

INFORMATION SYSTEM AND COMPUTERISED METHODS FOR RESCUE ARCHAEOLOGY

ABSTRACT

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In Rescue Archaeology, where the control of both efficient diagnostics, scientific control of operation, budget and planning are major constraints, computerised methods are the key of improvement of quality and productivity of the projects. Various computerised methods are described here and integrated into a global methodological framework for Rescue Archaeology. Four phases in Rescue Archaeology are described : Diagnostic, Evaluation, Operation and Publishing. For the operation phase, nine steps have been defined and detailed : specifications of the operation, complete documentation concerning the area under survey, logistic support, G.I.S. implementation, zoning, intrazone field survey by sampling, kriging & predictive modelling, intrasite operations by surface survey, geophysical survey, core surveys & excavations, sampling artefact collections, post-excavation studies and publishing preparation.

INTRODUCTION

THE HISTORICAL LINKS BETWEEN RESCUE ARCHAEOLOGY AND SAMPLING

If the concept of archaeological sample was recognised since the beginning of XX^e century by many archaeologists, it is certainly Vesceilius (1960) who the first recognizes the link between an archaeological sample and a statistical sample. But the success of the concept of statistical sampling in the context of the North-American Archaeology is certainly due to both G.L. Cowgill (1964) and L. Binford (1964), the first proposing to sample in large shard collections, the second using a probabilistic sampling to optimise surveys of archaeological sites. The development of the concept of sampling were then strongly associated with the first rescue archaeological projects, both in North-America between 1965 and 1975, remembered by the book "Sampling in Archaeology" (Mueller 1975) and in UK during the seventies : "The role of sampling in contemporary British Archaeology" (Cherry et al. 1978). The difficulties met by the application of probabilistic sampling, needing high rate of sampling for delivering results with low reliability and bad precision, obliged to test new other techniques, supposed to be more efficient, like Kriging (Zubrow and Harbaugh 1978) and Predictive Modelling (Scholtz-Parker 1982), but without the expected success (Djindjian 1991, 2001). The use of sophisticated methods for archaeological surveys of large rescue archaeological projects restarts during the nineties with the success of the Geographical Information System (G.I.S). The data management and cartography functions of G.I.S. packages offer then both the framework and the environmental information needed to implement easily simultaneously various techniques like probabilistic sampling, kriging and predictive modelling, alimented with the large cartographic data provided by the G.I.S. implementation (Wescost and Brandon 2000).

PRINCIPLES IN RESCUE ARCHAEOLOGY

The archaeological workflow of Rescue Archaeology is very characteristic of a project-oriented approach. Generally, the four following phases are considered :

Phase 1 : Diagnosis

The diagnosis phase, made by the contracting authority, must estimate, with the help of experts, the archaeological impact of projected works upon the concerned area.

Phase 2 : Evaluation

The evaluation phase, which is a further step of diagnosis for large operations, made by the contracting authority or subcontracting consulting specialists, allows obtaining the information needed to make the specifications of the operation, a budget and an agenda.

The evaluation phase is including in-depth diagnosis, audit by experts, preliminary documentation by use of various retrieval information systems, global surveys including aerial photography and satellite image, preliminary zoning, test surveys by random sampling, global specifications, use of configuration tools (templates using time and expenses ratios by categories of sites) for budget estimation, budget negotiations with third parties, etc.

Phase 3 : Operations

The operation phase realizes a rescue archaeological project. The operation is directed by the contractor, after a negotiation between the contracting authority (a public authority in Culture Resource management), the third party (generally a civil work company) and the contractor (a public or private company specialised in rescue archaeological projects).

Phase 4 : Publishing

The publishing phase is based on the definition of a standard framework for editing archaeological publishing, multimedia databases, CD-ROM and even Virtual reality.

THE 9 STEPS OF A RESCUE ARCHAEOLOGICAL PROJECT

A Rescue Archaeological Project may be split in several steps, which will be detailed below:

1. Detailed Specifications of the project,
2. Complete documentation concerning the area under survey,
3. Logistic support to install,

Computerised methods for Rescue Archaeology

4. G.I.S. implementation,
5. Zoning the area,
6. Field survey : finding archaeological sites by sampling, kriging & predictive modelling,
7. Intrasite operations: surface survey, geophysical survey, core surveys & excavations,
8. Sampling artefact collections,
9. Post-excavation studies and publishing preparation.

STEP 1 : DETAILED SPECIFICATIONS

Starting from the specifications made during the evaluation step by the contracting authority, the contractor must control and detail the received specifications, and before starting any operation, has to obtain a validation of the new specifications he has produced by the contracting authority :

1. To define precisely the area of the rescue project,
2. To obtain digitalized various maps of the area,
3. To get a general view of the area, by various means,
4. To obtain information about the archaeological sites known in the area (archaeological map),
5. To define the various constraints about the rescue project area,
6. To design an initial zoning of the area,
7. To validate the budget,
8. To elaborate a detailed agenda of the project,
9. To list the resources and skills needed.

STEP 2 : COMPLETE DOCUMENTATION

The complete documentation is the existing documentation concerning archaeological information of the discovered artefacts or archaeological sites and the archaeologist activities in all the places where the information may be stored.

- Museum documentation,
- Archives,
- Toponymy,
- Various maps, including altitude (DEM), hydrography (at a level n), vegetation, soil, modern infrastructure, etc.
- Aerial photography and satellite images,
- Geomorphologic studies,
- Archaeological map,
- etc.

STEP 3: LOGISTICS

Logistic support has a major role to improve the productivity of field works. Such a logistic support is listed below, as an example to emphasise the importance of an in-house prepared operation, before any field survey :

manpower (human resources), tool kits, machines, facilities (water, electricity, telecommunications, mobile home, etc.), food supply, storage, laboratory services, transport services, computers (hardware, software and customisation), recording procedures, methods (manual), security rules, training, insurances, code of practice, organisation & tasks of the project team, etc.

STEP 4: G.I.S. IMPLEMENTATION

Computer services need a complete organisation including resources, hardware, software and customisation, prepared before the rescue operation in a dedicated computer department, offering services for all operations.

- Dedicated G.I.S. resource,
- Computer dedicated for project : installation & customisation,
- Software products for the project management
 - Project Management (Pert or Gant diagram) : MS-project,
 - Budget control management : Excel or dedicated package,
 - Time and expenses management : Excel or dedicated package,
 - logistic support management : Access or any other DBMS,
 - G.I.S.,
 - AutoCAD,
 - Statistical package,
 - Dedicated sampling algorithms
- Import existing digitalized maps,
- Digitalization of needed published maps,
- Design of the data model,
- Import existing archaeological data,
- DEM model,
- Zoning at different scales,
- Sampling procedures,
- Recording survey data,
- Special software for sampling techniques,
- etc.

STEP 5: LOCATION & ZONING

The step of location and zoning is one of the most critical step of the operation.

Location may be realised by two techniques :

- Field localisation by GPS,
- Field marker.

Zoning is realised at different scales, first from the landscape map, and then at a macro and micro scales where intrazone sampling surveys are applied.

- Landscape Zoning (more than 1 km²)
- Macro-Survey Zoning (from 0.01 to 1 km²)
- Micro-Survey Zoning (from 100 to 10,000 m²)

STEP 6 : INTRAZONE SAMPLING SURVEY

Intrazone sampling survey are realised with three main statistical techniques used with an increasing efficiency : probabilistic sampling, kriging and predictive modelling.

The main characteristics and reliability of these different techniques are listed above :

Probabilistic Sampling

- Method
 - non straight random sampling,
 - clustered sampling,
 - Shape & size of the sampling unit : transect (l = 20 m, l = 1 m),
 - Sampling rate : 5 to 30 %
- Performances of surveys and excavations:
 - high rate, bad accuracy,
 - rare structures not discovered,
 - limited to initial sampling.

Kriging (Spatial Interpolation)

- Method
 - Initial Random Sampling,
 - Computation by Spatial Interpolation of a three-dimensional Graph estimating the probability of density of archaeological sites,
 - Priority of Survey of Higher Density Units
- Performances
 - Random Sampling Survey up to 25 % rate ?
 - 50 % of Sites discovered by Surveying 50 % of the Zone,
 - 100 % of Sites discovered by Surveying 75 % of the Zone
 - Potential of Gain 25 %

Predictive Modelling

- Method
 - Initial random sampling & kriging
 - Site & non site differentiation,
 - G.I.S. recording of topographical, ecological and settlement variables,
 - Discriminant analysis between sites & non sites (logistic regression, correspondence analysis),
 - Establish a list of the most explaining variables for the location of sites,
 - Produce the highest probability zones for location of sites, for surveys,
- Performances
 - predictability 75 %,
 - gain 50 %.

STEP 7: INTRASITE SURVEY

Intrasite surveys are methods oriented to find and locate the settlements.

- Surface collection techniques : structure or artefact location, walking procedure, collecting procedure, artefact typology, cartography, multidimensional spatial analysis,
- Sampling strategy : unit size, depth, sampling procedure : sampling & kriging, accuracy, simulations,
- Excavation strategy : adapted methodology to various fields, surface exhaustivity principle, recording exhaustivity principle

STEP 8: SAMPLING ARTEFACT COLLECTIONS

When numerous artefacts have been collected and stored, it is often useful to design a sampling procedure to avoid to study all the artefacts when a representative sample is only needed.

- | | |
|----------------------------------|-----------------------------------|
| - Cluster sampling | unit/arteifact |
| - limited to artefacts more than | 1,000 units |
| - rate | down to 5/10 % |
| - good accuracy | depends on the sampling procedure |
| - gain | up to 50% |

CONCLUSIONS

Rescue archaeology is an engineering application of archaeological science in a special context where diagnostics, scientific control of operation, budget and planning are major constraints. In such a case, a rigorous methodology helped by computerised tools is the only way to obtain the level of efficiency and of reliability needed by the project. We have tried to propose here a methodological framework to improve it.

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