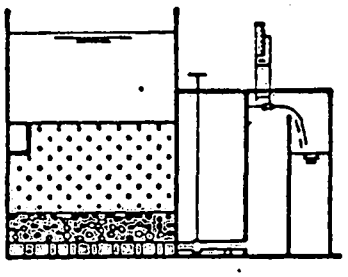
Slow Sand Filtration Project

MEETING OF REPRESENTATIVES OF SSF-PROJECT COUNTRIES

NAGPUR, INDIA - SEPTEMBER 15-19, 1980

International Reference Centre for Community Water Supply and Sanitation

P.O. Box 5500
2280 HM RIJSWIJK
The Netherlands



National Environmental Engineering Research Institute

Nehru Marg,
NAGPUR - 440 020
India

STATUS REPORT ON
SLOW SAND FILTRATION PROJECT
IN THAILAND

prepared by: Miss Sunanta Buaseemuang,
Mr. Anan Saipetch

September, 1980.

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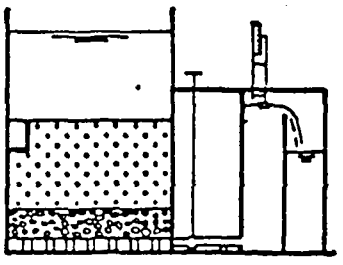

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ABSTRACT

Slow Sand Filters have been implemented in community water supply systems in Thailand since 1966. The technique has proved to be very suitable for the local conditions, especially because of its simple operation and maintenance. Since the cost of construction of Slow Sand Filter installations is higher than that of Rapid Filtration Plants and the available surface water is usually very turbid, Slow Sand Filters have until now, not frequently been constructed in Thailand.

The first part of this paper has been prepared to compare the cost of initial construction as well as operation and maintenance of Rapid and Slow Sand Filtration schemes under similar circumstances.

The characteristics of the community, such as social behaviour, education, occupation etc., are important factors that will influence the development of the community. The extent of the community participation depends on the needs of the community and the interest of the village leader. The study of socio-economic conditions of the communtiy provides the parameters to evaluate the readiness of the community to participate in the water supply project and the acceptance of the concept of self-help management of the water supply treatment plant.

A COMPARISON OF THE COST OF CONSTRUCTION, OPERATION AND MAINTENANCE OF RAPID AND SLOW SAND FILTRATION SYSTEMS.

1. INTRODUCTION

The Thai government, through its various agencies, has been engaged in the implementation of community water supply schemes since 1966. The majority of the schemes, completed since that time, incorporated a sequence of chemical coagulation, sedimentation and rapid sand filtration for the purification of surface water.

The treatment of deep well water, next to surface water the other available raw water source, consisted mainly of simple chlorination and aeration, sometimes followed by Rapid or Slow Sand Filtration.

The application of Slow Sand Filters has been rather limited in Thailand due to the high average turbidity of the raw water and the high initial cost of construction.

The International Reference Centre for Community Water Supply and Sanitation, The Netherlands, has, since 1976, sponsored the Research and Demonstration Project on Slow Sand Filtration in Thailand. In the second phase of this project three villages were selected for demonstration purposes. Two of the so called village demonstration plants have been completed and their performance is currently being monitored by the Asian Institute of Technology. The third plant is under construction since the beginning of 1980.

2. ECONOMIC COMPARISON BETWEEN RAPID AND SLOW SAND FILTRATION SYSTEMS.

2.1 Ban Bangloa * (Singburi Province)

Ban Bangloa is bordered on one side by the Chao Praya River and on the other side by an irrigation canal. In the vicinity of Ban Bangloa, the river and the canal run parallel to each other, about 300 meters apart. However, the houses of the village are mainly built along the banks of the river.

Before the installation of the Slow Sand Filter, the villagers used to take water from the river and from privately owned shallow wells. In the dry season, these wells run dry as the water level in the river decreases. The villagers then haveto descend the rather steep slope of the river bank and walk some distance on the dry bed of the river in order to reach the water.

Although the irrigation canal passes on the other side of the village, the Department of Irrigation has decreed that no pier may be constructed at any canal, thus considerably hampering the drawing of water.

The water used for the Slow Sand Filtration Plant is taken from the irrigation canal. From the canal it usually flows by gravity to a holding-pond of 40x 40 x 3 m^3 (approximately 5000 m^3 or about 45 days storage). Again by gravity, the water then passes through a horizontal-flow,coarse material pre-filter and the Slow Sand Filter to the clear well.

* for additional information, see interim report Thailand.

If the canal water happens to fall below the required water level in the holding-pond, a raw water pump can be used to lift the water from the canal into the pond. In order to lift the treated water up to the elevated tank, a clear water pump is also installed at the water works. From the elevated tank, the water is supplied to the consumers by gravity.

2.1.1. Cost of construction (ref. annex 1.)

If a rapid sand filtration system had been constructed, one filter would have been sufficient. Even if only one Slow Sand Filter had been built, the cost of construction of the Slow Sand Filter would still be higher than that of the Rapid Sand Filter.

2.1.2. Cost of operation and maintenance (ref. annex 2.)

The SSF-plant has been in operation since March, 1980. A village committee, consisting of seven members, has been formed to advise on the management of the water supply system. From the villagers, a man has been selected and trained as the operator of the treatment plant. He is responsible for the operation and maintenance, as well as for the reading of the water meters and the collection of the revenues. The revenues and the cost of operation and maintenance have been recorded since April 1980 as shown in annex. 2.

It can be noticed that the revenues average ฿ 4.100 (U.S. $ 205) per month, while the average expenses are ฿ 3.000 (U.S. $ 150) per month. This leaves approximately ฿ 1.100 (U.S. $ 55) per month as profits. A Rapid Sand Filter would have increased the cost of operation by ฿ 1.650 per month; about ฿ 1.200 for alum and about ฿ 450 worth of filtered water which would have been wasted due to back-washing. At the current price level, the initial higher cost of construction of a Slow Sand Filter would be balanced by the higher cost of operation and maintenance of a Rapid Sand Filter in about 8 years.

2.2 Ban Thadindam * (Lopburi Province)

The water supply scheme takes its water from a pond which is fed by a spring. This pond is situated about 800 meters from the village. The treatment plant

* for additional information see interim report Thailand.

was built on a gentle slope slightly below the level of the pond. In this way, both the Slow Sand Filter plant and the distribution system could be supplied by gravity and no pumps were required.

2.2.1. Cost of construction (ref. annex. 3.)

The cost of construction of the prefilter and the Slow Sand Filter amounted to ฿ 350.800 (U.S. $ 17.500), ฿ 19.800 (U.S. $ 1.000) more than the estimated cost of a Rapid Sand installation.

2.2.2. Cost of operation and maintenance

The construction of the plant was completed in December, 1979. A villager has been hired as operator for ฿ 500 (U.S. $ 25) per month. A village-committee, consisting of four members, has been set up to take care of the reading of the water meters and the collection of the revenues. For this work they receive ฿ 25 each per month.

The average monthly revenue in the dry season was about ฿ 1.400, but in the rainy season, this decreased to ฿ 1.200. After deduction of salaries and the cost of operation and maintenance (estimated at ฿ 200) profits between ฿ 400 - 600 per month or ฿ 4.800 - 7.200 (U.S. $ 240 - 360) annually may be generated. These funds will be very useful for further improvement of the water supply system.

The cost of operation of a Rapid Sand Filter is estimated to be about ฿ 200 per month higher than the operational expenses of a Slow Sand Filter, ฿ 140 for alum and ฿ 60 due to wasting of treated water. Initial construction cost of the Slow Sand Filter would again balance the cumulative recurrent cost of the Rapid Sand Filter after about 8 years.

2.3 Ban Thaluong, Lopburi Province

The village is presently situated on the banks of the Pasak river. However, the greater part of the population is supposed to give way to the highway which is planned and settle at the site of the new district capital. This new site is about 800 meters from the treatment plant, whereas the original village was about 2 km away. The raw water for the plant originates from an impounded spring and its quality is ideal for Slow Sand Filtration. In order to cut down

on investment cost, the pre-filtration unit has been deleted. In order to provide the village and the new settlement with a gravity supply, an elevated tank is needed.

2.3.1. Construction cost (ref. annex. 4.)

2.4 Conclusions and Recommendations

The following conclusions can be drawn in relation to the economic comparison between Slow and Rapid Sand Filters:

- the cost of construction of a Slow Sand Filter is about 7 ÷ 8% higher than a Rapid Sand Filter.
- depending on the degree of turbidity of the raw water, the cost of operation and maintenance of a Slow Sand Filtration plant may well be lower by 25 - 55% than that of a Rapid Sand Filtration plant.

If both the Rapid Sand Filter and Slow Sand Filter have operated continuously for about 8 years, the sum of the initial cost of the construction plus the costs of operation and maintenance of both systems would be equivalent.

One of the factors that has hampered the application of Slow Sand Filtration in the past, is the high initial cost of construction as compared to the initial cost of Rapid Sand Filtration. Generally, a water supply system is designed to function for at least 10 years without any problems.

This study clearly shows that Slow Sand Filtration within the standard design period, is not more expensive than Rapid Sand Filtration and may well turn out to be even cheaper in the long run. Therefore, it should be considered worthwhile to invest in the construction of Slow Sand Filters. Moreover, Slow Sand Filtration is more advantageous than Rapid Sand Filtration because of its simplicity of operation and maintenance.

IMPACT OF WATER SUPPLY SYSTEMS ON THE SOCIO-ECONOMIC CONDITIONS OF A COMMUNITY

Some Observations.

3. INTRODUCTION

It is necessary to study the socio-economic conditions of the community before one initiates a rural water supply project. The characteristics of the community, such as social behaviour, education, occupation, etc., are important factors that will influence the positive development and success of the water supply programme.

Influential villagers, such as the village headman, a religious leader, a headmaster, etc., can easily generate interest in such a programme. However, the degree of community interest most certainly depends on the need for the new facility. Furthermore, the willingness to participate in the water supply project also depends on the economic status of the community. Although the tap water provides better sanitary facilities in the households, some of the villagers are still reluctant to accept the new system because they feel they are unable to afford it.

3.1 Socio-economic survey

A set of questionnaires was developed and used for the collection of data for the study. These questions, together with informal interviews with the community members and other observations, served as indicators for the survey. Two communities were selected for the study:

3.1.1. Ban Bangloa (Singbury province)

Ban Bangloa is about 133 kms. from Bangkok on the bank of the river Chao Praya. The community has electricity supply and television for their home entertainment. Those who do not possess a TV will gather in their neighbour's house for the programmes.

Most people, living in this village, work outside the village as government officials. People who are not employed by the government usually work in the rice fields, leaving old people and small children at home. The older children attend the nearby school.

3.1.2. Ban Thadindam (Lopburi province)

Ban Thadindam is built on a piece of land which is cleared from the surrounding forest. The village houses are built fairly close together.

Before the completion of the water supply system, the people used to collect the water from the stream which flows through the village. The access to the village is by laterite road which is about 5 kms from the district of Chaibadal and about 198 kms from Bangkok. Electricity has been provided to the village about three months prior to the completion of the water supply project. Most people are active in agriculture, growing cotton, corn, tobacco, etc. The results of the baseline survey of these two villages are shown in Table 1.

Table 1 : Summary of the baseline survey on socio-economic aspects of Ban Bangloa, Singburi province and Ban Thadindam, Lopburi province.

Description	Ban Bangloa	Ban Thadindam
1. Percentage of houses surveyed	50 %	50 %
2. Population, total	314 families	159 families
	1.884 people	850 people
- male	46.5 %	50.0 %
- female	53.5 %	50.0 %
3. No. of people per family	2 - 13	2 - 13
- average	5	5
4. Owner status of the premises	99.0 %	99.0 %
5. Education		
- No. of schools	2	1
- literacy rate (age over 10 yrs)	83 %	86 %
6. Occupation distribution		
- farming	43.6 %	58.9 %
- stock-raising	3.7 %	0.2 %
- handicraft	2.4 %	4.3 %
- labour	9.7 %	8.0 %
- trading	6.3 %	2.0 %
- working ourside the village	5.6 %	0.8 %
- house-wife	2.9 %	1.0 %

- student	15.9 %	18.6 %
- unemployed	3.2 %	1.5 %
- unidentified	6.7 %	4.5 %
7. Sources of income		
- rice farming	44.0 %	1.0 %
- other crop farming	4.0 %	47.0 %
- stock-raising	4.0 %	1.0 %
- handicraft	2.0 %	17.0 %
- wage-earner	46.0 %	34.0 %
8. Average income / family / month	฿ 1.850 (US$ 92.5)	฿ 2.420 (US$ 121)
Average national income/family/month	฿ 1.930 (US$ 96.5)	฿ 2.400 (US$ 96.5)
Average national expense/family/ month	฿ 2.400 (US$ 120)	฿ 2.400 (US$ 120)
9. Present water sources	1. Chao Phraya River 2. irrigation canal	spring
10. Before installation of SSF		
- drinking water	rain	rain & spring
- for other purposes	river, well	spring
11. Treatment of drinking water		
- from rain water	direct 32 % boiling 11 %	direct 84 % boiling 10 %
- from river & well	alum 57 %	alum 6 %
12. Treatment of water for other purposes	alum 73 %	alum 7 %
No treatment	27 %	93 %
13. Refuse disposal		
- put into open pit for burning in surrounding areas	94 %	95 %
- other method	6 %	5 %
14. Having private latrine	92 %	83 %
15. Participation in		
- village affairs meeting	81 %	92 %
- health affairs meeting	67 %	39 %
16. Priority of village needs in relation to other needs	1. water supply 2. good road	1. good road 2. electricity 3. water supply
17. Needs for water supply	93 %	85 %

Description	Ban Bangloa	Ban Thadindam
18. willingness to participate in SSF project		
- through digging a holding pond (size 40x40x3 m^3)	97 % yes	93 % yes
- through labour for laying pipe line	97 % yes	97 % yes
- through purchase of water meter	97 % yes	97 % yes
19. willingness to pay for water meter		
- ฿ 1 per cubic meter	32 %	-
- ฿ 2 per cubic meter	35 %	18 %
- ฿ 3 per cubic meter	8 %	-
- not willing to pay	25 %	82 %
20. Preference on chlorine addition		
- agree	96 %	76 %
- disagree	4 %	24 %

3.2 Impacts of the water supply on the socio-economic conditions of the community

The Slow Sand Filter plant in Ban Bangloa was completed in March, 1980 and the one in Ban Thadindam in December, 1979. Since then, the socio-economic conditions of the opoulation have been monitored by provincial health workers. At this stage, the following impacts and changes in living conditions have become apparent.

3.2.1. Water usage pattern

After the installation of water supply, it was found that the rate of consumption during the dry season is 58 lpcd while the rate during the rainy season decreased to 26 lpcd. This resulted in an average charge of ฿ 2.30 per person per month during the rainy season and ฿ 5.20 per person per month during the dry season. This is caused by the fact that, during the rainy season, the population use rain and well water.

3.2.2. Increase in connection

It is noticed that one tap in each house for general use is neither sufficient nor convenient. There is a tendency to increase the number of taps in a house, for example, one in the kitchen and one on the the second floow. The use of plastic hoses connected to the existing tap has become very popular since it can supply the water to any place within the compound.

3.2.3. Community Participation

Before the construction of the water supply systems, the villagers in Bangloa have proposed to dig two holding ponds for the project. However, when the government initiated the construction, the participation of the villagers was reduced, resulting in only one holding pond being dug. In Ban Thaluang, the villagers have proposed to provide free labour to the equivalent of about 50 persons per day for pipe laying. But, when the former chief of the district was transferred to an other village, the interest declined and only a few people turned up to assist in the construction activity. It must be noted here that the provision of free labour poses difficulties for the supervision, since the labourers lack skills and experience in the work they are supposed to do.

3.2.4. Level of education of the operator

The future operator must have, at least, a fourth grade level of education and some additional experience in mechanical work in order to be eligible for our training course. We are confident that somebody who satisfies these requirements, can be trained to operate a Slow Sand Filter.

The difference between success and failure, with respect to the operation and maintenance of the Slow Sand Filter system, does not so much depend on the level of education but far more on his individual interest and job-motivation. This has been clearly demonstrated in the case of Ban Thadindam.

Except for the simplicity of the SSF system, it would have failed because of the operator's very low interest. The construction of a Rapid Sand Filter installation would, in this case, most certainly have led to a complete failure of the water supply.

3.2.5 Community leader

The role of the village headman (or leader) is one of utmost importance for success of the project. He must encourage the villagers to cooperate in the development project of the community. In case of rural water supply, he will determine the location of the plant site which usually is a compromise between the engineering recommendations and the land availability of the community. The extent of the community participation depends on his motivation. Therefore, the active interest of the headman will greatly enhance the success of the project.

3.2.6. The need to form a village committee for water supply

In Ban Thadindam, a village committee for water supply has been formed consisting of four people. This committee is responsible for reading the water meters and collecting revenues. Each of the four people receives ฿ 25 (US$ 1.25) per month for his work. The full-time operator is responsible for operation and maintenance of the system. He is paid ฿ 500 per month.

In Ban Bangloa, the village committee for water supply consists of seven persons but their duties and responsibilities differ from the committee in Ban Thadindam. They only give advice on the policy and management of the water supply and make decisions on such topics as water rates and the charges for new house connections.

3.2.7 Simplicity of Slow Sand Filter system enhances continued operation

At Ban Thadindam, the raw water is taken from a spring. The Slow Sand Filter is constructed on a slope providing sufficient head to supply the consumers by gravity without the need for pumping. The operator of this plant has shown very poor attention to his work because he complained that the salary paid to him is too low. Most of his time, he spends outside the village working on his farm. In spite of this, his absence does not trouble the villagers since the water is supplied by gravity and the system has automatically continued to function. This is a very ideal situation for a village water supply.

3.2.8 Familiarity

The villagers have now become familiar with the ease of the water supply. It is now difficult for them to return to the old way of life, travelling to fetch water. -The owner of one grocery store told me that, after her family had used tap water for a few months, her son, now, refused to go and fetch water from a pond, because he complained that the pond was too far and the tap water is readily available.

3.2.9 Influence of rain water during rainy season

People who have their private well will take water from it for their use during the rainy season. In summer months, the wells are almost dry so they have to resort to water from other sources. The water supplied by tap is obviously the most convenient source. The rainy season brings the water levels in the wells, back within easy reach. As a result, some of the consumers go back to use well water again. Besides, rain water is still considered better quality for drinking. It can be noticed that the revenue collection has decreased to about half during the rainy season.

3.2.10 Improvement of health education programme

The experience gained from the health education programme, has shown that people do not like to directly participate in such activities. For example, once there was a campaign in the demonstration village, to help the people to get rid of intestinal worms. The district health workers had prepared slides and films for demonstration at night time; however, they also had to entertain the villagers with their favourite movies, otherwise they would have stayed at home and only children and a few adults would have attended the programme. During the intermission, the health workers informed the villagers about the harmfulness of the

intestinal worms especially hook-worm, and asked them to come back again in the morning to take a laxative liquid. They could not get the people to cooperate in the programme since the population felt that it was not necessary for them and that they would be exhausted because of the laxative effects and also that they would have to leave their work for at least half a day.

The method of the approach on the village health education has to be revised and improved. For example, the movies have to be selected to meet their tastes with their favourite actor and actress, otherwise they will stay home and watch television instead. People like to have small things given free. Hence, the distribution of small gifts such as a pencil, a ruler or a sticker will attract their presence and ensure their participation.

ACKNOWLEDGEMENT

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The cost breakdown of various units of a Slow Sand Filter system as compared to Rapid Sand Filter System. Ban Bangloa, Singburi province.

Description	Unit cost of S.S.F. - Baht (US$ 1=฿ 20)	Unit cost of R.S.F. - Baht (US$ 1=฿ 20
1. Raw water pump house	51.000	51.000
2. Electrical pump for raw water	60.000	60.000
3. Clear water pump house	39.000	-
4. Electrical pump for clear water	60.000	60.000
5. Pipe connection within raw water pump house	14.000	14.000
6. Pipe connection within clear water pump house and treatment plant	61.000	61.000
7. Pre-filter	112.000	-
8. Slow Sand Filter	390.000	-
9. Rapid Sand Filter	-	380.000
10. Clear well	162.500	162.500
11. Elevated tank	247.500	247.500
12. Raw water distribution & delivery system	343.500	343.500
13. Chlorination tank	10.000	10.000
14. Tools for repair of engine & pipe connection	15.000	15.000
15. Miscellaneous items, fence, name plate etc.	123.000	123.000
16. Land	free	free
Total cost	1.689.000	1.527.500

Note : S.S.F. = Slow Sand Filter

R.S.F. = Rapid Sand Filter

Operation and Maintenance Costs of Ban Bangloa Water Supply Treatment Plant.
(US$ 1= ฿ 20)

Month 1980	Revenue	Operation and Maintenance costs						
		Salary	Fuel	Oil	Chlorine	Cleaning	Maintenance	Total Expenses
Dry season								
April	5.965	600	1.900	158	185	-	-	2.843
May	4.799	600	1.747	160	165	200	255	3.127
Rainy season								
June	3.050	600	1.468	132	150	-	275	2.625
July	2.550	600	1.554	125	140	200	315	2.932

The cost breakdown of various units of a Slow Sand Filter system as compared to a Rapid Sand Filter. Ban Thadindam, Lopburi province.

Description	Unit cost of S.S.F. - Baht (US$ 1= ฿ 20)	Unit cost of R.S.F. - Baht (US$ 1= ฿ 20
1. Pre-filter	108.200	-
2. Slow Sand Filter, cap 5 m^3/hr	242.600	-
3. Rapid Sand Filter, cap 10 m^3/hr	-	331.000
4. Clear well, cap 60 m^3	130.700	130.700
5. Main distribution system	327.000	327.000
6. Miscellaneous items, fence, name plate etc.	54.500	54.500
7. Land	free	free
Total cost	863.000	843.200

Note : S.S.F. = Slow Sand Filter
R.S.F. = Rapid Sand Filter

Cost breakdown of various units of a Slow Sand Filter system as compared to a Rapid Sand Filter system. Ban Thaloung, Lopburi province.

Description	Unit cost of S.S.F. - Baht (US$ 1= ฿ 20)	Unit cost of R.S.F. - Baht (US$ 1= ฿20)
1. Elevated tank	368.000	370.000
2. Clear water pump house	53.800	-
3. Clear well	199.360	200.000
4. Slow Sand Filter	527.000	-
5. Pipe connection for distribution system	43.850	45.000
6. Engine pump for clear well	60.000	60.000
7. Tools for repair of engine & pipe connection	15.000	15.000
8. Pipe connection within clear well pump house & treatment plant	167.090	170.000
9. Chlorination tank	18.000	18.000
10. Miscellaneous items, fence, name plate etc.	10.000	10.000
11. Land	free	free
12. Rapid sand filter, cap 20 m^3/hr.	-	443.000
Total cost	1.462.500	1.331.000

Note : S.S.F. = Slow Sand Filtration System

R.S.F. = Rapid Sand Filtration System.