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DEVELOPMENT OF WATER UTILIZATION AND APPROACH OF WATER QUALITY SUSTAINABLE MANAGEMENT IN PATTANI WATERSHED, SOUTH THAILAND

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Abstacts

Development of water utilization and approaches for sustainable management in the Pattani Watershed was subjected to study (1) the ecological development of water utilization in the Pattani watershed, (2) water utilization of the people in the Pattani watershed, and (3) to find efficient approaches to manage water and water quality in the crucial water resources in the Pattani watershed. Collected data were collected using in-depth interview of focus group and questionnaire. Sampling size was 21 samples for interview of focus group and 400 samples for questionnaires. Water samples were evaluated in term of chemical quality, physical quality and Biological quality. It was found that (1) use of water for agriculture and consumption was traced back in the past, but currently it was being used for plumbing. There was a system of waste water treatment established in the area, 2) Utilization of water for agriculture and consumption was still prominent as livestock and fishery used local plumbing water, 3) Good water management was a result of information perception, and participation of leader and people.

Key words: Water utilization, Water quality, Sustainable management, Pattani watershed.

INTRODUCTION

Water is vital to population of the world in all of its ages because all living things exist by the virtue of water as an important factor. As countries have been developing more and such development has spread, growth rate of population has added the importance of water. Due to communities, economic societies, and industries use water in careless manner, such as use of excessive water, discharge of untreated sewage, water resources have become deteriorated and caused impact on the environment. In many countries, the importance in sustainably maintaining the ecosystem equilibrium through proper use of water has therefore got the first place. However, reconsidering the problematic causes of water pollution in water sources, those issues mostly come from bad individual and households practices, including those from agricultural and industrial production levels. In fact, the solution of water quality deterioration of water sources is hard to achieve unless all concerned participate the actions in particular, from those individuals who involved with and surrounded water sources. Principally, human behavior modification is often based on several factors and conditions, internally and external. For educated person, modifying the behavior is based on individual relationship between factors like knowledge, attitudes, values, and external factors such as those of economic, social and cultural context. This suggests that behavior of water consumptions is of both positive and

negative. That is, there are still many people performing their daily activities that affect water quality, whereas some people started to modify behaviors that contribute to conservation of water quality. Such positive behavior modification is neither littering waste nor sewage into water, but collaborating campaign of monitor and maintaining the cleanliness of the water. This is because communities nearby water can and must take advantage of water rather than communities far from water sources (Vichit Rangpan, 2005).

In Thailand, solution of water issues is just the off hand actions which do not fix those issues from their real causes. As it is evidenced by the occurrence of floods and droughts in the same areas, i.e. the advantage of sudden rain causing flood (huge amount of water) is never considered to manage water shortage in the summer season. Similarly, the issue of no enough water to expel waste water in various polluted watersheds such as Songkhla watershed (Prince of Songkla University, 1997) is not supposed to happen as this particular watershed has sufficient amount of water, fresh, marine and brackish water circulating throughout the year. But with more community growth, industry expansion, uncontrolled effluent and wastewater ill treatment, adverse effects had occurred in 2002 resulting in more than 40 tones of dead fish in the cages, and loss of ฿40 million as well as rapidly growing weeds, and needs government manage at last (National Economic and Society Development Board, 2003: 57-62). Another instance is the shortage of water consumption in many provinces of Thailand, which urgently needs plumbing to be operated for every household.

Pattani watershed is one of the water resources in the region that is vital to the ecosystem and social structures shaping the watershed communities. The sovre of water is from the water upstream in the mountain ridge of Sankalakhiri, Betongdistrict,Yala province. Its stream flows to the north passing through Thanto, Bannangsta, Capital districts of Yala province, and to Nongchik and Yaring districts, and Pattani irrigation dams, and meets the Gulf of Thailand in Capital district of Pattani province. Whereas, Saiburi river has its headwater from various mountain peaks of Sankalakhiri ridge of Sankalakhiri, passing through Raman district of Yala province, Ruso and Srisakorn districts of Narathiwat province, and next to Raman district of Yala province and flows into the Gulf of Thailand in Pattani Bay, Saiburi and Yaring districts of Pattani province with total distance of 200 kilometers. Pattaniriver is an important ecosystem, comprising of different sub-ecosystems like Halabala Wildlife Group, which is of tropical rainforest, mangrove, swamp and freshwater ecosystems. Pattani with its brackish water ecosystem is a source of biodiversity that is rich in wild plants and animals (Forest Department, 1999: 47). Similarly, Pattani river watershed is an ecosystem composing of various lives including microorganisms, human as well as inanimate and various man-made structural buildings such as infrastructures of dams, water reservoirs, also ancient monuments, besides all forms of activities relating various land uses. All these are interacted each other contributing to important functions of the ecosystem.

RESEARCH METHOD

Both qualitative and quantitative approaches were used in this research. Qualitative data was based on the findings and all related reviewing documents including both primary and secondary documents and encompassing those written in Thai and foreign languages. Interviewing using in-depth (Deep Interview) with questionnaires was also included. For quantitative data, data survey for water quality and statistics relating to water consumption was employed. Guidelines for research and data sampling were also set, and they were the followings.

1. Reviewing Relevant Documents. This was done prior to field data collection. Water related information including its utilization, development, management, water quality in Pattani watershed and similar information was studied. Information sources included government

agencies that have various research papers and statistical data, and various libraries in the region and in Bangkok. These summarized and synthesized relevant documents were reported in Chapter 2.

2. Setting the Research Tool. Study tool consisted of two parts; questionnaire with in-depth discussion, and the setting of tools for collecting the water samples, examination of water quality.

3. Field Collection of Data. Field data collection was conducted separately in each provinces with methodology as below.

3.1 Water Sampling and Analysis. This was done to get data for examining and statistically **analyzing**. Quality of water samples were evaluated in 2 phases: the dry season and rainy season. Water sampling areas encompassed the key sites from the upper, middle, lower parts of Pattani watershed. Water quality data from the present study were finally compared with those of previous reports.

3.2 Qualitative Data Collection. In-depth interview used face-to-face or direct questioning based on prepared questionnaires and taped recorded.

4. Data Analysis. For the analysis of qualitative data, purpose-based classification of data was initially **conducted**, and data were then analyzed by comparing the semantic concepts, theory and research results altogether. Statistics was also used in this context to analyze and summarize results.

RESULT AND DISCUSSION

Water Quality: Total Solids. From 3 sections of the watershed, examination of 24 sites resulted as shown in Table 1.

Water sampling locations	**Sampling Sites**								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Upper	221.00	208.15	233.38	233.50	226.38	205.88			
Middle	224.13	222.63	233.13	230.75	229.50	233.00	211.13	217.00	229.13
Lower	221.25	213.63	219.50	225.38	223.00	231.00	238.50	245.63	248.25

Water Quality: Conductivity. From 3 sections of the watershed, conductivity examination of 24 sites resulted as shown in Table 2.

Water Sampling Locations	**Sampling Sites**								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Upper	133.54	110.38	126.05	152.08	137.51	156.18			
Middle	126.70	176.43	155.40	110.75	156.25	141.05	155.85	152.69	139.60
Lower	131.81	114.08	115.88	141.43	173.85	133.33	156.87	157.43	161.26

Water Quality: Acidity. From 3 sections of the watershed, acidity examination of 24 sites resulted as shown in Table 3.

Water Sampling Locations	Sampling Sites								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Upper	8.93	8.84	8.80	8.78	8.77	8.77			
Middle	8.94	8.90	8.73	8.81	8.72	8.82	8.74	8.75	8.67
Lower	8.86	8.87	8.85	8.76	8.80	8.78	8.85	8.77	8.78

Water Quality: Dissolved Solids. From 3 sections of the watershed, dissolved solid examination of 24 sites resulted as shown in Table 4.

Water Sampling Locations	Sampling Sites								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Upper	664.25	676.25	682.88	685.50	688.13	696.63			
Middle	707.25	695.13	714.63	708.63	726.00	714.88	682.00	684.63	679.25
Lower	684.88	696.88	685.88	688.88	676.88	695.00	695.13	696.75	710.38

Water Quality: Turbidity. From 3 sections of the watershed, Turbidity examination of 24 sites resulted as shown in Table 5.

Water Sampling Locations	Sampling Sites								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Upper	28.77	15.56	15.90	13.28	9.53	8.84			
Middle	21.36	7.63	12.76	14.88	16.96	30.00	14.11	16.65	16.30
Lower	17.66	12.23	20.83	15.66	14.53	12.50	12.30	9.24	21.39

Water Quality: Dissolved Oxygen. From 3 sections of the watershed, dissolved oxygen (DO) examination of 24 sites resulted as shown in Table 6.

Water Sampling Locations	Sampling Sites								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Upper	6.09	5.70	5.85	5.86	5.70	5.49			
Middle	5.61	5.61	5.20	5.33	5.71	5.73	6.09	5.70	5.88
Lower	5.85	5.54	5.60	5.60	5.56	5.68	5.68	5.63	5.80

Water Quality: Temperature. From 3 sections of the watershed, temperature examination of 24 sites resulted as shown in Table 7.

Water Sampling Locations	Sampling Sites								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Upper	27.38	27.39	27.43	27.10	27.31	24.65			

Middle	27.18	27.50	27.38	27.13	27.13	27.25	27.48	27.56	27.38
Lower	27.41	27.36	27.61	27.24	27.38	27.09	27.18	27.38	27.25

Water Quality: Coliform Bacteria Count. From 3 sections of the watershed, coliform bacteria examination (in MPN/100) of 24 sites resulted as shown in Table 8.

Water Sampling Locations	**Sampling Sites**								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Upper	396.88	419.25	430.25	416.25	470.25	380.50			
Middle	437.50	425.13	475.00	438.88	412.75	450.00	462.50	506.25	575.00
Lower	498.75	448.13	443.88	461.25	452.50	466.25	387.75	472.50	423.75

Quantitative finding from questionnaires showed that 200 female and male respondents were 40.5% or 163 persons aged in year 20-29, and 36.8% or 147 persons being in undergraduate **education**. As many as 274 respondents representing 68.5% were members of families, and they were mostly farmers representing 145 individuals or 36.3%, and 125 or 31.3% were generally employed. Further findings were of 148 or 37% respondents had land estate less than 10 acres with 183 or 45.8% having the net income per month from ฿5,000 to ฿10,000. Native residents of Pattani watershed were 350 respondents or 87.5%, and of these 190 individuals or 47.5% being residents of the lower part of the Pattani watershed (Yarang, NongChik, Yaring, Pattani capital), 118 or 29.5% of the upper (Betong, Thanto, Bannangsta), and 92 or 23.0% of the middle part (Krong Pinang, Yala capital). Sampling respondents of Pattani watershed aged 20-30 years old represented 132 individuals or 33.0%. Respondents of 243 persons or 60.8% had land estate, and of 109 or 27.3% inhabited 1-2 kilometers from Pattani river.

For the benefits of using water, comments leveled “more” in 2 cases, i.e. use in consumption with highest **average** percentage of 3.77, and use in plantation and livestock cultivation with average percentage of 3.68, and 3.32. Level least was of fishing (fish, shrimp cultivation) which was 2.80%.

For water source issues in the household, comments leveled “more” in cases of use local plumbing with score of 3.51%, whereas moderate level was 3.24% for the groundwater (wells rocking, pumping), 3.03% for regional plumbing, 2.99% for water storage wells and 2.71% for marshes. From such cases of water use, respondents answered on water source quality as for less taste of fresh water counted for 35 persons or 76.3%, and for water having clear color, 230 persons or 57.5%, and majority (354 or 88.5%) of respondents had sufficient water quantity.

Comments and Suggestions on Water Management in Pattani Watershed. On perception about water information and sustainable management, findings showed that the respondents answered on news and info channel being sufficient such as television, radio, telephone, and others with percentage of 3.35, and followed by the ease in getting such perception with score 3.28%, as well as the responsibility of respondents themselves scored 3.25%, of the leaders in presenting and outreach information scored 15.3%. However, the role of government units in providing and outreach information was minimum, only 12.3%.

Issues regarding water management, most respondents were found to have a moderate level of opinion, with cases of awareness of the importance of water accounted for 3.37%, followed by the willingness of state agencies (SAO/municipality/sub-district chief/village headman) to cooperate in the management of water, 3.34%, the readiness of publics to

cooperate with the government agencies, 3.31%, and the own sense of being part of participation in water management, 3.30%. Samples had perception that intention of government agencies (besides SAO/municipality/sub-district chief/village headman) to cooperate in water management with score of 3.28%, and the establishment of a "group for water", 3.23%. Also, consultation with local and native scholars or experts in water management and academic personals accounted for 3.22%.

In the cases of assessing water quality management for revision and improvement, findings showed that samples mentioned the assessment of water testing project done by local wisdoms accounted for 3.14%, the water quality assessment by the government scored 3.07% and to set stage/meeting. For assessing water status scored 3.04%. According to the investigation of water quality by Dr.Vichit found that table.

From investigating the quality of the water samples, found that water quantity was not exceed the standard limit. But there was plenty of water volume in areas of the lower part, especially in the rainy season. This situation was in accordance with that of Thidaporn (1997), who found the Bangpakong river water quality to be influenced by seasonal variation and depth. Suspended solids were found exceed during the rainy season due to the effect of fresh water mass on organic sediments with full of nutrients leading to an increase in plankton population as well as organic suspended sediments.

Wireangrong (2003) studied the water quality of the lower part of Thacheen using geo-information technological system (GIS), and found that the depth ranged from 1.8 to 15.6 m, water temperature varied from 27.3 ^{O}C to 32.6^{O}C, pH range was from 6.85 to 8.35 with the variation in salinity from 0-18.2 rpm, transparency is varied in the range from 40 to 180 cm, SS were varied in the range 6-310 mg, DO was in the range of 0.5 to 7.8 mg/L, the pH variation was in the range of 90 to 154 mg/L, nitrate was in the range of 0.**0202** to 0.7155 mg/L, variation in the ammonia was 0.8432 to 1.9149 mg/L, orthophosphate was varied in the range from 0.0617 to 06,842 mg/L, total chlorophyll A varied from 10.0155 to 75.5990 mg/m3, and BOD values varied from 1.4 to 5.5 mg/L. By contrast with the standard of water quality using GIS, it was found that range values of temperature, pH, nitrate, orthophosphate, chlorophyll A, and BOD during the dry and rainy seasons were coincidence with the water quality standards that are suitable for aquatic lives. Whereas, the values of dissolved oxygen and ammonia in the dry and rainy seasons were very much lower than that of the water quality standards, and as a consequence it was likely to be hazardous to aquatic lives. Using GIS Digital map displaying water quality in the lower part of Thacheen river. It was possible to compare the difference in water quality between seasons and to clearly indicate precautious areas, and it subsequently benefited the management of the fishery resources and water source with full efficiency and sustainability. The fnding is in agreement with Thailand Groundwater Quality Standard (Ministry of Natural Resources and Environment , 2008)

This research finding was also consistent with that of Abdulnaser and Md. Sani (2009), who investigated the residual amount of chemical pesticides, organochlorine group in the main rivers in the south Thailand, namely SaiBuri, Pattani, and Tepa rivers, and showed that their physical parameters of water quality were pH range of 5.0 to 9.0 with that of Pattani river was 6.8 to 9.1. Other parameters reported were the SS ranged from 13.2 to 31.8 mg/L, temperatures range was 27.7^{O}C to 30.2 ^{O}C, the conductivity ranged from 22 to 157 mc/cm and DO ranged from 6.0 to 7.3 mg/L. Water quality of Pattaniriver was found to be within the standard values. Stuart *et.al*. (2005) sampled in the coast of Georgia to assess water quality. Several variables were measured including pH, temperature, DO, specific conductivity, nitrate nitrite, total hardness, calcium, *magnesium* and *sodium bicarbonate*, *sulfate chloride potassium*, iron, and *manganese*. Value of pH was 6-8, of the specific conductivity was 250-275 ms/cm, and of temperature was 18 ^{O}C-24 ^{O}C.

The development of water consumption in the Pattani watershed had two phases: during

the first 10 years, direct use from water sources was for both urban and rural areas, the relevant wastewater was discarded in different forms, such as cooling water in rubber industries, wastewater as a result of the washing in industries. Such wastewater was thrown water directly. Currently, water is being used more and more for different activities, with the development of water supply system in urban and rural as well as village and mountain water supply. Sources and treatment of wastewater in various communities are developed and growing side by side with the academic advancement and legal support. Monitoring of water from publics is increasingly practiced in consistent with the advance in technology of water consumption.

CONCLUSION AND SUGGESTION

Development of utilizing and guidelines for sustainable management of water quality in Pattani watershed is targeted 1) to study and develop the use of water in Pattani watershed, 2) to study the utilizing by the people in Pattani watershed of water in different aspects, and 3) to study the better ways for managing water and its quality in the main water source in the area of Pattani watershed. This is the environmental research, which uses to collect data by in-depth interviews and group discussion as well as questionnaires. Results showed that 1) development of the utilizing of water has begun from the past by bringing raw water to agricultural activities, and direct consumption. Currently, water is being used through the water supply system in urban areas, rural, village, and mountain, beside having sources of support and water treatment, 2) the main use of water is in cultivation, and consumption, as well as animal husbandry and fishery which is in moderate, and also being used in the form of village water supply, 3) good water management is based on the perception and involvement of leaders and citizens with a sense of ownership as well as the establishment of water user groups. Important suggestions from this study are 1) establishing an alternative policy and public participation in the water consumption and management as well as jointly solving problems, 2) improving sustainable water management practices in Pattani watershed, 3) the establishment of water management to drive different concepts towards the next move, 4) practicing the management of water resources in Pattani watershed should have committees which come from all sectors of administration, 5) the implementation is better performed when there are clear guidelines and consistent with the local culture.

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