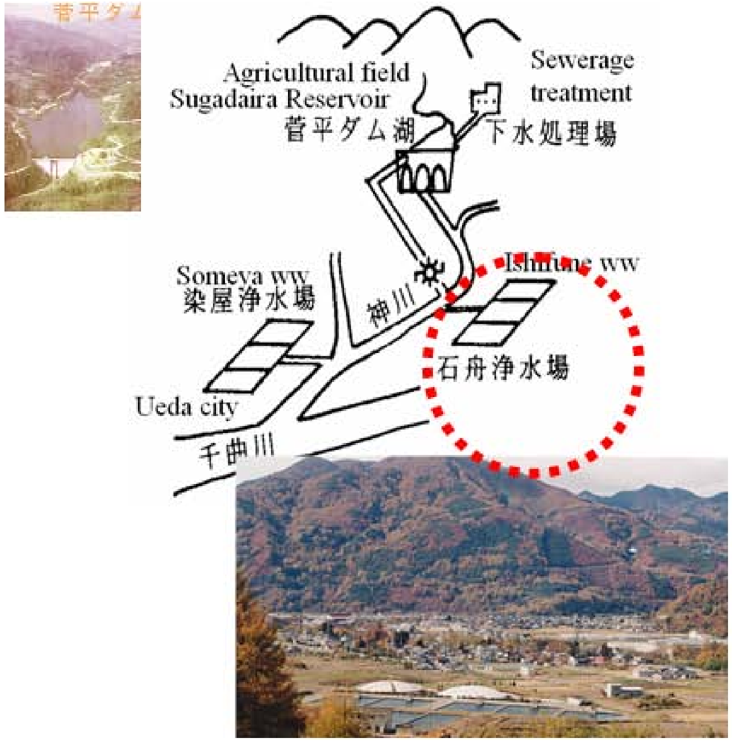
In case of the old filter, algae grows well and easily grow at the shallow place on a slant wall of the old filter. Seed of algae easily stop and hang on the slant wall.

Area of each one filter bed is 780m2. Total area of filtering space is 10,140m2 (＝ 780m2 x 13). If 13 filters are operated under normal Japanese standard filtering rate (4.8m/d), total capacity of filtered water is 48,672m3 (＝ 10,140m2x4.8m).
The capacity of water demand is 162,240 persons (0.3m3/d/person).

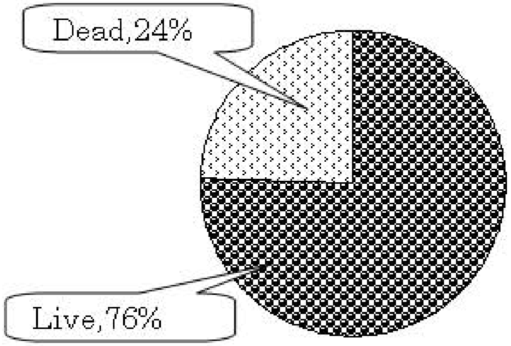
Ishifune (Ueda)

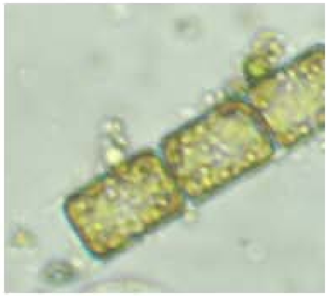
Contribution of Dominant algae by volume



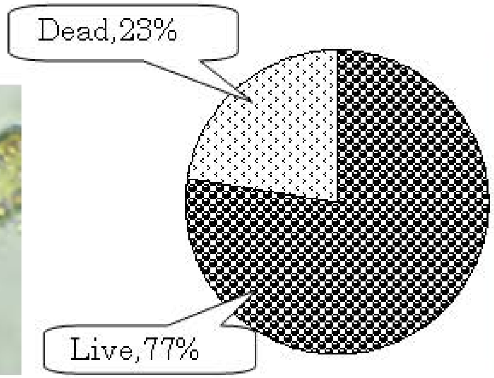


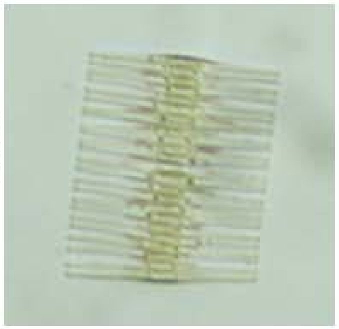
Fist Dominant: *Melosira*

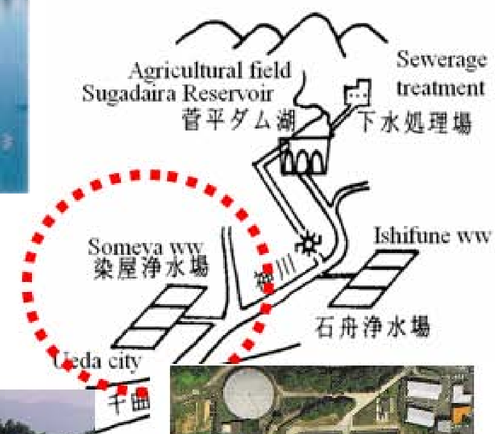




2nd Dominant: *Fragiralia*

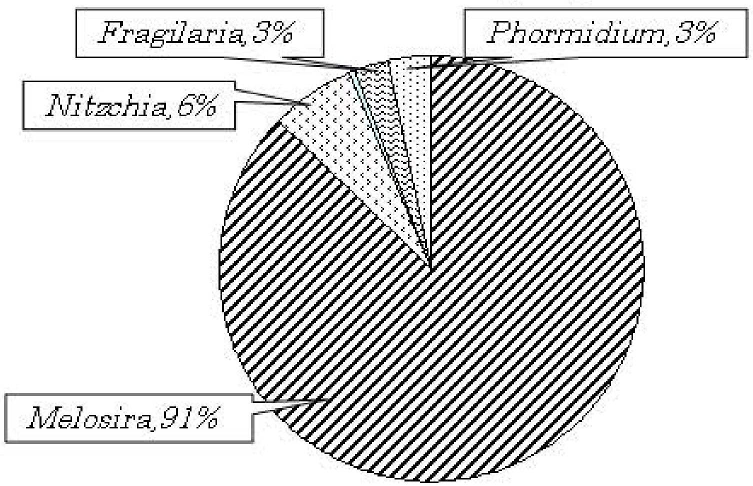




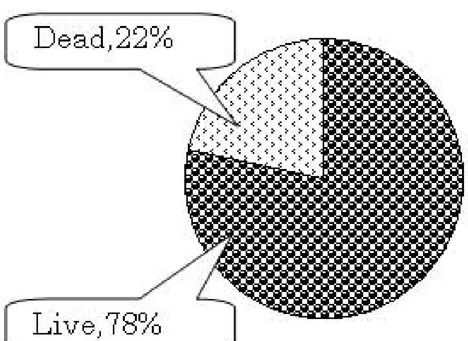


Someya(Ueda)

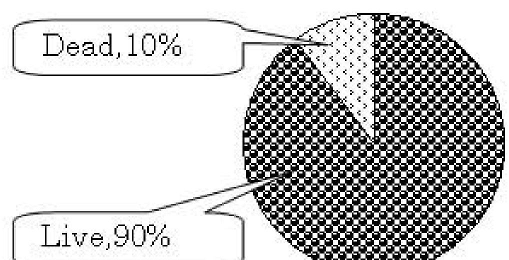
Contribution of Dominant alga by volume



First dominant: *Melosira*

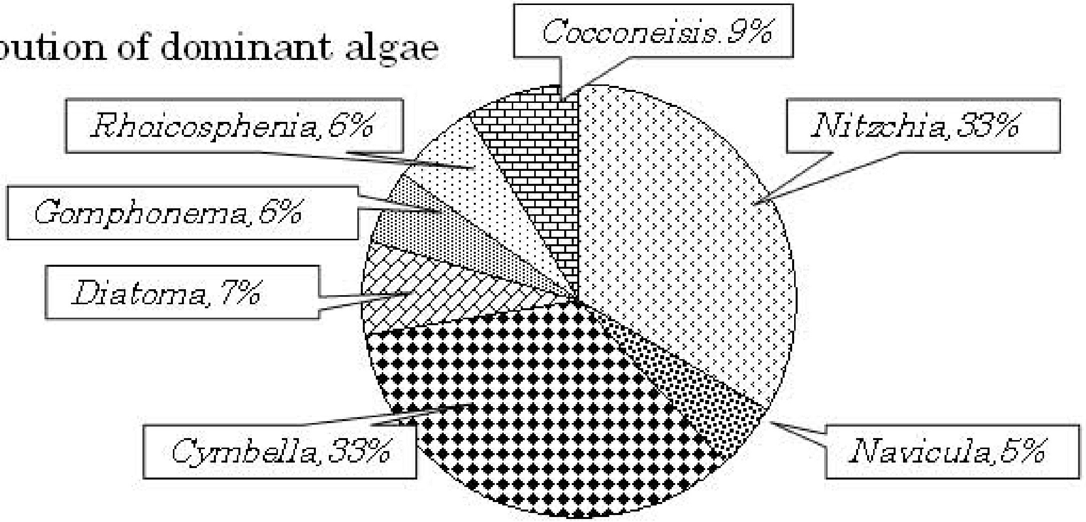


2nd dominant: Nitzchia

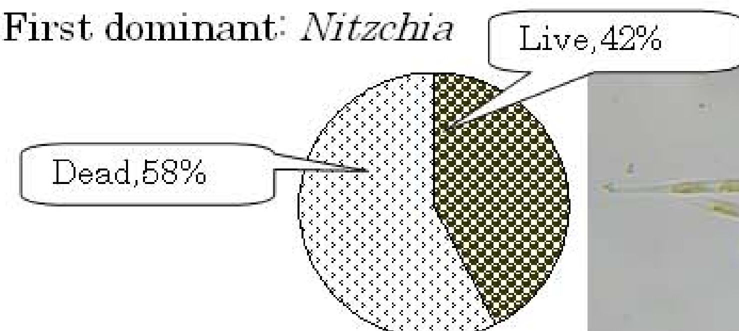


Koshigoe (Maruko, Ueda)

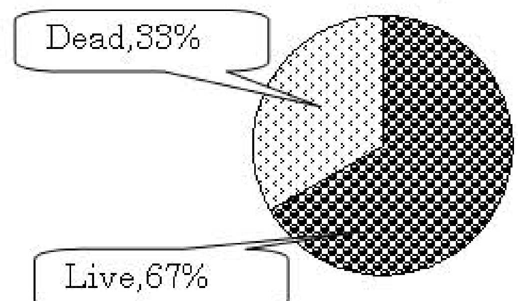
Contribution of dominant algae



First dominant: *Nitzchia*



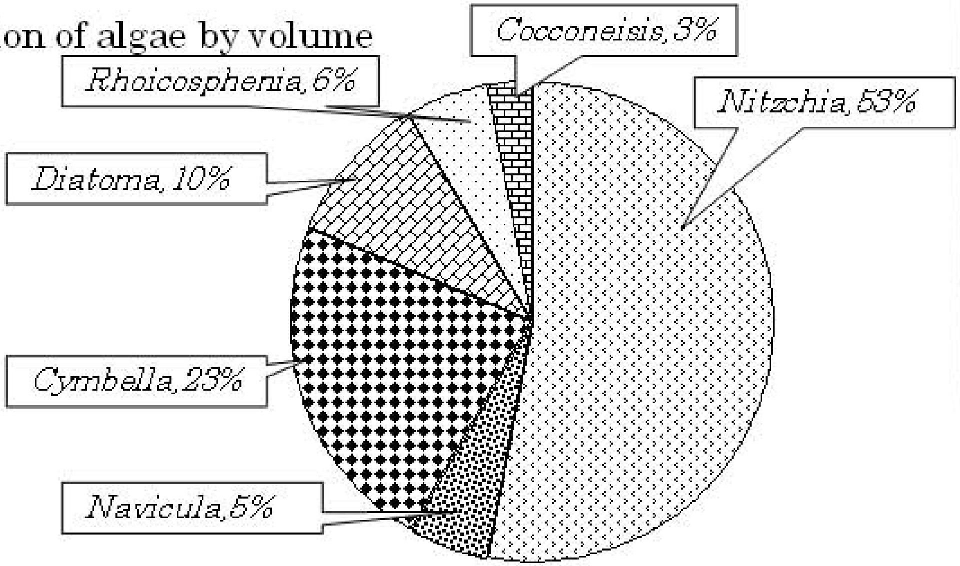
2nd dominant: *Cymbella*



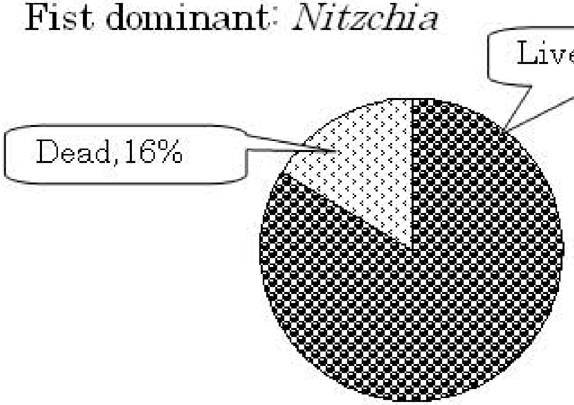
Koshi-go-e water works, Ueda-Maruko, Nagano: Surface water of a river → algaecide +coagulant → mixing → sedimentation → slow sand filter. Filter rate : about 3 m/d. Filter head loss became about 60 cm within one month. There is no active biological community in sand filters.

River bed (Chikuma River, Periphyton)

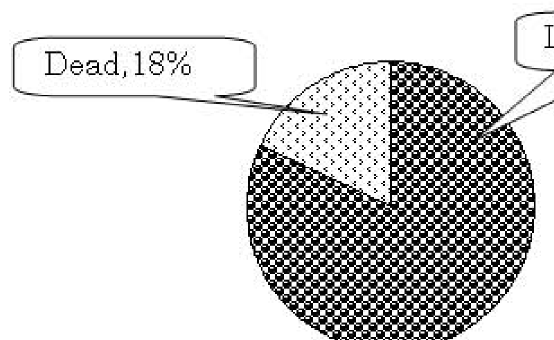
Contribution of algae by volume

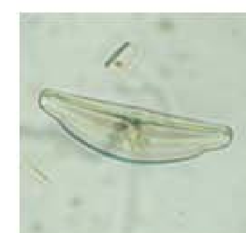


Fist dominant: *Nitzchia*

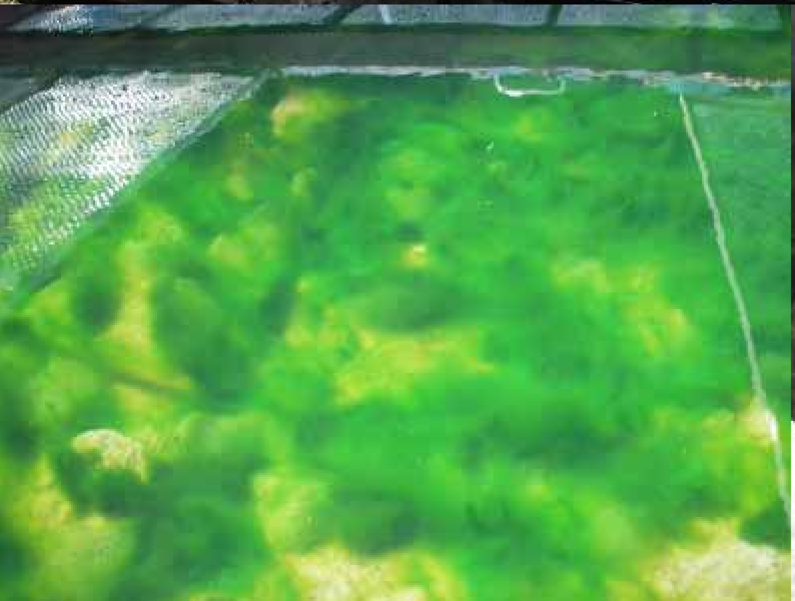


2nd dominant: *Cymbella*





Hongo plant, Shizuoka,River water, sedimentation pond, and half covered (shaded) slow sand filter to regulate heavy algal growth.

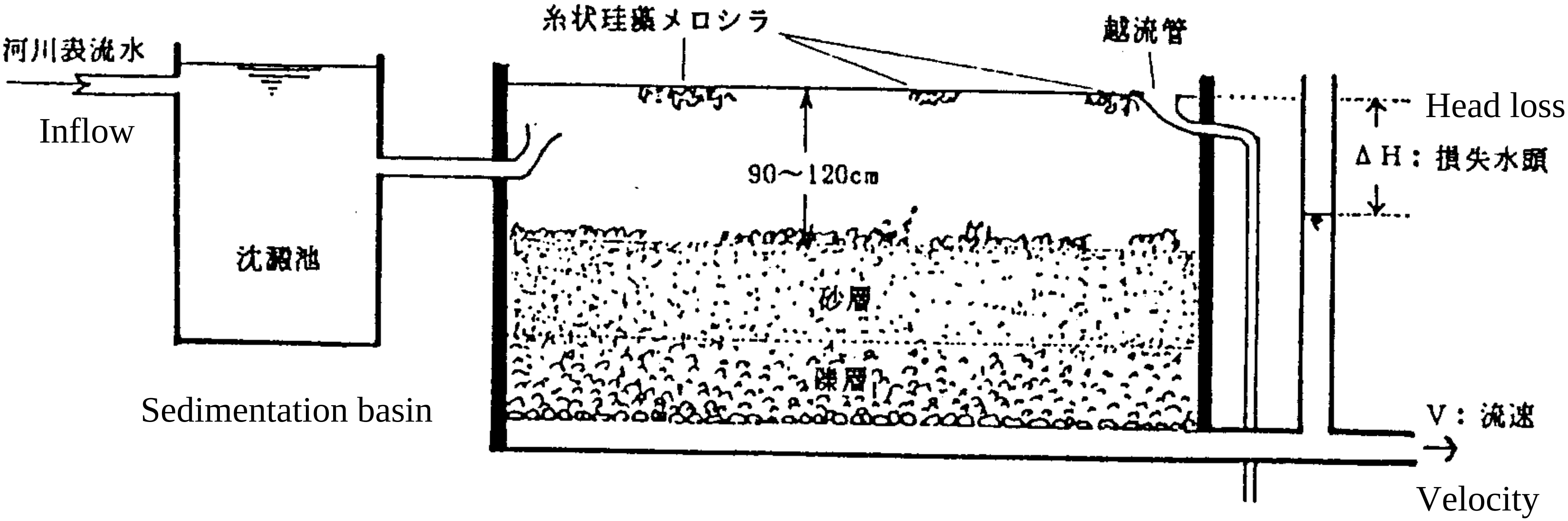


Turbidity is very small. It runs over two years without scrapping the surface mud.

Filamentous green algae, filamentous diatom, some snail are seen.


Water Purification plant for 100 persons in a village in Japan.
Intake pipe under river bed
Storage tank
Slow sand filter
Pre-filter: roughing filter
This plant does not any chemicals (coagulant, and chlorinated reagent)

Clog indicator: Head Loss



Clog indicator: Head loss（ΔH)
Head loss（ΔH) is proportional to velocity (V).

$$\Delta H = kV$$

Normal filter rate is 20cm/h (4.8m/d ：Vn). NHL(Normalized Head Loss ：Hn）at normal flow rate can calculated by the observed head loss and the observed flow rate.

NHL: Normalized head loss：Hn (cm)

$$Hn = (H \times Vn) \div V$$

Observed head loss：H (cm)
Observed flow rate：V (cm/h or m/d)
Normal flow rate：Vn (20cm/h or m/d)

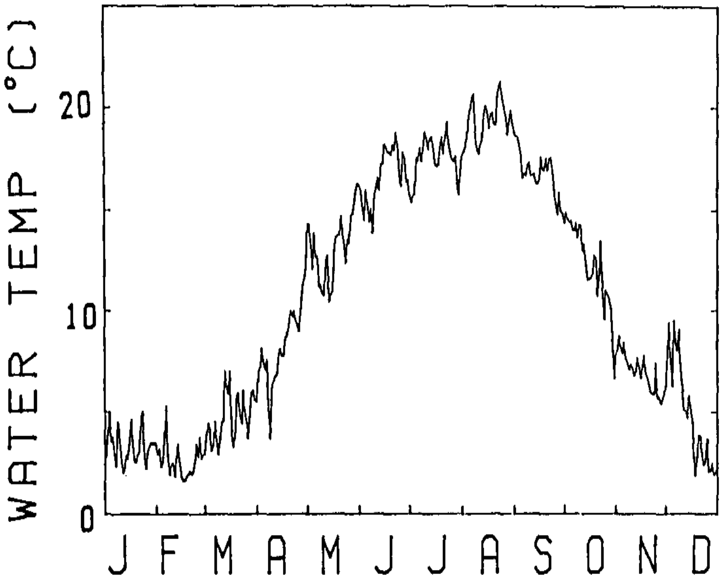
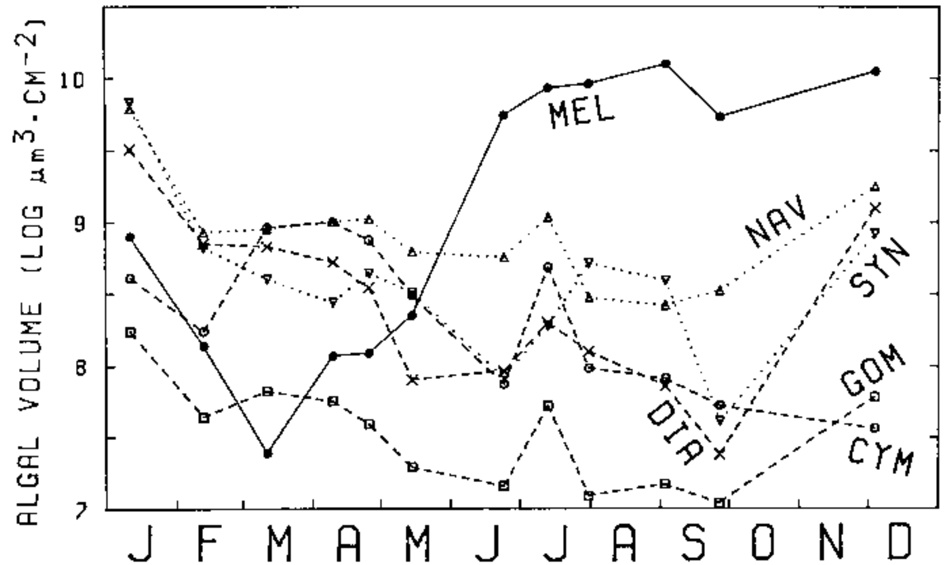


Fig. 1 . Seasonal variation of water temperature at Someya water works in Ueda, Nagano in 1988.



2 . Seasonal variation of algal flora on the slow sand filter at Someya water works.
MEL : *Melosira varians*, NAV : *Navicula* spp., SYN : *Synedra* spp., GOM : *Gomphonema* spp., DIA : *Diatoma* spp., CYM : *Cymbella* spp.

Someya waterworks, Ueda

Water temperature, algal flora change and contribution of filamentous diatom of *Melosira varians*.

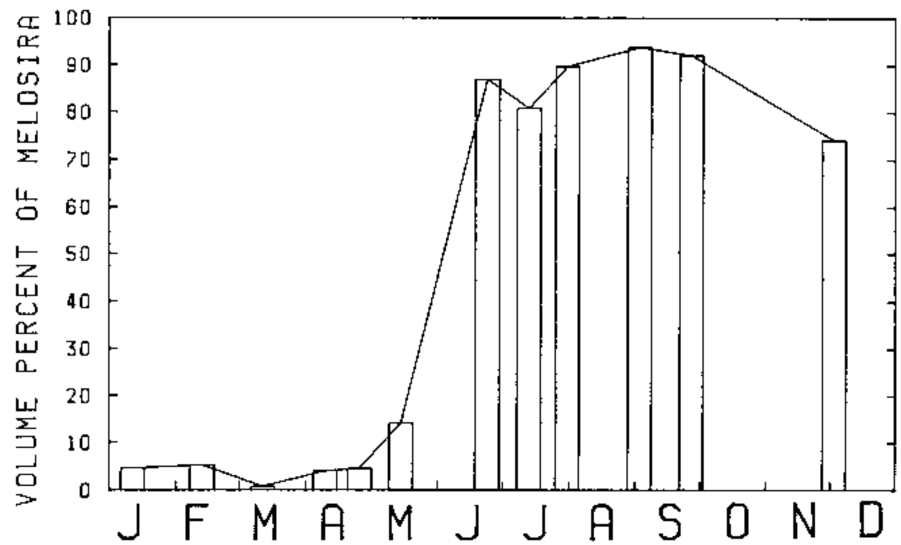


Fig. 3 . Percent contribution of Melosira spp. volume in algal mat at Someya water works in 1988.

Filter run and filter resistance (NHL)

Winter: rapidly clog

When algae grow in spring, resistance does not increase.

In cold season, air bubbles are trapped among sand layer. However, in warm period these bubbles are easily released. This phenomena is due to the viscosity of water.

In summer, at the end of filter run, head loss increased rapidly. It was caused by suddenly rapid change of high filter rate.

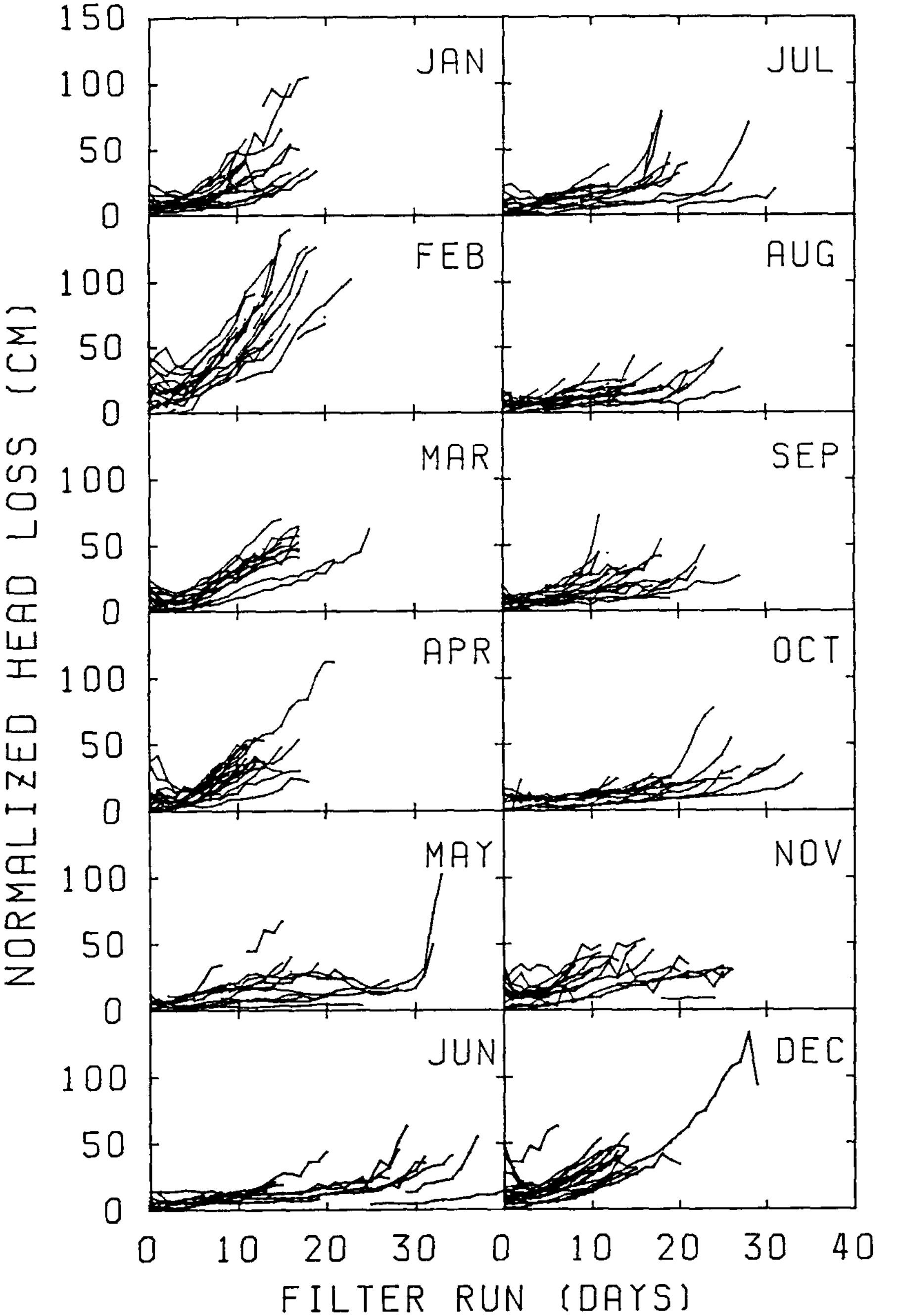


Fig. 4 . Relationship between days of filter run and normalized head loss in each month in 1988.

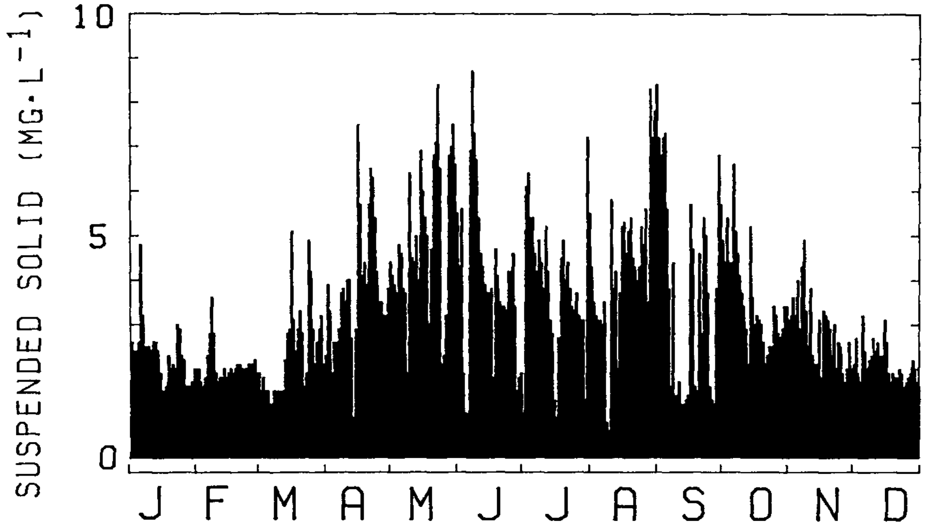


Fig. 6 . Seasonal variation of suspended solid concentration in the inflow water.

In summer, filter resistance does not increase even high turbidity. High biological activity is the most important to keep the low filter resistance.

Continuous culture system of filamentous algae is important. Small animals are also important in this system to collect particles and to keep a better condition of filter.

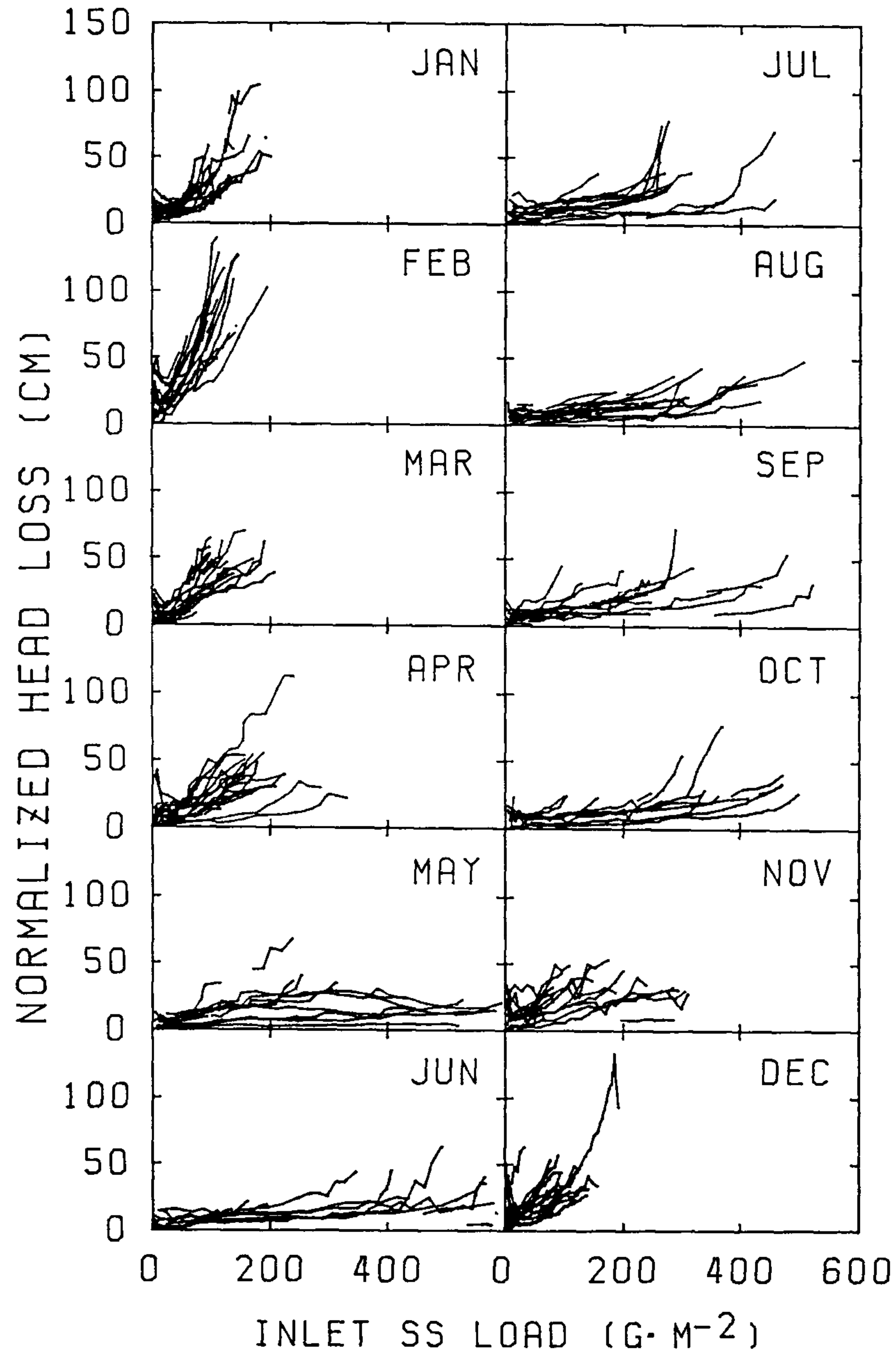


Fig. 7 . Relationship between load of suspended solid on the filter and normalized head loss in each month.