



CHAPTER I

INTRODUCTION

1.1 Introduction

“The earth is one but the world is not. We all depend on one biosphere for sustaining our live. Yet each community, each country strives for survival and prosperity with little regard for its impact on others”(Daniel, 1995)

This quoted statement prepared by the World Commission on Environment reflects the fact that the emergence of human civilization presents increasing challenges to our planet earth. Some of those challenges are directly associated with global warming, loss of biological diversity, desertification, deforestation, natural imbalance etc, causing a serious threat to human, animal and living environment. In the name of survival, prosperity and development, human activities have been contributed to the global climate change. The earth has been experiencing a crucial period as regards to environmental pollution. Like other methods of pollution, waste generation and its improper disposal deserve our attention since it easily contaminates land and water.

In Thailand, solid waste and wastewater treatment facilities are inadequate because of lack of human resource, financial capital and technical knowledge. As a result, wastewater from different sources is mostly and directly discharged into nearby waterways.

The Yom River, running through Sukhothai province, is one of four tributaries flowing into the Chao Phaya River and it can influence the water quality of the Chao Phaya, which is regarded as the lifeline of the Thai people. The water quality monitoring data accumulated by the Sukhothai Provincial Public Health office in the year 2000 indicated that the pollution in the Yom River soared and the water quality

was below the scientifically accepted level, especially in Srisumrong District area. Major pollution was caused by organic matters in high quantity. Oxygen quantity in the water was found to be only 0.8 milligram per liter, which was five times lower than the normal level of 4 milligram per liter. At the same time, the amount of coliform bacteria in water was reported to be 30,400 ppm per 100 milligram, which was 3 times higher than the standard value of 10,000 ppm per 100 milligram.

The main cause of such wastewater pollution is that in Sukhothai province, the local population live close to the Yom River and therefore the production of refuse is largely discharged into natural waterways. The household wastewater from daily activities of the local people in the community living close by the river is discharged directly in the Yom River. This waste is directly released from the toilets and it consists of human excreta and urine. In addition, sludge is also discharged from activities; such as, bathing, kitchen activity, laundry and other household works. Sludge contains some particular contaminants; such as, food residue and soap detergent. Microorganisms in the river rapidly decompose these domestic liquid wastes.

To develop waste disposal management to tackle the wastewater pollution and to avoid a total failure, local people's participation need to be incorporated from the beginning. If there is an effort to encourage local people to contribute their ideas, as well as doing it by themselves, they will be more interested and start to realize its value and benefit. Ultimately, they would become willing participants in waste management, which is the crux for the establishment of a sustainable waste disposal management

1.2 Background

Waste is always interwoven with human life. Where there is any form of life, the possibility of producing waste will be there and its generation characteristics also depends upon income, culture, behavior and the practice of each individual. Problems with waste disposal can be traced back from the time when human being began to live together in tribes, villagers and communities and the accumulation of waste became a by product of life.

Wastewater can be classified according to their origin, composition, collection and treatment as follows:

- 1) Domestic wastewater discharges from households as well as public buildings and other facilities, including water from street cleaning and fire fighting as well as wastewater from small local industries.
- 2) Commercial wastewater coming from commercial businesses, slaughterhouses, small industrial operations, and other public facilities.
- 3) Industrial wastewater produced by large industrial plants of all kinds as well as similar activities
- 4) Agricultural wastewater from livestock production and from plants and animal processing operations,
- 5) Seepage water (foreign water) from managed drainage, drainage pipelines and the artificial lowering of the groundwater level as well as groundwater that leaks into the sewerage system through pipelines and other installations.
- 6) Rainwater, including all form of precipitation: rain.
- 7) Surface water from those water bodies that feed directly into the river.

The nature of waste and the magnitude of its detrimental effect depends on the sources, which generate waste in different forms. The major sources are domestic waste, agricultural waste and industrial waste. Consequently, this problem cannot be addressed only in the area of controlling and managing waste, but also in the prevention and conservation aspects of human behavior.

In developed countries, municipalities generally collect 70 percent of the solid waste generated each day (Habitat, 1994). While in the developing countries, the average solid waste collection is 30 percents only; therefore, much of the solid waste generated remains uncollected each day. The waterways become the natural dumping ground for uncollected solid waste, where microorganisms in the water facilitates the natural decaying process. Liquid and solid domestic waste and untreated liquid waste from domestic sources also directly contribute to water pollution. The organic

compounds of household solid/liquid waste either dissolve in effluent or combines itself with other suspended matters.

At present, domestic wastewater pollution is one of the most critical environmental problems for most communities in Thailand. Rapid population growth, economic growth and industrialization have been playing significant roles in waste generation. The consumption behavior of the people has also been contributing much in increasing the waste generation and changing the pollution scenario from bad to worse.

In addition, the practice of disposing wastewater directly into water sources seem to go on unabated. As a result, it causes natural waterways to be contaminated and become unfit for fish as well as human. People can no longer use waterways for recreational purposes such as swimming and boating. Most importantly, the foul smell and unhealthy environment can produce long term and irreversible health effects to the people.

With a view to address this burning issue, development of plans and the implementation of practices for sustainable waste disposal management are becoming increasingly important in recent years, especially in Sukhothai where waste disposal has not yet reached internationally acceptable standards.

1.2.1 Environmental Condition of the Chao Phaya River

Four main rivers geographically form the Chao Phaya River; the Ping, Wang, Yom and Nan, in the north of Thailand, These four rivers converges at Nakhorn Sawan province. The 300 kilometers course of the Cho Phaya River passes through eight provinces in the central region covering an area of 178,000 square kilometers. This river water is used for consumption, agriculture, fisheries, industry and transportation; thus, it is considered the lifeline for the people living in the central region of Thailand.

Based on the data compiled by various government agencies, the water quality of the Chao Phaya River has reached a very critical condition. The upper parts of the river show a slight indication of pollution. The middle part of the river has begun to be

polluted at a rather high rate, the lower part of the river is deteriorating. Domestic sewage was found to be the major cause of the river water quality degradation. It has been revealed in a study by the Office of the National Environmental Board that sources of pollution from organic matter are attributed to: domestic waste 40.4 percent, restaurants, fresh market, hotel 32.2 percent, factories 25.3 percent and others 2.1 percent as shown in Table 1.1.

Table 1.1: Source of Pollution Discharged into Chao Praya River

Source of pollution	Bacterial Oxygen Demand Kg./day	Percent [%]
1. Domestic	74,182	40.4
2. Business service	59,070	32.2
3. Factories	46,403	25.3
4. Others	3,967	2.1
Total	183,622	100.0

Source: Office of the National Environmental Board, 1997

Domestic wastes seem to be the biggest source of pollution to be discharged into the Chao Phaya River. The waste from the large population residing adjacent to the river and their associated activities is a major contributor to the widely documented deterioration of the river. Most residents, especially floating houses dispose of their wastes directly into the river. Sources of water pollution come from toilet 11.42 gm/people/day, bathing 14.32 gm/people/day, and washing 3.15 gm/people/day, as illustrated in Table 1.2

Table 1.2: Wastewater from Residents Living Adjacent to the River [Bacterial Oxygen Demand]

Activity	Discharged Load [gm/people/day]
Toilet	11.42
Bath	14.32
Wash	3.15
Kitchen	23.97

Source: Ministry of Public Health, 1999

However, when we consider the quantity of toxicity [heavy metals, chemicals oil and other poisonous substances], which are more harmful to the health of the people, it mostly comes from industrial sources.

1.2.2 Environmental Condition of the Yom River

Since the Chao Phaya River originates from the Yom River, its quality partly depends upon the condition of the Yom River. The Yom River, which is 555 kilometers long, originates and flows from the high mountains of the Pea-Pun-Num and the Dan-Lao in Phayao, Phare, and Changrai provinces to the floodplain in Phare, Sukkhothai, Phitsanulok, and Phichit. The Yom River merges with the Nan, Wang and Ping Rivers at Chumsang district in Nakhonsawan province and form into the Chao Phaya River. The physical structure of the Yom River is dendrite with 77 branches. The bed layers were reported as shale, lime, and sedimentary rocks. The soil is of dark color that is fertile and appropriated for agriculture. The watershed area of the headwater consists of a mixed of deciduous forest, dry dipterocarp forest, and tropical evergreen forest where some parts have been invaded and destroyed by human. The upper part channel is larger than the middle but the lower part channel is wider. The gradient range was much less at the lower part of the channel. The drainage area and discharge, however, were larger and higher from the upper part compared to the lower part of the channel. The highest level of gage height is in rainy season and the lowest level of gage height is in summer where measurements are made in the middle of the channel.

The qualities of Yom River vary in accordance with the seasons, winter, summer and rainy season (?). The average water temperatures are 29.5, 25.12, and 32.3 degrees centigrade; The average turbidity are 87.87, 70.41, and 71.67 JTU (Jackson Turbidity Unite), the average conductivity are 264.6, 253.8, and 286.7 micro ohms/cm, the average TDS (total dust suspension) are 185, 178, and 200mg/l, the average pH are 7.6, 7.7, and 7.9, and finally, the average DO (dissolve oxygen) are 7.3, 6.6, and 5.7 mg/l respectively (Kulnat, 1998).

The water quality monitoring data by the Environmental Health and Occupational Health sector, Sukhothai Provincial Health Office indicates that the water quality of Yom River is below than the internationally accepted standard. Some areas show a slight indication of pollution since the river flows through residential area. (See Table 1.3)

Table 1.3 : Water quality of Yom River in Srisumrong District, Sukhothai Province (2000-2001)

Parameter	Standard	Result	
		Year 2000	Year 2001
pH	5-9	7.5	8
Hardness	<100 mg/l	101	120
DO	>6 mg/l	1.5	1.7
BOD	<1.5 mg/l	3	4.5
Total coliform	<5,000 mpn/100mg	22,600	26,600
Fecal Coliform	< 1,000 mpn/100ml	6,500	7,200
Water Quality Level	1-2	5	5

Source: Sukhothai Provincial Public Health Office in the Year 2000- 2001

The water quality in the year 2000 was reported below the normal level. Major pollutants were organic matters in high quantities. Oxygen quantity in the water was found to be only 1.5 milligram per liter, which was lower than the normal level of 4 milligram per liter.

At the same time, the amount of total coliform in water was found to be 22,600 mpn. (most probably number) per 100 milligram, higher than the standard value of 5,000 mpn/100ml. In addition, the amount of fecal coliform in the water was found to be 45,000 mpn./ml, higher than the standard value of 4,000 mpn./ml. The level of water quality in Yom River at Srisumrong station, Sukhothai was at level 5 (worst rating on water quality scale)

In 2001, water quality remained below the accepted level and worst than in 2000. Oxygen quality in the water was 1.7 mg/l and coliform in the water was 26,600 ppm/100mg, an increase of 17% from the previous year. At the same time, the amount of fecal coliform also increases 11% in one year and the water quality remained at level 5 for obvious reasons.

The domestic waste disposal from residences can be measured by BOD (Biochemical Oxygen Demand) which is one of the most important tests made to determine the strength or polluting power of sewage, industrial wastes, effluent polluted water. It is a biochemical test that measures the amount of organic matter likely to be oxidized by the activities of aerobic bacteria usually in five days at 20 C.

BOD test results can be interpreted in terms of the organic matter as well as the amount of oxygen consumed during its oxidation because definite quantitative relationships exist between the amount of oxygen necessary to convert a definite amount of a given organic compound to carbon dioxide and water. BOD loading as Table 1.4 below reveals that the pollution in the form of organic matter is present in the Yom river. In 2000, BOD for all the districts exceeded the standard of 1.5 mg/l and the levels were higher than in 1999

Table 1.4: BOD Loading in Yom River

District	Year	Year	Year	Year	Year
	1996	1997	1998	1999	2000
Srisauschanalai	2.04	<1.0	1.2	1.0	2.8
Sawankhalok	2.3	<1.0	1.1	1.2	3
Srisomrong	2.2	<1.0	>1.8	1.5	3.1
Muang	2.1	<1.0	>1.1	1.5	2.8
Mean	2.25	<1.0	1.3	<1.025	2.9

Source: Sukhothai Provincial Public Health Office in the Year 2001

1.2.3 The Solution to Waste Problems in Sukhothai Province

Due to the fact that the rural area is the main source of agricultural and livestock waste as well as domestic waste, no system has been developed as yet for the collection and disposal of waste in rural and non-urban area, the Sanitation Division of the Ministry of Public Health has been conducting environmental sanitation program for rural area of Thailand, which includes human waste disposal, solid waste disposal, housing sanitation and wastewater disposal management.

The aims of this program were (1) to educate the communities on how to store and use clean water, how to get rid of daily garbage and waste properly and (2) to assure the local people that the government has a good policy for them, and the government officials are determined to improve their standard of living so that they would be able to lead a more comfortable life and be happier. In Sukhothai province, this program was implemented in the villages located nearby the Yom River.

In getting rid of domestic solid waste, two major methods are being made popular. One is to turn it into compost and the other is to incinerate them. Motivation is being done through Village Health Volunteers and the program includes the supply of sanitary refuse container for households. The proper way to dispose of these refuse is clearly demonstrated to the villagers and the benefits outlined.

Proper wastewater disposal is being promoted by campaigns and demonstrations of how it should be done in a sanitary manner. For instance, the usage of seepage pit and drainage system for wastewater from dish washing and bathing.

Composting relates to the recycling of solid waste and incineration is one kind of traditional solid waste disposal method that are used for reducing voluminous amounts of refuse. The rural area of Sukhothai province is a vast source of domestic waste, which can be recycled and reused alongside other existing recycling methods besides composting. One of which is the practice of biogas generation from domestic waste

Promotional program influence waste disposal practices by improving the knowledge and attitude of the people. (Mihir, 1996). These promotional activities in regards to the rural solid and liquid waste disposal are being done as part of the components of the overall environmental sanitation program. In this program, individual families are responsible for refuse collection and dispose of the same. Promotional activities in the construction of seepage pit and drainage systems have been incorporated as an important method of liquid waste disposal.

The report of the Sanitation Division shows a satisfactory implementation coverage (82.54%) of the whole country until May 1994 (Mihir, 1996). In Sukhothai province, the program is being implemented since 1992 but was found to be intermittent due to lack of cooperation from the community.

1.3 Problem Statement

Water quality problem in rivers of Thailand results from human activities associated with populations concentrated along the river. It is evident that the overall quality of the water is poor and much below the accepted standards.

The Yom River in Sukhothai Province mostly contains organic wastes contributed by domestic sewage. The river is used not only for the purposes of transportation, recreation, bathing, but is also used as open sewers from households. Presently, bathing and washing are still practiced by local people living on or close to the Yom River. Therefore, individuals who use the water for daily consumption face a greater risk of health problems from the polluted river.

Water acts as a passive carrier of infectious diseases or chemical agent. The practice of throwing waste into the river causes breeding of microorganisms and also can be an important vehicle for transmitting chemical toxicants, which may lead to epidemic of water borne diseases. Water borne diseases are those transmitted through the ingestion of contaminated water. Water borne diseases are such as cholera and typhoid fever. Toxic chemical and pesticide residue may also contaminate the water

supply systems. Note that diseases caused by pathogenic bacteria, viruses, protozoan, and helminthes are transmitted through the fecal-oral route from human to human or animal to human. It is estimated that about 10 million people worldwide die every year due to typhoid, cholera and dysentery (Sastry C.A., 1995).

Water-washed diseases are those in which the pathogen spends an essential part of its life in water or depends upon aquatic organisms for the completion of its life cycle. The Yom River suffers from water-washed diseases due to poor hygienic habits and lack of proper sanitation of local people. Polluted water in the Yom River can no longer be used for washing and bathing for it will cause diseases that can endanger the eye and irritate the skin. In addition, this contaminated water also affects the aquatic ecosystem, in particular in our food chain where fishes caught contain high amounts of toxic chemicals unfit for human consumption.

The Yom River's pollution problem has seriously addressed by government agencies especially the Public Health Ministry and the Natural Resource and Environment Ministry. These various government agencies launched different projects to improve the river water quality of Thailand. The Sanitation Division of the Ministry of Public Health has been conducting environmental sanitation program for rural areas of Thailand that includes human waste disposal, solid waste disposal and wastewater disposal.

The Ministry of Public Health also establishes the water quality protection and environmental conservation project called; "Water Quality Conservation". The strategies of this project focus on community participation through Primary Health Care using Appreciate Influence Control approaches. The domestic waste disposal activity, rural solid refuse collection and disposal are being motivated through village health volunteers. The program includes supply of sanitary refuse container for households. Proper wastewater disposal is being promoted by campaigns and demonstrations to dispose of liquid waste through appropriate sanitary means; such as, seepage pit as well as water drainage system.

Unfortunately, the results of the water quality monitoring showed that the villagers still discharged wastewater from household to the Yom River directly and the water quality problem still remained in the communities. The major factor of the water quality project's failure is lack of a sense of involvement and acceptance from the local people. Most of the villagers did not understand the real situation and the impact of the problem, as a result, tended to view that the wastewater problems were problems for government agencies; not theirs. In addition, the government is the one establishing all strategies, with no local inputs down at the grassroots level. This resulted in the unsustainability of the project, as people tended to ignore and not participated in the project.

This research focuses on formulating a model of sustainable wastewater management by encouraging community participation and the implementation of problem-solving strategies that originates from the villagers' own perspectives. They are to be given opportunities to develop and create problem-solving activities without any pressure which will be the essential key to obtain a sustainable solution to the impending river water pollution problem

1.4 Research Question

- 1) What is the appropriate problem-solving model in the context of culture and lifestyle of the local people?
- 2) What are the lifestyle factors that relate to waste disposal of the local people?
- 3) What is sustainable wastewater management?

1.5 General Objective

To develop a sustainable waste disposal management model in the Yom riverside communities.

1.6 Specific Objectives

- To create a sense of ownership in the waste disposal management project among the villagers.
- To encourage the community to identify problems by using socio-cultural approach.

1.7 Operational Definition

Waste:

The WHO experts defined waste as “something that the owner no longer wants at a given place and time and which has no current or perceived market value”. This study is limited to rural domestic waste disposal. With that limitation, in this study, the definition of waste includes solid waste such as domestic and household waste and liquid waste such as wastewater coming from bathroom, dish cleaning, washing, other domestic sources including human excreta.

Waste Generation:

Waste generation encompasses activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal. It is important in waste generation to note that there is an identification step and that this step varies with each individual waste.

Domestic Solid Waste:

Domestic solid wastes are all the waste arising from human and animal activities in and around the house and are declared as unwanted. Domestic solid wastes are food waste, rubber, ashes, special waste, hazardous waste, rubbish, demolition and construction waste, etc.

Domestic Liquid Waste:

In general, domestic liquid waste means wastewater discharged from daily activities of people in the community. The waste can be classified into two types as follows:

- i. Toilet waste: This waste is directly discharged from the toilet and it consists of human excreta, urine, etc.
- ii. Sludge: This waste is discharged from other activities; such as, bathing, kitchen activity, laundry and other household work. Sludge may contain some particular contaminants; such as; food residue, soap, detergent etc. In this study, sludge will be considered as domestic liquid waste. Toilet waste will be beyond the purview of this study.

Waste Disposal:

Waste disposal may be defined as the discipline associated with the control of generation, storage, collection, transfer and transport, processing and other methods of removal of waste in a manner that is in accordance with the best principles of public health, conservation, and other environmental considerations.

Community Participation:

Community participation means giving the opportunity for people to participate in concept initiating, decision-making, operational performance and responsibility in various activities that may impact people and encourage them to join in problem-solving activities.

Sustainable:

Sustainable means participatory implementation leading to concrete actions; such as, capacity improvement of organizations, learning process, exchange of local wisdom knowledge, development of inter-sectoral coordination, awareness of problems and studies of solutions for local problems and creating a sense of ownership in the project.