FRAMING A COMPARATIVE ANALYSIS OF TROPICAL CIVILIZATIONS: SETS Project – Phase 1 (Volume 2)

Edited by

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Gyles dedicates this volume to Michael D. Coe, whose writings on the importance of the comparative analysis of tropical civilizations first inspired him as an undergraduate student, and more recently, whose kind words encouraged him when he subsequently started his own intellectual journey to contribute to this worthy endeavour.

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Cover Image:
Brihadisvara Temple, Thanjavur, Tamil Nadu, South India
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CHAPTER 1
THE SOCIO-ECOLOGICAL ENTANGLEMENT IN TROPICAL SOCIETIES (SETS)
PROJECT: A BRIEF INTRODUCTION

Gyles Iannone
(Trent University)

The Socio-ecological Entanglement in Tropical Societies (SETS) project has been specifically developed to promote the cross-cultural, transdisciplinary examination of the tropical experience, past and present, as a means to explore resilience and vulnerability to changing socio-ecological circumstances. An outgrowth of 23 field seasons of excavation-based research into the rise and fall of Classic Maya communities in the lowlands of Central America (e.g., Iannone and Connell 2003; Iannone 2014c; Iannone et al. 2016), Phase I of the SETS research program has employed an Insight Development Grant (2013-2015) from the Social Sciences and Humanities Research Council of Canada (SSHRC) to initiate a broader, comparative study of the development and denouement of complex societies in tropical South and Southeast Asia. This initial foray into cross-cultural research has been specifically aimed at evaluating the quality of various data sets relevant to the elucidation of the reasons for the “collapse” of a number of “classical” state formations in the latter part of what Victor Lieberman (2003, 2009, 2011) refers to as the “Charter Era” (CE 800-1400; see Figure 1.1 and Table 1.1). The theoretical and methodological basis for this study has been outlined in detail in an earlier report (Iannone 2014a), and thus will only be summarized here. The findings of the SETS Phase I data evaluation program are detailed in the various chapters that follow, and in an earlier edited volume (Iannone 2014b).

Figure 1.1. Köppen climate classification showing the world’s tropical zones and the locations of the SETS I case studies (modified from wikipedia.org).
<table>
<thead>
<tr>
<th>POLITICAL DIVISION</th>
<th>CHARTER STATE CAPITALS (ORIGINAL NAME &amp; KINGDOM/EMPIRE)</th>
<th>DATES</th>
<th>COMPLETED SETS PHASE I VISITATIONS</th>
<th>SELF-FUNDED VISITATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thailand</td>
<td>Sukhothai (Thai Kingdom)</td>
<td>1238-1378 CE</td>
<td>2013</td>
<td>2011</td>
</tr>
<tr>
<td></td>
<td>Lopburi (Lavo; Thai Kingdom)</td>
<td>468-1351 CE</td>
<td>2011</td>
<td></td>
</tr>
<tr>
<td>Myanmar</td>
<td>Bagan (Arimaddana Pura; Burmese Empire)</td>
<td>849-1287 CE</td>
<td>2013</td>
<td>2012</td>
</tr>
<tr>
<td></td>
<td>Koh Ker (Lingapura; Khmer Empire)</td>
<td>928-944 CE</td>
<td>2013</td>
<td>2012</td>
</tr>
<tr>
<td>North Vietnam</td>
<td>Thang Long (Dai Viet Kingdom)</td>
<td>1009-1400 CE</td>
<td>2014</td>
<td>2010</td>
</tr>
<tr>
<td>Central Vietnam</td>
<td>Cha Ban (Vijaya; Cham Kingdom)</td>
<td>986-1471 CE</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Duong Dong/My Son (Indrapura; Cham Kingdom)</td>
<td>758-986 CE</td>
<td>2014</td>
<td>2010</td>
</tr>
<tr>
<td>Java</td>
<td>Singhasari (Tumapel/Singhasari; Singhasari Kingdom)</td>
<td>1222-1292 CE</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kediri (Daha/Kediri; Kediri Kingdom)</td>
<td>1045-1222 CE</td>
<td>2014</td>
<td></td>
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<tr>
<td></td>
<td>Prambanan/Ratu Boko (Sanjaya Dynasty/Mataram Kingdom)</td>
<td>760-1000 CE</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Borobudur (Sailendra Dynasty/Mataram Kingdom)</td>
<td>750-860 CE</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td>South India</td>
<td>Gangaikondacholapuram (Chola Empire)</td>
<td>1025-1297 CE</td>
<td>2015</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thanjavur (Chola Empire)</td>
<td>848-1025 CE</td>
<td>2015</td>
<td></td>
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<tr>
<td></td>
<td>Madurai (Pandya Empire)</td>
<td>590-1333 CE</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>Polonnaruwa (Sinhalese Kingdom)</td>
<td>933-1310 CE</td>
<td>2015</td>
<td>2011</td>
</tr>
<tr>
<td></td>
<td>Anuradhapura (Sinhalese Kingdom)</td>
<td>377 BCE-933 CE</td>
<td>2015</td>
<td>2011</td>
</tr>
</tbody>
</table>

Table 1.1. Major charter state capitals visited as part of the SETS Phase I research, and via self-funded visitations.

THE FOCUS OF THE RESEARCH PROGRAM

When contemplating the relevance of such a study, it is important to consider that the world’s tropical zones were once regularly characterized as ecologically homogenous, energy-challenged, limited in terms of resources and agricultural potential – other than small-scale slash-and-burn farming – and thus unlikely places for state formation to occur (Boserup 1965, 1981; Coe 1961; Meggers 1954; Sanders and Price 1968; Winzeler 1976:624-626). We now know that such assertions are false. Tropical environments are relatively heterogeneous (Scarborough and Burnside 2010:178), and they were often the settings for high populations, intensive agricultural regimes, sophisticated water management systems, far-flung trade networks, and powerful state-level societies.

The SETS investigations are specifically focused on the impressive pre-industrial state formations that developed in the monsoonal, wet-dry outer tropics that occur between 5° and 20° North/South (Ewel and Bigelow 1996:195; Fletcher 2009, 2012; Kricher 2011:19; Weischet and
Caviedes 1993:11-12, 167), within the “sub-humid” Am and Aw climates in the Köppen-Geiger system (Köppen 1884; see Figure 1.1). Not only do these climate zones exhibit distinct wet and dry seasons, they also display considerable variability in terms of soil productivity, hydrological processes, and overall biodiversity (Kricher 2011; Marcus 2009; Scarborough and Burnside 2010:178; Weischet and Caviedes 1993:275-279). These environmental factors would have enabled or constrained specific behaviors, and conditioned the unique cultural developments that characterized the classical states under consideration.

To date, there have been few concerted efforts to try to understand issues of resilience and vulnerability specific to socio-ecological systems in the tropics (e.g., Isendahl and Smith 2013; Scarborough and Burnside 2010). Nevertheless, it has become clear that these civilizations do represent a divergent path to urban life, and they appear to have shared a certain range of vulnerabilities that ultimately contributed to their “collapse” (Fletcher 2009, 2012). The Phase I SETS study has examined the latter issue by focusing on the distinctive socio-ecological histories of a series of “Charter States” from various parts of South and Southeast Asia. These state formations are not only significant to this research endeavor because they ultimately collapsed in the latter part of the “classical period,” or “Charter Era,” but also because they provided a political and territorial “charter” that influenced how ensuing state level societies would develop for centuries following their demise, and arguably right up to the present (Lieberman 2003, 2009, 2011).

In order to explore shifting levels of resilience and vulnerability within the various Charter States, the SETS project has adopted an explicit historical-political ecology approach to the assessment and analysis of various pre-existing data sets. A unique form of intellectual inquiry, historical-political ecology is based on the following principles (see Balée 2006; Briggs et al. 2006:180-181; Costanza et al. 2007; Crumley 2003; Fabinyi et al. 2014; Offen 2004:21; Thompson 2014; Winterhalder 1994):

1) the transdisciplinary, multi-scaler (temporal and spatial) examination of recursive socio-ecological relationships from a complex adaptive systems perspective (i.e., such systems exhibit emergent behavior, and thus do not change in a predictable or linear manner; these systems can also exist in multiple stable states, and their various sub-systems do not always exhibit functional interrelationships; Walker and Salt 2006:31, 35);

2) the generation of field informed analyses based on detailed, integrated histories for specific, coupled socio-ecological systems;

3) the exploration of how and why socio-ecological relationships have changed over time and space, and consideration of the larger socio-economic and political implications of such transformations; and,

4) the assessment, through an “applied” approach, of how past events, processes, and trends can be used to guide contemporary and future tactics for dealing with socio-ecological issues, broadly construed.

WHY A COMPARATIVE APPROACH?

The SETS research program is unabashedly cross-cultural in focus. Nevertheless, our comparative research strives to be as rigorous as possible (see Trigger 2003:15). To begin, we adhere to Robert Ascher’s (1961:319) canon that we should “seek analogies in cultures which manipulate similar environments in similar ways”; hence our focus on the world’s tropical zones, where the different pre-industrial state formations had to contend with similar socio-ecological
issues over the course of their integrated histories. We also strongly concur that “data proximity” is crucial to the comparative approach (Drennan and Peterson 2012). There is no substitute for the phenomenological understanding of similarities and differences that has resulted from actual on-site visitations within the former realms of the various Charter States we are interested in learning about.

It is also important to stress that by adopting a comparative approach one is not necessarily devaluing the significance of more particular, agency or event-centered analysis. Roland Fletcher (2012:317) argues that: “Cross-cultural comparison is not about creating blanket generalizations that homogenize diverse cases. Rather, we need to construct operational models that can be tested against the varied scenarios of diverse human history across the planet.” In doing so, it is imperative that we craft comparative studies at are systematically “cross cultural and cross-temporal” (Bartolini 1993; emphasis in the original). Finally, with respect to the stated goals of the SETS research program, we also agree with Drennan et al. (2012:3), who underscore that: “Comparative methods are essential if archaeologists are to contribute to transdisciplinary research in the historical and social sciences and thereby broaden the scientific understanding of the past, the present, and the future of human societies” (see also Feinman 2012:22). In other words, it is through rigorous comparative analysis that we aim to generate a nuanced understanding of resilience and vulnerability in tropical state formations across both time and space.

**ON RESILIENCE AND ENTANGLEMENTS**

**Resilience**

What then, is “resilience”? To begin, resilience can be defined as “the capacity of a system to absorb disturbance; to undergo change and still retain essentially the same function, structure, and feedbacks” (Walker and Salt 2006:32). According to Redman et al. (2007:118), resilience is fundamentally about the “the capacity of an institution to adjust to perturbations… [it is not about] stability around a single state, but rather the possibility of multiple socioecological states that maintain the primary functional relationships of the socioecological system.” Importantly, resilience is “not about not changing,” but rather the ability to manage change, sometimes because staying the same will diminish resilience, at other times in efforts to avoid a critical transition (Walker and Salt 2012:24).

Scholars have outlined a number of specific criteria that can be used to pinpoint areas of resilience or vulnerability in socio-ecological systems (see Iannone 2016). These are best considered – especially from a comparative perspective – using Easton’s (1959:239) concept of “bundled continua of variation” (see Tables 10.2 and 10.3). The challenge for those who wish to explore resilience and vulnerability in the past is that the many of these criteria remain abstractions, at least from an archaeological perspective (they are notions concerning general qualities or characteristics of socio-ecological systems, rather than principles grounded in material realities). From an archaeological perspective, it is therefore imperative that we determine the material correlates for resilience and vulnerability.
<table>
<thead>
<tr>
<th>ADAPTIVE CYCLE</th>
<th>CHARACTERISTICS</th>
<th>ASSOCIATED CONCEPTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>r-phase</strong> (growth and expansion)</td>
<td>rapid movement into uninhabited or sparsely populated landscapes, rapid population growth, new technologies and food acquisition strategies</td>
<td><strong>niche construction</strong> refers to the process whereby “human beings initially adapt themselves to the dynamics of their environment, but over the long term societies’ needs are best served by modifications to the environmental dynamics” (Dearing et al. 2007:266; see also van der Leeuw 2007:215); <strong>colonized ecosystems</strong>, also known as <em>artificial</em> or <em>cultural</em> landscapes, result from “the deliberate and sustained alteration of natural processes that aim at ‘improving’ them according to society’s needs” (Weisz et al. 2001:123; see also Dearing et al. 2007:266; Fischer-Kowalski 2003; Haberl et al. 2011; Ponting 2007:67-69; Sieferle 2003; van der Leeuw 2007:214-215).</td>
</tr>
<tr>
<td><strong>K-Phase</strong> (accumulation and consolidation)</td>
<td>slow growth; conservation, accumulation, consolidation, and sequestration; intensification of production; increased management over, and investment in, a smaller number of key productive strategies; and, hypercoherence, which means there is a high level of integration</td>
<td>A <strong>risk spiral</strong> “is a dynamizing principle in the development of complex societies [wherein] the reduction of a particular risk leads to new types of uncertainty, which in turn require further (risky) innovations…[and a] permanent innovation pressure [that is] responsible for the restless transformations in complex societies” (Müller-Herold and Sieferle 1997:201-202); <strong>path dependency</strong> refers to a state in which people “cannot stop investing knowledge and effort into the system that they have modified, because any reduction in effort will allow natural dynamics to take over and transform the environment into one to which society is no longer adapted” (van der Leeuw 2007:215); <strong>sunk-costs</strong> or <em>Concorde effects</em> refers to a situation where agents “put more…effort into continuing with existing investments rather than exploring new ones,” which results in a tendency to undermine innovation (Cumming 2011:94; Janssen and Scheffer 2004; Walker and Salt 2006:87);</td>
</tr>
<tr>
<td><strong>Ω–Phase</strong> (release)</td>
<td>rapid, “creative destruction,” declining construction, abandonments, and the chaotic unraveling and release of resources</td>
<td><strong>tipping points</strong> (Gladwell 2000), <strong>critical transitions</strong> (Scheffer 2009), or <strong>collapses</strong> (Diamond 2005; Tainter 1988); <strong>revolt</strong> refers to a situation where “a critical change in one cycle cascade[s] up to a vulnerable stage in a larger, slower one” (Holling et al. 2002:75).</td>
</tr>
<tr>
<td><strong>α-Phase</strong> (reorganization)</td>
<td>increased diversity, migrations (mobility), innovation, and rapid restructuring</td>
<td>reorganization can lead to a <strong>phase change</strong>, which might involve reorganization and return to a similar form of system, a system more akin to an earlier form of organization (i.e., as is inherent in the concept of <strong>remember</strong> [Nelson et al. 2006:246]), a reorganization into a “degraded state” – which is a process known as a <strong>poverty trap</strong> – or a more dramatic <strong>regime shift</strong> (also referred to as a system or state flip) into an entirely new form of system, with an entirely different <strong>identity</strong> (Holling and Gunderson 2002; Scheffer 2009:357; Walker and Salt 2006); <strong>Exit</strong> refers to a possible “leaking” away of potential, and/or options as part of the shift from the Ω to α Phases (Holling and Gunderson 2002; Gunderson and Holling, eds. 2002; Walker and Salt 2006).</td>
</tr>
</tbody>
</table>

**Table 1.2.** Characteristics of the four phases of the Adaptive Cycle and other key concepts relevant to the application of Resilience Theory (Iannone 2016; see Holling and Gunderson 2002; Gunderson and Holling, eds. 2002; Nelson et al. 2006:409-411; Walker and Salt 2006:76-79).
CONTINUA OF VARIATION | RESILIENCE IMPLICATIONS
---|---
Flexibility to Rigidity | Over time there is diminished ability to change direction, to carry out controlled transformations.
Diversity to Uniformity | *Functional diversity* refers to the different functional groups that comprise a system, with these groups exhibiting *response diversity* (different capability to respond to perturbances). Declining functional and response diversity over time leads to diminished resilience (c.f., Nelson et al. 2011).
Innovation to Conformity | Systems move from having a significant capacity to learn, adapt, experiment, and embrace change, to being exemplified by strong calls for subsidies and “business as usual” on the part of dominant individuals and institutions.
Openness | This refers to the ease with which ideas and people are able to move into and out of a system, with systems [that are] too open or too closed being less resilient, because they are always in a state of transformation, or have a diminished capacity to receive innovations.
Significant Reserves to Diminishing Reserves | Over time, as a result of strategies of intensification, there tends to be fewer resources in play, and most resources tend to get “locked up,” meaning they are more tightly controlled, and more expensive.
Tight Feedbacks to Loose Feedbacks | Over time, systems start to see an increase in response times as a result of growing complexity, which makes the system as a whole less resilient.
Redundancy to Top-Down Control and Management | Redundancy and overlap in governance and institutional structures makes a system less specialized, with the various components being less reliant on each other, and hence, more resilient during times of stress. Over time this flexibility gives way to a greater degree of conservatism, with incentives being provided to inhibit change, and there is ever-increasing command and control, and a growing emphasis on process, which manifest itself in more rules, regulations, and greater adherence to procedure.
Intermediate Levels of Modularity to Too Much, or Limited Modularity | Intermediate levels of connectivity, as in modular systems with various subcomponents that exhibit tight interactions, but are more loosely connected to each other, have higher levels of resilience “because the system is neither isolated from changes or perturbations nor overwhelmed by them” (Cumming 2011:138).
Significant to Diminished Social Capital | Over time there is a diminished capacity for systems to exhibit collective action in the face of perturbances, as exemplified by effective leadership, well-developed social networks, and overall trust.
Resilience-Positive to Resilience-Negative Efficiency | Some efficiency is useful, particularly if it conserves human or natural resources, but over time there is a tendency for systems to stop taking into account the secondary effects of efficiency, and because of the elimination of redundancies and emphasis on a specific range of values and interests (i.e., an “optimal” condition for a particular ecosystem or organization), there is a diminished capacity for response diversity, resulting in a dramatic decline in flexibility, and hence resilience.

Table 1.3. Continua of variation for assessing resilience in coupled socio-ecological systems (Iannone 2016; see Holling and Gunderson 2002; Walker and Salt 2006, 2012).

**Entanglement**

One avenue that holds some potential for the archaeological examination of resilience is the notion of “human-thing entanglements,” as outlined by Ian Hodder (2011a, 2011b, 2012). “Entanglement” theory is based on the idea that as we live our daily lives humans and “things” (natural occurring and/or human-made entities) develop recursive relationships that are grounded in a “dialectic” between dependence – which is productive and enabling – and dependency – which is constraining and limiting; Hodder 2011a:175, 2012:17–18, 88). For example, a farmer
can create a breach in a creek bank to channel water into a series of adjacent wet-rice fields, which enables higher agricultural production (dependence), but in doing so they also become constrained by the annual rainfall and broader hydrological system that feeds water into the creek, assume certain maintenance tasks that are required for the irrigation system to work properly, and become reliant on the higher yields they are now able to produce (dependency). Alternatively, consider that a local leader may establish a shrine to conduct fertility rituals to enable community integration (dependence), but in doing so they become constrained by the ideological principles surrounding the shrine, assume the responsibility for sponsoring the rituals associated with the ritual edifice, shoulder the range of required maintenance and improvement costs, and become reliant on the shrine and its ideological efficacy for justification of their own legitimacy (dependency).

From a resilience theory perspective, such material entanglements are of particular concern because “people and things get trapped in entanglements that themselves direct the way further change can occur,” principally because “the entrapment of entanglement limits and channels innovation” (Hodder 2011a:178). This notion of “entrapment” is crucial to using material entanglements to assess resilience and vulnerabilities in past socio-ecological systems. Specifically, the enabling aspects of the entanglements we form to initially solve certain problems (i.e., dependence) – such as our investments in niche construction and the creation of colonized landscapes and/or agroecosystems that are aimed at growing more food – also tend to lead us into a risk spiral characterized by increasing dependency on these same systems as time progresses. In other words, the desire to initially solve smaller, and more immediate problems (the production of surplus using irrigation) can lead to larger, more difficult to contend with issues – unintended consequences – down the road that require more innovation and investment to resolve (salinization of fields), and which further entrap us in a particular set of dependency relationships that are increasingly complex and difficult to extract ourselves from.

The constraints created by the resulting dependency-based entanglements and risk spirals result in developmental trajectories characterized by constant innovation pressures (e.g., Herold and Sieferle 1997:201-202). However, new innovations are constrained by past decisions, and the dependency relationships that are established as a result of these ongoing entanglements limit both the nature and degree of subsequent innovation that may occur, leaving communities or organizations with a diminished set of options to deal with unexpected perturbances. Another way to think about this is that, as we become more entangled in relationships of dependency, we come to be increasingly entrapped, and as we begin to feel the constrains of the dependencies we have formed, we become more path dependent, and can even begin to exhibit the effects of conformist social learning and sunk costs, whereby we continue to invest in these relationships of dependency even though we receive less benefit for our investments over time (diminishing returns), and even though these same relationships limit our potential for dealing with changing circumstances.

In summary, entanglements can lead to relationships that make socio-ecological systems less resilient over time because they inhibit our ability to manage change in a truly innovative and proactive manner (we are constrained by many of our existing material and/or social entanglements, and the dependencies these entail). That is to say, human-thing relationships that were originally enabling (dependence) can eventually become constraining (dependency), which may lock us into a set of behaviors with negative consequences (e.g., resilience-negative efficiency), and which limits our response diversity when faced with unexpected circumstances.
It should be clear from this discussion that over-time socio-ecological systems tend to cultivate many human-thing entanglements that foster relationships of dependence, and which are therefore both productive and enabling (i.e., there is significant flexibility, diversity, innovation, openness, reserves, feedbacks, redundancy, social capital, and resilience positive efficiency; see Table 1.3). Such entanglements enhance, and even promote the ability to manage change in resilience terms. However, eventually some of the more significant human-thing entanglements are transformed into relationships of dependency, and they emerge as more constraining and limiting in resilience terms (i.e., there is increased rigidity, conformity, closure, and resilience negative efficiency, along with diminished reserves, looser feedbacks, less redundancy, and declining social capital; see Table 1.3). Such entanglements limit innovative potential and stifle the ability to manage change. Importantly for archaeologists or scholars of the past, entanglements – relationships of dependence and/or dependency – have material correlates, and their formation and transformation can therefore be examined over time as proxies for shifting levels of resilience and vulnerability (the shift from dependence/enabling to dependency/constraining situations).

EXPLORING RESILIENCE AND ENTANGLEMENTS ON THE GROUND

The question remains, what kinds of archaeological data can we work with that provide the best fit with resilience and entanglement theory? To begin, it is useful to follow the lead of Walker and Salt (2012:23), who stress that researchers should practice requisite simplicity when applying resilience theory to a specific case study. In other words, one should: “identify the minimum but sufficient information” required to explore the levels of resilience and vulnerability exhibited by a particular case study (Walker and Salt 2012:23). They posit that, in general, between three and five key variables will play the most significant roles in determining resilience in most situations (Walker and Salt 2012:23). It also seems most profitable to explore human-thing entanglements using variables for which we are able to chart shifts from dependence to dependency over the long-term.

In terms of examining entanglement and resilience within early tropical state formations, the most fruitful variables to examine appear to be:

1) Water Management: many tropical societies relied on sophisticated water management systems that needed to be constructed and maintained (see Marajh, this volume).

2) Agricultural Intensification: the majority of tropical societies were agrarian based, and highly reliant on agroecosystems and a specific staple crop (Fletcher 2012:298; see Macrae, this volume).
   a. Many of these pre-industrail states initially employed a combination of shifting cultivation (swidden) and more advanced flood plain agriculture.
   b. Initially polycultural in terms their agricultural strategies, many early tropical state formations became increasingly more reliant on both monocropping and sophisticated agroecosystems (colonized ecosystems, including irrigated fields, rice paddies, terraces etc) over time; this resulted in less biodiversity, and a growing dependency on the field and/or irrigation systems that took great effort to build, expand, and maintain.

3) Urban Epicentral Plan and Composition: overtime, all of the early tropical state formations put great efforts into building, elaborating, and maintaining the ostentatious
epicentral complexes that served as their sacred and political capitals (see Baron, this volume)

4) **Integrative Mechanisms**: all early tropical societies put considerable effort into building and maintaining integrative features, such as roads, bridges, temples, markets, administrative nodes, state controlled fields and water holding facilities, hospitals, rest houses, and a diverse range of sacred natural sites (see Hills and Mody, this volume)

5) **Settlement Patterns**: the various pre-industrial tropical state formations all seem to have developed a somewhat unique low-density, or dispersed urban footprint (Fletcher 2009, 2012; Scarborough et al. 2012); it is important to understand how and why this settlement pattern developed, and under what conditions it shifted to a more compact, axial or orthogonal plan? (see Walker and Savage, this volume).

**Specific Goals of SETS Phase I: Data Evaluation**

To reiterate, the specific goal of the recently completed Phase I SETS research was to assess the quality of the various data sets associated with the aforementioned variables. This assessment was achieved using a three-stage approach. Initially, SETS team members immersed themselves in the general literature on the culture history of South and Southeast Asia. Subsequently, on-the-ground visitations across eight different political divisions of South and Southeast Asia were carried out, including South India, Sri Lanka, Myanmar, Thailand, Cambodia, North and Central Vietnam, and Java. Prior to each field trip more specific literature reviews for each specific Charter State case study were conducted, and detailed itineraries were formulated. A total of 18 separate Charter State capitals (i.e., epicenters) were explored (see Table 1.1) as part of the SETS Phase I study. Various contemporaneous cultural features were also visited on each sojourn. These represented the four remaining variables that were established as the foci of the SETS I study (e.g., water management infrastructure, settlement features, integrative mechanisms, and agricultural systems). In combination with a series of self-funded research trips conducted by the Principal Investigator (Iannone) across the study region, over 550 unique localities have been visited by SETS team members thus far. As part of these visitations detailed background information and field notes have been compiled for each locality, and an electronic image library containing over 65,000 photos has been assembled.

Through these combined efforts we aimed to determine whether the five variables that were selected for analysis could be used to effectively examine the broader socio-ecological issues surrounding resilience and vulnerability in the various pre-industrial, tropical state formations under examination. Our overarching conclusion is that, for the most part, these variables provide sufficient detail to achieve our overarching research goal. However, as outlined in the various chapters in this volume (and Iannone 2014b), we also noted a certain unevenness in terms of the quality of specific datasets across both time and space. These limitations establish some parameters with respect to the degree to which shifting levels of resilience may be recognized within the various integrative histories were are attempting to craft as part of the broader SETS research program.

**General Goals of SETS Phase I: Questioning Resilience**

The SETS I data evaluation program has also allowed for the preliminary, cross-cultural comparison of pre-industrial state formations representing the tropical zones of South and
Southeast Asia, as well as Central America, using the range of pre-existing data sets. As such, even at this early juncture in our research cycle we are able to begin to address the following general research questions, many of which are commented on in this volume’s conclusions chapter.

1) Did all of the charter states share similar organizational principals?
2) Did these characteristics lead to specific levels of resilience and/or vulnerability to shifting environmental and/or cultural circumstances?
3) Was the pattern of material “entanglement” similar for all of the charter states?
4) Did the various charter states really “collapse,” or are their integrated socio-ecological histories better characterized by growth, punctuated by periods of less dramatic reorganization?
5) How similar and/or different are the organization properties and integrated socio-ecological histories of South and Southeast Asia from what we currently know about the ancient Maya of Central America?
6) Do contemporary nation states situated in tropical zones share certain qualities with the archaeological sample, and if so, do any of these characteristics suggest that these political formations are particularly vulnerable to environmental and/or cultural change?
7) Does the modern “megalopolis” – strings of interconnected metropolises encompassing rural and industrial space (Fletcher 2009, 2012; Gottman 1961) – share any characteristics, structural or otherwise, with the tropical low-density urbanism of the charter states in question, and if so, are there any risks or vulnerabilities that contemporary planners and policy makers should be made aware of?

CONCLUSIONS

In conclusion, the SETS investigations are envisioned as a long-term research program that will bridge the gap between the past and the present in order to examine socio-ecological relationships, and issues concerning resilience and vulnerability, in the world’s tropical zones. SETS Phase I constitutes the first stepping-stone in this endeavour. Through our detailed literature reviews and on-the-ground site visitations, we have been able to assess the quality available data associated with five key socio-ecological variables. This data evaluation exercise has set the stage for a much more sophisticated analysis of tropical resilience to be carried out, based on the crafting of more detailed, and integrated, socio-ecological histories for the various pre-industrial states in question. It will be the insights gleaned through this more comprehensive examination that will be most useful for assessing resilience in contemporary tropical state formations. The path towards this ultimate goal is discussed in more detail at the end of this volume’s concluding chapter.

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CHAPTER 2
WATER MANAGEMENT AMONGST THE ANCIENT STATES OF VIETNAM, SOUTH INDIA, AND SRI LANKA: A STUDY IN ENTANGLEMENT AND RESILIENCY

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INTRODUCTION

Research Focus

As a component of the SETS (Socio-ecological Entanglement in Tropical Societies) project, the focus of the research discussed herein is to evaluate the long-term effects of water management on the ancient Charter States of Vietnam, South India, and Sri Lanka. The specific goal is to determine whether water management was a mitigating factor in both the rise and eventual collapse of the various Charter States in question. Various criteria, including scale, quantity, and function are all considered and assessed in relation to the concepts of entanglement and resiliency (as detailed in Chapter 1). Preliminary findings indicate that the development and use of water management in these states was an essential part to their overall prosperity and eventual decline.

Research Sample

The research sample includes a series of kingdoms from Vietnam (380-1471 CE), one kingdom from South India (848-1279 CE), and one kingdom from Sri Lanka (377 BCE-310 CE). The first kingdom in Vietnam is the Dai Viet Kingdom (1009-1400 CE) which was centered on the capital of Thang Long in Northern Vietnam (Hanoi), while the second set of kingdoms, the that of the Chams (380-1471 CE) was variously centered on the capitals of Simhapura/Tra Kieu (350-758 CE), Indrapura/Dong Duong (758-986 CE), and Vijaya/Cha Ban (986-1471 CE), all located in Central Vietnam. In South India, the Chola Empire was centered on the capitals of Thanjavur (848-1025 CE) and Gangaikonda Cholapuram (1025-1279 CE), and in Sri Lanka, the Sinhalese Empire was centered on the capitals of Anuradhapura (377 BCE-933 CE) and Polonnaruwa (933-1310 CE).

The time period of interest (800-1400 CE) has been designated by Victor Lieberman (2003:23) the charter era, which effectively places all these kingdoms within the charter era, and makes them “charter states.” According to Lieberman, charter states formed through the territorial consolidation of smaller polities and subsequent development into large political formations whose administrative and political achievements provided a charter for succeeding states. All charter states reached their peak of development between approximately 1000 and 1250/1300 CE and collapsed at various points between 1250 and 1400 CE (Lieberman 2011:937).

Fieldwork
The first research trip led by Dr. Gyles Iannone to Vietnam took place over the course of 20 days in December 2014. During this trip the capitals of the Dai Viet and the Cham Kingdoms were visited. The trip began in Northern Vietnam in the capital city of Hanoi, formerly Thang Long, and then moved south, to Central Vietnam and the modern city of Quy Nhon, located in the Binh Dinh Province. This was once the area dominated by as the Vijaya Kingdom, with its former capital at Cha Ban Citadel. The SETS team subsequently relocated to the ancient town of Hoi An, located in the Quang Nam Province, and visited the ritual site of My Son, located 10 km from the historic town of Tra Kieu, formerly the capital of Simhapura. The present day village of Dong Duong, formerly Indrapura, located a short distance from the modern city of Da Nang, was also visited at this time.

The second trip took place over the course of 30 days in May and June 2015, and included visits to the two capitals of the Chola Empire in South India, followed by visits to the two capitals of the Sinhalese Empire in Sri Lanka. The trip began in Chennai, the current capital and largest city in the state of Tamil Nadu, South India. The team then travelled to Tanjavur (Tanjore), formerly a Chola capital, . This was followed by a stay in the town of Kumbakonam and a visitation to the second capital of Gangaikondacholapuram. On completion of the South Indian portion of the field trip, the SETS team relocated to Sri Lanka. After a brief stay in Colombo, the current capital city, the ancient capitals of Anuradhapura and Polonnaruwa were visited.

**Theoretical Framework**

Two particular theoretical frameworks that are central to the SETS project are Entanglement and Resilience theory. Entanglement, as discussed by Ian Hodder (2012:88), describes the dialectic relationship between dependency and dependence. Humans and things, things and things, things and humans, and humans and humans depend on each other, rely on each other, and produce each other. A related theoretical perspective, Resilience theory seeks to understand the role of change in societies from a socio-ecological perspective. At the core of resilience theory is the adaptive cycle. Adaptive cycles look at the transformation of complex adaptive systems, and are marked by four phases: exploitation/rise (r phase), conservation/prosperity (K phase), release/collapse (Ω phase), and reorganization (α phase; Holling 2001:394; Redman 2005:72-73). Movement though the cycle, from r phase to K phase coincides with an increase in connectedness or entanglement, and hence a decrease in resilience (see Table 1.2).

Embedded in these phases are a series of continua of variation with particular implications for resilience (Iannone 2014:7; see Table 1.3). These include continua of variations such as: flexibility, openness, reserves, social capital, and connectivity. According to Iannone, flexibility refers to the ability to make changes and control transformations; this however, changes overtime, as the capacity to do so diminishes, leading to a rigid system with greater control over regulations and procedures. Openness refers to how open or closed a system is to new ideas and people. Systems that are too open or too closed are less resilient as a result of continued changes or an inability to innovate. Reserves and social capital refers to how, overtime, fewer unclaimed resources are available and those that do exist are tightly controlled. Less collective action means less unity within a system, and greater difficulty united to deal with perturbations. Finally, too little or too much connectivity can isolate or overwhelm a system. Intermediate levels of connectivity, in contrast, exhibit the most resilience because while components have tight interactions, they are loosely connected to each other. All of these continua of variation have
material correlates, and they thus provide an ideal framework for examining water management systems, entanglement, and resilience archaeologically.

**Research Goals**

One of the overarching goals of the SETS project is to examine whether socio-ecological dependencies (i.e., entanglements) make a society more or less resilient overtime. In order to contribute to this research goal, a set of specific research goals concerning water management were created and assessed based on a list of chosen criteria. In-field objectives focused on the complexity and location of the system. In determining the overall complexity of the system scale, quantity, and function were all considered. Scale looks at the overall size of the system, quantity considers how many different features make up the system, and function examines the system’s function and purpose. In addition to determining the degree of entanglement within specific water management systems based on their overall complexity, the degree of resilience based on a continuum of variation within the society is also evaluated. This two-fold evaluation process allows for more substantiated conclusions in regards to determining resiliency.

**Research Methods**

The research methods for this project consisted of on-site visits, which included extensive photographic documentation, detailed note taking, meeting with local scholars, and museum visits. In addition, extensive background research on the research sample, particularly on water management systems, was undertaken beforehand and during the research trip to ensure a range of relevant system components were visited. This allowed for a more comprehensive representation of the system as a whole.

**BACKGROUND**

**Water Management Theory**

The earliest theory on water management that motivated further investigation in the field was Karl Wittfogel’s *Hydraulic Hypothesis*. Wittfogel (1957: 45) contended that centralized control over water was representative of more developed economies and that irrigation was a determinant for state formation. Subsequent scholars would argue for or against the *Hydraulic Hypothesis*, but this theory would generally be abandoned once it was confirmed that irrigation systems often developed after the emergence of states, and not before, as originally hypothesized (Mithen 2010:5251). The 1980s ushered in a new way of archaeological thinking about water management (Scarborough 2003:26). Instead of arguing for or against the *Hydraulic Hypothesis*, scholars began modifying this theory, and adding new dimensions to it. In 1983, William Kelly (1983:883) argued that the role of political authority in water management did not represent a simple dichotomy comprised solely of two ends of a continuum of centralized or decentralized organization, but was rather associated with many organizational possibilities.

**Climate, Agriculture, and Water Management in South and Southeast Asia**
Climate in South and Southeast Asia is monsoonal. Monsoon climates have wet and dry seasons, some more pronounced than others (Trewartha et al. 1961: 213-218). These seasons are influenced by the trade winds, which dictate the amount of precipitation and overall temperatures (Köppen 2011: 354). Despite plenty of rainfall during the wet season, all the areas in the research sample are located in dry zones, meaning natural water sources, such as rivers, lakes, and springs, are not enough to provide a sufficient water supply for a complex society (Bauer and Morrison 2008:1; Lieberman 2003: 349).

During the 9th or 10th century CE a climatic warming trend began that affected much of South Asia, Southeast Asia, Europe, and China. The years between approximately 900/950 CE to 1250/1300 CE were conditioned by the Medieval Climate Anomaly (Lieberman 2003:102). The Medieval Climate Anomaly exhibited warmer conditions with increased rainfall, longer monsoon seasons, shorter dry season droughts, and more evenly distributed rains throughout the year, which were ideal conditions for agricultural and political expansion (Lieberman 2011:933; Lieberman and Buckley 2012:1074). The Little Ice Age, a cooling period that brought changes in rainfall and temperature, followed the Medieval Climate Anomaly.

Vietnam is dominated by major river systems with corresponding river flats that are ideal for agricultural production (Hall 2011:12). The river flats were favourable areas for settlement of populations seeking to cultivate rice. Populations located in rice plain centers were easier to politically dominate than populations dispersed over multiple river-systems. South India consisted both of areas with rich soils and abundant water, as well as areas less suited for stable agriculture (Heitzman 1987a:60). Of particular importance was the Kaveri river and its delta, the location of the Chola capitals (Heitzman 2008:22). This area was not only ideal for agricultural production, but it would help stimulate agrarian expansion into other subsidiary riverine and peripheral areas, and reinforce the hegemony of the Chola kings (Heitzman 1987a:60). Much of the dry zone in Sri Lanka is dominated by soil that lacks the ability to retain water (Geekiyange and Pushpakumara 2013:94). This, coupled with the undulating topography which features underlying basement rock and overlying weathered rock, made large-scale agriculture difficult (Geekiyange and Pushpakumara 2013:95). Rich alluvial soils were, however, found in river flood plains and river valleys.

The climate shift that coincided with the Medieval Climate Anomaly, coupled with settlement locations near fertile alluvial plains, stimulated the building of more sophisticated water management systems in order to handle water shortage in the dry season, and to store and redirect abundant water in the wet season. These systems included but were not limited to reservoirs (tanks/wewas), canals, dams, bunds (walled wet-rice fields), sluices, wells, water temples, and bathing ponds. Each of these components had specific purposes and functions:

1) the collection and storage of water:
   a. reservoirs (tanks/wewas) and wells collected water for domestic use, agriculture, and religious purposes;
   b. water temples collected water for religious purposes, and;
   c. bathing ponds were filled with water for bathing;

2) the interruption or redirection of water:
   a. canals redirected water from rivers, reservoirs, and runoff;
   b. dams interrupted and slowed the flow of water;
   c. bunds retained water and withstood water pressure, and;
   d. sluices controlled water let out from a reservoir
Cham and Dai Viet Kingdoms of Vietnam

The Vietnamese capital of the Dai Viet Kingdom, Thang Long (Hanoi), was located between the Red River delta and its fertile upstream areas, while the Cham Kingdom dominated the south-southeast coastline (Hall 2011:12, 33; Lieberman 2003:23; Schweyer 2011:15-16). The Chams were dispersed along competing river valleys, which centered on agricultural production and international trading (Hall 2011:66). It has been widely acknowledged that Champa was never a unified kingdom, but a collection of trade ports extending from the Truong Son mountain-range plateau hinterlands to the Mekong Delta in the south (Hall 2011:68-69). In contrast, the Vietnamese of Dai Viets exhibited a developmental pattern trending towards centralization (Hall 2011:66). In the latter area economic expansion in both agricultural and commercial sectors reinforced royal hegemony among competing elites.

The oldest capital in Champa was Tra Kieu, located to the north, which initially served as the political and economic center for the region (Hall 2011:69). Primary and secondary centers were connected to Tra Kieu by road networks, raised embankments, and stone bridges built over canals (Hall 2011:70). Cham capitals were generally settled downstream, away from the more agriculturally oriented upstream communities that lay between the coast and highlands (Hall 2011:76-77). Although rice surpluses were meant to support networked temples, international trade was often favoured over agriculture (Schweyer 2011:9). Cham rulers have never been referenced in any records of water management, nor did they assign roles to elites to oversee water maintenance. Local water management work was, instead, a source of unity among communities (Hall 2011:85).

Early Vietnamese society consisted of small groups who farmed the area above the Red River delta, using the tides to support irrigation networks (Hall 2011:90). By the tenth century Vietnamese society was based in villages and had developed complex dike and drainage systems to control the floodwaters of the Red River delta. In contrast to the Chams, the Vietnamese were more established agriculturalists, and thus their economy was more dependent on wet-rice agriculture, with secondary focus in international trade (Hall 2011:95; Schweyer 2011:10).

The Cholas of South India

The Chola Empire has a long history extending as far back as the 3rd century BCE and continuing up until the 13th century CE. For this reason, Chola history is often divided into three periods: Early Cholas (200 BC – 848 CE), Medieval Cholas (848 CE – 1070 CE), and Later Cholas (1070 CE – 1279 CE). While capitals moved, being established by different kings in different areas, the heartland of the Cholas was consistently located in the lower parts and delta areas of the Vaigai, Kaveri, and Palar rivers (Frasch 2011:8). It was not until the latter half of the 9th century CE that the Chola Empire ascended to unparalleled power, uniting the whole area south of the Tungabhadra River, expanding into Bengal, and conquering Sri Lanka (Frasch 2011:1).

The two major capitals from ca. 900-1300 CE were Thanjavur and Gangaikonda Cholapuram. The areas extending beyond these capitals were just as important as the capitals themselves. Surrounding cities include Tiruchirappalli and Kumbakonam. Thanjavur is located in the center, with Tiruchirappalli to the west and Kumbakonam to the east. Tiruchirappalli, also known as Trichy, lies on the southern banks of the Kaveri River, where fertile irrigated riverine areas have long supported an economy based on rice production (Heitzman 1987a:39).
Kumbakonam is located within the Thanjavur district and is a short distance to the now small village of Gangaikonda Cholapuram. This area was an important center within the Chola Empire, and its rice production via artificial irrigation systems was dependent on the Kaveri River and its associated delta areas (Heitzman 1987a:39).

*Nadus* were the socio-economic sectors that made up the Chola state (Frasch 2011:8). While each varied considerably depending on climatic and environmental conditions, and how these ultimately affected local economic productivity, *nadus* within areas of the Kaveri were well irrigated and suited for rice cultivation. From the 10th to 12th centuries CE attempts were made to improve the economic value of these *nadus* with the construction of more sophisticated irrigation works, either by extending existing features or by implementing new facilities.

**The Sinhalese of Sri Lanka**

Sri Lanka, known as Ceylon until 1972, is an island in South Asia. Ancient Sri Lanka, referring to the time period 377 BCE to 1310 CE, had two major capitals: Anuradhapura and Polonnaruwa (Leach 1959:7, 12). The sacred city of Anuradhapura established itself as an impressive economic capital, and its tank building and agricultural development suggests a relatively stable economy for its growing population (Wickremeratne: 1987:48). The collapse of Anuradhapura saw the rise of Polonnaruwa, a capital that would not only try to retain the cultural identity of its people, but also embrace new elements in the social, political, economic, and religious realms (Smith 1987:81).

Regular cultivation in Sri Lanka was impossible without irrigation because of the dry environmental conditions (Leach 1959: 7). The region lacked navigational drainage and contained reddish-brown, infertile soils that had no capacity for holding water (Leach 1959:7; Scarborough 2003:134). Agricultural techniques did not rely on bringing water from elsewhere, but rather, were based on local storage of rainwater that was used throughout the year (Leach 1959:8). The population was distributed among small villages, with each village dependent on an area of irrigated rice paddy watered from a reservoir. Reservoirs (tanks/wewas) were constructed by building earthworks across a stream and damming the water behind it. While most village tanks were fairly simple in design, larger tanks included spillways and sluices.

Even at an early date, distinctions in type of tanks were being made. Three types were generally constructed: village tanks, large tanks, and feeder tanks (Scarborough 2003:136). Feeder tanks functioned as storage reservoirs for filling other reservoirs. Dams were also important, because of the flat terrain, and were often placed across seasonal drainage. However, as limitations in dam height and length were becoming problematic for continued irrigation, invention of more sophisticated hydraulic technology began to revolutionize Sinhalese society, leading to greater social complexity and a highly centralized political economy.

**FINDINGS**

Unless otherwise cited, all the information within the following two sections was obtained from signage at sites, displays at museums, maps and brochures, and speaking to local people.

**Water Management in the Dai Viet Kingdom**
Physical evidence of water management from the Dai Viet Kingdom is still extremely prominent in the present-day area. The Dai Viet period includes the Ly Dynasty (1010-1225 CE) and the Tran Dynasty (1225-1400 CE; Schweyer 2011:31;36). The Dai Viet occupied a large part of Vietnam, which extended 1,600 km down the east coast of the Indochinese peninsula, and comprising of a total of 3,500 km of coastal land (Schweyer 2011:15). The major area of cultivation was the Red River delta (an area of 15,000 km²). During the Ly Dynasty, Buddhism was established as the state religion, monasteries and palaces were built along roads, dykes and canals, and the first dike intended to control the flooding of the Red River was constructed (Schweyer 2011:31). The locations of temple sites were carefully chosen – in symbolic terms – so that surrounding communities continued to live in harmony with their surroundings (Schweyer 2011:34). A 13th century CE text details that the chosen landscape should include elements of water, fire, rice, and vegetation and should not be too close or far from houses. Water, thus, played a large role in the Dai Viet Kingdom, not just in regards to agriculture, but also for its symbolic and political significance.

In 1010 CE the Dai Viet capital moved to Thang Long (Hanoi). The Imperial Citadel of Thang Long was built and surrounded by inner and outer walls. The walls were used both as a defense system and as dykes against the flooding of the Red River. The Citadel is now a protected UNESCO world heritage site and has on display many artifacts and replicas of drainage features and wells (Figures 2.1-2.3). The Hai Ba Trung Temple (the Temple of the Two Trung Sisters) was founded in 1087 CE in memory of two historical figures who threw themselves into a river to avoid being captured by the Chinese (Schweyer 2011:286). A small lake is located opposite the temple (Figure 2.4). Hoan Kiem Lake (Figure 2.5), also called the Lake of the Returned Sword, is located in the heart of Hanoi, and holds great symbolic meaning. As the legend goes, during the 15th century CE a turtle emerged from the lake and offered a magic sword to Le Loi who led the resistance against the Chinese (Schweyer 2011:286). Thap Rua (Turtle tower; Figure 2.6) was built in the center of the lake in the 18th century CE. Finally, One-Pillar pagoda is a cultural and historic relic built in 1049 CE. The pagoda is shaped like a lotus blooming out of its stem and is also situated within a small lake (Figure 2.7).

Figure 2.1. Replica of a rammed brick well from the Tran Dynasty, Hanoi, Vietnam.
Figure 2.2. Excavated brick well at the Imperial Citadel of Thang Long, Hanoi, Vietnam.

Figure 2.3. Excavated drainage at the Imperial Citadel of Thang Long Hanoi, Vietnam.

Figure 2.4. Small lake opposite Hai Ba Trung Temple, Hanoi, Vietnam.
Figure 2.5. Hoan Kiem Lake (Lake of the Returned Sword) in Hanoi, Vietnam.

Figure 2.6. Thap Rua (Turtle tower) situated at the center of Hoan Kiem Lake, Hanoi, Vietnam.

Figure 2.7. One-Pillar pagoda situated in a small lake, Hanoi, Vietnam.

Kien So Temple was founded as the new school of Buddhism (Schweyer 2011:298). It features a meditation pond at the front of the temple site and a large well at the back (Figures 2.8-2.9). Across the road from the temple site, in an adjacent field, is an extremely large well with residential buildings nearby (Figure 2.10). Neighbouring areas feature extensive agricultural production (Figure 2.11). But Thap was founded in 1037 CE (Schweyer 2011:316). Its name
represents tranquil happiness. The temple site features a reservoir at the front of the temple, a humped-back stone bridge over a drainage channel, and a lotus carved well (Figures 2.12-2.14). (Schweyer 2011:318; 323). Adjacent to the site is a large lake, and across the road are agricultural fields (Figure 2.15-2.16).

**Figure 2.8.** Meditation pond at the front of Kien So Temple, Hanoi, Vietnam.

**Figure 2.9.** Large well at the back of Kien So Temple, Hanoi, Vietnam.
Figure 2.10. Extremely large well opposite Kien So Temple, Hanoi, Vietnam.

Figure 2.11. Agricultural fields in surrounding area of Kien So Temple, Hanoi, Vietnam.

Figure 2.12. Reservoir at But Thap, Hanoi, Vietnam.
Figure 2.13. Humped-back stone bridge over a drainage channel at But Thap, Hanoi, Vietnam.

Figure 2.14. Lotus carved well at But Thap, Hanoi, Vietnam.

Figure 2.15. Large lake adjacent to But Thap, Hanoi, Vietnam.
Dau Pagoda is one of the oldest pagodas in Dai Viet. Its name derives from Mulberry tree, which used to be cultivated by the locals (Schweyer 2011:308). The pagoda is also called Chua Phap Van, which means Pagoda of the Buddha of the Clouds. People would often come to this temple in times of drought and pray for the rains to fall. A unique architectural design is that the temple and its associated well are partially made from wood (Figure 2.17). The temple site also features a reservoir (Figure 2.18). Thay Pagoda was built in 1041 CE (Schweyer 2011:335). The pagoda was built facing a pond (dragon pond), where Thuy Dinh temple is located (Figure 2.19) (Schweyer 2011:335). Thuy Dihn dates to the 13th century CE and was dedicated to the guardian spirits. Lang Pagoda is one of the most sacred in the capital, and was built sometime during the 10th and 11th century CE (Schweyer 2011:296). It features two large wells at the back of the temple site (Figures 2.20-2.21). Located in the middle of Hanoi is the Temple of Literature. It was founded in 1070 CE and was the first Dai Viet University (Schweyer 2011:288). It is comprised of three courtyards. The first two courtyards have large wells; one on the right and one on the left (Figures 22-23). In the middle of the third courtyard is the Well of Heavenly Clarity (Figure 2.24; Schweyer 2011:289).
Figure 2.18. Reservoir at Dau Pagoda, Hanoi, Vietnam.

Figure 2.19. Thuy Dihn situated in the center of dragon pond, Hanoi, Vietnam.

Figure 2.20. Large well at Lang Pagoda, Hanoi, Vietnam.
**Figure 2.21.** Second large well at Lang Pagoda, Hanoi, Vietnam.

**Figure 2.22.** Large well in the first courtyard at the Temple of Literature, Hanoi, Vietnam.

**Figure 2.23.** Large well in the second courtyard at the Temple of Literature, Hanoi, Vietnam.
The capital of Simhapura/Tra Kieu (350-758 CE) is the oldest capital of the Cham Kingdoms. It is located in the Quang Nam Province. During this time the economy of Champa was based on international trade (Schweyer 2011:19). In the 8th century CE, King Indravarman created a capital at Indrapura/Dong Duong (758-986 CE), in the north of the country, which created a new lineage with its own political power and influence (Schweyer 2011:19). After 1050 CE, the Champa capital Vijaya/Cha Ban (986-1471 CE) at Quang Nam in the Bihn Dinh Province rose to power. While the 11th century CE saw peace and prosperity in trade relations, the second quarter of the 12th century CE was troubled, with attacks on the capital (Schweyer 2011:34).

Although the Kingdoms in Champa lack physical evidence of water management in comparison to the Dai Viet Kingdom, historical sources do cite irrigation systems. Small-scale water features were used for domestic and village use, while more extensive systems of tanks/reservoirs, flumes, terraces, and causeways were used for agriculture (Sox 1972:32). Cham use of water depended more on the water from streams and rivers than on precipitation, making settlement along coastal areas extremely important (Sox 1972:69). The Chams also attached great sacred value to springs in the mountains and built shrines and water temples nearby (Sox 1972:72).

The Quang Nam Province. The capitals of Simhapura/Tra Kieu and Indrapura/Dong Duong are both situated in the Quang Nam Province. Most of the structures are referenced in location to the ancient town of Hoi An, which was linked to Tra Kieu and the present day city of Da Nang, which is nearby to where the Indrapura capital was located. The ancient town of Hoi An is located on the north bank of the Thu River, which served as a major trade route in the 6th century CE and which lead to the capital of Tra Kieu, located on the south bank of the river, (Schweyer 2011:149). Several ancient wells are located in Hoi An, the round ones dating from the earliest occupation, while a large square well dates back to the Cham period (Schweyer 2011:167). Water from this particular well is reportedly used to make the traditional local dish – Cao Lau (Figure 2.25). My Son, the “scared mountain” is the largest group of Cham temple complexes (Schweyer 2011:177). It developed over ten centuries and includes multiple kinds of
architecture, sculptures, and inscriptions. Only eight temple complexes remain from the original seventy, and these are designated by letters. Groups B, C, D, H face groups A, E, F, G. One hypothesis was that the temples were oriented to face the river that runs through the site, and thus temple orientation depended on the bank on which a particular temple stood (Figure 2.26). However, recent excavations show that the river previously flowed further east, behind groups A, E, F, G. Elsewhere, Bang An tower – located to the Northeast of ancient Tra Kieu – was a part of a large complex of ramparts and other buildings (Schweyer 2011:200). Entrance to this temple site features a bridge over an agricultural field (Figure 2.27). The landscape in this province features extensive wet-rice cultivation.

Figure 2.25. Cham period well in Hoi An, Vietnam.

Figure 2.26. River at My Son, Quang Nam Province, Vietnam.
The Binh Dinh Province. The capital of Vijaya/Cha Ban is located in the Binh Dinh Province. The modern town of Quy Nhon is at the west entrance of Thi Nai Bay (Schweyer 2011:117). A bridge links the town to an island situated to the east. In earlier times the bay was a system of canals that allowed access to the seas. Banh It is a nearby temple complex located on a hill that was previously intercut with terraces (Schweyer 2011:122). The temples overlook fields of wet-rice agriculture (Figure 2.28). The former Vijaya capital, Cha Ban Citadel, is located between the Con and Quai Vac rivers (Schweyer 2011:128). It contains a large 14,000 m by 1,100 m rectangular, earth covered stone block, with ramparts enclosed by two dykes. Thap Thap Pagoda is also a part of the citadel (Schweyer 2011:129). The site features a large reservoir at its entrance and has four square, brick wells lined with stone on the inside (Figures 2.29-2.30). Nhan Thap is located on a hill, where the goddess Bodega, who taught the Chams how to cultivate rice, is worshipped (Schweyer 2011:112). The temple site features a large well (Figure 2.31). This province also features extensive wet-rice cultivation (Figures 2.32-2.36).
Figure 2.29. Reservoir at the entrance of Thap Thap Pagoda, Binh Dinh Province, Vietnam.

Figure 2.30. Square brick well at Thap Thap Pagoda, Binh Dinh Province, Vietnam.

Figure 2.31. Large well at Nhan Thap. Binh Dinh Province, Vietnam.
Figure 2.32. Irrigated agricultural field, Binh Dinh Province, Vietnam.

Figure 2.33. Irrigated agricultural field, Binh Dinh Province, Vietnam.

Figure 2.34. Irrigated agricultural field, Binh Dinh Province, Vietnam.
Figure 2.35. Irrigated agricultural field, Binh Dinh Province, Vietnam.

Figure 2.36. Irrigated agricultural field, Binh Dinh Province, Vietnam.

Water Management in the Chola Empire

Many reasons are often attributed to the expansion of the Chola Empire, including both political and military initiatives, the role of water management, however, should not be undervalued as a contributing factor, for it was the irrigation engineers who built reservoirs, dams, canals, and sluices that had a great deal to do with altering the agricultural landscape (Frasch 2011:5). While irrigation systems played a large part in the overall water management of the Chola Empire, temple tanks and associated hydraulic features constructed for temple use were also quite prominent.

Much of what is still in existence of ancient water management systems is in the form of tanks. “Tank” is a term used indiscriminately throughout much of South Asia to refer to both reservoirs for the purposes of agricultural and domestic use, and temple tanks that were used primarily for ritual and worship (Bauer and Morrison 2008:1). For this reason, evidence of both tanks (reservoirs) and temple tanks will be presented.

Temple Hydraulics. Chola temples were very much involved in hydraulic projects. From temple tanks to complex drainage systems, the role of water in ritual worship was clearly
important. Tanks associated with temples were both located within and outside temple complexes. It is unclear if any distinctions can be made, based on the placement of temple tanks. Specifically, it is hard to determine whether those located outside temple complexes could be used for other, non-ritualistic functions during the Chola period. Chola tanks ranged in size from very large to comparatively small, and they were made from masonry materials (Bauer and Morrison 2008:1). Larger tanks were able to hold a substantial amount of water, which was derived from the water table.

In the present day, temple tanks are used for a variety of purposes, particularly those located outside temple complexes, in the public domain. Although the quality of water is undetermined, these tanks are often used for bathing and washing clothes. Some tanks located inside temple complexes are surrounded by wire fences and are solely used for religious purposes by ritualists, while others are openly accessible but are in inoperable conditions, as some are dry and hold no water, while those that contain water are quite unsanitary and plagued with algae.

Temples are equipped with a very complex system of drains and spouts. This, in large part, has to do with the everyday poojas (ceremonies) that take place in the interior and inner sanctum of the temple. Hindu statues and murtis (idols) of Gods are located throughout the temple and are bathed in a liquid such as water or milk as part of a purification ritual. It also symbolizes the deity taking a holy bath in the water. The various liquid need to be drained out of the temple, and this is done via the intricate system of drains and spouts. These drains and spouts are also used for flood prevention during periods of excess rainwater.

The Brihadisvara Temple at Thanjavur is one of the UNESCO Great Living Chola Temples. It was commissioned by Rajaraja in 1003 CE and completed in 1010 CE. The temple is surrounded by a moat and features a complex system of drains and spouts (Figures 2.37-2.38). Several wells are also located inside the temple complex (Figure 2.39). It is the only identifiable major remain from the Chola period at Thanjavur. The Airavaesvara Temple at Darasuram near Kumbakonam is another UNESCO Great Living Chola Temple. Rajaraja II built it in the 12th century CE. After rainfall the entrance to the temple and areas within the temple typically floods (Figure 2.40). Similar to Brihadisvara at Thanjavur, this temple has a complex system of drains and spouts, and also features several wells (Figures 2.41-2.42).

Temples with hydraulic features located within surrounding areas of Thanjavur and Trichy are the Apathsahayar Temple (Figures 2.43-2.44), the 108 Sivalayam Temple (Figure 2.45), the Garbarakshambigai Temple (Figures 2.46-2.47), the Jambukeswarer Temple (Figure 2.48), the Sri Ranganathar Temple (Figure 2.49), the Sri Azhagiya Manacala Temple (Figure 2.50), the Panchavarneeswamy Temple (Figure 2.51), and the Samayapuram Temple (Figure 2.52). They feature drainage systems, spouts, wells, and tanks.
Figure 2.37. Brihadisvara Temple moat, Thanjavur, South India.

Figure 2.38. Brihadisvara Temple spout and drainage, Thanjavur, South India.

Figure 2.39. Brihadisvara Temple well, Thanjavur, South India.
Figure 2.40. Airavaesvara Temple Entrance (flooded), Darasuram, South India.

Figure 2.41. Airavaesvara Temple spout and drainage, Darasuram, South India.

Figure 2.42. Airavaesvara Temple well, Darasuram, South India.
Figure 2.43. Apathsahayar Temple spout and drainage, Thirupazhanam, South India.

Figure 2.44. Apathsahayar Temple well, Thirupazhanam, South India.

Figure 2.45. 108 Sivalayam Temple tank (dry), Papanasam, South India.
Figure 2.46. Garbarakshambigai Temple tank, Thirukarugavur, South India.

Figure 2.47. Garbarakshambigai Temple well, Thirukarugavur, South India.

Figure 2.48. Jambukeswarer Temple tank, Tiruchirappalli, South India.
Figure 2.49. Sri Ranganthar Temple tank, Tiruchirappalli, South India.

Figure 2.50. Sri Azhagiya Manacala Temple tank, Tiruchirappalli, South India.

Figure 2.51. Panchavarneeswamy Temple tank, Tiruchirappalli, South India.
The Vijayalaya Choleeswaram is a temple located in the Pudukkottai district, situated atop a rocky hill. It was rebuilt by Vijayalaya Chola, but is no longer a living temple. At the bottom of the hill are paddy fields and a small lake (Figure 2.53). Deep trenches lead to the temple (Figure 2.54). It is likely filled with water during certain times of the year. A depression on a sloping area on one side of the hill was also filled with water (Figure 2.55). The trench may be connected to this depression, as there is an opening on one side that possibly leads back up to the temple.

There are many temple tanks in and around the Kumbakonam area. The Mahamaham tank is the largest tank in Kumbakonam and is located within the center of town (Figure 2.56). It has 21 wells inside the tank, and covers over 2.43 hectares. The Potramarai tank is another large tank a short distance from the Mahamaham tank (Figure 2.57). The Potramarai tank is situated between the Sarangapani and Kumbeswara temples. The Kumbeswara Temple has a small temple tank located within the temple compound (Figure 2.58). Nearby is the Somerswara Temple, which features a spout, well, and complex drainage system (Figures 2.59-2.60).
Figure 2.54. Trench leading to Vijayalaya Choleeswaram, Pudukkottai, South India.

Figure 2.55. Depression with water at Vijayalaya Choleeswaram, Pudukkottai, South India.

Figure 2.56. The Mahamaham tank at Kumbakonam, South India.
Figure 2.57. The Potramarai tank at Kumbakonam, South India.

Figure 2.58. Kumbeswara Temple tank (dry), Kumbakonam, South India.

Figure 2.59. Somerswara Temple spout and drainage, Kumbakonam, South India.
Generally, photos were not allowed to be taken inside the main ritual areas of the temples. Some temples, however, did allow photos. The Swaminathaswamy temple is one of these temples. Photos taken in the interior areas of this temple show a spout coming out of the inner sanctum of the temple where water was dispersed into drains that eventually led outside (Figure 2.61) A well was also located inside (Figure 2.62). Outside the temple, but still within the temple complex, was a dry tank (Figure 2.63).

The Brihadisvara Temple at Gangaikonda Cholapuram is the third UNESCO Great Living Chola Temple. It was built by Rajendra I. There are several wells, spouts, and complex drainage system located within the temple complex (Figures 2.64-2.65). There is also a small lake outside the temple. Within the Nataraja temple complex in Chidambaram is the Sivagangai tank (Figure 2.66). This tank was surrounded by a wire fence and was closed off to the public. It had a sign that said the tank was sacred and not suitable for non-ritualistic activities such as washing clothes, swimming, and brushing teeth.

Figure 2.60. Somerswara Temple well, Kumbakonam, South India.

Figure 2.61. Swaminathaswamy Temple spout and drainage (inside temple), Kumbakonam, South India.
Figure 2.62. Swaminathaswamy Temple well (inside temple), Kumbakonam, South India.

Figure 2.63. Swaminathaswamy Temple tank, Kumbakonam, South India.

Figure 2.64. Drainage at the Brihadisvara Temple at Gangaikonda Cholapuram, South India.
Figure 2.65. Large well at the Brihadisvara Temple at Gangaikonda Cholapuram, South India.

Figure 2.66. The Sivagangai tank at the Nataraja temple complex in Chidambaram, South India.

Irrigation. Tamil Nadu is quite dry and depends largely on water management features such as tanks, dams, canals, bunds, and sluices to store and distribute water. Thanjavur, the rice bowl of Tamil Nadu, is located on the southern bank of the Vadavaru River. Inscriptions from the 10th and early 11th century CE refer to the city as Tanjai, stating that it was essentially a collection of villages controlled by the Cholas. Thanjavur gained importance during the reign of Rajaraja I. The Kallanai Dam, one of the oldest water diversion structures in the world is located within the Thanjavur district (Kunholathillath 2012:22). This ancient stone dam was built by the Chola King Karikalan in the 2nd century CE and is 329 m long, 13 to 19 m wide and 6 m high. extending across the Kaveri River (Kunholathillath 2012:22-23) The purpose of the dam was to divert water from the Kaveri across the delta for irrigation via canals (Figures 2.67-2.69) (Kunholathillath 2012:23).

Upon Rajaraja I’s death, Thanjavur lost its importance and Rajendra I shifted the capital to Gangakonda Cholapuram. The areas surrounding Thanjavur and Gangakonda Cholapuram have many reservoirs scattered throughout the landscape. These reservoirs vary in overall form. The reservoirs in close vicinity to the core of the cities are the most formal. They are large, brick, rectangular structures with steps. Reservoirs in periphery areas are slightly less formal. They
appear to be dugout reservoirs but contain a set of brick steps (Figure 2.70). The least formal reservoirs are located in small villages. These reservoirs are dugout, smaller in size, and have no steps (Figures 2.71-2.72).

**Figure 2.67.** Remnants of the Kallanai Dam (center-left), Tiruchirappalli, South India.

**Figure 2.68.** Remnants of the Kallanai Dam, Tiruchirappalli, South India.
Figure 2.69. Remnants of the Kallanai Dam, Tiruchirappalli, South India.

Figure 2.70. Dugout reservoir with brick steps, Gangaikonda Cholapuram, South India.

Figure 2.71. Dugout reservoir, Pudukkottai, South India.
Physical evidence of ancient water management in Sri Lanka is plentiful. The engineers of Sri Lanka were experts in irrigation and hydraulics. While much of the data presented is of large tanks (wewas), because they are the most accessible and visible, structures and features such as canals, dams, bunds, sluices, and even smaller tanks also play a part in the totality of the system. Sri Lanka extends over an area of 65,000 km² with Anuradhapura located in the northern lowlands (Gilliland et al. 2013:1013). It is a relatively dry area that demands water for irrigation. Wet rice cultivation was much better at producing higher yields than dry rice cultivation, but because having adequate water was a problem, irrigation systems were built. These systems involved the storage and distribution of rainwaters. Land that was high on three sides was used to build bunds while the fourth side was used to create tanks. The rice fields were located below the tank and received water through a network of irrigation canals.

A method called the Tank Cascade system was used. This system essentially involved recycling and reusing water through a network of both small and large tanks (Geekiyange and Pushpakumara 2013:94). Small tank cascade systems were also used in smaller communities for irrigation. An estimated total of 7600 small tanks currently exist in several provinces throughout Sri Lanka, with an additional 7700 abandoned tanks (Sutcliffe et al. 2011:786). These systems have threefold purpose, as they are meant to provide water for irrigation, supply water for domestic use, and to induce groundwater recharge.

Major dams were generally located at valley ends, while the specific placement of major dams depended on the location of rock outcrop suitable for a spillway (Sutcliffe et al. 2011:786). The biggest difference between major and minor dams was the design of the sluices. Major dams had dressed stone cistern/value tower sluices (bisokotuwa), while minor ones tended to have more simple devices. The bisokotuwa was a revolutionary piece of hydraulic technology invented in the 3rd century BCE by ancient Sinhalese engineers. As high water pressure was capable of damaging bunds and sluices, the bisokotuwa was meant to regulate the mass of water a tank sent out through a sluice. At the same time, the bisokotuwa acted as a valve in regulating
the entry points of water.

Larger tanks have gained more attention because of their design and construction features. These tanks were brick cored and had large masonry faced embankments. Many also contained complex sluice works and spillways (Leach 1959:9; Scarborough 2003:134). These tanks reflect sophisticated engineering because local basins were not enough to fill them. A complex system of river diversions and canals were constructed. The very important Kala Wewa (Figures 2.73-2.74) built by King Dhathusena in the 5th century CE is partly fed by the Dambulu Oya, which in turn feeds the Nachchaduwa tank, the Nuwarawewa, the Tissawewa, and the Basavakkulama tanks through a series of feeder canals (Sutcliffe et al. 2011:786).

The Basavakkulama tank (Figure 2.75) in Anuradhapura, originally named Abhaya Wewa, was built by king Pandukabhaya in the 4th century BCE and covers an area of approximately 103 hectares when full (Parker 1909:361). In the 3rd century BC, King Devanam Piya Tissa built Tissawewa (Figure 2.76) in Anuradhapura (Parker 1909:364). The embankment of Tisaawewa is 3353 m in length and 7.6 m high across the valley. It has a low level sluice in the northern side of the embankment and a high level sluice on the southern side. Thuruwila is a tank in Anuradhapura (Figures 2.77-2.78). It is believed to have been built by Prince Mahanaga, brother of Devanam Piya Tissa in the 3rd century BCE. Nuwarawewa (Figures 2.79-2.80) was built in the 1st century BC by King Wattagamini (Parker 1909:400). It is the largest tank in Anuradhapura. It is located on the east side of the Malwatu Oya in a flat valley with a drainage area of 46.7 km. Nachchaduwa (Figures 2.81-2.82) was built in the 3rd century CE by the great tank builder King Mahasen (Brohier 2000:23). The bunds of Nachchaduwa regulate the waters of the Malwatu Oya before it reaches the city (Brohier 2000:22). The embankment is 11.3 m high in the valley and 3.7-4.9 m wide on top. The tank has two sluices, two inlets, and two outlet culverts (Figures 2.83-2.84; Parker 1909: 401). Bulankulama Wewa (Figure 2.85) is a smaller tank within the Bulankulama village. Water from this tank is used by Bulankulama farmers for irrigation. A canal connected to the tank channels water to paddy fields (Figure 2.86).
Figure 2.74. Kala Wewa, Anuradhapura, Sri Lanka.

Figure 2.75. The Basavakkulama tank, Anuradhapura, Sri Lanka.

Figure 2.76. Tissawewa, Anuradhapura, Sri Lanka.
Figure 2.77. Thuruwila, Anuradhapura, Sri Lanka.

Figure 2.78. Thuruwila, Anuradhapura, Sri Lanka.

Figure 2.79. Nuwarawewa, Anuradhapura, Sri Lanka.
Figure 2.80. Nuwarawewa, Anuradhapura, Sri Lanka.

Figure 2.81. Nachchaduwa, Anuradhapura, Sri Lanka.

Figure 2.82. Nachchaduwa, Anuradhapura, Sri Lanka.
Figure 2.83. Nachchaduwa, Anuradhapura, Sri Lanka.

Figure 2.84. Nachchaduwa, Anuradhapura, Sri Lanka.
Similar to the temple hydraulics in South India, the majority of Buddhist monastic complexes in Sri Lanka also feature extensive hydraulic works such as small reservoirs, wells, bathing ponds, spouts, and drainage systems. The Ranmasu Uyana is a royal park built by King Devanam Piya Tissa. It is considered a marvel of ancient water management in Sri Lanka. Water through the main sluice gate is taken and diverted to several areas in the park, and then released to the paddy fields in the surrounding area (Figures 2.87-2.89). The park extends over 16 hectares. Kuttam Pokuna, also known as the Twin Ponds, are two bathing ponds aligned lengthwise (Figure 2.90). These ponds date back to the 7th and 9th centuries CE and were built for the bikkhus (monks) of Abhayagiri. The north pond measures 28 m in length and has a depth of 4.3 m, while the south pond is 43 m long and 5.2 m deep.

The Jetavanara monastery contained many hydraulic features including two wells. These wells were brick-built circular wells with a stone flight of stairs (Figure 2.91). It was most likely used for rituals. Another feature was a pond, which was an artistic creation used to store water for a variety of purposes. The pond is rectangular and was built with stone slabs (Figure 2.92). The Abhyagiriya monastery includes many reservoirs and ponds as well. There are 65 ponds in the monastery (Figures 2.93-2.95). These ponds collected rainwater, which fulfilled the water requirements of the monks and kept the water table high. A circular pond was built to retain surface water from the assembly hall premises (Figure 2.96). The use of bricks to build the pond, in comparison to those used to build the assembly hall, may date the pond to the reign of Kanittatissa in the 2nd century CE. Several dugout reservoirs were also present.

The Polonnaruwa period saw a revival of irrigation systems that the kings of Anuradhapura established. Many reservoirs in the Polonnaruwa area are also linked by feeder canals. The Elahera canal diverted water from the Mahaweli Ganga, which fed the Kaudulla Giritale, and Minneriya tanks (Sutcliffe et al. 2011:786). Parakramabhu I was the greatest tank builder of the time. He is said to have constructed or restored 165 dams, 3910 canals, 163 major tanks, and 2376 minor tanks. Parakrama-Smaudra (Figures 2.97-2.99) was the greatest of his irrigation works. It was formed by joining two existing tanks, Topawewa and Dumbutulu Wewa, and
filling it with waters of the Mahaveli River by damming (the Ambanganga Dam) and conducting water through the Ambanganga canal.

**Figure 2.87.** Pond at Ranmasu Uyana, Anuradhapura, Sri Lanka.

**Figure 2.88.** Reservoir at Ranmasu Uyana, Anuradhapura, Sri Lanka.
Figure 2.89. Ranmasu Uyana, Anuradhapura, Sri Lanka.

Figure 2.90. Kuttam Pokuna, Anuradhapura, Sri Lanka.
Figure 2.91. Jetavanara monastery well, Anuradhapura, Sri Lanka.

Figure 2.92. Jetavanara monastery pond, Anuradhapura, Sri Lanka.

Figure 2.93. Abhyagiriya monastery pond, Anuradhapura, Sri Lanka.
Figure 2.94. Abhyagiriya monastery pond, Anuradhapura, Sri Lanka.

Figure 2.95. Abhyagiriya monastery reservoir, Anuradhapura, Sri Lanka.

Figure 2.96. Abhyagiriya monastery pond, Anuradhapura, Sri Lanka.
Figure 2.97. Parakrama-Smaudra, Polonnaruwa, Sri Lanka.

Figure 2.98. Parakrama-Smaudra, Polonnaruwa, Sri Lanka.

Figure 2.99. Parakrama-Smaudra, Polonnaruwa, Sri Lanka.
Dipauyana (Isalnd Park) contains the ruins of many important monuments. It was built by King Nissankamalla. It features a bathing pond (Ananta Naga Pokuna) to the south and a water tank (Figure 2.100-2.102). Kumara Pokuna is a royal bath located in the royal palace built by King Parakramabahu (Figure 2.103). The pond is designed to get water from the adjacent watercourses, and is provided with outlets to drain off the used water. Within the Polonnaruwa archaeological park, at the northern gate in the main street area, lies a complex system of drainage, wells, and reservoir (Figure 2.104-2.107).

Sigiriya is an ancient palace built by King Kasyapa. It features an outer moat, an inner moat (Figure 2.108), and water gardens. The water gardens are an elaborate network of water pavilions, ponds, courtyards, and water courses. There are five units in the miniature water garden, with buildings surrounded by pools (Figure 2.109). The pools have pebbled or polished marble floors that were covered by moving water. The first water garden has four large pools (Figure 2.110), each located at a cardinal direction: North, South, East, and West. The central area between the pools used to be a pavilion area. The second water garden, known also as the fountain garden, has four fountains symmetrically built, two on each side, and two long pools (Figure 2.111). These fountains are fed by the two adjacent moats. The third water garden is built on a higher level and displays a simple design. There are two ponds, an octagonal pond on the left, and on the opposite side an “L” shaped pond (Figure 2.112). At the top of the palace are two ponds, one large pond and one small pond (Figures 2.113-2.114). Sigiriya Wewa, the tank for the palace, lies towards the outer city (Figure 2.115). Of the great irrigation works of Sri Lanka, the Minneriya tank (Figure 2.116) is among the most important. The ancient reservoir drastically changed the northeast of the Island by allowing settlement and cultivation.

Figure 2.100. Bathing pond (Ananta Naga Pokuna) at Dipauyana (Isalnd Park), Polonnaruwa, Sri Lanka.
Figure 2.101. Bath House connected at Dipauyana (Isalnd Park), Polonnaruwa, Sri Lanka.

Figure 2.102. Water Tank at Dipauyana (Isalnd Park), Polonnaruwa, Sri Lanka.

Figure 2.103. Kumara Pokuna, Polonnaruwa, Sri Lanka.
Figure 2.104. Drainage at Polonnaruwa Archaeological Park, Polonnaruwa, Sri Lanka.

Figure 2.105. Well at Polonnaruwa Archaeological Park, Polonnaruwa, Sri Lanka.

Figure 2.106. Well at Polonnaruwa Archaeological Park, Polonnaruwa, Sri Lanka.
Figure 2.107. Reservoir at Polonnaruwa Archaeological Park, Polonnaruwa, Sri Lanka.

Figure 2.108. Sigiriya inner moat, Sigiriya, Sri Lanka.

Figure 2.109. Sigiriya miniature water garden, Sigiriya, Sri Lanka.
Figure 2.110. Pool in first water garden at Sigiriya, Sri Lanka.

Figure 2.111. Pool in second water garden at Sigiriya, Sri Lanka.

Figure 2.112. Octagonal pond in third water garden at Sigiriya, Sri Lanka.
Figure 2.113. Large palace pond at Sigiriya, Sri Lanka.

Figure 2.114. Small palace pond at Sigiriya, Sri Lanka.

Figure 2.115. Sigiriya wewa, Sigiriya, Sri Lanka.
DISCUSSION

Entangled Water Management

*The Dai Viets and Chams.* The overall scale of the systems was fairly extensive. Both the Dai Viet and Cham Kingdoms had extensive water management systems, spanning across large portions of the landscape. Combined, the Dai Viet kingdom consisted of a cultivable area of 75,000 km$^2$ within the Red River Delta, with constructed dikes and canals for irrigation and flood control. In contrast, the Cham Kingdoms were never a unified nation, and thus had concentrated areas of water management within its polities. The Cham Kingdoms consisted of dispersed settlements among varying provinces along the southeast coast to the Mekong Delta. The types of systems were diverse and involved features for irrigation, flood control, and symbolism. These included but were not limited to reservoirs, wells, canals, dikes, pools, water temples, terraces and interconnected channels.

Wet-rice cultivation was a large facet of the economy. While agricultural surplus among the Dai Viets reinforced political hegemony, it supported networked temples for the Chams. Since both Kingdoms were situated near river deltas and coastal areas, flood control features were extremely important. Additionally, all temple constructions required some aspect of water in the temple complex. Water was one of four elements needed for populations to live in harmony. Water was linked to the turtle, an animal that holds great symbolic importance in Vietnamese culture. The turtle not only represents longevity, but is also linked to the river systems and wet-rice cultivation.

Both kingdoms had complex systems of water management, and thus, were largely entangled with it, as it held economic, political, social, and spiritual significance. Both relied on water management for agricultural production to support the economy, to prevent flooding along river deltas, and to represent symbolic importance by having an element of water linked to temples. While the Dai Viets also used water management to reinforce centralized political hegemony, the Cham people were responsible for the maintenance of the systems within their individual polities. The entanglements of water management, then, although slightly different in relation to

![Figure 2.116. Minneriya tank, Polonnaruwa, Sri Lanka.](image)
the roles and responsibilities of the people to these systems, were nevertheless, as embedded within a centralized kingdom as it was in a kingdom of dispersed settlements.

The **Cholas**. Similarly, the overall scale of water management was also quite extensive in South India. The ability to store, regulate, and distribute water helped to transform the Chola Empire into one of the longest ruling dynasties. Temple hydraulics was quite complex and construction and maintenance required both time and labour. While temple hydraulics were concerned more with ritualistic activities and flood prevention, they did not exist in isolation from other types of water management, particularly that of irrigation. Irrigation was by far, the largest form of water management within the Chola Empire.

The heartland of the Chola Empire in Tamil Nadu was located in a fertile delta, where the right environmental conditions, coupled with the proper hydraulic technology, would produce a successful harvest, and if conditions were favourable, possibly more than one per season. Producing a successful yield was extremely important for two reasons. The first concerns temple maintenance. In order to maintain temples, Chola kings set up land endowments by setting aside lands from certain villages, and the revenue generated from successful yields would be used towards the maintenance of the temples. Temples also claimed uncultivated areas and turned them into farming communities based on irrigated rice cultivation (Heitzman 1987b:815). These types of villages, with land revenue going towards the temple reinforced legitimacy of the king, helped fund construction and military initiatives.

The second reason was that agriculture was the main form of subsistence in the Chola economy. Land revenue, taxes, and resources were all collected by kings to build more sophisticated irrigation works and repair damaged ones. While many people made donations with either paddy land or cash for tank maintenance, securing payment of taxes was still important and needed for continued maintenance (Heitzman 1987b:806). Most communities had a tank committee for overseeing and ensuring regular tank maintenance (Rajan and Saha 2014:89). It was important that channels connected to tanks did not silt up causing unwanted damage and inhibiting water flow. At times, taxes specifically for maintenance of tanks could be imposed in addition to various irrigation taxes (Rajan and Saha 2014: 90).

Peasants were responsible for ensuring their fields were irrigated by obtaining water through either perennial rivers or reservoirs (Frasch 2011:5-6). Retrieving water from perennial rivers was an easier task as the works necessary for diverting water, such as embankments, posts, planks, and weirs could be easily constructed with little knowledge of hydraulics (Frasch 2011:5-6). The method of obtaining water from a reservoir is much more difficult. It requires a substantial workforce, which would need to be instructed and coordinated, as well as sophisticated hydro-technical devices such as culverts and spillways. These types of irrigation systems would need to be constructed by experts in hydraulic engineering.

The spread of tank based irrigation and other forms of sophisticated water management also had an impact on social and political dimensions. New groups of artisans, capable of constructing a sluice gate – a revolutionary piece of hydraulic technology developed in Sri Lanka – rose socially and politically, and were at times even mentioned by name, a privilege reserved only for the royal family (Frasch 2011:13). They also received special rewards and payments. Based on these factors, it can be seen that water management played a large role in the Chola Empire, and was thus extremely entangled, on both large-and-small scales, in ensuring the Chola controlled a thriving empire.

The **Sinhalese**. Although the island of Sri Lanka, and particularly, the areas of Anuradhapura and Polonnaruwa cover a smaller area than the previous two samples, water management in
ancient Sri Lanka is unlike anywhere else and encompasses every facet of life from religious, social, economic, and political. As a result of environmental conditions, water management was particularly important and included features such as reservoirs (tanks), wells, ponds, canals, dams, bunds, and sluices. The main source of water collection was by man-made tanks, which were used primarily for irrigation. This was extremely important, seeing as the economy was largely based on wet rice cultivation (Geekiyange and Pushpakumara 2013:93).

Tank construction was a specialized job, calling on those with specialized skills and knowledge (Leach 1959:8). While ordinary villagers did repair work on village tanks, specialized caste groups, who worked on contract and who were not associated with the state, undertook major repairs. While no evidence shows central state authority being mandatory in village tank management, few inscriptions reference monarchs who received praise for repairing village tanks. At first, many village tanks were unconnected to larger ones, but eventually, smaller ones were connected to larger ones through sophisticated channels.

Sri Lanka demonstrated a dispersed settlement pattern with large constructions at the administrative capital and residential clusters scattered throughout the landscape (Fletcher 2012:296). Water management within the dispersed villages was more autonomous, as it depended on the immediate tank system, not water channeled from the capitals. In contrast, the large tanks in the capitals would require a certain amount of state control to organize labour for construction. Repair was also expensive and flood damage and siltation would require regular maintenance. These large reservoirs had a hydraulic bureaucracy, which outlined the roles and tasks of individuals. Elites in the capital also maintained control over resources for sustaining populations, which established a degree of articulation between the villages and the state (Leach 1959: 10).

Ideology reinforced labour and resources at the center (Scarborough 2003:137). The major reservoirs in the capital symbolized elite power and conspicuous consumption (Scarborough 2003:134-135). The greatness of kings was not judged by military exploits or the building of cities, but by the size of their water works (Scarborough 2003:137-138). It is evident that ancient Sri Lanka was extremely entangled with water management. Not only were there over 30,000 tanks in a land area of about 40,000 km² (Geekiyange and Pushpakumara 2013:94), but also practically every aspect of Sinhalese life was embedded some way with hydraulics. Entanglement is seen on both small and large scales of water management, where individual villagers and farmers who used and maintained these systems were just as entangled as the hydraulic engineers and kings who commissioned and designed them.

The Adaptive Cycle and Resilience

When looking at the adaptive cycle and exploring the role of change to see how a society rises, endures and collapses, particular aspects, such as potential, connectedness, and resilience are important in understanding how a society responds to disturbances. As well, the society will also be evaluated based on a continua of variation.

The Dai Viet Kingdom. The Dai Viet represents a more consistent trajectory in relation to how a kingdom would prosper and decline. The Dai Viet Kingdom roughly dates from 1009-1400 CE. The ancestors of the Dai Viets grew wet rice, cast bronze iron, and supported networks of chiefdoms (Lieberman 2003:352). Heavily influenced by centuries of Chinese administration, the kingdom under the Ly Dynasty, from 1010-1225 CE, faced some difficulty in creating a strong foundational base (Lieberman 2003:352). While public works projects began during the
Ly Dynasty, with the building of roads, dykes and canals, further investigations reveal that no unified hydraulic system existed (Lieberman 2003:355-356; Schweyer 2011:31). The Ly era is representative of the transition from the r to the K phase in the adaptive cycle, where resources are being accumulated. The system at this point is high in potential and resilience, but low in connectedness. The system is flexible, diverse, and open to innovation.

The shift into the Tran Dynasty completes the transition into the K phase. The early Tran regime set out to improve tax collection, military draft, and river diking (Lieberman 2003:360). The taming of the environment, through laborious construction, drainage and irrigation works, although more taxing, was potentially more rewarding as it guaranteed rice harvests (Lieberman 2003:362). Large-scale engineering allowed for rapid expansion and population growth (Lieberman 2003:363). The Tran Dynasty began to centrally coordinate river control and took to enlarging and maintaining dikes within a unified hydraulic system for water distribution and flood prevention (Lieberman 2003:364). This contrasts with the Ly Dynasty, where dike construction and repair depended on local initiatives. The Tran government named a director-general to oversee water works and ordered military officials in each province to construct canals and dikes for agricultural production. The Tran also built dikes along the coast to protect against the tides. At this point, the Tran Dynasty is exhibiting higher connectedness, and lower potential and resilience. This is because the system is becoming more rigid, uniform and less open to innovation, and more dependent on conformity. These water management systems were now heavily entangled in all dimensions of society, including the political, social, economic, and spiritual.

The collapse of the Dai Viet Kingdom and the trigger from the K phase to the Ω phase can be attributed to several factors, such as climate change, dependence on hydraulic systems, external conflict, resource exhaustion, and so on. While all these factors certainly played a role, the focus remains primarily on water management. As seen by evidence of large hydraulic systems, the role of water management was important to the prosperity of the state, thus, it is argued that depleting available resources (Lieberman 2003:367-386), which would be fundamental to building new or repairing old systems, was instrumental in making the Dai Viets more vulnerable, and this vulnerability coupled with the aforementioned factors would have ultimately led to its collapse. At this critical point, resilience is too low and the society cannot absorb any more shocks or disturbances and continue to remain functioning.

**The Cham Kingdoms.** The Cham Kingdoms present a different trajectory of growth and decline. The three capitals were independent polities who all rose and fell at different points within the Charter Era. From the 5th to the 8th century CE the areas surrounding Tra Kieu constituted the political and economic center for the region. Its connection to the ancient town of Hoi An and the Thu Bon River made it an important trade route. From the 8th to the 10th century CE, Indrapura rose in power, but it was centered in an area of early contestation and witnessed many attacks (Lieberman 2003:349). From the 10th to the 14th century CE, Vijaya became an important coastal power with areas of intensive agriculture.

Wet rice agriculture was very productive in the Cham alluvial plain and plateau, and it was much more important to the overall economy before the 6th century CE (Lieberman 2003:349). Cham agriculture, however, could only sustain a small population, which prompted further development of trade routes in the 5th century CE. Cham cultural ties within the political economy, thus, depended more on trade than wet-rice agriculture (Lieberman 2003:351). Even though the political economy favoured trade, and there was no centralized hydraulic works, Cham hydraulics were still quite impressive. While little physical evidence remains, the site of
Tra Kieu was set amidst irrigated rice fields (Sox 1972:83). Reservoirs and tanks were common and could be found within all Cham settlements and temple complexes (Sox 1972:84). A special function of tanks was their association with temples, as they provided water for rituals and may have also supplied water to nearby crops. The largest tank was at Indrapura, which encompassed five hectares and was surrounded by a wall. The capital of Vijaya also featured many barrages (diversion dams).

The succession of polities, each with its own system of hydraulics proves difficult in pinning down particular transitions of the adaptive cycle within these societies. The inability to sustain a growing population while competing against emerging capitals certainly played a role towards decline. It is, however, contended that these polities were extremely entangled with water management systems, especially as each Cham settlement and temple complex had some aspect of water management. The use of agricultural surplus to support networked temples also reinforces the importance of these systems. The r phase would represent the collection of accumulated resources to build these temples and systems, while transition from the r phase to the K phase would indicate greater connectedness and dependence on associated water management systems to irrigate fields and provide a surplus for continued functioning of networked temples. The inability to sustain growing populations, contend with internal and external conflict, in addition to diminishing resources to repair water management systems would eventually lead to vulnerabilities which could consequently lead to collapse.

**The Chola Empire.** The trajectory in pinning down particular transitions from the rise to the collapse of the Chola Empire is possible due to the numerous sources that track the reigns of sequential kings. The Chola Empire was in the r phase trying to transition into the K phase for quite a long time, beginning in the 3rd century BCE. However, the Chola of this time were unable to acquire significant power because of their dominant neighbours, the Pandyas in the South and the Pallavas in the north (Frasch 2011:1). During this time the Chola Empire was high in potential and resilience but low in connectedness. This is because the early states were still very flexible with respect to changing circumstances, open to new ideas, and in the process of accumulating resources and capital. Water management at this time would have consisted of simple devices, such as earthen constructions and check dams made to help with natural drainage (Bauer and Morrison 2008:3). These systems would not have been able to support large-scale agriculture.

It was not until the 9th century CE, when the Cholas emerged as the dominant force with the region, that the transition from the r to the K phase became complete. This transition sees a change in potential, resilience, and connectedness. Resources and capital get tied up in building initiatives, such as temples and more sophisticated irrigation projects, causing potential to lower. The system also become much more rigid, as certain regulations and policies came into effect. New ideas that challenge old ones were less welcomed and connectivity increased as more things started to become dependent on each other, lowering resilience and increasing connectedness.

Thanjavur thrived as a capital and agricultural hub during the reign of Rajaraja I. Inscriptions recount his diligence in ensuring regular maintenance of temples and irrigation works. Large-scale agriculture developed as more sophisticated hydraulic features were implemented. Construction of large reservoirs, sluices, and irrigation canals, combined with alterations and repairs to existing dams allowed the people and economy of Thanjavur to flourish. Although Thanjavur lost importance to the Cholas after Rajaraja I died, and the capital was moved to Gangaikonda Cholapuram by Rajendra I, Thanjavur continued to prosper under the Nayaka and Maratha rulers.
The Chola Empire also continued to thrive in Gangaikonda Cholapuram until around 1146 CE, during the reign of Rajaraja II. Sophisticated water management features in irrigation and temple hydraulics not only created a strong religious presence that reinforced political hegemony but also led to a thriving economy that was deeply entangled with managed water. During the reign of Rajaraja II the Chola Empire began to weaken, with political unrest and warfare. Resources and capital put towards military campaigns took away from those normally allocated for the maintenance and repair of hydraulic systems. The end of the Chola Empire came during the reign of Rajendra III in 1279 CE, at which time connectedness was too high, and potential and resilience too low. The system was far too regulated and interconnected by this time, and far too weak to absorb disturbances.

What led to the collapse of the Chola Empire? Its fall cannot be explained by one causal factor. The shift from the K phase to the Ω phase can be attributed to many different things, including but not limited to the Pandyan invasion, political unrest, a weakening economic base exacerbated by deteriorating hydraulic systems, environmental change, and even possible natural disasters. That being said, because the Chola Empire was extremely entangled with water management, it undoubtedly played a large role in weakening the state’s economy once systems were no longer being maintained. Whether building initiatives and repair work stopped because revenue was limited or being directed elsewhere, malfunctioning systems coupled with other mitigating factors ultimately led to a less resilient state which could have potentially led to its collapse.

The Sinhalese Empire. The Sinhalese Empire consisted of two kingdoms: Anuradhapura and Polonnaruwa. King Pandukabhaya established the city of Anuradhapura as the capital in 377 BCE (Dharmadasa 1991:88). Prior to this, the Anuradhapura region consisted of small villages. During the reign of King Pandukabhaya until the reign of Duthagamani, the Sinhalese Empire was in the r to the K phase, where resources and capital were being accumulated and things were still relatively flexible and open to change. Even at this early time, irrigation tanks were already being built. However, it was not until Duthagamani came into power that the whole country was united under Anuradhapura.

The kingdom of Anuradhapura flourished during this time up until its decline, but it was often plagued with problems, from rulers being unable to keep the country united to fighting off invasions. As the economy was mainly based on agriculture, an ongoing priority was to put resources and capital towards irrigation projects. The construction of larger-scale tanks was initiated during the reign of King Vasabha (65-109 CE), and by 500 CE advanced hydraulic systems were already in place (Jayawardana 2010:128). Hydraulic building initiatives included large tanks, dams, canals, sluices and bunds. Of the many kings, Vasabha, Mahasena, and Dhatusena were the most dedicated towards building irrigation systems. This time is representative of the K phase where resources and capital are getting tied up, and more aspects of the society are becoming connected and dependent on each other. Potential and resilience are low while connectedness was high.

Although Anuradhapura faced a series of invasions throughout its history, which would not only weaken the kingdom by forcing resources and capital to be relocated towards other endeavours – such as military and aid relief – it was not until the Chola King Rajaraja I invaded Sri Lanka that Anuradhapura entered its final decline (Frasch 2011:15). Following this invasion, two successful military campaigns were launched by Rajaraja’s son Rajendra I, who pushed Anuradhapura out of the K phase into and the Ω phase, as resilience was much too low at this
point to absorb perturbations. Afterwards, the Kingdom of Anuradhapura became a part of the Chola Empire.

This, however, was not the end of the Sinhalese Empire. Once the city of Anuradhapura was lost, Sinhalese rulers established a new capital in Polonnaruwa. Prior to this, Polonnaruwa had already attracted royals and commoners alike, possibly because it was located in a safer place than Anuradhapura. This period encapsulates a reorganization (alpha phase) and new shift from an r to K phase within the adaptive cycle. The transition to the K phase came with the emergence of Polonnaruwa as the new capital, which brought changes in its political, economic, social, and religious realms. The Polonnaruwa period, which lasted for over two centuries, had 16 rulers and was marked by excellence in the areas of royal architecture, including palaces, summer resorts, council chambers, queens’ chambers, pavilions, and bathing ponds. Polonnaruwa also witnessed a revival of large irrigation systems and sophisticated hydraulic features. Parakramabatu I emerged as the greatest ruler of his time, bringing achievements in agriculture, irrigation and cultural activities. The time of his reign is said to be one of the greatest periods in Sri Lankan history.

Following this, Polonnaruwa saw a succession of weak rulers. The inability to keep the country united, an increase in the Tamil population, and intrusions in political power created many vulnerabilities. Polonnaruwa would not be able to recover from its weakened state, causing the city to be abandoned in the 14th century CE. It is difficult to say exactly what role water management played in the transition from the K phase to the Ω phase. If the state was in decline, what type of situation would be substantial enough for people to abandon the city? Change in environmental conditions, natural disasters, invasions, and a weakening economy combined with malfunctioning hydraulic systems could all be considerations. Whatever the reason, it is likely that water management played a role. A state already in decline will suffer both politically and economically. A weak ruler may not be able to provide the resources necessary to keep the state running. Failing to ensure proper maintenance of systems could potentially damage the economy, creating vulnerabilities in the state.

While inefficient water management systems would not single handedly lead to the collapse of the state, the effects this would have within social, political, economic and religious dimensions would be substantial and could potentially lead to a situation where resilience is too low to absorb perturbations.

Summary

In considering the role of water management, and whether or not it made kingdoms in these early states of South and Southeast Asia more or less resilient, it is the position of this author that, based on the findings that water management was significant to the prosperity of these kingdoms, any diminishment in management capacity would have created vulnerabilities, which when coupled with other contributing factors could have led to socio-ecological collapse. The impact of these water management systems was complex in that they affected the political, economic, social, and spiritual functions of the society. When all variables are considered, it is revealed that these kingdoms overextended themselves and could not remain functioning once certain thresholds and or boundaries were crossed.

CONCLUSIONS
Importance of On-Site Visits

There are several strengths and weaknesses within the research sample, which made the on-site visits imperative to the topic of study. The published data on water management in Vietnam during the charter era is limited. Most sources focus on temples, and even in discussing the different parts within temple complexes, water management features are very rarely mentioned. Previous research gave no indication of water features at many of the sites mentioned in this report. It was only from visiting them that the extent of water management was seen in relation to its association with temples and its overall significance to the community. In contrast, external conflict in Vietnamese history has unfortunately destroyed a lot of historical water management features. Data collection is, thus, not equal in terms of physical evidence amongst the two kingdoms in question. Many more features are still in existence in the Dai Viet area than in the Cham regions. Nonetheless, even without data sets or particular pieces of physical evidence, visiting these sites was extremely important in regards to understanding the general layout of these kingdoms in order to determine where previous systems may have been situated, and for recognizing that even thousands of years later, a lot of the same features and elements that existed back then can still be seen.

On-site visits were also extremely important in South India and Sri Lanka. While there is a great deal of published data on water management for both the Cholas and Sinhalese periods, there are many hydraulic features that are generally ignored in the literature. The temples of South India are impressive, especially in regards to their hydraulic features. The majority of temples did not allow photos to be taken within the interior and inner sanctums. The only way to see and understand how extensive these drainage systems are by visiting these sites. Another important aspect is the actual placement of tanks. Understanding not only how cities are oriented but also where certain features are located will help us to understand a wider variety of considerations such as settlement and agricultural patterns.

Sri Lanka has a very rich history in hydraulic innovation and development. Proper understanding of how large-scale and embedded these systems are within societies can only truly be understood by visiting these sites. While many of these large features are widely discussed, many of the smaller ones, although briefly mentioned, are not given much consideration. Simply put, the quantity of the smaller hydraulic features is quite impressive in comparison to the large ones. Both small and large tanks fill the majority of the landscape, reinforcing not only the skill and expertise involved, but also the overall importance and value water had and still has for the Sinhalese people.

Entanglement and Resilience

The aim of this report was to determine whether water management systems were important to the prosperity of the ancient states of Vietnam, South India, and Sri Lanka. It has been argued that water management played a significant role in the overall functioning of these kingdoms. Not only was water management integral for the development of wet-rice cultivation, but also critical in flood prevention, to reinforce political hegemony, to support ritual worship, and as a symbol for harmonious living amongst the people. As water management was entangled in all aspects of society, contributing factors that led to a lack of maintenance, such as climate change, external conflict, and resource depletion, significantly weakened the ability of these system’s to properly function, and hindered society’s ability to use them as intended. The amalgamation of
these factors, which created increasing vulnerability and lowered resilience, may have ultimately contributed to their collapse.

**Importance of Research**

In looking at socio-ecological systems, and particularly how water management affects them, it is the hope that this research will help to inform future generations as to how to achieve greater sustainability by looking to the past. Learning about water management practices from the past will not only help to contextualize how past societies dealt with similar problems, but it will also help equip present populations with information on how to deal with these issues as they arise.

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CHAPTER 3
AGRICULTURAL STRATEGIES AMONGST THE CHARTER STATES OF THE CHAM AND DAI VIET: A STUDY OF THE ADAPTIVE CYCLE AND SPATIAL RESILIENCE

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This chapter is focused on the agricultural strategies and intensification exhibited by the Southeast Asian charter states of the ancient Cham (380-1471 A.D.) and Dai Viet (1009-1400 A.D.) of Central and Northern Vietnam, respectively. The goal is to address the role of specific agricultural strategies within the socio-ecological systems created by these charter states. To accomplish this, each state needs to be assessed in terms of its environment, crops, production techniques, as well as production enclaves and overall agricultural strategy. To assess the changing relationships within the socio-ecological systems of these states and their agricultural strategies, the methodological approach of the adaptive cycle will be utilized. Special attention will be paid to the resiliency and vulnerabilities in the agricultural strategies through the use of spatial resiliency theory (Cumming 2011). To conclude this chapter current literature, specifically Bronson’s (1977) Riverine System Exchange model, will be assessed using the framework provided by the adaptive cycle and resilience theory.

To understand socio-ecological systems requires an interdisciplinary method that includes the multitude of variables necessary to evaluate the interconnectivity of both natural and social variables. The adaptive cycle is particularly beneficial because of its ability to model multiple variables over time in order to elucidate the resilience, entanglement, and vulnerabilities associated with these systems. It is thus essential to take a holistic and multiscaler approach to understanding the dynamic and specific nature of past agricultural strategies. In many cases, especially within the tropics, both past and present societies were/are confronted by the same variables, limitations, and advantages. Thus, by exploring the past, we can also better understand ourselves, and our present surroundings. In terms of past and present agricultural strategies, we can identify key socio-ecological entanglements, and nowhere is this more apparent than in tropical societies as a whole, especially within Southeast Asia. By exploring the past we can learn about the processes that shaped these societies and directed their future. Further, we can explore the similarities and differences in socio-ecological relationships compared to the present, and examine the ways that present circumstances developed put of past entanglements.

Similar to the tactic utilized in a previous SETs report (Macrae 2014), two methodological approaches are utilized in this study; Discourse and Research Assessment, and Contextualization and Reassessment. The former is achieved through extensive literature review, evaluation of relevant datasets, and the assessment of current theoretical paradigms. The latter involves visiting past and present state capitals and their environs to examine, first hand, field systems and the agricultural practices associated with these. The goal is to not only contextualize the research on past practices, but to reassess the literature from a comparative perspective using a broad, cross-temporal understanding of socio-ecological systems in the tropics. Fieldwork was conducted throughout northern and central Vietnam over a total of 18 days in December, 2014. At that time the SETS team visited key archaeological sites and museums, and assessed the surrounding agricultural field systems.
BACKGROUND

Environment

The environment that the Cham (Central Vietnam) and Dai Viet (Northern Vietnam) occupied has traditionally been broken into several different sub-regions, with varying degrees of success (Hall 2011:77). However, for the purposes of this chapter the environment of Vietnam will be broken in to three regions: Northern, Central, and Southern. The Northern region is composed of large mountain ranges on the West and North. Central to this region is the Red River (Song Hong) and its delta (Nuttonson 1963:117). The Red River delta is extremely important for both past and contemporary rice production. It flows from the mountains of the southern Yunnan Province in China to the Gulf of Bac Bo, draining an area of approximately 116,000 km² (Li et al. 2006:5; Masanari 2005:99; Tanabe et al. 2006:31). A high degree of silting occurs along both the Red river and its tributaries, making this area one of the most fertile regions in Vietnam (Li et al. 2006:5; Nuttonson 1963:117). The Red River delta is the fourth largest delta in Southeast Asia, at 15,000 km², and is only surpassed by the Mekong (Southern Vietnam), Irrawaddy (Myanmar), and Chao Phraya (Thailand) deltas (Masanari 2005:99; Tanabe et al. 2006:31). The delta has been divided into three zones based on surface topography and hydraulic processes; wave-, tide-, and fluvial-dominated zones (Li et al. 2006:6; Tanabe et al. 2006:32). In contrast, the Central region is composed primarily of high mountains in the West, which fall into small coastal plains in the East. Within these coastal plains there are small patches of fertile soils found along the river deltas, especially in the southern portion (Nuttonson 1963:117). This region is dominated by a series of river valleys running west to east, each separated by hilly and mountainous ridge lines. Finally, the Southern region is primarily composed of the broad plains of the Mekong river delta, an area known for its fertile rice production. The plains and delta cover an area of approximately 63,973 km² (Nuttonson 1963:118).

Figure 3.1. Flooded field system near Quy Nhon, Binh Dinh Province of central Vietnam.

The Climate in Vietnam is characterized as tropical monsoon, with moist subtropics in the southern lowlands and temperate tropics in the northern highlands (Li et al. 2006:6; Nuttonson 1963:19). Typically, there are high temperatures in the summer with ample rainfall. However,
the annual rainfall is known to have periods of fluctuation which can prove disastrous for farming activities (Nuttonson 1963:19). There are significant changes in climatic conditions between the three regions, with higher annual precipitation in the south (204 cm) compared to the north (174 cm), with 85% falling during the rainy season; the central region exhibits an extended rainy season due to the prevalence of typhoons (Nuttonson 1963:20). In the north, rain falls over an extended period, including a certain amount of winter rain. Pollen analysis has suggested that a series of climatic fluctuates were common across the study area, shifting from warmer to cooler and wetter to dryer. The time period that we are interested in, 380-1471 A.D., begins as a cooler wet period, then slowly changes to a warmer, drier climate with a documented drought occurring around 1247 A.D., followed by a dry, cooling period (Li et al. 2006:20-21).

Agricultural Production

Both the Cham and Dai Viet produced a series of different crops that were relevant to subsistence, famine, and prestige. Clearly rice, both wet and dry varieties, played an important role in subsistence. Particularly important to note is the variety of rice referred to as Cham rice, a floating variety of rice grown in up to several meters of water, that was known as relatively drought tolerant and early ripening; it is sometimes referred to as hundred-day rice. This rice was introduced from Champa to the Dai Viet and southern Chinese province of Fujian by the 11th to 12th century A.D. (Mabbett 1986:293; Whitmore 1986:123, 130). A series of archaeological, historical, and ethnohistorical studies have produced a list of other important crops grown in the study region (Li et al. 2006:8; Sox 1972:42, 46, 62, 76-77, 80; Wade 2011:142). Dry and wet crops of grains, tubers, and vegetables included millet, sugarcane, sweet potato, taro (wet and dry), sesame, eggplants, cucumbers, beans, peas, mustard greens, yam, and various ground nuts. Tree crops and fruits included, mangos, melons, oranges, lotus, jackfruit, bananas, longans, lychees, plums, areca, cassia, tea, cinnamon, palm (betel nut), coconuts, kapok, mulberry bushes (for silkworms), and various species of bamboo.

Figure 3.2. Crop diversity in market near Hoi An, Quang Nam Province of Central Vietnam.
Production Systems

The Cham and Dai Viet societies were not limited to a singular agricultural production system. Sox (1972) has best describes as an adaptive strategy that included a mix of wet and dry land cultivation, as well as gardens and orchards.

The single most used production technique by the Cham and Dai Viet was wet cultivation (Sox 1972:62). Wet cultivation can be practiced in bunded fields or floodplain agriculture (van Liere 1980; Wolters 2007). To explore these practices in further detail refer to SETS volume 1 (see Macrae 2014:60-61). A formal bunded field (padi) uses less land then dry-land cultivation, but it does require more water and a higher degree of labor investment and overall management (Mudar 1995:6; van Liere 1980:272). This requires the construction of interconnected bunded fields that distribute water between individual fields and systems (Figure 3.3).

Figure 3.3. Formal bunded field near Thap Canh Tien, Binh Dinh Province of central Vietnam.

Today, floodplain agriculture occurs along the sides of large rivers bounded by floodplains that can extend ten to twenty kilometers away (Figure 3.4). As in the past, during the rainy season the river expands and floods the surrounding plains until the dry season, when waters recede and the area returns to drought conditions (Wolters 2007:216, 227). Traditionally, these are difficult areas to manage due to the seasonally vast and fast moving water (van Liere 1980:265). Planting can occur within the receding flood waters (flood recession), or through the use of more sophisticated systems of dikes, bunds, reservoirs, or natural depressions designed to retard, spread, or capture the flood waters (Davivongs 2003:3; van Liere 1980:269, 271; Wolters 2007:216).
Dry-land cultivation can be practiced in several manners, including shifting horticulture or more expansive forms of swidden agriculture (Sox 1972:79). These areas were used for the production of staples such as dry rice and taro as well as millet, yam, a variety of vegetables, fruits, trees, and nuts (Sox 1972:62, 80). However, crops produced in dry-land cultivation are often only viewed as supplemental (Sox 1972:79). The decision to use dry-land production has been justified in several ways (Sox 1972:62, 79-80). First, it was the result of an expansion into lands where the local topographic or environmental circumstances made irrigation unfeasible. Second, it was used in areas with low populations that both demanded less food and lacked the labor or technology necessary to construct and manage irrigated fields. Third, it reflects the colonization of more marginal lands not immediately conducive to wet-land agriculture, and thus represents an initial stop-gap production method employed during the time leading up to the creation of the required irrigation infrastructure. Fourth, it was utilized as a security measure where farmers needed to ensure yields when insufficient annual precipitation was a possibility (Weber et al. 2010:82). Finally, it was part of an adaptive strategy designed to maximize production across the landscape using all the ecological niches.

Figure 3.4. Flood Plain Agriculture near My Son, Quang Nam Province of Central Vietnam.

Figure 3.5. Dry-land cultivation near Chua But Thap, Bac Ninh Province of northern Vietnam.
The intensive gardens of the Cham and Dai Viet are likely similar to those found across Southeast Asia. These can be found in enclosures near a household that contains a mixture of arboriculture, bushes, vines, vegetable, and root crops (O’Connor 1995:970; Sox 1972:77). Due to the proximity to the household these gardens can be easily accessed for sowing and reaping, providing a certain level of labor is available, a necessary requirement to successfully grow plants that are more delicate. These gardens are typically worked with hoe and irrigated through furrows and hand watering (Sox 1972:77). The diversity of garden crops requires a distribution of labor over time as different crops are planted and harvested at different intervals. The sizes of these gardens can vary from smaller household gardens to larger mixed, although less diverse orchards (Sox 1972:77). It has been argued that these practices could constitute as much as half of the household’s consumption, with surplus to be traded and sold (Davivongs 2003:2; Dove 1990). It has also been argued that this represents an early form of tropical cultivation which has often overshadowed by an emphasis on the study of both wet and dry land cultivation (Dove 1990:150; Hutterer 1983:187). There are a number of other techniques that have been discussed in terms of Cham and Dai Viet agricultural production. One of these includes dung fertilization, which is used amongst contemporary Cham in dry and wet fields, as well as household gardens. If used in ancient Champa fields it would suggest potential increases in the intensity of production and longevity of field use (Sox 1972:77).

Figure 3.6. Household garden near Thap Canh Tien, Binh Dinh Province of central Vietnam.

Agricultural Strategies and Production Enclaves

*The Chams.* The Champa region stretches from the North, boarding the Red River delta, to the south, tapering off into the Mekong delta (Hall 2011:77-78). The Cham society occupied a
series of networked river valleys and their tributaries, separated by rugged mountains, that ran from the western highland and mountains, known as the Central Highlands, to the coast (Hall 2011:74, 76, 78; Tran 2006:3). Where these river valleys meet the ocean there were a series of ports separated by thin coastal plains (Tran 2006:3). The natural divisions in the topography had a profound effect on the structure of Cham society and its broader settlement patterns, which influenced both the overall agricultural strategy and nature of production enclaves. The natural topography and knowledge of a series of different production techniques assists in understanding how Cham society developed a settlement pattern characterized by isolated, self-sufficient, river valley enclaves (Sox 1972:54).

The Cham charter states were never amalgamated into a single, centralized state, but rather persisted as a series of small kingdoms/polities that acted as trading ports, and which spanned the coastal region, resulting in a series of royal courts, each centered on a specific river valley (Glover et al. 1996:54; Hall 2011:64, 74; Lockhart 2011:23; Southworth 2011:104). This created a series of competing upstream river valley polities that were positioned to exploit the rich alluvial plains for agricultural production (Southworth 2011:113). Early epigraphy tells us that these river plain centers were important production enclaves for the Cham; today, they are still major producers of rice (Hall 2011:74; Southworth 2011:113). While these centers exhibited weak institutional linkages, they were united by common cultural and religious values (Hall 2011:83).

The Cham kingdoms, first emerging around 380 A.D., have been linked to the remains of the Sa Huynh cultural complex found scattered along the Vietnamese coast (Chapuis 1995:40; Glover et al. 1996; Lockhart 2011:26-27). The processes leading to the transition into the Cham is still a matter of debate. However, there is an increasing amount of evidence for a long continuation of cultural traditions stretching back to the Neolithic (Glover 2008:27). Despite the controversy concerning the formation of the Cham kingdoms, it is now clear, as indicated previously, that it Cham society persisted as a series of small kingdoms focused on the range of river valleys. Cham centers played two important roles (Hall 2011:67, 76-77). First, they were integral to the production of rice for both subsistence, and to outfit international traders who were using the coastal ports for resupply. Second, they provided important linkages between the highlands, where exotic goods and raw materials were traded to the coast for export. In the west of Vietnam were a series of highland tribes, some of which were related to the Chams. The highlands were important for providing forest products, and unique items for international trade, as well as serving as a place of refuge (Hall 2011:78; Lockhart 2011:30).

The river valley production enclaves provided a sharp contrast from the aridity of the narrow coastal plains, which were composed of sterile soils and sand dunes (Southworth 2011:113). These coastal plains were made cultivable in several areas, but most coastal centers subsisted primarily on trade from China that extended into the islands of Southeast Asia, and even further afield (Glover and Dung 2011:54). The organization of the Cham society is more reminiscent of that commonly found amongst the islands of Southeast Asia, rather than the other mainland centers (Hall 2011:100). It is important to note that this loose political structure and subsequent production enclaves did not stay in this state throughout the Cham occupation. Starting in the 10th century, and firmly in place by the 12th century, was a style of Cham kingship that fostered more interconnected and stable systems (Hall 2011:75-76, 84; Whitmore 2011:178). This resulted in a more centralized kingship system based on religious and political institution, which brought many of the local leaders and their less powerful kingdoms under the umbrella of a somewhat tenuous, hegemonic overlordship (Hall 2011:74; Whitmore 2011:178-182).
In terms of agriculture, the river valley enclaves most likely utilized a series of different production techniques (Figure 3.7). These included a blend of wet and dry fields, using mixed rotations and varying fallow periods, and relatively continuous use of both irrigated and unirrigated fields (Sox 1972:79). Unirrigated fields could be found along elevated areas above water sources, higher than the padi fields located along the valley sides and alluvial plains (Sox 1972:79). It is suggested that padi fields were cultivated in a rotational sequence, using rice, millet, vegetable, or sugarcane. In this manner the padi field would be in production even when dry (Sox 1972:79).

Figure 3.7. River valley production enclave near Thap Banh It, Binh Dinh Province of central Vietnam.

The Dia Viet. As noted previously, the Dai Viet Charter State was situated within the Red River flood plains and delta of Northern Vietnam. The agricultural systems within the delta and flood plains took advantage of the alluvial sediment deposits, rivers, and enclosed lakes (Masanari 2005:99; Tanabe et al. 2006:30). During the 10th century the Dai Viet declared independence from Chinese rule through a series of revolts (Hall 2011:67, 78). Prior to this, and for a short period of time after, agricultural production in the Red River delta was based on small communal groups that utilized the natural floods to support local irrigation networks for dry season irrigation in order to create vast padi fields. After independence these irrigation networks expanded into elaborate systems to regulate monsoon waters, under the control of surrounding villages (Hall 2011:90; Masanari 2005:99). During the 10th and 11th centuries, the now independent kingdom began to expand both its agricultural fields and commercial goals. Of particular importance to this study was the drive to claim agriculturally rich lands and settlements along the southern border, where conflict with the Cham arose (Hall 2011:67, 78, 95, 97). The aggression with the Cham on the southern border had important implications not just for the expansion of Dai Viet agricultural lands, but also for the procurement of labor in the form of
slaves. The drive to secure a large workforce has been argued by many scholars to have been important for offsetting a labor deficiency in most Southeast Asian polities. This is amply demonstrated in 1040 A.D. when 5,000 Cham individuals were captured and assigned to settle an undeveloped and unpopulated area along the southern border of Dai Viet territory (Hall 2011:98). Following independence, such aggressive agricultural expansion allowed the Dai Viet state to introduce a more centralized form of political control, with the ruler placing himself as the highest officiant. This political structure was very different from that of the Cham. Within the Dai Viet culture, the ruler symbolically embodied the fertility of agricultural production, and they often assisting agricultural rites, and in the symbolic planting and harvesting of crops. Furthermore, a series of roads and temple construction projects were put in place to connect the capital to all its regions for communication and transportation, which also helped bring greater centralization to the state (Hall 2011:98).

Through the expansion into new agricultural lands and infrastructure investment, including both roads and irrigation networks, the Dai Viet created an extensive production enclave along the Red River and its delta (Figure 3.8). Compared to the Cham, this development is much more similar to that of the large wet-rice producing mainland states situated elsewhere in Southeast Asia, where the trade of surplus was more important than tax revenues (Hall 2011:98-99). The emphasis of Dai Viet agricultural production was on both wet and dry rice. There are 12th century Chinese reports that describe the production of early ripening drought resistant Cham rice as well as indigenous varieties (Hall 2011:90). Reports also suggest the production of at least two rice harvests per year, indicating not only the productivity of the production strategy, but also confirming the use of both wet and dry rice production (Masanari 2005:104-105).

Figure 3.8. Flood plain agriculture along the Red River Tributary near Duong River, Hanoi Province, northern Vietnam.
THE ADAPTIVE CYCLE

The adaptive cycle can be used in the study of agricultural strategies of the ancient Cham and Dai Viet societies with great success. The adaptive cycle “is a heuristic model, a fundamental unit that contributes to the understanding of the dynamics of complex systems from cells, to ecosystems, to societies, to cultures” (Holling 2001:393). The adaptive cycle is exemplified by four stages that the system flows through; exploitation (r), reorganization (K), release (Ω), and conservation (α). Both the individual stage and the transition between them are important for analysis. When addressing this model it is important to understand that it is a model, a single hypothesis that data can be examined through but not forced into. While both societies exhibit different agricultural strategies that change over time, their comparison using this model provides important insights into their agricultural resiliency.

As discussed in a previous SETs report, it is important to understand that pre-industrial tropical societies did not develop in isolation or without history, but rather represent a continuous developmental sequence marked by periods of growth, stability, and decline (see Macrae 2014:77-78). Remember that local population often remain in place while states change. Local populations continue the agricultural practices that preceding states are built on. This is incorporated in the adaptive cycle through the notion of panarchy, and the mechanisms of remember and revolt. Panarchy describes how socio-ecological systems are comprised of a series of interconnected adaptive cycles situated at different scales in a hierarchy (Cumming 2011:38). It is used to explain changes in scale, and the evolving adaptive and evolutionary nature of hierarchical systems (Holling et al. 2002:74). Revolt represents periods of critical change, for example the independence of the Dai Viet from the Chinese. Remember represents the continuity of accumulated resources and ideas across critical transitions; for example, the continued use of padi field production despite changes in the overarching state.

This analysis is primarily interested in the hierarchal level of state organization and its involvement in agricultural production, although references to a more local level issues will also be made. Further, the aforementioned mechanisms stress the importance and complexities of the historical relationships that accompany different variables, and the implications they have when incorporated into the adaptive cycle. In social-ecological systems and complex systems, historical dependencies of specific variables contribute to their non-linearity and unpredictable nature (Berkes and Folke 1998:12; Costanza et al. 1993:546; Holling et al. 1998:352; Levin 1999-431). When addressing the entanglement between variables found within these systems, understanding such historical relationships is imperative to learning how dependencies may have developed, and how these will change between variables (Hodder 2012). It is through such understandings that archaeology truly provides important contributions to understanding different socio-ecological systems.

The Chams

With the somewhat illusive start of Cham kingdoms (380 A.D.) comes the targeted exploitation of the river valleys to create production enclaves. This is not to say, however, that they were not in use previously. It can be argued that at this point in time the agricultural strategy of the Cham was developing through r-Phase (exploitation) of the adaptive cycle. Initially, this is a period of great diversity, exhibiting innovations and restructuring of relationships (Holling and Gunderson 2002:35, 45-46). The Cham agricultural strategy of this period is characterized by the
expansion into the river valleys, creating high resilience through the exploration and utilization of a diverse suite of production techniques previously known to the local populations (Figure 3.9). Thus, this is a period with little connection between the production enclaves, while through expansion they are increasing production capacity. The r-Phase is a period defined by a rapid expansion and investment in a diverse agricultural strategy. This period eventually witnesses the establishment of several production enclaves, and we see the fluctuating importance of the role that different Cham ports played in supplying international trade vessels. During this period there is increasing connections between the production enclaves, as seen in the Chinese misrepresentation of the Cham as a single kingdom. Overtime, the agricultural strategy shows higher production and resilience as diverse agricultural strategies are employed in more areas.

The r-Phase can be argued to continue into the 10th century when there is a transition into the K-Phase that lasts several centuries. The latter period coincides with the adaptive strategy suggested by Sox (1972), and which was outlined above. Between the 10th and 12th centuries, Cham society begins to become more centralized (Hall 2011:75-76, 84; Whitmore 2011:178). The K-Phase (consolidation) is characterized by a switch from heterogeneity to homogeneity in the agricultural strategy through the increasing concentration on singular production technique, in this case wet-rice production (Holling and Gunderson 2002:32, 43). These changes create an agricultural strategy that is more rigid and less variable. Further, interconnections increase through expansion of the production enclaves. During this period, the Cham increase their investments in irrigation to produce larger padi fields, increasing their production capacity. There is also increased aggression along the northern border, on the part of both the Chams and Dai Viet, to capture both land and slaves for agricultural production, or as a response over population and poor weather (Hall 2011:243). Either way, this suggests a maximization of the river valley production potential. I would argue, however, that this did not represent the complete maximization of productive lands for the benefit of the local population, but rather it was aimed at meeting the state’s demand for rice production, which was used to encourage international trade. The Cham in all likelihood never reached the end of the K-Phase, at least with respect to their agricultural strategy, due to the 1471 A.D. invasion of the Dai Viet, which essentially ended the sovereignty of the Cham kingdoms. I would argue that the Cham agricultural strategy did not directly lead to this collapse, but it was definitely a contributing factor in that the expansive desire of the Cham state stimulated the hostilities that spurred the incursions by the Dai Viet.

Figure 3.9. Diversity of crop production, near Chua But Thap, Bac Ninh Province of northern Vietnam.
The Dai Viet

The Dai Viet kingdom achieved their independence from China in 1009 A.D. Prior to this the Red River delta was a production enclave controlled by the Chinese overlords. During this period, the agricultural production was based on small communal groups that utilized the natural floods to support local irrigation networks and create vast padi fields (Hall 2011:90; Masanari 2005:99). When considering this phase within the adaptive cycle it can be assigned to the early r-Phase, given the low connectivity between field systems and production enclaves, as well as the diversity in production techniques. With the independence of the Dai Viet, they enter the adaptive cycle at the transition between r-Phase to the K-Phase. At this time, there was a substantial change in the agricultural strategy. Establishment of the independent Dai Viet monarchy brought with it many changes. There was an expansion of field systems in the Red River and its delta, as well as along the southern border of the kingdom. This expansion stimulated the formation of more complex and larger irrigation systems that created vast padi fields. This increased the connection between field systems and production enclaves, and reduced the diversity of techniques and crops. These new field systems were further connected by an investment in roads. The Dai Viet kings also invested both politically and religiously in agriculture, specifically rice production. This drive to increase production came with the Dai Viet desire for international trade. This phase continued till 1471 A.D., and the invasion of the Cham, where our current interest ends.

Figure 3.10. Flood plain agriculture along the tributaries of the Red River near Chua Thay, Hanoi province of northern Vietnam.

Discussion

Comparison of the Dai Viet and Cham agricultural strategies, using principals from adaptive cycle theory, presents us with several clear similarities and differences. Exploring these can help illuminate both the resiliency and vulnerabilities found in both production strategies. First, it is clear that both societies enter the adaptive cycle at different points, experience different phases,
and stay in these phases for varying lengths of time. Even when existing in the same phase, their agricultural strategies present very different approaches. I feel that a comparison between the Cham and Dai Viet is best explored during the phase they both experience, the r-Phase and its transition to the K-Phase. In order to address the resilience of these agricultural strategies, and partially due to the availability of datasets and the collection of data from the SETS project, I will focus some discussion on the concept of spatial resilience.

RESILIENCY AND VULNERABILITY

Resilience is the capacity of a complex system to adjust to perturbations while maintaining its purpose and identity (Holling 1973; Redman et al. 2007; Walker and Salt 2006:76; 2012). In contrast, "vulnerability" can be described as the rigidity that develops within a system and the decision-making inertia that maintains this rigidity (Schoon et al. 2011). The resiliency of past agricultural strategies is revealed in the archaeological record by their ability to withstand and adapt to fluctuating variables, such as climate change, while sustaining their essential purpose and identity (Gunderson and Holling, eds. 2001; Holling 1973; Redman et al. 2007; Walker and Salt 2012). Spatial resilience, as put forward by Graeme Cumming (2011:4), refers to the “ways in which spatial variation – including such things as spatial location, context, connectivity, and dispersal – influences (and is influenced by) the resilience” of a socio-ecological system. This approach to resilience explores both internal and external elements of the socio-ecological system (Cumming 2011:21). The following analysis will explore spatial resilience through the analysis of small (internal) and larger (external) spatial scales. This provides important insights into agricultural strategies because the patterns and processes present in these different spatial scales can effectively increase or decrease the resiliency of a socio-ecological system (Cumming 2011:26).

Internal Elements

This small-scale of analysis addresses the agricultural strategies, specifically the production techniques, utilized by both the Cham and Dai Viet. Internal elements include spatial arrangement of system components and their interactions, and the spatial properties of the system itself (system size, shape, and boundaries; Cumming 2011:21). As discussed previously, both kingdoms practiced a series of different production techniques; padi, floodplain, dry-agriculture, and horticulture/swidden. This section will emphasize wet-field agriculture (padi and flood recession). Formal bunded fields are omnipresent throughout northern and central Vietnam. Field systems are composed of linked bunded fields that create the larger system. These fields are spatially arranged and interconnected in order to distribute water within the field system. Even though the fields are separated by the bunds, these are soft boundaries, as gaps between the walls can be opened to drain and fill individual fields. In order to accomplish this each field is set at a specific height so that water can flow effectively (Figure 3.11). Flood plain agriculture was also part of both the Cham and Dai Viet agricultural strategy, but it was much more prevalent amongst the Dai Viet. These field systems are very similar to the bunded fields in that bunds, dykes, and channels, as well as other irrigation and water management features, provided the ability to both disperse water between fields, and retain it after flood waters receded.
The internal elements of both these systems have important implications for the agricultural strategy and its resiliency. First, the use of these intensive practices facilitates a more effective water management scheme within the field systems. Water within the bunded fields can be used multiple times as it passes through the various fields in the system. In addition, water from rivers and annual floods can be distributed over a larger area than the flood plain itself through the use of these water management features. Second, the managed distribution of water facilitates a much longer period of production than afforded without intensive irrigation systems. As water is cycled through the system the dry padi facilitates a tightly managed production of multiple crops beyond wet-rice, including less drought resistant crops. Further, this water management plan facilitates the staggered production of rice within the field system (Figure 3.12). As several fields are drained to facilitate the harvest of rice, the fields that received the water can also be planted with seedlings.

**Figure 3.11.** Formal bunded field system with differential water distribution near Thap Nhan, Phu Yen province of central Vietnam

**Figure 3.12.** Formal bunded field system in different stages of wet-rice production near Thap Duong Long, Binh Dinh Province of central Vietnam.
The third implication is that the staggered nature of both the crops and production steps across the field systems allows for the highly effective distribution and use of labor. Each stage in rice production demands a different amount of labor, at a time when one field requires the highest amount of labor, another can be managed with only a minimal amount. In following this process throughout the field system, available labor can be maximized by rarely having a lull in the available labor. All of these implications have a beneficial effect for keeping the rice and wet agricultural strategy resilient.

External Elements

Any large-scale analysis must also address the external elements of the agricultural strategies developed by the Cham and Dai Viet, and assess them in light of the different environments that were utilized. External elements relevant to the resilience of these socio-ecological systems include both context (environment) and connectivity (aggregation, compartmentalization, and modularity; Cumming 2011:25). It is within these external elements that a clear differentiation between the agricultural strategies of the Dai Viet and Cham begin to appear.

Context refers to what surrounds the system. In terms of agricultural strategies, this refers to the natural environment and ecological niches that are exploited and/or created by farming practices (Cumming 2011:25). There is a clear difference between the smaller river valleys exploited by the Cham, and the Red River flood plain and delta exploited by the Dai Viet. On a larger scale, the Dai Viet utilized a relatively homogenous environment, focused on a singular drainage system and watershed. At the same broad scale, the Cham use several river valleys with unique ecological niches, independent drainages, and watersheds. These differences, amongst others, have important ramifications for the consideration of other external elements.

Spatial connectivity is explored in terms of compartmentalization, aggregation, and modularity. Compartmentalization refers to the subsystems in which there are stronger interactions amongst elements then in other systems outside of the compartment (Cumming 2011:16). In the agricultural strategy of the Cham and Dai Viet the field systems show compartmentalization. These systems are composed not only of the individual bunded fields but also the interconnectivity that combines these fields into a large system based on irrigation. This is referred to as aggregation; the “emergence of complex large-scale behaviors from the aggregate interactions of less complex or smaller-scale agents” (Cumming 2011:16). This can be visualized as the building blocks used to construct a complex system. These compartments can be considered the various production enclaves. As discussed previously, the production enclaves occurred in various sizes, from the relatively restricted nature of the Cham river valleys, to the larger Red River systems of the Dai Viet. Modularity refers to the “compartmentalization of the system in space, in time, or in organizational structure” (Levin and Lubchenco 2008:31). In terms of the agricultural strategies, this concept can be used to refer to the linkages between, and proximity of, different production enclaves (note that modularity normally refers to redundancies, and thus self-sufficiencies, in a system; with “connectivity” being a more common term for the spatial relationships discussed herein; see Iannone 2016). The Cham production enclaves are smaller, and are at a greater distance from each other, due to the environmental context described above. Linkages are therefore relatively weak (i.e., they exhibit poor connectivity). This is because, although access to production enclaves along a single river valley is easy, accessing enclaves in different valleys is more very difficult. The Dai Viet production
enclaves were larger and more tightly connected due to the focus on exploitation of the Red River and its delta. These enclaves were also tightly linked through the increasing investments in roads and infrastructure. Thus, the Cham agricultural strategy exhibits greater modularity than the Dai Viet.

Exploring the external elements (context, compartmentalization, aggregation, and modularity) on the larger spatial scale brings a dynamic aspect to understanding resiliency and vulnerabilities. The Cham exploited their diverse environment (context) which resulted in a lower production capacity but increased the diversity of production due to its ecological niches and changes in elevation. The Dai Viet had a greater production capacity due to the larger capacity of their agricultural systems, but it exhibited a reduced resilience due to the low diversity of context. This lack of diversity would have retarded the ability to effectively overcome fluctuations; a singular flood event or drought along the Red River would be detrimental to the entire system and most of its components. Such a situation therefore results in a comparatively less resilient system.

The compartmentalization and aggregation aspects of the field systems in question are exhibited in the expansion of the internal elements, which enhances resiliency. When exploring the resiliency that spatial modularity brings to the system, it can be viewed as a double edged sword; too much or too little modularity can reduce resiliency (Iannone 2016). The Cham exhibited resilient level of modularity in their agricultural system due to the lower level of connectivity compared to the Dai Viet. Modularity describes the degree of disassociation between the production enclaves. Higher modularity increases the resiliency by providing not only the benefits of diverse environment (context), but facilitates creates failsafe redundancies. If a problem occurs in one production enclaves, it may not to occur in them all. If one enclave fails, there are others to rely upon. Although, it must be noted that if a system is too modular, production enclaves may not be connected enough to effectively mitigate/compensate for environmental fluctuations and/or other perturbances. In summary, I suggest that the river valleys of the Cham were better able to compartmentalize disturbances while maintaining a degree of connection and linkage when compared to the Red River flood plain and delta of the Dai Viet.

REASSESSMENT OF CURRENT AND PAST MODELS

When this chapter was originally conceived the goal was to present the adaptive cycle and insights provided by spatial resilience as an alternative approach to the Riverine System Exchange (RES) model (Bronson 1977). The goal was going to be to assess whether the RES model was more or less accurate. However, through the analysis and writing of this chapter this idea has been abandoned in the realization that both models address very different questions.

Bronson (1977) proposed a model to describe the functions of trade and exchange along the thinly-populated coastlines of insular Southeast Asia, as well as several other areas. This model describes settlement along river systems progressing from the coast to the inner hinterlands, categorizing them from A-F, and X (Figure 3.13). The relevance of this system is that agricultural products are produced in the upstream E and F centers. These products are then passed downstream through intervening centers until reaching center A, the principal center situated close to the coast to facilitate trade with an external power, referred to as X. Although this characterization will suffice for my purposes, the model itself is much more complicated
then expressed here, especially with respect to addressing the relationships between different centers (see Bronson 1977).

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<tr>
<td>A</td>
<td>The first center locates at the river mouth. Responsible for trade with X.</td>
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<tr>
<td>B and C</td>
<td>Second and third order centers located upstream at primary and secondary river junctions.</td>
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<tr>
<td>D</td>
<td>The center farthest upstream to interact with the A market system. The first point of collection for products originating from remote parts of the watershed.</td>
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<tr>
<td>E and F</td>
<td>The production enclaves. Potentially based on non-market exchange system.</td>
</tr>
<tr>
<td>X</td>
<td>The overseas purchasers of goods exported from A.</td>
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**Figure 3.13.** Bronson’s Riverine System Exchange model based on river systems centers, production enclaves, and overseas powers (Modified from Bronson 1977:Figure 1).

Bronson (1977) did not originally attribute this model to the ancient Cham. However, when some authors confirmed that Champa was occupied by a series of independent kingdoms that exploited the river valleys, they suggested the model as a potential fit. Kenneth Hall (2011:22-29) has explored this possibility by comparing the charter states of Champa to Java and other island states. There is still a debate as to whether this model is a good explanatory fit for the Cham. The best analysis of this model, in terms of the ancient Cham, is presented by Southworth (2011), who addresses the individual points of Bronson’s model, and considers whether they correlate with the Cham. Southworth (2011:115) concludes that Bronson’s model does not encapsulate the changes seen in the Cham area over time, especially the transition to greater centralization during the 9th-12th centuries.

The adaptive cycle is specifically designed to deal with such changes. However, I would suggest that, instead of whole sale abandonment of the Riverine System Exchange model, researchers should consider it in relation to the adaptive cycle. Specifically, they should consider how the basic settlement pattern defined by the RSE model changed with the different stages of the adaptive cycle? For example, when clear discrepancies are identified, such as Southworth suggests for the 9th-12th centuries, where can this change be situated in the phases of the adaptive cycle? In this report I suggest that this occurred during the transition from the r-Phase to K-Phase. Can the model and the relationships described be adjusted to this phase and period? Furthermore, how does our understanding of resiliency influence the model, specifically the
implications of both internal and external elements? The insights provided through this perspective provide new ideas on production capacity and resilience in the enclaves and upstream center as well as addressing the implications of effective labor distribution through the concepts of interconnectivity, compartmentalizing, and modularity. I feel that this is an interesting avenue to address Bronson’s model, and to explore the potential path to increase system robustness. Along the same line, how would both resiliency and the adaptive cycle play out within the models for the vast rice plains of mainland Southeast Asia? These are all important questions that provide ample space for future exploration and research.

CONCLUSIONS

This report presented a unique opportunity to compare two charter states which exhibited very different agricultural strategies, yet utilized similar production techniques. In this discussion the variables that compose both the Cham and Dai Viet agricultural strategies have been presented. The changes in these variables were mapped onto the adaptive cycle framework, noting both the similarities and differences. The resiliencies of the agricultural strategies were explored using concepts from spatial resilience, which addressed the similarities in the internal elements and differences amongst the external variables. The results of the latter analysis suggested that, due to the modular nature of the ancient Cham production enclaves (specifically the redundancies and moderate connectivity within and between enclaves), they represented a more resilient agricultural strategy. Finally, the implications and insights from both the adaptive cycle framework and resiliency were addressed in light of the past and current concerns using Bronson’s Riverine System Exchange model for Champa.

In summation of this chapter it is relevant to turn our attention to what these results mean beyond the archaeological record and discourse about current agricultural practices. Despite the continuation of the Dai Viet charter state beyond the Cham era, the Cham agricultural strategy proved to be the more resilient approach. This is because it was based on a fine balance of diversity, modularity, and linkages. Unfortunately, in today’s agricultural strategy one can see greater similarities not with the resilient Cham practices, but the more vulnerable Dai Viet strategy. Farms are continuously growing in size, transforming vast landscape into uniform, anthropogenic environments, and investing heavily in monocropping. In light of our changing climate and economic demands, perhaps it is time that we turn to past agricultural systems for new lessons, not only of what worked and what did not in the past, but also to determine what aspects brought greater resiliency in the face of change.

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CHAPTER 4
IDENTIFYING AGRARIAN LOW-DENSITY URBANISM AMONGST THE CHARTER STATES OF THE CHOLA AND SINHALESE EMPIRES

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This chapter is focused on the agricultural strategy and intensification exhibited by the Southeast Asian charter states of the ancient Chola (849-1279 A.D.) and Sinhalese (1009-1400 A.D.) Empires. The goal is to address the role of the agricultural strategy within the socio-ecological system created by these charter states. To accomplish this, each state needs to be assessed in terms of its environment, crops, production techniques, as well as their production enclaves and overall agricultural strategy. To assess the changing relationships within the socio-ecological systems of these states and their agricultural strategies, the methodological approach of the adaptive cycle will be utilized. Special attention will be paid to the concept of agrarian low-density urbanism and its role in building or reducing the resiliency of these empires. In order to achieve these goals, the characteristics and archaeological indicators of agrarian low-density urbanism need to be addressed.

To understand socio-ecological systems requires an interdisciplinary method, with the inclusion of multiple variables that are necessary to identify the interconnectivity of both the natural and social components of a socio-ecological system. The adaptive cycle is particularly beneficial for its ability to temporally model multiple variables in order to extrapolate the resilience, entanglement, and vulnerabilities of such systems. This makes it essential to take a holistic and multiscaler approach to understanding the dynamics and intimate nature of past agricultural strategies. In many cases, especially within the tropics, both past and present societies encounter(ed) the same variables, limitations, and advantages. Thus, by exploring the past, we as a whole can better understand ourselves and our present surroundings. Connections between past and present agricultural strategies are nowhere more apparent than in tropical societies as a whole, especially within Southeast Asia. By exploring the past we can learn about the processes that shaped these societies and directed their future. Further, we can understand the similarities and differences that are encountered today, as well as explore our entanglements with the past.

Similar to previous reports (Macrae 2014, Chapter 3), two methodological approaches are utilized herein; Discourse and Research Assessment as well as Contextualization and Reassessment. The former is achieved through extensive literature review, evaluation of relevant datasets, and the assessment of current theoretical paradigms. The latter involves visiting past and present agricultural capitals and field systems to assess farming practices. The goal is to not only contextualize the research, but to reassess the literature from a comparative perspective using an understanding of socio-ecological systems. Fieldwork was conducted throughout southern India and central Sri Lanka in the Spring of 2015. Research focused on the Chola capitals of Thanjavur (CE 848-1025) and Gangaikonda Cholapuram (CE 1025-1279), and the Sinhalese capitals of Anuradhapura (377 BCE-CE 933) and Polonnaruwa (CE 933-1310). A total of 30 days were split between South India and Sri Lanka, with the SETS team visiting key archaeological sites and museums, as well as assessing the surrounding agricultural field systems.
BACKGROUND

Environment

_South India._ The ancient Chola Empire encompasses the contemporary states of Tamil Nadu, as well as parts of Karnataka and Andhra Pradesh. These states are classified as semi-arid to arid tropical environments, and are dominated by a variety of vegetation regimes ranging from dry deciduous forest, dry scrub forests, grasslands, to dry savannah. These environments are lasting legacies of a long history of human interaction and manipulation (Krishna and Morrison 2010:3). The Chola Empire expanded to encompass a heterogeneous landscape with differing soil types, climatic conditions, and rainfall regimes (Krishna 2010:54). There were three major geological sub-regions encompassed within the empire; the Deccan Plateau, Eastern Ghats, and the eastern Coromandel Coast. The Deccan Plateau is located in central and southern India, and is classified as an arid, tropical environment. This geographical sub-region consists of a raised plateau that drains from west to east by a series of rain fed rivers. This area exhibits both Red (Acrisols and Alfisols) soils and Black (Vertisols) soils. Red soils are limited in depth and capacity to hold both water and nutrients, characteristics amplified by excessive drainage and runoff (Krishna and Morrison 2010:36; Krishna 2010:66). Black soils are highly fertile if cultivated, due to their high clay content and capacity for moisture and nutrient retention. This soil, however, becomes very hard when dry, and sticky when wet, which creates difficulties for cultivation and management (Krishna and Morrison 2010:36, 68). Moving eastwards the next geological sub-region is the Eastern Ghats, a semi-arid tropical environment. The Eastern Ghats are composed of a discontinuous mountain chain that runs along the east side of South India. This region is dominated by fertile black soils but also exhibits a considerable amount of red soils (Krishna and Morrison 2010:36). The final landscape that was encompassed by the Chola Empire is the Coromandel Coast, along the Bay of Bengal, which consists of sandy, coastal plains. Similar to the riverine systems that crosscut the Deccan Plateau and Eastern Ghats, the coastal plains exhibit pockets of fertile alluvial soils (Krishna and Morrison 2010:65).

Throughout these geological sub-regions access to water played an important role within the Chola Empire. An important source of water for the empire was the Kaveri River. The Kaveri River runs northwest to southeast, originating in the Western Ghats, crossing the Deccan Plateau and Eastern Ghats, and terminating in a delta in the Coromandel Coast. This river system provided important alluvial soils and irrigation water for the Chola Empire. The river, like the rest of India, is controlled by the monsoons. The majority of rainfall occurs from June to September, during the Southwest monsoon period (Randhawa 1980:21). However, contrary to what is generally understood about the rainy monsoon season, the geological sub-regions in question actually receive little to moderate precipitation from the Southwest monsoon. This is because the Western Ghats mountain range intercepts the monsoon rains, placing the sub-regions to the east within a rain-shadow. Highland areas within the Deccan Plateau and Eastern Ghats receive 650 to 750 mm of annual precipitation (Wikramanayake 2002:328). This situation is further compounded in the south-eastern portion of Tamil Nadu, where the sub-region receives 80% of its annual precipitation, 945mm, after September, during the Northeast monsoon period (Nathan 1998:3; Randhawa 1980:21).

_Sri Lanka._ Sri Lanka is an island located approximately 32 km off the southeast coast of India. The island is dominated by the Central Highlands, a high plateau situated 2,500 m above sea level that runs 65 km north to south (Sutcliffe et al. 2011:786). To the east, west, and south
are a series of hills and deep valleys that transition into the coast. North of the Central Highlands there is a gentle transition into large plains with granite ridges. The coastal belt surrounding the island exhibits a range of geographical features from beaches and lagoons, to natural harbors. The Central Highlands are the origin point for approximately 100 rivers, streams, and tributaries feeding catchments throughout Sri Lanka (Sutcliffe et al. 2011:786). The Mahaweli, Kelani, and Walawe River provide important catchments that the Singhalese Empire exploited (Premathilake 2006:94). The Mahaweli River is the longest in the country, flowing 335 km to the dry zone, creating the Mahaweli River Basin, which supported the agricultural production of both the ancient capitals of Anuradhapura and Polonnaruwa (Withanachchi et al. 2014:330, 335).

Similar to the Chola Empire of Southern India, rainfall and water catchment in Sri Lanka is heavily dependent on the rains of both the Southwest and Northeast monsoon (Sutcliffe et al. 2011:786; Withanachchi et al. 2014:335). Climatically, Sri Lanka exhibits a wet and dry zone with an intermediate zone separating the two. The wet zone includes the Central Highlands and southwestern portion of the island. It receives a high annual precipitation of over 2,000 mm (Withanachchi et al. 2014:332). The dry zone encompasses all of the north, east, and southeast portions of the island, which fall into the rain shadow of the central highlands. This zone receives an average annual precipitation of less than 1,200 mm (Withanachchi et al. 2014:335). Throughout history, the dry zone has been prone to prolonged droughts and diminishing precipitation (Withanachchi et al. 2014:330). Buffering between the two zones is an intermediate zone, which receives average annual precipitation between 2,000 and 1,200 mm (Withanachchi et al. 2014:332). The ancient capital of Anuradhapura is located in the semi-arid dry zone, and today receives most of its 1,450 mm of annual precipitation from the Northeast monsoon (Gilliland et al. 2013:1013; Sutcliffe et al. 2011:786). In addition to the monsoons, El Nino (ENSO) played an important role in Sri Lankan precipitation, causing both floods and droughts. During El Nino years rainfall intensifies from October to December, inundating the downstream areas in the dry zone, and from March to July rainfall decreases, reducing the runoff from the highlands and causing drought in the dry-zones (Gilliland et al. 2013:1013; Sutcliffe et al. 2011:786; Withanachchi et al. 2014:337).

**Agricultural Production**

Southern India and Sri Lanka provide a corpus of research that highlights the different crops exploited throughout history. In order to understand the full scope of agricultural production, references need to be drawn from historical texts, archaeological evidence, and linguistic analyses, all of which address agricultural production. The vast majority of this data focuses on southern India, specifically the pre-Chola and Chola periods. To complicate matters further, prior to and during these periods there were a series of domesticates introduced. For the sake of brevity general crop names will be provided here; for more detailed descriptions and contexts refer to the following sources (see Fuller et al. 2004; Korisettar et al. 2001; Krishna and Morrison 2010; Misra 2001; Nene 2006).

Large cereals and grasses include barely, wheat, rice, sorghum, and millet (brown top, sawa, yellow foxtail, bristle, little, kodo, pearl, and finger). Pulses, such as lentils and beans, included horsegram, mung, black gram, green gram, urad, hyacinth, pigeonpea, chickpeas, cowpea, peas, and lathyrus. Arboriculture focused on toddy palm, tamarind, palas, teak, mango, pipals, bamboo, jujube, fig, java plum, banana, papaya, plantain, and coconut. There are also a series of vegetables, nuts, and non-consumption products that include cucumber, luffa, linum, okra,
gourds, parenchyma, onion, garlic, eggplant, sugarcane, hemp, sesame, peanut, sunflower, mustard, linseed, and cotton.

Production Systems

As in the charter states of Southeast Asia (see Macrae 2014, Chapter 3), there is a division between the production of dry-land crops and wet-land crops. The distribution of these two strategies is traditionally based on the environmental prerequisites, specifically access to water for wet-land crops. The Chola and Sinhalese Empire, like the many charter states of adjacent Southeast Asia, invested heavily in irrigation to modify their natural environment and expand the wet-land zones. Wet-land agricultural production is categorized into bunded fields or floodplain agriculture (van Liere 1980; Wolters 2007). To explore these practices in further detail refer to SETS volume 1 (see Macrae 2014:60-61). A formal bunded field (padi) uses less land then dry-land cultivation, but it does require more water and a higher degree of labor investment and overall management (Mudar 1995:6; van Liere 1980:272). This farming practice requires the construction of interconnected bunded fields that distribute water between individual fields and field systems (Figure 4.1). In contrast, floodplain, or flood recession agriculture occurs along the sides of large rivers bounded by floodplains that can extend ten to twenty kilometers away. During the rainy season rivers expand and flood the surrounding plains until the dry season, when waters recede and the area returns to drought conditions (Wolters 2007:216, 227).

Figure 4.1. Wet-land padi fields, Anuradhapura, Sri Lanka.
Dry-land cultivation can be practiced in several manners, including shifting horticulture or more extensive swidden agriculture (Sox 1972:79; Figure 4.2). Belts of swidden fields are found throughout much of the Chola Empire; where water access is limited, this farming practice is therefore prevalent in higher elevation uplands, especially in western Tamil Nadu (Krishna and Morrison 2010:70; Morrison In Press:4). Rain dependent field systems are known for producing crops such as millet, pulses, sorghum, oilseeds, groundnuts, and other drought tolerant crops (Krishna and Morrison 2010:70; Randhawa 1980:407). Dry-land farming is often perceived as being a risky undertaking due to its reliance on rainfall and susceptibility to droughts. This can have important implication when considering the relatively high frequency of severe droughts, which can occur one to three times in ten years (Asouti and Fuller 2008:33). This may foster an emphasis on drought tolerant species, such as millet and pulses (Asouti and Fuller 2008:83).

Figure 4.2. Dry-land production near Thanjavur, South India.

During the early history of India and Sri Lanka there are a few references to dry-land horticulture in the form of gardens. Gardens are described and inferences are drawn from numerous inscriptions, often in association with the rise of cities and urban life. Primarily they are used to describe gardens as an elite practice found in palaces, monasteries, forest hermitages, and temples (Ali 2003:223). These areas are carefully constructed, with artificial and ornamental production areas for vegetables, flowers, and other high-value and high-effort medicinal or cosmetic crops (Ali 2003:223). A garden requires significant labor for cultivation, especially the laborious act of watering, which often involving the drawing and carrying of water from wells (Ali 2003:225). These elite gardens are recorded in 5th century Sigiriya, 12th century
Manasollasa, and 13th century Sarngadharapaddhati texts. These references, as well as other inscription, depict the elite gardens as playing a role in both the scared understanding of the cosmos but also as places of relaxation (Ali 2003; Figure 4.3). The second function of gardens that is not referred to, but likely a regular occurrence, was the use of gardens for household consumption or exchange in markets (Dove 1990).

Figure 4.3. Gardens with in the Jambukeswarar Temple compound, South India.

Agricultural Strategies and Production Enclaves

Chola Empire. The Chola Empire, at its peak, encompassed a vast territory in southern India that included the Deccan Plateau, Eastern Ghats, Coromandel Coast, and even at times parts of Sri Lanka. Within these diverse semi- to arid sub-regions of India, the Chola Empire constructed vast irrigation networks that supported interconnected agricultural field systems. Synonymous with the Chola Empire is the Kaveri River and its delta, which contains one fourth of all riverine water in Tamil Nadu (Heitzman 1997:40). Systems of anicuts (dams), canals, and reservoirs have transformed the delta and river valley into a production enclave for rice and other water based production (Heitzman 1997:37; Figure 4.4). Similar intensification is visible along the other major rivers, including the Pala, Cheyyar, Vaigai, and Tambraparni, although they only amount to 7% of the cultivated lands (Murton 2001:159). Overall, this intensively irrigated wet-land agroecosystem could produce more than one crop per year (Heitzman 1997:50).
Figure 4.4. Padi production near Kunnandarkoil, South India.

Nevertheless, it is conceivable that the majority of agricultural production within the Chola Empire was derived from dry-land farming (Krishna and Morrison 2010:31; Murton 2001:159). A great deal of research has addressed the impressive irrigation works along the Kaveri River and beyond, which created vast areas of wet-land rice production. This research emphasis, and the limited archaeological evidence left behind from dry-land farming, have diminished the latter’s importance within the literature. When examining the vast territories of the Chola Empire, it is clear that much of the lands under their control are classified as arid to semi-arid environments that would have been dependent on rainfall for irrigation. Although lacking targeted research, many leading scholars have therefore posited that the role of dry-land farming may have been greater than anticipated. References highlight both the large tracts of lands available, and their potential role within the greater subsistence and commercial network: “higher-elevation upland areas… receive relatively high rainfall and support a distinctive suite of tropical crops and productive practices from swidden agriculture to commercial foraging” (Morrison In Press:4; Figure 4.5).
The Chola Empire and its subjects had a well-founded knowledge of the agricultural potential in the different sub-regions within their realm. There are Sanskrit texts that describe standardized farming strategies suited to specific locations, soil fertilities, seasons, and farmer capabilities (Krishna and Morrison 2010:14, 30). These lands were further partitioned for specific crops, for example cereals, vegetables, and gardens (Krishna and Morrison 2010:14). Lands were also demarcated based on soil fertility and cropping pattern into parched lands, fertile lands, and littoral lands (Krishna and Morrison 2010:37). Farmers utilized a number of techniques to maximize these lands by intercropping, mixing, and sequencing crops to compliment the capacity of soils and irrigation systems. These fields were modified by mulching, manuring, and even by creating a liquified fertilizer with farm refuse (Krishna and Morrison 2010:17-18, 37).

**Sinhalese Empire.** Agricultural production during the Sinhalese Empire is often characterized by the rapid expansion of intensive irrigation schemes. The capital of Anuradhapura was the first to initiate this expansion, beginning around 400 B.C. (Gilliland et al. 2013:1026). This investment continued until 1,100 to 1,200 A.D., coinciding with the abandonment and establishment of the new capital at Polonnaruwa. Polonnaruwa exhibits early intensification, augmented by a similar expansion in irrigation systems co-occurring with its designation as the capital in 1,100 A.D. This scenario held until 1,280 A.D., when the capital shifted again. The construction of these expansive systems created wet-land production enclaves in the dry zones of
Sri Lanka (Figure 4.6). The development of these irrigated systems would have played a large part in over-coming periodic droughts and floods that plagued the dry zone (Gilliland et al. 2008:8-9). The manipulation and irrigation of these dry-lands contribute 70% of the national paddy cultivation today (Withanachchi et al. 2014:330).

Figure 6.6. Expansive wet-land production irrigated by reservoir near Polonnaruwa, Sri Lanka.

Similar to the Chola Empire, the role of paddy production had an ever increasing importance within the subsistence and trade of the Sinhalese empire. However, in certain cases the dry-land cultivation and the production of pulses and dry grains were important before, during, and after the Sinhalese Empire. Gunawardana (1971:16) describes inscriptions from the 9th and 10th century that make references to dry-land, swidden production. These inscriptions suggest that the importance of the crops likely stretched back to a much earlier time (Gunawardana 1971:16).

THE ADAPTIVE CYCLE

The adaptive cycle is a heuristic device that provides a useful means to model these complex relationships over time (see Chapter 3). It can often be used, with great success, to explore the cycles within agricultural strategies. However, a great deal of data pertaining to chronological changes is required to use this method effectively. The data also needs to be representative of all levels within the hierarchal socio-ecological system that the researcher wishes to model. This is best understood through the concept of “Panarchy.” Panarchy is a term used to explain the evolving, adaptive, and evolutionary nature of a hierarchical system based on a range of adaptive cycles, some changing slowly, others more quickly, some restricted in scale, others all-encompassing (Holling et al. 2002:74). The goal behind panarchy is to provide the simplest framework necessary to describe faster/small and slower/large changes across a complex adaptive system.
When exploring both the agricultural strategies of the Chola and Sinhalese Empire the scale of analysis needs to be in line with the available data and current level of synthesis. Unfortunately, while agriculture is sometimes the topic of discussion for those who study these empires, it more often than not takes a backseat to considerations of the impressive irrigation works. As a result, there is a lack of understanding of change in agricultural strategies overtime. As a result, in order to assess these societies using the adaptive cycle approach, a higher hierarchical scale must be used, at the cost of generalizing the minutia of agricultural change. Nevertheless, the framework of the adaptive cycle provides an avenue to explore the resiliency of the Chola and Sinhalese Empires as this relates to their agricultural strategies. There are four phases of the adaptive cycle framework through which the socio-ecological system in questioned passed; exploitation (r), reorganization (K), release (Ω), and conservation (α). While the Chola and Sinhalese Empires follow a similar path through these phases, their agricultural strategies exhibit different characteristics and trajectories, and this shaped their unique development as agrarian-based societies.

**Transition from R-phase to K-phase**

The agricultural strategies during the early period of the Chola and Sinhalese Empires can be characterized as being in the process of transitioning into the K-phase of the adaptive cycle. During the transformation from r-phase (exploitation) to K-phase (consolidation), the previously heterogeneous agricultural strategies became much more homogenous. This transformation was the result of both states applying pressure to increase production through mono-cropping (wet-rice), and the systematic expansion of a singular production technique (padi), at the expense of the diversity that was inherent in the previous agricultural strategies. Overtime, there is an expansion and intensification of the agricultural systems, as seen in the conversion of dry-land production zones to wet-land production through expansion of irrigation systems. The drive to expand wet-land production of rice was likely the result of several different factors. During this period there is increasing evidence to suggest that the consumption of rice, typically by the urban elites, became a symbol of status and prestige (Morrison In Press:29). Dry-land produce was associated with poor classes while wet-land and garden produce were designated as essential parts of upper class diet (Morrison In Press:34). This consumption pattern extended to the religious realm, and such foods were also demanded by the elite religious practitioners (Morrison In Press:31). These consumption patterns were further escalated by the increasing urban-based, non-agricultural populace, who ranked higher in the socio-economic hierarchy than the agrarian producers. Cities were rapidly expanding at this time, and by the early 16th may have been inhabited by up to 500,000 people (Morrison In Press:35). These large centers would have placed an ever increasing demand on agrarian production, with a special emphasis on the prestigious rice crop. The final factor that contributed to the rapid expansion of wet-land production can be found in the concept of status/merit building. An essential activity amongst the elite of South Asia was to prove their prestige and political legitimacy through the endowment and maintenance of irrigation systems and agricultural fields (Morrison In Press:5). In many ways, the competitive nature of these endowments perpetuated increased investment, driving up the size of each gift. These activities are evident in the prevalence of stone and copper plates with inscriptions describing these endowments (Morrison In Press:5; Murton 2001:164, 173).

*The Chola.* The Chola Empire had its beginning within the Kaveri delta and the conquest of Thanjavur (850 A.D.). Roughly a century later, under the rulership of Rajaraja I (985-1014
A.D.), the Chola Empire expanded across South India (Heitzman 1987:38; Heitzman 1997:6). Prior to the Chola expansion, many aspects that characterized the empire, in terms of irrigation and the associated high-level of agricultural production, were already in place, although at a much smaller scale (Heitzman 1997:48, 50). At this time the Chola Empire were developing large capitals such as Thanjavur and Palaiyaru, each with their extensive urban complexes. During this early period there was a rapid expansion of water management features that extended wet-land farming into dry-land zones that had traditionally been farmed using swidden (Murton 2001:165-172). This expansion of irrigation facilitated the increased production of rice which was used to support the ruling elite, growing religious institutions, and an urban, non-agriculturalist populace, primarily within the river valleys (Heitzman 1997:50). This drive to expand wet-land agricultural production therefore coincided closely with the expansion of the empire itself. As the Chola kings expanded along the Kaveri River and its tributaries, they created alliances with local nobles who controlled large tracts of lands in these riverine systems. These local leaders were targeting specifically because of the large amounts of agrarian production they could bring to the Empire. Once incorporated, local leaders often fell in line with the drive for wet-land production to curry favor both with the ruling elite, and local religious institutions (Heitzman 1997:50).

The Sinhalese. The first capital of the Sinhalese Empire was Anuradhapura, which was founded around 400 B.C. The capital and surrounding hinterlands, located in the northern drylands, exhibits an earlier village occupation associated with dry-land, swidden agricultural practices (Gilliland et al. 2013:1027). During the establishment of the capital there was a rapid introduction and expansion of irrigation practices, often at a massive scale, and shortly after the introduction of wet-land rice production (Gilliland et al. 2013:1026-1027; Smith 2006:485). Once again, the expansion of large-scale irrigated rice cultivation mirrored the increase in urban population, religious centers, and transient agricultural workers (Gilliland 2011: 13, 382; Gilliland et al. 2013:1012). The expansion of these irrigated lands was perpetuated by the patronage and donations from the elite members of society that were made to Buddhist monks and monasteries (Ludden 1999:79). This in turn attracted people to assist with the construction and cultivation of these lands (Ludden 1999:79). The expansion continued into the 7th century A.D., with ongoing transformation of areas previously used for swidden and domestic settlements being converted into wet-land production zones, and the concomitant reorganization and modification of older paddy fields, a process that continued until the abandonment of Anuradhapura (Gilliland 2011:382; Gilliland et al. 2013:1027). Another major city during this period, Polonnaruwa, followed a similar trajectory when it became the new capital in 1250 A.D. (Gilliland 2011:57).

The Latter Part of the K-phase

The latter part of the K-phase witnessed agricultural strategies that were consistently associated with the implementation of homogenous farming practices. This resulted in significant entanglements between the Chola and Sinhalese societies and the production of a mono-crop (rice) through a singular production strategy (wet-land production). This period is therefore characterized by an increasingly predictable and productive strategy, although it was inherently rigid in terms of purpose and with respect to its capacity to manage change. The rigidity and connectivity of the agricultural systems left the strategy both vulnerable and fragile, with little capacity to adapt to stresses and fluctuations (Holling and Gunderson 2002:43-44). Ultimately,
the K-phase ends with an abrupt transition into the release, or Omega-phase (Ω). Such shifts are usually stimulated by the introduction of a negative catalyst(s), either internal or external to the system (Folke et al. 2005). Such a catalyst(s) may not have previously had such a dramatic effect on the system, but due to the structural vulnerability of the more rigid agricultural systems, they can were apparently no longer able to mitigate such perturbances (e.g., Holling and Gunderson 2002:45).

**Chola.** During the reign of Rajendra I (1012-1044 A.D.), the empire expanded northward, reaching its maximum extent. As the Empire expanded outside of the Kaveri River and its delta, other river systems were incorporated into the agricultural strategy, often leading to the exploitation of earlier water management features, or creation of new irrigation systems. However, the further away from the capitals and the ecological niche of the riverine systems of southern India the system was pushed, the strategy for expansion of wet-land cultivation began to falter. Archaeological investigations in Pudukkottai, a relatively dry micro-region along the Vellar River south of the Kaveri River, hints at the rigidity of the Chola agricultural strategy. The Chola conquered Pudukkottai by 900 A.D. During the 11th century there was an investment in the irrigation systems; however, these attempts ultimately failed to permanently alter the agricultural landscape due to the ecological limitations and unsustainable nature of the established institutions (Heitzman 1997:49).

**Sinhalese.** Anuradhapura was abandoned after the 1017 A.D. invasion by the Chola Empire (Gilliland et al. 2013:1012). The large-scale irrigation systems and associated agricultural fields surrounding the capital fell into disuse. However, the abandonment of the hinterland agricultural systems was a much slower process. As the population dispersed they left behind small groups of agriculturalists who continued using small-scale irrigation and agricultural production for another 100 years (Gilliland 2011:383; Gilliland et al. 2013:1012, 1026-1027). At this point, the capital officially moved to Polonnaruwa, bringing with it a burgeoning urban population (Gilliland et al. 2013:1012). Polonnaruwa continued to prosper into the early 13th century A.D. (Morrison In Press:30). The final collapse of the empire has been attributed to a series of events and tragedies, such as repeated invasions, internal disputes over power, loss of trade importance, and cycles of drought and famine (Gilliland et al. 2013:1027). Assuming that both capitals were in a stable state prior to collapse, these disturbances suggest that the surrounding support populations in the hinterlands were suddenly unable to support the urban centers (Gilliland 2011:8-9). Recently, research suggests that there were a series of droughts and concomitant political instability prior to abandonment, suggesting that over the long-term the productivity of the hinterlands was maintained only to a point, upon which they were no longer capable of dealing with these fluctuations, ultimately leading to collapse of the broader socio-political system (Gilliland 2011:8-9; Gilliland et al. 2013:1027). These collapses have therefore been linked to the unstable and uncertain nature of reliance on standing water irrigation (Gilliland 2011:8-9).

**Summary**

Through the analysis of the Chola and Sinhalese agricultural strategies, using the adaptive cycle framework, we see several similarities and differences between these two charter states. Similarity is found in the progression through the K-phase of the adaptive cycle, which is exhibited by the increasing emphasis on, and scale of, wet-land rice production. However, differences are found in the final stages of the K-phase. The Chola Empire expanded
dramatically in southern India, imposing its rigid agricultural strategy on an increasingly diverse suite of environmental niches. In doing so, they potentially encountered difficulties due to the inability to adjust to the diversity exhibited by these regions. The Singhalese Empire continued expanding and intensifying its agricultural strategy within the same regions, only switching intensity with the abandonment of Anuradhapura and a shift to Polonnaruwa. During this process it is likely that the diversity associated with using a mixed strategy of both dry-land and wet-land cultivation diminished alongside the growing emphasis on wet-land production. While this would have increased productive capacity, it created a rigidity and reduced the overall resilience of the agricultural system to the point that it could no longer mitigate fluctuations. Ultimately, a catalyst(s) caused a failure within the rigid agricultural strategy of the hinterlands, and the system itself collapsed.

It must be noted that two factors have restricted this analysis. First, the limited nature of the data and analysis available for examining changes in the agricultural strategy, within both empires, has made drawing inferences about subtler responses to change difficult to determine. Over time, as archaeological research targets the agricultural strategies used during these transitional periods, it is hoped that more detailed insights will be gained. The second limiting factor is the time scale within which the research is framed. As evident in many of the charter states within neighboring Southeast Asia, agricultural strategies are rarely a revolutionary occurrence, and they are in fact a progressive process based on the exchange of ideas over long stretches of time that encompass periods both prior to, and following the demise of, the specific charter state in question. Exploring the periods prior to, and following, the florescence of the various charter states in South and Southeast Asia (see Iannone, Chapter 10) would allow one to follow the agricultural strategy through all phases of the adaptive cycle.

IDENTIFYING AGRARIAN-BASED, LOW-DENSITY URBANISM

The concept of low-density urbanism gained traction within archaeological discourse after Roland Fletcher’s 2009 publication “Low-Density, Agrarian-Based Urbanism: A Comparative View”. In this seminal article Fletcher describes the prevalence of low-density urbanism within the archaeological record. In 2012, Fletcher took a comparative approach, expanding his original analysis of ancient cities around the world as well as emphasizing the implications that the agriculture strategy associated with agrarian low-density urbanism had on the chronological sequences of these cities (Fletcher 2012). Drawing from a series of case studies, Angkor, Anuradhapura, Bagan, Copan, and Tikal, Fletcher dispells any preconceptions that these low-density urban settlement types did not occur in the past.

Since these land-mark treatments, archaeologists have been grappling with the concept of agrarian-based, low-density urbanism. When originally incorporated into archaeological discourse the concept described these ancient tropical cities as sharing specific cycles of growth, decline, and reorganization, as well as a suite of characteristics (Fletcher 2012:302). These included: “centers with numerous monumental stone temples surrounded by large homogeneous areas of sprawling low-density settlement, with considerable agricultural modification of the landscape” (Isondahl and Smith 2013:133; see Fletcher 2012:302). Unfortunately, this has left us with a definition as rather vague. Today, archaeologists are continually working on enhancing this definition (see Iannone 2015). With the increasing number of ancient cities falling within the classification of low-density urbanism, archaeologists have also had to contend with the implications this holds for the interpretation of past and present cities (Iannone 2015; Isondahl
and Smith 2013; Scarborough et al. 2012; Smith 2014). As part of an IHOPE initiative, inferences from these past cities were made to inform our current understanding of the sustainability of contemporary urbanism (Isendahl 2012; Scarborough et al. 2012; Smith 2012).

This section of the paper will address the agrarian aspects of low-density urbanism. Agricultural production amongst these cities is best understood as being omnipresent; “settlement structures are relatively spread-out in the landscape, inter-mixing ‘traditional’ urban land uses with green areas and agricultural production zones such as gardens, orchards, infields, and agro-forestry reserves” (Isendahl 2012:27). Fletcher (2012:306) associates the agricultural strategy of this urban form with “extensification,” describing the cities as being surrounded by extensive and repetitive landscape modification. These modifications can often be described as agricultural intensification, such as terracing or banded fields. A number of case studies have striven to define and describe these agricultural processes. Isendahl and Smith (2013:137) describe the appearance of a variety of different agrosystems within Maya cities as indicators of agrarian low-density urbanism. These include household gardens, larger infields, orchards, and arboriculture. Evidence ranges from the obvious anthropogenic terraced landscape of Caracol, to more subtle phosphate and geochemical identification of household gardens at Sayil and Xuch, or the fertile soils of vacant urban lands referred to as infields in the Puuc region (Barthel and Isendahl 2013:227; Isendahl and Smith 2013:137). These case studies are starting to describe how the agrarian landscape would appear within low-density urbanism. However, a clear definition and description of archaeological indicators is still illusive.

The case studies of the Chola and Singhalese Empires can contribute to this endeavor. It is argued that cities based on agrarian low-density urbanism have been removed from contemporary urban organization (Fletcher 2009). However, this can be disputed to a certain extent, as there are still vestiges of these agricultural practices in the traditional communities that continue to occupy the landscape these ancient cities were found. Exploring the current agricultural strategies exhibited in the study areas facilitates a correlation between the present and the archaeological record.

The ancestral lands of the Chola capitals of Thanjavur and Gangaikonda Cholapuram exhibit few remaining examples of agrarian low-density urbanism today. This has been replaced by what may be considered industrial urbanism, a form of production much more familiar to us today. We see a high density of settlement surrounded by production areas. These field systems are mono-cropped and have been industrialized through pump irrigation and mechanical farming (Figure 4.7). Within the cities there is little to no agricultural production, even vacant lands are denuded of agricultural production. In contrast, all unoccupied spaces are expected to be incorporated in the production system within a city exhibiting agrarian low-density urbanism (Isendahl and Smith 2013:137).
There are, however, indications that gardens once played a role within the city. Almost all temple complexes visited by SETS exhibited a garden. Gardens were of varying sizes and produced a variety of different plants, although mostly arboriculture exhibiting species from shade trees to bananas trees (Figure 4.8). These gardens may be similar to those described in the relic inscriptions (Ali 2003).

Furthermore, as one moves away from the cities and into the more rural villages, agricultural characteristic become more reminiscent of what is expected in agrarian low-density urbanism.
Field systems reduce in size while becoming more numerous. There is also a change from the mono-crops in the larger fields to greater diversity of crops exhibited in the smaller field systems which surround and creep into the villages (Figure 4.9). These fields are reminiscent of the mixed agricultural strategies described during the earlier Chola period and in areas where irrigation systems could not be constructed. The Chola area may not represent all the characteristics of agrarian-based, low-density urbanism, expected, but it does present a few lasting legacies.

![Figure 4.9. Mixed cropping beside rural village, near Kumbakonam, South India.](image)

The relic anthropogenic landscape of the Singhalese Empire is always present when traveling around Anuradhapura and Polonnaruwa. In many cases, communities continue utilizing ancient water management features. Agricultural production in these areas is much more reminiscent of what would be considered agrarian-based, low-density urbanism. Within the cities and surrounding rural settlement, gardens of varying sizes are found in almost every household. These gardens exhibit a diversity of fruits and vegetables, as well as non-edible economic crops (Figure 4.10).

![Figure 4.10. Household garden exhibiting a diversity of crops, Anuradhapura, Sri Lanka.](image)
As one leaves the contemporary Sri Lankan cities there are larger fields of increasing size, as the settlement slowly becomes more dispersed. When in the more rural areas, or the intervening zones between villages, the agricultural landscape continues exhibiting larger fields with a mixture of cash crops and fruit trees. In many cases, the bunds found in these fields are covered in trees/palms which act as both structural support as well as contributing to agricultural production. These field systems clearly exhibit a much higher biodiversity than those found in the Chola area. Within the larger field systems, we find what Furer-Haimendorf (1962) has referred to as islands. These are found floating amongst a sea of rice or as peninsulas attached to the edges of field systems (Figure 4.11; Figure 4.12). These islands consist of raised plots of land, and exhibit diverse arboriculture components (coconut/banana/mango) as well as vegetables (tomatoes, pumpkin, peppers).

Figure 4.11. Island of raised land within a large padi fields, Polonnaruwa.

Figure 4.12. Peninsula of raised land within a large padi field, near Thuruwila village, Sri Lanka.
Dispersed within these larger field systems are settlements, smaller clusters of houses, or single houses surrounded by fields (Figure 4.13; Figure 4.14). This makes the edges of towns and villages difficult to decipher (a characteristic of low-density urbanism; Iannone 2015). It can be hypothesized that the continuous distributions settlement within productive areas would have been more prevalent in the past than now, due to the advent of centralizing infrastructure (i.e., roads, water mains, and electrical connections). The traditional agricultural strategy exhibited in contemporary Anuradhapura and Polonnaruwa regions, although lacking in archaeological correlates, provides an excellent example of what can be considered vestiges of, agrarian-based, low-density urbanism. The larger cities, however, do not exhibit this to the same degree.

**Figure 4.13.** Settlement located within agricultural field system, near Anuradhapura, Sri Lanka.

**Figure 4.14.** Settlement located within agricultural field system, near Polonnaruwa, Sri Lanka.
It is clear in this brief summary that further research needs to be conducted in other areas, especially in Southeast Asia, where traditional agricultural practices are still in use within the regions delineated by ancient charter states. Exploring these contemporary case studies provides an essential avenue of research to help define and provide examples for this illusive concept of agrarian low-density urbanism. It may even offer new concepts of agricultural production that have not yet been identified in the archaeological record. Further, it can be used to assess some of the implications that archaeologists have assigned to ancient cities that fall into this urban classification. In Fletchers’ 2012 publication, he explores the role that the omnipresent, “extensification” processes, associated with the agriculture strategy of agrarian low-density urban, has on cities. He suggests that over time, the self-similarity and expansive nature of the strategy ultimately increases the rigidity of the socio-ecological system, making it vulnerable to both cultural and natural perturbations. This process is attributed to the shared cycle of decline within these cities. The case studies present a possibility that even though there is self-similarity in the application of this agricultural strategy throughout the landscape, this strategy, when examined at a smaller scale, exhibits a high level of biodiversity, variability in field sizes, and locational diversity, which brings a great deal of resiliency to these socio-ecological systems. This level of analysis is often difficult to achieve within a purely archaeological investigation.

CONCLUSIONS

Investigating the agricultural strategies exhibited by the Chola and Singhalese Empires has brought new revelations and possibilities to our interpretations. This research also highlighted a few problems. In both case studies, there is a lack of research dedicated specifically to agricultural production, outside of the irrigation methods and rice production. The literature that is available is superb, and hints at the potential for future archaeological investigations. Partially due to the lack of resources and information, the site visitations and travel through the regions became exceptionally important to this sub-project of the SETS I study. This is most apparent when exploring the concept of agrarian low-density urbanism. The contemporary agricultural practices provided a lasting legacy of the charter states that was used to further refine our understanding of the concept.

When exploring how the ancient agricultural strategies of the Chola and Singhalese Empires fit within the adaptive cycle, we are again confronted by a lack of evidence. This required a larger scale analysis. However, it did prove successful in that we were able to identify the phases which the agricultural strategies transversed. The agricultural strategies did not complete the full cycle within the defined timeframe of the charter states. Rather, during the reign of the charter states and emphasis on irrigation and wet-land production, the agricultural strategy entered the K-phase from the r-phase, continuing through to, or close to, the normal endpoint of the K-phase. To complete the analysis it is clear that a larger timeframe needs to be considered, a timeframe that can explore the agricultural strategy before and after the Chola and Singhalese Empires. This highlights a fascinating point about the agricultural strategy. To some degree, it is independent of the state and has a much longer history then immediately apparent. This may account for its legacy within contemporary agricultural production. Further research, however, is necessary to confirm these observations.
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CHAPTER 5
THE TIES THAT BIND: KINGS AND EPICENTERS
IN VIETNAM, INDIA, AND SRI LANKA

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The study areas presented in the Socio-Ecological Entanglements in Tropical Societies (SETS) project all include large monumental religious structures, but the large construction works also apply to the capital cities and royal palaces. Many of these cities are described as being large and expansive, but many do not have the physical archaeological remains left to show this. My research will discuss the different features of the epicenters found in the cultural areas of the Dai Viet and Cham culture areas of north and central Vietnam (respectively), the Chola empire from the province of Tamil Nadu in South India, and the Sinhalese empire of Sri Lanka. It will also discern the influence of the leaders and religion in how the centers were built and run. By using the data sets available to scholars, along with first hand observations of the environment and archaeological remains and local knowledge of the sites, researchers can begin to make conclusions regarding how these states collapsed under stress due to multiple factors in the society. These factors will allow the SETS project to assess the role of entanglement and resilience in the Charter States being analyzed. By determining the resiliency of leaders and their relationships to epicenters, we can learn how it affected the collapse of the entire state.

RESEARCH GOALS

The goals of this research are to evaluate the type of buildings found within the epicenter and how the leaders used the epicenter to their advantage. By observing how the types of buildings and use of spaces changed over time, one can predict how leaders needed certain buildings or spaces to promote their own legitimacy within the region. The elite needed the power given to them by the people and which was projected by the religious centers. However, this power may have waxed and waned over time. One can address these changes by analyzing them through resilience and entanglement methods. Other research topics include whether these cities fit the criteria of a microcosm model or a galactic polity model. Each model has its own attributes. The microcosm model implies that the epicenters represent, and replicate the heavens on earth (Geertz 1985). The galactic polity is similar, but the leader or king has more influence, being considered the ultimate ruler, and a universal being (Heitzman 1997; Tambiah 1977). This treatise also tries to determine how religion influences the way the rulers ran their kingdoms and how entangled they were with each other. These research goals were initially outlined in initial Socio-Ecological Entanglement in Tropical Societies (SETS) project volume (Iannone 2014).

BACKGROUND

The Charter States of the Dai Viet (CE 1009 – 1400) and the Cham kingdoms (CE 380 – 1471) ruled over northern and central Vietnam using two very different governance styles. The Dai Viet were more influenced by the Chinese style and the Cham had stronger connections with
the Khmer of Angkor, Cambodia. This can be seen in many ways, especially through their architecture. These Charter States, as defined by Victor Lieberman (2011), were influential even after their collapse, and even into a modern period. These states built large capitals, even though their populations were not concentrated in the epicenters themselves. Rather, populations fanned out around the epicenters, creating a low-density urbanism settlement pattern (Fletcher 2009). These Charter States not only shared a similar tropical environment, but also certain political and social characteristics that make them useful for comparative analysis using concepts from both entanglement and resilience theory. Elsewhere in South Asia, the Chola dynasty expanded outward from the province of Tamil Nadu, reaching its peak of power between 849-1279 CE. The Chola had their own artistic style that has persisted in the construction of South Indian religious temples since their rule. The contemporaneous Sinhalese Empire (377 BCE-1310 CE) was located on the island of Sri Lanka, and was focused in a series of capitals, including Sigiriya, Anuradhapura, and Polonnaruwa.

In Southeast Asia, epicenters were not only centers for administrative or royal power, but also for religious reasons. Epicenters were designed to mimic the cosmos and how the universe was ordered, and through these complexes royals were set up at the center of their own universe, with various walls, buildings, and other edifices surrounding them. This symbolized the ideal order that was needed to maintain a strong and vibrant state (Dumarcay 1991). Multiple such centers could be set up, depending on resources or the power of the kings, but only the epicenteral capitals would have exhibited certain features of both religious and administrative importance. These epicenters were often built around new or existing temples or shrines; they provided the central node around which the epicenters would grow (Whitmore 2006). Both the Dai Viet and Cham regions had two different artistic styles in terms of decorations and adornments, but built their palaces in very similar construction styles. Dumarcay (1991) believed that the palaces would have been easily changeable, based on historic archaeology, which showed that such wooden structures did not have solid bases.

**HISTORICAL SETTINGS**

**Dai Viet**

The Thang Long citadel (epicenter) was occupied by the Ly (1010-1225 CE) and Tran (1225-1400 CE) dynasty’s (Whitmore 1997). The royal family set up the Thang Long capital after moving from nearby Hoa Loc. During the Ly dynasty, all political decisions were considered religious proclamations (Taylor 1986:150). Not only were the leaders the center of attention within the center of the city, but their centrality was also a sort of religious statement (Taylor 1986:162). The kings consistently used their power to build and repair temples (Whitmore 1997). Taylor (1986:162) notes how there are historical sources that indicate that Dai Viet kings were regularly visited by spirits, and these spirits supported the power and legitimacy of their rule, making them “virtuous kings.” The Tran dynasty eventually overthrew the Ly dynasty and took control of Dai Viet (Wolters 1995).

**Champa**
The Cham collective was made up of many different provinces (Shiro 2011), with the principal, or hegemonic capital of the region moving depending on which kingdom was in power at a given time. Capitals often changed location based on trade, and most were focused on the coast for easy maritime access (Hall 1979). Each Cham region had their own rulers, but periodically one hegemonic ruler would emerge to rule over all of them. The principal Cham capital moved numerous times, and was variously found at, Tra Kieu (Simhapura), Dong Duong (Indrapura), and Cha Ban (Vijaya). The first two capitals have very little archaeological remains left, and those that do remain are found within museums and are usually sculptures of deities and gods. Early on in their history, Dai Viet and Champa entered into near perpetual conflict, resulting in the destruction of the early capitals of Hoa-Lu in the Dai Viet region and Dong Duong (Indrapura), forcing both to move their capitals from coastal regions inland (Hall 1979). The fighting did not end for a couple of centuries, however, meaning that there was limited non-martial interaction between these two states.

**Chola Dynasty**

The Chola were one of the longest standing dynasties in India’s long history. They conquered many lands to the north and west of Tamil Nadu, including the island of Sri Lanka. Before the Chola took over southern India, four dynasties competed for power; the Pandyas, Pallavas, Chera, and the Chola. King Vijayalaya, who laid claim to the Chola throne, established himself as the ruler after conquering the Kaveri River area and building his new capital at Thanjavur (Heitzman 1997:5). With the growth of this and other Chola cities, the urban plan would follow a pattern that followed the arrangement of streets closest to the temple, and as the temples and cities began to grow, new streets would follow the existing plan urban plans, with consideration of the need for caste segregations (Heitzman 1987:816). The boundaries of the city, which were always fluctuating, had temples at each of the main cardinal directions (Heitzman 1987:817). These features were all considered integral parts of each of the Chola cities. The capital was eventually moved from Thanjavur to Gangaikondacholapuram, near modern day Kumbakonam. At its peak – during the 10th and 11th centuries – the Chola empire was ruled by royal families who had enough resources and power to carry out the large temple construction projects and to sponsor the rituals that took place within them (Heitzman 1997:147).

In the 10th century, the Chola kings decided to try to eliminate the neighboring Sinhalese empire by taking over the island of Sri Lanka. The Chola managed to take and hold Sri Lanka from 993-1077 CE, at which time the island kingdom was able to regain its independence.

**Sinhalese Empire**

Much of the archaeological remains and what is known about the Sinhalese empire clearly reflects what the SETS project is trying to determine. The long history and new excavations still occurring in the country allow researchers to learn more about each center every year. One can clearly see the progression of construction phases and document the movement of people and kingdoms between capitals. Sri Lanka is almost an ideal case study when looking at resilience and entanglements. All palaces follow the same requirements; an area enclosed with galleries on either side with an entrance at the east. Anurādhapura has the longest history as a Sinhalese
capital, stretching into the early 1st millennium BCE, but Sigiriya (477-495 CE) remains one of the earliest recognizable capitals and royal palaces of the Sinhalese empire. The political power moved back to Anurâdhapura after the decline of Sigiriya, and then finally to Polonnaruva (1070-1310 CE). None of the former capitals completely lost its importance to the people, with all three persisting as places of religious importance even to this day.

**METHODS**

Vietnam was visited in December 2014 over a period of 3 weeks in order to examine archaeological sites from the Charter States of Dai Viet (1009 – 1400) in northern Vietnam and the Cham kingdoms (380 – 1471) in central Vietnam. Along with numerous related archaeological sites (e.g., temples), the capitals or citadels that were visited were Thang Long of the Dai Viet and Cha Ban of the Champa peoples. Geographically, between modern Hanoi in the north and Qui Nhon in central Vietnam is the area where archaeological sites were visited over the field season. During our summer 2015 field season, the SETS project visited South India, specifically the province of Tamil Nadu, over a period of two weeks. South India has a very long history, but the time period that will be focused on is the Chola period, centered on the capitals of Thanjavur, Kumbakonam, and Gangaikondacholapuram. The next two weeks were based in Sri Lanka around the capitals of Sigiriya, Anurâdhapura, and Polonnaruva. Numerous other sites including temples and more modern sites were visited for comparison, but these are not the focus of this study. I will be focusing on a time period approximately between 900 and 1400 CE, during the Charter States or Classical era, prior to the appearance of colonial intrusions from the west.

SETS fieldwork consists of visiting the sites, taking photographs, acquiring local knowledge, and finding scholarly sources not available in North America. Visiting the sites is essential for this type of research because it allows the researchers to understand the environmental conditions and the surroundings that were important for how the center was built or planned around. Much debate was held during the project as to where some of the more obscure archaeological remains could be. Very little research has been done to locate much of the archeological record. Anne-Valerie Schweyer’s (2011) *Ancient Vietnam* was a great help to our fieldwork, even though some of the maps were sometimes misleading. The names in the book sometimes did not match up with local knowledge, as locals had different ideas of what the citadels had been and equated them to more modern constructions, as was the case of Cha Ban citadel in Vietnam. Along with local knowledge of sites and buildings, a more comprehensive history can be obtained. This has already started in the Binh Dinh province of Vietnam by recording and making public the archaeological sites that people want to know about at the following website, http://baotangbinhdinh.vn.

Many of South India’s great temples have been restored or are still “living” temples, but many of the capital buildings and cities are not found anymore. Because of the numerous inscriptions from the walls of temples and other buildings, there is supplementary information about life during the Chola period. A very important tool that informs our project in more ways than one are the site signs. They help us understand the name, location, chronology and even give us a map or description of what we are observing. Sri Lanka was very good for labeling their archaeological sites and helping visitors and scholars understand what they are looking at. This was more difficult in India and Vietnam because most sites do not have labels and their
locations are often misconstrued. Signs were important to this research to inform me of inscriptions and debates surrounding the buildings, particularly in Sri Lanka.

A comparative approach is used as to discern patterns of importance to the project and to see if similar reasons are presented for the downfall of the people. “Comparative analysis is the only way to identify unique features of human societies” (Smith and Peregrine 2012, 4). Ian Hodder’s (2012) theory of entanglement allows for researchers to understand how everything, humans and objects, have a dependence (enabling) or a dependency (constrain) on other things. By comparing the resiliency and entanglement effects of each of the centers, we can begin to understand how these cities would have functioned and what became of their power.

**FINDINGS**

**Dai Viet**

*Thang Long.* Thang Long citadel in Hanoi was occupied until the 1800s when a the Nguyen dynasty created a new capital in Hue, in Central Vietnam. Since then, it has been turned into a UNESCO world heritage site with ongoing excavations in the citadel and surrounding areas. Currently, the new Forbidden Palace built by the Nguyen dynasty in 1805 sits atop of the older fortress (Logan 2005, 2006). We can see similarities in the gates (Figure 5.1- 5.3) and walls (Figure 5.4) surrounding the enclosure. These gates and walls would have restricted the access of those who were allowed into certain areas of the citadel or capital. Schweyer (2011:278) notes a historical source giving this description, “The sovereign lives in a palace of four storeys… All of these buildings are painted with red varnish… At the palace gates stands a tower and in that tower a great bell…” Further inside, gates and walls restrict access to the royal residences on the other side. These three walls protected the inner palace of the king. The protection for the royal family was necessary considering that the fighting against the Cham people was still happening as the citadel was built. Whitmore (2006) notes that this citadel brought segments of the country together under one ruler due to the stresses at the time. Much of the fortress and palace that can still be seen are more modern, rather than dating back to the Dai Viet era. But there are still excavations going on at the citadel that keep pushing the original date of exposed architecture back in time, and artifacts like royal seal’s that let the researchers understand the continual history of the site continue to be found. Also, we can infer that the citadel would have been similar to the current model based on historical sources and excavations that have already been completed.
Figure 5.1. Inside gate including portions of the wall of the Thang Long Citadel, Vietnam.

Figure 5.2. Inside gate of the Thang Long Citadel, Vietnam.
Figure 5.3. Innermost Gate of the Thang Long Citadel, Vietnam.

Figure 5.4. North Gate of the Thang Long Citadel, Vietnam
Cham

Cha Ban. Cha Ban citadel was one of the capitals during the Cham reign. Because they would move every so often, new capitals came about and old ones were destroyed by others after use. Remains of the original capitals can be found around modern structures. These remains were very difficult to see and find while looking on the ground, but Schewyer (2011:128) argues that the remains of Chan Ban can still be seen from the air looking down. It “Consists of a large rectangle, 1,400 m from north to south and 1,100 m from east to west, created by levies of earth covered in blocks of stone”. Earthen embankments (Figure 5.5, Figure 5.6) can be found on separate sides of what would have been the citadel. Though we could not determine if they were covered in stone because there was lots of brush on them, they all seemed to be man-made. Near what would have been the royal residence according to a plan in *Ancient Vietnam* (Schewyer, 2011), elephant statues were found. While their dates are unknown, they seem to be gates into the area as they are situated roughly 20 m from each other (Figure 5.7, Figure 5.8). Though they may be seen as different styles of sculpture, the elephants are in very similar positions across from one another, separated by a road and a neighbor’s farm. Nearby is the temple of Cahn Tien (Figure 5.9), which is situated in the very center of the city enclosure atop a small rise. From this temple, one has a view of a modern cemetery (Figure 5.10) and one can see Phuoc Loc tower off in the distance.

![Figure 5.5](image). Earthen embankments potentially from Cha Ban Citadel, Vietnam.
Figure 5.6. Earthen Embankments from another view, with modern road cut through, Cha Ban, Vietnam.

Figure 5.7. First potential elephant gate, Cha Ban, Vietnam.
Figure 5.8. Second potential elephant gate, Cha Ban, Vietnam.

Figure 5.9. Cahn Tien Tower, located in the center of the city enclosure, Cha Ban, Vietnam.
Figure 5.10. Looking out from Cahn Tien tower at the Vietnamese countryside, what would have been Cha Ban citadel lands, with the Phuoc Loc Tower in the distance.

My Son and Other Religious Sites. Two lintels have been found at My Son that show images of leaders as prominent figures with others situated around them, possibly showing some involvement in a religious event. The first scene, split into two photos (Figure 5.11, Figure 5.12), is described by the Da Nang Museum is “court life” from lintel E4 at My Son (Guillon, 2001). Dancers, musicians, and servants fanning the king seem to be depicted around him. The king is seated holding a staff with his left arm raised, and he is wearing a hat and possibly large earrings. The second lintel shows the king, larger and clearly the focus of attention, located in the center of the scene sitting on a lotus flower-style throne with many more people surrounding him than in the first example (Guillon, 2001; Figure 5.13, Figure 5.14). In the Binh Dinh museum there was also a depiction of the royal symbol of the sun-wheel (Figure 5.15) found at the Banh It temple complex. Originally designed with five towers, the remaining four sit on top of a hill overlooking Vietnam (Figure 5.16), in the center of what would have been three citadels, Thinai, Cha, and Doban (information gleaned from signage from Banh It temple complex).
Figure 5.11. Part of the My Son E4 lintel with the leader in a sitting position with a sword in hand, Vietnam.

Figure 5.12. Right portion of My Son E4 lintel, Vietnam.
Figure 5.13. Second lintel from My Son E4 with the leader sitting in the center holding a sword and in decorative dress, Vietnam.

Figure 5.14. Another view of second lintel from My Son E4, Vietnam.
Figure 5.15. “Wheel of sun-symbol,” representing power of Royal dynasty, from the decorative relief of Bahn It tower, Binh Dinh province, 12th century” (from the Binh Dinh Museum in Qui Nhon, Vietnam).

Figure 5.16. Two of the four Bahn It towers, Vietnam.
India

Thanjavur. Thanjavur was also known as Tanjai in the 10th and 11th centuries in the inscriptions. The city was only a collection of villages when it was conquered by the Cholas in the middle of the 9th century. After Thanjavur was conquered, Rajaraja I (985 – 1014 CE) constructed the Brihadisvara temple (Figure 5.17). He purposely built it as a ceremonial center to celebrate his victory in battle and show how great his empire had become (Vanamamalai 1974:26). Thanjavur is called a temple city because of the many temples found within the city boarders. With the temple at the center, the city was designed with an inner quadrangle around the temple and then had an outer circuit for professional groups (Sign at Brihadisvara temple). King Rajaraja had every temple in the Chola empire send guards and give money to help pay for his city and temple (Vanamalai 1974, 31). This might show that the temple and city might not have been sustainable under his governance after it was built. This city was important because it was the first time that the people were brought together under one ruler (Nagaswamy 1970: 13). The death of Rajaraja I brought the move of the capital to Gangaikondacholapuram. The only archaeological ruins remaining of this initial time period and from the city is the temple, which has been restored and added to over time. Later, a more modern palace was built close to it (Figure 5.18). This indicates how important the temple was to the community, and that it continued to attract the power of the ruler.

Figure 5.17. Brihadisvara temple at Thanjavur exhibiting the grandness that King Rajaraja I wanted to show to the people and foreign invaders, South India.
Figure 5.18. Dated to a later time, a palace outside of the Brihadisvara temple, South India.

Gangaikondacholapuram. For over a hundred years, Gangaikondacholapuram was the capital of the Chola kings, CE 1011-1118. The city itself was built by Rajendra I to commemorate his conquering of lands all the way to the Ganges River, and it was said to reflect his personality (Nagaswamy 1970: 1). Gangaikondacholapuram was built out of the king’s need to show off his victories in battle, which also culminated in a spectacular temple complex (Figure 5.19). The temple of the same name is meant to be a replica of the temple in Thanjavur, in addition to being the most prominent building on the landscape (Figure 5.20). Much of the architecture is similar to the Brihadisvara Temple, and the new temple complex is also laid out in a very similar way. Nagaswamy (1970:13) believes that the location for the new capital city was picked because of a personal attachment to the area, especially since the village was unheard of before the city was built. Unfortunately, Rajendra I would never be crowned there, instead his eldest son Rajakesari Rajadhiraja assumed the throne at the new capital (Nagaswamy 1970:8). The city was flanked by the Gangaikondan lake to the west and Vadavaru River to the east. About 3.20 km from the Gangaikondacholapuram temple is the palace of Maligaimedu (Figure 5.21 and Figure 5.22). At this location there have been three separate palaces built, with five different kings who issued their orders from there (Information from sign at
Gangaikondacholapuram temple). The dates from inscriptions dates the palaces from approximately 1031 to 1119 CE. Excavations have not been conducted since 1991, and only limited archaeological ruins remain today.

**Figure 5.19.** Gangaikondacholapuram temple, South India.

**Figure 5.20.** Gangaikondacholapuram temple, similar to Brihadisvara temple, South India.
Figure 5.21. Palace of Maligaimedu, South India.

Figure 5.22. Palace of Maligaimedu, South India.
Sri Lanka

Sigiriya. Sigiriya became the seat of power in the fifth century under the King Kāśyapa I (also referred to as Kassapa I), during a time when alternate seats of power became important to maintain influence (Bandaranayake 2007:299). This is the time that the archaeological remains of the palace date to. The rock of Sigiriya rises almost 200 m above the plain and is surrounded by gardens to the east and west (Figure 5.23; Bandaranayake 2007:309). Bandaranayake (2007:309), one of the researchers at the site, notes that the original urban plan of the city was rectangular in shape with five sections; an inner citadel, the palace, ceremonial precinct, outer city, and the western precinct that included the gardens. The city itself was “approximately 2750 m from east to west and 925 m from north to south” (Bandaranayake 2007:310), and was surrounded by moats and ramparts (Figure 5.24). This is the only identifiable palace from the Anurādhapura period. The Lion’s Paw Terrace, approximately halfway up to the top of the rock, faces north with two paws and legs of the animal in a crouching position (Figure 5.25). The northern gate leads to this terrace. The Sigiriya palace itself covers an area of three and a half acres with three different sections including a lower palace, upper palace, and the gardens (Bandaranayake 2007:311). The upper palace would have had a viewing gallery and a 360-degree panorama of the city and surrounding area (Figure 5.26). This upper palace was thought to have had tiled roofs, plastered walls, and timber super structures (Bandaranayake 2007:312). Further down, one can observe that the palace has been terraced into the different sections that give the rock depth as well as a better viewing of the surrounding area (Figure 5.27). The upper palace also includes multiple baths and ponds that have been cut into the original rock, with the architecture formed around it (Figure 5.28). While walking among them the gardens at Sigiriya appear quite impressive; however, from the top of the upper palace an even better understanding of just how expansive they were can be gleaned (Figure 5.29). Sigiriya has one throne that allowed for the ruler to sit with not only a view out into his city and lands, but also into the majority of the palace. There is a single staircase that leads up to it, with the actual throne cut directly out of the rock (Figure 5.30 and Figure 5.31). To this day, no one is allowed to sit on upon the throne.

Figure 5.23. Sigiriya rock, Sri Lanka.
Figure 5.24. Moat around Sigiriya, Sri Lanka.

Figure 5.25. The Lion’s Paw Terrace, Sri Lanka.
**Figure 5.26.** The top of Sīgiriya rock from the royal/upper palace, Sri Lanka.

**Figure 5.27.** Multiple levels of the upper palace, Sīgiriya, Sri Lanka.
Figure 5.28. Multiple terraces of the upper palace, including a bathing pond, Sigiriya, Sri Lanka.

Figure 5.29. Sigiriya’s east gardens, view from the royal/upper palace, Sri Lanka.
Figure 5.30. Staircase leading up to the throne of Sigiriya, Sri Lanka.

Figure 5.31. Closer look at the throne of Sigiriya carved from the rock, Sri Lanka.
Anurādhapura. This city has a long tradition stretching from the first millennium B.C. to the restoration of the city in the 12th century by King Parākramabāhu I (Bandaranayake 2007:295). With this kind of history, and the expansive amount of land that the city covers, archaeological excavations are still being done at this UNESCO heritage site. Six separate construction phases have been identified at the city and its various religious monuments (Bandaranayake 2007:299). While there are many accounts and epics from the time of the ritual architecture of the monasteries and temples, there are very few tales of how the royal and secular architecture would have looked in contemporary times (Bandaranayake 2007:307). One building at Anurādhapura, the citadel or Lovamahapaya, has been tentatively called a palace (Bandaranayake 2007:310; Figure 5.32). The supposed palace is much smaller than the one at Sigiriya. It is a quadrangular enclosure with forty monolithic pillars and is close to the alms hall, the Maha Vihana (Bandaranayake 2007:312). It is still very impressive to look at, but the specific function of the building is still unknown. Anurādhapura does have gardens, including the royal ‘goldfish’ park, the Ranmasu Uyan (Bandaranayake 2007:315). The Palace of Vijayabāhu was established for his coronation ceremony as a temporary building (Figure 5.34). King Vijayabāhu did not use Anurādhapura as the capital, but instead used Polonnaruva (Palace of Vijayabāhu sign at location). It would have been a two-storied structure built in Polonnaruva style architecture, but instead was located in the inner city of Anurādhapura. There are still very faint plaster paintings remaining at the site that shows the use of multiple colours, but just the outline of the picture remains (Figure 5.35). There are three walled sections to the palace, including two entrances. Opposite the palace are two parallel platforms that local knowledge suggests to be where the king would get on to ride his elephants (Figure 5.36).

King Mahinda V (982-1029 AD), said to be the “last of the Anurādhapura kings,” finally abandoned the city sometime in between his claim to the throne in 982 and when the Chola empire conquered the city in 993 CE (Bandaranayake 2007:298). Polonnaruva replaced Anurādhapura as the political and ritualistic center in the 10th century. According to Prematilleke (2007:361) “complex developments in the political authority and religious environment over a period of more than a millennium, and the resultant changes, led to the decline of Anurādhapura as the capital.” With the Cholas from South India closing in on Anurādhapura, this further led to Polonnaruva becoming the prominent city on the landscape.
Figure 5.32. Lovamahapaya, potentially a second palace at Anurādhapura, Sri Lanka.

Figure 5.33. One of the royal baths at Ranmasu Uyana park. Carvings of elephants can be seen on either side of the bath, Anuradhapura, Sri Lanka.
Figure 5.34. Palace of Vijayabāhu, Anuradhapura, Sri Lanka.

Figure 5.35. Painted plaster still present at the palace of Vijayabāhu, Anuradhapura, Sri Lanka.
Polonnaruva. Polonnaruva, also known as Pulatthipura, was the seat of power during the 11th century to 13th century CE. This city had always been a strategic position for the military and the polity rulers as it sat in between Anurādhapura in the north, and Māgama in the south (Prematilleke 2007:361). According to Prematilleke (2007:361) “Royalty of Anurādhapura seemed to have been attracted towards Polonnaruva during the last three centuries of the first millennium.” Polonnaruva was used as a summer pavillion and vacation destination for the different kings during the Anurādhapura period. The city had 16 rulers over the two centuries of its dominance (Prematilleke 2007:362). King Vijayabāhu I wrestled Sri Lanka back from Chola after the invasion and then establishes Polonnaruva as the new capital. Parākramabāhu I has been hailed as the hero of the time as he built up a lot of the city.

The city lies on a north-south axis, and this geometric plan is easily observable when walking on the grounds. It follows the reservoir, which forms a natural boundary on the west. Included in the citadel are the royal palace, queen’s chambers, halls, quarters, and bathing pond. The bathing pond still has water in it and has been built up with multiple levels (Figure 5.37). This location, where the Queen would bathe, formed the most southern part of the citadel. Within the council chamber there is an inscription on the belly of a lion throne that shows it is where the king sat with other councilors and chairmen seated around him (Figure 5.38 and Figure 5.39). The inscriptions for their seats are recorded on the columns (Sign at site). The roof would have been made of wood and clay tiles. The arrangement of the council is particular and cannot be found anywhere else in Polonnaruva.

The audience hall of Nissankamalla is thought to have originally been a palace, as a smaller and more elegant building has been found beneath several construction levels (Figure 5.40). The inner citadel is surrounded by defensive walls, which were heavily fortified to allow soldiers and
guards to walk along and guard the royalties and officials living in the citadel (Figure 5.41). This king also built a summer island pavilion that is found adjacent to the palace (Figure 5.42). Within the citadel lies the royal palace, the council chambers, and other buildings. Parākramabāhu palace is multi-storied building with a main court and a courtyard (Figure 5.43). Its name is the Palace of God Sakra, which suggests a complex relationship between the king and the gods. Large wooden beams would have been present in the slots in the brick walls. An epic called the *Mahavamsa* relates that this palace had a thousand chambers within it. Plaster is still present with just a little bit of paint still colouring it (Figure 5.44). The building of the palace is impressive, especially given how tall the seven stories would have been (Figure 5.45). Only three stories remain of the eastern wall. The pond near Parākramabāhu’s palace was built outside of the citadel but is accessible by a staircase near it (Figure 5.46). The building beside the pool is thought to be a changing pavilion.

The slab found in Figure 5.47, gives a description from King Nissankamalla of how those who take the throne in Polonnaruva should not be from Chola or Kerala (South Indian culture areas), and even those who follow such leaders will be considered traitors. This gives a good indication of how political relations between Sri Lanka and South India were.

Prematilleke (2007:361) notes that Polonnaruva is “Orthogenetic to a stage of being not yet heterogenetic” (2007, 361). John Miksic (2000) describes orthogenetic and heterogenetic cities as two different types of urban context. Orthogenetic cities allow for more stability and ritual plays a larger part in integration of the population. Heterogenetic cities are more intricately associated with change, particularly in terms of economics (i.e., there is a shift away from principally agrarian economies to those based more on trade), and tend to leave very few monuments behind. Polonnaruva started as a religious site that had been used by other rulers as a summer palace, but with a more stable authority over the site, rulers built new buildings that marked a change in civic functions.

*Figure 5.37.* Royal baths, Polonnaruva, Sri Lanka.
Figure 5.38. King’s throne within the council chamber, inscription is located on the underside of the lion, Polonnaruva, Sri Lanka.

Figure 5.39. The pillars were carved with the names of different council members to represent their seat, Polonnaruva, Sri Lanka.
Figure 5.40. The audience hall of Nissankamalla, Polonnaruva, Sri Lanka.

Figure 5.41. The fortified wall found around the citadel of Polonnaruva, Polonnaruva, Sri Lanka.
Figure 5.42. The summer pavilion near the council chamber and across from the supposed palace, Polonnaruva, Sri Lanka.

Figure 5.43. Palace of Parākramabāhu, Polonnaruva, Sri Lanka.
Figure 5.44. Pained plaster still remaining at Parākramabāhu’s palace, Polonnaruva, Sri Lanka.

Figure 5.45. Parākramabāhu’s palace with children walking through for scale; the multi-storied building is still observable, Polonnaruva, Sri Lanka.
Figure 5.46. Royal pool found outside the citadel with a changing pavilion to the right, Polonnaruva, Sri Lanka.

Figure 5.47. Slab of inscriptions produced by King Nissankamalla about who should rule the throne, Polonnaruva, Sri Lanka.
DISCUSSION

While there are few archaeological remains of epicenters, and especially palaces, still left for examinations in the regions dominated by the ancient Charter States, those that are accessible are important to record and investigate. Many temples in Vietnam still exist, but have been heavily damaged due to other historical events like the Vietnam War. The citadels in the Cham region have also been destroyed due to other dynasty’s becoming more powerful and taking over. More often the old citadels would be built over top, covering any remains from the older buildings. There is also an extensive amount of scholarly literature, but these works are based mainly on trade relations between different regions within the area and other historical sources talking about these peoples. Temples and religious places in southern India also do not allow photos in the inner sanctums so without visiting these places the SETS project would not have been able to make the same observations. Finally, some of the archaeological ruins are not fully documented because excavations have had very contentious histories past (Selvakumar 2010).

Entanglement theory (Hodder, 2012) can still be applied by looking at the epicenter and society as creating a situation that has connections to everyone and everything. The main idea behind Hodder’s theory is that humans are connected to humans, things to things, and even humans and things have a relationship that is tangible. Decisions made by one person could affect buildings, agriculture strategies, and other aspects of societies. Coupled with resilience theory, which looks at how a society can adapt to change, researchers can look at how not only epicenters, but also ancient leaders, spurred on the collapse of these Charter States through their decision making and the entanglements they formed.

The SETS study shows how entangled the leaders were with each of the epicenters. Court scenes from the religious site of My Son demonstrate that the king also had influence, not only in the epicenters, but also into other parts of life. Even with the symbol of the royal dynasty on the Bahn It tower, subtle reminders of the role the elites played in everyone’s lives, including religious practices. Earthen embankments helped to protect the king but also built up the epicenter to become a grand center. These embankments can still be viewed in modern times, showing how these boundaries can persist over time. Especially for the Cham peoples, boundaries were especially important due to each of the regions having their own leaders. The kings needed the boundaries to acknowledge what was theirs and they relied on the epicenter to legitimize their control over the area. After the Chola had invaded and lost Sri Lanka, fortified walls were built at Polonnaruva. This might show how anxious the king might have been about the Chola or other foreign invaders returning. Anurādhapura was lost as a capital when the Chola overtook the island, but the Sinhalese people won it back and subsequently move the capital. Instead of becoming resilient by building defensive walls when the Chola invaded, they became entangled and invested in the protection of the walls at Polonnaruva. Thanjavur life as a capital was short lived and ended when the ruler most closely connected to it died. The people were not wholly entangled with the ruler in order to keep living at and around the city and the temple. The city, as a capital, needed the connection with the ruler to be considered an important place for administration to survive. The temple still survives as a Great Chola Living temple and a UNSECO heritage site into present day. The city itself was resilient in the way it kept its importance after a new ruler moved the capital to Gangaikondacholapuram, which also became
the site of a new royal palace. Thanjavur therefore survived as a key place on the landscape long after the entanglement with the Chola ruler, Rajaraja.

Whitmore noted that Thang Long in Vietnam not only protected the royals, but also brought together the country. The focus of this study is to look at the entanglements of the epicenters with the kings and how this cultivated their legitimacy, but Thang Long also shows how important the capital became to the people as a place of strength and power over others. The ruler gained his legitimacy from his use of the citadel and his power over the people by creating this image of stability. While this image was clearly needed for the people, it did not last as new dynasties took over and moved the capital.

As discussed above, the Chola capitals were built around the temple. Scholars have identified this type of urban planning as a model of the galactic polity or microcosm, a replica of the heavens here on earth (Geertz 1985; Tambiah 1977). We would expect to see administrative buildings next to the temple to show how close the rulers would have been to the religious center. At Thanjavur, a more modern palace resides close to the Brihadeeswarar temple, but nothing dating back to the time period being examined. Gangaikondacholapuram houses both a palace complex and a large temple of the same name. The remains of the palace are only 3.20 km away from the temple and the descriptions found in Nagaswamy’s edition show how Gangaikondacholapuram is very similar to the descriptions of what the microcosm should look like. Heitzman (1997:17) also notes that the gods supported the king and his ascension to the throne and the decisions he made. The King presented his decisions as actions from the gods, giving them power over the people and stressing how important it was to follow such proclimations. This investment in the idea of a microcosm was not limited to India. It can also be seen in Sri Lanka and how they built their capitals and even incorporated such themes into the architecture and decorations of the building. The Palace of Parākramabāhu is supposed to have a mandala or microcosm diagram built into the floor. While I could not find it, or it was not observable anymore, it was described at the museum near the citadel of Polonnaruva. Many of the features and concepts mentioned are present in either two or all of the study areas. Cities across Southeast Asia are similar in the way they use religion and a particular way of building their cities in order to emulate the power of the gods. By putting the three study areas and seven cities together, it allows the researchers and readers to see the similarities across time and space.

CONCLUSIONS

More excavations are always needed to contribute to the archaeological data and to create new conclusions about the culture areas. Whitmore (2006) calls for more work to be done on the eras before the colonial period in Vietnam and this is still true for all three of the study areas. More work also needs to be done looking at the society itself, rather than how it was linked to outside Charter States and maritime trade. Historical sources cannot tell us everything about the Cham and Dai Viet peoples, Chola dynasties, and Sri Lankan kingdoms. Archaeological excavations are a way to do accomplish this. This knowledge can only help any investigation of the area to create a more complete history of the world using multiple lines of evidence including geographical, environmental, and political. A data set of the sites in the Dai Viet and Cham regions, the Chola Empire, and the island of Sri Lanka will help the SETS project to attain its goal of analyzing the socio-ecological factors that led to the collapse of these Charter States.
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CHAPTER 6
URBAN CENTRES, SUPPORT POPULATIONS, AND THE SYSTEMS THAT BIND THEM: SETTLEMENT PATTERNS OF THE DAI VIET AND CHAMPA KINGDOMS DURING THE CHARTER ERA

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This study evaluates the available evidence for charter era settlement systems in the Dai Viet (CE 1009-1400) and Champa (CE 380-1471) Kingdoms of northern and south-central Vietnam. The charter era, as recognized by Lieberman (2003:23), refers to the religious, political, and administrative charters provided by these kingdoms for subsequent empires, between the 9th to mid-13th centuries CE. The majority of scholarship associated with these kingdoms is dominated by an orthodox view of Indochinese influence (Lafont and Po Dharma 1991; Leadbetter 2014; 72; Shiro 1999; Vuong 1986; Wheeler 2005). Only recently have revisionist perspectives emerged that rightfully consider the impact of local Vietnamese populations upon these regional histories; however, further examinations of this topic are needed (Lieberman 2011; Kenoyer 2008; Kim 2013; Tana 2014). Settlement analysis is an especially sparse feature of current scholarship. Apart from a few citadels, most archaeological materials in Vietnam prior to the 10th century CE come from burial sites, making early settlement patterns of the Cham and Dai Viet kingdoms difficult to interpret (Masanari 2005:103). A greater number of historical sources and archaeological sites are present for the later part of the charter era, but comprehensive settlement analyses have not been undertaken. The goal of my research is to assess the quality and availability of evidence for the structure and distribution of support populations within the Dai Viet and Champa kingdoms, and to present a preliminary reconstruction of these settlement systems. Drawing on concepts from entanglement and resilience theory, this study aims to provide insight into the strengths and limitations of these systems in the context of the integrated political and socio-ecological environments from which they were produced and maintained.

METHODS AND DATA

Data collection for this project took place during the 2014 winter field season, and was centered on reconnaissance surveys of urban and religious landmarks contemporary with the charter era, which belonged to the Dai Viet and Champa Kingdoms of Vietnam. Given that these landmarks represent epicenters from which low-density agrarian-based urbanism was likely centered (Evans et. al 2007; Fletcher 2009), these surveys offer insights into the distribution and densities of past support populations. The primary sites of interest are clustered within the Red River Basin in northern Vietnam, as well as along its central coast. These sites are presented in Figure 6.1.

Secondary methods of data collection included museum visits, which provided an assortment of material evidence for past domestic architecture, and observations of modern low-density settlements through ground surveys. Archaeological, historical, and ecological studies of Southeast Asia are referenced as well, which provide context to these observed local settlement patterns, both past and present.
Figure 6.1. Map of key surveyed sites within the Dai Viet and Champa Kingdoms (data from Scholars GeoPortal http://geo2.scholarsportal.info/).
BACKGROUND

An Overview of Environmental Change

An important point of departure for understanding settlement in the Dai Viet and Champa Kingdoms is to consider the impacts of environmental change. The beginning of the charter era in Vietnam corresponds with the Medieval Warm Optimum (650-1200 CE), a Sub-Atlantic climatic episode resulting in annual temperatures a few degrees warmer than today (Smith 2000:365). During this period, the climate was also significantly drier than in modern times, evident through pollen studies, which demonstrate a rapid decline in aquatic vegetation between 1100 -1300 CE (Li et al. 2006: 21). An expansion of mangrove forest at the GA site around 1000 CE suggests a retreated coastline, and core samples from the Taihu drainage basin in China indicate a period of regional drought prior to 1247 CE (Li et al. 2006:21-22; Wang et al 2002). In general, however, this was a period of reduced seasonal fluctuation, with more evenly distributed rainfall providing excellent conditions for agricultural intensification and population growth (Tana 2014:332). After 1300 CE, the climate gradually became cooler and wetter, corresponding with the Little Ice Age (Gajewski et al. 2007: 136). The 14th and 15th centuries constitute the most humid period within the last millennium, evident from a substantial increase in both wild and cultivated rice, as well as from the gradual disappearance of mangrove forests (Li et al. 2006: 22). The climate remained humid and relatively cool throughout the succeeding centuries, with a slight increase in annual temperatures and precipitation around 1800 CE (Li et al. 2006: 22-23), resulting in the warm and wet environment of the modern day country.

Domestic Structures of the Charter Era in Vietnam

Due to the perishable nature of the organic materials that were likely used to build domestic structures, little can be said regarding domestic structures on local scales during the charter era in Vietnam. It is probable, however, that utilitarian structures were influenced by local resource availability and ecological needs, rather than by the ideological considerations that influenced the imperial styles of temples and royal courts (Lieberman 2003, 2011). Saddle-roofed and pile-built houses were ubiquitous among the preceding Dong Son culture (500 BCE- 300CE) in both northern and central Vietnam (Waterson 2009:18-19), and the building of stilt houses is especially apparent in the north (Figure 6.2, 6.3, and 6.4). Building materials for domestic structures would have likely included softwoods or bamboo for frames, and various local grasses for thatching (Waterson 2009). Whether or not these building forms continued among Champa and Dai Viet populations remains unknown.

Field reconnaissance yielded a single stylistic representation of house types for the charter era: an engraving of six houses acting as a stylistic motif on the facade of Thap Canh Tien temple in the Cham region (Figure 6.5). Based on this example, it seems that stilt house styles continued to be built, perhaps resting on stone platforms rather than the earthen piles of the Dong Son house types. Evidence of bronze and iron casting industries in the latter half of the Dong Son period are known to have led to advancements in tool types (Masanari 2005). When the availability of superior tool types is considered, it is plausible that house types in the charter era took a more permanent form with stone platforms. The fact that the landscape was significantly dryer than today may have provided more stable housing foundations, with a reduced risk of erosion for these heavier structures. Evidence for increasingly sedentary agrarian practices in the north and stabilized port centres along the central and southern coasts may be correlated with a reduction in residential mobility, also supporting the possibility of more permanent housing structures (Le et al. 1990; Lieberman 2011; Shiro
The absence of the remains of stone platforms in archaeological studies of these regions may be attributed to modern urban sprawl, which covers much of the past landscape attributed to the Dai Viet and Champa Kingdoms. In addition, riverine fluctuations, a submerged coastline, and an ultimate increase in groundwater since the 13th century CE, may have eroded and/or buried the majority of these structural residues in rural areas. It is also possible that, due to the general deficiency of systematic archaeological surveys in these regions, stone platforms simply remain undiscovered. This is but one reason why further regional studies are needed.

**Figure 6.2.** A sketch of a stilt house decoration on a Dong Son bronze drum at Hanoi National Museum, Vietnam.

**Figure 6.3.** Dong Son Bronze Drum with engraving of stilt house at Hanoi National Museum, Vietnam.
Figure 6.4. House Stilts ca. 500-1CE, Dong Son Culture at Hanoi National Museum, Thanh Hoa Province, Vietnam.

Figure 6.5. Stylistic representations of residential structures on a facade of Thap Canh Tien Temple (CE 1200), Champa Kingdom, Binh Dinh Province, Vietnam.
Evidence of a pronounced ceramic industry in the Dai Viet and later Cham periods invites the possibility of fired brick or ceramic tiles as common building materials outside of their known uses in constructing temples and palaces (Shiro 1998). The presence of miscellaneous piles of historic roof tiles recovered through ongoing excavations in the vicinity of the Imperial Citadel of Thang Long support this consideration (Figure 6.6). These tiles are comprised primarily of porous, high-tempered terracotta fabrics and undecorated recumbent forms that are considerably more utilitarian than the roof tiles known to have been used in the construction of royal court buildings (Figure 6.7). At the very least, this may represent a distinction between peasant and merchant-class housing structures.

Figure 6.6. Utilitarian roof tiles from palace vicinity, Kinh Thein palace, Hanoi.

Figure 6.7. Display of tubular tiles from imperial building (1300 CE), Kinh Thein Museum, Hanoi.
THE DAI VIET KINGDOM

Political History

From ca. 1009 to 1400 CE, the Dai Viet Kingdom ruled the Red River basin and its southern coastal extension. One of the most influential differences between the Dai Viet Kingdom and other territories within Southeast Asia was its unique exposure to Chinese culture; the incorporation of this area into the Chinese empire throughout the first millennium CE provided political unification (Lieberman 2003:338), as well as religious unity with the spread of Buddhism in the 5th century CE (Wheeler 2005:11). Masanari (2005:105) notes that, between the 4th and 9th centuries, the Giao Chi Chinese administrative division of the Red River plain was one of the most important commercial centres, involving inter-regional trade with northern China and other coastal regions in Southeast Asia.

With a gradual separation from Chinese rule beginning ca. 939 CE (Lieberman 2003:23), Dai Viet expanded in both population and territory, developing progressively centralized urban centres and advancements in agricultural productivity. In the late 12th century, Mongol attacks weakened Dai Viet’s Chinese-style bureaucracy, and in its place emerged a patrimonial system of untaxed semi-hereditary estates (Lieberman 2011:942; Vickery 2009:53). Shiro (1998:18) has suggested that Dai Viet monarchs of this later period relied on military might and religious charisma to exercise rule over local leaders and populations.

Nearing the end of the charter era, the Dai Viet kingdom suffered from an economic downturn, rural uprisings, and external attacks that eventually culminated in the collapse of its central administration, and the brief loss of its independence to Champa (Lieberman 2003:25; 2011: 942). This degradation may have been largely due to Dai Viet’s vulnerable position as a trading centre when marine trade routes developed between China and the Champa Kingdoms. While Shiro (1998) has argued that Dai Viet was not particularly Sinicized in regards to its economic and political structures, Lieberman (2003:345) maintains that the previously instilled political and economic cohesion afforded by Chinese dominance led to a relatively limited rupture in the 14th century compared to contemporary Southeast Asian institutions. Indeed, the Dai Viet Kingdom experienced only a momentary collapse, re-emerging in the 15th century and dominating the majority of the Cham territories, and gaining control of their coastal trade centres (Vickery 2009:56).

Physical Geography

The Dai Viet territory was dominated by tropical upland and subtropical lowland monsoon forest zones (Li et al. 2006: 16). In addition to these forests – which in modern times have been largely displaced – the region included estuary marshes and secondary forests comprised of bamboo, shrubs, and grasses. Mountains fragment this northern region of Vietnam, leading to stream-watered valleys where water sources were permanent, unaltering features of the landscape. Beginning in the southwest mountains of China, the Red River extends across northern Vietnam to the western coast of the South China Sea, converging into a sedimentary basin of fertile soils at its mouth that is approximately 500 km long and 50 km wide (Figure 6.8). Known as the Red River basin, this area comprises one of the largest deltas in Southeast Asia (Li et al. 2006:5). The south-eastern portion of the Red River basin is dominated by summer monsoon winds and strong waves, while the north-eastern portion is sheltered by Hainan Island, and is tide dominated (Li et al. 2006:6).
Regional Settlement Patterns

On a regional scale, settlements were oriented around the Red River and its subsidiaries throughout the charter era. According to Lieberman (2011:943), local records and chronicles point to growing land constraints during Dai Viet rule, with reclamation of local areas moving from the mountainous northwest of the Red River Basin to its coastal south and east, where the building of irrigation and drainage networks corresponds to evidence of agricultural intensification. The presence of perennial streams and rivers corresponds with the construction of weirs to divert water into field-watering canals for wet rice production.

![Digital elevation model of northern Vietnam](http://geo2.scholarsportal.info/)  
*Figure 6.8.* Digital elevation model (30 m) of northern Vietnam, and the extent of the Red River Basin (data from Scholars GeoPortal).

Irrigation-based wet rice cultivation was – and still remains – the primary mode of subsistence in the northern region (Figure 6.9 and 6.10), supplemented by sweet potato, taro, and yam cultivation in scattered fields throughout the surrounding highlands (Lieberman 2003; O’Connor 1995; Shiro 1998). From the 12th century, two types of rice cultivation are known to have been prominent in the Red River Delta: the tenth-month rice harvest took place on drier land where irrigation systems had greater control of water flow, and the fifth-month rice harvest took place in colder areas of the delta where the tenth-month rice could not be planted because of summer flooding (Tran 2014:333). The central importance of wet rice cultivation to the Dai Viet lifeway is further supported by the fact that, despite population pressure in the valley and coastal lowlands, populations did not expand to the adjoining highlands, and subsistence opportunities along hills were never truly exploited (Le et al. 1990:8-9). Although irrigation practices allowed Dai Viet populations to expand along the southern coast, coinciding with the emergence of various epicentres, the Red River Basin
continued to support the most intensified wet rice cultivation (O’Connor 1995:974). It is not surprising that Than Long citadel, which is central to the basin, remained the largest political and economic centre within the Dai Viet territory, with sequential dynastic occupations until the 18th century CE (Nguyen Vinh Phuc 1994).

Figure 6.9. Modern irrigated wet rice near Kien So temple, eastern Hanoi, Vietnam.

Figure 6.10. Canal system in hinterland of western Hanoi, Vietnam.

While the Dai Viet territory had decreased in importance as a South China Sea trading centre by 1000 CE, it still depended on the control of a vast trade network, which, in addition
to agricultural surplus, supported population densities above those of more self-sufficient agrarian states (Shiro 1998:2). It is likely that, in addition to agricultural settlements being oriented around the fertile plains of the Red River Basin, settlement nodes were positioned along the waterways that served as trade routes. Wheeler (2005:12) explains that the Dai Viet secured tribute relations with China through these routes, and overtime this led to the control of larger trade networks and the export-oriented production of ceramic wares and other luxury goods. Indeed, the Dai Viet kingdom can be understood as both an agrarian and commercial state, centred on a wet-rice heartland that was capable of supporting higher population densities. It is thus possible, contrary to the view of Lieberman (2003), that the centralization of the Dai Viet Kingdom had less to do with political sinicization, and more to do with niche construction in a resource-rich environment.

THE CHAMPA KINGDOM

Political History

The Champa Kingdoms were distributed along the coasts of central and southern Vietnam. The arrival of Cham populations from Austronesia began as early as the end of the first millennium BCE (Vickery 2009:45). The earliest known epicentres in Champa are the sites of Tra Kieu (CE 350-758) and the My Son sanctuary (CE 400-1400). Little is known about the development of Champa prior to the 7th century CE, especially with regards to their social and ethnic composition (Guillon 2008:79), but evidence of Hindu practices characteristic of the Cham are known from as early as 200 CE (Wheeler 2005:11). The Champa Kingdoms likely formed gradually between this time and the 6th century, with the migration of small ethnic groups to the region (Shiro 1999:36).

Similar to Dai Viet, Champa’s prosperity rises in correspondence with the expulsion of Chinese authority, which historical sources suggest occurred in the 6th century CE (Schewyer 2010:22). In the late 8th century CE attacks from Javanese and Cambodian populations hindered prosperity, but by the 9th century Champa continued its expansion as an independent state (Vickery 2009:49). While the period from the 10th to 14th centuries CE is generally understood as the most affluent period in Champa history (Shiro 1999:36), several conflicts are discernible that certainly affected the kingdom’s prosperity. The expansion of the Chams into north-central Vietnam in the 10th century CE marks the beginning of a turbulent history with the Dai Viet kingdom, with two significant Dai Viet invasions occurring in 1044 and 1069 CE (Vickery 2009:51). The period from ca. 1130 to 1250 CE was a time of constant warfare with Cambodia, which effected both the central and southern coastal areas with brief periods of defeat and victory on both sides (Vickery 2009:52). Political strife continued between 1278 and 1285 CE as the Champa Kingdoms, similar to the Dai Viet kingdom, defended against Mongol invasions (Vickery 2009:53).

Historical reconstructions for the 14th century CE tell of increasingly frequent conflict with the Dai Viet Kingdom, leading to thirty years of war between these kingdoms, between 1360 and 1390 CE, the result of which was the near conquest of Vietnam in totality by the Cham (Shiro 1999: 37; Vickery 2009: 56). Powers shifted as conflicts with the Dai Viet continued in the 15th century CE, and by 1402 CE the Cham had already given up large portions of the Quang Nam area. The Champa Kingdoms continued to diminish, and by 1471 CE only the southern portions of the kingdom remained in Cham control, while the rest of the territory – including the primary port centres – were claimed by the re-established Dai Viet polity.
Physical Geography

The geography of the central coast is substantially different from the north, with small seasonal rivers – the most prominent being the Thu Bon River – that run steeply down mountain slopes, and flooding alluvial plains before emptying into the South China Sea (Wheeler 2005:8). This terrain is depicted in Figure 6.11. Unlike the clay rich soils of the Red River Delta, the sandy coastal plains contain nutrient-poor soils with a high drainage speed as well as a low water-holding capacity (Leadbetter 2014:72). While the central coast is famous for its heavy precipitation, it rains much less in the south-central plains, with only 1,650 mm precipitation falling annually around Qui Nhon and the Cha Ban Citadel (Shiro 1999:35). Given the drier climate prior to the 14th century CE, the Thu Bon valley would have been particularly arid in the dry season. The southern coast is equally dissimilar from the north, as the Mekong Delta is prone to unpredictable flooding and a harsher typhoon season (Shaw 2006: 4).
Figure 6.11. Digital elevation model (30 m) of south-central Vietnam, and sites of the Thu Bon River valley.

Regional Settlement Patterns

At the beginning of the first millennium CE, the Chams began to develop polities (Leadbeater 2014: 72). Jacques (1986:333), in his review of ancient Cham inscriptions, notes that Cham territory was “divided more often than not.” Champa was composed of several chiefdoms prior to the charter era; sculptural finds from various areas demonstrate different styles, which probably indicate locally-defined traditions and polities (Schweyer 2010:26-29). The Cham region seems to have been more unified in the charter state era, which is evident from Chinese texts that use the phrase Houan Wang (“circle of kings”) to describe the region prior to 859 CE, and the phrase Zhan Cheng (“city of the Chams) to describe the region after this time (Schwyer 2010:33).

In the mid-9th century CE, new architecture and epigraphy show the Thu Bon river valley as the most important Champa polity, with Dong Duong becoming an important epicentre (Vickery 2009:50). Agricultural practices in the region focused on flood farming, where the seasonal run-off of streams and rivers was either naturally or intentionally diverted to water fields (Huke 1982). Flood-management schemes used tanks and domestic ponds to collect water, and river-extending canals to flood fields. The nature of this agricultural system would have had a profound effect on the distribution of support populations. Since flooding is often unpredictable throughout the region, it is not surprising that observed modern day settlements along the central coast were located on higher ground. Reconnaissance surveys of major epicentres in the Quy Nhon and Hoi Ann areas demonstrate a similar pattern of raised settlements (Figure 6.12).

Figure 6.12. View of modern flood agriculture from atop Thap Banz It Temple, near Quy Nhnon, Vietnam.

A limited rice cultivation season due to seasonal rainfall fluctuations, a reliance on flooding for irrigation, and the scarcity of nutrient-rich soils, would have required populations to become more dispersed throughout Champa compared to Dai Viet, in order to sustain sufficient food yields. O’Connor (1995:970-972) and Sox (1972:107-108) suggest that house gardening – a practice commonly known among larger but low-density urban villages situated on higher ground in Southeast Asia – was a common practice among Cham populations. The primary benefit of house gardening is that “some fruit or vegetable is
always in season and no scrap of sun, soil, or moisture [needs] to be wasted” (O’Connor 1995:969). Such horticultural practices would have allowed Cham support populations to be self-sufficient in their agricultural production. In the modern day region, house gardening and the storage of private crops are apparent among homesteads and village residences alike (Figure 6.13).

**Figure 6.13.** Modern house gardening and storage behind village residence at Hoi Ann, Vietnam.

While the Dai Viet Kingdom had access to the Asian continent through the Red River, the Champa Kingdoms benefitted from the strategic position of the central coast along the South China Sea’s travel routes. As Wheeler (2005:8) explains, “the dangerous shoals of the South China Sea forced oceangoing vessels sailing between China and India to hug the central coast, making it one of the best travelled sea routes of the ‘Maritime Silk Road’.” These locations would have also allowed the Cham to exploit coastal resources. Within the Cham region, population density would have increased towards the coast, where fishing and inter-regional trade were important and reliable modes of subsistence (Shiro 1999; Sox 1972). This is demonstrated by the proximity of urban centres in the Thu Bon Valley.

**THE CHARTER ERA OF VIETNAM:**
**THEORIES OF ENTANGLEMENT AND RESILIENCE**

The Dai Viet Kingdom’s realm stands as an excellent illustration of what Weisz and colleagues (2001:123) have termed a colonized ecosystem. The Dai Viet lifeway was intrinsically entangled with the Red River Delta, exploiting its potential for irrigation-based wet rice cultivation to a maximum. While the Red River Delta led to an agricultural revolution during the charter state era, it was also instrumental in the state’s undoing. Increased population density and extensive building projects created a path dependency with wet rice cultivation, where populations were forced to increasingly invest in irrigation
networks to sustain their economical and social way of life. This led to an over-exploitation of the area’s resources, which was further exacerbated by climate change. With the advent of a cooler and wetter climate in the 13th century CE, several floods compromised the structure of Dai Viet’s political and economic system. The worst of these episodes seems to have occurred in 1270 CE, when the streets of Thang Long were only passable by boat (Tran 2014:332). An extensive dyke system was built under the Tran dynasty at this time to remedy the situation. Unfortunately, these man-made changes altered the course of the Red River tributaries, eroding several sectors of the irrigation-based wet rice system that was so essential to the economic structure of the kingdom and the lifeway of its populations (Tran 2013:333). This would have also impacted the kingdom’s secondary dependency on inter-regional trade, as the changed course of the Red River would have also disrupted navigation and commerce along trade route waterways. Both of these factors would have led to economic and political instability, leaving the state vulnerable to advances from Champa in the 14th century CE. After a period of economic decline and political strife, Dai Viet re-stabilized, and effectively conquered Champa in the late 15th century (Wheeler 2005:12). This re-establishment of the Dai Viet state may be contributed to the cooperative nature of the subsistence-settlement system, where interactive communication and solidarity were required in order to maintain equilibrium, leading to resilience of the centralized political system.

Unlike the Dai Viet Kingdom, wet rice cultivation in the Champa Kingdoms was marginal, as massive flooding in the coastal river valleys prevented the construction of irrigation networks. In their place, large tanks and domestic ponds were built to store water. These constructions were quite durable and lacked the local cooperation required by Dai Viet peoples to maintain their irrigation constructions. Locally-sustained food production increased resilience where strategies were flexible and controlled individually; horticulture and fishing supplemented the seasonal rice yields. However, the nature of this flood-agriculture required the low-density dispersal of Cham populations across the landscape, preventing centralization throughout the kingdom and leading to political divisions throughout Cham prehistory. At the same time, constant threats from foreign states maintained social cohesion among the Cham polities, at times leading to the unification of the kingdom under a single ruler. Instead of agricultural intensification, the Champa Kingdoms invested in a complex and expansive sea trade network which further supported the economy and led to the establishment of powerful regional centres. The kingdom’s political divisions, however, resulted in struggles for control of these powerful sea trade centres, creating instability.

Indeed, in the Champa Kingdoms self-sufficiency was amplified, and centralization deemphasized. Periods of conflict with other states maintained a certain level of solidarity, but a fundamental deficiency in regional cooperation was ultimately the downfall of Champa. As the Chams conquered the north, their fragile sociopolitical system became increasingly unstable; internal struggles for power weakened the kingdom’s military might, and its low-density cities were difficult to wall and defend (Leadbetter 2014: 76). Without an economic and political heartland to retreat to, when Champa finally fell to the Dai Viet kingdom in the 15th century, it crashed. This may suggest that a certain amount of entanglement between mechanisms of subsistence-settlement systems in tropical systems is required in order to keep urbanism afloat.

These ancient kingdoms of Vietnam were equally predisposed to inter-regional connections of peoples, goods, and ideas, but differed substantially in there ecological adaptions, leading to very different settlement systems. Settlement clusters and urban networks encountered periods of greater prosperity in the Dai Viet kingdom compared to Champa, but also experienced more dramatic shifts throughout time. In the Champa
Kingdoms, settlement nodes were self-sustaining but were less connected to one another, in both space and spirit. Ultimately, it was the Dai Viet who prevailed in the cultural history of Vietnam, suggesting that socio-political centralization among tropical low-density urban populations is a critical factor in their sustainability.

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CHAPTER 7
SETS 2015 SETTLEMENT STUDY:
HINTERLANDS OF THE CHOLA AND SINHALESE EMPIRES

Daniel Savage

This report represents the settlement-survey component of the 2015 *Socio-ecological Entanglement in Tropical Societies* (SETS) study of low-density urban settlements in tropical South Asia. My purpose is twofold: first, to provide a foundation for future comparative socio-ecological studies of the societies in question by assessing the quality and availability of archaeological data pertaining to the settlements of the rural and suburban populations, and second, to present some preliminary analysis and conclusions towards this same end.

This study focusses on two imperial dynasties which went into decline towards the end of the 13th century: the Chola Empire (CE 849-1279) of Southeastern India, and the Sinhalese Empire (377 BCE-CE 1310) of the dry zone of north-central Sri Lanka (Figure 7.1). The Chola Empire was centered in the Kaveri river delta of east-central Tamil Nadu. Thanjavur was the initial seat of power, though during the 11th century the capital was moved northeast to Gangaikonda Cholapuram, now a ruin outside of contemporary Kumbakonam. In contrast to the relatively short-lived Chola capitals, the city of Anuradhapura was the center of Sinhalese power in Sri Lanka for nearly fifteen-hundred years until the Chola conquest of the region in CE 993, after which the capital moved south to Polonnaruwa. Our study of these regions took place from the 14th of May through to the 9th of June 2015, with approximately a week’s stay in each of Thanjavur, Kumbakonam, Anuradhapura, and Polonnaruwa, as well as shorter trips to numerous other cities, towns, and villages.

![Figure 7.1. Map of Southern India and Northern Sri Lanka.](image-url)
The Chola and Sinhalese empires present a pattern of settlement that is unique to the tropics: large but dispersed populations organized into settlement clusters, which are embedded directly into an anthropogenic landscape of agricultural field systems and water-management features, such as canals, tanks, and artificial lakes (Fletcher 2012). This otherwise self-similar settlement pattern is punctuated by centers of political, administrative, and religious power with impressive works of monumental architecture; nevertheless, these centers are integrated into the same agricultural landscape as the smaller towns and villages, often with fields adjacent to, and sometimes within, the city walls (Fletcher 2012; Heitzman 2008). Many tropical societies practiced similar forms of low-density, agrarian based urbanism, often for centuries, which demonstrates that these urban forms were socially and ecologically viable, and highly resilient to external shocks (Scarborough and Lucerno 2010). Paradoxically, these same societies underwent decline and reorganisation, such that large-scale low-density agrarian based urbanism was no longer in practice by the 19th century (Fletcher 2012).

The questions raised by the rise and fall of the Chola and Sinhalese empires have currency for our societies in the present. How were these low-density urban forms able to display such resilience over long periods of time, and of equal importance, how did they lose that resilience and ultimately go into decline? The goal of this report, and the SETS project more broadly, is to add to our understanding of these low-density urban forms from the perspective of entanglement and resilience. By placing theories of socio-ecological dynamics within a deep historical framework, we may be able to better understand the condition of tropical societies today, and perhaps their resilience in the face of future change.

METHODS

This report is principally the result of ground-level reconnaissance of a selection of settlement features, both “living” and archaeological. Accordingly, the dataset consists of roughly 3,400 digital photographs recording all manner of observations, from the sculptures and iconography of ancient temples to broad swaths of landscape. Although we were able to visit many sites relevant to the study, such as temples, water tanks, canals, dams, monasteries, and museums, the importance of travelling between these locations should not be understated. In fact, the view from the van window furnished perhaps the best sense of contemporary settlement patterns, and in some cases, the relationship between the contemporary and the ancient.

BACKGROUND

The Temple Towns of Southern India

The distinction between urban and rural settlement under the Chola Empire is poorly defined; rather, the landscape is characterized by a polycentric network of population clusters which, though of varying size, demonstrate the centrality of the temple at both local and regional scales (Heitzman 1987a, 2008). Temples served as nodes of local administration and commerce, as well as avenues of integration for the larger Chola state and economy through political and mercantile funding to the temples themselves, as well as tax-free endowments of land to families of brahmanas (Heitzman 1987a, 1987b:58, 2008:46). Furthermore, they provided an avenue for local rulers to gain legitimacy through association with Chola royalty (Heitzman 2008:44).

The temples attracted artisans, merchants, agriculturalists and brahmanas, creating population
clusters on the landscape (Heitzman 1987a:793). Some temples grew into cities unto themselves, for example, the Sri Ranganathaswamy Temple, on the island of Srirangam north of Tiruchirāppalli, contains 78 hectares of residential, commercial, and religious space within seven concentric walls, the outer of which measure a kilometer at each side (Heitzman 2008:46). The streets immediately outside the temple walls were home to members of the upper castes, while secondary roads radiated outwards, linking neighborhoods, and surrounding villages with the temple (Heitzman 1987a:793).

Although temples became the focal points of villages, towns, and cities, the agricultural foundation of Chola period society was never far away. Gardens and orchards were integrated into the urban matrix, while fields of rice paddies and associated reservoirs and irrigation systems extended to the edge of the settlement (Heitzman 1987a:793; 2008:46). Führer-Haimendorf’s (1962) ethnoarchaeological account of Apa Tani villages in northeastern India vividly illustrates a low density settlement pattern which may be similar to that which existed during the period of Chola rule in Tamil Nadu:

…the villages, like small mediaeval towns with winding streets and long rows of gabled thatched roofs, pressing round them the dark groves of Pinus excelsa [Himalayan pine] and light-green bamboo gardens, which in the spring are broken by the pink blossoms of fruit trees, and in the centre the brilliant expanse of flooded rice-fields, an expanse one might mistake for a lake, were it not for the irregular lines of dissecting dams. From this luminous sea emerge islands clothed in groves and gardens, and irregular peninsulas of dry fields and pasture… [Führer-Haimendorf 1962:15-16]

Houses in the Kaveri delta were similarly organized into widely spaced clusters within an encompassing network of fields, gardens, and reservoirs (Heitzman 1987a:793, 819). This pattern of population clustering in direct association with agricultural fields characterized both large and small settlements, with the distinction only apparent through a gradation of ever more closely-spaced settlement clusters (Heitzman 1987a:793, 819).

**Settlement in the Sri Lankan Dry Zone**

Settlement in Sri Lanka, as with Southern India under the Chola dynasties, was centered on religious and administrative nodes. The capitals of Anuradhapura and Polonnaruwa were characterized by central, often walled royal precincts nested within an inner city of administrative and monastic elites, and an outer city of lesser nobles, merchants, and artisans. Ringing the city center were monasteries of enormous size, containing thousands of monks and monumental stupas, which continue to dominate the landscape today (Bandaranayake 2007a:219). Further out, smaller monasteries may have served religious, administrative, and economic roles for the support population (Coningham et al. 2007:717).

The substantial water management infrastructure and field systems of the surrounding countryside hint at large suburban agricultural populations within the vicinity of the city center (Bandaranayake 2007a:234). However, little is known of these populations from either historical records or archaeological excavations, which have mostly focused on palatial and monastic architecture at the expense of the more ephemeral structures of the suburban and rural areas (Bandaranayake 2007a:222, 225). Nevertheless, historical records from later periods speak of village clusters centered on irrigation reservoirs, and dispersed amongst a network of rice
paddies, household gardens, and orchards of fruit trees (Codrington 1938:1). These villages often consisted of families belonging to the same specialized occupational caste, though some of the larger villages contained multiple such castes (Codrington 1938:1). Generally speaking, this “tank village” (Bandaranayake 2007a:236) settlement pattern of the 18th century exhibits many similarities with the low-density urban arrangements found in southern India under the Chola dynasty. However, given the absence of large-scale horizontal excavations of residential and rural areas in the Sri Lankan dry zone, extending these patterns back to the Anuradhapura and Polonnaruwa periods is speculative.

The same can be said for the residential structures themselves. While structures of a monastic, royal, or administrative nature were built of durable materials such as brick and stone, the majority of the suburban and rural residences from the Anuradhapura or Polonnaruwa period were of perishable materials, and thus, no longer survive (Bandaranayake 2007b:305). Once again, the direct historical approach may be employed to the extent that we are comfortable presuming that the materials and methods of household construction represent a conservative aspect of Sinhalese culture over the last millennium.

Traditional domestic architecture of the present and recent past consists of rectangular structures on raised earthen platforms with a superstructure of timber and thatch, wattle and daub, or compressed mud (Bandaranayake 2007b:306; Karunaratne 2007:561-562). Timber posts support rooves of palm thatch, rice, or straw, or in the case of wealthier households, clay tiles (Karunaratne 2007:561). Floors consist of a mixture of cow-dung and clay drawn from ant hills, a method which continues today (Ariyapala 1956:312). The smallest houses were of one room, while those of wealthier households had multiple internal divisions as well as separate structures oriented around a central courtyard (Ariyapala 1956:313; Karunaratne 2007:563). Grain silos of mud and reed, known as bissas, were common components of household compounds in rural villages (Karunaratne 2007:563).

**FINDINGS**

**Strengths and Limitations of the Dataset**

Very little remains of the settlements in question, which is not surprising given the centuries that have passed since the dissolution of the Chola and Sinhalese empires. As discussed previously, the domestic structures of the support populations were built of perishable materials and leave no traces above the surface of the ground, while the written records of the time, as well as the archaeology of the present, have tended to privilege the monumental religious, ceremonial, and administrative centers. Furthermore, the substantial population growth of the past few centuries, and the urban sprawl associated with it, has partly obscured the settlement patterns of the more distant past (Heitzman 1987a:793). Consequently, the distribution of settlement in the past must be inferred, to the extent possible, from what remains on the surface in the present.
Fortunately, there are a number of architectural features from the Chola and Sinhalese empires that persist on the landscape today, and which can be used to anchor key points of the ancient landscape into contemporary settlement patterns and land use practices. The most obvious of these temporal anchors include the many Hindu temples of Tamil Nadu and Buddhist monasteries of Sri Lanka, as well as the tanks, reservoirs, canals, and dams which represent the massive investment in water management infrastructure by these societies. As well, some of the contemporary roadways lie on ancient road beds (Heitzman 2008:48) while others may follow the paths of ancient trails. Finally, many of the towns and villages on the landscape today can be expected to have substantial antiquity as population clusters, though given the population growth of both regions, many are likely to represent newer developments as well.

Figure 7.2 (a) The countryside around Thanjavur, South India; (b) Granite plutons at Vijayalayacholeswara, south of Tiruchirāppalḷi, South India. SETS team in foreground.
Ancient and Contemporary Settlement in the Kaveri Delta

Our study in India took place within the Kaveri delta, a flat, fertile plane (Figure 7.2a) bounded by the numerous tributaries of the Kaveri River, which part ways at Tiruchirāppaḷḷi and flow east to the Bay of Bengal. A series of granite plutons within and around Tiruchirāppaḷḷi provide a stark contrast against the otherwise flat topography and represent the only obvious relief in the region (Figure 7.2b). The landscape is characterized by a mix of rice paddy

Figure 7.3. (a) The edge of Tiruchirāppaḷḷi, from the Erundeeswarer Temple, South India; (b) Rice paddies within Tiruchirāppaḷḷi, from the Erundeeswarer Temple, South India.
agriculture, and open land covered with scrub, low bushes, and stands of trees.

We focused on three population centers and their surroundings: Kumbakonam, Thanjavur, and Tiruchirāppaḷḷi, listed from east to west. All three cities now represent high-density urban centers of over a hundred-thousand people with a clear, if gradual, transition to the much lower density countryside (Figure 7.3a). Nevertheless, the low-density urban form of the past is clearly visible towards the edges of the cities, where agricultural fields intermingle with blocks of suburban homes, and sometimes even form pockets contained almost entirely within urban

![Figure 7.4. (a) A dry water tank at the 108 Sivalingam Temple in Papanasam, South India; (b) The Aiyarappar Temple overlooking the village of Tiruviyaru, South India; (c) A small temple in the countryside around Tiruchirāppaḷḷi, South India; (d) A small temple surrounded by fields outside of Kumbakonam, South India.](image)

settlement (Figure 7.3b). The granitic plutons of Tiruchirāppaḷḷi afford the only birds-eye view available for any of these cities, and from above, it is hard to believe that the city hosts nearly a million residents. The picture, however, is very different at street level, where the bustling crowds belie Tiruchirāppaḷḷi’s low-density appearance.

Large, visually impressive Chola period temple and tank complexes lie at the center of Kumbakonam and Thanjavur, while one of the largest temples in India is found on the island of Srirangam just to the north of Tiruchirāppaḷḷi. The centrality of these temples is repeated at a
smaller scale throughout the countryside. Every town and village has at least one temple, often located near the center, and usually associated with a water tank (Figure 7.4a, b). Small temples and shrines are found even further from population centers, either among small clusters of houses or standing alone in the middle of paddy fields (Figure 7.4c, d). The temples exist in a nested hierarchy of size, which correlates with the density of the surrounding population. As such, they provide substantial redundancy at the local level, in terms of their religious and administrative functions, as well as the provisioning of irrigation and drinking water from their associated tanks.

Interestingly, the association between the ancient temples and water provisioning appears to continue to this day. Modern water towers can be seen adjacent to many of the temples throughout the smaller towns and countryside (Figure 7.5). This association suggests that the
temples were intentionally built on high ground, which is also favorable for the placement of water towers. If so, this indicates that visibility was an important criterion for selecting temple locations. Furthermore, if we assume that slight elevations on an otherwise flat plain would be desirable in general, then it appears as though the temples were given primacy on the landscape, and served as the focal point around which population centers developed (see also Heitzman 1987a). However, to suggest a more prosaic explanation, the modern water towers may simply be drawing water from the existing tank infrastructure, which would demonstrate the degree to which ancient hydraulic engineering continues to shape settlement in the Kaveri delta. In either case, this is a pattern worth further investigation.

The visibility of the temples appears to be an important design factor regardless of their location on the landscape. The gopurams (entrance towers) of even the small temples stand clearly above the trees, while those of the larger temples dominate the otherwise flat landscape on a regional level (Figure 7.6). Furthermore, temples are found atop the plutons around Tiruchirappalli, which provide the only natural sightlines in the region (Figure 7.7). From a perspective of social integration, the visibility of the large urban temples from the rural areas may have blurred the distinction between the rural and urban populations (Heitzman 1987a:819), further reinforcing the nested, self-similar nature of the settlement pattern.

**Low Density Urban Settlement in North-Central Sri Lanka**

Anuradhapura and Polonnaruwa lie within the North-Central province of Sri Lanka, a relatively dry, forested region of low mountains and broad valleys. Both cities are surrounded by
numerous natural and anthropogenic lakes, which were created in antiquity by damming natural drainage valleys. The remaining valley bottoms of the countryside are characterized principally by rice paddies.

The ancient low-density footprint is much more evident in the contemporary urban areas of Sri Lanka than in the Kaveri delta. Large blocks of rice paddies are distributed in a mosaic pattern amongst suburban neighborhoods (Figure 7.8). The paddies themselves are occasionally interrupted by small orchards of economically useful trees. Though the modern centers of both Anuradhapura and Polonnaruwa lie adjacent to the ruins of the royal and religious precincts, the massive stupas of the ancient capitals continue to dominate the skyline and remain in use today.

Figure 7.7. The Erundeeswarar (top) and Vijayalayacholeswara (bottom) temples sit atop granite plutons overlooking the surrounding settlement and countryside, South India.
As with the temples in South India, visibility appears to have been an important factor in the location and design of the Buddhist stupas, in terms of both their massive size and their location on exposed mountain peaks (Figure 7.9b). This may have allowed them to perform as nodes of ideological control for the capitals, even as they also served local administrative and economic functions (Coningham et al. 2007).

The transition from the cities to the rural areas is marked only by the ever-shrinking size of the urban blocks, eventually reaching the point where the houses are strung in a thin, though fairly consistent line along the roadways. These rural houses often possess small gardens, while

**Figure 7.8.** Large blocks of rice paddies can be found right in the center of Polonnaruwa (top), while further outside the city agricultural blocks alternate with low-density suburbs (bottom, image taken from Dimbulagala monastery), Sri Lanka.
large blocks of rice paddies cover much of the rural landscape. However, the *bissas* (grain silos) discussed in the literature are rarely found associated with modern rural houses, and no alternative form of household agricultural storage is immediately apparent.

With the exception of the massive monastic complexes that ring the royal precinct and inner city, the smaller stupas and bodhi tree shrines seem to lack the urban centrality of the Hindu temples in southern India, instead they seem to be distributed more towards the edge of the settlements, often within stands of trees (Figure 7.10). At the extreme end of the scale are the monastic retreats located in the forests and mountains. Some of which remain in use today, such
as Kaludiya Pokuna (Figure 7.11).

Though nothing remains of the houses of the suburban and rural support populations, traditional house construction techniques are still employed in some rural areas. We were able to see many such techniques up close, including houses with wattle and daub or compacted clay walls, thatch roofs, and cow-dung floors (Figure 7.12). However, though these techniques are known to be traditions of the last few centuries, their projection back to the Anuradhapura and Polonnaruwa periods must remain speculative.
RESILIENCE IN SUBURBAN AND RURAL SETTLEMENT

The few elements of Chola and Sinhalese period settlement which remain visible today demonstrate that small-scale resilience in social praxis existed alongside large scale political, religious, and infrastructural entanglement. The many small temples and shrines distributed across the landscape demonstrate both a heterarchical organization of religious, administrative and economic functions at the local level, while simultaneously existing in a nested hierarchy of size, elaboration, and regional visibility anchored by the massive temple/stupa complexes of the city centers. Furthermore, donation records from the rural temples in South India demonstrate an economic and political tie with the power and prestige of the Chola royalty (Heitzman 2008:44).

![Meditation houses in the rocks of the Kaludiya Pokuna forest retreat, Sri Lanka.](image)

*Figure 7.11. Meditation houses in the rocks of the Kaludiya Pokuna forest retreat, Sri Lanka.*

Similarly, water management projects are present as both small village and temple tanks, as well as regional projects such as the irrigation canals and dams of the Kaveri delta, and the massive reservoirs of Anuradhapura and Polonnaruwa. On the one hand, these projects would have helped to insulate local irrigation against water shortages, while at the same time, they represent expenditures of labour and resources in the maintenance of systems which tie individuals and communities to specific locations on the landscape, and particular modes of subsistence, all of which may reduce their ability to adapt to dramatic social and environmental change.

The suburban and rural settlements of the Chola and Sinhalese empires appear, at the local scale, to have taken the form of resilient heterarchical arrangements, but were also embedded
within a larger scale framework of regional political, economic and environmental entanglements and centralising authority. Given the limitations of the present dataset, the trajectory of these competing forces over time cannot be addressed; however, Heitzman (1987b:54, 58) argues that the Cholas were undergoing a process of greater centralization and local involvement towards the end of their rule.

Finally, a comparison between past and contemporary settlement patterns can provide some insights into resilience and entanglement in South India and Sri Lanka today. Large agricultural tracts within the urban areas, especially notable at Anuradhapura and Polonnaruwa, reduce the social and economic costs of transporting staple resources long distances (Isendahl and Smith 2013:133). Furthermore, a local food supply can be invaluable if the regional and national food markets are temporarily disrupted, although this is largely dependent on issues of local land ownership and resource redistribution, which are beyond the scope of this study. Similarly, the household gardens and local orchards of the rural areas provide a redundant food supply for agricultural communities in case of broader market disruption; however, the apparent lack of grain storage at the household level suggests that agricultural surplus is being quickly sold on the market. This opens rural households to vulnerabilities from both regional and international markets; currencies and food stores can both rapidly lose market value in times of crisis, but the food remains edible nonetheless.
Finally, the small suburban and rural temples and shrines remain in use, providing social and religious redundancy at the local level while also demanding an economic cost in maintenance, and entanglement with the landscape. This latter point is reinforced by the addition of modern water towers on the grounds of so many temples in the Kaveri delta. Though the exact relationship between the two is currently an unknown, if the water towers do in fact draw on the ancient reservoirs, then they represent further entanglement with millennia old hydraulic systems. Stacking infrastructure on top of infrastructure creates a situation where a change in the water table that causes a failure of the ancient water system will also jeopardise the modern water supply.

CONCLUSIONS

Though little archaeological evidence exists for the suburban and rural populations of the Chola and Sinhalese empires, the low-density urban patterns of the past are apparent from the conspicuous monuments and infrastructure that remain, as well as the layout of the modern settlements. The impression that I developed while travelling through these landscapes is of highly redundant and localized settlement traditions being pulled towards greater complexity and centralisation by the capitals of the respective empires. The trajectory of these competing processes, as well as their impact on the disintegration of the Chola and Sinhalese empires, can only be assessed with a better understanding of how these factors changed over time.

The patterns discussed in this report provide a direction for more systematic and diachronically oriented research in the future. However, this report also demonstrates the importance of travelling broadly through the landscape: a focused chronological study of a limited area would likely have missed a number of spatial patterns discussed here. For example, the placement of a water tower next to a temple hardly seems worth noting until the fourth or fifth such combination passes by the car window. The archaeological and historical literature is invaluable, but is also limited to the patterns which were both noticed and deemed noteworthy by previous observers, and denies the opportunity to discover other patterns which are present on the landscape. Similarly, I have no doubt that I have left some patterns behind for future researchers to discover as well.

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CHAPTER 8
INVESTIGATING THE SOCIO-ECOLOGICAL ENTANGLEMENT OF INTEGRATIVE MECHANISMS IN EARLY LOW-DENSITY AGRARIAN TROPICAL SOCIETIES: CASE STUDIES FROM VIETNAM, SOUTH INDIA, AND SRI LANKA

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INTRODUCTION

At the forefront of contemporary affairs is a concern for how factors such as climate change, the depletion of natural resources, population growth, and increased globalization will affect society in the near future, which in turn has raised an interest in socio-ecological systems (see Iannone 2014). Constanza and colleagues (2007:8) suggest that because the present state of socio-ecological systems is contingent on the past, an understanding of the present will require research that reaches back through the millennia. Thus, given that our data sets are both comprehensive and demonstrate considerable time depth, archaeologists are poised to play a significant role in this important research (Drennan et al. 2012:1; see also Iannone 2014). It is within this academic climate that the Socio-ecological Entanglement of Tropical Societies (SETS) project was initiated (Iannone 2014). The prime objective of the SETS project is to produce a comparative study of the socio-ecological dynamics in a variety of low-density tropical urban civilizations, with a specific focus on the factors that resulted in the “collapse” of a number of “Charter States” (CE 800-1400) throughout South and Southeast Asia (Iannone 2014).

This chapter’s specific contribution to the SETS project is the examination, evaluation, and comparison of the integrative mechanisms evident within a sample of charter states from Vietnam, South India, and Sri Lanka. States seek to increase economic, socio-political, and ideological integration. Such integration is simultaneously achieved through both vertical power relationships of inequality, and horizontal group affiliation (Blanton et al. 1996; DeMarrais et al. 1996; Schoenfelder 2004:402). Although various methods of integration have been identified, this research concentrates on the monumental public architecture and spaces of the built landscape which foster integration (Chase and Chase 2009:17-18; DeMarrais et al. 1996:16; Lawrence and Low 1990:459, 463; Lohse and Gonlin 2007; Peuramaki-Brown 2012:241; Schoenfelder 2004:402). Such integrative mechanisms may include roads, temples, monasteries, markets, administrative nodes, hospitals, rest houses, and storage facilities. The construction and subsequent maintenance of these integrative mechanisms would have been an important factor in the consolidation and stability of early tropical charter states. However, through their construction and continual maintenance, states often become highly entangled in a web of reliance and resource input with these integrative mechanisms. This form of entrapment may then lead to a lower level of resiliency. Thus, it is through a cross-cultural comparative approach of these integrative mechanisms that a greater understanding of the dynamics of early complex societies may be attained (Fletcher 2012:325; see also Iannone 2014; Smith 2012).

Theoretical Underpinnings: Resilience and Entanglement

Entanglement theory and Resilience theory provide productive tools for the analyses of early tropical states and their integrative mechanisms (see Iannone 2014). Resilience theory strives to
more fully comprehend how societies change through time via the core concept of adaptive cycles. Adaptive cycles demonstrate the transformation(s) of states as they transition through four specific phases. These phases include: exploitation/rise (r phase), conservation/prosperity (K phase), release/collapse (Ω phase), and reorganization (α phase; Holling 2001:394; Redman 2005:72-73). A variety of continua factor into the resilience and vulnerability of states, which ultimately induce the movement from one phase to the next. Such continua include flexibility to rigidity, diversity to uniformity, innovation to conformity, openness of the system, significant reserves to diminishing reserves, tight feedback to loose feedbacks, redundancy to top-down control and management, intermediate levels of modularity to too much, or limited modularity, significant to diminished social capital, and resilience-positive to resilience-negative efficiency (Iannone 2014:Table 1.2; see also Holling and Gunderson 2002; Walker and Salt 2006, 2012).

Hodder’s (2012; see also 2011) theory of entanglement focuses on the ways in which humans and things become entangled with one another, which can lead to particular entrapments. While Hodder’s theory of entanglement closely mirrors Latour’s (1993, 1999, 2005) concepts of the lives of things and Actor Network Theory (ANT), Hodder’s theory differs slightly, but in a profound way. “…Rather than talk of things and humans in meshworks or networks of inter-connections, it seems more accurate to talk of the dialectical tension of dependence and dependency, historically contingent. Rather than networks we seem caught; humans and things are stuck to each other. Rather than focusing on the web as a network we can see it as a ‘sticky entrapment’” (Hodder 2012:94).

By dependence Hodder (2012:17-18) is referring to a sense of “relying on,” that is enabling while dependency involves a form of restraint or contingency. Entanglement involves four sets of dependences and dependencies; humans depend on humans, humans depend on things, things depend on humans, and things depend on things (Hodder 2012:88). “The social world of humans and the material world of things are entangled together by dependences and dependencies that create potentials, further investments and entrapments” (Hodder 2012:89). Thus, it appears that as states move through the adaptive cycle from r phase to K phase, the states demonstrate an increase in entanglement and a resulting decrease in resilience.

The Research Sample

This research evaluates the quality of integrative mechanisms as they pertain to the investigation of long-term socio-ecological dynamics and entanglement of early tropical charter states. This specific chapter will focus on the research performed on the following tropical charter states located in Vietnam, South India, and Sri Lanka:

- The Dai Viet Kingdom (CE 1009-1400), Northern Vietnam, centered on the capital of Thang Long.

- The Cham Kingdoms (CE 380-1471), Central Vietnam, centered on the capitals of Simhapura/Tra Kieu (CE 350-758), Indrapura/Dong Duong (CE 758-986), and Vijaya/Cha Ban (CE 986-1471).

- The Chola Empire (CE 849-1279), South India, centered on the capitals of Thanjavur (CE 848-1025), and Gangaikonda Cholapuram (CE 1025-1279).
The Sinhalese Empire (377 BCE- CE 1310), Sri Lanka, centered on the capitals of Anuradhapura (377 BCE-CE 933) and Polonnaruwa (CE 933-1310).

Field work for these early tropical charter states took place during two separate research trips. The first research trip took place over the course of three weeks during the month of December in 2014, and focused solely on the ancient kingdoms of modern day Vietnam. During field research, six days were spent in the city of Hanoi, investigating sites associated with the Dai Viet Kingdom; five days were spent in the city of Qui Nohn investigating sites associated with the Cham Kingdoms; and five days were spent in the city of Hoi An, also investigating sites associated with the Cham Kingdoms. The second research trip took place over the course of approximately four weeks, straddling the months of May and June in 2015. Time during this research trip was evenly divided between the investigation of the ancient empires of modern day South India and Sri Lanka. During this field research, six days were spent in both the city of Thanjavur and the city of Kumbakonam in South India, investigating sites associated with the Chola Empire; and six days were spent in both the town of Anuradhapura and the town of Polonnaruwa, investigating sites associated with the Sinhalese Empire.

The goals of this research were to evaluate the integrative mechanism data sets from the early tropical charter states located within Vietnam, South India, and Sri Lanka. This evaluation included assessing the quality, variety, and availability of the data sets. Research such as this is important as it aids in building towards a transdisciplinary and cross cultural study of entanglement in the tropical societies of the past. As contemporary states in the tropics are finding themselves further and further entangled in the structure and commodities of their society, this work can help elucidate some of the potential problems. Additionally, this work has the potential to demonstrate how certain strategies were effective in the dis-entanglement from these structures and commodities.

The main research methods adopted for this phase of the research by the Principle Investigator, Dr. Gyles Iannone, are based on the theory of data proximity (Iannone 2013, 2014). This theory argues that proximity to data and first-hand accounts are crucial to comparative studies (Drennan and Peterson 2012). Of paramount importance in data proximity is on-site visits to each archaeological site. It is important to point out that during these on-site visits no archaeological excavations or formal survey took place. Rather, methods employed during these on-site visits included detailed photographic and written documentation, visiting the site museums, and acquiring information from local sources. Additionally, background research is essential to provide context to these investigations. It is also a hope that through such liaisons, difficult to attain resources such as primary sources may be acquired.

**BACKGROUND: LITERATURE REVIEW**

As previously stated, an in depth review of background literature of these sample of early charter states and their associated integrative mechanisms is essential for this research. Although the following background research is by no means exhaustive, it does provide a good foundation for our understanding of integrative mechanisms, and the role they play in socio-ecological dynamics and entanglement of each early state. A literature review of each charter states is provided below, with emphasis on their various integrative mechanisms.
The Cham Kingdoms (CE 380-1471), Central Vietnam, centered on the capitals of Simhapura/Tra Kieu (CE 350-758), Indrapura/Dong Duong (CE 758-986), and Vijaya/Cha Ban (CE 986-1471) 

The Cham Kingdoms of Vietnam date from the end of the fourth century CE to the fifteenth century CE. The Cham Kingdoms territories ranged from the area south of the Quảng Bình Province to the Bình Thuận Province, which includes the coastal plains and the highlands of South-Central Vietnam (Trần 2006:3). The oldest Cham capital was Tra Kieu, which served as a political and economic center in the north (Hall 2011:68-69). This study utilizes the term “Kingdoms” to refer to the Cham, given that it is widely observed that the Cham were never fully unified into a single kingdom.

Temples. Arguably, the most significant legacy of the Cham Kingdoms that remains are the brick temple-towers, which are found across the coastal lowlands, with a few in the highlands (Trần 2006:7). According to Trần (2006:7), most temples of the Cham Kingdoms were erected along the main rivers of the region. Such a geographical layout of Cham temples maps well to Bronson’s (1977) political and economic model for the Cham Kingdoms, which he called the “riverine exchange network” (see also Trần 2006:4). In such a model, the kingdoms are organized along the river networks, and thus, we would expect to also find temples located near the rivers. In addition to mostly being located near rivers, Hall (2011:73) suggests the most important royal Cham temples were also associated with a sacred mountain.

Temples and temple complexes, or religious sanctuaries of the Cham Kingdoms, exhibit certain similarities as they were strongly influenced by South Asian Hindu elements (Trần 2006:8). In particular, Cham temple complexes or sanctuaries demonstrate a certain configuration in which the sanctuary is centered on a core temple, known as the kalan (Hall 2011:73). Influenced by the Hindu sikhara, the roof of the Cham kalan could be interpreted as mount Meru, while the sanctum sanctorum, or inner chamber, housed the sacred image or a yoni-linga (Trần 2006:8). The core temple or kalan was then encircled by small towers or temples, ancillary buildings, and surrounded by a wall (Trần 2006:8). Continuing with the South Asian Hindu influence, Cham temples almost always face east (Hall 2011:73).

According to Trần (2006:6-7) the primary characteristics of Cham temple architecture included a flat foundation of the main sanctuary, a square cylindrical inner sanctum or chamber, and a three-stage pyramid-shaped roof. Corbel building techniques were an important part of the Cham temple aesthetic (Trần 2006:7). This architectural technique involved stacking the building material in a slightly offset manner to the spire of the roof. This corbel style resulted in tall structures with relatively large vaulted internal spaces. This architectural technique and style was also utilized by the Khmer and the kingdoms of Central Java (Trần 2006:7).

Cham temples demonstrate a variety of sandstone carved sculptures, and various motifs carved into the brick walls, which give Cham temples a “subtle beauty” (Trần 2006:12-13). However, there are certain motifs that are common across the Cham region. The motif of female breasts is one common element found carved on Cham temples and pedestals across several centuries (Trần 2006:12-13). This decorative motif of female breasts, as well as depicting individuals with hairstyles in which the hair is tied in a bun at the back of the neck, are apparently typical art features indicative of Austronesian people (Trần 2006:12-13). In contrast, art features typically associated with Austroasiatic people include sculpted individuals depicted with hair that is long and curly, which falls down the shoulder, and large round ears with ornaments (Trần 2006:14).
According to Cham inscriptions, it appears that temples built prior to the 7th century CE were constructed from wood; however, these were all destroyed during conflicts (Trần and Nakamura 2008:5, 11; 2012:268). Thus, brick and sandstone temples subsequently appeared in the 7th century onward (Trần 2006:8). The most commonly used construction material was baked brick, whereas sandstone appears to have only been used as a building material for pillars, lintels, and some decorations such as sculptures (Binda et al. 2006:1480; Trần and Nakamura 2008:10). Bricks of different lengths and thicknesses were used for a variety of different purposes and were rubbed together until their fit was perfect. In many cases the exterior of temples were sculpted; however, this was carried out after all the bricks had been laid and the building was completed (Trần 2006). Investigations at the religious sanctuary of Mỹ Sơn indicate that the temples were constructed from fired bricks jointed by extremely thin layers of natural resin (Binda et al. 2006:1480). Trần (2006:23) notes that the resin was a natural glue, which could have been produced in large quantities each year. The resin functioned as an adhesive and when mixed with dry clay was used as a fine mortar. These techniques resulted in a bond between the bricks so tight that the joints were almost invisible. Additionally, the resin was waterproof and was used to coat the walls of the building to avoid moisture absorption.

Temples and temple complexes or sanctuaries appear to have been mainly commissioned by the rulers (Southworth 2012:76). Ancient inscriptions from the religious sanctuary of Mỹ Sơn state that the king, Phạm Hồ Đạt, erected a temple at the site and made a land endowment for the purpose of maintaining the temple (Trần and Nakamura 2008:4; 2012:268). After the Cham temple’s construction was commissioned, the temple was then sustained through “meritorious tax-free transfers of income from designated lands that were dedicated to support the temples” (Hall 2011:71). Although within inscriptions rulers are the prominent figures identified as the commissioners of temples, it appears other individuals also donated structures. Inscriptions have been recovered that describes the donation of two monastic buildings and two temples within the plain of Phan Rang (Southworth 2012:80). Although the man’s name is indicated (Samanta), and it is noted that the inscription was commissioned by his son, the man’s hierarchical position within Cham society is not indicated (Southworth 2012:80).

Monasteries. There is very little discussion of monasteries within the literature. However, it appears that the religious sanctuaries may have also functioned in some kind of monastic capacity. Mỹ Sơn was the Cham region’s most important religious sanctuary and economic center, which was located in the north of the Cham region (Hall 2011:69). Located approximately 450 km south of Mỹ Sơn, was Pô Nagar Nha Trang, the Cham region’s secondary religious sanctuary (Hall 2011:69; Trần and Nakamura 2008:11). While the literature does not discuss the customary monastic use of the sanctuaries, Trần and Nakamura (2008:10; 2012) argue that the artistic representation and geography of the two distinct sanctuaries reflects their own characteristics of cosmological dualism. “Mỹ Sơn is located in a deep valley surrounded by mountain ranges; while the Pô Nagar Nha Trang sanctuary is located on a riverside hill near an estuary. Mỹ Sơn belonged to the Amaravati state in North Champa; while the Pô Nagar Nha Trang sanctuary belonged to the Kauthara state in South Champa. Thus from [the] 8th until the 13th century, the two royal sanctuaries of the Cham kingdoms manifested their dualistic characteristics as follows: Mỹ Sơn = Bhadresvara (Siva)/Mountain/Father; Pô Nagar Nha Trang = Bhagavati- Pô Yang Inu Nagar/Sea/Mother” (Trần and Nakamura 2008:10). This may suggest the co-existence of dualist states/clans, and manifested a cosmological dualist cult centered on the two sanctuaries (Trần 2008:6; Trần and Nakamura 2008:18; 2012). This type of cosmological
dualism can also be observed in contemporary Cham communities along the south central coast of Vietnam (Trần and Nakamura 2008:19: 2012).

Additional information regarding monasteries comes from inscriptions. As previously stated, inscriptions were recovered that describe the donation of two monastic buildings within the plain of Phan Rang (Southworth 2012:80). The monastic buildings were commissioned by a man named Samanta, however, his hierarchical position within Cham society does not appear to be indicated (Southworth 2012:80).

Roads. Within the literature there is very little discussion of road networks within the Cham Kingdoms, however, there is some evidence to suggest they existed. Upon their arrival in Vietnam, nineteenth century French archaeologists were highly impressed with the remains of Cham urbanism and regional networking. In particular, within the Tra Kieu region they found primary and secondary centers that were linked by road networks on raised embankments which were paved with stone, as well as stone bridges built over canals (Hall 2011:70).

Additional information regarding roads suggests that in 992 AD Lê Hoàn sent 30 men to build a road from modern Cửa Sòt (Thạch Hà county, Hà Tĩnh province) to the Cham-Viet border in Hoành Son area (which is north of Hội An; Li 1998). However, the author mentions nothing else regarding the road.

Administrative Nodes. A Cham Kingdom is understood as a mandala, which indicates that it was not a unified political entity, but rather, a federation of regions, each with their own political centers (Trần 2008:4). As previously stated, the political and economic networks of the Cham kingdom appear to follow Bronson’s (1977) model which he called a “riverine exchange network.” Within this model, each mandala has its own riverine exchange network. Nakamura (1999:60) suggests that the “connection between the centers and the peripheries were built on patronage and personal magnetism, instead of institutionalized bureaucracy. As a result, smaller centers tended to look in all directions for security, and centers of spiritual authority and political power shifted endlessly. Thus the characteristics of the Cham state can be seen as a loose, marginally interdependent alliance network among a series of river-mouth urban centers whose very nature was politically and economically unstable. Thus, administrative nodes appear to have been relatively autonomous smaller centers.

Trần (2008:5), however, suggests that each Cham state, or mandala, established three prominent centers along the river: “1. A centre of trade or the port-city at the estuary; 2. A centre of royal power or the royal city; 3. And a centre of royal religion or the sanctuary”. Therefore, one could argue that outside the royal city or epicenter, a main administrative node was the center of trade or port city (Trần 2008:5).

The Dai Viet Kingdom (CE 1009-1400), Northern Vietnam, centered on the capital of Thang Long

The Dai Viet Kingdom emerged during the eleventh century CE, as a result of the breakup of the Tang Dynasty in China (Whitmore 2006:105). The Dai Viet ruled over Northern Vietnam until the fifteenth century CE, with the Kingdom’s capital Thang Long (Hanoi) being located between the Red River delta and its fertile upstream areas.

Temples. Whitmore (2006:118-122) suggests that the long established religious centers of the Dai Viet, which included Buddhist temples and spirit shrines, were located in the mid-river zone of the Red River. The Buddhist temples were mainly located at riverine crossroads of important waterways. The temples formed the center of large estates, which were economically
self-sufficient, as they included agricultural, fishing, artisan, and commercial communities (Whitmore 2006:118). Royalty initially established/commissioned the Buddhist temple at the center of the estate, and then subsequently controlled and maintained the entirety of the estate (Whitmore 2006:118).

According to Whitmore (2006:107), the temples were a key factor in the growth of the Dai Viet Kingdom. Due to their associated economic property through the estates, the growth of temple complexes in the mid-river zone of the Red River increased the political stability for the Lý dynasty (Whitmore 2006:109). From the chronicles, scholars have identified an increase in the construction of Buddhist temples during the first half of the 11th century CE, under the Lý dynasty (Whitmore 2006:108). The chronicles identify approximately 1000 Buddhist temples that were constructed during the initial years of the second Lý reign (Whitmore 2006:108). Throughout the 12th century CE and into the 13th century CE, the Buddhist temples continued to be a major economic force, which helped to create a strong foundation for the Dai Viet state (Whitmore 2006:113).

**Administrative Nodes.** During the reign of the Lý rulers, royal outposts (hành cung, “travel palaces”) were eventually established deeper in the delta of the Red River (Whitmore 2006:108). These outposts were located on waterways, centered on Buddhist temples, and included royal residences, storehouses, and production centres. Whitmore (2006:108) suggests that these royal outposts functioned not only as local bases for royal operations, but also as local centres for trade in the area. In the middle of the twelfth century CE, there a proliferation of these royal outposts in the lower delta of the Red River (Whitmore 2006:111). In the middle of the thirteenth century, the Trâgn rulers extended the central control of the Dai Viet state into the regional areas, and they placed classically trained scholars from the coastal areas in the official positions in these locations (Whitmore 2006:116). These scholars took up administrative positions within the capital, and in the provinces (Whitmore 2006:117).

**The Chola Empire (CE 849-1279), South India, centered on the capitals of Thanjavur (CE 848-1025), and Gangaikonda Cholapuram (CE 1025-1279)**

The Chola homeland was centered on the delta of the Kaveri River in the modern state of Tamil Nadu, South India (Allchin 1995:148; Chakrabarti 1995:274). The Chola had two heights in power in which they ruled: during the beginning of the Christian era, followed by resurgence from the ninth to thirteenth century CE, the latter of which is of main concern for the current research. The two major capitals during the latter resurgence of the Chola Empire, were Thanjavur and Gangaikonda Cholapuram, with the surrounding cities of Tiruchirappalli and Kumbakonam also being of great importance.

**Temples.** According to Champakalakshmi (1996:58), socio-political power and institutional permanence within medieval South India was validated through ideology. This ideology was provided through the vehicle of bhakti, or devotion, which was most often expressed via the Hindu temple (Champakalakshmi 1996:58, 67). It appears validation was sought by members of all sects of society, particularly through the act of gift-giving. Ritual requirements were supplied by the peasantry, artisans, and shepherds who lived in the immediate vicinity of the city or village site of the temple (Champakalakshmi 1996:64). By participating in gift-giving and temple management, members of the nagaram (mercantile group) also sought validation (Champakalakshmi 1996:45). The ruling elite and the king specifically were also reliant on the act of gift-giving to ensure legitimization. Part of ensuring the safety and security of the people
was providing ritual rites that would protect the people from the “menaces of nature” (Champakalakshmi 1996:67). Therefore, the erection and maintenance of temples was key for the legitimization of Chola kings (Champakalakshmi 1996:67). The ruling families, however, also erected temples to legitimize their actions. For example, in order to legitimize inter-regional commercial ventures, religious grants would be provided by ruling families through their political and commercial agents (Champakalakshmi 1996:51-52).

The Brahmana priests were a key component of the temples as they were the mediators between the people and the gods (Champakalakshmi 1996:67). The Brahmana priests were also the agents for “legitimizing sovereignty through divine sanction and fabricated genealogies of divine descent” (Champakalakshmi 1996:59). Therefore, the Brahmana priests had control over the temple and functioned as their economic administrators (Champakalakshmi 1996:59-60). While Hinduism was the main religion of the Chola Empire, Ray (1994:8-9) suggests that Buddhism also played a key role in creating and securing the ruler’s socio-political bonds. For example, in 1003 CE the king of Srivijaya made a donation for the construction of a Buddhist shrine at Nagapattinam in Tamil Nadu, the major port of the Chola Empire. Additionally, in 1005 CE the Chola ruler Rajaraja donated the revenue of an entire village to fund the maintenance of the Buddhist shrine at Nagapattinam. Ray (2003:291) also suggests that in early India the community in general also participated in donating to the Buddhist religious order.

The temple was the ceremonial focal point of the Chola urban center. In certain urban centers, the locus of the ceremonial complex would shift from one temple to another as new rulers patronized new temples in order to legitimize their sovereignty (Champakalakshmi 1996:66). Rulers also sponsored the erection of large temples as a deliberate act of royal policy to create new ceremonial cities, which were the symbol of centralizing power. Hence, Chola rulers continuously replicated the central role of the temple through the renovation of old stone shrines and the construction of new temples. The major temple projects, however, were erected only in the royal/ceremonial centers (Champakalakshmi 1996:61-62). For example, information regarding the construction of Thanjavur was recorded on the temple walls, which states that royal efforts to create the city required over 600 employees and an estimated (although the estimate is questionable) seven to eight years for the construction of the temple alone. These employees were requisitioned from communities across the Chola Empire (Champakalakshmi 1996:63). Another type of Chola urban center, the sacred center, originated and evolved around a cult center or sacred place on the landscape, and thus, the locus of the ceremonial complex never shifted and had the character of a pilgrimage (Champakalakshmi 1996:66). Power within these centers, thus, was intrinsically linked to the “evolution of large temple structures from the nucleus of a single shrine” (Champakalakshmi 1996:68).

Within urban cities and smaller communities, the temple played an innovative role, as it facilitated the advancement in the knowledge of architecture, sculpture, painting, etc., through ritual display (Champakalakshmi 1996:61). Champakalakshmi (1996:42) suggests that the temple also acted to restructure the society. First, land relations were organized around the temple, allowing the temple cult to emerge as a local elite. Second, the concept of purity-pollution facilitated the placement of occupational groups in a ritual hierarchy around the temple, which kept certain groups, such as the untouchables, out of the temple precincts.

The rise in construction of religious edifices, such as monolithic temples and temple centers, was visible in the seventh to ninth centuries CE, just prior to the early phase of the Chola Empire (Champakalakshmi 1996:41). Champakalakshmi (1996:68) argues that the most stylistically sophisticated temples were constructed between the seventh and the eleventh centuries CE, with
its culmination occurring under the middle Chola period (985-1044 CE). This architecture, he suggests, represents the pinnacle of the Chola Empire’s socio-political hierarchy. Then, in the twelfth and thirteenth centuries CE, new authority relations introduced significant changes in the variation of temple architecture, which now included additional structures as well as enclosures, which made the horizontal footprint of the temple complex much larger. This also allowed for diversity in gift-giving, as the outer gopura (gateway) was mainly sponsored by dynastic families and their subordinate chieftains, whereas the inner space and smaller buildings were constructed by powerful agricultural and commercial communities in an effort to acquire validation. In addition to the construction of the temples, ritual paraphernalia and temple servants were also required; the temple servants mirroring the servants of the royal court and their duties (Champakalakshmi 1996:61-62). Furthermore, in the late Chola period, many temples, particularly those in newly controlled territories, required not only servants, but also armed guards (Champakalakshmi 1996:69-70).

**Administrative Nodes and Markets.** The ruling Chola focused strongly on encouraging external trade connections and placed their agents or officers in positions to supervise and control the flow of goods (Champakalakshmi 1996:30). Thus, it is not surprising that ports and markets or commercial centers known as *nagarams* were important administrative nodes within the Chola Empire. The Chola controlled one of the major ports at the time, Kaveripaninam or Poompuhar, which was located on the east coast, and was critical to the economic and political power of the Empire (Rajan 1994:98, 103). Underwater archaeology has also identified a palaeo-channel of the Kaveri River where a wharf or small port of sorts was located at Kilaiyur (Rajan 1994:100). Some ports functioned as an entrepot, collection center, or gateway city to the Chola hinterlands (Champakalakshmi 1996:28-29). These ports, however, were heavily affected by changes in sea-level and shifts in the course of the Kaveri River. In fact, the present course of the Kiveri River flows approximately two kilometers to the south of the ancient port of Kaveripattinam (Poompuhar; Rajan 1994:99).

*Nagarams* were important within the Chola Empire as they helped create a unified political organization and economic exchange, while also functioning as interdependent agents of political synthesis (Champakalakshmi 1996:45). We see the development of market or commercial centers known as *nagaram*, which became extremely important in the trade networks in the subsequent Chola period (Champakalakshmi 1996:44). These markets or commercial centers were generally located at the confluence of rivers in the Kaveri delta which functioned as nodes on the landscape (Champakalakshmi 1996:44). In the Chola period, the *nagarams* became important for the local communities rather than just the royal centers as in earlier centuries, which brought the Chola into a larger inter-regional and international trade network (Champakalakshmi 1996:44, 381-382). After a territorial conquest, the Chola would erect a new *nagaram*, which provided important inter-regional links, and thus, became politically influential (Champakalakshmi 1996:45). Champakalakshmi (1996:46) suggests that royal and political support to commercial organization was key to the stability of the Chola. Also important was the creation of protected mercantile towns located on trade routes and settled agricultural areas from the eleventh century CE onward (Champakalakshmi 1996:52). In the late Chola period, many *nagarams*, particularly those in newly controlled territories, were left in the charge of armed guards (Champakalakshmi 1996:69-70).

Just prior to the emergence of the Chola Empire a trading community emerged as a distinct class in the seventh to ninth centuries CE (Champakalakshmi 1996:30). Later, during the Chola period, their emerged pronounced specializations in marketing and trade, which resulted in
organized and distinct groups that specialized in the trade of specific goods such as textiles and horses (Champakalakshmi 1996:46). It is interesting to note that markets within ceremonial or sacred centers were not of great consequence, as Champakalakshmi (1996:63) suggests that the markets of Thanjavur were neither central nor dominant, but rather simply a product of centers demands.

The Sinhalese Empire (377 BCE- CE 1310), Sri Lanka, centered on the capitals of Anuradhapura (377 BCE-CE 933) and Polonnaruwa (CE 933-1310)

Situated on the island of Sri Lanka, the Sinhalese Empire was centered on two main capitals: Anuradhapura and Polonnaruwa. Anuradhapura is located in the North Central Province of Sri Lanka, within the dry zone (Coningham and Allchin 1995:173). Anuradhapura can be divided into two sections; the ancient city known as the Citadel, and the peripheral zone which includes many monastic complexes and four great stupas (Coningham and Allchin 1995:159). While Anuradhapura dates back to as early as the second millennium BCE, the beginning of the golden age at Anuradhapura and the Sinhalese Empire occurs in the third century CE and continues until the sixth century CE (Coningham and Allchin 1995:163, 169). First mentioned in the reign of Aggabodhi III (A.D. 624-640), Polonnaruwa became the capital of the Sinhalese Empire in the eleventh century CE after Anuradhapura was attacked by the Chola. Polonnaruwa then remained the capital of the Sinhalese Empire until the fourteenth century CE.

Temple. Prior to the Sinhalese Empire, early Anuradhapura was religiously heterogeneous, and included Hindus, Nirgranthas, Jainas, Ajivakas, and Buddhists (Coningham and Allchin 1995:182). The earliest recording of a religious construction is that of a temple for the Nirgranthas (Coningham and Allchin 1995:182). Sacred Buddhist buildings include the bodhi tree shrine, the stupa, the image house, and the chapter house, all of which are often embedded within or associated with a monastic complex (Prematilleke 2007:373-374). These structures were mainly constructed and utilized during the reign of the Sinhalese Empire. These sacred structures were inclusive integrative mechanisms, open for worship to the holy and laity alike, and thus, all members of the community took part in donating to them in order to gain merit (Prematilleke 2007:373-374). Donations were recorded at sites on pillars, with a change in practice to inscribing donations on portable copper plates in the fourth century CE (Ray 2003:140-141).

The first Buddhist stupa constructed at Anuradhapura was the Thuparama Dagoba, whose foundation dates to the arrival of Mahinda and Buddhism in Sri Lanka in approximately 246 BCE. Archaeological excavations suggest that between the third and sixth centuries CE, the preceding experimentation in brick and limestone construction gave way to superior construction techniques and the extensive use of ashlar slabs and pillars made of gneiss (Coningham and Allchin 1995:169). During the Polonnaruwa period there were many invasions from South India, thus while large-scale Buddhist constructions continued, the Polonnaruwa capital also contains the remains of many Hindu temples (Prematilleke 2007:372, 404). We see some more unique architectural styles in the Polonnaruwa period, particularly due to these South Indian invasions (Prematilleke 2007:397). Prematilleke (2007:410) suggests that the South Indian architectural traits were “mellowed down,” which naturalized them and made them appear as local traits.

In the third century BCE, a cutting of the original Mahabodhi tree was brought from India to Anuradhapura and established with its associated shrine, as well as the Cetiya vihara and its attendant religious monuments at Mihintale (Coningham and Allchin 1995:183; Eck 1987:7).
The site of the bodhi tree formed the axis mundi of the Sinhalese Empire, and the axial point of its capital, Anuradhapura, which remained constant, similar to the center or hub of a wheel around which the capital rotated (Eck 1987:7; Wickremaratne 1987:54). Ray (2003:154) suggests that one of the main factors attributing to Anuradhapura’s rise to power was the successive endowment of Buddhist symbols received by the city. These include such things as the sapling from the original bodhi tree, as well as the alms bowl and bones of the Buddha. In the Polonnaruwa period, rather than the bodhi tree, the Tooth relic of the Buddha became the center of the empire, which could be relatively easily moved and enshrined in different temple locations (Wickremaratne 1987:57). Bodhi-tree shrine traditions continued into the Polonnaruwa period, however, the ruins of only a few remain and they are quite simple (Prematilleke 2007:388).

Monasteries. The city of Anuradhapura could be viewed as the center of a ring of extensive monastic complexes, as well as other architectural features (Coningham and Allchin 1995:183). King Vattagamini Abhaya constructed one of the earliest monastic complexes at Anuradhapura, Abhayagiri monastery and its associated stupa, during the first century BCE (Bopearachchi 1994:62). During the late third and early fourth centuries CE, King Mahasen constructed the Jetavanarama monastic complex and its associated stupa, which is the largest Buddhist stupa in the world (Bopearachchi 1994:62; see also Coningham and Allchin 1995:183).

The monasteries were also major consumers of a variety of commodities such as oil, incense, etc. (Ray 2003:278). Excavations within Abhayagiriya and Jetavanarama monasteries at Anuradhapura suggest that these monastic complexes were large consumers of imported goods as well, which included goods from as far away as Rome and Persia (Bopearachchi 1994:70-71). Like the sacred structures, monasteries were also funded through donations that would have not only paid for the construction of the buildings, but also their maintenance, and these would have included such local and imported goods as described above. These donations were often recorded at the sites themselves. For example, within Sri Lanka twenty-eight sites recorded that local chieftains made donations to the Buddhist monasteries (Ray 2003:147).

Monasteries were extremely large complexes that appeared to be completely self-sufficient, as they included living quarters, refectories, hospitals, lavatories (baths and toilets), wells, ponds, pools, gatehouses, walks, assembly halls, exhortation halls, and meditations houses (Bandaranayake 2007:355-356; Prematilleke 2007:373). Additionally, sacred structures such as bodhi tree-shrines, stupas, image houses, and chapter houses were often embedded within the monastic complex or directly associated with the monastery (Prematilleke 2007:373-374). During the Anuradhapura period, certain structures such as refectories and bath-houses demonstrate a standardized plan (Bandaranayake 2007:356). Even when the capital moved to Polonnaruwa, the tradition of building extensive monasteries continued to follow the same general stylistic and construction traditions. Monasteries did not really deviate in style over time, with the exception of two changes: 1) a preference for using brick rather than stone; and, 2) the introduction of South Indian elements of design and embellishment (Prematilleke 2007:373, 411). We also see the continued tradition of the forest dwelling sect of Buddhist monks who resided in caves; however, the tapovana style monasteries that had a double platform found in the earlier periods falls out of use (Prematilleke 2007:373). The Sinhalese monasteries also appear to have included natural parks filled with fruit trees and flower trees (Prematilleke 2007:376).

Hospitals. According to Prematilleke (2007:401-402), the hospital was one of the most important structures belonging to the monasteries, the earliest being found at Mihintale (Prematilleke 2007:401). These hospitals included both living and treatment areas, as well as
lavatories, and medicine troughs cut into stone slabs used to treat ailments such as arthritis and snake bites. Excavations at hospital sites have uncovered medicinal paraphernalia such as surgical instruments and fragments of jars that once contained herbal oils for treatments (Prematilleke 2007:402).

**Administrative Nodes.** Ports were extremely important administrative nodes within the Sinhalese Empire. Mathai, which was arguably the most important port in Sri Lanka, was located close to the Aruvi River or Malwathu Oya, which in turn linked it to the Sinhalese capital of Anuradhapura (Bopearachchi 1994:63). By the fifth century CE Sinhalese Sri Lanka was the main center of trade in the Indian Ocean (Bopearachchi 1994:70). Closure of the Manthai port, unfortunately, occurred because of the destruction of Anuradhapura, and because of the devastation to the “complex system that irrigated the river,” caused by Chola invasions (Bopearachchi 1994:63). The closure of the Manhai port, however, did not signal a decline in the importance of seaports in the Sinhalese Empire. During the eleventh century CE the Gokunna harbour or port flourished as it was connected to the new Sinhalese capital of Polonnaruwa via the Mahawali River (Bopearachchi 1994:63).

It is interesting to note that prior to the Sinhalese period there were administrative functionaries known as parumakas, that included individuals in charge of storehouses at seaports; however, this term was no longer used after the second to third centuries CE (Ray 2003: 148).

**Roads.** With regards to roads within the sacred centers of the Sinhalese Empire, Wickremeratne (1987:45) states: “The major streets, radiating from the center to the cardinal points and the city gates were the means by which the power of the center extended outwards to bring prosperity and stability to the kingdom at large.” Thus, roads were important integrative mechanisms that allowed the ruling elite to control the peripheries, while also functioning as conduits through which the “profane” from the peripheries gained access to the sacred center (Wickremeratne 1987:51). Some major streets, however, were considered Royal Roads, and thus, they were not allowed to be used by the common people, particularly on ceremonial occasions (Wickremeratne 1987:51). Like the ports, their appeared to be administrative functionaries known as parumakas that were superintendents of roads, but once again, this term was no longer used after the second to third centuries CE (Ray 2003: 148).

Rivers were also extremely important integrative mechanisms as they functioned like roads in the movement of both people and trade goods. There were five main rivers that appear to have been navigable year round. Due to seasonal monsoons, rivers originating in the wet zone are perennial, while all rivers in the dry zone (other than the Mahaveli Ganga) are only occasional. Nevertheless, due to well-engineered hydraulic structures, the dry zone had waterways routed over long distances (Bopearachchi 1994:64).

**PRELIMINARY FINDINGS FROM THE RESEARCH TRIPS AND FIELD WORK**

In this section, some of the preliminary findings from fieldwork undertaken during the research trips will be discussed. The results will be disseminated according to geographic area and the associated early tropical charter state(s).
Vietnam: The Cham and Dai Viet Kingdoms

The temples of the Cham Kingdoms are quite similar to those of the Khmer (Figure 8.1). The Cham and Khmer temples both, in general, follow the South Asia Hindu model in their construction. However, within this stylistic framework, it is suggested that individuals and communities altered the customary model to suit their specific needs, and that these stylistic and architectural modifications could be studied spatially and diachronically (Mitch Hendrickson, personal communication 2014). The results of such a study could demonstrate spatial and temporal changes in ideological integration and provide insights into community identity and agency throughout Greater Angkor and the Cham region. Unfortunately, very few temples in the Cham region have survived, and thus, the existing data does not allow for a robust study unless integrated into the larger Angkor study.

Although few of the temples remain from the Cham Kingdoms, those that are still intact or have been reconsolidated are quite large. In many ways, they are comparable to the early brick temples of the Khmer. It is obvious that these monuments required an immense amount of material, labour, and skill; however, quantifying this could be quite challenging. As previously mentioned, however, discussions with new scholarly liaisons have provided new insights into possible methods of quantifying the amount of material used to construct the monuments of Angkor using the results from LiDAR, and through simple measurements of the structure using tape measurements performed in the field (Mitch Hendrickson, personal communication 2014). A similar method could also be used to quantify the materials required to construct the Cham temples (as well as the Chola and Sinhalese temples). Although no LiDAR has been conducted within Vietnam, once the volume of bricks has been calculated for temples in Cambodia, these calculations could then be employed on the Cham temples of Vietnam.

In comparison to the temples of the Cham Kingdom, the Dai Viet temples appear far less impressive, and bear absolutely no resemblance to the Khmer temples to the west (Figure 8.2). The Dai Viet temples are generally single storey structures, where the focus does not appear to be on the exterior of the structure, but rather on the numerous ornate statues contained within the building (Figure 8.3). It is my assumption that the temples of the Dai Viet Kingdom required less materials and labour in their construction than those of the Cham Kingdom. What is also interesting is that the temples of the Dai Viet Kingdom appear to be continuously used and maintained for everyday religious purposes, up to the present day. This, however, does not appear to be the case with the Cham temples.
Figure 8.1. Top: Chien Dan Temple Complex of the Cham Kingdom, Vietnam. Bottom: Prasat Pram Temple Complex of the Khmer Empire, Cambodia.
Similar to the issue encountered in the literature on Java, the importance of overland transportation networks within ancient Vietnam has not been thoroughly researched. This is likely due to the fact that most conceive of both the Cham and Dai Viet Kingdoms as functioning on the “Riverine System Exchange,” in which rivers are the most important means of transportation and shipping goods (Bronson 1977; see also Hall 2011). Due to the geography of Vietnam, the Kingdoms of Cham and Dai Viet were located along a narrow strip of land, sandwiched between mountains and the coastline. Unlike Java, it does not appear that extensive overland routes would have been necessary, although certainly some must have existed. Those ancient roads that did pertain to the Cham and Dai Viet Kingdoms are likely located below the contemporary roads and highways of Vietnam. In general, I would suggest that some of the most utilized overland routes were the berms created by the rice patties, which also could have functioned as local roadways. However, for moving long distances coastal and riverine travel would have been far more efficient.
Figure 8.3. Interior Embellishments of the Quan Thanh Temple of the Dai Viet Kingdom, Vietnam.
South India: The Chola Empire

The temples of the Chola Empire are highly standardized in their construction and style (Figure 8.4). While certainly each temple differs slightly from the next, their similarity in form, style, and embellishment is quite apparent. Such standardization suggests to me a high level of state control radiating out from the center of the Empire into the peripheries, where local temples were constructed and renovated to mimic the larger and more important temples in the main ceremonial centers. The mimicking of the main temples, I would suggest, is an attempt on the part of the Chola state to replicate itself across the landscape. According to Scott (1999), states endeavor to make societies more legible and organized as a means of gaining and maintaining power and control. The state, through rationalizing and standardizing, transforms societies into a format that is more convenient from both a legible and administrative perspective. Thus, the standardization of the Chola temples could be understood as a means of state consolidation and integration in order to sustain dominance throughout the Empire.

Figure 8.4. The Entrance (Gopura) of Various Temples from the Chola Empire, Tamil Nadu, South India. Top Row Left: Apathhasayar Temple; Middle: Aiyarappar Temple; Right: Jambukeswarer Temple. Bottom Row Left: Kasi Viswanathar Temple; Right: Sri Sarangapani Swamy Temple.
During site visits, it was also apparent that the standardized form of the temples also functioned as integrative mechanisms at the community level. Each temple has two practical characteristics that encouraged members of the community to gather at the temples and engage with others in the community. First, each temple has fairly large (relative to the temple’s size) open areas of colonnades that are covered in order to provide cool, shaded areas for local patrons to sit and relax (Figure 8.5). At many of the temples, I witnessed large families sharing meals on the shaded floors of the temples, individuals sleeping in the cool stone colonnades, and people in general loitering under the roofed portions of the outer temple precinct. Secondly, each temple has some kind of water source, generally formal tanks, either embedded within the temple complex, or directly associated with the temple complex (Figure 8.6). During my visit to these temple water sources many were no longer in use as they were dry or had been severely neglected, and the water was no longer potable. Nevertheless, those water tanks that still had large amounts of relatively clean water were being utilized by community members for a variety of reasons, including bathing and washing clothes. In the dry zone of the Chola Empire, where temperature levels are very high and water was not necessarily readily available in most homes in the community, the large shaded areas and water tanks of the temple are, and would have been, enticing to community members and would have encourage community interaction with the temples.

![Figure 8.5. Community Members Resting and Eating in the Shaded Colonnades of Sri Ranganather Temple, Chola Empire, Tamil Nadu, South India.](image)

Clearly, the Hindu temples of the Chola Empire were extremely important integrative mechanism, which formed the ideological foundation for consolidation of the state. The Chola temples also represent a high level of “thing entanglement.” Certainly large amounts of resources, time, labour, and money were invested in the construction of these massive edifices, but we must also factor in the extensive amount of resource input required to maintain the temple complexes. After the initial investment in the construction of the temples the state and community would have become entrapped in a cycle of maintenance. Visiting the temples of the Chola area provided excellent examples of such costly maintenance, such as the copious amounts...
of oil, flowers, and pigments required to properly perform offerings and rituals, as well as the numerous ritual practitioners and “servants” required to facilitate the daily activities of the temple. The most explicit example of entanglement, however, was demonstrated through the continuous physical maintenance of the temples, such as the annual re-painting of their lavishly embellished exteriors (Figure 8.7). This appeared to be an extremely expensive, time consuming, and labour intensive task.

**Figure 8.6.** Water tank Associated with Brihadeeswara Temple (Left), and Water Tank Located within the Panchavarnaswamy Temple Complex (Right), Tamil Nadu, South India.

**Figure 8.7.** Scaffolding Erected on the Exterior of Chakrapani Temple (Left) and Sri Sarangapani Swamy Temple (Right) for the Purposes of Re-painting and Refurbishment of the Gopuram (entrance towers), Tamil Nadu, South India.

While driving through what would have been the medieval Chola landscape, it is apparent that roads would have been extremely important mechanisms for the movement of people and goods throughout the empire. The literature review did not provide information regarding roads or road networks, but rather, focused on riverine transport and their connection with the ports and market/commercial centers. However, as stated in the literature review, these
market/commercial centers, ports, and riverine systems would have been heavily affected by changes in the sea-levels and in the course of the rivers. While exploring the landscape it appeared that they would have also been heavily affected by short-term changes in the water-level of the river during the dry season. It would appear that large swaths of the rivers would have been unnavigable during times of low water levels in the river, which would have placed more importance on land routes.

**Sri Lanka: The Sinhalese Empire**

The research trip to Sri Lanka revealed a stark contrast between the “living” stupas of the Sinhalese Empire and the “living” temples of the Chola Empire. While the Sinhalese stupas also demonstrate some standardization, considering the simplistic form and style of the stupa, it was interesting to see some variety in the shape, style, and size of the stupas (Figure 8.8), especially those located within small peripheral communities across the landscape. Additionally, the focus is often not on the stupa itself but on the resident Bodhi tree-shrine. Thus, rather than demonstrating the state’s ability to replicate itself across the landscape, this may be evidence of local agency being expressed through the construction of small-scale community stupas and shrines. Also in contrast to the Chola temples, the Sinhalese stupas do not provide the same kind of attraction for community members to congregate for extensive periods of time, as the stupas provide no shade and few associated water tanks. While in Anuradhapura, large droves of people were visiting the great stupas of the center; however, the stupas were quickly circumambulated and offerings were expedient. Additionally, it appears that far less effort is required to physically maintain the stupas. Large amounts of oil and flowers are still required for daily offerings; however, there is very little in the way of appointed ritual practitioners, or physical maintenance to the stupas themselves in comparison to the Chola temples. Rather than the physical maintenance, resources continue to be focused on gaining merit through contemporary sponsorship of public feasts by a variety of individuals (mainly male business owners) from throughout Sri Lanka.

**Figure 8.8** Thuparamaya Stupa (Left) and Mirisawatiya Stupa (Right), Anuradhapura, Sri Lanka.

Within the Sinhalese empire, monasteries and their associated sacred structures such as the stupa, would appear to be a better example of “thing entanglement” (Figure 8.9). Many of the monasteries visited during the research trip are massive complexes covering large acreages. In
ancient times – and many ways right up to the present – these monasteries acted as self-contained communities with their own refectories, hospitals, water supplies, etc., and they supported, at times, thousands of monks. The massive amount of donations required to construct and maintain these large facilities would have been sizeable. The pressure to obtain merit through donations would have been a major resource drain on the laity, and particularly on the ruler through such donations as land grants and tax exemptions. In this case, we can see both the people and ruler of the Sinhalese empire as being trapped in a cycle of gaining merit, which entangles them with the physical attributes of the Buddhist monastic complexes.

Figure 8.9. Examples from the Abhayagiri Monastery Complex, Anuradhapura, Sri Lanka. Top Left: Pavilion Entrance to Residences; Top Right: Abhayagiri Stupa; Bottom Left: Refectory; Bottom Right: Kuttam Pokuna (Twin Ponds).

A point of interest while visiting the center of Polonnaruwa was the remnants of permanent brick market stalls located near the entrance gate to the epicenter of the city. The stalls vary slightly in size, with some located closer to the edge of the causeway while others are located further back. Until this SETS fieldtrip, the research team had seen no archaeological evidence of city markets, although they surely existed. The permanency of the market stalls and their location(s) may suggests a higher level of state involvement in the administration of the city market, perhaps involving rental fees for the stalls.

While the literature review did not discuss bridges within the Sinhalese Empire, during the research trip, we encountered stone bridges within monastery complexes, and one stone bridge and its associated ancient road located in the peripheral area of Anuradhapura. While the latter
stone bridge required large stone slabs for its construction, it is by no means a large bridge and is quite simplistic in its structural engineering (Figure 8.10). It would appear that the construction and maintenance of these bridges were not overly cumbersome tasks. Thus, although the bridges of the Sinhalese Empire would have been an example of “thing entanglement,” the bridge entanglement would have been minimal in comparison to that of other early states, such as the Khmer Empire, who had very large and sophisticated bridges, such as Spean Praptos.

![Figure 8.10. Sinhalese Period Stone Bridge Located in the Peripheral Zone of Anuradhapura, Sri Lanka.](image)

![Figure 8.11. Spean Praptos Stone Bridge, Khmer Empire, Cambodia.](image)

**DISCUSSION**

The lack of scholarly literature on particular types of integrative mechanisms, and the varying amount of literature available on each state under investigation by SETS, continues to be an issue. Literature on the Cham state, although not very robust, was available. In contrast,
literature on the Dai Viet was minimal at best. This is not due to the fact that little archaeology is being conducted in Northern Vietnam, on the contrary. Rather, there are simply few western-language publications on Northern Vietnam and the Dai Viet Kingdom (Stark 2006:413). Furthermore, much of the literature published in western languages with regards to Vietnamese states is published in French, and this contributes to the issue of accessibility. In contrast, literature on the Chola and Sinhalese empires was more accessible; however, again there is a disparate focus of the various integrative mechanisms. Temples continue to be a focus within scholarly publications because these often have ancient inscriptions and chronicles associated with them. Thus, temples and temple complexes continued to be one of the most comprehensive and comparable data sub-sets.

**Addressing the Research Question**

As previously stated, the goal of this research is to explore the development and organization of various integrative mechanisms within the sample of early tropical state societies. In order to provide focus to this research, a number of research questions were developed. While it can be argued that much more research needs to be completed before these questions can be answered sufficiently, a preliminary attempt to address the questions will now be attempted.

1. **What types of integrative mechanisms were employed by each charter state?**

   Please refer to Table 1.2, which demonstrates what types of integrative mechanisms can be identified within each charter state. As is evident from the table, there is often a discrepancy between what integrative mechanisms are recorded in the literature, and what can be identified archaeologically during the site visits.

<table>
<thead>
<tr>
<th>Integrative Mechanism</th>
<th>Cham Literature</th>
<th>Cham Field</th>
<th>Dai Viet Literature</th>
<th>Dai Viet Field</th>
<th>Chola Literature</th>
<th>Chola Field</th>
<th>Sinhalese Literature</th>
<th>Sinhalese Field</th>
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<tbody>
<tr>
<td>Temples</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Monasteries</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
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<tr>
<td>Libraries</td>
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<td>N</td>
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<tr>
<td>Roads</td>
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<td>N</td>
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<td>C</td>
<td>Y</td>
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<tr>
<td>Rest Houses</td>
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<td>N</td>
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</tr>
<tr>
<td>Markets</td>
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<td>C</td>
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<td>C</td>
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<td>Y</td>
<td>C</td>
<td>Y</td>
<td>C</td>
<td>Y</td>
<td>C</td>
</tr>
</tbody>
</table>

**Table 1.2.** This Table Demonstrates Which Mechanisms Were Employed by Each Charter State.

2. **At what point during the development of each charter state were these integrative mechanisms introduced?**

   Within all charter states it appears that temples were an extremely important integrative mechanism, which were already introduced prior to the establishment of each of the charter states. Administrative nodes in the form of ports of trade, also appear to have been established
prior to, or at the same time as all four charter states. However, it should be noted that administrative nodes are an ambiguous category of integrative mechanism, which should perhaps be focused on within the settlement sub-project. Additionally, I would argue that although there is little to no literature regarding roads and markets, it is likely that local road networks and small local markets were present since the inception of the charter states. Monasteries do not appear to be part of the Hindu religion, and thus were unique to the Dai Viet Kingdom, the Cham Kingdoms (to a certain extent), and the Sinhalese Empire. Although there is very little information on the Cham monasteries, it appears the monasteries were a very late development within the kingdom, emerging in the eighth century CE. In contrast, there is a robust body of literature on Sinhalese monasteries, which document their emergence very early in the first century BCE, nearly contemporary with the establishment of the Sinhalese Empire. The Dai Viet Kingdom is an interesting case, as there appeared to be little in the literature regarding monasteries; however, they were encountered during research in the field and within Vietnam tourist guides.

3. When did they show increased popularity and/or energy investment?

The Cham Kingdoms appear to demonstrate an increased investment in the energy of temple construction after the 7th century CE. It is at this time that the Cham cease to construct their temples out of wood, and begin the construction of mainly brick temples with stone pedestals, lintels, and embellishments. Although we have little information on the Cham road network, the literature indicates investment in the construction of a large road during the 10th century. Under the Lý reign, the Dai Viet Kingdom demonstrated an increase in the construction of Buddhist temples during the first half of the 11th century CE. Also during the Lý reign, there is an increase in royal outposts during the middle of the 12th century CE. During the Trần reign, there appears to be an increase in placing scholars in positions of power in administrative nodes in the provinces. Unfortunately, little is known regarding the increased energy investment in other integrative mechanisms with the Dai Viet Kingdom.

Within the Chola Empire, there is a distinct rise in the construction of temples between the seventh to ninth centuries CE, with the most stylistically sophisticated temples being erect in the seventh to eleventh centuries CE. From the current research, it is difficult to discern at what point during the Chola period there was an increase in the investment in the various administrative nodes; however, there does appear to be an increased importance in the creation of mercantile towns in the eleventh century CE.

Between the third and sixth centuries CE in the Sinhalese Empire there is a move towards superior construction techniques with regards to temples. Although the literature does not suggest there was an increase in the amount of temples being erected, superior construction techniques do suggest an increased investment in temple construction. With regards to monasteries, an increase in investment is difficult to discern, although arguably two of the largest monastic complexes, the Abhayagiri and the Jetavanarama monastic complexes, were constructed in the first century BCE and the third to fourth centuries CE, respectively. Administrative nodes in the form of ports were important during both the Anuradhapura and Polonnaruwa periods; however, sources suggest that Gokuna harbour/port particularly flourished in the eleventh century CE.

4. When were they abandoned?
At present, I find it difficult to answer this question accurately based on the current research and findings. In general, it is easier to discover when these integrated mechanisms were introduced and/or constructed, rather than when they were abandoned. Of course, the simplest answer is that all the integrative mechanisms were abandoned when we see the fall of the charter states. However, particular integrative mechanisms continue to be used by the contemporary populations today. This is particularly true of the temples of the Dai Viet kingdom, the Chola Empire, and the Sinhalese Empire. During the research trips, the temples of these charter states were visited by members of the local communities as well as people who had made a “pilgrimage” to the temples. The Chola temples were particularly interesting, as almost every temple visited was a living temple that had never been abandoned. The temples continue to be the locus of traditions and ritual activities, practiced in what appeared to be essentially the same way as during the Chola period.

5. **Who sponsored the construction and maintenance of each type of integrative mechanism for each charter state, and who physically carried out the construction and maintenance?**

Inscriptions from the Cham Kingdoms suggest that the ruler was the main individual who commissioned temples and other buildings at the religious sanctuaries. Additional inscriptions suggest that individuals other than the king also commissioned temples and monastic buildings; however, whether such individuals were noble or commoners, is unknown. Maintenance of the temples and religious sanctuaries were achieved through tax-free transfers of income from lands dedicated to support the temples. Currently, however, there is no information regarding who physically constructed the temples. The only information concerning the construction of roads in the Cham Kingdoms suggests it was commissioned by the ruler, and constructed by thirty men. The nature of the labour force (i.e. slave labour, courvé labour), unfortunately, remains unknown.

The literature review suggests that temples within the Dai Viet Kingdom were established by royalty, and subsequently maintained by royalty as a part of the large estate. Administrative nodes within the Dai Viet Kingdom also appear to have been established by royalty. Unfortunately, there is little information to suggest which parties were responsible for the maintenance of these integrative mechanisms.

Within the Chola Empire, temples were constructed through the act of gift-giving in which all members of the Chola community took part. Nevertheless, those most involved in the gift-giving and thus, would have commissioned highest quantity and highest quality temples, were the kings and ruling elite, who were most concerned with gaining legitimacy through gift-giving. Additionally, members of the nagaram (mercantile groups) were also heavily invested in temple gift-giving as a means of gaining validation within the social hierarchy. It appears the temples were constructed by paid employees who were requisitioned from communities across the Chola Empire. Concerning the administrative nodes, it is difficult to discern who sponsored their erection and maintenance and who physically carried out the construction and maintenance.

Similar to the Chola temples, all members of the community were involved in donating to the construction and maintenance of the Sinhalese temples and monasteries in order to gain merit. Documents do suggest that kings were the largest sponsors, as it was the kings who commissioned the construction of some of the largest Sinhalese monastic complexes. Unfortunately, the current literature review does not provide information on who physically
constructed and maintained the temples and monasteries. However, it could be assumed that as the monasteries were fairly self-sufficient, it was the monks who dealt with the daily maintenance of the monastic complexes. Concerning the administrative nodes and roads, it is difficult to discern who sponsored their erection and maintenance or who physically carried out the construction and maintenance.

6. **Who managed the integrative mechanisms?**

Currently there is little information to suggest who was responsible for the management of the integrative mechanisms within the Cham Kingdoms. Within the Dai Viet Kingdom, it appears that royalty was ultimately responsible for the management of the estates on which the temples were located. During the Lý reign, administrative nodes in the form of royal outposts appear to have been managed by royalty. However, during the Trần reign, scholars were appointed administrative offices within the administrative nodes, and appear to have become responsible for their general management.

Within the Chola Empire, management of the temples was in the hands on the Brahmana priests. In contrast, the administrative nodes in the form of ports and commercial centers or nagarams appear to have been under the management of agents or officers of the ruling Chola. Again, due to the fact that the Sinhalese monastic complexes were self-sufficient, it would appear that the monastery and its associated sacred structures would have come under internal management by the monks of the monastery. It is interesting to note that prior to the Sinhalese Empire the term *paramakas* was used to signify individuals who were administrative functionaries for storehouses at ports and for roads. It is possible then that during the Sinhalese Empire there continued to be administrative functionaries for such integrative mechanisms, and that these administrative positions were likely appointed by the ruling Sinhalese.

7. **Can we assess the cost of labour, materials, and administration for each type of integrative mechanism?**

The cost of labour, materials and administration is difficult to assess from the current data. In the case of the Cham Kingdoms, investigations at the religious sanctuary of Mỹ Sơn have uncovered ancient building techniques such as the use of natural resin as a mortar between the bricks. Some documentation regarding the costs of labour and materials for the construction of Chola and Sinhalese temples are available, but they are generally not extensive. Quantification of the materials used in brick and stone structures such as temples, however, may yet be possible. As previously mentioned, quantification of construction materials could be ascertained through the use of LiDAR as well as through simple tape measurements. These methods could provide us with both a diachronic and spatial picture of material investments in the temples of the Cham Kingdoms. This may be an avenue to explore during the proposed Phase II of the SETS project.

While utilizing LiDAR may allow for the quantification of materials, it does not provide us information regarding labour costs. It should also be noted that while construction methods and materials for the Dai Viet temples was not found in the literature, during the research trip it was clear that the temples were mainly constructed of wood. Thus, quantification of materials could not be ascertained through LiDAR for the Dai Viet temples.

Material and labour costs for other types of integrative mechanisms currently cannot be assessed for the sample of charter states. Thus, it cannot be determined with certainty which type
of integrative mechanism required the most amount of initial investment. Nevertheless, first hand experiences from site visits during the research trips suggest that within the Cham, Dai Viet, and Chola state the temples required the most amount of initial investment. While monastic complexes and their associated sacred structures of the Sinhalese Empire would have required the most amount of initial investment as well as high maintenance costs.

8. Which segments of the society were using each type of integrative mechanism?

This is a complex question as it is likely that a variety of segments of the society were using a variety of integrative mechanisms at varying degrees and for different reasons. Furthermore, there is very little in the literature that specifically indicates which segments of the society were utilizing each type of integrative mechanism. However, it seems clear that all segments of the society would have utilized temples and roads in one way or another within all the sample charter states. Nonetheless, it is interesting to note that the literature states that certain areas within the Chola Hindu temples would have been restricted to certain members of the society, such as the untouchables, while certain royal roads would have been restricted/inaccessible to the commoner population.

9. Which segment of the society was most reliant on each type of integrative mechanism?

While it was difficult to ascertain which segments of the society utilized the various integrative mechanisms, it is slightly easier to determine which segments of the society were the most reliant on each integrative mechanism. Although everyone utilized the temples, I would argue that the rulers were most reliant on temples, particularly for the purpose of ideological integration throughout the Cham and Dai Viet Kingdoms, and the Chola and Sinhalese Empires. Similarly, the ruler appears to have been most dependent on the administrative nodes as means of integration.

CONCLUSIONS

This chapter has outlined the preliminary results from the fieldwork performed during the SETS research trips that took place during December of 2014 and May-June 2015. Data proximity via on-site visits has proven to be an extremely fruitful component of cross-cultural comparative research. It was through on-site visits and first-hand experience that a true understanding of the scale and quality of the various integrative mechanisms could be obtained. During the research trips the SETS crew often encountered integrative mechanisms that were not extensively discussed in the current scholarship. SETS often visited sites and monuments for which there was little to no literature, and no photos. It was only with the aid of local guides and community members that we were able to gain access to these remote sites and monuments. Additionally, many of the temples visited during the research trips did not allow photographic documentation, and thus, experiencing these locations could only occur through on-site visits. It was also through data proximity that we could begin to comprehend the costs of the daily and yearly maintenance of the temples, and grasp an understanding of the integrative role the temples play within their respective communities. Data-proximity is an invaluable tool for the purposes of SETS research, without which a holistic analysis could not be achieved.
A preliminary analysis of the literature and on-site observations has demonstrated how each of the sampled early tropical charter states exhibit a unique suite of integrative mechanisms, and display varying levels of reliance on different types of integrative mechanisms to facilitate integration. Yet, a common thread is the importance of temples as a means of demonstrating authority and legitimacy, and for fostering integration through both religious iconography and the development of a pan-societal identity. Additionally, temples are excellent examples of the structures/commodities in which all of the sample states became highly entangled, particularly the Chola Empire. Temples appear to have often required the highest levels of initial in-put in terms of money, labour, and materials, but also required the highest levels of maintenance in terms of such things as rituals, endowments, management, and structural and cosmetic maintenance. While temples of the Sinhalese Empire also required large initial, and some continual, investments, it can be argued that the monastic complexes as a whole, which include the sacred structures such as stupas, were the integrative mechanisms in which the state was most entangled. Consequently, state entanglement with large ritual complexes in the form of temples and monasteries appear to be an important factor in the loss of resiliency within these early tropical charter states.

Acknowledgements. This important research would not have been possible without the generous funding from SSHRC provided through Gyles Iannone. I am eternally grateful to Gyles for making me a part of the SETS team, and for his constant guidance and support in all my research endeavours. I would also like to thank the people of all the beautiful countries that we visited, especially our drivers who worked tirelessly to transport us safely to what were often difficult to access and “remote” destinations. Special thanks go to Anil and Dushara from Sri Lanka Tours, thank you for taking such wonderful care of us in fabulous Sri Lanka.

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CHAPTER 9
SOCIO-ECOLOGICAL ENTANGLEMENT IN TROPICAL SOCIETIES:
A STUDY OF SACRED FORESTS IN SOUTH INDIA AND SRI LANKA

Zankhna Mody
(Trent University)

From May to June 2015, the researchers from the Socio-ecological Entanglement in Tropical Societies (SETS) project travelled to southeastern India and north-central Sri Lanka to evaluate the available data in order to conduct a comparative study of resilience within the various Charter States of South and Southeast Asia (see Iannone, Chapter 1). The specific Charter States focused on in this study include the Chola Empire (CE 849-1279) of Southern India (the modern day state of Tamil Nadu) and the Sinhalese Empire (377 BCE-CE 1310) of Sri Lanka (Iannone 2014). These states grew under the influence of Hinduism in India and Buddhism in Sri Lanka, with archeological evidence of historical overlaps between the two religions and civilizations. The Chola Empire capitals were centered near the Kaveri River in India, with the early capital Thanjavur succeeded by the site of Gangaikonda Cholapuram, while the Sinhalese Empire in Sri Lanka was controlled through the western city of Anuradhapura and later by the city of Polonnaruwa (UNESCO 2015).

The research team spent about a week in each of the historic capitals: Thanjavur and Kumbakonam (near the site of Gangaikonda Cholapuram) in Tamil Nadu, India, and Anuradhapura and Polonnaruwa in Sri Lanka. The research team also explored the surrounding communities and the rural areas around the cities in order to visit sites relevant to the Charter States. One of the main goals for this research was to assess the quality and type of data collected from these visits for adding to the comprehensive study of resilience in tropical societies over a long-term period and through an integrated socio-ecological and historical perspective.

The key purpose of this chapter is to explore the roles that sacred forests and trees played in socio-ecological entanglements within the Charter States of India and Sri Lanka, and to add to the comparative analysis of these tropical civilizations based on the initial field observations and literature reviews. Some of the questions brought forward during the course of the research have relevance to the study of both ancient and contemporary tropical societies in terms of social, environmental, and political issues. These questions broadly include: What complex socio-ecological roles did sacred groves play in the Charter States? How have these roles changed over the course of history, and what implications do they have in the modern day context? How did the sacred groves impact elements of political power and governance of resources within the Charter States? In what ways have sacred groves contributed to the resilience and/or eventual decline of these tropical civilizations? By seeking answers to these questions through an initial analysis of various forms of data, this report, and the SETS research project as a whole, is adding to a comprehensive historical framework of knowledge concerning socio-ecological issues in tropical societies.

METHODS

This research is focused on the complex socio-ecological factors involved in sacred groves within the Charter States, which requires proximity of the researchers to these places. By conducting the necessary background research to familiarize ourselves with the sites, visiting
them in person, photographing the sites in detail, writing down observations, and consulting local guides, we were able to gather qualitative and nuanced data which would have been difficult to procure through literature review alone. This methodology is very useful when visiting multiple sites in both India and Sri Lanka in order to derive a broad understanding from their comparative historical analysis. Patterns and variations were noticed in the different sacred forest sites visited. Additionally, visits to other sites relevant to the Charter States, such as temples, monasteries, dams, bridges, canals and water tanks, helped to form a comprehensive picture of historical and modern day India and Sri Lanka. Particularly important to understanding socio-ecological entanglement of these civilizations was travelling between the different communities, during which we began to acquire a macrocosmic knowledge of how the various sites fit together while enabling us to encounter some local sites which were, as of then, unknown to us.

BACKGROUND

The words “grove” and “forest” are used interchangeably in this report, to refer to a group of trees growing distinctly from their surrounding landscape. The description of “sacred: is used to identify the tree groves, forests, or a singular tree that hold spiritual reverence for past and present cultures (Barnett 2007). Archaeologist Darice Birge (1982:226) defines a sacred grove as: “a stand of trees in a religious context, with or without structures such as altars or temples. Such groves are differentiated from their surroundings territories by visible boundaries and/or special regulations.” For the purposes of this report, examples of singular sacred trees and sacred forests are grouped together as they contain many similar socio-ecological elements of significance to this study.

![A Banyan Tree (Left) and A Bodhi Tree (Right).](image)

**Figure 9.1.** A Banyan Tree (Left) and A Bodhi Tree (Right).

The sacred trees and forests in India and Sri Lanka are comprised predominantly of two species: the Banyan tree (*Ficus benghalensis*) and the Bodhi tree (*Ficus religiosa*; Figure 9.1), both of which are considered ecologically vital “keystone” species, are long lived, and can grow to impressive sizes (Gadgil and Guha 1999). In South India, the sacred groves are referred to in the Tamil language as *koyilkatu*, roughly translating as “forest temple,” *camitop*, meaning “god-grove,” or *kattle irukkira koyil*, meaning “the temple within the forest” (Kent 2013). Collectively, the cultural knowledge about the sacred groves is known in Tamil as *varalaru*, or “myth histories,” as the cultural practices and ideologies surrounding these forests were historically passed on through oral traditions (Kent 2013). In Sri Lanka there are reports of temple-forests or *aranya* in Sinhalese, and these are referred to in Buddhist texts as far back as
200 BCE (Sponsel 2012). How sacred groves came to exist is uncertain, and the speculations differ based on the sites concerned. Researchers Hughes and Chandran (1997) argue that primitive societies were bound by animistic belief systems and spiritual relationships with their biophysical environment and expressed this reverence in specialized forested areas. Over time, as agriculture lead to a growth in population, these initial sacred groves were spared due to enduring primitive belief systems, until these were co-opted into larger, mainstream religions.

Unlike temples, stupas, and other structures built by the Charter States, the sacred groves are a more amorphous and variable form of an anthropogenic landscape, without a distinct utilitarian purpose or meaning. As a result, a diversity of sacred groves survive today in India and Sri Lanka, and they evolved throughout history, playing shifting cultural and ecological roles. As Barnett (2007:263) explains, “Sacred groves… are a complex field of alternative readings and layers of dissonance. As a memorial landscape, visited regularly on religious occasions over a vast span of time, the sacred grove cannot be assumed to have fixed meanings. Instead it should be understood as providing a broad physical framework that helped shape the communal experience of the sacred.”

**FINDINGS**

The majority of these sacred groves, as encountered in modern times, are often embedded in rural anthropogenic environments, whether these are agricultural lands, pastoral fields, mountainous areas, or village communities, and they tend to be located far from more developed urban and industrial landscapes. As such, they are sometimes difficult to find since they blend with the natural flora of the landscape, unlike other sites of worship, like the towering Hindu temples and Buddhist stupas. These sacred forests, however, are not “wildernesses,” a concept that implies a separation of humans and nature, even though they are distinct from the more inhabited elements of the surrounding landscapes, and they can be described as a “threshold between the cultivated and the wild” (Barnett 2007:257). Indeed, we observed that many of the sacred groves are heavily influenced, if not created and sustained, by significant anthropogenic involvement. Most of these forests and trees have ancient and contemporary material structures such as shrines, small temples, terracotta statues, monastic dwellings, artistic elements, prayer flags, tree supports, and enclosures (Figures 9.2, 9.3), as well as a living layer of cultural practices that govern these forests and trees such as social taboos and rituals, spaces of gendered separation, and religious ceremonies and order. These material and social markers were often the primary means of identifying whether a forest or a tree was sacred to the communities.
The Sacred Groves of South India

There are several significant remaining sacred groves in areas where the Cholas once ruled in Tamil Nadu. These include the two groves that we had the chance to visit at Saluppai village in Ariyalur district, near the ancient capital of Gangaikonda Cholapuram (Figure 9.4), and at Kili-Aal-Amman site, near the state temple of Chidambaram (Figure 9.5). The grove at Saluppai has a recently built Hindu temple (which can be accessed only by men), a water tank, and is surrounded by a forest. Near the temple one can find several large trees with offerings and small statues of local deities. Given the age of the temple, one can hypothesize that the grove is in transition from being an intact sacred forest to a more traditional Hindu temple and worship site.
While travelling to the site at Kili-Aal-Amman, one can almost miss the sacred grove if not for the small, new Hindu temple by the side of the road leading into the grove. It was interesting to find that as we walked from the road deeper into the forest, it was as if we were walking back in time. While by the side of the road one finds the most recent construction, the path soon leads to an older temple just outside the forest, and then finally the oldest shrines and terracotta figurines in the heart of the forest, furthest from the road. Passing conversations with the villagers present informed us of the varieties of medicinal and sacred plants growing within the forest, and while the forest had been affected by the recent development nearby, it was clear that it still held a significant value to the people who lived there.

What we also observed while travelling between the Chola sites was the large number of singular tree shrines in and around local communities, temples, and along roads. These trees were recognizable from their material evidence of being adorned with prayer cloths, small statues, and other ceremonial offerings, and often these trees were in the traditionally sacred *Ficus* family, and of a significant size. One can evidently see the local cultural reverence for trees blending with the religious practices of Hinduism for these sacred trees that are interspersed amongst the local communities. While it is difficult to find out how long these sacred groves and the innumerable sacred trees we encountered have existed, and how much they have since been affected by modern lifeways, they are still able to provide us with a glimpse into the historical relationships between people and forests during the time of the Charter States in Southern India.

Figure 9.4. Saluppai Village Grove, South India.
The Forest Hermitages and Sacred Bodhi Trees of Sri Lanka

The sacred groves of Sri Lanka seem to fall into two distinct categories: the first are the sprawling, ancient Bodhi trees grown in Buddhist sites of worship (Figure 9.6); and the second are the significantly sized mountainous forest reserves in which Buddhist monasteries and hermitages were embedded (Figures 9.7). The most notable Bodhi tree is the Jaya Sri Maha Bodhi in Anuradhapura city, which was planted in 249 BCE and is said to have originated from a branch of the Sri Maha Bodhi tree in India, under which the Buddha attained enlightenment (UNESCO 2015). The Jaya Sri Maha Bodhi site is considered one of the most sacred places in Sri Lanka. For millennia it has continuously been protected, with communities maintaining the tree with functional structures such as protective walls and tree limb supports, as well as preserving its sanctified space with religious structures such as small shrines, guard stone carvings, and offerings. Apart from this ancient Bodhi tree, there are other Bodhi trees of varying ages planted in almost every sacred center of the communities that we visited within Sri Lanka. These Bodhi tree sites can be considered as “living historical sacred relics” in which ancient cultural and religious practices are upheld, such as the segregation of genders observed at one of the sites at Turuwila Rajamaha Viharaya village, where men were allowed to sit closer to the Bodhi tree (Figure 9.8). Sacred Bodhi trees appear to be a powerful symbol of the integration of religion, nature, and culture in both ancient and contemporary Sri Lanka.

The two ancient forest hermitages we visited were the archeological sites of Ritigala (near Anuradhapura), and Dimbulagala (near Polonnaruwa). Both monastic sites are comprised of densely forested mountains, with Ritigala dating back to the 1st century BCE, and Dimbulagala dating back to the 12th century CE (Sri Lanka Department of Archaeology 2015). Unlike the Bodhi trees, the mixed tropical forests around these hermitages are not cordoned off, and the monks would have had the constant presence of the forest around them while they engaged in spiritual practices. The hermitage structures made use of the local rocks and materials from the forests, blurring the distinctions between the human and natural spaces. From the material
structures present, it is observed that the religious practices where integrated into the forest itself. In Ritigala, there were several paths specifically designed for meditative walks within the forest, and both Ritigala and Dimbulagala had outlook points where monks would have engaged in meditation while overlooking the forest. The most noticeable difference between the forest hermitages and the monastic sites found within the cities of Anuradhapura and Polonnaruwa was the lack of large, dominating architecture such as stupas, temples, and carvings of the Buddha. In these remote hermitages it appears that the forest itself replaces the spectacular material aspects of other religious sites, and this forms a different sense of entanglement between people and their sacred landscapes.

![Figure 9.6](image1.png)

**Figure 9.6.** Jaya Sri Maha Bodhi, Sri Lanka.

![Figure 9.7](image2.png)

**Figure 9.7.** Ritigala (Left) and Dimbulagala (Right), Sri Lanka.
DISCUSSION

Strengths and Limitations of the Dataset

The primary issue with the data set is that there are very few remains of the former material structures used within sacred groves during the Charter State era, with the exception of some well-preserved archaeological relics at the forest hermitages in Sri Lanka. Therefore, much of the material culture that makes sacred groves conspicuous from their surroundings is of modern origins. As well, given the fluid definitions of sacred groves and their varying compositions, it is sometimes difficult to have clear distinctions between the sites and their surrounding landscapes. Since many smaller, local sacred groves and trees are not recorded and known outside of their respective communities, encountering them was sometimes a matter of chance during travel between communities, or suggestions made by local guides. An added complication is the fact that studying sacred groves involves researching living organisms of commercial value, which are susceptible to exploitation and damage, which further complicates the observations conducted at the sites. A challenging but interesting aspect of this study is that many of these groves are still living sacred sites and continue to evolve and merge with the surrounding landscape, mainstream religions, and contemporary cultures. This gives us a window into the complex relationships that existed and are still forming between tropical cultures and their forests. More extensive field research is needed concerning the cultural and archaeological dimensions of sacred groves in order to better understand these initial observations concerning this dataset, and how these intriguing features relate to the broader topics of socio-ecological entanglement.

Socio-ecological Entanglement, Resilience, and the Power of Sacred Forests

One of the ways that I have come to view sacred groves during this research is to understand them as “islands of cultural and ecological history” embedded in a modern context which often distances human societies from the environmental landscapes they inhabit. Kent (2013) argues that in many ways sacred groves are environmental and cultural relics which harbor primitive
forms of socio-ecological relationships that have been superseded by mainstream religions and cultures elsewhere. They were, and continue to remain, powerful sites for the people who worship there, and the forests and trees are seen as the embodiments of the gods themselves or as the living places where the gods or deities reside (Kent 2013). Analyses of the sacred groves do show disturbance in recent times, primarily by factors of modernization such as roads and other forms of development (Gadgil and Guha 1999). While the groves have changed significantly since the time of the Charter States, they still remain vital living conduits to the study of the past.

Barnett (2007:267) explains, “The nature and function of groves show that the conditions of emergence, difference and disturbance are significant cultural attributes of landscapes, and that analysis of these unique conditions can shed light on how humans experience and construct their physical world.” Experiences within sacred groves helped to construct the cultures of the Charter States that in turn shaped their social and ecological landscapes. Working from Hodder’s (2012) theory of entanglement to include not just material entanglement, but also spiritual and cultural entanglement that involves the landscape and other living species, one can begin to outline the crucial roles that sacred forests have played in actively shaping past and present human interactions with their surrounding ecology. Through a cultural lens that enacts the sanctity of forests in various practices, parts of the natural forest landscape were integrated into co-dependent relationships with their surrounding communities. The trees and forests that were spared from exploitation and preserved due to the sacredness attributed to them in turn entrenched the communities in a closer relationship with their environments. The very physical “rootedness” of sacred forests and trees make them immobile and unable to transition with the changing capitals and concentrations of power in the Charter States, thereby entangling cultures to a specific place.

According to Kent (2013), the spread of Hinduism lead to the decline of decentralized worship in sacred groves compared to the centralized worship in temples. Over time, sacredness was eventually associated not with the deities embodied by the forest, but with deities confined to idols and architecture, which lead to the destruction of the forests to make way for larger and larger temples. Hinduism, a polytheistic religion, has historically incorporated or engulfed local gods and deities as it was spread by rulers throughout Southern Asia in order to make it more appealing and to concentrate religious power within the temples under the authority of the kings. Viewed in this perspective, the decentralized sacred groves, forest hermitages, and monasteries challenged the religious powers of the state and the opulence of the kings and their temples. Materially speaking, these sacred forests constituted valuable property, often rich in natural resources and biodiversity held within the commons, with socio-cultural taboos against exploitation often preserving the grove’s integrity for long stretches of time, leading to an increased ecological and economic resilience for the communities surrounding these forests (Chandran and Hughes 1997). This lends a significant amount of power, independence, and value to the village communities living near these sites, the impacts of which cannot be isolated from the socio-political conditions of the state. The relationship between tropical communities and sacred groves can be also viewed as an alternative form of forest management; the study of sacred groves has the potential to redefine our current models of forest and biodiversity conservation that are currently based on secular and technocratic perspectives (Gadgil and Guha 1999).
CONCLUSIONS

This research on sacred groves within the Chola and Singhalese Charter States is but a small piece of the puzzle that informs us as we begin to grasp the broad range of historical changes that affected the resilience of these complex tropical civilizations over centuries. The combination of empirical on-site research and theoretical literature reviews help to create a multi-faceted understanding of the complex and shifting roles of sacred groves over time in these civilizations. What we can begin to learn from the integrated historical study of sacred groves is the vital impacts they had and continue to have in the socio-ecological entanglement of human cultures with their environments, and what benefits and risks these relationships inscribe onto the long-term sequences of the rise and fall of specific tropical civilizations. We can hope that the pursuit of this knowledge, combined with an in-depth comparative analysis with the other civilizations and topics within the SETS framework, will contribute significantly to the ongoing discourse on socio-ecological issues, and guide us as we continue to contemplate modern human-nature relationships in tropical societies.

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CHAPTER 10
KEY INSIGHTS FROM THE PHASE I STUDY

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In this final chapter I will attempt to summarize some of the key findings of the SETS Phase I data evaluation exercise. Along with a focus on some of the key strengths of each of the data sets of interest, I will also provide some preliminary commentary on our general findings relating to resilience and vulnerability in the pre-industrial, tropical state formations we have been investigating. These musings should be taken in the manner that they are delivered. Little of what I say can be considered definitive in any way. However, I hope that these ideas do stimulate further interest in certain areas of investigation. My specific intention is to introduce some themes that the SETS team might follow-up on as part of the forthcoming SETS II research, during which we will expand our initial investigations into tropical resilience both spatially and temporally.

THE DATA EVALUATION EXERCISE

Water Management

Leah Marajh (2014, 2016, Chapter 2) has documented the extensive water management features associated with the various case studies making up the SETS I research sample. Given that all the early states in question were situated in the tropics (whether they developed in South and Southeast Asia, or Central America) – where the vagaries of the annual monsoons conditioned precipitation – it is not surprising that water management figured prominently in the emergence, consolidation, dissolution, and reformulation of these complex societies. The communities that comprised these states needed to store and redirect water collected during the rainy season to maintain their basic lifeways, and to sustain agricultural productivity, during the inevitable dry season. These same features also helped these societies to contend with an excess of water coinciding with periodic tropical storms, or unusually wet rainy seasons. It is therefore not unexpected that there is so much data attributable to water management in the SETS research sample. Nor is it shocking to see so much academic interest, and such a diverse literature, associated with the study of water management in the tropics, past and present (as presented by Marajh 2014, 2016, Chapter 2).

Reservoirs of varying sizes and degrees of formal construction – alternatively refereed to as tanks (South India), lakes (Sri Lanka), or barays (Cambodia) – are both prominent and ubiquitous within the former territories of the agrarian-based, tropical states under investigation. Tropical reservoirs range in size from the vast, lake-sized tanks of Sri Lanka and the large Barays of Cambodia, to the comparatively small reservoirs found in association with the Maya communities of Central America. The systems of which these reservoirs were part similarly range from the extensive, highly complex, interconnected networks found in places like South India and the Red River Delta of North Vietnam, to the comparatively more disarticulated, localized components constructed by the Maya. The latter difference is, at least partially, explained by the fact that the Maya relied on maize agriculture rather than wet-rice production, and they therefore employed less formalized, and less extensive irrigation strategies.
Beyond reservoirs, Marajh (2014, 2016, Chapter 2) demonstrates that additional water management features in the study sample include major components, such as terraces, embankments or field bunds, dams, weirs, sluices, and canals, as well as smaller-scale, but no less omnipresent water diversion and collection mechanisms, such as stone or ceramic eaves, spouts, drains, and storage urns. In South and Southeast Asia in particular, these are consistently found in association with both temple and monastery complexes, as well as other elite constructions made of masonry. One can presume that simpler, but often perishable versions of these water management components must have existed within both the elite and non-elite residential compounds that were principally constructed of wood.

To reiterate, within the early states of South and Southeast Asia the storage and redistribution of water was not only driven by basic consumption and hygiene needs, but also the need to sustain agricultural productivity, especially because of the increasingly greater reliance on wet-rice production that occurred overtime. The ability to divert excess water, and avert floods and infrastructure damage, was also a crucial goal of water management. Beyond basic economic factors, the distribution and control of water that resulted from the creation and expansion of sophisticated water management systems played an integral role in establishing and maintaining leadership on multiple spatial scales, from the local community to the broader polity (e.g., Dirks 1987:144; Hall 2014:130; Heitzman 1997:4, 181; Karashima 2009:140; Lucero et al. 2015; Scarborough and Lucero 2010; Subbarayalu 2012:240-241). Nevertheless, there is sufficient evidence to suggest that polity rulers often only had indirect involvement in the sponsorship and administration of water management networks, normally through donations to the local agents who built and maintained the various components of these systems (Heitzman 1997:24; c.f., Subbarayalu 2012:240-241). As underscored by Marajh (2014, 2016, Chapter 2), these water management features – whether they be culturally modified, albeit natural settings, or predominantly artificial constructs – assumed greater symbolic significance over time, and they fostered greater entanglements between the polity rulers and local leaders, including religious organizations and their principal edifices (i.e., temples and monasteries).

Finally, it is important to comment on the fact that many of the capitals of the early states in question were situated in fertile lowlands that were comparatively “dry zones,” such a Bagan (Myanmar), Angkor (Cambodia), Sukhothai (Thailand), and Thanjavur (South India; Andaya and Andaya 2015:35; Lieberman 2009:16, 2011:942-943; Lieberman and Buckley 2012:1076). At first blush – and in traditional Wittfogelian terms – this seems to imply that these early states developed in a disadvantageous location, precipitation wise, and that the need to develop water management systems to support growing populations stimulated their precocious societal developments. However, it should also be considered that during the period of the Medieval Climate Anomaly (900-1300 CE) – which in the tropical zones of South and Southeast Asia witnessed increased annual precipitation that was distributed more evenly throughout the year, resulting in fewer droughts and diminished storm events causing floods (Lieberman 2009:33, 2011:944–947; Lieberman and Buckley 2012) – the supposed “dry zones” may have in fact offered ideal conditions for effective water management (Iannone 2015a, 2016a). In other words, following the “Goldilocks Principle,” because water management systems tend to work best when there are moderate flows of water through the various components (e.g., Buckley et al. 2010), during the Medieval Climate Anomaly the dry zones of Southeast Asia may have actually fostered the precise circumstances required for the precocious agricultural, economic, and political expansion characteristic of the Charter Era.
As should be clear, the study of water management continues to generate significant insights into the economic, social, political, ideological, and religious aspects of the pre-industrial agrarian-based state formations of the world’s tropical zones. What remains to be determined in more detail, through more nuanced investigation, is:

1) How did the various water management systems develop over time (e.g., Evans et al. 2013; Heitzman 1987, 1997, 2008; Kumma 2009; Stargardt 1990, 1998)?

2) How did these systems impact the natural environment (e.g., Kummu 2009)?

3) Through what manner were existing water management features and/or small-scale systems incorporated into larger, and more complex state sponsored networks requiring more sophisticated, and costly engineering and maintenance (e.g., Kumma 2009)?

4) To what degree did water management features, including surrounding embankments, function as attractors that “pulled” settlement towards them, and in doing so serve to reconfigure, and hence formalize, broader settlement patterns (Evans et al. 2013:12597-12598; Fletcher 2012:298; Hall 2014:129; Hawken 2013:353; Heitzman 1987:61, 1997:24, 37, 50, 114, 2008:46; Lucero et al. 2015; Miksic 2009:138; Scarborough and Lucero 2010)?

5) What role did climate change and/or other natural disasters play in the development and denouement of water management systems and the societies that relied on them (e.g., Buckley et al. 2010, 2014; Lieberman and Buckley 2012)?

6) How entangled with, and therefore path dependent, did communities and polities become on their increasingly more sophisticated water management systems (Iannone 2016a)?

7) Were there ultimately costs to complexity which eventually undermined the ability to expand and/or maintain water management systems, and which contributed to the collapse and subsequent reorganization of the early tropical states in question, such as growing maintenance costs, the draining of coffers to fund wars in an increasingly contested landscape, the propensity for subjects to flee increasingly onerous tax demands, ineffective governance, and shifting trade networks (see discussions in Marajh 2014, 2016, Chapter 2)?

Agriculture

Sometimes lost in the examination of the overabundance of water management features in South and Southeast Asia – and to some degree in the Maya subarea – is the fact that these networks were not, in-and-of-themselves, the end goal of those who organized and carried out their construction. Although some components were specifically aimed at channelling and storing water to make ideological and/or religious statements, and to maintain overall health and hygiene, the vast majority were intended to facilitate agricultural production. In other words, it was not the control of water, per se, that perpetuated successful communities, but rather the ability to generate predictable agricultural surpluses on a regular basis. Water management simply facilitated this predictability, given the monsoonal character of the tropical regions in question.

Unfortunately, as outlined by Scott Macrae (2014, Chapters 3 and 4), the actual material residues associated with ancient field systems – whether they be the extensive rice paddies of South and Southeast Asia, or the terrace networks of the Maya subarea – are limited, and the comprehensive investigation of past agricultural strategies thus remains a challenge. Nevertheless, archaeologists are able to engage with this topic through a variety of means,
including the examination of proxies for agricultural activities – such as the water management features previously discussed (Hawken 2013:348, 351; Pottier 2000) – the consultation of surviving texts that discuss the agrarian economies of pre-industrial states – such as those found in South India (Heitzman 1987, 1997) – by exploring the relic field systems discovered through remote sensing (e.g., Evans et al. 2007, 2013; Evans and Fletcher 2015:1411-1415; Hanus and Smagur 2015; Hawken 2013; Macrae and Iannone 2014, 2015; Pottier 2000), and sometimes even through the results of excavations (Báty 2005; Macrae and Iannone 2011, 2015) and on-the-ground assessments of topography and spatial patterning, including consideration of the proximity to, and orientation with, other cultural features (Hawken 2013; Macrae and Iannone 2011, 2014, 2015; Pottier 2000). In addition, many of the contemporary field systems one drives past or walks through when visiting the tropics – especially those situated in rural areas or located adjacent to monasteries or temples – can be considered palimpsests which, although they are continually being modified, retain some vestiges of their initial form and function (e.g., Hawken 2013:347-348, 364). Nevertheless, the incremental manner in which these field networks have been modified overtime, both in terms of their constituent components and the types of crops they yield, does mean that retrodicting past agricultural practices remains one of the most challenging, but also most important aspects of our “on-the-ground” SETS research program, as amply demonstrated by Macrae (2014, Chapters 3 and 4).

All of the pre-industrial state formations under investigation were initially characterized by a broad spectrum, shifting agricultural strategy marked by moderate labor inputs and limited technological requirements. These shifting cultivation regimes subsequently became more intensive and productive over time, likely along the lines of the “high performance” swidden systems of the ancient Maya (Ford and Nigh 2015). It is also clear that, coinciding with increasing populations and socio-political complexity, there was eventually a further shift in all of the case studies towards the creation of agroecosystems that exhibited less biodiversity, and even greater investments in infrastructural enhancements (Iannone 2015a). The resulting anthropogenic landscapes incorporated the range of water management features discussed by Marajh (2014, 2016, Chapter 2). In South and Southeast Asia these developments had their roots in the proto-state cultures who began to focus some of their broad spectrum, shifting cultivation strategies on wet-rice production in the productive floodplains of the major rivers systems, where the water table was close to the surface and rich silts were deposited annually (Fox and Ledgerwood 1999; Hawken 2013:352). As noted by Macrae (2014, chapters 3 and 4), from these initial flood-recession strategies, forays into more intensive cultivation were facilitated by incrementally incorporating new water management technologies into what would become, over time, much more extensive irrigated field systems that extended out and away from the rivers themselves. In Java there is evidence to suggest that the state actually provided tax concessions to transform forests or swidden lands into irrigated rice paddies (see Wiseman Christie 1991:30-31). In areas where state control was strongest, water management networks, and their component features, served to bring greater formality to the spatial arrangement of temples, settlements, and agricultural field systems (Evans et al. 2013; Hawken 2013:353, 357).

As discussed by Macrae (2014, chapters 3 and 4), the natural environment both enabled and constrained the development of these agroecosystems. According to Macrae (chapter 3), in places like the Red River delta of Northern Vietnam, expansive irrigation systems allowed the Dai Viet to produce massive amounts of wet-rice, the resulting surplus being used to provision the capital of Thang Long and its support population. In contrast, the smaller river valleys of Central Vietnam limited the creation of large irrigation systems, but those that were created were
still sufficient enough to support the various Champa kingdoms that called these valleys home. Investments in infrastructure also ranged across the various case studies. Like their counterparts in the Red River delta, the Khmer of Cambodia created an extensive water management system, and in doing so converted their surrounding landscape into a rice bowl that was able to support significant population growth and unsurpassed socio-political complexity. In contrast, the Burmese of Myanmar, even though their capital of Bagan was situated adjacent to the Ayeyarwady River, choose to improve more suitable areas for agriculture located further afield, such as the Minbu and Kyaukse valleys, in order to generate the rice surplus required to support state development. In other words, the varying environmental settings conditioned how, where, and to what degree shared technological innovations were implemented to increase productive capacity.

Regardless of how much emphasis was placed on irrigation agriculture overtime, swidden-based shifting cultivation likely continued in the more marginal areas of all of the study zones right up to the present (e.g., Fletcher 2012:285, 306-309). The resulting hybrid systems that probably dominated in the more productive rural areas of the South and Southeast Asian pre-industrial states, wherein shifting cultivation and intensive multi-cropping (polycultural production) would have been used to grow a variety of both wet and dry crops, presumably contrasted with the greater emphasis on monocropping and wet-rice production nearer the various capitals. The same contrast between rural polyculture and monocultural production of maize in the heartland may have also occurred in the ancient Maya world, although this remains to be determined. This scenario is not unlike what one sees driving across parts of South and Southeast Asia today. For example, the extensive monocropping of rice, sugar cane, or maize (i.e., cash crops) adjacent to large cities in Java contrasts with the more diverse, polycultural farming systems that persist in more rural areas.

At the same time, whether in rural zones or the center of a Javanese city, individual households demonstrate a penchant for planting kitchen gardens, or even small-scale wet-rice fields, in and adjacent to their homes. This is undoubtedly a contemporary manifestation of a long-standing farming practice that characterizes household production across the study zone – from Belize to Vietnam – and was clearly a factor in the development and perpetuation of the dispersed, agrarian-based urban settlement pattern found throughout the tropics (Iannone 2015a). For example, within the urban centers of South India, gardens, pastures, and agricultural plots were commonly found around the central temples and between houses and neighborhoods, and fields, gardens, and irrigation works starting at the very edge of the urban center (Heitzman 1997:92, 2008:47). Growth of these urban centers occurred in a way that preserved prior land use, as well as enclaves based on craft and/or status, meaning that the agrarian economies of the pre-existing villages – and their diverse components – were simply incorporated into the larger temple cities of the pre-industrial world (Heitzman 1997:111, 220).

With respect to the role of the various tropical states in the initiation, expansion, and formalization of these vital agricultural systems, both the historical (text-based) and archaeological (remote sensing, survey, and excavation) studies arrive at similar conclusions. In South India (Heitzman 1987:60, 1997:24, 42, 50-52, 112-113, 138, 220), and Angkor (Hawken 2013:363), for example, there is inscriptive evidence that confirms that Brahman (elite) families – often under the support and encouragement of the state – played a crucial role in establishing new production enclaves or enhancing established ones. Beyond their direct involvement in the expansion of productive lands through the aforementioned means, South Indian texts inform us that the participation of rulers and local elites in the expansion of
agricultural productivity was generally indirect, and limited to the sponsorship of infrastructure projects (i.e., water management features), the aim of which was to build merit and enhance legitimacy, rather than to generate revenue per se (Dirks 1987:144; Hall 2014:130; Heitzman 1997:181; Karashima 2009:140; Subbarayalu 2012:240-241).

Temple institutions served to confirm and record these meritorious acts, and ultimately assumed the principal duties of managing infrastructure and collecting surplus for many of the larger, more formalized, and increasingly more productive wet-rice field systems that developed in the tropical states of South and Southeast Asia (e.g., Hawken 2013; Heitzman 1987, 1997). As a result, temples and their supporters ultimately emerged as the primary beneficiaries of these improved field systems, although some surplus was also channeled to the state itself via its central temple authorities (Hawken 2013:363). Nevertheless, there are differences of opinion in terms of just how effective such temple-based institutions would have been in terms of managing surplus, with some documenting a high level of efficiency (see Champakalakshmi 2011:482, 496; Heitzman 1997:107, 112, 163 for the Chola of South India), and others concluding that they had limited success in doing so (see Hawken 2013:365 for the Khmer of Cambodia).

Archaeological analysis confirms the complexities inherent in the agrarian economies suggested by the text-based studies. For example, the spatial arrangement of some of the more centrally located wet-rice field systems at Angkor, in particular their orthogonal form (square or rectangular), and the degree to which they shared the cardinal orientation of adjacent temple complexes and water management features, suggests that state-influenced agricultural production was in place by at least the 10th century CE, if not earlier, even though much of this may have been directed by local authorities (Hawken 2013:354, 357, 364). In contrast, evidence suggests that some of the more peripheral field systems were developed by local small-holders and/or farming collectives over an extended period of time (i.e., through accretion), beginning in the era prior to the establishment of some of Angkor’s major water management facilities, such as the West Baray (Hawken 2013:360, 364-365). State influence over these less orthogonal (i.e., coaxial), topographically influenced field systems appears to have been minimal, and most of the myriad ponds and small temples associated with them seem to have been introduced into a previously established field plan (Hawken 2013:364-365). In other words, in direct contrast to what was found in Angkor’s central zone, water management features and temples initially played a minimal role in terms of determining the spatial arrangement of the agricultural landscape in the center’s peripheral zones. However, it is also clear that such features did play a larger role in influencing field expansion and organization over time, in conjunction with more direct elite involvement.

Similarly, in the Maya region smaller, but better crafted terrace systems surrounding pioneer farmsteads in Belize’s North Vaca Plateau dating to before the 7th century CE were eventually interlinked by more extensive, but comparatively poorly made sections of terracing at a time when small-scale local kingdoms were first being established (Macrae and Iannone 2011). This has been interpreted as evidence for a shift in the degree to which the state influenced expansion and intensification of production, with the intention of stimulating higher yields and greater surplus. Nevertheless, local farming lineages seem to have continued to maintain control over the manner in which they augmented their field systems based on their own sophisticated knowledge of local hydrology and topography.

In summary, the study of ancient agricultural practices continues to be an important, yet developing area of investigation in South and Southeast Asia, as well as the Maya subarea. Key
questions that can guide the ongoing advancements in this line of inquiry include, but are not limited to:

1) How did tropical agroecosystems develop over time (e.g., Fox and Ledgerwood 1999; Hanus and Smagur 2015; Hawken 2013; Macrae and Iannone 2011, 2014, 2015)?
2) How did these systems impact the natural environment (e.g., Hawken 2013:347)?
3) In what ways were shifting cultivation, hybrid polycultural practices, kitchen gardens and houselot farming, and monocropping incorporated into overarching agrarian production systems (e.g., Hawken 2013)?
4) In what ways did the reliance on these different productive systems change over time, and which segments of the society benefited the most from these shifts in cultivation practices (e.g., Hawken 2013; Macrae and Iannone 2011)?
5) Did the state itself assume greater control over agrarian practices over time, and if so, through what means, and for what ends (Hawken 2013; Macrae and Iannone 2011)?
6) To what degree did state controlled production centers function as attractors that “pulled” settlement towards them, and in doing so, serve to both reconfigure, and formalize broader settlement patterns into what has been referred as “temple urbanism” (Heitzman 1997:82-142; see also Hall 2014:129)?
7) What role did climate change play in changing agricultural strategies?
8) How entangled, and thus path dependent, did communities and polities become on the increasingly more productive and centralized, but less diverse cultivation regimes (in terms of both biodiversity and actual farming practices)?
9) Were there ultimately costs to complexity which eventually undermined the ability to expand and/or maintain agrarian productivity, and which contributed to the collapse and subsequent reorganization of the early tropical states in question, such as growing the costs of extensification, concomitant environmental degradation, expensive martial conflicts, the propensity for subjects to flee increasingly onerous tax demands, ineffective governance, and shifting trade networks?
10) In what ways did agricultural strategies influence broader settlement patterns and urban development, and how did the relationship between agricultural practices and community development change over time (e.g., how did agricultural strategies condition dispersed urbanism)?

**Epicenters**

The sophisticated water management systems and agricultural schemes developed by the various preindustrial tropical state formations not only sustained large agrarian populations, they also supported a smaller elite class, and allowed for the creation of the grand civic-ceremonial centers that continue to draw the attention of academics and the general public alike. As Lindsay Shirkey (2014, 2015) and Natalie Baron (Chapter 5) have indicated, in our SETS research we refer to these agglomerations of monumental architecture as “epicenters,” based on a conceptual model outlined by Arlen Chase and Diane Chase (1987:51-52) for the ancient Maya center of Caracol. Although this is not an ideal term, it does allow us to capture the focal characteristic of such civic-ceremonial nodes, even though they existed within highly dispersed, low-density urban landscapes that contrasts significantly with the more compact urbanism that is traditional in other parts of the world.
As underscored by Paul Wheatley (1983:3): “urbanism is a concept which, enmeshed in a web of semantic ramifications, has persisted for some five millennia as a means of detonating sets of qualities possessed by certain of the larger, and usually more compact, clusters of settlement features that at any particular moment in time have represented centroids of continuous population movements.” Nevertheless, Wheatley (1971) has been able to demonstrate that more dispersed urban forms often preceded the formation of compact cities in different parts of the world, and that the dispersed urban plan persisted in some areas, such as tropical Southeast Asia and Central America, at least until the era of European influence. A type of urban footprint unique to the tropics, agrarian-based, low-density urban settings exhibit the following characteristics (Iannone 2013, 2015a):

1) Monumental epicenters of stone construction situated within a landscape of dispersed, self-similar (homogenous) settlements and ritual monuments (Fletcher 2009:3, 6, 2012:302; Isendahl and Smith 2013:133; c.f., McIntosh 1991);

2) The overall plan of the urban center, and its constituent buildings, spaces, and adornments, demonstrate an emphasis on royalty and sacredness (Miksic 2009:144);

3) Significant levels of investment in infrastructure and landscape modifications, such as roads, water management features, and especially agricultural field systems (Fletcher 2009:3, 6; Isendahl and Smith 2013:133; Miksic 2009);

4) Agricultural extensification (Fletcher 2012:306), which results in large tracts of productive land continuing to exist within the urban zone (Isendahl and Smith 2013:133, 137; c.f., Miksic 2009:144);

5) The spatial concentration of settlements in and around water sources and good farmland, which creates “urban clusters” (Isendahl and Smith 2013:133; McIntosh 1991; Smith 2011:51, 54);

6) These urban clusters exhibit significant economic autonomy within what are generally decentralized political formations displaying “Type A” Charter Administration, wherein greater levels of independence existed the further away one was from the capital, state control fluctuated, economic control was weak, religious institutions were virtually autonomous and had significant economic and social functions, and tributaries were semi-autonomous (Lieberman’s 2003:31-33, Figure 1.7; see also Isendahl and Smith 2013:133-134; McIntosh 1991; Scarborough and Lucero 2010; c.f., Scarborough et al. 2012:22; Wiseman Christie 1991, 1995);

7) The overall settlement pattern fosters a “spread-out urban culture” (Heitzman 1997:220), and “open” (Hansen 2000:604), or “edgeless” (Fletcher 2009:4) urban forms that, according to some, generate larger “string[s] of closely interconnected metropolises,” ultimately forming what Gottman has called a regional megalopolis (Fletcher 2009:3, 2012:285).

The utility of the term “epicenter” lay in the fact that within dispersed, low-density urban landscapes it is often impossible to determine precisely when one has left the urban “center” proper and entered the rural landscape (e.g., Heitzman 1997:110, 114). For example, James Heitzman (1997:110) posits that: “the large agrarian component in the local economies of the ritual centers determined the village-like character of places that experienced large concentrations of populations and occupational specialization in the Chola period.” For this reason, rather than employing the term “city” – which would technically leave one referring to nothing and everything at the same time – an epicenter can more readily be conceived of as the
very heart of a comparatively unbroken urban-rural continuum, a large part of which actually constitutes the low-density urban city itself. Adopting this perspective does not imply that there is no feasible way to distinguish the actual footprint of an epicenter from the broader settlement system in which it was enmeshed. Rather, it only underscores that, as we move outward from the immediate confines of the grandiose monumental features that are so conspicuous within the low-density urban landscapes of the tropical world, where one sees an epicentral complex ending may be highly subjective, and thus somewhat arbitrary. The same might be said for the ambiguous boundaries of the broader low-density urban formation itself.

This issue is especially true in the case of the ancient Maya, where there are few real delimiters that break-up the urban-rural settlement continuum. Maya epicenters, and the low-density urban cities for which they are the pivotal political nodes, are truly “edgeless.” In South and Southeast Asia, however, walls and moats have long provided some means to delineate – at least in a somewhat less subjective manner – where the epicenter ends and the broader urban-rural settlement zone begins. As discussed by Shirkey (2014, 2015) and Baron (Chapter 5), this has allowed SETS researchers to use the location of walls and moats, whenever possible, to help bring some focus to the on-the-ground research activities of the epicenter sub-project. We have done so even through we acknowledge that, in actuality, epicentral-style spaces and activities often spilled out beyond these walls (e.g., Bagan, Myanmar). In addition, we also remain cognisant of the fact that walls and moats could be used to contain different components of the settlement continuum – from single temple compounds to entire epicentral complexes (e.g., Angkor Thom, Cambodia; Cha Ban Citadel, Vietnam) – and that what walls and moats could contain changed dramatically over both time and space (Evans et al. 2013; O’Connor 1983:62-65). Nevertheless, by concentrating the epicenter sub-project on what is found inside the most significant walls and moats encountered across the various charter state capitals we are investigating, we have been able to bring some consistency to our various investigations. At the same time, this approach also allows us to differentiate this particular research focus from that of the settlement and integrative mechanisms sub-projects. Finally, attention to walls and moats has the potential to foster a better understanding of the changing role that these features played in the long-term development of epicenters across the various case studies under investigation.

Within South and Southeast Asia, the template for the expansive, moated and walled epicenters that were characteristic of the Charter Era can be traced back to the period between 500 BCE and 500 CE, when “early urban” communities surrounded by earthen embankments and moats connected to drainage systems began to appear across the region, often in more arid, yet agriculturally productive zones (Kim 2013; Stark 2015:77-83). These communities, which are believed to have served as a combination of ritual node, economic hub, and political capital, contained restricted access elite residences (ruler’s palaces), other domestic features, ritual architecture made of brick, and mortuary contexts (Stark 2015:79, 81). They often existed as one of a number of similar communities in a vast polycentric landscape (Evans et al. 2013). Overtime, however, some of these small, moated and walled capitals developed into more expansive, and increasingly more complex epicenters that stood out from the majority of other settlements in the surrounding area. As part of this process, they also began to take on greater ideological significance, as the rulers of these proto-states, and the more powerful kings that followed them in the Classical, or Charter Era, strove to cultivate their legitimacy by creating a seat of power that replicated the macrocosmic realm of the gods on the microcosmic scale of the corporeal world (e.g., Geertz 1980; Stuart-Fox and Reeve 2011). As Lindsey Shirkey (2014, 2015) and Natalie Baron (Chapter 5) underscore, it is here where epicenters begin to figure.
prominently in specific entanglements that are, at first, enabling (dependence), but overtime, increasingly more constraining (dependency).

As discussed by Martin Stuart-Fox and Paul Reeve (2011:107-109), many, although not all, of the epicenters of South and Southeast Asia came to be modelled on a “macrocosm-microcosm parallelism” that derived from the Hindu and Buddhist traditions of India, but likely had its roots in ancient Mesopotamia. According to Stuart-Fox and Reeve, within this parallelism epicentral plans, and the rituals and political practices that were centered on these pivotal microcosms, were purposely structured on the cosmological model of Mount Meru – both the spiritual and physical center of the universe – with the aim to provide an earthly residence for the deities, and to allow rulers to draw on “divine potency” through emulation of the precise qualities of the sacred macrocosm (see also Tambiah 1977). In other words, the construction of an epicenteral complex came to be correlated with the corporeal establishment of what Stuart-Fox and Reeve (2011:107-109) refer to as a set of “symbolic equivalences” that could be used to legitimately advance both political and spiritual agendas. The end result of cultivating these equivalences, or parallels, was the creation of a “royal capital, which…stood in a similar relationship to the rest of the kingdom as the divine macrocosm did to the earthly microcosm over which the gods had dominion. Power flowed from the former to the latter via the king alone, a conduit reinforced by rituals that only the king could conduct” (Stuart-Fox and Reeve 2011:107). As a result, within a low-density urban landscape the pivotal epicenter was “exemplary,” in that it was simultaneously a model of the universe writ small, as well as the physical manifestation, and conceptual font, of worldly political order (Errington 1989; Geertz 1980:13; Tambiah 1977; Wheatley 1971). It was from the epicenter of the low-density urban “city” from whence rulers wielded the sacred authority bestowed upon them from on high. In the Southeast Asian tradition, this “cosmological topography” has been captured in the concept of the “mandala,” and the notion of the “galactic” or “solar” polity, wherein purity, morality, the capacity for regeneration, and sacred power diminish the further one moves away from the exemplary epicenter (Tambiah 1977; see also Lieberman 2003:32-33, 2009:22-23, 764).

Given the importance of providing both a suitable earthly abode for the supernatural forces, and a means to focus the power exercised by earthly rulers, it is not surprising that temples and shrines figure prominently in the epicentral plans of the various tropical societies under investigation. In fact, we often first come to appreciate places like Tikal, Guatemala, Borobudur, Java, and Thanjavur, South India precisely because of their towering temples. Nevertheless, it is important to stress that the epicenter is about more than the creation of a “macrocosm – microcosm”, wherein purity, morality, the capacity for regeneration, and sacred power diminish the further one moves away from the exemplary epicenter (Tambiah 1977; see also Lieberman 2003:32-33, 2009:22-23, 764).
The broader low-density urban footprint, and the blatant macrocosm-microcosm parallelism of the epicenter, combined to foster a particular kind of urban community referred to as orthogenetic (Redfield and Singer 1954; see also Aung Aung Hlaing 2011; Miksic 2000; Wheatley 1983:426). Such “cities” tend to be located in ecological centers (e.g., agrarian heartlands), and are characterized by:

1) monumental architecture that is ritual and political in focus;
2) redistributive activities;
3) state economies based principally on the indirect control of surplus staple production through taxation and tribute;
4) distributed manufacturing nodes;
5) elite-controlled exchange and display of exotic status symbols;
6) dispersed populations;
7) specialized urban populations (e.g., royals, elites, retainers, administrators, religious practitioners, military personnel); and,
8) comparative stability.

In contrast, heterogenetic cities are found on ecological edges (e.g., coastal zones), and demonstrate:

1) less emphasis on ideologically charged, monumental architecture;
2) an emphasis on manufacturing and free enterprise;
3) a more developed, diverse, and centralized market economy;
4) the use of currency;
5) compact (dense) populations; and,
6) persistent transformations.

Admittedly, this is a somewhat false dichotomy (Aung Aung Hlaing 2011), although when these city “types” are employed in polythetic fashion they do provide us with some insight into “process,” and how the ideological and economic character of tropical urban centers changed over time.

Clearly, epicenters are important foci of analysis from a resilience theory perspective because they generate unique sets of entanglements that are both enabling (dependence) and constraining (dependency). To reiterate, the same ideological principles that infuse the temples and shrines of the epicentral complex with their sacrosanct qualities also support the sacred political authority encapsulated in the capital and its ruler. This relationship of dependence can, however, also spawn relationships of dependency that are equally constraining. Because such sacred authority rarely translates into direct economic control, rulers often have to allow more economically autonomous agents – such as temple institutions and land-holding entities – to share in their spiritual powers to secure sufficient tax flows back into the capital and its institutions (Iannone 2016b). As a result, the qualities of the epicenter cannot be entirely contained within its walls, and in practice the characteristics of the exemplary center tend to manifest within other nodes in a polycentric political landscape.

For example, James Heitzman’s (1997:82-142) notion of the “temple city,” which he developed after considerable consideration of the historic records from Chola dominated South India, captures the process through which urban growth was closely tied to agrarian expansion, which in turn was intricately linked to temple activities and management practices, and the donations that were made to non-state temples outside of the Chola capital by imperial kings,
chiefs, and other local elites (Heitzman 1997:107, 121). This diffusion of sacredness and legitimacy beyond the principal epicentral complex of the capital is also captured in the concept of the “mandala,” and the “galactic” or “solar” polity models, which have been used to describe the “cosmological topography” of the pre-industrial Southeast Asian state (Tambiah 1977). According to Tambiah, in polities that are organized in a mandala/galactic polity manner: “The capital is the starting point for the performance of annual cosmic rites – rites of regeneration and purification – and in a ripple effect the graduated provincial centers replicate in temporal succession the same rites on a diminishing scale” (Tambiah 1977:79-80).

“What emerges is a galactic picture of a central planet surrounded by differentiated satellites, which are more or less ‘autonomous’ entities held in orbit and within the sphere of influence of the center. If we introduce at the margin other similar competing central principalities and their satellites, we shall be able to appreciate the logic of a system that as a hierarchy of central points is continually subject to the dynamics of pulsation and changing spheres of influence” (Tambiah 1977:76).

In terms of other entanglements, epicentral complexes, with their vital temple institutions and grandiose monumental architecture, served as crucial attractors for surrounding populations, which was especially important in the pre-industrial tropical state formations where access to labor was a key limiting factor (Andaya and Andaya 2015:4; Lieberman 2009: 764-765, 2011; Scarborough and Burnside 2010:180; Scarborough and Lucero 2010). Nonetheless, to continue to maintain this “gravitational pull” within a cosmologically-charged landscape, where new attractors are constantly emerging, more and more of the polity’s resources must be assigned to embellish on the settings and rituals that have long worked to lure people into the capital, and helped to establish and perpetuate key patron-client relationships. This can result in both diminishing returns (greater expenditures to achieve the exact same result), and at times, even sunk costs (ongoing investments into outmoded integration schemes), as traditional practices and nodes of engagement no longer hold the same attraction in an increasingly more competitive, and at times progressively more localized, landscape.

Entanglements of the dependency variety also occur because rulers, and the polities they lead, must constantly protect their all-important epicenters from capture and/or destruction by enemies, or from the seizure of the key idols or relics that imbue the various shrines and temples with supernatural powers. Not only do such debasing activities diminish the perceived spiritual potency of the epicenter itself, they are also signs of declining supernatural support for the current ruler and their political regime. Other perturbances that impact a polity’s fertility and prosperity, such as environmental degradation, climate change, blight, famine, and pandemics may also be taken as indicative of the loss of supernatural endorsement. Such circumstances may lead to the destruction and/or abandonment of the epicentral complex on the part of traditional supporters because it, for all intents and purposes, is a material manifestation of the ruler’s divinely sanctioned authority, and thus a fundamental component of the failed ruler’s identity, which is now eroded to the point of being refutable (Iannone et al. 2016b).

Finally, specific epicentral entanglements may carry on after the death of an individual ruler. For example, Maya kings were often tethered to certain locales because key ancestors and offerings had previously been interred there to help focus supernatural forces, compelling subsequent leaders to revamp, expand upon, or build over the remains of earlier epicentral plans. This may have come at a cost in certain situations, particularly when new rulers inherited
degraded local environments that, in resilience terms, should have stimulated them to establish a new capital elsewhere. Alternatively, in South and Southeast Asia new rulers were often required to assume the start-up costs of founding an entirely new sacred epicenter and polity capital as a means to confirm their legitimacy within a contested political landscape. This left earlier capitals to assume the role of ancestral temple complexes which, given their ongoing importance to the polity, still required human and natural resources to support their daily operations and upkeep.

In summary, the study of ancient tropical epicenters continues to be an important, yet demanding area of investigation in South and Southeast Asia, as well as the Maya subarea. As discussed by Shirkey (2014, 2015) and Baron (Chapter 5), the challenges not only stem from the complexities associated with fully capturing the vast range of entanglements emanating from these key civic-ceremonial nodes, but also the difficulties associated with exploring these from an archaeological perspective. Although the various epicenters under investigation still contain monumental architecture of significant quality and quantity – making most ideal locations for inclusion on the UNESCO world heritage list – the remains tend to be biased towards certain types of features, namely the largest and/or most ornate temple compounds. Far less is known about the various residential palaces and sundry special function courtyards and patios that would have been the settings for activities of considerable import to the polities in question. The limited understanding if these non-temple spaces results for a number of factors, including:

1) they have simply drawn less archaeological attention;
2) other than in the Maya area, the palaces and other architectural features were normally constructed of wood and other perishable materials (e.g., palm or grass thatching), except for the periodic use of some masonry footings and/or basal walls, tiled roofs, and “paved” or tiled floors, meaning that not only did these structures not preserve well, they are often difficult to find;
3) contemporary cities often grew up, over, and around the early epicenters, leading to considerable destruction of features;
4) due to their significance to the polities in question, epicenters were often the focus of enemy attacks and the wanton destruction that coincided with these; and,
5) the penchant for shifting capitals in conjunction with the coronation of a new ruler, or for various other reasons for that matter, meant that the location of older epicentral compounds and their defunct capitals were sometimes lost to history (e.g., the early Mataram capital of Central Java).

Nevertheless, the remains of epicenters, if only in partial form, are available for study in all of the case studies in question. Even where significant destruction has occurred, such as in the case of Thang Long (Hanoi), recent excavations, inscriptions, historical maps and descriptions, and even scale reconstructions, have helped the SETS team explore different aspects of these former exemplary centers (see Baron, Chapter 5; Shirkey 2014). Still, there is much to learn when it comes to the factors that contributed to the development, denouement, and/or transformation of the magnificent epicenters that were once the very heart of each of the charter states we are studying. For example, recent LiDAR mapping and accompanying excavations at Ankgor have demonstrated that the area immediately adjacent to the Angkor Wat temple was at some point filled in with a very formal, densely packed, and repetitive, orthogonal arrangement of house-mounds, each with its own small pond (Evans and Fletcher 2015). Significantly, this settlement pattern seems to have taken hold prior to the construction of the complex’s large encircling wall (Stark et al. 2015). Although the nature of this occupation continues to be
investigated, it may reflect efforts at greater centralization, and the ability to resettle, and support a large number of non-agrarian specialists – possibly administrative staff – in the vicinity of Angkor’s principle temple complexes (Evans and Fletcher 2015:1410; Iannone 2015a).

Key questions that can guide future research into the study of tropical epicenters include, but are not limited to:

1) What types of spaces and activities characterized the epicenters that emerged amongst the earliest “urban” societies (e.g., Stark 2015)?
2) How, and in what ways, did epicenters and their surrounding urban settlement zones change over time (e.g., Evans et al. 2013)?
3) What roles did walls and moats play in delineating epicentral and broader urban space, and how did these roles change over time (e.g., Evans et al. 2013; O’Connor 1983)?
4) When, why, and through what means, did epicenters assume their highly sacred connotations (e.g., Hietzman 1997)?
5) In what contexts where temples and palaces amalgamated in a single epicentral complex, and in what contexts, and for what reasons, were these particular architectural features spatially separated?
6) Why, outside of the Maya subarea, were palaces constructed of perishable materials when contemporaneous temple architecture was built using more permanent masonry?
7) How did the emergence and development of distinct epicenters influence, and reflect, the formation of tropical, agrarian-based, low-density urban settlement patterns (e.g., Evans et al. 2013)?
8) When, where, and for what reasons, did epicenters, and the broader urban capitals of which they were part, begin to transition from low-density urbanism to more high density, orthogonally arranged, city plans (e.g., Evans et al. 2013; Evans and Fletcher 2015; Hietzman 2008)?
9) What role did the ability to support large numbers of non-agrarian specialists play in the aforementioned settlement pattern shift?
10) What were the principle epicentral entanglements, how did these change over time, and what are the implications of these for understanding charter state resilience and vulnerability?

Settlement

In the various pre-industrial state formations under consideration there were different social strata (horizontal divisions of society), with a small number (<5%) of elite and/or noble groups occupying the most prestigious status positions – the highest station being held by a divine or semi-divine ruler, or king – and the vast majority of the people being “commoners” who were either agrarian primary producers (>80%), or individuals who toiled in menial tasks for the state (10-15%; Haberl et al. 2011, Table 1; Ponting 2007:65); there was sometimes also a small strata of slaves. This general demographic profile underscores that any assessment of resilience and vulnerability in early tropical formations must strive to incorporate non-elite settlement patterns, and the daily practice of commoners, into the analysis. Unfortunately, as outlined in the various reports from the SETS settlement sub-project (Coria 2014; Demarte 2014; Savage, Chapter 7; Walker, Chapter 6), examining settlement patterns in the tropics is extremely difficult.

For one, outside of the Maya area, where archaeologists have been mapping and excavating house-mounds since the 1930s (Ricketson and Ricketson 1937; Thompson 1931; Wauchope
1934), few archaeological projects in South and Southeast Asia have attempted to carry out detailed analysis of non-elite settlement components. Be that as it may, ongoing settlement investigations in the vicinity of Angkor – where remote sensing, surface reconnaissance, and excavations are being employed in unison – do hold great potential for expanding our understanding of this charter state’s support population (e.g., Evans et al. 2007, 2013; Pottier 2000; Stark et al. 2015). Unfortunately, such studies continue to be a rarity elsewhere in South and Southeast Asia. A large part of the problem is that the residential features that represent the agrarian-focused segment of the various charter state societies are difficult to discern archaeologically. This is because most vernacular architecture in the tropics was made of perishable materials, and in places where stone foundations were not used, houses were raised on stilts, making their surface remains even more difficult to detect (Coria 2014; Demarte 2014; Savage, Chapter 7; Walker, Chapter 6). The reasons for such construction methods are four-fold:

1) such architecture was easily constructed, maintained, and expanded on using cheap, and often readily available materials such as poles, palm thatch, and clays;
2) houses and outbuildings of this type were easily disassembled and moved, which allowed home owners to shift their residence to more suitable locations quickly and affordably if so desired (Waterson 2009);
3) houses made out of perishable materials, using traditional constructions methods, have proven to maintain their structural integrity during the earth tremors associated with volcanoes and earthquakes (Idam 2011; Sidle et al. 2004:188; c.f., Prihatmaji et al. 2011, 2013); and,
4) when damaged, such buildings are also easier, and more economical to repair or replace.

Regardless of the aforementioned issues, we are able to examine the settlement patterns of the various charter states under consideration using a variety of means, even when the surface manifestation of the remains of vernacular architecture is limited. For example, the distribution of refuse, such as broken ceramics, bricks, and ceramic roof tiles, as well small ponds, and household or community shrines, have been used effectively to explore the nature of Angkor’s support population (Evans et al. 2007:14278; Evans et al. 2013; Pottier 2000). Distribution maps, most often produced through some type of remote sensing (e.g., Evans et al. 2007; Evans et al. 2013; Evans and Fletcher 2015; Pottier 2000), also provide crucial information on settlement patterns (although there is a paucity of such studies). In some instances, there are also written inscriptions that inform us as to how many people were attached to a particular monastery or temple (e.g., Fletcher 2012:302).

The members of the SETS settlement sub-project considered the following in their efforts to provide useful insights into ancient settlement patterns (Coria 2014; Demarte 2014; Savage, Chapter 7; Walker, Chapter 6):

1) Archaeological, historical, and ecological syntheses in journal or monograph form;
2) Excavations summaries;
3) Maps of settlement distributions produced through a variety of pedestrian and remote sensing techniques;
4) Depictions of houses and communities found in painted murals, and carved into both base reliefs on buildings, and other portable objects;
5) Museum visitations, which often contained written information, domestic artifacts, and even reconstructions of vernacular architecture and larger community dioramas;
6) Considerations of landscapes and the location of relic settlement nodes vis-à-vis each other, and specific landscape features (e.g., water sources, topographic relief, farmland);
7) Observations of contemporary settlement patterning and land-use practices whilst travelling through each study area (as proxies for past socio-ecological relationships);

What then, do we know about the broader settlement patterns of the tropical charter states of South and Southeast Asia? To begin, early European explorers regularly commented on the fact that Southeast Asia, in general, exhibited low population densities compared to neighboring India and China (on average only a 6\textsuperscript{th} or 7\textsuperscript{th} of the density), which made human labor a highly sought after resource (Andaya and Andaya 2015:4, 35; Lieberman 2009:764). This overall low population density has been explained by endemic warfare, and the “fragility of life in a tropical environment” (Andaya and Andaya 2015:4), in particular the range of infectious tropical diseases (especially malaria and dengue, but also syphilis and small pox), scarcity of arable land, and the small family size promoted by “semi-nomadic agriculture,” all of which limited birthrates and overall lifespans (Andaya and Andaya 2015:35, 138-139; Lieberman 2003:93, 2009:764). Also noteworthy is that the dispersed, low-density settlement pattern may have limited the development of immunities to infectious diseases (Andaya and Andaya 2015:139).

In discussing the factors influencing settlement distributions in tropical environments, Scarborough and Burnside (2010:178) have suggested that, “the dispersed availability of resources [meant that] humans were required to disperse as well…what we find in [the tropical case studies] is a huge population base, but one spread out widely across the forested landscape in a manner mimicking the tropical rhythms and tempo” (see also Iannone 2015a; Scarborough 1998; Scarborough et al. 2012; Scarborough and Lucero 2010). For example, Victor Thompson (2016:321) discusses how, in regions with marked rainy seasons, water can collect for part of the year in low-lying areas such as oxbow lakes and sloughs, which in turn serve to concentrate fish and other aquatic resources. The exploitation of such resources, given the time restrictions on their availability, would have fostered cooperation and intensification, and this may have served to increasingly tether settlement to these locales.

Ultimately, given the very high number of farmers that made up the majority of the charter state societies, and the significance of the agrarian economy to the state itself, it is not surprising that the nature of the tropical landscape resulted in the spatial concentration of settlements in and around water sources and good farmland (e.g., Iannone 2013, 2015a; Walker, Chapter 6), creating what some have referred to as “urban clusters” (Isendahl and Smith 2013:133; McIntosh 1991; Smith 2011:51, 54). From an economic perspective, Victor Lieberman (2009:15) posits that these “dispersed population clusters” would have coincided with the diffusion of a key critical resource, labor, which would have in turn contributed to the decentralized character of the galactic or solar polities found in Southeast Asia (Lieberman 2009:764). Roland Fletcher (2012:198) argues that such low-density settlement patterns tend to be “self-similar” – others have also highlighted the fractal qualities of Maya settlement (Brown and Witschey 2003) – and he sees this as a reflection of the considerable overlap in “daily praxis” of most of the inhabitants of the urban matrix (most of the population worked in the agricultural sector, and lived in rural farming communities).

In contrast, others have suggested that there was a significant level of specialization embedded within this landscape. This has been documented for various tropical societies, including those found in Africa (McIntosh 1991; Scarborough and Lucero 2010; Smith 2011), Asia (Wisseman Christie 1991; Heitzman 1997:110-111; Scarborough and Lucero 2010), Central
America (Isendahl and Smith 2013; Smith 2011), and the Maya subarea (Hutson et al. 2008; Isendahl and Smith 2013; Scarborough et al. 2012:22-23; Scarborough and Lucero 2010; Smith 2011; Scarborough and Valdez 2009). The various specializations were often related to the uneven distribution of specific natural resources, and they were integrated at a higher spatial scale, creating a network of closely interacting communities, or “urban clusters” (McIntosh 1991:199), that were in spatial proximity to each other, and which, in combination, provided services to a wider settlement zone (e.g., Scarborough and Valdez 2009). These clusters were therefore tightly linked to each other, but they were not amalgamated into a single economic and/or political entity. The bottom-up nature of this economic network, and the services that it provided, contributed to the dispersed nature of the settlement pattern, heightened the relative autonomy of the spatially discrete urban clusters, and enhanced the overall decentralized qualities of the broader socio-economic systems of most tropical polities (Scarborough and Lucero 2010). This does not mean, however, that the overall system was entirely organic in character. Epicenters and higher governance structures did play a significant role with regard to influencing the low-density settlement pattern.

One of the principal avenues of top-down influence was the penchant for the rather decentralized polities of the pre-industrial tropical world to induce temple organizations, monasteries, and elite families – often through the allocation of tax-free land grants – to take on the task of bringing unproductive land under cultivation, and to assume the duties associated with organizing local agrarian production, and redistributing the resulting surplus. This process has been documented for the Cholas of South India (Heitzman 1997:24, 42, 50-52, 112-113, 220), the Khmer of Angkor (Hawken 2013:363), and the Burmese of Bagan (Lieberman 2003:119–120, 228, 2011:940), to name a few. The establishment of these government sponsored, economically focused civic-ceremonial nodes in the hinterlands of the various epicentral capitals helped create the dispersed, polycentric, low-density urban footprint characteristic of the pre-industrial tropical state formations. That is, these top-down initiatives would have served to augment the broader dispersed settlement pattern fostered by the more localized, organic growth of networks of interacting settlement clusters, especially those involved in particular types of craft specialization (see above).

Beyond the spatial aspects of low-density urbanism, certain temporal trends associated with this unique settlement pattern are also worth noting. For example, in all of the low-density urban contexts we see an eventual shift towards greater centralization over time (Champanalakshmi 2011:629-635; Heitzman 1987:54, 1997:173; Lieberman 2003:33-34, 2009:24, 38), and in some cases this appears to have contributed to the “formalization” of the settlement pattern. Specifically, where environment and topography permitted, the processes of centralization, which normally involved increased investment in infrastructure – including roads, water management features, and shrines – drew greater numbers of people to certain nodes on the landscape. In addition, because of the “axial” character of road and canal networks, these infrastructure features also tended to structure the distribution of habitation and field systems in a manner that created a more orthogonal settlement plan. This transition, from a more dispersed, low-density settlement pattern to a denser, axial urban matrix structured by extensive road and canal systems, seems to have occurred at both Trowulan, east Java (as noted above; Miksic 2009:138), and Angkor, central Cambodia (Evans et al. 2013:12597-12598). It also appears that, where investment in such infrastructure was restricted by environmental or topographic conditions – as at Bagan, Myanmar (where most irrigation could only be carried out a considerable distance from the epicenter) – and/or limited by the degree to which the polity was
able to finance such public works – as was true for most of the ancient Maya polities of Central America – the low-density urban pattern prevailed. It is also plausible that the ability to support a larger number of full-time administrative staff, or “non-agricultural urbanites,” who needed little or no access to cultivable land, may have also been a factor in the development of the denser, orthogonal settlement pattern that appeared over time in and around epicentral complexes such as Angkor Wat and Angkor Thom (Evans et al. 2013: 12597-12598; Evans and Fletcher 2015; Iannone 2015a). Nevertheless, it is also true that low-density, or dispersed urban forms did remain the norm across much of South and Southeast Asia until the arrival and entrenchment of the European powers (Wheatley 1971), at which point the orthogonal plan was sometimes forced upon, or complicity adopted by, specific indigenous communities (e.g., Andaya and Andaya 2015:262).

In the end, the factors that contributed to the agrarian-based, low-density urban landscapes characteristic of the pre-industrial charter states were diverse, and historically contingent. This means that we must remain critical of any assertions that the processes that stimulated the formation of low-density urban landscapes over a millennium ago equate with the developments responsible for the formation of contemporary suburban and peri-urban communities. For example, although the study of pre-industrial low-density urbanism may provide some insights into issues relating to contemporary urban sprawl and/or the formation of expansive megalopoli (e.g., Fletcher 2009:11, 2012:285; Smith 2010:34), these insights have primarily comparative value because the general processes involved undoubtedly differed in some significant ways. Sprawl is by definition an inward-outward, centripetal process, where populations from densely populated, compact urban centers move outwards into the countryside. The actual demographic processes involved in the formation of pre-industrial low-density urbanism did not involve such inward-outward demographic shifts because epicenters, until very late in the developmental sequence of the charter states, were not densely populated, compact centers, but rather civic-ceremonial contexts inhabited by a small, highly specialized population. In actuality, the principal demographic processes in the charter state case studies were quite the opposite from contemporary sprawl, being both more localized – based on the “gravitational pull” of the myriad settlement nodes scattered across the rural landscape that represented ritual sanctity and improved agricultural potential via extensification strategies – and centrifugal in character, with populations only shifting inward, towards the urban capitals, later in time, when significant numbers of non-agrarian specialists could be housed and supported by the state. The fact that capitals moved frequently – either because of competition or the general trend for new rulers to establish their own capital to legitimize their regime (see above) – would have only served to continuously pull populations towards new nodes on the socio-political landscape. This, in turn, would have perpetuated the dispersed, low-density urban footprints of the various charter states because it would have stunted the processes of demographic agglomeration around a single epicenter (although this does occur later on, around places like Angkor Thom; see above).

With respect to the particular issue of whether past low-density urbanism can inform the examination of contemporary urban issues, it is also interesting to consider the notion of “high-density ruralism” (aka the “ruralopolis”), which is commonly encountered in contemporary South and Southeast Asia (Qadeer 2000; see also Demarte 2014), and which has been posited to have been present in the ancient Maya world (Scarborough et al. 2012; Scarborough and Valdez 2014). The concept of high-density ruralism refers to rural population densities that normally exceed 400 persons per km², and which can extend over thousands of km² (Qadeer 2000:1583). According to Qadeer (2000:1583): “By the density criterion, these extended regions should be
classified as urban, but their agrarian economies and relatively more traditional social structures characterise them as rural, notwithstanding steady social change.” As with the low-density urban model, the examples of high-density ruralism are also believed to constitute distinct settlement systems (Qadeer 2000:1584). Of significance is that the descriptions of high-density ruralopolises correspond closely to the way that low-density urban contexts are characterized. For example, Gardner (1995:23) discusses ruralopolises in Bangladesh as exhibiting: “few horizons which are devoid of settlement, but where they (settlements) begin and end is often impossible to judge.” Two issues that arise within high-density rural contexts is competition for quality agricultural land, and a scarcity of the types of resources and institutional organizations that normally service such dense populations in traditional urban contexts (Qadeer 2000:1584).

To summarize, the principal characteristics of ruralopolises include (Qadeer 2000:1584-1585):
1) high population densities within a heterogeneous settlement system;
2) an agrarian-based economy;
3) lengthy “chains,” or “corridors” of “high-density districts,” including villages and farmsteads, extending across farmland and forests, and interspersed between larger towns and cities;
4) competition for, and heavy use of, scarce quality farmland;
5) a growing demand for urban-style community institutions, infrastructure, and services.

These qualities are similar to what McGee (1991:8) has referred to as the Asian Deskota, which constitutes a settlement pattern in which urban characteristics – especially the urban economy – increasingly penetrates into rural zones (Qadeer 2000:1589-1590; see also Fletcher 2012:285). The ruralopolis does, however, differ somewhat in terms of formal characteristics, implying that these high-density rural zones are not simply the result of an extension of the urban economy into rural settlement zones (Qadeer 2000:1590). Rather, the ruralopolis is a zone of “incipient urban spatial forms and community structures,” and it includes localized versions of “rural sprawl” (Qadeer 2000:1599). The ruralopolis is a distinct path to urbanism, and unlike the Deskota, is characterized by “a process of implosion, building up the dense spatial organisation from ‘inside’ the rural areas, instead of cities expanding out into the countryside” (Qadeer 2000:1601; emphasis mine). As such, a ruralopolis also contrasts with the notion of a peri-urban zone in which squatters are pushed to the outskirts of an urban center (Qadeer 2000:1589).

Although there are many similarities to theagrarian-based, low-density urbanism of the past, high-density ruralism – which to reiterate is modelled on contemporary urban contexts in South and Southeast Asia – differs in one substantial way. Specifically, the near continuous strips, or “corridors” of high-density settlement that extend across farmland and forest, and link contemporary cities, villages, and towns in places like Java – which the SETS team experienced in person during our one-month visitation to this country – are not present to the same degree in the pre-industrial contexts. In such high-density “ruralopolises,” one can travel for extended periods of time along transportation corridors and never really leave a city-village-town context. One does not get this same feeling when traversing the settlement zones of the various pre-industrial state formations (i.e., in the sparsely populated Vaca Plateau of west-central Belize), or when viewing them in map form. Rather, the ancient low-density settlement pattern appears to have been much more spread-out, and truly dispersed over a wide area. The generally higher populations, economic differences, and prominence of highway transportation corridors in contemporary nation states largely explain this difference, and in doing so essentially nullifies
the explanatory potential of the high-density rural concept with respect to the pre-industrial low-density contexts.

Much remains to be learned about the settlement systems of the pre-industrial tropical state formations. Some of the key questions that can guide this future research include, but are not limited to:

1) What were the principal ecological determinants of tropical settlement patterning, and did these change over time?
2) What were the primary economic, social, political, and ritual factors conditioning settlement location, size, and purpose, and did these change over time?
3) What were the key centripetal and centrifugal forces that governed demographic trends, and what role did these play in the development, perpetuation, and ultimately transformation of the low-density urban footprint?
4) What roles did warfare and disease play in these demographic trends?
5) What part did occupational specialization play in the formation and transformation of the low-density urban settlement pattern?
6) What factors fostered the creation of the larger, specialized urban clusters, and how did these settlement nodes influence the broader low-density settlement pattern?
7) What influences led to the self-similar character of the broader low-density urban footprint?
8) From the perspective of the support population, does the low-density urban footprint have inherent resilience characteristics given the unique characteristics of tropical environments?
9) What factors contributed to the resettlement of more people from the hinterland into the epicentral capitals over time, and does such a movement coincide with an increased level of vulnerability on the level of the broader socio-ecological system?
10) Was such resettlement state driven, or where their broader ecological, social, and political factors at play?
11) In terms of the broader settlement system, can we isolate entanglements that were initially enabling (dependence), but which eventually became constraining (dependency) over time, and if so, what do these tell us about the overall socio-ecological resilience of the pre-industrial tropical state formations?

Integrative Mechanisms

Kendall Hills effectively examines the data associated with what SETS refers to as “integrative mechanisms” in Chapter 8 (see also Hills 2014). In many ways, integrative mechanisms can be considered the quintessential material entanglements which, across their diverse range, span the economic, social, political, ideological, and religious aspects of society. As such, many of the integrative features that emerged in the life histories of the various tropical state formations under investigation by SETS have already been presented in the discussions of the other sub-projects. For example, water management features always had a certain integrative draw in the seasonally moist tropics, whether they be the small reservoirs and ponds found in association with Maya settlement clusters, or the artificial “lakes” constructed by the Sinhalese. At Angkor, the large embankments surrounding the large barays apparently served as the ideal location for the development of new communities (Fletcher 2012:298; Hawken 2013:353). Similarly, good soils, and especially improved field systems – including the various wet-rice
systems of South and Southeast Asia, and the upland terraces of the Maya world – attracted, and were able to support, higher populations. Finally, the ostentatious epicentral complexes that are still the hallmark of the various pre-industrial tropical states were conceived of as microcosms that represented the home of the gods on earth, and as such these agglomerations of sacred architecture served as the principal “attractor” nodes of vast galactic, or solar polities.

That said, the various “homegrown” shrines and temple complexes, monasteries, and elite agricultural nodes that were sponsored by the state, but operated somewhat autonomously, constituted integrative mechanisms that were able, more often than not, to draw key resources – including labor – away from the epicentral capitals. The effectiveness of these specialized urban clusters, in their role as competing integrative nodes, was lamented by many a tropical ruler, as has been discussed in relation to the monasteries of Myanmar (Aung-Thwin 1985; Lieberman 2003:180, 2011:940-941), the temple organizations of South India (Heitzman 1987:58; Iannone 2015b), and the competitive rural elites (i.e., “little kings,” local chiefs, and/or governors) of the Burmese (Aung-Thwin and Aung-Thwin 2012:138; Iannone 2016a), Maya (Houston and Inomata 2009:63; Iannone et al. 2016), Chola (Champakalakshmi 2011:578; Heitzman 1987:52-53; Karashima 2009:153; Subbarayalu 2012:210-211, 223), and Khmer (Lieberman 2003:138; Iannone 2016a) realms. This is because the state, often through the direct involvement of the ruler and their immediate family, initially funded these integrative mechanisms as a means to cultivate both a more productive economy, and more cohesive political federation. They did so through the conferral of tax free land and labor grants, provision of infrastructure investments, and the bestowal of emblems and titles on local leaders (Iannone 2016b). Nevertheless, these same economic and socio-political investments created entanglements which, although they were initially enabling (dependence), eventually became constraining (dependency), as they served to enhance the integrative capacity of the various specialized urban clusters scattered across the broader low-density urban landscape at the direct expense of the epicentral capital itself (Iannone 2016a, 2016b; Lieberman 2003:33:). This clearly worked against the original intent of these state sponsored initiatives, and served to enhance the character of the decentralized, low-density landscapes (Iannone 2015a; Scarborough and Lucero 2010).

A case in point is how Chola kings of South India would use elite Brahmana families to integrate unproductive regions into the broader economy by granting them tax free status (Heitzman 1997:107-116, 217-222). According to James Heitzman, once these lands had been improved through sophisticated water management systems, and sufficient support population had solidified around the various infrastructure features and elite house compounds, the landholdings and associated irrigation networks were often released to monasteries to acquire merit. In summary, although wastelands had been brought under the yoke as a result of a top-down initiative, the end result was the formation of rather autonomous urban clusters embedded within a vast arrangement of productive fields and orchards (Heitzman 1997:107-108).

Through such processes, a network of diverse integrative mechanisms was established and perpetuated across each of the agrarian-based, low-density landscapes under investigation by the SETS research team. In order provide some focus to the integrative sub-project, it was decided to concentrate on a small range of integrative features that, compared to epicentral temple complexes, improved field systems, and water management features, are often given short shrift in assessments of the development and denouement of pre-industrial tropical states. These include rural temples, monasteries, roads, bridges, rest-houses, administrative nodes, markets, and hospitals (Hills 2014, Chapter 8). Some of these integrative mechanisms are quite easy to study – particularly the rural temple and monastery complexes – because there is significant
inscriptional detail and historic documentation outlining the factors associated with their founding and operation (i.e., the nature of donations for establishment and maintenance, specifics of their economic and ritual activities, and the character of their associated membership and overall workforce). In addition, these nodal urban clusters are normally well preserved, and in some instances they continue to serve their original function even today.

Although they are difficult to delineate due to their poor preservation, and often minimal surface expression, roads have drawn some academic attention in the Maya subarea (Chase and Chase 2001), and in the Angkor region (Hendrickson 2007, 2010, 2011, 2012). Although vestiges of roadways are visible in almost all of the case studies, and the historical literature and inscriptions often refers to their existence, we continue to know very little about these integrative mechanisms in most contexts. The use of bridges to span waterways is also documented for many of the case studies – including the ancient Maya (Pusilha) – and some impressive examples still exist in certain areas (e.g., Spean Praptos bridge outside of Angkor; see Hills 2014, Chapter 8). Once again, however, the interested researcher is somewhat limited in their ability to discuss these components of the larger transportation corridors created by the various pre-industrial tropical states. Other features associated with formal roadways, such as rest houses and shrines, have received little scholarly attention outside of recent studies in the Greater Angkor region (Hendrickson 2007, 2010, 2011, 2012). The same can be said for administrative nodes and markets. Although we can presume that these existed both within and outside the various epicentral capitals, given historical documentation attesting to this fact, the SETS team was rarely able to physically study the remains of these important political and economic contexts (see Hills 2014, Chapter 8). Finally, hospitals, some of which were intricately connected to monasteries, remain an interesting, but little examined integrative mechanism in all of the case study areas (see Hills 2014, Chapter 8).

One potentially unintended consequence of increased investment in infrastructure such as roads and associated bridges (along with canal systems), is that they may have contributed to the transition to a more orthogonal settlement plan. For example, the quasi-axial pattern reflected in the ruins of ancient Trowulan, east Java, is believed to have been structured, to a great degree, by the linear nature of roads and water sources, and the location of hilltops used for pilgrimage activities (Miksic 2009:138). That said, it is also important to underscore that these linear features, and the economies they were meant to enhance, were not sufficiently developed to attract populations to the degree that they would form the high-density settlement corridors – “the strings of pearls” – typical of the contemporary urban megalopolises (Fletcher 2009, 2012) and ruralopolises (i.e., high-density ruralism; e.g., Demarte 2014; Scarborough et al. 2012; Scarborough and Valdez 2014) discussed in the literature on low-density urbanism (see above). In other words, they were simply not strong enough attractors to work against the centrifugal pull of both the agrarian economy, and the dispersed land-holdings and smaller “urban clusters” upon which it was based. Ultimately, major rivers, such as the Ayeyarwady, Mekong, Chao Phraya, and Kaveri, and the more informal foot and cart paths that criss-crossed the landscape, continued to play a larger role in the movement of people and goods across and between the pre-industrial tropical states, even after the appearance of more extensive, formal road systems (see also Hills, Chapter 8).

Much remains to be learned about the various integrative mechanisms that were manifest in the various case studies under investigation. As we move forward, the SETS team will strive to address a range of questions about these important settlement features. These questions will include, but not be limited to:
1) What types of integrative mechanisms were present in the various pre-industrial state formations?
2) Which of these integrative mechanisms were cross-cultural, and which were unique to specific case studies?
3) Where certain integrative mechanisms more or less active in certain case studies, and if so why?
4) Did the effectiveness, or prominence of certain integrative mechanisms change over time, and if so in what ways, and for what reasons?
5) Which integrative mechanisms were the most persistent, and why?
6) In what ways did certain integrative mechanisms create relationships of dependence (enabling), and for what reasons did specific mechanisms eventually lead to relationships of dependency (constraining)?
7) In what ways did specific integrative mechanisms contribute to the development and perpetuation of the low-density urban footprint?
8) In what ways did specific integrative mechanisms contribute to the transition towards a more formal (i.e., axial and orthogonal), higher-density urban landscape?
9) What roles did different integrative mechanisms play in the resilience of socio-ecological systems in the tropics?
10) What roles did different integrative mechanisms play in the formation of the decentralized, galactic/solar polities typical of the charter/classical states, and which integrative mechanisms allowed for more centralized state formations to develop?

Sacred Natural Sites

In the summer of 2015 a new SETS sub-project was initiated to focus on the role of sacred natural sites in the development and transformation of low-density urbanism footprints across the various tropical state formations that are the focus of our research program (see Mody, Chapter 9). As outlined by Catherine Allerton (2009), the concept of sacred natural sites encompasses a range of different spiritual places that served as key interstitial nodes within the complex socio-ecological systems of Southeast Asia, and elsewhere in the world. As sacred places that were dramatically charged by animistic powers, caves, sacred groves, mountains, and water sources played integral roles in how communities perceived their surrounding landscapes, and the universe in general.

Given that these locales were often utilized over the long-term, they comprise palimpsests of ritual practices spanning considerable periods of time. As such, they provide persistent echoes’ of how spiritual landscapes of the past formed a backdrop for ideological praxis. For example, there are a multitude of Mount Meru replicas scattered around South and Southeast Asia (e.g., Stuart-Fox and Reeve 2011), and many of these are physically located on points of higher elevation. As microcosmic centers of the universe that were embellished with temples and shrines in order to create a suitable earthly home for the gods, and a seat of authority for their terrestrial representatives (i.e., the kings), such “temple mountains” (Zéphir 1995) effectively demonstrate the recursive relationship between humans and their environments.

Similarly, the cross-cultural attraction that caves held, and continue to hold, for those who wish to engage with nature in a spiritual manner, is amply displayed in the artefactual offerings, statuary, and architecture found at places like Huyen Khong (Marble Mountains, Central Vietnam), Pak Ou (Central Laos), Dambulla (Central Sri Lanka), and the various caves.
that have been extensively studied in the Maya subarea. The associations with sacred water are often less intensively marked by cultural features, but here too one does encounter some significant efforts to modify natural spaces in order to convert them into cultural places. A classic example is the carved river bed at Kbal Spean, located in the Kulen Hills north of Angkor (Tawa 2001). Similarly, sacred groves – whether they be a forest or small copse of trees – were often venerated though cultural practices that did not leave the types of material residues that archaeologists study. But, as is discussed by Mody (Chapter 8), such spiritual locales are sometimes marked by readily apparent tree-focused shrines, especially in South India and Sri Lanka. These shrines may simply be denoted by a cluster of offerings, such as small Ganesha idols, pottery, and candles, or they can be represented by large spiritual complexes, such as the Maha Bodhi Tree temple at Anuradhapura.

Ultimately, examination of the antiquity of such sacred natural sites is an important endeavour, as is the evaluation of how they were incorporated into, transformed by, or employed by forces who desired to resist the processes of, state formation and expansion. The challenge for such a research sub-project is not simply that many of these sites are not officially recorded or discussed in any way in the literature (SETS found many sacred groves simply by looking for them as we drove through the various communities in South India and Sri Lanka), but also that the interpretation of their significance can range quite widely. For example, whereas some see the existence of sacred groves as a sign of the existence of long-term conservation-oriented practices (Balée 1998:9, 2006:85), others argue that they are much more socio-politically charged locales in which ancestors are interred, and social conflicts mediated (Chouin 2002; Fabinyi et al. 2014).

In the end, the study of sacred natural sites holds great potential for adding significant depth to our assessments of resilience and vulnerability in pre-industrial tropical state formations. Our own foray into this area of research is in its infancy, and as a result the questions guiding these investigations remain preliminary in nature:

1) What types of sacred natural sites are manifest within the various case studies under investigation?
2) Which of these sacred natural sites seem to be cross-cultural, not simply with regard to their occurrence, but also in terms of their meaning and significance?
3) How did the cultural interaction with, and meaning of, different sacred natural sites change over time?
4) In what ways were sacred natural sites incorporated into, or how did they serve to structure, the development of agrarian-based, low-density urbanism?
5) Were some sacred natural sites more easily incorporated into state ideologies than others?
6) Were some sacred natural sites more readily employed as tools for resistance to state integration?
7) To what degree were sacred natural sites about environmental conservation, and did their role in this change over time?
8) To what extent did sacred natural sites play a role in ancestor veneration and the mediation of socio-economic and political conflict?

**DISCUSSION**

Ultimately, the “classical” or “charter states” that are the focus of this discussion were both enabled and constrained by the initial conditions provided by their wet-dry tropical
environments. They adopted a unique, dispersed low-density settlement pattern, developed sophisticated agricultural and water management strategies, and practiced a comparatively decentralized governance structure. These were ideal mechanisms for dealing with the limitations of the tropical soils, contending with seasonal precipitation, maintaining biodiversity, mapping settlements onto dispersed natural resources, and at times modifying the landscape to concentrate key resources and make them more predictable and stable. From the perspective of climate change, these early tropical state formations clearly adopted various means to “hedge” their bets against the often fickle monsoon rains. Under normal climate conditions – where annual precipitation was expected to vary somewhat – and given certain demographic and socio-economic conditions, this set of socio-ecological relationships was likely exceedingly resilient.

A highly detailed example of how such a resilient system may have looked on the ground under such ideal conditions has been provided by Christophe von Fürer-Haimendorf’s (1962) ethnography of the Apa Tanis of Assam, Northeast India. Unlike their neighbors, who practiced traditional shifting cultivation, the Apa Tanis drained swamps and developed a sophisticated land-use strategy based on the irrigation of expansive bunded and/or terraced rice fields within which a variety of different rice varieties were grown (i.e., they ripened at different times, and required more or less water) using a range of different methods, all interspersed with slightly elevated dry fields of millet, maize and vegetable gardens, cattle pasture, “islands” of bamboo, pine, and fruit trees (Fürer-Haimendorf’s 1962:13-17, 23, 27-37). These low-lying cultivation plots and groves were surrounded by treed hills, the lower reaches of which were terraced for irrigated or dry rice production, and/or carefully tended to provide building materials, the upper elevations being home to more natural, untended forests that provided convenient trapping and hunting territories (Fürer-Haimendorf’s 1962:13-17, 23, 27-37). Such a mosaic of differentially utilized lands – which mimicked the natural biodiversity of the tropical environment – was replicated in the sustaining area of each of the seven compact Apa Tanis villages (Fürer-Haimendorf’s 1962:14-15, 28). These settlements contained myriad kitchen gardens, and were surrounded by granaries, nurseries for rice seedlings, and additional groves of bamboo, pine, and fruit trees (Fürer-Haimendorf’s 1962:14-15, 28). In summary, each Apa Tanis small-holder owned and cultivated “land of various kinds,” using various techniques, and involving numerous crops and crop varieties, which allowed most families to be fully independent with respect to food supplies (Fürer-Haimendorf’s 1962:14), and undoubtedly provided a significant level of resilience against the vagaries of the tropical climate. Taken as a whole, this “uniform” settlement pattern was replicated across the Apa Tanis territory (see Fürer-Haimendorf’s 1962:14), resulting in an incipient low-density urban landscape.

The question remains, can such a finely tuned system can be maintained if:
1) populations grow too large;
2) more old growth forests are brought into crop production;
3) pressures on land force a contraction of individual land holdings;
4) greater reliance on artificial water management systems calls for increasingly more expensive, and sophisticated infrastructure, maintenance programs, and overall management;
5) economic and political circumstances require a shift away from a full-fledged polycultural cultivation to one based on a smaller range of crops;
6) agricultural lands are increasingly infilled by the residences of non-agricultural specialists;
large portions of the population are no longer “self-sufficient” when it comes to meeting their own subsistence needs through cultivation; and,

centralized decision making is further removed from local circumstances in both time and space.

It is plausible that a combination of these factors could, over time, lead to a shift away from a low-density urban footprint, creating a situation in which the urban pattern begins to look a lot more like those found in temperate zones. Such an urban tradition may be far more vulnerable to environmental perturbations – such as the shift out of a climate optimum into a cooler, more arid regime – because it is not as fitting for the specific conditions offered by tropical environments.

Returning to the examples of early civilizations that emerged within the wet-dry outer tropics, vulnerabilities must have emerged when stable climate optimums periodically ushered in eras when annual precipitation was both more predictable and consistent throughout the year, because such conditions fostered unprecedented growth and complexity, and created scenarios in which intensive cultivation and water management infrastructure could be expanded unchecked, even into previously marginal areas (Lentz et al. 2015:294; Weischet and Caviedes 1993:168-169), leading to increased deforestation, loss of biodiversity, and resource denudation. Not surprisingly, such “optimums” were often immediately followed by recognizable cultural disruptions, or “collapses,” when more erratic and/or consistently drier climate regimes took hold. These, often abrupt, transitions challenged the complexity that had been achieved under the ideal conditions which had previously existed (Lentz et al. 2015:294; Weischet and Caviedes 1993:168-169), and underscored the inherent weaknesses within a settlement pattern that had progressively moved away from the traditional low-density footprint, resulting in a socio-ecological system that was far less fitting for its particular environmental context because it was less flexible, and inherently more brittle.

Crucial to this interpretation is the assertion that we should consider agrarian-based, low-density settlement as a land-use strategy, rather than a political scheme? When more intrusive political regimes became involved, higher density settlement patterns based in orthogonal/axial grid patterns began to emerge. Amongst the classic/charter states of South and Southeast Asia, this new way of organizing settlement, water management, and agricultural production was the harbinger for precipitous socio-political declines, and subsequent economic, social, and political reorganizations.

**SETS RESEARCH QUESTIONS**

At the outset of our Phase I research I posed a number of broad questions that I hoped we would ultimately be able to address as part of the SETS long-term research program (Iannone 2014a; see Chapter 1). For obvious reasons our preliminary investigations – which were explicitly aimed at data evaluation – are not sufficient to allow for a sophisticated assessment of the many facets of the tropical lifeway, and its resilience and entanglement aspects. Nevertheless, our literature reviews and on-the-ground research do lend themselves to some brief statements relating to the questions we posed at the outset of this research endeavour. The broader support for these brief answers has been sprinkled throughout this summary chapter.

1) **Did all of the charter states share similar organizational principals?** The short answer to this question is an unequivocal “yes.” All of the Classical/Charter states were decentralized
polities of the galactic or solar variety. They displayed “Type A” Charter Administration (Lieberman’s 2003:31-33, Figure 1.7), wherein greater levels of independence existed the further away one was from the capital, state control fluctuated, economic control was weak, religious institutions were virtually autonomous and had significant economic and social functions, and tributaries were semi-autonomous. These polities also shared a similar agrarian-based, low-density urban footprint. Nevertheless, many of the classical/charter states also began to develop more centralized governance structures, and more high-density, orthogonal settlement patterns over time – some to greater degrees than others – but these transformations appear to have been unsustainable.

2) **Did these characteristics lead to specific levels of resilience and/or vulnerability to shifting environmental and/or cultural circumstances?** Both the decentralized governance structure and dispersed, low-density settlement pattern appear to have been particularly resilient given the environmental conditions of the outer tropics. However, the unchecked growth, greater centralization, and more formalized settlement patterns that developed in the ideal climate conditions of the Medieval Climate Anomaly (or the period between 250-650 CE in the Maya subarea) seems to have been unsustainable when conditions shifted back to the more erratic, and often drier climate regime of the Little Ice Age (or the 750-1050 CE period in the Maya subarea).

3) **Was the pattern of material “entanglement” similar for all of the charter states?** Once again, given the shared environmental conditions, agrarian economy, decentralized governance structure, and low-density settlement pattern, the various classical/charter states – including the Maya – do seem to have shared a significant number of material entanglements. This is especially true for those entanglements associated with water management, agricultural production, the sacred qualities of epicentral complexes, the perpetuation of urban settlement clusters, specific modes of integration, and a long-term preoccupation with sacred natural sites.

4) **Did the various charter states really “collapse,” or are their integrated socio-ecological histories better characterized by growth, punctuated by periods of less dramatic reorganization?** If the definition of collapse involves a significant downturn in socio-political complexity, over the course of two to three generations (Tainter 1988:193, 2006:332), then what we see at the end of the Classical periods or Charter Era in most of the case studies can be deemed to have been a collapse. At the same time, there is considerable continuity in cultural traditions that not only helped to spur the subsequent reorganization phases (i.e., the “remember” aspect of Panarchy Theory), but which also serves to mask, at least in archaeological terms, the full extent of the upheaval that likely occurred during the demise of the various polities under investigation.

5) **How similar and/or different are the organization properties and integrated socio-ecological histories of South and Southeast Asia from what we currently know about the ancient Maya of Central America?** The short answer to this question is that there is a great degree of similarity. Even though the Maya and the Cham of Vietnam are likely the closest in organizational properties, given the range of small, coexisting polities that dominated in these two case studies, the economic, social, political, and ideological characteristics of even the more centralized, and significantly more powerful Chola, Burmese, and Khmer polities, were analogous, at least at the base level.

6) **Do contemporary nation states situated in tropical zones share certain qualities with the archaeological sample, and if so, do any of these characteristics suggest that these
political formations are particularly vulnerable to environmental and/or cultural change? To answer this question effectively will require much more consideration of the contemporary comparators. So, for the moment, I will defer commenting on this important aspect of the ongoing SETS research program.

7) Does the modern “megalopolis” – strings of interconnected metropolises encompassing rural and industrial space (Fletcher 2009, 2012; Gottman 1961) – share any characteristics, structural or otherwise, with the tropical low-density urbanism of the charter states in question, and if so, are there any risks or vulnerabilities that contemporary planners and policy makers should be made aware of? As previously discussed, I believe that the processes that have led to the formation of the high-density corridors characteristic of both the contemporary “megalopolis” and “ruralopolis” (see above) are very different from those that stimulated the agrarian-based, low-density urban footprints of the classical/charter states. The dissimilarities in the economic bases, modes of transportation, and governance structures are especially pertinent to these posited differences. Urban sprawl did not create ancient low-density urbanism. In fact, I would argue that the scenario was quite the opposite: over time increasing numbers of people moved into what were originally sparsely populated urban epicenters, rather than out and away, into the suburbs and hinterlands of these tropical capitals (e.g., Evans et al. 2013). Low-density urbanism was, at its core, a land-use strategy developed over the long-term to meet the challenges of the tropical environment. This unique, historically contingent, settlement pattern not only emerged within, but also served to enhance, a decentralized socio-political landscape where economic control was traditionally weak, and the majority of the population (>80%) was involved in agricultural production. Nevertheless, the agrarian-based, low-density urban footprint that characterized the pre-industrial states of the world’s tropical zones continues to have comparative value, and it can provide insights into the potential resilience capacity of new urban initiatives – such as the “rubanisation” (or rurbanisation) movements currently being advanced in India and Southeast Asia (Tay 2013) – which are purposely being designed to diverge in meaningful ways from current modes of compact, yet spatially expansive, urban living.

THE IMPORTANCE OF ON-SITE VISITATIONS

On-site visitations were a crucial component of the SETS Phase I research program. Although extensive literature reviews were also conducted, these were no substitute for the “data proximity” (Drennan and Peterson 2012) provided by on-the-ground examinations. It was determined, time and time again, that many points of interest – such as sacred groves, minor temples and shrines, smaller water management features, architectural embellishments (water spouts, decorative elements), and less significant locales in general – were often not discussed in the literature at all, or if they were, they were only mentioned in passing, with no visual accompaniment. While visiting the different locales – both small and large, well-known and obscure – we were also able to informally engage with knowledgeable local guides and community members who were able to provide interesting details relevant to our study. We were also able to peruse informative signage and display texts at the various sites and museums we visited, and acquire monographs and shorter guidebooks that are not readily available outside the country of origin.
As noted by Macrae, Mody, Savage, and Walker (this volume), data proximity was especially crucial to carrying out the agriculture, sacred natural sites, and settlement sub-projects, as evidence for these important components of the ancient tropical lifeway are not as well preserved, primarily due to their palimpsest nature. In addition, there is both limited literature, and a paucity of archaeological research, associated with these areas of investigation. It was often by travelling from one study location to the next that we were able to observe, from the vantage of the van or train window, vestiges of the ancient settlement pattern, pockets of intensive agricultural production, and examples of previously unknown sacred groves. Particularly when travelling by van, we were able to stop at locations that were not on our formal itinerary to explore and take pictures of features of interest. As such, first hand knowledge of landscapes, and the distribution of both past and present settlement features of various kind, ended up being instrumental in allowing us to follow through with these particular SETS sub-projects.

It was also much easier to gauge the actual extent and overall quality of temple complexes and monasteries, urban epicenters, water management systems, and even agroecosystems by roaming around, through, and between different components of these. Our extensive on-the-ground wanderings also made it much easier to ascertain the associations between different material elements of the overall settlement pattern – either of kind (e.g., reservoirs and canals) or not (e.g., temples and reservoirs) – thus providing us with a more holistic understanding of the broader settlement footprint and its various entanglements. In South India there was the added benefit of being able to visit many of the “living temples,” and in doing so engage, in a phenomenological manner, with the sights, sounds, smells, and actions that, although part of the contemporary world, are still reminiscent of those that framed the social and spiritual life of the early state societies we are striving to learn about. With respect to these living temples, the on-site-visitations were vital to because photographs are generally not allowed within the inner sanctums of the more popular temple complexes, and our first-hand encounters with these spaces therefore proved invaluable.

In summary, our understanding of the various material entanglements that constituted each of the early state formations in questions was clearly enhanced by our exhaustive visitation itineraries, the resulting notes we were able to take, and the extensive digital image library we were able to compile. Finally, we were also able to verify whether the apparent differences in the material footprints of the various early state formations was a product of real differences in organization – as determined by on-the-ground visitations – or an artifact of differential reporting, or in some cases preservation.

**LEVERAGING THE RESULTS OF THE SETS PHASE I STUDY**

Beyond the two comprehensive interim reports (Iannone, editor 2014, this volume), the SETS Phase I research has already resulted in one book chapter (Iannone 2016a), four conference papers (Iannone 2013, 2014b, 2015a, 2015b), and two Master’s theses (Shirkey 2015; Marajh 2016). Three additional theses are currently in progress (Baron, Goldberg, Mody), and four papers will be presented at the 2016 Society for American Archaeology meetings in Orlando (Hills, Iannone, Marajh, and Macrae).

It is our plan to leverage the results of the Phase I data evaluation exercise to help frame a larger SSHRC *Insight Grant* (SETS Phase II) that will be used to expand our investigations, both spatially and temporally. Specifically, it will allow us to include places like Assam and...
West Bengal (East India), the Malaysian Peninsula, and Bali in our case studies, and enable us to explore, in considerable detail, the development and transformation of tropical, agrarian-based, low-density, urbanism across three significant climate change regimes: the Roman Climate Optimum (500 BCE – 400 CE), Medieval Climate Anomaly (900-1300 CE), and the initial stages of the Little Ice Age (1300-1570 CE). The Phase II study will therefore provide the means to assess the resilience qualities of this distinctive settlement pattern over the long term, and across varying socio-ecological contexts.

The insights generated through the Phase II research will eventually allow us to craft a SSHRC Partnership Grant (SETS Phase III) aimed at supporting a series of workshops involving select senior international scholars, local archaeologists, and graduate students who will convene to evaluate existing data sets and understandings of water management, agricultural production, urbanization, integrative mechanisms, sacred natural sites, disease profiles, and settlement systems in early tropical state formations. The overarching goal of these workshops will be to produce a series of “action items” that will stimulate future research projects to collect data relevant to, and mobilize knowledge concerning, contemporary socio-ecological issues in the world’s tropical zones (SETS Phase IV). Such issues include, but are not limited to: population growth, increasing disease rates (e.g., malaria and dengue), growing poverty, deforestation, expansion of agricultural production and monocropping, diminishing biodiversity, food and water security, urban sustainability, and the effects of climate change.

Archaeologists have a significant role to play in this important research endeavor because, although the many issues that are impacting contemporary tropical societies are historically contingent, the onset of some of these problems extend back to the earliest examples of state formation. We therefore require a comprehensive understanding of their root causes if effective mitigation strategies are to be developed. Ultimately, through our SETS investigations we will be able to assess whether the historic low-density settlement pattern holds any benefits – from a resilience perspective – when compared to the more high-density urban forms that dominate contemporary South and Southeast Asia, as well as Central America. In particular, it is our hope that, over the long-term, the SETS research program will enable us to inform the contemporary urbanisation initiatives currently underway in Southeast Asia (Tay 2013) and India.

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