
Research Proposal for May 2018:
IRAW@Bagan Settlement Archaeology Project

Submitted by

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IRAW@Bagan Mission Statement

The world’s tropical zones are witnessing the negative impacts of unchecked population growth, increasing wealth disparities, unbridled agricultural expansion, growing water demands, diminishing biodiversity, environmental degradation, escalating disease rates, and climate change. These are all urban issues. The proposed IRAW@Bagan study will highlight archaeology’s true strength – namely the ability to trace changes in urban forms and lifeways over time, and across multiple climate regimes, technological advances, and socio-ecological changes – to explore the root causes of the myriad issues faced by contemporary tropical metropolises.
The IRAW@Bagan Logo

The IRAW@Bagan logo on the cover of this proposal is derived from Jataka plaque #543 from the West Hpetleik Stupa: *Sāma Jātaka (Sāma the Devoted Son)*. In the traditional Pali canon this story is listed as #540 of 547, but at Bagan three additional stories are often included as #s 497, 498, and 499 (for a total of 550), which pushes this story to #543.

A summary of the story can be found here: [http://usamyanmar.net/Buddha/Article/Sama%20jataka.pdf](http://usamyanmar.net/Buddha/Article/Sama%20jataka.pdf)
IRAW@Bagan Project Summary

The IRAW@Bagan project (Phase I) will generate an integrated socio-ecological history for residential patterning, agricultural practices, and water management at the Classical Burmese (Bama) capital of Bagan, Myanmar (11th to 14th century CE) across a range of significant ecological, climatic, economic, socio-political, and religious changes. This objective will be achieved through a settlement archaeology study within the peri-urban (mixed urban-rural) settlement zone immediately surrounding Bagan’s regal-ritual epicenter, which is still clearly defined by remnants of its original walls and moat. The importance of the proposed program of survey, excavations, and geo-spatial inquiry is grounded in the fact that our current understanding of Bagan society continues to be biased towards its upper echelons, namely its high-ranking nobles and religious functionaries. A settlement archaeology study within Bagan’s peri-urban zone will: 1) generate a more nuanced understanding of Bagan as a dynamic capital city; 2) provide insights into the unique characteristics of early urbanism in the tropics; and, 3) contribute to considerations of resilience and vulnerability in contemporary tropical metropolises.

One of history’s great Buddhist kingdoms, Bagan’s peri-urban settlement zone covers roughly 80 km² and encompasses over 2800 Buddhist monuments, including temples with decorated interior space, solid stupas containing relics, and monasteries. Given the context, it is understandable that scholarly investigations at Bagan have almost exclusively focused on elite and/or religious architecture, art work, and texts. Nevertheless, inscriptions and retrospective chronicles suggest that Bagan’s peri-urban zone was also home to a large and diverse support population that lived in well-organized (i.e., orthogonally planned) “clusters” or “wards” based on commonalities in status, ethnicity, occupation, and clientage (i.e., formal “bondage” to a patron, such as the Crown or Church). Unfortunately, the veracity of this tightly integrated and highly organized, “cellular” residential pattern has yet to be confirmed on-the-ground. Recent archaeological investigations have also suggested that Bagan’s peri-urban zone was of the “dispersed,” agrarian variety, and included significant green space as well as productive land, in addition to a small-scale, but nonetheless sophisticated water management system. Once again, these suppositions require empirical confirmation. Taking these issues into consideration, the following questions will serve to frame both the methodological approach for the IRAW@Bagan settlement archaeology study, and the integrated socio-ecological history that will result from this long-term research program.

1) How accurate is our current understanding of the commoner population that inhabited Bagan’s peri-urban settlement zone, given the elite-centric focus of our current data sets?
2) Can the posited heterogeneity and cellularity of Bagan’s peri-urban population be materially confirmed, given the diversity in status, ethnicity, occupation, and bondage suggested by the historic records?
3) If such diversity can be recognized archaeologically, what might this tell us about commoner agency, and shifting levels of adherence or resistance to the dominant, merit-based, Buddhist ideology, and the system of bondage that supported it?
4) Did different segments of Bagan’s peri-urban population exhibit varying degrees of resilience to changing socio-ecological circumstances – such as climate change – and if so, why?
5) How were individual Bagan houses, house-lots, and villages configured, what kinds of activities took place in these residential spaces, and did the nature of these spaces change over time?

6) Does the residential patterning in Bagan’s peri-urban zone reflect the orthogonal/compact tradition of China, or the quasi-orthogonal/dispersed tradition found elsewhere in the tropics?

7) Did Bagan’s city-scape transition from being more dispersed and haphazard to more compact and grid-like over time?

8) How extensive and interconnected were Bagan’s peri-urban water management and agricultural systems, how did they develop, and in what ways did different stakeholders engage with them?
ပေါ် အတွေးအရေးကို အားလုံးကိုကြည့်ရှုပ်သည်ဖြစ်ကြသေးသော တရားကို အဆင့်များ အခြွင်းအရေးအပေါ် အစိတ်အပိုင်း (စိုက်) ပြောသည်။ အဆင့်များကို အခြွင်းအရေး အသုံးပြုပါသော သော အတွေးအရေးကို အခြွင်းအရေးကို အသုံးပြုပါသမှားသည်။

1) သို့သော်လည်း အားလုံးကိုကြည့်ရှုပ်သည်ဖြစ်ကြသော တရားကို အဆင့်များ အခြွင်းအရေးအပေါ် အစိတ်အပိုင်း (စိုက်) ပြောသည်။

2) အပိုင်းသို့ဖြင့်သော်လည်း အစိတ်အပိုင်းကို အဆင့်များ အခြွင်းအရေးအပေါ် အစိတ်အပိုင်း (စိုက်) ပြောသည်။

3) သို့သော်လည်း အားလုံးကို ကြည့်ရှုပ်သည်ဖြစ်ကြသော တရားကို အဆင့်များ အခြွင်းအရေးအပေါ် အစိတ်အပိုင်း (စိုက်) ပြောသည်။

4) သို့သော်လည်း အားလုံးကို ကြည့်ရှုပ်သည်ဖြစ်ကြသော တရားကို အဆင့်များ အခြွင်းအရေးအပေါ် အစိတ်အပိုင်း (စိုက်) ပြောသည်။
5) ပုရပ်နှစ်မျိုးပြုသော အကျော်အလှယ်များ ဖြန့်ချေအားအဖြစ်လုပ်ဆောင်ရင် မဟုတ်ပါ။ မည်ကောင်းလို့ ပြုလုပ်လောက်ရှိသလို ကြည့်ကြည့်ပြီး ဖြန့်ချေအားများကို ထောက်သားပြုလုပ်နိုင်စေမလို ၊ မည်သည်များကို ဖြန့်ချေအားလောက်ရှိသလို အချက်အလက်များကိုလည်း ပြုလုပ်နိုင်စေမလို ၊

6) ပုရိပ်နှစ်မျိုးပြုသော အကျော်အလှယ်များ ဖြန့်ချေအားအဖြစ်လုပ်ဆောင်ရင် မဟုတ်ပါ။ မည်ကောင်းလို့ ပြုလုပ်လောက်ရှိသလို ကြည့်ကြည့်ပြီး ဖြန့်ချေအားများကို ထောက်သားပြုလုပ်နိုင်စေမလို ၊ မည်သည်များကို ဖြန့်ချေအားလောက်ရှိသလို အချက်အလက်များကိုလည်း ပြုလုပ်နိုင်စေမလို ၊

7) ပုရိပ်နှစ်မျိုးပြုသော အကျော်အလှယ်များ ဖြန့်ချေအားအဖြစ်လုပ်ဆောင်ရင် မဟုတ်ပါ။ မည်ကောင်းလို့ ပြုလုပ်လောက်ရှိသလို ကြည့်ကြည့်ပြီး ဖြန့်ချေအားများကို ထောက်သားပြုလုပ်နိုင်စေမလို ၊ မည်သည်များကို ဖြန့်ချေအားလောက်ရှိသလို အချက်အလက်များကိုလည်း ပြုလုပ်နိုင်စေမလို ၊

8) ပုရိပ်နှစ်မျိုးပြုသော အကျော်အလှယ်များ ဖြန့်ချေအားအဖြစ်လုပ်ဆောင်ရင် မဟုတ်ပါ။ မည်ကောင်းလို့ ပြုလုပ်လောက်ရှိသလို ကြည့်ကြည့်ပြီး ဖြန့်ချေအားများကို ထောက်သားပြုလုပ်နိုင်စေမလို ၊ မည်သည်များကို ဖြန့်ချေအားလောက်ရှိသလို အချက်အလက်များကိုလည်း ပြုလုပ်နိုင်စေမလို ၊
2018 Field Crew

1. **Dr. Gyles Iannone (Trent University)**, Principal Investigator
2. **Dr. Pyiet Phyoe Kyaw (Mandalay University)**, Co-director
3. **Dr. Scott Macrae (Trent University)**, Co-Director
4. **Kong Cheong (American University)**, Field Director
5. **Dr. Nwe New Moe (Mandalay University)**, Unit Supervisor
6. **Saw Tun Lin (University of Yangon)**, Unit Supervisor
7. **Nyein Chan Soe (Yadanabon University)**, Cultural Anthropologist
8. **Keiko Lui (Eco K Company)**, Environmental Consultant
9. **Naing Soe (University of Yangon)**, Cultural Anthropologist
10. **Ellie Tamura (Trent University)**, Field Assistant
11. **Kathleen Forward (Trent University)**, Field Assistant
12. **Raiza “Stephany” Rivera-Borbolla (Trent University)**, Field Assistant
13. **Khin Lay Maung (University of Yangon)**, Field Assistant
14. **Kyawswar Win (Mandalay University)**, Field Assistant
15. **Paing Thet Phyoe (University of Yangon)**, Field Assistant
16. **Moe Sat Wathan (Mandalay University)**, Field Assistant
17. **Yuan “Lucy” Qin (George Washington University)**, Field Assistant
18. **Khin Kyi Phyoe Thant (University of Yangon)**, Field Assistant
19. **Hsu Thin-Za Toë (Mandalay University)**, Field Assistant
2018 Ethnoarchaeology Study: Water and Ritual at Bagan

In May 2018, the IRAW@Bagan team will continue its ethnoarchaeology study in ten traditional villages located in the vicinity of Old Bagan. Some of the villages lay inside what was once the ancient city’s peri-urban settlement zone, while others are located in more rural settings. The general goal of the ethnoarchaeology study is to explore the material correlates of domestic lifeways specific to Myanmar’s “dry-zone.” This information will enhance our ability to both recognize and interpret the archaeological residues of ancient settlement patterning in Bagan’s peri-urban zone. The May 2018 research activities will include site visitations, written and photographic record taking, and strategic questioning of residents concerning ritual practices relating to water use and water management features. Ethics Board approval for the interviews has been obtained through Trent University. The information generated through this ethnoarchaeology study will inform the future analysis of water usage, perceptions, and symbolic meaning in ancient Bagan. The goal of the latter research will be to provide a better understanding of the relationship that water management had with other institutions within Burmese society, such as those relating to religion, politics, and agriculture production. The villages to be visited as part of this study include the following:

1) Minnathu
2) East Pwa Saw
3) West Pwa Saw
4) Thuhtaykan
5) Kon-Tan-Gyi
6) Kon-Sin-Kye
7) Hypauk-Seik-Pin
8) Zee O
9) Shwe Hlaing
10) Thae Pyin Taw
၂၀၁၈အမ ုုအ းနလုုပ္အ ကင္မမမခကးြင္
င္းိအလည
လကက္င္း
ႈက
ဓကး္ပပုုမရး္းမ္းမခကးယမက္င္း
ရင္ညိအးႈ
မပ္န္တ္ြပမမလ်ကဏကမခကး ိအး္ ပုုးကပိက္င္း ရင္ည ုုွင္ တ္ည
်ွုုး်ြယ္ယပုုေ်တ္မမဓအလညမခကး ရင္ည
ုုွင္ တ္ည
္အးပာအ ကအမး္ြန္းမခကးအမးကမန္းက္င္း
ႈ တ္းွုုတပာ၀င္ပာမတ္သ ႈ္င္းကဗခ း္းြ်္
လွုု်္နကးမတ္ည
ခင္ည၀း္ ွုုင္းက်ွႈရမခကး ရင္ည္တ ငးန္တး်ၠ ွုုလ္်
္ြင္ညကပိ္ခ်္းယမ္ပညပာ တ္သ ႈ္င္းးင္း ကး ုုွင္းကအးရးအ ကင္း ုုအး နိအလညလကအးး
လုုပ္ငနး္မခကးန ဥ းးတ္္ခ်္မရက း၊ က ကအးး းးတ္္ခ်္မရကအ္က်္ပာ္းွုုင္းက ႈ္ပာ တ္သ
ယင္းအလညလကအးးန
္ႈွး္္ပွုုင္း
းႈ္္ုု
က ႈ္တ္ညိအ်ခး ြကမခကးမရကအ္က်္ပာ္းွုုင္းက ႈ္ပာ တ္သ
1) မင္းနန္ မ
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Figure 1. Map showing the seven traditional villages located within the Bagan peri-urban settlement zone (modified from http://dpsmap.com/bagan/).
2018 Nat Yekan Sacred Water Tank Study: Summary


Project Summary: The IRAW@Bagan project is aimed at developing an integrated socio-ecological history for residential patterning, agricultural practices, and water management at the Classical Burmese (Bama) capital of Bagan, Myanmar (11th to 14th century CE). As part of this long-term research program investigations have been initiated on Mount Tuyin, located 11.25 km southeast of Bagan’s walled and moated epicenter. This upland area figures prominently in the chronicles of early Bagan, given that it was one of five places around the city that a royal white elephant carrying a Buddhist tooth-relic kneeled down, prompting King Anawrahta (1044-1077 CE) to build a pagoda (i.e., temple) there. Numerous 13th century religious monuments were subsequently built on the summit of the mountain. Recent explorations on Mount Tuyin have drawn attention to an additional feature of historical significance, a rock-cut tank located along the eastern edge of the Thetso-Taung ridge. Referred to by local villagers as Nat Yekan (Spirit Lake), this reservoir appears to have been integral not only to the initial collection and subsequent redistribution of water across the Bagan plain via a series of interconnected canals and reservoirs, but also, through its associated iconographic imagery, it may have been intended to symbolically purify this water, enhancing its fertility prior to its flowing into the city’s peri-urban zone. The proposed investigations will employ hydrological modelling, excavations, and both iconographic and epigraphic analysis to build a multilayered understanding of Nat Yekan’s economic, political, religious, and ideological significance during Bagan’s classical era.

Project Importance: Our proposed research program will further our understanding of the multifaceted character of human-water relationships in the early state formations of the seasonally wet-dry tropics. These investigations also hold broader significance for 21st century communities. For one, they will generate insights into the efficacy of traditional rainwater harvesting systems. The proposed research will also help elucidate the unique aspects of urban development in the tropics today, particularly as these relate to issues of both water and food security. More broadly, we firmly believe that the examination of the development, expansion – and at times demise – of water management systems is one of the key ways that archaeologists can contribute to our understanding of socio-ecological systems, and social change in general.

Project Funding: Funding for this field research has been provided by a National Geographic Society grant.
လုပ္ငန္း္ခဥ္း္ခိပ္:

ပုရပ္းဦးဦး နလုပ္ငန္းတ္ိကမ

န္မက းွုတန ရ ဆိုက်က းွ္ တ္ည
ပုုရပးရွ

အးႈ မပန္တ္ြပက္င္း ွုု်္ပခွိးးွပ္ ွမ္ယက

ွမ္ယကအနငွုုင္မမပပုုႈပမခကးြ်္ မီးအပာင္းးႈတ္းးတ္းိအ က

င္းြ်္မတ္ည ပုုခပိးမခကးန

းွုုးး်္မမးရွလကအႈးန္ တ္းယ္ပာ တ္သ

္အးးရတ္ အ ကင္းြ်္မတ္ည ုုအး န္ႈ ္ႈဥ္န

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းတ္းရွအ က းုုးင္ ်္ ွုုး

အးကင္ငွပ္မခကးးြင္

းတ္ငကး္ပညအေ်ကင္း းကုု၀င္မခကးးြင္

းးအလကႈမးႈမ္းအလညလကအးး

းမခကး တ္မွုုင္း ုုွင္းကငမးက္ကးမမးရွ က ြင္ကပင္လ်ကဏကမခကး

း၊ ုုွ္းကးမခကး္ ုု ွးကပ း တ္

အး်န္မခကး္ ုု ွးကပ း တ္ည

အးႈင္အးက္္ယမ္ ်ွုုိအ က

းင္တႊ န္းအန တ္ည

အ်ၤး္က ႈ္ယမ ုုွင္မတ္ညိကမွိ

က ပိအ်ခးလ း္္ းွ ယကမခကး   ွုုတ

မႈ း င္းမ န္တႈင္လခ်္ အကမေ ုုက

ေ်ြယ္၀အႈးန္ႈ မပအ ကင္းြ်္ငကးက္င္း

အ္း၊ က်ွုု ွးရွးပာ တ္သ

ႈမးႈမ္းအလညလကမမမခကး တ္

၂၁းကႈုုလမတ

္ ြပတ္ႈတ္းမခကး္းြ်္

ပွုုမွုု်ခယ္ကပန္တလက တ္ည

ငင္းရကးမမးႈ္္ုုလပက ႈ္ပာ တ္သ

းမးအ က္အလညလကက္င္းမခကး

းုုပ္ းုု င္းးုုအလညလကအးးနရင္ညိအးရး

အ ကင္းႈကမခကး္ြပက္မ္

ပွုုမွုုနကးလတ္

အ္း၊ ကအပာ်္လကအႈးန္ိအ က

င္းြ်္မတ္က ႈ္ပာ တ္သ

၂၁းကႈုုလမတ
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အောက်ပါတွင် National Geographic Society ကို သိရွက်ခဲ့တယ်။

ယုန်းတယ်ကို ကြည့်စုံစောင်းနိုင်သည်။ မိဘ ဒါကို ကြည့်စုံစောင်း ကြိုးစားနိုင်ပါတယ်။
2018 Schedule and Major Equipment to be Brought into Myanmar

April-May 2018 Research Schedule

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<tr>
<td>KE074 departs 12:40</td>
<td>KE471 departs 18:40</td>
<td>Arrive RGN 22:15 Yangon Hotel</td>
<td>Night bus to Bagan</td>
<td>Set-up Day &amp; Tour</td>
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29 Bagan Hotel: Field Day
2 Vans

30 Bagan Hotel: Field Day
2 Vans

1) Foreign staff hotel days = 26 (24+2); Myanmar staff hotel days = 24
2) Foreign staff meal days = 27 (25+2); Myanmar staff meal days = 25
3) van rental days = 2

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May 2018

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13 Bagan Hotel: Field Day
2 Vans

14 Bagan Hotel: Field Day
2 Vans

15 Bagan Hotel: Field Day
2 Vans

16 Bagan Hotel: Field Day
2 Vans

17 Bagan Hotel: Field Day
2 Vans

18 Bagan Hotel: Field Day
2 Vans

19 Bagan Hotel: Day Off

20 Bagan Hotel: Field Day
2 Vans

21 Bagan Hotel: Field Day
2 Vans

22 Pack-Up
2 Vans
Night Bus to Yangon

23 Yangon Hotel: KE472 Departs 23:25

24 Arrive ICN 7:35
KE073 departs 9:35
Arrive YYZ 9:45

25 26


Major Equipment to be Brought into Myanmar for Research Purposes

1) Total Station (N=1)
2) Total Station Tripod (N=1)
3) Total Station Prism (N=1)
4) Total Station Prism Pole (N=1)
5) Laptop Computers (N=8)

Note: No major equipment will remain in Myanmar after the 2018 field season.
**2018 Nat Yekan Sacred Water Tank Study: Detailed Description**

**Project Title:** Water, Ritual, and Prosperity at the Classical Capital of Bagan, Myanmar (11th to 14th Century CE): Exploration of the Tuyin “Water Mountain” and the Nat Yekan Sacred Water Tank.

**Project Description:** Bagan, like most of the historic Buddhist capitals of Myanmar, was located in the central “dry zone” (Aung-Thwin 1987:88, 1990:1; Aung-Thwin and Aung-Thwin 2012:38; Hudson 2004, 2008:553; Stadner 2013:12; Strachan 1989:8; Stargardt 1968), Myanmar’s “most arid” region (Cooler 1997:19-20). As the only significant upland area on the Bagan plain, Mount Tuyin is believed to have played a significant role in water management strategies at the ancient city (Moore et al, 2016; Win Kyaing 2016), especially with respect to the flow of runoff downslope, from the western side of the Mount Tuyin summit, towards the expansive Mya Kan Reservoir (aka Emerald Lake or Kyanzittha Reservoir; Aung-Thwin 1990:28; Luce 1969:56; Figures 1 and 2). Located atop Mount Tuyin, Nat Yekan (Spirit Lake) was likely a key collection node within this broader water management system (Figure 3). This rectangular tank is 26.5 m x 14 m in size, 7.3 m deep, and could have held as much as 2660 m$^3$ of water (Ni Tut 2013:161; Figure 4 and 5). Nat Yekan was largely hewn from the sandstone substrate – possibly initially having been a quarry – although on its east side an 11-m long, 5 m high sandstone slab retaining wall was used to close off the reservoir (Ni Tut 2013; see also Moore et al. 2016:295; Figure 6). A smaller (2.7-m long) section of retaining wall was also used to close off the eastern corner of the north wall. A round hole, ca 20 cm in diameter, is carved into the very center of the tank, possibly having served to hold a pillar to measure water depth (Figures 7 and 8).

![Figure 1. Location of the Tuyin-Thetso Range, Mya Kan Reservoir, and Nat Yekan Sacred Tank.](image-url)
Figure 2. The Tuyin-Thetso range, looking from the west.

Figure 3. Nat Yekan Tank and its associated religious and water management features.
Figure 4. Drone photo of Nat Yekan Tank (note stairway on the bottom right-hand side).

Figure 5. Nat Yekan Tank interior, looking northwest, towards the proposed spillway.
Figure 6. Multi-course sandstone wall closing-off the eastern side of the Nat Yekan Tank.

Figures 7a & b. A hand-cut round hole in the center of the Nat Yekan Tank (a, left) which was possibly used for holding a “lotus pillar” that was symbolic of fertility and useful for gauging water volume (b, close-up on right).
Three carved stairs lead down into the Nat Yekan tank, with each stairway descending to a different water level (Figures 5, 6, 9, 10). These are reminiscent of the intricate stairway systems associated with the stepwells (baoli) of Medieval India (Bhattacharya 2015:36; Shubhangi and Shireesh 2015). As with the Indian stepwells, which “were often carved profusely with elaborate detail” (Bhattacharya 2015:36), a number of iconographic images are incised into Nat Yekan’s walls (Figures 9-13), including a lizard, water labyrinth, Naga-serpent, three hamas birds (geese), a crocodile or Makara (water monster), an egret, two tortoises, two small fish, one large fish, a crocodile, and a Naga-Buddha or Muchalinda image within a niche (referencing the time when the Naga King used his hood to protect the meditating Buddha from a rain storm; Fisher 1993:23, 175; Leidy 2008:170; Luce 1969:171; Moore 2007:244; Stadner 2013:34). Water imagery is clearly evident in all of these depictions, and many are also tied to notions of purity, fertility, and power within the Buddhist belief system (e.g., Beer 2003:5, 69, 72, 77, 97; Fisher 1993:23).

Also noteworthy is that the natural sandstone rim in the northwest corner of the tank has been purposely cut down by roughly 1-2 m, in a clearly symmetrically manner (Figure 9). The very center of this lower portion of the tank rim – which is roughly 8 m in length – articulates precisely with the top of the carved niche enclosing the Naga-Buddha image. The northwest stair also begins its descent into the tank at exactly the same elevation, confirming that this lower wall level was once an exposed “living” surface, possibly a spillway for the tank. Above this lower section of the tank rim is an inward sloping, 3-4 m high embankment containing myriad sandstone boulders (>25.6 cm in length) configured in a series of terraces (Figure 14). This artificial embankment appears to have been used to dam off the proposed spillway in the northwest corner of the reservoir at the same level as the higher rock-cut and stacked sandstone slab walls enclosing the rest of the tank. To the north of this embankment the hillside gradually descends to the western foot of Mount Tuyin, and the area of the Mya Kan reservoir (Figure 15).
Figure 9. Images associated with the northwest corner of the tank, beneath the proposed spillway.

Figure 10. Images associated with the southwest corner of the tank.
Figure 11. Images associated with the west wall of the tank: Left, a goose? Right, a lizard?

Figure 12. Images associated with the south wall of the tank: Left, two fish facing each other; Right, an egret?

Figure 13. Two possible tortoise images on the south wall of the tank, both highly eroded.
Figure 14. Terrace-style embankment that is posited to have dammed-up the proposed spillway.

Figure 15. The slope descending from the base of the proposed Nat Yekan spillway towards the Mya Kan Reservoir (the green area in the middle of the photo), with Bagan’s peri-urban settlement zone off in the distance.
Nat Yekan clearly offers some tantalizing evidence for ancient water management practices, but there are many questions that remain to be answered concerning its broader significance to the Bagan community:

1) How did water enter the Nat Yekan tank?
2) How much water could the tank hold?
3) Could the tank hold water year-round?
4) Would climate changes have impacted the tank’s water storage capabilities?
5) Was Nat Yekan physically connected to a broader water management system?
6) When was the tank constructed, and what was its original form?
7) How was water withdrawn from the tank?
8) Did the lower section of sandstone rim in the northwest corner of the tank initially serve as a spill-way, and did it direct water into the Mya Kan catchment?
9) If a spillway did exist in the northwest corner, how regularly did the tank discharge water?
10) When, and why, was the artificial retaining wall/dam in the northwest corner of the tank constructed?
11) If a spillway originally existed in the northwest corner of the tank, does its surface contain additional iconography?
12) Where the multiple stairs found within Nat Yekan modelled on those of Indian stepwells, and if so, what is the significance of this emulation?
13) Does the assemblage of iconographic elements and available inscriptions support the idea that Nat Yekan was a “sacred water tank” that served to sanctify water, thereby increasing its powers of fertility?
14) Do further iconographic features exist within the tank, and are there any other inscriptions of relevance to our understanding of this water management feature?

**Goals and Objectives:** The Net Yekan investigations will enhance our understanding of water management at Bagan, in addition to providing information on the efficacy of traditional rainwater harvesting systems, a topic which has recently drawn considerable attention in India (Bhattacharya 2015:31). Our research will also allow us to explore the broader significance of Nat Yekan, both within the classical Bagan cityscape, and with respect to the wider Southeast Asian cultural sphere. We hypothesize that Nat Yekan’s was a “sacred water tank” from which water flowed downslope, into an extensive water management system that serviced Bagan’s agricultural field system and peri-urban settlement zone (Figures 15 and 16). We also posit that Nat Yekan’s iconographic elements served a similar purpose as the Shaivite imagery found in association with the intricately carved river beds along the Stung Kbal Spean River in the Kulen Hills, northeast of the Khmer city of Angkor (Figure 17; see Boulbet 1979; Chevance, 2005; Feneley et al. 2016:282-284; Hendrickson 2011:451; Jacques and Dumont 1999; Tan 2014:3; Tawa 2001:134). Across Southeast Asia, such iconographic imagery has long been employed to reaffirm the ideological connection between water and ritual (Boomgaard 2007:6). As has been underscored by Barbara Andaya (2016:243): “For Southeast Asian societies generally, ritual water was highly valued because of its life-giving, healing, and transformative properties. Together with the appropriate ceremonial, the very act of pouring water over a tangible emblem
of fertility (like an upright linga) could ensure the community’s well-being.” If the sacred nature of Nat Yekan can be verified, it would also imply that Mount Tuyin was a “water mountain” (Scarborough’s 1998), a specialized ritual and economic node that enhanced agricultural production through the collection, sanctification, and redistribution of water, under the auspices and patronage of societal elites (Scarborough 2003:84).

Figure 16. Pyiet Phyo Kyaw in the Nat Yekan Tank in October 2015 (at the end of the rainy season).

Figure 17. The carved river bed at Kbal Spean, Greater Angkor region, Cambodia.
Methodology: The following methods will be employed to address the 14 research questions outlined earlier in this proposal:

**Hydrological Analysis – Questions 1-5** (Macrae and four assistants): This sub-project will involve a GIS-based hydrological study of Nat Yekan and surrounding area, including the Mya Kan Reservoir. The analysis will be based on hydrological modeling programs (Arc Hydro [see Maidment 2002]) within a geographical information system (ArcGIS [ESRI 2016]). The foundation of this innovative analysis will be a high resolution digital elevation model (DEM) derived from existing remote sensing datasets (i.e., recent aerial photographs and prior mapping initiatives) and traditional total station and GPS survey data collection. The hydrological analysis will include the direction of flow, flow accumulation, and watershed delineation (see Macrae 2017:214-225; Macrae and Iannone 2016:374-388). The identification of these hydrological characteristics across the landscape will allow for an advanced, geo-spatially informed understanding of both naturally occurring features – such as slope, streams, and seasonal ponds – as well as cultural features, including reservoirs, canals, trenches, and moats. The hydrological modelling sub-project will build upon the high precision photogrammetric mapping of the Net Yekan tank conducted by Nyi Lynn Seck of 3xvivr Virtual Reality Productions in December 2017 (Figure 18).

![Figure 18. High resolution 3D scan of the Nat Yekan tank produced by Nyi Lynn Seck of 3xvivr Virtual Reality Productions in December 2017.](image)

**Excavation and Artifact Analysis – Questions 6-10** (Iannone and six assistants): This sub-project will involve the excavation of a 2 x 4 m trench through a portion of the artificial embankment (i.e., dam) in the northwest corner of the Nat Yekan Tank (Figure 14), thereby
exposing the posited spillway surface and any associated iconography (Figure 9). This excavation unit will be axially aligned with the exact center of the proposed spillway, and the Naga-Buddha image located just below it. High resolution 3D mapping of the various excavation levels will be carried out using georeferenced ground control points, a handheld digital SLR camera, and state-of-the-art “Structure from Motion” (SfM) photogrammetric software that will stitch together a series of photo images into a 3D point cloud (Agisoft LLC 2017a, 2017b; Green et al. 2014:173; Koenig et al. 2017). This Structure from Motion (SfM) technique will also be used to precisely record all excavation contexts, on-floor artifact distributions, features, and both top plans and sections, allowing for the production of high resolution orthophotos, digital elevation models, accurate 3D and 2D maps, precise post-excision measurements, and geospatial analysis in ArcGIS (Benavides López et al. 2016; Green et al. 2014; Koenig et al. 2017; Quatermaine et al. 2014). All context information will be entered into a Microsoft Access database. Samples for radiometric and/or luminescence dating will be collected to augment chronological assessments based on ceramic seriation. All artifacts will be processed, recorded, and preliminarily analyzed in the field laboratory over the course of the field season.

If time permits, an additional 1 x 2 m trench will be used to examine the interior wall (north side) of the 2nd water tank that is posited to exist to the east of Nat Yekan (see Figure 3), on the opposite side of the Tuyin-Thetso summit. These excavations will also allow us to assess the potential depth of the sediments that have infilled this possible tank feature. The large depression indicative of what we believe to be a 2nd water tank was encountered during field reconnaissance in December 2017. The feature appears to be similar in size to Nat Yekan in terms of its circumference. Although it is currently filled with sediments, the posited tank feature does exhibit evidence for a stacked sandstone enclosure wall on its north side that is reminiscent of Nat Yekan’s eastern embankment wall (Figure 19). Two evenly spaced, parallel rows of postholes found in association with the surrounding embankment suggest that a roofed area may have partially surrounded the presumed water tank.

![Figure 19. Section of exposed sandstone brick enclosure wall encompassing the northern embankment of the 2nd water tank posited to exist on the eastern edge of the Tuyin-Thetso ridge.](image)
**Art Historical and Epigraphic Analysis – Questions 11-14** (Pyiet Phyo Kyaw and three graduate students): This sub-project will collect and analyze relevant inscriptions and chronicle references to Nat Yekan, in addition to examining all the iconography associated with the tank itself. This will include any iconography associated with the proposed spillway and any newly documented images located inside the tank. The iconographic study will employ applicable inscriptions, chronicles (e.g., Pe Muang Tin and Luce 1923), and handbooks focusing on Buddhist symbols (Beer et al. 2003; Fisher 1993; Leidy 2008) to determine the possible significance of individual images and/or clusters of images. These investigations will also consider the history of all religious edifices and institutions located on Mount Tuyin, and those associated with the Mya Kan reservoir, in order to better contextualize Nat Yekan’s use-life.

**Results:** In combination, this component of our broader IRAW@Bagan research project will result in a detailed understanding of the construction history, hydrological characteristics, socio-political significance, and ritual-ideological meaning of the Nat Yekan Tank. The resulting datasets – especially the high precision hydrological and SfM photogrammetric data – will allow for ongoing GIS analysis of a highly sophisticated quality. It is expected that the dissemination of results will focus on both culture history and methods, and involve:

1) Four major conference presentations;
2) Four journal publications;
3) Four theses and/or PhD dissertations.

**Capacity Building:** Myanma academics have recently begun to actively seek out research collaborations with international scholars. From an archaeological perspective, the stated goal of such collaborations is to expose Myanma scholars and students to current theories and methods. Sensitive to these needs, the proposed research program will involve students from both North America and Myanmar in field-based research based on cutting edge archaeological theory and methods, including training in excavation and survey techniques, Geographical Information Systems (GIS), GIS-based hydrological analysis, and SfM photogrammetry.

**Future Plans:** A single field season of excavations and hydrological analysis is planned for Nat Yekan. If a spillway with iconography and/or epigraphic evidence is indeed found in the northwest corner of the tank, a second season of funding may be sought in order to fully expose this feature. If it can be verified that the eastern tank is similar in size and depth to that of Nat Yekan, a second field season of research in association with this feature may also be considered worthy of additional funding.

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