Information Technologies in Management of Listed Buildings

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ABSTRACT

Currently it is a critical situation when every year due to aggressive external factors, thousands of listed buildings are under threat of destruction around the world. In many ways, the state of affairs is due to the lack of effective integrated management of listed buildings. Lack of an integrated tool for the operating of different data, which determines the structural integrity of listed buildings and condition of environment, has led to the fact that most of the regional and municipal authorities are not able to handle the diversity of information.

To address these problems the specialist of Department of City Planning and Community Development of Rostov State University of Civil Engineering developed the methodology and information-analytical support system of listed buildings' preservation. Information technologies in management of listed buildings can help municipalities with a limited budget to get the most out of existing services as these are the technologies that help different departments to work more closely with each other.

INTRODUCTION

The UN Conference on Environment held in Rio de Janeiro with adoption of Sustainable Development Concept was followed by international Conferences on Sustainable Construction (Tampa, USA, 1994), Construction and Environment (Paris, 1997) and the Rio+20 summit (Rio de Janeiro, 2012). These conferences defined the notion of sustainable urban development as "the creation and responsible maintenance of a healthy built environment based on efficient resource use and ecological principles".

According to V.P. Knyazeva, "Sustainable development that is not based on culture is soulless and thus cannot be sustainable ... Cultural heritage and its material component – listed buildings - constitute an essential part of the Earth ecosystem, the source of spiritual culture, knowledge, mastery and experience of earlier generations, as well as an informational resource of planetary intellectual potential, which must be preserved for future generations" (V.P. Knyazeva, 2005). As follows therefrom, it is necessary to provide preservation of natural environment and protection of cultural heritage as a whole. Therefore, the study of that heritage with its informational content becomes a task of paramount

importance together with preservation of historically existing architectural environment. Preservation of listed buildings requires a highly sophisticated and efficient system for comprehensive control of their condition. System-wide information is necessary, including the environment, ecological and geological factors affecting a building, the structure and properties of its materials, and structural integrity. To preserve outstanding examples of culturally significant buildings, a permanently established monitoring system is required in order to perform research and creation of general databanks of all listed buildings. Monitoring combined with information technologies is exactly the tool that will allow preserving cultural value of a building to the possibly maximum extent.

METHODOLOGY

The method developed for preservation of listed buildings is based on environmental monitoring (Sheina et al, 2012). Environmental monitoring of a listed building as the basis of its preservation in terms of urban ecology management includes the following components: monitoring of the territory of historic premises and their surroundings, eco-environmental monitoring of a listed building, and monitoring of its structural integrity and functional utilization (see Figure 1).

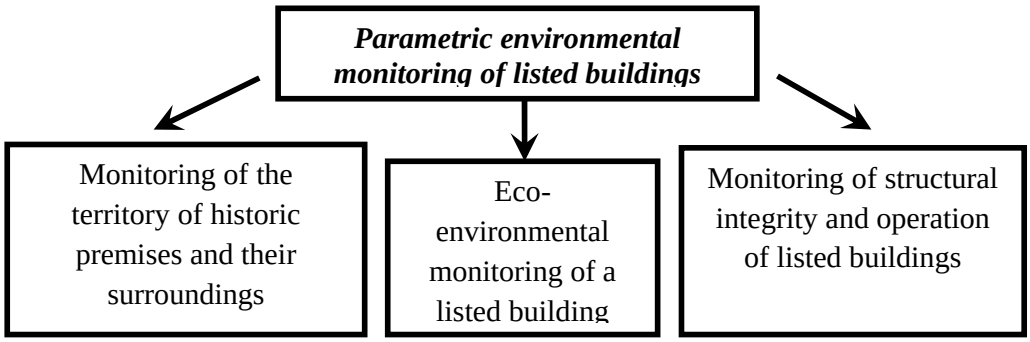

Figure 1. Components of environmental monitoring in the system of "Environment – listed building".

Data collected from three monitoring subsystems serve as input parameters in the model used for selection of an efficient ecological urban solution in order to ensure preservation and restoration of the monitored listed building and the most efficient manner of its operation. Specific methods and data analysis tools have been developed for each monitoring section resulting in the creation of software solution that allows arranging and processing the data using geographic information systems and technologies (GIS technologies), computer-aided design (CAD) systems and database management systems (DBMS).

Results and finding. The sources of data related to the architectural and town-planning urban heritage are plentiful. However, the data are often scattered and not readily accessible for specialists of various fields. Therefore, we have set and accomplished the goal of collecting the data about cultural heritage objects, systematizing the existing data on listed buildings, their structural integrity and operation, environmental conditions and arrangement of the data in a common database featuring support of GIS tools for visualization of the objects in space. Users of the developed information-analytical support system can view the

pictures of a listed building or an urban area, its history, architect's name, style and other information, as well as 3D models of the buildings on an electronic map.

Collected data are arranged in appropriate folders stored on a server and used during database generation. The database of Rostov-on-Don listed buildings includes tables containing information about outstanding samples of urban development and listed buildings (architectural ensembles and areas, historic blocks, etc.), architects and their projects, architectural styles, historic references, about owners and operation of the buildings, legal documents, etc.

The client application features access to computer map (***Show on the map*** button) developed on the ArcGIS ESRI platform and demonstrating the city plan structure with the objects of architectural and urban planning heritage described in the database, and 3D models of the buildings (see Figure 2).

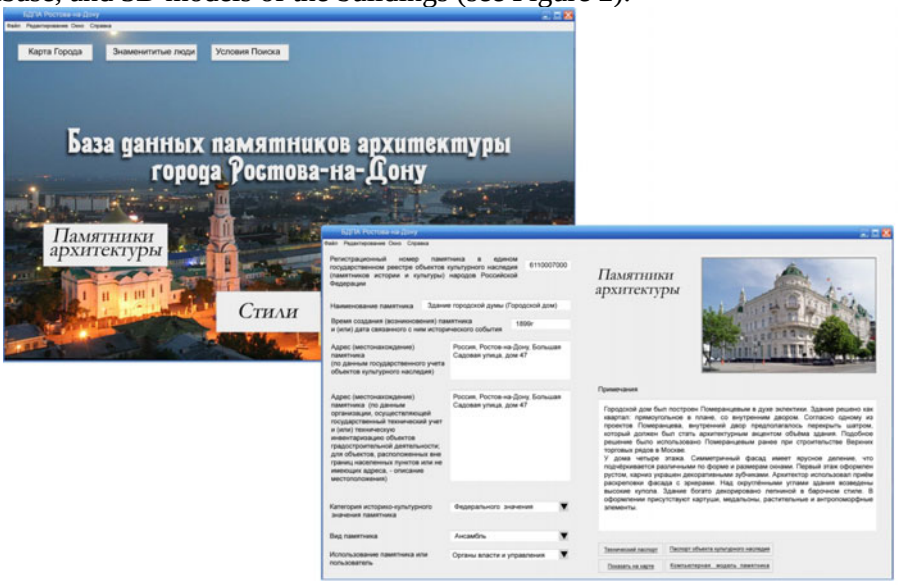

Figure 2. Window of listed building database.

Within the database, each building has two electronic passports associated with it, one of them acts as a counterpart of a cultural heritage object's passport, while the other serves as technical specification of a Real Estate Registration Bureau offering, however, broader functionality.

In view of largely varied types of the data collected, the developed information-analytical support system for preservation of listed buildings can use various information technologies. The system is designed to function as a suite of accumulative reference modules based on key indicators reflecting the status of territory and listed buildings, which allows using GIS technologies, CAD and DBMS to present the data as necessary. An example of combined and systematized planning, spatial, environmental, operational and functional information is demonstrated in the Figure 3. While generating the information, the created modules must remain open to allow addition of new data about the condition of historic premises, their territory and surroundings as well as structural integrity of listed buildings and their operation (Sheina et al, 2013).

The model is implemented using the city of Rostov-on-Don as an example. The data analysis system is based on ArcGIS ESRI electronic map of the city. The map consists of various subject-based layers containing information about buildings

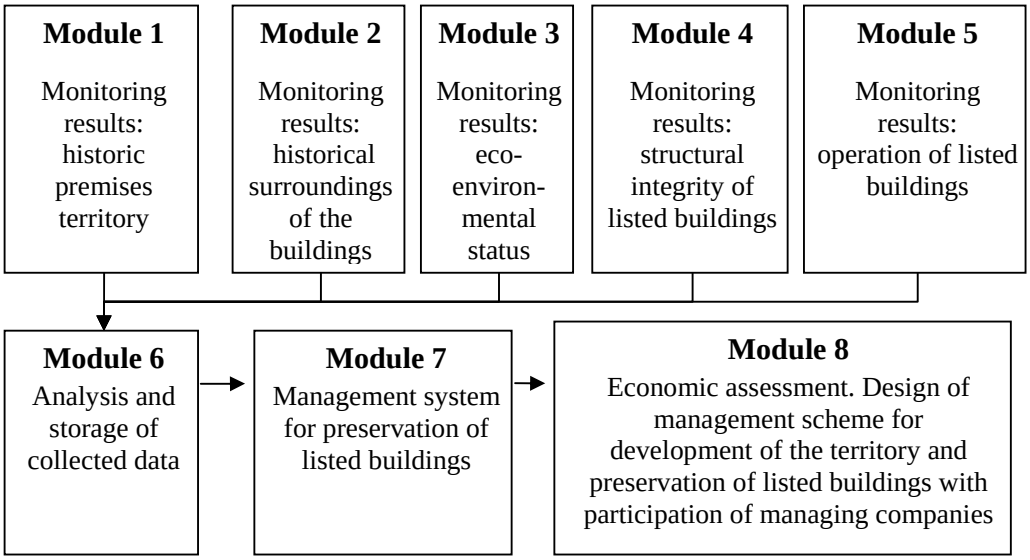

Figure 3. Data systematization model employed for preservation of listed buildings based on environment monitoring.

and constructions, hydrographic data, streets and roads, green areas, infrastructure, etc. Separate layers provide information describing the functional, planning and spatial organization of the city, historical urban typology, safeguard zones of historical and cultural monuments, environmental specifics of the urban territory. The maps are built to scale 1:10000 and 1:25000.

Module 1, **Monitoring results**: historic premises territory, contains the results of historical and town-planning analysis of historic premises as well as inventory surveys of their surroundings. The module is represented with the maps reflecting analysis of historical urban typology (see Figure 4); historical and cultural value and the potential of the territory of historic premises (see Figure 5); project proposals of the city master plan as well as land use and city development rules (see Figures 6-7); project of the safeguard zones of historical and cultural monuments, conditions and specifics of visual perception and identification of the areas influenced by the composition and view of the listed buildings, landscape- and aesthetics-based assessment of the territory (see Figures 8-10); locations of new residential construction (see Figure 11) (RSRDIUD, 2008).

Module 2, **Monitoring results: historical surroundings of the buildings**. The module provides information about the closest neighborhood of historic premises including urban components, some of which increase the overall environmental impact (stations, garages, highways, construction in immediate vicinity of heritage objects, industrial facilities, etc.), do not affect the load (residential houses, business areas, trading areas, etc.), while others decrease negative impact (green areas, waterspaces, etc.).

Module 3, **Monitoring results: eco-environmental status of historical buildings**. Information about the load danger category of environmental factors is summarized in the Module 3 of the data analysis system. Module 3, Monitoring results: eco-environmental status, contains the results of eco-environmental monitoring of historic premises, i.e. ecological and geological safety of a city (see Figures 12-13).

Cartographic database is created on the ArcGIS ESRI platform and represented by series of maps containing information about the group of dangerous stress factors of the urban environment affecting both historic premises, heritage objects and the people: pollution of the atmosphere, groundwater and geological environment; density of noise pollution; overall soil pollution; condition of green areas and territory topography; karstic erosive leakage and landslides; the rate of underground water rise, etc.

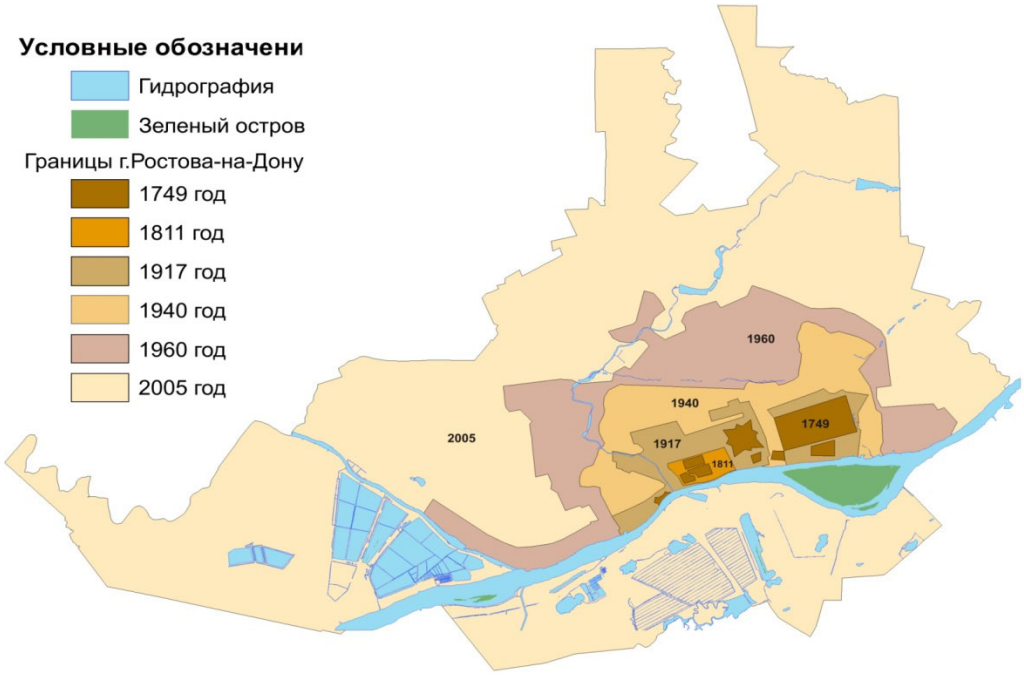

Figure 4. Map of historical urban typology of Rostov-on-Don, Russia.

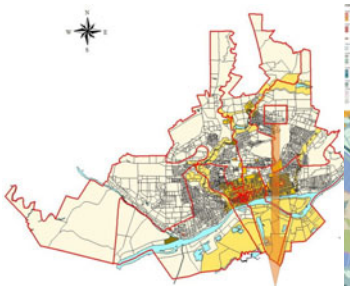

Figure 5. Historical urban typology of Rostov-on-Don

Figure 6. Project proposals of the city master plan of R-n-D development

Figure 7. Land use and city development rules in Rostov-on-Don

Figure 8. Project of the safeguard zones of historical and cultural monuments

Figure 9. Conditions and specifics of visual perception of listed buildings

Figure 10. Safeguard zones of listed buildings. Landscape- and aesthetics-based territory assessment

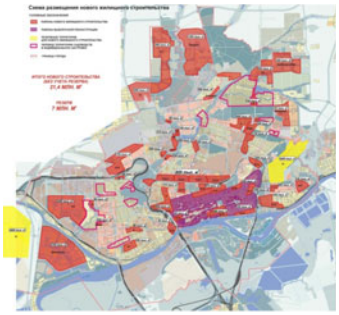

Figure 11. Location scheme of new residential construction

Figure 12. Computer map including the zones of ecological safety

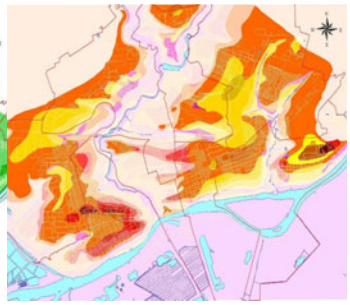

Figure 13. Computer map including the zones of geological safety

Module 4, **Monitoring results: structural integrity of buildings**, contains the results of technical inspection of listed buildings recorded in an examination card, including information about the need for repair and restoration, reinforcement of constructions or adaptation of a listed building for a new purpose. Module 4 includes output results produced by the Housing and Utilities Data Analysis System (HUDAS) developed by the Department of City Planning and Community Development of the Rostov State University of Civil Engineering. HUDAS allows development of various prospective models of management planning in order to control the integrity of buildings depending on their structure, condition and the need for (conservative or remedial) restoration works.

Module 5, **Monitoring results: operation of buildings**, contains monitoring data describing functional utilization of listed buildings.

Module 6, **Data analysis and storage system**, contains the informational part of the system, its cartographic database and specialized software (module 7) that allows to manage the condition of listed buildings.

Module 7, **Management system for preservation of historical premises**, is a hub for development and utilization of the software modules necessary for management of geological and ecological safety in order to ensure preservation of historic premises; one of the modules allows to advise the complex of preventive, protective and restorative procedures in zones of varied geological safety (see Figure 14), the other one allowing to determine the complex of local and area-wide steps bound to decrease the impact on zones of varied ecological safety (see Figure 15).

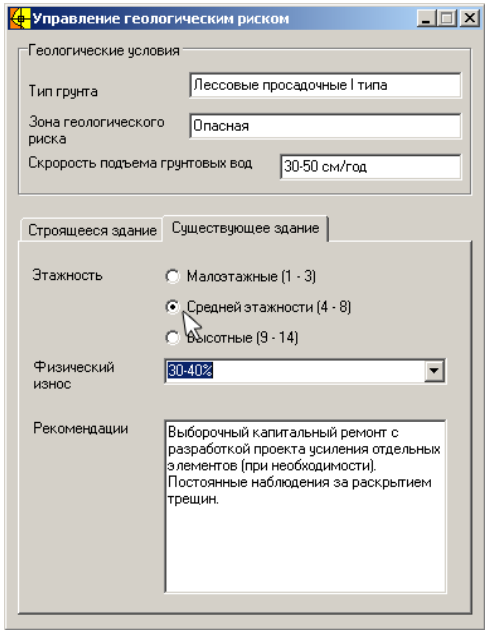

Figure 14. Window of geological safety management module

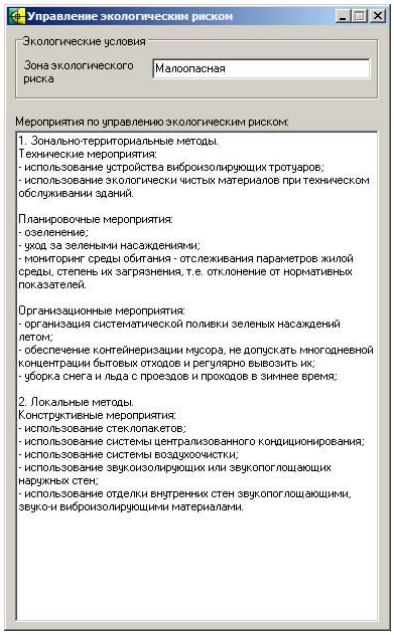

Figure 15. Window of ecological safety management module

Module 8, **Economic assessment. Design of management scheme for development of the territory and preservation of listed buildings**, offers the assessment of resources for the target program of historic premises preservation, financial analysis and feasibility study for the entire territory of historic premises. This section implies management scheme design for development of the territory and preservation of listed buildings with participation of managing companies.

Thus, the technology of geoinformational modelling allows to consider the town-planning aspects and environmental factors while creating tools based on integration between GIS technologies, CAD and DBMS in a common shell acting as the basis for preservation of historic buildings during reconstruction of urban territories.

CONCLUSION AND RECOMMENDATIONS

It was demonstrated that the use of modern information technologies allows collection, analysis, storage and subsequent presentation of spatial information describing the functional, planning and spatial organization of the city, results of technical inspection of listed buildings, environmental and geological conditions of the territory based on GIS-technologies, CAD and DBMS.

Theoretical postulates, methodology solutions and informational systems combined as suggested in the paper will enable municipal authorities in charge of historic heritage protection, ministries and agencies supervising and regulating city construction activities to make strategical, tactical and current decisions in the process of urban development whenever they encounter the need to preserve listed buildings of the past.

Above all, in order to minimize the risk of destruction of listed buildings and to maintain integrity of database at information-analytical support system of listed buildings' preservation, regional and municipal authorities' managers need to have an effective knowledge about the listed buildings, to understand how

environment, ecological and geological factors affect a listed building and to have skills to arrange and process the data of environmental monitoring using IT-technologies.

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