GIS AND THE ARCHITECTURAL HERITAGE OF DUBROVNIK – A BASIS FOR THE CONTINUOUS EXPANSION OF OTHER DATABASE SYSTEMS

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Abstract

Contrary to other large geoinformation technologies, the GIS data for the architectural heritage of Dubrovnik is based on a significantly different database structure. The geometrics, position, and inter-relationship and features of buildings are considered more important than the less significant segment made up of topographic data. They are the base upon which basic systems can be expanded upon. A third group of data dealing with cadastre lots are connected to buildings, which are gathered from a land-registry office, court records, and the actual state in the field. This brings into correlation the geometrics of real estate-buildings and the state of ownership.

The protected architectural heritage of Dubrovnik is made up of cca. 850 buildings, which are linked by rows and blocks. Its systematic compilation shows various aspects and areas. It is an ideal base for research into the potentials and needs of implementing huge quantities of data via one matrix. The continuity of gathering and compiling such information for the purposes of restoration over a period of more than 20 years has resulted in significant know-how, which is the topic of discussion in this paper.

Introduction

Various studies and much research have been carried out for the purposes of executing restoration programs. The existing state of buildings was continuously documented, except during the period of aggression in Croatia. The Institute for the Restoration of Dubrovnik collected a huge quantity of expert documentation after only ten years of restoration work, which necessitated a separate approach to the categorization and storage of the massive and various data.

The restoration of Dubrovnik commenced after the 1979 earthquake, primarily to repair the sustained constructional damages. A deadline was set for its duration, considering the initial haste and the significant funds invested yearly by the Republic of Croatia. After many centuries, this was the first time that an attempt was made for the systematic repair and revitalization of the city core. In 1991, restoration work was to have started on housing and the infrastructure, after the restoration of thirty of the most valuable buildings in the historical core. Unfortunately, everything came to a halt with the start of war and the destruction of Dubrovnik.

The new devastating damages suffered in 1991-92 were an additional threat to the already earthquake-shaken structures of buildings. The deliberate aggression on Dubrovnik, which was targeted by thousands of mortar shells, resulted in damaged rooftops, and in the devastation of stone facades, fountains, walls, and stone pavements. The damages affected 70% of the buildings. Nine palaces and a house were consumed by fire, 600 rooftops were destroyed, the repair of which is still ongoing.

The first initiative to compile an integrated geoinformation system on Dubrovnik started in 1990, but this was halted due to the devastations of war.
GIS in restoration work after the 1979 earthquake

The city, as a living organism, cannot stand partial solutions. Buildings are viewed as micro-locations and through their interaction with the city. The connection between issues related to the restoration of certain buildings and urban space implies the long-term management of the city structure, through planning, projects and the finalization of restoration work.

Already in 1984, for the aforementioned reasons, the restoration program integrated data from a detailed urban plan of the Old Town core of Dubrovnik, such as conservation analyses, building function, plan of use, earthquake insurance, etc., and the Detail town plan was adopted in 1986. The possibility of reinstating activities following changes to the Detail town plan, on the basis of new knowledge concerning certain buildings, contributed towards its vitality, which is why it is still valid even today.

As no system existed for any monitoring and cataloguing, it was impossible to compare the planned and actual state of affairs in the field. The Institute for the Restoration of Dubrovnik, which had an overview of the most significant changes in restoration work, was formally given the task of monitoring the Plan. Other changes, which were not included in the program of the Institute, were not systematically noted anywhere.

The GIS, in which a graphical base is built and brought into correlation with textual attributes, was ideally suited for the complex and various data that the city had to store and monitor. In this manner, the basic system is used to create new graphic presentations and the main storage code, upon which other various graphic and textual systems can be connected.

In 1990, the Institute for the Restoration of Dubrovnik carried out the initial steps needed for the formulation of a GIS database. The Faculty of Geodesy at the University of Zagreb prepared a project proposal, “A Basic Informational System for the Old Town of Dubrovnik” /published 1994/. Due to financial constraints, only the historical core with its ramparts was included, without the surrounding integral parts of the architectural heritage.

The projected Geoinformational System was supposed to collect, store, compile and present data on the historical core, in order to optimally plan the restoration and conservation work of this area. It is important to note here that all the local and state level institutions that were involved with this site were interested in the project. They could implement their own database system using the main database one.

The graphic base of the informational system was defined – precise spatial geometrics in digital form, portrayed as topographic – cadastre photo imagery of the city in the 1:200 /± 20cm/ scale. This scale was shown to be optimal as a base for the planning of projects dealing with infrastructure, public utility equipment, urban equipment, urban-architectural competitions, etc. Up until then, a topographic cadastre map dating to 1955 at a 1:1000 scale was used, and partial and detailed photo imagery was made for each specific project.

Various data was assigned to the detailed and exact geometrics of the terrain and architecture, primarily buildings, and later each institution expanded on its own. The Institute for the Restoration of Dubrovnik intends to gradually add on a detailed graphic documentation system to this database, architectural photo imagery of buildings by blocks, rows and individual buildings.

The devastations of war halted the realization of this project up until 1995, as the aerial photo imagery needed for the compilation of the aerophotogrammetric imagery of the city, which was needed as a base for the reambulation or detailed topographic-cadastre base was not possible.

In order to modernize the presentation of the collected data on the city, maps made by the Institute of Informational Technology Dubrovnik were used temporarily. This Institute digitalized the existing cadastre maps and the Detail town plan maps of the old historical core for restoration purposes. In this manner, an attribute database of buildings was formed, which was later converted to the new graphic database that contains:
- a coded drawing of basic spatial units /insulae, blocks, buildings/
- the actual state of architectural photo imagery
- number of floors, purpose and ownership of the building
- historical value and year of construction
- seismic micro-zoning and level of earthquake damages
- overview of restored buildings.
The data and the maps are regularly updated and are used for various reports, programs, animation and promotional activities used in the planning and financing of restoration work. Particularly important are data on the restoration status of earthquake-damaged buildings, which were halted in order to repair war damages. Due to the critical aseizmic state of many buildings, work is being continued through a program using the injection of outer support walls, and the repair of the most valuable buildings that was started earlier on.

GIS and restoration after the devastations of war

Even during the aggression on Dubrovnik, the Institute was responsible for continuing work on the compilation of an informational database system of the city. Accordingly, in 1992, a map showing rooftops and cadastre was made together with the former Institute for the Protection of Cultural Monuments, and with the collaboration of UNESCO.

In 1995, the Institute for Land Measurement in Split began the preparatory work needed for the compilation of a new graphic database. They continued working on the execution of the project under the expert guidance of the Faculty of Geodesy in Zagreb. During this year, under the international CRODYNG project, the measurements and connection of the new survey network of the city to the European survey network via satellite /GPS/ were completed. Three main points were included within this for the historical core, as a base for the new measurement plan.

During the restoration of the city from the devastations of war, the already started project was once again activated. The State Cadastre Office recognized its broader impact, undertook the financing, and so it was turned into a pilot project. The state project of the time, “A Normative Proposal for the Execution of Digital Cadastre Plans” gained importance and support for its cadastre measurements and digital compilation.

The basis for building the graphic database of this informational system were the Land Registry Office and the Land Registry Records that were compiled on the basis of the cadastre survey measurements taken in 1955, the public utility cadastres and the Detail town plan data. The technical base is the cadastral survey of land measurements. The reambulance of measurements was taken on the basis of aero photogrammetric imagery, in order to update the status and to obtain the necessary level of details, for a 1:200 scale.

The main graphic bases are: portrayal of buildings, cadastre lots according to new and old identification codes, rooftop layouts, a map with elevation data and a map showing basic spatial units according to categorization /insula, block, building/.
The following GIS data were covered for the restoration of war damages:
- map of damages to housing, public and sacral buildings, walls, streets, public utility buildings,
- map of restored buildings,
- map of projectile strikes on roof charts,
- map of the status of rooftop restoration.

In GIS, the rooftops compiled by building, significantly helped to calculate the damaged surface area and to evaluate the funds needed for repair. The same applies for calculating the area of restored buildings, the state of architectural survey, etc. Presently, the Institute uses a working version of GIS, in which earlier databases have been integrated, and in which new data on the state of restoration from earthquake and war have been added, as well as updated architectural photo imagery and rooftop repairs. The entire data changes, depending on the realization of the yearly plan, so that it is important to monitor changes and to update the database. The completion of an attribute base is lacking, as well as the connection to other, for now separate, systems. Following the official verification of the cadastre, the database could be made available for other users in the city.

The advantages of using GIS in the restoration of the historical center of Dubrovnik

The modern storage and continuous systematic expansion of the GIS database by the Institute would be made easier by receiving information on the buildings and owners.
The expert documentation level of a monument is improved on, and its potential use is thereby made more widespread. The overlap and interaction of various database systems is made possible, which are established on the basis of basic identification codes, whether graphic or textual.

The servicing of population needs is encouraged, who continuously use the available graphic and textual data. To this end, the Institute has been ordering all architectural survey documentation in digital form for already eight years, connecting them by set identification marks in the GIS database.

The preparation of a program and restoration plan, investment projects and studies, have been modernized and made easier. Monitoring their realization can be made clearer, better documented, and readily available to everyone via the Internet. The potential encouragement of donators, visitors, and expert collaborators is thus made possible. Further, superior expertise is achieved among other world cultural heritage centers.

Finally, the execution of various multi-media presentations of city areas in all dimensions is made possible following the digitalization of the architectural survey of the entire architectural holdings.

1. Map of the city with basic spatial units (insulas, blocks)
2. The actual state of architectural survey

3. A coded drawing of spatial division with attribute table

4. The example of block of buildings with text descriptions

5. Seizmic micro-zoning of the historical core of Dubrovnik
6. Map with levels of earthquake damages in 1979 and reconstructed buildings

7 Cadastre map - old and new survey and GPS points

10 Status of rooftop restoration
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