99D011 I

RXV BK01

PROPOSAL FOR A SUSTAINABILITY PLAN FOR THE RATTANAKOSIN AREA

An Interactive Qualifying Project

submitted to the Faculty of

WORCESTER POLYTECHNIC INSTITUTE

in conjunction with Chulalongkorn University

in partial fulfillment of the requirements for the

Degree of Bachelor of Science

by

Danielle LaBrecque

Brittany Noga

David Schwalb

Date: March 1, 1999

Approved:

Professor Richard Vaz, Major Advisor

Doctor Wanida Jinsart, Co-Advisor

Professor Karen Lemone, Co-Advisor

Abstract

The goal of this project, sponsored by Chulalongkorn University in Bangkok, Thailand, was to develop a plan of sustainability for Bangkok's historic Rattanakosin area. Accomplishments included recommendations on how to improve the environmental, financial, and cultural aspects of the region to sustainable levels, specifically the water quality of the canals, tourism, and condition of the artifacts at the temples. The second accomplishment was the creation of a list of sustainability indicators to help track the development of the area.

Acknowledgments

This project group would like to thank the following people for their help and guidance that contributed to the successful completion of our IQP, "Proposal for a Sustainability Plan for the Rattanakosin Area". We would like to thank Professor Richard Vaz for his constructive criticism and guidance throughout the course of this project. His concern for our sesquepedaleinistic behavior greatly improved our writing. We would also like to thank Professors Karen Lemone, John Zeugner, and Steve Weininger for their thoughtful ideas and suggestions. Our biggest thanks to Doctor Wanida Jinsart, for without her, there would not have been a project. Her ideas and interest in our education on Thailand gave us an invaluable experience.

We would also like to thank the faculty and staff at the General Science Department of Chulalongkorn University. Also, we can't forget "The Girls", Lisa, Gue, Mon, Lee, and Jay. They helped us improve what little we know of the Thai language, showed us around town, and gave us information for our report. They have truly made our visit to Bangkok, Thailand, complete.

We would like to also extend gratitude to the Thailand Tourist Authority and the Urban Development Center. The knowledge and information we received from them were key factors in researching our project.

Authorship

In any project completed by many students, it is impossible for each student to contribute equally. We feel, however, that through our editing, and collaborative re-writing, we have achieved as much as is possible an equal balance for the authorship of the following material.

Table of Contents

List of Tables:

List of Figures:

Executive Summary

Bangkok, the capital of Thailand, is home to the Thais' historical and cultural heritage. Within Bangkok lies Rattanakosin, an island capital established in 1782 by King Rama I, Chao Phraya Chakri. He moved the capital to the Rattanakosin area from Thonburi because he believed that Rattanakosin would be more defendable. The Chao Phraya River forms a protective peninsula around the area; canals dug for further military defense, transportation, and waste disposal help form the "island" called Rattanakosin. Most of these canals have since then been filled in due to requests from westerners and other foreigners for roads. The remaining canals are now severely polluted due to increased urbanization and interrupted water flow from the filled in canals.

A solution to the problem of polluted canals must take into consideration current economic problems in Thailand that make environmental issues a second priority. Also, the historical and cultural significance of the Rattanakosin area must be an important factor in any solution.

Chulalongkorn University, located in Bangkok, Thailand is sponsoring this project to establish a framework for creating an environmentally feasible solution. This solution will take into consideration all factors affected by action taken to clean the canals. The goal of this project is to create a sustainability plan that will balance these environmental, economical, and cultural issues. Part of this planning process will include suggesting ways to improve the current conditions of the canals to a sustainable level and creating indicators that will track the growth and development of the area. Indicators are specific factors that can be measured quantitatively to monitor how the development is progressing.

A sustainable plan of development is one that meets the needs of the present without endangering the ability of future generations to meet their own needs. Sustainability is not an unchanging state, but rather a dynamic process that needs continual adjustment and monitoring. Sustainability plans not only meet present needs, but also achieve a balance between long-term economic environmental issues, while still preserving the cultural and historical heritage.

For a sustainability plan to be proposed for the Rattanakosin area, a basic knowledge of the area and of sustainability theory must be attained. Research about the Rattanakosin area and other relevant data was completed for this project, along with research about other previous sustainability plans. The temples and other historical and government buildings within Rattanakosin are important to tourism and to maintaining the Thai culture. While visiting important historical sites such as Wat Pho and the Grand Palace, we noticed that some artifacts such as statues and murals were in need of repair. Murals were peeling and the Buddha images' gold layers look picked apart. All of these items were within reach of the visitors. In order to protect items from further degradation, protective measures should be initiated. Ropes and other barriers between visitors and the items would protect them from further damage.

Other relevant research included analysis of the water quality in the canals and investigation of previous work done by Chulalongkorn University environmental scientists. This research was necessary to know the extent of the pollution in the canals. Some test results, for example fecal bacteria counts, showed extremely dangerous levels of pollutants in the water tested. It was found that one cause for this pollution was a lack of sewer systems in the waterfront communities along the canals. If proper management and control of wastes were implemented, then fewer pollutants and bacteria would enter the canal systems.

A survey was also administered to the residents of the Rattanakosin area and tourists visiting the area to determine opinions on the canal water quality. The impact environmental quality of the canals has on tourism directly relates to our original project goals. Tourism can play either a negative or positive role on the Rattanakosin area, so one of our objectives is to promote the positive aspects of tourism while minimizing the detrimental effects on the environment. Ecological tourism stresses this balance between nature and tourist activities and emphasizes minimal human impact on the environment. Adaptation of proper management techniques will enable Thailand to implement this environmental tourism without draining the resources of the nation.

Sustainability indicators are designed to monitor the aspects of a community easily and accurately. For the environmental, financial, and cultural issues we detected in Rattanakosin, we found indicators that would meet these standards. The water quality of the canals can be tracked by measuring the fecal bacterial count because it is a direct reflection of the amount of sewage. Since the Tourism Authority of Thailand already keeps track of the major tourist statistics, the location and amount of money spent per tourist can be used to reflect the state of national tourism. It is much more difficult to measure the status of the artifacts at the temples; however, we found that experts at the temples who currently care for the grounds could rate the state on a quantitative basis. By tracking these indicators from year to year, while implementing the recommended programs for solving the associated problems, Rattanakosin can start moving toward a more sustainable future.

1 Introduction

Known as the Venice of the East, Bangkok has many rivers and canals that intertwine throughout the city. However, as in Venice, these waterways have become polluted. Sewage, household waste, and even industrial waste now clog water that is needed for fishing and transportation. An area of particular importance is Rattanakosin, which houses many important government and historic sites. For example, The Grand Palace, the Democracy Monument, and Wat Pho are all located in this district of Bangkok.

With the financial problems Thailand is experiencing in the 1990's, environmental issues are being put aside. However, cleaning the canals has long-term financial benefits, which can be shown through increases in the tourist industry, reduced traffic, and a local source of fish. There are studies done by government agencies showing that if work is done on the canals the city will see an increase of revenue from tourism. Part of our project will be to demonstrate that an environmental cleanup and economic improvements can go hand in hand.

1.1 Goal

The Rattanakosin area is the home of a serious pollution problem that must be resolved. However, there are many circumstances that hinder the clean up of this region. The goal of this project is to propose a sustainability plan that will achieve a balance between environmental and health issues, economic factors, cultural issues, and the historical significance of Rattanakosin. In order to do this, we will suggest ways to improve the current conditions to a sustainable level and then propose indicators that can track the growth and development of the area.

1.2 Objectives and Justification of our Goal

Many of the most important historical sites of Bangkok are contained in or near the Rattanakosin area, which is formed by a series of canals that connect two parts of the Chao Phraya River as seen in Figure 1-1. The pollution of these waterways is predominantly caused by wastewater discharge and littering from surrounding factories and households. Two main effects of these impurities are the deterioration of the water quality and disruption of canal transportation. In order to recommend a feasible solution to reach a sustainable level of development and a high quality of water in the canals, we plan to:

Figure 1-1: The Rattanakosin Area
[Excite maps]

1. Ascertain the important social and historical sites in the Rattanakosin area.
2. Determine revenue sources of the Rattanakosin area.
3. Determine the environmental water quality.
4. Conduct survey of waterway residents and Rattanakosin tourists.
5. Analyze the Humanizing Bangkok Project.
6. Create an initial list of possible sustainability indicators.
7. Make recommendations for improvements of the Rattanakosin area to sustainable levels.

The economic analysis will not only take into account the direct cost of implementing the plan, but will also consider indirect costs. The cost of various possible solutions will be analyzed in reference to available funds, the benefits of the solution, and the economic situation of Thailand at the present time. Recently, compared to other currencies, the value of the baht has fallen. Hence, the

environmental impact of pollution might not be one of Thailand's top priorities. Moreover, in the Thais' eyes, the aesthetic benefits of a clean up might not be worth the, cost, or nuisance of the solution.

Additionally, since Rattanakosin is the historical heart of Bangkok, numerous cultural factors must be accounted for. Based on the historical significance of the area, we will be forced to consider the impact of both the problem and its possible solutions on the cultural heritage of the area. Furthermore, we will have to consider political factors in the management plan. Thailand, as does any other country, has specific regulations on pollutants that must be followed in accordance with their legislation.

Taking all of these factors into account, our plan of sustainability will help place issues of environmental, economic, and historical significance into equilibrium. Performed in collaboration with the department of General Science at Chulalongkorn University, this project will form the basis for an implementation of a sustainable development plan for the Rattanakosin area.

1.3 Overview

In this chapter we have introduced our project and goals. The second chapter discusses some general background and literature review information that is vital to understanding our project. Chapter three contains the methodology, describing exactly what we did and how accomplished it. The fourth chapter will present the results and analysis achieved through our methodology. The last chapter will contain our recommendations for improvement and an outline for a long-term plan to insure that the future development of the Rattanakosin area will not be at the cost of the environmental quality of the canals.

2 Background and Literature Review

This chapter details the background information and key sources that were pertinent to our project. Included is an overview of the history of Thailand and Bangkok, a detailed description of the Rattanakosin area, and material on sustainability. There is also information on environmental terms and issues.

2.1 Overview of Thailand

According to Tim Locke, one of the authors of Exploring Thailand, "Thailand has now [1990's] joined the second wave of emergent Asian economies. The 'dragon' nations, Thailand, Malaysia, Indonesia, and the Philippines, are racing to catch up with the richer 'tigers', Hong Kong, Singapore, Taiwan and South Korea." However, some sources say that the Thai people are upset with this change towards becoming a more internationally economic country because it has led to the loss of some of the traditions and individuality of Thailand. Additionally, the growth of industry and urbanization has also created severe problems that endanger the ecosystem in Bangkok.

The following sections cover a wide range of topics important to Thai culture, history and future. In order to understand how to approach the current problems, it is necessary to know basic information about the country. [Locke]

2.1.1 Buddhism

Buddhism is Thailand's official religion. However, a variety of religions including Islam, Christianity, Hindu, and Sikh, can be found in Thailand, since the freedom to practice any religion is guaranteed by the Thai constitution. Plamintr, a Buddhist monk, states that Buddhism, however, "...has become so integrated with

Thai life that the two are hardly separable." Understanding Buddhism is an essential ingredient to understanding the Thai way of life.

At first glance, one will notice that Buddhists are generally happy and content with their life. Buddhism is a religion of self-help, and is sometimes considered more of a philosophy for the mind than a religion. There are no gods, only the Buddha, or "the enlightened one". This founder of Buddhism was a prince, Sittatta, born around 623 BC and was destined to be a great monarch. At the age of twenty-nine, unhappy with his life, he left his kingdom and family to find meaning and truth in life. Six years later, and after many failed teachings by great religious men, he finally discovered the truth in life himself, and became enlightened. He had discovered the Dhamma, a practice of becoming a better person, and realization of the "four noble truths."

Buddhism, as with most religions, has certain elements that characterize it. These elements include a founder, teachings, congregation of followers, a system of worship, religious sanctuaries, and sacred objects. The Buddha's teachings, the Dhamma, are considered by many people to be the most important aspect of the religion. One other important component is the followers; without them, there would be no Buddhism. This congregation is broadly divided into two groups; the monks and nuns form one group, and the laity is the other. Each group has specific rules and responsibilities about their behavior, worship, and interaction with each other. This is to keep a spiritual and traditional bond that instills cooperation. Basic ceremonies and religious rites can be traced back to the beginning of Buddhism, but in recent times some changes have been instilled that reflect each culture's personal needs and this generation's new ideas.

Religious sanctuaries include monasteries, shrines, pagodas, Dhamma halls, and stupas. Occasionally, these places may be used for communal activities such as town meetings. These places of worship are built and maintained through the lay community. Sacred objects include Buddha images, relics of the Buddha, symbolic representations (for example: a lotus plant), the wheel of Dhamma, and Buddha's footprints, and many more items that can be included as sacred objects. These objects serve as reminders of higher ideals and standards.

In practicing Buddhism, one prepares for the next life. If people do well in their present life, it is believed, the next life will be a comfortable one. On the other hand, if they do poorly in life, a miserable next life is unavoidable. It is the Buddhist, and therefore Thai, belief you largely get what you deserve. This view on life will greatly influence how we interact with the Thai people, and how we will give our recommendations.

Since Buddhism is a complex belief that has existed for thousands of years, it cannot be fully discussed in this section. However, we strove to have a basic understanding because it is such a fundamental part of the life for the people of Thailand. [Plamintar]

2.1.2 Agriculture

Thailand has always been a prolific agricultural country, with rice being the predominant crop, exceeding 20 million tons harvested yearly. However, rubber, corn, cassava, sugar, soybean, and coconut are also abundant. Most government sources state that these products constitute between a range of 11% to 13% of the gross domestic product. Since the introduction of chemical fertilizers, irrigation canals, and pesticides, there has been a large increase in crop yields. These yields have recently

dropped because of a long-term drought in the northeastern regions. Also, the crops being planted are severely depleting the soil nutrient content, inevitably leading to land that is no longer suitable for farming. [Cummings, Locke, Urban Development Center]

2.1.3 Manufacturing Industries

Sources agree that throughout the 1990's, the manufacturing industry has grown and now constitutes over one third of the gross national product. The manufacturing industry additionally benefits from the large quantity of cheap semi-skilled labor supplied by the rural areas. This increase in industry has also caused an increase in air and water pollution that is further discussed in a later section. [Locke, Buckley, Krack]

2.1.4 Economy

Bangkok's stock exchange is extremely volatile, yet still attracts a large amount of trading. The city has become an active finance center holding more than 30 commercial and foreign banks in addition to over 100 finance and security firms. An influential Thai family owns the largest local bank in Bangkok, The Bangkok Bank, which is also the largest commercial bank in Southeast Asia. Since the middle 1990's, the country has been hit by a recession, which is causing difficulties for the enactment of any new social or developmental programs.

The Gulf War and world events in the late 1990's have caused Thailand's economy to drastically slow down. Thailand was the first in a series of Asian countries to enter a recession. The Thai baht drastically dropped to half of its original value and has since then stabilized to a middle value. In comparison to the United States dollar, the exchange rate of the baht to the dollar was 25 baht/dollar, the

currency fell to a rate of 56 baht/dollar, and has recently, in mid to late 1998's, it has stabilized at 36 baht/dollar. Previous predictions from a major newspaper in Bangkok, The Bangkok Post, were that Thailand would be one of the world's top eight economies by 2020. However, the country would have to suffer greatly in order achieve this goal. To keep up with the fast pace of development in Thailand, they said, the gap between the rich and poor would have to be increased as commonly occurs when a country undergoes rapid growth. The rich would have to get richer, and the poor poorer. The World Bank has estimated that there is currently fourteen million Thais living below the poverty line, and to meet the Bangkok Post's economic prediction, this figure would increase further. Additionally, a decrease in the exportation of rice has also contributed to a decline in the economy. In the 1980's, Thailand was the world's leading rice supplier, but Vietnam has gradually been taking over the market. [Bangkok Post, Krack, Locke]

2.1.5 Tourism

Seven million foreigners come to Thailand each year, arriving at a rate of eight hundred per hour. Fodor's Guide states that the average tourist will spend over US $1,000, summing a total of $8 billion a year, accounting for half of Thailand's total foreign income; Krack, however, estimates that the average tourist will only spend $625. Two thirds of the GNP can be attributed to tourism. Based on statistics from the Urban Development Center, tourism has risen from 1.85 million visitors in 1980 to 3.48 million in 1987, 4.8 million in 1989, and 5.3 million in 1990. The Urban Development Center states that "approximately 10,000 tourists visit the Rattanakosin area every day, making this area the most important in Thailand for both history and economy". Additionally, in recent times, the interest in travel by the Thai people has

grown. The Urban Development Center estimates that almost 40 million Thais can now be classified as tourists within their own country.

Since Thailand began actively campaigning tourism in 1987, the number of foreign tourists dramatically increased. The decade following 1987 has been nicknamed the "Golden Decade" of Thai tourism with 42.5 million visitors during that period. This increase is mainly due to the shift in the market growth from European and American countries to the Pacific Rim. This has influenced foreign investment markets, which in turn has encouraged development in countries such as Thailand. As Thailand's economy grew, the number of Thai tourists also grew as well. At first, they vacationed within Thailand but recently, they have begun to travel internationally lowering the net tourism income. This is further discussed in the last two chapters concerning results and our recommendations.

As do to other countries with a thriving tourism industry, Thailand recognizes both the positive and negative effects of this industry. The effects of this industry are especially apparent in regards to the environment. Thailand now understands that "tourism can only survive and prosper in a clean and unspoiled environment which will benefit both the visitors and the local people...Without proper management, planning and regulation, tourism as an industry is likely to develop in a totally haphazard way, providing the catalyst for rapid deterioration of the environment. Polluted beaches, impaired scenery, deforestation, despoliation of archaeological sites and local culture are inevitable partners of this overall deterioration." (Urban Development Center, 1994). However, Thailand has just recognized the serious effects that tourism has on its environment and is beginning to research and implement environmental management plans. If a proper environmental management plan is undertaken, the opposite effect may be achieved. The Urban Development

Center states that the "preservation of the environment as well as restoration of indigenous art and culture to their original glory will not only be a source of national pride but will also continue to attract both overseas and local visitors."

The Thai Government, through the Tourism Authority of Thailand (TAT), has adopted environmental policies. Thai Government and TAT are striving to create a "sustainable tourism" in which economic needs are balanced with ecological responsibilities to create worthwhile and long-term benefits for all. The government has also emphasized the importance of preserving the environmental quality by revising laws. The Enhancement and Conservation of National Environmental Quality Act, B.E.2535 (1992) sets environmental quality standards regarding prevention and correction policies of environmental problems. This act also stresses the "polluter pays" principle whereby polluters are required to finance public and private anti-pollution operations.

The PATA, or Pacific Asia Travel Association, of which the TAT is an active member, has acknowledged the relationship between tourism and the environment. In accordance to PATA, a program has been created so that a sustainable future can be planned. PATA defines environmentally responsible tourism as meaning:

- recognizing the necessity to ensure a sustainable future
- meeting the needs of the tourism industry today
- not compromising the ability of this and future generations to conserve the environment

Ariya 'Narn Aruninta, author of ecological and tourism material, believes that sustainable tourism is not only a worthy objective but an essential ingredient in Thailand's tourism development. [Tourism Authority of Thailand, Urban Development Center, Locke]

2.2 Review of Bangkok

In 1782, Bangkok became the capital of Thailand; before that, the settlement was known as Bang Makok, meaning "Place of Olives." Bang Makok was only an outlying district of Thonburi Si Mahasamut (now Thonburi), located on the East bank of the Chao Phraya River. A group of wealthy Thais originally founded Thonburi, helping it become an important trading city during the 17th and 18th centuries. After the Burmese defeated Ayuthaya in 1765, Phraya Taksin, a Thai General, established a new capital at Thonburi. King Rama I, Chao Phraya Chakri, moved the capital to the Bangkok district in 1782 because he believed that it would be easier to defend against an attack from sea. King Rama I used thousands of war prisoners to build city walls and to expand the canal system to form a royal 'island', Ko Rattanakosin.

Construction of temples continued to be a main activity up until the reign of Rama III. Under Rama IV (King Mongkut), the residents of Bangkok used canals as the main source of transportation; in response to requests from foreigners, roads were slowly added in the 19th century. By the time Thailand established a constitutional government, in 1932, the population had risen drastically and the canals were proving inadequate for transportation. Bridges were built over the Chao Phraya River and canals were filled in to provide space for the increasingly popular roads. This cut off many of the remaining canals, leaving them inadequate for the remaining users of the waterways.

In 1998 there were 7.7 million people officially residing in Bangkok's 36 districts, with a density of over 3,560 people/km^2. The majority of economic, industrial and trade activities are concentrated in the Bangkok area, creating ample opportunities for employment. In response to these opportunities people have been migrating towards Bangkok, causing an increase in the population. However, due to

the recession, there have been major job cuts leaving a large segment of the population unemployed. [Locke, Krack, Osborne]

2.2.1 Bangkok's Environment

With extreme economic growth during the 1990's, the natural environment of Thailand has taken a drastic downfall. Pollution has become a serious problem that cannot continue to be ignored. Air pollution, for example, is of such concern that taxi drivers and traffic officers often wear dust masks to help prevent the inhalation of toxic fumes. Dhira Phantumvianit and Khunying Suthawan Sathiradhia, two activist Buddhist monks, express that, "In recent decades, Thailand has increasingly become an environmental disaster, largely as a result of the nearly wholesale acceptance of westernization, including industrialism, urbanism, materialism, and consumerism." [Swearer, Locke]

2.2.1.1 Air Pollution

Since the first half of the 1990's, the number of cars in Bangkok has been increasing at record numbers. Locke, a writer on Thailand, states that nearly 2 million cars account for the 5 tons of lead and other toxic matter released into Bangkok's air every day. However, the traffic is not the only cause of air pollution. More than half of the country's industry is located in Bangkok, emitting toxic matter into the air, and unpaved roads in the less developed areas around the city contribute large amounts of fine dust in to the air. In some sections around Bangkok, this value reaches as much as 0.12 mg/m^3 per cubic meter. In comparison to the standards set by many western countries, such as the United States, the set levels of particulate matter smaller than 10 microns can be no greater than 0.15 mg/m^3 per cubic meter. [Locke]

2.2.1.2 Water Pollution

The level of mercury contamination in the Chao Phraya River ranges between seven to forty times the acceptable level set by the Thai government. The fish and shellfish contain 10 to 20 times the acceptable level of heavy metals. The rate at which Bangkok is using water is so high, that diverting another river into the Chao Phraya River is being considered.

The rural areas are not doing much better; chemical fertilizer and pesticides from the farmers are finding their way into the water supply. Residue from these contaminants can be found in the canals, rivers, and reservoirs. Once these contaminants get into the soil they eventually end up in the food supply, causing fatality to animals and illness in humans. A possible alternative to the problem of contaminants is "Buddhist Farming", proposed by Masanobu Fukuoka. This practice replaces the use of chemical fertilizers and pesticides with natural herbal sprays and the encouragement of natural predators, for example birds. Soil nutrient content is maintained by using leaf-based fertilizers and inter-cropping which incorporates a multitude of different crops in the same field.

Thailand's pollution problem links back to its rate of economic growth. Instead of competing with Asia's other 'tiger' economies, Tim Locke argues that "Thailand's future does not lie in industrialization and all its associated environmental problems, but rather in an agricultural, food-processing and service economy." [Locke, Aruninta]

2.2.2 The Rattanakosin Area

The Rattanakosin area contains many of the most important temples, or Wats, in Bangkok. The first king of the Chakri Dynasty, King Rama I, decided to relocate

the capital from Thonburi to the eastern banks of the Chao Pharya River. The two main factors that affected King Rama I's decision both dealt with the peninsula shaped section of land. He felt that the land was more suitable because it would be easier to defend upon attack and land erosion could be avoided. He ordered all governmental buildings to be moved to the east bank of the Chao Phraya. The Rattanakosin Area is sectioned off by surrounding canals, or "klongs," and contains the Grand Palace and other historical palaces which have been converted into government offices. The following section reviews the current situation of the Rattanakosin area, specifically outlining the organization by zones, temples, palaces, tourist attractions, the Humanizing Bangkok Project, and other additional commercial areas. [Urban Development Center]

2.2.2.1 Organization by Zones

The Rattanakosin area is divided into 3 zones by semi-circles delineated by the klongs as shown in Figure 2-1. This was done for several reasons, primarily urban development purposes. Zone one contains the Grand Palace and many of the oldest sites; construction of any new buildings in this area has been prohibited and any renovations must be approved. Zone 2 is further away from the Chao Phraya River and is not as strictly regulated. Zone 3 is

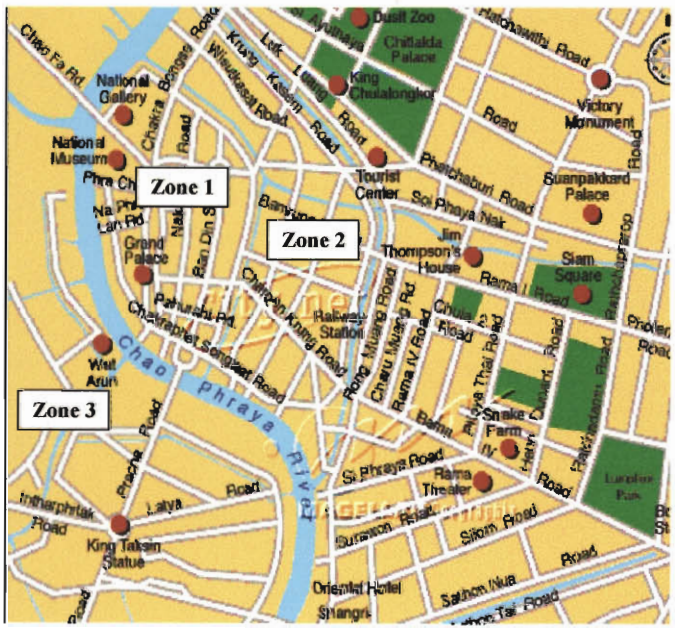


Figure 2-1: The Zones of Rattanakosin [Excite maps]

not actually adjacent to the first two zones but on the other bank of the Chao Phraya River at Thonburi. This was the site of the capital before it was moved across the river. [Urban Development Center]

2.2.2.2 Palace, Temples, and other Tourist Attractions

All sources agree that the Rattanakosin area houses the largest number of tourist attractions in Thailand. As stated previously, 10,000 tourists visit Rattanakosin Area daily. The following buildings and other various sites are the most historically important and significant sites for tourism.

- *Wat Phra Kaew and Grand Palace*

Wat Phra Kaew, more commonly known to the foreign visitors as the Temple of the Emerald Buddha, adjoins the Grand Palace. Built during the move of the capitol of Thailand across the Chao Phraya River in 1782, the 945,000 square meter area includes over 100 buildings built over a span of 200 years. The Wats' styles of architecture became known as the Bangkok era, or Rattanakosin style. These buildings have extremely colorful and gilded exteriors, with marble and teakwood being the predominant building materials. Murals inside of the temple describe Thailand's history in 178 sections. However, these murals have needed several restorations due to corrosion caused by various reasons including pollution, wear, and time.

- *Wat Pho*

Wat Pho, the oldest and largest temple in Bangkok, features an enormous Buddha image along with the world's largest collection of smaller Buddhas, numbered at 394. Construction of Wat Pho began in the 16th century and restorations made minimal changes in 1781. Wat Pho houses the national headquarters for the

preservation of traditional Thai medicine and Thai massage. For those interested, classes in traditional Thai massage are offered. The temple also contains a 46-meter long by 15-meter high Buddha finished in gold leaf.

- *Wat Arun*

Nicknamed the Temple of the Dawn, this temple is the most famous and photographed of all temples and sites in Thailand. It is located on the far bank of the Chao Phraya River in Thonburi near the site of the old capitol. The 82-meter tall spire is in the old Khmer style and was reconstructed during the reigns of Rama II and Rama III. The brick core of the structure is covered in plaster with a mosaic Chinese style porcelain covering. The use of broken porcelain for temple ornamentation is typical of the Rattanakosin style. The nickname, Temple of the Dawn, comes from lights that reflect off the porcelain and illuminate the area.

- *Wat Suthat (Giant Swing)*

The famous Sao Ching Cha, or Giant Swing, is the Wat Suthat's most famous asset. Sources believe that the doors to Wat Suthat were carved by Rama II. The swing was originally used for a Brahmin ceremony held once a year in which Siva and Vishnu visited the temple. In this ceremony, practiced until the 1940's, men would swing in an attempt to reach a fifty foot pole where there would be a prize. The majority of sources say that the prize was a bag of gold; however, the Bangkok Metropolitan Administration disagrees and instead proclaims that the prize was of silver. Due to the numerous deaths associated with this ceremony, it was abolished and only the teak structure of the swing remains.

- *National Museum*

King Rama V opened the first public museum, the Bangkok Museum, in 1874 to exhibit the former royal collection of King Rama IV. In 1926 the museum was

relocated to Wang Na and became known as the National Museum. The collections of the National Museum pertain to the cultural heritage of Thailand with the majority of the emphasis on art, archaeological and cultural objects dating from early Thailand up to present day.

- *Democracy Monument*

The Democracy Monument commemorates Thailand's change from Absolute Monarchy to a Constitutional Monarchy on June 24, 1932. The monument was designed by Professor Silpa Bhirasri, a French Artist, with the core structure in the form of a large copper tray carrying the Constitution, supported by a pedestal. The copper tray is the largest in Thailand with a height of three meters and weight of four tons. [Bangkok Metropolitan Administration, Locke, Cummings]

2.2.2.3 The Humanizing Bangkok Project

At the request of Dr. Bhichit Rattukul, the mayor of Bangkok, the United Nations Educational, Scientific, and Cultural Organization, (UNESCO) worked with the Bangkok Metropolitan Administration to create the Humanizing Bangkok Project. The goal of this project was to promote sustainable development in the Rattanakosin area, "...to improve the quality of the Bangkok people." With participation of local people in the four specific areas mentioned below, a series of renovations are going to be used to change the current landscape into "forms of the three dimensions and the four elements".

The three dimensions are:

1. Urban elements- Architecture, flowers, and trees
2. People's ways of life- activities and atmosphere
3. Religion- monasteries, influences on people

The four elements include:

1. Earth: major environmental ingredient- trees, flowers, roads
2. Water: river of life- including water springs and ponds
3. Air: breath of life- cultural diversity
4. Fire: breath of civilization- sunlight and shade

The four sites located within the Rattanakosin area that this project focused on are: Tah Prachan, Tah Chang Wang Luang, Tah Tian, and Phraeng Phuthorn.

- *Tah Prachan*

The Tah Prachan area was once the former palace of Prince Prachack Silpakhom. Currently this area is the river crossing point and transportation change junction between the road and river transport systems. The result of a large volume of daily passengers on both of these systems has created a dense commercial area. The ferry is operated by a private company and is designed to mainly serve the students and staff from Siriraj Medical School on the West Bank of the river, and Thammasat and Silpakorn University students on the east. One of the oldest roads in Bangkok, Phra Chan Road, starts in this area and leads to the Royal Field (Sanam Luang).

- *Tah Chang Wang Luang*

Tah Chang Wang Luang, literally meaning elephant pier of the Grand Palace, was constructed during the reign of King Rama I. The elephants from the Grand Palace were given a bath here. This area is home to a large number of retail shops and a market. A ferry jetty serves as the main means of transportation to this area. Thirty-three decorated shops are located at the corner of the Tha Chang area. Built during the reign of King Rama V, these European style houses were constructed with plaster pediments, pilasters, and stucco. Owned by the Royal Crown Property Bureau, these shops are leased to private tenants and are registered as conserved historic buildings.

- *Tah Tian*

In the past, the Tah Tian area was one of the most significant communities in Rattanakosin. During the reign of Rama IV, it became a foreigner residential area with a foreign Court of Justice, and then a port for merchandise transportation. Today the area is no longer used as a commercial port; instead it is used as a river crossing spot to visit the Temple of Dawn.

- *Phraeng Puthorn*

Phraeng Puthorn is another former palace of the royal family. A new road has cut through this area and contains European style shop houses alongside it used for commercial purposes. [Bangkok Metropolitan Administration and Urban Development Center]

2.2.2.4 Additional Areas of Interest

Along with the cultural and historic sites specific to Thailand in the Rattanakosin area, there are other important sites. Thammasat University, International Trade Department, Bangkok Bank, City Hall, and Ministries of Foreign Affairs, Commerce, Interior, and Justice, and theTreasury Department all reside within zone one of Rattanakosin. Zones two and three are the locations of Metropolitan Waterworks Authority, Tourism Authority of Thailand, National Economical Development Center, Royal Navy Headquarters, and the Royal Military Academy.

- *Thammasat University*

The area that now constitutes the Thammasat University campus was originally the southern part of the Crown Prince's palace. This area was given to the military department and was later transformed into Thammasat Law and Political

Science University in 1934. This was the second modern university in Thailand and originally offered courses in only law and political economics. Later, the university adopted additional fields of study and became known as Thammasat University.

- *Ministry of Commerce*

A former palace transferred to the government during the reign of King Rama VI, this site became the Ministry of Commerce. The building style was strongly influenced by European architecture as occasionally occurred during the building of royal structures of that time. There is a statue of Prince Chanthaburi Narunant, the first Minister of Commerce, in front of the porch of the main building. The Ministry of Commerce is responsible for goods and services in both domestic and foreign trade.

- *Tourism Authority of Thailand*

The Tourism Authority of Thailand was created in 1987 because the economy of Thailand had increasingly become dependant on tourism. Responsible for advertising tourist attractions and sites in Thailand, the TAT has developed ties to many countries such as Japan and the United States. The TAT has also helped in the formation of a particular police. There are now several tourist police stations throughout out the city specifically designed to help tourists with the issues they commonly face. The TAT makes projections for the number of tourists, the amount of money each is likely to spend, and the duration of their stay. The TAT also encouraged a change in the tourism and Visa laws enacted during January 1999, allowing visitors to stay longer and consequently spend more money. [Tourism Authority of Thailand, Bangkok Metropolitan Administration, Urban Development Center]

2.2.3 Waterways of Interest in Rattanakosin

In the past, the people of Bangkok commuted by means of boat, and canals, known as klongs in the Thai language, were the predominate routes of transport. Although the canals are no longer the principal means of transportation, they still retain significant value. Now that they have become severely polluted, clean up measures and environmental studies have begun.

2.2.3.1 Seasonal Changes

Since Thailand has rainy and dry seasons, the water levels and turbidity drastically differ throughout the year. Sources agree that approximately 70% of Thailand's rain falls between May and October. The water quality of the Chao Phraya River is affected by this change in precipitation, especially in dissolved oxygen and biochemical oxygen demand, which will be discussed in later chapters. The klongs in the Rattanakosin area are fed from the Chao Phraya River, so the actual discharge capacity of the klongs varies depending on the water level of the Chao Phraya River. The environmental planning and management board measured the maximum discharge rate of the klongs to be about 5 cubic meters per second in the dry season, and up to 50 cubic meters per second during the wet season. [Aruninta, Locke]

2.2.3.2 Klong Bang Lam Poo and Klong Ong Ang

Klong Bang Lam Poo and Klong Ong Ang are two of the most severely polluted canals in the Rattanakosin area, as judged by various studies conducted by Chulalongkorn University and other environmental agencies. Klongs Bang Lam Poo and Ong Ang are two of the largest canals in the Rattanakosin area. The two canals comprise the barrier between zone one and zone two of the Rattanakosin Area. The team will be using four pre-determined stations along Klong Bang Lam Poo and

Klong Ong Ang to collect the water samples used for the water analysis, discussed further in Chapter 3. These sites have been chosen because an environmental history has been previously established. Past studies, done by Chulalongkorn University and environmental agencies provide additional knowledge necessary to a complete understanding of the Rattanakosin area. A detailed description as to the exact extent of this pollution is contained in Chapter 4. [Aruninta, Dr. Jinsart]

2.2.3.3 Past Studies and Recommendations

In collaboration with the Bangkok Metropolitan Administration (BMA), the Japan International Co-operation Agency (JICA) did a study in 1995 to begin to deal with the pollution problems facing the canals without further damage to the Chao Phraya. The study proposed, as an urgent remedial measure, dilution of the canals with water from the Chao Phraya River and aerated lagoon treatment from two existing ponds, the Makkasan Pond and Rama IX pond. It is believed that it would be easy to add enough water to sufficiently alleviate the obvious aesthetic pollution at a fairly low cost. The pumping would mean a refitting of the current pump stations so that they could reverse the flow of water. However, this could only be done during the dry season, since it is impossible to add more water to the canals during the wet season without flooding. [Bangkok Metropolitan Administration, Aruninta]

2.3 Environmental Risk Assessment

In 1989, the Environmental Protection Agency (EPA) adopted a formal process for conducting a baseline risk assessment. This process includes data collection and evaluation, exposure assessment, and risk characterization. The general procedure is described below; however, risk assessment is site-specific. This

information was used in order to become familiar with as many of the possible environmental water quality issues as possible.

2.3.1 Data Collection and Evaluation

The data collection and evaluation plan of an environmental assessment involves the gathering and analyzing of site-specific data. The data is analyzed in the interest of human health concerns for the purpose of identifying what exactly is in the water. This step involves the collection of background information as well as the preliminary identification of potential human exposure through sampling. As background information is collected, the following have to be identified:

1. Possible contaminants at the site;
2. Concentrations of the contaminants in key sources, and media of interest, characteristics of sources, information related to the chemical's release potential;
3. Characteristics of the environmental setting that could affect the fate, transport, and persistence of the contaminants.[Mackenzie]

The review of this site information will make it possible to initially identify potential exposure pathways and points that will be important for assessing the overall exposure. From this background data a conceptual model can be formed that will help refine data needs.

2.3.2 Exposure Assessment

Exposure assessment is used to estimate the severity of the pollutants that come in contact with people. The magnitude of this exposure is based upon the pathways and chemical intake of exposure. However, the pathway of exposure will not always be clear. In cases that it is not clear, one has to consider an individual's potential contact with all contaminated media through all possible routes of entry.

Table 2-1 shows these possible routes of entry. The total exposure assessment is the evaluation of all major sources of exposure. [Butler] After reviewing the available data, it may be possible to increase or decrease the level of concern for a particular route. Elimination of a pathway of entry can only be justified if:

1. The exposure from a particular pathway is less than that of exposure through another pathway involving the same media at the same exposure point.
2. The magnitude of exposure from the pathway is low.
3. The probability of exposure is low and incidental risk is not high. [Mackenzie]

The exposure can be quantified through two methods: point estimate methods and probabilistic methods. The EPA recommends using the point estimate procedure by estimating the reasonable maximum exposure (RME). The RME is the highest exposure that is reasonably expected to occur and is supposed to be a conservative estimate of exposure within the range of possible exposures.

Table 2-1: Potential Contaminated Media and Corresponding Routes of Exposure [Mackenzie]

Media	Routes of potential exposure
Groundwater	Ingestion, dermal contact, inhalation during showering
Surface water	Ingestion, dermal contact, inhalation during showering
Sediment	Ingestion, dermal contact
Air	Inhalation of airborne (vapor phase) chemicals (indoor and outdoor)
	Inhalation of particulates (indoor and outdoor)
Soil/Dust	Incidental ingestion, dermal contact
Food	Ingestion

2.3.3 Risk Characterization

In risk characterization, all of the collected data from the exposure and toxicity assessments are reviewed to obtain a qualitative and quantitative conclusion about the risk. Calculations are derived from the risk and route of entry for each media source. For low-dose cancer risk (risk below 0.01), the quantitative risk assessment is calculated as:

$$\text{Risk} = (\text{Intake})(\text{Slope Factor}).$$

The slope factor can be obtained from IRIS, integrated risk information system, maintained by the EPA for background information on potential carcinogens. For high carcinogenic risk levels (risk above 0.01), the one-hit equation is used [Butler]:

$$\text{Risk} = 1 - \exp\left[-(\text{Intake})(\text{Slope Factor})\right]$$

2.3.4 Risk Management

Zero risk is impossible to achieve; instead risk management is performed to decide the magnitude of risk that is tolerable in specific circumstances. This policy weighs the results of risk assessment against costs and benefits as well as the benefits as well as public acceptance.

2.3.5 Definitions and Classification of Hazardous Waste

A waste material is found to be hazardous by (1) its presence on the EPA-developed lists, or (2) by evidence that the material exhibits ignitable, corrosive, reactive, or toxic characteristics.

2.3.5.1 EPA's Hazardous Waste Designation System

The EPA has designated five hazardous waste categories, each given an EPA Hazardous Waste Number (referred to as the Hazardous Waste Code). The five categories are described as:

1. Specific types of wastes from nonspecific sources; examples include halogenated solvents, non-halogenated solvents, electroplating sludges, and cyanide solutions from plating batches. These wastes have a waste code prefix letter F.
2. Specific types of wastes from specific sources; examples include oven residue from the production of chrome oxide green pigments and brine purification muds from the mercury cell process in chlorine production where separated, pre-purified brine is not used. These wastes have a waste code prefix letter K.
3. Any commercial chemical product or intermediate, off-specification product, or residue that has been identified as an acute hazardous waste. Examples include potassium silver cyanide, toxaphene, and arsenic oxide. These wastes have a waste code prefix letter P.
4. Any commercial chemical product or intermediate, off-specification product, or residue that has been identified as hazardous waste. Examples include xylene, DDT, and carbon tetrachloride. These wastes have a waste code prefix letter U.
5. Characteristic wastes, which are wastes not specifically identified elsewhere, that exhibit properties of ignitability, corrosivity, reactivity, or toxicity. These wastes have a waste code prefix letter D. [Butler]

2.3.5.2 Ignitability

If a sample of the waste exhibits any of the following properties it is said to be ignitable:

1. It is a liquid, other than an aqueous solution containing less than 24 percent alcohol by volume, and has a flash point less than 60°C.
2. It is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture, or spontaneous chemical changes; and, when ignited, burns so vigorously and persistently that it creates a hazard.
3. It is an ignitable, compressed gas.
4. It is an oxidizer.

A solid waste that exhibits the characteristics of ignitablity has an EPA Hazardous Waste Number D001.

2.3.5.3 Corrosivity

If a sample of the waste exhibits any of the following properties it is said to be corrosive:

1. It is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5
2. It is a liquid that corrodes steel at a rate greater than 6.35 mm per year at a test temperature of 55°C.

A solid waste that exhibits the characteristics of corrosivity has an EPA Hazardous Waste Number D002. [Butler]

2.3.5.4 Reactivity

If a sample of the waste exhibits any of the following properties it is said to be reactive:

1. It is normally unstable and readily undergoes violent change without detonating.
2. It reacts violently with water.
3. It forms potentially explosive mixtures with water.
4. When mixed with water, it generates toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment.
5. It is a cyanide or sulfide bearing waste that, when exposed to pH between 2 and 12.5, can generate toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment.
6. It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.
7. It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.
8. It is a forbidden explosive, as defined in the Department of Transportation regulations (49 CFR 173.51, 173.53, and 173.88). [Butler]

A solid waste that exhibits the characteristics of reactivity has an EPA Hazardous Waste Number D003. [Butler, Corbit, Davis, Liu]

2.4 Sustainability Theory

The following section includes a brief overview of the sustainability theory. More specifically, a definition of sustainability is stated, and some recent developments are discussed.

2.4.1 Definition of Sustainability

Sustainability is development that meets the needs of the present without endangering the ability of future generations to meet their own needs. It is not an unchanging state, but rather a dynamic process that needs continual adjustment and monitoring. Sustainability not only meets the needs of the present, it also achieves a balance between economic and environmental issues, while still preserving cultural and historical heritage.

2.4.2 United Nations Conference on Environment and Developments

The United Nations Conference on Environment and Development, or UNCED, is a group of international leaders that tried to link environmental issues with the concerns of communities. The result of a meeting by this group called "Earth Summit" in 1992 was Agenda 21. This program is designed for specific communities to deal with the issues of ecology and economy on a local scale. The UNCED set up a set of guidelines to aid in each community's development in creating their own Agenda 21 program. This program contains guidelines on what is considered to be the three parts of a sustainability program, citizen participation, monitoring of the program, and implementation.

2.4.3 Individual Sustainability Programs

All sustainability programs vary from each other, but contain the following three features:

- Citizen Participation
- Monitoring of Program
- Policy Implementation

2.4.3.1 Citizen Participation

Sources agree that the participation of citizens is the single most important feature in any sustainability program. It is the residents who live in the area that have to deal with everyday changes; they are the only ones who can bring about changes to the environment. One way to help get the public involved is to make them a vital part of identifying the issues of concern. This is often done by using public forums or surveys. Once the program is implemented, the public should be aware of and interested in the process. It is necessary to maintain public support throughout the entire program. In each case of sustainability that we reviewed the first step was a survey of the resident population regarding what popular opinion was toward the various topics and what should be monitored. The implementation of any policy must have the thoughts, support, and input of the public.

2.4.3.2 Monitoring of Program

After the public have had input into what a sustainable area constitutes, it is necessary to determine how the monitoring of certain key parameters will be taken into effect. The selection of these parameters, known as indicators, are very important. UNESCO, along with the OECD (Organization for Economic Cooperation and Development), has created sets of universal environmental, economic, and social indicators. The advantage to using these universal indicators is that they can easily be compared to other sustainable communities. Following is the criteria for the selection of environmental indicators, published by the OECD. The criteria for indicator selection below is only for environmental indicators, but the criteria can be applied to economic and social indicators as well.

Criteria for Indicator Selection

An environmental indicator should:

- Provide a representative picture of environmental conditions, pressure on the environment, or society's responses;
- Be simple, easy to interpret and able to show trends over time;
- Be responsive to changes in the environment and related human activities;
- Provide a basis for international comparisons;
- Be either national in scope or applicable to regional environmental issues of national significance;
- Have a threshold or reference value against which to compare it, so that users are able to asses the significance of the values associated with it.

Analytical Soundness

An environmental indicator should:

- Be theoretically well founded in technical and scientific terms;
- Be based on international standards and international consensus about its validity;
- Lend itself to being linked to economic models, forecasting and information systems.

Measurability

The data required to support the indicator should be:

- Readily available or made available at a reasonable cost/benefit ratio;
- Adequately documented and of known quality;
- Updated at regular intervals in accordance with reliable procedures.

Once indicators have been chosen, the method of data collection must be determined. It is pertinent to see if each indicator is linked to any other indicators. The term "linkage" is used to describe the effects when one indicator plays an important role in the results of another indicator. An example would be the effect pollution in a waterway would have on fish living in it. The number of the fish would be linked to the amount of pollution in the waterway. When the policy is ready to be implemented the higher the number of links each indicator has increases its importance within the policy. For example, in a recent sustainability study, a group in Venice found that if they could track the population of a specific sea animal, they could accurately determine the general quality of the water in the lagoons. [Crispo]

2.4.3.3 Policy Implementation

Data collected from the indicators will be the main method behind the initiatives in the policy development. If perhaps some of the data collected shows that the policy is moving towards an unsustainable direction, then it is obvious that a new plan must be introduced.

2.4.3.4 Review of Existing Sustainability Programs

Since there have been other clean up projects on other canals in Bangkok and various other places in the world, there is a large amount of relevant experience that we were able to draw upon. It was important for us to look into these projects so that we can benefit from their work and use it in ours. Making use of these prior projects greatly enhanced our own knowledge and understanding of our own project. This was done by studying the specific points in previous projects that had relevance to our site, then expanding on these points so that they would be applicable to our canal. This was done early in the project so that we knew how best to continue. A large majority

of the studies that the team found focused on the idea of sustainability and the implementation of Agenda 21 in a variety of forms. We focused on situations similar to what our program would be; usually, each case aided in the understanding of one particular aspect.

- *Truckee Meadows, Nevada, United States*

In 1991, the local government of Truckee Meadows wanted to develop a report that would track the growth and development of their community. "Life in the Truckee Meadow: 1994 Quality of Life Index" was the first use of a sustainability program that team researched. The study set up a fairly elaborate set of indicators for different aspects such as finance, environment, health, and community. For each of these categories, several numerically measurable indicators were identified. This allows for a simple and easily understandable program to be followed. This was invaluable because we could follow the progress from when they determined what the main problems were, to creating indices. These indices could then be used to track the current state of the problems they were concerned with.

- *Jacksonville, Florida, United States*

The Jacksonville sustainability program from the United States has little to do with environmental issues, but instead focuses on issues of the quality of life. This version of sustainability is obviously much more concerned with the attitude of its residents than directly measuring financial and environmental aspects of the community. As opposed to the Truckee Meadows case, which focused more on indicators which could be easily quantified and judged, the Jacksonville sustainability program incorporated subjective indices such as their population's opinions. The

percentage of change in the ratings over the preceding years is used as the indicator of how the public feels the development has progressed.

- *Institute for Housing and Urban Development Studies*

In 1992, the Institute for Housing and Urban Development made a study of the klongs within Rattanakosin Area. Ecological and landscape architectural aspects in urban waterfront development: A case study in Bangkok, Thailand was in response to the increased pollution and stench that was a result of the various types of pollution and stagnant water. Several recommendations were made based on different situations and levels of financial investment. One such recommendation was the renovation of the klong water pumping stations. With upgrades made to the pumps enabling them to force water both ways, fresh water from the Chao Phraya River could be used to dilute the canals. This method of reducing the aesthetic pollution could only be used during the dry season when the canals could hold additional water. During the wet season, the flow rate of the water is much higher and pollutants accumulated are cycled through the klongs at a quicker rate. Although this is only one possible solution, and it is only a "band aid" for the immediate future, this proposal gave us impressions on what the governmental departments are considering in order to balance financial and environmental concerns.

2.5 Summary

This chapter has presented an overview of various topics that pertain to the basic understanding of this project, along with references to the pertinent literature associated with each section. Although there are some contradicting sources on various topics, most sources agree on the main issues that are relevant to the waterways in the Rattanakosin area.

3 Methodology

A description of the steps taken in the construction of our sustainability plan is further discussed in this chapter. For a sustainability plan for the Rattanakosin area to be successfully implemented, a basic knowledge of this theory must be attained. The theory of sustainability has only become more widely known since the previously mentioned United Nations' conference in 1992. By making case studies of previous sustainable sites, a framework was made in which we were able to make a plan of sustainability in the Rattanakosin area. The project's goals, objectives, and methods are presented. Thorough descriptions of each objective, as well as the proposed methods, are presented.

3.1 Project Goal

The Rattanakosin area is the home of a serious pollution problem that must be resolved. However, there are many circumstances that hinder the clean up of this region. The goal of this project is to create a sustainability plan for the Rattanakosin area. First we will make recommendations to improve the area to sustainable levels. Then we will modify the sustainability indicator program set up by the United Nations Council, called Agenda 21, to fit the needs of the Rattanakosin area. Once our plan is finalized, we will distribute it to local environmental analysts and policy makers.

3.2 Objectives and Tasks

In order to formulate the sustainability plan for the Rattanakosin area we will be required to achieve a balance between environmental and health issues, economic factors, cultural issues, and the historical significance of the area. The following are

the specific objectives and tasks necessary for a successful completion of our project goal.

1. Objective: Ascertain the important social and historical sites in the Rattanakosin area.

Tasks:

- Review literature regarding religious and historical locations.
- Locate an expert on preservation and restoration of historical artifacts.

2. Objective: Determine revenue sources of the Rattanakosin area.

Tasks:

- Familiarize ourselves with possible revenue sources.
- Gather relevant data on tourism.
- Conduct an interview with professional at the Tourism Authority of Thailand.

3. Objective: Determine the environmental water quality.

Tasks:

- Go on waterway site visits.
- Collect water samples from the four stations: Paknum, Pradithar, Duppleng, and Samqwate.
- Perform numerous on site tests including; pH, turbidity, suspended solids, visibility, dissolved oxygen, salinity and coliform counts.

4. Objective: Conduct a survey of waterway residents and Rattanakosin tourists.

Tasks:

- Interview residents and tourists in the Rattanakosin area.
- Take pictures of the waterfront community
- Gather the socio-economic data of the area.

5. Objective: Analyze the Humanizing Bangkok Project.

Tasks:

- Interview personal at the Urban Development Center.
- Gather background information on the Humanizing Bangkok Project and the four specific areas of the project.

- Compare present-day pictures with proposed improvement sketches created by the Urban Development Center.

6. Objective: Create an initial list of possible sustainability indicators.

Tasks:

- Research existing sustainability programs, paying specific attention to the indicators that were used.
- Determine what international and universal indicators are pertinent.
- Produce a list of possible local indicators.

7. Objectives: Make recommendations for improvements of the Rattanakosin area to sustainable levels.

Tasks:

- Analyze all of the pre-existing data as well as all of the data obtained through this study.
- Compare the data to specific previous programs.
- Make recommendations on improving the three aspects of the Rattanakosin area to sustainable levels.
- Deliver sustainability plan and recommendations to the Tourism Authority, Association of Architects and Urban Planners, Urban Development Center, Institute for Housing and Community Development, and Thai Environmental Community Development Association.

3.3 Specific Methods

The following section describes the specific procedures for reaching our project goal. More specifically, we plan on using case studies, water quality evaluations, surveys, and an analysis of the Humanizing Bangkok Project.

3.3.1 Case Study

To most effectively utilize the work done by other groups working on the issue of sustainability, we analyzed several relevant communities. This helped us understand how to balance the economic, environmental, and cultural aspects we encountered. It also helped us formulate a useful framework for us to implement the indicators we would develop.

3.3.1.1 Truckee Meadows, Nevada, United States

The Truckee Meadows case tried to balance the growth of a small rural area as well as all of the factors involved in a community. Our situation is much more limited, however, since new development is forbidden on portions of the island and heavily restricted on others. Also, we are concerned with only water quality of the canals and certain social aspects. Despite the fundamental differences in location and scope, this study gave us a guideline on how to set up our proposal by demonstrating how a sustainability index is developed and formatted.

3.3.1.2 Jacksonville, Florida, United States

This Jacksonville sustainability used a version of sustainability that was obviously much more concerned with the attitude of its residents, than directly measuring financial and environmental aspects of the community, additionally it gave us a method for using subjective data as indicators. As opposed to the Truckee Meadows case, which focused more on indicators which could be easily quantified and judged, the Jacksonville sustainability program incorporated subjective indices such as their population's opinions. Their method for using these more subjective values became the basis for how we decided to rate our section on residential and tourist surveying. These methods included determining the difference in approval ratings and other answers. The percentage of change in the ratings over the preceding years is used as the indicator of how the public feels the development has progressed.

3.3.1.3 Institute for Housing and Urban Development Studies

In 1992 the Institute for Housing and Urban Development made a study of the klongs within Rattanakosin Island. Ecological and landscape architectural aspects in urban waterfront development: A case study in Bangkok, Thailand was a result form

the types of pollution and the stench that was a result of the types of pollution and the stagnant water. Several recommendations were made based on different situations and levels of financial investment.

The biggest contribution this particular study was for our purposes, was its relevance to the canals in Bangkok. It gave us a wealth of background regarding the problems currently being addressed and treated. Additionally, the report outlined the existing laws and procedures associated with environmental issues.

3.3.2 Water Quality Evaluation

A detailed water quality evaluation will comprise the main source of information on the canals. While the water samples were being obtained, a different group member went through the following inventory and made field notes on the various topics:

1. Station number
2. Canal width
3. Watercolor
4. Trash
    - General
    - Construction
    - Food
    - Botanical
5. Oil
6. Canal banks/sides
7. Surrounding area
8. Wildlife

The following tests also were performed on site with the exception of the coliform counts being done in a laboratory. Students of Chulalongkorn and a member of our team, experienced in environmental testing, did these tests:

9. Temperature
10. pH
11. Transparency
12. Dissolved Oxygen
13. Coliform Counts

14. Turbidity
15. Conductivity

All of the evaluation criteria listed above are explained and described in detail below.

1. Station Number

Each of the stations was given a specific number so that future reference would be easier. Each of the sites visited were existing sites previously chosen by past studies done by Chulalongkorn University so that a comparative yearly analysis could be made. We kept the same numerical identification system so that a direct correlation could be maintained between the past and future data. Stations one through three are located on the border between zone one and zone two, as can be seen in Figure 3-1. Station one is on Klong Bang Lam Poo, station two on Klong Ong Ang, and station three is situated at the intersection of Klong Bang Lam Poo and Klong Ong Ang. Station four is located within zone one near the outlet of Klong Lam Poo into the Chao Phraya River.

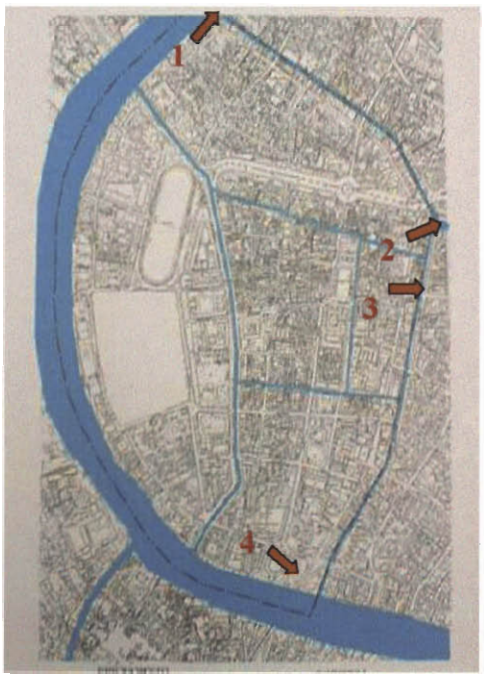


Figure 3-1: Station Locations

2. Canal Width

The approximate width of each canal station was noted at its narrowest point by relating the station in question to the known measurement of station one, ten meters.

This evaluation is significant because the overall width effects other criteria such as flow rate and turbidity.

3. Water color

The overall color of the canal water was given a numerical rating, based on the degrees of brown and green hues. The color of the water was given a numerical rating of 0 if it was brown, 1 if it was brown with a tint of green, 2 if it was green with a hint of brown, and 3 if it was green. The numerical rating system is significant because when the water is green it means there are a lot of algae present, and brown corresponds to low organic compounds and possible wastes. Ideally the water color should be clear.

4. Trash

It was specifically noted what types of trash were prevalent in the canal. Since the category of trash is so wide, we further broke the category into the following sub-categories: general, construction, food, and botanical. The sub-category of construction trash will consist of the items that are related to building materials and other construction activities. The sub-category of food trash will include the types of food that are in the canal. The sub-category of botanical trash consists of the different types of flora in the canal. The type of trash in the water was relevant to the overall quality of the water because it gives a clue into what types of things were being thrown into the water.

5. Oil

Any oil film on top of the water was noted because it told the team whether or not oil was present in the water. This is significant because oil is extremely toxic to wildlife.

6. Canal Banks/Sides

It was noted whether or not there was any 'sludge' or discoloration on the sides or banks of each canal. Also, the color of the sludge was observed. The coloring of the banks or sides of each canal was very important because the discoloration confirmed the color of the water.

7. Surrounding Area

The area surrounding each canal was surveyed and documented. Specific attention was paid to the type of housing, buildings, and religious artifacts nearby. The surrounding area criterion was extremely important because it displayed a lot about what types of possible pollution may be occurring and whether or not raw sewage or trash was being dumped directly into the canal. This data can also show what housing or schools, for example, the pollution may affect.

8. Wildlife

It was noted whether or not there were signs of wildlife including fish, turtles, etc. in the water. The criterion of wildlife is significant because it let the team know if the canal was sustainable for life.

9. Temperature

The temperature was found primarily for comparison between the sites and past years. This is a common measurement that is used as a reference.

10. pH

The pH was measured by using a pH meter. The apparatus uses a probe that contains an ionic fluid and an electrical device. Depending on the percentage of H^+ in the sample, the ionized probe conducts a charge converted by the computer to a pH level on a logarithmic scale. The pH level is significant because it directly measures the acidity or alkalinity of the water. This reading was useful in determining what

type of pollutants are being dumped in the water such as acids or chemicals that become acidic after a reaction with water. Ideally the pH of the water should be 7.2.

11. Transparency

The visible depth was measured by using a black and white disk attached to a string. The disk was lowered into the water until it was no longer visible from the surface. The water level was then marked on the string and the disk was removed. The visible depth, in centimeters, was then obtained by measuring the distance from the disk to the water level mark. The visible depth is pertinent to water quality; the larger the visible depth, the fewer suspended solids in the water.

12. Dissolved Oxygen

The dissolved oxygen was measured by adding a mixture of alkaline chemicals that react with all of the dissolved oxygen within the sample, and change the solution into a dark green color. Acidic chemicals are then added in 1ml aliquots. When enough acid is added, the sample solution will revert back to a normal color. The amount of acid added is used in a standard formula to calculate the amount of dissolved oxygen in the water sample. When the dissolved oxygen levels are low, fish have difficulty breathing, leaving the water barren. Low dissolved oxygen levels are due to the oxidation of organic compounds such as food.

13. Coliform Count

Coliform is a general term used for bacteria and other biological organisms in water. We are concerned with a specific type of coliform called fecal coliform. A common type of fecal bacteria is *Escharichia coli*. Nutrients that aid in the growth of all types of coliform were added to the water samples taken at the test sites and then incubated. This gave us a count of how many sample sites contained normal coliform. Next, another set of nutrients was added that would only allow *E. coli* to

grow. Based on indicators, it can be determined if there is fecal coliform growth. To determine the amount of *E. coli* in the water, the original water sample is added to a nutrient containing petri dish and then incubated. Then, individual colonies can be counted and the amount of fecal coliform per ml is determined. If there is a high coliform count, it is indicative of sewage waste runoff. This is a problem commonly found in areas that have recently experienced explosive growth.

14. Turbidity

The turbidity of the canal was measured by calculating the time, in seconds, it took for a ping pong ball to travel five meters. The turbidity, or flow rate, was measured at approximately one meter from the bank of all canals. Since flow rates differ at various distances from the bank, the measurement of one meter from the bank was chosen to remain consistent with previous data. The turbidity of the water is important because a high flow rate helps flush the canals, by keeping the water moving and replacing it with new and cleaner water.

15. Conductivity

Conductivity tests measure how easily electricity flows through the water. This flow of electricity depends primarily on the salt content. When the water contains high amounts of salt, it can give clues to specific types of pollutants.

3.3.3 Survey

For this project we created a survey to complete our assessment of the Rattanakosin pollution problem. There are two different types of surveys. We used a combination of both to extract the pertinent information.

- Needs Assessment – used to get opinions about problems and get possible solutions.
- Evaluation – to learn about the effect of programs and/or policies.

In order to compose an effective survey there are particular areas in which we became more knowledgeable. One of these main areas deals with the reaction the Thais will have to our survey. Background about the Thai culture has been researched in our background portion of the paper; however, we still required further knowledge about the correct way to administer a survey. Research by Professor Joseph Petrucelli of Worcester Polytechnic Institute and by Priscilla Salant and Don A. Dillman, co-authors of How to Conduct Your Own Survey was used to obtain this needed knowledge. Help from Dr. Wanida Jinsart was also necessary in developing a correct and understandable translation to the Thai language. We constructed numerous drafts of sample surveys to find one that best suited our needs. From this data and a study of the Thai culture, we determined the best way to take a public opinion survey in the Rattanakosin area.

We used the same questionnaire for both the waterfront residents and the tourists so a direct comparison can be made between the two. Our survey creates a basis for judging the local awareness and attitude of the quality of the canals. With research from the Tourism Authority of Thailand, we will try to establish the condition of the canals has a direct relationship with the tourist industry. The specific data and facts from the Tourism Authority of Thailand helped in defining the target group to be surveyed. The team wanted to make sure that the tourists surveyed were a correct proportion of the total population of the tourism in Thailand. Despite feeling more comfortable approaching certain tourists based on cultural and language similarities, but the team made sure that the surveys received reflected the statistics provided by the Tourism Authority of Thailand.

Appendices F and G show the final survey questions asked to the tourists and residents. Our participants included Rattanakosin residents as well as national and

international tourists visiting the Rattanakosin area alongside the canals as well as near the Grand Palace and other popular tourist sites. We made sure to visit a variety of different areas for both the residents and tourists in order to obtain a suitable sample of the population, reaching all social classes in appropriate ratios. For the residents, the team had the help of four Chulalongkorn students who were able to communicate with other Thai speaking people. Approaching the tourists, on the other hand, required a large amount of skill and tact. The team wanted to survey an appropriate demographic percentage of each nationality. A large percentage of Thailand's tourists come from other Asian countries and were unable to speak English. So, in order to fulfill our requirement of Asian tourists the team would approach the tour guides, whom generally spoke English, and use their guidance as to which of the tourists could speak English or let them assist us in translating the questions.

3.3.4 Humanizing Bangkok Project

We conducted a thorough analysis of the Humanizing Bangkok Project in which we compared the present situation of the Rattanakosin area to future plans. We did this by using comparative photos and testimonies from the waterfront residents and senior urban development personal. The Urban Development Center is currently working on the Humanizing Bangkok Project where proposed architectural drawings were drawn up for specific areas within Rattanakosin. The present day photos were compared to the proposed drawings to find out specifically what changes are being proposed. Through this analysis we were able to determine how the canals and the area have changed during the years.

3.4 Summary

In this chapter we restated our goal and specifically defined how we were going to meet that goal. Through outlining our objectives and tasks, we were able to clearly show how our needs will be met to set the framework for the sustainability of the Rattanakosin area.

4 Results and Analysis

In the previous chapter dealing with methodology, we presented how we were going to perform the steps needed to create a sustainability plan. Now, we will give the data that resulted from those steps.

The data was collected on three specific days. On 25 January 1999, our team, along with five Chulalongkorn fourth year Environmental Science students, visited stations one through four. Water samples were taken from these four stations, as well as measurements of flow rate, pH, water color, visual depth, and dissolved oxygen. On the second day, 28 January 1999, we performed in-land fieldwork. The team, along with four Chulalongkorn graduate students, visited the Grand Palace, Wat Phra Kaew, and Wat Pho in order to determine the state of the murals and other cultural artifacts. The third day of fieldwork, the 10th of February 1999, the team revisited the water stations in order to conduct surveys of the residents, again, with the help of the Chulalongkorn students. A modified version of this survey was also given to tourists.

This chapter contains all of the results and analysis obtained from fulfilling the objectives mentioned previously. In review, these objectives were:

1. Ascertain the important social and historical sites in the Rattanakosin area.
2. Determine revenue sources of the Rattanakosin area.
3. Determine the environmental water quality.
4. Conduct survey of waterway residents and Rattanakosin tourists.
5. Analyze the Humanizing Bangkok Project.
6. Create an initial list of possible sustainability indicators.
7. Make recommendations for improvements of the Rattanakosin area to sustainable levels.

The last two objectives along with the recommendations based on these results and analysis are discussed in Chapter 5.

4.1 Social and Historical Sites in Rattanakosin

The Rattanakosin area is the heart of the Thai culture and history. A balance must be obtained between environmental improvements and preservation of important historical artifacts and sites of the Rattanakosin area. The inside of the Grand Palace and temples house murals that convey a large majority of Thai and Buddhist history. Due to environmental factors, these murals are deteriorating. Wat Pho has many murals that are in danger of being lost. One specific example of the decay of the murals is shown in Figure 4-1. This mural specifically portrays a story about the Buddha. However, the underlying meaning of the mural is lost due to damage caused by erosion. High levels of air pollutants and natural occurrences like rain and humidity, for example, have caused the rapid deterioration of the murals in Wat Pho and other areas in Rattanakosin.

Figure 4-1: Deterioration of a Mural at Wat Pho

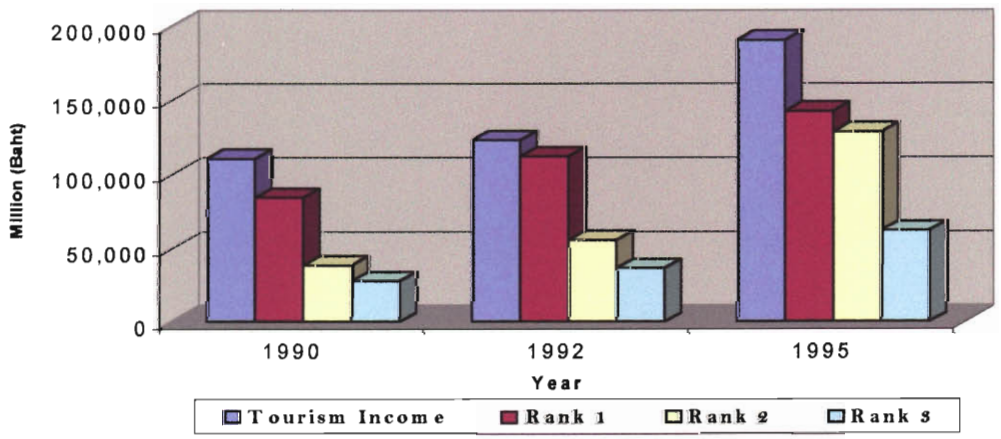
Not only has the environment caused numerous deterioration to the artifacts found within the Rattanakosin area, the daily amount of visitors also plays a great role in this decay. A large number of gold plated Buddha images are displayed within Wat Pho, most of which are leafing. Figure 4-2 shows a sample of one of the worst case scenarios with large portions of gold covering missing. While the team was observing the environmental effects on the

Figure 4-2: Peeling Buddha

artifacts at Wat Pho, it was noticed that a large number of the tourists were touching these images, causing further damage. Although the tourists were handling images, very few Thai visitors did so.

4.2 Revenue Sources

During our interview with the Tourism Authority of Thailand, we obtained data regarding statistical information on tourism that was used to make various assumptions. We have included this information in Appendix H.



Rank 1= manufactured garments
Rank 2= computer equipment
Rank 3 year = 1990 Rice, year = 1992 Jewelry, year = 1995 Plastic products

Figure 4-3: Comparison of Income Sources in Thailand
[Tourism Authority of Thailand]

As can be seen by Figure 4-3 "Comparison of Income Sources", since 1990, tourism has been the dominant source of income in Thailand even surpassing rice, jewelry and other exported products. The income derived from tourism has grown faster than other sources increasing the nations' dependency upon this source.

Since an active program to attract international tourism began, the number of tourists visiting Thailand has drastically increased as seen in Figure 4-4. This dramatic increase has caused both positive and negative effects. Although the

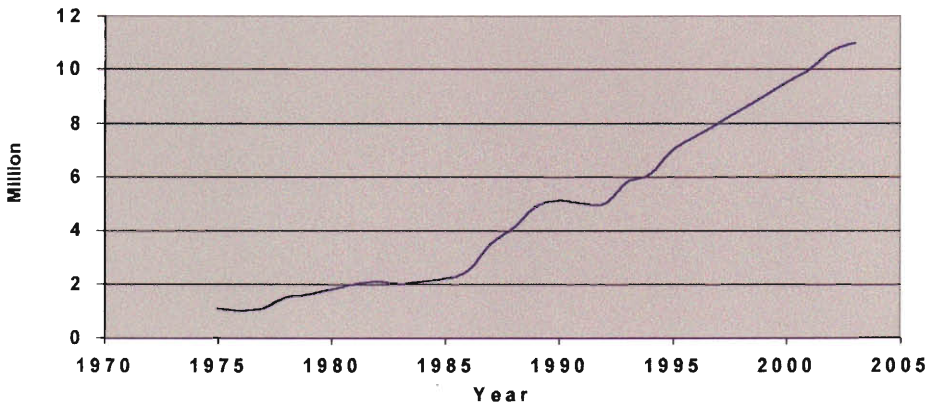


Figure 4-4: International Tourism Trends in Thailand
[Tourism Authority of Thailand]

economy has benefited as shown by the previous graph, the additional drain on resources such as electricity and water has caused problems. Improvements in the overtaxed sewer system have been aimed at accommodating hotels instead of expanding to include canal front residents. Since these residents do not have access to the city system, they have been forced to continue using the canals for waste disposal.

When the Tourism Authority of Thailand started to target specific groups, they decided on other Asian countries, especially Japan. This was for the obvious reason

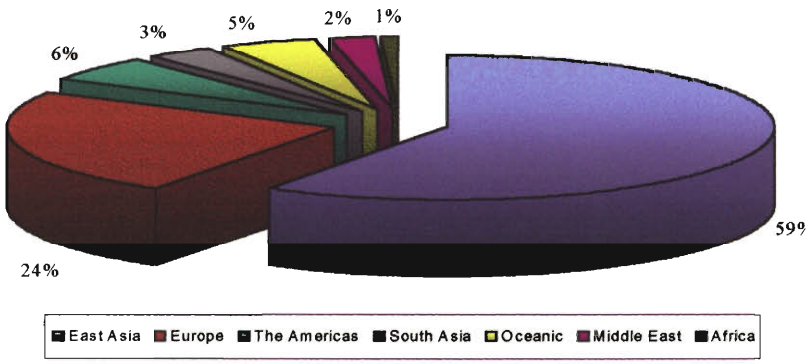


Figure 4-5: Tourist Breakdown by Origin
[Tourism Authority of Thailand]

that the travel distance would be more feasible for these people, and Japanese people have the resources to vacation more often. Twice as many people from Asian

countries came to Thailand in 1997 than Europe and the Americas combined as can be seen in Figure 4-5.

A new interest in the environment by the Western nations, however, has created a new opportunity for tourism in Thailand. "Thailand Tourism: Vision 2012," created at the end of 1998 by the Tourism Authority of Thailand, is a long-term plan on the future of tourism in Thailand.

This proposal by the TAT proposes to introduce a new type of tourism. Following the example of other countries such as Costa Rica, ecological tourism will be advertised in the northern, less developed regions. The idea of eco-tourism is to show tourists the beauty and natural benefits of the area without polluting or damaging the local area by making major renovations for accommodations. By inviting tourists to vacation in the jungles without damaging or negatively impacting the area, the local area will gain a new source of income without draining the already strained resources of Thailand.

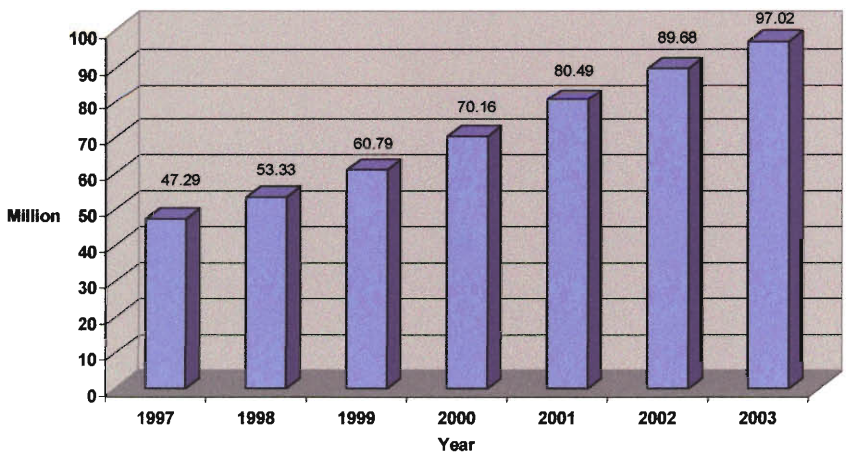


Figure 4-6: Forecast of Thailand's Domestic Tourist
[Tourism Authority of Thailand]

As Figure 4-6 shows, as the number of tourists coming to Thailand has increased, so has the number of Thais travelling within the country. The main tourist

destination within Bangkok is Rattanakosin, due to its historical and religious

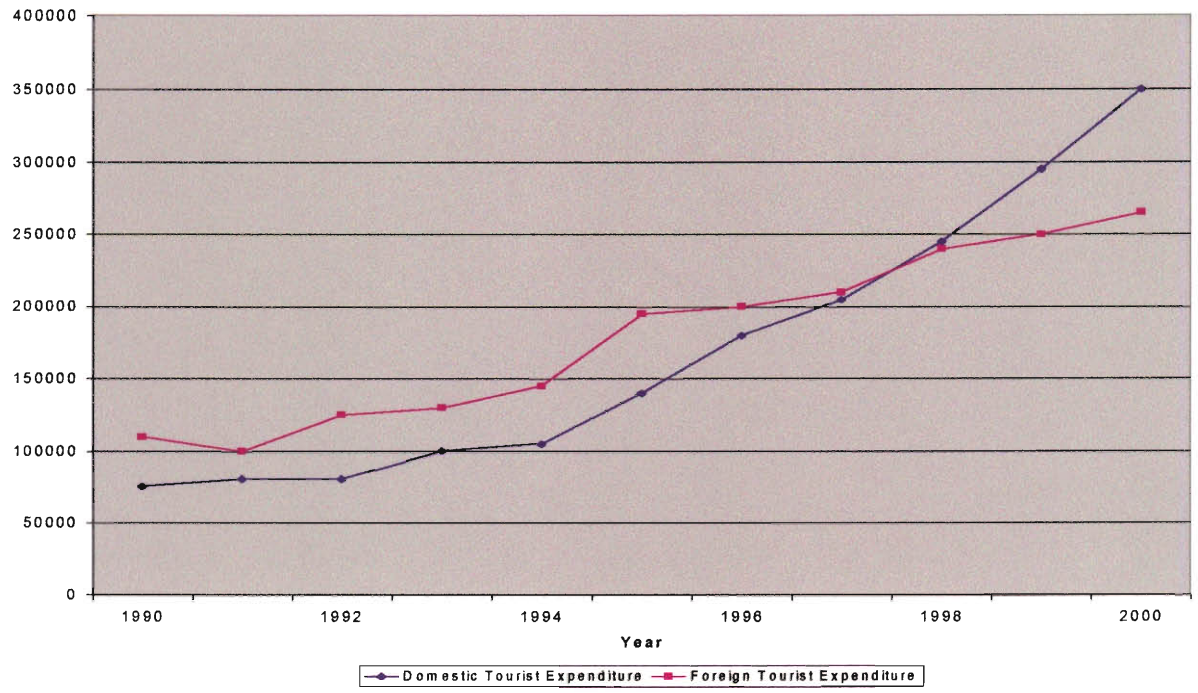


Figure 4-7: Comparison of Domestic vs. Foreign Tourism Expenditure [Tourism Authority of Thailand]

importance to the Thai culture. However, Figure 4-7 shows that since international flights have become more readily available, Thais have become more interested in traveling abroad. This has had an adverse effect on the revenue from tourism.

If the trend continues as predicted, and the baht remains comparatively weak, this will create an economic problem. Basically put, tourism is making a profit for Thailand now, but in the future it may actually be costing the country money. As can be seen by this graph, the number of Thais leaving was less than the number of foreigners arriving, but in the near future, this trend will change. By the year 2001, more money will be expended by Thai nationals abroad than by foreigners in Thailand.

4.3 Environmental Water Quality

Testing the quality of the water in the klongs was an important task because the data acquired could give clues to which pollutants were causing problems. The following data on water quality shown here was collected by the methods previous described in Chapter 3.

4.3.1 Environmental Quality Documentation

While the water samples were being drawn for analysis, overall water quality was also documented. Each of the evaluation criteria listed below is thoroughly described in Chapter 3. The results from the evaluation are listed below:

Station number: one
Canal width: 10yds.
Water color: 1
Trash:
- General: straws, plastic bags, ribbons, rubber bands
- Construction: house frame, rope, wood
- Food: none
- Botanical: none

Oil: yes
Canal banks/sides: none
Surrounding area: elementary school, small waterfront housing area
Wildlife: fish

Station number: two
Canal width: 10yds.
Water color: 0
Trash:
- General: plastic bags, straws
- Construction: ashes
- Food: none
- Botanical: none

Oil: none
Canal banks/sides: none
Surrounding area: large number of water taxis
Wildlife: none

Station number: three
Canal width: 10yds.
Water color: 2
Trash:
- General: plastic bags, straws, rubber bands
- Construction: none
- Food: cabbage, fruit
- Botanical: none

Oil: yes
Canal banks/sides: green sludge
Surrounding area: large waterfront resident community
Wildlife: none

Station number: four
Canal width: 40yds.
Water color: 1
Trash:
- General: plastic bags, rubber bands, paper, plastic bottles, Styrofoam
- Construction: wood
- Food: bananas, cabbage
- Botanical: full plants

Oil: none
Canal banks/sides: none
Surrounding area: restaurants, large number of water taxis
Wildlife: none

The four stations are all obviously heavily polluted. However, not all of the four stations were polluted to the same degree. The reasons for the variation of pollution can be attributed to numerous different factors.

- *Width*

The first three stations, stations one through three, were all approximately ten yards wide. From the team's observation, this is the standard canal width of Klong Bang Lam Poo and Klong Ong Ang. However, station four was approximately forty yards at its narrowest point. This discrepancy is due to the location of station four, near the outlet of Klong Ong Ang into the Chao Phraya River. The difference in the width between station four and the other three stations will have to be taken into account when the data is analyzed.

- *Water color*

The water color of Klong Bang Lam Poo and Klong Ong Ang varied from one station to the next. However, the overall color of the two canals was generally brown with a tint of green. If the color of the water is green it means there is a lot of algae present, and brown corresponds to high suspended solids and possible wastes. The water color of station one and station four were both given a rating of one. A rating of "one" refers to the water being brown with a green tint. However, station two was rated as a "zero", corresponding to a brown color of water. Station three was rated as a "two", meaning the water was green with a brown tint. Station two is a site of wastes and contains large amounts of suspended solids.

- *Trash*

Klong Bang Lam Poo and Klong Ong Ang both contain a large amount of trash floating on the surface of the water. Plastic bags and straws were found in all of the four stations. A large number of the plastic bags found were the ones in which drinks are poured. Other additional general trash found included rubber bands (stations one, three, and four), plastic bottles, paper, and Styrofoam (station four). Construction trash was found in all of the stations except station three. This could be due to the fact that station three has a large population of water taxis that continuously operate for the majority of the day. Also, station three contains a heavily populated waterfront community and room for construction is very sparse.

Figure 4-8: Trash Accumulation in Canal

Food trash was only found in Stations three and four. The subcategory of food trash consisted of edible wastes floating on top of the canal. Heads of cabbage and bunches of bananas were the most common types of food trash found. Stations three is located near a large community of waterfront residents. These waterfront residents use the klongs as their trashcans, as any unwanted or useless item is usually thrown into the canal. While in the process of taking our water samples we witnessed numerous instances of residents dumping trash into the canals. Since station three is located near a large population of the residents, it was not surprising to find a large amount of food trash. Station four is located near a number of restaurants which can account for the amount of food trash found. Botanical trash was only found in station four. Overall, station four contained trash in all four of the subcategories: general, construction, food and botanical.

- *Oil*

Stations two and four were the only two in which oil film on top of the water was not noted; however, there was a discoloration on the banks of the canals indicative of staining caused by oil. These two stations contain a large amount of water taxis that help keep the oil from pooling on the water. Oil might be present at stations two and four, but was not noticeable because of the turbidity.

- *Wildlife*

Signs of wildlife were only found at station one, where the team noticed a small fish population.

4.3.2 Water Quality Analysis

The following table contains the raw data obtained at the four sites along the Bang Lum Phu and Ong Ang Canals.

Table 4-1: Water Quality Data

Station Name	1 - Paknum	2 - Pradithar	3 - Duppleng	4 - Samqwate
Temp. (°C)	27.9	27.7	27.4	27.2
pH	6.65	6.50	6.67	6.69
Transparency	50cm	50cm	56cm	54cm
Dissolved O_2 (moles/ml)	2.8	1.0	0.9	2.7
Total Coliform/100ml sample	2.60×10^6	2.40×10^6	1.60×10^6	3.30×10^4
Fecal Coliform/100ml sample	3.30×10^3	2.70×10^3	3.30×10^3	3.40×10^3
Turbidity (s/m)	26.1	25.3	27.8	30.2
Conductivity (1/ohm)	1650	2250	2400	3500
Canal Width	10yds.	10yds.	10yds.	40yds.

The results of each of these measurements, with the exception of canal width and temperature, are all considered to be at either high or dangerous levels. Turbidity fluctuates depending on the season, and although a higher rate would be preferred to flush the dirty water through, there has been no significant change since records have been kept. However, the most disturbing data is that of the coliform counts. In each case, the levels of fecal coliform are exceptionally high. This proved to be the case in additional canals tested throughout the area not included in this study, showing that this is a widespread problem.

The maximum safe count for fecal coliform for water issued by the Ministry of the Environment is set at 2000 MPN/100ml. MPN meaning the most probable number, is a measurement of bacterial count. In each case, the actual number found, as can be seen in Table 4-1, is significantly higher. The first and third stations are 65% over this limit, the fourth is 70% higher, and even the cleanest has 35% more fecal bacteria than is safe. These fecal bacteria, *E. coli*, can cause serious and potentially fatal illnesses. For the waterfront community, in which health care is less likely to be attained, this is even more of a concern.

We have determined that the major cause of this extremely elevated fecal coliform count is due to poor waste disposal systems by the low income, "squatter" communities. Many of these families live on docks on or near to the canals, without access to city piping and the sewage is dumped into the canal. Since all of the squatter communities are in this situation, large amounts of raw sewage are disposed of into the canal, leading to these extremely high levels of fecal coliform.

4.4 Survey of Waterfront Residents and Tourists

On the 10th of February 1999, the team revisited the water stations in order to conduct surveys of the residents with the help of the Chulalongkorn students. Surveys of the tourists were also done on the 11th and 12th of February, 1999. The goal of the surveys was to enable the team to determine the thoughts of the residents or tourists on the canals in the Rattanakosin area. All samples can be expected to misrepresent the population to some degree. However, using a larger sample size can reduce the amount of error. The team decided to survey a total of one hundred people, fifty residents and fifty tourists. A proper demographic sample of the Thai residents was obtained.

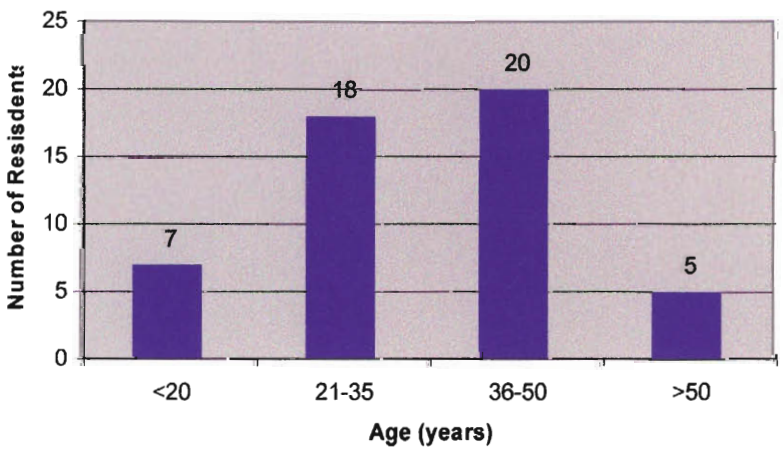


Figure 4-9: Age of Residents Surveyed

Figure 4-9 shows that the age of the residents falls mainly within the ranges of 21 to 35 and 36 to 50. Of the surveyed residents 60.0% were male and 40.0% were female. The percentage of males surveyed was a slightly high because females were generally more resistant to filling the surveys out. The education levels of the residents are shown in figure 4-10. A significant number of the sample residents have either a high school (38.0%) or college education (36.0%). These statistics reflect a proper demographic sample of the Rattanakosin residents. Because of Thailand's economic situation, a lot of college graduates are unable to find employment and have housing in this community.

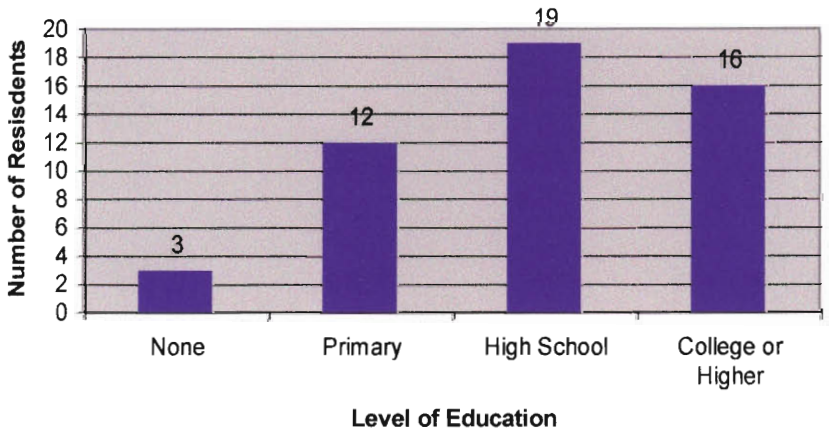


Figure 4-10: Education Levels of Surveyed Residents

Our sample of tourists originated from a variety of different countries. Instead of dealing with all of the countries separately, we divided the countries into three categories: America, Europe, and Asia. Figure 4-11 shows the demographic percentages of our sample.

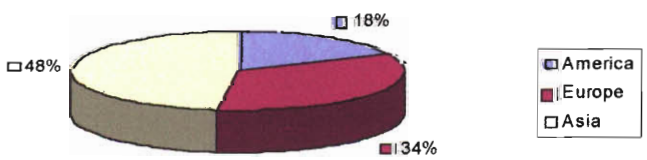


Figure 4-11: Surveyed Tourist Origin by Percentage

Compared to the information given by the Tourism Authority of Thailand, this is a decent representation of the origin of the tourists. Asian tourists were slightly underrepresented and tourists from America were slightly over represented. When comparing the age groups we surveyed, we had only an error of 5% in the over 50 age group. However, the data for the year this survey was done has not yet been compiled and may better reflect our sampling. The following data and explanations come from these three days of field research.

1. In regards to the canals around Rattanakosin, did you notice any of the following?

a. Odor
b. Trash
c. Oil or other pollutants
d. Unusual color
e. Wildlife (animal, plant)

The specific responses to question one by the residents and by the tourists varied with different degrees.

a.) In reference to the tourists, odor received the highest response with a total of 90.0%. 66.0% of the surveyed residents have also reported noticing an odor coming from the canals. An explanation for this difference may be that the residents might have become accustomed to the odor, therefore making it less noticeable.

b.) Trash was the most popular answer for the residents. 82.0% stated that they have noticed a large amount of trash floating through the canals. This is a similar value to the response from tourists as 88.0% of tourists also reported seeing litter in the water. One interesting trend found is that all but two of the residents living in the area for twenty or more years still noticed the accumulation of trash in the klongs, showing that although odor has become accepted among the residents, trash has not.

c.) A smaller number of residents (16.0%) and tourists (54.0%) noticed oil and other pollutants. Still the percentage of tourists that noticed these forms of pollutants were still quite higher than that of the residents.

d.) 44.0% of tourists noticed an unusual color of the water, while only 28.0% of the residents did. Again, the majority of the residents have probably become accustomed to the color of the klong.

e.) Signs of animal and plant life were more noticeable to the residents (22.0%) than to the tourists (18.0%). However, the response results were still fairly close.

2. *Whose responsibility is the canal water quality?*
    a. Government's
    b. Resident's
    c. Both
    d. No one's
    e. Other

The second question was intended to ascertain the opinion of who holds the responsibility for water quality. The two most popular answers for both the residents and the tourists were government or both the governments and the residents. 40.0% of the residents believed the canal water quality was the government's responsibility, compared to 56.0% of the tourists. 42.0% of the residents, in comparison to 36.0% of the tourists, believed the water quality was both the government's and resident's responsibility. A large majority of the Rattanakosin residents believe that taking care of the environment is their responsibility as well as the government's.

3. *Is the environment in Rattanakosin more important than other parts of Bangkok?*
    a. Yes
    b. No

The results from the above question show a definite trend between the responses from the residents and from the tourists. Two-thirds (66.0%) of the Rattanakosin residents believe that the environment in the Rattanakosin area is more important than other places in Bangkok. This trend is probably due to the large

significance that the area plays on their historical and cultural beliefs. However, this may show a bias to their home. Conversely, almost two-thirds (64.0%) of the tourists believe that Rattanakosin's environment is not more important than the rest of Bangkok. The majority of the tourists however, may be unaware of the historical and social significance of the area. The tourists may believe that the entire environment is equally important.

4. In comparison to 5 years ago, the water quality in the canals is:

a. Better
b. Same
c. Worse

Question four was asked to the residents of the Rattanakosin area only. It was designed to find out what the popular opinion is of how the present day environmental situation compares to that of five years ago. Over half (64.0%) of the sampled residents believed that the water quality in the canals has improved, while 12.0% believed it has stayed the same, and 24.0% thought that it has gotten worse. Looking at just the respondents who have been residents of the Rattanakosin area for twenty or more years, the general response (50.0%) is that the quality of the water in the klongs has improved. This in fact may be true as there has been recent legislation aimed at the issues of population growth.

5. In comparison to your expectations of the water quality in the canals, was the water:

a. Cleaner
b. About the same
c. More Polluted

The fifth question was asked only to tourists to see how the canals compared to their original expectations. The majority (60.0%) of the tourists thought the canals were more polluted than what they had expected. 36.0% of the respondents thought that the pollution of the canals was the same as their expectations. Upon review of the surveys the team questioned some of the tourists who believed the water was more

polluted than their expectations, if they were likely to return to the area. The general response was that they would have to think about it. Meaning the area had not made enough of a significant impression on them to guarantee a return visit.

6. Is canal clean up:
   a. Very important
   b. Important
   c. Not important

Every participant of the survey believed that canal clean up was important or very important. 58.0% of the residents thought that cleaning up the klongs was very important; nearly the entire remainder (42.0%) thought it was important. 100.0% of the tourists believed that a clean up of the water was either important, or very important.

4.5 Humanizing Bangkok Project

The Bangkok Metropolitan Administration along with the United Nations Educational, Scientific, and Cultural Organization (UNESCO) created the Humanizing Bangkok Project. The goal of the Humanizing Bangkok Project is the conservation of historic and cultural influence through sustainable development of the Rattanakosin area. Renovations are being proposed to four specific smaller areas within Rattanakosin. Present day pictures were compared with the proposed architectural drawings.

Land use problems are a major concern in Bangkok, especially in the Rattanakosin area. Problems have arisen between different land uses. The main category percentages of land use by zone are:

- Zone one: Waterfront resident 37.37%, undeveloped space 21.11%, and government offices 12.16% the remaining percent consists temples, educational, and various other buildings.

- Zone two: Government owned land 28.69%, residential 26.50%, temples 15.98%, educational land 13.04%, and a small commercial area. Zone two has no undeveloped space.

- Zone three: Residential 38.70%, warehouses 17.51%, commercial area 12.59%, and a small agricultural area.

Additional land use problems are due to the fact that Bangkok has a very small amount of public space for recreation. The Thai government has proposed that by the year 2001 the park standard will be 5 Rai: 1,000 population. In reference to other large cities the amount of public park area in Bangkok is extremely scarce, as seen in Figure 4-12.

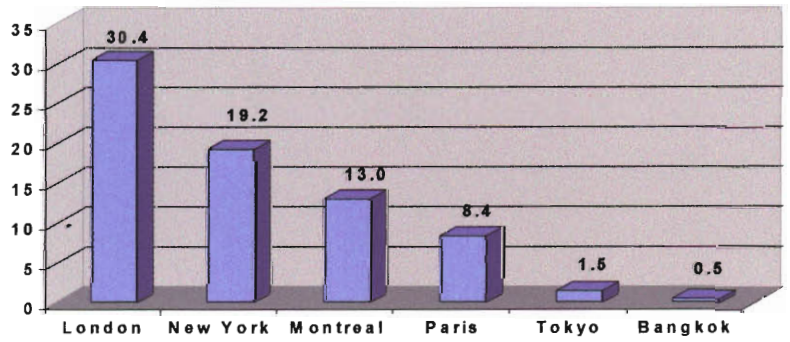


Figure 4-12: Public Parks Area: Person (unit =square meter) [Aruninta]

In comparison, the amount of area of public park space per person in London is 60 times higher than in Bangkok. Tokyo, a densely populated city, has 1.5 square meters of public park per person; compared to Bangkok, Tokyo has a ratio of three times higher. Social and health problems are caused by the lack of public parks. Blood pressure of the Rattanakosin residents is higher than the rest of Thailand in part because there is nowhere to exercise. It is also believed that accident and mortality rates are higher than average because there are no places for recreation and relaxation. Children are commonly found playing in busy streets. [Aruninta]

The Humanizing Bangkok Project has taken these things into account. There are many proposed changes between the 1998 image of Tah Chang, Figure 4-13, and the proposed architectural drawing, Figure 4-14. Tah Chang is one of four areas specifically targeted in the renovation plans of the Humanizing Bangkok Project. A small park has been added to the proposed drawing. There are more pedestrian walkways and shady places to sit. Trees, flowers, and water springs have been added to improve the physical appearance of the area and additional lighting has also been added. The awnings have been removed and replaced by an additional roof to restore the storefronts have been returned to their original European style.

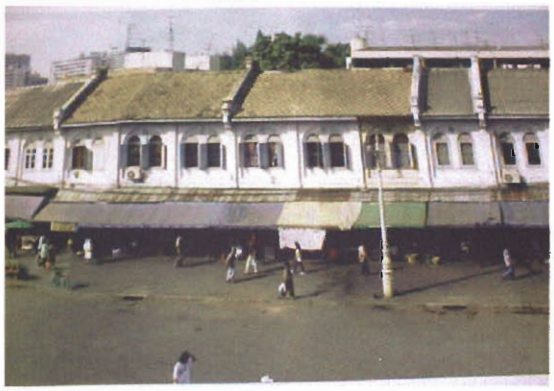


Figure 4-13: Tah Chang (1998)
[Urban Development Center]

Figure 4-14: Tah Chang (proposed)
[Urban Development Center]

Figures 4-15 and 4-16 portray the current and proposed architectural changes to Tah Tien. A large block of roadway is proposed to be converted into a public park. Trees, benches, and flowers have been added to the photo as physical improvements. The large neon signs are removed in the architect's drawing. The architect has composed a drawing full of "unity" by making all the windows' shutters and the awnings over

Figure 4-15: Tah Tien (1998)
[Urban Development Center]

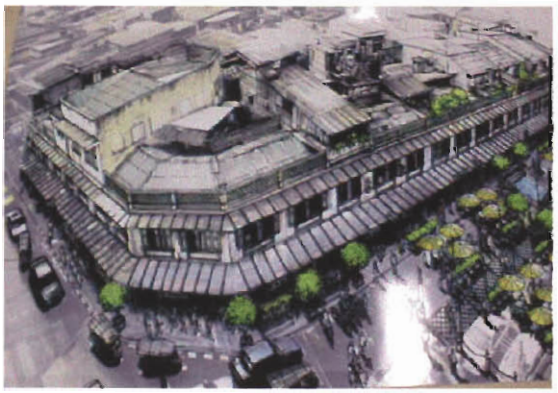


Figure 4-16: Tah Tien (Proposed)
[Urban Development Center]

all of the windows the same. Instead of an area with different buildings randomly placed, the architect has given the area its own identity. The repetition of patterns and familiar shapes within the architecture gives the viewer a restful feeling. Figure 4-15 portrays an area that is hectic and full of very different stores and buildings. The hectic feeling is shown by all of the random neon signs, different storefronts, and awning. Figure 4-16 gives the area a the confident, well thought-out image. The repetition of the awnings and the lack of randomly placed signs help portray this confident image.

Additional aesthetic renovations have been proposed to the Rattanakosin area. A total upgrade of the entire electrical system, specifically the power lines, has been planned. Huge transformers with a multitude of cables are presently situated on large poles in sight of all pedestrians. Aesthetic pollution has also been caused by condenser units from air conditioners located in front of buildings or on their sides. The Humanizing Bangkok Project realizes that these forms of aesthetic pollution should be improved. However, after questioning the senior personnel at the Urban Development Center, the team determined that they were not working cooperatively with the local utility companies. The Humanizing Bangkok Project has proposed the removal of these transformers and condenser units, although after questioning as to their new location, they did not have a suitable answer.

The Humanizing Bangkok Project was a valuable resource by allowing for a comparative study to be made between the present day areas and the proposed architectural changes. This project deals strictly with aesthetic pollution with the

hope of improving the quality of life for the residents and increasing local tourism, however, our project goes further and includes environmental pollution, specifically water quality in the canals.

4.6 Summary

The results from the first five of our objectives have been presented above along with a detailed analysis. The remaining of our two objectives six and seven, create an initial list of sustainability indicators, and to develop a framework for a sustainability program for the Rattanakosin area, are included within our recommendations.

5 Recommendations

Following the completion of this study, recommendations to the area of Rattanakosin and for future project topics have been established. The suggestions that are addressed to Rattanakosin were drawn from the analysis of the data collected throughout the study. These suggestions include a clean up program of the water canals, protection of the cultural areas, and new targets for tourism. The recommendations that are addressed to future project teams involve expanding our plan of sustainability to a larger scale both in size and comprehensiveness.

5.1 Steps to Reach Sustainable Levels

Tourism and the development of the city has caused heavily polluted klongs as well as degradation of cultural artifacts in the Rattanakosin area. The following steps are proposed to bring these issues in Rattanakosin to sustainable levels.

5.1.1 Tourism

Because tourism has become necessary to the Thai economy during the 1990's, a program must be enacted to ensure that the industry is sustainable. In order to accomplish this, a shift in the countries targeted for tourism is necessary. Since the Tourism Authority of Thailand was established, the shift in the targeted tourism has been to attract the people in other Asian countries, as shown by the statistics in the previous chapter.

The omission of western countries in tourism advertising was partly due to the lack of interest and confidence the west had in the region. However, the well documented rise and decline of the economy during the 1990's caught the attention of the rest of the world. Because western currencies such as the dollar and the Euro

currently have favorable exchange rates in Asia, westerners may become more attracted to Thailand, thereby creating a new demographic.

People in European countries and America have become more interested in ecological attractions, as is evidenced by eco-tourism in other parts of the world. By attracting foreigners to go to the conservation regions in Northern Thailand, the TAT can relieve the tremendous draw on resources in Bangkok. This new tourism has been successfully implemented in locations with environments similar to Thailand's, such as Costa Rica and Hawaii.

The shift in the targeting of tourism should also include the characteristics of the Thai's travel styles. Advertising should be done to encourage the Thai people to visit the Rattanakosin area, instead of vacationing internationally. By encouraging national travel, Thailand will help ensure a positive net income from tourism and avoid the predictions shown by Figure 4-7: "Comparison of Domestic vs. Foreign Tourism Expenditure". Since there is a cultural and religious connection in the Rattanakosin area, programs should focus on visiting these historical zones of Bangkok.

In summary, we recommend a shift in the targeting of tourism by the Tourism Authority of Thailand. People from Europe and the Americas should be invited to visit the northern regions for ecological tourism, and the Thai people should be encouraged to vacation within the country by visiting the Rattanakosin area. The purpose of these changes in the policies regarding tourism in Thailand is to reduce the drain on the resources of the Rattanakosin area, and maintain or possibly increase the revenue earned by tourism.

5.1.2 Water Quality of the Canals

Since the quality of the water in the klongs is not nearly at a level that can be considered worthy of sustaining, measures must be taken to improve it. An analysis of the quality of the water shows that the majority of all the levels evaluated are higher than the safe levels. However, coliform and fecal coliform tests presented us with the most alarming piece of information. These levels are between 30%-70% above the maximum and are the cause of the odor that a majority of the people surveyed mentioned noticing. The bacteria present in the water can also be the cause of serious illness. These facts strongly demonstrate the need to keep household wastewater and sewage out of the klongs.

We recommend that the Ministry of Public Works expand the sewage system to include the waterfront residents. This will prevent the need to use the klongs as a waste dump as is currently being done. Because the sudden rise in tourism created a need to expand the sewage systems to accommodate the newly built hotels, attention was diverted from the Rattanakosin area of Bangkok. However, if recommendations to shift some of the tourism to Northern wilderness area are successful, this will allow for future construction of sewer lines to be built to the waterfront areas without overburdening the sewage systems.

5.1.3 Cultural and Historical Artifacts

Because the main draw of the Rattanakosin area is the presence of the Grand Palace and temples, the artifacts at those places are under heavy scrutiny. For example, the murals and gold leaf plating are constantly being touched or photographed by thousands of tourists every day, causing them to slowly degrade.

Renovations are being done to restore these places; however, damage is continually being done.

In places such as Wat Phra Kaew, tourists are free to touch the gold leaf shingles that make up the exterior of the spires. This inevitably causes wear and the eventual loss of the original gold shingles. Also, the murals are fading and peeling due to environmental wear. In order to preserve these relics for future visitors and the cultural significance they have for the people of Thailand, protective measures need to be taken.

To preserve these delicate artifacts, the respective temples should make the minimal investment to install boundaries around the gold Buddhas and install a Plexiglas covering over the murals. It is important, however, that the coverings on the murals obstruct the details of the drawings as little as possible. In most cases, it should be sufficient to only mount the thin plastic coverings over the most exposed murals.

5.2 Selection and Substantiation of Sustainability Indicators

There are many factors specific and important to the Rattanakosin area. We have broken down these issues into three categories: environmental, financial and cultural.

5.2.1 Water Quality

The primary and most important step deals with the dangerous levels of fecal coliform found in the klongs within the Rattanakosin area. As has been previously discussed, these levels are elevated due to the wastewater dumped in the water. **Therefore, fecal coliform count should to be used as the main indicator for water**

quality. Chulalongkorn University students, as part of their fourth year requirement projects, regularly do these tests.

Most of the aesthetic qualities of the water, such as odor, are due to wastewater and sewage. As the survey indicates, residents and tourists both notice these characteristics. If the water quality is not improved, the odor may give the area a poor image, threatening tourism. **Therefore, surveys regarding the water quality should be used as indicators to determine the opinions of the residents and tourists**. These statistics can be compiled and compared to those from the previous year to detect changes in the way the people view the water quality.

If measures to improve sewage and wastewater disposal are implemented, fecal coliform counts should begin to drop drastically. As the counts drop, other pollutants, previously masked by the characteristics of the coliform, may begin to appear in the form of odor, color, or problems with the general health of the community. At this point, the second step of the water quality improvement aspect of the plan involves reducing these other pollutants by an additional clean up program specifically targeted for the newly arisen pollutant.

5.2.2 Tourism

The Tourist Authority of Thailand maintains statistics on many important aspects regarding tourism. These include number of tourists, origin of tourists, average amount of baht spent per tourist, and breakdowns of visited locations. **However, the most useful statistic for an indicator is the locations that international tourists choose.**

The indicators listed in Table 5-1, "List of Sustainability Indicators", will allow for the necessary information on international tourists to be easily tracked.

However, it is also important to track the resident population's tourism patterns. **Therefore, the indicator showing the locations that Thais choose to visit should also be used.**

The final indicator that can be used to track tourism is the net income from tourism. It is important to make an effort to insure the net income is positive in order to bring money into the country. The greater the net income the better, as long as the drain caused on the resources is kept low. However, the amount of net profit is not as important as preventing a net loss.

When these indicators are found each year, the values should be compared to the previous year's value. For example, the values we have accumulated should be compared to next year's values. If there are either sudden drops in quality or the degeneration slows, protective measures should be adjusted accordingly as seen fit by the experts making the judgments.

5.2.3 Cultural and Historical Icons

Because traffic in the historical districts of Rattanakosin inevitably harms the artifacts, protective measures should be installed. Restoration programs at sites such as Wat Pho and Wat Phra Kaew should be continued. Pollution sensitive artifacts, such as the murals, should be covered with a Plexiglas covering to keep them protected, yet allow visitors to still see them.

The indicator chosen to track these artifacts is the expert opinion of the people in charge of art at the temples. Based on a scale of 1-100, each expert would judge the current state of the artifact. If the rating drops below a certain level to be set for each artifact, then adjustments to the restoration efforts should be made to improve the state of the artifact.

5.3 Monitoring of Sustainability Indicators

Using the statistics that were found crucial to the respective areas of concern in Rattanakosin, we formulated a table of sustainability indicators. This list, shown in Table 5-1, contains brief descriptions and the units of each indicator.

The list of indicators has been split into three sub-categories of environmental, economic, and cultural and historical issues to help achieve a complete and full coverage of the three areas.

After these statistics have been made in the future, they still need to be combined and analyzed to know the adjustments that need to be done. Fourth year students from Chulalongkorn University can continue to monitor the environmental indices. The economic indices are currently documented by the Tourism Authority of Thailand, therefore this organization is a prime candidate for overseeing these indices. An expert from the National Museum could rate the status of the historical and cultural artifacts. **We recommend that one expert from each of the categories: environmental, economic, and cultural and historical, monitor their respective indices and meet semi-annually to discuss the status of their indices and develop recommendations based on the progress of the program.**

Table 5-1: List of Sustainability Indicators

dicator Name	Description	Units
vironmental Issues		
cal coliform	The fecal coliform count by the test described	MPN/100ml
inion of Residents regarding: Odor Color Change from last year	Using the survey, the percentage of those residents surveyed regarding odor, color, and the yearly change	Percentage/percentage change from previous year
inion of Tourists regarding: Odor Color Expectation of water quality	Using the survey, the same measurements made of the tourists regarding the same issues	Percentage/percentage change from previous year
nancial		
cation of Visit of International urists	Location the tourist visited	Percentage of visit locations of total
cation of Visit of Visit of National urists	Specific location of the visit	Percentage place by total
t Tourist finance	What is the Net income or deficit caused by tourism as a whole	Ratio of international to national
ultural and Historical		
atus of murals	Opinion of the status by the staff at the respective sites and by other experts	Scale of 1-100
atus of gold tiling	Percent change to previous year	Percent change
atus of Buddhas	Percent change to previous year	Percent change

5.4 Humanizing Bangkok Project

The Humanizing Bangkok Project was an asset to our proposal; however, we would like to make a few suggestions and additions to their work. Cooperation is the key to any project. Proper communication between the Humanizing Bangkok personnel and the public utilities would be a valuable addition. **We recommend that personal from the Urban Development Center contact the public utilities and discuss proper placement for the transformers.**

5.5 Conclusions

In order to promote a better future for the Rattanakosin area, we have made the preceding recommendations. Again, they are as follows:

1. The Tourism Authority of Thailand should encourage ecological tourism for international visitors, and encourage Thais to vacation in the Rattanakosin area.
2. The Ministry of Public Works should connect the waterfront and surrounding communities to the city sewage system.
3. Temples and museums should install protective coverings on the murals and barriers around the golden Buddhas and spires.
4. Use of indicators to monitor progress by Chulalongkorn University, the Tourism Authority of Thailand, and the National Museum.

Thailand has just begun to implement sustainability programs within various aspects of their culture. "Proposal for a Sustainability Plan for the Rattanakosin Area" was initially focused on how to improve the water quality in Klong Bang Lam Poo and Klong Ong Ang. Other aspects that were eventually added to the project included tourism and cultural/historical icons along with a list of indicators so that each could be monitored. By showing that financial and cultural concerns are linked to the

environment, the team demonstrated that the water quality has widespread implications.

For future projects, we suggest that a broader and more comprehensive plan of sustainability be developed. This plan can include ours as a base, but should cover other aspects of the larger Bangkok vicinity. After a broad plan of sustainability is put into effect for Bangkok as a whole, then smaller and more specific plans can be devised.

Bibliography

- Aruninta, Ariya. "Ecological and Landscape Architectural Aspects In Urban Waterfront Development: A Case Study in Bangkok, Thailand," Environmental Planning and Management, December 2, 1994.

- Bangkok Metropolitan Administration. Amazing Bangkok. Bangkok: Comform Publishing Company, 1998.

- Barbiroli, Giancarlo and others. "A Proposal for a New Method to Develop Synthetic Quality Indices for Air and Water." Journal of Environmental Management, August 4, 1991, p. 237-252.

- Baryza, Jill et.al. "Sustainability: Strategic Urban Development". Worcester Polytechnic Institute and Delft University of Technology, 1996.

- Buckley, Michael. Bangkok Handbook. California: Moon Publishers, 1992.

- Cluis, Daniel A. and others. "Indice de qualite de l'eau permettant le suivi environnemental et la mesure des impacts locaux." Institut National de la Recherche Scientifique. December 22, 1987.

- Corbit, Robert A. Standard Handbook of Environmental Engineering. New York: McGraw-Hill Publishing Company, 1989.

- Crispo, R. et al. "Sustainable Venice": A Local Implementation of Agenda 21 in Venice, Italy. IQP. WPI, 1996.

- Cummings, Joe. Bangkok a Lonely Planet City Guide. Australia: Lonely Planet Publications, 1997.

- CWM PO*WW*ER™ Evaporation-Catalytic Oxidation Technology. United States Environmental Protection Agency. September, 1993.

- Davis, Mackenzie and David A. Cornwell. Introduction to Environmental Engineering. Boston: McGraw-Hill Publishing Company, 1998.

- Dillman, Don and Priscilla Salant. How to Conduct Your Own Survey. John Wiley & Sons, Inc. 1994.

- Edwards, Ward and Detlof Von Winterfeldt. Decision Analysis and Behavioral Research. Cambridge: Cambridge University Press, 1986.

- "Environmental opportunities in Thailand will explored at Thai/U.S. conference." Business America, February 1995, p. 36.

- Exposure Factors Handbook. United States Environmental Protection Agency, August, 1997.

- Guide to the Grand Palace. Thailand: Thai Watania Panich Press Co., 1998.

- Kjeldsen-Kragh, Soren. "Environmental Economics."

- Krack, Rainer. In and Around Bangkok. Singapore: Graham Brash, 1991.

- Liu, David H.F. Environmental Engineers' Handbook. New York: Lewis Publishers, 1997.

- Locke, Tim and others. Exploring Thailand. New York: Fodor's Travel Publications, Inc. 1997.

- Odemerho, Francis O. and Boyowa A. Chokor. " An aggregate index of environmental quality: the example of a traditional city in Nigeria." Applied Geography. January 1, 1991.

- Osborne, Christine. Essential Thailand. Boston: Little, Brown and Company, 1990.

- Plamintr, Sunthorn Ph D. Getting to Know Buddhism. Bangkok: Buddhadhamma Foundation, 1994.

- Pornchokchai, Sopon. Business Location Guide Bangkok. Bangkok: Agency for Real Estate Affairs, 1998.

- Suksri, Naengnoi. The Grand Palace. Bangkok: River Books Guide, 1998.

- Swearer, Donald K. "The Hermeneutics of Buddhist Ecology in Contemporary Thailand: Buddhadasa and Dhammapitaka," Buddhism and Ecology, The Interconnection of Dharma and Deeds. Cambridge: Harvard University Press.

- "Thailand." The 1994 Information Please ™ Environmental Almanac, Annual 1993, p.532-3.

- Tourism Authority of Thailand. Operational Study Project to Determine Ecotourism Policy. Thailand Institute of Scientific and Technological Research, June 1997.

- Treasures from the National Museum Bangkok. Bangkok: Thai Watana Parish Press Company, 1995.

- Tuker, Mary E. and Duncan R. Williams. Buddhism and Ecology. The Interconnection of Dharma and Deeds. Cambridge: Harvard University Press, 1997.

- Urban Development Center. "The Humanizing Bangkok Project Exhibition." Convention Room Bangkok City Hall.

- Watson, Stephen R. Decision Synthesis: The Principles and Practice of Decision Analysis. Cambridge: Cambridge University Press, 1987.

- "Where there's muck... environmental business in Asia." The Economist, August 20, 1994, p.53-54.

Appendices

Appendix A: Glossary of Toxicological Terms [Mackenzie]

Acute toxicity	An adverse effect that has a rapid onset, short course, and pronounced symptoms
Cancer	An abnormal growth process in which cells begin a phase of uncontrolled growth and spread
Carcinogen	A cancer-producing substance
Carcinomas	Cancers of epithelial tissues. (ex. Lung and skin cancer)
Chronic toxicity	An adverse effect that frequently takes a long time to run its course and initial onset of symptoms may go undetected
Genotoxic	Toxic to the genetic material (DNA)
Initiator	A chemical that starts the change in a cell that irreversibly converts the cell into a cancerous or precancerous state. Needs to have a promoter to develop cancer.
Leukemias	Cancer of white blood cells and the tissue from which they are derived
Lymphomas	Cancers of the lymphatic system
Metastasis	Process of spreading/migration of cancer cells throughout the body
Mutagenesis	Mutagens cause changes in the genetic material of cells. The mutations may occur either in somatic (body) cells or germ (reproductive) cells.
Neoplasm	A new growth. Usually an abnormally fast-growing tissue.
Oncogenic	Causing cancer to form
Promoter	A chemical that increases the incidence to a previous carcinogen exposure
Reproductive toxicity	Decreases in fertility, increases in miscarriages, and fetal or embryonic toxicity as manifested in reduced birth weight or size
Sarcoma	Cancer of mesodermal tissue such as fat and muscle
Subacute toxicity	Subacute toxicity is measured using daily dosing during the first ten percent of the organism's normal life expectancy and checking for effects throughout the normal lifetime.
Teratogenesis	Production of a birth defect in the offspring after maternal or paternal exposure

Appendix B: Map of Thailand and Bordering Countries

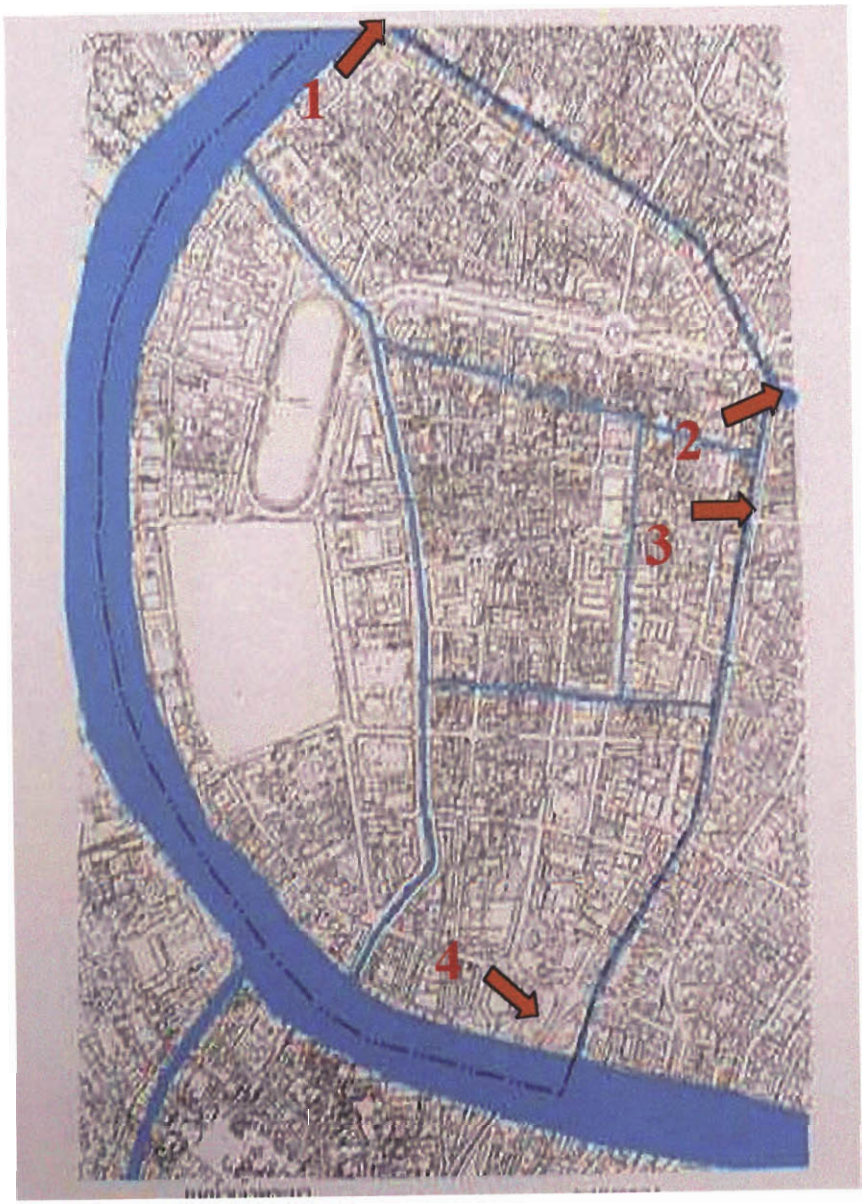
http://www.exitemaps.com

Appendix C: Rattanakosin Island, Bangkok, Thailand

http://www.exitemaps.com

Appendix D: Zones of the Rattanankosin Area

Appendix E: Rattanakosin Canal Water Sample Stations



Appendix F

Rattanakosin Canal Survey

Rattanakosin Canal Survey

Chulalongkorn University
Bangkok, Thailand

Worcester Polytechnic Institute
Massachusetts, U.S.A

The purpose of the following survey is to help us gain a better understanding of opinions about the environmental quality of the canals in the Rattanakosin area. These questions will take no more than two minutes to answer.

1. In regards to the canals around Rattanakosin, did you notice any of the following?
   a. Odor
   b. Trash
   c. Oil or other pollutants
   d. Unusual color
   e. Wildlife (animal, plant)

2. Whose responsibility is the canal water quality?
   a. Government
   b. Residents'
   c. Both
   d. No one's
   e. Other

3. Is the environment in Rattanakosin more important than other parts of Bangkok?
   a. Yes
   b. No

4. *For residents only:* In comparison to 5 years ago, the water quality in the canals is:
   a. Better
   b. Same
   c. Worse

5. *For tourists only:* In comparison to your expectations of the water quality in the canals, was the water:
   a. Cleaner
   b. About the same
   c. More polluted

6. Is canal clean up:
   a. Very important
   b. Important
   c. Not important

Personal information
Age (years):
   Under 20
   21-35
   36-50
   Over 50

Gender:
   Male
   Female

Level of Education:
   None
   Primary
   High School
   College or higher

Nationality:

Residents only:
Residence in Rattanakosin
   Past 5 years
   Past 10 years
   Past 20 years

   Over 20 years

Appendix G

Rattanakosin Canal Survey (Thai)

การสำรวจคลองรอบเกาะรัตนโกสินทร์

จุฬาลงกรณ์มหาวิทยาลัย
กรุงเทพฯ ประเทศไทย

สถาบันวูสเตอร์ โพลีเทคนิค
แมสซาชูเสต สหรัฐอเมริกา

วัตถุประสงค์การสำรวจนี้เพื่อเพิ่มความเข้าใจในข้อคิดเห็นเกี่ยวกับคุณภาพสิ่งแวดล้อมของคลองบริเวณเกาะรัตนโกสินทร์ คำถามเหล่านี้ใช้เวลาในการตอบไม่เกิน 2 นาที

1. ในบริเวณคลองรอบเกาะรัตนโกสินทร์ ท่านสังเกตสิ่งต่อไปนี้หรือไม่
   a. กลิ่น
   b. ขยะ
   c. น้ำมัน หรือ มลพิษอื่น
   d. สีที่ผิดปกติ
   e. สิ่งมีชีวิต(สัตว์, พืช)
2. ใครเป็นผู้รับผิดชอบต่อคุณภาพน้ำในคลอง
   a. รัฐบาล
   b. ผู้พักอาศัยในบริเวณนั้น
   c. ทั้งข้อ a & b
   d. ไม่ใช่ความรับผิดชอบของใคร
   e. อื่นๆ
3. สิ่งแวดล้อมบริเวณเกาะรัตนโกสินทร์สำคัญมากกว่าส่วนอื่นของกรุงเทพฯ
   a. ใช่
   b. ไม่ใช่

สำหรับผู้พักอาศัยเท่านั้น :

4. เปรียบเทียบกับ 5 ปี ที่ผ่านมา คุณภาพน้ำในคลอง
   a. ดีขึ้นกว่าเดิม
   b. เหมือนเดิม
   c. แย่ลงกว่าเดิม

สำหรับนักท่องเที่ยวเท่านั้น :

5. เปรียบเทียบกับความคาดหวังของท่านเกี่ยวกับคุณภาพน้ำในคลอง ท่านเห็นว่า
   a. ดีกว่า
   b. เหมือนกัน
   c. แย่กว่า
6. การทำให้คลองสะอาด :
   a. สำคัญมาก
   b. สำคัญ
   c. ไม่สำคัญ

ข้อมูลส่วนบุคคล

อายุ(ปี) :
- ต่ำกว่า 20
- 21-35
- 36-50
- มากกว่า 50

เพศ :
- ชาย
- หญิง

ระดับการศึกษา :
- ไม่ได้รับการศึกษา
- ชั้นประถม
- ชั้นมัธยม
- วิทยาลัย หรือสูงกว่า

สัญชาติ :

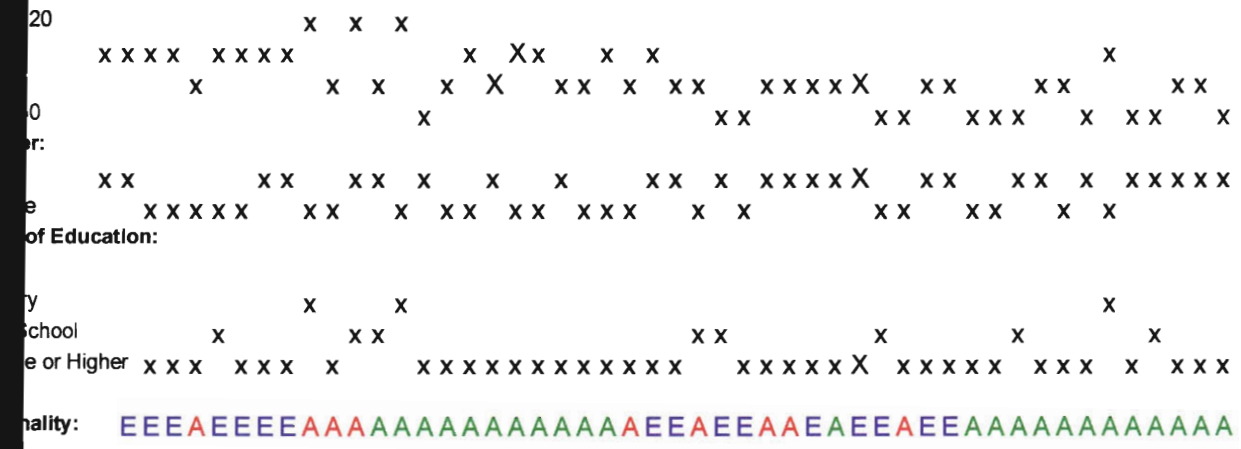
สำหรับผู้พักอาศัยเท่านั้น :

ผู้พักอาศัยบริเวณเกาะรัตนโกสินทร์
- 5 ปี มาแล้ว
- 10 ปี มาแล้ว
- 20 ปี มาแล้ว
- >20 ปี มาแล้ว

Pages were cropped in original

IQP/MQP SCANNING PROJECT

Appendix H: Tourist Survey Results



ents only:

years
0 years
0 years
20 years

1:

2:

3:

dents only:

4:

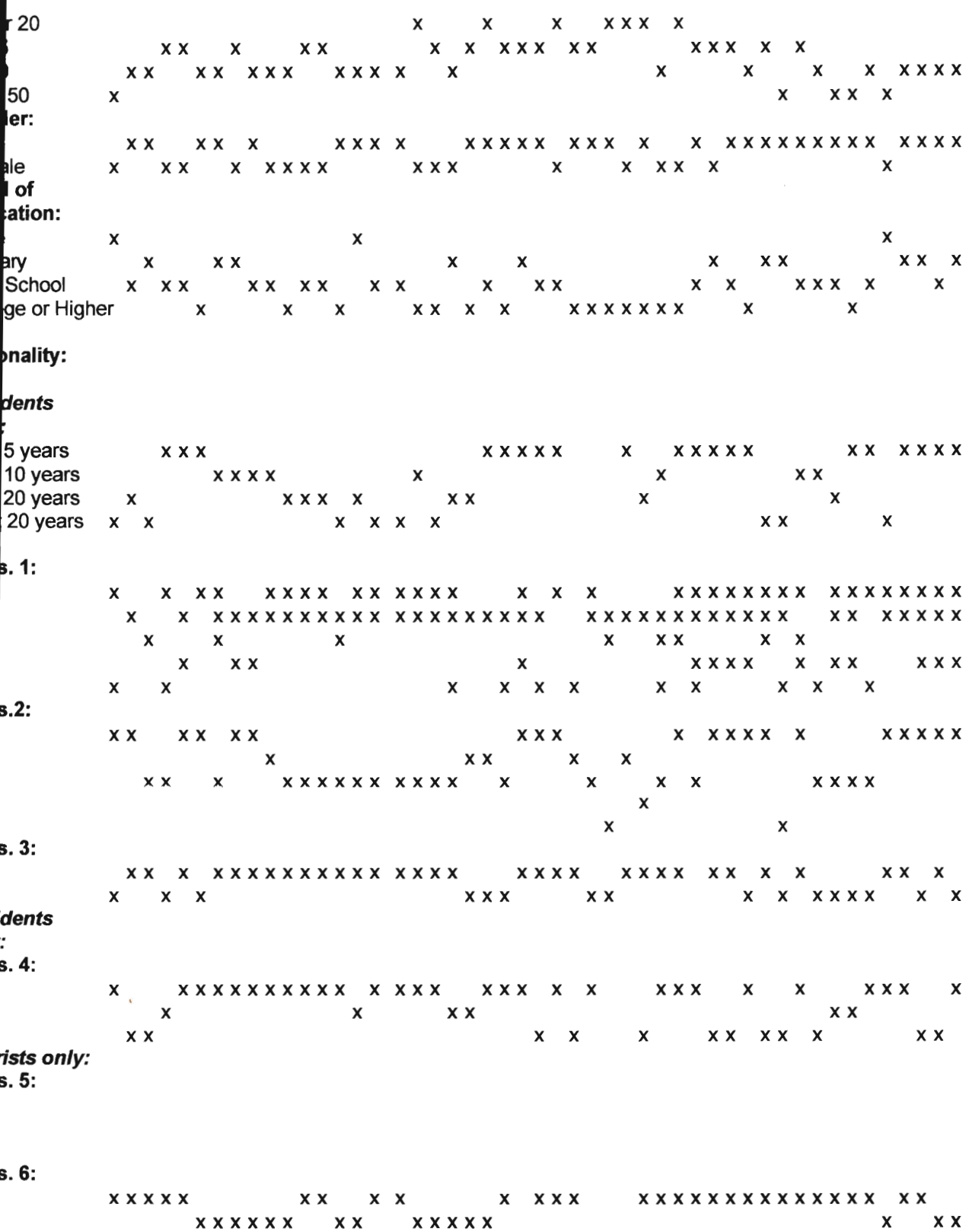
sts only:

5:

6:

A=America E=Europe A=Asia

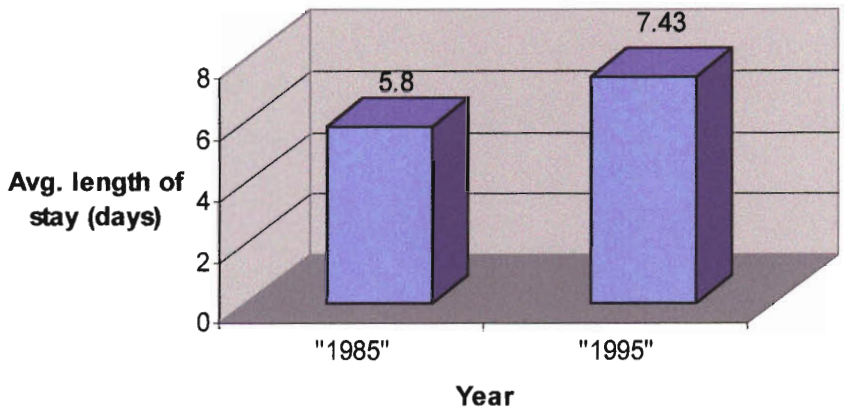
Appendix I: Resident Survey Results



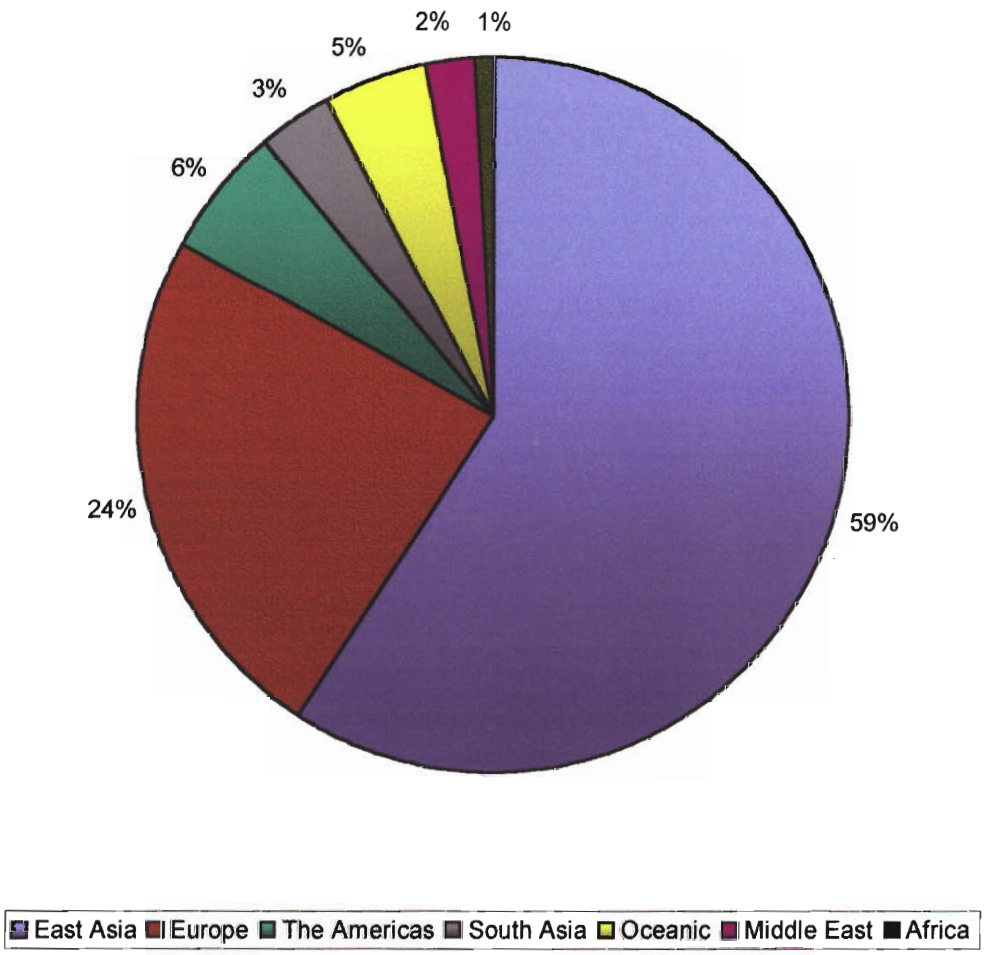
Appendix J

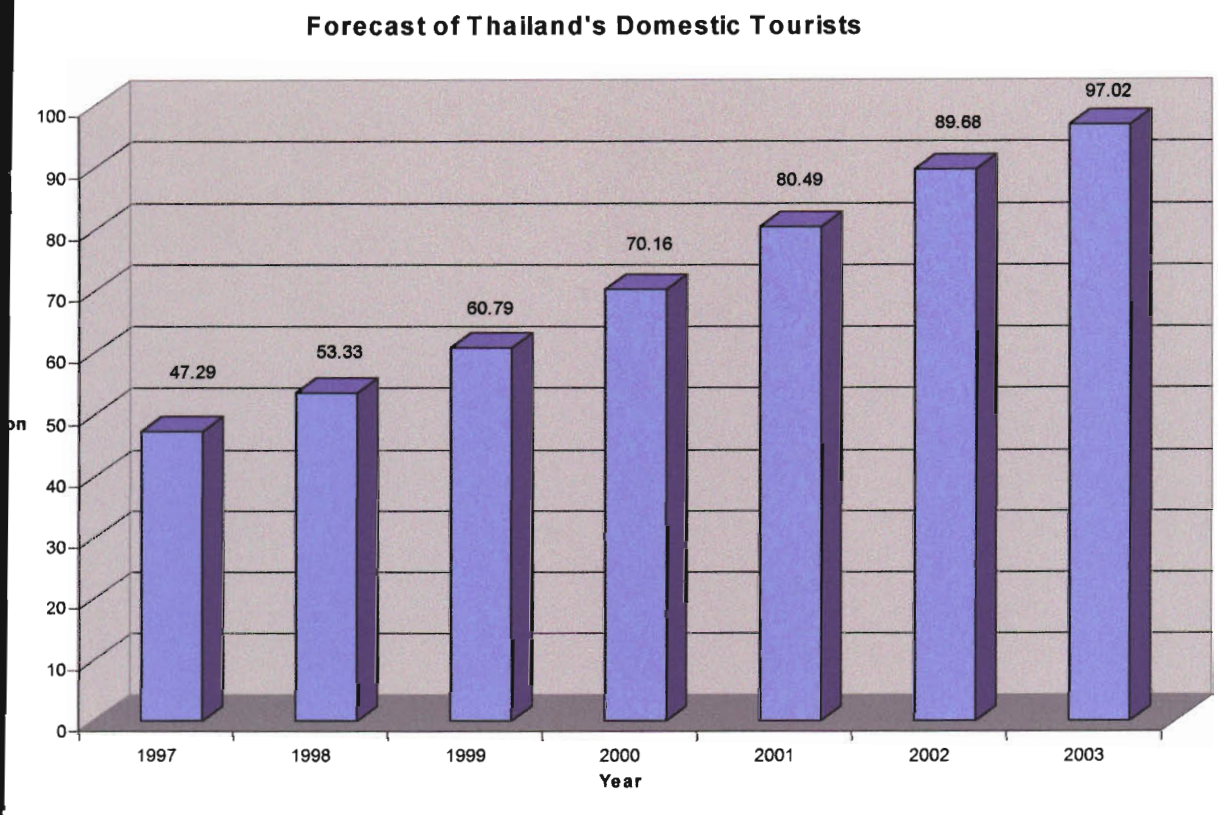
Tourism Statistics

Average Length of Stay of International Tourists



International Tourists Arrivals to Thailand by Country of Resisdence




Forecast of Thailand's Domestic Tourists
100
90
80
70
60
50
40
30
20
10
0
47.29
53.33
60.79
70.16
80.49
89.68
97.02
1997
1998
1999
2000
2001
2002
2003
Year

Appendix K

Agenda 21- Chapter 28

Chapter 28

LOCAL AUTHORITIES' INITIATIVES IN SUPPORT OF ADGENDA 21

PROGRAMME AREA

s for action

Because so many of the problems and solutions being addresses by Agenda 21 their roots in local activities, the participation and cooperation of local authorities will be a rmining factor in fulfilling its objectives. Local authorities construct, operate and maintain nomic, social and environmental infrastructure, oversee planning processes, establish local ronmental policies and regulations, and assist in implementing national and subnational ronmental policies. As the level of governance closest to the people, they play a vital role in cating, mobilizing and responding to the public to promote sustainable development..

ectives

2 The following objectives for this programme area:

(a) By 1996, most local authorities in each country should have undertaken a consultative cess with their population and achieved a consensus on "a local Agenda 21" for the mmunity;

(b) By 1993, the international community should have initiated a consultative process
d at increasing cooperation between local authorities;

(c) By 1994, representatives of associations of cities and other local authorities should
increased levels of cooperation and coordination with the goal of enhancing the exchange
formation and experience among local authorities;

(d) All local authorities in each country should be encouraged to implement and monitor
rammes which aim at ensuring that women and youth are represented in decision-making,
ning and implementation.

vities

Each local authority should enter into a dialogue with its citizens, local
anizations and private enterprises and adopt "a local Agenda 21". Through consultation and
sensus-building, local authorities would learn from citizens and from local, civic, community,
iness and industrial organizations and acquire the information needed for formulating the best
tegies. The process of consultation would increase household awareness of sustainable
elopment issues. Local authority programmes, policies, laws and regulations to achieve
enda 21 objectives would be assessed and modified, based on local programmed adopted.
ategies could also be used in supporting proposals for local, national, regional and
rnational funding.

Partnership should be fostered among relevant organs and organizations such as)P, the United Nations Center for Human Settlements (Habitat) and UNEP, the World Bank, nal banks, the International Union of Local Authorities, the World Association, the World ciation of the Major Metropolises, Summit of Great Cities of the World, the United Towns nization and other relevant partners, with a view to mobilizing increased international ort for local authority programmes. An important goal would be to support, extend and ove existing institutions working in the field of local authority capacity-building and local ronment management. For this purpose:

(a) Habitat and other relevant organs and organizations of the United Nations are d upon to strengthen services in collecting information on strategies of local authorities, in icular for those that need international support;

(b) Periodic consultations involving both international partners and developing ntries could review strategies and consider how such international support could best be ilized. Such a sectoral consultation would complement concurrent country-focused sultations, such as those taking place in consultative groups and round tables.

5 Representatives of associations of local authorities are encouraged to establish cesses to increase the exchange of information, experience and mutual technical assistance ng local authorities.

ans of implementation

(a) Financing and cost evaluation

It is recommended that all parties reassess funding needs in this area. The ference secretarist has estimated the average total annual cost (1993-2000) for strengthening national secretariat services for implementing the activities in the chapter to be about $1 on on grant or concessional terms. These are indicative and order-of-magnitude estimates and have not been reviewed by Governments.

(b) Human resource development and capacity-building.

This programme should facilitate the capacity-building and training activities ady contained in other chapters of Agenda 21.