Community Participation in Pollution Abatement and Water Quality Conservation through Bio Monitoring

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Abstract
Bang-Pa canal located in Ratchaburi province is a natural waterway passing through different communities with its various usages. An alteration in canal's geography due to the development of industrial estate coupled with the pollutant discharges by upstream community has hindered the use of canal water for the downstream community who depends on the canal most. This research project is carried out to mobilize stakeholder's participation on environmental issues of Bang Pa canal. It involves capacity building of the community in water quality conservation through water quality monitoring and biological assessment using macroinvertebrates. For this, 60 volunteers from four sub-districts were actively involved. The integrated results of water quality and macroinvertebrates analysis show that the upstream water quality of the Bang-Pa canal is better as depicted by physico-chemical and biological parameters (water quality index). As the canal passes through the community, the quality deteriorates as the polluted water flows into the canal through alternative paths. The activities of the project have been integrated with the ongoing environmental efforts of the villagers on the conservation of the canal to maximize the effect. The involvement of local administration was rated as satisfactory by the community towards the issues of the canal. However, participation especially from the women residents is further required for conservation of water quality.

Keywords: Water quality, biomonitoring, macroinvertebrates, community participation, capacity building.

Introduction
Bang-Pa canal is a natural waterway located in Ratchaburi province, a fast growing peri-urban community 80 kilometers southwest of Bangkok. The canal has a total length of 37 kilometers spanning from Potharam District to Muang District of Ratchaburi Province. The canal passes through six sub-districts, namely, Klongkoi, Chedsamean, Don Sai, Sam Ruan, Pikulthong, and Bang-Pa. The uses of Bang-Pa canal varies as it passes through one community to another. During the past decade, the geography of the canal is altered due to the construction of Ratchaburi Industrial Estate located in Chedsamean sub-district where parts of canal were filled up in order to create land area set aside for future development. Nowadays, the canal blockage has hindered the usages of canal water in the surrounding areas where the waterway is prone to discharge from industries and also as a channel to receive wastewater discharged from household and livestock farms on daily basis by the villagers (Ongsakul, R. and Thongbhakdi, A., 2006).

The eminent pollution problem not only create burden and loss for those who rely on the uses of canal water but also creates conflict on transboundary social issues among the stakeholders; especially in the downstream area of Sam Ruan Sub-district since people here

depend on water from the canal for their daily activities. Many villagers are engaged in the ornamental fish business (for export), fruit, vegetable and rice farming. An initial effort was made with the collaboration of PDA (Population and Development Association) through the establishment of conservation clubs as community based organizations (CBOs) for "Conservation of Bang Pa Canal" which is funded by Ratchaburi Power Plant. Their activities are confined to plantation of trees, establishment of small parks along the banks, growing grass as natural water treatment system, and collecting garbage and weeds. However, the conservation groups organized in each village do not have good coordination of their activities among each other. As a result, the core problems remain in place and the pollutions in Bang Pa Canal continue to persist.

The project is carried out in the lower part of Bang Pa canal covering 4 sub-districts namely: Don Sai, Sam Ruan, Pikulthong and Bang Pa, with the collaboration of PDA focusing on the development and capacity building of community for water quality monitoring system using biosensors for water quality conservation. Sam Ruan sub-district was the main focus area of the project and the other 3 sub-districts were considered as the dissemination area.

Methodology

Preliminary survey was performed through questionnaire distributed to the members of local conservation clubs and local people randomly in order to identify the linkages between community and their activities with respect to the existing canal condition. Questions were also asked to verify the level of satisfaction of the community towards the various aspects of local governmental actions on canal conservation. Opinions were distinguished based on gender equality.

The project had identified volunteers through series of meetings based on the existing conservation clubs, active groups such as: women groups, local school and local governmental agencies for the mobilization of local community within their own villages. During the meetings, activities to be conducted were presented for prioritization by the participants. Prioritized activities maximized the level of public participation in the project through their own decision making according to Appreciation Influence Control Process (AIC) which helped in better implementation the of project activities. However, for each group of volunteers, "Activity Calendar" was developed with different activities formulated under the project and these were integrated with the annual plan based on "Conservation of Bang Pa Canal" funded by Ratchaburi power plant. These volunteers participated in water quality assessment, monitoring, and determination techniques. Additionally, three major meetings were arranged during the project period with the volunteers of 4 sub-districts before the training.

A total of 11 sampling points (identified as RA1-RA10) had been determined and all recorded with GPS coordinates which includes; 1 reference sampling point (man-made irrigation canal) and 10 sampling points located along the canal and waterways which passes through the 4 sub-districts. A detail sketch of the canal and waterways including 10 sampling points is given in figure 1.

Field analysis of physico-chemical parameters for water quality was conducted with the active participation of volunteers. Parameters that were measured include pH, Dissolved Oxygen (DO), Conductivity, Total Dissolved Solids (TDS) and Temperature using onsite portable

field instruments. Phosphate analysis was done in the laboratory. Apart from water quality analysis using physico-chemical parameters, biological samplings for macroinvertebrates were carried out in Sam Ruan sub-district to develop a biological community based water quality monitoring system.

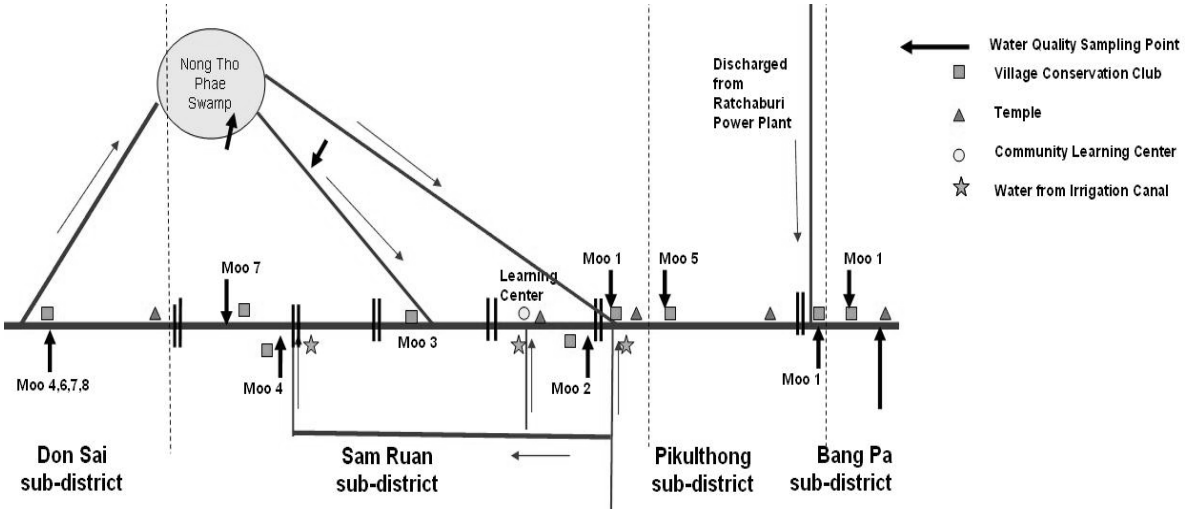

Figure 1. Schematic sketch of Bang Pa canal and the location of 10 water sampling points

This was carried out along the water sample collection with the collaboration of PDA, local volunteers and project team. Samples of macroinvertebrates collected were identified on-site using a reference guide (Tilling and Kanjanavanit, 2000). Unidentified samples were preserved in 90% ethyl alcohol and taken back to be identified at the laboratory. Water Quality index was developed based on giving pollution score to the macroinvertebrates and assessment of water quality was done by using the water quality index (Tilling and Kanjanavanit, 2000).

Training on water quality monitoring for the local community was conducted by the development of a learning center at the local school for their technical capacity building. The center was developed as a base for information system and laboratory for water quality analysis and monitoring. The center provides learning resources based on the skilled level of the community regarding water quality monitoring and the management of environmental issues raised by the community members. Volunteers were trained at first at their respective conservation clubs during water and macroinvertebrates sampling. The formal training was performed at the learning center for the school children, volunteers of each village, PDA officers and the community with the presentation of results of water quality analysis and monitoring.

Results and Discussion

Bang Pa canal plays an important role in livelihoods of people living along the entire path of the canal, especially in Sam Ruan sub-district. Due to its flat topography, the area is suitable for agriculture. Villagers are involved in ornamental fish farming (Moo 3), vegetable and rice farming and cattle farming. The canal is therefore used as an input of water for fish pond, vegetable gardens and paddy fields.

It was found from preliminary survey that there is still high level of dependency on the use of canal water (73%). Among them 74% are male and 26% are female. Canal water is utilized primarily for domestic use (cooking, laundry, dishwashing) and also for bathing and other uses such as plant watering, car washing. Only 47% of the respondents who use canal water do pre-treatment before using. Around 44% of the whole population is involved in canal conservation activities (32% male, 12% female) such as removal of aquatic weed, clean up along the canal, providing environmental knowledge to the community and improving environmental surroundings along the canal. The villagers opinion towards the local governmental agency Tambon Administration Organization (TAO) about the pollution issue was some how satisfactory in terms of priority but the satisfaction level decreases when considered the policy and promotion done by TAO.

Water quality assessment through physico-chemical and biological analysis

A total of 60 volunteers were identified by the project team from 4 sub-districts during the meetings for the community based water quality monitoring. They are the members of the conservation clubs, heads of villagers, local public health officers, members of women groups, ornamental fish farm owners, senior elders, members of local government agency (TAO), public health officers, local school teachers and students. The developed activity calendar maximized the volunteers/community participation during water quality analysis and monitoring. The meetings allowed them to discuss their own experiences with the project team which helped the team to serve and guide them according to their needs.

Bang-Pa Canal is classified as “Surface Water Type 2” under PCD’s (Pollution Control Department) Surface Water Quality Standard. Water depth in the canal is generally more than two meters with some exceptions where the canal passes through the main communities, water depth is decreased due to large amount of sediments. The canal channel is wide (> 6 meters) with the shape of stream bank steeply sloped. The bottom of the stream is muddy.

There are several species of aquatic plants covering the surface of the canal. The dominant species is water hyacinth which hinders the flow of water in the canal. Stream sides are being used as grazing area for cattle. The sites are also used as place of waste dumping and open-burning near the houses. Water flow is interrupted at the upstream of Sam Ruan sub-district by the development of a blockage between Don Sai and Sam Ruan sub-districts in order to prevent the flow of polluted water from upstream communities into Sam Ruan sub-district.

The dissolved oxygen concentrations of Bang Pa canal varied from 1.53-4.04 mg/l. The lowest value (RA1:1.53 mg/l) was measured at the blockage point of Don Sai (Don Sai side) sub-district where water is totally stagnant. Dissolve oxygen values were higher at the upstream of the canal (RA2:4.04 mg/l, RA3:3.96mg/l) in Sam Ruan sub-district where upstream polluted water could not pass through from Don Sai to Sam Ruan (Figure1). Additionally they are located near irrigation canal which receives clean water from Tha Rab sub-district. But as it passes through the community of Sam Ruan, water quality deteriorates (lowest RA5: 1.81 mg/l, near Nong Tha Pae swamp) as the water from upstream flows into the canal through alternative paths (Nong Tho Pae swamp) along with the pollution from community.

Conductivity was measured together with the determination of Total Dissolve Solid (TDS) in water. In general, conductivity values measured (ranging from 337 to 1042 µs/cm) were higher than the established standard of type 2 (< 500 µs/cm). The highest value was obtained

at the point of lowest DO (RA5). Higher values were obtained from two sampling points: RA1 (994µs/cm) and RA2 (999 µs/cm) which are situated at the opposite site of the blockage point.

The nutrient loading in terms of phosphate concentration varied from 0.1566 to 0.5058 mg/l within Sam Ruan sub-district. The upstream of Moo 4 had the lowest value. The results of macroinvertebrates sampling were translated into Water Quality Index (WQI) and assessment of water quality was done based on that index. Table 1 and 2 shows WQI developed based on the number of total macroinvertebrates found during the survey conducted by the project team with the identified volunteers and the assessment of water quality based on that. The assessment shows that the water quality varies from average to rather clean water. When the results of physico-chemical analysis were integrated with the results of macroinvertebrates, it showed that the quality of upstream water in Sam Ruan sub-district of Bang Pa canal is better. This is mainly due to the location of the blockage point and the irrigation canal. Although polluted water cannot pass through the blockage but the people still experiences the pollution at the downstream through alternative paths.

Table 1. Assessment of water quality based on WQI score

WQI Score	Assessment of water quality
5.1-7.5	Rather clean-clean water
2.6-5	Rather dirty water- average
1.0-2.5	Dirty water
0	Very dirty water (no life at all)

Table 2. Macroinvertebrates and pollution score in Sam Ruan sub-district

Macroinvertebrates found and pollution scoring		Villages			
		Moo 7	Moo 4	Moo 2	Moo 1
Intermediate/ Low Pollution Tolerant Species (6-10)	Stonefly nymphs (10)	n/a	n/a	n/a	n/a
	Mayfly nymphs (10)	n/a	n/a	n/a	n/a
	Caddisfly larvae (10)	n/a	4	2	n/a
	Dobsonfly larvae (9)	n/a	n/a	n/a	n/a
	Dragonfly nymphs (6)	3	6	n/a	n/a
	Damselfy nymphs (6)	n/a	n/a	6	n/a
	Freshwater limpets (6)	n/a	15	n/a	n/a
	Swan mussels (6)	n/a	10	n/a	n/a
	Pagoda snails (6)	30	7	15	35
Intermediate/ High/ Very High Pollution Tolerant Species (1-5)	Waterbugs(non-classified) (5)	10	30	3	n/a
	Water boatman (5)	50	20	n/a	15
	Beetle larvae (5)	15	n/a	n/a	n/a
	Freshwater shrimps (5)	50	50	20	15
	Other snails (3)	18	5	20	33
	Leeches (3)	n/a	n/a	5	2
	Segmented Worms (1)	n/a	2	n/a	3
	Mosquito Larvae (1)	10	n/a	5	3
	Fly Larvae (1)	2	n/a	5	3
Total Number of Animals		188	149	81	106
Total Score		889	785	346	474
Water Quality Index (WQI)		4.73	5.27	4.27	4.47
Assessment of Water Quality		Average-Rather Clean Water			

*n/a= not available

The training (Figure 2) was conducted covering all the basics technical knowledge of water quality monitoring through classroom activities for volunteers from conservation club as well villages, PDA officers and school children. The technical capacity of the individual was build during the training by lending the equipment and analyzing the samples for water quality and macroinvertebrates by themselves. Apart from the classroom lessons, field survey were conducted around the community and environmental management sites, which made them able to identify the sources of pollution and best sustainable solution for the management of the canal. These were also discussed during the training. Besides canal management issues, additional activities on other environmental issues were conducted to support and enhance the technical knowledge of the villagers such as the analysis of locally produced compost from aquatic and organic wastes and use of locally produced effective microorganisms' solution as pre-treatment of water before using it for culturing ornamental fishes in the fish pond. During the training, suggestions were also made to improve the quality of such locally produced product. The training allowed the project to find the strength and weakness of each community so that, the strength of one community become a valuable knowledge to be transferred and shared with other communities and enhance inter-community participation.

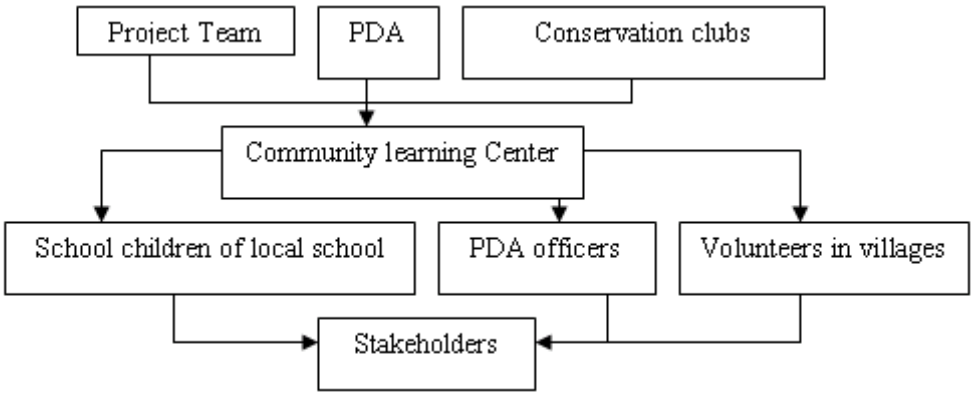

Figure 2. Flow diagram for training

Figure 3. Capacity building of the community

Conclusions and Recommendations

The obtained results imply that water condition in Bang Pa canal has been deteriorated dramatically at some points within Sam Ruan sub-districts (DO value 1.81 mg/l) from anthropogenic point sources and non-point sources (agricultural runoff) due to the daily activities of the villagers. The better quality of upstream water is due to the human made interruption of water flow. Conversely, the results from questionnaires show that there is still high dependency on the use of canal water. An effort was made by the project to implement a low cost simplified method of biomonitoring technique and to maximize the public participation on canal conservation activities through training.

Since its initiation, the project has brought together many different stakeholders from various sectors including local communities, governmental agencies and community based organizations in pollution prevention and canal conservation.

The increase in interest in water quality domain can be made through stakeholders/local community participation. It is necessary to increase local community involvement including both genders in water projects as this participation helps to ensure public perception in terms of environmental awareness, trust and ownership towards the initiation of community driven water quality monitoring program.

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