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Designing with water for climate change adaptation and cultural heritage preservation

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Abstract
Climate change is a global challenge and one of its major impacts is on flooding, which has become more unpredictable and destructive in both the UK and Thailand since the beginning of the 21st century. Designing with water (DWW) and natural-based solutions are emerging as some of the most important approaches for dealing with climate change and adaptation for a resilient future. Flooding is a natural phenomenon and in the UK, and Thailand, as in many other parts of the world, local communities over millennia have learnt to live and co-exist with seasonal inundation, and their tangible and intangible heritage and lifeways celebrate their relationship with water. However, in part to the increase in the frequency and severity of floods but also exacerbated by rapid urbanization and floodplain encroachment, has resulted in many nationally and internationally important heritage sites in Thailand being at increasing risk because of longer inundation periods during the rainy season. In addition, climate change has made flooding in Thailand more unpredictable and widespread. Fragmented planning and management in the cultural sector, particularly the lack of integration between regulatory organisations responsible for flood protection, is also a major problem. The study investigates several successful DWW case studies from the built environment that highlights good practice and international expertise that will help scholars and practitioners designing in flood pone regions to develop their knowledge and strategies. These cases present integrative whole system approaches, which put DWW and more natural-based solutions at the heart of their design strategies for climate adaptation front and centre of cultural heritage management and preservation. The paper presents a series of recommendations to turn flood threat into an opportunity to improve water resources and community resilience at regional and community.

Keywords: *Designing with Water; Climate Change Adaptation; Sukhothai; Cultural Heritage*

1. Introduction

This study argues that designing with water (DWW) has created a resilient approach to living with water for a more sustainable future. Serious flooding impacts on cultural heritage assets have increased public awareness of Thais and relevant organisations to work more on flood resilient design; especially in heritage contexts which has insufficient information in Thailand. Previous studies suggest that urban conservation of heritage projects is a multi-faceted process of change and development rather than romanticism or drastic redevelopment (Elnokaly, and Elseragy, 2012; Elnokaly and Elseragy, 2013).

Sukhothai which is the first kingdom and capital city of Siam experienced both flooding and drought. Even if Sukhothai ancient town was planned and designed with an effective irrigation system. The heritage buildings/sites were surrounded by a waterscape making the site become unique and outstanding, however, more prone to

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flooding. The city's economy has been influenced by the highest level of tourism since Sukhothai historic town and associated historic towns (Sukhothai, Si Satchanalai, and Kamphaeng Petch) have been registered as UNESCO World Heritage Sites since 1991 (UNESCO, 2021). Similar to other heritage cities around the world, these mixed interweaved heritage forms part of the city's eminent significance of its historic value, which tend to represent and symbolise a diverse set of ideals of the city's identity, including its history, culture and mixed ideologies on one hand, and its local economic viability on the other (Elnokaly & Elseragy, 2007; Elseragy et al, 2007). Resource value and responsibility towards the others have been identified as key parameters for revitalization and conservation of heritage sites (Lichfield, 1988) as it saves more resources than demolishing and constructing new sustainable buildings (Elnokaly & Elseragy, 2013; Elnokaly & Wong, 2015).

For nearly a half-century the land use of Sukhothai has been replaced by corridors of roads and a great number of tourism-based services. The ancient city plan has been encroached by networks of roads and lost its traditional wisdom of hydro-scape design (UNESCO, 2021). Impacts from rampant urbanisation together with climate change are major driving factors resulting in unpleasant flooding in the city of Sukhothai. Therefore, this study aims to explore how to apply design with water in Sukhothai heritage sites to cope with climate change for a more sustainable future.

The paper is structured into five main parts. In the first part, the historical overview of the site of Sukhothai is provided, starting with its importance as a nation and world heritages followed by its unique hydro-scape design. The second part is the research methodology followed by observations from fieldwork in the third part. The fourth is good practice in designing with water which is discussed for further applications. A conclusion and recommendations are presented in the last part.

2. Sukhothai Heritage Sites

Sukhothai is located in the Lower Northern Region of Thailand which is about 427 km (Britannica, 2009). from Bangkok. The name of the city refers to the dawn of happiness. Sukhothai was the first capital of the Thai Empire (found by King Ramkhamaeng) for 140 years (1238-1438) (Britannica, 2009) and it is rich in both tangible and intangible cultural heritage; as Sukhothai has been the UNESCO World Heritage in 1991 and the UNESCO Creative Cities Network for Crafts and Folk Art since 2019 (UNESCO Creative Cities Network, 2019). The geography of Sukhothai can be divided into two parts; the centre of the city is mainly laid by the Yom River basin while the north and the south are shaped by mountainous and plateau areas. The city reflects the glory throughout its almost 1000 years of existence (UNESCO, 2021). The current city was located by the Yom River which is about 12 km far from the historic town (Wiener, 2018).

Fig. 1.Sukhothai Historic Town and its water reservoirs (Illustrated by Witiya Pittungnapoo, 2021).

The ancient Sukhothai was well planned with water management and the heritage monuments were designed with hydroscape making Sukhothai an outstanding value historic city. In 1991, Sukhothai and Associated Historic Towns were designated as the UNESCO World Heritage Historical Park, resulting in a great many visitors coming from around the world each year. Sukhothai has earned global attention from cultural heritage tourism, which had an enormous economic benefit on the city, the country and its local people.

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3. Research Methodology

This part of the study presents the preliminary investigations and hence, the methodology was based on both secondary data collection and observations from fieldwork in Sukhothai heritage sites. Designing with water approaches was reviewed with a preliminary observation made in both dry and rainy seasons in 2021 and 2022. Documentary analysis was made to investigate how Sukhothai's ancient town planning and interventions were designed to manage flood risk. The second part is fieldwork to explore how heritage sites are affected by flooding along with locals' wisdom in designing with water which can be seen in vernacular houses. A qualitative discussion with semi-structured interviews was employed to explore how relevant organisations and key stakeholders can respond to the impact of flooding and climate change on the Sukhothai heritage site. However, these remain to be the initial explorations for this research work and further investigations remain to be undertaken including cross-case investigations with successful global examples from the built environment.

4. Observations from Fieldworks

The observations were conducted on two aspects of designing with water (DWW). The former is in heritage sites and the latter is in vernacular houses to explore how existing approaches do respond to climate change.

4.1. DWW in Sukhothai Heritage Sites

The Sukhothai historic town has a distinctive hydraulic and irrigation system which consists of extensive water reservoirs, networks of canals and roads which were considered an advanced-technology in the last 700 years ago. The ancient lands were occupied by paddy fields, betel nut trees, coconut, and various fruit orchards. Importantly, a large reservoir named *Sareed Phong* was built on the western mountain outside of the ancient town to maintain the flow of water throughout the canal networks connected by public ceramic pipes to the ancient city for year-round consumption (Fig 2 & 3).

Fig. 2. *Sareed Phong Earth Dam* (Source: Pittungna-poo, 2020).

Fig. 3. Water Pipes displayed in Ramkhamhaeng National Museum (Source: Pittungnapoo, 2022).

4.1.1 Sukhothai's DWW Wisdom

Sukhothai heritage park and its associated towns have reflected how ancient cities were designed with water management by gravitational canals and reservoirs connected among the three associated towns (Sukhothai-Srisatchanalai-Kamphengphet) as revealed by the remote sensing system technique (Tiva Suppajanya, 2004). Sukhothai heritage park was planned with a hydroscape design which can be seen in and around the heritage buildings in the ancient city walls. These waterscapes made Sukhothai an outstanding cultural landscape. The ancient temples, pagodas and monuments were built based on Khemer's influence (Shinawatra, 2021) along with waterscape and ponds (Baray/ *Traphang* called in Sukhothai Heritage Park) functioned as water reservoirs to manage water for living during the rainy and dry seasons. There are a great number of *Traphang* surrounding the heritage buildings in and around Sukhothai ancient town. More specially, *Traphangs* (Fig. 4) are also used for carrying *Loi Krathong Festival* – held annually in

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November during the rainy season – in which Thais pay respect to the Goddess of Water. However, with severe drought due to increasing climate change, a shortage of water in these reservoirs has become more obvious which can be seen during *Loi Krathong* Festival. Therefore, extra water supply has to be filled into *Traphangs* during this traditional festival over the last few years (Sukhothai City Planning Department, 2021).

Fig. 4. Wat Traphang Thong was designed as a water reservoir (Source: Pittungnapoo, 2020)

Fig. 5. Chedi Yod Hak (Source: Pittungnapoo, 2021)

4.1.2 Innundated Heritage Sites

Increasing impacts from rampant urbanisation together with climate change not only have made Sukhothai an ancient town faced with flooding but also resulted in severe flooding in a new city (which is located in a lower area of the historic city). From observations made by Pittungnapoo in September 2021 (during flooding), there are certain heritage monuments located by roads that are inundated after rain due to a lack of a proper drainage system. Chedi Yod Hak was selected for observation. It is a derelict temple located outside Sukhothai Historic Town. The Chedi Yod Hak was built outside the ancient city wall in the East (about 1.5 km from the broken wall gate) which is a reason why there are limited sources of reference and documentation about this temple. This small temple plan was arranged on the East-West sides along Jarodwitee road. The chamber was built on a rectangular foundation (about 6 m. x 12 m.) with a base of a Buddha Image on the earthen ground. It was composed of six-room spans of laterite columns to support the wooden structure of the tiled roof. The main Chedi was built from bricks in cubic forms (about 5 m. x 5 m.) in the West of the chamber (Fig. 5). Additionally, there is a tiny chedi beside the North of the main chedi. Even if the temple was built in connection with hydroscope design; however, due to unfriendly urbanization, road encroachment, an increase in built-up areas together with climate change have made these heritage buildings affected by waterflood. The loss of a proper drainage system has made this heritage monument is in high risk of long-stay inundation during the rainy season. Therefore, it is timely for this project to investigate climate vulnerability; particularly in terms of impact from flooding (building structure, materials, foundation, and surrounding landscape) in order to develop a conservation plan for achieving a resilient future.

4.1.3 Locals' Wisdom of Living with Water

Learning how to live with water is a unique way of living which can be seen in many water-based settlements in Thailand. DWW is not a new idea for Thais who have learned to live with flooding and climate change for ages (Pittungnapoo, 2016; Tajai, S. and Pittungnapoo. W (2021). One evident adaptation can be seen in vernacular houses built on stilts to allow flood water flow during the rainy season (Fig. 6a). Traditionally, stilt houses are commonly seen by the river, canal and near other water-courses. Interestingly, many stilt houses were also built by the corridor of roads (Fig. 6b); as this area has become intruded by urban flooding due to a lack of a proper drainage system. Data from observation affirms that DWW has already existed in Sukhothai's wisdom since its ancient history which can be seen in its heritage sites.

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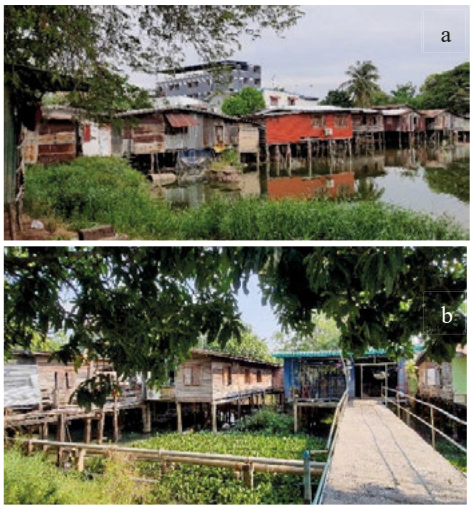

Fig. 6 (a). Stilt houses by the canal (*Klong Pho)* in the city of Sukhothai (Source: Pittungnapoo, 2022) (b) Stilt houses by the city road of Sukhothai (Route No.12) (Source: Pittungnapoo, 2022)

Moreover, vernacular houses have reflected how DWW was applied to Thais' ways of living. Stilt houses (Fig. 6 (a&b) are good practices in climate adaptation which can be commonly seen in either traditional settlements or urban areas.

5. Designing with Water and its Concern

Design with Water has become a global concern as experienced by many countries in order to cope with flood risk, water supply, and water cycle and its system for achieving a sustainable future. There are various aspects which should be taken into account for DWW beginning with the upstream and downstream areas: water resources, catchment management, rivers and waterways, coasts including ecosystem services; and built-up areas: demand management, green infrastructure, buildings and public realm, urban retrofit, asset management, and smart infrastructure (ARUP, 2022). Undoubtedly, integrated collaboration across organisations is imperative for DWW to manage the above areas in cohesive approaches. Unfortunately, there has not been enough attention paid to cultural heritage buildings. Recently, the literature study of Allan, Richards, and Fatoric (2021) pointed out four aspects of barriers and challenges to research on cultural heritage and climate change which are; 1) Technical issues in terms of methodological barriers, lack of understanding of climate impacts and its complication, and conservation challenges; 2) Knowledge and practice issue: lack of collaboration and loss of traditional practice; 3) Institutional issues: regulatory and policy challenges, and academic credibility of disciplines; and 4) Economic and financial constraints. They reviewed that even the study combined cultural heritage with climate change: however, this collaboration was limited within the same geopolitical region. Therefore, global knowledge exchange should be transferred across different regions for achieving interdisciplinary approaches (Allan, Richards. and Fatoric. 2021).

Therefore, it is timely for this project to work closer by integrating DWW for climate change adaptation into the heritage sector transferring knowledge across Thailand and the UK.

6. Conclusions

This paper argues that designing with water is the future for adaptive design in flood-prone regions. The case study analysis presented in this study argues that Thais have learned to live with flooding from generation to generation through imperative wisdom and resilient approaches. However, increasing impacts from climate change have made indigenous knowledge no longer able to cope with flooding; therefore, a combination between local wisdom and affordable technology should be developed to preserve Sukhothai heritage sites and to deal with flooding and climate change adaptation in a more resilient way. Learning from Sukhothai's historic town reminds Thai people to concern more about their own design with water approaches. It maintains that a comprehensive understanding between heritage, climate change, and scientific development is crucial for reaching resilience and sustainability as agreed by Allan, Richards and Fatoric, 2021). More specifically, DWW and its further applications should be implemented by a collaboration between public, private and community sectors.

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Therefore, it is important to encourage all to be engaged from the initial stages of the research. The paper highlights the importance of DWW not only in heritage sites; but also in local implementations which should be widely promoted at the policy level. Importantly, DWW is a resilient approach for climate adaptation which should be simultaneously integrated into professional practise in related fields across design and planning disciplines (e.g. architecture, town planning, landscape and urban design) and cultural heritage management to preserve cultural heritage in broader perspectives. The findings and recommendations that emerged from this study are useful to introduce designing with water and climate change adaptation into design disciplines and cultural heritage management.

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References

Allan, S. O., Richards. J. and Fatoric, S. (2021). Climate Change and Cultural Heritage: A Systematic Literature Review (2016–2020), *The Historic Environment: Policy & Practice*, 12:3-4, 434-477.

Ancient World Heritage (2011). *Urban Planning: Ancient Sukhothai.* Retreived from http://www.aseanworldheritage.com/2011/09/urban-planning-sukhothai.html. (11 April 2022).

ARUP (2022). *Design with Water.* Retrieved from www.arup.com/perspectives/publications/promotional-materials/section/design-with-water.

Britannica (2009). The Editors of Encyclopaedia. "Sukhothai kingdom". Encyclopedia Britannica, 10 Apr. 2009, https://www.britannica.com/place/Sukhothai-kingdom. (25 April 2022).

Elnokaly, A. and Elseragy, A. (2007). Environmental scrutiny of traditional Mediterranean forms for contemporary application (an empirical study). In: Euro-Mediterranean Regional Conference Traditional Mediterranean Architecture. Present and Future", July 12-15, 2007, Barcelona, Spain.

Elseragy, A. and Elnokaly, A. and Alsaadani, S. (2007). The reflection of Euro- Mediterranean historical culture on contemporary architecture in Alexandria. In: Euro- Mediterranean Regional Conference Traditional Mediterranean Architecture. Present and Future", July 12-15, 2007, Barcelona, Spain

Elnokaly, A. and Elseragy, A. (2012). Historic city centres as catalysts for wider sustainable urban regeneration. In: Requalifying the Built Environment: Challenges and Responses. Advances in People-Environment Studies . Hogrefe Publishing GmbH Merkelstr. 3, 37085, Göttingen, Germany, pp. 30-49.

Elnokaly, A. and Elseragy, A. (2013). *Sustainable heritage development: learning from urban conservation of heritage projects in non western contexts.* European Journal of Sustainable Development, 2 (1). pp. 31-56.

Elnokaly, A. and Wong, J. F. (2015). Demystifying vernacular shop houses and contemporary shop houses in Malaysia; a green-shop framework. Proceedings of the 30th International PLEA conference 2014. pp. 295-303.

Alseragy, A., Elnokaly, Amira and Abul-Ela, M (2018). Heritage-led Urban Regeneration as a catalyst for Sustainable Urban Development. In: 6th International Conference on Heritage and Sustainable Development, 12th - 15th June 2018, Granada, Spain.

Lichfield, N. (1988). Economics in Urban Conservation (Cambridge University Press, Cambridge.

Pittungnapoo W. (2016). ‘’Water based cultural landscapes traditional settlements of Ban Kong and Ban Pakklong, Thailand’’. Context: Built, Living, and Natural. Special Issue on Asia and Urban Heritage Vol XII, 2016. *Journal of the Development and Research Organisation for Nature, Arts, and Heritage* (DRONAH). pp. 43-50.

Shinawatra. W. (2021). Flood and wáter management: Case Studies in Thai History: What Lesson that we should learn? *Social Science Asia*, Volume 7 Number 4, 2021, pp. 1-8.

Tajai, S. and Pittungnapoo W. (2021). “Prehistoric Settlement: Lampang Mounds in Connection with Water, Thailand’’. *Social Science Asia,* Vol. 7 No.4. October 2021. pp.17-25.

Tiva, S. (2004). Remote sensing data using guideline in the conservation of the first World Heritage of Thailand: Sukhothai-Srisatchanalai-Kamphengphet. In Scientific Seminar on ICOMOS and Cultural Heritage Conservation Network in Thailand Proceeding by ICOMOS Thailand: pp. 224-227.

UNESCO Creative Cities Network (2019). Sukhothai Crafts and Folk Art. Retrieved from https://en.unesco.org/creative-cities/sukhothai. Accessed 25 April 2022.

UNESCO World Heritage Convention (2021). *Historic Town of Sukhothai and Associated Historic Towns*.https://whc.unesco.org/en/list/574/?fbclid=IwAR2bQ9U0XN_-WGYwtby3Vhd0mgZL7kex-StmHI-gQAj_zAQJfHDw_mlX92aA.

Wiener. J. B. (2018). Sukhothai in *World History Encycopedia.* https://www.worldhistory.org/Sukhothai/

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