Field Mapping the *Ahu* Ra'ai, La Pérouse Area, Rapa Nui (Easter Island)

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Introduction

This paper outlines a method, we are developing, for combining several different types and scales of data, within a GIS, in order to build a model, proto-historic, human ecology in Rapa Nui (Easter Island). This method uses direct and indirect data entry techniques, primary field data, and archival data, and data gathered at a variety of scales and resolutions. Global positioning system (GPS) and electronic measuring (EDM, or Totalstation) equipment were used to gather field data. The precision of these techniques allows for the integration of less precise data sources, into a two-tiered data set, suitable for analytical modeling.

The broader analytical purpose of our work is to provide a tool, for addressing one of the enigmas of Rapa Nui's prehistory, the population collapse of the late seventeenth and early eighteenth century proto-historic period (Belwood 1979, 1987). Among other things this disaster has been explained as an example of a Malthusian crisis, or as a result of a chronic misdirection of social energies (Mulloy 1970, Kirch 1994). These notions make fascinating discussion points, particularly in the light of contemporary theories of global environmental change. Resolving this question turns on developing plausible models of the pre- and proto-historic lifeways of the Island's inhabitants, especially the basic patterns of human ecology, prior to the population collapse. A human ecological zonation of the island, based on correlating, known proto-historic habitation sites and the landscape's physical-geographic characteristics, would allow researchers a method for systematically exploring proto-historical patterns of carrying capacity.

To develop such a model, several diverse data sets must be incorporated into oneanother. Basic physical-geographical parameters, such as slope, aspect, soils, hydrology, and wind exposure, must be included along with archaeological field data. Archived archaeological data must be incorporated with current field observations. Several scales and qualities of materials must be rendered into a commensurate form. In this paper, we shall outline a method we are developing, for combining several different types and scales of data within a GIS, in order to build a model of Easter Island's prehistoric human ecology. This method uses direct and indirect data entry techniques, primary field data and archival data, and data gathered at a variety of scales and resolutions.

The site, from which field data were gathered, is the *ahu* Ra'ai, on the northern shore of Rapa Nui. This presents several technical challenges, as it is remote by local standards -it is several kilometers down an unpaved road. More important, it is remote by global standards- Rapa Nui is one of the most isolated, inhabited spots on Earth. Its central feature is an *ahu* ceremonial platform, surrounded by several habitation sites, some subsidiary structures, including walls and boundary markers, and a fishery watch tower. Behind the site there are some areas of rock garden and a set of petroglyphs. Immediately in front is the ocean. The entire study area measures 700m by 450 m, and some parts are fairly steeply sloped, rising from sea level to about 18 m.

Techniques

Vector GIS is gaining acceptance as the standard mapping and data management tool for archaeologists. Beyond the most basic mapmaking and data-base management functions, there are almost limitless, analytical possibilities for GIS; however, archeologists are only now starting to explore the modeling potential of the technology. Much of the novelty lies in the remarkable capacity of GIS, to incorporate a variety of types and scales of data, and to digitally model dynamic and complex surfaces. Despite the comparatively high costs of equipment, and some daunting technical manuals, the flexibility of such digital techniques, for data management and spatial modeling, are becoming increasingly popular.

There are a variety of indirect and direct techniques, that can be used to assemble spatial digital data sets. Indirect methods include digitizing and scanning of pre-existing paper maps, import of previously digitized spatial data, or the linking of non-spatial digital data, to GIS data. Direct methods center on GPS and EDM.

Indirect data entry techniques provide the majority of the GIS data, currently in use. The most commonly employed technique, of indirect data entry in archeology, is to digitize (more rarely scan) a map, drawn using traditional survey techniques, and then geo-reference it, and link it to an attribute table describing the object it depicts. All of the indirect methods share a sequence, in which the objects that comprise the study area are classified, measured, and then, rendered into an analog form. Digitizing this analog information requires the reduction of continuous forms, such as curves into simplified lines, and imposes an artificial precision of machine coordinate systems onto the data. Each of these data manipulations might be described as a filtering process, and serves to distance users, of the end product, from original field observations. Yet, they are unavoidable necessities of the process of creating GIS data, and constitute a logical extension of what Mark Monmonier describes as ". . . the cartographic paradox: in order to present a useful and truthful picture, an accurate map must tell white lies" (1991:1).

Direct data entry techniques, those in which field measurements are incorporated into the GIS, without intermediate processing steps, rely on two technologies: GPS and EDM. GPS provides data that are already geo-referenced, and so constitute a working GIS, in themselves. However, at present, even the best systems are somewhat inaccurate, particularly in their measurements of elevations. EDM data, in contrast, are highly accurate, but are in this particular case, based on a free coordinate system, which must then be georeferenced. Both direct techniques share the distinguishing characteristic that they record data at a scale of 1:1. The most immediate advantage of direct systems is that data entry is extremely convenient. The distance from the field to the final rendition can be shortened considerably. Further, the surveyor is given tremendous power over the quality and nature of the final data product, as walking the landscape and mapping it become the same thing.

Data

The data resources currently available for Rapa Nui could be compared to one's relatives at a large family gathering. A few are deserving of unequivocal respect; the rest are, in varying degrees, problematic. They are numerous, some are surprisingly old, some are suspiciously rich, some are of doubtful provenance, some are of questionable veracity, and they are all impossible to ignore.

Useful observations were made over two centuries ago, in 1774, by Captain James Cook, and in 1786 by La Pérouse. In the nineteenth century, William J. Thomson (1891), produced a survey of the Island, which although over a century old, still stands as an important source. The Franco-Belgian expedition of 1934-5, and the Norwegian expedition of 1955-56, yielded many high-quality data (Heyerdahl 1968). In the past decade or so, modern archeological techniques have been employed by researchers, such as Wallin and Martinsson-Wallin (1996), and have generated many detailed observations. Data available from other sources include Chilean Navy maps of the Island's coast and interior relief, aerial photograph stereo pairs, land-use, soil and vegetation maps produced by the University of Chile, and historical maps in the British Museum and the British Royal Geographical Society. In addition, meteorological data of sufficient quality, to allow for the construction of a climatological model of the island, are publicly available.

Our contribution to these data was to develop a digital map of the *ahu* Ra'ai, using a combination of direct data entry techniques. A GPS was used to generate georeferencing points for an EDM survey, and to produce an outline of the coastline, fronting the site. The EDM was used to outline and label the major features of the site, and to produce a network of elevation points, that were then used to generate an elevation model.

Method

Comparing our field data, to the archival and published materials available, it is immediately apparent that the two data sets have been gathered at radically different scales, and with different methodologies and objectives. While not actually incommensurate, this diversity presents an interesting methodological challenge. Two problems must be addressed: first, these widely differing data sets must be rendered into a sufficiently similar form, to be measured against one another; second, a systematic method, for establishing human ecological zones on Rapa Nui, must be devised.

The first problem can be addressed, by rendering all data into a digital form, and into the global coordinate system provided by the GPS, regardless of scale. Our geo-referenced, digital data provide the basis for this work. The combination of the GPS reference points and the coastline map allow us to digitize or scan published and archived maps, and air photos, and evaluate them alongside the directly entered data.

The second problem requires the systematic extraction of several spatial correlations, from the combined data sets. This is a three-stage process, which is outlined in figure 1:

- the basic physical characteristics of the *Ahu* Ra'ai, such as slope, aspect, elevation and soils must be extracted from our field data
- the same characteristics must be extracted, from the indirect data for other site locations
- sites must be classified, according to the number of characteristics, that match *ahu* Ra'ai

This procedure will produce a zonation scheme, driven by the similarity of any given site, to the one site for which we have primary data. The two key criteria, that determine the zonation scheme that will result, are the characteristics of the primary data, and the classification breaks used to define quantitative variables such as slope and elevation.

There is no particularly good reason to use the *ahu* Ra'ai data as our baseline; neither is there any particular reason *not* to use it as the starting point for the model. And as it is the site for which we have directly entered data, it seems the logical place to begin the project. The classification schemes, for the quantitative data, are rather more problematic. In the absence of any other information, determining critical cut-off values, for quantifiable characteristics of the landscape, is a risky business. Our ultimate purpose is not to find some objective, critical value at which, say, slope can be deemed to have changed. Rather, it is to try and discern what constituted an effective change in slope, for the people who used to inhabit the area.

Two strategies allow for this second, more serious, question to be addressed. By reiterating the process of zone definition, using different classification breaks, several different zonation schemes can be developed from the same data set. By referring to the literature, and by cross-referencing the zonation schemes developed with other data sources, such as artifacts and organic remains from excavations, the best, or at least the more plausible zonation schemes, can be identified.

This type of procedure has been employed by other researchers, interested in Polynesian archeology, such as McCoy (1976) and Terrel (1986). However, recent developments in software and computing power, make possible the generation of much more complex models, that include a greater variety of data, than was possible in the past. And several researchers have now started to explore the possibilities of correlating social variables, such as territoriality, to cross-reference analyses, developed from normative models, such as this (Roscoe 1992, Llobera 1996). In our case, the appropriate approach seems to be, to use a combination of excavation data and a method that McCoy (1976:70) describes as the judicious use of ethnohistoric and ethnographic records, the relevant aspects of which are projected with care, back in time.

Conclusions

An essential component, for developing modeling applications of GIS is the production of appropriate data structures. These, ideally, incorporate all available materials, including published, archival, and field data. As with any analytical exercise, that uses data other than those purpose-gathered by the researcher, problems of compatibility and commensurability quickly become apparent. Careful model design, and the judicious use of technologies, such as GPS and EDM allow for many of these secondary data sources to be added to data sets, based on primary survey work. In the case of the *ahu* Ra'ai excavation, the speed and accuracy of the combined GPS and EDM survey, allowed us to circumvent some very immediate problems such as the remoteness of the site, and the short time available for data gathering. More important, it allowed us to develop a GIS data structure, suitable for making a first pass, human ecological model of the Rapa Nui, during the proto-historic period. What remains is to reiteratively run the model, and to evaluate the results, in the light of findings developed, using more traditional archaeological research methods.

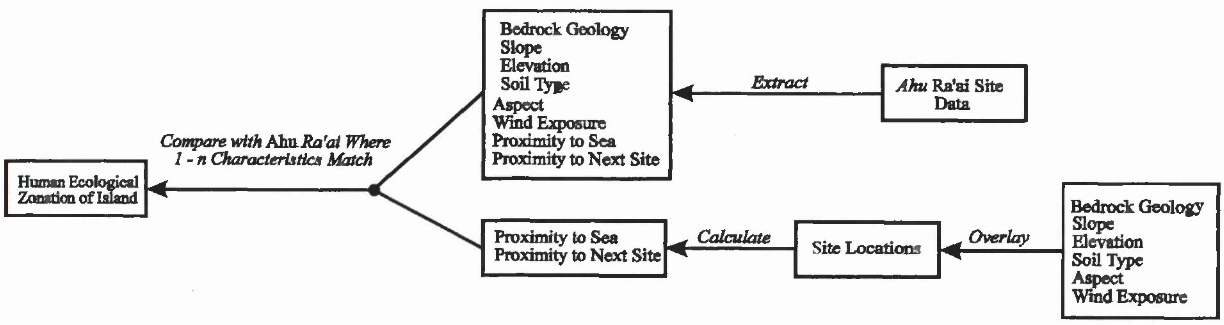

Figure 1. Model of GIS Analysis

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Sources Cited

BELLWOOD, P. (1979), *Man's Conquest of the Pacific: the Prehistory of Southeast Asia and the Pacific.* Oxford University Press, Oxford.

_________. 1987 ed. *The Polynesians: Prehistory of an Island People.* Thames and Hudson: London.

HEYERDAHL, T. (1968), "The prehistoric culture of Easter Island", in: YAWATA I. and SHINTO Y. H. (eds), *Prehistoric Culture in Oceania.* Bishop Museum Press, Honolulu.

KIRCH, P. V. (1994), *The Wet and the Dry: Irrigation and Agricultural Technology in Polynesia,* University of Chicago Press, Chicago.

LLOBERA, M. (1996), "Exploring the topography of mind: GIS social space and archeology", *Antiquity,* 70:269, pp. 612-622.

McCOY, P. C. (1976), *Easter Island Settlement Patterns in the Late Prehistoric and Protohistoric Periods,* Bulletin Five, Easter Island Committee, International Fund for Monuments Inc.

MONMONIER. M. (1991), *How to Lie with Maps,* University of Chicago Press, Chicago.

MULLOY, W. (1970), "A speculative reconstruction of techniques of carving and transporting Easter Island Statues.", *Archeology and Physical Anthropology in Oceania.* 5, pp. 1-23.

ROSCOE, P. B. (1992), "Warfare, terrain and political expansion", *Human Ecology.* 20:1, pp. 1-20.

TERRELL, J. (1986), *Prehistory in the Pacific Islands,* Cambridge University Press, Cambridge.

THOMSON, W. J. (1891), *Te Pito Te Henua, or Easter Island,* Smithsonian Institution, United States National Museum, Washington.

WALLIN, P. and MARTINSSON-WALLIN H. (1996), *Archeological Excavations at the Ahu Hekii Complex, Easter Island,* The Kon-Tiki Museum, Oslo.