

DATABASE “MONARCH” FOR THE KEEPING AND PROCESSING OF THE DATA ON CULTURAL HERITAGE

S.V.Morozov^a, D.Yu.Hookk^{a*}, A.N.Mazurkevich^c

^a Dept. of Computer and Information Technologies, the State Hermitage Museum, Dvortsovaya emb., Saint-Petersburg 190000 Russia – hookk@hermitage.ru

^b Dept. of Computer and Information Technologies, the State Hermitage Museum, Dvortsovaya emb., Saint-Petersburg 190000 Russia – morozov@hermitage.ru

^c Dept. of the Eastern Europe and Siberia Archaeology, the State Hermitage Museum, Dvortsovaya emb., Saint-Petersburg 190000 Russia – oaves@hermitage.ru

KEY WORDS: Archaeology, Cultural heritage, Databases, History, Fuzzy Logic, GIS

ABSTRACT:

The report gives information about the “MonArch” program complex which in addition to the traditional database contains spatial information about the environment of the archaeological monuments. The results of the long-term multidisciplinary archaeological prospecting in the north-west of Russia are the basis for the program complex.

The database including data on prehistoric monuments and their environment is the main tool of the investigations. Besides text information it may include media-data that allows presenting the archaeological materials more fully. The second component of the program complex is the geo-information system (GIS) which allows to receive interactive maps of micro-regions and to build 3D-models of a landscape. The internal layer of the software is used to link together these two components. For the combination of these two components in the program complex the layer interface of an intermediate level is used.

These materials allow archaeology to be raised today to a new level of research – the modeling of prehistoric processes.

RÉSUMÉ:

MonArch est un programme complexe constitué d'une base de données textuelles et graphiques, et d'un système de cartes. La base prend en compte les sites archéologiques ainsi que les renseignements qui ont trait à leur environnement. Dans son état actuel la base contient les résultats des longues recherches pluridisciplinaires menées dans le bassin de la Dvina et de la Lovat.

La présentation des résultats peut être faite en multimedia sur les cartes GIS interactives et pour certaines micro-régions en 3D. A la racine, un logiciel régule les liens entre la base de données et les cartes. La juxtaposition de l'ensemble de tous ces éléments permet d'un modèle des processus historiques. Les possibilités offertes par ce système en font un outil de recherche scientifique de première importance.

1. INTRODUCTION

The computer technologies have been applied to the archaeology for a long time, since second part of XX century (Компьютеры в археологии, 1996). The possibility to transfer paper archives and catalogues, used practically by every archaeologist to digital form in computer databases. The databases allowed to store big volume of data which was impossible to process manually, to retrieve data after many parameters and to use methods of statistics. Recently the most part of archaeologists uses databases in their investigations.

From the beginning of 1990s the increasing of productivity of the personal computers, their availability, the appearance and wide distribution of GPS results in usage in archaeology of such resource-consuming technologies as geo-information systems (GIS). With the help of space data GIS allowed to connect archaeological and space data, to fix archaeological monuments of place, to find out the tendencies of their distribution, to forecast their possible position on unknown territories. Now this field of computer technologies application in archaeology is developing in many countries. Problems of GIS-technologies are discussed on conferences, seminars and round tables, in

archaeological publications. Thus, in modern archaeology many tasks can be solved: collecting and ordering of information on monuments from one territory in database, analyzing of the archaeological monuments distribution in some geographical and temporal conditions, reconstruction of the paleolandscape with the help of GIS, fixation of materials in field and 3D reconstructions with graphic editors, statistical processing of materials with mathematical packages (Смирнов, 1999).

2. METHODS

The recent tendency consists in creation of the integrated products. The database of archaeological materials related with digitized maps is able to analyze data in space and allows

* Corresponding author. This is useful to know for communication with the appropriate person in cases with more than one author.

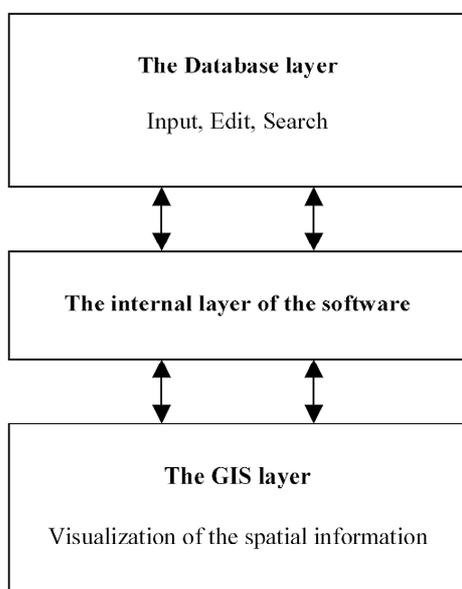


Figure 1. The scheme of interaction of the modules in the program package

finding out internal tendencies and correlations. The program package “Monarch” developed at the Department of the Computer and information technologies of the State Hermitage Museum presents an example of such products. The program package is based on complex archaeological and multidisciplinary prospections which have taken place in the basin of Upper Dvina and Lovat Rivers and resulted in discovery and investigation of numerous archaeological monuments dating as Mesolithic - early Middle age (Долуханов, 2003; Dolukhanov et al. 2004). These exclusive materials allow passage to the new level of investigations – to the modeling of paleohistorical processes including the proving and constructing of new models.

The main tool for the investigations is database which includes the main information on archaeological sites and their natural environment. The description of archaeological objects includes the following categories: ‘archaeological site’; ‘littoral profiles’; ‘geomorphic setting’; ‘stratigraphy of site’; ‘animal remains’; ‘C-14 age’; ‘structure/dwelling objects’; ‘structural elements’; ‘inner arrangement’; ‘pottery’; ‘lithic implements’; ‘bone and antler implements’; ‘metal implements’; ‘amber implements’. The information about a monument is divided on nine blocks inside which there are totally 90 parameters. For some parameters of description there are lists meanings but additions after user needs are also possible. The usage of lists allows both fast search on database and the minimization of distinctions during data input. The model of a monument is described with the number of archaeological objects, which define its content and structure (littoral profiles, constructions, holes etc.). The description of each object includes the physical, structural and morphological characteristics. The description of each archaeological object was unified with the use of the same variables, regardless of chronological or cultural periods and the material. This was aimed at facilitating the retrieval of the fullest possible information, the initial classification and the creation of new knowledge. This basic principle of the normalized data description enables one to avoid the typological series, which are often, nothing less than the imposition on the material of preconceived concepts. In contrast to traditional relational tables, our hierarchical data model

operates with numerical codes and provides a full description of an object in multidimensional space that enables a search based on any combination of any parameters. Database includes both text data and media data in order to present archaeological materials as full as possible.

The data processing is available as inside the database and outside with help of any statistic package of other special program. For example, the results of dendrochronological analysis of the wooden samples from the Neolithic peat bog dwellings on the northwest of the east European plain. It was not provided by some analogies or previous dendroscales for the region. That is why only a local floating chronology could be constructed. The conservation of neolithic wood in the peat is perfect but there are many difficulties in fixation and measuring of tree-rings. Wood is soft and not available for cutting and polishing and became very fast deformed after changing of environment, more over author allowed new methods of the comparison of the tree-rings series based on the fuzzy logic. Type of wood samples was defined after the microstructure of wood, then some parts of fur-tree constructions were taken for analysis and very simple algorithm of comparison resulted in very fast identification of the groups of construction of among numerous traces of constructions in the same place. There were 20 tree samples from dwells and 23 14-C dates to check our hypothesis. It seems to be not many but each of them required the work of diver during the underwater excavations. The preliminary result shows, that the complex analysis of the data including 14-C dates for the same wood samples found out the possibility of the construction of floating dendroscale, the possibility of the relative correlation of the dendroscale to the calendar dates, the possibility of the chronological identification of the archaeological materials after differences in technology and ornamentation of ceramics, and made available the back checking of 14-C dates by dendrochronological data and analysis of ceramics.

The second component of the program package is the GIS-technology. The results of the prospection of the archaeological monuments and geological sections (Kul’kova, 2001) have precise geographical location, which makes possible their positioning on the electronically digitised map. It is very important to have paleolandscape maps in digitised form, not as simple illustrations. That is why the information on archaeological monuments is transferred to the digitised topographical maps simultaneously with data on archaeological landscapes. The scalability of maps is provided by this digitizing of the topographical maps. This method allows to get dynamically the interactive maps of microregions and to construct 3D-models of landscape.

Стратиграфия слоев

№№№	Название	Глубина (см)	КС
1	Кембрийский песок	15	80
2	Светло-желтый песок	50	60
3	Рыжая супесь	15	40
4	"Оторфованный" слой	20	30
5	"Подзолистый" горизонт	20	25
6	"Почвенный" слой	10	15
8	Серый озерный песок	40	
9	"Озерный" суглинок	35	38

Описание слоя

Время отложения культурных остатков: _____
 Культурная принадлежность: _____
 Уточненная культурная принадлежность: _____

Описание слоя
 Мелкозернистый песок желтого цвета, полимиктовый, неравнозернистый

Минеральный состав
 кварц-40%, полевой шпат, плагиоклаз-50%, слюда-8%, ширком, гранат, титаномагнетит-2%

Палеогеографическая реконструкция

Литологическая характеристика
 литат холодный, сухой

Линологическая характеристика

Включения
 отдельные включения гальки

Спλοистость
 отсутствует

Мощность
 15-20 см

Характер залегания

Постояние водоёма

Продукт водоёма

Способ образования
 флювиогляциальные отложения

Климат.врем.срезы
 конец плейстоцена

Реконструкция
 элемент рельефа: терраса

Figure 2. The input-output form of the block "Stratigraphy"

Список находок и их описание

№ полявой	№ инв.	Название	Квадрат	X	Y	H
5992	316-11275	керамика	A-2	74	117	-169
1994-3		кремень	6-8	75	66	-12
1994-4		кремень	6-8	85	50	-10
1994-5		кремень	6-8	135	40	-9
1994-6		кремень	6-8	100	89	-12
1994-7		кремень	6-8	67	113	-14
1994-1		кремень	A-9	128	124	15
1994-8		кремень	6-8	48	99	-13
1994-9		кремень	6-8	143	68	-11
1994-10		кремень	6-9	160	40	-7
1994-11		кремень	6-9	142	63	-6
1994-12		кремень	6-9	118	58	-8
1994-13		кремень	6-9	103	74	-7
1994-14		кремень	6-9	90	84	-8
1994-15		кремень	6-9	80	90	-8
1994-16		кремень	6-9	90	39	-9
1994-17		кремень	6-7	149	60	-20
1994-18		кремень	6-7	145	64	-20

Описание артефакта

Параметр описания

на горизонтальном срезе	три
на вертикальном срезе	одна
Высота ленты	9мм
Скрепление лент	вертикальное
Лопатка/наковальня	по всей поверхности
на внутренней поверхности	есть
на внешней поверхности	есть
Примеси	песок+отощитель+есть
тулова	округлое+отощитель+

Выбор параметров и значений описания

- Керамика
 - Техника лепки
 - округлое
 - ребристое
 - бугристое
 - плоское
 - винтообразное
 - составное
 - Количество лент
 - шар
 - эллипс
 - цилиндр
 - конус
 - конус расходящийся
 - лицилип
 - Высота ленты
 - усеченное
 - усеченное дважды
 - выгнутое
 - ровное
 - закругленное
 - заостренное
 - Лента
 - с пазом
 - с шейкой
 - с валиком
 - с шейкой валиком
 - без шейки
 - г-образный
 - Скрепление лент
 - сдвоенное
 - стреловидное
 - многогранное
 - треугольное
 - четырёхгранное
 - многогранное
 - уплощенное
 - Лопатка/наковальня
 - с пазом
 - с шейкой
 - с валиком
 - с шейкой валиком
 - без шейки
 - г-образный
 - Расчески
 - с пазом
 - с шейкой
 - с валиком
 - с шейкой валиком
 - без шейки
 - г-образный
 - "Полива"
 - с пазом
 - с шейкой
 - с валиком
 - с шейкой валиком
 - без шейки
 - г-образный
 - Примеси
 - песок+отощитель+есть
 - Скрепление частей сосуда
 - вертикальное
 - горизонтальное
 - диагональное
 - иное
 - Температурный режим (в градусах)
 - высокая температура
 - средняя температура
 - низкая температура
 - иное
 - Термическая обработка
 - есть
 - нет
 - Части сосуда
 - край
 - венчик
 - горло
 - тулова
 - дно
 - Поддон
 - Мерные признаки
 - высота сосуда
 - высота горла
 - диаметр по краю
 - диаметр горла
 - максимальный диаметр тулова

Figure 3. The input-output form of the block "Artefacts"

The following approach was realized during the program package "Monarch" development. All attributes of the archaeological monuments and included objects are stored in separate database. The same database includes geographical coordinates of objects. The data on landscape is included in

database of the GIS. For the connection of these two components the interface layer of the software is used. This layer is necessary to adopt the package to various GIS. So, the

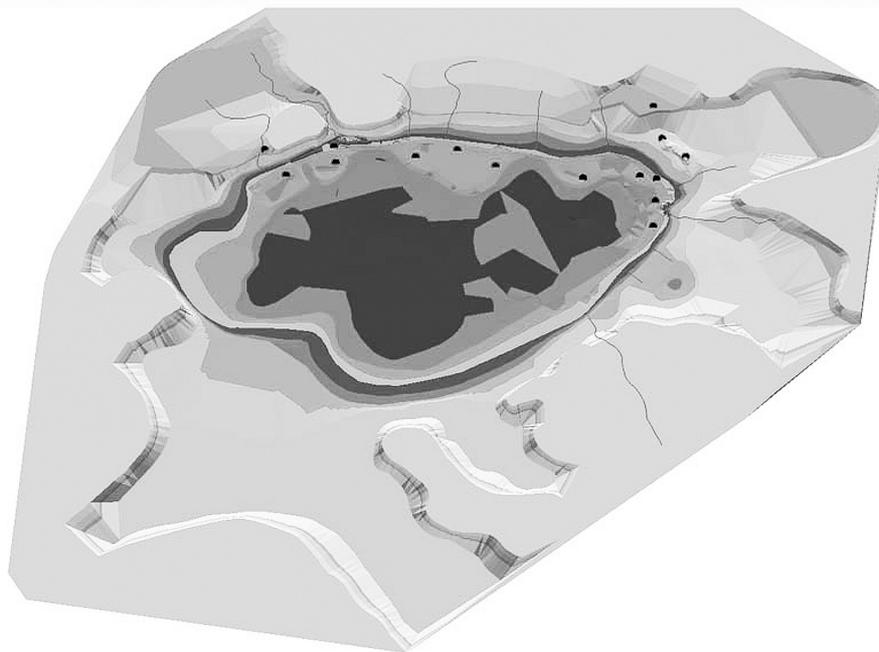


Figure 4. 3D-model of the archaeological microregion in Serteya basin

program package “Monarch” can be divided on three levels (fig. 1). The software components of each level interact only with software from near-by layer. The components of the upper layer are responsible for input, edit, search and presentation of all attributes of the archaeological monuments and are not related with GIS (fig. 2, 3). The main task of the level – multi-user data input in database. The presentation of the data on map requires creating some query, which will be transferred to the next level. The modules of the interface level are interpreting this query after the properties of the GIS and pass them to the lower level on which the information is presenting on the electronic map (fig. 4).

The realized approach to the development of the search and retrieval system provides the independence from some only one GIS, that means that we can change GIS saving data. From the one hand, in this case only the software of the intermediate layer will be changed. From the other hand, if on the working place there is no need of the presentations of data on the digitized maps, it is possible to install only the software of the upper layer and reduce the expences.

The program package “Monarch” is developed with help of client-server database Oracle 8i (versions Oracle 7.3 – 10 are also available). The upper layer software, which is responsible for the data management is developed with the help of oracle Forms 6i. The GIS component is functioning in environment of ESRI ArcView 3.1.

3. CONCLUSION

For the moment the database includes the data on 463 archaeological monuments from the bassin of Upper Dvina and Lovat rivers. The topographical maps of the region are electronically digitised. As a result, the program package, which includes the digitised map and database with attributes allows:

- To make search of archaeological monuments on different criteria (dating, location, structure etc.) and to compile report for scientific research;
- To create the series of the interactive digitised maps on separate microregions presenting the changes in the site topography and in their household structure related with water level fluctuation in hydrosystem;

To design the 3D-models of landscape at the different stages of its formation displaying the archaeological monuments.

4. REFERENCES

- Компьютеры в археологии, 1996. *Материалы конференции «Опыт компьютерной обработки археологических материалов»*. Москва.
- Смирнов А.С., 1999. Использование компьютеров в археологии. 26-й конгресс САА (Барселона, 1998). *Российская археология*, № 2. С. 242–245.
- Dolukhanov P. et al., 2003. Modeling of the prehistoric processes. CIDOC/АДИТ-2003. Saint-Peterburg. pp. 125–129.
- Dolukhanov P. et al., 2004. The Holocene Environment and Transition to Agriculture in Boreal Russia (Serteya Valley Case Study). *Internet Archaeology* - 17 <http://intarch.ac.uk/journal/issue17>.
- Kul'kova M.A. et al., 2001. Chronology and paleoclimate of prehistoric sites in western Dvina-Lovat' area of North-Western Russia // *Geochronometria*. Vol.20. pp. 87–94.

5. ACKNOWLEDGEMENTS

The financial support of the multidisciplinary investigations is provided by the Program of the Ministry of Foreign Affairs ECO-NET №16333YJ and European Commission №FP6-NEST-028192.