

GIS Applications in Archaeology: Distribution Patterns of Early Iron Age Sites in Sri Lanka

Suneetha Samarathunga

Department of Archaeology
Sri Lanka
Suneetha65@hotmail.com

Abstract

This paper seeks to present the results of the application of GIS to understanding the material and cultural parameters associated with archaeological sites of the Early Iron Age in Sri Lanka. It also seeks to reveal something about the social formations of this period in micro and macro ecological contexts. The aim is to document the flexibility of GIS applications in probing the material data along with epigraphy and literary data within the chronological period and the spatial area under study. It also provides a test of the validity of previous research on this time period and region.

1 Introduction

The primary objective of contemporary archaeologists is to place before the public the manner in which ancient societies behaved, their processes of interaction, and their cognitive culture. This is carried out through reconnaissance systems, excavations, analytical systems, presentations, and interpretations. For these purposes, the archaeologist retrieves and manages data from a multiplicity of interdisciplinary sources and applied techniques. One of the most important tools and methodological applications of the archaeologist is digital and information technology. Despite the centrality of space to archaeological theory and practice, there have been numerous frustrations and limitations with archaeological data about spatial behavior and the ways in which archaeologists can analyze, interpret, and present their conclusions. These obstacles derive from theoretical problems in partitioning behavioral and material patterns into arbitrary spatial units, and methodical issues relating to the systematic and concurrent considerations of space, time, and form. Geographic Information Systems (GIS) techniques could be used to overcome most of these theoretical and methodological problems.

This paper is based on the first experimental research in Sri Lanka investigating new methods in geographic information systems (GIS) for spatial studies in archaeology. It also seeks to reveal important information regarding the social formations of Iron Age societies in their micro and macro ecological contexts. The paper will document the value and flexibility of GIS applications for probing material data in conjunction with epigraphy and literary data relevant to the Iron Age. In addition, it will provide a test of prior research on this time period in Sri Lanka.

2 Methodology

The methodology adopted in this study is based on GIS techniques and is comprised of three main phases. They are as follows:

1. Data collection, which was done by field survey and

literary survey;

2. Database creation and management;
3. Data Analysis, including distance calculation, cluster analysis, nearest neighbor analysis, and viewshed analysis.

3 Analysis and Interpretation

The Mesolithic Balangoda culture has been identified as the earliest techno-cultural formation in Sri Lanka, though a possible presence of the Upper Paleolithic is not ruled out (Deraniyagala 1992:693). The Mesolithic culture essentially functioned within a hunting-gathering-fishing economy. The Stone Age was succeeded by the early Iron Age. Conclusive evidence of an intervening Neolithic or Calcolithic is not yet established. The Early Iron Age may be identified as the Formative Period in Sri Lanka where recognizable institutional formation took place for the first time in the broader geophysical areas, i.e., marine and littoral zones, hinterland plains, and in the lower montane sub plains. Early Iron Age culture introduced to Sri Lanka the use of metal, paddy cultivation, other varieties of domesticated plants, domesticated animals, sedentary village settlement, household crafts producing metal objects, beads, and pottery, including megalithic memorial ritual pottery. Figure 1 shows the Protohistoric Sites of Sri Lanka.

Our investigations now indicate that the earliest intrusions into the montane region by the Early Iron Age groups may have taken place around 6th century BC. Attention was focused on the environmental context of Protohistoric sites. Within the 1-3 km buffer, 11% of Protohistoric sites are located inside a 1 km buffer. In addition, 42% and 57% of Protohistoric sites are located inside 2 km and 3 km buffers, respectively. Of the Protohistoric sites, 57% are burials, while 43% percent are habitations. Half of the habitation sites are situated inside the 1 km buffer. Most of the burials are situated outside 3 km buffer. In general, 58% of the Protohistoric sites detected were located outside the 3 km

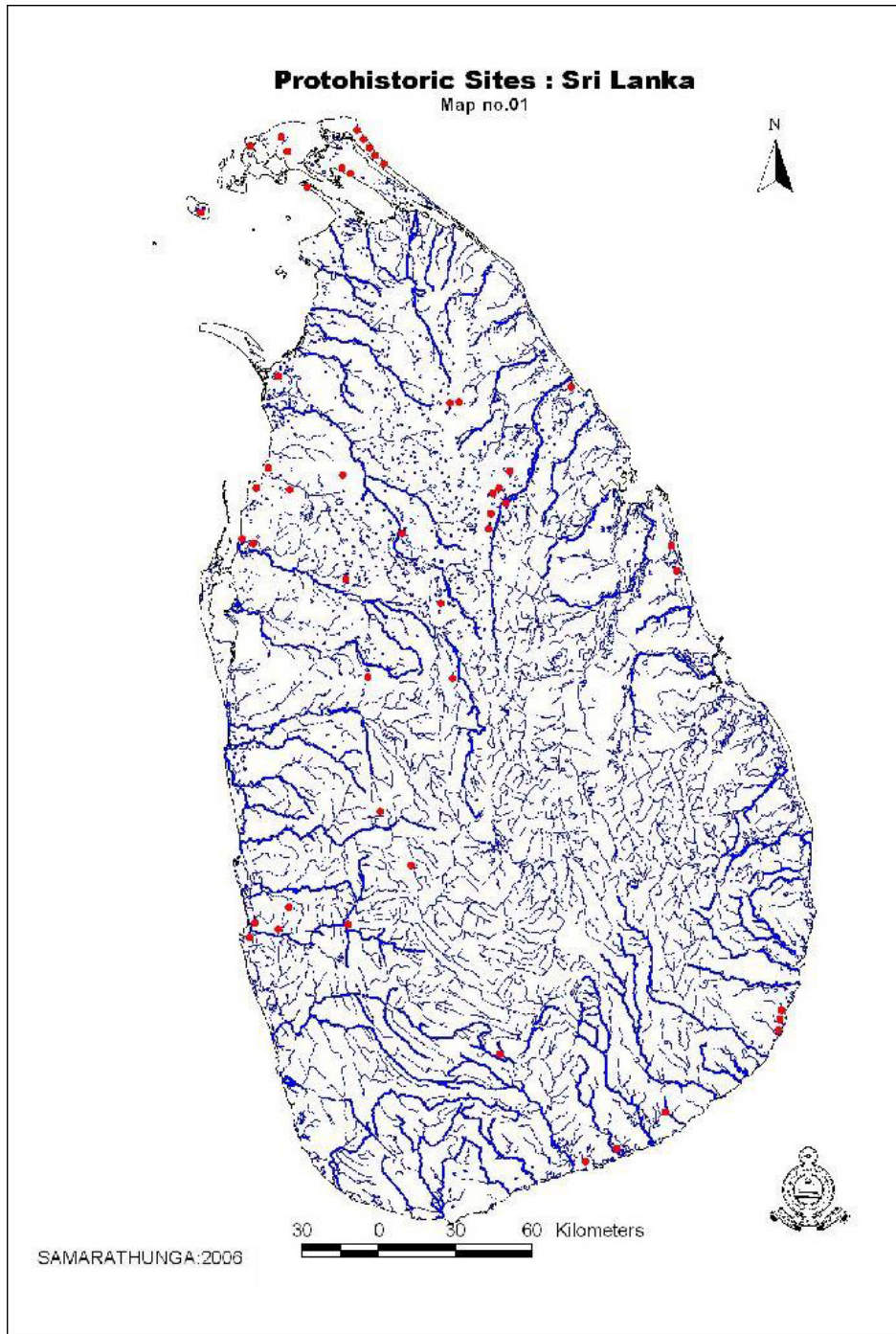


Figure 1 shows the Protohistoric Sites of Sri Lanka.

buffer.

Our investigations indicate that Protohistoric sites are located in various soil regions. Twenty-six Protohistoric sites are located in soil regions that are good for *chena* and paddy cultivation while 21 sites are located in the areas unsuitable for cultivation. Nineteen sites in the area suitable for paddy cultivation are burials and only seven sites are habitations. Fifteen habitation sites and six burials are located in the areas that are unsuitable for even swidden cultivation. It is clear that 95% of Protohistoric sites are located in the regions with elevations at 150 meters or lower. The area having the highest density of Protohistoric sites coincides with the hot, arid/dry, lowland, tropical bio-climatic

region which has an annual rainfall of 25-70 inches in a single monsoon season.

According to above results, the main question raised is why most of Protohistoric sites were located in relatively inhospitable terrain and natural environments. Water management is essential even in an area suitable for agriculture. The establishment of more complex irrigation systems certainly post-dates the 1st century BC. Given the lack of irrigation systems, the Prehistoric material and social resource base had to come from one or more alternative sources. Perennial or seasonal rivers not only provided water, but were ritual routes of communication linking these sites to other areas, especially with the central hills that had various

sources of raw materials. Fifty-eight percent of Protohistoric sites are located outside a 3 km buffer created along rivers. Out of these Protohistoric sites, 34% are burials and 24% are habitation sites. From the above data, the following ideas can be presented.

There were transportation routes near habitations inside a 3 km buffer, and these habitations bear importance when compared to habitations situated further away from the 3 km buffer. Most of the burials that are inside 3 km buffer belong to people who came to the sites for resources.

There are two significant developments related to the eco-zones during the Protohistoric to Early Historic transition. One is the expansion of the techno-cultural zone beyond the original micro ecological niche. This development is seen in the formation of macro eco-zones incorporating several micro zones within its physical region, a pattern common during the Protohistoric and Early Historic transition in South India, as well (Seneviratna 1984). The second is the movement of the Early Iron Age techno-cultural groups to the foothills regions of the central montane zone of Sri Lanka. As mentioned earlier, our investigations now indicate that earliest intrusions into the montane region by the Early Iron Age populations may have taken place around 600 BC. These community movements took advantage of the physiography and traversed the banks of the main rivers and their tributaries. These sites are located in the Upper Walawe Valley, Keleni Valley, Upper Maha Oya Valley, Deduru Oya Valley, and Kala Oya Valley.

Associated with these findings is the occurrence of Early Brahmi Inscriptions in the montane region in the subsequent period, indicating the expansion of the physical area covered by the Early Iron Age culture into regions farther away from the plains and the dry zone. According to our investigations, when distribution routes to the inland protohistoric sites decreased, Brahmi Inscription sites increased. Figure 2 shows the relationship between Protohistoric and inscription-bearing sites in varying buffers. Our investigations now indicate that all Brahmi inscription-bearing sites are located inside the km buffer from the rivers. It is clear that most of the sites are located close to natural bodies of water. Trade routes for raw materials and resources were situated close to rivers and tributaries. Caves, which were located close to rivers, were selected for resources. It is possible to suggest that rivers were used as transportation media and that there were routes and habitations close to these caves. Monks who live in caves were fed by villages and travelers.

The community movements that took place around the 6th century BC represented more than the diffusion of technologies and other cultural traits. The expansion of the Early Iron Age culture within the valley may be recognized as the second phase of the development. This phase also represents a greater proliferation of sites on an expanded scale, indicating somewhat complex and uneven distribution patterns. Trans-basin interaction becomes more apparent only during this phase. In order to identify these development phases, greater attention was focused on the areas of Kala Oya, Maha Oya, Deduru Oya, and the Upper Mahaweli River. Throughout the above mentioned valleys, the distribution of Early Iron Age culture can be identified very easily.

Internal diffusion seems to have been triggered from

several nuclei situated within the valley. Such sites are represented by early historic BRW, drip ledged cave shelters (with or without Brahmi inscriptions), and early stupa sites. This phase also represents a greater proliferation of sites on an expanded scale, indicating a somewhat complex and uneven distribution pattern. Trans-basin interaction becomes more apparent only during this phase.

It is very important to focus our attention on the socio-political landscape of this region. The site distribution pattern provides the first clue about the physiography associated with the ecology in this region. The highest density of Early Iron Age burials, drip ledge caves, and inscription-bearing sites are also located in the middle valley, which is demarcated by the contour lines of 500 and 1000 ft above sea level. This appears to form the “core area” during the Early Iron Age. Early Brahmi inscriptions with political and socio-economic titles are also located in the middle region of these valleys.

Figures 3 and 4 show the political and socio-economic titles of the Kala Oya, Maha Oya, Deduru Oya, and Upper Mahaweli valleys in relation to towns. Inscriptions made by Parumakas are located in these valleys. It is significant to note that Parumaka inscriptions are clearly located in relation to Protohistoric sites. Most of the Parumaka inscriptions are located within a 15 km buffer from the Protohistoric sites. Parumaka can be considered as the megalithic ancestors who extended some form of control over resources and resource movement in and between the core regions.

Inscriptions at Bambaragala record a Kolagama, which is interpreted as the village of metal smiths (Paranavitana 1970:15). Inscriptions at Pidurangala record a village called Kolagama (Paranavitana 1970:873). Inscriptions from Demada Oya in particular record the arrival of *manikara* (lapidarist). Inscriptions from Galmamduwa mention a *manikara* of village Wadamanaga (Wadamanaga gama), and another inscription from Mihintale mentions a *manikara* of village Kana (Kanagama) (Paranavitana 1970:1033). An inscription from Gallewa vihara mentions a *kabara* (metal smith) (Paranavitana 1970:1049a). Vegeiriya inscriptions offer a record of a *datika* (ivory worker) (Paranavitana 1970:807). This information confirms that from the second century BC and afterwards, specialized craft producers were definitely functioning in this region, and sometimes their labor was under the authority of local lineage chieftains. Craftsmen often resided close to resource areas and formed themselves into villages that were situated adjacent to *nagara* (towns) or production-distributions centers. Inscriptions in this region record the existence of four *nagara* and their affiliated *gama* (village settlements)

Spatial analysis revealed that Brahmi inscriptions mentioning the political titles Parumaka, Maharaja, Raja, Aya, Abi, Amati, and Senapati were situated in clusters around Aba *nagara* (Aba town) and Bama *nagara* and are more plentiful in number than inscriptions at the other two towns. Aba *nagara* and Bama *nagara* possessed the correct ecological base and developed a better material base, which entailed more advanced institutional formation. The location of inscriptions mentioning socio-economic titles, along with the greater number of inscriptions with socio-economic titles, clearly reveals a more complex and stable economy

RELATIONSHIP OF THE LOCATIONS OF PROTOHISTORIC SITES & BRAHMI INSCRIPTION BEARING SITES WITH VARYING BUFFERS

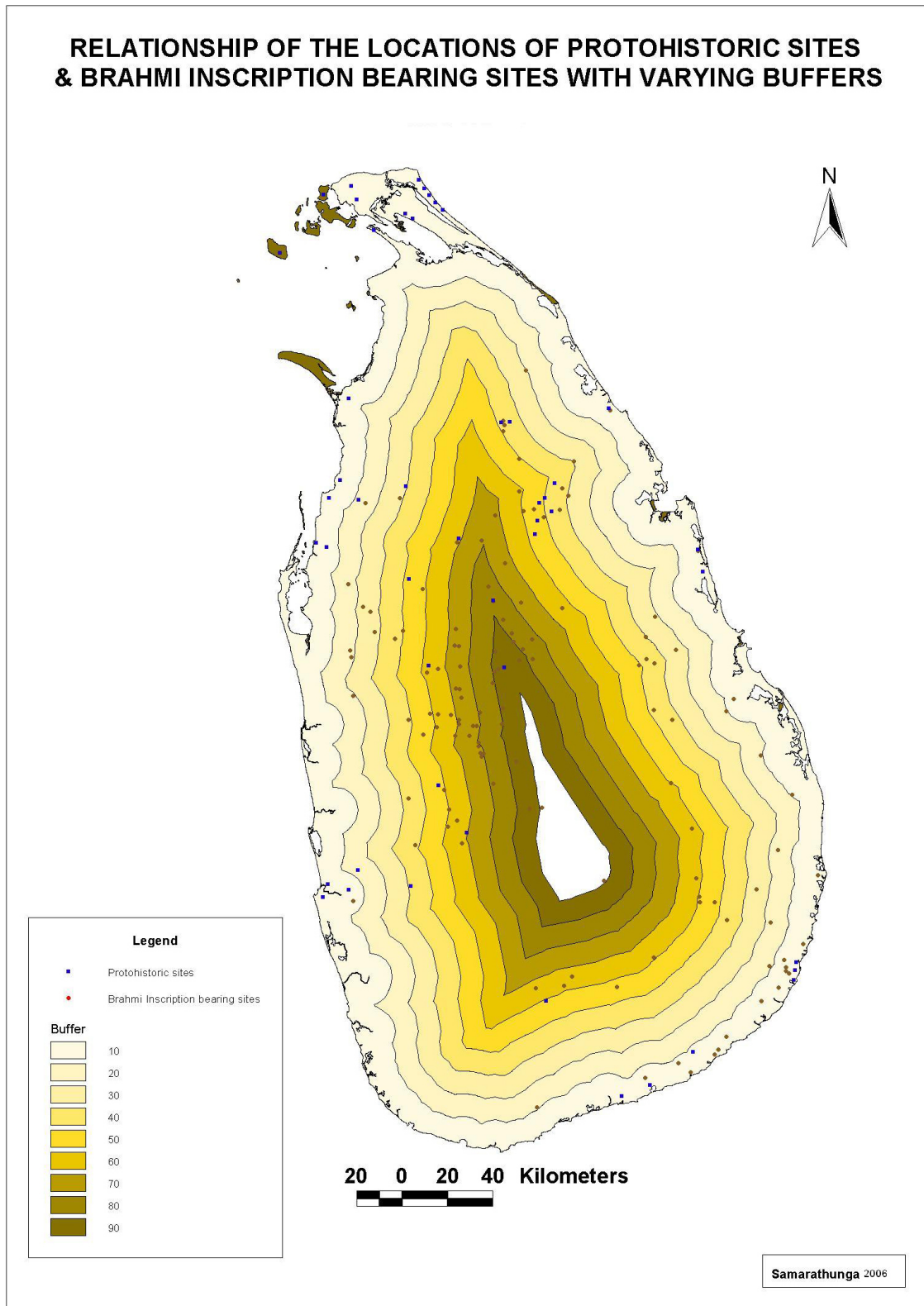


Figure 2. Relationship between Protohistoric and inscription-bearing sites in varying buffers.

and exchange system.

Our study clearly indicates that there was a grid of interrelation in Early Historic Sri Lanka. The Bata individuals, who number over 57 in the region under study, formed an intrusive group since they were members of the affluent Barata of South India. However, they were integrated into the local society and culture through a positive assimilation into the existing socio-economic structure, as well as

through the religious establishment. The high number of Bata individuals spread throughout this region indicates their involvement in linking this region to the long-distance trade network. The Early Iron Age site distribution pattern appears as a route network of three river valleys converging into one in the Upper Kala Oya, with access to the central hills. The three routes had primarily functioned to connect the above mentioned three towns.

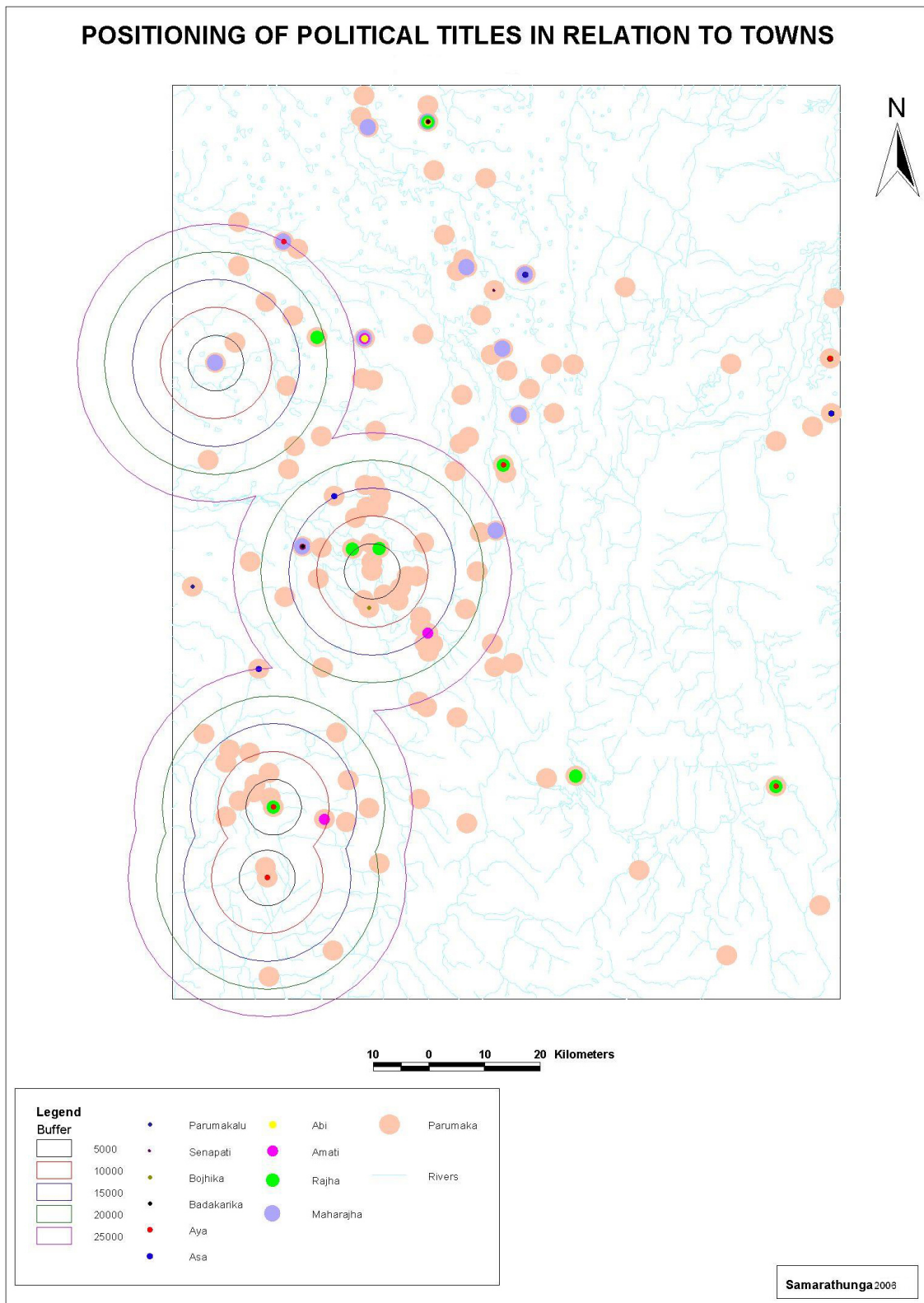


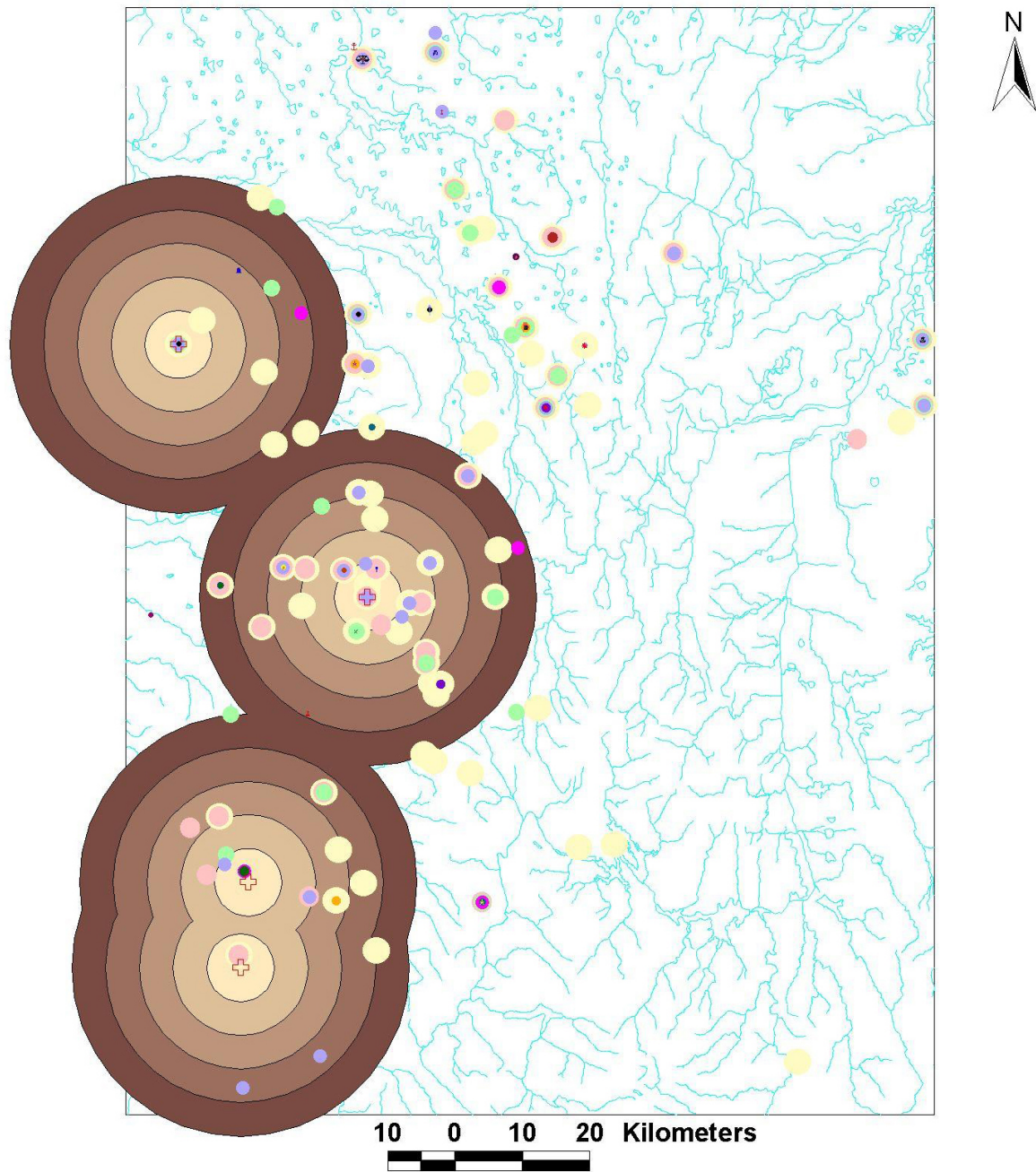
Figure 3. political and socio-economic titles of the Kala Oya, Maha Oya, Deduru Oya, and Upper Mahaweli valleys in relation to towns.

1. Trans basin routes connecting Deduru Oya and Kala Oya via Aba nagara to the south and the Mahaweli basin to the North, extending to Anuradhapura, one of the major political centers.
2. Trans basin route connecting Maha oya and upper Mahaweli valley.
3. Trans basin route connecting Kala oya and upper

Mahaweli basin.

Figure 5 shows the route network of the study area. Minimum distances between archaeological sites, epigraphical evidence, suitable topography for access, and environmental factors were considered when preparing this route network.

POSITIONING OF SOCIO-ECONOMIC TITLES RELATION TO TOWNS



| Legend | | | | | | | | | | | |
|--------|------------|---|-------------------|---|--------------|---|-------------|---|------------|---|----------|
| + | Nagara | † | Tanabumikabojhika | † | Nagaragutiya | • | Dadika | • | Vavihamika | ● | Gapati |
| ⊖ | Vetigopaka | ⊖ | Taladara | • | Kutaragaya | • | Abelavabara | • | Nada | ● | Bata |
| • | Vesaya | † | Rupadaka | • | Kubutika | • | Ananika | • | Kabara | ● | Parumaka |
| ▲ | Vejha | † | Pehekara | • | Kubala | • | Asaruya | • | Aciriya | ● | |
| ⊕ | Vanijha | ▲ | Pakaraadeka | ▲ | Ganaka | • | Asajiriya | • | Adikaya | ● | |
| • | Vamakara | ⊕ | Navika | * | Dorakani | • | Gahapati | • | Gamika | ● | |
| ⊕ | Todika | × | Nakatika | • | Datika | • | Danugaya | • | Manikara | ● | |

| Buffer | |
|----------------|--------|
| Lightest Brown | 5000 |
| Light Brown | 10000 |
| Medium Brown | 15000 |
| Dark Brown | 20000 |
| Darkest Brown | 25000 |
| Blue Line | Rivers |

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Figure 4. political and socio-economic titles of the Kala Oya, Maha Oya, Deduru Oya, and Upper Mahaweli valleys in relation to towns.

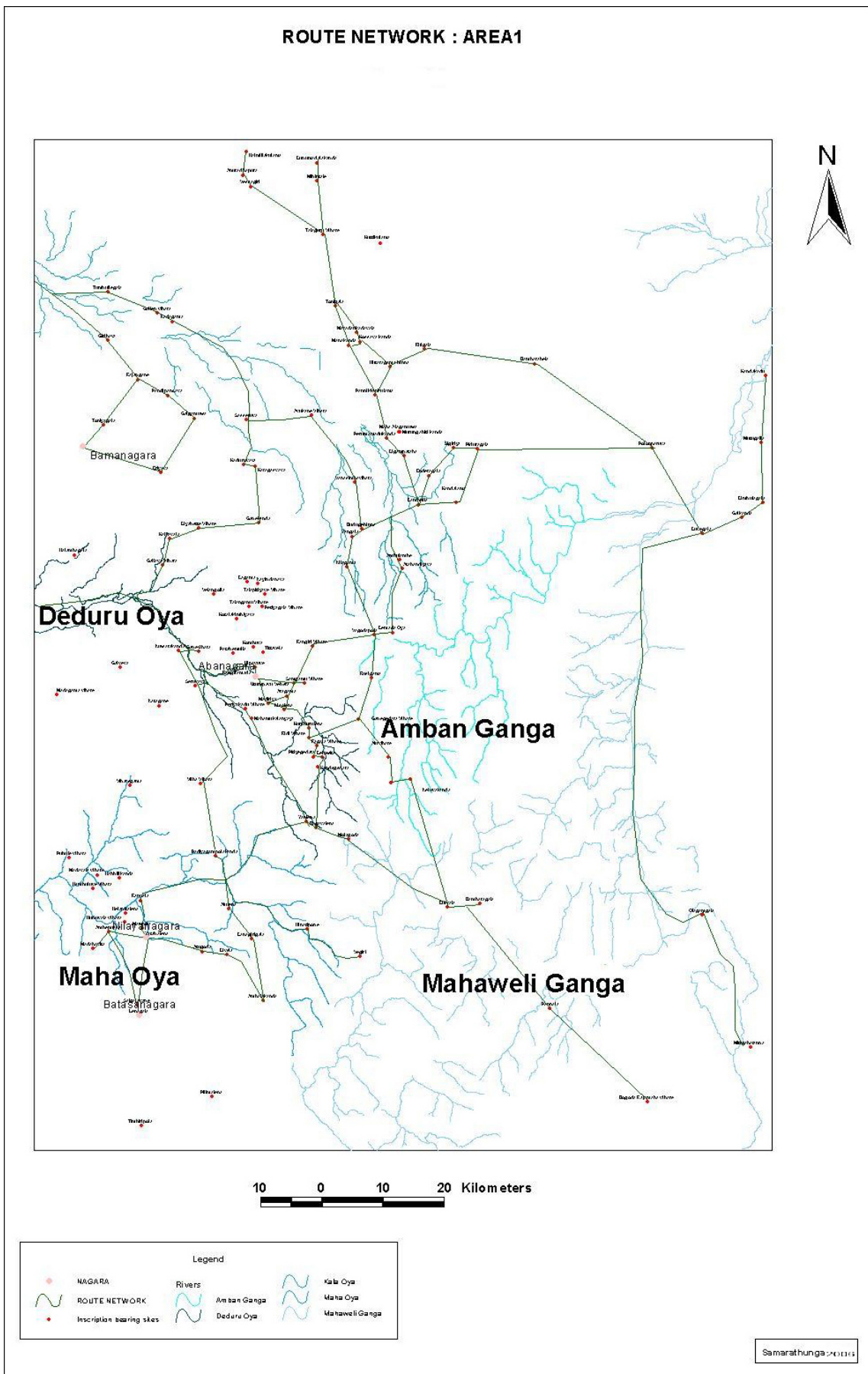


Figure 5. the route network of the study area.

4 Conclusion

In the final analysis, it is clear that from an archaeological perspective, GIS has enormous potential. That potential is only being touched upon at present in Sri Lanka, and it is expected that more imaginative studies will be undertaken in the future. Further research is expected to provide a complete understanding of the total cultural ecology of the Early Iron Age in Sri Lanka.

References Cited

Champalakshmi, R. and Gopal, S., eds. 1996 'Peripheral Regions' and 'Marginal Communities': Towards an alternative explanation of Early Iron Age material and social formation. In, *Tradition, Dissent and Ideology*, pp. 264-312. Delhi: Oxford University Press.

Deraniyagala, S. U. 1992. *The Pre History of Sri Lanka part I & II*. Colombo: Department of Archaeological Survey

Paranavitana, S. 1970. *Inscriptions of Ceylon vol. I*, Colombo: Department of Archaeology.

Seneviratne, S. 1984. The Archaeology of the Megalithic Black and Red Ware Complex in Sri Lanka. *Ancient Ceylon* 5:237-307.