30th WEDC International Conference, Vientiane, Lao PDR, 2004

PEOPLE-CENTRED APPROACHES TO WATER AND ENVIRONMENTAL SANITATION

Planning for the management of conflicting water uses in Thailand watersheds: A case study

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This paper presents part of the results from a project for Study of Environmental Situation in Upper Watersheds of Chiang Mai Province, carried out in 1998-2002 for the Office of Natural Resources and Environmental Policy and Planning. The Huai Mae Tia Watershed, one of selected watersheds in the project, represents a watershed with serious conflicting uses at different times of the year. It critically needs planning and implementation for watershed management plan which assigns appropriate allocation of the watershed's water resources to achieve efficient optimal overall use. A watershed management plan has been developed which features integration of public participation in the planning and implementation processes. A core planning team including representatives of stakeholders in the watershed has been formed for developing the plan. This team was then modified to suit the needs for plan implementation.

Introduction

It is clear from past water supply crises in many communities that future water use must be sustainable. This implies closer cooperation between water users than has typically been in the past (Heathcote, 1998). Guidelines for successful river basin planning during the past decades increasingly emphasize the need for coordination and cooperation at local, regional and national levels (Schramm, 1980).

The Ping River is one of Thailand important rivers with its source in the northern hills of Chiang Mai Province. Traditionally, clean water was easy to find while people could grow crops all year round and people could provide water for all. However whenever competition for scarce natural resources increases, traditional harmonies among communities and with nature prove fragile. Conflicts over water uses between upstream and downstream communities intensified to the point that solutions had to be found for the Ping River Basin (ADB, 2004), similar to other major rivers.

A project for Study of Environmental Situation in Upper Watersheds of Chiang Mai Province, carried out for the Office of Natural Resources and Environmental Policy and Planning (ONEP) in 1998-2002, aims at evaluating the environmental situation, preparing environmental guidelines, and recommending an appropriate organization management system (ONEP, 2002).

Huai Mae Tia is one of the watersheds selected under the project to represent a watershed with very serious conflicts in water resources utilization (for agriculture and domestic demands). Conflicts among user groups have peaked several times over the past several years, especially in dry periods. This requires assessment of the problem and development of the appropriate public participation management plan.

Watershed data

Huai Mae Tia watershed is located in Chomthong District, Chiang Mai Province. It is classified as a mini-watershed in Mae Klang Sub-watershed in the Ping River Basin. Mae Tia is the main stream that drains an 80-sq.km watershed, which partly lies in two national parks. Figure 1 shows the boundary and key components of the watershed. As detailed in Table 1, there are a total of 8 villages (with total population of more than 3,000) comprising hilltribe and lowland people living in the watershed. Some of these villages and associated agricultural activities lie in sensitive watershed areas resulting in deforestation and erosion.

The watershed data collected include baseline data characterization on water and environment together with field investigation results of key environmental issues including deforestation and erosion, pollution control, and allocations of available water. Assessment of the watershed situation was conducted using four-tired scale suggested by ADB (1997). The results clearly showed and emphasized the need for establishing a system for optimal utilization of the watershed's limited water resources.

The data collection process required a lot of work (including land and water use, potential pollution sources, and water management and controls) as recommended by a handbook of USEPA (1993), as described in the following paragraphs.

Land and water use

Evergreen and deciduous forests are the primary watershed land use, followed by field cropping, paddy, horticulture and village areas, respectively. Land use data were also used for collecting cropping patterns, types, areas and schedules. Based on the land use data, water utilization needs within the watershed are estimated for meeting household and ir-

Table 1. Villages and population in the watershed

Village	Tribe	Household	Population
Ban Hin Lek Fai	Karen	103	521
Ban Huai Som Poi	Karen	132	768
Ban Huai Kanoon	Karen	72	394
Ban Mae Tia Nai	Karen, Thai	110	220
Ban Mai Mae Tia	Thai	79	372
Ban Choeng Doi	Thai	145	561
Ban Mae Tia Tai	Thai	47	163
Ban Pa Kluai	Kmong	135	795

Source: Data collected in 2001

rigation demands. As irrigation demands a greater quantity, estimates for such demands are especially important.

Potential pollution sources

Potential pollution sources are closely related to human activities within the watershed. Agriculture-related activities are typically considered as non-point sources of pollution. Pollutants which may originate from agricultural land include nitrogen, phosphorus, sediment, animal manures, salts, and pesticides (USEPA, 1982). Some agro-chemicals are used for cabbage and rice plantations. According to the surveyed records, the amount of pesticides used for cabbage is approximately 17 cu.m/sq.km/month (for 2 months of each cropping season). Fertilizer applied for cabbage and rice is estimated at 30 g/sq.m/year. Villages (typically with poor sanitation facilities) and roads are also of concern for pollution sources. These include sanitary wastewaters and solid wastes. Batteries are normally used as power source in some villages with no electricity.

Water management and controls

Water utilization within the watershed is reliant upon gravity flows from high level streams and natural rainfall. In the upper watershed areas, headwaters are piped for household uses. Most of flat areas along stream bank utilize diversion channels for irrigated rice fields. Sprinkling is also used for cabbage crops during dry period or rainfall shortage (usually in the early rainy period). A mini hydropower plant along Huai Manao (a tributary of Huai Mae Tia) supplies electricity for most villages in the watershed. There are three major water user groups in the watershed area - namely Ban Som Poi, Ban Pa Kluai and Ban Mae Tia.

Traditional people private irrigation (called chon-la-pra-tarn-rat) with gravity flow through a number of weirs constructed along the stream is operated by villagers. This typically plays a major role in the lower and downstream watershed. Each weir is managed by a group (with a nominated head who is responsible for coordinating with other groups of weirs along the stream). During dry and low flow periods, user groups suffer water shortages, making complaints to the upstream users. If most of user groups face with water shortages, there are normally conflicts among user groups in the lower and upper watershed areas. The most recent conflict involved resources conservation and human right groups, and committees (at both province and district levels) were appointed to resolve the issue.

Assessment results

Data collection and applicable standards

There are three streamflow stations related to the watershed area. Two of them, maintained by the Department of Energy Development and Promotion, are along Huai Mae Tia stream. Water quality data along Mae Klang River were collected by the Provincial Public Health Office. Three stream sampling stations were selected as a sufficient number to represent different baseline environments and human activities (including land use types, watershed classes and soil types). Stations HT1, HT2 and HT3 are at the most upstream, middle and most downstream points, representing no village, some villages, and villages with agricultural activities, respectively. Monitoring was undertaken 3 times/year (to cover early rainy, rainy and dry periods). Parameters measured include flow rate, as well as physical, chemical, biological, and toxic substances such as heavy metals and pesticides for current status assessment and for future monitoring programs.

In Thailand, the most related standards available for receiving waters are the Surface Water Quality Standards (PCD, 1997). These include 5 classes of standards, representing different sets of conditions of pollution and suitability for various potential uses. Of these the most applicable for the present assessment purposes is the classification for “clean fresh surface water resources.” These are the values shown in one of columns of Table 2. Other applicable standards as related to water resources in the project area including for human and aquatic utilizations were also reviewed with the values also given in the same table.

Water Use

Assessment for water use focused on irrigation which dominates the amounts for other demands. Collected data on cropping pattern and area were used together with rainfall, potential evapotranspiration, crop water requirement coefficients and percolation data to calculate effective rainfall and hence water shortage for each of the three periods. Figure 2 shows the results of water shortage analysis.The results of water use assessment show that the increasing conflicts on utilization of water use for agriculture both in the upper watershed (mainly diversion for paddy rice and sprinkling

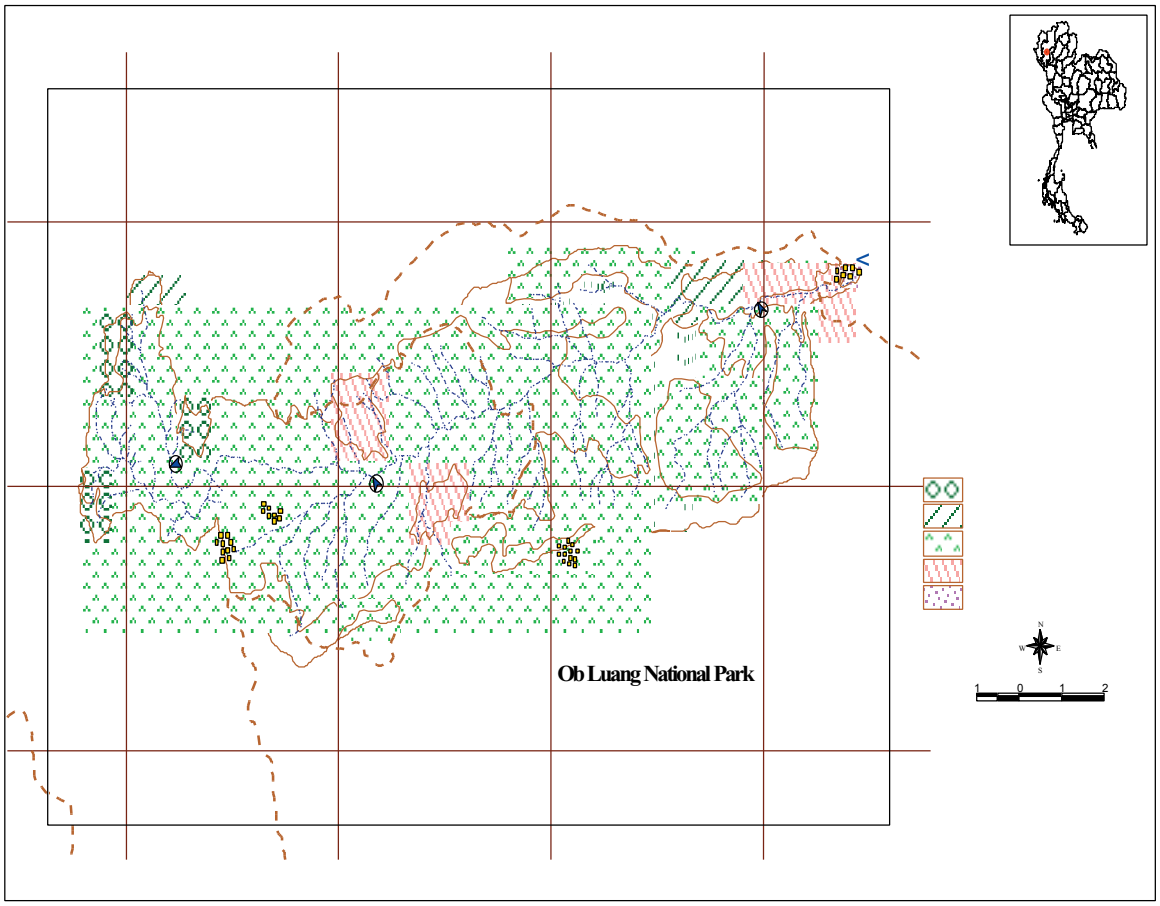


Figure 1. Huai Mae Tie watershed

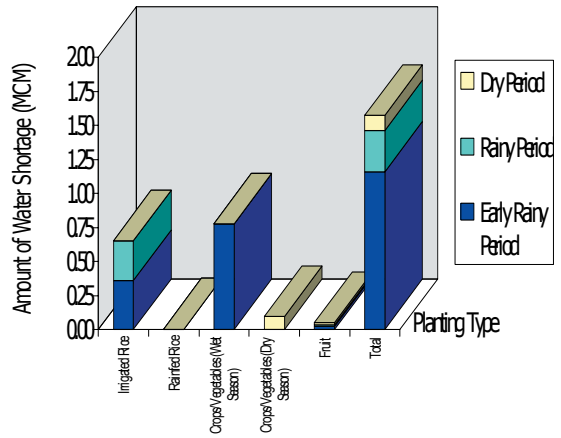


Figure 2. Water shortage in the watershed
Source: ONEP (2002)

for vegetables) and the lower watershed (mainly traditional people private irrigation by weirs for paddy rice and fruit trees) during dry and early rainy periods are critical. This is consistent with the period of serious conflict between user groups often occurring in April-June. Water shortage is mainly dominated for crops/vegetables (during early rainy period) and irrigated rice (during dry and early rainy periods). The increased demand due to land use changes has also led to declined streamflow in the downstream, especially during the dry months shown by the study in the Mae Taeng watershed (TDRI, 1995).

Water quality

The monitoring results of receiving water quality compared with applicable standards are given in Figure 3 (for key parameters), indicating that the major concerns for receiving waters are suspended solids (SS), fecal coliform bacteria (FCB), and lead (Pb). High concentrations of SS were found at the two lower sampling stations during early rainy periods, due to erosion in the watershed area. FCB concentrations are high in the populated areas, especially during early rainy period. Significant Pb concentrations in every station are due to presence of lead quarry within nearby area of the watershed. Low concentrations of pesticides were found. Since there are only few parameters with water quality exceeding the standards in some stations, it can be said that the degradation of water quality is less critical as compared with inadequacy of water quantity in the watershed.

Guidelines and monitoring program

The process for setting appropriate ambient standards for receiving waters includes the following steps (Lohani et al., 1993):

1. Monitoring of existing water quality situation in water body of concern to establish existing levels for pertinent pollution parameters;
2. Evaluation of pollution loading discharging to waterbody including public/private agencies and liquid/solid wastes, and existing waste management practices;
3. Evaluation of effectiveness of government's regulatory system for controlling pollution discharge for present and likely future situation;
4. Collection, collation and evaluation of comparable standards utilized by developing, industrialized countries and international assistance agencies; and
5. Based on above, setting tentative standards which match the reality of what can be achieved with diligent efforts within the constraints of the country system.

Applying the above steps using watershed zoning has resulted in a recommended ambient criteria and monitoring program for receiving waters in the watershed, as also presented in Table 2.

Management Plan

Due to the urgent needs for proper management of the Huai Mae Ta watershed, it was suggested at one of the provincial seminars that a pilot watershed be selected for demonstrating how to prepare and implement appropriate management plan for typical watersheds. The objective of the pilot watershed plan is to carry out the planning and implementation processes with emphasis on adequate public participation.

Approach and public participation

The management plan for Huai Mae Tia watershed has been prepared by a core planning team (CPT) consisting of representatives from various stakeholders (a total of 20 members). There are three main types of activities for preparing the plan as follows:

1. CPT meetings (total of 7)
   - Determining vision
   - Determining goal, objectives and guidelines
   - Preparing and reviewing alternative planning strate gies
   - Selecting and making the most appropriate plan
   - Finalizing the plan

2. General planning activities
   - Preparing vision
   - Delineating planning goal, objectives, and guide lines
   - Collecting and evaluating pertinent basic data
   - Preparing draft management plan
   - Public consultation
   - Conclusions on use of public participation recommendations
   - Preparing presentation of the plan

3. Public participation meetings (total of 3)
   - Introducing and identifying key issues
   - Consulting on goal, objectives and guidelines
   - Consulting on the draft plan

Key issues and stakeholders

Key issues relating to water uses include inadequate water for use in dry period, sedimentation along the streams, and contamination of chemicals. The impact on hydropower plant along the Huai Manao is not an issue due to small size and water storage capacity of the plant insignificantly contributing to the water uses. There have been some sedimentation problems near downstream but without reference to flooding in the watershed. The people in the watershed and nearby are not concerned with contamination from chemicals on groundwater but mainly on surface water as it is the main water source including in the dry period.

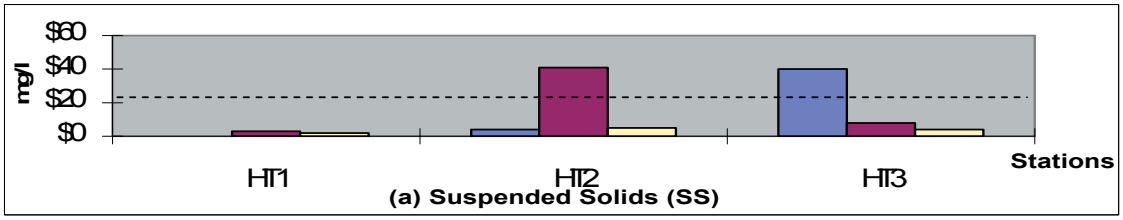
The stakeholders of the watershed include government officials of district and sub-districts, village heads, officials of local agencies (Tambon Administration Organizations or TAOs), members of community groups, members of NGOs, media and other interested people. Members of the CPT participated in the public participation meetings. Photograph 1 shows a picture taken during a meeting among stakeholders.

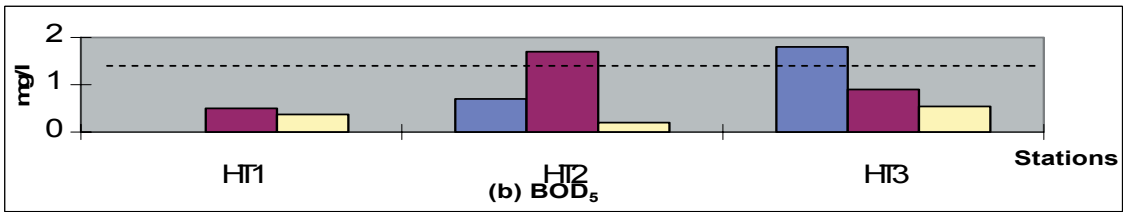
Objectives and Strategies of the Plan

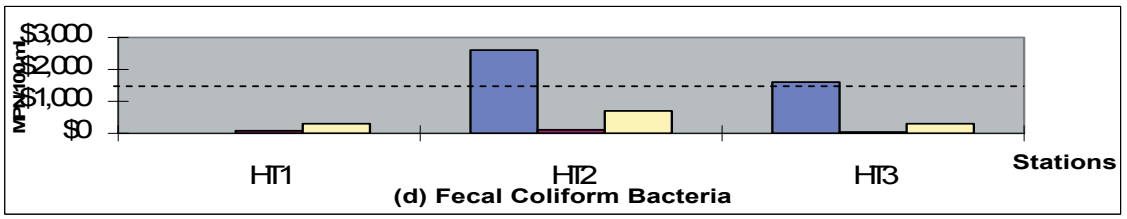
The objectives are:

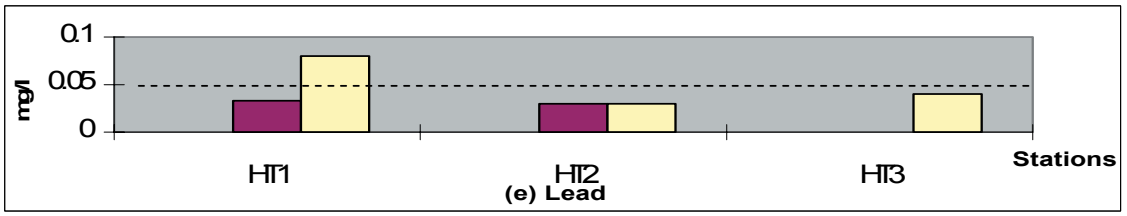
1. To enable the stakeholders in the watershed to participate in information acquisition, thinking, decision, and operation with continuing evaluation of the plan's adequacy and corrections as need for plan implementation.
2. To establish and promote organizations in the watershed for preparation and implementing the plan.
3. To raise the people's quality of life in the watershed based on local culture with appropriate utilization of resources.

Photograph 1. A meeting among stakeholders









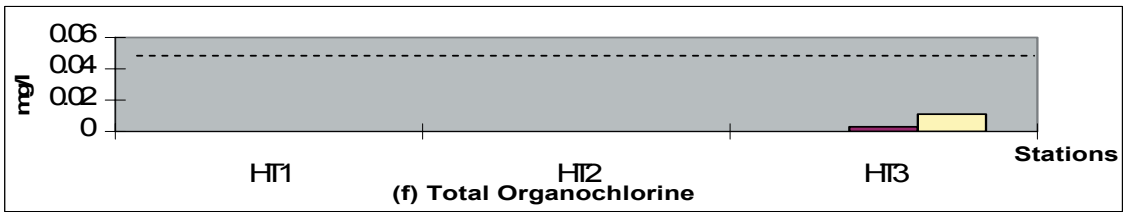


Figure 3. Monitoring results for receiving water quality

Source: ONEP (2002)

Table 2. Recommended criteria and monitoring program for receiving water in the watershed

Parameter	Unit	Monitored Values*	Available Standards				Recommended Criteria for Watershed Zone			Moni-toring
			A	B	C	D	1	2	3	
1. Physical Parameter										
1.1 Flow Rate	10^3 cu.m./s/ sq.km.	0.00-430	NA	NA	NA	NA	0.10	0.10	0.05	X
1.2 Suspended Solids (SS)	mg/l	1.0-985.0	NA	25 1/	NA	<10% change	10	25	50	X
1.3 Total Dissolved Solids (TDS)	mg/l	33-261	NA	NA	1,000	NA	200	300	400	X
1.4 Temperature	^{0}C	17.2-30.0	n'	23-32 1/	NA	<2 ^{0}C increase	21-26	22-27	23-28	X
2. Chemical Parameter										
2.1 pH	--	5.7-8.7	5.0-9.0	5.0-9.0 1/	NA	6.5-9.0	7.5	7.5	6.0	X
2.2 Dissolved Oxygen (DO)	mg/l	1.4-9.6	6	3 1/	NA	6.0	7.0	6.0	6.0	X
2.3 BOD_5	mg/l	0.1-2.8	1.5	NA	NA	NA	1.0	1.2	1.5	X
2.4 Nitrate (NO^-_3)	mg/l	0.02-0.85	5.0	NA	NA	NA	1.0	2.0	3.0	X
2.5 Total Phosphorus (TP)	mg/l	0.05-0.35	NA	NA	NA	0.1	0.1	0.2	0.3	X
3. Biological Parameter										
3.1 Total Coliform Bacteria	MPN/ 100ml	70-16,000	5,000	NA	NA	NA	2,000	4,000	5,000	X
3.2 Fecal Coliform Bacteria	MPN/ 100ml	40-16,000	1,000	NA	NA	NA	500	800	1,000	X
4. Heavy Metals										
4.1 Iron (Fe)	mg/l	0.07-29.8	NA	0.3 2/	0.3	1.0	1.0	3.0	5.0	X
4.2 Lead (Pb)	mg/l	0.01-0.10	0.05	0.05 2/	NA	0.005	0.05	0.05	0.05	X
4.3 Cadmium (Cd)	mg/l	0.001-0.009	0.003	0.0012 2/	NA	0.002	0.003	0.003	0.003	X
5. Pesticides										
5.1 Total Organochlorine Pesticides	mg/l	NA	0.05	NA	NA	NA	0.03	0.03	0.05	Y
5.2 Dieldrin	µg/l	ND-0.008	0.1	2.0 2/	NA	2.0	0.02	0.02	0.05	Y
5.3 Aldrin	µg/l	ND-0.018	0.1	NA	NA	0.01	0.01	0.05	0.10	Y
5.4 Heptachlor & Heptachlor Epoxide	µg/l	ND-0.004	0.2	0.4 2/	NA	0.01	0.05	0.05	0.10	Y
5.5 DDT	µg/l	ND-0.012	1.0	0.5 2/	NA	1.0	0.1	0.1	0.1	Y

Remark: * = second lowest and second highest values monitored in the project
n' = naturally but changing not more than 3 ^{0}C
NA = not available
ND = non-detectable
A = Thailand's surface water quality standards (class 2)
B = Thailand's water quality criteria for protection of aquatic animals
C = WHO's rural drinking water standards
D = Australia's guidelines for aquatic system (Australian and New Zealand Environment and Conservation Council, 1992)
1/ = suitable value
2/ = maximum allowable concentration
X = three stations (watershed zones 1, 2 and 3) and 3 times/year
Y = one station (watershed zone 3) and 3 times/year

There are a total of 10 strategies and guidelines developed to support the objectives. Some of them are:

1. Identify management zones (with guidelines for each zone associated with key issues of the watershed) utilizing present land use data and protected areas in the watershed, with participation of people from the upper, middle and lower watersheds.
2. Promote a community organization network in the watershed that can identify joint practices and agreements among the people.
3. Prepare a map of watershed data for use as tool of community discussion and survey for developing management zones with community participation.

Implementation

The management organization for implementing the plan is in the form of committee which represents a modification of the CPT with local agencies taking the lead. This committee is also responsible for coordinating with other committees and agencies concerned. The modification was made by change in chair persons from chief of the district office to chairman of a TAO which covers the greatest area of the watershed. This allows best utilization of the strength of the chair persons in planning and implementation stages.

The implementation of the plan should be according to the following steps:

1. Review of the actions that are compatible with the plan
2. Establish working groups to prepare procedural steps for implementation and collect necessary data involving public participation
3. Prioritize actions for implementation
4. Prepare detailed action plans including budget and responsible parties
5. Monitor and evaluate jointly, regularly and continuously

The plan has been completed at end of 2002 and submitted to the province. The province has recommended that the proposed plan and committee operation be utilized in the on-going study recently started by ONEP for preparing a comprehensive basin plan for management of the Ping River Basin.

Conclusions

The results of water resources assessment show that increase in water uses both in the upper and lower watersheds during early rainy and dry periods are now at a critical level. Appropriate and efficient allocations of water among different user groups, especially in the dry years are therefore urgently needed. The major concerns in regard to receiving water pollution are high concentrations of coliform bacteria, followed by some heavy metals but not yet at significant levels. The management plan of the watershed has been prepared by the CPT considering the key issues that the watershed is facing and incorporating the needs of the watershed residents as expressed at the public participation meetings. The organization set up for implementing the plan is to be responsible for preparing and implementing actions that are compatible with the plan. The plan and committee of this mini-watershed is being incorporated for utilization in the on-going study for its major river basin plan and organization.

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