Imagining Calabria. A GIS Approach to Neolithic Landscapes. Some Critical Thoughts on Modelling the Effects of Agency and Qualifying Landscapes in Terms of Human Activity

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Abstract. The recently finished PhD research by the author engaged in a discussion of agency and taskscapes based on a GIS analysis of economic landscapes in southern Calabria (Italy). In the context of current postdoctoral research the methodology used was critically evaluated giving rise to a number of discussion points concerning modelling the effects of agency and qualifying physical environments in terms of environmental type, yield, human presence, cost and human activity. These are briefly discussed in relation to a summarised presentation of the project and its GIS models.
Keywords: GIS modelling, Neolithic Calabria, agency, taskscapes, socio-economic landscapes

1. Introduction

It is clear from CAA conferences that both simulation technology and theoretical debates concerning modelling past human behaviour are advancing rapidly. In particular, increasingly different visualisations of spatial data within GIS software have allowed a degree of systematic modelling going beyond ecologically focussed research to include GIS analyses considering socio-cultural factors, using a combination of anthropological values and physical environmental variables (e.g. Van West and Kohler 1996; Whitley In press). For example, GIS research with a focus on cognition and perception has been introduced over the past decade, especially within cost-surface and viewshed analyses (e.g. Wheatley's relevant transformations, 1993; Gaffney et al. 1996; Maschner 1996). This includes concepts of uncertainty, organisation of time, space and society, and affordances (e.g. Zubrow 1994; Gillings 1996; Llobera 1996; Gillings 1998; Loots et al. 1999; Nackaerts et al. 1999). Adding in ethnographic data (e.g. Dalla Bona and Larcombe 1996), historic cartographic information (e.g. Attema 1999), elements from psychology (e.g. Maschner 1996) and sensual geographies (e.g. Rodaway 1994) can help interpret spatial patterns as well.

More recently, GIS has been used to model agency. Witcher (1999: 16) argued that, as agency mediates between the reception of spatial information and the formation of mental insights and practical action, space can be assigned values to understand it better, within 'humanized' GIS models. Whitley (In press) introduced the use of proxies, which relate physical spatial variables with agency, motivation and causality and become, therefore, a key element in the reconstruction of social and cultural landscapes within GIS. Doctoral research by the author (Van Hove 2003) modelled the effects of agency through a simulation of economic landscapes within Southern Calabria. Using the environmental effects of a range of economic strategies, a stage was built from which to imagine a Neolithic world on a socio-cultural level, and from which to critique the relationships between humans, agency, choice, action and effect.

This article is mainly concerned with presenting a series of discussion points concerning modelling the effects of agency (section 3) and qualifying a physical environment in terms of human behaviour (section 4). This resulted from a critical evaluation of the project (section 2) and its GIS methodology (section 4) within the context of current postdoctoral research and was inspired by Whitley's work on using GIS to outline and understand the ways in which people have thought about and utilised their surroundings (cf. Whitley 2002; 2003, in press).

2. Imagining Neolithic Behaviour within Calabria

The discussed doctoral research reinterpreted off-site Neolithic land use within southern Calabria through synchronic and diachronic GIS approaches (cf. Van Hove 2003).

The synchronic GIS model included an exploratory analysis of how a set of predefined economic choices play out in a simulated Neolithic environment in Calabria, in order to analyse the relationships between human choices (economic inputs) and their immediate effects (off-site land use outputs) at one given point in time. Using values of yield within a reconstructed qualified environment one focussed on how a chosen economic strategy translated into effective physical land needs around the site. Through associated values of cost the feasibility of site implementation and of community survival in certain areas was explored. This articulated with a much-needed critique of existing functionalist and spatially limited socio-cultural models of Neolithic society in southern Italy. By examining the consequences of the implementation of a range of economic strategies through space and time, land use patterns of daily activity became the backdrop for imagining Calabrian Neolithic society on a wider spatial and temporal scale, showing how one can adequately model the effects of human agency within a GIS framework.

The diachronic GIS model achieved a dynamic view of changing Neolithic landscapes. By generating land use patterns as a result of a conscious economic choice and feeding the resulting landscapes into a cumulative sequence of land use, land exhaustion and land recuperation, the nature, intensity of use and frequentation of off-site environments was simulated through time. As these are generated through a long-term accommodation of human dwelling action, a dynamic view of changing landscape use also reflects the potential taskscapes created, their boundaries and their significance (Ingold 1993: 158–159).

3. Modelling the Effects of Agency

Human choice and subsequent action are a result of agency. For the discussed doctoral research, agency was defined as the ability to intervene in and come to terms with the world by the construction of diversity and difference (Robb 1999: 4), relating to how people control their own actions, including issues like intentionality, choice, indeterminacy, consciousness, reasoning and volition. Agency was seen as crucial within the negotiations that take place between communities and environments, emphasising the importance of people's practical engagement with their surroundings (McCall 1999: 16; Robb 1999: 3; Dobres and Robb 2000: 3–10; Barrett 2001: 141–142). By inference, human agency was considered as involved in routine and symbolic practice, resulting in the creation, configuration, utilisation and fragmentation of space and landscapes. Both economic and socio-cultural use of land were thus viewed as the effects of agency (Robb 1999: 8). Ultimately agency is responsible for the construction of human landscapes.

To integrate this idea within GIS requires a rethinking of its inputs. The need for geographically referenced data in GIS modelling often restricts inputs to environmental and ecological domains. Although environmental models are not truly representative of reality, as they exclude political, social, cognitive and religious factors (Kohler 1988: 19–22), the poor spatial resolution of these elements and the false distinction made between physical-economic and socio-cultural components within a human landscape as a result of a difference in scale prioritised physical environmental information, leading unwillingly to the reduction of the socio-cultural component (e.g. van Leusen 1995; Lock and Harris 1996; Kvamme 1997; Witcher 1999). Even so, the latter is a non-dismissible part within modelling of human spatial behaviour. The idea of agency as individuality in a socio-cultural context while simultaneously present in a natural environment may indicate a solution to this problem.

I propose that social and cultural variables can be introduced into GIS analyses in a much more subtle way than simply adding another layer to the spatial database. Through a combination of people's complete, incomplete and perceived spatial knowledge regarding environmental parameters reflected within their material culture, Whitley (2003) clarified notions of social identity within Afro-American slavery societies using GIS. This went far beyond a unidirectional approach in which people are defined mainly by their actions as based on environmental pressures and did not necessarily relate to separately introduced, cultural GIS layers. Incorporating the fuzzy and complex nature of human reasoning and cultural behaviour, his GIS analysis illuminated past human activity and agency. Within later work Whitley illustrates how cognitive decision making processes and social agency can be modelled within GIS by learning to identify empirical phenomena with cognitive behaviour, within what he calls spatial proxies (Whitley In press).

While remaining in the same mindset of simulating the ideas people may have had about space, my doctoral research took a subtly different approach. The resulting spatial patterning of a range of economic choices was interpreted as a snapshot of the implications of socio-cultural decisions influenced by agency. Within the modelling of the spatial effects of human choice the imposing of arbitrary structures (people with predetermined structural conditions or specific symbolic 'programs') was avoided to allow the imagination of spatial behaviour based on the effects of a set of straightforward daily activities.

4. Qualifying the Landscape

This section details the generic methodological steps involved in both synchronic and diachronic GIS simulations. Each step is critically evaluated to assess how qualifying a landscape in terms of environmental type, yield, human presence, cost and human activity can explore associated socio-cultural landscapes.

4.1 Environmental Type

On the basis of elevation, slope and river proximity parameters, ecological and archaeological literature and local field observations, seven ecological zones were identified, forming a current environmental niches map of the study area. This collection of environmental niches became the basis for modelling Neolithic economic action. The zones identified were coastal plain, river channels, lowland plateaus, lowland hills, highland plateaus, highland hills and cliffs.

Provided such a qualified landscape reflects the reality of an environmental situation, classifying a region in terms of physically diverse niches sets up an excellent basis from which to explore its different uses. It allows the simplification of more complex eco-systems, whilst simultaneously presenting an accurate predictive framework for particular behavioural processes, within a preset frame of reference (Séror 1994: 20), giving meaning to the specified parameters to be implemented in a computer environment. Both top-down and bottom-up procedures are advisable for the qualifying of environments in terms of ecological type. This was achieved by combining terrain observation with environmental literature about the region in question.

When qualifying a landscape in terms of environmental type as part of an analysis into human spatial dynamics, one effectively assumes that people understand their surroundings by classifying it into categories of some kind (cf. mental mapping, mindscape, Forte In press). However, are the types of classifications archaeologists make and the types of units at the basis of analyses representative of the things that had particular meaning to the people of the past, the latter not always being accurately measurable? This is where I believe we need to emphasise the implementation of measurable variables which stand-in for those elements that are not, but were of importance to how people behaved. In relation to this, Whitley (in press) discussed direct causal, indirect causal and non-causal reference variables as spatial proxies for cognition.

4.2 Yield

By the attribution of yield values to each environmental niche the presumed Neolithic environment was evaluated in terms of its general utility for farming, herding and foraging activities, which provided a means of visualising how economic regimes adopted by Neolithic groups play out within the defined environmental niches. Each niche was assigned a series of values, the highest numbers being assigned to optimal environments, the smallest to unsuitable ones, for each land use strategy (Table 1).

Niche	Environment	Farming	Herding	Foraging
1	Beach and dunes	1	1	2
2	River channel	1	2	3
3	Lowland plateau	3	3	3
4	Lowland hill	2	3	3
5	Highland plateau	3	3	3
6	Highland hill	2	3	3
7	Cliff	1	1	1

Table 1. Yield values for specific land use (3 = large, 2 = medium, 1 = small).

This particular way of qualifying a landscape in terms of yield is an extremely simple one. Values (Table 1) are relative and coarse grained. Absolute values are impossible without more detailed knowledge about Neolithic environment and economy in Calabria. Such information is currently not available but equally unnecessary to justify specific land use choices. Regarding the values given, the *relative* value of yield as an indicator of potential human use and a visualisation of the generic structure of economic behaviours in a chosen environment is emphasised. Qualifying a landscape in terms of specific resources originates from the Von Thünen regional land use model, which, based upon an agricultural landscape, represented a qualitative environment based on food production (cf. Block and DuPuis 2001). Further applications, for example within site catchment analysis, claimed that settlements were organised economically to take advantage of their environmental setting, using uniquely defined 'catchments' per land use (Higgs and Vita-Finzi 1972; Higgs and Jarman 1975). More recently, Whitley (2002) explored the different qualities of an environment by reclassifying a range of digital data themes into spatial representations of projected cost or benefit. All classifications were based upon the logical premise that environmental, ecological and socio-cultural factors of importance to site selection and site placement can be defined, so to project a cognitively assigned resource value per land unit in the past.

4.3 Human Presence

To be able to translate an economic strategy into actually used off-site terrain, the known Neolithic sites for the chosen Calabrian landscape were located within the environmental niches map. Nine reliably dated Neolithic sites with diagnostic pottery were included for analysis, including Umbro, Penitenzeria, Castello Bova Superiore, Melito modern city, Cufolito, Salto La Vecchia, Prastara, Molaro and Saraceni (cf. Van Hove 2003, Chapter 4). Although this project is concerned mainly with off-site land use within wider landscape approaches, these site data provide useful information on humans traversing and inhabiting different surroundings.
Based on house and site sizes and house numbers, Robb and Van Hove (2003: 245) argued that sites in Calabria were probably substantially smaller than Neolithic villages elsewhere in southern Italy (e.g. Passo di Corvo: 250 people; Tinè 1983). Therefore, the notional value of 50 people was chosen as a reasonable estimate for people living in a Neolithic settlement in Calabria. To develop an accurate predictive model of economic space use based on known site data, these data have to objectively represent the total landscape under observation. The existing Neolithic site record does not conform to any objective knowledge on where people were active in the past and a simulation based on it would only replicate its current biases, assumed to be the result of a lack of research, not of an absence of archaeology (Van Hove 2003, Chapter 4). To enhance the quality of analysis, a random sample of points throughout the Calabrian study area was created, representing areas where Neolithic sites could potentially have existed but no archaeological research has been done. By comparing patterns of land use around potential Neolithic settlements to those associated with archaeologically attested sites, areas currently without Neolithic site presence can be evaluated for their settlement potential and the understanding of Neolithic living conditions throughout the study area could be enhanced (Van Hove 2003, Chapter 5). In order to investigate cognitive landscapes within the Greater Yellowstone Region (USA), Whitley (2002) chose to focus on the nature of site selection instead. To predict how people were active in a chosen landscape he used behavioural premises including issues of past land use, site selection processes and generic human/landscape interaction and combined dynamical systems research, fuzzy logic and neural network analogues for the construction of a logical decision making model with regards to site locations and potential economic behaviour.

4.4. Economy

Groups inhabiting the modelled sites were given a range of potential economic strategies, incorporating farming, herding and foraging in different combinations expressed as a

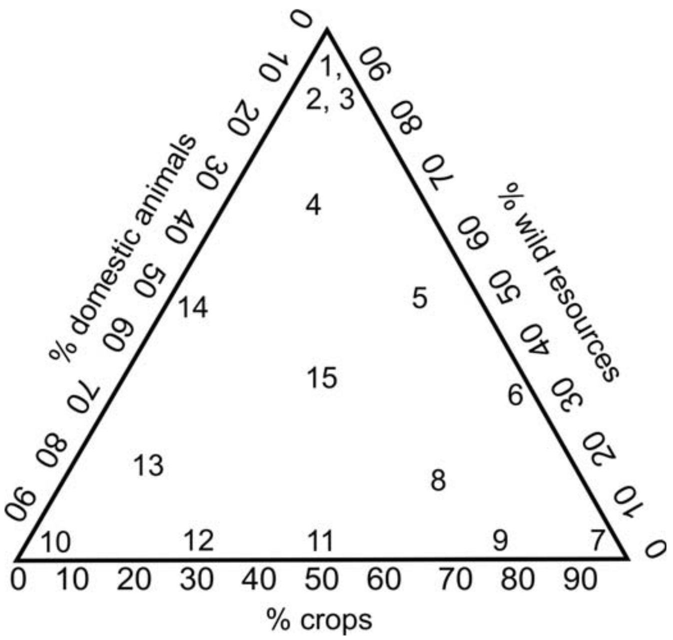

Fig. 1. Relative variety of economic choices within the Calabrian GIS analysis (after Robb and Van Hove 2003: Figure 3)

percentage of the average calorific intake within the modelled communities. These were chosen specifically to represent a broad range of land use practices possible within the Neolithic (Figure 1).

Data for specific land use area needs were based on a study by Gregg (1988), who discussed and modelled the interaction between central-European Neolithic farmers and foragers. Even though Gregg worked with a specific data set and based herself on partly arbitrary choices, her work provides a benchmark for any other study of subsistence strategies as it summarises a great deal of information on dietary requirements and land use models. Results of Gregg's simulations allowed a straightforward linkage between a predefined number of people and the areas needed for acquisition of a sufficient number of calories to survive for a year, including farming, herding and foraging space. As basic biological and economic data are similar to these of Neolithic Italy, it was considered a minimal but adequate basis for the study of Calabria land use.

4.5 Cost

To assess how a range of predefined economic choices translate into daily landscapes of use, a synchronic simulation model was designed which articulated land use throughout the Calabrian Neolithic environment to acquire enough resources (expressed as area size) for a range of sites of 50 people to survive upon, based on a variety of economic inputs and areas of high yield only. Human requirements for land, land availability and land accessibility were combined to produce off-site territories for farming, herding and foraging at an abstract point in time. By incorporating these territories into simulations that model their use through time, accumulated utilisation histories could be examined as well. In both cases, a GIS model of a utilised landscape at human scale was generated.

This modelled landscape was evaluated using cost-surface analyses. These visualise the relative cost of human movements across a specific terrain starting from a location of choice, which necessitates the creation of a friction surface reflecting a plausible assumption of the cost involved in traversing a particular terrain (for factors of importance: cf. van Leusen 1999). By looking at the cost values associated with each zone of human activity, the relative feasibility of each economic model could be assessed and the way in which an area is ultimately integrated within human society could be imagined.

Cost-surface analyses based on environmental factors only are not always representative of real world situations. Amongst others, Wheatley and Gillings (2002: 155) emphasised that there is more to cost surfaces than merely slope and energy expenditure on a physical basis, as patterns of movements within landscapes are influenced by symbolic resources too. Whitley (2002) discussed the concept of cost in terms of cost/benefit, distance and friction surfaces, indicating a possible variance according to the nature of each land unit, its distance to other land units, and its friction value in preventing or helping someone to reach other land units. Such cost surfaces were key to his cognitive landscape model of the Greater Yellowstone Region (see 4.3).

Although socio-cultural factors should thus be included when assessing accessibility, there was no hard evidence available within the Calabrian study area to include these factors, as typical areas of higher socio-cultural cost such as cemeteries, ritual grounds, rock art locations and ceremonial caves have not been identified. This observation, in addition to the decision to focus on the degree of accessibility rather than on directional and absolute cost measures, led this research to choose an environmental and isotropic cost surface model (Marble and Machovina 1997: 120):

$$M = 1.5W + 2.0(W+L)\,(L/W)^2 + n(W+L)\,(1.5V^2 + 0.35\,VG)$$

M = metabolic rate in watts
W = weight of the unclothed person in kg
L = load carried by the person (including clothing) in kg
n = terrain factor
V = speed of walking (km/h)
G = grade (%)

4.6 Human Activity

The synchronic analysis resulted in maps showing utilised landscapes for different activities, as based upon a set of predefined economic strategies (Figure 2). This classified a chosen environment into archaeologically meaningful entities, which formed a basis for discussing extensively the exact land use methods of agriculture, animal husbandry and foraging, for elaborating on the associated socio-cultural worlds and for analysing in detail the impact of each land use on site implementation. What is emphasised is a qualified landscape in terms of activities. In future analyses this could be broken down further to reflect the resources people were farming, herding or foraging for, including seasonal issues and specific tasks (Whitley, pers. comm.; Trifkovic, pers. comm.).

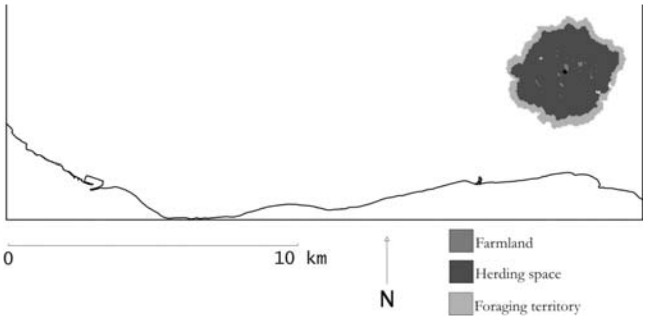

Fig. 2. Example of synchronic simulation output: farmland, herding space and foraging territory around Penitenzeria (62.9% farming, 23% herding, 14.1% foraging).

Land use maps resulting from the diachronic analysis present a pattern of frequentation zones, which indicate a potential utilisation of varying intensity through time (Figure 3).
To discuss these in terms of specific tasks is impossible without more detailed archaeological and environmental knowledge but models like these allow a glimpse at the potential long-term landscapes resulting from a particular human choice at a given point in time. In addition, the resulting spatial signatures allow insight into the nature of use of a certain area. Using this backdrop, spheres of understanding based on accumulated activity, called taskscapes (cf. Ingold 1993), can be discussed.
Overall, the final result of both GIS analyses is a qualified landscape in terms of human activity, whether this is in an abstract or diachronic timeframe. However, it is important to specify the particular way through which this doctoral research has explored the connections between the human use of particular areas (simulated through economic GIS models) and the social agency present within (asserted from the resulting maps). The results of the economic land use simulations define a backdrop (or stage), which is not particularly human, social or dynamic in itself but a non-dismissible part when imagining human social behaviour within a landscape. What is emphasised is that the simulation results, the land use maps, do not represent social interpretation as such but demonstrate a basis from which to experimentally play out the consequences of a variety of theories, in this case economic strategies and accumulations of human land use over a time. The simulations attempted to effectively define the stage set in which a social drama can be discussed.

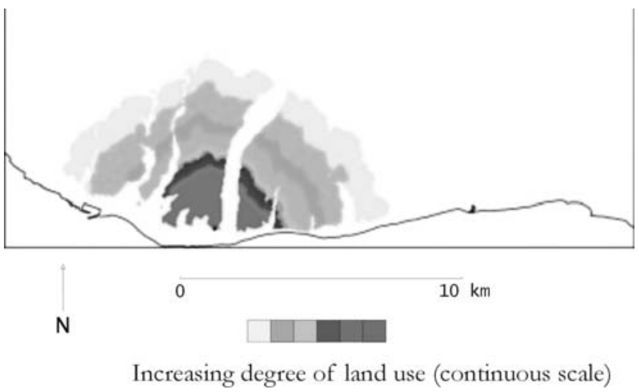

Fig. 3. Example of diachronic simulation output: herding space for Melito modern city (62.9% farming, 23% herding and 14.1% foraging).

5. Conclusion

This article presented a series of explorative, critical thoughts with regards to the subject and modelling procedure of PhD research into economic space use in southern Calabria. It was demonstrated that the specification of human economic choice as input encourages the usage of social, cultural and temporal elements from the outset, allowing the simulation of realistic, holistic and especially dynamic and culturally experienced human landscapes.
Modelling the effects of human agency was made possible through the definition of a series of qualitative landscapes, introducing in different ways values of possible importance to past spatial behaviour. These include classifications of environmental type, linked to the physical and mental mapping processes when observing particular surroundings, measures of yield and cost to enable both visualisation and evaluation of how particular human activities find their translation into spatial land use signatures, and, finally, a landscape of human presence and activity, a systematically produced backdrop of human behaviour, from which a socio-cultural world can be understood.

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