

Digital Atlas of lands and human impact on the environment by the example of Nuratau

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1 ANNOTATION

The Digital Atlas proved to be an important tool of analysis of human impact on the environment. It is used to work with various datasets and represents the instrument of thematic classification, storage, analysis and visualization of a wide range of geographic information. The Digital Atlas is, first of all, the software designed to visualize geographic information with some mathematical functions. The Atlas allows the user to view various spatial data from an unexpected perspective. Using the Digital Atlas it is possible to associate information by various objects with mapping information. This enables better understanding the interaction between people and the environment, and revealing main indicators of threats based on the analysis of these data. The Digital Atlas is designed to view raster maps developed on the basis of GIS technologies. The Atlas contains a series of thematic and analytical maps reflecting modern condition of lands, dynamics of the changes occurred for the last 15 years, level of development pressure and the corresponding indicator of manmade threats for the environment of the test site. The thematic maps were developed on the basis of the analysis of satellite imagery obtained at different times using GIS software MapInfo, with following vector-raster transformation. Population data for 2002 were taken from the State Statistics Department.

This work reviews functions and complexes of tasks of the Digital Atlas.

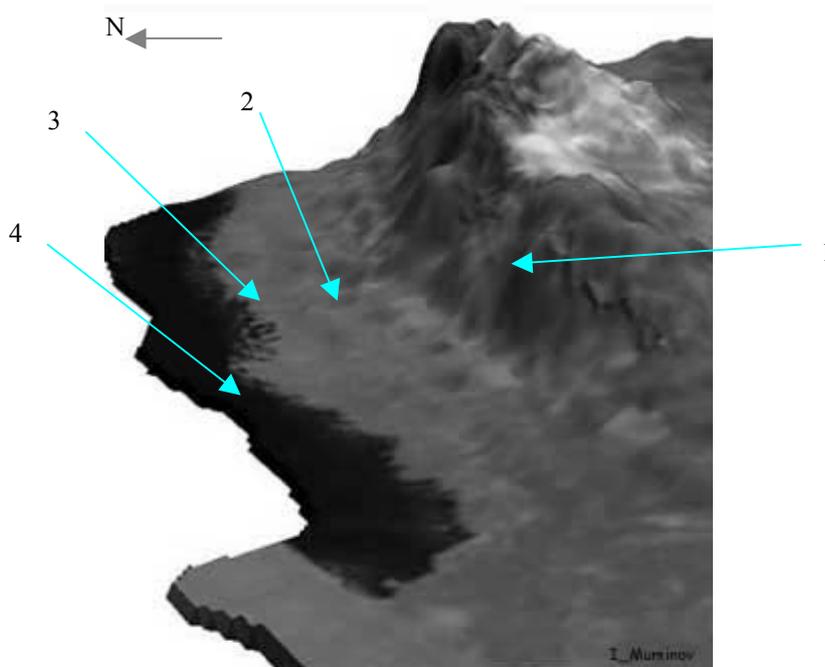
2 INTRODUCTION

The idea of development of the Digital atlas was started up due to the problem of insufficient completeness of data on environmental condition and assessment of human impact, existing information fragmentation and inaccuracy. The objective of this work was development of an infrastructure in enabling to classify and analyze large volume of a variety of thematic information on environmental condition and assessment of human impact. The Digital Atlas is designed for collection, recording, classification, storage, editing, analysis, carrying out some mathematical calculations, and visualization of various geographic data. This Atlas can be used in the field of environmental objects registration: conservation areas, game husbandries and national parks. Novelty of the results lies in the fact that the Digital atlas enables effective classification and analysis of large volume of various spatial data sets. Furthermore, it has simple and user friendly interface making application of the Atlas accessible for ordinary computer users who do not possess specific knowledge in digital mapping. Application of this Atlas enables to improve assessment of reliability of the received information obtained for various conditions, develop recommendations for rational use of the natural resources. Thus, the Digital Atlas becomes an important tool for geographic information analysis for the specialists who do not have substantial computer technology knowledge.

It is appropriate to note that the Atlas utilizes raster mapping base.

3 THE TEST SITE

The test site was selected in Nuratau and adjacent territory, including Farish steppe and Aidar-Arnasay depression. The test site is located in the center of the Republic of Uzbekistan at the borders of Navoi, Djizak, and Samarkand Regions. The Study Area includes foothill alluvial fan deposits plain, which starts from northern slopes of Nuratau, sandy clay plain occupied by sand and honeycomb ridges and hillock sands. On the south of the territory there are northern slopes of Nurata Ridge which are dissected with dingles. Graph 1 shows the Study Area. On the scheme of physiographic zoning for the Republic of Uzbekistan, the northern slopes of Nurata Ridge with adjacent alluvial fan deposits plain are distinguished as independent Farish physiographic zone. The latter, as a part of the Golodnosteppe physiographic territory is characterized by internal patchiness determined by complexity of geological-geomorphological condition that influence climate, soils, and vegetation cover. Selection of this site was justified by the fact that this area is, first of all, not a sample of a wild nature model. Secondly, human impact on this territory has been in place since c Paleolithic age. Thirdly, this territory is subject to desertification processes, land and vegetation degradation, as a result of human activity. Fourthly, this territory has conservation areas, including Nurata state reserve, and Arnasay wildlife sanctuary. Fifthly, this territory is the zone of contact of settled and nomadic cultures.



Graph 1: Test site.

1- Northern slopes of Nurata Ridge; 2 – Alluvial fan deposits plain; 3 – sandy clay plain occupied by sand and honeycomb ridges and hillock sands; 4 – The Aidarkul Lake (1).

4 PURPOSE OF THE ATLAS

The Digital Atlas is designed to fulfill complex inventory, analysis and registration of assessment of human impact on environment. The Atlas is a thematic database with information editing functions (see Graph 2).

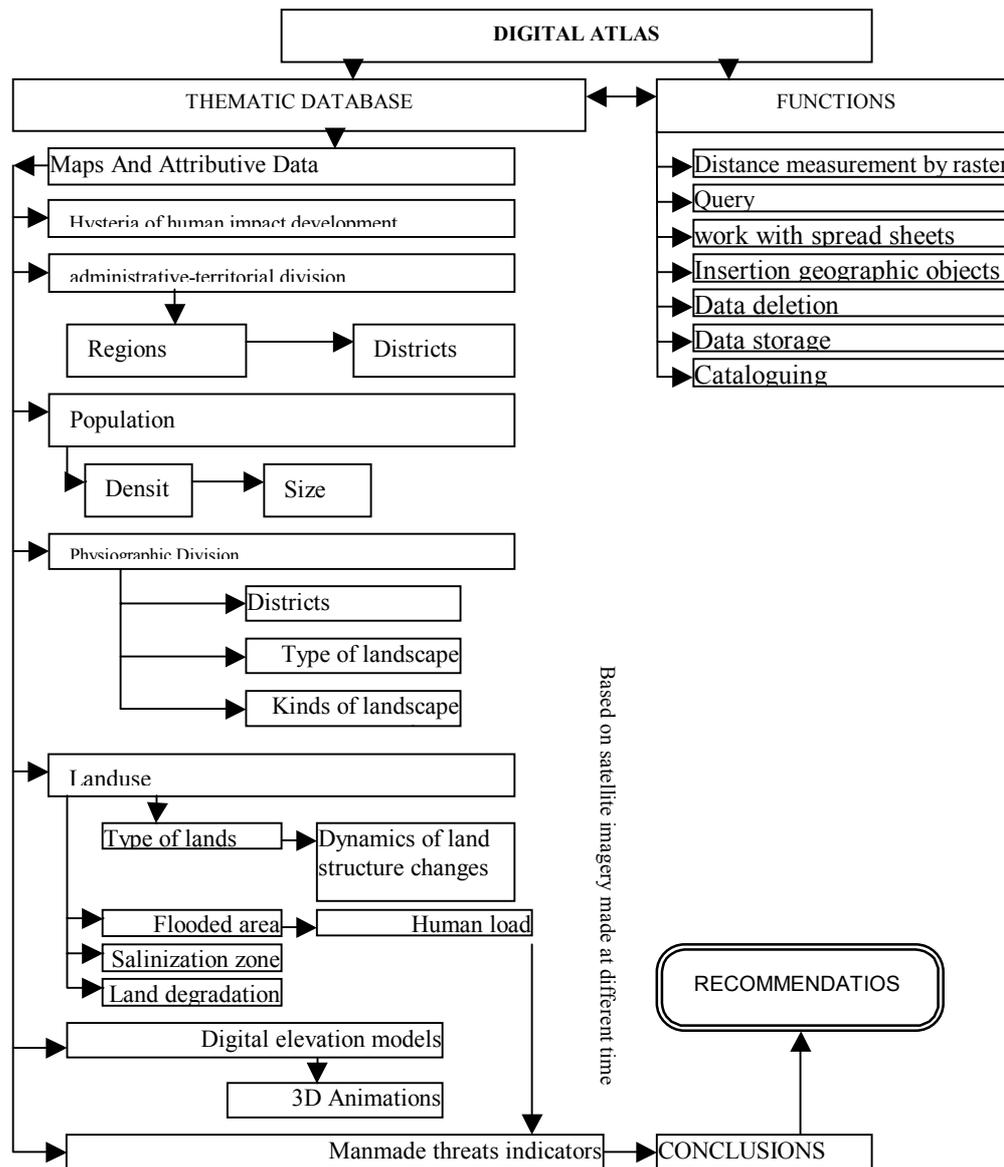
Functional purpose of the Digital Atlas is:

- Registration and timely updating of qualitative data about environmental condition and assessment;
- Insertion of information on mapping base;
- Assessment analysis and to revealing of human threat indicators;
- Development of recommendations to improve environmental condition.

Thus, having such a tool with a broad set of spatial data and some editing functions at hand, the user can view the Study Object from an unexpected perspective. The unexpected perspective shakes the established concepts, refreshes day-to-day, almost familiar perception, and forms new ideas and possibly directions on the study object.

The Atlas has several components. The first component includes the map of human impact development on this territory, from its beginning in Holocene period and to the beginning of the 20th century A.D. this map is compiled on the basis of archaeological and historical data. The second component includes a number of maps on administrative-territorial and physiographic division, particularly, types and kinds of landscapes were determined using satellite imagery visual interpretation. The third component is dedicated to population, its size and density at the oblast level. The fourth component contains thematic maps on land types, changes dynamic, flood zones, salinization zones, land degradation, as well as development pressure. The sixth component includes Digital Elevation Models and 3D animations, which allow viewing the Study Area in perspective. The seventh and the last component includes combined thematic map on manmade threats. This map was developed using overlay analysis of several thematic maps: land use, road network, sources of water discharge, flood zones.

The end result of the development is the software enabling to view various datasets consisting of geographic images, maps in raster data format, text descriptions, spreadsheets, and tools to work with this information (classification, and editing). The Digital Atlas consists of information, mathematical, language as well as software tools: centralized collection, storage, editing, and visualization. The Digital atlas has a function of arbitrariness and retrieval of any stored information both as separate data and in arbitrary combinations with other datasets as required. The Atlas, as it has already been mentioned, works with raster geographic data in BMP format. This graphics format was selected because it is open and it has structural description, and, furthermore, it is commonly used. The Atlas works with text data in *.txt format, Digital spreadsheets in format close to *.xls, it allows to view animated files in ai format.



Graph 2. Information structure of the Digital atlas

4.1 Functional Specifications Requirements

The Digital Atlas functions as an open, semiautomatic structure that performs data entry, storage, classification, editing, analysis, and visualization.

The Digital Atlas consists of the following modules:

- The data entry module
- Module of thematic classification and information editing
- Information visualization module

In relation to the information, all modules are linked together with common semantic database. ID numbers of the objects, identification classes, their names, and numerical characteristics of the objects and etc., are entered into this database.

Composition and content of the data entry module (E) is determined by the following main input data types:

- Graphics raster format (thematic maps, photographs);
- Text format (geographic, historical descriptions);
- Spreadsheet format (geographic, administrative-territorial, attributive);
- Video – animation visualization format (3D animations of elevation models),
- The part of data (text and tables) in the data entry module are entered using the keyboard as well as CD ROM drive, also graphics data formats are entered (thematic maps, photographs, video animation).

Information thematic classification and editing module (TC & IE) allows the following kinds of operations:

- Thematic cataloging of the project *;
- Opening of the project (graphics raster format with a thematic map);
- Changing of the project (insertion of new graphic information on the thematic map);
- Connection of an attributive database to the project;
- Mathematical functions (measurement of distances between graphic objects, thematic queries, work with Digital spreadsheets);
- Saving changes in the project.

* The project means an original of the graphics data format (thematic map).

Information Visualization Module (V) is used for combined viewing of graphic data formats (thematic maps, photographs), video formats (3D animation) and the semantic database.

All the information of the three modules has a uniform data format common for most of users.

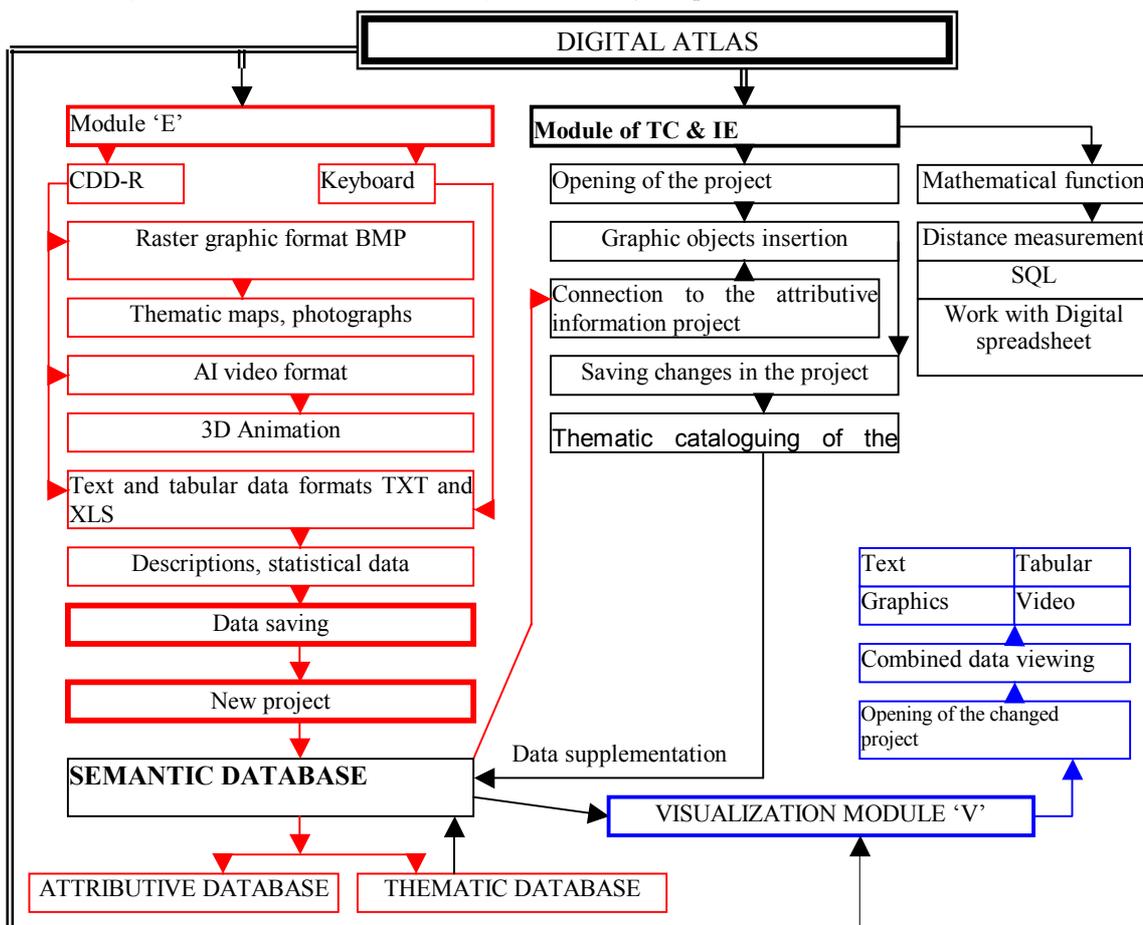
4.1.1 Information Compatibility Requirements

The input graphics information (thematic maps) entered to the Digital Atlas is in the BMP standard data format. A special format is used for output. The Digital Atlas works under MS Windows 98 SE operating system. It was developed using Delphi programming language.

4.1.2 Functions, Complexes of Tasks, That can be Solved by the Digital Atlas

The Digital Atlas foresees automated data exchange with the entry module, thematic classification and editing, as well as visualization. All information at every stage of the work is saved as a project in this semantic database, in the module of thematic classification and editing. The scheme of functional structure of the Digital Atlas is presented in Graph 3.

Data entry module «E» solves the task of entry of a wide range of spatial data on the status of environment and assessment of human

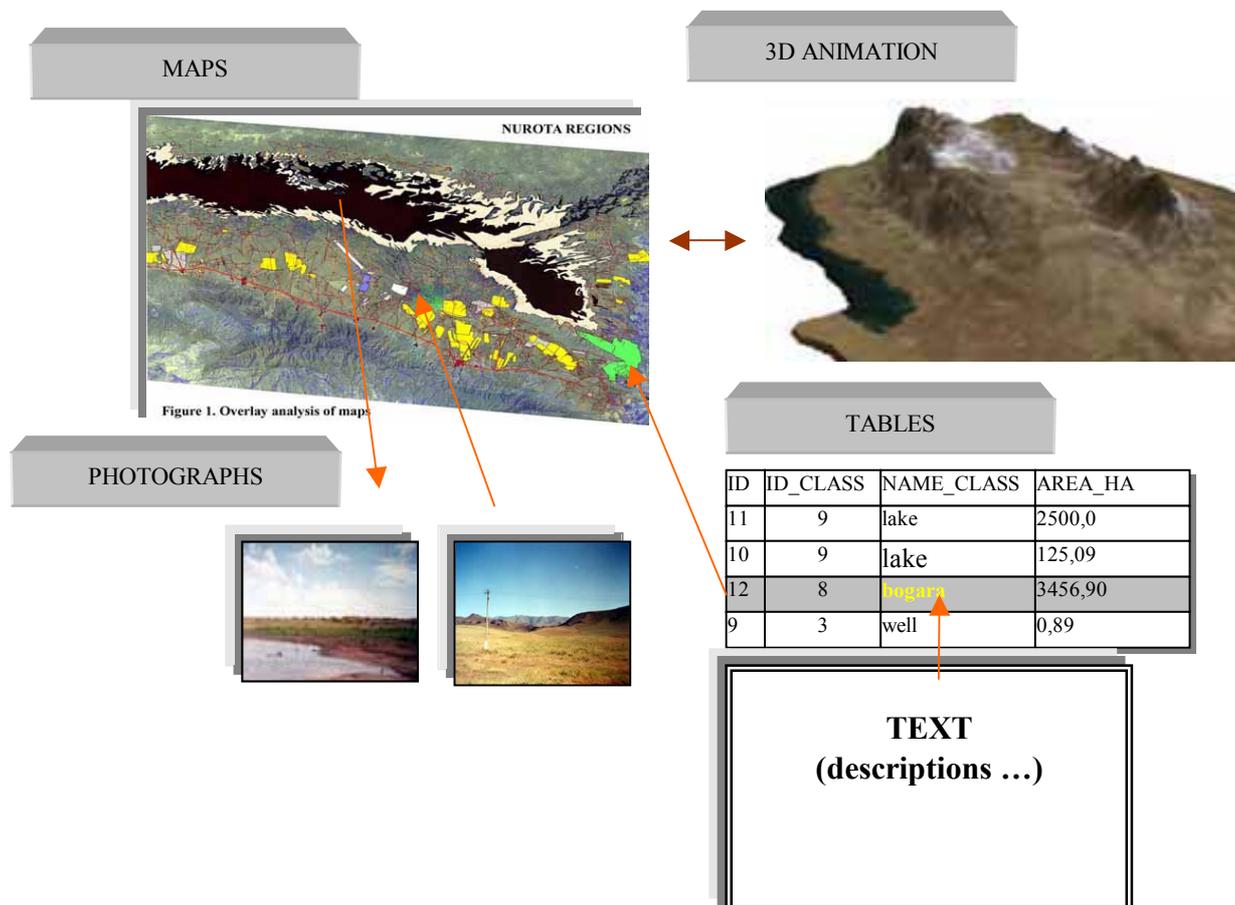


Graph 3

impact (taking into account numerical indicators, such as dynamical change in area of lands, aquarium of water surfaces, land degradation, zone salinization and flooding and etc.).

Also, entry of different types of raster thematic maps (see graph 2), photographs of landscapes, text and geographic and analytical descriptions of the territories and objects, statistical data in tabular form and 3D animation of the test site is carried out. All graphic information is saved as a new project in the semantic database into the subsection of thematic databases, and all the text and tabular information is saved in the subsection of attributive databases. Then, the TC & IE module is used to open the project. The product

itself consists of raster thematic maps with overlay of graphic objects (map symbols), which in their turn are interactive. At that, this graphics objects have hyperlinks to the semantic database and when pressed – windows with additional information about the study object open. Furthermore, this module enables to add new text information to the existing one (using some functions of the data entry module), as well as to save them. Also, the functions of distance measurement on the thematic map from one object to the other. In addition, there is a system of thematic queries by the keywords. Link of the spreadsheets to the TC & IE module and work with them is foreseen. After changes to the project were made (editing) the project is saved under a new name and is recorded into the thematic catalog, which is added to the thematic database, included in the semantic database. Then, using the visualization module the changed project is open and combined viewing of all data types both from the attributive and thematic databases is carried out. The combined viewing of these data enables to have both mapping base of different themes on environmental status, as well as numerical indicators on land changes due to human impact, besides there are photographs of landscapes changed by people and the Digital Elevation Model that shows the test site in perspective and in motion. Thus, we can visualize both mapping statistics and descriptive information about environmental condition and assessment of human impact in the Digital Atlas (see graph 4).



Graph 4. Combination of different spatial datasets

The atlas enables to classify this information, as well as to edit and update it, while carrying out integrated registration of changes. Having classified and combined spatial environmental data and human impact assessment information the specialist can easily perform an integrated analysis and develop necessary recommendations on rational natural resource use.

5 CONCLUSION AND FUTURE RESEARCH

Thematically classified spatial information opens new ways of more rational and cost-effective use of natural resources.

In the modern complex world not a single significant problem can be solved without processing of large volumes of information and established communication processes. One feature of information attracts attention: when it is accumulated and processed from certain perspective, it provides new information and knowledge. Updating information from the environment, its analysis and generation is one of the main functions distinguishing human being from the rest living creatures. Information enables people to orientated in the environment. Search for information is one of the main functions of creativity [2].

Work of a scientist is closely linked with “information raw materials” processing, at that, nowadays, this process is complicated with abundance of information sources and their dispersion... needed information is first of all to be retrieved from the information ocean. Furthermore, information must be important, accurate, and up-to-date. To assess modern condition of environment and development pressure in arid zones efficiently and objectively an infrastructure that enables to systemize and analyze fragmented data comprehensively is required. The Digital Atlas is an instrument enabling to classify dispersed different-type information thematically, combine, store, update and analyze it. At that, this instrument is rather user friendly for those are not so good in computers, as the Digital Atlas uses common and open formats not requiring installation of special software.