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Archaeologia is a peer reviewed journal dedicated to scholars who have made a remarkable contribution to the field of Archaeology. It invites original research articles based on a broad scope of themes related to archaeology covering field research and theoretical exercise with multi-disciplinary or cross-disciplinary approaches. The main objective of this journal is to convene national and international scholars and systematic academic research participants of the South Asia. Archaeologia was initiated with the vision of sustaining and promoting research in Archaeology from the countries forming part of the South Asian Association for Regional Cooperation (SAARC). Thus, from its inception in 2005, Archaeologia has disseminated wide-ranging quality research articles and reviews.

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Research Articles

Report

Archaeologia
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Editorial Note

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On behalf of Archaeologia, Journal of South Asian Archaeology and our editorial board, we are proud to hereby present the outline which directs you to the four main sections of each journal to be published. The first section focuses on an original research study that provides the scholarly perspective on an issue pertinent to the subject of archaeology. Secondly, the journal is to contain a report of a recent field survey, excavation or laboratory analysis that demonstrates a sound contribution to the knowledge in the field. The third section is a critical review on one of the recent publications of the subject. A felicitation or commemoration note of an erudite archaeologist of the field in South Asia is to be included in the final section of the journal.

The editorial team consisting of review editors, editorial board and editors with various responsibilities are involved in the entire process starting from the submission to the ultimate approval. The complete review process is mindfully constituted in order to prevent the possibility of prejudice and the journal is currently an open access journal for online readers.

We are extremely thankful to Archaeologia review editors, editorial board and editors who have assumed responsibilities of the Journal as well as the readers and contributors for making this Journal of South Asian Archaeology a great success.

We look forward to your submissions and cooperation.

Editors-in-chief
archaeologia@kln.ac.lk

Areal View of Jaffna fort ; Jaffna Post-disaster Archaeological Research Project

Archaeologia
JOURNAL OF SOUTH ASIAN ARCHAEOLOGY

Piloting Post-disaster Archaeological Heritage Protection at Jaffna Fort, Sri Lanka

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Abstract

Heritage is globally at risk from multiple challenges, including unchecked accelerated development, natural disasters, targeted destruction through conflict and looting, climate change and neglect. In addition to preparing strategies to mitigate these pressures, there is also an urgent need to develop agile responses for post-disaster scenarios for the protection of surviving and vulnerable heritage. After witnessing at first hand the heritage protection challenges presented by the 2015 Gorkha Earthquake in Nepal, a team of archaeologists, heritage practitioners, policy makers alongside key and first responders co-designed a method for approaching, recording and protecting earthquake-damaged heritage. Based on a simple method of gridding a damaged site for the systematic and careful removal of debris and artefacts for recording and recycling, the method's transferable application to other post-disaster archaeology was soon apparent. In response, the Central Cultural Fund (Government of Sri Lanka), University of Jaffna with the Department of Archaeology (Government of Sri Lanka) and PGIAR, and Durham University's UNESCO Chair on Archaeological Ethics and Practice in Cultural Heritage initiated the 'Jaffna Fort Post-Disaster Archaeological Research Project' in 2017. As well as undertaking archaeological research to better understand the origins and development of Jaffna Fort, the project piloted post-disaster archaeological methods at the Kruys Kerk, a Dutch period monument within the Fort's interior that had sustained significant damage during the conflict. Not only has this facilitated the identification of in-situ surviving walls and floor surfaces, as well as materials that can be reused in future rehabilitation programmes, but our post-disaster clearance activities recovered artefacts and architectural fragments which enhance our understanding of the monument's biography. We strongly suggest that this methodology is applied to other damaged heritage sites across Sri Lanka, including those affected by the 2004 Tsunami.

Keywords : *Jaffna Fort, Kruys Kerk, Post-Disaster, Conflict Archaeology*

Introduction

While recent research has demonstrated tantalising archaeological evidence of human activity in its vicinity as early as the first millennium BCE (Pushparatnam 2015; Davis et al. 2018), the Dutch Fort at Jaffna remains “one of the best and largest fortifications in the east” of the Early Modern Period (Nelson 2004: 82a). Despite the damage it sustained during the 26 year armed conflict between the Sri Lankan Government and the Liberation Tigers of Tamil Eelam, its most visible characteristics remain the imposing geometric pattern of seventeenth and eighteenth century walls, moats and earthworks. Unfortunately, the majority of the freestanding monuments within its interior were less fortunate, including the Kruys Kerk. A Dutch Reform church initiated in 1706, it was laid out in the form of a Greek Cross and constructed from limestone, coral and imported Dutch bricks bound in lime mortar (Jaffna Christian Union 1967: 9). Containing bells and ledger stones from an earlier Portuguese Church within the fort, the Dutch Period interior was augmented during early British rule with the installation of additional memorial tablets and ledger stones (De Silva and Beumer 1988: 310-311).

When the first archaeological teams started recording the Fort at the end of armed conflict, all that remained of the Kruys Kerk was a large rubble spread with substantial sections of collapsed and unstable masonry. This situation was strikingly similar to the remains of many historic monuments in Nepal that had collapsed during the 2015 Gorkha Earthquake. Kathmandu's post-disaster environment had seen the initial deployment of bulldozers and backhoe loaders to clear rubble before it had become clear that this had resulted in the unnecessary destruction of archaeological deposits and mixing of modern and historic materials (Coningham et al. 2018). In response, a method for recording and protecting earthquake damaged heritage was co-developed by Durham University's UNESCO Chair, the Department of Archaeology (Government of Nepal), Pashupati Area Development Trust alongside key and first responders in the collapsed remains of the Gurujyu Sattal at Pashupati (Coningham et al. 2018). Implemented within the Kathmandu Valley's UNESCO World Heritage Site, it successfully demonstrated that the approach could be quickly implemented at, and transferred to, any collapsed monument and could also be implemented by non-heritage experts without specialist equipment.

As noted, based on a simple method for gridding a damaged site before the systematic and careful removal of debris and artefacts for recording and recycling, the transferability of the post-disaster clearance excavation method was apparent. Therefore, it was piloted in Sri Lanka at the Kruys Kerk in 2017 as part of the 'Jaffna Fort Post-Disaster Archaeological Research Project', initiated by the Central Cultural Fund (Government of Sri Lanka), University of Jaffna with the Department of Archaeology (Government of Sri Lanka) and PGIAR, and Durham University's UNESCO Chair on Archaeological Ethics and Practice in Cultural Heritage.

Materials and Methods

The methodology was initiated by the laying out of a five by five metre grid of six squares over debris located adjacent to a visible portion of in situ wall at the north-east of the Kruys Kerk. A replica grid of six squares was then created close to the excavations on open ground using wooden elements and metal sheeting available at the site (Figure 1). This allowed for the rapid removal of debris from the site grid onto the corresponding replicated grid, providing spatial control for any material removed, including artefacts and structural elements.

Prior to removal, a photograph was taken of each grid square with a shovel pointing north. This acted as a scale for the site record, as ranging rods and specialist archaeological equipment might not be available in a post-disaster situation. Debris was then removed within each grid square until the surviving in-situ archaeology or old land surface was exposed below, which included walls (Figure 2). By removing debris carefully and systematically, elements of the monument that had not been damaged during the disaster phase could be saved from further damage. It also meant that material that might otherwise have been bulldozed away through levelling could be recorded and recovered. A record photograph of each grid square with a shovel as scale was taken after the removal of debris.

All sculptural fragments and artefacts were catalogued and provided with unique special find numbers. Spatial recording also meant that salvaged material could potentially be reused in future reconstruction and conservation. Salvaged material from

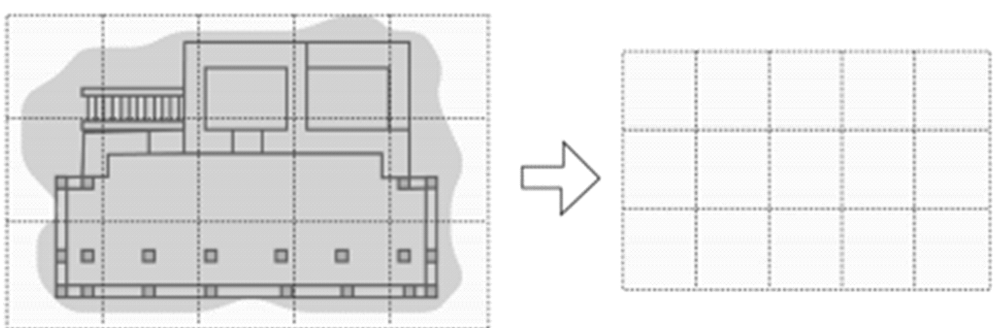

Figure 1: Exemplar of a post-disaster clearance grid laid over collapsed building on left with replica grid on right.

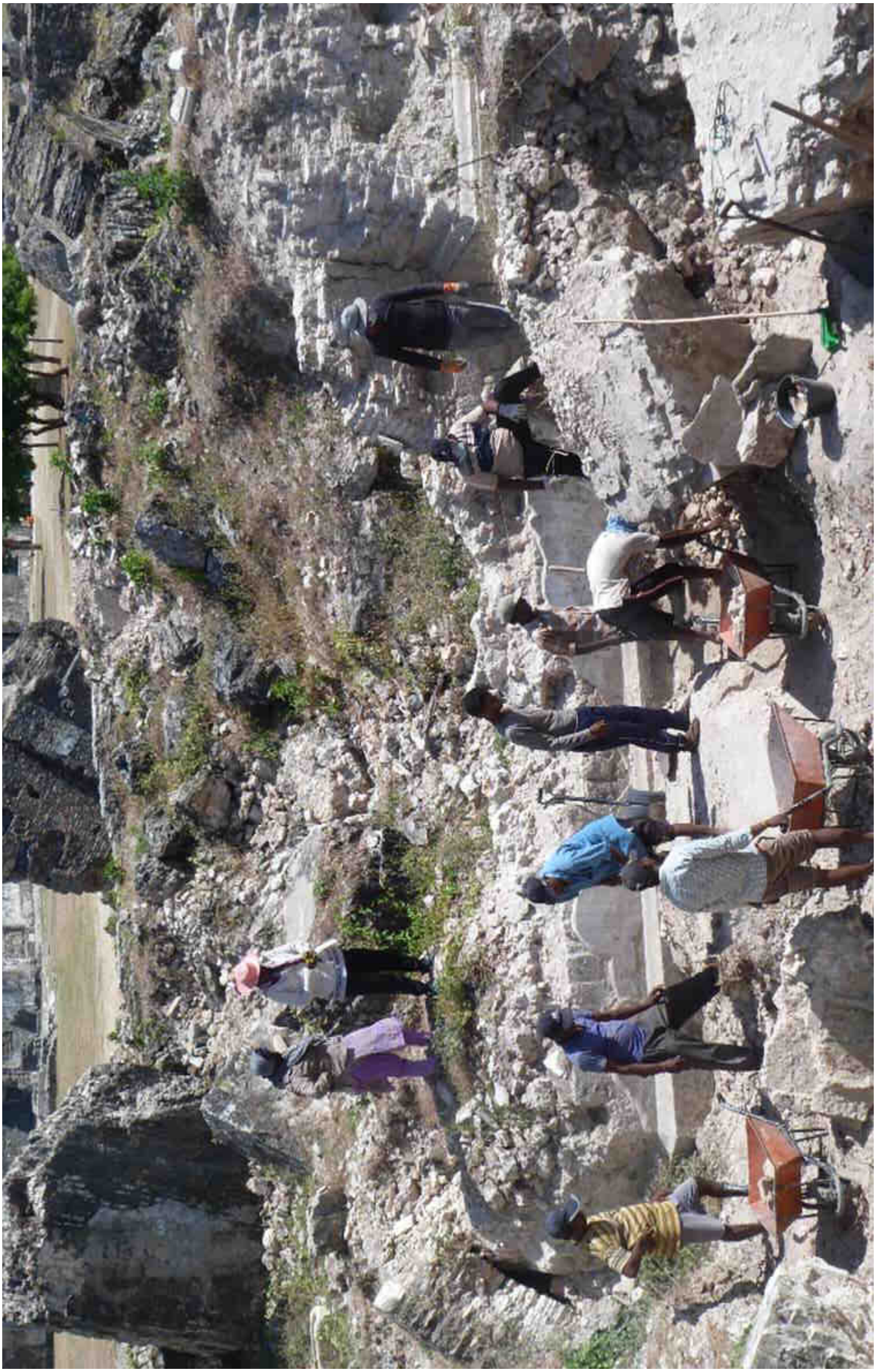

Figure 2: Undertaking post-disaster clearance excavation at the Kruys Kerk in 2017.

Figure 3: Salvaged Dutch bricks, sorted and stacked for possible reuse in future rehabilitation initiatives at the Kruys Kerk

each grid square was categorised, sorted and counted and weighed according to material. This included construction and building materials, such as tile, brick and coral (Figure 3). This is pertinent to the monuments within Jaffna Fort as many of the construction materials are non-renewable, having been constructed from coral blocks, illegal to procure under national and international legislation, and also historic Dutch bricks, which would be expensive, if not extremely difficult to reproduce in large numbers.

Results and Discussion

Having been trained during the 2017 pilot season, officers from the Central Cultural Fund's Jaffna Office then completed the full clearance and removal of debris exposing the Kruys Kerk's surviving standing walls and floor surfaces, revealing its Greek Cross layout, as well as a later extension to the north-east (Figure 4). The case-study of the Kruys Kerk has illustrated the value of the post-disaster approach for protecting surviving in situ heritage within the debris of damaged monuments and has not only salvaged material for potential reuse, but has also uncovered new information on the Kruys Kerk's biography.

Whilst it was already known that elements of an earlier Portuguese church in the vicinity, including bells and ledger stones, had been reused within the Kruys Kerk (Jaffna Christian Union 1967: 9), we were able to confirm the presence of architectural elements

Figure 4: UAV image of the Kruys Kerk after full implementation of post-disaster clearance excavation.

from even earlier structures. As noted previously (Pushparatnam 2015: 97), a number of carved granite blocks were recovered from within the debris of the Kruys Kerk (Figure 5). Patterns of white wash and cement suggested that they had been built into the church's fabric and it is highly likely that they had been reclaimed from the debris of Portuguese monuments demolished after the Dutch siege of 1658 (Pieters 1908: 76). Carved with lotuses, it is most likely that they are elements from pre-colonial temples and the reuse of these architectural elements is not confined to the Kruys Kerk as several have also been found within the fort's damaged Dutch era bastions (Pushparatnam 2015: 98). These finds hint at the monuments that were to be found in the Jaffna Peninsula prior to European colonial rule and prior to the Kruys Kerk's construction. Indeed, Professor Indrapala published an eleventh century CE inscription of the Chola ruler Rajendra I (r. 1014 – c. 1044 CE) recovered from the Dutch fortification in 1970 and suggested "that materials from this big temple (at Nallur) were used for building the Jaffna fort" when the capital was sacked by the Portuguese (Indrapala 1971: 53). As a result of these deprivations, little is now visible of Jaffna's rich pre-colonial architectural heritage.

While the majority of the monumental Dutch and British ledger stones from the Kruys Kerk were removed to Vaddukoddai for safekeeping before the church's

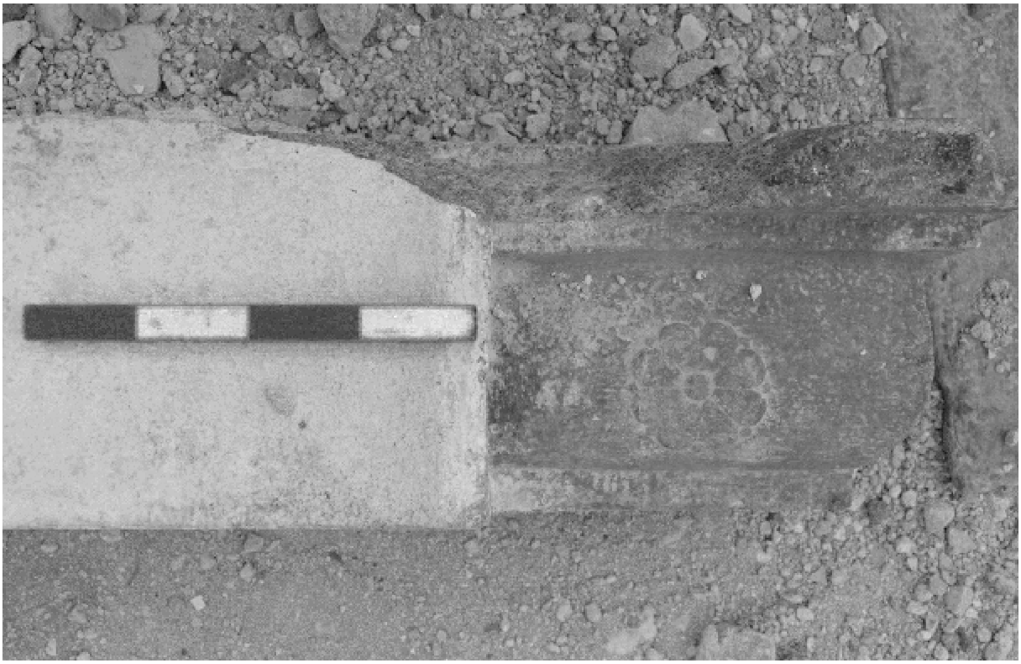

Figure 5: Detail of lotus design carved within granite bracket found within the debris of the Kruys Kerk.

destruction, other unknown histories have been uncovered during the removal of debris. This included the exposure of a portion of a previously unknown inscription set into the exterior north wall of the building. Perhaps relating to the initial construction of the monument, it was later incorporated into the new Vestry built into the space between the north and east wings of the original church (Figure 6). Dr Alicia Schrikker, Assistant Professor of History at Leiden has kindly reviewed images of the damaged coral slab and initially suggests that it may record a wife [*vrouw*] born in 1716 and died [*overleden*] in Jaffna [*op Jafenapatnam*] in the 1750s (pers. comm.); it may have been concealed behind later furniture in the Vestry as it was unrecorded by Lewis in his survey of the church's inscriptions (1913). When officers from the Central Cultural Fund were recovering the square granite floor slabs from the debris, they noted one with a Tamil inscription. Also unrecorded by Lewis, it records the 'wife of Father Wemiraman' (Figure 7). These discoveries indicate the hidden diverse stories that may have been lost without careful recovery of material.

The implementation of the post-disaster excavation methodology has also resulted in the salvaging of previously known and recorded items. This includes fragments of memorial slabs from the Kruys Kerk, providing information on individuals who were interred or commemorated within its walls. From pieces found in the north-east of the debris, for example, we were able to reconstruct a British Period marble memorial

Figure 6: Damaged Dutch inscription identified, which was incorporated into the new Vestry, built into the space between the north and east wings of the original church construction.

Figure 7: Floor slab from the interior of the Kruys Kerk with Tamil inscription recording the 'wife of Father Wemiraman'

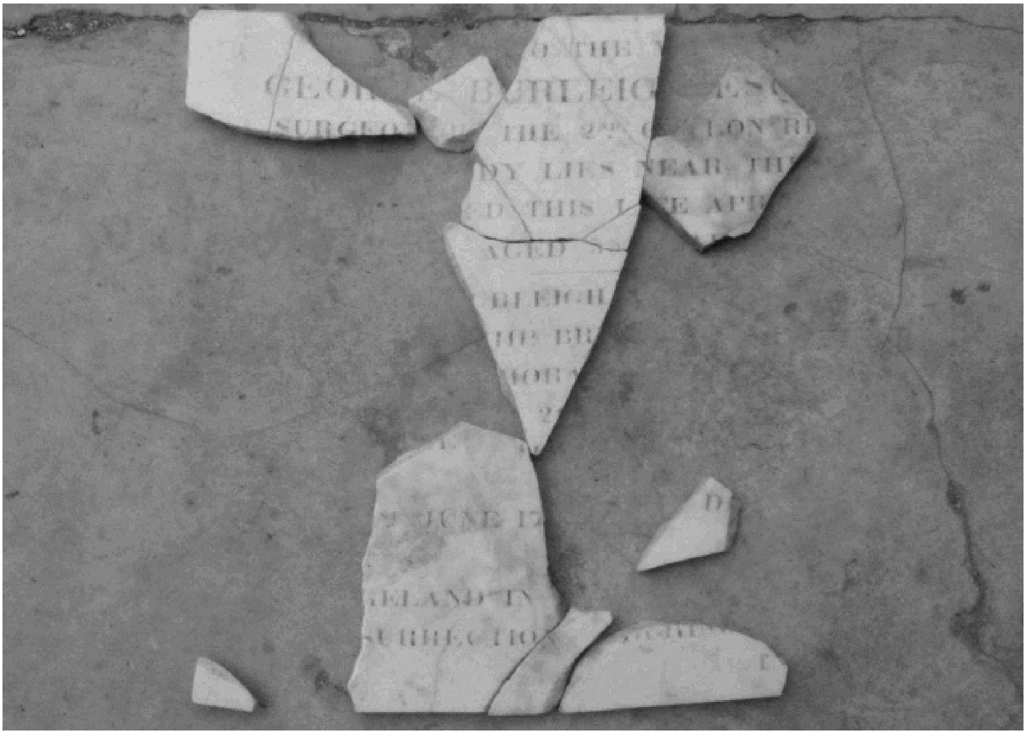

Figure 8: The remnants of the memorial slab of George Burleigh Esq., recovered from the Kruys Kerk.

tablet dedicated to George Burleigh, a surgeon of the 2nd Ceylon Regiment, who died in 1826 (Lewis 1913: 223) (Figure 8). The Kruys Kerk's more recent past was also evident from the recovered remains, which included fragments of barbed wire, ration packs and bullet casings. Therefore, the pilot recording of cultural material during the post-disaster clearance has demonstrated the value of the careful and systematic excavation of debris. This approach has facilitated the piecing back together of a monument's past, and that of its past communities, as conservation efforts look forward to the monument's future stabilization and rehabilitation.

Conclusion

A number of the finds recovered during our post-disaster clearance excavations at the Kruys Kerk have now been displayed alongside artefacts recovered from stratigraphic excavations within the fort at a tri-lingual temporary exhibition, which was opened at Jaffna Fort at the end of our 2018 field season. The display of these objects, and the stories they tell, and the Kruys Kerk's history are now being disseminated to the public. One of the most striking displays reflects on the impact of the discovery of a rich pre-colonial past: 'If Jaffna's history was condensed into a single day, the colonial era would only start just after three minutes before midnight'. In terms of capacity strengthening, the pilot training program was also successful as 91% of the officers from the Central Cultural Fund's Jaffna Office trained in 2017 stated that they felt better equipped to protect heritage after a disaster.

The success of piloting the post-disaster clearance methodology at the Kruys Kerk illustrates its potential for transference to other post-disaster scenarios in Sri Lanka, South Asia and globally. These include natural catastrophes, such as the 26 December 2004 Tsunami, which devastated the coastline of Sri Lanka, with 82 heritage sites identified as damaged or destroyed through an ICOMOS Sri Lanka survey of the Northern Maritime Region (Pushparatnam 2005). The post-disaster methodology piloted at Kruys Kerk provides a further archaeological approach for heritage and non-heritage specialists alike to rescue and recover material culture from heritage sites that can be utilised in the restoration, reconstruction and rehabilitation of monuments damaged during natural and humanitarian catastrophes.

Acknowledgements

Post-disaster fieldwork at Jaffna Fort was generously sponsored by HEFCE-GCRF, the Central Cultural Fund (Government of Sri Lanka), Durham University, the British Academy and Durham's Institute for Medieval and Early Modern Studies. The fieldwork would not have been possible without the hard work, enthusiasm and dedication of project participants, and institutional support, from the Central Cultural Fund; University of Jaffna; Department of Archaeology (Government of Sri Lanka); Postgraduate Institute of Archaeological Research, University of Kelaniya; Durham University; and colleagues from the Lumbini Development Trust and Department of Archaeology (Government of Nepal). We are particularly grateful to Mrs Sumedha Mathota and Mr Laxman Chandana Maithreepala of the Central Cultural Fund and Mr K.D. Palithaveerasinga, Mr B. Kabilan and Mr V. Manimaran of the Department of Archaeology (Government of Sri Lanka) for their support and co-ordination. We record our gratitude to Dr Alicia Schrikker for her initial reading of the unrecorded Dutch memorial slab, and Mr S. Thaceenthan and Mrs Ajiththa Suganthan for their assistance. Finally, we are also very grateful to the communities of Jaffna for their interest and support in the project.

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A Technological Study of Ancient Sri Lankan Kodithuwakkuwa: A Case-study of Kodithuwakkuwa at Ratnapura Maha Saman Devalaya

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Abstract

This paper tries to understand the technology of manufacturing the gun barrel of Sri Lanka's highest calibre gun known as "Kodituwakkuwa" by examining the surface features inside the gun barrel using Endoscopic Microscopy. Since the gun barrel is made out of forged iron, the inside surface of the gun barrel could not have been subjected to direct forging. It was anticipated that some clues relating to its manufacturing process may have been left behind on the inner surface of the barrel. This paper examines the surface features observed and tries to correlate them to its manufacturing process. Apart from this it also explores incidentally the social background in producing iron in the contemporary Kandyan society which ascertains the amount of supply of iron was an influencing factor because of which the Kandyan gun makers did not proceed beyond the calibre of the Kodituwakkuwa.

Keywords : *Kodituwakkuwa, Gun barrel, Microscopic Analysis*

Introduction

This article examines from a metallurgical point of view the manufacturing technology of the only known Sri Lankan made highest calibre gun commonly known as 'Kodituwakkuwa' a canon of small proportions. With the technological findings of this study, we try to understand how the technology of making Kodituwakkuwa itself would have been restricted to making gun barrels that are higher in strength than the calibre of Kodituwakkuwa. This paper also addreses the issue of whether the technology or the resources (i.e. iron) being critical for the gun-makers in developing the local gun producing industry.

The main objective of this study is to understand the local technology of making the high calibre iron gun barrel used in Kodituwakkuwa, which is a light canon. The visual investigation of Kodituwakkuwa indicates that it may not have been produced by iron casting technology as in the case of cannons made using iron by Chinese, European and Arabs (Wickramasinghe 2004), who were the pioneers of this technology. So far no archaeological or literary evidence have been found to prove that iron casting had been done on the Island during early times.

As such, the main research question is, how they have made it using wrought iron if they had not produced the gun's barrel of Kodituwakku by iron casting.

The Technology of Kodithuwakkuwa: Insinuation

The most important part of an ancient gun would be the gun barrel, a long tube of which the rear end is closed. Firepower is mainly dependent on the caliber (diameter) of the barrel. High calibre means usage of more gun powder to generate a more powerful explosion inside the barrel and to eject a big mass with higher velocity resulting in high kinetic energy for the ammunition.

The kinetic energy thus created is a product of mass and a square of the velocity of the ammunition ultimately implicating more destruction when struck against an object due to transferring of the high kinetic energy of the ammunition. The amount of gun powder used is in proportion to the resultant energy of that explosion, on the other hand, the gun barrel should be strong enough to withstand the power of the explosion inside the barrel. This is where the ancient gun-makers had played a crucial role by producing gun barrels with higher calibre strength enough to withstand the power of the explosion. The earliest gun barrels were produced by casting into one piece to achieve its strength using both bronze and cast iron by the Chinese in the 12th century CE (Needham 1974). In Europe, the earliest gun barrels were produced by bronze casting. They were exposed to the casting of gun barrels with strong and cheap cast iron, from the Chinese only around the 15th century CE (Needham 1974). Subsequently, they replaced their expensive bronze cannons with cast iron cannons. The strength of the barrel was achieved by making it a single piece by metal casting with varying thickness according to the calibre. It has not been ascertained when the Sri Lankans made canons but it is well known that Kandyans rarely used canons (Wickremesekera 2004:100). However, those were light guns, while the Kodituwakku was the largest calibre gun during the Kandyan Period. Even though the knowledge of bronze casting technology was known to Sri Lankans, it is doubtful if gun makers cast barrels of Kodithuwakku with bronze during the Kandyan period. But there are references to the effect that the Sinhalese army used bronze cannons during the time of Rajasinghe I (1581-1593) of Sitawaka. He had used 150 bronze artilleries at the siege of Colombo (Ruberu 2003). Most probably as indicated by Rebeiro and Knox, those guns have been imported from Calicut in India to fight the Portuguese. If bronze casting has been locally practised at that time, we may infer that their number would have been extremely few. The fact that no locally made bronze cannons or moderately high calibre guns like Kodithuwakkuwa in bronze have not been found. The archaeological context also indicates the fact that there was no wide local production of guns casting bronze.

Possible reasons for this will be discussed in this case study. All the known Kodithuwakkus of Sri Lanka have been made out of iron. But so far, no metallurgical study has been carried out to investigate the local traditional technology of making gun barrels using wrought iron. The well-preserved and still-functioning Kodithuwakkuwa at Maha Saman Devalaya at Rathnapura was studied to understand the local technology of making gun barrels.

Kodithuwakkuwa at Ratnapura Maha Saman Devalaya

The study was mainly carried out through both visual and microscopic investigations. An endoscopic microscope was used to study the inside surface of the gun barrel. The diameter of the barrel is 6.35 cm, the length is 65 cm and the thickness is 0.9cm (Figure 1).

By applying raking light over the inside metal surface of the gun barrel it was possible to observe some signs of cracks all over the inside metal surface of the barrel (Figure 2). Boundary joints with different metal masses were also visible.

The microscopic images of these cracked marks on the somewhat smooth inner surface of the barrel show different orientations of the surface features of the two adjacent

Figure 1: Locally made Kodithuwakkuwa at Mahasaman Devalaya, Ratnapura

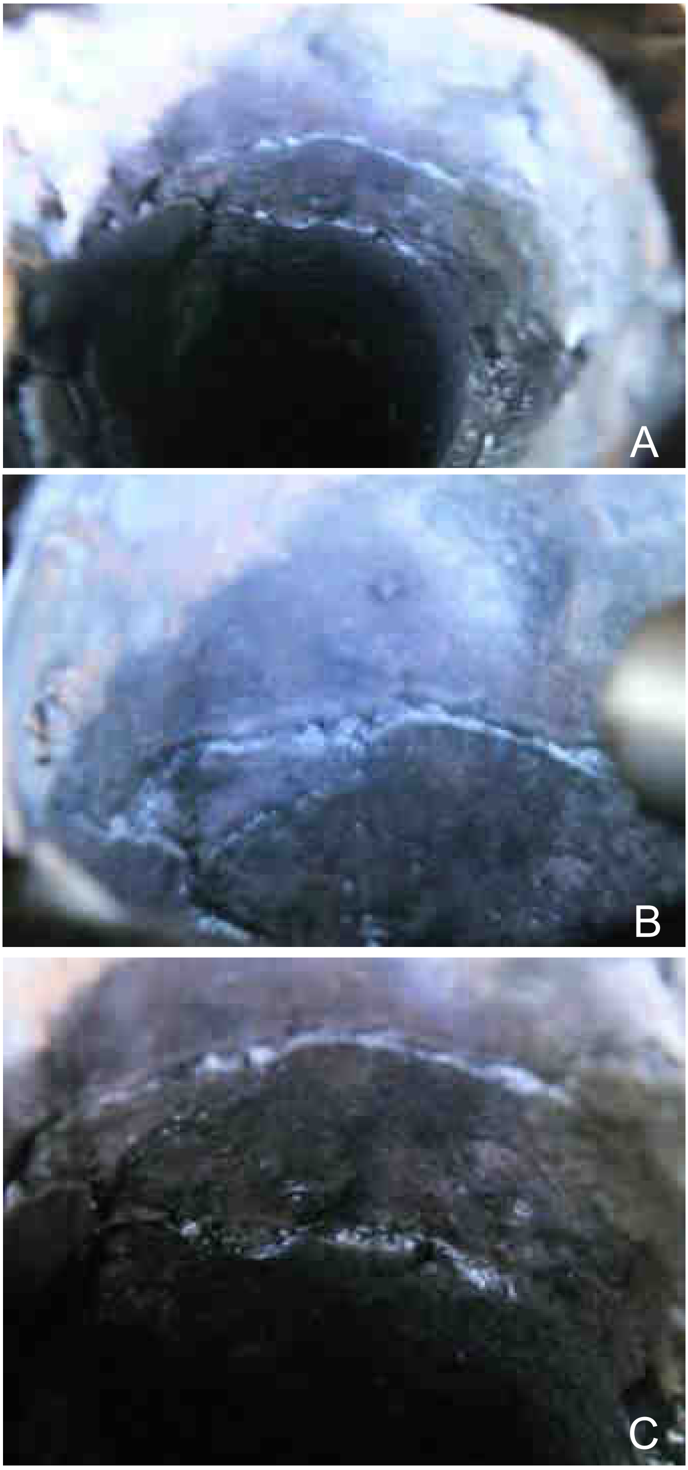

Figure 2: The cracked marks seen inside surface by the raking light

metal masses separated by cracked marks (Figure 3). This indicates that these marks are not cracks but boundary lines connecting two different metal masses. Connecting boundary lines of these metal masses are clearly shown only on the inside surface of the barrel (Figure 4). The inability of forging the inner surface could have been the reason for these marks. The inside surface would have only been pressed, possibly, by an iron rod due to the hammering from outside the process during which the margins of different metal masses have joined together without welding, so close that have disappeared the joints. These welded boundaries are not visible on the outside surface of the barrel. This is because repeated forging would have welded different metal masses closely.

On the other hand, a reduction of the wall thickness by hammering would have increased the hardness of the metal. It is not known whether the iron used to make these

Figure 3: Microscopic images of cracked features. See the different orientations of features on the different metal masses separated by the boundaries (1 x 100)

Figure 4 : Improper joining of different metal masses

barrels were carbonized (converted to steel). It needs a metallographic study to ascertain this fact.

Further, the microscopic images show some places where small cavities on the joint boundaries indicate the improper joining of separate metal masses inside the barrel (Figure 5). A barrel that had been constructed by joining (welding) different metal blooms by using joining technology definitely would have definitely imposed maximum restrictions on the calibre enabling it to withstand the firing explosion. To produce a gun barrel beyond this maximum calibre, it is essential to make the barrel as a single piece by metal casting in bronze or east iron. By compromising the technology and calibre there would certainly be a maximum limit of the calibre that could be achieved with confidence with the available technology. The incidents where locally made Kodithuwakku gun barrels had burst had been recorded in the literature sources (Wickremesinghe 2004:101). This may compel us to think that the bursting of barrels had been a problem with the local gun-making industry. This indirectly indicates the maximum possible calibre with the local barrel-making technology would have been the maximum calibre size used in the Kodithuwakkuwa, and larger calibre guns beyond Kodithuwakkuwa would not have been possible with the local barrel-making technology.

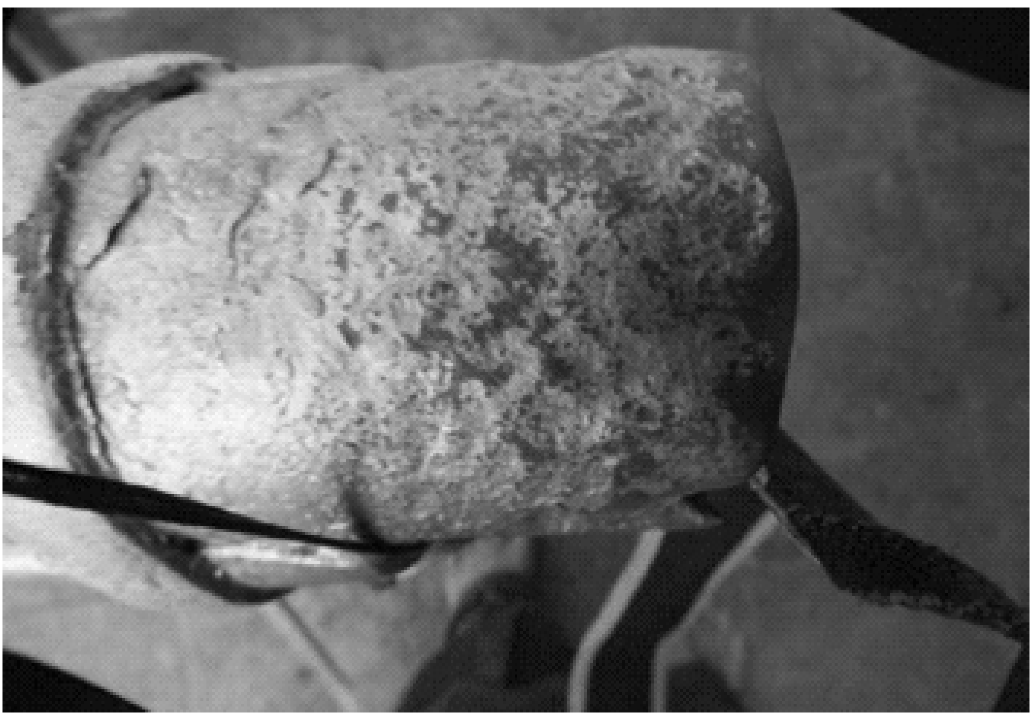

Figure 5 : Outside surface of the barrel. No crack like features seen

The two damages seen in the front face of the Kodithuwakku barrel at Maha Saman Devale at Rathnapura are clearly due to the detachment of two small metal masses utilized to make the barrel (Figure 6). The concave-shaped walls of the detached area give an insight into the shape of the detached metal mass. Since these detached small metal masses are bound to the barrel only on a limited surface area; surrounding metal masses might have glided completely in all directions. This would be the main reason for the detachment of small metal masses of the barrel surface. The more strength needed at the back end of the barrel would have been most probably obtained by annealing as one-piece using a big metal mass to avoid such failures. however, it was not possible to examine the back end of the barrel due to the closure of the end.

Even though it was not possible to conclude without a metallographic study, it may be presumed that the wrought iron masses (balls) produced using the later crucible technology, would have been sufficient for the production of gun barrels. Possibly, the iron produced in this manner might have been hardened to make steel before using it for the production of gun barrels; the authors believe that this could have been the most possible case.

Figure 6: Two concave cavities on the face of the barrel

No archaeological evidence has been found so far to prove whether the technology of cast iron was known to Sri Lankan gun-makers throughout its history. It could be assumed that the technology of producing cast iron was most probably not known to the Sri Lankans in the past. Hence, the only possibility of making high calibre guns such as cannons to increase the firepower of the local armies would have been casting of cannons with bronze; but it is was a rare phenomenon.

It is a well-known fact that the walls of the Portuguese forts were not strong enough to face the explosion of later Dutch guns. But the Portuguese forts were fortified enough only to face Sinhalese guns even with their maximum calibre.

Conclusion

As mentioned earlier, high calibre canons had to be made as one-whole-piece by casting to withstand powerful firing explosions. Since Sri Lankan gun-makers did not possess the knowledge of cast iron and iron casting technology, the production of bigger iron cannons were not possible throughout history.

It seems the technological limitations of making high calibre gun barrels with the available technology restricted the increase of firepower which has remained almost the same without any development from the inception of kodithuwakkuwa from the Portuguese times to the later British period. It is important to reconsider whether the technological restraints of making high calibre guns such as canons locally had been a problem of resource (i.e.iron) availability (Wickremesinghe 2004:101) or lack of technological competence.

As mentioned earlier, the lack of using canons in the Kandyan period has been attributed to the difficulties in supplying the required quantity of iron. However, appendix 2 explains how the state acquired iron under the feudal system of administration in the Kandyan kingdom. Accordingly, it is not possible to think that the scarcity of iron would have been a reason for not making bigger canon guns during the Kandyan period.

On the other hand, high calibre canons could be cast with bronze. Since bronze casting was known to the Sri Lankan gun-makers long before the colonial era it would be an extremely valid question to ask why no evidence is available in literature or archaeology. It is argued that problems of supplying copper and other necessary metals required in large amounts for casting cannon barrels (production of one canon gun required hundreds of kilos of metal) would be the main reason for not producing high calibre guns with bronze. The present authors discovered a local copper deposit at Seruwila, in the Eastern province of Sri Lanka. However, the local copper production from this source had been abandoned after the Polonnaruwa period (Thantilge et al. 2013). The recent field studies carried out in the Seruwila area by the authors of this article revealed the reason for this sudden disappearance of local copper production: it was primarily due to the exhaustion of raw material at the deposit. Hence, it would have been impossible to supply a large amount of copper needed for making canons locally. The only other possibility would have been importing the required bronze metal from a foreign country. But the geopolitical and political conditions after the capture of maritime areas by colonial powers (all the harbours and coastal areas were under their rule) might not have allowed acquiring the required amount of metals through trade. Therefore, it may be concluded that the problem of scarcity of resources was the main reason for not producing high caliber gun barrels with bronze which resulted in a decrease of firepower despite the knowledge of bronze casting technology.

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Appendix 1

History of Gun battles in Sri Lanka

Before the advent of Portuguese to Sri Lanka in 1505, the ancient cinnamon trade from the country to Europe was in the hands of Arab traders (Rohanadeera 1997). Most probably the Sri Lankans would have got their first experience of a gun from the Arab traders before the presence of Europeans in this region. The determination of the Portuguese to get the cinnamon trade to Europe into their hands from Arabs had led to several sea expeditions to Asia. In order to hold the trade in their own hands, the acts of resistance put forth by moor traders against the Portuguese resulted in the first reported gun battle on the island in 1517. It was reported that Moor traders were the followers of Samarian at Calicut and had bronze cast canons in their hands (Wickremesinghe 2004, Ruberu 2003). By referring to this first gun battle witnessed by locals, the ancient Sinhalese chronicle *Rajavaliya* says 'by seeing firing big guns of Portuguese Sinhalese were ……' (Suraweera 1997 223). This emphasized the Portuguese guns would have been more powerful than the Moors'. Ultimately, the cinnamon trade has fallen into the hands of Europeans mainly owing to the superior firepower of their ships.

Thereafter, provincial rulers in the country have tried to acquire this new influential technology by getting the help of the Portuguese through the Muslim traders with a view to secure their territories (Peris 1920:46-48). In 1521, King Buwanekabahu of Kotte Kingdom fought against his brother Mayadunne with the assistance of the Portuguese and defeated him mainly due to the firepower of the Portuguese (Peris 1920:49-51). Thereafter, in 1539 it was Mayadunne the first to acquire the firepower for his local army with the assistance of Calicut (Peris 1920:46-48). Thereafter, the technology of making guns was invented by locals and in 1550 local army led by Mayadunne, fought with the Portuguese who advanced to the interior in order to conquer Sitawaka Kindom, with the newly acquired firepower. Even though Mayadunne was not successful at the first time, in 1560, the local army managed to uplift their firepower to fight against the Portuguese mainly with the locally made guns, especially guns with the highest calibre called 'Kodithuwakkuwa' (Peris 1920:84-85). The Sitawaka army successfully defeated and expelled the Portuguese from Kotte in 1564 with the firepower acquired with the locally made guns. Other than their fortifications in which they had used imported cast canons, the Portuguese have manufactured guns locally (mainly the Kodithuwakku) in their local factories by using locally produced iron collected through the same 'raajakaari' tax system of Sithawaka kingdom.

According to Rebeiro, by 1618, there were 4000 men in the Portuguese Kodithuwakku regiment of the low land area (paatharata) and Sithawaka against the 5000 men of the King Senerath's troops of Udarata (highland) which gives a good picture of the firepower of the troops in the country at that time (Ruberu 2003:128-129). This indicates almost all the firepower of the troops is dependent on locally made guns. Because of this reason, the Portuguese only fortified their forts to withstand the firepower of Kodituwakku (containing bullets of 4 oz.). When the Dutch arrived in 1650, they had big cast guns (canons) capable of firing more weighted bullets. The big canon guns discovered in the ancient Dutch ship, sunken off the Galle coast named 'Avonstar' gives an insight into the sophistication of their guns. They had been cast as a one-piece using the cast iron. The walls of the Portuguese forts were not meant to withstand such high calibre firepower.

Appendix 2

Ways of collecting Iron by the Kandyan kings through feudal system

During the Kandyan period, the production of iron has totally come under the state, and the state collected their iron requirements through a feudal system of tax-payment for using state lands for agriculture in producing their own foods (D'oyly 1929). In fact, the state has its iron-producing villages (gabada gam) where total production goes to the state and blacksmith villages were to exclusively produce the requirements of the state (Ruberu 2003).

After the conquest of kingdom of Kotte by Portuguese, they decided to continue the existing feudal system of collecting iron as taxes by the Sinhalese Kings. Portuguese literature give insights into the amounts of iron they collected from the territories ruled by them:

Place	**Amount (iron balls)**
Kuruwita Korale (Nugadanda and Kosgoda)	1500
Pasdun Korale (Bombuwela)	660
Atakalan Korale (Atakalanpanna)	1550
Dolosdahas Korale (Kirama)	2403
Meda Korale (Kirama)	240

Under this system, the state could have enhanced of the iron tax and collect more quantities of iron if a requirement increased. It is argued that the absence of production of high caliber canon type guns produced by using iron would be solely a technological issue rather than resource-availability.

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Geophysical Survey, Archaeological Risk Maps and Heritage Protection at Jaffna Fort and its Environs, Sri Lanka

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Abstract

Heritage has been identified as a major focus for introducing social and economic benefits through the promotion of tourism and associated infrastructure development within Jaffna and northern Sri Lanka. However, such initiatives and programmes also have the potential to damage or destroy undocumented and less visible subsurface heritage through encroachment and unchecked intrusive digging. In response, archaeologists from the Central Cultural Fund (Government of Sri Lanka), the University of Jaffna, the Postgraduate Institute of Archaeology Research, University of Kelaniya, the Department of Archaeology (Government of Sri Lanka) and Durham University's UNESCO Chair on Archaeological Ethics and Practice in Cultural Heritage undertook Ground Penetrating Radar (GPR) survey at several locations within Jaffna Fort and Jaffna town as part of the 'Jaffna Fort Post-Disaster Archaeological Research Project'. By identifying, mapping and characterising subsurface heritage within these open spaces, the team have been able to identify lost monuments of Jaffna Fort, including the remains of the Portuguese Our Lady of Miracles church, as well as previously unknown structures in historic Jaffna town, including a large potential Portuguese era church. These results not only provide indications of Jaffna's cultural past, but also through the development of provisional Archaeological Risk Maps, tools for the future protection of this finite and vulnerable heritage.

Keywords: *Archaeological Risk Maps, Geophysical Survey, Heritage Protection, Jaffna Fort, Jaffna Town*

Introduction

National and international tourism has been identified as a potential resource that can contribute to post-conflict renewal, peace-building and economic development in northern Sri Lanka. The role that heritage can play in this process has been highlighted by Professor Pushparatnam, who stated that "To promote cultural tourism in Northern Sri Lanka, we have to make a positive approach to popularize the cultural heritage symbols and monuments of this region, such as its ancient history and relevant historical sites and monuments. It will not only preserve the heritage symbols and promote cultural tourism, but also earn a lot of valuable foreign-exchange" (2014: 10).

However, there is also the possibility that infrastructure and amenities developed within such programmes, and unanticipated constructions linked to such projects, can risk damage to heritage, particularly the subsurface archaeological remains which are undetected and invisible below the current ground surface. Indeed, the Jaffna peninsula, and Jaffna town in particular, have recently seen developments of new constructions, including the newly built Jaffna Cultural Centre to the east of the Fort. Such activities are a concern without prior archaeological assessment. It has been identified elsewhere in South Asia, principally Nepal, that rapid and unchecked developments can destroy earlier phases of cultural heritage, particularly in areas that, though apparently empty of structures and monuments in the present, were not always devoid of habitation in the past (Coningham et al. 2018).

A collaborative team of archaeologists from the Central Cultural Fund (Government of Sri Lanka), the University of Jaffna, the Postgraduate Institute of Archaeology Research, University of Kelaniya, the Department of Archaeology (Government of Sri Lanka) and Durham University's UNESCO Chair on Archaeological Ethics and Practice in Cultural Heritage, undertook Ground Penetrating Radar (GPR) survey in 2018 to identify, map and characterise subsurface heritage within Jaffna Fort and locations throughout Jaffna town (Figure 1). Provisional Archaeological Risk Maps were then developed to help guide site managers on the risks to subsurface heritage through any potential future developments undertaken in these locations.

Materials and Methods

Geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance**.** As it was anticipated that the remains of limestone or fired brick structures might be present beneath the ground surface, potentially below the deposits of rubble and levelling. We selected Ground

Figure 1: GPR Survey Locations within Jaffna Fort and Jaffna Town

Penetrating Radar (GPR) for surveys within Jaffna Fort and at six locations within Jaffna town.

GPR generates a short high-frequency radar pulse, which is transmitted into the ground via an antenna; the energy is reflected by buried interfaces and the return signal is received by a second antenna. The amplitude of the return signal relates to the electromagnetic responses of different sub-surface materials and conditions, which can be features of archaeological or historic interest. The time which elapses between the transmission and return of radar pulses to the surface can be used to estimate the depth of reflectors. In addition to conducting traditional 2D area surveys, GPR also has a depth component which can be used to create pseudo-3D models of the data, provided sufficient data are collected at closely-spaced intervals; these models can then be viewed in the plan at selected depths known as 'time-slices'.

The GPR surveys were conducted using a Malå GeoScience RAMAC X3M radar control unit, mounted directly onto a 500MHz frequency shielded antenna. The antenna and control unit were mounted in a rugged cart with a RAMAC XV monitor attached and an odometer on one wheel to trigger the GPR pulses. Returned energy wavelets were recorded from many depths in the ground to produce a series of reflections at each location, called a reflection trace. Series of traces collected along each transect produce a radar profile or radargram. For these surveys, data traces were logged at 0.05 metre intervals along parallel traverses spaced 0.25 metres or 0.5 metres apart. The start and end points of the traverses were recorded using a Leica TS15i total station survey instrument and tied to the existing features. ReflexW v7.5 software was used to process the GPR profiles, to stack and interpolate the profiles to produce 3D data volumes, and to produce greyscale images of profiles and time-slices and develop archaeological interpretations. In some instances within Jaffna Fort, these interpretations were related to, and further characterised through, the results of archaeological excavation.

Results and Discussion

Within the Fort

Recent excavations within Jaffna Fort have identified traces of earlier phases of cultural occupation pre-dating European contact (Pushparatnam 2015; Davis et al. 2018) and GPR survey confirmed the presence of several anomalies below its Parade Ground (Figure 2). Although this area had been an open space since the Dutch remodelling of Jaffna Fort, several seventeenth century maps and plans indicated that structures were located throughout the interior during the Portuguese era (Nelson 1984; De Silva and Beumer 1988).

Figure 2: Geophysical Survey of the Parade Ground within Jaffna Fort

Strong reflections in the central part of the survey area indicate the probable remains of a large sub-circular or octagonal structure, measuring 30 metres across at a depth of approximately one metre. Its character and function remain unknown and do not appear to be related to any features present in maps or images of the Dutch or Portuguese Forts. A strong circular reflection, measuring approximately five metres in diameter, is clearly defined in the north-west of the survey and a similar feature has been detected in the south of the area, at greater depth, perhaps 0.65 metres, which could persist down to about almost two metres depth. These features may relate to wells that are pictured within views of the Dutch period Fort's interior (De Silva and Beumer 1988: 307, 309). This latter feature sits at the centre of a quadrangular enclosure measuring roughly 27 metres across at its widest, with walls measuring 1.3 metres wide at a depth range of between 0.7 and one metre. Appearing to form a cloister, with an additional 'annex', or some form of small defined space on its north-eastern side, this structure was on a slightly different alignment to the Dutch period structures visible on the surface today (Figure 3). It was postulated that, from its form and location, this anomaly may represent the foundations of the church 'Nossa Senhora dos Milagres de Jafanapatão' (Our Lady of Miracles), depicted in the centre of maps of the Portuguese period Fort (Schmidt et al. 2019).

Targeted excavations confirmed that these anomalies represented wall alignments from this Portuguese era structure that were robbed-out, possibly after damage incurred during the Dutch siege of Jaffna in 1658. The large limestone block footing in lime mortar was all that remained in the base of the foundations, which had cut through earlier occupation levels. The open robber cuts were then filled with broken coral pieces, brickbats and tile fragments as part of an episode of levelling to create the Parade Ground of the Dutch Fort.

Within the Town

Outside the Fort, surveys were taken within six locations that corresponded to areas of potential settlement within seventeenth and eighteenth century maps of Jaffna town (De Silva and Beumer 1988): Jaffna Car Park, Jaffna Car Park West, land opposite Jaffna Magistrates' Court, Jaffna Police Station, Jaffna's Thuraiyappa Stadium, Sports Stadium and St Anthony's Church.

At Jaffna's Thuraiyappa Stadium, Sports Stadium and Jaffna Car Park, little archaeological significance was identified. At St Anthony's Church, an open-air shrine on the south-west earthworks of Jaffna Fort, traces of the original rampart and landscaping of the glacis were identified. Rectilinear features identified in Jaffna Car Park West may

Figure 3: Detail of GPR survey results within Jaffna Fort

represent remains of the district of historic Welligame, and remnants of structures in the Jaffna Police Station, may be associated with historic Jaffna town. Similar features were identified in an open area opposite Jaffna Magistrates' Court (Figure 4). In addition to near surface rectilinear anomalies reflecting recent constructions, the GPR survey of an area measuring 99 by 60 metres, rectangular anomalies in the north and a possible street front of rectilinear features running across the south were identified (Figure 5). These too are likely to represent remnants of settlement within the historic Jaffna town.

The presence of a monumental structure was detected in the empty plot opposite the Magistrates' Court. The plan was strikingly similar to the layout of a church, particularly Portuguese monuments built in South Asia during the sixteenth and seventeenth centuries, those in Goa such as the Church of St Anne, Talaulim, and the Church of Our Lady of Rosary, Old Goa (Rajagopalan, 1987; Pereira 2002). The monument uncovered in the field opposite the Magistrates Court is aligned to the coastline on a broadly north-east/south-west, axis, whereas it is usual for the apse to point exactly east. It appears that the orientation of this church may have been determined by pre-existing town plans and the space available at the time of construction. Its orientation

Figure 4: Empty plot in Jaffna Town opposite the Magistrate's Court

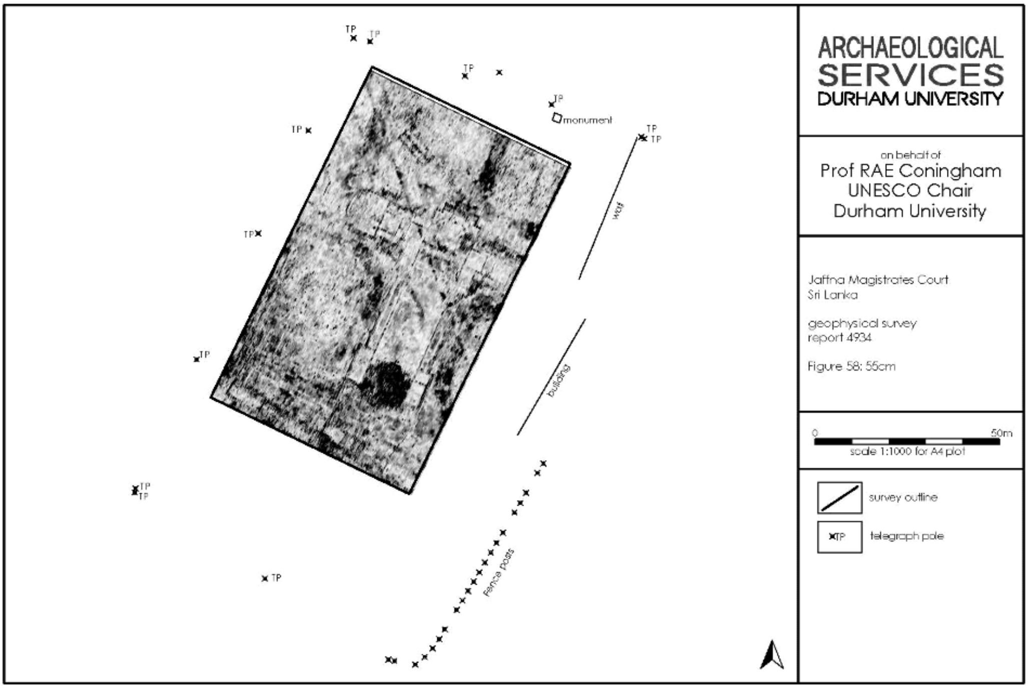

Figure 5: GPR Survey results opposite the Magistrate's Court

towards the coastline also matches that of the Our Lady of Miracles Church identified in the centre of Jaffna Fort, and is fairly similar to that of the Dutch Kruys Kerk, which may suggest a localised construction tradition for the alignment of Church buildings.

Although the alignment is slightly different, the layout uncovered is typical of a cruciform church. The southern end of the building is in part obscured by a circular spread of rubble or similar, but there are clear indications of a narthex or atrium, flanked by additional rooms, possibly tower bases, followed by a nave with aisles along each long side, then two substantial transepts to either side, a crossing and a chancel. The chancel is most evident in time-slices between 10-15ns, c.0.5-0.75 metres depth, although it becomes less evident with depth and obscured by a large circular feature. In the survey data, an apse does not appear at the northern end (the liturgical 'east' end) (Figure 6).

The church measures approximately 55 metres in length, while the southern ('west') end of the church measures approximately 21 metres in width; the nave, including its relatively narrow aisles, measures approximately 19 metres in width. At the north end of the nave, the church widens again to 21 metres, then the transepts extend a further 21 metres to each side. Each transept is clearly divided into several smaller spaces, some of which will almost certainly be chapels. Strong reflections in some of the spaces in the

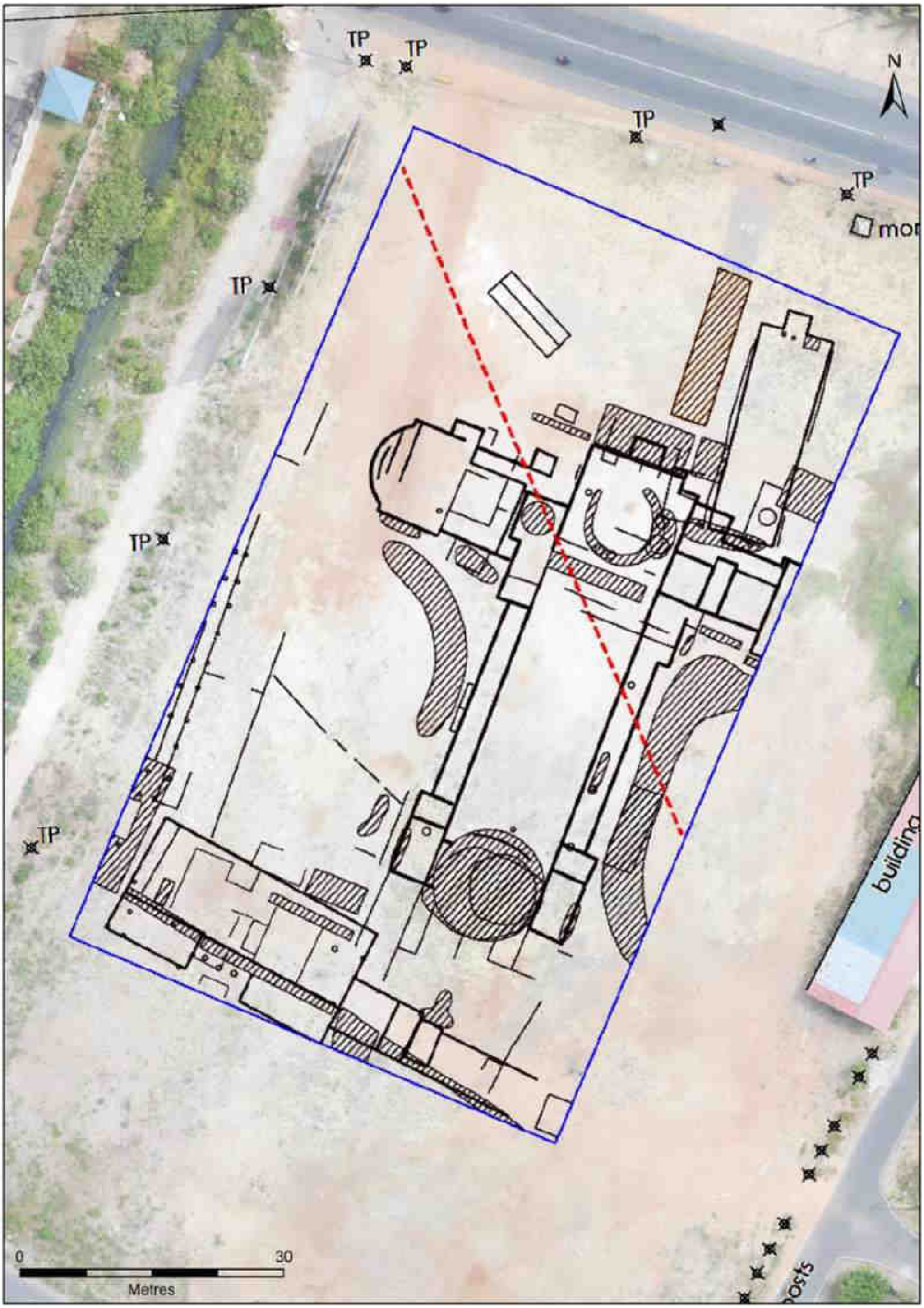

Figure 6: Archaeological interpretation from GPR survey opposite Jaffna's Magistrates' Court

western transept could possibly indicate the survival of floors there, just beneath the present ground surface. The eastern end of the east transept extends beyond the edge of the surveyed area. The chancel extends approximately 7.5 metres north-east beyond the crossing and transepts.

These features were found below high amplitude reflections located across the survey area at a depth of c.0.35 metres possibly indicating a rubble deposit, or levelling layer. This is reminiscent of the sequence within the interior of Jaffna Fort and the robbed-out remains of the structure identified as the Portuguese period Our Lady of Miracles church. Whilst further research and archaeological investigations are required, there is a strong possibility that the church identified through GPR survey in the area opposite Jaffna Magistrates' Court was a Portuguese era construction and, like the Our Lady of Miracles church, was damaged and robbed-out for building material and then levelled after the Dutch siege of Jaffna Fort and town. We note from a recent google earth satellite image that this plot is now being built on, resulting in the destruction of an unrecorded part of the history of Jaffna Town, a part which if properly researched might also have cast more light on Jaffna's rich but buried pre-colonial maritime past (Pushparatnam 2015; Davis et al. 2018). This unfortunate situation reinforces the necessity to undertake more archaeological geophysics survey in advance of development as well as the completion of heritage impact assessments prior to construction or intrusive activities to better protect and understand the sequences of Sri Lanka's rich cultural heritage.

Conclusion

Recent GPR surveys have uncovered previously lost, and also unknown, structures and phases of occupation within Jaffna Fort and town, highlighting areas that appear to be open but which are, in fact, locations of culturally rich archaeological sequences that require enhanced protection from intrusive developments. This is pertinent in relation to developments within Jaffna Fort and for future rehabilitation of the Kruys Kerk, as well as protection of areas within Jaffna town outside the ownership of the Department of Archaeology and Central Cultural Fund (Government of Sri Lanka). This evidence not only provides future research trajectories can also facilitate the development of provisional Archaeological Risk Maps. Archaeological Risk Maps provide a visual guide for site managers, statutory authorities and developers of areas where archaeological remains are at potential risk from intrusive development and display these through a traffic light system of red through amber to green. First developed at Lumbini, Nepal (Coningham & Acharya 2013), five different risk factors, from Very High Risk through to Very Low Risk are allocated, with recommendations for site managers and planners on how to guide the subsequent physical planning and development within a site.

It is recommended that areas highlighted as 'Very High', 'High' and even 'Medium' Risk, should have no intrusive development whatsoever – everything should be 100% non-intrusive and fully reversible. Intrusive activities include the use of mechanical diggers and heavy machinery, soil extraction and the digging of foundations. Areas that are 'Very High' and 'High' should remain as pristine as possible. Development in areas of 'Medium Risk' should be fully reversible and sympathetic to the material and character of the archaeology of the site (Table 1). Areas of 'Low' and 'Very Low' Risk indicate areas where there is little risk to archaeological structures or material; however, any development should still be avoided where possible and again this should be non-intrusive and fully reversible.

Table 1: Risk Categories and Recommendations for Archaeological Risk Maps.

Very High Risk	These areas contain the most important archaeological remains in Jaffna and are of significance not only for understanding the development of the site, but also Northern Sri Lanka. No intrusive activities should be undertaken, and any development, such as visitor infrastructure (i.e. new walkways), must be completely non-intrusive and fully reversible, and use appropriate and sympathetic materials. Any existing modern structures should be removed, and any current damaging activities should be stopped. This land should be immediately purchased to ensure its long-term protection and that no further intrusive development should be allowed in this area.
High Risk	These areas contain important archaeological remains that are of significance to understanding the development of Jaffna. No intrusive activities should be undertaken, and any developments must be completely non-intrusive, fully reversible and use appropriate and sympathetic materials. Any existing modern structures should be removed, and any current damaging activities should be stopped. This land should be immediately purchased to ensure its long-term protection and that no further intrusive development should be allowed in this area.

Medium Risk	These areas contain or may contain archaeological remains that can inform us about the development of Jaffna. Development in these areas should be avoided, although there is no pressing need to remove existing modern structures. However, it is important that any development aims to be non-intrusive, fully reversible and use appropriate and sympathetic materials.
Low Risk	These areas contain minor archaeological remains, which may be able to inform us about the development of Jaffna. Development in these areas is possible, but should be non-intrusive, fully reversible and use appropriate materials. Landscapes should be kept simple and any alterations should be kept to a minimum.
Very Low Risk	These areas contain no archaeological remains, and any developments that are required should be focused in these areas. However, such developments should be fully reversible and use appropriate materials.

These maps are designed to be used as a guide for planning and managing future developments, land purchase and land controls. They should not be taken as a complete map of the presence or absence of archaeological material, but as an indication of the risk to subsurface material. It is recommended that any developments within these locations should be avoided wherever possible and if deemed essential, strictly monitored through rescue excavations and/or watching briefs. A provisional map for within the Fort has been developed here (Figure 7) as the heritage of Jaffna is a finite resource, and cannot be recovered once damaged, encroached upon or destroyed. Moreover, we reiterate the need for more archaeological geophysics survey in advance of development as well as the completion of heritage impact assessments within Jaffna Town prior to construction or intrusive activities to better protect and understand the sequences of Sri Lanka's rich cultural heritage.

Acknowledgements

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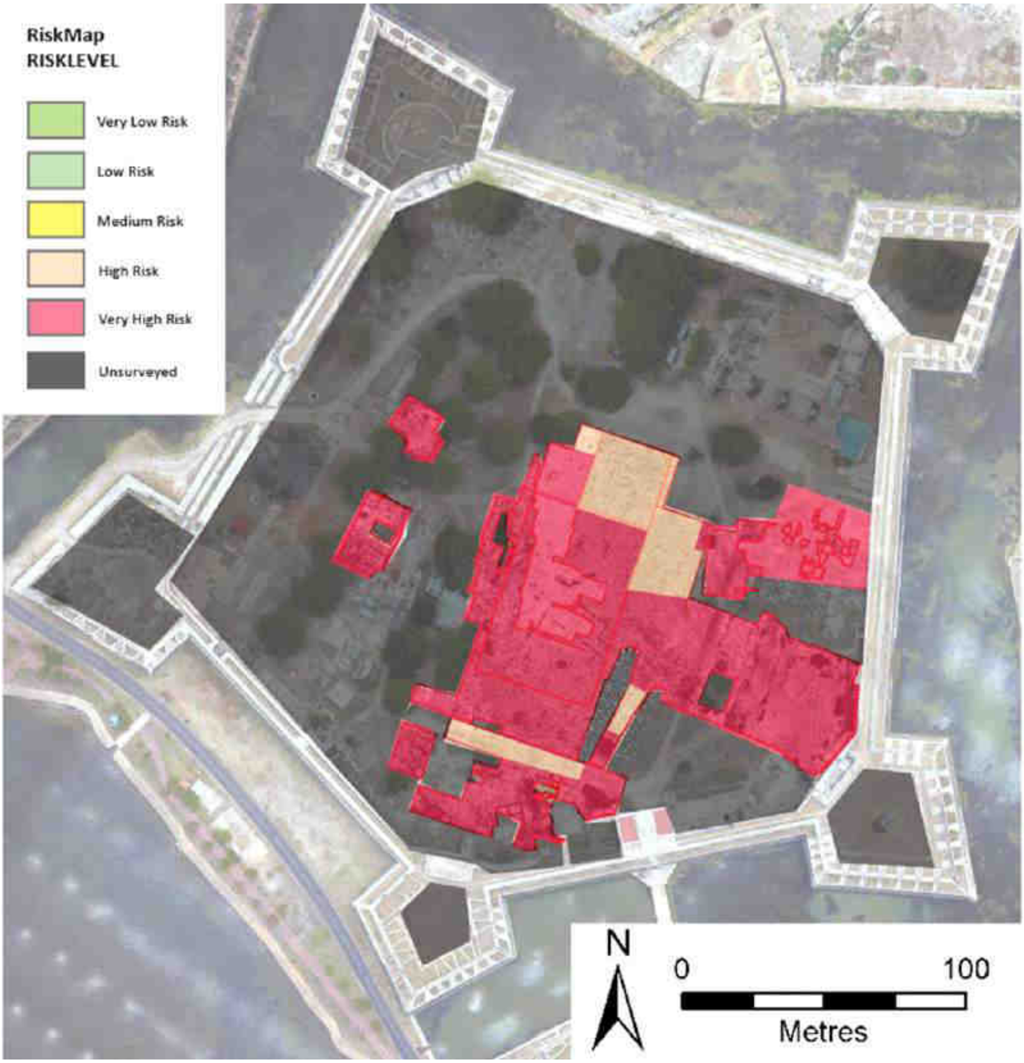

Figure 7: Provisional Archaeological Risk Map for areas surveyed by the GPR within Jaffna Fort

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Collapse or Transformation?
The end of the Anuradhapura Kingdom, Sri Lanka

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Abstract

This paper reassesses the historical description of Anuradhapura's "collapse" and abandonment through explicit reference to the archaeological record. After summarising the textual narrative of Anuradhapura's late 10th, early 11th century "collapse" the paper examines the archaeological record within Anuradhapura's Citadel, Sacred City, and Hinterland for evidence of crisis, invasion and destruction, and abandonment.

Keywords: *Anuradhapura, City, Sangha, Transformation*

Introduction

For around fourteen-hundred years Anuradhapura dominated Sri Lanka; the stupas of the Sacred City towering over the island's northern plains, its enormous reservoirs irrigating huge tracts of otherwise arid land, and its Kings and Queens exerting their power over the entire island. We have historical accounts of Buddhist pilgrims travelling from as far away as China in the east (Hulagalle 2000: 14), while Sri Lankan diplomats were sent as far as Rome to the west (ibid.: 2), while trade from East Asia and the Persian Gulf flowed through the island and its capital for centuries (Coningham 1999 & 2006). For almost one and half thousand years Anuradhapura not only survived (in what might easily be described as a marginal environment) but flourished as a seat of Buddhist teaching and learning, thrived in its hydraulic engineering and agricultural productivity, and firmly established Sri Lanka as a hub of Indian Ocean Trade.

However, by the time the Portuguese invaded Sri Lanka in the 16th century, the northern plains of the island were largely abandoned, and when the British sailor Robert Knox travelled through the Anuradhapura region in the 17th century he described "*a world of hewn Stone Pillars, standing upright, and other heaps of hewn stones, which I suppose formerly were buildings*" (Knox 1681: 256 & 265).

Anuradhapura's reign had clearly ended - but what happened? What transformed this great kingdom and city into an overgrown forest of stone pillars and crumbling stupas? In search of answers, scholars turned to Sri Lanka's great Pali chronicles, specifically the *Culavamsa*.

The Chola Invasion

The *Culavamsa* describes a tenth century crisis resulting in Anuradhapura's sacking in the early 11th century CE by the Chola Empire, and directly resulting in the abandonment of Anuradhapura – with power and royal rule moving to Polonnaruva. Codrington, writing in 1960, described how Sena V;

> *"murdered his general's brother with the result that the general rebelled, went to India, returned with an army, and though he allowed the king to retain his throne, "made over the country to the Tamils", that is the mercenaries. Anuradhapura was indeed so full of these... that Sena's successor Mahinda V found it difficult to govern; in his twelfth year the revenue being withheld he could not pay his hired troops, and on their rising fled to Ruhuna" (Codrington 1960: 94).*

Here, the *Culavamsa* appears to blame both Sena V and Senapti Sena for these events. While the execution of Mahamalla (Senapti Sena's brother) by the 12-year-old monarch is excused (*Cvs*.liv.57), describing how Mahamalla, had "*committed an offence with his mother*" (the Queen) (*Cvs*.liv.60), Senapti Sena is blamed for hiring a mercenary army of some 95,000 Tamil soliders into the country, whereupon he "*gave over the country to them*" (*Cvs*.liv.64) resulting in after which they "*plundered the whole country like devils and pillaging, seized the property of its inhabitants*" (*Cvs*.liv.66-67). Compounding this situation King Sena V, allowed by Senapti Sena to return to power in at least name, is described as effectively drinking himself to death at just 22 years old; "*After taking intoxicating drinks he was like a wild beast gone mad. As he could no longer digest food the Ruler... died in the tenth year (of his reign)*" (Cvs.liv.185) after being misled by "*evil friends*" (Geiger 1929: 185).

Sena V was succeeded by his brother, Mahinda V (r. 982 - 1029 CE), the last Sri Lankan king to rule from Anuradhapura (Coningham 1999: 157). Unfortunately, Mahinda "*wandered from the path of statecraft and was of very weak character*" and as a result the "*peasants did not deliver him his share of the produce*" (Cvs.lv.3). The *Culavamsa* then describes how, by the tenth year of his reign, Mahinda had "*entirely lost his fortune*" and was left unable to pay his Tamil mercenaries (*Cvs*.lv.4) resulting in their going on strike, besieging the palace and even blocking food from entering to the king, declaring that; "*So long as there is no pay he shall not eat*" (*Cvs*.lv.6).

However, Mahinda was able to escape through a hidden tunnel – fleeing to Ruhuna (*Cvs*.lv.7-8), abandoning the rest of the island to be governed as the mercenaries saw fit (*Cvs*.lv.12-13). News of this conflict and power vacuum reached the Chola ruler, Rajaraja I, (Cvs.lv.13-14) and Rajaraja; "*took advantage of this state of affairs and conquered much of the Island. Ceylon* [sic]*, save for the remote parts, was now a province of the Chola Empire, with its capital at Polonnaruwa, surnamed in the Chola manner, Jananathapura*" (Codrington 1960: 94).

The *Culavamsa* goes on to describe the subsequent victory of Vijayabahu I over the Cholas several decades later, and the relocation of the Sinhalese capital to Polonnaruwa, without ever giving a reason for the abandonment of Anuradhapura by subsequent monarchs, beyond the description of the city as "*utterly destroyed in every way by the Chola army*" (Cvs.lxxiv.1).

However, after more than a century of archaeological investigations in and around Anuradhapura, this narrative of destruction and collapse is arguably not really supported by the archaeological evidence.

The City

It is important to stress that Anuradhapura was never a western city as defined by Childe's seminal paper on urbanism (1950). Instead, Anuradhapura is perhaps best described as a low-density urban settlement (Lucero *et al*. 2013), and one that, archaeologically at least, can be best understood as three distinct zones; a fortified royal Citadel of around 100ha in the centre; a surrounding monumental monastic zone (the Sacred City) measuring around 25km^2; and an expansive and heavily populated hinterland beyond that (Coningham *et al*. 2007: 703). However, none of these zones evidence significant destruction at the hand of the invading Cholas or indeed the rampaging Tamil mercenaries, nor do they arguably evidence collapse or complete abandonment (see Strickland 2017; Manuel *et al*. In Press).

The Citadel

At the centre of Anuradhapura lies the Citadel, a sub-rectangular walled enclosure measuring around 1km^2 that is home to royal palaces and Buddhist shrines. Archaeological investigations here have shown a continuous cultural sequence running from the site's earliest form as an Iron Age village through to the monumental stone pillared palaces and shrines of the mediaeval period (Coningham 1999; 2006). The Citadel effectively represents the seat of "secular" power in Anuradhapura, the royal palaces – and although we see no archaeological evidence of a Chola invasion within the Citadel - no direct evidence of violence, no Chola artefacts, no "destruction horizon" - here, we do see evidence of a late crisis.

Coningham's excavations at ASW2 identified a late phase (C,D & E) marked by endemic levels of robbing activity rather than new structures, seemingly focussed upon the recycling of earlier construction materials. At ASW2 this crisis takes the form of 17 robber pits measuring up to 40.0 cubic metres in volume (Coningham 1999: 80). Coningham interpreted this as evidence of the excavation and reuse of stone blocks, bricks and other construction materials on a systemic level (*ibid.*).

However, this robbing activity was not confined to the area of the 10m x 10m ASW2 trench – indeed, it appears to have been near universal across the Citadel, seen in the artefactually mixed "*rubbish heaps belonging to the upper stratum*" described by Paranavitana (1936: 11) during his excavations at Building A. Paranavitana also described similarly disturbed deposits present at the Mahapali excavations (1936: 26), where both the Daldage and Mahapali structures were severely damaged by such robbing (*ibid.*). Similar robber pits were identified in every one of Deraniyagala's 13 sondages

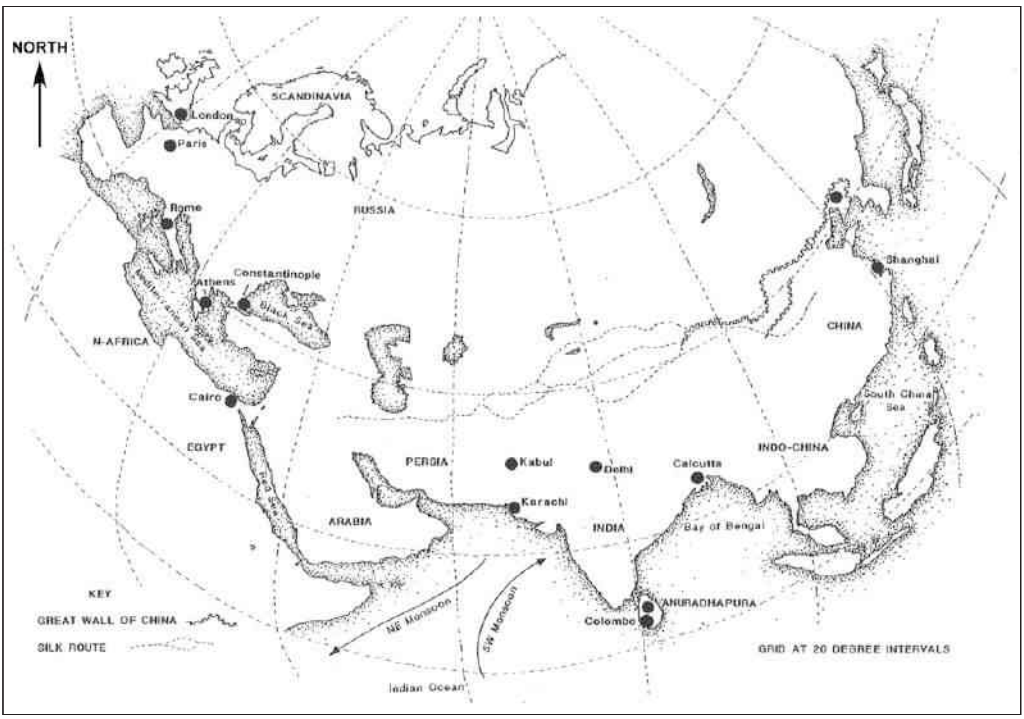

Figure 1: Anuradhapura within the Indian Ocean (after Coningham 1999: 05).

(Coningham 1999: 80), and Deraniyagala's excavations at the Gedige, corresponding to his stratum 6, 8 and 9 (Deraniyagala 1972: 59) as well as stratum Ia (Deraniyagala 1986: 39). In all cases Deraniyagala describes "*structural detritus*" within extensive robber pits, as well as "*artefacts in random orientation*" (i.e. *ex situ*) (*ibid*.). Such mixed deposits and intrusive cuts were also identified in the excavations at the southern ramparts of the Citadel (Ueyama & Nozaki 1993: 30), where the disturbed strata (Phase III) were described as consisting of "*largely disturbed and cut-pits containing many brickbats*" (*ibid*.).

Reused materials can be seen in several structures within the Citadel, but perhaps most significantly (and most substantially), we see them in the later phases (phase 6) of the ramparts (Coningham & Cheetham 1999: 54). This work appears to have been carried out in a hurry, and at a time of vastly reduced resources, with structures within the Citadel cannibalised in order to provide building materials for this reinforcing and expanding of the ramparts (ibid.). While there are many symbolic reasons for the construction of ramparts around a settlement (see Uziel 2010 for full discussion), the hurried expansion of the existing ramparts (already well over 4m in height), at the cost of the very structures the ramparts are protecting, appears likely to be a direct response to perceived external threat.

While the dating for this activity is comparatively imprecise, we might attribute the work to either the civil unrest caused by the 95,000 Tamil mercenaries brought over by Senapti Sena in the 10th century (*Cvs*.liv.64), or indeed the besieging of the Royal Palace by the same Tamil mercenaries a generation later after Mahinda V was unable to pay them (*Cvs*.lv.4-6) – the very events that the *Culavamsa* attributes with sparking the subsequent Chola invasion. Consequently, while it is impossible to archaeologically identify the supposed Chola sacking of Anuradhapura, the structural robbing, extension of the ramparts and the subsequent period of abandonment (seen in the slow siltation of the robber-pits (Coningham 1999: 80)) clearly identify a late phase crisis within Anuradhapura's Citadel.

And, the 11th and 12th century structural phases of the Citadel do show a clear change from the earlier fluorescence. It would appear that during this phase the inhabited area of the Citadel was reduced from 100ha to around 70ha. Ayrton (1924) excavated a large area to the west of the Gedige, exposing approximately six structures cardinally oriented along a road running north-south (*ibid*.: 51). Only the foundations, of these structures survived and these were constructed with reused brickbat and worked stone from earlier periods (*ibid*.), as was also seen in both ASW2 and Paranavitana's excavations. The superstructure of these "houses" appears to have been comparable to what Ayrton describes as "*modern peasant*" houses - with wattle and daub walls and cadjan leaf roofs (Ayrton 1924: 51).

However, we do also see later monumental construction within the Citadel – from the brick edifice of the Gedige, which Burrows described as looking "*...like a bit of Polonnaruva suddenly transplanted to this capital*" (Burrows 1886: 6), to "Vijayabahu's Palace". Frustratingly, the latter was completely excavated and restored between 1949 and 1950 with no excavation report published (Coningham 1999: 21). This structure, located in the southwest corner of the Citadel, has been loosely interpreted as an eleventh century construction by Vijayabahu following his reclamation of the city around 1070 CE, and has also been linked to Parakramabahu's apparent restorations at Anuradhapura (*Cvs*. xxiv.8-11) in the twelfth century AD (Coningham 1999: 21). It is interesting to note that rather than the classic Anuradhapura period granite or even limestone pillars, "Vijayabahu's Palace" made extensive use of wooden pillars and featured almost no decorated or finely carved stonework – again this is at odds with the classic Anurahdapura architecture of earlier periods, but again similar to structures at Polonnaruwa (Seneviratna 1994: 138).

Artefactually, there is a clear economic downturn between the fluorescence of Anuradhapura in the early 1st millennium CE and the 10th / 11th century CE, reflected in the specialised manufacturing of stone and glass beads, the production of the glass ear reels, as well as in the architectural forms discussed earlier. A similar change is also seen in the quantities of long-distance trade goods within the Citadel, though these appear to peak later. It is also interesting to note that the long-distance trade appears to have been primarily focussed upon the west, with the eastern trade only really picking up around the eighth or ninth century CE (Strickland 2017: 86).

The Sacred City

The Sacred City, with its monumental stupas, is composed of some 25km^2 of Buddhist structures (monastic complexes, shrines, temples etc.) belonging to the three great viharas; the Mahavihara, Abhayagiri Vihara, and Jetavana Vihara – each for the most part each within its own distinct area (Figure 2). Writing in 414 CE, the Chinese pilgrim Faxian described Anuradhapura as home to over 10,000 monks and nuns (Bandaranayake 1974: 7), a figure that Bandaranayake estimates "*had surely doubled or trebled*" prior to Anuradhapura's 11th century collapse (*ibid*.).

However, despite its scale and splendour, archaeologically it contributes very little here – despite substantial excavations at both Jetavana Vihara (e.g. Ratnayake 1984)

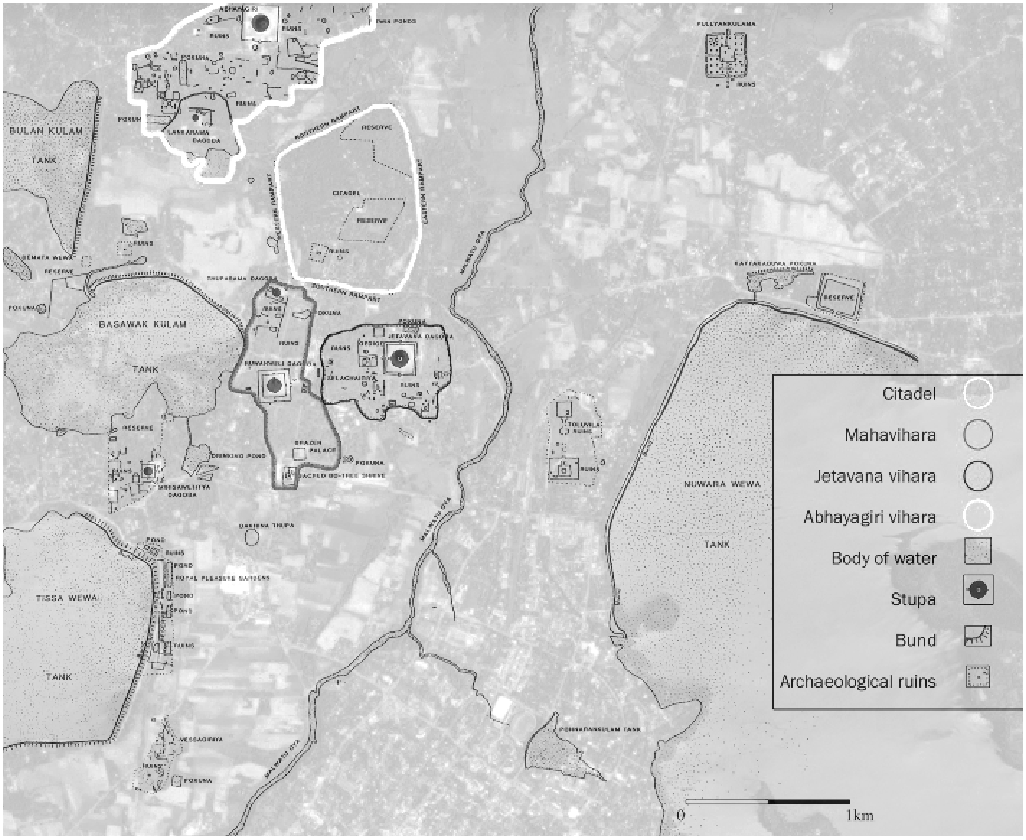

Figure 2 : The Citadel and Sacred City of Anuradhapura (after Coningham 1999: 29).

and Abhayagiri Vihara (e.g. Wikramagamage 1984 & 1992). Perhaps unsurprisingly, as in the Citadel, we see no evidence of a terminal sacking – Chola or otherwise – there are no signs of violence, no Chola artefacts, no "destruction horizon", burning or similar. However, significantly, the Sacred City does not appear to show the endemic structural looting that so disturbed the latter phases of the Citadel, and there is absolutely no archaeological evidence to suggest that the Sacred City was in any kind of crisis or decline prior to its abandonment around the 11th century CE. Indeed, if anything the Sacred City is flourishing, with the construction of the Western Monasteries in the north-western suburbs of the Sacred City around the late 9th or early 10th century CE (Wijesuriya 1998), as well as the ongoing maintenance and upkeep of the rest of the Sacred City.

That said, we do see the re-use of earlier materials in some late period ephemeral structures within the Sacred City. At AVP site three stone balustrades and bricks from earlier structures were used in an ephemeral structural enclosure with what appears to be a human inhumation just outside it (*ibid.*: 18) along with "some stone cists", crude pottery that resembled Polonnaruwa period wares and what appears to be an area of metalworking or a small smithy (Wikramagamage *et al*. 1983: 352). Several similar structures were found nearby (*ibid*.) suggesting that during Period B occupation of the Sacred City continued along with industrial activity, but perhaps in a slightly reduced fashion. It is also worth noting the later period appearance of possible Hindu temple forms within the Sacred City, such as the so called “Hindu ruins” (Bell 1904: 5) the *Thuparama patimaghara* (the so called “Trident Temple”) which displays Brahmanical influences in its floor-plan, and has far more in common with Saivite shrines from Polonnaruwa and South India than the other *patimagharas* of Anuradhapura (Bandaranayake 1974: 199). However, these interpretations are uncertain and a strong case could be made for Mahayana Buddhist influences rather than Saivite Hindu ones (Strickland 2017: 107).

As at the Citadel, and despite references throughout the Abhayagiri Vihara Project excavation reports to the “Chola invasion” (e.g. Wikramagamage *et al*. 1983: 48; Bouzek *et al*. 1986: 255; Bouzek 1993: 17) there is no direct archaeological evidence of a Chola presence within the Sacred City; no Chola coins, inscriptions, weaponry, graffiti, regalia etc. (Strickland 2017: 106-107).

The Hinterland

Recent survey of Anuradhapura's hinterland (Coningham & Gunawardhana 2013) found that throughout the Anuradhapura period it was characterised (Figure 3) by small, short-lived, and mobile rural settlements alongside long-lived and static monastic sites (Coningham *et al*. 2007). Moreover, these monastic sites, most commonly located

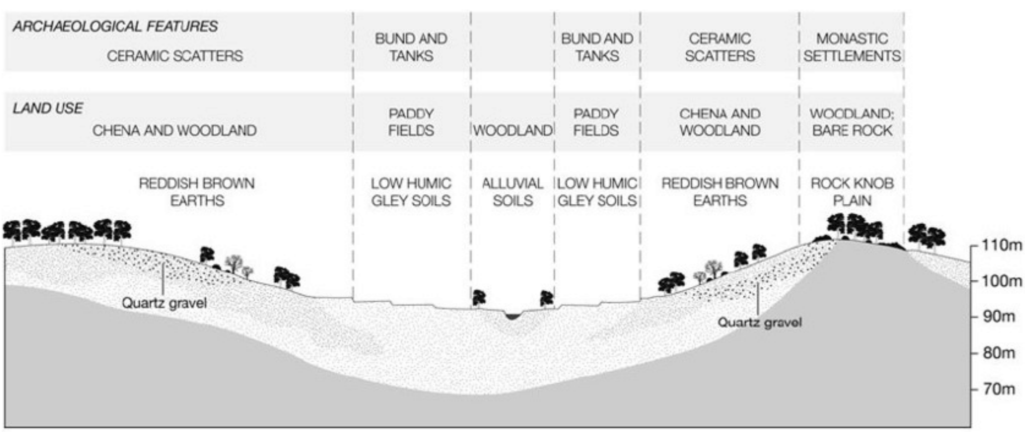

Figure 3: Diagrammatic topographic representation of the Anuradhapura hinterland (Gilliland et al. 2013: 1014).

upon the numerous granite ridges that traverse the landscape, were commonly associated with both industrial activity and hydraulic features–most notably tanks (*ibid*.). Unfortauntely, phasing the rural settlements is extremely difficult, and at this point it is impossible to identify significant populations trends in the settlements themselves. However, the hydraulic landscape can be dated a little more precisely.

The hydraulic infrastructure of the hinterland represents a colossal and sustained investment, and as established, a critical investment for the maintenance of any sedentary communities in the northern Dry Zone – without which such communities would be impossible (Farmer 1954: 23; Jayatilaka *et al*. 2001: v). Developed and constructed between c.400 BCE and c. 450 CE, this hydraulic system depended upon a combination of both the numerous small-tank cascades within the valleys of the undulating landscape (Farmer 1954: 23-25; Jayatilaka *et al*. 2001: 3) and canals with a bund on the lower side only, thus trapping rainfall run-off from the higher ground and diverting it into tanks (Karunananda 2006: 264), as well as a number of larger tanks that functioned as both "*drought hazard mitigation structures*" and "*flash flood moderators*".

Although the hydraulic landscape was established long before the final centuries of the Anuradhapura period, the ownership and administration of this landscape is still important in understanding Anuradhapura's collapse. Across the Anuradhapura hinterland, thousands of small tanks can be found in the vicinity of villages. These smaller tanks are typically constructed by building an earthen bund transversely across a natural drainage and damming up the seasonal water flow from rainfall and run-off behind this bund (Jayatilaka *et al*. 2001: 3).

By the 19th century the majority of such small tanks were owned by their respective villages (Karunananda 2006: 246), but it is clear from historical records that during the Anuradhapura period these tanks were owned either by private individuals or by the *sangha* (Paranavitana 1958: 01; Seneviratna 1989: 33). This involvement in irrigation management and ownership by the *sangha* appears to have started gradually but accelerated rapidly, including the direct donation of tanks or canals to monasteries (*ibid*.: 105 & 108). Indeed, judging by epigraphic records this practice increased dramatically during the final centuries of the millennium (Dias 1990: 151) so that by the end of the tenth century CE the *sangha* appears to not only be the primary management of the wider hydraulic system, but also the primary economic beneficiaries (Gunawardana 1979: 58).

This hydraulic system appears to have been abandoned around the 12th century CE with channels and tanks beginning to silt up (Gilliland et al. 2013: 1026), suggesting the widespread abandonment of the hinterland (ibid.). However, the hydraulic landscape appears to have been functioning until then – suggesting that the abandonment was part of the wider shift to Polonnaruva, and the reigns of Vijayabahu I and Parakramabahu I.

The Economic Role of the Sangha

If we see no significant archaeological evidence of Anuradhapura's destruction why did Vijayabahu not restore Anuradhapura as capital? Why abandon the huge investment, the economic productivity, that the hydraulic hinterland represented? Why did he, and subsequent Sinhalese monarchs, rule from Polonnaruva rather than from Anuradhapura, a city; "*specially deserving of honour, since its soil was hallowed while he lived by the feet of the Master, distinguished by the wheel with its thousand spikes and its rim, and because it was the place where the southern branch of the Sacred Bodhi tree (was planted) and where a dona of relics was preserved*" (Cvs.lxxiv.2-4)?

One possible answer lies in the role that the sangha played in the economic administration of Anuradhapura. Recent archaeological research within the Anuradhapura hinterland has proposed that Buddhist monasteries within the hinterland performed the; "*...administrative, economic and political functions usually associated with towns*", acting as a network for; "*...production and the accumulation of economic surplus*" (Coningham *et al*. 2007: 717). This administrative network had developed over centuries, with the three major fraternities of the Sacred City wielding huge wealth and power, not to mention the countless monastic sites within the Anuradhapura hinterland that were occupied throughout the Anuradhapura period, were the *only fixed sites* within that landscape (ibid.: 709-10), and which, as already discussed, were heavily involved in the administration, ownership, and economic benefit of and from the hydraulic hinterland surrounding the city.

Individual members of the *sangha* were prohibited from owning or even using money (Olivelle 1974: 61), and though the storage of goods was considered a practical necessity, they were also forbidden from engaging in trade (*ibid*.). However, from the beginning of Indian Ocean trade in the Early Historic period we see a synergy between Buddhist monasteries and trade centres (Ray 1989: 437 & 456), with monasteries initially clustering along trade routes (*ibid*.: 455) before becoming directly involved in the trade, and through that involvement accumulating significant wealth (Kosambi 1955: 60-61). Furthermore, the *sangha* was formally recognised as an incorporate body, and while individual members were not permitted to own property, the *sangha* as a body could (Liyanarachchi 2009: 105).

There can be little doubt that by the tenth century the *sangha* had become both powerful and wealthy (Dias 2001; Liyanarachchi 2009: 102), due in no small part to the tradition of donative *sannas* granting lands, immunities and other resources such as water rights to monasteries (Gunawardana 1979: 58; Dias 1990: 151; Liyanarachchi 2009: 106-108). This practice started around the second century BCE (Seneviratna 1989: 32) and continued throughout the following centuries – increasing dramatically during the final centuries of the millennium (Dias 1990: 151). These grants donated a range of facilities and were gifted by kings, officials and private individuals (Liyanarachchi 2009: 106). They typically granted exemption from taxes, barred royal officials from entering the specified area, and/or exempted villagers living within gifted lands from *vari* or forced labour - including working on maintaining the hydraulic landscape (Dias 1990: 154-55). Indeed, from epigraphic evidence and from clarifications of *vinaya* within the *Samantapasadika* (e.g. Kopp 1977 vol.3: 121-124, 345-346, 679), it would appear that the influence and control that the *sangha* wielded over the hydraulic system of Anuradhapura had grown steadily throughout the first millennium CE, resulting in the creation of ever increasing quantities of legislature to control access to and management of that system (Paranavitana 1958: 3; Seneviratna 1989: 125).

These immunities were granted in perpetuity to institutions that had, by the tenth century, often existed for a thousand years, and so each grant reduced the resources that the monarchy ruled over. Conversely, as the estate of the monarch was weakened, the *sangha* became ever more powerful and wealthy as the land and resources they commanded grew steadily larger (Liyanarachchi 2009: 108). This led to the *sangha* wielding increasing influence upon the general populace, both spiritually and economically, forcing the monarchy to woo the *sangha* to ensure a good relationship and to maintain peaceful and successful governance (Rahula 1993: 70). The relationship between monarch and *sangha* was always a complex one, with the monarch regarded as both the secular head and defender of the *Sasana* (Rahula 1993: 66), a role that variously saw different monarchs command, serve, and come into conflict with the *sangha*. The latter appears to have been a reasonably common occurrence, and from time to time the monarch would "purify" the *Sasana*, "*...whenever they found it to be disorganised or corrupt*" (*ibid*.: 67).

However, such a balance was undoubtedly extremely difficult, and would only have been possible for the more powerful monarchs (Liyanarachchi 2009: 111). Clearly the relationship between the *sangha* and royalty, while not always harmonious, was vital in legitimising royal rule (Houtart 1977: 208), as well as in providing the connection between the rural production of surplus, and the centralised collection and storage of that surplus (Coningham *et al*. 2007: 717). It is worth noting in passing, that the Burmese historian, Michael Aung Thwin, has made a strikingly similar argument for the collapse of the Pagan Kingdom in mediaeval Myanmar (Aung Thwin 1985).

"Collapse" or Transformation?

By around the ninth century CE the economic and political structure of Sri Lanka had crystallised over move than a millennium. Phillips (1979: 138) has suggested that, "*the problem is not that states collapse... but rather that some states last so long*". Phillips argued that it takes time for a state to utilise its resources efficiently (*ibid*.: 140), however, efficiency results in a lack of flexibility in resource allocation (*ibid*.).

Phillips argued that during its early phase a state controls a large and expandable resource base, but has not yet developed the institutions to efficiently exploit this resource base. At this time a large proportion of these resources will be utilised in non-critical ways (for example monumental construction). This can be seen in the case of Anuradhapura in the construction of both the gigantic stupas and monumental tanks, all of which were constructed between the third century BCE and the fifth century CE. This results in the creation of a hidden resource reserve, as such non-essential activities can be suspended at times of crisis (*ibid*.). Over time social and political institutions emerge to efficiently exploit these resource bases, and in turn use greater resources themselves (*ibid*.: 141). Eventually the state reaches a point where the majority of resources are allocated to supporting these institutions, leaving no reserves and thus no flexibility in resource allocation, leaving the centre susceptible to disruptions (Phillips 1979: 142).

Here it is possibly helpful to integrate Tainter's (1988) *Marginal Productivity of Increasing Complexity* model with Phillips' (1979) *Insufficient Response to Circumstances* model. At its most basic, Tainter's model argues that more complex societies are costlier to maintain, and as societal complexity increases so too does the cost (Tainter 1988: 93). Eventually that cost reaches a point of diminishing marginal returns, at which time increased investment fails to yield proportionately increased returns. The marginal costs continue to increase, but the marginal returns decline and the very complexity that so defines that society becomes increasingly costly, less productive and thus less beneficial to the members of that society (*ibid*.: 121). At this point the state is now vulnerable to what Phillips terms "historical accidents"; the crises that an emerging state would manage comfortably, but that a society experiencing declining marginal returns, a state already operating at peak efficiency in a challenging environment, simply cannot respond to – leading to collapse.

Conclusion

Except of course, the Anuradhapura “collapse” is not truly a collapse at all. As has been shown, there is continued occupation, activity, trade etc. within the Citadel, Sacred City, and indeed Hinterland (Strickland 2017: 129-131). Moreover, and more importantly, there is overwhelming continuity between the Anuradhapura and Polonnaruva periods – in material culture, in architecture, in language, in religious practices, and even in lineages and population. This is not a *new* state emerging from the ashes of Anuradhapura's collapse – so much as the mediaeval Sri Lankan state transforming and adapting. And, by moving their capital to Polonnaruva, the Sinhalese monarchs arguably *avoided* collapse by introducing a new resource – a new hinterland (Strickland *et al*. 2019), and potentially a new method of administering that landscape (Manuel et al. In Press). This had a similar effect to a Boserupian escape clause (Boserup 1965 & 1981) – providing a new resource, a new hinterland, that was inefficiently exploited (see Phillips 1979) and the exploitation of which could be intensified, providing the Rajarata Kingdoms with a degree of resilience– sufficient at least for a few more centuries.

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Project Report :

Geophysical Survey: Anuradhapura Mahavihara Area

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Introduction

The Mahavihara,originally occupied by a royal pleasure garden known as the Mahamegha Park, was founded by King Devanampiyatissa in the third century BCE (Mahavamsa.xv.24). It was during his reign (r.250-210 BCE), and that of his brother, that the first major structural foundations and plans were initiated. They included the Ruvanvalisaya stupa, the Bodhi tree shrine, a Lohapasada or 'brazen house', an upostatha hall, a refectory, the Thuparama stupa built over the Buddha's collar bone, and a stupa built over Mahinda's remains (Mahavamsa.xv-xx). The location of most of these monuments has been identified but clearly the original structures have been altered and the gaps between them filled with smaller residential monastic structures or parivenas, structures which Bandaranayake has attributed to the great monastic developments of the fourth century CE (1974: 49). The Mahavihara was traditionally the most powerful and orthodox of Anuradhapura's monastic establishments but temporarily lost its influence when the Jetavana and Abhayagiri viharas were constructed.

Whilst other monastic complexes at Anuradhapura such as the Jetavana, and areas within the Citadel have been the subject of intensive archaeological investigation, the Mahavihara has largely been overlooked. Whilst large-scale clearance and reconstruction of monuments have occurred, these have tended to favour the later levels and historic, rather Early Historic, iterations of construction and occupation. Excavation programs elsewhere at Anuradhapura (ASW2 - Coningham 1999, 2006) and in South Asia (Lumbini, Tilaurakot) have utilised new archaeological techniques and methodologies to expose earlier – in particular timber and non-brick – architecture and occupation sequences within sites. This approach has also been successfully applied in Kathmandu to assess the structure development and adaptation of individual monuments and the intense evaluation of foundations is key for modern conservation and stabilisation (Coningham et al. 2016). It is likely that the morphology of Mahavihara has altered significantly over time and it is only through the application of new archaeological techniques and integrated methodologies, can we hope to identify the earliest levels and sequences of the Mahavihara. Through investment by ADB, UNDP and other multinational organisations, Buddhist pilgrimage is a rapidly growing market. The Asia Development Bank (ADB) predicts that Buddhist pilgrimage to South Asia will reach an annual figure of 22 million by 2020, compared to four million in 2012. Much of this growth is from newly emerging markets in Southeast Asia, areas that predominantly follow Theravada Buddhism. ADB investment has largely been focused in northern India, Bangladesh and Nepal but benefits can be felt further afield in Sri Lanka. From the ADB's perspective "tourism development can create expanded economic opportunities, generate employment and incomes, and promote infrastructure development," and "increased tourism... can also contribute to mutual understanding and development of a stronger sense of community among the countries and peoples of the region". This is shared by the World Bank's Buddhist Circuit Strategy, which stressed that pilgrimage will deliver "sustainable and inclusive economic growth" and that "benefits reach deep into local households" (IFC/2013).

Long-term Research Questions

This program aims to develop and disseminate an enhanced understanding and presentation of the role and nature of early religious practice and pilgrimage within the Mahavihara complex. It will do so through the following objectives:

- To identify and characterise structural and artefactual evidence for early (3rd century BCE) monastic occupation within the Mahavihara complex;
- To reconstruct structural and artefactual evidence for early Buddhist practice and pilgrimage within the Mahavihara complex;
- To evaluate the foundation and structural development of key monuments within the Mahavihara;

- To evaluate the extent to which the landscape and environment been altered within and around the Mahavihara complex;
- To identify and mitigate current risks to surface and subsurface archaeology and heritage within the Mahavihara complex;
- To map and evaluate the current social and economic impacts of pilgrimage and tourism to the Mahavihara complex, and within the wider context of Anuradhapura;
- To consider and evaluate the structural and artefactual evidence for the collapse and continuity of occupation in Anuradhapura after the 11th Century CE.

Terms of Reference-Season One–Pilot Assessment

The proposed activities for the 2018 pilot season were as follows:

1. Mapping: The Mahavihara complex will be mapped using an unmanned aerial vehicle (drone) in order to create a high-resolution geo-rectified topographic and photographic map of the site. This will be critical in situating all further archaeological research, for planning purposes and creating an Archaeological Risk Map.
2. Geophysics: Selected areas of the Mahavihara complex – including the platform around Thuparama and the area between Thuparama and Ruvenvelisaya for Ground Penetrating Radar survey. This will test the efficacy of GPR in the area, and provide an initial subsurface.
3. Auger-Coring: A north-south and east-west transect of hand-drilled soil augers will be taken focused around Thuparama to identify the presence, absence and depth of cultural material, and to ascertain the depth of natural soil / bedrock. This is important for identifying the location of key areas for subsequent archaeological excavations, assisting with the GPR survey interpretation (from Geophysics) and creating future Archaeological Risk Maps.

This report presents the results of these activities, undertaken between July 1 and August 2 2018, with colleagues from the Central Cultural Fund.

Results of the 2018 Field Season

The first season of activity at Mahavihara took place in July and August 2018 – with geophysics undertaken on the 14th July, whilst drone mapping and auger-coring were undertaken between the 27th and 2nd August. The work was carried out in conjunction with the post-disaster archaeological fieldwork in Jaffna Fort, and was funded by the Central Cultural Fund and Durham University. The focus of the fieldwork was around Thuparama, and the area of open land between there and Ruvenvelisaya.

Mapping

Mapping was undertaken through a combination of ground-based total station and an unmanned aerial vehicle (drone). The aim was to create a basemap against which to situate and present the results of the archaeological investigations, and to help aid site managers and planners in future infrastructure development and monitoring.

In total, 4,927 aerial images were recorded using the UAV through sixteen different flight missions. The images were captured using Pix4D Capture on a DJI Phantom 4 Pro drone. Twelve of the missions were flown at a height of 50 metres, with the camera positioned vertical to the ground with a 70% overlap between each image. These images provide the basis for the map, however, due to restrictions imposed by the Civil Aviation Authority of Sri Lanka we were unable to fly within 100 meters of either Ruvenvelisaya or Thuparama. As such, we were unable to obtain reliable georectified images of the two stupas. Instead, we flew two circular missions at each stupa, maintaining a distance of 100 meters, with the camera at two different angles in order to capture data for 3D models of both. Unfortunately due to the restrictions, the data for the two stupas is of a lower quality than we would ideally require. The images were processed using PIx4Dmapper to create georectified digital surface models and geotiffs of the complete area (Figure 1).

Due to processing restrictions, the model was created in two sections – a northern area around Thuparama and a southern section around Mahavihara, using photos from Mission 16 in both to create overlap. The two stupa areas were processed separately, and then merged with the wider landscape maps to provide greater consistency in colour and accuracy, particularly with regards to the Digital Surface Models (DSM) and Digital Terrain Models (DTM).

Geophysics

Ground Penetrating Radar surveys were conducted within the boundary of the Thuparama complex to test the applicability of such techniques, and to provide an initial subsurface map of archaeological features at the site. The principal aim of the surveys was to assess the nature and extent of any sub-surface features of potential archaeological significance in each area, which would in turn facilitate research and inform management and conservation issues. The geophysical survey was conducted by Mark Woolston-Houshold of Archaeological Services Durham University, the commercial archaeology

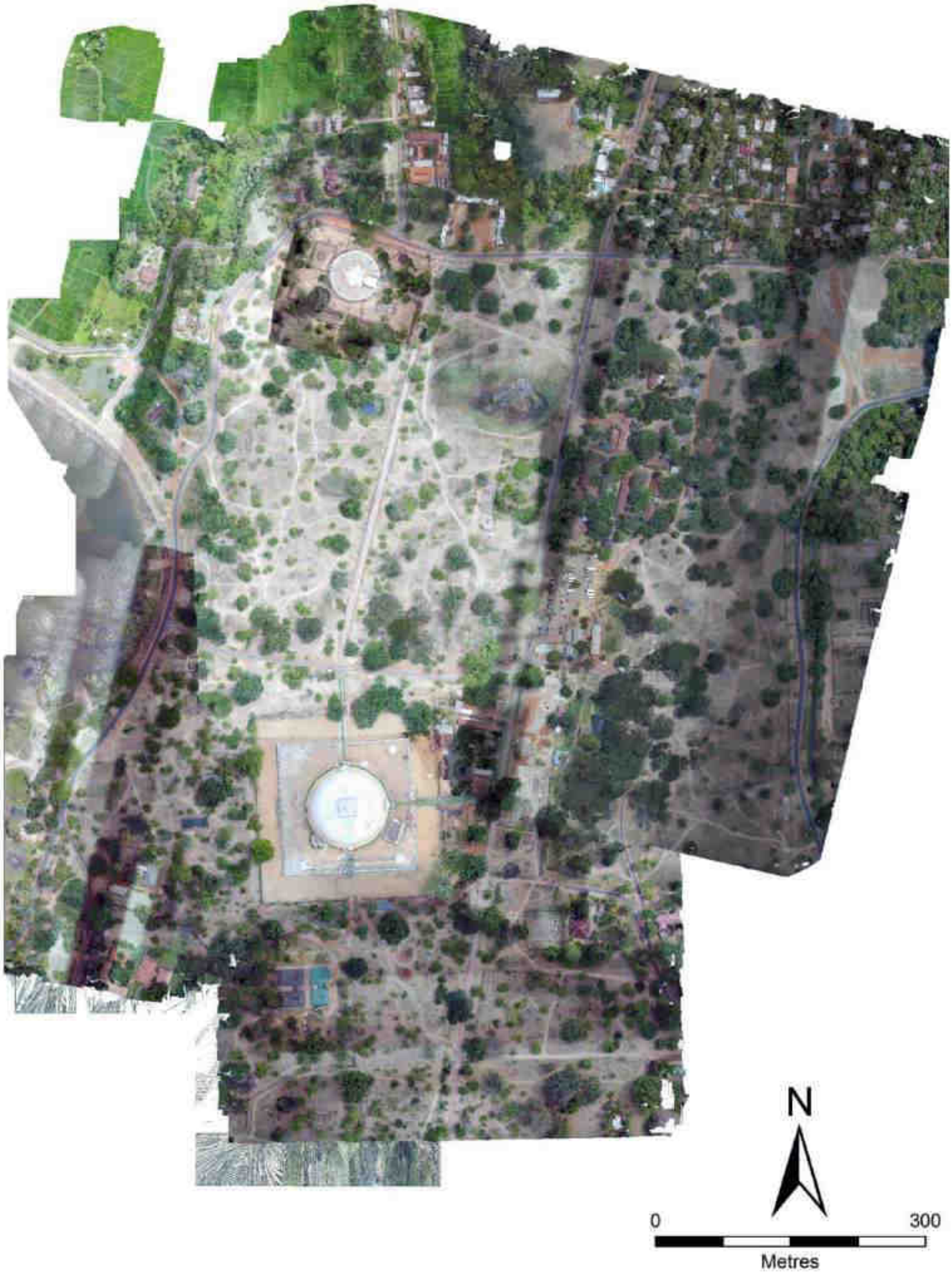

Figure 1. Processed drone image of Mahavihara complex. The colour discrepancies can be smoothed out with further processing

unit of Durham University, who have extensive experience of conducting geophysical surveys in the UK and South Asia with durham's UNESCO Chair.

Methods, Standards and Techniques

The surveys and reporting were conducted in accordance with the EuroGPR Association's Code of Conduct (ETSI 2009); Historic England guidelines, Geophysical survey in archaeological field evaluation (David, Linford & Linford 2008); the Chartered Institute for Archaeologists (CIfA) Standard and Guidance for archaeological geophysical survey (2014a); the CIfA Technical Paper No.6, The use of geophysical techniques in archaeological evaluations (Gaffney, Gater & Ovenden 2002); and the Archaeology Data Service & Digital Antiquity Geophysical Data in Archaeology: A Guide to Good Practice (Schmidt 2013).

Geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance and can involve a suite of complementary techniques such as magnetometry, earth electrical resistance, ground-penetrating radar, electromagnetic survey and topsoil magnetic susceptibility survey. Some techniques are more suitable than others in particular situations, depending on site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

For these surveys, it was anticipated that the remains of fired brick structures might be present beneath the surface, and that other types of feature such as ditches, pits, fired features and trackways, for example, might also be present. Given the anticipated nature and depth of targets, an electromagnetic technique, Ground Penetrating Radar (GPR), was considered appropriate. GPR generates a short high-frequency radar pulse which is transmitted into the ground via an antenna; the energy is reflected by buried interfaces and the return signal is received by a second antenna. The amplitude of the return signal relates to the electromagnetic responses of different sub-surface materials and conditions, which can be features of archaeological or historic interest. The time which elapses between the transmission and return of radar pulses to the surface can be used to estimate the depth of reflectors. In addition to conducting traditional 2D area surveys, GPR also has a depth component and so can be used to create pseudo-3D models of the data, provided sufficient data are collected at closely-spaced intervals; these models can then be viewed in plan at selected depths known as 'time-slices'.

The GPR surveys were conducted using a Malå GeoScience RAMAC X3M radar control unit, mounted directly onto a 500MHz frequency shielded antenna. The antenna and control unit were mounted in a rugged cart with a RAMAC XV monitor attached and an odometer on one wheel to trigger the GPR pulses.

GPR data were collected using a 500MHz frequency antenna, with a time window of 58.9ns enabling data acquisition to a depth of approximately 3 metres. Returned energy wavelets were recorded from many depths in the ground to produce a series of reflections at each location, called a reflection trace. Series of traces collected along each transect produce a radar profile or radargram. For these surveys, data traces were logged at 0.05m intervals along parallel traverses spaced 0.25 metres apart. The start and end points of the traverses were recorded using a Leica TS15i total station survey instrument and 7 tied in to existing features. Data were downloaded into a laptop computer on site, backed up onto removable hard-disks and subsequently transferred to a desktop computer for processing, interpretation and archiving.

ReflexW v7.5 software was used to process the GPR profiles, to stack and interpolate the profiles to produce 3D data volumes, and to produce greyscale images of profiles and time-slices.

Combinations of the following processing functions have been applied to the GPR profiles: dewow removes very low frequency components by subtracting the mean from each trace static correction moves the start times for traces in each profile to 0nS gaining the data compensates for energy loss as the radio pulse penetrates deeper and/or amplifies the area of interest by adding a determined value bandpass filter removes low-amplitude frequencies (Butterworth values) background removal reduces data ringing migration a Stolt migration was performed to reduce the axes and enhance the apexes of hyperbolic reflections to resolve individual objects.

Preliminary Results

Three areas around the Thuparama complex were surveyed (Figures 2 &3). Each area will be discussed below.

Area 1 (Figure 4) was located in the south-eastern corner of the stupa enclosure. The survey produced few radar reflections. One relatively strong linear reflection was detected across the area, aligned north-west/south-east; the reflection is at about 1 metre depth and may reflect a service or pipe.

Area 2 (Figure 5) was located within the north-western corner of the stupa enclosure. A strong semi-circular reflector evident in the southern edge of the top two images could

Figure 2. Areas where GPR was undertaken at Thuparama in 2018.

Figure 3. Results of GPR survey in Area 2 (at 3ns) and Area 3 (at 1ns).

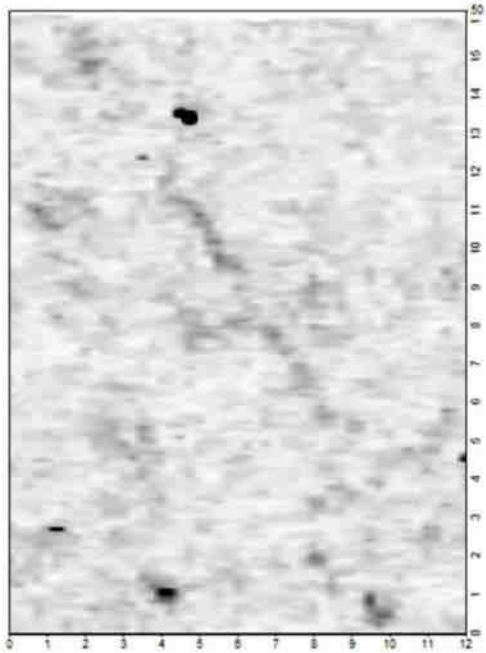

Figure 4.4. Area 1 time-slice at 18ns

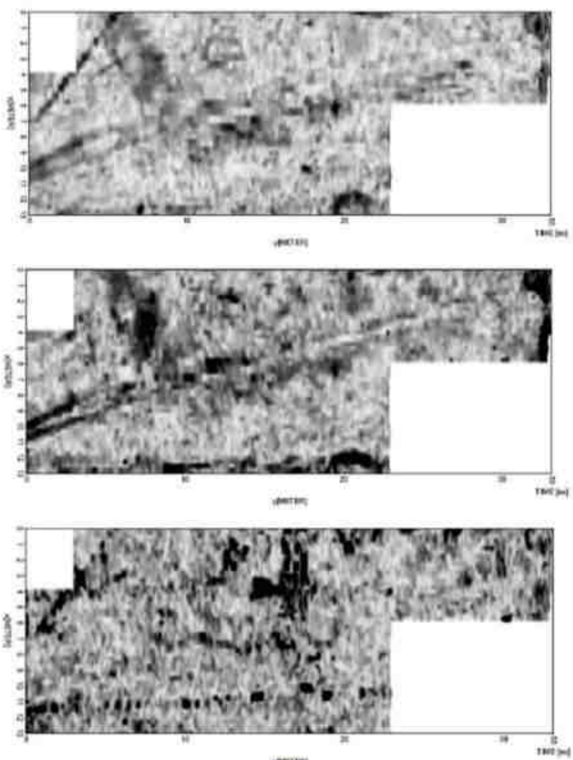

Figure 5. Area 2 time-slices at 3ns (top), 7ns and 12ns (bottom)

reflect a curving brick wall, perhaps part of a small stupa measuring 3.5 to 4 metres in diameter. The location of this feature is such that it could be one of four small stupas erected in a square arrangement around the large central stupa. The two parallel linear reflections, aligned diagonally (east-west) across the survey area, correspond to a track seen on aerial photographs. Two further linear reflectors, one near the southern edge of the survey and one across the north-west corner, may indicate services or pipes.

Area 3 (Figure 6) was located within the western edge of the stupa enclosure. Of particular interest here is another small circular feature, at the western edge of the survey. This could represent another small brick stupa, possibly with a small central feature. Several strong linear reflectors detected in the south of the survey could indicate the presence of brick walls, perhaps associated with rectilinear brick structures.

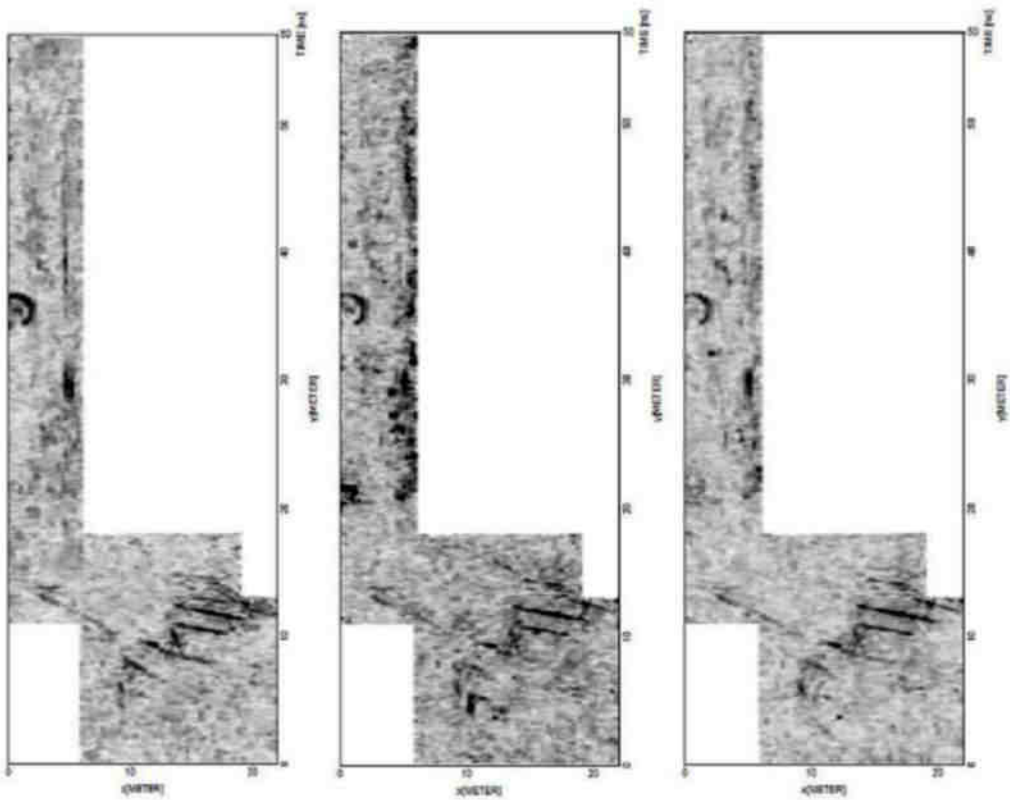

Figure 6. Area 3 time-slices at 1ns (left), 12ns and 19ns (right)

Auger

A total of eight auger cores were undertaken starting just to the north of the Ruvenvelisaya complex and then running northwards to Thuparama (Figure 7 & Appendix 1). The final two augers were undertaken inside the Thuparama complex to provide a profile to aid the GPR interpretation (above). The augers provided an insight into the overall soil profile of the area and will aid future archaeological excavations.

Broadly speaking Augers 1-4 follow a similar pattern of between 0.6-1.0 metres of mixed upper topsoil that is highly compact and contains pottery, brickbat and stone. It is likely that this represents a mixture of modern levelling and infilling, and the remnants of the old town that was located and removed following the implementation of the 1942 Anuradhapura Preservation Ordinance. Below this was a cultural layer measuring between 0.2 to 0.6 metres in depth which is more likely to represent archaeological material dating to the Anuradhapura period. Natural sands were encountered at around 1.6 meters depth across this area, with a transitional layer between the cultural and natural layers in some instances.

Continuing north, Auger 5 had the same upper 1.0 meters of modern or recent leveling. However, from 1.0 to 2.8 meters depth was tank infill material – silty and sandy clays containing washed-in cultural material. This suggests that the depression that still exists and collects water to the east today may have been larger in the past. It also raises the question as to whether this was a formal tank –perhaps cut into bedrock–or a natural depression that was utilized to capture water. Natural sands were encountered at 3.0 meters depth.

Auger 6 was similar to Augers 1-4, but the evidence of cultural material was more ephemeral, as were remnants of the modern town. It's location between the Thuparama complex and the tank may suggest that it was largely unoccupied in the past, or formed part of the sacred space around the stupa.

Auger 7 was undertaken in the southeast corner of the Thuparama complex, close to where the Ceylon Electricity Board had previously dug trenches for cabling. Despite trying in three separate locations each auger here hit solid stone at about 0.5 meters - suggesting a widespread structural layer or paving in this area. Auger 8 was located in the northeast part of the complex and was more successful. The top 1.0 meter consisted of a relatively modern sandy silt leveling phase containing fragments of pottery and brickbat. Below this were two phases of sand terrace, sandwiching a layer of cultural material. The upper sand terrace extended from 1.0 to 2.0 meters depth and consisted of

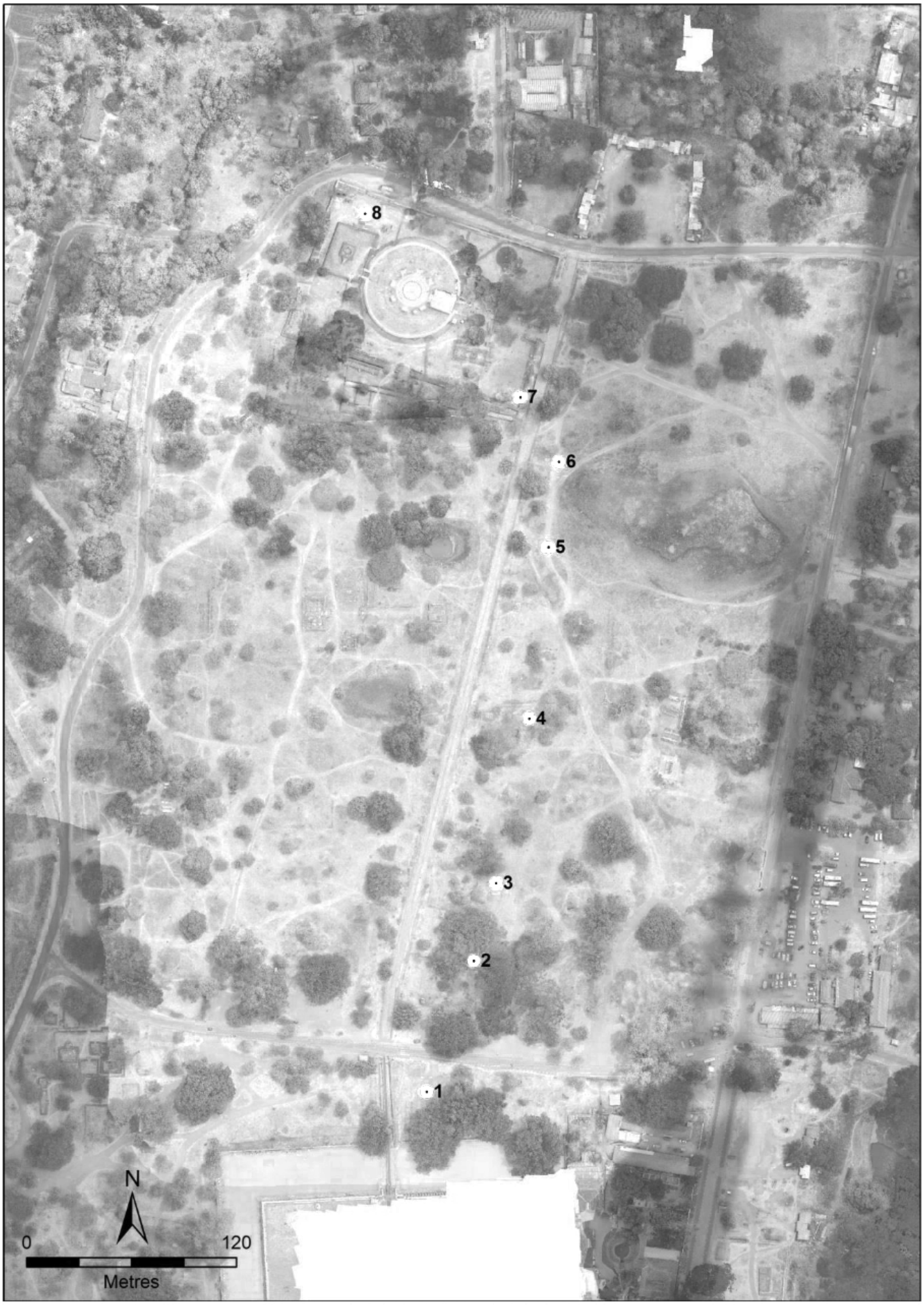

Figure 7. Location of augers (yellow dots) undertaken at Mahavihara, in a north-south line running from Ruvenvelisaya to Thuparama

clean, strong brown coloured sand. The lower sand terrace was found at 2.4 to 3.0 metres depth and was a much coarser, dark reddish brown sandy clay with some cultural inclusions. Between the two was a 0.4 meter deposit of sand containing large amounts of pottery, some of which was burnt. This perhaps represents a period of occupation utilizing the lower sand terrace before a redevelopment of the complex. Further excavation would help elucidate this chronology. Natural clayey sand was encountered at 3.0 meters depth.

Unregulated damage to the Thuparama Complex and Risk Mapping

During our initial field visit to the Thuparama complex at the beginning of June, we observed the cutting of a series of foundation pits and trenches just beyond the south and west of the side of the stupa terrace. This work was not being undertaken by trained archaeologists but by labourers engaged by the Ceylon Electricity Board. The pits were roughly one by one metre in area and were cut to depths below one metre. Some of the pits were empty and some had already been filled with concrete to act as foundations for lampposts. The presence of piping at the base of the concrete pillar indicates that slots had also been cut between each of the new foundations, causing further damage to the archaeological deposits.

From a field examination of a number of these pits, they cut right through tile collapse stratigraphy and had damaged the archaeological sequence at the site and fragments of glazed tiles were lying uncollected on the surface. We also observed other areas where labourers were cutting trenches for electrical cables, apparently without an archaeological watching brief and the use of heavy vehicles to erect the new lampposts. These activities should be stopped immediately as they cause irreversible damage to the subsurface archaeology of the site. This is even more highly significant as the area surrounding the Thuparama has never been subject to scientific excavations in the past and its sequence is, as yet, unknown. We strongly recommend that that the whole area is subject to geophysical survey so that site managers can use the resultant Risk Map to guide the placing of such potentially damaging activities infrastructure.

Archaeological Risk Maps

Archaeological Risk Maps should be used to play an important role in translating the different elements of archaeological research and investigation into a coherent, spatial visualisation of those areas which contain the most valuable and vulnerable archaeological and heritage assets. Such maps have been commissioned by the Asia

Development Bank in Bangladeshi World Heritage Sites and by UNESCO at Lumbini, the Birthplace of Lord Buddha. The use of Archaeological Risk Maps was also adopted by the 2014 Lumbini Declaration of the International Buddhist Conference on Promotion, Protection & Preservation of Buddhist Culture and Heritage:

"Recognizing that Buddhist archaeological sites form living cultural landscapes, that any new structures at sites are located only in areas of low risk to heritage and that they respect 8 design concepts: (1) Non-intrusive, (2) Reversibility, (3) Shelter, (4) Visibility, (5) Focus, (6) Access, (7) Ownership and (8) Authentic materials; that interventions or new constructions with Buddhist cultural sites should be tested against these criteria during Heritage Impact Assessments" (Lumbini Declaration 2014: 3)

Archaeological Risk Maps should be used as a guide for designing and planning future developments, land purchase and land controls at each site. They should not be taken as a complete map of the presence or absence of archaeological material, but as an indication of the risk to subsurface material. Any development within the vicinity should be avoided wherever possible and strictly monitored if deemed essential. The heritage of the Anuradhapura's Sacred City is a finite resource, and once damaged, encroached upon or destroyed cannot be recovered.

These maps will designate risk to heritage and recommended that those areas that have been highlighted as 'Very High', 'High' and even 'Medium' Risk should have no intrusive development whatsoever –everything should be 100% non-intrusive and fully reversible. Intrusive activities include the use of mechanical diggers or JCBs, soil extraction, sand/silt processing, the digging of foundations and heavy machinery. Areas that are 'Very High' and 'High' should remain as pristine as possible. Development in areas of 'Medium Risk' should be fully reversible and sympathetic to the material and character of the archaeology of the site (see below). Areas of 'Low' and 'Very Low' Risk indicate 20 areas where there is little risk to archaeological structures or material; however, any development should still be avoided where possible and again this should be non-intrusive and fully reversible. We strongly recommend that additional archaeological and geophysical evaluations are conducted as soon as funding is available.

Levels of Risk

Five levels of risk are designated across a site: Very High, High, Medium, Low and Very Low. The sections below outline the criteria and descriptions of each level of risk.

Very High Risk

These areas contain the most important archaeological remains and are of significance not only for understanding the development of the site, but also the Sacred City and beyond. No intrusive activities should be undertaken, and any development, such as visitor and pilgrim infrastructure, must be completely non-intrusive, fully reversible and use appropriate and sympathetic materials.

High Risk

These areas contain important archaeological remains that are of significance to understanding the development of the site. No intrusive activities should be undertaken, and any developments must be completely non-intrusive, fully reversible and use appropriate and sympathetic materials.

Medium Risk

These areas contain or may contain archaeological remains that can inform us about the development of the site. Development in these areas should be avoided, although there is no pressing need to remove existing modern structures. However, it is important that any development aims to be non-intrusive, fully reversible and use appropriate and sympathetic materials.

Low Risk

These areas contain minor archaeological remains, which may be able to inform us about the development of the site. Development in these areas is possible, but should be non-intrusive, fully reversible and use appropriate materials. Landscapes should be kept simple and any alterations should be kept to a minimum.

Very Low Risk

These areas contain no archaeological remains, and any developments that are required should be focused in these areas. However, such developments should be fully reversible and use appropriate materials.

It is also recommended that if intrusive development-related activities are approved, within areas of lower risk, they should be accompanied by a 'Watching Brief'. The latter may be defined as a "formal programme of observation and investigation conducted during any operation carried out for non-archaeological reasons. This will be within a specified area where there is the possibility that archaeological deposits may be disturbed or destroyed. The programme will result in the preparation of a report and archive (CIFA 2014b). It is key that the 'Watching Brief' is conducted by trained archaeologists and that they are empowered to halt the development-related activities in archaeological deposits are encountered so that they can be properly evaluated and then either recorded and excavated or the works diverted to avoid them and preserve them in situ.

Conclusion

We have the following recommendations for implementation and further archaeological activities.

- An immediate cessation of any further digging of trenches for electricity and other services;
- Development of a process for heritage impact assessments in advance of any future infrastructure developments;
- Any such process must contain archaeological assessments of areas to be targeted for infrastructure development in advance of the work
- Any resultant infrastructure work should be as non-intrusive as possible and be undertaken in conjunction with an archaeologist who has the power to stop work if necessary;

Recommended archaeological activities for 2019. We would recommend that the following activities take place in 2019 at Mahavihara:

1. **Geophysics:** further geophysical survey of the interior of the Thuparama complex, as well as the areas surrounding the outer wall.
2. **Excavation:** targeted trenches within the Thuparama complex to look for evidence of earlier occupation, earlier phases of architecture and to date them. Exact trench locations to be determined based on geophysics, auger and discussions with CCF.
3. **Geoarchaeology:** program of geoarchaeological investigations in order to reconstruct the early environmental sequences of Thuparama, hydraulic networks associated with it, and the date of construction of monuments and buildings.
4. **Mapping & auger-coring:** mapping of the Mahavihara complex using an unmanned aerial vehicle (drone). Further auger-coring to ascertain the morphology of the tank and areas to the north and west of Thuparama.
5. **Community engagement:** a program of research to evaluate the social and economic impacts of pilgrimage, tourism and community at the site. This would involve

structured and semi-structured interviews with different stakeholder groups to look at how the site is used, and the impacts upon it and local communities.

6. **Exhibition and workshop:** We would host a temporary exhibition during the period of the field project, and host a workshop in Anuradhapura at the end of the season. This workshop would bring academics, students and stakeholders together.

7. **Training and mobility:** The field project would act as a Durham UNESCO Chair Field Laboratory, aimed at CCF trainees and (if possible) invited undergraduate students. Practical training and theoretical lectures will be provided to officers, trainees and students who would be embedded within the project.

8. **Establishment of an archaeological risk map:** Creation of a risk map through combining all the archaeological data from 2018 and 2019.

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Appendix 1 : Details of auger cores

AUGER 1

Depth	Colour	Soil	Cultural Inclusions	Natural Inclusions	Interpretation
0-20	5YR 3/3 Dark Reddish Brown	Sandy silt	Brickbat	Small stones	Fairly recent mixed topsoil; Possibly the old town
20-40	5YR 3/4 Dark Reddish Brown	Sandy silt	Brickbat	Small stones	
40-60	5YR 3/4 Dark Reddish Brown	Sandy silt	Brickbat	Small stones	
60-80	5YR 3/3 Dark Reddish Brown	Sandy silt	Brickbat	Small stones	
80-100	5YR 3/3 Dark Reddish Brown	Sandy silt	Brickbat	Small stones	
100-120	7.5YR 4/4 Brown	Sandy silt	Brickbat	Stones; Quartz	Transitional; Collapse?
120-140	5YR 4/4 Reddish Brown	Sandy silt	Lots of Brickbat & Pottery	-	Cultural Layer
140-160	5YR 4/6 Yellowish Red	Silty sandy clay	-	Stones; Gravel	Transitional
160-180	5YR 3/4 Dark Reddish Brown	Sandy clay	-	Gravel; Degraded Bedrock	Natural
180-200	5YR 3/4 Dark Reddish Brown	Sandy clay	-	Gravel; Degraded Bedrock	

AUGER 2

Depth	Colour	Soil	Cultural Inclusions	Natural Inclusions	Interpretation
0-20	5YR 3/3 Dark Reddish Brown	Sandy silt	-	Small stones; Quartz	Fairly recent mixed topsoil; Possibly the old town
20-40	5YR 3/2 Dark Reddish Brown	Sandy silt	-	Small stones; Quartz	
40-60	5YR 3/3 Dark Reddish Brown	Sandy silt	-	Small stones; Quartz	
60-80	5YR 3/3 Dark Reddish Brown	Sandy silt	Large pieces of pottery	Large stones, Quartz, Gravel	Thick Cultural Layer
80-100	5YR 2.5/2 Very Dark Brown	Sandy silt	Large pieces of pottery; Ash lenses	Stone; Quartz, Gravel	
100-120	10YR 2/2 Very Dark Brown	Sandy silt	Brickbat; Pottery	Stone; Quartz, Gravel	
120-140	10YR 3/2 Very Dark Greyish Brown	Sandy silt	Brick flecks	Gravel	Ephemeral Cultural Layer
140-160	10YR 3/2 Very Dark Greyish Brown	Sandy silt	-	Gravel	Transitional
160-180	10YR 6/4 Light Yellowish Brown	Silty sand	-	Gravel; Sandy lenses	Natural

180-200	10YR 6/6 Brownish Yellow	Silty sand	-	Gravel; Sandy lenses	
200-220	10YR 6/6 Brownish Yellow	Silty sand	-	Gravel; Sandy lenses; Degraded bedrock	

AUGER 3

Depth	Colour	Soil	Cultural Inclusions	Natural Inclusions	Interpretation
0-20	10YR 3/2 Very Dark Greyish Brown	Sandy silt	Brickbats	Stones	Fairly recent mixed topsoil; Possibly the old town
20-40	10YR 32/2 Very Dark Brown	Sandy silt	-	Stones; Gravel; Sandy lenses	
40-60	7.5YR 3/2 Dark Brown	Sandy silt	-	Gravel; Sandy lenses	
60-80	7.5YR 3/2 Dark Brown	Sandy silt	Small fragments of pottery	Stones; Gravel	Cultural Layer
80-100	7.5YR 3/2 Dark Brown	Sandy silt	Brickbats; Pottery	Stones	
100-120	10YR 3/2 Very Dark Greyish Brown	Sandy clay	Large fragments of pottery;	Stones; Gravel; Quartz	
120-140	10YR 4/3 Brown	Sandy clay	-	Stone; Gravel; Tree roots	Transitional
140-160	7.5YR 4/4 Brown	Sandy clay	-	Stone; Gravel; Degraded bedrock	
160-180	10YR 6/4 Light Yellowish Brown	Clayey sand	-	Stones; Degraded bedrock	Natural
180-200	10YR 6/4 Light Yellowish Brown	Clayey sand	-	Stones; Degraded bedrock	
200-220	10YR 6/4 Light Yellowish Brown	Clayey sand	-	Stones; Degraded bedrock	

AUGER 4

Depth	Colour	Soil	Cultural Inclusions	Natural Inclusions	Interpretation
0-20	5YR 3/2 Dark Reddish Brown	Sandy silt	Brickbat	Stones	Fairly recent mixed topsoil; Possibly the old town
20-40	7.5YR 3/3 Dark Brown	Sandy silt	-	-	
40-60	5YR 3/2 Dark Reddish Brown	Sandy silt	-	Stones; Quartz	
60-80	5YR 4/2 Dark Reddish Brown	Sandy silt	Brickbat	Stones; Quartz	

80-100	7.5YR 3/2 Dark Brown	Sandy silt	-	Stones; Quartz	
100-120	7.5YR 3/1 Very Dark Grey	Sandy clay	-	Stones	
120-140	7.5YR 4/4 Brown	Sandy clay	Brickbat; Large pieces of pottery; Bone	Stones	Cultural Layer
140-160	7.5YR 5/6 Strong Brown	Clayey sand	-	Stones; Gravel	Transitional
160-180	10YR 6/4 Light Yellowish Brown	Clayey sand	-	Stones; Gravel; Degraded Bedrock	Natural
180-200	10YR 6/4 Light Yellowish Brown	Clayey sand	-	Stones; Gravel; Degraded Bedrock	
200-220	10YR 6/4 Light Yellowish Brown	Clayey sand	-	Stones; Gravel; Degraded Bedrock	

AUGER 5

Depth	Colour	Soil	Cultural Inclusions	Natural Inclusions	Interpretation
0-20	5YR 3/3 Dark Reddish Brown	Sandy silt	Brickbat	Stones	Fairly recent mixed topsoil; possibly old town or more recent tank infill
20-40	7.5YR 4/3 Dark Brown	Sandy silt	Brickbat; Pottery; Iron slag	-	
40-60	7.5YR 4/3 Dark Brown	Sandy silt	Brickbat	Stones	
60-80	7.5YR 3/3 Dark Brown	Sandy silt	Brickbat; Pottery	Stones	
80-100	7.5YR 3/3 Dark Brown	Sandy silt	Brickbat	Stones	
100-120	7.5YR 3/2 Dark Brown	Silty clay	Pottery	Stones	Tank infill deposit, inlcuding cultural material that has been washed in
120-140	7.5YR 3/2 Dark Brown	Silty clay	Brickbat; Pottery	-	
140-160	7.5YR 3/3 Dark Brown	Silty clay	Brickbat; Pottery	Stones	
160-180	7.5YR 3/3 Dark Brown	Silty clay	Brickbat; Pottery	Stones	
180-200	7.5YR 3/2 Dark Brown	Silty clay	Charcoal	-	
200-220	7.5YR 3/2 Dark Brown	Sandy clay	Charcoal; Brickbat	Water Table	
220-240	7.5YR 3/1 Very Dark Grey	Sandy clay	-	-	
240-260	7.5YR 3/1 Very Dark Grey	Sandy clay	Charcoal	-	
260-280	7.5YR 3/2 Dark Brown	Sandy clay	Large pieces of pottery; Brickbat	Gravel	

280-300	7.5YR 3/2 Dark Brown	Clayey sand	-	Gravel	Transitional
300-320	10YR 6/4 Light Yellowish Brown	Clayey sand	-	Gravel	Natural
320-340	10YR 6/4 Light Yellowish Brown	Clayey sand	-	Gravel	
320-340	10YR 6/4 Light Yellowish Brown	Clayey sand	-	Gravel	

AUGER 6

Depth	Colour	Soil	Cultural Inclusions	Natural Inclusions	Interpretation
0-20	5YR 3/2 Dark Reddish Brown	Sandy silt	Pottery	Stones; Gravel	Fairly recent mixed topsoil
20-40	5YR 3/4 Dark Reddish Brown	Sandy silt	-	-	
40-60	10YR 3/3 Dark Brown	Sandy silt	-	-	
60-80	10YR 3/4 Dark Brown	Sandy silt	Brickbat; Pottery	-	Ephemeral Cultural Layers
80-100	10YR 3/4 Dark Brown	Sandy silt	Pottery; Charcoal	-	
100-120	10YR 4/4 Dark Yellowish Brown	Sandy silt	-	-	
120-140	10YR 2/4 Dark Greyish Brown	Sandy silt	Charcoal	-	
140-160	10YR 4/6 Dark Yellowish Brown	Sandy silt	-	-	
160-180	10YR 4/6 Dark Yellowish Brown	Sandy silt	Pottery	-	
180-200	10YR 5/8 Yellowish Brown	Clayey Sand	-	Stones; Gravel	Natural
200-220	10YR 4/6 Dark Yellowish Brown	Clayey Sand	-	Stones; Gravel	
220-240	10YR 6/5 Yellowish Brown	Clayey Sand	-	Stones; Gravel	
240-260	10YR 6/5 Yellowish Brown	Clayey Sand	-	Stones; Gravel	

AUGER 7

Depth	Colour	Soil	Cultural Inclusions	Natural Inclusions	Interpretation
0-20	10YR 4/3 Brown	Sandy silt	Pottery	-	Mixed topsoil

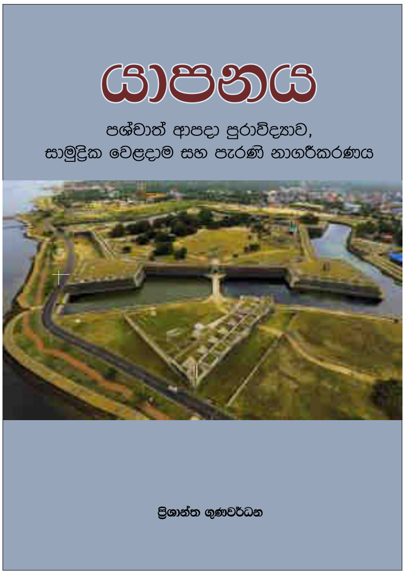
20-40	7.5YR 3/3 Dark Brown	Sandy silt	-	-	
40-60	10YR 4/3 Brown	Sandy silt	-	-	
60-80	SOLID STONE				Structural layer

AUGER 8

Depth	Colour	Soil	Cultural Inclusions	Natural Inclusions	Interpretation
0-20	7.5YR 3/4 Dark Brown	Sandy silt	-	Stones	Upper mixed toposil; Cultural layer
20-40	7.5YR 3/3 Dark Brown	Sandy silt	Brickbat	Stones	
40-60	7.5YR 4/3 Strong Brown	Sandy silt	Pottery	-	
60-80	7.5YR 4/3 Strong Brown	Sandy silt	Pottery; Brickbat	-	
80-100	7.5YR 4/6 Strong Brown	Sandy silt	-	Stones; Gravel	
100-120	7.5YR 5/8 Strong Brown	Sand	-	Stones; Gravel	Sand Terrace 2
120-140	7.5YR 5/8 Strong Brown	Sand	-	Stones; Gravel	
140-160	7.5YR 5/8 Strong Brown	Sand	-	Stones; Gravel	
160-180	5YR 4/6 Yellowish Red	Silty Sand	-	Stones; Quartz; Sandy lenses	
180-200	7.5YR 5/8 Strong Brown	Sand	-	Quartz; Gravel	
200-220	7.5YR 5/6 Strong Brown	Sand	Burnt pottery	Quartz; Gravel	Cultural Layer
220-240	7.5YR 3/4 Dark Brown	Sand	Pottery	Quartz; Gravel	
240-260	7.5YR 3/3 Dark Brown	Sandy clay	-	Quartz; Gravel; Coarse sand	Sand Terrace 1; Possible foundations or levelling
260-280	5YR 3/4 Dark Reddish Brown	Sandy clay	-	Quartz; Gravel; Coarse sand	
280-300	5YR 3/4 Dark Reddish Brown	Sandy clay	-	Quartz; Gravel; Coarse sand	
300-320	5YR 3/4 Dark Reddish Brown	Clayey sand	-	Quartz; Gravel	Natural
320-340	5YR 3/4 Dark Reddish Brown	Clayey sand	-	Quartz; Gravel	
340-360	5YR 3/4 Dark Reddish Brown	Clayey sand	-	Quartz; Gravel; Degraded bedrock	
360-380	5YR 3/4 Dark Reddish Brown	Clayey sand	-	Quartz; Gravel; Degraded bedrock	

Book Review

Prishanta Gunawardhana, 2020, '*Yapanaya: Pashchath apada puravidyawa, samudrika weladama saha parani nagarikaranya*' (Jaffna: Post-Disaster Archaeology, Maritime Trade and Ancient Urbanization) by Neptune Publisher, Colombo; 978-624-5200-56-6 pages. 184.



Sinhala publications on the archaeology of the Jaffna peninsula in northern Sri Lanka, the historical land of the Sri Lankan Tamils, are scarce (but see Koralage and Asanga (2017) and Dias, Koralage and Asanga (2016). This, however, does not suggest that there are many books in Sinhala about other elements of Jaffna and the Sri Lankan Tamils. It is not an overstatement to say that scholarly work in Sinhala is noticeably silent on Jaffna's culture and history, as well as on Tamil people or their culture and politics in general. But, Sunil Ariyarathne (2008), Niramal Ranjith Devasiri (2015) , and Sirinimal Lakdusinghe (2019) are exceptions in this regard. Nonetheless, the published prose in Sinhala media has been loud in portraying Tamils as terrorists and Jaffna as the homeland of terrorism – a mainstay of Sinhala news media during the war between the Sri Lankan government and the LTTE guerillas, in the 1980s through 2000s. However, there are a significant number of popular Sinhala songs that confront the nationalist political realities that oppress the island's Tamils and strain Sinhala-Tamil relations. For example, popular vocalists such as Nanda Malini, Gunadasa Kapuge, Fredy Silva, Sunil Edirisinghe, Niranjala Sarojini, Amarasiri Peris, Karunarathne Divulgane, Dipal Silva, Dipika Priyadharshini, Jagath Wickramasinghe, Senanayake Weheraliyadde, and Rashmi Sangeetha have all sung emotionally charged and, at times, defiant songs emphasizing the need for reconciliation, and the plight of Tamils in Sri Lanka. Similarly, there are a number of creative writers – novelists and short story writers, such as A. V. Suraweera, Gunasena Vithana, Sirinimal Lakdusinghe, K. Jayatillake, Chandrarathne Bandara, Manjula Wediwardhana, Kumari Kumaragama and Nissanka Wijemanna, to name a few, who have composed creative texts addressing the plight of Tamils and minorities in Sri Lanka. Irrespective of the form that the idea of Jaffna takes in the imaginary of the Sinhala south, it is a significant symbolic and strategic force in Tamil identity politics in Sri Lanka. It is a signifier loaded with metonymic significance for the Tamils of the island. As a consequence, Jaffna plays a key role in the island's nationalist politics. More often than not, neither Sinhala nor Tamil historians and archaeologists have been able to speak of Jaffna outside of their ethnonationalist frames of reference (see Gunawardana (1995) for a critique of this condition in historical scholarship). Ethnizing archaeological data is one of the hideous intellectual crimes that many Sri Lankan archaeologists commit, some inadvertently though. The Sinhala nationalist scholars would like to think of Jaffna merely as a minor extension to the main civilizational processes of the island since the emergence of Anuradhapura in the third century BCE (Deraniyagala, 1992, pp. 712-714) as the ruling cynosure of the island, and that it has always been directly under the control of the Sinhala rulers. Conversely, nationalist Tamil scholars would prefer to imagine that Jaffna has always been an independent kingdom with no ties to the rest of the island. It is against this rather pathetically myopic tradition of scholarship on the past of Jaffna that Prishanta Gunawardhana launches his book. Writing against the grain, he presents to Sinhala readers, supported by archaeological and historical evidence, the important role that the Jaffna peninsula played in the maritime history of the island of Lanka. Being an island in the Indian Ocean at an important midpoint on the sea routes that linked east-west maritime routes across the Indian Ocean, Lanka's history has been pivotally linked to the major and minor historical waves of maritime transactions that took place in the Indian Ocean, the larger scenario, and across the Pork Strait. The archaeology of Jaffna, therefore, should be understood as an entangled participant in the larger picture of the archaeology of Sri Lanka. As can be discerned from this book, the archaeology of Jaffna cannot be contained within a binary relationship with the rest of the island, as Tamil nationalism fantasizes, nor can it be contained within a process of erasure of its subjectivity, as Sinhala nationalists seek.

The archaeological past that Prishanta Gunawardhana narrates for Jaffna works outside the populist-nationalist rhetoric that often besets Sri Lankan archaeology, and for this writer, that is a remarkable stand. No grandstanding here. Kudos to Prishanta Gunawardhana, who is Chair Professor of Archaeology at the Department of Archaeology, University of Kelaniya.

The book contains seven chapters, including the introduction. The brief introduction alerts the reader to the paucity of archaeological research in Jaffna and remarks that the lack of archaeological work has resulted in relying on textual sources for the construction of historical propositions for Jaffna. Perhaps, the author is implying that the scientific validity of the propositions thus presented is questionable. But he doesn't dwell on that proposition any further. The introduction concludes with a paragraph introducing the archaeological work carried out at the Jaffna Fort as part of a Post-conflict Archaeological Studies program organized by the Central Cultural Fund, when Gunawardhana was its Director General, along with Prof. Robin Conningham of Durham University, UK. The project consisted of a multidisciplinary team consisting of specialists in archaeology, museology, geoarchaeology, etc., from the UK and Sri Lanka. The project also incorporated multivocality in that it interacted with different categories of people in Jaffna who expressed interpretive interest in the work at the Fort. At this point, the writer would like to digress and register an important aspect of the archaeological projects that Gunawardhana organizes; he and a few archaeologists of his generation, such as Gamini Adikari, Arjuna Thantilage, Wijerathne Bohingamuwa, Thusita Mendis, Chandana Vitanachchi, and Mangala Katugampola, always follow the principle that archaeological research is multidisciplinary and multivocal. But the reader may ask, isn't that a basic ethical principle in archaeology that is axiomatically linked to the scientificity of archaeology that needs no special merit? Of course, it is, but not among most Sri Lankan archaeologists, hence the mention here! Most Sri Lankan archaeologists prefer to work with students, not with colleagues of equal status.

The first three chapters after the Introduction, chapters two, three, and four, provide the reader with a pan-Indian Ocean maritime background for his archaeological propositions on the archaeological past of Jaffna. In chapter two, he sets up Sri Lanka in the larger picture of maritime trade in the Indian Ocean. Here he touches on larger episodes in the Indian Ocean maritime trade at different times and their bearing on the island and the role different communities, such as Arab, Chinese, and Muslim traders have played in these episodes. And then in chapter three, the reader encounters the historical role China played in Sri Lanka's maritime trade. This chapter has special resonance with contemporary Sri Lankan politics and economics, given China's trade interests in the Indian Ocean and Sri Lanka in particular. Gunawardhana gives a fairly descriptive account of the China-Lanka historical relations. It appears to have been alive with vibrant commerce, social, and diplomatic contacts. In the following chapter, chapter four, the author focuses on Sri Lanka's historical ports, including the ports of Jaffna, as well as the country's maritime trade. It is in this chapter that the reader sees how Jaffna has been well connected with the rest of the island. To put it another way, the chapter shows how Jaffna as a region resonates with the rest of the island in terms of maritime trade.

The main indicator of that resonance is the presence of many ports in Jaffna and, as shown by P. Vidanapathirana (2016) , the ancient road system that linked Jaffna to the rest of the island. There have been 6 historical ports in the Jaffna peninsula alone, five of them mentioned in literary sources. Archaeological evidence for those is yet to be found, and the port at Alliapatti in the Kayts island is confirmed with archaeological remains. On page 61, Gunawardhana reproduces an important map of the island, from A.W.I. Siriweera (2013, p. 85), that shows the locations of historical ports along the shoreline of the island: some of those ports are found only in literary sources, as yet, and some are archaeologically established. At this point, the writer would like to draw the reader's attention to Vidanapathirana's (2016) important and informative publication, '*Marga Puranay'* on ancient roads, to which I have already refered to in this paragraph, where she has produced a map of the island showing the island-wide road network for the period from 3rd century BCE to 13th century CE, that incorporates Jaffna into the general road system. Vidanapatirana produced this map after years of archaeological field work funded by the Postgraduate Institute of Archaeology. These two maps, when juxtaposed, assert an archaeological claim that Jaffna has not been an outlier to the main system, but an active participant in the larger system that was Lanka.

After establishing this background information - the broader picture of maritime trade in the Indian Ocean and the place of Lanka in it - Gunawardhana takes us through three chapters, each addressing a particular theme. These are the three final chapters of the book: chapters five, six, and seven. In these chapters, Gunawardhana concentrates on the archaeology of Jaffna.

These three chapters inform the reader with a wide-ranging array of information with historical, geographical, political, and regional substance that demonstrates the cultural and historical significance of the archaeological finds from the Jaffna peninsula in general and the Fort in particular. In the fifth chapter, Gunawardhana gives us the story of Jaffna from the perspective of maritime trade and urbanization. It is here that we read the complex story of urbanization at Kantharodei, archaeologically established. Gunawardhana spends a considerable number of words, from page 95 to 106, emphasizing the archaeological importance of this site. Drawing on Gordon Child's model that characterizes urbanization in archaeological contexts (Child, 1950), and concurring with Ponnambalam Ragupathy (1987) to an extent, Gunawardhana proposes an emergent urbanization at Kantharodei during 500 to 300 BCE (p.102-103). This time period is significant because it is also the time period designated for early urbanization in

Anuradhapura. In the sixth chapter, the reader can further engage with the idea of Jaffna as an archaeological entity made up of a range of material evidence that further confirms the idea that Jaffna has been an active participant in the maritime trade processes that defined the island's history over the centuries. Here, Gunawardhana presents a detailed picture of the findings of the post-disaster archaeological project carried out at the Jaffna Fort in 2017.

The concluding chapter of the book, chapter seven, focusing on ceramics found from archaeological works in Jaffna, illustrates the past of Jaffna through millennia, from about 1000 BCE through 1800 CE. The inventory of ceramics from Jaffna given in this chapter is comprehensive. Gunawardhana presents 32 types of ceramics. Each type is briefly described. This long inventory of ceramics demonstrates an active and centuries-long history of national, regional, and international interactions. In terms of trade relations and social change, the final two chapters position Jaffna fittingly in line with the historical developments in the rest of the island. At this point, I would like to reiterate what I said in a previous paragraph. As suggested, if one takes the map showing the distribution of historic ports along the shoreline of the island and then compares it with the historic road map of Vidanapatirana, and takes a close look at the inventory of artifacts found from archaeological sites in Jaffna, as given in chapters 5, 6 and 7 of the book, while considering the time-line chart for ceramics on page 162, then the reader will find that the archaeology of Jaffna cannot be separated from the historical concatenations that produce the island of Lanka as an object of historical and archaeological study. What Davis et al (Davis, et al., 2019, p. 1) surmised, writing on the new findings from Jaffna Fort, Gunawardhana, with additional support from the Sino-Lanka Archaeological Project sponsored by Shanghai Museum, China in 2018 and 2019, at Allaipitti (also spelled as Allaipiddy), an ancient port site in the Kayts island in the proximity of the peninsula, confirms the 'potential time-depth' ascribable to the archaeological past of Jaffna and its connectedness to the rest of the island.

Overall, Gunawardhana's publication is an excellent book on the archaeology of Jaffna, on a modest scale. He shows us, unassumingly, the archaeological exergy of Jaffna. However, at times it seems like the book might have benefited immensely from a slightly more engaging discussion of the issues it foregrounds. He could have constructively engaged with how maritime trade impacted the historical political realities of the island, or with Ragupathy's "exclusionist" and environmentally deterministic view of the idea of Jaffna (Ragupathy, 1987, p. 3), and similarly with the "expansionist" view of Sinhala scholars. Or, perhaps, he could have addressed how nationalist archaeologists are deployed to buttress ethnonationalist claims in popular politics. Gunwardhana does not do any of those, and stays within guarded confines of minimum interpretation, so it seems. To be fair, however, this book is already sufficiently informative for a discerning reader to insert basic interrogatives into the text and to find the idea of Jaffna for herself unshackled from the ethnonationalism that plagues Sri Lankan archaeology.

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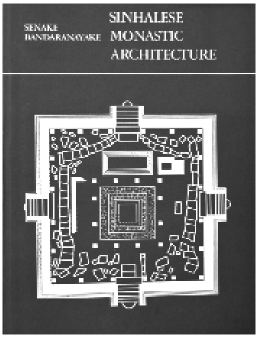
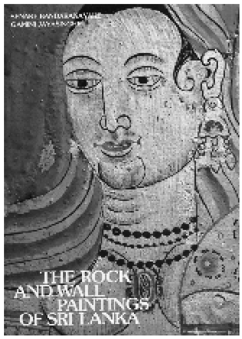
Commemoration :

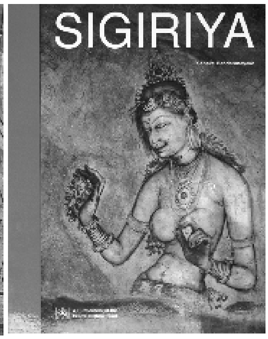
Professor Senake Bandaranayake (1938-2015)

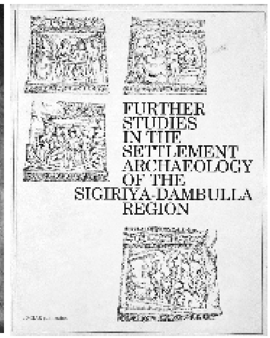
Professor Senake Bandaranayake held a unique position in the field of Sri Lankan Archaeology as a scholar who rendered an invaluable service to it. He joined the University of Kelaniya in 1975 as a senior lecturer in archaeology and rose to the level of a professor in 1980 demonstrating his prowess as a scholar avidly dedicating his time to archaeological research. In 1983, he was appointed as the Head of the Department of Archaeology of the Faculty of Humanities in the University of Kelaniya. Professor Senake Bandaranayake, who was ardently committed to taking the subject of Archaeology to the society, established the Postgraduate Institute of Archaeology in 1986, affiliated to the University of Kelaniya and became its first director. Professor Senake Bandaranayake who was appointed as the Vice Chancellor of the university in 1997 pioneered to introduce non-traditional archaeology to the field of Sri Lankan archaeology. In pursuance of this, he initiated introducing the university teaching staff to local and foreign knowledge. Subjects such as geology, cultural and physical anthropology, archaeological methodology, settlement archaeology, ancient meteorology, ancient Sri Lankan landscape architecture and cultural heritage management were introduced to the curriculum of Archaeology envisioning a transformation from the hitherto known traditional teaching pattern to a new direction and enabled the undergraduates of Archaeology to obtain practical training in their chosen fields. In 1999, he was appointed to the post of Ambassador in France and concurrently held the post of Permanent Representative of UNESCO in France. In 2000, he was appointed as the High Commissioner in India and concurrently held the post of Ambassador in Bhutan. He was the Director General of the Central Cultural Fund for the years 1997 and 1998. He is the writer and the editor of a number of publications on archaeology and culture of Sri Lanka. Few of them are The Sinhalese Monastic Architecture, Sri Lanka Island Civilization, Sigiriya Excavation and Research, The Settlement Archaeology of the

Sigiriya -Dambulla Region, Sri Lanka and the Silk Road of the Sea, The Heritage of Asia and Oceania, Ivan Pieris Paintings 1938 – 88. Professor Senake Bandaranayake who was among the world's greatest archaeologists, passed away on March 2nd 2015 at the age of 76.









Editors

Archaeologia
JOURNAL OF SOUTH ASIAN ARCHAEOLOGY

Required Research Article Format for Archaeologia

1. Article Length : Articles can contain a maximum of 10 pages including references | Body Text: No more than 3500 words in length | Format: *page size; B5, margins;2cm each size.*

2. Research Tittle: Produce a state short descriptive title of no more than 15 words | *Format: Garamond,16- points font size, bold*.

3. Authors' Names: State title, first name in full and family name in full | *Format: Times New Roman, 12 point font size.*

4. Author Details or Authors' Association: Association should state the university/institution, country and email address. When more than one author is involved, use superscript letters to match authors and association which should be noted per line, prefixed with the relevant superscript letter | Format: *Times New Roman, 8- point font size.*

5.Corresponding Authors: These details should be stated in the article. under "Corresponding Authors:" | *Format: Times New Roman, 11-point font, bold, left aligned* | Leave one-line space | name, title, institution, address, email, phone, fax – each on a new line | *Format: Times New Roman, 8- point font size.*

6. Abstract: In no more than 100-200 words, summarize what your research article will be about | *Format: Times New Roman, 10- point font size.*

7. Keywords: Max. 5 words | *Format: Times New Roman, 10 point font size and italic*.

8. The Text Body: Should be stated sub-titles along with introduction in the beginning, conclusion in the end | *Format: Times New Roman, 11-point font size.*

Introduction should provide a clear overview of the topic, purpose and results of the study.

Conclusion should restate the major argument and reiterate the most significant evidence supporting the research article.

Sub-headings focusing on the major issues addressed in the research article and the potential significance of the work should be included | *Format: Garamond,14-point font size.*

9. Illustrations: All illustrations, figures, and tables should be placed within the text at the appropriate places. Provide Photo credit for the photos used in the article.

E.g. :

...... (*Eppawela*) is an abandoned monastic site consisting of several double platforms and bridges with associated rock-cut cisterns and moats (Figure 01). This site is a *Padhanaghara Parivena*-type ....

Figure 01: Site C 112 during excavation in 2007
(Format: Time New Roman, 11 point font size, Italic)

10. Acknowledgements (if needed)**:** Include after the conclusion. | *Format; Times New Roman, 10- point font size.*

11. End Notes (if needed)**:** Include prior to the reference list. | *Format; Times New Roman, 8-point font size.*

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13. References: Use the APA (American Psychological Association) reference system at the end of the research article.| *Format; Times New Roman, 10-point font size.* Use the link below for more information https://www.mendeley.com/guides/apa-citation-guide/

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