

Applications of Scientific Data to the Studies of Ancient Tambralinga's Agriculture and Brick Monuments in Sichon

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Abstract

This article goes beyond the historical narratives to apply scientific methods to the archaeological studies of the ancient kingdom of Tambralinga in Southern Thailand. Its objectives are (1) to examine the geography related to agriculture and settlement pattern using data from ground surveys, aerial photographs, and Geographical Information System, (2) to determine the dates of some important brick shrines using data from the thermoluminescence dating technique, and (3) to reveal the layout of the ancient Khao Kha religious complex using the data from the Structure-from-Motion technology in the area of Sichon District, Nakhon Si Thammarat Province. It proposes that the ancient communities of approximately the 6th to 11th centuries CE lived in the areas suitable for wet-rice cultivation, with sufficient supply of water and alluvial soils. It may also be hypothesized, based on the calculation of the amount of rice produced in the floodplain, the density and dates of brick shrines, and the complicated layout and massiveness of the Khao Kha religious complex, that this area between the Tha Khwai, Tha Chieo, and Tha Thon rivers in Sichon District was one of the most significant centers in the Tambralinga Kingdom.

Keywords: Tambralinga, Sichon, archaeological science, wet-rice cultivation, thermoluminescence dating

Introduction

Thriving in the maritime intraregional exchange network in Southeast Asia since the late centuries BCE, coastal communities in Nakhon Si Thammarat, on the western edge of the Gulf of Siam, were probably later regarded collectively under the name "Tamali" in Mahanidesa, an Indian Pali text dated to around the 2nd or 3rd century CE as a destination of Indian merchants. Historians tend to agree that Tamali was Tambralinga, the name of a kingdom that appears in local inscriptions, and Tan-ma-ling, the name used in the Chinese accounts, among other names [1]. Historical evidence has suggested that the coastal land of Nakhon Si Thammarat was the heartland of Tambralinga; however, only a few archaeological investigations have been conducted in its heartland. Thus, this research explores the physical and cultural landscape of the area in Sichon District, in which there was the highest density of archaeological sites dated to the 6th to 11th centuries CE, using scientific methods. GIS data of the area and thermoluminescence dating of some important sites are discussed. This project has been the first to use thermoluminescence dating and state of the art geographical technologies in collecting data in this important area of one of the most significant early states in Southeast Asia. The applications of these scientific data help enhance the understanding of the agriculture, settlement pattern, and dates of brick shrines in the Tambralinga kingdom. It is also expected that this pilot project will inspire the application of scientific methods and modern technologies to archaeological explorations in the area in the future.

The coastal lands of Nakhon Si Thammarat

The coastal lands of Nakhon Si Thammarat province were the heartland of the Tambralinga kingdom. It is an almost rectangular area covering 1,275 km² (127,500 hectares), 85 km long in the north-south direction and 15 km in the east-west direction. It is flanked by a mountain range in the west and the sea of the Gulf of Siam in the east. Its northern reach is at Phlai Dam Mountain, between Khanom and Sichon districts, where the smooth coastal plain is interrupted by a group of mountains and hills before reaching the Bay of Bandon; its southern limit would seem to be at Sao Thong River, beyond which the archaeological record thins out (**Figure 1**) [2].

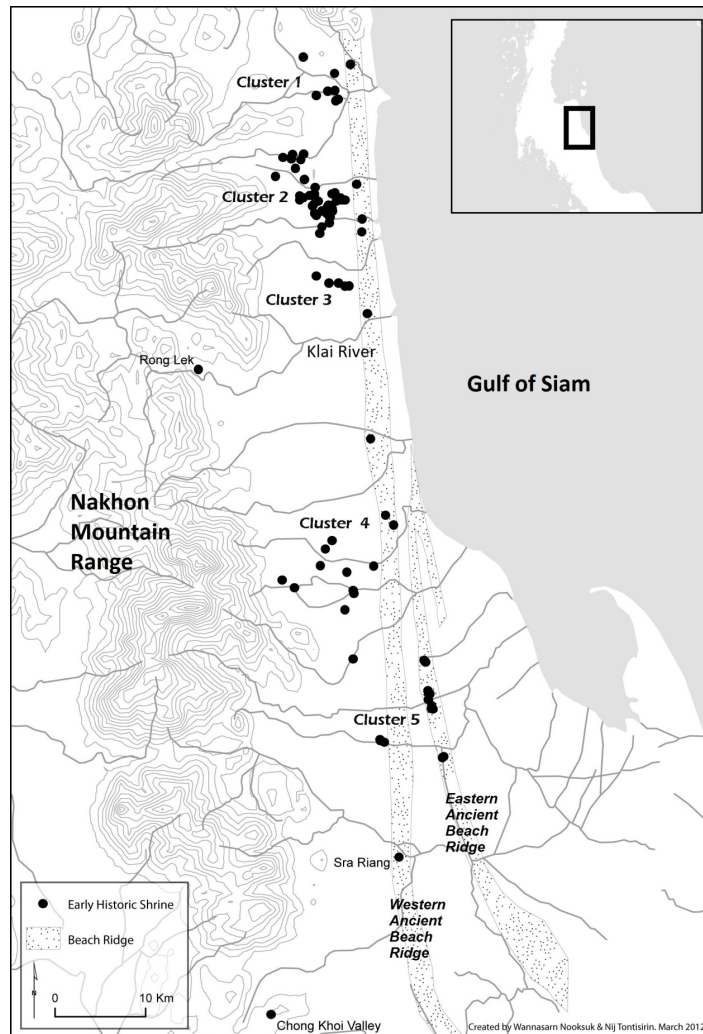


Figure 1 The geography of Tambralinga's heartland and the distribution of archaeological sites (c. 6th - 11th centuries).

The coastal lands of Nakhon Si Thammarat province were mostly formed by the accumulation of erosions from the Nakhon Si Thammarat mountain range (colluvial and alluvial deposits) and by the movement of waves in the Gulf of Siam (coastal wave-dominated deposits). The colluvial and alluvial deposits closest to the Nakhon Si Thammarat range were formed in the Pleistocene epoch (2,588,000 - 11,700 years BP). This area was fertile and suitable for rice cultivation and orchards. The coastal wave-dominated deposits were marked by the formation of beach ridges during the maximum transgression of sea water in the years 6,000 - 8,000 BP. After that, the sea started to regress and formed new sandy beach ridges running parallel to the older one in the north-south direction [3]. These ancient beach ridges are a very important geographical feature in the settlement pattern in this area. They provided coastal high ground that would not normally be flooded in the rainy season and also served as highways for communication along the coast.

A number of short rivers flow from the Nakhon Si Thammarat Mountain range to the coastal plains and the Gulf of Siam, leaving fertile alluvial deposits on the flat plain before cutting across the beach ridge to the sea. During the rainy season, the area behind the beach ridge floods, as it acts as a natural dam containing water inside before letting it go to the sea. Although seasonal flooding is usually short-lived because of the many rivers channeling water to the sea, it leaves sufficient alluvial deposits on the coastal plains to provide suitable support for wet rice agriculture. The human occupation on this coastal land most clearly starts with the Neolithic Period (3000 - 700 BCE).

The focus of this article is on the area between the Tha Khwai, Tha Chieo, and Tha Thon rivers in Sichon district, Nakhon Si Thammarat province, since this area has the highest density of ancient brick shrines dated to the Tambralinga period (c. the 6th to 11th centuries CE) in the coastal lands of Nakhon Si Thammarat. This fact suggests that this area was a significant center of Tambralinga Kingdom, which deserves more archaeological investigation.

The archaeological geography of Sichon

The area between the Tha Khwai, Tha Chieo, and Tha Thon rivers in Sichon district is situated between the Nakhon Si Thammarat mountain range in the west and the Gulf of Siam in the east. Around 50 years ago, people in this area used walking trails and rivers to commute with communities in both the mountain and seashore areas. Although the people in the mountain areas sometimes take a journey to the communities on the seashores and vice versa, the communities in Sichon area also served as an important link between communities in those 2 different ecozones to facilitate the flow of goods and social interaction. This area was also a significant area for wet rice cultivation and cattle production. It has been said until now by people in Nakhon Si Thammarat that the best cattle come from Sichon.

To study the landscape in the past, information layers of aerial photographs, satellite images, and GIS data were created and overlaid on top of one another using a GIS software (ArcGIS 9.3) to analyze the distribution of sites (all of them have brick shrines, most likely of Hinduism) and suitable areas for agriculture between the Tha Khwai, Tha Chieo, and Tha Thon rivers in Sichon district (**Figure 2**). The coordinates of the sites of the Tambralinga period had been collected using a handheld GPS unit with reference to the WGS 84 datum (zone 47) and the UTM/UPS system. There were 45 sites found and recorded in this area, and among these sites, 29 of them were condensed in a small area of 12.5 km² at the middle of the cluster. When overlaying these coordinates on the aerial photographs and drainage layers, it was found that the sites were far from the modern rivers between 17.7 - 1129.4 m with an average at 302.5 m. Yet, there was a standard deviation at 241.4 m. Therefore, after removal of the extreme numbers in the statistics, the average distance between the sites and the rivers should be between 61 - 543 m. However, when we took into account the traces of possible ancient rivers and floodplains, we found that all of the sites were close to the water.

In terms of soils, all the 45 sites were located in 4 types of soil, in which 7 of them were on loam, 8 on alluvium, 19 on sand loam, and 11 on silt loam (**Figure 3**). The slope gradient of this area was around 1 - 5 %. The soils in this area were formed by the alluvial deposits carried by waters from the mountains, especially in the rainy season when this area was flooded. Therefore, the physical environment in this area is suitable for wet-rice cultivation.

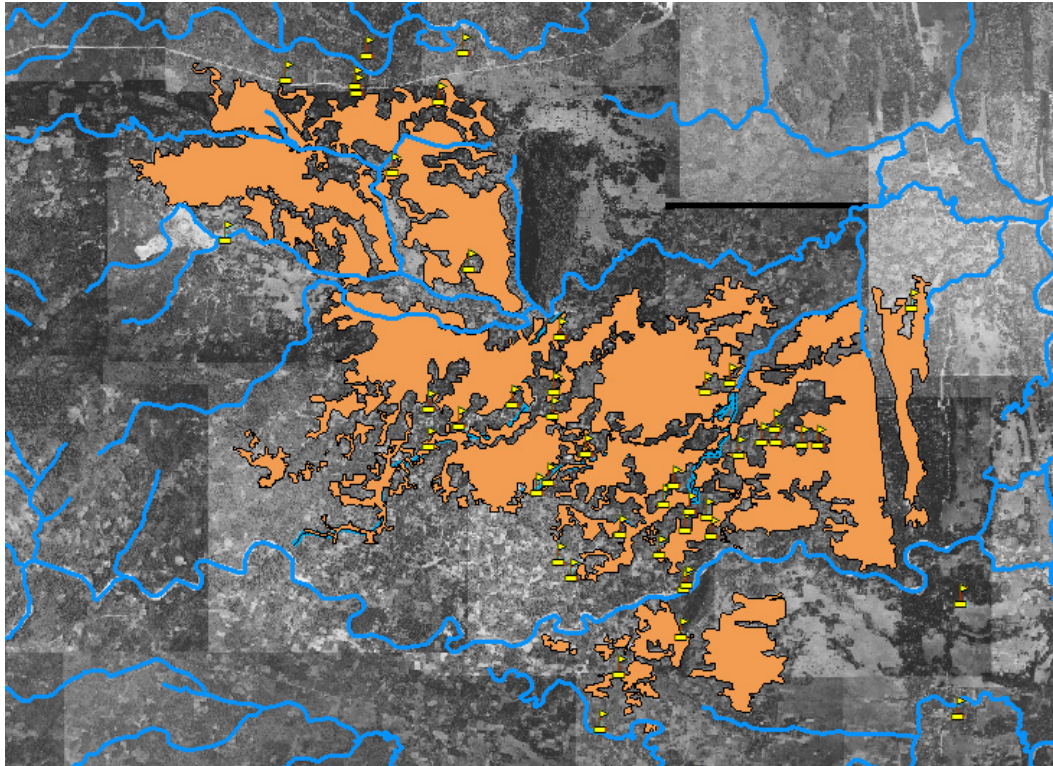


Figure 2 The distribution of sites and the floodplain in Sichon (Southern Part of Cluster 2 in **Figure 1**).

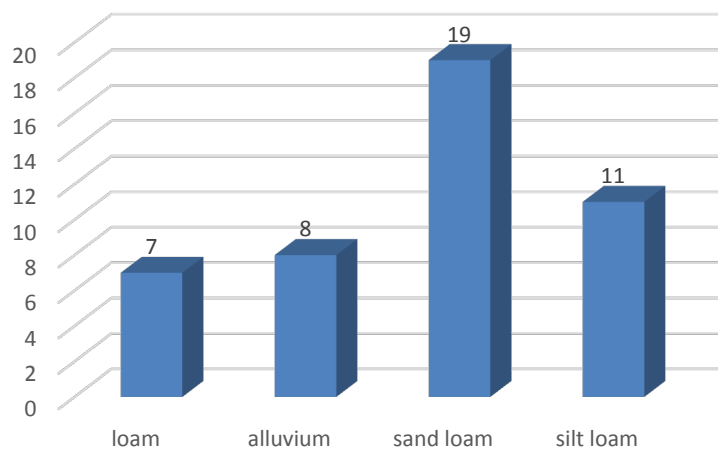


Figure 3 Number of sites in each soil type.

Past agriculture and population

It is always difficult in archaeological research to study agricultural practices in the past because this subject requires meticulous, expensive examinations of the physical environment, settlement pattern, sediments, and plant remains usually from coring and excavations. However, this research is not designed

or has funding for such specific types of detailed scientific examinations. Therefore, this article only attempts to serve as a starting point in the study of past agriculture in Sichon area which has not been conducted in any previous research. Various strands of evidence are used to discuss the possibilities of agricultural area and population size in the Tambralinga period.

We assume that the physical environment in this area in the recent past, including the rainfall and floodplain, are not radically different from that in the Tambralinga period. There is also something perennial about agricultural practices based on simple technology and energy of humans and draft animals. Thus, we also assume that wet-rice cultivation was also practiced in the Tambralinga period. There is also a large reservoir called "Sra Di" that is around $50 \times 150 \text{ m}^2$ and around 1 km north of Khao Kha, but it may have been used mainly for consumption, not mainly for wet-rice cultivation in the past, as the cultivation in this area seems to have been mainly rain-fed. This reservoir was cut by the modern irrigation canal but we can still see the traces of its rectangular shape (Figure 4).

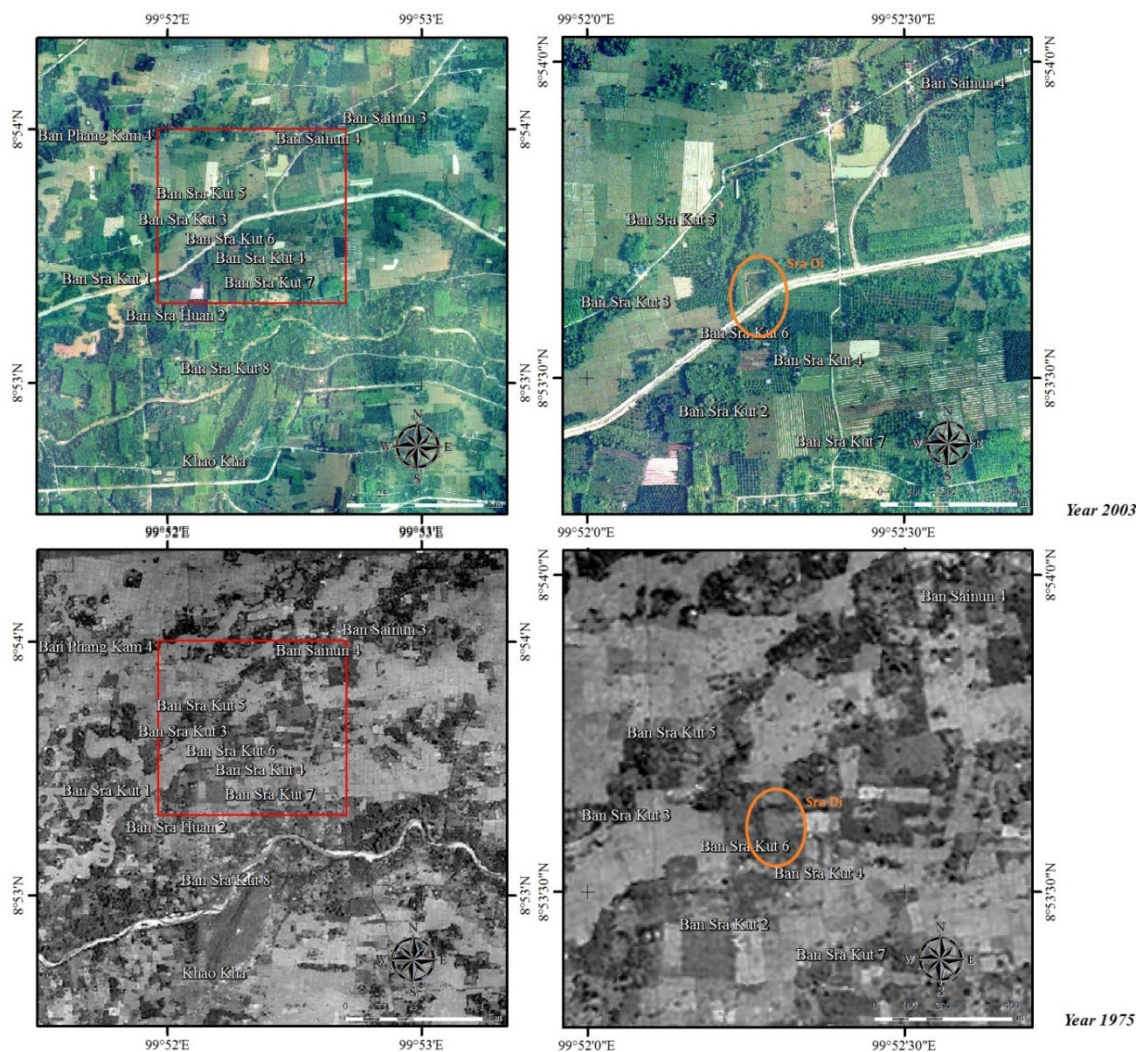


Figure 4 Sra Di, an ancient large reservoir (approx. $50 \times 150 \text{ m}^2$), around 1 km north of Khao Kha.

We then delineate the floodplain area based on the studies of aerial photographs and overlay them with the coordinates of 45 archaeological sites. It shows that the floodplain is 21,768,431 m², and this area should be the minimum size of area for wet-rice cultivation although we take into account that high-ground rice cultivation may have been practiced as well, which would add even more agricultural area into our calculation. The wet-rice cultivation in this floodplain area could depend on natural rainfall and would not need large irrigation constructions.

We interviewed old villagers and found out that there had been a variety of native rice in this area but now they were replaced by Jasmine Rice introduced by the government. They told us that, in the recent past, native rice grown with local technology once a year in this area would usually yield around 400 kg of rice per 1,600 m² (1 Rai), so our floodplain would yield at least 5,442,000 kg of rice per year in total. They continued to inform us that one person would usually consume around 380 g of rice for one day, which would be around 138.7 kg per year. Thus, our floodplain may have been able to feed approximately as much as 39,235 people per year.

Although this is an approximate calculation, it opens up a discussion on the population size in this area. If we also take into account that this area has the highest density of brick shrines (45 sites) and man-made ponds associated with the shrines, and one of the sites is Khao Kha, which is one of the largest religious complexes in Peninsular Thailand, occupying the whole hill, we may see that it makes sense for this area to have a large population. It is the scale of a city or even a capital city, not just an ordinary community.

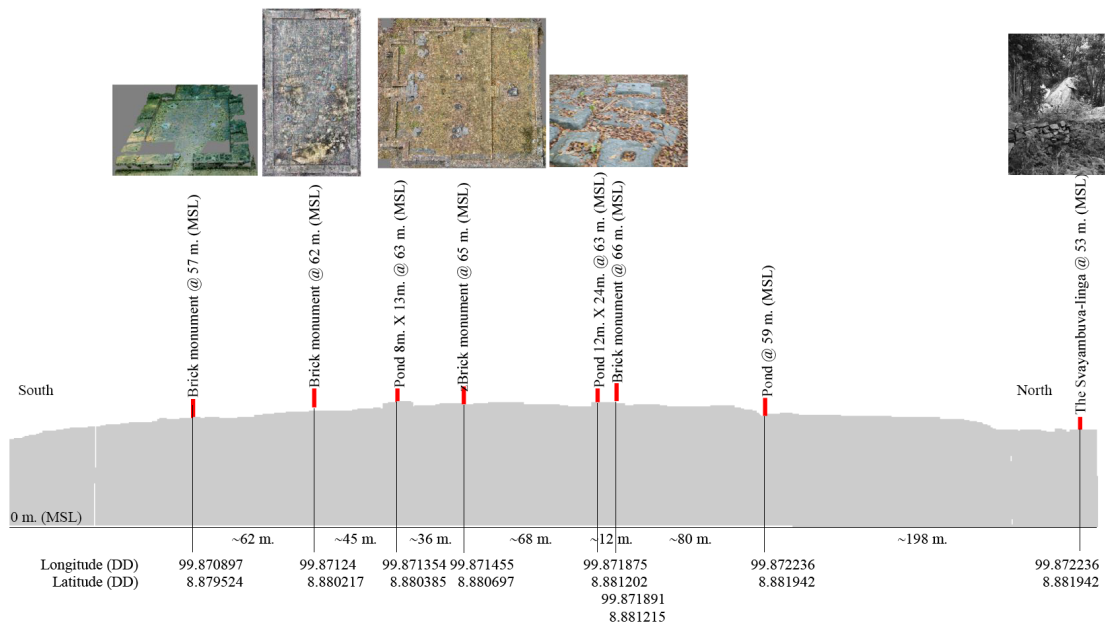


Figure 5 Elevations of Monuments at Khao Kha from Sea Level.

Khao Kha: A religious center

Among the sites found in this area, Khao Kha is the biggest one. It is a massive Hindu religious complex built on a natural hill with at least 7 religious structures. The hill is around 850 m long and 300 m wide, with the height of around 72 m from the sea level [4]. The Tha Thon river is only around 50 m to the northwest from the hill. There was an ancient walkway from the river up to the hilltop at around the middle of the western side of the hill, suggesting the importance of river transportation in the past. On the

bank of the river at the foothill of Khao Kha, some polished stone axes were found, an indication of human occupation in this area perhaps prior to the foundation of the Hindu shrines here.

Some shrines at Khao Kha were made of bricks with some stone architectural parts but some were made purely of stones, such as the boulder-linga with a stone platform at the northern end of Khao Kha. There are also at least 3 ponds that were dug out of bedrock on the ridges of the hill. As a pilot project to integrate modern technology into archaeological investigation to map and study Khao Kha in details, 3-dimensional mapping methods were employed. Data and images from, such as total station theodolite, digital cameras, 3-D scanners, drones (UAV), and Structure-from-Motion (SfM) technique [5], were used to create informative images and study the elevations of Khao Kha (**Figures 5 and 6**). This work is the first one of its kind in Southern Thailand and can be developed for further geographical and environmental analyses in the laboratory for years to come.

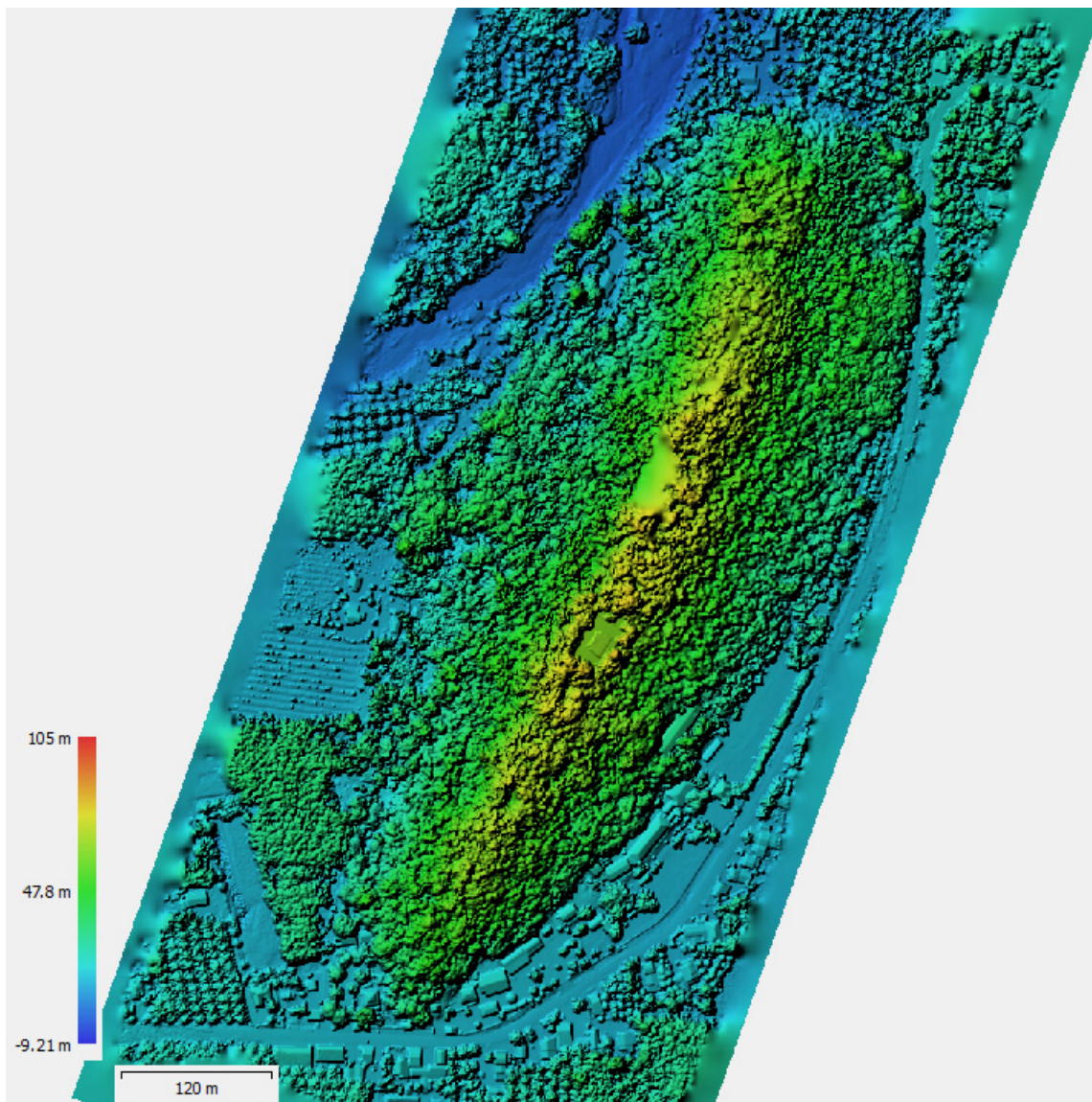


Figure 6 Image of Khao Kha's elevation generated using a drone (UAV) and SfM Technique.

Thermoluminescence (TL) dating [6]

This research project also has the first scientific dating program at this important area. Two brick samples acquired during survey in the unexcavated area on the ridge of the hill, south of this linga, were TL-dated in 2014 by the TL Lab at Kasetsart University to 1,536±123 BP and 1,562±109 BP or 355 - 601 CE and 343 - 561 CE, suggesting that the brick structure(s) on the hill may have been first constructed at a very early time.

There are also 2 more TL dates from the brick shrines from Sichon district. The first was from Ban Theparat, not far from Khao Kha to the southwest. It was TL-dated in 2014 by the same lab mentioned above to 1,655±125 BP or 234 - 484 CE, suggesting that the communities and brick shrines in the Sichon area may have been part of one of the earliest centers in the historical period of Southeast Asia. The second TL date came from Wat Khao Phanom Trai. It was TL-dated in 2011 by the same lab to 670±50 or 1291 - 1391 CE, suggesting that some communities in this area continued until the 14th century CE.

Conclusions

Taking into account all the scientific data mentioned above, it may be proposed that the ancient communities, which built and maintained the brick shrines, lived in areas suitable for lowland agriculture, especially for wet-rice cultivation, with sufficient supply of water and alluvial soils. It may be hypothesized, based on the calculation of the amount of rice produced in the floodplain, the density of brick shrines, and the massiveness of the Khao Kha complex, that this area between the Tha Khwai, Tha Chieo, and Tha Thon rivers in Sichon district was the most concentrated center of population in the Tambralinga Kingdom (c. 6th - 11th centuries CE), if not the capital city. Also, this food-producing area may have not been completely abandoned after the fall of Tambralinga Kingdom and some communities still occupied this area until the rise of Nakhon Si Thammarat Kingdom in the 13th - 14th centuries CE as suggested by the TL dates.

Acknowledgements

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