"Interpreting the Hydrological System of the Sukhothai Historical Park"

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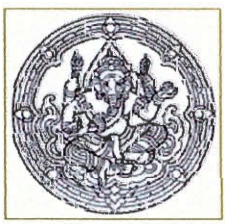

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Abstract

Our team assisted the United Nations Educational, Scientific, and Cultural Organization and the Fine Arts Department of Thailand to improve the interpretation of the hydrology at the Sukhothai Historical Park. After compiling our field data with existing information provided by the sponsors, we designed and constructed prototypes for three interpretive materials to educate park guests: A visual display board, an informational pamphlet and two suggested bicycle routes. Through presenting a more complete image of ancient Thai civilization, we hope visitors will gain an improved appreciation for the culture that once flourished there.

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Introduction

Effective interpretation of the past allows for the improved preservation of historically significant places and the promotion of understanding between cultures. Organizations such as the United Nations Educational, Scientific, and Cultural Organization (UNESCO) have made great efforts to implement cultural resource management strategies in an attempt to promote cultural understanding worldwide. As a custodian of world heritage, UNESCO created the World Heritage Committee. This committee formed the World Heritage List of historical sites to promote cultural resource management, define our past, and preserve the treasures of humanity.[1]

The city of Sukhothai was the first capital of Thailand and played an integral role in its cultural development. The managers of the Sukhothai World Heritage Site seek to educate visitors about the significance of Sukhothai. The art, religion, and language of the Thai people flourished under the rule of King Ramkhamhaeng III and successive kings; this advancement in culture represents the "Golden Age" for Thai people. Visitors of the modern historical park can see the numerous religious, artistic, architectural and cultural accomplishments of the Sukhothai era. The 70 square kilometer site includes hundreds of monuments, temples, agricultural fields, courtyards, stone inscriptions, defensive walls, moats, canals, reservoirs and ponds. This assortment of artifacts and monuments reflects the remarkable ingenuity of the first Thai people.

Several national and international organizations[2] have been working together to improve the level of interpretation of the Sukhothai World Heritage Site for visitors. Through their work, extensive landscaping enhancements have been made to improve park functions; tourist infrastructure has been upgraded at the Sukhothai site to include informational displays, pamphlets and museum exhibits to educate visitors about the various temples, shrines, and culture of the era.

Problem Statement and Methodology

Currently, interpretation for visitors is limited to exhibits in the Ramkhamhaeng National Museum and informational boards located throughout the park presenting brief histories of the monuments. Although researchers have examined the complex hydrology that exists between the Saritphong Dam (Thomnop Phra Ruang) and the Yom River, interpretational materials do not exist that describe the flow of water for visitors.[3] We established our goal to be improving the interpretation of the hydrology for Sukhothai park visitors. To help us achieve our goal, we created the following objectives: develop an understanding of the hydrology at Sukhothai; plot the flow of water through the inner city; perform an observation of visitors; and design and create interpretation materials.

Our research phase began with the analysis of the available resources at Sukhothai including contour maps, aerial photographs, Internet sources, text references, and hydrological reports. These sources provided information pertaining to the political, religious, agricultural, and industrial history of Sukhothai. We then explored hydrological features that we believed were significant and began to develop a story of how water moves throughout the system. In addition, we reviewed UNESCO's intentions for site interpretation and sought materials outlining effective interpretation techniques.

For our first objective, we gathered existing data such as GIS layers, contour maps, and spatial maps. From these sources we were able to determine the slope of the land, as well as the location of bodies of water in relation to monuments. Next, we examined hydrological structures and currents by performing field research. The city was divided into six sections to be surveyed. For each section, we hand sketched and digitally photographed water bodies, control mechanisms and visible water currents. The last component of this objective was to locate key inlets and outlets to the city. This was accomplished with field excursions in which we surveyed the wall and moat system. We noted the existence of hydrological control mechanisms and wall breaches through sketches and digital photographs. Any place where water flowed was classified as an inlet or outlet depending on the direction of current.

Our second objective was to plot the flow of water through the inner city. We consolidated the information gathered in field campaigns and transposed them onto a working spatial map. Here we depicted bodies of water, their water control mechanisms, and the direction of water current.

The next objective was to determine characteristics of visitors to the park and museum to assist in designing interpretational materials for the historical park. We monitored the park entrance for two complete weekdays and recorded the number and types of people entering the park (Thai or foreigner), approximate age, and mode of transportation. From the museum and park offices we obtained data of the number of Thai, foreign, student and total visitors for the months of October, November, December 2002 and January 2003.

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[1] UNESCO. *UNESCO 1945-2000* <http://www.unesco.org/general/eng/about/history/back.shtml> (24 October 2002)

[2] These organizations include: United Nations Educational Scientific and Cultural Organization (UNESCO), The International Center for the Study of the Preservation and Restoration of Cultural Property (ICCROM), the World Heritage Committee (WHC), and the Thailand Fine Arts Department.

[3] UNESCO. *Draft Project Document: Enhancing the Authenticity of the Landscape at the Historic Town of Sukhothai and Associated Cities of Si Satchanalai and Kamphaeng Phet.*

The final step in this phase of our project was to generate an interpretational hydrological story in a form that we could present to the visitors of the museum and park. To do this we first consolidated all the facts, history, and field data collected into a single cohesive story describing the hydrology of Sukhothai. Then, we used our collected visitor demographics to help design interpretational materials that communicate the hydrological story to park guests.

The Sukhothai Hydrological Story

The Sukhothai water system can be divided into four regions: the mountain reservoir, the city moats, the inner city and the Yom River. The story of the Sukhothai hydrological system begins three kilometers west of the city in the Phra Bat Yai and Kiew Ay Ma hills. Every year, seasonal rain causes seventeen mountain streams to swell and flood into the horseshoe shaped valley below. Observing this surplus of water, the first urban planners of the 13th century recognized the region's hydrological potential and constructed a dam to retain the wet season's floodwaters for use in the dry season. The reservoir created by the construction of the dam is called Saritphong I (Thomnop Phra Ruang) and serves as Sukhothai's primary source of water. A series of spillways and floodgates are used to regulate the amount of water entering the canals feeding the city.

Before the water enters the inner city, it flows through a network of moats. Sukhothai employs a triple wall/moat configuration, called a tribun, to surround the inner city. Water enters the moat system through a primary inlet located in the southwest corner of the city wall. From there it flows through all sides of the city, supplying water to the inner city and moving waste water to the Mae Rumphan canal to be disposed of in the Yom River. The city of Sukhothai was built on a gradually sloping flood plain. The land slopes downward from the highest point in southwest to the lowest point in northeast corner of the city. There is a slight bulge in the center of the city encouraging water to flow north or south instead of directly northeast.

There are four types of water bodies within the city walls: canals, reservoirs, retaining ponds and stagnant pools. Canals are long, narrow waterways used to move water between larger bodies of water. Reservoirs are the largest and would be the last water source to dry up. Retaining ponds are used to hold floodwater that accumulates during the wet season. Stagnant pools are bodies that have no visible inlets or outlets. These structures work together to deliver water to and from the important temples, industrial facilities, and residential communities within the city walls both in ancient times and at present.

Water enters the inner city through the inner western moat. A series of canals directs water from the moat into two major reservoirs, Traphang Tra Guan and Traphang Ngoen. The water from these two reservoirs moves through canals and ponds to the north and south respectively. After water has been used, it continues to flow into the northern or southern moat. The water then travels through the moats towards the northeastern corner until it is released into the Mae Rumphan canal.

Interpretation Materials

Based on visitor demographics and practical considerations, we developed a list of criteria to govern the selection of interpretation materials:

- Factual
- Entertaining
- Visually stimulating
- Easily understandable
- Containing both detailed and general information
- Available in multiple languages
- Portable

Because a number of these criteria conflict, multiple interpretational materials were chosen to better serve a variety of park guests. We selected three interpretational materials to present the Sukhothai hydrological system to park visitors: a visual display board, an informational pamphlet, and bicycle/walking routes through the park.

Visual Display Board (Figure 1)

Features:

- Quick and easily understandable reference of Sukhothai hydrology
- Design consists of a large spatial map depicting the inner city surrounded by pictures and informational text boxes
- Arrows document the flow from one body of water to another within the city
- Text is in Thai and English (See Appendix D for English text)
- Information is visually based so that it is not necessary to read the text in order to understand the general flow of the hydrological system

Informational Pamphlet (Figures 2 and 3)

Features:

- Portable information source on the hydrological system to interested visitors
- Includes a map that highlights monuments and hydrological features
- Contains a graphical and textual account of the flow of water
- Provides some technical and historical pieces of information
- Available in both Thai and English (See Appendix E for English template)

Self-Guided Bicycle/Walking Routes (Figure 4)

Features:

- The "red route" highlights points of hydrological interest and suggests a logical route in which to view them, starting from the inlet in the southwest and proceeding eventually to the outlet in the northeast
- The "yellow route" incorporates the hydrological story with a tour of the temples found throughout the park
- The routes can be walked or bicycled
- Routes are included within the designed pamphlet.

Recommendations for Implementation

We recommend the following steps for implementing the three interpretational materials we have designed:

Visual Display Board:

- Translate the English text into Thai
- Enlarge the display to 1m x 1.25m for ease of viewing
- Install the visual display board in the following locations:
    - Ramkhamhaeng National Museum
    - Near the entrance of the historical park

Informational Pamphlet

- Translate the English text into Thai
- Distribute printed copies at the following locations:
    - Main entrance of the park/or near the visual display board
    - Front desk of the Ramkhamhaeng National Museum
    - At bicycle rental establishments

Bicycle/Walking Route

- Post route name, route direction and distance markers along the self-guided bicycle routes or paint on the pavement.
- If routes are printed separately from the pamphlet, distribute copies at the following locations:
    - Main entrance of the park/or near the visual display board
    - Front desk of the Ramkhamhaeng National Museum
    - At bicycle rental establishments

Recommendations for Future Work

From our research, data gathering efforts, and analysis, we have proposed a list of recommendations for future enhancement of the Sukhothai Historical Park:

- **The Ramkhamhaeng National Museum should create an interactive hydrological display**- The output of this recommendation would be an interpretive material with no language barrier. The display would be understandable for multiple levels of intellect and would be compatible with the other forms of hydrological interpretation we suggest.
- **The Thailand Survey Department should resurvey the inner city and surrounding landscape to create a high resolution contour map of the area (0.5m)**- This could help future research projects predict additional water flow patterns within and on the outskirts of the old city or use in determining how groundwater may fill stagnant ponds.
- **The Fine Arts Department of Thailand should obtain a ground penetrating radar satellite scan**- With this scan, researchers may locate ancient watercourses hidden by earth and/or vegetation inside and outside the city.

It has been our pleasure to work with UNESCO and Thailand Department of Fine Art's by assisting them in the development of an interpretation that will enhance visitor understanding of the Sukhothai Historical Park. By providing our interpretation of the hydrological system, we hope it will draw visitors' attention while educating them about how the ancient civilization of Sukhothai was able to recognize the potential of their natural surroundings.

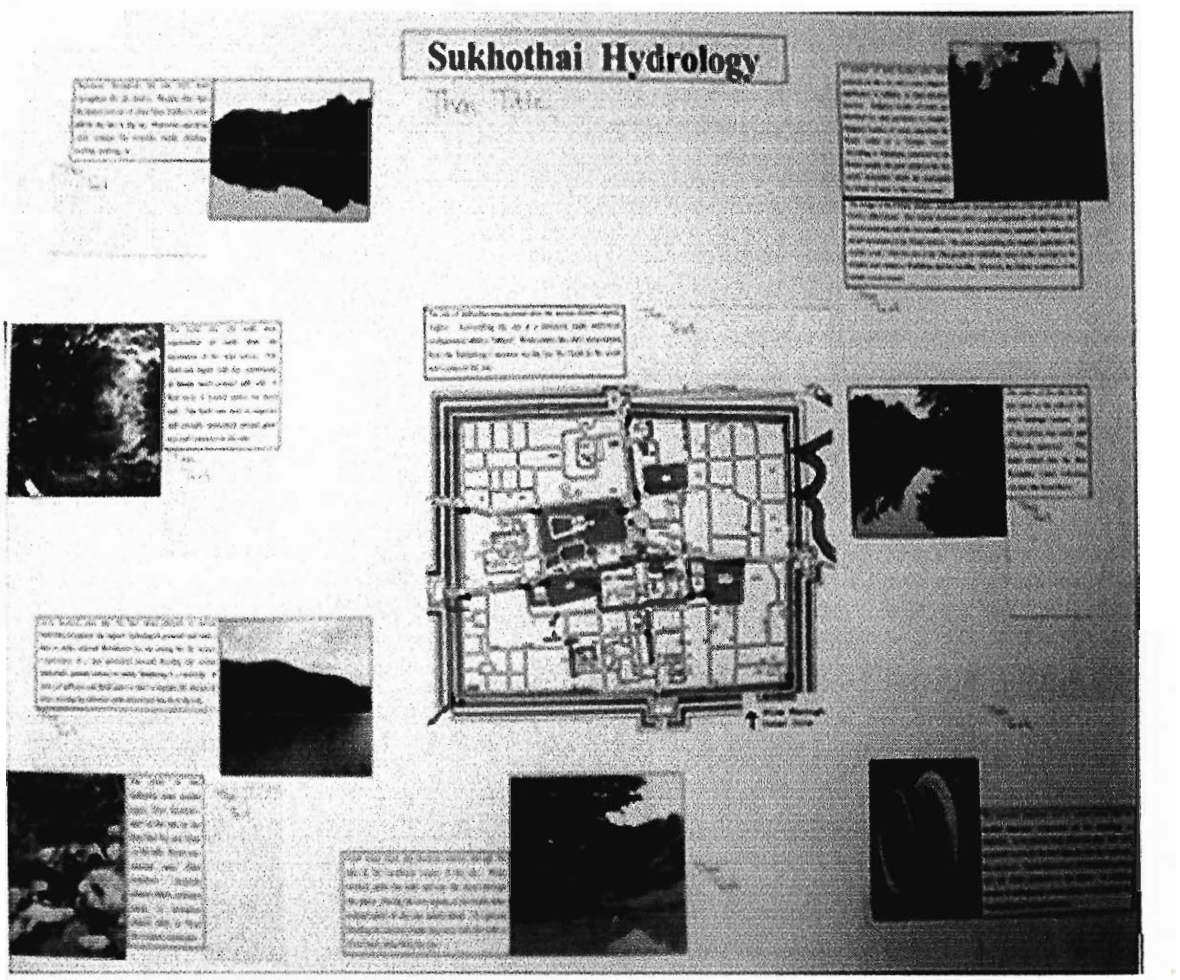
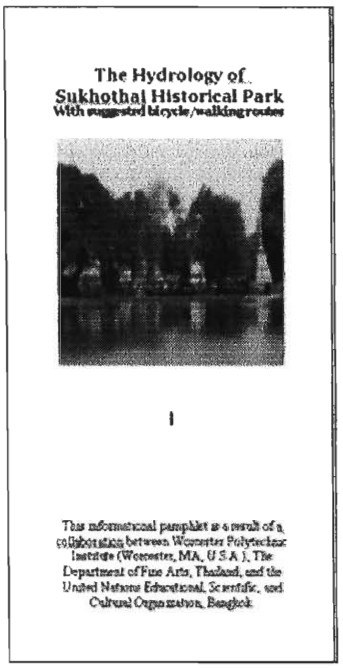


Figure 1: Digital Photo of Visual Display Board Prototype

The white space is available for the Thai translation to be posted on the visual display board alongside the English explanation.



On the left the front cover of our informational pamphlet can be seen in Figure 2. Below, Figure 3, is a picture of the inside flap of the pamphlet; which can be viewed in its entirety in Appendix E. The suggested bicycle/walking routes are on the reverse side of the informational pamphlet. (Figure 4)

Figure 2: Front cover of the informational pamphlet

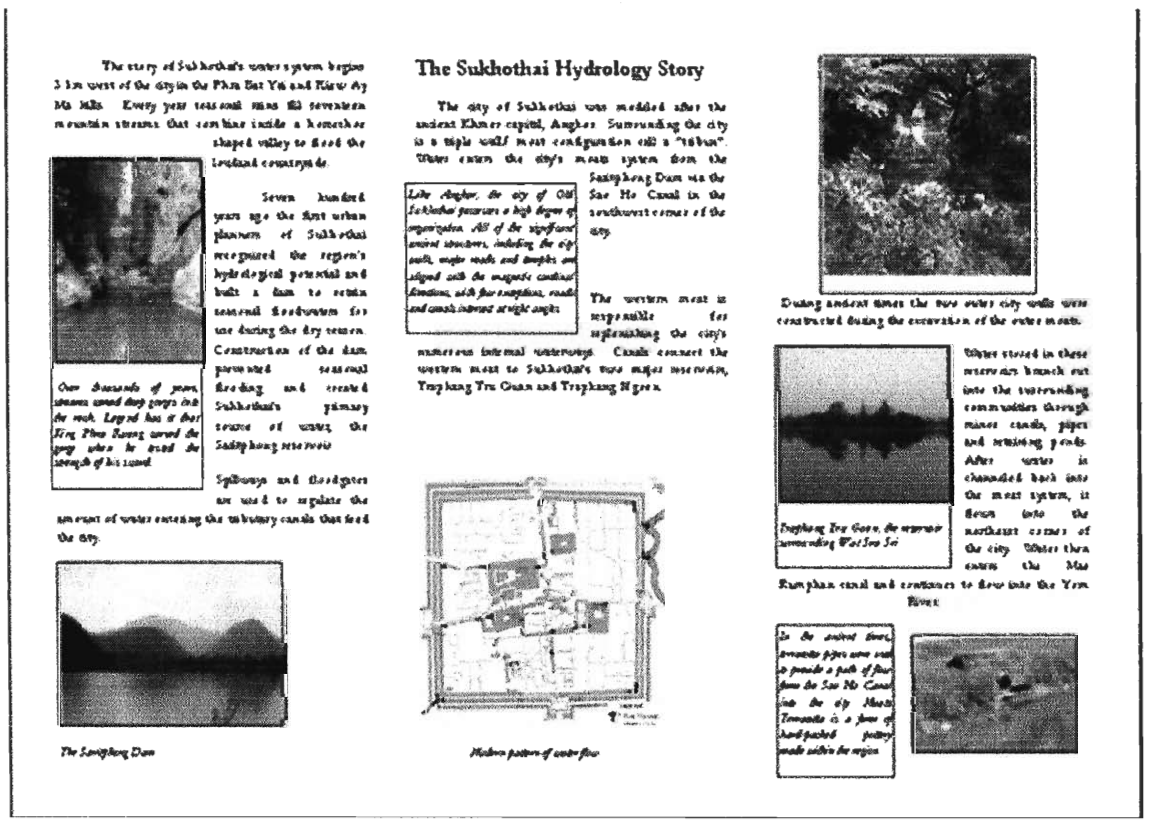


Figure 3: Inside Fold of Pamphlet

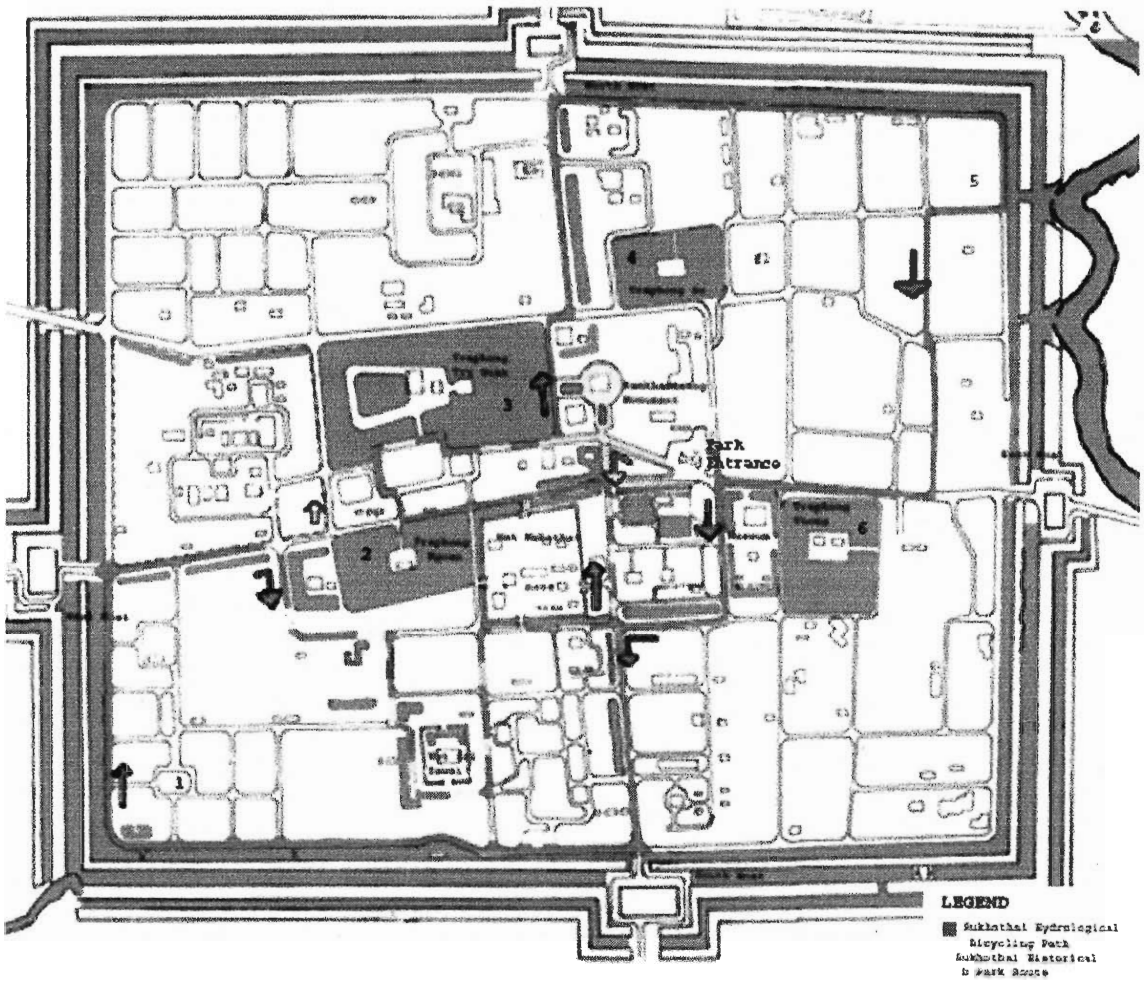


Figure 4: Suggested Bicycle Routes

1 INTRODUCTION

Effective interpretation of the past allows for the improved preservation of historically significant places and the promotion of understanding between cultures. Organizations such as the United Nations Educational, Scientific, and Cultural Organization (UNESCO) have made great efforts to implement cultural resource management strategies in an attempt to promote cultural understanding worldwide. As a custodian of world heritage, UNESCO created the World Heritage Committee. This committee formed the World Heritage List of historical sites to promote cultural resource management, define our past, and preserve the treasures of humanity.[4]

It is a goal of the World Heritage Site at Sukhothai to educate visitors of the significance of the first capital of Thailand. The city of Sukhothai played an integral role in the cultural development of Thailand. The art, language, and religion of the Thai people flourished under the rule of King Ramkhamhaeng III and successive kings; this advancement in culture represents the "Golden Age" for the Thai people. Visitors of the modern historic park can see the numerous religious, artistic, architectural and cultural accomplishments of the Sukhothai era. The 70 square kilometer site includes hundreds of monuments, temples, agricultural fields, courtyards, stone inscriptions, defensive walls, moats, canals, reservoirs and ponds. The assortment of artifacts and monuments reflects the remarkable ingenuity of the first Thai people.

Several national and international organizations[5] have been working together to improve the level of interpretation of the Sukhothai World Heritage Site for visitors. In 2002, the focus of the UNESCO sponsored Sukhothai project favored the development of Sukhothai as a historically accurate portrayal of the ancient Thai culture with emphasis on the interpretation of the landscape. UNESCO and the Thailand Fine Arts Department, a division under the Ministry of Culture, consulted with experts to create a master cultural resource management plan for governing the implementation of future projects at the Sukhothai World Heritage Site. Using this plan, managers have made extensive landscaping enhancements to improve park functions; tourist infrastructure has been upgraded to include informational displays, pamphlets and museum exhibits to educate visitors about the various temples, shrines, and culture of the era. In addition to physical landscape enhancement, a geographic information system (GIS) database is currently in development. An integrated GIS will assist future site managers in making important detailed decisions regarding the cultural landscape of the region.

Currently, interpretation for visitors is limited to exhibits in the Ramkhamhaeng National Museum and informational boards located throughout the park presenting brief histories of the monuments. Although researchers have examined the region stretching from the tributaries of the Saritphong Dam (Thomnop Phra Ruang) to the Yom River, an interpretation that describes how the water flows through

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[4] UNESCO *UNESCO 1945-2000* <http://www.unesco.org/general/eng/about/history/back.shtml> (24 October 2002)

[5] These organizations include: United Nations Educational Scientific and Cultural Organization (UNESCO), The International Center for the Study of the Preservation and Restoration of Cultural Property (ICCROM), the World Heritage Committee (WHC), and the Thailand Fine Arts Department.

the inner city's complex network of manmade canals and dikes is not currently available.[6] We saw this as an opportunity to improve the interpretation of the hydrology for park visitors of Sukhothai.

Working within UNESCO's framework, our team analyzed the available resources at Sukhothai, including contour maps and hydrological reports, to establish our area of research. Once this was determined, data gathering field excursions were organized to obtain a more in-depth knowledge of the land and its hydrological resources. We analyzed the information collected during our research and field excursions to design materials that interpret the Sukhothai hydrological system for park visitors. Through presenting a more complete image of the ancient Thai civilization, we hope visitors will gain an improved appreciation of the culture that once flourished there.

[6] UNESCO. *Draft Project Document: Enhancing the Authenticity of the Landscape at the Historic Town of Sukhothai and Associated Cities of Si Satchanalai and Kamphaeng Phet.*

2 BACKGROUND

Understanding the hydrological system located within the Sukhothai Historical Park is essential to the development of effective interpretative materials for the hydrology of Sukhothai. Working towards this end, our study began with a review of the history and culture of Sukhothai and its associated cities. We continued our review with a description of the site's cultural resources, including monuments, landscapes and waterways. Additional areas of review were the agencies involved in the cultural restoration and preservation efforts, as well as the recent efforts being made at Sukhothai to implement a system of cultural resource management. Finally, we examined Geographic Information Systems as a possible tool to assist us in the design of interpretative materials.

2.1 History and Heritage of Sukhothai, Thailand

The history of Sukhothai illustrates the cultural importance of the region. Rising from the outskirts of an aging Khmer empire, Sukhothai etched its own path and culture in Southeast Asia. Below is a brief history of Sukhothai and its associated cities followed by a description of Sukhothai's cultural resources.

2.1.1 History of Sukhothai, Thailand and Associated Cities

The Thai people regard the establishment of Sukhothai as the emergence of Thailand as a distinct nation.[7] Prior to the founding of Sukhothai, various groups of Tai-speaking[8] people inhabited a mountainous plateau south of the Yangtze River. Three powers rivaled the Tai in Asia: the Mongols of Tibet in the northwest, the Chinese Tang Dynasty in the northeast, and the Khmer empire centered in the Southeast, including territory in present day Cambodia and eastern Thailand.

In order to defend against the Mongols of the west, the Chinese created the friendly state of Nanchao. The creation of Nanchao buffered the Tai from the Mongol and Chinese threats of the north. Had Nanchao not existed, the early Tai-speaking people would likely have been assimilated into Chinese culture.[9] Nanchao allowed the Tai to focus on a single rival power, the Khmer.[10]

Sukhothai was founded by the Khmer to serve as an outpost on the western fringes of the Angkor Empire. The Khmer enthusiastically embraced Hindu Buddhism, a religion that emphasizes the belief of sacred kingship. The Khmer built numerous palaces and temples to "glorify its monarch." The Khmer's interest in Hindu Buddhism may have weakened its empire because many resources were devoted towards the construction of temples, and its system of agriculture seemed to be neglected. This oversight granted the Tai people an opportunity to rise to power. In 1238, a Tai prince married to a Khmer woman of the ruling family spurred a rebellion against the Khmer leadership. Led by two chieftains, Khun Bang

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[7] Mahidol University, Sukhothai, <http://www.mahidol.ac.th/Thailand/history/sukhotha.html>, (25 October, 2002)
[8] Note: Shortly after the transition of power away from the Khmer, the Tai people changed their name to "Thai" which can be translated as "free."
[9] Library of Congress, 1987, Thailand: A country Study, <http://lcweb2.loc.gov/frd/cs/thtoc.html> (25 October 2002)
[10] Kwame Anthony Appiah and Henry Lousis Gates Jr. The Dictionary of Global Culture, (Location: Publisher: 1996) p354.

Klang Tao and Khun Pa Muang, the Tai removed Khmer authority and established Sukhothai as the first capital of Siam, present day Thailand.[11]

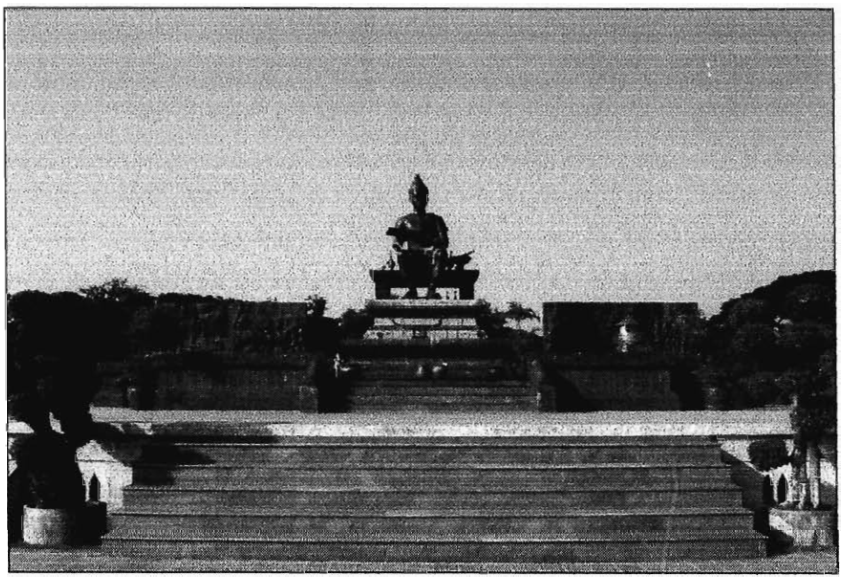

Figure 1: King Ramkhamhaeng Monument located near the entrance of the Sukhothai Historical Park.

The Sukhothai era represents the golden age of Thai Culture. While military conquest played a prominent role in Sukhothai's early expansion, strategic marriages and alliances with ruling families along with the use of a common religion aided relations with neighboring states. King Ramkhamhaeng III is remembered as the most famous leader of Sukhothai and has a monument dedicated to him as seen in Figure 1; he lead the Thai people into their most glorious era.[12] He forged relationships with numerous neighboring states in an effort to establish Sukhothai as a permanent and reputable state; King Ramkhamhaeng also incorporated elements of old Khmer culture into the empire to aid Thai acceptance in the region. He is credited with the development of the Thai language and implementing Sukhothai's benevolent paternal monarchy. The King did not consider himself a figure of god, as the Khmer king did, but viewed himself on the same level as his subjects. He widely promoted Buddhism and supported the construction of temples and monasteries in nearby cities. In an effort to boost the economy, King Ramkhamhaeng encouraged Chinese artisans to move to Sukhothai and further develop its ceramics industry; furthermore, he did not impose taxes on trade merchandise, income or inheritance. These conditions set the stage for Thailand's most productive era of artesian achievement.

The empire of Sukhothai lasted approximately 160 years. In 1378, Sukhothai submitted its land to the larger Thai empire of Ayutthaya. Despite attempts to break away, Sukhothai was eventually incorporated as a province of Ayutthaya.[13] Similar to Sukhothai, the empire of Ayutthaya assimilated neighboring cultures. Hence, the traditions of Sukhothai did not fade away immediately. Many elements of Sukhothai culture, particularly its ceramic, pottery and construction techniques have survived for hundreds of years. The Thai people do not view the decline of Sukhothai as a detriment to their culture, rather they value its presence and respect the wonderful achievements made during its time.[14]

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[11] Mahidol University, Sukhothai
[12] http://www.asiatour.com/thailand/e-05nort/et-nor14.htm (10 February 2003)
[13] Library of Congress, 1987, Thailand: A country Study.
[14] Mahidol University, Sukhothai

Originally known as Chalieng, Si Satchanalai was once the cultural center for the Yom River Valley. Designated a historical park in 1983, the area of Si Satchanalai is a smaller section of the greater Sukhothai World Heritage Site.[15] The community is well known for its ceramics, iron working and bronze casting industries. An example of the ceramics produced by the Thai people can be seen in Figure 2 and found in the Ramkhamhaeng National Museum. Si Satchanalai is most famous for its intricate Suwankhalok pottery techniques that were refined during the Sukhothai era. Unfortunately, unregulated modern commercial ventures have invaded the city and detract from the once serene landscape.

Figure 2: An example of ceramics found in Si Satchanalai

Kamphaeng Phet is the smallest section of the Sukhothai World Heritage Site, located south of Sukhothai on the banks of the Ping River. Nominated as a historical park in 1980, Kamphaeng Phet served as a defensive military outpost preceding the rise of Ayutthaya. A combination of sixty Sukhothai and Ayutthaya era monuments and structures are located within the city of Kamphaeng Phet.[16]

2.1.2 The Sukhothai World Heritage Site

The World Heritage Committee inscribed Sukhothai and its associated cities to the World Heritage List in 1991 as a cultural property. Sites nominated for this distinction must satisfy certain criteria and a test of authenticity. According to the World Heritage Committee, the Sukhothai site satisfies the following "[c]riteria for the inclusion of cultural properties in the World Heritage List." The property "represent[s] a masterpiece of human creative genius" and "bear[s] a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared."[17] (See Appendix B for full cultural property criteria.)

In addition to being a cultural property, the Sukhothai site is a cultural landscape. UNESCO defines cultural landscapes as the "combined works of nature and man"[18]; they provide evidence of a society-environment relationship. A combination of horticulture, waterways and monuments characterize the landscape of the civilization that once made up the original village of Sukhothai.

[15] UNESCO, Draft Project Document, 1.
[16] Ibid, 3.
[17] World Heritage Committee, Criteria for the inclusion of cultural properties in the World Heritage List. http://whc.unesco.org/opgulist.htm#para23 (Accessed 2002 October 23)
[18] World Heritage Committee, Criteria for the inclusion of cultural properties in the World Heritage List. http://whc.unesco.org/opgulist.htm#para23 (Accessed 2002 October 23)

2.1.3 Sukhothai's Cultural Resources

International and local agencies working with the managers at the Sukhothai Historical Park are attempting to restore and preserve the culture of the era. The first Khmer rulers of Sukhothai constructed a beautifully sophisticated urban infrastructure supporting agriculture, defense and domestic activities. The seventy square kilometer site includes hundreds of monuments, temples, agricultural fields, courtyards, defensive walls and moats, canals, reservoirs and ponds. Figure 3 shows Wat Mahathat, a beautiful example of the many monuments and temples that can be found in the historical park. In the center of Sukhothai stand religious sanctuaries, a monastery, statues of Buddha and housing complexes. Stone inscriptions offer a comprehensive look into the intricacies of Sukhothai culture. Several of these inscriptions describe the very nature of the landscape, including the vegetation.[19]

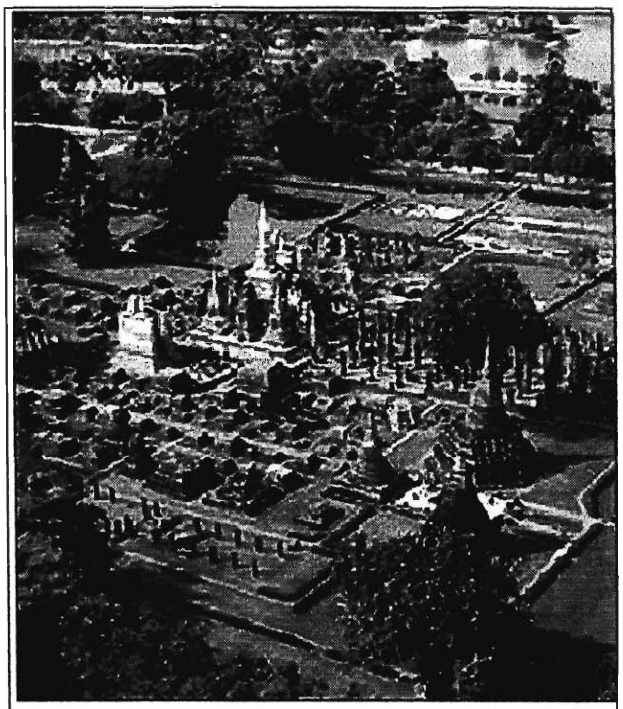

Figure 3: Wat Mahathat is a beautiful example of the many monuments in the historical park.

Many of the structures are extremely ornamental in nature. Techniques of the Khmer, Indian and Chinese cultures are very visible in the region. Magnificent religious shrines constructed under the direction of the Khmer empire can still be seen as they were before the rise of Sukhothai[20] as the Thai capital, such Wat Sri Sawai, shown in Figure 4. Many of the temples incorporate ornamental stucco sculpting techniques on both interior and exterior surfaces. Majestic India lotus-bud dome rooftops, known as stupas, once surmounted towers overlooking the city walls.[21]

Figure 4: Khmer influenced shrine, Wat Sri Sawai

[19] UNESCO, Sukhothai, an Ancient Thai Civilization http://www2.unesco.org/clt-bv/html_eng/sukhotai_eng.htm (15 November 2002)
[20] Mark Swalding and Tim Baker, Masterworks of Man & Nature, preserving our world Heritage, (Location: Publisher: 1996).
[21] UNESCO, Sukhothai, an Ancient Thai Civilization http://www2.unesco.org/clt-bv/html_eng/sukhotai_eng.htm (15 November 2002)

Figure 5: Kiln on display in the Ramkhamhaeng National Museum

Many structures, including the royal palaces, are thought to have been built from timber and have since disappeared. All that remains are the foundations for these structures. However, the few surviving wooden artifacts illustrate the master craftsmanship of this culture. Elaborate roofing techniques and door construction incorporating bronze inscriptions and ornamentation can be found.

Sukhothai was famous for its statuettes, figurines, vases, glazed terracotta ware, and celadon ware.[22] Some of the infrastructures used to build them still exist, as can be seen in Figure 5. Numerous kilns, oven like structures used to bake ceramics, can be found beyond the city walls.[23] Displays of the Sukhothai ceramics may be appreciated at the Ramkhamhaeng National Museum located next to the historical park.

Sophisticated networks of waterways formed an important part of Sukhothai culture. These waterways were used for military defense, irrigation and domestic trade, while contributing to the aesthetic splendor of the site. Many of the waterways have been restored, and regular maintenance exposes the beauty of the system to park visitors. Figure 6 shows the reservoir Traphang Tru Guan after restoration.

2.1.4 Hydrology of Sukhothai

The city of Sukhothai is located in the Chao Phraya river basin. The Chao Phraya river basin consists of two primary plains areas, the Yom and Nan river plains. Each year inefficient water-flow from the Yom and Nam rivers to the Chao Phraya river contributes to widespread flooding in the region. Because of its location in the river basin, Sukhothai relied on an extensive flood control system for survival. Not only did the ancient water system control flow from between the Phra Bat Yai and Kiew Ay Ma hills and the swelling rivers during the wet season, but it also served as an irrigation system, channeling water through the area's agricultural canals.

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[22] http://www2.unesco.org/clt-bv/html_eng/sukhotai_eng.htm (10 February 2003)
[23] UNESCO, Sukhothai, an Ancient Thai Civilization http://www2.unesco.org/clt-bv/html_eng/sukhotai_eng.htm (15 November 2002)

A *baray*, or manmade reservoir used to store water for distribution to an irrigation system, can be found in the area between the Phra Bat Yai and the Kiew Ay Ma hills (Figure 7). The Saritphong Dam was built in ancient times to create the *baray* and is still in use today. During the Sukhothai era many other structures were used for irrigation purposes from Sri Satchanalai to Kampaeng Phet. These structures include weirs, *luks* and canals. A weir is a small-scale dike that is used to control the flow of water within narrow irrigation canals. *Luks* are bamboo water lifting mechanisms which use the energy of moving water to lift water above the level of the riverbank.

Figure 6: A restored waterway, Traphang Tan Guan, in front of Wat Sra Sri

Sukhothai's agriculture represents a blending of Khmer and Tai irrigation systems. The Khmer's lower yielding system employs a pond and gravity feed system. The *muang fai* irrigation system was used primarily for small scale projects by the Tai people. A *fai* was constructed from bamboo and wooden stakes driven into the riverbed that allowed water to pass through and over the barrier while it restricted the rate of flow in order to raise the water level. The water that the *fai* held back was directed to major and minor canals known as *muang* in which gates, *fang*, controlled flow rates[24]

Figure 7: The Saritphong Dam located between the Phra Bat Yai and Kiew Ay Ma Hills

[24] http://www.atse.org.au/publications/focus/focus-falvey3.htm (22 January 2003)

2.2 Past and Current Efforts for the Restoration of Sukhothai

Since the park's inception in 1978, numerous local and international agencies have been involved in efforts to restore Sukhothai to its authentic state. Working together, these agencies have created a Master Plan to enhance the cultural resources located within the park. Below is a summary of the agencies currently assisting in the Sukhothai project followed by a review of the Original Project Draft Document and the Intermediate Progress Report as of January 2003; UNESCO's Bangkok Regional Office provided both documents. (See Appendices C and D to view both documents in their entirety)

2.2.1 Agencies Currently Assisting the Sukhothai Site

The numerous international and local agencies involved in the current restoration effort include: the United Nations Educational, Scientific and Cultural Organization (UNESCO), the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), the Southeast Asian Ministers of Education Organization (SEAMEO), and the Fine Arts Department (FAD). These organizations work together to preserve and promote cultural heritage.

UNESCO is a branch of the United Nations and strives toward global peace by encouraging understanding of cultural heritage. In addition, they provide experts in the fields of education, restoration, communication, history, planning, etc. to assist in the areas of future education, science, culture, preservation and communication. UNESCO works towards the development of knowledge and its distribution using research, training and education activities.[25]

ICCROM, a branch of UNESCO, functions as an intergovernmental organization that has the ability to promote the conservation of movable and immovable heritage in all forms around the world. The institution works towards improving the quality of conservation and the education of people for the benefit of cultural heritage. Their policies are aimed toward preserving cultural heritage through five main aspects: training, information, research, cooperation and advocacy.[26]

SEAMEO-SPAFA is an organization set up by UNESCO in Southeast Asia to focus their efforts on a regional level. The SEAMEO-SPAFA Regional Centre cultivates awareness and preservation of cultural heritage through archaeological and cultural activities and developing professional competence in the fields of archaeology and fine arts among the countries of Southeast Asia.[27]

The local agency responsible for site coordination of the World Heritage Site Sukhothai is the Fine Arts Department of Thailand. The FAD abides by the Acts on Monuments, Artifacts, Art Objects and National Museums, and advocates other conservation laws/legislation to "preserve, conserve, revive, promote, create and disseminate the knowledge, wisdom, and Culture of the nation"[28] in various areas. The Department also provides education to students interested in the study and research of cultural

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[25] UNESCO. *What is UNESCO.* < http://www.unesco.org/general/eng/about/what.shtml> (23 October 2002)
[26] ICCROM. *What is ICCROM.* <http://www.iccrom.org/eng/about/whats.htm> (7 November 2002)
[27] UNESCO. *SEAMEO SPAFA.* < http://www.unesco.org/culture/links/Detailed/267.shtml> (25 November 2002)
[28] Mission and functions of the Fine Arts Department <http://www.finearts.go.th/zemissiond.htm> (10 November 2002)

heritage. Several urgent projects of the Department include the prevention of illicit export/import of antiquities as well as supporting local architectural identities.[29]

2.2.2 UNESCO Proposed Project for Sukhothai

Previous efforts at Sukhothai as stated in the UNESCO Draft Project Document, *Enhancing the Authenticity of the Landscape at the Historic Town of Sukhothai and Associated Cities of Si Satchanalai and Kamphaeng Phet*, reach as far back as 1978. At a UNESCO General Conference in 1978, the governing body adopted a plan of action for the preservation and enhancement of the Sukhothai Site. The following year the Director General of UNESCO launched an appeal for an International Safeguarding Campaign. The Campaign aimed to revitalize World Heritage Sites and their local communities through preserving physical structures, restoring neglected buildings, reviving the landscape, improving the communication infrastructure, and developing tourism.[30]

In 1986, architect/planner Sohiko Yamada and landscape architect Hiroshi Tanaka visited the Sukhothai World Heritage Site. Their mission was to evaluate the progress of the management plan and then advise both the Thai government and UNESCO on the work of the Campaign. Yamada and Tanaka noted the lack of a comprehensive archaeological survey and adequately trained permanent local staff. In addition, they observed that the site required further foreign technical assistance. Yamada and Tanaka suggested the following recommendations to meet the listed challenges: upgrade the landscaping plan, adopt a zonal approach to park landscaping, establish technical guidelines for planting, and consolidate park landscape and management functions.

Due to funding constraints, the management plan was incomplete until 1993, two years after the inscription of Sukhothai on the World Heritage List. During this time, the Fine Arts Department on-site staff actively participated in training workshops in collaboration with local communities to discover sustainable conservation efforts, understand the use of a Geographic Information System in cultural resource management and to promote World Heritage education for the youth of Thailand.

The main effort of the UNESCO project proposes to "assess the current landscape situation, develop guidelines and build [an] internal human resource capacity within the Fine Arts Department for future landscape work within a framework which stresses the authenticity of the sites."[31] Landscape works as of 2002 have emphasized the urgent and practical needs of the site in three categories: scenic improvements designed to improve park functions, landscape facilities to aid park activities, and infrastructure facilities for landscaping.

As of January 2003 a working group of local and national experts was established to perform an extensive review of research relating to archaeology, horticulture, hydrology and architecture/urban planning. Their main goals were to perform an assessment of the current landscape, develop guidelines and build an internal human resource committee working within the Fine Arts Department.[32]

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[29] Ibid, 25.
[30] Ibid, 12.
[31] Ibid, 12.
[32] Intermediate Progress Report, 25 December 2002. Montira Horayangura

In April 2002 one of the anticipated results was creation of a GIS-based data inventory of archaeological, horticultural, hydrological and infrastructure data to be housed in the historical park management office. The creation of a horticultural handbook of plant tree species authentic to the area with guidelines for their locations, planting, and maintenance was also one of the projected results. Other results were to be a complete botanic garden with attached nursery and an interpretation plan of the site with designated walking trails and en-route information posts.

In the January 2003 progress report the anticipated results had been modified to include an integrated historic database containing information relating to Sukhothai, Si Satchanalai and Kampaeng Phet; a botanical garden/nursery at Wat Asokaram, Sukhothai; a cultural/natural trail along the Phra Ruang Road, Sukhothai; and an environmental transformation study at Wat Phra Prang, Si Satchanalai.

One of the focuses of the UNESCO sponsored project was the development of a comprehensive GIS database allowing the database to become a tool to help guide on-going research as well as to assist with daily management of the historical park. The Royal Thai Survey Department provided a preliminary database created from digitized remote-sensing data and maps. GIS data was then gathered in three separate areas: the entire area comprising of Sukhothai, Si Satchanalai, and Kampaeng Phet; the Sukhothai historic town and its immediate environment; and the historic Phra Ruang Road.

Several different experts collected the data for the GIS database. Dr. Manas Watanasak of Mahidol University initiated a study of the environmental transformation using paleo-ecological research techniques. The aim of Dr. Manas' research was to allow for a comparison of the different environmental conditions in historic Sukhothai to those of the present day. To aid in the understanding and identification of historic plant life, Mr. Picha Pitayakajornwuti of the Royal Forestry Department initiated a horticultural research project. In early 2003, his research had already identified over 200 species of plants, with more field campaigns planned. Dr. Surat Lertlum, of the Asian Institute of Technology, worked on a comprehensive GIS for Sukhothai World Heritage Park. He incorporated remote sensing research with geophysical information and cartography of the area. The aim of the remote sensing research was to analyze and consolidate existing data to aid in the identification of historic features and landmarks.

2.3 Use of Geographical Information Systems for Spatial Data Analysis

There are several tools available to manipulate and analyze spatial information. One of these tools is a Geographic Information System (GIS). GIS is a computer-based technology used for the storage, retrieval, mapping, and analysis of data in a spatial context. Commercial GIS software is widely available in most countries.[33] Due to its numerous capabilities, GIS is currently used in areas such as engineering, communications, human services, and natural resource management.[34]

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[33] Ibid, 12.

[34] Barlow, Johanna. Nassar, Nicholas. Picorelli, Melissa. Tynes, Jason. "Technology in Anti-Trafficking Efforts in Thailand" WPI IQP completed in Thailand. 2002

The power of GIS comes from its use of "layers." Layers are sheets of map information that can be superimposed relative to their real world coordinates. The concept of layers allows one to combine two types of data, base mapping and application data. Base mapping involves the display of topographic features such as roads, rivers and mountains. Application data involves "thematic maps and resource inventories generated for a specific application."[35] By superimposing various layers of information in a spatial context, it is easier to distinguish relationships between data sets. Performing a similar analysis on a numerical spreadsheet would be much more time-consuming and less accurate. Furthermore, the ease of adding additional layers allows one to quickly visualize the impact changes in one layer may have on other layers.

There are several types of sources for creating a GIS base map. Existing paper maps are the most widely available source for GIS base maps. Most countries have at least a very basic mapping system, which can be enhanced using GIS. Other sources include satellite imaging, aerial photography, ground surveys, Global Positioning System and airborne radar. Even though these sources are very accurate, occasionally the information requires small corrections for distortions caused by the data gathering technique. Camera movement, plane tilt or the varying elevations in the earth's surface can such distortions.

A properly implemented GIS dataset can be an extremely useful tool for cultural resource management, allowing park managers the ability to view a site on the macro scale and to easily monitor park activities. In regards to hydrology, contour maps can be integrated with aerial photographs, allowing visualization of the natural paths water will take throughout a region.

[35] Ibid, 12.

3 METHODOLOGY

This project assisted the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Thailand Department of Fine Arts in enhancing the interpretation of the hydrology at the Sukhothai World Heritage Site. Our team examined the current condition of the site and then proposed interpretive materials that could be used to emphasize the hydrological aspects of the city. The primary objectives of our project were to:

1) Develop an understanding of the modern Sukhothai hydrological system using maps and field research, then consolidate field evaluations onto a large spatial map to aid in the generation of a current hydrological picture;
2) Determine interpretational criteria based on visitor statistics; and
3) Design interpretational materials for visitors focusing on the hydrology of the inner city.

The purpose of this chapter is to describe how we achieved each objective. This documentation of methods is intended to aid future additions to the interpretation of the Sukhothai hydrological system.

3.1 Understanding the Modern Sukhothai Hydrological System

The creation of an effective hydrological interpretation requires an understanding of the entire system with its smaller interrelated parts. This section outlines the system-wide evaluation conducted by the team in order to visualize the flow of water from the Saritphong I Reservoir to the Yom River. We collected existing information and conducted field research that was incorporated into the complete hydrological story.

3.1.1 Information Sources

Our team explored several sources to obtain a basic understanding of the hydrology of Sukhothai. Useful information was acquired from paper maps, aerial photographs, GIS data, research reports and online sources. Paper maps were used to obtain a general idea of how the bodies of water were placed throughout the city, which was essential in determining the flow of water. The contour map provided the general idea of the elevation pattern from the hills west of the Saritphong Dam to the Yom River located east of the city. The topographical information obtained from the museum office helped us generalize the slope of the landscape and the probable direction of water flow. Aerial photographs were used in conjunction with the paper maps to identify and describe each body of water within the city walls. GIS layers provided a visual representation on the location of bodies of water and streams.

While existing sources provided us with a foundation of information about the area, alone they were unable to satisfy all our information requirements. We were able to find detailed aerial photographs that accurately displayed all the bodies of water; however, we did not locate any specific information detailing the water currents within the system. Furthermore, we were unable to locate information about the various structures such as dikes, dams, and other flood control mechanisms found throughout the city.

Consequently, field excursions were designed to obtain information that was useful in identifying and explaining the structures and functions of the modern hydrological system. The information collected during field excursions fell into three main categories: geographic, functional, and historical data.

- **Geographic information** includes general data describing the physical appearance and layout of the system. This project required general approximations for the size and shape of waterways and supplementary control structures. In addition, water flow information proved very helpful in determining the direction of water current. This information was extrapolated from paper maps, aerial photographs, GIS layers, and field evaluations executed by the team. A complete geographic picture allowed us to visualize the entire hydrological system.

- **Functional information** explains how each structure is utilized within the modern system. The functionality of each piece helps explain how and why they are combined to create an effective system and provide some insight as to how the system may have worked during ancient times. Some functionality information was obtained from existing resources; however, the majority of the functional data was obtained during field evaluations. Many of the functionality questions are addressed in the analysis phase of this report.

- **Historical information** includes data and hypotheses describing the technology and the historic timeline of construction. While this information is not critical for understanding how the system functions, it provides insight as to why it developed as it did, how the ancient people used it and to what degree it has changed over time. Historical information was located at the local Fine Arts Department office in Sukhothai and at the Ramkhamhaeng National Museum.

Our studies were restricted to the four-week period of January 12, 2003 to February 7, 2003, Thailand's dry season, and we were therefore unable to directly observe the system's operation during the wet season. All information pertaining to the hydrological behavior during the wet season was determined from existing sources of information or deduced from geographical evidence (e.g. erosion patterns).

3.1.2 Identifying Water Currents and Hydrological Structures in Present-day Old Sukhothai

Our first field campaign aimed to identify the water currents and hydrological structures within the city. The information we gathered allowed us to construct a hydrological representation of the modern water system at Sukhothai. This illustration, in the form of a detailed spatial map of the area, let us visualize how water flows through the city and is distributed to various bodies of water.

We used existing paper maps and GIS layers to divide the study area into six sections. Then, we studied each section of the city using enlarged area paper maps for fieldwork notations. Upon these maps we sketched the relative location of each pond and their visible inlets and outlets. Furthermore, manmade hydrological control structures were documented using digital photographs and their locations recorded.

In addition to locating the hydrological structures, we also studied the current flow and direction. If the waterway had a visible current, its direction was noted. If there was no visible current, we examined the waterway's elevation and spatial position along with associated structures to determine which way water would flow during the wet season. Each waterway was classified based on the direction of the water current. Because the waterways intersect each other at right angles and the park's walls are aligned with cardinal directions, currents were designated as north, south, east, or west. Moreover, we identified stagnant bodies of water by observing a lack of current and one or more of the following: very low water levels, excessive algae growth, water vegetation covering the surface, or a lack of visible water control structures.

The collected information was compiled into a master map that included the modern hydrological structures. Accompanying photographs and descriptions were stored electronically for later use.

3.1.3 Identifying Key Inlets and Outlets for the Moat System in Present-day Old Sukhothai

A complete hydrological analysis requires an understanding of how water enters and exits the city. Our second field campaign aimed to identify key inlets and outlets for the moat system. We surveyed the city walls in their entirety and marked individual waterways entering or exiting the city.

To begin, we looked at contour maps and aerial photos of the area and saw a canal flowing from the mountains into the southwest corner of the city wall and moat system. We located a second canal near the northern portion of the eastern city walls and moat system that seemed to be the outlet. Based on this information, we surveyed the city walls looking for verification that these were in fact the only inlets and outlets of the city. In addition, we noted any other water control mechanisms within the moat system.

In order to survey the walls in a methodical manner, we divided the team into two groups. Group one searched the southwest corner of the city for inlets, the region with the highest elevation. Group two searched the northeastern corner of the city for outlets, the region with the lowest elevation. Using enlarged copies of the spatial map, we sketched the location and layout of the inlets and outlets viewed during fieldwork. Digital photographs and written descriptions were also used to document the discovery of an inlet or outlet. Moreover, we noted any possible water currents and flow controls between or along the city moats.

The collected information was compiled into the master map and the accompanying photographs and typed descriptions were stored electronically for later use.

3.1.4 Consolidating Hydrology Information onto a Master Map

The second step in delivering an effective hydrological interpretation is the analysis of the gathered information from field campaigns to generate a large-scale hydrological model. An in-depth look at the information gathered from the field in conjunction with relevant maps and GIS layers (e.g. contour maps and aerial photographs) allowed us to develop a hypothesis of the modern water currents within the Sukhothai city walls.

The information obtained in our efforts to understand the hydrological system was organized on 8x14 sections of the larger spatial map. The groups carried these sheets into the field to compare existing map data with the physical geography. Undocumented structures were sketched onto the map, as were indications of water current, designated by red arrows. The information obtained by all the individual field excursions was then consolidated onto a large, single sheet spatial map in order to generate a useful model. An older spatial map, provided by the local Fine Arts Department office, displayed a representation of present day inlets, outlets and breaches in the city wall and moats. Occasionally, we located ponds, streams and structures that were not represented on our existing spatial map obtained from the local Fine Arts Department; these changes are reflected in the final version of our spatial map.

Our field research did face some limitations. In several instances, we were unable to investigate specific areas for likely structures due to the layout of the bodies of water; these structures may have been concealed by water or buried underground. Sometimes we overcame these restrictions by other analysis of the landscape. We formed several recommendations based on this experience.

3.1.5 Investigating the Ancient City and Ancient Technology

An ideal interpretation of the hydrology at Sukhothai should include a comparison the ancient system with the one found today. Upon investigating the present-day Old Sukhothai city, we discovered that most of the hydrological system had been modernized. This made an interpretation of the ancient hydrology difficult to achieve. While some modern structures resemble their ancient forms, others share little similarities. This section describes how we discerned between modern and ancient structures and how we developed parts of the ancient hydrological story.

After surveying the modern hydrological system, we formed the hypothesis that larger hydrological structures were most representative of their ancient form. These structures include the reservoirs, moat system, and dams. It is possible that the size, religious significance and/or defensive purposes of these structures discouraged altering their form. In addition, stone inscriptions found in the Ramkhamhaeng Museum described their ancient appearance.

To accompany our site research, we explored the Internet and several English libraries for sources relating to the history, technology, mythology, hydrology, ceramics, etc of the Sukhothai period. Most of these searches yielded little or no practical information. However, we were able to track down several books on the Kingdom of Sukhothai and several others on the art of the Sukhothai era. The books were somewhat helpful, but most of the information dealt with monument reconstruction, period history, and art.

To ensure we did not leave potential sources unchecked, we visited the National Museum of Thailand to see if they had in their possession ancient Sukhothai tools or descriptions of the hydrology. Additionally, we interviewed site archeologists from Si Satchanali and Sukhothai. From these we hoped to determine structures made or changed in the hydrological system within the past century. An interview with the previous director of the Sukhothai Historical Park was particularly useful for ascertaining information on several of the newer bodies of water.

3.2 Assessing Current Visitation and Interpretation at the Historical Park

In order to provide an effective interpretation of a location, it is necessary to take into consideration the viewing audience(s). Interpretation is defined as "a particular adaptation or version of a work, method, or style; a teaching technique that combines factual with stimulating explanatory information"[36]. Methods of interpretation vary greatly depending on the audience. When designing an interpretational strategy, many visitor characteristics can be considered, including reading level, spoken language, age, relative level of interest and education. Appreciation for these parameters allows for the design of interpretational material that may best benefit the visitor. A technical audience may desire intricate details, while a younger audience may better benefit from interactive exhibits and visual displays.[37] Before designing our interpretation material we determined it beneficial to examine visitor parameters so that our final product would be of benefit to a wide range of visitors.

While the hydrological system played an important role in the development of Sukhothai, it is not a current focus of the historical park. We assumed that the majority of Sukhothai historical park visitors desire to learn about the historical temples, monuments, and ancient culture of the Sukhothai period. It was also assumed that an additional hydrological interpretation would not attract a substantial new audience. Based on these assumptions, our team designed a project to enhance the experience of tourists already visiting the park.

To further refine our target audiences, we conducted a field campaign to observe visitors entering the park and associated museum. We sought to know the number, approximate age and nationality of park guests. Since the project goal could involve the design of a bicycle path, we also wanted to know the number of guests renting bicycles from nearby vendors. This information was obtained using visual observation combined with interviews of park and bicycle rental staff; rental staff owners were approached and asked when their busy season was as well as what was the average number of bicycles rented per day.

In order to perform a general visitor assessment, we designated two week days for collection of guest statistics. For the historical park, group members were positioned at the main gate in shifts during the park's operating hours. There they made visual observations to obtain the following information: number of guests entering the park, mode of transportation, and approximate ages. We made logical assumptions to determine language, and whether guests were Thai or foreigners. Records from both the museum and

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[36] Webster's Third International Dictionary, *interpretation* pg. 1182

[37] http://www.strategictransitions.com/whyvisuallearning.htm (10 February 2003)

park offices detailing the number of Thai, foreign and student visitors were obtained for the months of October, November, December 2002 and January 2003. The information acquired was stored electronically in spreadsheets for future use and analysis.

The data gathered from this field campaign was analyzed in order to characterize the visitors in general. Using the collected demographic data, we chose general design criteria which we would use to brainstorm a list of interpretational materials. Based on the established criteria, we selected three different materials to communicate the hydrological story to park guests.

3.3 Developing Interpretation Materials

The final steps in our methodology were to generate an interpretational hydrological story in a form that we could present to the visitors of the museum and park, and to develop materials to convey the story. To do this we first consolidated facts, history, and field data into a single cohesive story describing the hydrology of Sukhothai. Then, we used visitor information to help design interpretational materials to effectively communicate the hydrological story to park guests.

The hydrological story was created by examining the path of water as it flows from the tributaries of the Saritphong Dam (Thomnop Phra Ruang) between the Phra Bat Yai and Kiew Ay Ma hills to the Yom River. Using current data and digital photographs, we developed an illustrated storyline highlighting points of interest along the water's path. We incorporated information about the large reservoir Saritphong I, other large baray outside the city walls, and the main tributary entering the city. After the water entered the city, the story delved deeper into the culture of Sukhothai. The waterways were described by function and were classified as ponds, canals, reservoirs or seasonal flood control devices. In addition, modern hydrological structures were noted as our story also compared how the ancient and modern civilizations controlled the flow of water through the city. Finally, we described the water's departure from the city into the Yom River.

The selection of interpretational materials was largely based on the results of our efforts to gather visitor statistics and project schedule constraints. After examining the demographics, we divided visitors into specific target groups. Based on these groups' characteristics, we developed a list of criteria our interpretational devices should satisfy:

- Interesting and visually stimulating information
- Easy to understand
- Storyline of hydrology
- General information
- Detailed information
- Portable vs. stationary
- Availability in multiple languages
- Factual and engaging
- Promotion of individual exploration

We used these criteria to pick our interpretive materials from the list below. Some implementations were not considered because of our limited expertise, but will be incorporated into recommendations for

future work. Through brainstorming sessions, we developed the following list of potential interpretational materials:

- Interactive hydrological display
- Informational pamphlet
- Documentary video
- Path through the park
- Book
- Informational signboards
- Tour guides
- Visual display board
- Audio cassette or CD self-guided tour

Once we selected our interpretational materials, we designed prototypes for each. We used our story and the maps we generated along with computer software and paper tracings to create our prototypes by using basic principles of visual design.

4 THE SUKHOTHAI HYDROLOGICAL STORY

For ease of readability, we have divided the story of Sukhothai's hydrological system into three separate sections: *Mountain Reservoir, Structures of Sukhothai* and *Flow through Sukhothai.*

Mountain Reservoir

The story of the Sukhothai water system begins three kilometers west of the city in the Phra Bat Yai and Kiew Ay Ma hills. Every year, seasonal rains cause mountain streams to swell and flow into the valley below. Over thousands of years, these streams carved deep gorges into the rock. Some of the sites are so extraordinary legends were created to explain them. The gorge seen in Figure 8 is said to have been created by a king of Sukhothai when he tested his sword on the rock. The gorge, named So So Phra Ruang Longprakan, is approximately 6 meters wide, 60 meters tall and 60 meters long. Due to seasonal rains, the stream flowing through the gorge changes from a brook to a river with a water depth of 1-1.5 meters. Every wet season, seventeen comparable mountain streams combine inside a horseshoe shaped valley and, prior to the construction of a dam, flooded the lowland countryside.

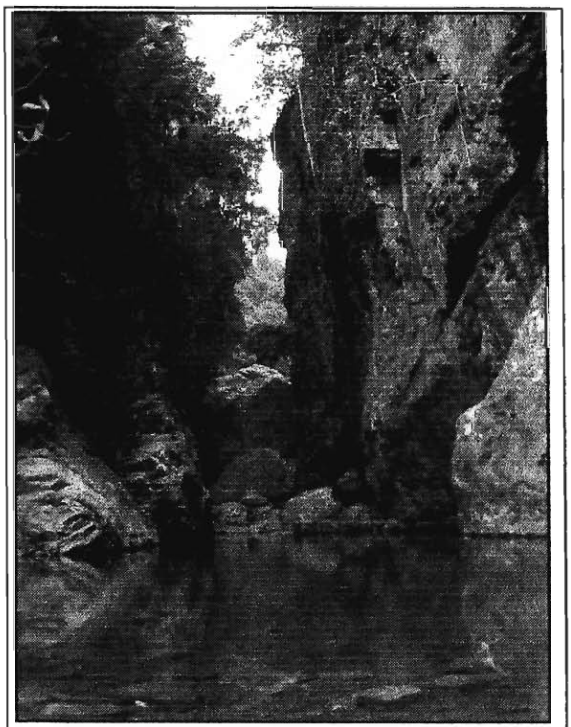


Figure 8: So So Phra Ruang Longpraken

The urban planners of ancient Sukhothai recognized the region's hydrological potential and constructed a dam across the valley to retain seasonal floodwaters for use during the dry season (see Figure 9). Construction of the dam created a reservoir called Saritphong I. Saritphong I serves as the primary water source for the city of Sukhothai, storing over 100,000 cubic meters of water. A series of spillways and floodgates is used to regulate the amount of water entering the tributary canals which lead directly to the city.

Water from Saritphong I must travel approximately 3 km before it enters the city; small agricultural communities tap into the water supply along the way. During the Sukhothai era, farmers used the *muang fai* irrigation system; this system is characterized by a series of major and minor canals controlled by *fai* structures. A *fai* is a type of dyke constructed from bamboo and wooden stakes driven into the riverbed. It allows water to pass through and over the barrier while restricting the rate of flow in order to raise the water level. Water flow can be controlled throughout the subsystem by modifying the *fai*.[38] Figure 10 is a diagram of a *muang fai* system.

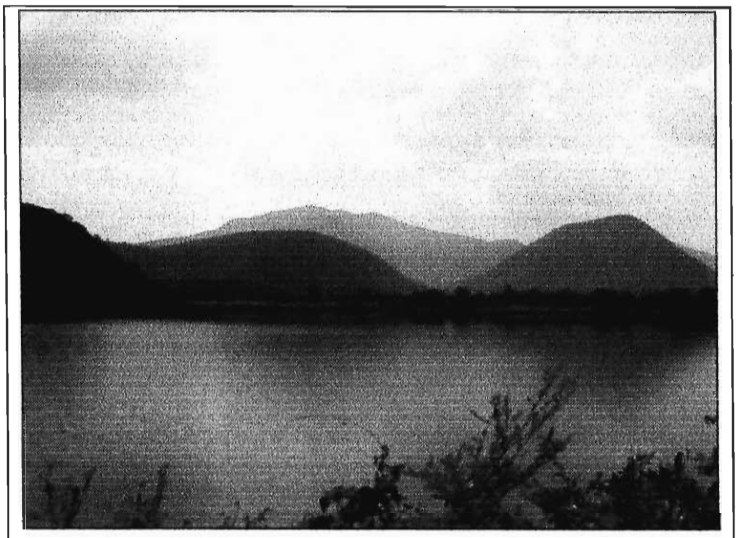


Figure 9: Mountains surrounding Saritphong I

Experts are presently investigating a historic secondary water source that may have also served ancient Sukhothai. Located approximately 6 km south of the city, Saritphong II was a large reservoir capable of holding approximately one million cubic meters of water. The remnants of an earthen dike believed to have retained this water can still be seen within nearby agricultural fields. This dike is approximately two to three meters tall and extends for an entire kilometer.

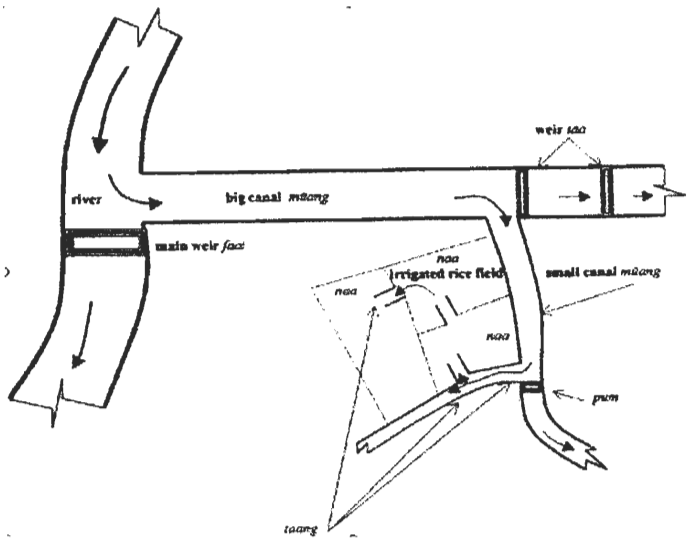


Figure 10: Diagram of the Muang Fai Irrigation System[39]

Because no ancient or modern canals connecting the reservoir to the city have been verified, experts are assuming this reservoir was an independent water system. Today, Saritphong II remains dry for the majority of the year. The water that is collected during the rainy season is used for agricultural purposes.

[38] http://www.atse.org.au/publications/focus/focus-falvey3.htm (22 January 2003)
[39] Professor J L Falvey FTSE, ATSE Focus, No. 115, Jan/Feb 2001 http://www.atse.org.au/publications/focus/focus-falvey3.htm (11 February 2003)

Structures of Sukhothai

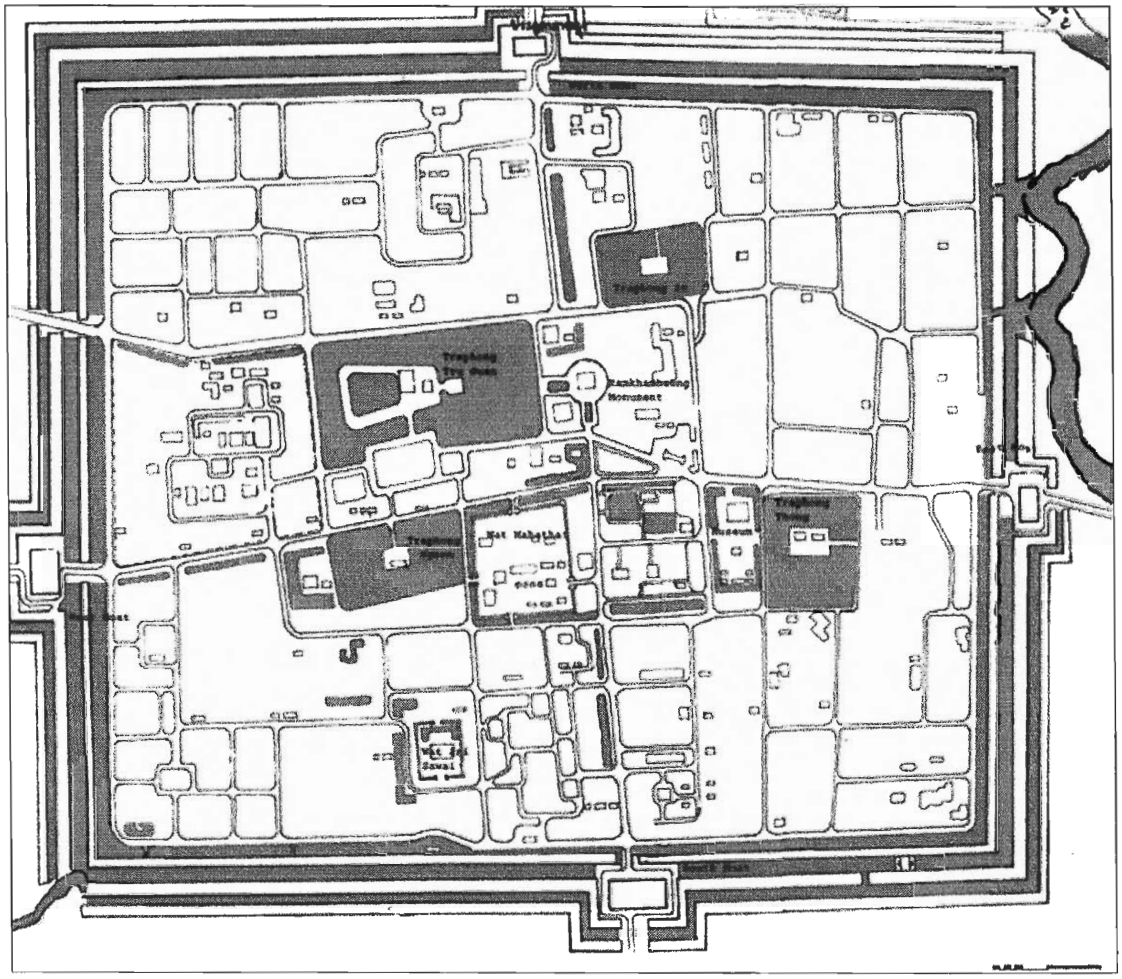


Figure 11: Old Sukhothai spatial map

The city of Old Sukhothai possesses a high degree of structure and organization. All of the significant ancient structures, including the city walls, major roads and temples, are aligned with the magnetic cardinal directions; with few exceptions, roads and canals intersect at right angles. First, we will describe the structures within the city, then we will examine how they work together to move water through the city. A map of the entire city can be seen in Figure 11.

The city of Sukhothai was modeled after the ancient Khmer capital, Angkor. The geography of the region as well as the control mechanisms used to control the water are very similar. The city of Sukhothai was built on a gradually sloping flood plain. The land slopes from the highest point, 63m above sea level in the southwest, to the lowest point, 54m above sea level in the north-eastern corner of the city as indicated on the contour map in Figure 12. There is a slight bulge in the center of the city encouraging water to flow north and south instead of directly northeast. Surrounding the city is a defensive triple wall/moat configuration called a "tribun."[40] An example of this wall/moat pattern is evident in Figure 11. The outer two city walls were constructed of earth from the excavation of the outer moats. The third

[40] Sukhothai: Dawn of Happiness. Ministry of Education. 2000.

and largest wall was constructed of laterite brick covered with soil. A final moat is located within the third wall. Clay brick was used to improve wall strength, particularly around gates and road entrances to the city.

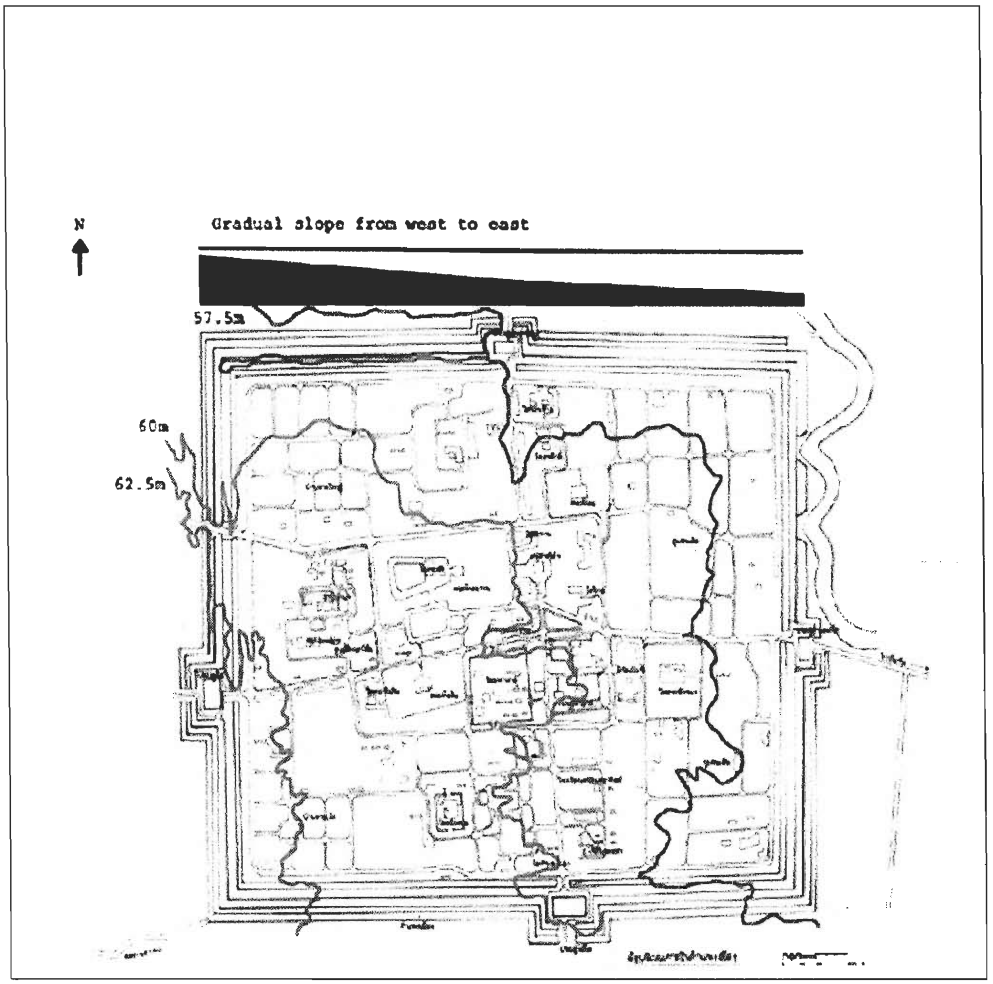


Figure 12: Colored Contour map of Old Sukhothai

Sukhothai's water structures can be divided into four major categories: canals, retaining ponds, reservoirs, and stagnant ponds. Canals are used for water transport within the city, are typically 3-4 meters wide, and can extend for hundreds of meters. Retaining ponds are used to hold excess water accumulated during the wet season. Retaining ponds may have served as sources for drinking water, agriculture and industry. Reservoirs are the largest and deepest bodies of water within the city walls. They are characterized by their size and the existence of a religious temple built on a central island. Because of the amount of water the reservoirs are able to hold, they would be the last to dry up in the dry season. Finally, a series of stagnant ponds are scattered throughout the city. These ponds have no visible inlets or outlets allowing water to flow. In addition to the four types of water bodies, a significant number of operational wells were visible across the city. The observed water level in the wells varied with elevation, but did not exceed two meters. This information lead us to believe that certain water structures are supplied by a shallow water table or natural underground springs.

A number of water bodies serve dual purposes in the city. Some water bodies carry religious significance in addition to their physical function. Religious bodies of water are identified by their proximity to temples. Religious bodies of water represent the Hindu belief of a "cosmic ocean." According to Hinduism, practiced by the Khmer people, the gods reside in the five sacred mountains, which are surrounded by a body of water or the cosmic ocean.[41] The design of the Khmer temples symbolizes the heavenly residence of the gods with five towers, called *prasats*. The central dominant tower or *prasat* represents Mount Meru, the central mountain, and the four smaller towers, one at each corner, represent the other four sacred mountains of the Hindu heaven. The moat surrounding the temples symbolizes the cosmic ocean. After the rise of the Thai people in Sukhothai, many of the carvings on the temples were related to Buddhism and the Buddha. However, the Khmer renditions of the cosmic oceans remain.[42]

Figure 13: Ceramic pipes used in Sukhothai

The manmade structures used to control water flow are another important component of the hydrology at Sukhothai. In the ancient times terracotta pipes were used to provide a path for the flow from the Sao Ho Canal into the city moats.[43] Terracotta is a form of hard-packed pottery and was widely produced in the region.[44] Remains of underground ceramic piping, as seen in Figure 13, can be found in the associated museum. Ancient flow control structures, dikes and dams, were likely constructed of brick and earthen materials.

The present day park combines ancient techniques with modern forms of water control. The ancient system has been augmented with concrete piping, spillways, and culverts to ensure smooth transfer of water as well as additional flood control safeguards.

Flow through Sukhothai

Water enters the city's moat system from the Saritphong I dam via the Sao Ho Canal in the southwest corner of the city (see Figure 14). The water entering the city diverges into the western and southern moats. The southern moat is primarily used for flood control during the wet season and for fishing ponds of the residential communities. In the wet season, dikes can be constructed in the three western

[41] http://www.cambodia-travel.com/khmer/architecture.htm. (18 November 2002)
[42] http://www.cambodiaportal.com/tourism/khmertourist/content.php?mycontent=architecture. (18 November 2002)
[43] Sukhothai: Dawn of Happiness. Ministry of Education. 2000. (16 November 2002)
[44] http://www.encyclopedia.com/html/t1/terracot.asp. (12 November 2002)

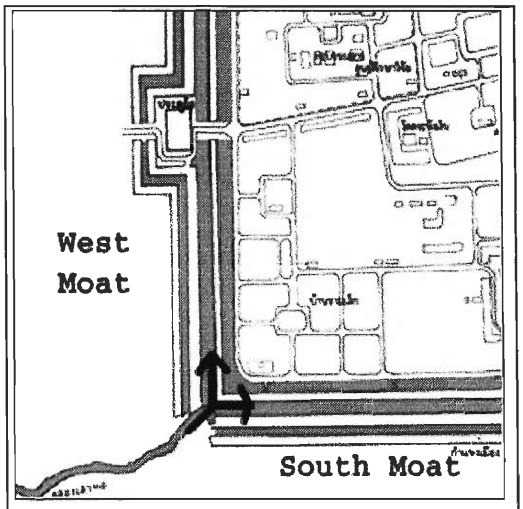


Figure 14: Water flows into both the west and south moats

moats to divert floodwater through the southern moat for immediate drainage into the Mae Rumphan Canal. These temporary dikes are often necessary to protect the old city from internal flooding. In addition brick spillways have been constructed within the inner moat, Figure 15, to restrict the flow of water and reduce erosion during the wet season.

During the dry season, there is not enough water available to fill all three city moats. Currently, the water is directed through the middle and inner moats for aesthetic purposes. Park staff has the ability to divert all the water to one moat or the other using an earthen dike in the case of excessive water present.

The western moat is responsible for replenishing the city's numerous internal waterways. As seen in Figure 16, water enters the inner city through two main canals flowing perpendicular to the western moat. Water from these canals enters two of the major reservoirs, Traphang Tru Guan and Traphang Ngoen, surrounding Wat Sra Sri and Wat Traphang Ngoen, respectively. From these reservoirs, the water branches out to numerous retaining ponds and canals.

The water from the reservoir surrounding Wat Traphang Ngoen flows south through a series of four canals before it reaches the religious reservoir of Wat Sri Sawai. Additional southern water control networks move excess water into residential communities such as the Ram Lek Village and provide drainage into the southern moat. This reservoir is also responsible for maintaining adequate water levels in the ponds/moats surrounding Wat Mahathat. The water from Traphang Ngoen flows over a spillway and through pipes into Wat Mahathat's moat. This moat is responsible for filling the three internal ponds of Wat Mahathat (Figure 17).

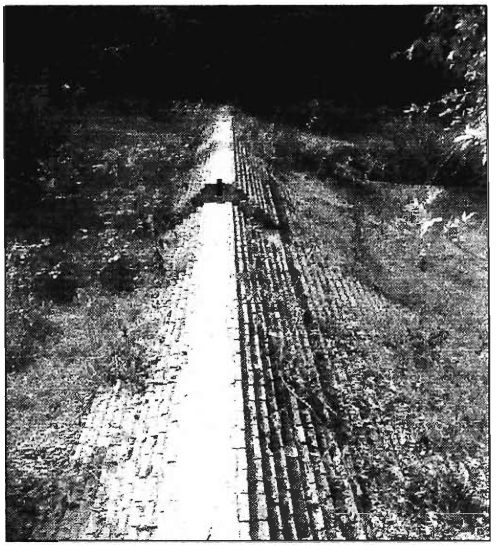


Figure 15: Brick Spillway in the Inner Moat

The water from Wat Mahathat continues east into another canal through concrete pipes. Traveling beneath a modern road, water empties into the moat surrounding the Ramkhamhaeng National Museum. From there, the water flows underneath another road before it reaches its final destination, Traphong Thong, the reservoir surrounding Wat Traphang Thong. This reservoir has a spillway located in the northeastern corner draining excess water into a modern concrete drainage system that takes water directly to the eastern moat.

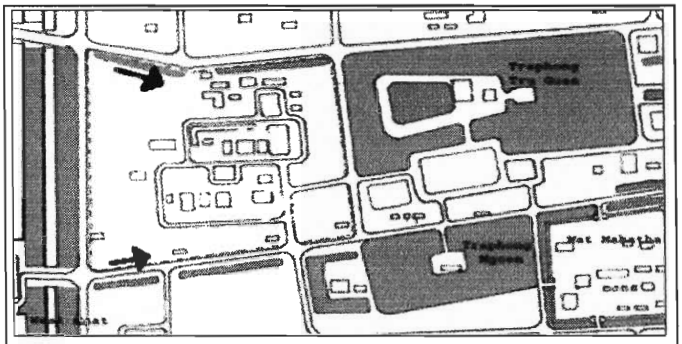


Figure 16: Water enters the city through two canals flowing from the western moat

The largest reservoir, Traphang Tra Guan, surrounds Wat Sra Sri and is responsible for providing the northern half of the city with a consistent supply of water. Traphang Tra Guan is connected underground by modern pipes to a series of ponds surrounding the King Ramkhamhaeng monument. A modern pumping mechanism is used to maintain the water level of at least one of the two brick enclosed pools aside the King's Statue (Figure 18).

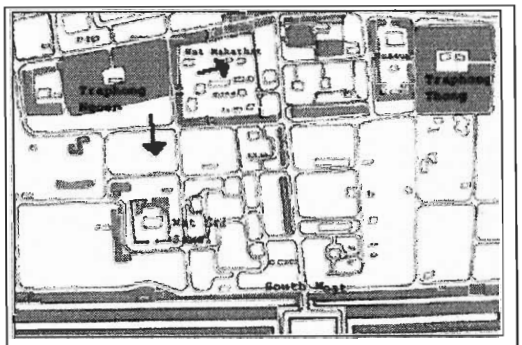


Figure 17: Water flow from Traphang Ngoen to Wat Mahathat, Ram Lek Village, and Wat Sri Sawai

In addition, water from Traphang Tra Guan also flows directly north into a series of canals and pipes which directs water beneath Highway 12, to the northern moat. Side canals are used to fill Traphang So, the reservoir surrounding Wat Traphang So, and the religious bodies of water around Wat Sorasak and Wat Son Khao.

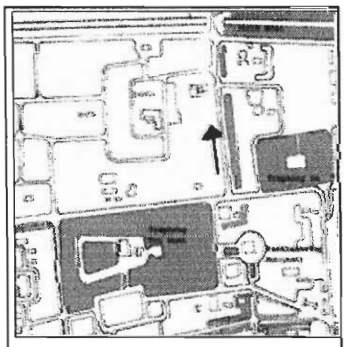


Figure 18: Water flows from Traphang Tra Guan to the King's Statue and the northern moat

The story of Sukhothai's hydrology is complete after the water has made its way through the ponds, canals, and reservoirs of the city; it empties through the eastern wall to the Mae Rumphan Canal. The Mae Rumphan Canal leads the water away from the city to the Yom River in New Sukhothai, 12km east of the old city. Eventually, these waters join those of the Ping and Chao Praya rivers. Together, they flow south through the capital, Bangkok, and into the Gulf of Thailand.

5 DEVELOPMENT OF INTERPRETATIONAL MATERIALS

The hydrological story narrated in Chapter 4 is far too detailed, lengthy, and perhaps unexciting for casual park guests. Interpretational materials are needed to better communicate the hydrological story to park guests. In this chapter, we outline our approach for selecting interpretational materials for a varied audience. Using preliminary observations we categorized the types of visitors entering the park. Next, we developed a list of demographic information requirements and conducted visual observations to obtain that information. Using the collected demographic data, we then chose general design criteria, which we would use to brainstorm a list of interpretational materials. Based on the established criteria, we selected and created three interpretational materials to communicate the hydrological story to park guests.

5.1 Preliminary Audience Observations

From our day-to-day interactions in the park we gained a general understanding of the types of people visiting the park. We noticed that three categories of visitors typically entered the park on a regular daily basis: school groups, tour groups, and independent parties.

School Groups: Every day school busses would transport several hundred students to the historical park. The students entering the park varied in age from elementary children through college students, but the majority of the children appeared to be fourth to eighth year students. In addition to the school instructors, guides provided by park staff often accompanied school groups.

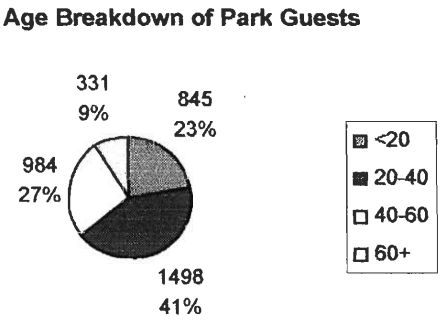
Tour Groups: It was observed that approximately 50% of park guests travel as part of a tour package and are typically led by a professional tour guide. Visitors in tour groups typically were of approximately 20-60 years of age, with some over 60 as well.

Independent parties: We defined independent parties as small, unguided groups of travelers who like to explore and move along at their own pace. It was assumed that most independent travelers arrive prepared with a general understanding of the park from guidebooks or other sources.

5.2 Visitor Demographics

Although the types of visitors entering the park was generalized through preliminary observations, more specific demographic details were needed in order to assist us in the creation of interpretational materials for the variety of visitors. To obtain these demographic details we conducted observational surveys to record information about the guests entering the historical park. These surveys were conducted during the operational hours of 0600 to 1900 for two consecutive weekdays. We grouped the park audience by approximate age, nationality (Thai, other Asian, or Westerner) and whether or not guests were riding bicycles. We also noted the number of school groups and tour groups entering the

park. Figures 19 and 20 illustrate the age range breakdown of park guests and the percentages of cyclists and non-cyclists, respectively.



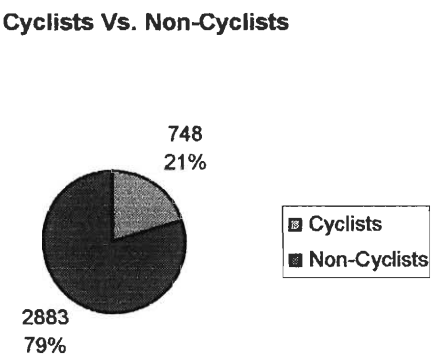


Figure 19: Approximate Age Breakdown of Park Guests Figure 20: Percentages of Park Cyclists vs. Non-Cyclists

As can be seen from Figure 19, guests of all ages entered the historical park. During our two-day evaluation we observed 10 organized school field trips of young students and 71 tour groups entering the park; members of the tour groups were primarily over the age of 20. It is important to note that bicycles were rented from vendors located near the park by 21% or 748 of the total guests over the two-day period. Most cyclists visiting the park fell into the 20-40 age bracket and entered in small groups.

5.3 Criteria for Interpretation Materials

In order to determine possible interpretation materials, we created a list of criteria which we believe our materials should satisfy. The creation of this list was based on the demographics of our audience, personal experience, and existing interpretation materials found throughout the park and museum. Each of our materials should take the following into consideration:

- Visually stimulating
- Easily understandable
- Storyline of hydrology
- General and detailed information
- Portable
- Available in multiple languages
- Factual and engaging
- Promotion of exploration

Because a number of these criteria conflict, multiple interpretational materials had to be selected to better serve a variety of park guests. Keeping this in mind, the following is a list of materials that were brainstormed from the above criteria:

- Interactive hydrological display
- Informational pamphlet
- Documentary video
- Path through the park
- Book
- Informational signboards
- Tour guides
- Visual display board
- Audio cassette or CD self-guided tour

Considering the limited resources available, feasibility, simplicity, and the above criteria we selected three interpretational materials to present the Sukhothai hydrological system to park visitors: a visual display board, an informational pamphlet, and bicycle/walking routes through the park.

Visual Display Board: A visual display board can tell the hydrological story using pictures as well as general and detailed information. The complexity of the text can be adjusted to assist younger school children in understanding the information. Multiple languages can be incorporated to accommodate different nationalities, in particular Thai and English-speaking visitors. Text boxes on the board will allow interested viewers to delve deeper into facts of the hydrology system or explain engaging stories.

Self-Guided Bicycle/Walking Path: Self-guided bicycle or walking routes encourage independent exploration of the hydrology. Bicycle routes may also appeal to the cyclists and independent parties entering the park and group tours could incorporate the path into their preplanned agendas.

Informational Pamphlet: The informational pamphlet is a portable version of the visual display board and also illustrates the self-guided bicycle or walking routes we developed. Moreover, the pamphlet can be translated into multiple languages. This interpretational material may be useful to most park visitors and can be kept as a memento.

6 INTERPRETATIONAL MATERIALS

This chapter presents the interpretational materials we designed to aid in the understanding of the hydrology at Sukhothai. We briefly describe how we created each interpretational material, and then present a list of features which explain what each interpretational material will provide for the visitor.

6.1 Visual Display Board

To create the prototype of our visual display board, we reduced the hydrological story to its basic components. We presented this information using pictures and text boxes positioned around a detailed map of the inner city. Additional text boxes were used to present more detailed information on the hydrological system for readers with greater interest. Figure 21 below shows our prototype of a visual display board.

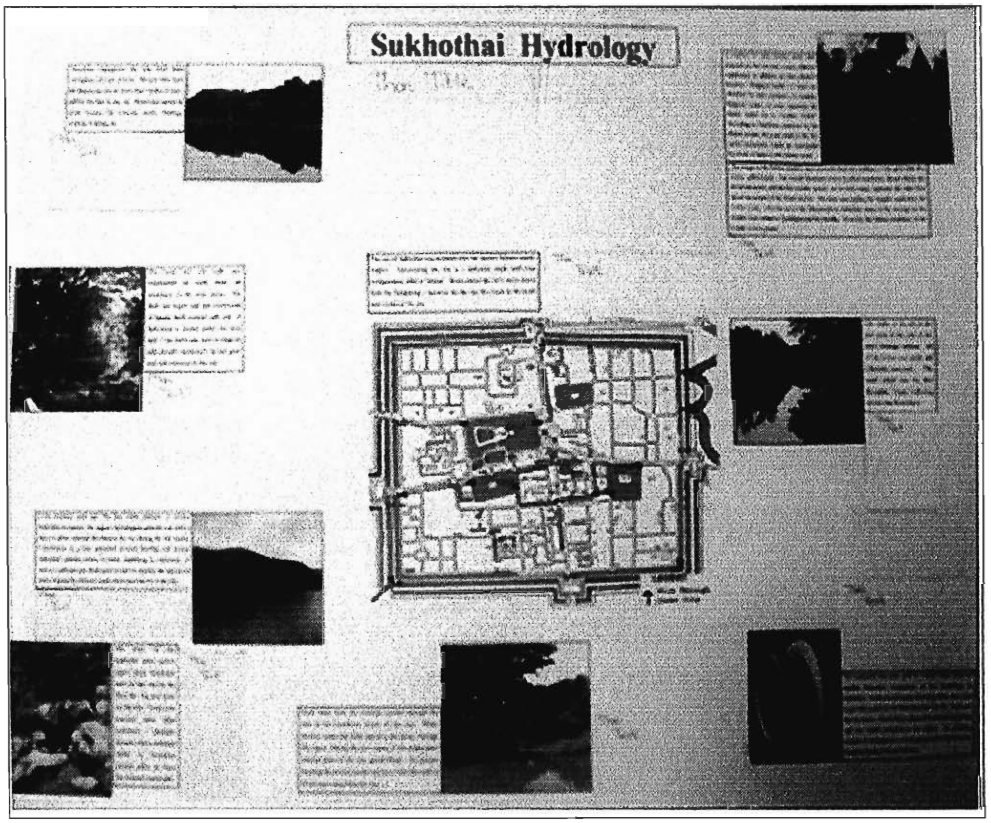


Figure 21: Visual display board illustration

Features:

- Quick and easily understandable reference of Sukhothai hydrology
- Design consists of a large spatial map depicting the inner city surrounded by pictures and informational text boxes
- Arrows document the flow from one body of water to another within the city
- Text is in Thai and English (See Appendix F for English text)

- Information is visually based so that it is not necessary to read the text in order to understand the general flow of the hydrological system

6.2 Informational Pamphlet

The informational pamphlet is a compact version of our visual display board. The information is presented as a narrative accompanied by pictures. Supplementary information was placed in sidebars and boxes around the story. The front cover and inside panel of the informational pamphlet can be viewed in Figures 22 and 23, respectively.

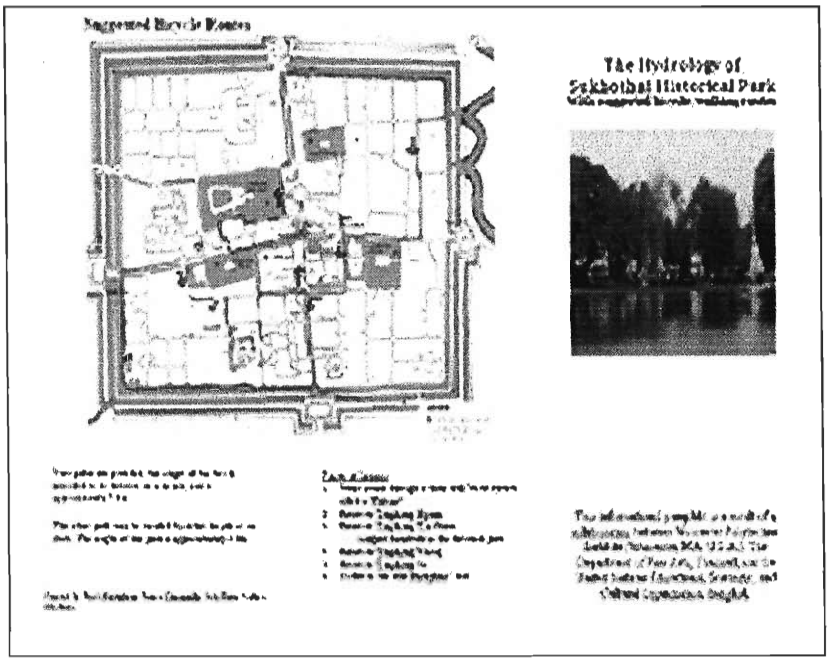


Figure 22: Front cover of informational pamphlet

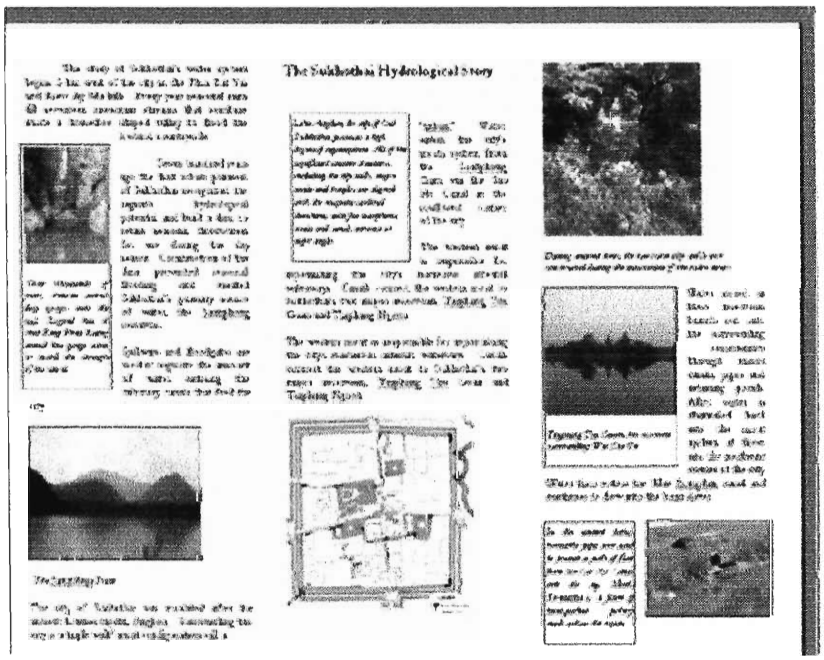


Figure 23: Inside of informational pamphlet

Features:

- Describes the hydrological story of Sukhothai (printed in multiple languages)
- Side bars use pictures of the area and text to convey additional information and historical facts
- Detailed inner city map shows the flow of water through the system
- Easy for guests to take along with them

The pamphlet may be viewed in its entirety in Appendix E

6.3 Bicycle Routes

Self guided bicycle routes through the park allow visitors to leisurely explore the hydrological system at Sukhothai. The routes were designed based on our experience gathered during our month long stay within the city and daily ventures through the park. The first route is shown in Figure 24, and the second in Figure 25.

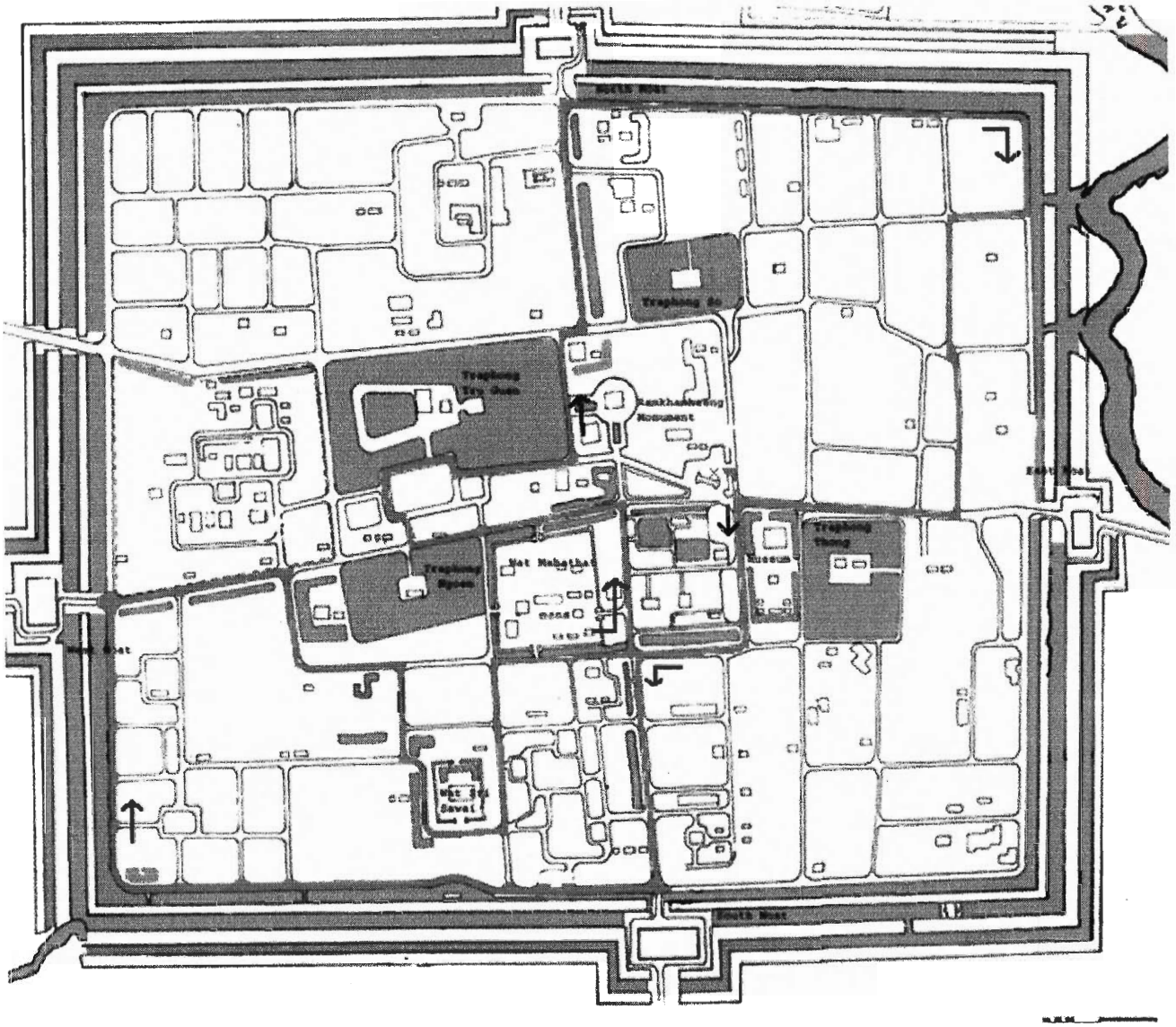


Figure 24: First suggested path through the Sukhothai Inner City

Features:

- Path I: Sukhothai Hydrological Bicycle Path
    - Comprehensive path following the flow of water through the city
    - Approximate length: 7km
    - Follows flat paved roads
    - Rest areas are found along the path and throughout the park
    - The middle of the path passes near the starting point so that users can decide if they wish to take a shorter or longer tour

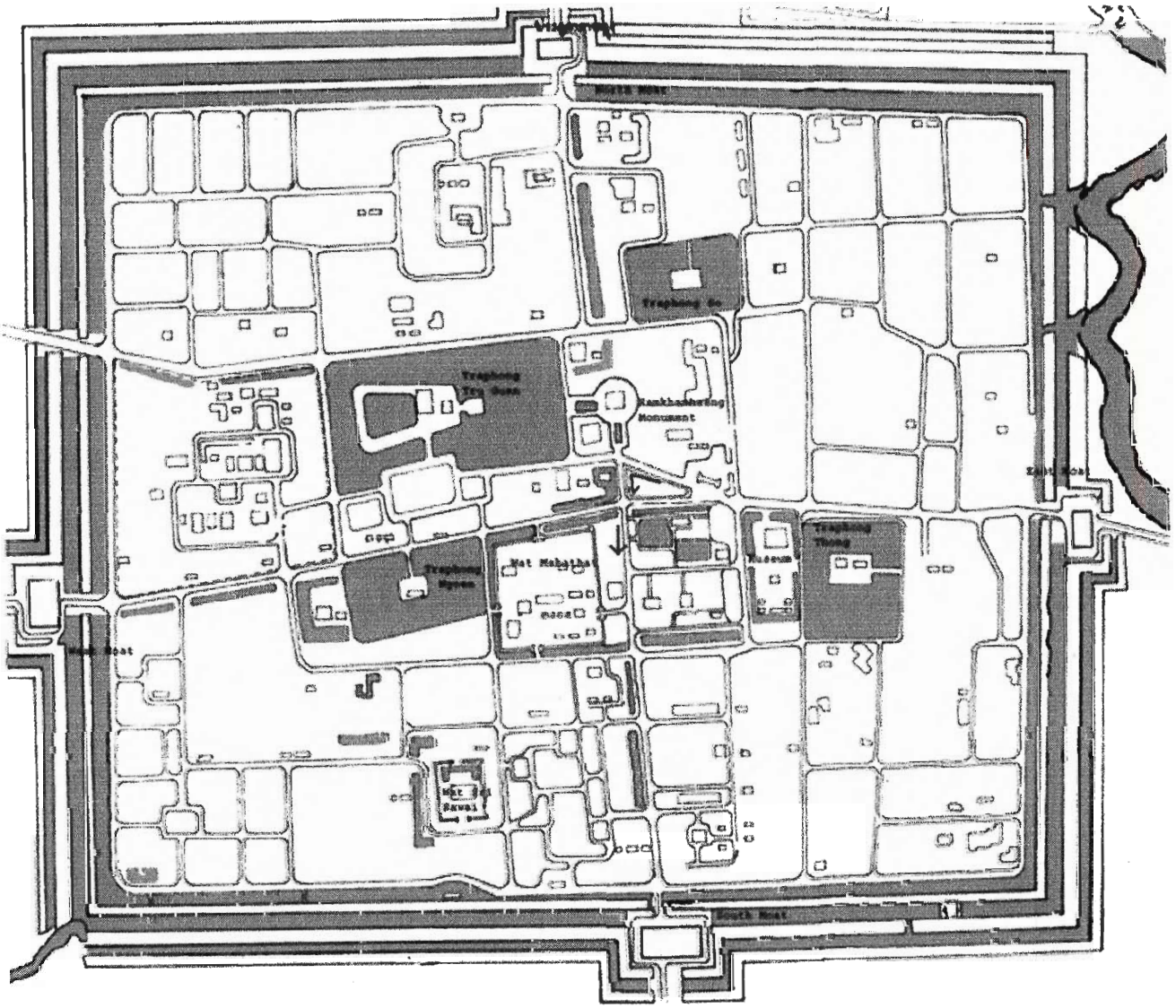


Figure 25: Second suggested path through the Sukhothai Inner City

Features:

- Path II: Sukhothai Historical Park Route
    - Scenic path that takes visitors past the more popular monuments
    - Approximate length: 3km
    - Follows flat paved roads
    - Rest areas are found along the path and throughout the park

7 IMPLEMENTATION AND FUTURE WORK

This chapter contains recommendations for the implementation of the interpretational materials developed. We also list potential endeavors that we believe would be beneficial to the Sukhothai World Heritage Site in their efforts to enhance the interpretation of the hydrological system.

7.1 Implementation of the Hydrological Interpretation

We recommend the following steps for implementing the three interpretations we have designed:

Visual Display Board:

- Translate the English text into Thai
- Enlarge the display to 1m x 1.25m for ease of viewing
- Install the visual display board in the following locations:
    - Ramkhamhaeng National Museum
    - Near the entrance of the historical park

Informational Pamphlet

- Translate the English text into Thai
- Distribute printed copies at the following locations:
    - Main entrance of the park/or near the visual display board
    - Front desk of the Ramkhamhaeng National Museum
    - At bicycle rental establishments

Bicycle/Walking Route

- Post route name, route direction and distance markers along the self guided bicycle routes
- If printed separately from the pamphlet, distribute copies at the following locations:
    - Main entrance of the park/or near the visual display board
    - Front desk of the Ramkhamhaeng National Museum
    - At bicycle rental establishments

Because of time limitations and challenges associated with obtaining cost estimates given the language barrier, the material selection and construction costs of the display board as well as the production costs of the pamphlet and signs with bicycle symbols were not addressed.

7.2 Future Work

From our research, data gathering efforts, and analysis, we have proposed a list of recommendations that we believe would be of assistance to future work at the Sukhothai Historical Park in the interpretation of the hydrological system.

- **The Ramkhamhaeng National Museum should create an interactive hydrological display**- The output of this recommendation would be an interpretive material with no language barrier. The display would be understandable for multiple levels of intellect and would be compatible with the other forms of hydrological interpretation we suggest.
- **The Thailand Survey Department should resurvey the inner city and surrounding landscape to create a high resolution contour map of the area (0.5m)**- This could help future research projects predict additional water flow patterns within and on the outskirts of the old city or use in determining how groundwater may fill stagnant ponds.
- **The Fine Arts Department of Thailand should obtain a ground penetrating radar satellite scan**. With this scan ancient hydrological structures, such as examples of the *muang fai* system, that have not yet been uncovered may be located. This procedure has aided in the discovery of similar systems in Angkor.

It has been our pleasure to work with UNESCO and Thailand Department of Fine Art's by assisting them in the development of an interpretation that will enhance visitor understanding of the Sukhothai Historical Park. By providing our interpretation of the hydrological system, we hope it will draw visitors' attention while educating them about how the ancient civilization of Sukhothai was able to recognize the potential of their natural surroundings.

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APPENDIX B: Criteria for the inclusion of cultural properties in the World Heritage List

23. The criteria for the inclusion of cultural properties in the World Heritage List should always be seen in relation to one another and should be considered in the context of the definition set out in Article 1 of the Convention which is reproduced below:

"monuments: architectural works, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features, which are of outstanding universal value from the point of view of history, art or science;

groups of buildings: groups of separate or connected buildings which, because of their architecture, their homogeneity or their place in the landscape, are of outstanding universal value from the point of view of history, art or science;

sites: works of man or the combined works of nature and of man, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological points of view."

24. A monument, group of buildings or site - as defined above - which is nominated for inclusion in the World Heritage List will be considered to be of outstanding universal value for the purposes of the Convention when the Committee finds that it meets one or more of the following criteria and the test of authenticity. Each property nominated should therefore:

a.

i. represent a masterpiece of human creative genius; or
ii. exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design; or
iii. bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared; or
iv. be an outstanding example of a type of building or architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history; or
v. be an outstanding example of a traditional human settlement or land-use which is representative of a culture (or cultures), especially when it has become vulnerable under the impact of irreversible change; or
vi. be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance (the Committee considers that this criterion should justify inclusion in the List only in exceptional circumstances and in conjunction with other criteria cultural or natural);

and

b.

i. meet the test of authenticity in design, material, workmanship or setting and in the case of cultural landscapes their distinctive character and components (the Committee stressed that reconstruction is only acceptable if it is carried out on the basis of complete and detailed documentation on the original and to no extent on conjecture).

APPENDIX C: April 2002, Draft Project Document

UNESCO

DRAFT PROJECT DOCUMENT

Enhancing the Authenticity of the Landscape at the Historic Town of Sukhothai and Associated Cities of Si Satchanalai and Kamphaeng Phet

Country:	Thailand
Project Title:	Enhancing the Authenticity of the Landscape at the World Heritage Historic Town of Sukhothai and Associated Cities of Si Satchanalai and Kamphaeng Phet
National Implementing Agency:	Department of Fine Arts, Ministry of Education
International Executing Agency:	United Nations Educational, Scientific, and Cultural Organization (UNESCO)
Funding Source:	International Safeguarding Campaign for Sukhothai
Duration of Project:	18 months
Project Costs:	$76,242
Primary Function:	Direct support
Sector, sub-sector:	Culture, culture preservation and development

1) Background and justification

Sukhothai is recognized in Thai history as the birthplace of Thai civilization, and served as the first capital of Thailand from the 13th to the 15th century. The Historic Town of Sukhothai and its associated cities of Si Satchanalai and Kamphaeng Phet were listed as World Heritage Sites in 1991, in recognition of their fulfillment of Criteria I (represent a masterpiece of human creative genius) and Criteria III (bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared.)

The three cities were registered as ancient monuments in Thailand under the Act on Monument, Ancient Objects, Art Objects and National Museums in 1961. Through the cooperation of the Fine Arts Department, UNESCO, the Royal Survey Department, other government agencies and universities in developing the masterplan, the 70 square kilometer historic city of Sukhothai was declared a historical park in the Royal Gazette in 1976. Si Satchanalai and Kamphaeng Phet were declared historical parks in 1983 and 1980, respectively.

There are almost 200 ancient structures in the Sukhothai Historical Park, along with an extensive system of waterworks including ponds, dams, reservoirs, canals and defensive moats. The ancient city had developed a highly sophisticated urban infrastructure which served the needs of the population for domestic uses, agriculture and defense. Major changes to the landscape have been carried out in the planning and implementation of the historic park project. Two hundred households were resettled, roads and infrastructure were built to allow for the consolidation of the monuments and the grounds, and to ensure the comfort of domestic and international visitors. As a result, the historic park offers immaculately landscaped grounds as a setting for the monuments, but at the expense of the historic atmosphere of the site.

The Si Satchanalai Historical Park occupies an area of 45.15 square kilometers and includes 215 historic buildings. Originally known as Chalieng, it had been a cultural centre in the Yom River Valley even before being taken over by Sukhothai. The town is renown for its Sawankhalok ceramics industry, and was also the production site of iron working and bronze casting. The landscape is less constructed than at Sukhothai, but visual obstructions in the form of modern infrastructure and unregulated commercial activities detract from the landscape, particularly in the sites outside of the city proper. At the same time, limited archaeological excavation work has put a damper on more guiding historically-appropriate site consolidation work.

The Kamphaeng Phet Historical park occupies an area of 3.83 square kilometers, and contains 60 ancient monuments. Located south of Sukhothai on the banks of the Ping river, it was an important military defensive outpost up to the Ayutthaya period. As a result, the site has a combination of Sukhothai and Ayutthaya-era monuments.

The inscription of the three sites into the World Heritage List has had a tremendous impact on spurring tourist arrivals, which has placed a priority on developing the sites to accommodate visitors. The scarcity of site staff and funds has not allowed for the thorough historical research necessary for implementing guidelines which would better serve the long-term preservation of the site. The consolidation of the landscape was identified as one of the priorities at the launch of the International Safeguarding campaign, and will be the focus of this next phase of the campaign.

2) Previous UNESCO assistance to safeguard the site

In 1978, at the request of the Thai government, the UNESCO General Conference adopted a resolution to prepare a plan of action for the preservation and enhancement of Sukhothai. With the cooperation of UNESCO and an interdisciplinary team of experts from government agencies and universities, a Master Plan for the Sukhothai Historical Park Project was prepared in 1978.

In 1979, the Director General of UNESCO launched an appeal for an International Safeguarding Campaign, with the aim of "reviving the historic atmosphere of the ancient city by preserving and restoring ancient monuments and buildings, reviving the landscape, improving communications systems and development tourism and revitalizing local communities." UNESCO provided US $500,000 from the regular budget and US $ 77,000 from the funds-in-trust for the conservation and restoration of monuments.

In 1986, architect/planner Sohiko Yamada and landscape architect Hiroshi Tanaka undertook a mission to evaluate the progress made on the Sukhothai Historical Park Project, update the Master Plan and advise the Government of Thailand and UNESCO on the work of the International Campaign.

The Yamada mission reported that the major challenges for implementing the Master Plan at the level of recommended technical detail and comprehensiveness included:

1. Lack of comprehensive archaeological survey
2. Lack of adequate permanent trained local staff and required foreign technical assistance.

The Tanaka mission reported that landscaping efforts were concentrated in the areas around the historical

monuments, but a holistic plan for landscaping monuments for landscaping monuments for the whole park area in relation to the monument sites still needed to be developed. Furthermore, the technical staff required for planning and designing the park were totally absent at the time. In order to improve and carry out the Master Plan, Tanaka recommended the following steps:

1. Upgrading the landscaping plan
    a. Basic survey should be undertaken in order to upgrade the landscaping plan in concert with updated master plan which would include information for formulating a general landscaping plan, topographic maps for informing the general landscaping plan and planting plan, information for park use, guidelines for the maintenance and design of the landscape facilities.

    b. The landscape development categories should be expanded and re-organized into the following four groups:
        i. Landscape development aimed at preserving the environment (including ancient landscaping based on stone inscriptions and ancient waterscaping based on restoration work);
        ii. Scenic improvements designed to improve park functions (shading, park boundary, etc by various greenery);
        iii. Landscape facilities to aid park activities (roads, outdoor furniture, signage);
        iv. Infrastructure facilities for landscaping (stormwater drainage, irrigation, sanitation, electric installation, etc.)

2. Adopting a zonal approach to park landscaping, to assist in creating a clear hierarchical organization of the site.

3. Establishing technical guidelines for planting, including utilization of exiting trees and new planting, especially the introduction of a greater variety of species

4. Consolidating park landscape management functions
    a. Timely landscape maintenance programme, experienced personnel, and maintenance manual for personnel
    b. Nursery

Owing to funding constraints, the updating of the Master Plan was not complete until the end of 1993, and limited work has been done to implement the landscape recommendations.

Meanwhile, Fine Arts Department site management staff from throughout Thailand, including the Sukhothai site staff, have participated actively in UNESCO training in heritage management. Aspects of the training workshops include the collaboration with local communities in sustainable conservation efforts, the use of ICT such as Geographic Information Systems in heritage management, and the promotion of World Heritage education for youth.

In addition to these on-going activities, more directed and concrete UNESCO input in the form of technical assistance for improving the site conditions of the Sukhothai and its associated towns is required. Also, as Ayutthaya and Ban Chiang sites are currently in the early process of expanding landscaping work, the rigorous historically-informed development of the landscape at Sukhothai and associated towns will prove to be a timely test case and example for future work.

3) Current state of conservation and need for assistance

The approach to the landscape work which has been carried out thus far has emphasized the urgent practical needs of the site, falling into the latter three development categories: scenic improvements designed to improve park functions, landscape facilities to aid park activities, and infrastructure facilities for landscaping. While the work has been carried out with the goal of aesthetic harmony with the site, the

consideration of historical authenticity has not been systematically addressed, beyond using the tree species mentioned in the historic stone inscriptions.

The landscape work undertaken so far has been largely monument-specific, which has not facilitated the understanding of the site as a whole environmental system. For instance, the deterioration and neglect of the historic landscape infrastructure of waterways which were crucial for the functioning of the historic cities has hampered both the functioning of the modern sites as well as the understanding of the historic cities. UNESCO input will be directed at providing the guidelines and infrastructure necessary to support both system-wide landscaping work and projects aimed at improving the interpretation of the landscape as a whole.

The understanding of the site as an "inherited landscape", to use the words of Tanaka, both from a built and natural standpoint, taking into account trees as well as archaeological remains, should be embedded in all four categories, and is most explicitly addressed in the first category of landscape work, ie, landscape development aimed at preserving the environment. As mentioned above, this category includes work involving ancient landscaping based on stone inscriptions and ancient waterscaping based on restoration work.

This proposed project would be carried out within the framework of the operational guidelines on cultural landscapes. The inclusion of cultural landscapes on the World Heritage List and the under the protection of the World Heritage Convention recognizes that cultural landscapes represent the "combined works of nature and of man" designated in Article 1 of the Convention. The World Heritage Center notes that cultural landscapes are "illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal. The term "cultural landscape" embraces a diversity of manifestations of the interaction between humankind and its natural environment." As such, it becomes imperative to treat Sukhothai and its associated towns not as a collection of monuments, but as a historic settlement embedded within the landscape consisting of both natural and human-made features in need of conservation.

This project proposes to assess the current landscape situation, develop guidelines and build internal human resource capacity within the Fine Arts Department for future landscape work within a framework which stresses the authenticity of the sites.

The approach will draw on the pioneering work undertaken at Sigiriya, Sri Lanka, where the concept of authenticity is interpreted through an approach of "environmental archaeology", that is, the study of the material evidence of human interaction with the natural world over time. In commenting on the proposed project for the Sukhothai campaign, Professor Senake Bandaranayake, pointed out the lessons from the multi-faceted Sigiriya Environment Program. The research at Sigiriya is not confined to the monuments, but extends to the "total archaeological landscape" of prehistoric and historic sites, considering the urban complex, the palace and the garden system. By clarifying the relationship of humans and the natural landscape will allow for the interpretation of Sukhothai and its associated towns as an important landscape of cosmological significance, cultural production, and agricultural/industrial function.

The scope of the project will consist of four parts: first, scientific study and consolidation of research into GIS. Second, development of guidelines for landscaping. Third, developing an interpretation plan which emphasizes an understanding of the archaeological sites within their natural and manmade environmental context. Fourth, implementing the landscaping guidelines and interpretation plan at the pilot site.

3) Project Objectives in the Short and Medium Term

The objectives of the project will be to provide technical support to the Government of Thailand's Fine Arts Department in order to carry out the five components of the project herein proposed:

a. **Research:** scientific review, research and consolidation of research into GIS

b. **Planning:** development of guidelines for horticultural planning, physical landscaping and for upgraded site interpretation

c. **Implementation:** implementation of horticultural projects to serve all sites and physical landscaping at a pilot site

d. **Training and education:** training of site managers in appropriate landscaping, training of site staff in proper landscape maintenance, training of guides in upgraded interpretation approach

e. **Documentation:** production of training manuals and summary evaluation report

5) Foreseen project activities

To achieve the above-mentioned objectives, it is foreseen to undertake the following activities within the terms of the project herein proposed:

5.1) Working group will be constituted, which will consist of national experts in horticulture, landscape architecture, hydrology, architecture/urban planning, archaeology and history of Sukhothai, Si Satchanalai and Kamphaeng Phet. Working group members will carry out the research and advisory work listed below, and will meet as necessary to coordinate work.

5.2) Existing research in the above specializations regarding the historic landscape will be reviewed comprehensively, and further research will be conducted as necessary to fill in gaps. The research will be summarized in a form which will be ready for consolidation into a geographic information system (GIS).

5.3) A GIS-based data inventory of the collated research will be set up on-site, and designated site management staff will be trained in its use. The GIS will be important for identifying and recording historical and contemporary information in order to inform site management decisions and allow on-going monitoring.

5.4) National workshop on "Rethinking Approaches to Landscape Management for Thai World Heritage Sites" will be organized, with participation by members of the national working group, Fine Arts Department staff, World Heritage site management staff, and regional experts involved in exemplary World Heritage landscape projects. The workshop will be comprised of best practice presentations and on-site survey with international experts of Sukhothai and associated towns as a case study. The participation of personnel from other Thai World Heritage sites is key, since they face similar challenges in conceptualizing and implementing historically-appropriate landscape plans.

5.5) Workshop will be followed by smaller work session of international experts and national working group to present research and formulate preliminary recommendations.

5.6) Based on the consolidated research using GIS interface and the workshop discussions, the working group will make recommendations for clarifying the structure of the historic landscape will be made. In particular, the feasibility of using historic infrastructure to serve present-day needs (ie, drainage, irrigation), thereby partially restoring the functional meaning of the landscape, will be restored. Priorities for further archaeological excavations and restoration to undertake the recommendations will be set for the future.

Horticultural authenticity

5.7) A horticultural handbook of native species and guidelines for location, planting and maintenance will be prepared for use by site staff, on the basis of comprehensive research carried out to determine which species are suitable for planting. Historic research will draw on epigraphic, ceramic, artistic, and existing paleoecological sources. Contemporary research will consist of a horticultural inventory of native species in the site and surrounding areas.

5.8) Technical training for staff and practical training for site landscaping crew in proper care and maintenance of plants will be organized to introduce proper use of handbook guidelines.

5.9) A botanic garden with historic and native species will be established. Through explanatory placards, visitors will be given a stronger understanding of the landscape system and its relationship to historic ways of life.

5.10) A nursery of commercially-unavailable recommended species will also be established as an adjunct to the botanic garden.

Site interpretation

5.11) Enhanced visitor understanding of the landscape as an overall system, by the development of an interpretation plan of the entire site. This will include the designation of walking trails which indicate systems of agricultural, industrial (ie, ceramics), and cultural production which operate at the level of the entire historic urban settlement, as seen in terms of botanical, hydrological, archaeological significance. Three-dimensional perspectival drawings showing reconstructions of historic sites will be erected at strategic locations. Training for official guides in this interpretive approach will be included.

Pilot implementation

5.12) A pilot site will be selected in order to design and implement the recommended landscaping improvements. The site management agency has identified the peninsular area around the Bayon-style complex of Wat Phra Sri Ratana Mahatad in Si Satchanalai. The landscaping improvements will include:

- Develop a hierarchy between monument sites and nearby areas by incorporating different varieties of native species into existing planting.
- Carry out further archaeological work as necessary to document historic landscape elements, including hydrological structure.
- Use updated archaeological knowledge to carry out needed infrastructure work for irrigation in the dry season and drainage in the rainy season.
- Remove visual obstructions.
- Consolidate the monuments in the context of the site.

Reporting

5.13) Documentation after the research and planning phases will be compiled for national dissemination, and a summary report after the project phase is completed will be produced.

5.14) A final workshop at the end of the project phase will be organized in order to disseminate results and recommendations for other site managers in the country, and if applicable, in the region.

6) National and international contributions

Contributions of the Government of Thailand

6.1) The provision of the services and full participation of national Fine Arts Department personnel in the field work and training activities of the project for the duration of 18 months, including computer specialists, archaeologists, photographers and draftsmen. The number, duration, and specialization of personnel will be decided upon joint agreement of UNESCO and the Fine Arts Department, and is subject to change upon approval of both parties.

6.2) Services of a driver/interpreter to assist the project coordinator and international technical experts.

6.3) Accommodations for national and international experts while in the field, provided by the historic parks.

6.4) Provision of sufficient office space and facilities to enable conduct of field activities.

6.5) Facilitation of access to relevant Department and national archives for national and international project staff as necessary, and possible use of government scientific laboratories and computer facilities.

6.6) Provision of other services and expendables as required and available.

Contributions of UNESCO through the International Safeguarding Campaign

6.7) Provision to the Government of Thailand of the services of the Project Coordinator and local and international experts through contractual arrangements.

6.8) Financial contribution to the upgrading of site equipment, including hardware, software and training needed to run GIS.

6.9) Making contractual arrangements for the national training workshop on "Rethinking Approaches to Landscape Management for Thai World Heritage Sites", training sessions and concluding workshop.

6.10) Provision of technical backstopping, administrative and advisory services through the office of the UNESCO Regional Advisor for Culture in Asia and the Pacific.

6.11) Expert supervision by the UNESCO Regional Advisor for Culture in Asia and the Pacific.

7) Foreseen Outputs

At the end of the present project, it is expected to have the following outputs:

7.1) A GIS-based data inventory of archaeological, horticultural, architectural, hydrological and infrastructural data will be set up on-site, and designated site management staff trained in its use.

7.2) Handbook of recommended plant and tree species, including guidelines for location, planting and maintenance.

7.3) Botanic garden, with attached nursery.

7.4) Interpretation plan of the site, with designated walking trails and en-route information posts with historical introductions and "virtual reconstructions".

7.5) On-site improvements at the complex surrounding Wat Phra Sri Ratana Mahatad, as a pilot example of upgrading the historic atmosphere of the site.

8) Monitoring/evaluation

The technical progress of work and budgetary status will be reviewed every four months by a representative of UNESCO, the Government of Thailand, and the Project Coordinator. Reviews will include on-site inspection of work. Reports of these review sessions, including terminal evaluation report, will be communicated in writing to the Government of Thailand and to UNESCO headquarters.

9) Workplan

Project coordination

Activity	National input	UNESCO input	Output
Form national working group	• Assist in identifying national experts • Identify existing research and scope of new research needed	• Contract national experts • Coordinate meetings	• National experts identified • Research needs identified
Review and collate existing research	• Prepare existing FAD material • Facilitate expert research • Provide assistance for on-site surveys	• Define scope of research	Research collated on: • Horticulture • Historic landscape, including hydrology • Archaeology • Architecture/ planning
Set up on-site GIS	• FAD staff collaboration • Prepare base maps • Collect existing data • Provide assistance for on-site surveys	• Expert advice in GIS design • GIS training for site staff • Additional hardware and software	• Research and baseline data consolidated into GIS • Staff trained
"Rethinking Approaches to Landscape Management for Thai World Heritage Sites"	• FAD staff collaboration • Facilities, accommodations and logistical support as available • Provide assistance for on-site surveys • Internal FAD staff arrangements	• Set workshop programme • Identify and contract international experts	National workshop
Work session to review research and formulate preliminary recommendations	• FAD staff collaboration • Facilities, accommodations and logistical support as available • Provide	• Coordinate work session • International experts	Preliminary recommendations

	assistance for on-site surveys		
Formulate recommendations and identify priorities	• FAD staff collaboration • Facilities and logistical support as available	• Coordinate work session • International experts • RACAP participation	Recommendations
Horticultural handbook	• Facilities, accommodations and logistical support as available • Provide assistance for on-site surveys	• National experts	Horticultural handbook
Train site staff in horticultural maintenance	• Facilities, accommodations and logistical support as available • Provide assistance for on-site work	• National expert • Training materials	Training sessions
Set up botanic garden/nursery	• Site staff labor and supervision • Facilities, accommodations and logistical support as available • Provide assistance for on-site work	• National expert • International expert advice	Botanic garden/nursery
Draft site interpretation plan	• FAD staff collaboration	• National experts • International expert advice • RACAP advice	• Interpretation plan, including thematic trails
Implement site interpretation plan	• Site staff labor and supervision • Facilities, accommodations and logistical support as available • Provide assistance for on-site work	• National experts • Contract production of on-site infrastructure • Contract production of visitor material	• On-site infrastructure for trails • Visitor guide material • Upgraded tourist guides
Implement pilot project in Wat Phra Sri Ratana Mahatad in Si Satchanalai	• Site staff labor and supervision • Facilities, accommodations and logistical	• National experts • International expert advice • RACAP advice	• Archaeological work • Updated landscape plan • Removal of visual obstructions

	support as available • Provide assistance for on-site work		
Concluding national workshop: review of work and future prospects	• FAD staff collaboration • Facilities, accommodations and logistical support as available • Internal FAD staff arrangements	• National experts • Set workshop programme	Concluding workshop
Summary report	• Documentation	• National expert contributions • International expert post op review • Editing • Printing	Summary report

Project timeline

Activity	2002 Q3	2002 Q4	2003 Q1	2003 Q2	2003 Q3	2003 Q4
Form national working group						
Review and collate existing research						
Set up on-site GIS						
"Rethinking Approaches to Landscape Management for Thai World Heritage Sites"						
Work session to review research and formulate preliminary recommendations						
Formulate recommendations and identify priorities						
Horticultural handbook						
Train site staff in horticultural maintenance						
Set up botanic garden/nursery						
Draft site interpretation plan						
Implement site interpretation plan						
Implement pilot project in Wat Phra Sri Ratana Mahatad in Si Satchanalai						
Concluding national workshop: review of work and future prospects						
Summary report						

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IQP/MQP SCANNING PROJECT

APPENDIX D: January 2003, Intermediate Progress Report

International Safeguarding Campaign for Sukthothai

Intermediate progress report
Montira Horayangura
Consultant, UNESCO
25 December 2002

Project summary

The final phase of the International Safeguarding Campaign for Sukthothai is focused on improving the authenticity of the historic cultural landscape at the Sukhothai World Heritage Sites and associated towns of Si Satchanalai and Kampaeng Phet. The project timeframe is mid-2002 to end of2003. The project will be jointly undertaken with the Thai Fine Arts Department under the Ministry of Education, the national agency in charge of historic parks and cultural World Heritage sites. The project will establish guidelines for future landscaping work to be incorporated into the Second Masterplan for Sukhothai, Si Satchanalai and Kampaeng Phet. Nationally and regionally, the project will establish best practice guidelines for managing historic cultural landscapes. These will eventually be included as curricular material for use within the UNESCO Chairs network.

Project objectives and conceptual approach

This phase will assess the current landscape situation, develop guidelines and build internal human resource capacity within the Fine Arts Department for future landscape work within a framework which stresses the authenticity of the sites. UNESCO input will help develop the guidelines and infrastructure necessary to support physical landscaping work and improve the interpretation of the landscape as a whole system. Clarifying the relationship of humans and the natural landscape will allow for the interpretation of Sukhothai and its associated towns as an important landscape of cosmological significance, cultural production, and agricultural/industrial function.

The project starts with the understanding of Sukhothai, Si Satchanalai and Kampaeng Petch as a cultural landscape, which can be defined as "landscape as a human artifact". Using a research-based academic approach, the project seeks to improve the current understanding of the historic cultural landscape of Sukhothai, Si Satchanalai and Kampaeng Petch through integrated research of historic natural ecology, ecological changes over time, and human interaction with the sites. Human interaction includes constructing cities, buildings and gardens, roads, waterworks, etc.

Projected project output

The research will guide pilot projects at sites to be jointly identified. The pilot projects aim to test practical concepts that may be used in:

1. Future physical landscaping guidelines, including landscape design and planting, to clarify historic condition of site
2. Improved interpretation of the sites by visitors as a cultural landscape composed of many natural and man-made systems

The useful output of the project will be:

1. **Integrated historic data** about Sukhothai, Si Satchanalai and Kampaeng Petch, in GIS format

a. **Archaeological mapping of historic cities areas, including monuments, hydrology, fortifications, roads**

b. Paleoecological survey of various sampling points inside/outside historic city areas
c. Horticultural survey of various sampling points inside/outside historic city areas, including natural areas
d. Other geomorphological layers: soil types

2. Pilot project I: **Botanical garden/nursery** at Wat Asokaram, Sukhothai (tentative site, pending research results)

3. Pilot project 2: **Cultural/natural trail** along Phra Ruang Road, Sukhothai (tentative site, pending research results)

4. Pilot project 3: **Environmental transformation study** at Wat Phra Prang, Si Satchanalai (tentative site, pending research results)

5. Guidelines for future historic reconstructions or more historically sensitive landscaping at cultural landscape sites will be formulated based on the pilot projects. These will be applicable at other national and regional sites, including UNESCO World Heritage sites.

Overall project timeline

The research phase was originally projected to occur during the third and fourth quarter of 2002. However, due to delays in field work due to weather conditions and an extended rainy season, the research phase has been extended into the first quarter of2003. The research summary and commencement of the implementation phase is expected to occur in April 2004. The detailed time line is as follows:

June 2002 — Form national working group

July 2002 — First working group meeting/site visit to Sukhothai, Si Satchanalai, Kampaeng Phet
- Presentation of multidisciplinary research methods
- Identification of pilot sites

- Drafting of tentative research phase work plan

Aug 2002 Second working group meeting
- Refinement of research phase work plan
- Establishment of research phase timeline

Sept 2002 Research phase begins

Dec. 2002 Third working group meeting: research progress report

Jan. 2003 Fourth working group meeting: research progress report

March 2003 Final working group meeting: research summary
- Summary of research results
- Identification of implementation sub-projects
- Drafting of implementation phase workplan

Research scope of project

Regional/international precedents for research:

The approach to the project is aligned with the conceptual guidelines that WHC has outlined in defining and managing cultural landscapes. Outstanding regional examples applicable to the project include Sigiriya in the Cultural Triangle in Sri Lanka.

Applications of research for future site management:

The site managers of Sukhothai, Si Satchanalai and Kampaeng Phet have identified the need to clarify and redefine site boundaries for the protected areas, due to new archaeological discoveries, expansion of communities, and ongoing infrastructural construction. This redefinition will be the major thrust of the updated masterplan, scheduled to be revised in 2003. The research, which will be conducted as a part of the UNESCO project, will improve the information database of the sites considerably and will thus contribute significantly to this undertaking.

Research directions for the project

The following techniques have been applied in various contexts in other countries, allowing for the establishment of appropriate scientific methodologies. However, for the purpose of cultural resource management and historic landscape study/reconstruction, the integrated combination of techniques is path breaking not just for Thailand but also for the region.

a. Paleo-ecological research into historic plant species as evidence of natural and human activities on-site.
b. Remote sensing research using satellite imagery and other sources to supplement existing archaeological evidence of historic structures and urban infrastructure.
c. Horticultural research into existing plant species, to compare evidence of historic species with current plants, with a focus on identifying native species.
d. GIS use for managing inventories of site information.
e. Virtual reality 3D reconstructions as a tool for testing historical hypotheses, modeling implementation options and enhancing site interpretation.
f. Identification of pilot sites for research survey and future implementation

On the basis of the research methodologies proposed, on July 28,2002 the working group undertook site surveys to identify pilot sites for research and future project implementation. The sites surveyed included:

a. Wat Phra Sriratanamahatad (Wat Phra Prang), Si Satchanalai
b. Si Satchanalai ancient city
c. Si Satchanalai site museum of ceramic kilns
d. Wat Sri Chum, Sukthothai
e. Wat Asokaram, Sukhothai
f. Phra Ruang Historic Road, Sukhothai
g. Saritpong dam, Sukhothai

After the site visits, the working group reconvened to discuss the work plan for the research phase. Specific areas for collection of research samples were discussed and identified, with a focus on developing an understanding of the evolution of the sites over time as a result of natural changes and human intervention. A comparison of sites within the urbanized area of the historic city, areas under cultivation, and natural areas would provide a comparative historical profile.

The strategic formulation of the research approaches will have a direct practical implementation as the research results will be used to develop landscaping guidelines and interpretation approaches which will be tested at pilot sites. Out of the seven sites, Wat Phra Sriratanamahatad, Wat Asokaram and Phra Ruang were identified as tentative sites for pilot projects, pending research results.

In order of feasibility and importance of output, the tentative pilot projects include:

Pilot project 1: Botanical Garden/nursery at Wat Asokaram, Sukhothai

Location of site:
- Outside of Sukhothai historic city, towards southeast
- Near historic Phra Ruang Road
- Nearby 4 other wats
- Moated site with ruins of temple structure left
- Currently sparsely planted

Interest in site:
- Inscriptions refer in detail to much planting at this wat
- Minimal reconstruction/archaeological work should yield reasonably pure paleoecological samples

Proposed objective for pilot project:
- To undertake a range of research for the site, including paleoecological study, dating, horticultural survey, study of inscriptions and other historical evidence
- To design botanical garden/nursery incorporating species, based on
  - Historical sources
  - Local villagers' use of plants
  - 3D reconstruction of design options
  - Species might come from various locations, not just this site, with explanations of what types of species found where and used for what
  - Interpretation of natural and cultural aspects of landscaping via on-site signs, web display
  - Nursery can be source of plants and planting guidelines for Sukhothai residents and visitors

Further questions:
- Should pilot project focus on historical garden reconstruction or botanical garden of historic/native species?

Maybe virtual 3D reconstruction and physical botanical garden
- Comparative research of planting inside city (in palace, along roads, in barays) vs planting outside city (in fields, in dam, in outside wats)

Useful applications of project at other sites:
a. Multi-disciplinary research methodology
b. Botanic guidelines for planting and maintenance
c. Landscape reconstruction/design methodology (using research and 3D reconstruction)
d. Historic interpretation (3D reconstruction on signs and on web)
e. Botanical interpretation (through signs, tours, nursery)

Pilot project 2: Cultural/natural trail along Phra Ruang Road, Sukhothai

Location of site:
- Historic road running roughly north-south to the east of Sukhothai connecting to Si Satchanalai and Kampaeng Phet

Interest in site:
- Historic structure connected Si Satchanalai, Sukhothai and Kampaeng Phet, with various parts possibly serving as road, embankment, and flood control device
  - Currently is a raised earthen embankment about 4-5 meters, wide current condition is fairly intact, with natural growth of trees and plants, little archaeological research has been done of historic and natural value of the Road and may serve as a physical and conceptual backbone for trails connecting the cities or sites along the Road

Proposed objective for pilot project:
- To undertake range of research along Phra Ruang Road, including:
  - Remote sensing interpretation

- Archaeological research at selected points
- Horticultural survey at selected points

- To create cultural/natural trail for walking/biking along Phra Ruang Road
  - Connect sites along the way
  - Experiment with signs and maps with thematic information about cultural/natural significance
  - Other historic reenactments to create understanding of historic use of the road
    - Carts for hire, etc.

Useful applications of Pilot project 2 at other sites:

a. Application of remote-sensing data in research and in interpreting site for visitors
b. Cultural interpretation of historic road (through signs, trail maps, explaining connection between cities)
c. Botanical interpretation of existing plants (through signs, trial maps)

Pilot project 3: Environmental transformation research study at Wat Phra Prang, Si Satchanalai

Location of site:

- Outside of Si Satchanalai to the south, in historic city of Chalieng
- Site located in peninsula formed by bend of Yom river
- Site contains one ancient vihara, next to a modern temple complex and planted area

Interest in site:

-Historic siltation at site from Yom River resulting in 1.5 m high buildup around temple compound may provide interesting data about ecological changes over several centuries
- Site is hypothesized to have some water control mechanisms, which might be uncovered through excavation and research

Proposed objective for pilot project:

- Coordination between archaeological and paleoecological study
- Research about hydrology of site to inform eventual restoration
- Improvement beautification of landscape
  - Excavate silt build-up to expose wat compound wall
  - Build retaining wall
  - Construct drainage pipe
  - Bury electric cables underground
  - Plant historic plants

Detailed interim progress summaries

A. Paleoecological research

Primary investigator: Professor Manas Watanasak, Mahidol University, Thailand
The strategy for the paleo-ecological research aims to enable a comparison between different environmental conditions in historic Sukhothai. Samples will be collected from the following four types of zones. Tentative sites in each zone have been identified below. The choice of sample sites has been limited by the need for moist or swampy conditions which best preserves organic matter, by excavation for archaeological and general settlement purposes, and by contamination from more modern rain run-off in the 700 years since the peak of Sukhothai.

The zones and sample sites identified initially are as follows:

1. Urban
   - Inside Sukhothai historical city
2. Religious
   - Wat Phrapai Luang
   - Ex-urban area ("aranyik" zone)
   - Wat Asokaram
   - Wat Kungwai
3. Ex-urban agricultural area
4. Natural
   - Saridpong Dam #1

Based on further field investigation, preliminary sample taking and analysis, and interviews with site officials, a number of the initial samples sites identified did not yield feasible data for further analysis. For instance, excavations at some sites have compromised the authenticity through contamination of more recent data traces. As a result, a number of proxy sites have had to be identified. Heavy rains during the fieldwork period starting October 2002 have made it difficult to collect samples, thus delaying the work. As of mid-December, over 500 individual samples from six sites have been collected for palynological analysis and carbon dating. Samples were collected using an open pit method, since preliminary experiments with a
D-section borer were only able to capture samples less than 25 cm in depth. Processing through conventional palynological methods is currently being undertaken, so final results about the paleoeoclogical conditions are not yet available.

The initial survey progress is arranged by zone below.
1. Urban zone

- Wat Takuan

Located inside the boundary of the city wall itself, Wat Takuan is behind the monument to Pokhun Ramkhamhaeng. The northern moat of Wat Takuan is the only site, which remains undredged in the city zone. A total of 33 organic samples were taken at this site, including charcoal and organic matter. Other material found in the excavation includes brick, tile and cement. Laboratory processing of the samples is underway and near completion.

2. Religious zone

- Wat Phrapai Luang -initially identified as the main religious site for further investigation in the ancient Sukhothai area. However, due to extensive dredging in the site, a, nearby alternative temple was selected as a proxy.
- Wat Nern Ron Tong, located to the south of the moat of Wat Phra pai Luang. A total of28 samples were collected, ranging in depth from 20 cm to 67 cm. Laboratory processing of the samples is underway and near completion.

3. Ex-urban zone

- Wat Asokaram

Located to the southeast of the historic city core, has been identified as the site of a possible botanical garden and landscape reconstruction. Due to floodwater inundation in the moat surrounding the site, sample collection at the site was delayed.

Samples were collected at two points in the temple area, to the north and the east. On the north side, 68 organic samples were collected, from a depth of 0 to 187 cm. A total of 73 organic samples, mostly palynological samples, were collected from the east, from a depth of 0 to 100 cm.

- Wat Kung Wai

Wat Kung Wai is one of the few temples where no digging has been recorded. Its ex-urban location makes it a prime candidate for yielding data about rural settlement patterns. The temple site has both an inner and outer moat. A total of 103 soil and charcoal samples were collected from a depth of 40 to 100 cm. Laboratory processing of the samples is underway and near completion.

- Wat Pa Mamuang

Located in the vicinity of Wat Pasak, Wat Pa Mamuang is located further from the old city core than the other sites. A total of 95 samples were taken, from 0 to 173 cm in depth, which should reveal some information about both rural settlement patterns as well as agricultural patterns in historic Sukthothai.

4. Natural zone

- Saritpong Dam #1

The initial interest in the collecting samples at the dam was in order to find data about natural environmental conditions further upstream. However, field survey revealed that the due to lack of swampy deposits in the upper end of the reservoir, and maj or intervention at the dam in 1969 to lift the dam level, organic samples will be either lacking or non-representative of the historic period.

B. Remote sensing research

Primary investigator: Professor Surat Lertlum, Asian Institute of Technology, Thailand

The strategy for the remote sensing research aims to analyze and consolidate existing data for the Sukhothai area in order to identify historic features and landmarks in the greater natural and cultural landscape. This information base will be used to inform the other research at the site and will also serve as the foundation for a comprehensive GIS-based inventory to be used for future site management purposes. The information is being gathered for three areas:

- The entire area comprising of Sukhothai, Si Satchnalai and Kamphaeng Phet
- Sukhothai historic town and its immediate environment
- The historic Pra Ruang road

The following data sources have been identified, obtained, and digitized:

Landsat 7 ETM (entire area covering three sites, geo-referenced to 1 :50,000 maps from Royal Thai Survey Department)

GlobeSAR (entire area covering three sites, geo referenced to 1: 10,000 maps from Royal Thai Survey Department)

Aerial photographs from 1956 and 1993 (Sukhothai historic town, 1:50,000, converted to 1: 10,000 after scanning and geo-referenced to 1: 10,000 maps from Royal Thai Survey Department)

A preliminary GIS inventory has been developed from the digitized remote-sensing data and from maps from the Royal Thai Survey Department (1 :50,000 for the entire area covering three sites and 1: 10,000 for the Sukhothai historic town) and from the Fine Arts Department (1:10,000 of the Sukthothai historic town). The different scales of the base data have resulted in occurrences of features, which do not overlap precisely when viewed at the same time.

The GIS inventory will contain the following layers:

- Archaeological features, including buildings, walls and monuments.
  The Fine Arts Department has recorded the location of over 200 temple sites around the Sukhothai historical city using a GPS survey.
- Hydrological features, including modern and ancient waterways.
- Transportation features, including modern and ancient roads and paths.
- Historical information including locations cited in inscriptions.
- Elevation information (contour lines) that will be used to generate Digital Elevation Model of the city and surrounding areas.

The on-going research in remote-sensing data will expand and consolidate GIS database for the three areas of interest, using additional data sources including RADARSA T data.

Georeferenced and Filtered GLOBE SAR

Georeferenced Aerial Photos (1954, 1996)

Sample GIS Layers over 1996 Aerial Photo

-Remark: the yellow and purple vector lines are from 1:10,000 scale map from RTS

-The black line are from 1 :25,000 scale map from FAD

C. Horticultural research

Primary investigator: Forest Botany Division, Thai Royal Forestry Department

The strategy for the horticultural research also adopts a comparative approach, both terms of area coverage and historical comparison. The identification of existing plant species will aid in understanding and identifying historic species. There are two zones under consideration:

1. Urban zone
   - Inside Sukhothai historical city
2. Ex-urban zone ("aranyik" area)
   - Wat Asokaram
   - Other aranyik site to be determined
   - Phra Ruang road

Detailed survey according to conventional horticultural practice will allow for investigation of sample plots within these four areas. Species will be collected for identification at the Forest Botany Division, and identified by markers in the field.

Originally, a third zone was under consideration: the natural zone ofKhao Luang Mountain, which is near Sukhothai Historic Town. However, the scope of such a large-scale survey was not compatible with the limited time frame of this project. It is expected that some of the data from Phra Ruang Road and the other ex-urban site will be able to proxy in part for natural species.

Due to the extended rainy season in 2002, the horticultural fieldwork has just commenced in early December. Results are expected by the end of March.

D. GIS information management system for the Fine Arts Department

Primary investigator: Professor Danai Thaitakoo, Chulalongkorn University

An associated project, which will lay the groundwork for implementation of GIS technology within the Thai Fine Arts Department, is currently being undertaken by a FAD team in cooperation with UNESCO consultants. The project is focused on building the GIS infrastructure and database structure, which will be compatible and appropriate for FAD management and archival purposes, using pilot data from the Ayutthaya World Heritage site. Current GIS layers, which have been developed, include buildings, water features, topography contour lines, roads, and trees.

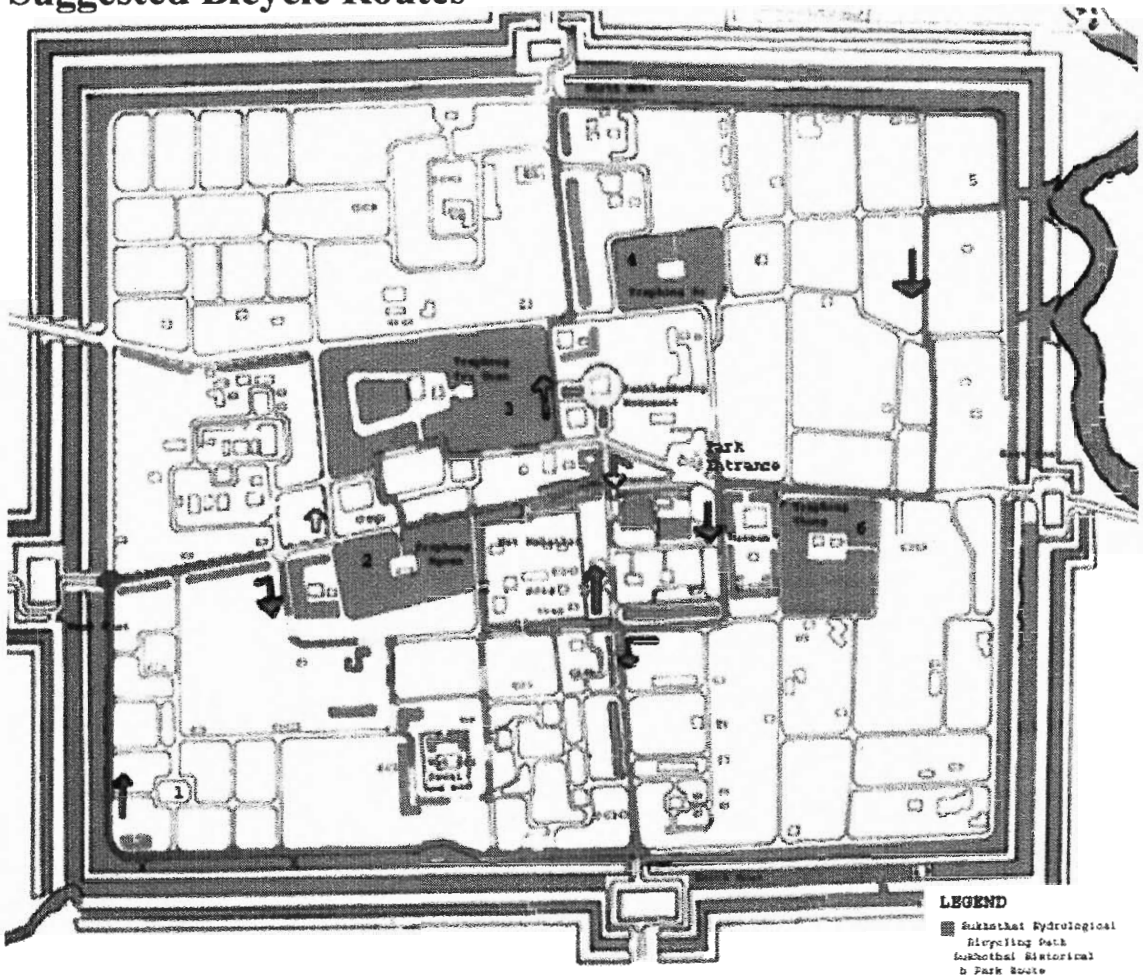
E. Virtual reality reconstruction research

Primary investigator: Professor Panjai Tantatsanawongse, Silpakorn University
The next phase of the project will involve the use of virtual reality simulations in testing alternatives in historical reconstruction using the research findings. A pilot study is currently being conducted, without direct UNESCO funding, by the Computer Center at Silpakorn University. Data is being collected for Wat Si Chum in order to create a 3-D virtual walk-through of the building. Wat Si Chum houses a large Buddha figure inside roofless mandhapa, and is also renown for picturesque carvings of the jataka within the double walled structure of the building itself. Due to conservation considerations, the interior of the building is no longer accessible to visitors. A combination of interior reconstructions and historical information will allow visitors to gain added value and understanding of their trip. The techniques and methods used in structuring, presenting, navigating historical information will be useful in future reconstructions for the landscape project.

Recommendations for remainder of research phase

The working group meeting held on December 11, 2002 concluded with the following recommendations for on-going research. Due to the multidisciplinary nature of the research work, greater coordination must be introduced into the process. For future research and field surveys, the remote-sensing data should be used as a guide for identification of detailed survey sites for paleo-ecological and horticultural sample selection. The analysis of historic waterway and settlement location should be particularly useful in this regard. As data is analyzed to yield conclusions, all research findings should be integrated into a comprehensive GIS, allowing the GIS database to become a tool to help guide on-going research, as well as eventually to assist in the daily management work and future infrastructure projects on-site. The GIS database (particularly monuments and urban infrastructure features) should have a time-based presentation component, so that the historical evolution of the site can be better understood for both academic and research purposes.

Suggested Bicycle Routes



Two paths are provided, the longer of the two is intended to be traveled on a bicycle, and is approximately 7 km.

The other path may be traveled by either bicycle or on foot. The length of this path is approximately 3 km.

Points of Interest

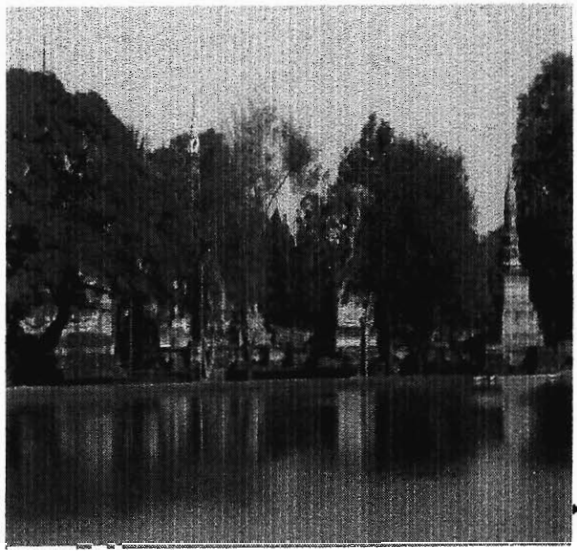
1. Water enters through a three wall/moat system called a "Tribun".
2. Reservoir Traphong Ngoen
3. Reservoir Traphong Tru Guan
   -Largest Reservoir in the historical park
4. Reservoir Traphong Thong
5. Reservoir Traphong So
6. Outlet to the Mae Rumphan Canal

Created by: Jacob Castiglione, Teresa Cheromcha, Codi Dean, Andrew Hickman

The Hydrology of Sukhothai Historical Park

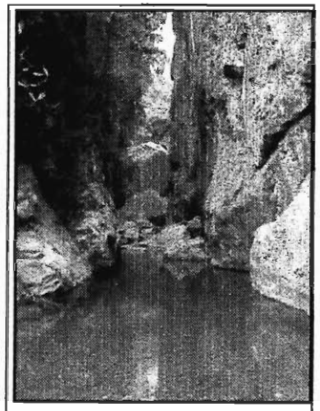
With suggested bicycle/walking routes

APPENDIX E: Informational Pamphlet



This informational pamphlet is a result of collaboration between Worcester Polytechnic Institute (Worcester, MA, U.S.A.); The Department of Fine Arts, Thailand; and the United Nations Educational, Scientific, and Cultural Organization, Bangkok.

The story of Sukhothai's water system begins 3 km west of the city in the Phra Bat Yai and Kiew Ay Ma hills. Every year seasonal rains fill seventeen mountain streams that combine inside a horseshoe shaped valley to flood the lowland countryside.



Over thousands of years, streams carved deep gorges into the rock. Legend has it that King Phra Ruang carved the gorge when he tested the strength of his sword.

Seven hundred years ago the first urban planners of Sukhothai recognized the region's hydrological potential and built a dam to retain seasonal floodwaters for use during the dry season. Construction of the dam prevented seasonal flooding and created Sukhothai's primary source of water, the Saritphong reservoir.

Spillways and floodgates are used to regulate the amount of water entering the tributary canals that feed the city.

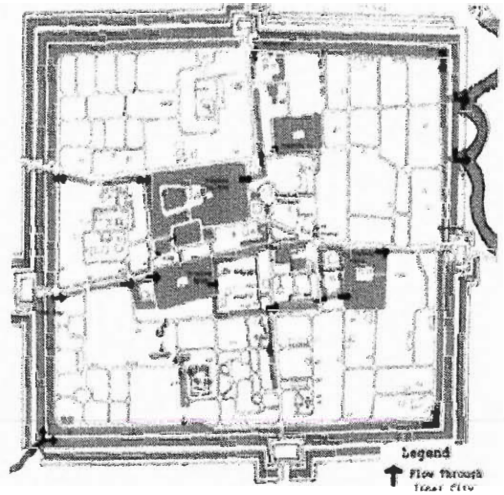
The Saritphong Dam

The Sukhothai Hydrology Story

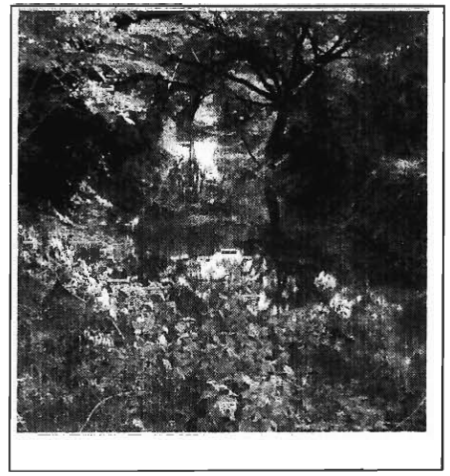
The city of Sukhothai was modeled after the ancient Khmer capital, Angkor. Surrounding the city is a triple wall/ moat configuration call a "tribun". Water enters the city's moats system from the Saritphong Dam via the Sao Ho Canal in the southwest corner of the city.

Like Angkor, the city of Old Sukhothai possesses a high degree of organization. All of the significant ancient structures, including the city walls, major roads and temples are aligned with the magnetic cardinal directions; with few exceptions, roads and canals intersect at right angles

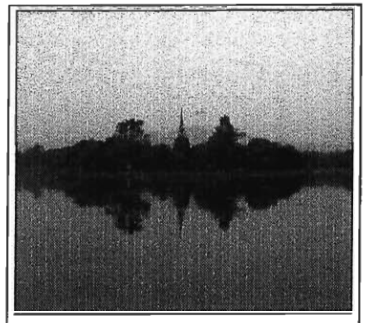
The western moat is responsible for replenishing the city's numerous internal waterways. Canals connect the western moat to Sukhothai's two major reservoirs, Traphang Tru Guan and Traphang Ngoen.



Modern pattern of water flow



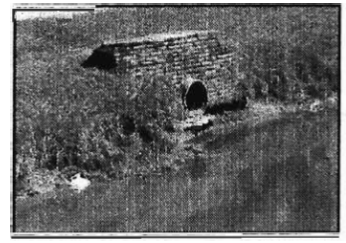
During ancient times the two outer city walls were constructed during the excavation of the outer moats.



Traphang Tru Guan, the reservoir surrounding Wat Sra Sri

Water stored in these reservoirs branch out into the surrounding communities through minor canals, pipes and retaining ponds. After water is channeled back into the moat system, it flows into the northeast corner of the city. Water then enters the Mae Rumphan canal and continues to flow into the Yom River.

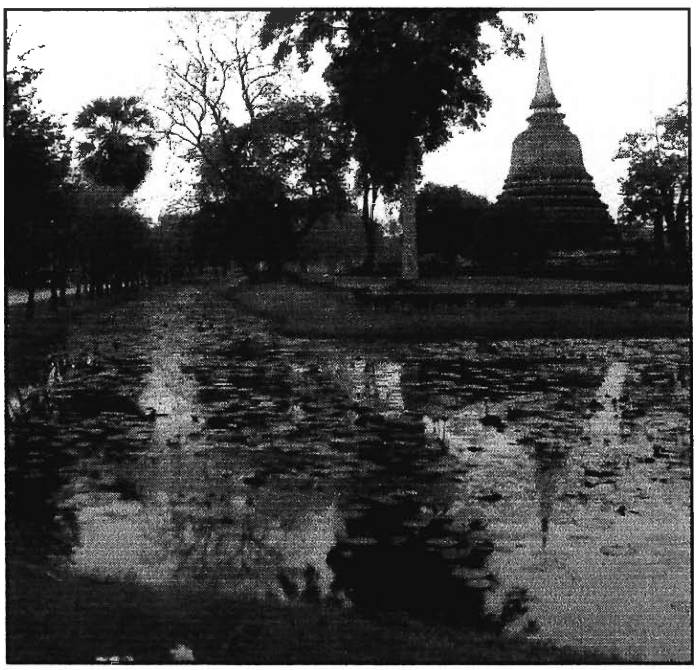
In the ancient times, terracotta pipes were used to provide a path of flow form the Sao Ho Canal into the city Moats Terracotta is a form of hard-packed pottery made within the region.



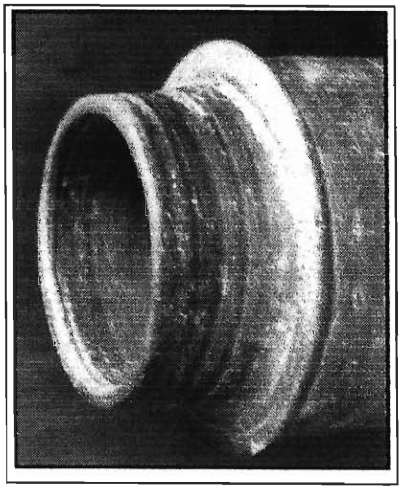
APPENDIX F: Visual display board text boxes with associated pictures

The outer two city walls were constructed of earth from the excavation of the outer moats. The third and largest wall was constructed of laterite brick covered with soil. A final moat is located within the third wall. Clay brick was used to improve wall strength, particularly around gates and road entrances to the city.

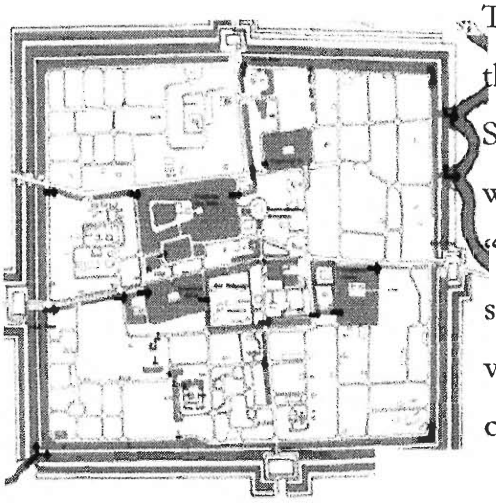
A number of water bodies serve dual purposes in the city and a carry religious significance in addition to their physical function. Religious bodies of water are identified by their proximity to temples. Religious bodies of water represent the Hindu belief of a "cosmic ocean". According to Hinduism, practiced by the Khmer people, the gods reside in the five sacred mountains which are surrounded by a body of water or the cosmic ocean.



The design of the Khmer temples symbolizes the heavenly residence of the gods with five towers, called *prasats*. The central dominant tower or *prasat* represents Mount Meru, the central mountain, and the four smaller towers, one at each corner, represent the other four sacred mountains of the Hindu heaven. The moat surrounding the temples symbolizes the cosmic ocean. After the rise of the Thai people in Sukhothai, many of the carvings on the temples were related to Buddhism and the Buddha. However, the Khmer renditions of the cosmic oceans remain.

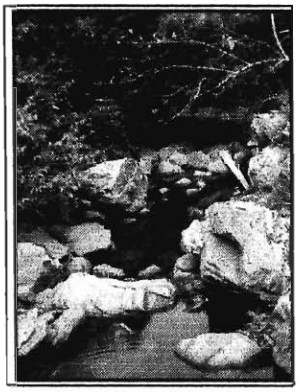


The manmade structures used to control water flow are another important component of the hydrology at Sukhothai. In the ancient times, terracotta pipes were used to provide a path for the flow from the Sao Ho Canal into the city moats. Terracotta is a form of hard-packed pottery and was widely produced in the region. In addition, remains of underground ceramic piping can be found in the Ramkhamhaeng National Museum.

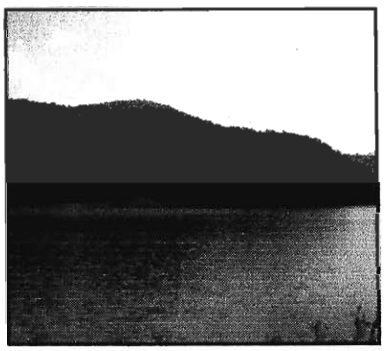


The city of Sukhothai was modeled after the ancient Khmer capital, Angkor. Surrounding the city is a defensive triple wall/moat configuration called a "tribun." Water enters the city's moat system from the Saritphong I reservoir via the Sao Ho Canal in the south west corner of the city.

The outlet of the city in the east moat is the end of the city's drainage system. All of the refuse was easily and efficiently removed. The water exited into the Mae Rumphan Canal, following on into the Yom River.



The story of the Sukhothai water system begins three kilometers west of the city in the Phra Bat Yai and Kiew Ay Ma hills. Every year, seasonal rains filled seventeen mountain streams which combined inside a horseshoe shaped valley to flood the lowland countryside.



Seven hundred years ago, the first urban planners of ancient Sukhothai recognized the region's hydrological potential and built a dam to retain seasonal floodwaters for use during the dry season. Construction of a dam prevented seasonal flooding and created Sukhothai's primary source of water, Saritphong I, a reservoir. A series of spillways and flood gates is used to regulate the amount of water entering the tributary canals which lead directly to the city.

Reservoirs throughout the city hold water throughout the dry season. Because they have the largest amount of water these bodies of water will be the last to dry up. Reservoirs served as water sources for everyday needs; drinking, cooking, washing, etc.

Fresh water from the reservoir entered through the inlet in the southwest corner of the city. Water traveled under the walls and into the moats through clay pipes. During the wet season, if too much water entered parts of the city would flood. To prevent flooding the ancient people may have built dirt walls to divert water away from the city.