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GIS in landscape architecture and design

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SUMMARY

The necessity of introduction of methods of the geoinformation analysis of territories to decision-making systems in landscape-architectural and landscape-design activity is substantiated.

The key role of GIS in the procedure of creating landscape projects and plans in connection with the European Landscape Convention is identified.

There is a need to integrate GIS software with special tools for landscape designers and architects, namely: AutoCAD, Google SketchUp, RealTime Landscaping Architect, etc. It is dictated, in particular, by the priority of substantiation of ecological decisions at creation of plans and projects of the organization of landscape spaces of home gardens, cities, regions.

Educational space and the state of the national spatial data infrastructure are considered as determining factors in the perception and use of GIS by landscape architects and designers in Ukraine.

GIS is considered as a spatial environment for the synthesis of natural science intelligence for landscape architecture and design. In particular, GIS is defined as a tool for finding the parametric location of territories (morphometric, hydrological, lithological, soil, biocoenosis, process, etc.) in the geographical diversity of landscapes. The information potential of GIS application in the organization of public spaces is outlined in connection with the spatial analysis of the Digital Elevation Model.

Introduction

The European Landscape Convention presented a pan-European concept for the protection, management and planning of all landscapes, not only outstanding ones. In this regard, the content and features of the organization of the landscape architect are determined.
According to the International Federation of Landscape Architecture (IFLA): Landscape architects plan, design and manage natural and built environments, applying aesthetic and scientific principles to address ecological sustainability, quality and health of landscapes, collective memory, heritage and culture, and territorial justice. The IFLA identified a number of challenges in relation to new conservation priorities. Some of them are: 1) conducting research and analysis to develop sustainable landscape design, planning and management practices, theories, methods and development strategies to promote green infrastructure, the sustainable management of natural, agricultural, rural and urban landscapes and the sustainable use and management of global environmental resources; 2) managing digital technologies and representation of spatial systems, and client and/or community presentations related to the environment and landscape (IFLA, 2020).
Landscape planning is a branch of landscape architecture. The landscape plan, which offers solutions for the creation of sustainable landscape spaces, has the opportunity to obtain a positive conclusion of the Strategic Environmental Assessment (SEA), and hence the possibility of implementation. The same applies to any architectural projects. All of them must go through the Environmental Impact Assessment (EIA) procedure and get a positive conclusion. Therefore, any planning and design activities of the architect should be associated with a comprehensive vision of nature and forecasting of possible environmental impacts of new spaces. The geoinformation environment is organic and absolutely sufficient for the synthesis of information from the spatial vision of the projected object. It is proposed to consider some problems and features of implementation of landscape-oriented priorities and GIS in landscape-architectural activity.

Method and Theory

Landscape architects have played a leading role in the emergence of GIS software. Warren H. Manning (1860-1938) was a key figure in the history of American landscape architecture and co-founder of the American Society of Landscape Architects. He developed an environmental planning model based on the concept of collecting and organizing discrete types of environmental data, in particular, such as soils and vegetation, followed by their mapping in cartographic form. His methods of mapping were later adopted by the famous landscape architect Jan McGarg. He, one of the preeminent landscape architects of the twentieth century, is considered one of the giants of GIS, primarily because of the overlay analysis techniques he documented in his book “Design with Nature”. In 1969, landscape architect Jack Dangermond founded ESRI, the preeminent GIS firm in the world. Despite the outstanding achievements of architects, founders of GIS, landscape architecture as a profession has almost always been a follower rather than a leader in GIS. Computer Aided Design (CAD), Google Sketchup, and Realtime Landscaping Architect play a key role in creating 21st century architectural drawings.
Landscape architects, including those in Ukraine, are in no hurry to introduce GIS. And there are reasons for this. Some of them are the availability of spatial data and sufficient competence of the subjects of landscape and architectural activities to use appropriate methods of data analysis and the use of software. The competence and content of the activities of landscape architects is formed in connection with the system of higher education and the system of standards in the specialty. The fact of availability and accessibility of spatial data is determined by the composition of the national geoSpatial Data Infrastructure (SDI).
The national standard of higher education in the specialty 191 "Architecture and Urban Planning" was approved in 2020. The analysis of this document shows its vagueness in terms of providing the educational process in the part of "Landscape Architecture", both in terms of content and IT.
A thorough approach to the organization of educational activities for the training of specialists in the field of landscape architecture is presented in the document "Setting up the education of landscape architecture in Europe". This document was developed by teachers working in higher education. For the field of landscape architecture, this was done as part of a project called "New opportunities for learning, research and education, LE: NOTRE". The project was organized by the European Council of

Schools of Landscape Architecture (ECLAS). This document defines the tasks of landscape architecture. Landscape architecture as a field of professional activity, and an academic discipline, is concerned with the shaping of landscapes at various scales. Core competences of land-scape architecture centre on the process of intervention in landscapes to create new or revitalised places, by means of landscape planning, design and management, as well as by project implementation. This document identifies the main areas of subject competencies in the field of IT in landscape architecture, in particular the skills of using GIS for analytical purposes and CAD for presentation, visualization, calculations; use of spatial databases for landscape analysis; use IT in to understand the environment (Tuning Landscape Architecture Education in Europe, 2010).
IFLA Europe and ECLAS have signed Memorandum on Cooperation. It is intended that the document "Setting up the education of landscape architecture in Europe" will also be used by the community of practice of landscape architects and by stakeholders in the profession such as governmental organizations, commissioners, employers and non-governmental bodies.
The national geoSDI is currently being formed. The Law of Ukraine on the National Infrastructure of Geospatial Data was adopted on April 13, 2020.
Following the adoption of the INSPIRE Directive, which aims to support EU environmental policy was created pan-European SDI. Currently more than 150,000 datasets are documented and accessible (for searching, viewing and downloading) within the pan-European INSPIRE infrastructure Components of the INSPIRE geoportal such as elevation, geology, mineral resources, atmospheric conditions, meteorological geographical features, soil, hydrography, orthoimagery, cadastral parcels, transport networks, protected sites, national risk zones, land cover, biogeographical regions, species distribution, habitats and biotopes, sea region, administrative units, agricultural and aquaculture facilities, energy resources, buildings, population distribution, production and industrial facilities, human health and safety are crucial for landscape architectural activities (INSPIRE, 2020). INSPIRE geoportal information and data and educational achievements are sufficient for European architects to build a sustainable environment with organic natural spaces.

Results

Landscape architects were instrumental in the early development of GIS technology and methods. But while academics in the field of landscape architecture, lendscape ecology and its relatives continue to advance both GIS-cience, and GIS, the majority body of practicing landscape architects appears to be far behind current advances.
Significant achievements in the context of GIS implementation in landscape planning and development of landscape-ecological initiatives in the practice of territorial management are offered, in particular, in the works of Ukrainian scientists (Bilous L. (2019), Grodzynskyi M.D. (2014), Havrylenko O., Shyshchenko P., Samoilenko V., Bilous L. (2020), Samoilenko V. et al. (2019), Samoilenko V., Bilous L., Havrylenko O., Dibrova I. (2020), Shyshchenko P.H., Havrylenko O.P., Tsyhanok Ye. Yu. (2019) and etc).
World scientific research experience has provided the transition of geographic information technologies in an era when GIS analysis can be integrated into the design process immediately after the moment when the sketches of the back of the napkin are created. When you first get to know the site, using OpenStreetMap (OSM) and Global Positioning System (GPS), you can quickly get preliminary parametric data about the object and its environment. And in the case of the national SDI, it is possible to synthesize a fairly thorough description of natural and anthropogenic parameters of the environment. GIS is a decision-making environment for landscape architects at the regional and global levels. The real strength of GIS is its ability to manage large quantities of spatial data, and to provide the tools for querying and analyzing data. Landscape architects, however, can use GIS at all scales to evaluate the suitability of locations, examine the feasibility of proposals, allocate uses within a site, and predict the impacts of different decisions.
The tasks of landscape architecture and GIS are closely related to the spatial planning procedure. In Ukraine, the following levels of spatial planning system are distinguished: 1) state with a General Scheme of territorial planning; 2) regional with Schemes of planning of territories; 3) local with General plans of settlements; Territorial zoning plans; Detailed plans of territories.

The current General Scheme was approved by the Law of Ukraine in February 7, 2002. It expires in 2020. The activity program of the Cabinet of Ministers of Ukraine envisages the development of a new General Scheme in the coming years. It is established that the main issues that need to be addressed in the new General Scheme are: the construction of a planning framework linked to the European Planning Framework; taking advantage of growth points; development of functional regions; development of the National Ecological Network on the basis of the Emerald Network of Ukraine; development of a modern settlement system; changing the structure of land use and increasing the share of nature conservation and recreational areas. The decisions of the General Scheme should be based on the approved Strategy for Regional Development of Ukraine until 2027. The new General Scheme should be created as an interactive geoinformation model in the uni ed state reference system of USC-2000 coordinates, publicly available for use by public authorities and local governments, and include the following main maps: Planning structure of the territory of Ukraine, functional zoning by types of preferred use, comprehensive assessment of the territory, system of settlement and perspective administrative-territorial structure of the state, transport system, natural framework (Palekha Yu.M., 2020).

Information about the place of Ukraine in the natural world order, in particular, in the habitat and biogeographical space; in the ecoregional space, especially in the Global 200 and the biosphere reserve; in the system of CORINE Land Cover; in the system of ecological networks Natura-2000 and Emerald should be decisive in the development of a new General Scheme.

GIS should provide the architect with access at all territorial levels of his activity to information about the landscape environment of spaces that represent his area of interest.

The geoinformation analysis of topological properties of landscape space offered by us for consideration testifies to ultrahigh potential of GIS, even in the course of knowledge of a place of object of planning and is projected in the natural environment.

The starting point of knowledge of the object is the topological niche of its landscapes. Its understanding is a prerequisite for the organization of so-called "new landscapes" in connection with the topologically defined ecological conditions of the territories. Knowledge about the relief and the results of its spatial analysis will help to determine the topological place of the object of landscape architecture.

Methods of building a digital elevation model (DEM) using GIS have been considered by us before (Bilous L.F., Shyshchenco P., Samoilenko V., Havrylenko O., (2020). It should be noted that it is advisable to use the data obtained as a result of digitization of topographic bases and their current values using GPS to construct the DEM. The application of the ArcGIS TOPOGRID interpolation technique to correctly organized source data provides an opportunity to build a highly reliable DEM (Figure 1).

Its spatial analysis, in particular morphometric and hydrological, allows to obtain information on surface slopes (Figure 1.1), aspect (Figure 1.2), residual landscape components (Figure 1.3), denuded landscqape components (Figure 1.4), directions of movement, places of concentration of water flows, watersheds. Derivative digital models of spatial organization, obtained as a result of spatial analysis of DEM, are decisive in the planning and design activities of a landscape architect.

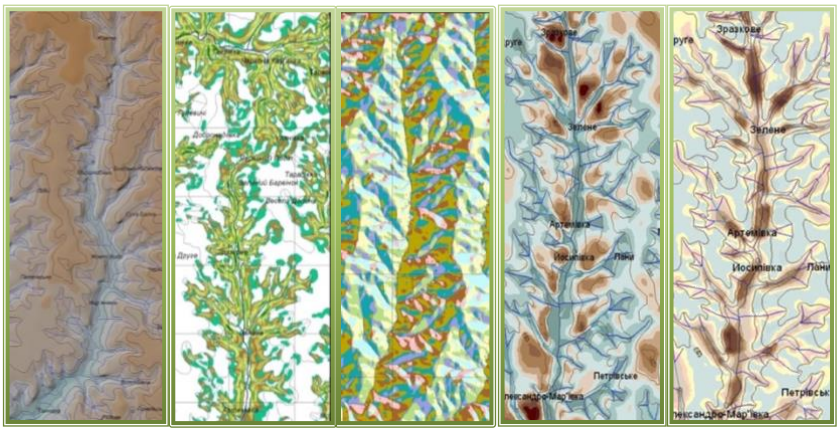

Figure 1 DEM - 1; slope - 2; aspect - 3; residual components - 4; denuded

Slope is a fundamental geomorphometric parameter that determines the content of architectural and planning decisions and is naturally associated with the following processes and characteristics of the landscape: surface runoff and drainage, erosion intensity, soil profile thickness. The amount of solar energy also depends on the slope, because it determines the angle of incidence of sunlight on the earth's surface. Aspect has a significant effect on the microclimate. The amount of solar radiation directly determines the intensity of plant development and their biological productivity. Variants of the series

of heat (moisture) security (Cold => Heat; Wet => Dry) by insolation exposure: orientation series; traditional "compass" series; Whittaker series. Regarding the models of the denuded landscape components and the residual landscape components, it should be noted their decisive role in planning the ecological framework of the territory, which ensures its natural stability. Features of their modeling and interpretation were considered earlier (Bilous L.F., Shyshchenco P., Samoilenko V., Havrylenko O., 2020). Determinant for landscape-architectural activity is the hydrological analysis of the DEM. ArcGIS Hydrology Modeling module, in particular, using Flow direction, Watershed and Flow accumulation functions. Hydrological analysis in the procedure of making architectural decisions about the location of catchments is decisive. In particular, this applies to artificial reservoirs and rain gardens (RG). RG, as an important storm water management practice, are common tool in landscape creation of public spaces. Their ecological characteristics include collection, processing, infiltration, transpiration and filtration of storm water, which are increased by strong economic aspects because of its relatively low-cost demand and final money savings. These low terrain depressions planted with perennials, shrubs and small trees are notable aesthetic and landscape element used by landscape architects worldwide.

Conclusion

Due to the recognition by the international community of nature-centric life landmarks, GIS should be defined as an environment for making landscape-architectural and design decisions. Educational space and the state of the national SDI play an important role in the perception and popularization of GIS among landscape architects in Ukraine. GIS is defined as a tool for finding the parametric location of “new spaces” (morphometric, hydrological, lithological, soil, floristic, process) in the landscape diversity of the territory. The information potential of GIS application in the organization of public spaces is outlined in connection with the spatial analysis of the DEM. The possibility of using national SDI and geoinformation analysis tools allows the community of Ukrainian architects to join the European integration procedures for environmental protection, in particular, through daily planning and design practices, and, accordingly, implementation of the concept of sustainable development of urban spaces, united territorial communities and regions.

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