

THINKING ABOUT THE SPATIAL ARTICULATION OF THE ARCHAEOLOGICAL RECORD: THE ROLE OF STATISTICAL TECHNIQUES

1. INTRODUCTION

In archaeological research, as well as in the rest of the disciplines which study social phenomena and its interaction with natural phenomena, the application of quantitative methods cannot be obviated. Nowadays, aims and research programs of most of the professionals of this discipline imply, necessarily, a quantitative and computerized processing of the empirical record.

The ultimate goal when using quantitative methods, especially statistical techniques, is to improve the objectivation of the record manipulation process, that is, to be more rigorous in the archaeological praxis (Fig. 1). This so-called improvement can be observed, above all, in the standardization of the data description it strengthens the reasoning and the inferences. Once the quantification's importance is accepted as the objectivation vehicle of the observations of the empirical record data, the next step must be to carry out an adequate selection of the quantitative tools to ensure the validity and reliability of the data. A good research design must include rigorous proceedings of observation, recording and systematization of the empirical data.

Undoubtedly, the irruption of quantitative methods and computers in archaeological research has had a considerable impact. Overall, its appearance is clearly positive, even though many imprecisions and inevitable errors have been made. Apparently, a very wide integration has been attained regardless of absurd refusals of minority sectors. However, there are several aspects still to be solved:

1) the professionals of the archaeological discipline must improve their training in their school years in order to integrate and normalize, once and for all, the application of quantitative methods and the use of computers. This improvement would minimize errors and the incorrect usage product of the inexperience and carelessness, or what is more, of the disregard for the instrumental proceedings.

2) the usual tendency to unnecessary sophistication, which has caused the understandable refusal by the less receptive sectors, must be overcome (BARCELÓ *et al.* 1994; WÜNSCH *et al.* 1995). Along this line, we consider adequate to defend an approach based on the principle "the easier, the better". More simple technical solutions must be given as much priority as possible because, usually, the posed problems are simple too.

3) the reflection about the quantitative methods must be integrated within the frame of the theoretical-methodological general discussion. It is

important to set an adequate connection between the evaluated theoretical aspects and the design of the instrumental methodology. The best solution would be to establish a gradation from theoretical to empirical aspects, without leaving any gap.

This process of reflection is closely linked to the archaeological praxis, since the nature of the archaeological record is defined as the representative material entity of the social activity. Several properties of the archaeological material record which are prone to be quantified are structured by means of the overlapping, association and recurrence principles (LUMBRERAS 1981). We are going to focus on only those related to the spatial articulation because they enable us to obtain information about the organizational strategies of human communities.

2. FROM THE SPATIAL ARTICULATION OF ARCHAEOLOGICAL RECORD TO THE MANAGEMENT OF THE SOCIAL SPACE

In the archaeology of hunter-gatherer communities a line of research about the management of social space has been clearly defined (WUNSCH 1991-92, 1992). Synthesizing, this line presupposes that the spatial articulation of the archaeological record reflects aspects which are implied in the management of the social space (Fig. 2). This management includes not only the logistical aspects related to the conditioning and cleaning of the space, but also the articulation among social units, the location of the working processes, the distribution of food and goods, etc. It also affects the development of the general productive process, and therefore, it includes the results of the interaction between the production, distribution and consumption processes.

It is operational to propose an "analytical gradation" of the social space. Such gradation ranges from the most wide category, the territory, as the physical frame in which the dialectics between the human communities vs. environment takes place, to the smallest category, the settlement or occupation place. Generally, and leaving aside terminological nuances, there is a plural approach to the social space resulting from the transformation of the environment through work and the productive activity aimed at the obtention of material goods.

This wide and restricted "spatiality" gradation means to face the notion of record representativeness. As in other research fields, it is essential to evaluate the "archaeological universe" that is being studied in order to decide its validity and degree of reliability. Therefore, we meet the problem of the representativeness of the sample because, undoubtedly, the archaeology professionals study samples of a total "population" of dimensions which are seldom known. Nevertheless, any approach to this wide spatial notion of interaction among complementary settlements can profit from the applica-

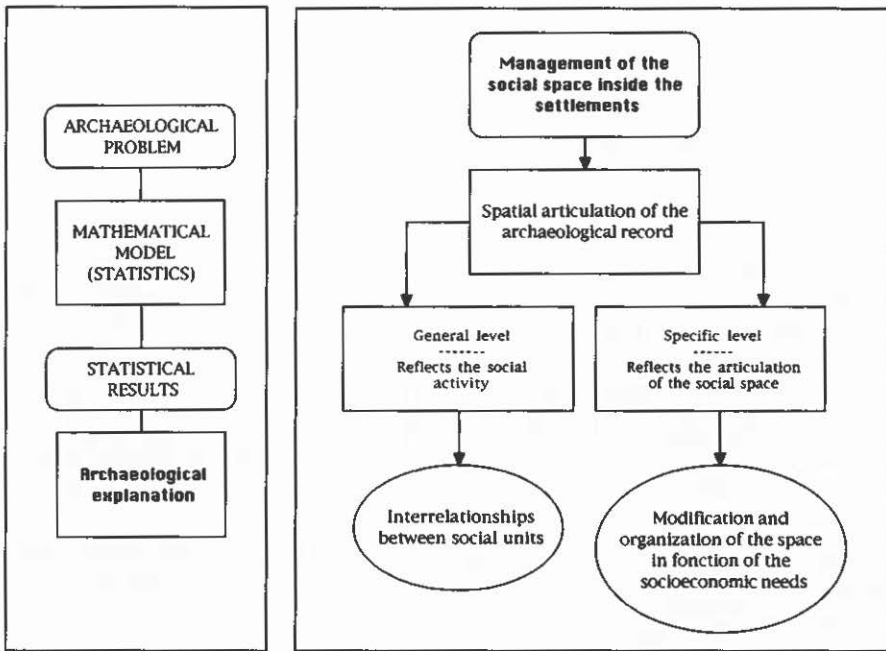


Fig. 1 – The major steps in the application of the quantitative methods, basically statistics, in the archaeological research.

Fig. 2 – The diagram include the most important features included in the concept of the management of the social space.

tion of the probabilistic sampling techniques.

With these techniques the archaeological record is connected to the notions of probability and randomness. This notion of probability which lays upon the probability theory becomes the credibility or confirmation degree in the light of the available empirical evidence. Moreover, it is very useful when establishing the validity degree of an inference or a reasoning. The notion of randomness must be understood as the absence causal determinism. It is obvious, thus, that randomness is essential in relation to the informative potential of the spatial articulation of the empirical record.

The contextual condition of the archaeological record attaches the importance of the association and recurrence principles which bestow relevance and social signification to the analyzed material remains. It is for this reason that a spatial notion restricted to the inner space of the settlements implies a previous reflection about the objectivation possibilities by means of quantification. The problem does not lie so much on the sample's representativeness, if we accept the settlement or occupation place as a significant social context, but on the establishment of a processing design of the record according to the needs and to the informative expectations.

On the whole we see that, from the beginning, it is almost impossible to think about all the different questions implied in the application of quantitative methods in archaeology. Above all, we ought to outline the importance of the randomness concept versus non-randomness. This is a basic concept for emphasize the significant data and eliminate the irrelevant information.

3. THE SPATIAL PROPERTIES OF THE ARCHAEOLOGICAL RECORD

To focus our attention on the study of the spatial articulation of the archaeological record means to define the connection between the archaeological context and the mathematical models, in this case, statistical models which are more suitable for its analysis. We should be able to clearly define the archaeological problem that is to be solved, and subsequently select the statistical models and techniques which are relevant for the obtention of the significant and informative results. For this reason to make the spatial articulation into a study object implies to profit from the spatial properties of the archaeological record.

Our proposal of approach to the study of the spatial articulation is built upon the design of the spatial interrelationships analysis (ANITES). In this previous elaboration process of the methodology, special attention has been given to the application of quantitative methods (Fig. 3). The main idea is to profit from the quantifying possibilities of the spatial properties of the archaeological record. In order to do so, several statistical techniques have been selected. With these techniques we can evaluate aspects related to causality, probability, signification and randomness (WÜNSCH 1989a, 1989b, 1991, 1991-92, 1992, 1994, 1995).

We have given special attention to the elaboration of the instrumental methodology, which is understood as the whole set of instrumental proceedings implied in the processing of the empirical record. In the process of reflection about the operational design, several relevant features and its eventual relationships with mathematical models are determined. Namely, we have selected three of the most relevant and informative properties of the archaeological record (Fig. 4):

- 1) the distribution of the material remains. The aim is to measure the degree of difference with respect to the randomness of a distribution of remains considered as points within a limited three-dimensional space. This measure based on mutual distances between points allows us to discriminate the non-random patterns and keeps it from being causally interpreted. The approach to the non-random patterns is carried out by means of the nearest-neighbour analysis remodeled in 3D (WÜNSCH 1994, 1995). This test determines the existence of random and non-random patterns, by discriminating in the latter case its tendency to clustering or scattering.

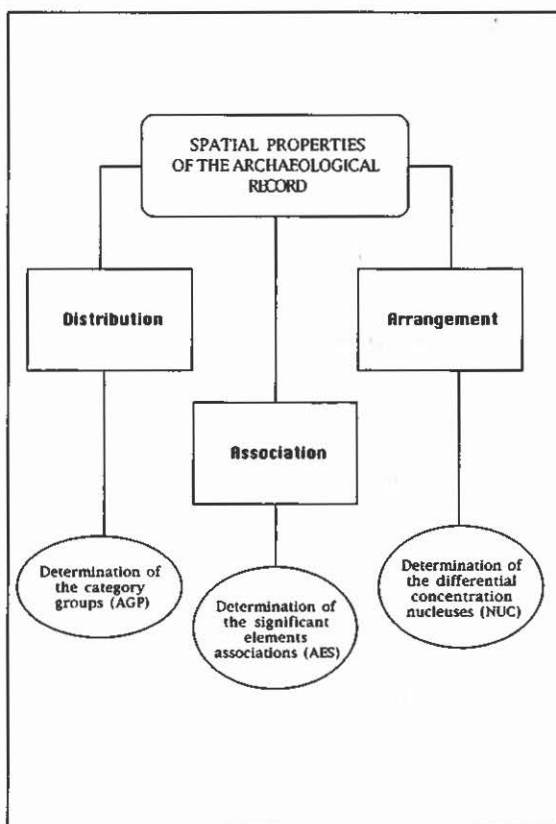
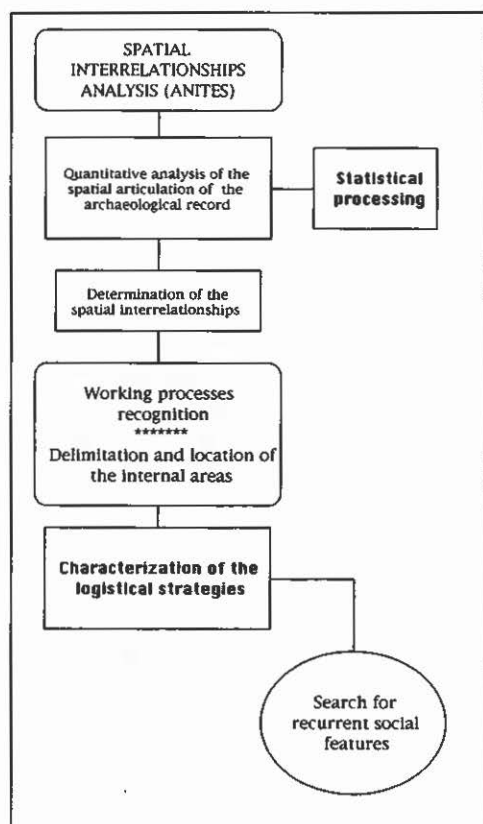


Fig. 3 – The graphic shows the main aspects of the operational design of the ANITES methodology.

Fig. 4 – The diagram shows the three spatial properties of the archaeological record studied by the ANITES methodology.

The determination of the distribution patterns is the first, but not the most important, step in the characterization of the spatial properties of the archaeological record. In fact, it only provides us with an example of non-homogeneity, nevertheless, the inferences based on these patterns must be alternative and accurate. However, this determination is basic because it facilitates the study of the non-random patterns and, consequently, the search of causal explanations.

We ought to take into account that it is not advisable to interpret mechanically the patterns in terms of its implications respecting the social activity that they reflect. For instance, the scattered distribution needs not be interpreted as a reflect of an anthropical or postdepositional alteration without taking into account other alternative hypotheses. Moreover, a clustered

distribution not always shows the exact location of the working processes, considering the tools, remains and refuse accumulations, with more or less disturbing postdepositional impact.

We must insist on the fact that the determination of the distribution pattern only presents a dim view about the spatial articulation. Its validity is directly conditioned to the analytical determination of the significant category groups (AGP), if they exist. In our design of the ANITES, we have used as a measure of the grouping a critical distance of rupture (WÜNSCH 1995) from which the different groups of points are formed. These groups are a first general characterization of the basic tendencies about the distribution of the material remains within the analyzed space (the excavated surface).

2) the arrangement of the material remains. The aim is to measure the degree of spatial autocorrelation, that is, the intensity of the existent relationship between the adjacent remains or values. Parallely, it can inform us about the signification of eventual tendencies to a specific location, such is the case of the semicircular arrangements or the alignments. The measure of the arrangement must be understood as a complementary view which is necessary in respect to the distribution and, moreover, cannot be regarded as an alternative. In general, it provides new information and enables a greater comprehension of the spatial articulation of the archaeological record. In its minimal informative level, it enables us to prove once more the non-homogeneity of the record (the non-randomness) and also to determine the tendency to clustering or to scattering.

In the case of the processing of three-dimensional remains there are not simple measures and the quantification is difficult to carry out. For the processing of non three-dimensional remains we have selected the application of spatial autocorrelation tests, namely the Moran's I coefficient (WÜNSCH 1995).

As in the above mentioned case, the determination of the arrangement pattern of the remains has relative interest by itself. Its informative potential and validity are conditioned by an analytical determination of the differential concentration nucleuses (NUC), and by means of a comparisons grid, square by square, using the Chi-squared test (WÜNSCH 1995). And hence, it is possible to obtain a concise description of the basic arrangement tendencies of the material remains as far as location and/or concentration degree is concerned.

When the applicability conditions of the statistical techniques are proper, especially concerning the minimal number of effectives, the results of the distribution patterns and those of the arrangement patterns must be complementary and, above all, they should not be contradictory. In case there is a significant pattern of clustered distribution, we would be able to state parallely a clustered arrangement pattern, that is, a clear tendency to concentration.

3) the spatial association of the material remains. The most immediate aim is to measure the degree of spatial association of the selected analytical categories. We try to determine the signification of the contextual relationship based on the differential location within the analyzed space. While the distribution and arrangement measures give information on the categories of the material remains that have been obtained at an individual level, the measures of spatial association are focused to state the interrelationship among categories.

This analytical approach to the spatial association of the archaeological record enables us to obtain a global and strong view of the spatial articulation. It is also the base for the isolation of the significant elements associations (AES). In order to determine these associations we have selected several techniques that furnish more details about complementary aspects. On the one hand, we have selected the association or similitude tests, namely the Jaccard's I coefficient and the Phi-coefficient (WÜNSCH 1995). These tests are adequate for the measuring of the relation degree between those categories which are studied two by two, at a presence/absence level. This is an important aspect of the operational design of the ANITES because qualitative categories can be processed.

Furthermore, we have selected an approach which offers a wider view of the relationship among categories and the basic excavation grid that is used to delimit the locations. In most of the cases, the percentages table of the Lien offers a fairly close view of the most significant presences or absences. However, very often the application of the correspondence analysis (AFC) helps to strengthen the already observed tendencies and/or to extract complementary data because it relates all the variables each one with another (WÜNSCH 1995).

The final determination of the significant elements associations is based on the integrated evaluation of the different analyzed aspects. It takes into account not only the differential locations or concentrations within the analyzed space but also the significant associations among categories. We end up having a final synthesis of the spatial articulation of the archaeological record.

4. DISCUSSION

The joint evaluation of the three spatial properties of the archaeological record is the analytical base of the spatial interrelationships concept which defines the methodology of ANITES. In any case, the problem is to establish the nexus between the statistical signification and the archaeological signification, as the base for the explanation of the social phenomenon. Since this explanation intends to acquire a generalizing character, it is important to overcome the irrelevant particularism and focus the attention to recurrence.

Another important aspect that is to be taken into account is that those patterns determined using statistical processing are not necessarily preexistent in the data. On the contrary, they respond to an analytical approach which is only valid within the designed theoretical-methodological frame. If we accept a 'codification' of the archaeological record, which gives way to the existence of a spatial articulation which is analytically discriminable, we can extract analytical patterns that can be used as a comparative model for the search of recurrent social features.

This is the most outstanding utility of the spatial interrelationship patterns (PIE) which are configured as the synthesis of the delimitation and location of the internal areas of the studied settlements (WÜNSCH 1992). These patterns must serve as synthesizing hypotheses of the main tendencies of the management of the social space. They are obtained through an analytical characterization of the spatial articulation of the archaeological record. Its real relevance will only stem from the later prove of significant recurrences.

The first exploratory applications and the controlled experimental processing of the ethnoarchaeological records (WÜNSCH 1993) seem to evidence the operativity of the statistical data processing and hence the interest of the ANITES methodological proposal.

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ABSTRACT

The aim of this paper is to present a short reflection about the connection between the spatial articulation of the archaeological record and the role of the statistical techniques. The basic idea is to process three spatial properties of the archaeological record: the distribution, the arrangement and the association. We include this idea inside the theoretical-methodological framework of the ANITES proposal. Briefly, we present the informative potential of these properties and the statistical techniques selected.