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Integrating Geographic Information System (GIS) in the Education of Landscape Architects in Bulgaria

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ABSTRACT

The applicability of geographic information systems (GIS) in the education of landscape architects is the focus of discussion at the paper. The cardinal study goal at illustrating a concrete instance of applying GIS technology in the training of Bulgarian landscape architecture students. Producing a series of thematic maps is the most important part of the semester student's project in academic discipline "Landscape Science" of the Department of Landscape Architecture at the University of Forestry in Sofia, Bulgaria. Specifically, the design studio requirements include analysing the distribution and the main characteristics of the landscape components in a mountain region and delineating sites for establishing future tourist activities and conservation areas. GIS software provided the capability to analyze large data sets and ensured the accurate integration and analysis of topographic and forestry map layers, to create resultant layers and facilitated quality control procedures. This paper discusses also the GIS features and basic criteria that it should meet data types in order to make the best use of GIS at the education. The process of learning about GIS is itself beneficial to students. GIS technology has provided the means to conduct a more rational analysis of the factors that set the patterns for the landscape planning.

Keywords: geographic information systems, education, landscape architects, thematic mapping, database, layouts

INTRODUCTION

This article illustrates the use of GIS technology for educational purposes, and created project has discussed as a student's manual, that teachs students how to think and analyze information from a spatial perspective, although the sphere of its application can be broader. The main features and basic criteria, which is necessary to fulfill GIS database were defined and it was proved that computer technologies offer efficient ways and means of realizing investigations in the field of landscape science. The practice in recent years has shown, that continuously increases count of the students which have skills in computer designing, but at the same time it is notice, that absolutely small percent of them are capable of creating landscape analyses and projects. In response to the increasing impact of computer technology in landscape architecture is imperativ to exploit computer methods in design studios, and employing them to enhance the effectiveness of technical classes. Thus actuality of present article is obvious. The primary goal at adapting GIS "Youndola" to the educational purposes was creation a suitable material for training the students in methods of landscape investigations, analyses and maping. Besides that present article has an additional goal to inform about creation a practical aplicable development, assigning to problems of landscape and forest design. To achieve these goals present GIS database had to be created first of all. The general tasks, which were worked out at its creation can be generalized in the following four trends:

- collecting necessary data for investigated area;
- digitalizing and converting these data in suitable file format;
- joining converted data into GIS training project;

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The object of this project are terrains within the Experimental Forest Department "Youndola" which is attached to the University of Forestry in Sofia. Youndola Forestry is located on the boundary between two mountains (Rila and Rodopi) is managed by the University of Forestry as an outdoor classroom and research facility. This region of dramatic physiographic and biologic diversity includes a broad spectrum of vegetation and natural sightseeing and phenomena. During educational practice classes the students visit this department and have possibility to get acquainted on a place with landscape special features of the area. Besides Youndola region are mountain klimatical resort with national importance, and has large recreational potential and is a subject to deep landscape investigations and analyses. GIS "Youndola" contains actual data about terrain and vegetation. Moreover using a real object in process of training increases interest of the students, as also their motivation about acquiring of knowledge.

THEORETICAL AND EXPERIMENTAL PRECONDITIONS FOR GIS APPLICATION IN STUDENTS CLASSES

"GIS for the educational purposes as whole have to answer some basic criteria, that guaranteed effective use of computer technique, as well as to be satisfied requirements of educational programme, and at last to be achieved deeper analysis and more precise processing database (Moore 1995)". Strong & Shield (1995) formulated criteria concerning GIS data as follows:

- to be quite supplied with necessary drawing and attribute data for all landscape components generating recreational potential of territory. It gives an opportunity for manufacturing relevant thematic maps in conformity with determining educational programme;
- to be maximum stratify on themes and characteristic and it is necessary for data to be able to match in many different combination to be created oportunity for deeper and more complete analyses of the landscape, for acheiving the desired result - either drawing or tabulared, or decision formulating task, however difficult and insoluble it might be by means of manual methods of processing and visualization of the information;
- to contain new sections, untouched in former practice;
- to be capable to reflect everyone new change, in erder to maintenance them in a urgent condition.

At creation of GIS "Youndola" the described criteria were fulfilled and now its structure allows teachers and students to choose and represent necessary data in a suitable aspect. It gives rich opportunities for depict and colour registration submitted mapping materials, especially graphic. So disappears the problems, related to technical registration of course tasks, which consumeed too much time up to now and reduced terms for composite rationalization of the projects.

Poultney (1998) and Swanson (1998) said that the content of drawing and tabulared base data have to be sufficient for illustrate the whole material on relevant educational discipline, or a complete section of it. GIS "Youndola" includes a material from the whole units "Landscape - Ecological Planning " and exists an opportunity of adding information, because the system is open and is able to introduction of drawing and semantic data, as well as, for updating with received derivative information "for example derivative thematic maps received at a combination of primary data in environment of the system (Antenucci & Brown 1991)". Mosher (1999) said that GIS structure have to be performed in acordance with adopted and authorized in educational process criteria concerning:

- taxonomycal representation of the material;
- the degree of detail of drawing data, as well as the attitude characteristics;
- continuation scope of the incorporated data,
- representativeness of the data;

- the opportunities of adaptation and updating dynamical character data (for example connected with the vegetative components of the landscape);
- way of the image till by themes and by objects, and separate characteristics of incorporated objects.

GIS is maximum stratified environment created by arranged and linked on certain way spatial (drawing) and attribute (tabulared) data. "For the purposes of training, as well as for a high-grade expression of opportunities and incorporated information, the system is structured in some blocks:

- data concerning relief. This block is made from topographic layers.
- data condcerning some geographical characteristics of wood plantings. Includes map layers and appropriate tabulared information describing orographycal, geological, pedological, biogeographical and landscape-geographical characteristics.
- data concerning taxation characteristics, present and future structure of woods.
- data about settlements, the transport network and other infrastructural facilities. (Tepeliev & Koleva 1999)"

"So worked out system represents imformation environment in which students can develop following more important skills:

- to set variety of logic questions to the attribute information,
- to select the necessary information for definite purposes,
- to organize drawing and textual information,
- to analyze the information and to answer concrete questions (Ramirez & Althouse 1995)".

CREATION ON GIS "YOUNDOLA" IN ARCVIEW® 3.1.

Creation GIS about Youndola region passed through some technological stages and was used combination of different **tools, approaches and methods** for the decision of put tasks. **Starting data** which were used can be clasifyed in some basic groups acording to their applicability and information source:

- drawing data about woods (1:10000-scale forest maps and files in "ditagraphic" format);
- semantic data about woods (taxation indices of forest subdivisions from the last inventory of the Forestry since 1998);
- drawing data about agricultural lands (1:10000-scale maps of agricultural lands);
- semantic data about agricultural lands (registers on agricultural lands);
- data about relief, hydrography network, settlements, transport network, powersuply net, toponymy and some details of terrain (1:10000-scale topographic maps);
- statistical data (forestry managing project of the department).

Basic stages in process of creation drawing base data are given there were following:

- *scaning* at 600 dpi/inch of 1:10000-scale topographic maps with 10 m relief section, in result from which has turned out raster image which was treating by means of Photoshop where were filtered only contours.
- *registration* (attachment raster image to geodetic coordinate system). That stage expressed in the identification of basic points from drawing material (1:10000-scale) on top of the raster image and accomplished affinity transformation. After that was eliminated initial material deformations.
- *vectorising* was made semiautomatically in AutoCAD-Softdesk 8 environment. By means of this method (on screen digitalization) higher simplicity and speed in work is achieved and are eliminated personal mistakes of the operator.

As result of these three stages the digital model of topografic map has turned out. The rest of the topographic map information was structured in the following layers: rivers, chanels, railways, tunnels, asphalt-paved roads, dirt roads, cart-track, forest walks, geographical names, elevations, electric transmision network, map sheets, boundary of the Forestry, buildings etc. (fig. 1). In creation these layers was applied the same approach again. Vectorizing of forest maps was worked out after “ditagraphic” files convertion to .dwg file format. Received files were manipulated by means of AutoCAD Map. As result was created a digital model of the forest map (fig. 2). The map elements are digitized and organized in layers. In reference to the forest divisions and subdivisions were created two layers – a polygonal (for areas) and a linear (for boundaries). Each element of mentioned layers holds a unique identifier indicationing syninymously its place in relevant attribute table. Besides, each forest area division or subdivision has an identical number under which it figures in taxation tables and in starting drawing material. At processing drawing information for agricultural lands approached on the same way, as well as at forest maps, as initial files were converted from .zem to .dxf file format. At

last, problematic zones on the border between agricultural and forested lands were "cleaned” during them joining.

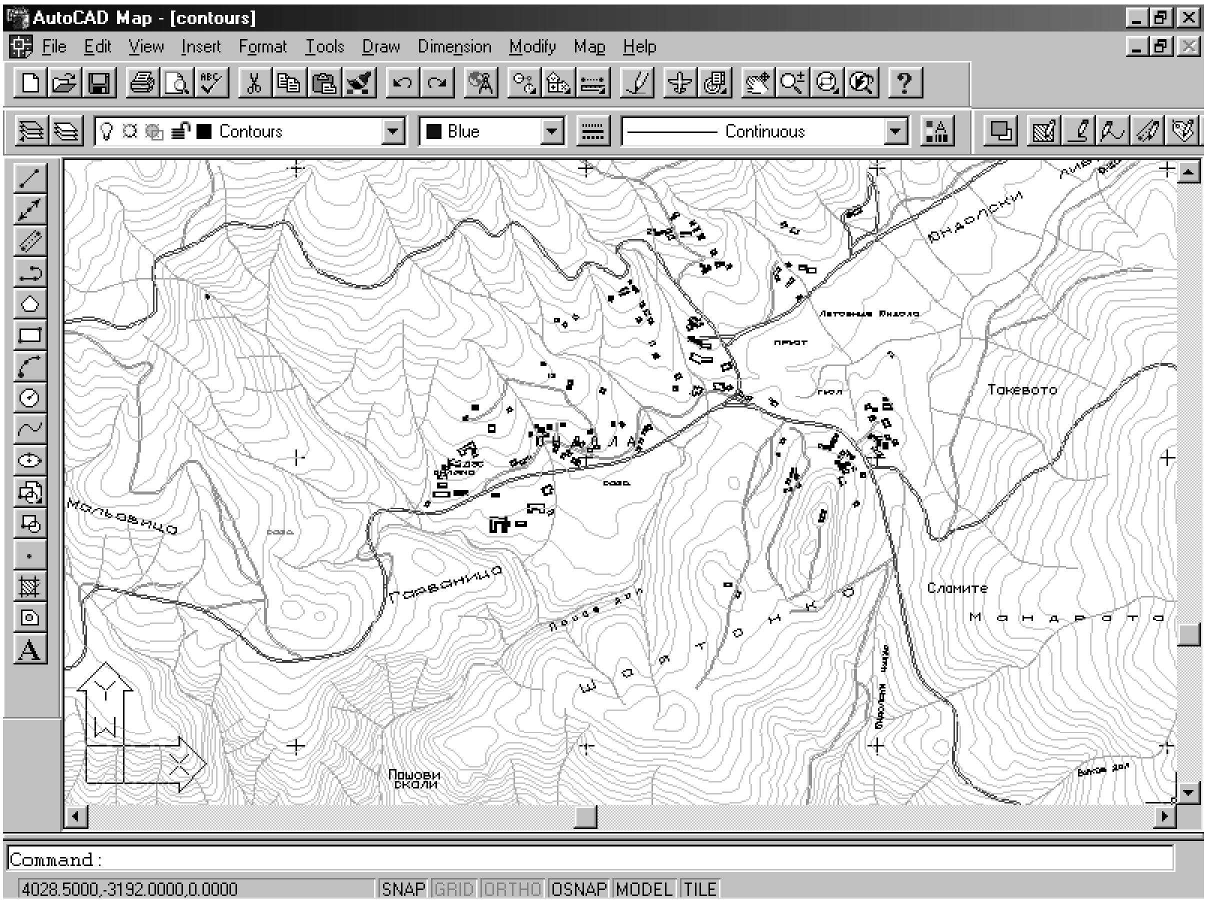


Figure1. *Vectorizing topographic map information.*

The attribute table database contains taxational indices and was set up firstly in MS Excel tables which include: the basic characteristics of the forest departments and sections; some phisiogeographical characteristic of sections; taxation indices of vegetation; description of the future structure and some additional details. So these tables have been introduced in ArcView® 3.1 successfully. (fig. 3)

After ensuring the conformity between drawing and tabulared data the preparation of the desired analyses, ilustrating by relevant thematic maps and charts became possible using created in ArcView® 3.1 project. In case of change in data it is possible to update them, because GIS is open for updating and additional upgrading.

RESULTS OF GIS APPLICATION IN EDUCATIONAL PROCESS

During the practical classes in educational disciplines "Landscape Science" and "Landscape protection and conservation" the students prepare a complete semester project for landscape-ecological evaluation of certain area. This project contains a series of thematic maps, showing spatial distribution and quantitative value of landscape components through various coloring, hatching or marking special symbols. Registration and printing preparation of these thematic maps in GIS ArcView® 3.1 is carried out in specially intended for that module called "Layouts". Thematic maps are compiled and prepared for colour printing there. The computer technology application enables higher speed at work and more highly quality of created drawing materials which allows quickly vizualization of different variants and choseing the best from them. Printings, tables and charts, attending created maps can be connected (live linked) to their analogues in the modules that they was created and edited, so that every change in them original automatically was reflected in the map.

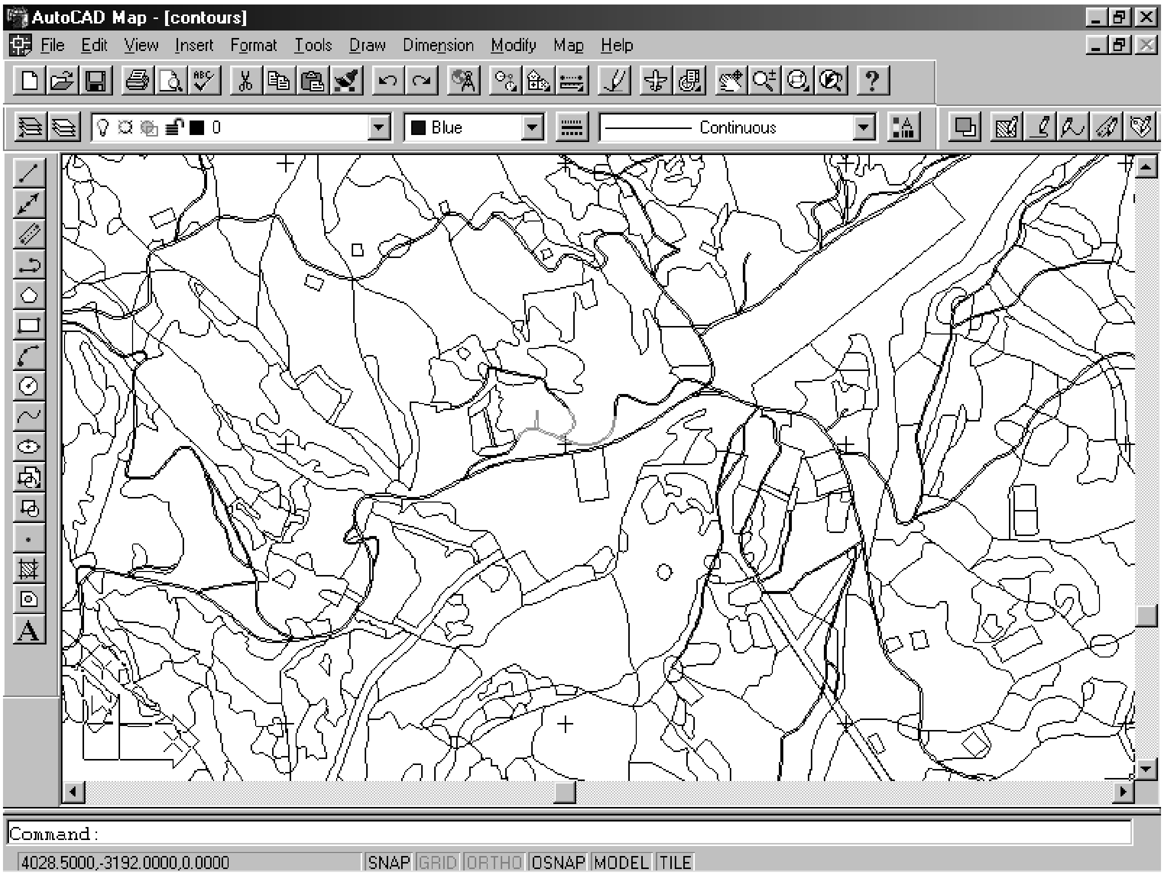
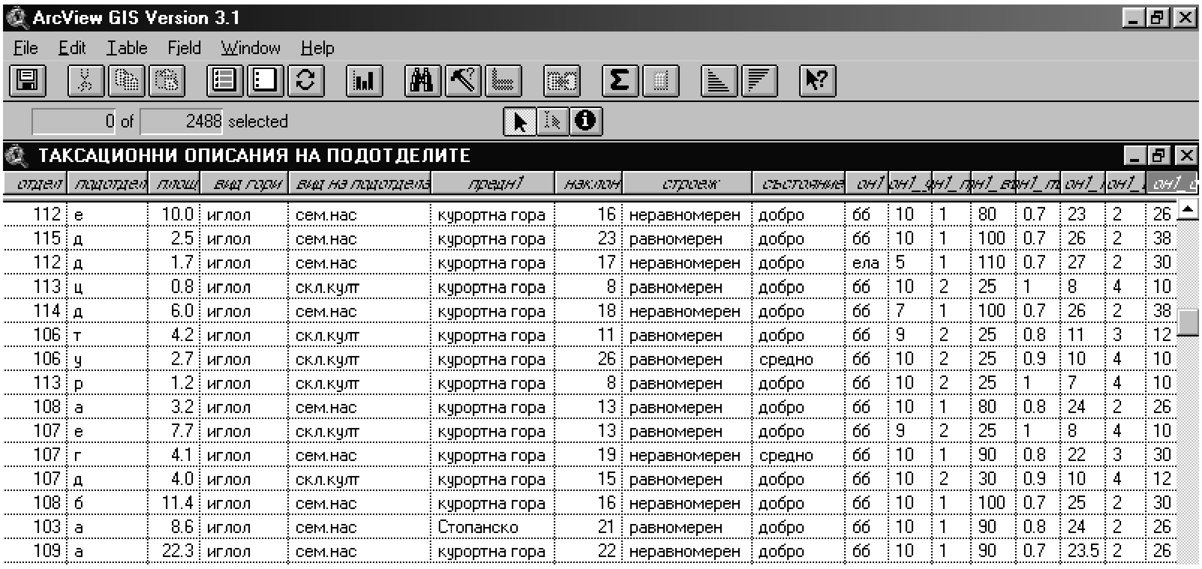


Figure2. *The digital model of the forest map.*

The analyses of the data obtained showed the amounts and spatial distributions of some forest attributes that are of great importance for the scenic beauty and recreational potential of the forest landscape. This gave a reason for preparing a recreational assessment of forest landscapes, as result of landscape-ecological analises depicted in a series of thematic maps (fig. 4) illustrating the main forest characteristics: species diversity, density, canopy, compactness etc. Up to now these maps had been produced using manual techniques.



отдел	подотдел	площ	вид гори	вид на подотдела	предн1	наклон	строеж	състояние	он1	он1_	он1_	он1_	он1_	он1_	он1_	он1_
112	е	10.0	иглол	сем.нас	курортна гора	16	неравномерен	добро	бб	10	1	80	0.7	23	2	26
115	д	2.5	иглол	сем.нас	курортна гора	23	равномерен	добро	бб	10	1	100	0.7	26	2	38
112	д	1.7	иглол	сем.нас	курортна гора	17	неравномерен	добро	ела	5	1	110	0.7	27	2	30
113	ц	0.8	иглол	скл.култ	курортна гора	8	равномерен	добро	бб	10	2	25	1	8	4	10
114	д	6.0	иглол	сем.нас	курортна гора	18	неравномерен	добро	бб	7	1	100	0.7	26	2	38
106	т	4.2	иглол	скл.култ	курортна гора	11	равномерен	добро	бб	9	2	25	0.8	11	3	12
106	у	2.7	иглол	скл.култ	курортна гора	26	равномерен	средно	бб	10	2	25	0.9	10	4	10
113	р	1.2	иглол	скл.култ	курортна гора	8	равномерен	добро	бб	10	2	25	1	7	4	10
108	а	3.2	иглол	сем.нас	курортна гора	13	равномерен	добро	бб	10	1	80	0.8	24	2	26
107	е	7.7	иглол	скл.култ	курортна гора	13	равномерен	добро	бб	9	2	25	1	8	4	10
107	г	4.1	иглол	сем.нас	курортна гора	19	неравномерен	средно	бб	10	1	90	0.8	22	3	30
107	д	4.0	иглол	скл.култ	курортна гора	15	равномерен	добро	бб	10	2	30	0.9	10	4	12
108	б	11.4	иглол	сем.нас	курортна гора	16	неравномерен	добро	бб	10	1	100	0.7	25	2	30
103	а	8.6	иглол	сем.нас	Стопанско	21	равномерен	добро	бб	10	1	90	0.8	24	2	26
109	а	22.3	иглол	сем.нас	курортна гора	22	неравномерен	добро	бб	10	1	90	0.7	23.5	2	26

Figure3. *The attribute table database.*

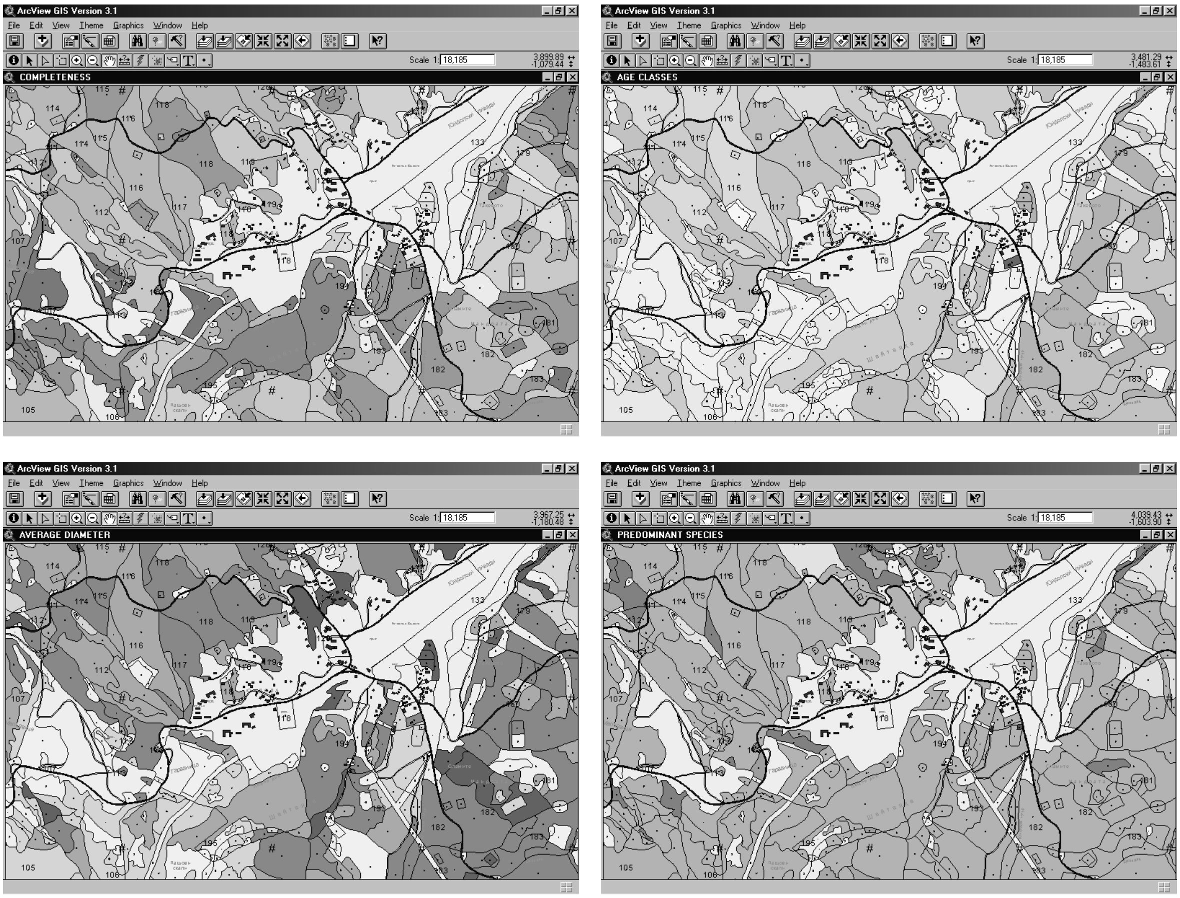


Figure4. *Thematic maps.*

After the thematic maps follows the raster elevation model created by scanning the topographic contours of a 1:10000-scale map, creating a TIN, and then converting the TIN to a grid. From this elevation grid, grids are generated of slope, aspect and insolation. (fig. 5) Knowledge of the spatial analisis and distribution of the phisiographic characteristics is critical for determining potential sites for new recreational areas. It allows students to find the best location of recreational facilities depend on factors like elevation, aspect, slope, surface area, insolation, etc.

Students use GIS mapping tools to implement concepts and methods learned in the classroom, namely to determine the recreational value of forested areas.

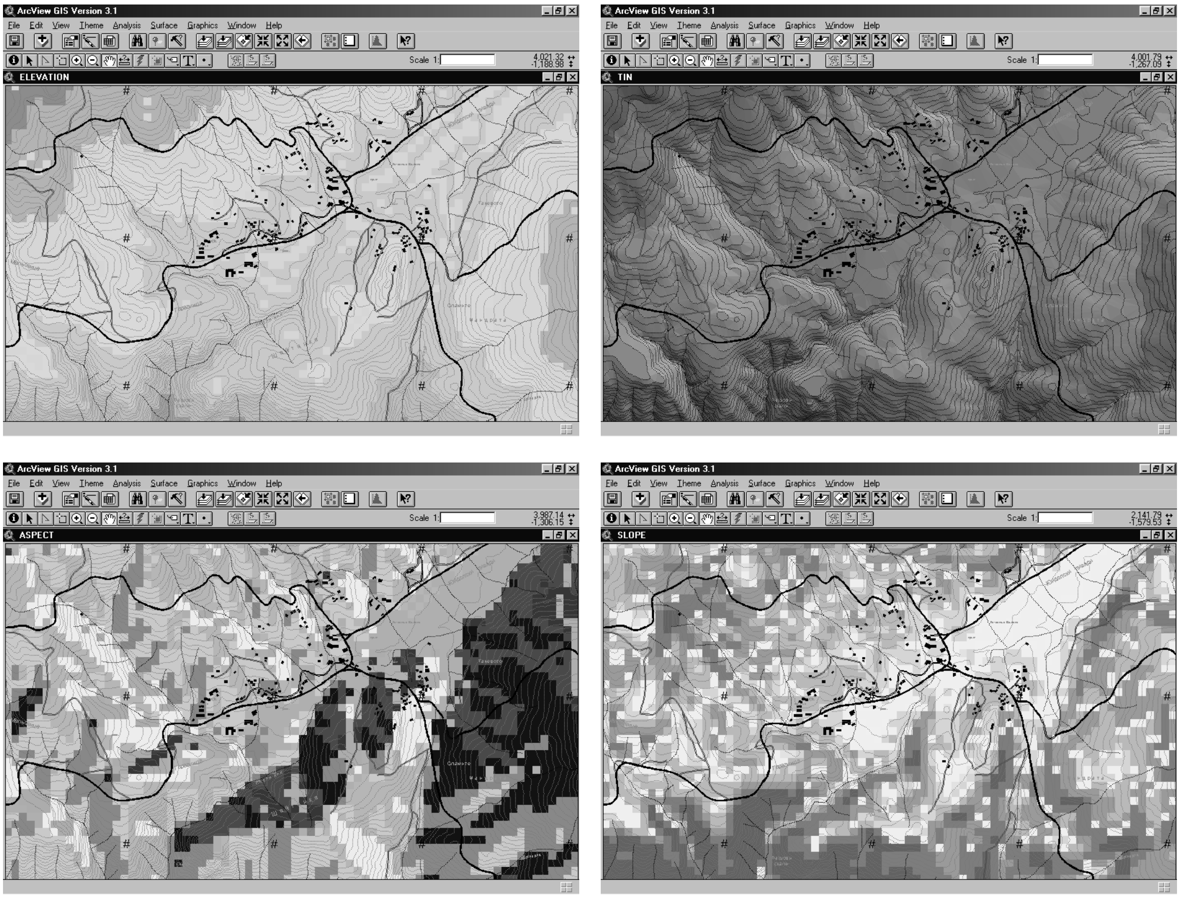


Figure5. *Grid analyses.*

Finally a classification of visual forest landscapes for needs of the landscape planning and design of recreational facilities has created. In order to create that sort of classification main characteristics of the forest subdivisions have been examined in the light of their visual impact and spatial importance for different recreational activities. Landscape units were classified by grouping stands into recreational types depending on the natural attributes of its features recorded in the forest inventory. This classification tells us something about the optimum possibilities for making the best recreational use of forest landscape. (fig. 6) Students learn a method for assessing the visual impact of the forest vegetation and open spaces. Created classification is closely linked to the indices of the forest taxation. It has a high potential for providing planning assistance in multiple-use forests and also provides a clearer picture of the aspects such as aesthetics and recreation.

Combining the topographic data with vegetation data and the other landscape components data gives up absolutely all characterizations of landscapes. They are completely presented and are accessible for 3D visualization. Landscape architecture students use Arc Scene ^{TM} 3D Analyst to map a three-dimensional representation of the terrain (fig. 7) as a final step of their intensive design studio requirements. They use this model to create any kind of landscape design projects, especially when is importantly the study of what can be seen from where.

ACKNOWLEDGEMENT

Sphere of application created GIS is very wide. It could be used not only in training of the students, but also in forest designing, and on planning and organizing of daily work in the Forestry too. On the other hand so created and organized database is quite sufficient as base for working out landcsape

planing projects. In the graphical database can be added digital satellite images or aerophotographs which give opportunities for detailed specification of borders and area, marking some changes if they have come etc. Updating taxation data about wood tree vegetation can be realized very easily and quickly too. At this situation the questions about accuracy and actuality of every kind of projects concerning area of Youndola Forestry is quite solved. Finally, GIS application can be very widely at carrying out of scientific researchs. It will be easy to create complex classifications, juxtapositions, calkulations, analyses and many others skills and mechanisms, used in scientific developments.

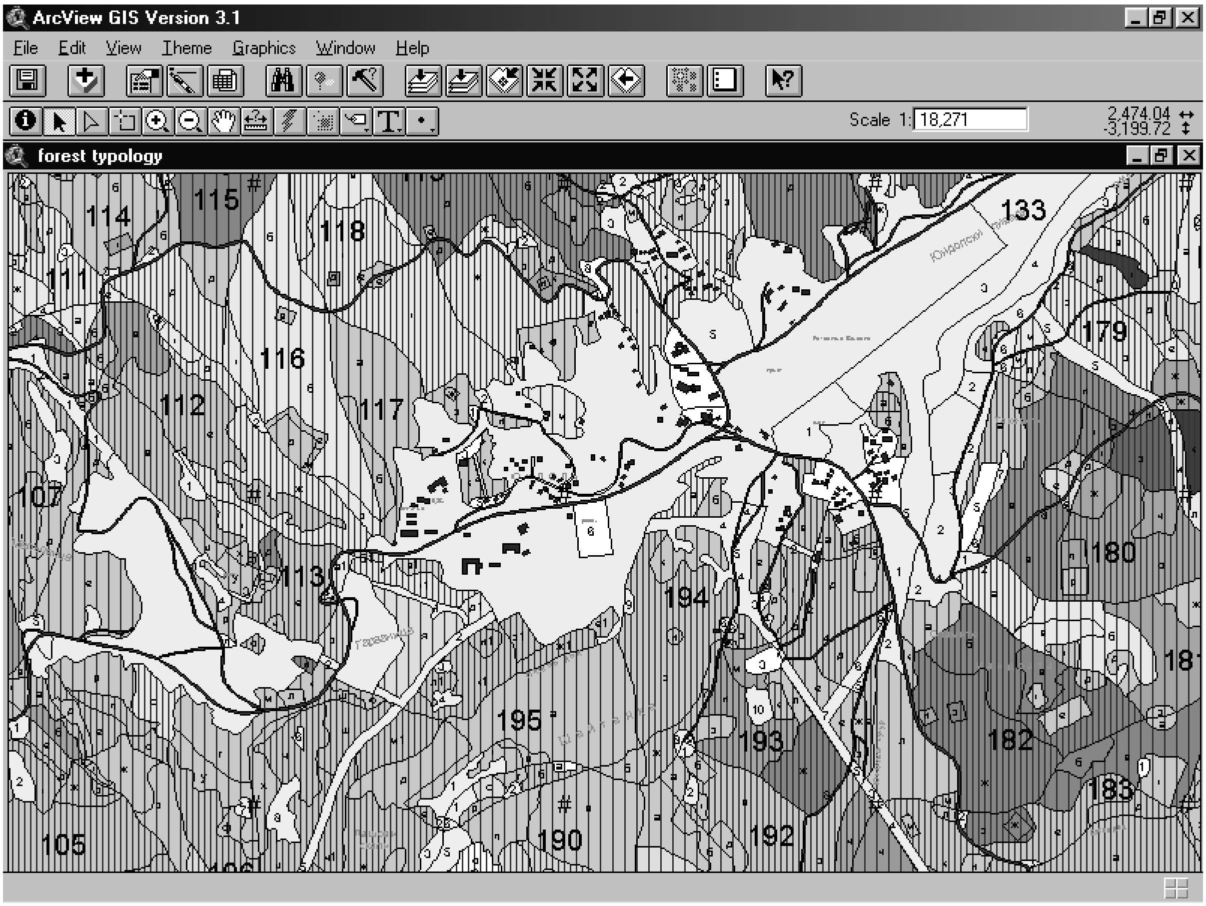


Figure6. *Typification of the forest landscapes.*

Students are introduced to data about the landscape, all related to various topics in courses and projects specific to their academic discipline "landscape science". GIS is more than computer maps, and it gives them the power to link databases to maps, and to create dynamic displays. More importantly, it provides tools to visualize, query, and overlay those databases in ways not possible with traditional spreadsheets.

Computational approaches to graphic representation offer new ways of analyzing and depicting landscapes, which increasingly enable our students to make proposals and ask questions about forest landscapes with multimedia presentation tools, particularly to:

- visualize data as maps.
- design simple to sophisticated "what-ifs" in the form of database an map queries.
- display the results of queries in the form of maps, charts, and tables.
- perform basic statistical analysis and spreadsheet functions.

- join data from outside sources to existing geographic data.
- create and edit geographic and statistical data.
- link photos, video, text, and graphics to specific locations for complete multimedia presentations.
- design and print map, chart, table, and graphic images.
- export maps, graphs, and tables into other software packages.

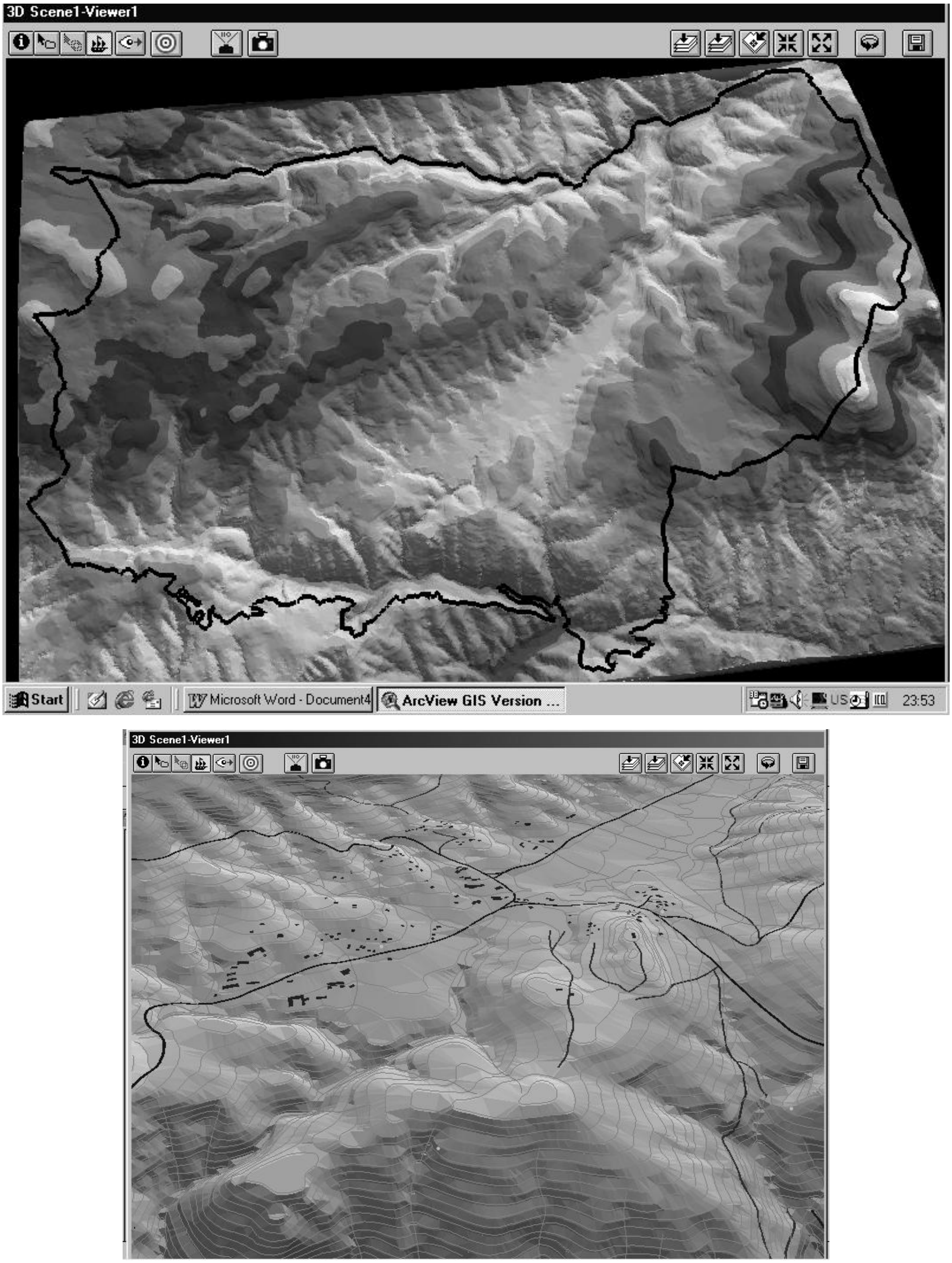


Figure7. *Three-dimensional terrain models of the whole area and of a fragment.*

The mission of GIS "Youndola" in educational process is to show the students wide range of opportunities that computer technology gives in sphere of landscape investigation, and extend their skills at level of competence, beyond which they independently will be able to improve their skills in the future. the future.

In summary it is necessary to mark that GIS "Youndola" make students aware of relevant tools for landscape analysis, design synthesis, simulation and evaluation of landscapes and prepares them for entry into landscape design practice.

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