Development of a small water treatment system for supplying safe drinking water to people in the rural area

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1. Background

① Lack of good water sources in rural village in Vietnam.
(Surface water is highly turbid and groundwater contains Fe and Mn.)
②Water sources are treated improperly and utilized as drinking water. The quality of treated water does not meet the Vietnam drinking water quality standards.
③ Infant mortality rate is high due to diarrhea etc.(about 10 times that of Japan)
④ Govt has a policy that the introduction of advanced technology like membrane filtration treatment. But it is not appropriate in terms of cost and technology for the village people.

2. Purpose

To develop a small water purification system for drinking water in rural villages.

Development Conditions

① Raw water contains high turbidity, iron and manganese.

② Ensuring stable treatment for producing safe water

③ System should be so simple such as slow sand filter that local residents can operate it easily .

④ Water purification system should be inexpensive in initial cost and running cost.

3. Equipment overview(water purification method)

1) Small-scale water purifier treatment flow: S.W.S; Safe Water Supply

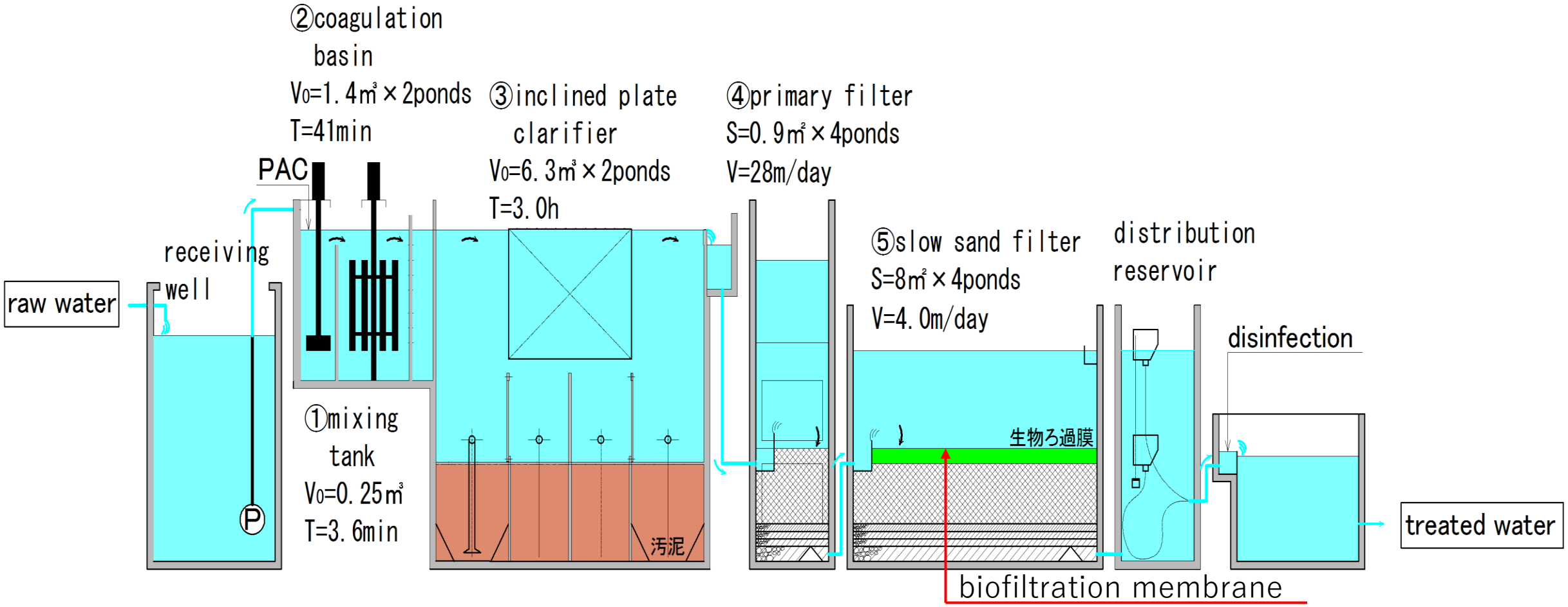
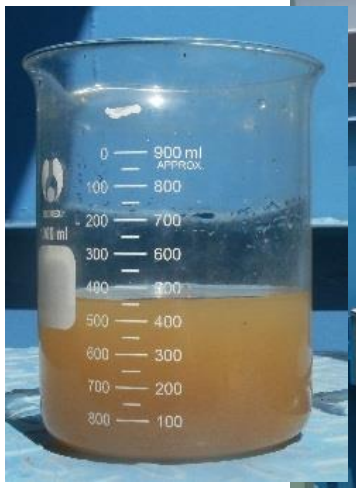


Fig.1 Flow diagram of S.W.S(processing capacity 100m3/d)

2) Appearance of the device



Raw water

Purified water

Fig.2 S.W.S demonstration experiment device (treated water amount Q=20～40m3/day, installation area 4.0m×15.0m)

4. Outline of the demonstration experiment

1) Experiment location: DOWACO (Bien Hoa, Dong Nai Province)
2) Period: Feb./2016 to Mar./2017
3) Scale: 20~40m3/d
   Changing the water flow rate
   in the rainy season
4) Operation time: 24 hours/day
5) Chemical use: Pac, Calcium hypochlorite

4. Outline of the demonstration experiment

6) Operation and Maintenance work (manually): 1 person/ daytime

- Check water quality of raw water, treated water;
  1 time/day for Cl, turbidity
- Monitor the water level at primary filter basin;
- Control the coagulant dosage;
- Backwashing for the primary filter (drained to sludge pond);
  1 time/week (open and close the valves)
- Sludge draining for the sedimentation tank;
  2～3 times/ month (open& close the valves)
- Sand scraping for the slow sand filter and washing the the sand media;
  1 time/ 3~4 months

Current status of raw water

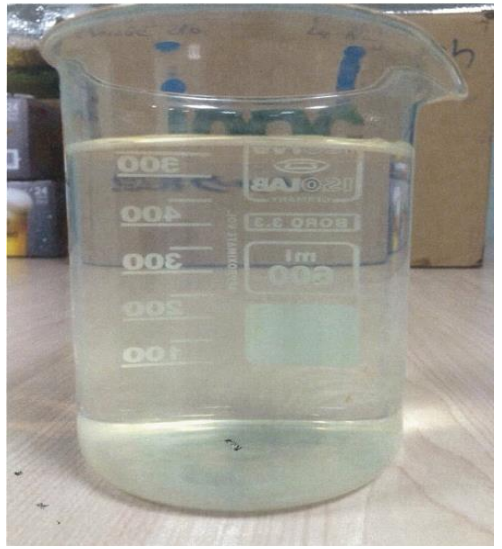
Surface water

Fig .3-1 Dong Nai River
(in the rainy season.)

This experiment targets only surface water.

Ground water

(Immediately after sampling)



(1 day later; Fe oxidized.)

Fig.3-2 Groundwater
(pH:6.2,Mn:0.21,Fe:1.89mg/ℓ)

5. Results of the demonstration experiment

The results of the experiment in Vietnam (DOWACO) with S.W.S device (Fig.4) is showed below

1) Turbidity (water quality standard in Vietnam is 2 NTU)

① Settled water NTU

Raw water NTU varies greatly (20～200NTU)in the rainy season (from July to December). On the other hand, settled water NTU is steady approximately less than 5

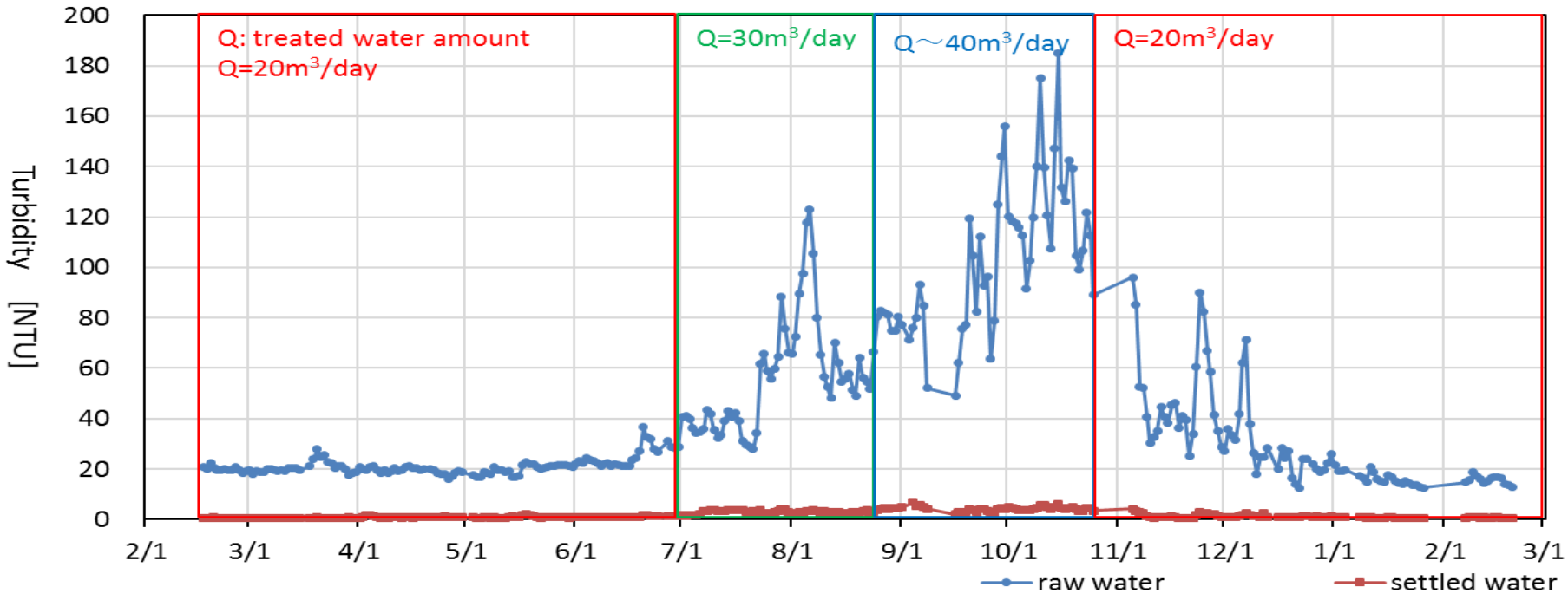


Fig-4 Turbidity of raw water and settled water

②Slow filtrated water NTU

Slow filtrated water NTU is steady approximately less than max 0.4 even in the rainy season.

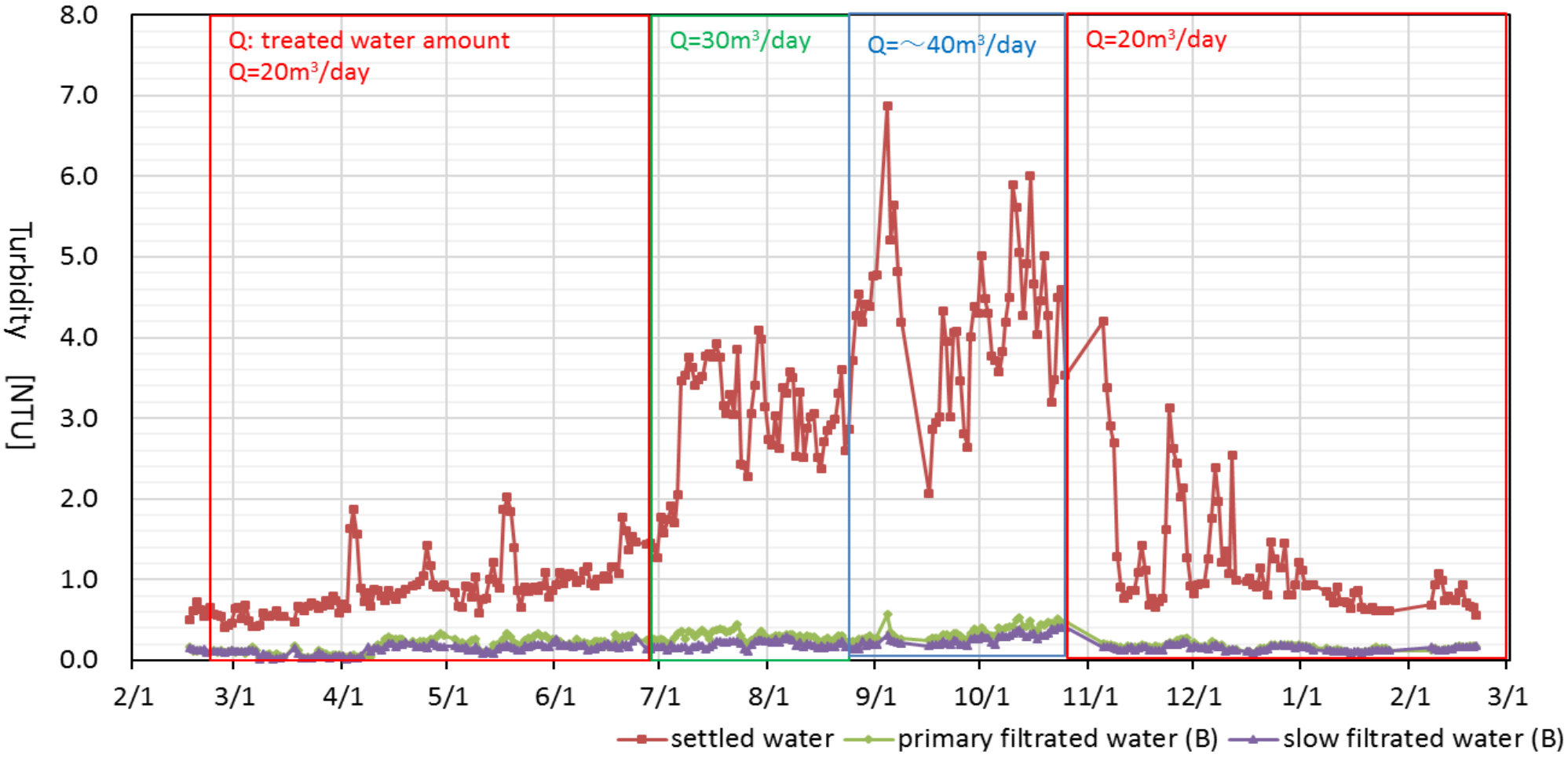


Fig-5 Turbidity of settled water, primary filtrated water, slow filtrated water

2) Iron (Fe)

Fe in the raw water exceeds 1.8mg/L (detection limit) in the rainy season, however, Fe in the slow filtrated water is steady at approximately less than 0.1 mg/L (water quality standard value in Vietnam is 0.3mg/L)

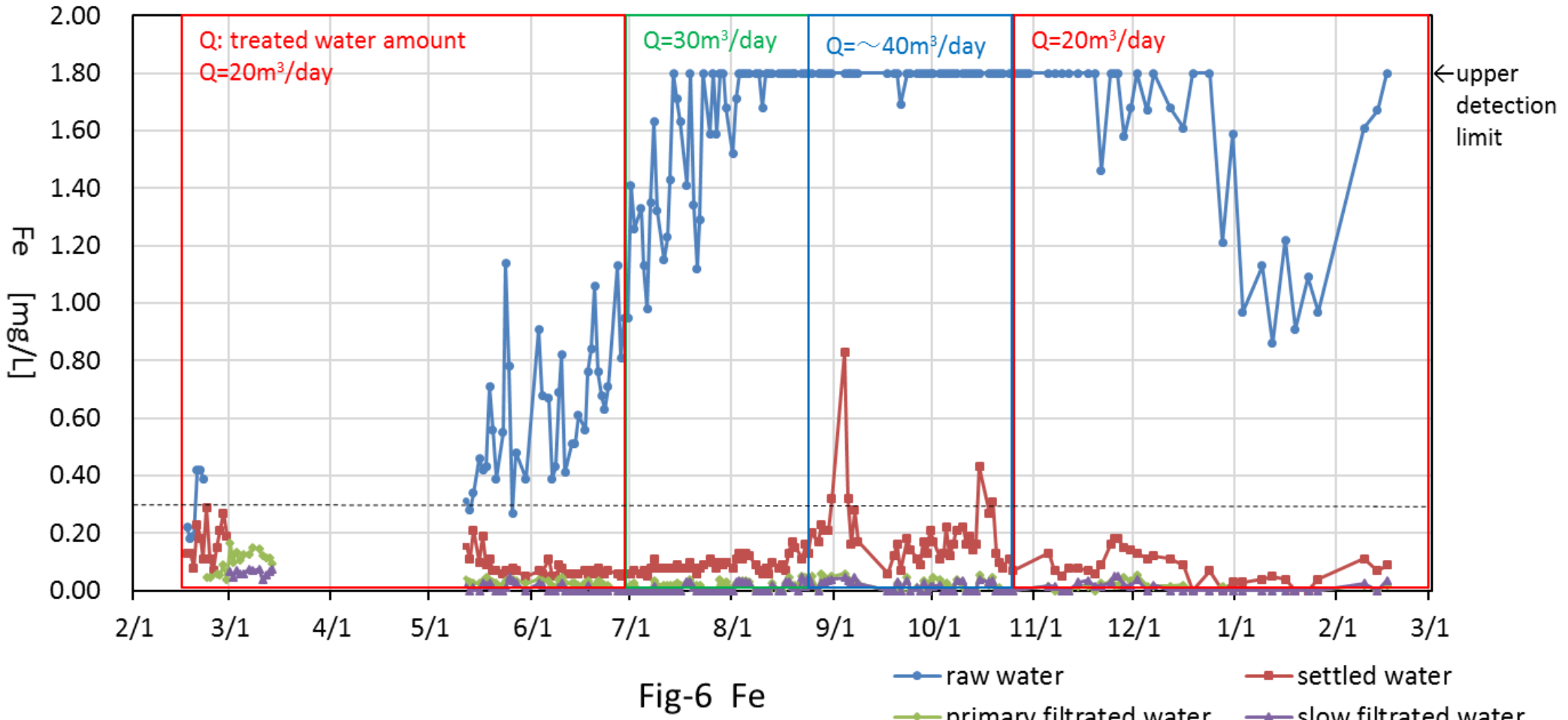


Fig-6 Fe

3) Manganese (Mn)

Dissolved Mn in raw water is almost less than 0.3mg/L (water quality standard value in Vietnam is 0.3mg/L). Mn in the slow filtrated water is almost eliminated except in the rainy season.

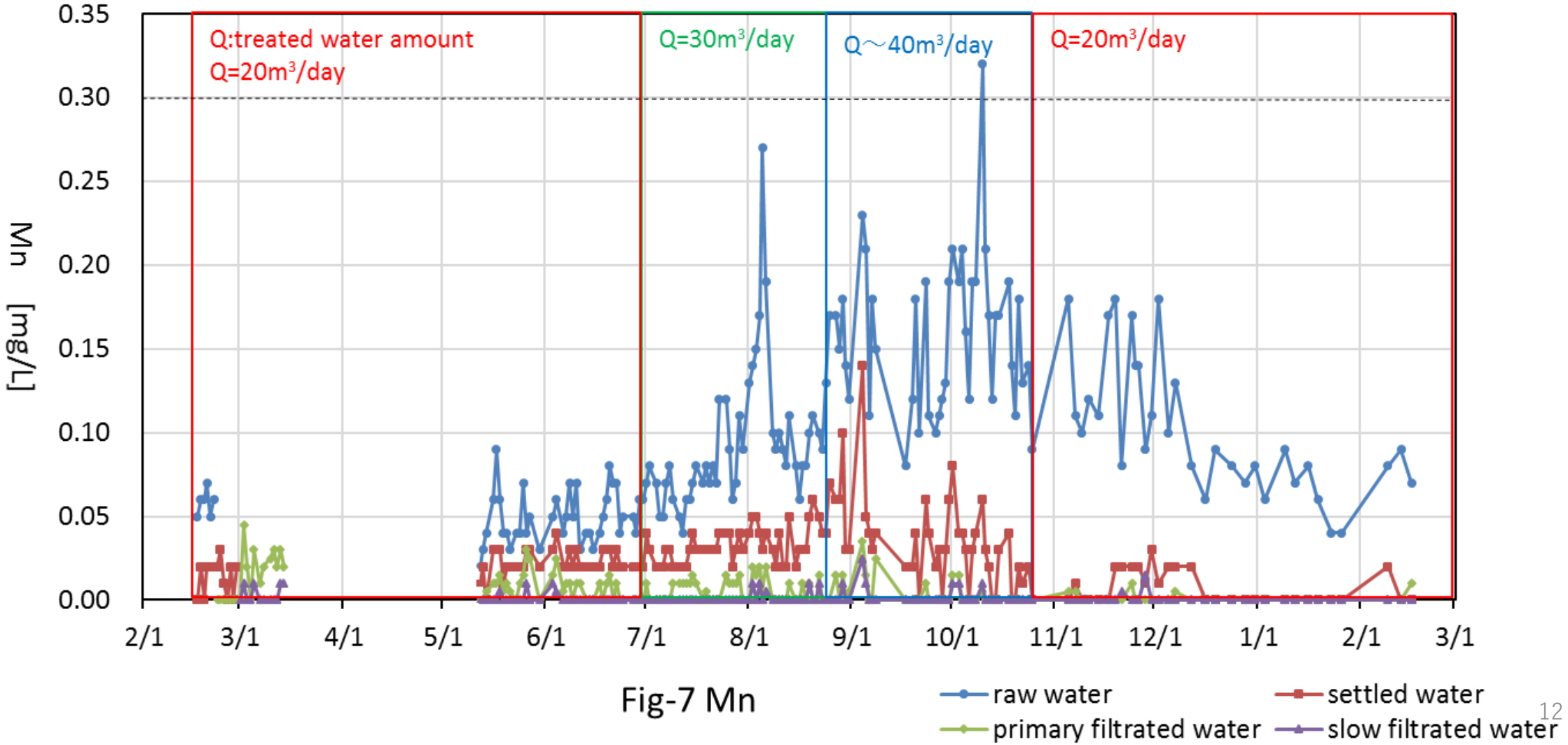


Fig-7 Mn

4) Ammonium nitrogen

Ammonium nitrogen in the raw water is less than 0.25mg/L (water quality standard value in Vietnam is 3mg/L). It is reduced 50% in the treated water.

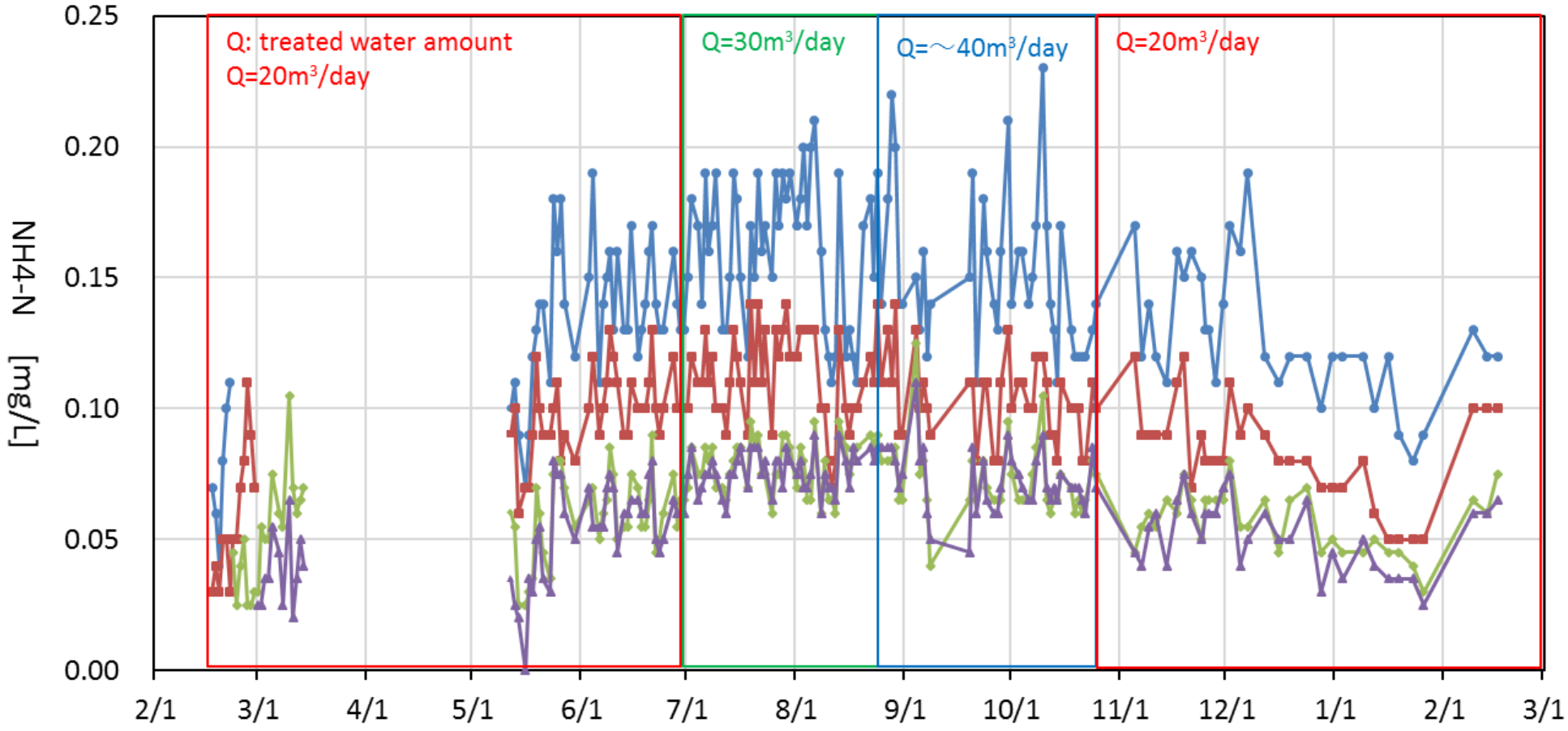


Fig-8 ammoniacal nitrogen (NH4-N)

5） Head loss in primary and slow sand filters

Thanks to the primary filter, the slow sand filtration can process continuously for 3 to 4 months. The primary filtration basin is blocked after 1 week operation and requires backwashing. Without the primary filter, the slow sand filter will be blocked in a week.

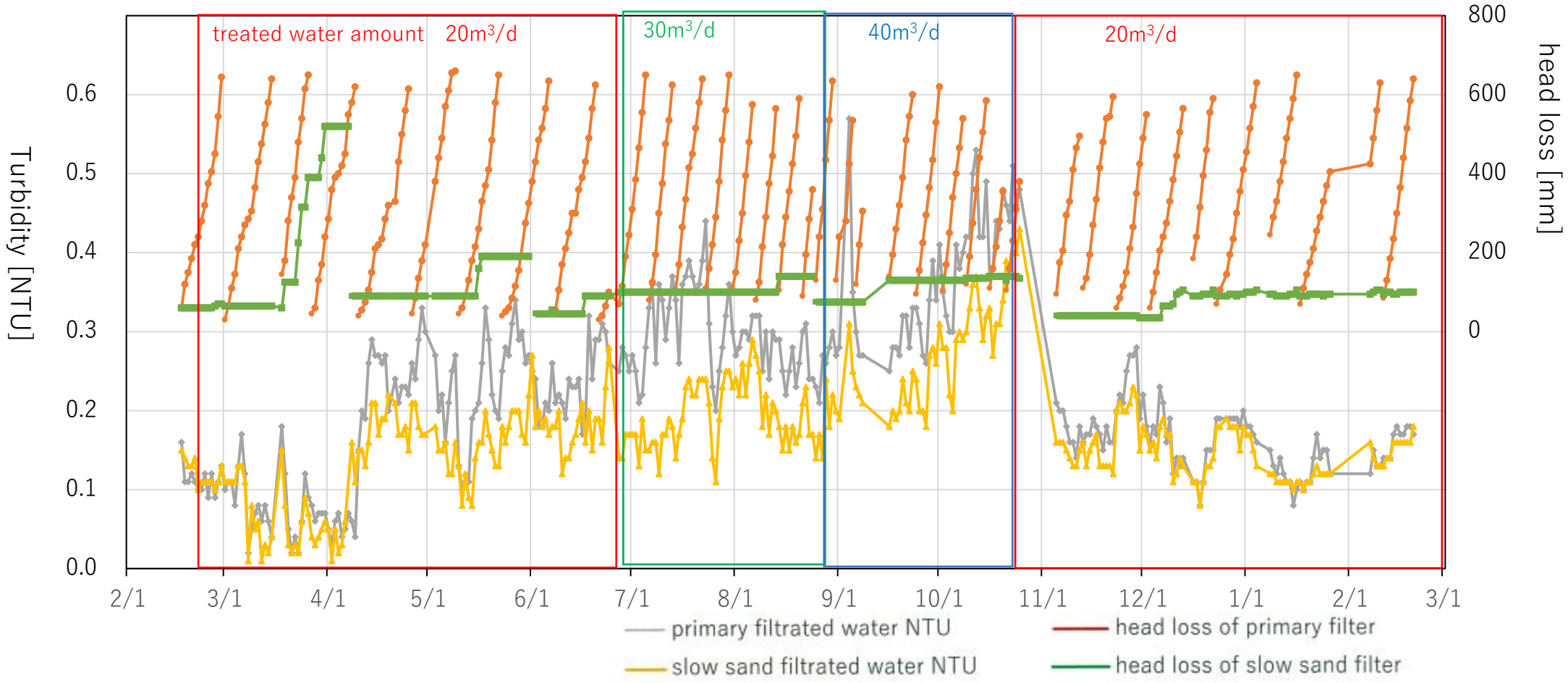
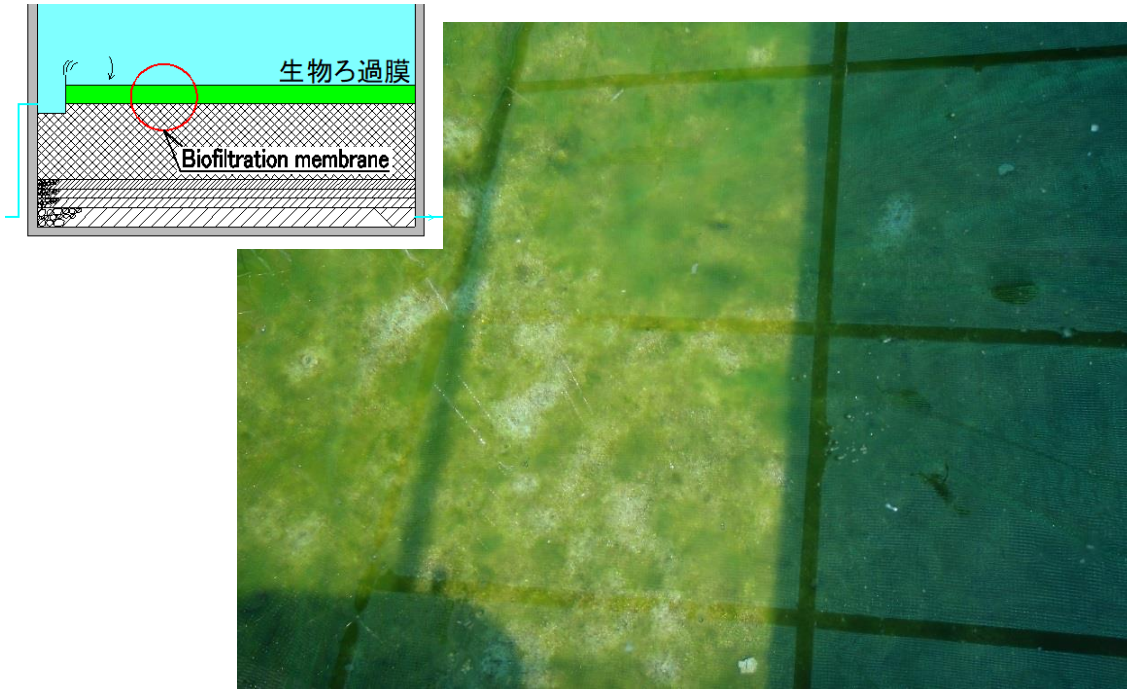


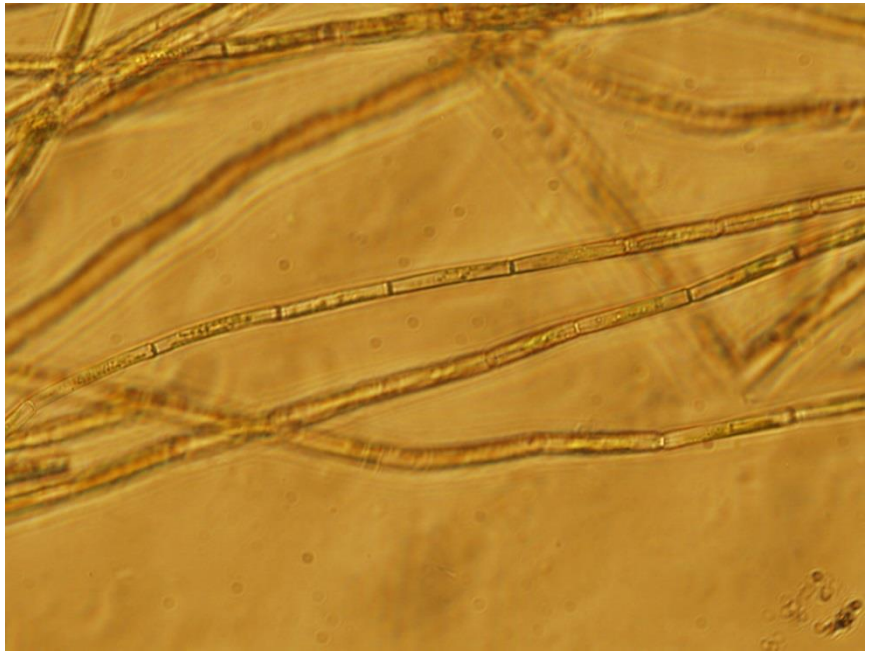
Fig.9 NTU of primary filtered water, slow sand filtered water and head loss

6） Biofiltration membrane

A） Status of biofiltration membrane（after 1 month）



B） Filamentous algae micrograph (Has a water purification function)



7) Other water quality parameters

Table-1 Water technical regulation on drinking water quality(QCVN01:2009/BYT)

	item	Standard value		item	Standard value		item	Standard value
1	Common Bacteria	0/100mL	20	Chloroform	0.2mg/L	38	Phenols	0.001mg/L
2	E.coil	0/100mL	21	Dichloroacetic acid	0.05mg/L	39	pH value	6.5~8.5
3	Cadmium	0.003mg/L				40	Taste	not abnormal
4	Mercury	0.001mg/L	22	Dibromochloro methane	0.1mg/L	41	Odor	not abnormal
5	Selelum	0.01mg/L				42	Color	15TCU
6	Lead	0.01mg/L	23	Bromate	0.025mg/L	43	Turbidity	2NTU
7	Arsenic	0.01mg/L	24	Total trihalometane	0.1mg/L	44	Ammonia	3mg/L
8	Chromium(VI)	0.05mg/L				45	Chlorite	0.2mg/L
9	Nitrite content	3.0mg/L	25	Trichloroacetic acid	0.1mg/L	46	Chlorine	0.3~0.5mg/L
10	Cyanide ion and cyanogens	0.07mg/L				47	Acrylamide	0.0005mg/L
11	Nitrate and Nitrite	50mg/L	26	Bromodichloro methane	0.06mg/L			
12	Floride	1.5mg/L	27	Bromoform	0.1mg/L			
13	Boron	0.3mg/L	28	Formaldehyde	0.9mg/L			
14	Carbon tetrachloride	0.002mg/L	29	Zinc	3.0mg/L			
			30	Aluminium	0.2mg/L			
15	cis-1,2-Dichloroethylen and trans-1,2-Dichloroethylen	0.03mg/L	31	Iron	0.3mg/L			
			32	Copper	1.0mg/L			
			33	Sodium	200mg/L			
			34	Manganese	0.3mg/L			
16	Dichloromethane	0.02mg/L	35	Chloride ion	250mg/L			
17	Tetrachloroethyler	0.04mg/L	36	Hardness	250mg/L			
18	Trichloroethylen	0.07mg/L	37	Total dissolved solids contents	1000mg/L			
19	Benzene	0.01mg/L						

(The major parameters of 47 out of 109 items are shown in the table left.)

The treated water was tested by outside lab in 109 parameters, which are regulated by the VNDWQS, and confirmed to meet the all parameters.

6. Conclusion

Followings were confirmed

1) Stable supply of safe and secure water quality

It is possible to respond to turbidity fluctuations in the rainy season and dry season.

2) Easy operation and maintenance, and less frequent failures.

3) Fe and Mn can be treated below the water quality standard.

*S.W.S was developed at the request of Dong Nai Provincial Agriculture and Rural Development Bureau which has the policy to improve the access to the safe water supply in the rural communities.

But the demonstration experiment did not include the awareness raising of the people about how important safe water supply was. As a result, people were not willing to drink water produced by S.W.S.

7. Way forward

1) Confirm the improvement points obtained from the demonstration experiment and improve the system .
2) It is necessary to raise the awareness of local residents about safe water (necessity of disinfection, etc.).
3) Try to supply safe water by utilizing this SWS. Select the most suitable area with the condition of the community scale, water quality of raw water, and the residents' cooperation.
4) In the future, expect to supply to a community of 1000 people.
5) Contribute to improving the safe water supply rate in rural areas of Vietnam.

Remarks

This experiment was conducted as a joint project with VINA TAK Co.,Ltd and FUYOU CONSULTANT Co., Ltd