
2018-2023 Research Plan for the IRAW@Bagan Settlement Archaeology Project

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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
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 2200 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. That said, inscriptions and retrospective chronicles also suggest that Bagan’s peri-urban zone was 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. The traditional literature also suggests that the Bagan’s peri-urban zone had poorly developed agricultural and water management systems. In contrast, recent archaeological investigations have 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.

It is these contrasting views of Bagan’s peri-urban space that frame the IRAW@Bagan research program, and provide its impetus. With respect to the broader importance of the proposed investigations, the world’s tropical zones are currently 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 study will highlight archaeology’s true strength, in this case 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 resulting knowledge will be relevant to academics, students, the general public, urban planners, and a range of international, national, and community based not-for-profit organizations whose interests lay in tropical urbanism.
### PROPOSED IRAW@BAGAN ANNUAL SCHEDULE

#### April 2018

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**Notes:**
1) Foreign staff hotel days = 31 (27+4); Myanmar staff hotel days = 27
2) Food Days = 27
3) Van rental days = 25

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DETAILED DESCRIPTION

OBJECTIVES: Insight Grant (IG) funding is requested to support Phase I of a long-term archaeological research program aimed at generating an integrated socio-ecological history of residential patterning, agricultural practices, and water management at the “classical” Burmese (Bama) capital of Bagan, Myanmar (11th to 14th century CE). The IRAW@Bagan project gains its importance from the fact that our current understanding of Bagan society is biased towards its upper echelons, being based almost entirely on elite-focused texts, art, and architecture. A settlement archaeology study within the peri-urban (mixed urban-rural) zone immediately surrounding Bagan’s walled and moated, regal-ritual epicenter will: 1) provide much needed balance to our conception of Bagan as a dynamic capital city; 2) generate insights useful to elucidating the unique aspects of urban development in the tropics; and, 3) inform considerations of resilience and vulnerability in contemporary tropical metropolises.

CONTEXT: Bagan (aka Pagan), 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; Cooler 1997:19-20; Hudson 2008:553; Strachan 1989:8), on the eastern bank of the strategic and economically important Ayeyarwady River (Higham 2001:134; Hudson 2004:221, 265). Recent archaeological and scientific assessments support a mid-9th century CE date for the establishment of the Bagan community (Hudson 2004:220, 265-266; Moore et al. 2016:285; Nyunt Nyunt Shwe 2011:26), with the 11th to 14th centuries being the period when Bagan was the capital of a polity that controlled much of what is now the country of Myanmar (Daw Thin Kyi 1966:187; Galloway 2006:35; Higham 2001:134; Hudson 2004:183, 266, 2008:553, 555; Kan Hla 1977:17; Moore et al. 2016:285; Stadtner 2011:214-215, 2013:14, 18). Bagan’s florescence was followed by an era of socio-political “collapse” and reorganization, after which time it saw continued usage as a provincial capital and pilgrimage center (Hudson 2004:234-245, 266, Table 15, 2008:555; Hudson et al. 2001:53; Stadtner 2011:215-216, 2013:14, 18). These periods of growth and decline coincide with, and may have been influenced by, two significant climate changes: The Medieval Climate Anomaly (MCA; 900-1300 CE), marked by warmer conditions with increased rainfall, longer monsoon seasons, shorter dry season droughts, and rains more evenly distributed throughout the year – which were ideal conditions for agriculture – and the subsequent Little Ice Age (LIA; 1300-1570 CE), a cooling period that brought negative changes in both rainfall and temperature, and hence deteriorating agricultural conditions (Buckley et al. 2010, 2014; Cook et al. 2010; Lieberman 2003:103, 2009:330, 792, 2011:939; Lieberman and Buckley 2012:1052; Wohlfarth et al. 2016; Wündsch et al. 2014; Yamoah et al. 2017).

The Bagan epicenter, as is true for other historic Myanmar capitals, was an “exemplary” center that was imbued with cosmological and regal-ritual significance, at the same time that it was home to royals, nobles, military leaders, guards, servants, and elite craft workers (Aung-Thwin 1985:50-51, 1987:88, 94-98; Aung-Thwin and Aung-Thwin 2012:81, 100-101; Daw Thin Kyi 1966:187; Hudson 2004:221; Kan Hla 1977:21). Such epicenters were normally characterized by a walled and moated regal-ritual space with 12 gates that housed royal temples (with interior space), stupas (solid cores with offerings), ordination halls, libraries, monasteries, “preaching halls,” and a palace (Aung-Thwin 1985:50-52, 1987:89-91; Aung-Thwin and Aung-Thwin 2012:81; Daw Thin Kyi 1966:179; Hudson 2004:220; Stadtner 2011:219-220).

Historically, Myanmar epicenters were roughly 2.5 km² in size (Aung-Thwin 1987:90; c.f., Daw Thin Kyi 1966:179). Bagan’s epicenter is slightly smaller, at 1.5 km² (Aung-Thwin and Aung-
Thwin 2012:78), although it is impossible to determine its original dimensions because its western wall washed into the Ayeyarwady River sometime in antiquity (Daw Thin Kyi 1966:179; Hudson 2004:221; Luce 1969:7, 106; Stadtner 2013:125).

When considered today, Bagan’s epicenter clearly: “represents an elite core, not an urban boundary,” given that a dense amalgamation of brick temple complexes, stupas, and monasteries extends out and away from the walled enclosure in all directions, thereby forming an extensive peri-urban settlement zone (Hudson 2004:221; see also Aung-Thwin and Aung-Thwin 2012:101; Kan Hla 1977:21; Luce 1969:229). Most of these features were constructed during Bagan’s florescence (Hudson 2004:236), and the spatial extent of the peri-urban zone itself appears to have been established by the end of the 11th century (Kan Hla 1977:18). This peri-urban zone is estimated to have covered around 80 km² (Grave and Barbetti 2001:75; Hudson 2004:237; Hudson et al. 2001:48; Moore et al. 2016:294; c.f., Aung-Thwin and Aung-Thwin 2012:91; Kan Hla 1977:15), and possibly as many as four thousand (Aung-Thwin 1985:169; Kan Hla 1977:15; Pricha 1992-2003). The emphasis on channeling resources into monumental architecture during Bagan’s early development suggests that these edifices were considered strategic mechanisms for broader societal integration (Hudson 2004:243; Hudson et al. 2001:51; see also Trigger 1990). Crucial to this integration was the Buddhist notion of “merit,” which was fundamental to the Bagan belief system, and indeed to the daily life of all members of the kingdom (Aung-Thwin 1987:89; Aung-Thwin and Aung-Thwin 2012:83-84). It was good deeds, and more significantly donations of capital and both human and natural resources to the Buddhist church (the Sangha), that allowed all citizens – but mostly those with access to such resources – to secure “social recognition and spiritual benefits,” along with a higher quality rebirth (Aung-Thwin 1985:26, 43-44, 169-171; Aung-Thwin and Aung-Thwin 2012:94; see also Luce 1969:89-90, 107, 109, 112, 115; Stadtner 2013:18).

Hudson et al. (2001:70) posit that: “By the twelfth century A.D., [Bagan’s peri-urban zone was] characterized by a low-density, monument-rich complex that could expand without the constraint of a predefined outer boundary,” such as a perimeter wall or any other type of defensive feature (Daw Thin Kyi 1966:187; Kan Hla 1977:19). The inscriptions inform us that although the majority of temples and stupas were made of brick, some monasteries, and the many palaces, commoner residences, and schools scattered throughout the peri-urban zone were crafted from wood and built on “stilts” (Aung-Thwin and Aung-Thwin 2012:91; Kan Hla 1977:20; Luce 1969:229; Strachan 1989:7). As a result, other than the clay roof tiles used in elite structures, these buildings have all perished (Aung-Thwin and Aung-Thwin 2012:91). According to John Miksic (2001:100): “Subjective impressions of Pagan obtained by walking over the ground suggests that many areas in fact may have been densely inhabited, to judge from the dense scatters of ceramic sherds littering the ground” (see also Aung-Thwin and Aung-Thwin 2012:79-80; Daw Thin Kyi 1966:187; Stadtner 2013:15, 50). Hudson et al. (2001:70) concur, positing that: “Spatio-temporal evidence from Bagan’s key multi-attribute artifacts, its buildings, indicates that there may have been a number of long-term settlements spread throughout the urban complex” (see also Strachan 1989:7). Indications are that these settlement “clusters” were normally surrounded by greenery, and located adjacent to agricultural plots of various size (Kan Hla 1977:21; Moore et al. 2016:294). Recent analysis also indicates that the peri-urban zone contains remnants of a complex and extensive, yet comparatively “small-scale” water management system (Cooler 1997:22-23; Moore et al. 2016:285, 294-300, 302; Win Kyaing 2016).
What then do we know about the population that inhabited Bagan’s peri-urban city-scape? It is here where Bagan’s inscriptions and retrospective chronicles provide us with some important information. We are told that a small portion of Bagan’s society was made up of officials of upper and lower rank, and an even smaller number of nobles, including those comprising the royal court (Aung-Thwin 1985:71, 96; Aung-Thwin and Aung-Thwin 2012:97; Stadtner 2013:25). The apex of the commoner class included village heads, artisans, and crown service troops (Aung-Thwin 1985:72-73). By far the largest segment of Bagan’s support population was made up primary producers, most of which were involved in some form of agricultural production (Aung-Thwin 1985:71-73, 95; Aung-Thwin and Aung-Thwin 2012:49). Besides farmers, Bagan was also home to myriad craft specialists (Aung-Thwin and Aung-Thwin 2012:49, 90-91; Higham 2001:134; Hudson 2004:212; Kan Hla 1977:21; Luce 1969:108, 112, 230-232; Miksic 2001:100; Stadtner 2013:25). Regardless of their occupation, most commoners were formally “bonded” to either the Crown, the Sangha (Buddhist church), or less frequently to wealthy nobles, in a complex web of patron-client relationships that were codified into law (Aung-Thwin 1985:71, 74, 78, 87, 1987:88; Aung-Thwin and Aung-Thwin 2012:97). Indications are that Bagan’s support population was multi-ethnic (Aung-Thwin 1985:71; Aung-Thwin and Aung-Thwin 2012:88, 96-97), and although Theravada Buddhism was the state religion, other Buddhist schools (i.e., Mahayanist), traditional animistic practices, and even Hindu beliefs were apparently tolerated (Luce 1969:72-73; Nyunt Nyunt Shwe 2011:26). The historic texts also imply that this societal heterogeneity conditioned Bagan’s residential patterning, giving it both a clustered and cellular character, wherein a combination of one’s “socio-spiritual” status, clientage, occupation, and ethnicity determined where and with whom one lived (Aung-Thwin 1985:74, 91-96; Hudson 2004:212).

Regardless of the apparent details provided by the historic records, it is accurate to state that there is little attention paid to the general lifeways of Bagan’s peri-urban population (Luce 1969:116; Miksic 2001:91). We must also remain cognizant of the fact that such elite-focused representations are, by their very nature, one-sided, and they should therefore not only be reviewed with a critical eye, but also actively challenged using alternative datasets. This is likely to result in contrasting, multivocal, and undoubtedly more realistic renditions of Bagan society (see Feinman 1997; Overholtzer 2013). The elite-biased perspective that governs our current understanding of Bagan’s peri-urban population stimulates a series of research questions that will help guide the long-term IRAW@Bagan 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 text-based 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? and, 4) Did different segments of Bagan’s peri-urban population exhibit varying degrees of resilience to ecological, climatic, economic, socio-political, and religious changes, and if so, why?

Another area that requires further investigation is the character of Bagan’s peri-urban ground plan. The inscriptions and retrospective chronicles relating to Bagan have led some to imply that its peri-urban settlement zone was formally planned on an orthogonal, grid and block system, with distinct “wards” housing individuals sharing the same occupation (Aung-Thwin 1987:92; Aung-Thwin and Aung-Thwin 2012:91; Kan Hla 1977:21), not unlike what is found in the
Chinese tradition of “compact urbanism” (Wheatley 1971). Others have underscored that Bagan’s peri-urban zone does not appear to have been either grided or orthogonal in plan, although the placement of prominent structures was surely intentional (Kan Hla 1977:21-23; Moore et al. 2016:302). The latter characterization has also been advocated by those advancing a cross-cultural, comparative perspective, wherein Bagan’s city-scape is considered an example of a quasi-orthogonal, “low-density” (Fletcher 2009, 2012; Hudson et al. (2001:70), or dispersed urban center (Iannone 2015). As such, it is posited to equate with a unique urban tradition that persisted for a considerable length of time in the world’s tropical zones (Fletcher 2009, 2012; Haviland 1969:431-432, 1970; Iannone 2015; Isendahl and Smith 2013; Miksic 2001:102, 2012:179; Stark et al. 2015:1442; Wheatley 1971). Given these alternative perspectives, four additional questions will help frame the IRAW@Bagan research program: 1) 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? 2) Does the residential patterning in Bagan’s peri-urban zone reflect the orthogonal/compact tradition of China, or the quasi-orthogonal/dispersed traditions of the tropics? 3) Did Bagan’s city-scape transition from being more dispersed and haphazard to more compact and grid-like over time? and, 4) 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?

**METHODS:** The IRAW@Bagan project will employ theoretical and methodological tools from the applicants’ previous settlement archaeology project in the Maya subarea (e.g., Iannone 1996, 2003, 2004, 2005; Iannone and Connell 2003; Iannone et al. 2008; Longstaffe and Iannone 2011; Macrae and Iannone 2011, 2016; McCane et al. 2010), and their six years of comparative research (2010-2016) into socio-ecological resilience in South and Southeast Asia (Iannone 2014a, 2014b, 2015, 2016; Iannone et al. 2015). Three interconnected sub-projects will frame the research program.

The Residential Patterning Sub-Project: This sub-project will explore diversity in settlement unit location, size, composition, ground plan, orientation, and activities, with the goal of evaluating the tight integration, residential clustering/cellularity, and orthogonal/grid-block ground plan suggested by the historic records (Aung-Thwin 1985:74, 91-96; Aung-Thwin and Aung-Thwin 2012:91; Kan Hla 1977:21). The principal challenge for the residential patterning sub-project is that: “Excavations in Mainland Southeast Asia have yet to reveal a single complete house plan” (Higham 2017:369; emphasis mine). Indeed, the settlement patterns and residential architecture of the classical period polities of Southeast Asia have rarely received archaeological attention (Miksic and Goh 2017:26, 358), with the exception of Angkor, Cambodia (Bâty 2005; Stark et al. 2015.), and Trowulan, East Java (Miksic 2001:100, 2012), where recent excavations have been specifically aimed at exposing house remains. As such, the fundamental goal of Phase 1 of the IRAW@Bagan residential patterning sub-project is to find ancient living surfaces and reveal the city’s first complete house plans. As is common practice in such “exploratory” situations, our initial investigations will employ non-probabilistic (purposive/judgmental) sampling methods to enhance the potential for finding buried residential features (Banning 2002:28-29; French 2015:21). This sampling strategy has been informed by prior archaeological observations concerning the possible locations of settlement clusters at Bagan (Hudson 2004:208-220, 234--266; Hudson et al. 2001:53-62). Based on such knowledge, preliminary surface reconnaissance by the IRAW@Bagan research team (May 2017) resulted in the discovery of four potential residential loci, given the presence of exceptionally dense ceramic
scatters: 1) Shwe Creek, 2) Otein Taung, 3) South Wall, and 4) Kiln #4. Our Phase I excavations will focus on these four possible residential sites, and any other possible sites encountered during GPS-guided pedestrian survey of three 250 m wide transects (see the field work plan [below] for more details). These “purposively” situated transects will be used to locate extensive scatters of ceramic detritus (Banning 2002:90), a plausible proxy for residential occupation (Banning 2002:15, 75, 206). This reconnaissance will be aided by scheduling our fieldwork in April-May, coinciding with the end of the dry season and the time when ground cover is most limited. A series of 1 x 4 m test trenches and larger 4 x 4 m horizontal exposures will subsequently be used to search for and uncover buried residential features, such as postholes (please see the fieldwork schedule [below] for more details). Context information will be recorded in notebooks and on level/feature forms and entered into a Microsoft Access database. A hand-held digital SLR camera and georeferenced ground control points (using a total station) will be used to record all excavation contexts, on-floor artifact distributions, features, and both plans and sections. Processing of these data using “Structure from Motion” (SfM) photogrammetric software (Agisoft LLC 2017a, 2017b) will allow for the production of high resolution orthophotos (sub-millimeter), digital elevation models (DEMs), accurate 3D and 2D maps, precise post-excision measurements (e.g., lengths, heights, and volumetrics), and geospatial analysis in ArcGIS ([ESRI 2016]; Benavides López et al. 2016; Green et al. 2014; Koenig et al. 2017; Quatermaine et al. 2014). Samples for radiometric (bone or charcoal) and/or luminescence (ceramics) dating will be collected to aid in chronology building. Artifacts will be processed and analyzed using standard procedures (e.g., Rice 1987), including the use of both identification guides (e.g., Brown 2000) and reference collections in the Bagan Museum.

The Agricultural Practices Sub-Project: The Bagan polity was supported by an agrarian economy, but the city itself was not well suited to wet-rice cultivation (Aung-Thwin 1990:8; Cooler 1997:22-23). This sub-project will therefore explore the agricultural potential of the peri-urban settlement zone in terms of “dry weather crops” – such as sesame, millet, sorghum, legumes, palm trees, dry rice, onions, and root crops (Aung-Thwin 1990:5-6; Cooler 1997:23; Kan Hla 1977:15; Moore et al. 2016:302-303; see also Spate 1945:524-526) – in addition to assessing the distribution of fields, gardens, and granaries. This research will build on earlier assessments of Bagan’s agricultural capacity (Aung-Thwin 1990), taking into consideration that the agricultural potential of Bagan’s peri-urban zone would have varied across the MCA and LIA climate regimes. The agricultural practices sub-project will involve total-station mapping and excavation of possible remnant field “walls” and adjacent field surfaces (1 x 2 m trenches) encountered during the transect surveys (please see the fieldwork schedule [below] for details). Excavation areas will be selected based on their connection with identified hydrological features and proximity to known settlement units (see Macrae 2017:123). Soil samples collected from each stratigraphic profile will be subjected to pedological tests, including: soil taxonomy, textural classes, organic matter, exchangeable micro- and macro-nutrients, and trace element concentration, as well as chemical constituents such as pH, electrical conductivity, and estimated cation-exchange capacity (French 2015). Subsequent analysis will focus on interdependent soil characteristics such as soil fertility, soil moisture retention capability, and vulnerability to soil erosion (Macrae 2017:155-168). The soil samples will also be subjected to macro- and micro-botanical analysis (phytolith, starch, and pollen). Results of these tests will be examined in terms of expected crop production and intensity. A developmental model for sections of the ancient Bagan agricultural field system will then be generated using excavation data, proximity to datable hydrological or settlement features, and correspondences between fields and
temple/monastery spatial orientations, as determined through remote sensing (e.g., Hawken 2013). Finally, a global information system (GIS) model for crop suitability and productivity potential will be produced through an analysis of crop suitability based on precipitation (as extrapolated from regional climate signatures), soil quality (from the archaeopedological analysis), topographic conditions (from available DEMs and hydrological mapping), and the biophysical requirements of the crops identified by macro- and micro-botanical analysis (Macrae 2017:226-253). Production potential will be modeled by examining the manipulation of crop suitability through farm management practices, technological advances, and cropping systems, assigning each management condition a unique value that influences potential levels of production (Elsheikh et al. 2013:98). Production potential will then be evaluated for a series of crop groups (cereal, fiber crops, oil crops, roots and tubers, stimulants, fruit trees, and vegetables) under different management practices.

**The Water Management Sub-Project:** Access to water was an endemic issue at Bagan (Cooler 1997; Luce 1969:7), and most kings attempted to augment the city’s water supply through the construction of brick wells, dams, canals, and brick or stone-lined holding tanks (Kan Hla 1977:22; Luce 1969:76, 84, 256; Pe Muang Tin and Luce 1923:65, 131; Stargardt 1968:360-361). This sub-project will attempt to reconstruct the broader water management system associated with Bagan’s peri-urban settlement zone. It will build on prior examinations of Bagan’s water management system, (Moore et al. 2016:283; see also Win Kyaing 2016; c.f., Cooler 1997:32), including preliminary examinations of known water management features in the peri-urban zone carried out by the IRAW@Bagan research team in May 2017. This sub-project will involve a GIS-based hydrological study of Bagan’s peri-urban settlement zone. 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 analysis will be a high-resolution 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 provide information on both naturally occurring features – such as slope, streams, and seasonal ponds – as well as cultural features, such as reservoirs, canals, weirs, and moats. Identifying potential areas of strategic water management and zones of high flow accumulation will provide the basis for traditional total station survey of both natural and anthropogenic water flow. Sub-meter accurate GPS devices will be used to ground-truth and map these features in real time. The results will be used to both identify and differentiate between natural and cultural features, and these observations will be used in conjunction with data derived from remote sensing to facilitate the analysis of changing hydrological processes. This analysis will include assessments of localized weather patterns indicative of annual wet and dry periods (see Aung-Thwin 1990:6), providing the necessary comparative data for identifying changing water levels across the anthropogenic system. This analysis will also facilitate investigation of the potential ramifications that the MCA and LIA climatic regimes had on both domestic water security and agricultural production during Bagan’s rise and fall as a political center. Targeted excavations of water management features will focus on cross-sectioning canals and weirs (1 x 2 m trenches) that functioned to distribute water between the agricultural fields and larger reservoirs (please see the fieldwork schedule [below] for details). The location of these excavations will be based on considerations of the hydrological flow and accumulation maps, and insights generated through the systematic transect
surveys. Excavations will address both the chronological sequence and techniques of construction. Soil samples will be collected and soil organic matter (SOM) will be radiocarbon dated to substantiate the results of ceramic date attributions, and to facilitate direct temporal correlation with adjacent agricultural fields and settlement units.

Our proposed **fieldwork schedule** is as follows. **November 2018:** The PI (Iannone) will spend time reviewing the artifact collections at the Bagan museum to aid in subsequent analysis, and to facilitate the crafting of data recording forms and the formulation of the Microsoft Access database. **April 2019:** Quadrant-based surface collection (diagnostic sherds and special finds) and sub-surface testing of the Shwe Creek and Otein Taung occupation sites, including excavation of a 1 x 4 m trench in the center of each ceramic scatter (N-S orientation), and a 1 x 4 m trench 10 m to the east or west of the central units (E-W orientation); Reconnaissance and mapping of a 250-m wide x 1.75-km long NE-SW transect between Shwe Creek and Otein Taung occupation sites. **May 2020:** Surface collection and sub-surface testing of the South Wall and Kiln #4 occupation sites, including excavation of a 1 x 4 m trench in the center of each ceramic scatter (N-S orientation), and a 1 x 4 m trench 10 m to the east or west of the central units (E-W orientation); Reconnaissance and mapping of a 250-m wide x 2.15-km long NW-SE transect between Otein Taung occupation site and Minnanthu Village. **May 2021:** Surface collection and sub-surface testing of two occupation sites discovered during the Years 1 and 2 transect surveys, including excavation of a 1 x 4 m trench in the center of each ceramic scatter (N-S orientation), and a 1 x 4 m trench 10 m to the east or west of the central units (E-W orientation); Reconnaissance and mapping of a 250-m wide x 2.75-km long SE-NW transect between Otein Taung occupation site and the South Wall occupation site. **May 2022:** Horizontal excavation of the previously tested occupation site with the clearest signs of residential occupation. This will involve 3-4 contiguous 4 x 4 m excavation units strategically positioned based on the results of prior test excavations; Sectioning of field walls and adjacent field surfaces (1 x 2 m trenches), soil sample collection and flotation analysis (macro-and micro-palaeobotanical recovery), ground-truthing of GIS-based hydrological analysis, and test excavation (1 x 2 m trenches) of canals and weirs along the three survey transects; Artifact analysis for socio-cultural reconstructions and chronology building. **May 2023:** Horizontal excavation of a second previously tested occupation site with clear signs of residential occupation. Once again, this will involve 3-4 contiguous 4 x 4 m excavation units strategically positioned based on the results of prior test excavations; Sectioning of field walls and adjacent field surfaces (1 x 2 m trenches), soil sample collection and flotation analysis (macro-and micro-palaeobotanical recovery), ground-truthing of GIS-based hydrological analysis, and test excavation (1 x 2 m trenches) of canals and weirs along the three survey transects; Artifact analysis for socio-cultural reconstructions and chronology building.
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KNOWLEDGE MOBILIZATION PLAN

The ultimate goals of the proposed research program are to: 1) foster an understanding of peri-urban development at the “classical” Burmese capital of Bagan, Myanmar (1100-1400 CE); 2) explore the broader implications this knowledge holds for understanding the unique characteristics of early tropical urbanism; and, 3) mobilize knowledge of the past to better equip communities and policy makers to deal with the various issues that are currently facing urban centers in the tropics. The knowledge mobilization plan has four components:

- **Public Outreach**: We will strive to disseminate knowledge generated through the proposed pilot project through a series of public lectures at Trent University and other universities and museums, and in Myanmar itself, where we have been building strong ties with both the newly founded Myanmar Archaeological Association, and the various communities surrounding “Old Bagan.”

- **Scholarly Conferences**: We will present annually at two major scholarly conferences, the American Anthropological Association meetings (winter), and the Society for American Archaeology meetings (spring). We will also present at one regional conference (SEAMEO-SPAFA) that attracts archaeologists, educators, and government officials from across Southeast Asia (usually held every two to three years).

- **Publications**: It is anticipated the project will result in annual open-access field reports that will be published online through the Trent University Occasional Paper series. We also anticipate at least three open access journal articles (likely in a regionally specialized or methods focused journals), three book chapters, and three “research bulletins” to be published in Myanmar. It is also expected that between 5-10 individuals Master’s theses (Trent University and University of Yangon), and 2-3 PhD dissertations (University of Yangon), will result from the proposed project.

- **In-Class Instruction**: A significant portion of our knowledge mobilization occurs in our classrooms, where we are able to share the results of our research with future public and private sector leaders. Over the past six years the PI (Iannone) has transitioned his teaching load to focus on four principal courses that are high enrollment and cross-listed with multiple departments (Anthropology, Environmental Sciences, Geography, and Ancient History and Classic), and which will all benefit from various aspects of the proposed research program: *Archaeology of Natural Disasters, Archaeology of Climate Change, Human Impact on Ancient Environments, and Collapse of Complex Societies.*
EXPECTED OUTCOMES

This project will: Enhance graduate-level HQP training, and augment undergraduate instruction; Build collaborative and logistical networks in Myanmar; Advance understanding of the methods and theories of settlement archaeology and resilience theory within Southeast Asian archaeology; Permit the training of graduate students from North America and Myanmar in both the theory and methods of an “integrated” settlement archaeology, and the application of resilience theory to the study of early urban communities in the tropics; Make a significant contribution to our understanding of urbanism in the tropics, with particular emphasis on the nature of the early urban footprint, its resilience aspects, and the factors responsible for, and implications of, the transition from dispersed to compact urbanism over time.

The project will also foster: Critical knowledge of the unique characteristics of early urbanism in the tropics, and the factors contributing to the eventual transition from dispersed to more compact urbanism that occurred across Southeast Asia; Economic outcomes by providing information about Bagan’s early peri-urban community that can be shared with the growing number of tourists that are visiting Bagan year-over-year, and which will augment the current application for UNESCO World Heritage Site status, the conferring of which will have huge financial benefits for Myanmar, and especially the contemporary communities surrounding the archaeological park; New collaborations by pioneering research partnerships with faculty and students at the University of Yangon, as well as UNESCO Myanmar, the Departments of Archaeology of Myanmar, its local administrative office at Bagan, and the Bagan Museum.
RESEARCH TEAM AND TRAINING

A) DESCRIPTION OF THE RESEARCH TEAM: A team approach is required to carry out most archaeological field work, and this endeavour is no exception. The Principal Investigator (Iannone) and Co-applicant (Macrae) have worked together on archaeological projects since 2005, and this bodes well for the success of the proposed research program. When initiating a large project in a foreign country a strong collaborator is also crucial, and Pyiet Phyo Kyaw (University of Yangon) has already proven to be an invaluable colleague in terms of navigating government bureaucracy and community relations.

In brief, the proposed “Integrated Socio-Ecological History of Residential Patterning, Agricultural Practices, and Water Management at the “Classical” Burmese (Bama) Capital of Bagan, Myanmar” project (IRAW@Bagan) has been crafted to take advantage of the Principal Investigator’s (Iannone) extensive understanding of “integrated” settlement archaeology and the comparative approach to tropical resilience, both of which are areas of research that are not well developed in Myanmar. The project also leverages the Co-applicant’s (Macrae) understanding of tropical agricultural practices and methodological skills in GIS-based geospatial analysis and hydrological studies. Finally, the collaborator (Pyiet Phyo Kyaw) has considerable experience with Bagan’s art and architecture, textual record, and water management system. Clearly, the combined skillsets of these three are highly complementary, and promise to result in a successful research project. Further details concerning areas of expertise, and the roles and responsibilities of the three principal participants in the IRAW@Bagan pilot project, are outlined below.

Principal Investigator: Gyles Iannone, PhD: Professor, Department of Anthropology, Trent University. The PI will be responsible for roughly 50% of all project related activities. No other major research projects will be taken on during the proposed investigations. The PI’s principal areas of expertise include: 1) Archaeology; 2) Resilience Theory; 3) Settlement Archaeology; 4) Early Tropical States; 5) Mesoamerica; and, 6) South and Southeast Asia. In terms of the ability to lead the project, the Principal Investigator has considerable experience with formulating and overseeing a large, well-funded, transdisciplinary settlement archaeology project in Belize (1999-2014) that included examinations of integrative mechanisms, residential patterning, agricultural practices, water management, climate change, and advanced geospatial data. The Principal Investigator has also devised and overseen an extensive field-based investigation of resilience in early tropical state formations across South and Southeast Asia (2013-2015), and has visited Bagan three times (2012, 2013, 2017). He has published extensively on settlement patterns, socio-ecological systems, climate change, resilience theory, and the collapse of complex societies. During the proposed IRAW@Bagan settlement archaeology project the Principal Investigator’s roles and responsibilities will include: 1) serving as the Principal Investigator; 2) administration of all intellectual, regulatory (e.g., fieldwork permits), and financial aspects of the project; 3) field supervision of the residential patterning (survey and excavations) sub-project; 4) oversight of the agricultural practices and water management sub-project; 5) co-supervision of all field and lab activities; 6) co-ordination of, and major contributions to, an effective program of knowledge mobilization; and, 7) direct supervision of 5-7 MA students from Trent University.

Co-Applicant: Scott Macrae, PhD: Adjunct Graduate and Research Faculty, Trent University. The Co-applicant will be responsible for roughly 40% of all project related activities. No other major research projects will be taken on during the proposed investigations. The Co-applicant’s areas of expertise include: 1) Mesoamerican and Southeast Asian Archaeology; 2)
Environmental Archaeology; 3) Comparative Archaeology; 4) Socio-Economic and Socio-Political Systems of the Ancient Maya; 5) Agricultural Strategies; 6) Relic Agricultural and Water Management Systems; 7) Settlement Patterns; 8) Landscapes Archaeology; 9) Applied Anthropology; 10) Socio-Ecological Systems; 11) Resilience Theory; 12) Geographic Information Systems; 13) LiDAR; 14) Remote Sensing; and, 15) Archaeological Field Methods. The Co-applicant has considerable experience supervising sub-projects focused on residential patterning, agricultural practices, and water management. His use of GIS-based spatial analysis tools is particularly well developed and innovative. The Co-applicant has also participated in the Principal Investigator’s comparative study of early tropical state formations in South and Southeast Asia (2013-2016), and he has visited Bagan once (2013). Although a “new scholar,” the Co-applicant has already begun to develop a laudable publication and conference presentation record, a large portion of which focuses on ancient agricultural practices and water management strategies in the tropics, with particular emphasis on GIS-based geospatial analysis. During the proposed IRAW@Bagan settlement archaeology project the Co-applicant’s roles and responsibilities will include: 1) assisting with the administration of all intellectual, regulatory (e.g., fieldwork permits), and financial aspects of the project; 2) field supervision of the agricultural practices and water management sub-projects; 3) assistance with the residential patterning sub-project, especially the transect surveys and associated total station mapping; 4) supervision of all of the remote sensing, GIS-related, and “Structure from Motion” (photogrammetry) aspects of the project; 5) co-supervision of all field and lab activities; 7) assistance with, and major contributions to, an effective program of knowledge mobilization; and, 8) co-supervision of 5-7 MA students from Trent University.

**Collaborator: Pyiet Phyo Kyaw, PhD:** Lecturer, Department of Archaeology, University of Yangon and Advisor, Myanmar Archaeological Association. The Principal Investigator and Collaborator recently met at the SEAMEO-SPAFA archaeology conference in Bangkok (May-June 2016), and have been in regular contact since that time. They co-supervised preliminary field investigations relating to the proposed study in May 2017. The Collaborator will be responsible for roughly 10% of project related activities, with his principal focus being collateral projects in his areas of interest, which include: 1) Myanmar History; 2) Archaeology; 3) Art History; 4) Iconography; 5) Material and Visual Culture (Semiotics); 6) Ancient History; and, 7) Landscape Archaeology. In terms of his value to the project, the Collaborator has extensive experience with the history, art and architecture, and landscape of Bagan, and has published on the city’s art and epigraphy, as well as its water management system. During the proposed IRAW@Bagan project the Collaborator’s roles and responsibilities will include: 1) assistance with regulatory issues (e.g., permitting processes); 2) service as the principal liaison with government and archaeological officials, the Myanmar Archaeological Association, and local communities and their principal stakeholders; 3) contributions to an effective program of knowledge mobilization; and, 4) direct supervision of 3-5 MA students from the University of Yangon, all of whom will participate in the proposed IRAW@Bagan fieldwork.

**B) DESCRIPTION OF ONGOING AND PREVIOUS RESEARCH RESULTS:** The proposed IRAW@Bagan research program will build on the Principal Investigator’s 24 years (1991-2014) of settlement archaeology experience, which focused on ancient Maya communities in Central America. Most relevant is the project he directed in Belize’s north Vaca Plateau, which included both thesis and dissertation work on the part of the Co-applicant. Our Phase I investigations (1999-2005) – supported by a SSHRC Standard Research Grant (#410-2002-0150 [2002-2005]) – involved extensive excavations within the regal-ritual epicenter of
Minanha. This research provided us with a view of the rise and fall of this small city-state capital from the perspective of its royal court. Our subsequent Phase II (2006-2009) investigations – also funded by a SSHRC Standard Research Grant (#410-2006-0788 [2006-2009]) – generated a multifaceted history of the commoners who inhabited the settlement zones surrounding Minanha’s epicentral court complex, thus providing us with a view of the rise and fall of the city-state from the standpoint of its support population. Finally, our Phase III Investigations – supported by two separate grants from the Alphawood Foundation of Chicago (2010-2014) – expanded our research focus from the Minanha micro-region to the north Vaca Plateau sub-region, resulting in an integrated socio-ecological history that incorporated considerations of integrative mechanisms, residential patterning, agricultural practices, water management, and climate change. This research program was augmented by a multi-project “consortium” grant from Alphawood (2012-2013) for LiDAR acquisition, which allowed the Co-applicant to conduct a sophisticated hydrological analysis of a relic agricultural field system southwest of Minanha.

The transition to a similar settlement-focused investigation in Myanmar was enhanced by six self-funded visitations made by the Principal Investigator to South and Southeast Asia (2010-2016), and a two-year SSHRC Insight Development Grant (#430-2013-001006[ 2013-2015]) in support of the Socio-ecological Entanglement in Tropical Societies (SETS) project. The latter project allowed the Principal Investigator to lead student research teams – including the Co-applicant – on four field trips to the “classical” capitals of South India, Sri Lanka, Cambodia, Thailand, Vietnam, Java, and Myanmar, resulting in a number of detailed field reports, book chapters, and conference presentations (in Canada, the United States, and Thailand). The original intent of the IDG study was to assess the quality and quantity of various data sets in preparation for a broader, comparative study of resilience in tropical societies. Although the investigations did indicate that there was sufficient data to carry out a more comprehensive comparative study, it was also readily apparent that the data sets for residential patterning, agricultural practices, and water management strategies were extremely limited in South and Southeast Asia. The subsequent offer to conduct archaeological fieldwork at Bagan focusing on these three areas – which was extended to the Principal Investigator by UNESCO-Myanmar following presentation of some of the results of the initial IDG study at a SEAMEO-SPAFA conference in Bangkok in 2016 – was therefore both timely, and intellectually enticing. The current Insight Grant proposal aims to take advantage of the extraordinary opportunity to utilize a similar theoretical and methodological approach to the one that has been effectively employed by the Principal Investigator and Co-applicant in their past investigations in the Maya sub-area, and the ability to leverage the knowledge gained from the recent comparative study of tropical societies, to expand our understanding of the complex socio-ecological relationships at the base of one of Southeast Asia’s most renowned preindustrial urban centers.

Preliminary groundwork for the proposed investigations was carried out by the Principal Investigator and the Collaborator in May 2017, with support from Trent University’s Vice-President of Research Strategic Initiatives Fund (2016-2017). This funding allowed the IRAW@Bagan research team to examine all of Bagan’s known water management features, and to carry out surface reconnaissance in areas that our literature review suggested were likely to contain residential sites, resulting in the discovery of the four potential occupation loci that are the focus of the current grant proposal. Finally, a pending National Geographic Society grant submitted by the Principal Investigator, Co-applicant, and Collaborator will support forthcoming ethnoarchaeological research (December 2017) within ten traditional villages located in and
around what was once Bagan’s peri-urban settlement zone. These investigations will inform the proposed settlement archaeology study by enhancing our understanding of the characteristics of traditional houses, house-lots, villages, and both water management strategies and agricultural practices.

C) DESCRIPTION OF PROPOSED STUDENT TRAINING STRATEGIES:

- **Build both academic (research and teaching) competencies and general professional skills, including knowledge mobilization, that would be transferable to a variety of settings.**

  o The various MA and PhD students involved in the IRAW@Bagan project – including those based at both Trent University and the University of Yangon – will acquire various “transferable” skills as a result of their formal training and practical experience in:
    - Settlement archaeology
    - Excavation methods
    - Settlement survey
    - Soil sampling, processing, and analysis
    - Artifact processing, curation, and data-basing
    - Total station and GPS mapping techniques
    - Structure from Motion (photogrammetry) recording and imaging
    - GIS-based geospatial analysis, including hydrological analysis

  o The students will also be encouraged to actively assist in the dissemination of project results through the following means:
    - Production of annual site report chapters
    - Presentation of research proposals and results at their home institution, and to interested local groups, such as the Myanmar Archaeology Association
    - Presentation of research findings at professional conferences in North America and Southeast Asia
    - Publishing of their research results as book chapters and/or journal articles (including open access versions)

  o The students will also benefit from being taught the theory and methods of settlement archaeology, broadly construed, in both the classroom and field setting, and in countries with very different archaeological traditions.

  o Student participants will also be instilled with a strong sense of research ethics by contributing to an international research program, by working with their Myanmar colleagues, by living in Myanmar communities and consulting with diverse stakeholders, and by conducting research on an archaeological site that not only attracts many tourists, but which has been recently nominated for UNESCO World Heritage status.

  o At its heart, the IRAW@Bagan project is transdisciplinary – with its focus on residential patterning, agricultural practices, and water management – meaning that students will learn the value of focusing on specific research problems but drawing on diverse methodological and theoretical approaches, without being hindered by the conceptual parameters of traditional, disciplinary specific research (i.e., the “silo” approach).
Students on the IRAW@Bagan project will also be fully involved in the daily operations of the project, including field and lab work, and daily project management; this will not only allow them to appreciate the complexities of running a research project, but also instill in them the importance of building research teams and fostering individual leadership skills.

- **Include international and/or intersectoral opportunities whenever possible and applicable.**
  - The IRAW@Bagan is largely an international project, and students will gain from working with faculty and team members from both Canada and Myanmar.
  - The students will also engage with local and federal resource managers on a regular basis, and as Bagan moves towards designation as a UNESCO world heritage site, they will also be encouraged to participate in intersectoral workshops and seminars involving myriad stakeholders.

- **Include specific, effective mentoring and institutional support.**
  - Full-time MA students attending Trent university will be provided with teaching experience through the Graduate Teaching Assistantship program.
  - Trent students will also be able to take advantage of various career enhancement workshops and seminars while at Trent.
  - Both Myanma and Canadian students will be able to attend IRAW@Bagan faculty-led training seminars on an annual basis, in both Yangon and Bagan; these training sessions will focus on specific archaeological methods, and be arranged in conjunction with Myanmar’s Department of Archaeology, and the Myanmar Archaeology Association (e.g., the Principal Investigator led a seminar on settlement archaeology in Yangon in May 2017, with assistance of the Myanmar Archaeology Association).