spatium

Priroda nije samo jedinstvo svih pojava stihijnim razvojem nastalih na ovoj planeti. Ni samo izvor sredstava za održavanje života na njoj. Ona je i prostor u kome se taj život odvija.

U okvirima prirodnog prostora ljudski rod je dejstvovao, i prilagodjavajući pojedine njegove delove svojim potrebama menjao im je sadržaj i svojstva. Tamo gde je njegovo dejstvo bilo isključivo eksploatatorskog karaktera, prirodni prostor je devalozizan i pretvoren u pustoš. Na drugim mestima, gde je ono bilo smišljeno i trajno,usmereno na stvaranje novih vrednosti, nastala su polja, put, kuća, selo ili grad.

Tako se razvija - u početku kao retke enklave u beskrajnom prirodnom prostoru a kasnije sve širi, celovitiji i složeniji PROSTOR LJUDSKOG ŽIVOTA DRUŠTVENIM RADOM FORMIRAN, ORGANIZOVAN I OPREMLJEN. Radi razlikovanja od prirodnog, kosmičkog, apstraktnog ili bilo kog drugog prostora, nazovimo ga analogo "urbanizmu" i "regionu" - "SPACIUM".

Time je nastao pojam koji obuhvata i region i grad i zgradu i prostoriju - sve kategorije prostora u kome se odvija ljudski život. Individualni i društveni, sa svim njihovim manifestacijama i oblicima i sektorima društvenih delatnosti.

Opšta je karakteristika spaciuma da je on izraz i preduslov egzistencije društvene zajednice; da mu zajednica odredjuje sadržaj i svojstva; i da joj on u značajnoj meri predodredjuje uslove i način života i rada.

Celokupna privredna baza i društvena nadgradnja odražavaju se višestruko u spaciumu.Otuda isključiva osobenost spacijalnih jedinica da predstavljaju materijalizovani otisak ljudskog života, iz koga se taj život može da upozna kao praistorija iz otkrivenih fosila.

Medju svim produktima ljudskog rada spaciuma i spacialni elementi odlikuju se nekim specifičnim svojstvima.Kao najizrazitija i najopštija vidimo: funkcionalitet, spacijalne pojave i odnose u spacijumu, i proces nastajanja spacijalnih jedinica.   Definicija i utvrdjivanje zakonitosti, prema kojima se ta svojstva izražavaju, omogućiće nam da lakše ili efikasnije rešimo neke probleme, čiju suštinu nismo uspeli do sada da sagledamo.

SCOPE AND AIMS

The review is concerned with a multi-disciplinary approach to spatial, regional and urban planning and architecture, as well as with various aspects of land use, including housing, environment and related themes and topics. It attempts to contribute to better theoretical understanding of a new spatial development processes and to improve the practice in the field.

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EDITORIAL

Dear readers,

In this issue of *Spatium* we publish a number of papers from the field of: architectural constructions; sustainable tourism development; land use property rights and transportation land use; and urban planning and design of particular urban areas.

A special part of this issue comprises an article of architect Milorad Macura, who was the first director of the Institute of Architecture and Urban & Spatial Planning of Serbia as from the time when Institute became independent scientific organisation (in 1961). Otherwise, the Institute was founded in 1954 as a University of Belgrade institution, within the Faculty of Architecture.

The original article of Milorad Macura, in Serbian language, here translated into English language, was published in the professional journal *Savremene urbanističke teme*, 2-1964. Here, a photo-copied facsimile of the original article is also enclosed. The article was but one among other contributions to the *Third Congress of Urban Planners of Yugoslavia*. Now, we publish this translation on the occasion of the 60th anniversary of the Institute of Architecture and Urban & Spatial Planning of Serbia.

In the article, architect Macura addressed the theme of spatial planning and some related issues. He was among the pioneers, on the international academic scene of that time, of a multi-disciplinary academic and practical research, which he depicted as 'spatiology', to denote a general method of dealing with a number of aspects of spatial planning as an eminently social science, but also including other relevant aspects, i.e. technical, aesthetic, regional, functional, environmental, institutional, organizational, that of use of natural resources, and so on. Within this realm, he introduced a number of categories that only later became standard notions, viz., 'social production of space', 'space as a societal product', 'spatio-societal processes', 'Lebensraum', 'spatio-societal manifestations and relations', 'spatiological research', 'spatiological dialectics', 'spatiological problematic', and so on. In his usage, these and similar categories were imbued with the spirit of that time, which was, on the one hand, enthusiastic and optimistic, and at same time already carrying the early worries about negative ecological aspects of social and economic progress, on the other. Architect Macura further developed main issues of his seminal article in a number of his subsequent papers, published in the mid-1960s.

Editor-in-Chief

GLULAM BEAMS REINFORCED WITH FRP STRIPS AND THEIR APPLICATION IN ARCHITECTURE

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This paper emphasizes the advantage of using carbon polymers while producing and strengthening glulam beams. Due to advanced research carried out in this field, the first application of carbon polymers based products was implemented in Western countries. Structural elements containing carbon polymers, or being reinforced by them, show higher resistance and durability properties, as well as the ability to be produced in various shapes. These features can find best application in architecture so the architects' imagination in design could be realized. Many attractive buildings were constructed over the last decade, each of them showing exceptional safety, resistance to atmospheric influences, durability and cost-efficiency. Beside application of carbon polymers in the construction of new buildings, they are even more important in the field of historic heritage restoration. The original research carried out on ten samples in the laboratory is presented in the second part of the paper. Position of the reinforcement on the samples was chosen as it would be done in practical retrofit cases. Deformations of the samples exposed to pure bending were measured, so their behaviour in the elastic range could be analysed based on the results. Measured results were compared to those calculated by using FEM model, developed with software package AxisVM. Based on performed analysis, the conclusion was made that by strengthening timber glulam beams with FRP strips, the simple and efficient static load bearing capacity upgrade is gained.

Key words: FRP strips, glulam strengthening, architectural structures, testing samples, FEM model.

INTRODUCTION

It was in the 1960s when two new epochal products emerged in the chemical industry, which found wide use in all areas of life. Firstly there were strips consisting of carbon fibres (CFRP), and beside them, adhesive epoxy resins (ER). Originally they were used in the military industry for weapon production: fighter jets, remote-controlled aircrafts, ships, automatic weapons, bulletproof wests, etc. Furthermore, these materials found wider purpose in the car industry for the production of race car bodies, as well as safety cabins which protect the driver due to high impact resistance, even at speed of 150mi/h. It might be interesting to mention that certain products were modified in order to get more elegant and stronger ones: tennis racquets, golf clubs and fishing rods, wind power plants propellers, generator blades, strips for heavy lifting, sport protective equipment, etc. Modern composite materials production technology basically uses numerous thin fibres made of carbon polymers. This enables production of very durable materials. Solid beams, square cross-section, rectangular, circular or jagged shapes could be formed by twisting (pultration) from carbon fibres CFRP (Carbon Fibre Reinforcement Polymer) that are only 5-10 μm thick. Most often the cross-sections of the load-bearing structures are formed as composites from traditional materials (timber, steel or reinforced concrete), strengthened by carbon materials in the shape of rod, strip or panel, in the major stress zone. Content of carbon fibres in standard strips is approximately 50% of the volume, or 70% of the total mass, while the rest are fillers and epoxy resin used to connect fibres. If we compare carbon fibre strips characteristics with steel bars, with same cross-section areas, we come to see that carbon strips tensile load bearing capacity is 6 to 8 times higher, while the weight is 75 to 80% less than steel, and 30% less than aluminium.

Another product of modern technology that makes reinforcement possible is a high quality adhesive that creates a good bond between the surface of the beam that is being strengthened and composite reinforcement. This multi-component glue contains epoxy resin as the main component. Adhesive strengthening does not take much time and a good bond of high endurance to shear, so good elastic properties between the elements are quickly achieved. Bond quality is reached if the reinforced element surface is compact and if the pull-off test shows required strength.

When it comes to large span timber constructions, higher stresses in the cross-sections are being reached, which results in a need for strengthening. The first reinforcements were carried out with a steel reinforcement set in the lower section of the beams – Bohannan (1962), and Mark (1961) with aluminium reinforcement. The idea of strengthening the timber spread rapidly afterwards, especially in countries that are rich in timber. Research teams engaged in the experimental studies of the behaviour of reinforced timber structures were formed at university centres. Investigations showed issues due to separation of reinforcement, known as 'delamination' (Theakston, 1965).

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IMPLEMENTATION OF FRP PRODUCTS IN ARCHITECTURE

From the point of view of architecture, the main advantage of using FRP materials is that in conjunction with other building materials, load-bearing capacity can be increased only in points where needed, reducing the height of the structural element, and therefore the weight. These characteristics have given the opportunity to architects to express their creativity in designing and implementing them in constructing objects that were, until then, almost impossible to be realized.

Aesthetic appeal of the object is of main importance even for the large span construction elements. Composite elements fully satisfy other requirements made by modern society, such as energy efficiency of buildings, environmental impact, resistance to aggressive environment and moisture.

Architecture of constructing timber structures is improved by using composite materials, especially in those countries with great economic growth. This will be illustrated through several examples that have been realized in the last fifteen years.

The Road bridge Tynset

The bridge consists of three arches, with the largest span of 70m, in a shape of lattice girder, with two smaller glulam arches, 26.5m in span each. Total length of the bridge is 124m. It has elegant appearance despite being exposed to dynamic effects and vibration due to heavy traffic and earthquakes. Therefore the suspended road slab was made of glulam beams and reinforced concrete slabs, prestressed with steel cables.

Specific attention is paid to protect structure from moisture, and it is stabilized at 10%. In order to achieve this, elements made of impregnated pine were covered with copper along the top surface, while the road slab was protected with waterproof membrane. In addition, the bridge is cost-efficient considering building and maintenance.

Figure 1. The Tynset Bridge crossing the upper part of the river Glomma in Hedmark, Norway (2001).
Source: http//www.go-explore-trans.org/wp-content/uploads/ images/tynset_glulam_bridge.jpg

Church structures –The Cathedral in Oakland

Church objects demand special conditions when it comes to size, aesthetics and acoustics. This can be achieved by using glulam curved beams, arches and lattices. Such unique structure was built as the temple of the Holy Saints of Christ in Oakland. It was constructed from two curved glulam and steel frames forming walls. Frames are circular, intersecting with each other, forming a shape of football stadium. The inner circle is 100m in diameter, while the outer one is 103m. The structure was designed with seismic resistance to return period of 1,000 years earthquake.

Figure 2. The Cathedral of Christ the Light, in Oakland, California, USA (2008).
Source: http://upload.wikimedia.org/wikipedia/commons/ thumb/1/14/Oak_Cathdrl_1.jpg/250px-ak_Cathdrl_1.jpg

The LeMay Car Museum

The largest car museum was designed to demonstrate the love of a society which is the largest car manufacturer in the world. It was decided to use glulam not for aesthetics purposes only, but to achieve lower construction cost, due to limitations in the budget. The construction of the LeMay museum cost approx. $1,120 per m², while the typical museum cost varies between $4,500 and 9,000 per m².

When entering the exhibition hall, beside the line of sparkling classic cars, visitors can see the roof system with curved laminated beams. The frame span is 104m. It is strengthened with FRP strips in corners. In general, it is one of the biggest framed structures in the world. Fire resistance of this structure is 1 hour, and it also meets the specific requirements set forth by the National Earthquake Hazards Reduction Program. The roof cover, which is curved at the corners with a radius of 17m, is very impressive. It consists of shiny metal sheets, like aero-dynamic surface of a car. The structure offers a distinct sense of grandeur and aesthetic perfection of vast space.

Figure 3. The LeMay Car Museum in the city of Tahoma, USA (2012).
Source: http://www.tripadvisor.com/Attraction_Review-g58775-d3203900-Reviews-LeMay_America_s_Car_Museum-Tacoma_Washington.html, or http://media-cdn.tripadvisor.com:/media/photo-t/02/88/27/bb/lemay-museum-at-marymount.jpg

Nowadays, other composite materials such as: self-compacting concrete for filling precast joints (Okrajnov-Bajić, 2009), and fiberglass waterproof cloth membranes for covering domes (Vavan-Vučeljić, 2009, Nenadović, 2010) are being used for raising this type of objects.

FRP strengthening methods for existing buildings

In comparison to above mentioned buildings, there is much larger number of existing objects in need of static strengthening, due to changes in function. This occurs in cases when new, additional load is to be applied to the girder, when it needs to be transferred to another static system, or if the existing system is deformed, and needs to be retrofitted. The procedure of reinforcing glulam elements is very simple and gives excellent results shortly. It can be applied successfully when repairing timber elements in old buildings representing protected historic monuments, or in the buildings with changed room function. Strengthening of domes, towers, chimneys and silos is performed in a similar manner, by circular wrapping with FRP strips, so critical stress zones are covered.

FRP is perfectly flexible material which can be adjusted to a circular shape, fits well to the surface and the ring can be accomplished by overlapping the ends over each other. Reinforcement has a primary role in stiffening spatial structure by accepting unintended horizontal shear forces which may occur unexpectedly during earthquakes. The technique of strengthening with carbon FRP strips enables constructing buildings resistant to seismic impacts or restoring buildings damaged by the earthquake. Considered cases of strengthening structures have justified application when upgrading the building and strengthening protected cultural monuments. Due to high demands that must be met in the

strengthening approach, quality testing of the materials from which the element was made is recommended, as well as assessment of its condition. Based on these results, it is possible to make the best choice for retrofit project. For these purposes, it is recommended to develop numerical model for analysing limit stress state in the model.

Carbon fibres are durable and do not lose their mechanical properties over time. Their exploitation period is more than 50 years. However, despite the time resistance, it is necessary to check their load bearing capacity periodically and, if necessary, renew protection or replace them.

Having high compressive strength, being lightweight and resistant to corrosion, it can be concluded that, when it comes to strengthening elements, FRP strips are superior to high-performance steel intended for prestressing concrete.

PROPERTIES OF REINFORCED GLULAM BEAMS

Additional important glulam beam properties will be highlighted in this part of the paper. When comparing the strengths of wooden beams, it can be noticed that solid timber has lowest strength due to inhomogeneity of the material or due to orientation of the fibres in single direction only (Figure 4). When it comes to glulam elements, timber fibres are arranged in layers in the same direction, so the beam has greater strength. If such beam is strengthened with FRP strips, even larger strength is achieved.

It is important to notice that solid timber beams show largest dispersion of results, due to greater possibility of occurrence of defects in the material. These faults are leading to the fracture.
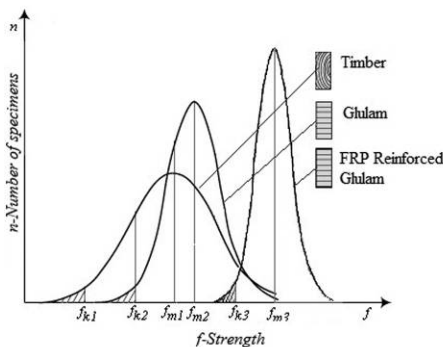
Figure 4. Average compressive strength in the cross-section of the timber beam).
Source: Jobin and Garzon-Barragán (2007)

When it comes to choosing strengthening reinforcement we can make a comparison of all known materials with the same cross-section surface areas, using operating stress/strain diagrams. Carbon fibres have highest strength and stiffness of all fibres used in structural and homogenous strengthening materials. Carbon FRP strips are divided into several categories based on the modulus of elasticity.

Environmental impact is of great importance in the selection of suitable materials for construction process, as well.

In this respect the glulam beam is biodegradable with the possibility of being recycled, i.e. production of glulam beams requires about two times more energy than the energy needed for production of the solid timber beams. FRP strips are also made of material that can be recycled.

Fire resistance is significantly better when compared to steel, since timber conducts heat 300-400 times slower than steel. Timber element exposed to fire creates a carbonaceous layer on the surface, so the heat transfers to the inner parts of the cross section at a speed of 0.6 to 1.1mm/min. At such temperatures beam does not deform, does not apply additional pressure on the supports and does not collapse (Kuzman, 2010).

In recent years, experiments were carried out on sample beams exposed to gas flame at 800°C. After being exposed to fire, samples reinforced with FRP strips retained their form and load bearing capacity as opposed to the non-reinforced samples that have undergone major changes. It is believed that strengthened surfaces of the beams suffered less because of the FRP strips blocking the flow of oxygen to the timber. This means that FRP strengthened glulam beams can withstand the fire for 1 hour, which is long enough to evacuate the people from the building in case of fire emergency (Ogawa, 2000).

The energy efficiency of timber and carbon is reflected in the fact that they are both good heat and sound insulators. Even though a large amount of carbon-dioxide is being released in the process of burning these materials, this harmful gas is absorbed by increasing the forest areas. For this reason, afforestation is important for environmental preservation. Production and processing of timber creates the conditions for increasing its use in buildings construction. Such goal can be achieved by developing a National plan for the conservation of wood resources and the environment in the upcoming century, like the one being implemented in Japan (Ogawa, 2000).

From ecological point of view, as a housing space consumer one must follow bio-climatic principles and have a responsible approach towards the environment he is part of. Keeping this in mind he should tend to choosing transparent facades as well as natural and simple materials, in order to achieve the effect of presence of surrounding inside of the object (Kosorić, 2011, Bajić, 2011).

LABORATORY STUDIES

The first study which will be presented in this paper began in 2006. FRP reinforcement strips were applied to laminated wooden beams, which were later experimentally tested (Solarov *et al.* 2011). The aim of the research was to study the behaviour of glulam timber beams-samples exposed to short-term bending load. Based on the measured values of deflection and strain at characteristic points of the samples, the effect of reinforcement can be analysed, comparing the deformation of the non-reinforced and reinforced samples. Along with the laboratory testing, calculation of impact on numerical model was carried out as well.

Previous examinations

These tests were conducted in order to determine the actual mechanical properties of the materials that can be used for the development of computational models, and the selection of equipment for loading and measuring deformations on the samples. For this purpose, several preliminary tests were conducted in order to collect data:

The *first testing* showed whether it was possible to strengthen glulam elements with FRP strips. They transmit large forces, so it is necessary for timber surface to be resistant to tension (pulling). 'Pull off' method was used for this purpose. Three measurements were made with this equipment. Each measurement gave results that were higher than the min. values for the substrate of 1.5 N/mm^2. This way, it was concluded that the surface was able to undertake strengthening.

The second test was related to the determination of the quality of the adhesive connecting the timber slats, or to determination of shear forces that can be accommodated by the compound. The tests were carried out on three samples composed of glued lamellas. The procedure was performed by the device for applying vertical forces, and fracture in all cases occurred at a wooden lamella at forces between 24.40 and 25.0kN.

The third test was performed in order to

determine the quality of adhesives used for bonding FRP strips and timber lamellas. FRP strip was glued between two timber lamellas with epoxy glue Sikadur-30. The load was applied gradually using the same device as in the previous experiment; however, the fracture appeared in the timber earlier at a force of 11.5kN. This confirmed the good bond quality, but also a FRP strip feature that shows it receives considerable pressure when applied to the timber surface (due to the small scale samples, buckling could not be reached).

The fourth testing aimed to determine the modulus of elasticity of timber lamellas. Two timber samples in the form of a simple beam were subjected to bending. Modulus of elasticity of 16,748 N/mm^2, which is significantly higher than the value given by EN-1194 for wood GL-24 class, which is 11,000 N/mm^2, was experimentally determined.

Other tests results were taken from the manufacturer, FRP strips and timber imported from Austria.

Testing samples

To obtain as reliable data as possible while testing, it is necessary to take as many samples as possible in order to get the results which could be analysed using statistical methods (Figure 4). For the research purposes, 10 beams were made and divided in three groups of which one beam was unstrengthened, and the rest were strengthened with various amounts of reinforcement in different spots. Positions of the reinforcement were carefully chosen to closely

represent practical cases preformed in rehabilitation of structures. In Figure 5 dimensions of cross sections for every group of samples are given, and in addition, the position, type and length of reinforcement.

The choice of the beams length and cross sections was made according to the manufacturers recommendations related to the testing of timber beams, where there is no need for taking the stress corrections. Series 1 consist of 4 samples, series 2 is lower for the height of one lamella and consists of three samples, while the samples from the series 3 are almost the same height as the samples from the series one, and consists of three samples. Every sample has one unstrengthened sample.

Deflection measuring instruments were placed in the middle of the span (largest deformation), at supports and at the points where the pressure was applied (Figure 6). The measurements at supports were important, since the deflections occurred due to crushing of timber, which affected the deflection in the middle of the span. Additional tensometers were used during the experiment for control measurements. Strain gauges were used for measuring dilatations by electric reading in the middle of the span on the top and bottom lamellas.

The aim of the experiment was not to cause the fracture in the beams, but to monitor the behaviour of the specimens in elastic and plastic deformation range. After the measurement, the zero reading was performed as well as the control of residual deformation.

Research results analysis

Samples were exposed to bending in a way that the load was applied in several steps. For the future analysis only one representative measuring is given. In order to show results, deflections in the middle of the specimen from the series 1 are given in Figure 7. It can be seen from the graph that behaviour of every sample was liner up to the point when load bearing capacity reached 2x24(48)kN. After reaching this point deformations grew faster. The same behaviour can be noticed for series 3, while the series 2 (cross section with less height) reaches the critical load at 2x22.5(45)kN.
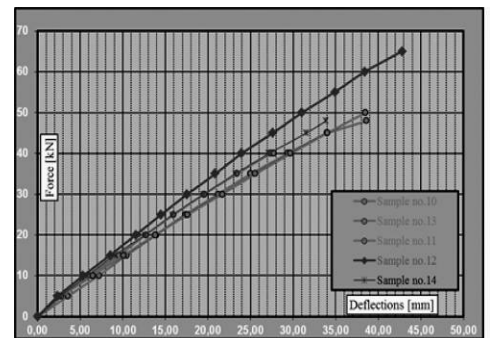
Figure 7. Deflections measured at mid-span for five samples of series 1

Using these observations two characteristic zones in which the sample can be found can be distinguished:

Zone I, linear elastic behaviour between deflection and load, so only the behaviour of the specimen for the load level of 2x10(20) kN and 2x20(40) kN will be taken for further analysis

Zone II, non-linear behaviour between deflection and load – the zone of unpredictable specimen behaviour for the higher load level:

− Series 1, the deformation of the sample was manifested in the form of irregular crushing of timber fibres on the surface (more than 3mm), where the load was applied at supports as well, which caused section warping and rotation of the entire sample,

− Series 2, deformation of the unstrengthened specimen no. 20 led to vertical fracture in the middle of the range, while in case of strengthened specimen no 22, the fracture appeared in the timber under the strengthened lamella, Figures 8 and 9, and

− Series 3, the deformation appeared in the strengthened sample no 31, as a fracture, but in the spot where the strengthening was ending.
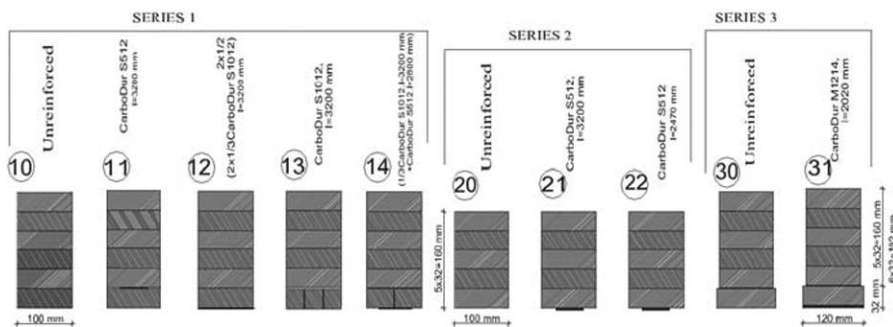
Figure 5. Cross sections of 10 sample beams grouped in three series
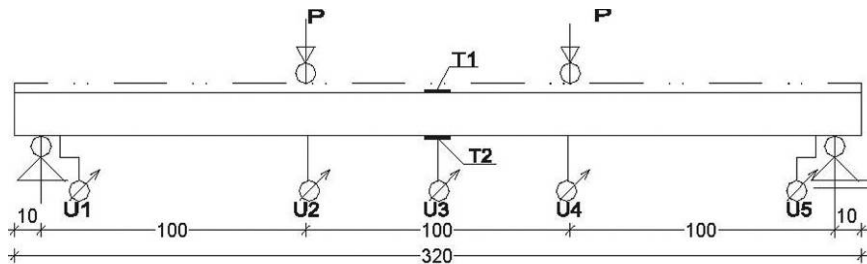
Figure 6. Testing subject with positions of measuring instruments (measures are given in cm)

Figure 8. Cracking and crushing of timber fibres in the sample no. 22

Figure 9. Broken sample no. 22

Numerical model

3D numerical beam model was developed in the AxisVM ® software package based on the finite element method. It supports important features for modelling transient and boundary conditions using the links for two types of elements (lamella-lamella and lamella-carbon, 'link' finite element), and for beams using a shell ('Shell' finite element). The bond between the wooden lamellas was accomplished with the glue for wood, while the connection of lamellas and FRP strips was formed with two-component epoxy adhesive. Used 'Shell' finite elements have three translational degrees of freedom and three rotational degrees of freedom in the finite element node. The final element in the node comprises stress state caused by axial force, bending and shear. To define the parameters determining final elements, the input data of mechanical properties of the material were used (class of laminated wood, the data from the FRP strips and epoxy adhesives testing), cross section geometry and beam-model span obtained by previous research (Section on previous examination). To be precise, these technical characteristics are as follows:

− for timber: $Ex=11,000kN/cm^2$ or $Ex=16,748$, $Ey=37kN/cm^2$, (Ex-modulus of elasticity for timber parallel to wood fibres, Ey- modulus of elasticity for timber perpendicular to wood fibres), $v=0.21$(Poisson ratio), $\alpha_t=8x10^{-6}1/°C$ (thermal expansion ratio), $\rho=420kg/m^3$ (timber mass) and $d=32mm$ (timber lamella thickness),

− for FRP strip, type S: $Ex=16,500kN/cm^2$, $Ey=16,500kN/cm^2$, $v=0$, $\alpha_t=4x10^{-7}1/°C$, $\rho=1,800kg/m^3$ and $d_s=1.2mm$ and

− for FRP strip, type M: $Ex=21,000kN/cm^2$, $Ey=21,000kN/cm^2$, $v=0$, $\alpha_t=4x10^{-7}1/°C$, $\rho=1,800kg/m^3$ and $d_M=1.4mm$.

In order to achieve greater accuracy sections were divided into final elements, 10cm in length, which define positions of the load and strengthening FRP strips length. The bond between lamella and FRP strips was made
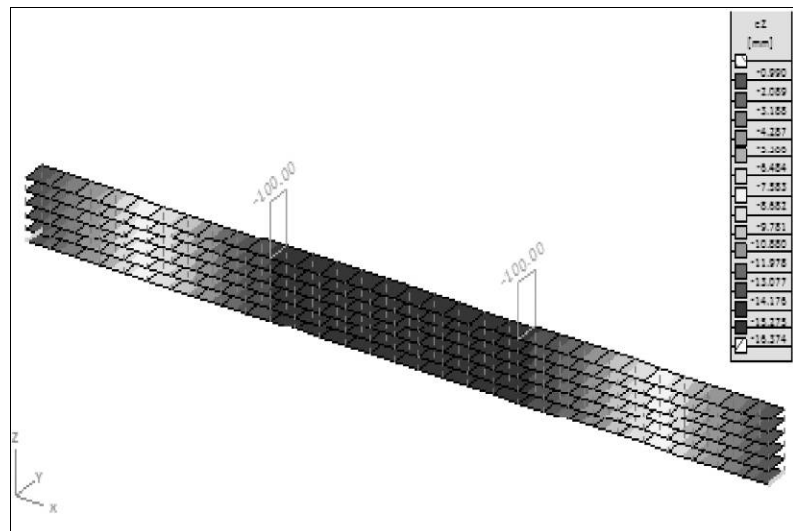
Figure 10. 3D deflection surface for the model no. 10

through translational and rotational stiffness, which was 107kN/m and 107kNm/rad, for the supports stiffness of 105kN/m/m.

As a result of the 3D model calculations, a wired model with iso-surfaces in various modes was obtained. State of deflection of the specimen no. 10 is presented in the Figure 10. Similar iso-surfaces were obtained for tensile and compression stress states for this and other specimens.

Analysis of measured and calculated results

Data for deflexion and normal stresses in the top and bottom lamellas of the beams, in timber as well as in reinforcement, are taken for comparison of numerical and measured values. The differences in results are obtained from experimental testing and numerical model. In all cases the measured deflections are lower than the computational, as well as stresses. Deflections analysis points out small differences between measured and calculated deflections, which would almost overlap perfectly if presented by curves.

Numerical analysis of the model was performed with the two modulus of elasticity, $E = 11,000N/mm^2$ modulus of elasticity (provided by the EN 1194 for glulam GL24h), and $E=16,748N/mm^2$ modulus of elasticity, obtained by examining the structure in this study.

If measured values are compared to numerical ones, for the first value of modulus of elasticity, it can be noticed that computational deflections are 26-58% higher than measured. The similar situation is with computational tension in timber which is 20-37% higher than measured. Computational tension in carbon is 0-46% higher, while this ratio for the pressure in timber varies between 26-63%. Comparing measured with computational values, for real modulus of elasticity, these variations are getting lower. Computational deflections values are higher by 3-12%, tension stresses in timber are higher by 0-46%, while pressure stress is larger by 0-13%. The conclusion can be derived from the analysis that the numerical model is reliable and safe, so it can be used for static analysis for beams retrofit.

CONCLUSION

Numerous advantages of using carbon FRP strips for strengthening glulam beams were listed in the paper. Certain conclusions necessary for implementation of this system in retrofit of new and existing structures were derived from research on specimens and computational models. Contribution to strengthening of timber glulam beams by using FRP strips enhancing tensile strength up to 40-60% (Johnsson, 2006) was stated in cited papers. In this research, following conclusions were obtained from laboratory testings:

– Comparing the non-reinforced specimens with the reinforced ones, deflections are reduced by about 20%, stresses by 25% and flexural stiffness is increased by 24%.

– Horizontal reinforcement is better than vertical, since it gives smaller deflections and stresses and enables great rigidity.

– The best position for the reinforcement is below lowest lamella.

– Full contribution of the reinforcement is obtained when FRP strip is extended over the supports, along the entire span of the beam, because it receives bending and shear forces, and at the same time prevents torsion.

– Deflections and stresses decrease when reinforcement surface increases.

– Measured values for deflections and stresses are lower than results obtained from numerical models.

– Strengthening with FRP strips with higher modulus of elasticity enables greater capacity.

– Increasing loads leads to reaching critical value of stresses in the cross section of the beam, and finally to fracture of the element, defined as failure. Failure of each element occurred in tensioned zone of the timber.

Based on these observations it can be said that FRP strip reinforcement applied on timber beams improves load bearing capacity, and is dependent on parameters that were modified in this study: position, length and surface of reinforcement.

In order to obtain high-quality reinforcement of glued laminated beams it is necessary to proceed with further research in this area. It might be interesting to direct further research onto behaviour of timber glulam beams exposed to permanent load (load being applied for longer than three years), since it is known that timber's load bearing capacity reduces by up to 40%, and FRP strips have minimal extension. Frame and arch structures are interesting for testing as well. Further studies in this field should be focused on the zone of unpredictable behaviour of the beam with rotation and warping of the cross section appearing. This phenomenon could be prevented by placing pads of various sizes on load application spots and inserting side supports – stiffeners in various places.

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LAND USE TRANSPORT INTERACTION MODELS:

APPLICATION PERSPECTIVES

FOR THE CITY OF THESSALONIKI

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Land use patterns and transport system are considered to be the two basic components of the urban development process, and as such they have been in the core of spatial planning policies for the last 4 decades. Land use transport interaction models are computer tools that could help us understand land use changes and organization of human activities in relation to existing or planned transport infrastructure. In this context this paper examines the perspectives of applying a land use transport interaction model for the city of Thessaloniki. Obtaining, preparing and validating socioeconomic data is a crucial part of the modeling process, therefore an extensive search of the required data was performed. The quest for appropriate and suitable data concluded with a detailed recording of emerged problems. In response to the inability of finding suitable data to perform the first step of the modeling process i.e. calibration, the paper concludes with some thoughts related to data availability, organization and standardization issues. Last but not least, the paper stresses out the significance of data availability for utilization of land use transport models, so as not to remain purely academic products but tools with practical value in planning.

Key words: Land use transport interaction models, urban models, calibration, Thessaloniki.

INTRODUCTION

Land use patterns and transport system are considered to be the two basic components of urban development process, and as such they have been in the core of spatial planning policies for the last 4 decades. Therefore, urban form and land use structure were important determinants of the quality of urban space through respective urban and regional planning policies. Furthermore, in more recent years, finding the optimal spatial organization of urban functions in conjunction with a balanced transport system was the necessary condition for sustainable urban development and mobility in modern cities.

Land use transport interaction models (LUTIM) are computer tools that could help us understand land use changes, establishment of new spatial patterns and organization of human activities, in relation to existing or planned transport system. The issue of the interrelationship between land uses and the transport system has been extensively discussed in the relevant Greek literature but mainly on the basis of its qualitative dimension (like in articles of: Pitsiava *et al.* (2013), Pitsiava & Kafkalas (2010), Basbas *et al.* (2012) and Pyrgidis *et al.* (2013)), while the quantitative dimension, as expressed through the use of LUTIM, has been neglected. Thus, although in Greece in the last thirty years there have been designed and implemented significant transport infrastructure projects (i.e. Athens Metro System, Thessaloniki Metro System, Attiki Odos in Athens, Outer Ring Road in Thessaloniki etc.), the use of such models in practice is non-existent.

In contrast, in many European countries and the US the use of LUTIM is a prerequisite to long-term and medium-term strategic plans for sustainable urban development. Relative international bibliography refers in great detail to the use and utility of LUTIM, as tools for evaluating the impacts of urban development policies (US EPA, 2000 and Spiekermann &Wegener, 2004). Actually, in the USA it was the passage of two US federal policies in the early 1990s (Clean Air Act and Intermodal Surface Transportation Act) that brought LUTIM from academic circles to planning practice.

In Europe the issue of understanding and designing a sustainable urban transport and land use system was prevalent in the research agenda since early 1980s. Relevant reports by the European Conference of Ministers of Transport (ECMT 1995, 2002 & 2006) highlight not only the importance of developing integrated land use and transport policies, but also the importance of high quality implementation schemes and the need to gain public confidence and acceptability to support these policies. In this framework several research programs were initiated (i.e. EC Policies for Land Use and Transport for Increasing Urban Sustainability – PROPOLIS) to identify key elements for sustainable urban transport policies (Lautso *et al.*, 2004), and to create decision support tools in an effort to gain public acceptability and to engage actively key stakeholders into the planning process (Banister, 2000, Banister, 2008). Today, LUTI models are

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considered to be an essential part of urban transport policies and practices, mainly through the development of strategic plans for multimodal urban transport system, such as the Sustainable Urban Transport Plans – SUTPs (EC 2005, 2007), and the Sustainable Urban Mobility Plans – SUMPs (EC, 2014). Both SUTPs and SUMPs combine multi-disciplinary planning, policy analysis and decision making, where LUTI models are incorporated as tools for developing alternative scenarios and helping involved stakeholders to understand better the effects of the measures and policies discussed in the relevant plans (Bührmann *et al.*, 2011).

In this context, the paper examines the perspectives of applying a LUTIM for the city of Thessaloniki. The paper starts with the definition of LUTIMs and describes their usability and functionality within the planning context. It continuous with the description of TELUM – Transportation Economic Land Use System, a LUTIM widely applied in the USA, and focuses on recording its data requirements. Following there is an attempt to collect the data necessary for the city of Thessaloniki, in order to perform the first stage of the modeling process, model calibration. The paper concludes with a description of the problems emerged during the process of data acquisition and stresses out the significance of data availability in the use of LUTIM or any urban model for that matter[2].

LAND USE TRANSPORT INTERACTION MODELS

Urban models and more specifically LUTIM were the way in which planners began to use the capabilities of personal computers, a tool to process large volumes of spatial data quickly, reliably, and accurately. The first generation of ITLUM occurred in the 1950s in North America, where rapid economic growth and the need for systematic study of interactions between land uses and the transport system set the conditions for creation and exploitation of the first urban models (Brail and Klosterman, 2001).

Land use transport interaction models are a class of urban models that focus primarily on population and employment location preferences in urban space, taking into account spatial interactions between different locations
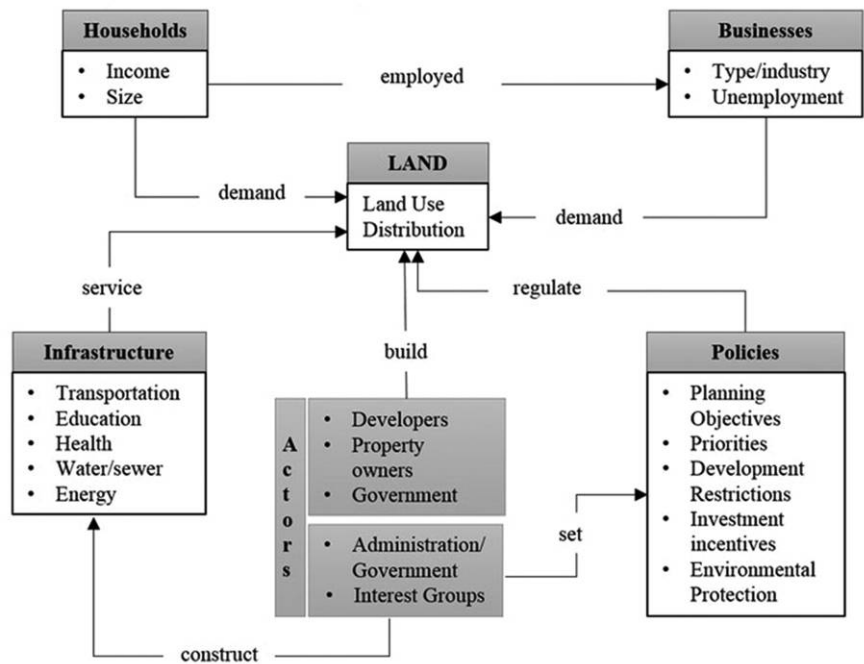
Figure 1. Interactions in a typical LUTI model

of these activities, and in relation to the transport system. Several LUTIMs have been developed, but regardless of their underlying theoretical background, their main objective is to simulate the behavior and interactions of factors and parameters that shape space, and translate their effects in a systematic way using algorithms. In this way it is possible to extrapolate the behavior of these parameters in the future, taking into account alternative development scenarios such as population growth, new infrastructure, environmental constraints, restrictions on construction, etc.

Figure 1 illustrates, in an abstract way, a typical LUTIM. The diagram represents interactions between three key players: households, businesses and government. The purpose of the diagram is not to depict in an exhaustive way the processes and interactions that might take place in such a model, but to provide a framework within which the reader can understand the process of simulation, the impacts and interdependencies for each one of these three factors.

TELUM - TRANSPORTATION ECONOMIC AND LAND USE MODEL

There are several integrated land use transport interaction models that have been applied and a few are publicly available. Current research focuses on the application of TELUM, one of the most popular LUTIMs applied in the US that is made freely available by the US Federal Highway Administration. TELUM – Transportation

Economic and Land Use Model, is a land use simulation model that can be used as a forecasting and policy analysis tool. Development of TELUM, which is part of a larger decision support system, was initiated and funded by the Federal Highway Administration (US Department of Transportation), with Rutgers University and the North Jersey Planning Authority being responsible for designing and developing the system. Funding started in 1998 with $1 million per year, over six years period. In 2005 new funding was approved focusing on the implementation and widespread adoption of the system. Today the system is copyrighted and every metropolitan planning organization is eligible to use TELUM at no cost.

TELUM is an integrated interactive system that can be used to assist in evaluating the effects of a region's planned transportation projects. It may also be used to make long term forecasts of a region's spatial patterns. It uses current and prior residential, employment, and land use data to forecast future locations of each of those by employment sector, household income group, and land use type. The interrelationships between transportation and land use can be just as important, and in some cases more important, than the individual direct consequences of either. Having articulated a framework for examining, analyzing, or understanding transportation and land use interactions, it then becomes possible to consider the consequences of a wide assortment of different kinds of policies. This includes policies that attempt to achieve their

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aims by changes on the demand side, in terms of urban planning and land use control, as well as those that attempt to achieve their aims by acting on the supply side in terms of various kinds of transportation improvement. These transportation improvements can be for highways, transit or combinations thereof, as well as in increases in utilization efficiency of existing facilities (Putman, 2005).

Model Description and Data Requirements

TELUM evolved from Putman's earlier work (Putman, 2010) and is designed to project the location of new residential and nonresidential development based upon analysis of (1) prior and existing residential and nonresidential development, (2) the location of transportation improvement(s), and (3) overall congestion in the system. TELUM forecasts the location and amount of household and employment growth for up to 30 years, information needed by an external travel demand forecasting model to estimate network flows and subsequent congestion induced changes in travel times.

Basic parts of TELUM are TELUM-RES and TELUM-EMP, a residential and an employment location model embedded with other auxiliary modules in one system. Figure 2 portrays the interrelationships between models, sub-models and their computational utilities. It also outlines the modeling process in TELUM. The chart itself is quite self-explanatory. The modeling process starts with acquiring and compiling the necessary data. It continues with calibrating the model parameters for both TELUM-EMP and TELUM-RES. TELUM-CALIB, the computational utility that performs the calibration process, uses a modified gradient search technique to calculate TELUM-RES and TELUM-EMP parameters, or coefficients, that produce the best fit for the model equations to region's data. These parameters also assure the accuracy of forecasts into future time periods. Modeling process continues with forecasting employment and household growth and calculation of the associated land demand. Based on this land demand, TELUM-LANCON estimates the change in the amount of land (per zone and locator type). If we would like to make any changes in the forecasts produced by the model, i.e. incorporate local knowledge into the system, this can be done by adjusting the attractiveness of land (TELUM-ATRMOD-attractiveness modification utility). Following is a brief description of the two most basic parts of TELUM, the employment and household allocation models, in order for the reader to understand the complexity that these models entail.
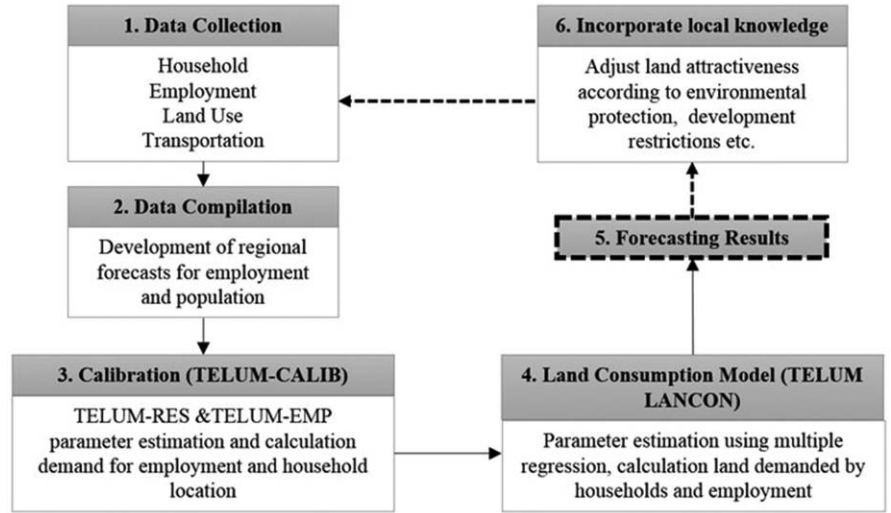
Figure 2. The modelling process in TELUM

A. TELUM-EMP-The Employment Location Model

TELUM-EMP is a modified version of the standard singly-constrained spatial interaction model. There are three modifications: 1) a multivariate, multiparametric attractiveness function is used, 2) a separate, weighted, lagged variable is included outside the spatial interaction formulation, and 3) a constraint procedure is included in the model, allowing zone and/or sector specific constraints (Putman, 1992).

TELUM-EMP model normally uses 4-8 employment sectors. Parameters λ, α, β, a and b of the equation are estimated individually for each one of the employment types through the calibration process. The equation structure used for TELUM-EMP is as follows:

$$E_{j,t}^k = \lambda^k \sum_i P_{i,t-1} A_{i,t-1}^k W_{j,t-1}^k c_{i,j,t}^{a^k} \exp(\beta^k c_{i,j,t})$$
$$+ (1 - \lambda^k) E_{j,t-1}^k \quad (1)$$

where

$$W_{j,t-1}^k = \left(E_{j,t-1}^k\right)^{a^k} L_j^{b^k} \quad (2)$$

and

$$A_{i,t-1}^k = \left[\sum_l \left(E_{l,t-1}^k\right)^{a^k} L_l^{b^k} c_{i,l,t}^{a^k} \exp(\beta^k c_{i,l,t})\right]^{-1} \quad (3)$$

where

$E_{j,t-1}^k$ = employment (place of work) of type k in zone j at time t-1

$E_{j,t}^k$ = employment (place of work) of type k in zone j at time t

L_j = total area of zone j

$c_{i,j,t}$ = impedance (travel time or cost) between zones i and j and time t

$P_{i,t-1}$ = total number of households in zone l at time t-1

$\lambda^k, a^k,$
b^k, β = empirically derived parameters

B. TELUM-RES - The Residential Location Model

TELUM-RES is also a modified version of a singly-constrained spatial interaction model. There are two major modifications: 1) a multivariate, multiparametric attractiveness function is used, 2) a consistent balanced constraint procedure is included in the model, allowing zone and/or sector specific constraints. The model normally uses 3-5 (current maximum is 8) household categories whose parameters are individually estimated (Putman, 1992 and Putman, 2010)[3]. The equation structure is as follows:

$$N_i^n = \sum_j Q_j^n B_j^n W_j^n c_{i,j}^{a^n} \quad (4)$$

where

$$Q_j^n = \sum_k a_{k,n} E_j^k \quad (5)$$

and

$$B_j^n = \left[\sum_j W_i^n c_{i,j}^{a^n}\right]^{-1} \quad (6)$$

and

$$W_i^n = (L_i)^{q^n} (x_i)^{r^n} (L_i^r)^{s^n} \prod_{n'} \left(1 + \frac{N_i^{n'}}{\sum_n N_i^n}\right)^{b_{n'}^n} \quad (7)$$

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[3] A more detailed description of models' structure is available in related scientific texts (Putman, 2010, 2005, 1992)

where

E_j^k = employment of type k (place of work) in zone j

N_i^n = households of type n residing in zone i

L_i^v = vacant developable land in zone i

x_i = 1.0 plus the percentage of developable land already developed in zone i

L_i^r = residential land in zone i

$a_{k,n}$ = regional coefficient of type n households per type k employee

$c_{i,j}$ = impedance (travel time or cost) between zones i and j

q^n, α^n, r^n = empirically derived parameters
$s^n, b_{n}^n,$

TELUM-RES is also capable of including additional attractiveness variables in the spatial potential term Wi, but there has been little use of this option in practice because such variables require the subsequent development of a means for their updating in forecast runs of the model.

TELUM data requirements

The success of every forecasting or analysis project is critically dependent upon the quality of its data inputs. In general, the more comprehensive and complex the proposed forecasting method is, the more extensive and expensive the required input data is.

Data requirements for TELUM can be grouped in categories depending on the different level of spatial, sectoral, and temporal detail required. It is important to distinguish between the information needed in regard to the overall modeling *region*, and the *zone-specific* information that is necessary for detailed spatial representation and analysis. *Region*, as used in TELUM, represents the total geographic area modeled. This area is defined by the researcher or agency depending on the modeling purposes. Following is a description of data requirements for TELUM along three basic dimensions for the modeling process: the geographic, the temporal and the activity/sectoral dimension.

Geographic Dimension: The level of geographic detail used in the model depends on the requirements and limitations of models employed. Also one should be aware that the greater the degree of the geographic detail (i.e.

the smaller the individual zones or analysis areas), the greater the cost of obtaining the data, the greater the required complexity of the model, and, inevitably, the lower the statistical reliability of the forecasts.

Prior applications of TELUM in the USA (Putman, 2010, Pozoukidou, 2014) have shown that the use of the US Bureau census tracts and more often aggregations of few tracts has been a satisfactory geographical level of analysis. It should be noted that most of the time analysis zones tend to be 'smaller' when they are located closer to the core of the area being modeled and progressively larger as moving away from the core. Apart from selecting the appropriate analysis zones, a quite trivial issue is defining the limits of the study area or the region modeled. There is no rigid definition imposed by the model, and a general rule would be to define the regional boundary were the amount of economic, social and other spatial interactions diminishes. Since most of the time it is not possible to define this boundary with accuracy, it is suggested that external zones are added in order to encompass the interactions outside the defined analysis zones.

Temporal Dimension: For the purpose of calibration TELUM needs data in two different time periods. The ideal would be to have base data in reference to a census year while the lag time point would be five years earlier. As far as forecasting, TELUM calculates forecasts in five-year increments i.e. if we set the current year in 2010 then forecasts will be five years beyond, starting from 2015, 2020 etc. Five-year increment is considered to be a safe choice for both calibration and forecasting, since there is little chance that sufficient data will become available in the near future to enable the use of shorter time periods. On the other hand, using larger time increments i.e. ten-year, can cause several problems. The most significant one is that too much can take place in ten years, meaning the interactions between locator types, as well as between activities and the transport system, won't be depicted in the data. However, data availability is the factor that determines the time frame of the data used, which sometimes might be less than the ideal data set.

Sectoral Dimension: TELUM models the behavior of several locator types, which can be up to eight employment and eight household types. The precise number of different locators depends on both data availability and the intended use of the model outputs. The differences in location behavior are determined from statistical analyses of the base year data for the specific region, to which the models are being applied.

Another type of data needed for calibration and forecasting purposes is transportation data. A 'description' of the transport system, which may include highway as well as transit, is taken from exogenous sources. These would be outputs of a transportation model that will provide a zone-to-zone travel time and travel cost on various modes that a user might experience. Based on the number of travel cost, as well as on the base year data regarding the initial locations of employment and households, and on a set of regional forecasts of total employment and total households, a calculation can be made that will estimate their location in the zones of the region. Often, a whole series of such forecasts will be made, at five or ten-year intervals from some base year, out to some long-term planning horizon (Putman, 2005).

Calibration Data Requirements

Model calibration is the first step of the modeling process and has to do with fitting TELUM-RES and TELUM-EMP models into the real world. This is achieved by estimating the parameters for each locator type (i.e. high income households, manufacture etc.), that will be used in models' equation. These parameters will be the ones that best fit the structure of the dataset used and will minimize the discrepancies between model results and real data. Calibration process used by TELUM CALIB module is based on the maximization of the likelihood function and employs a gradient search method (Putman, 2005).

Accuracy of the data used in the calibration process is extremely crucial, since it predefines the accuracy of the subsequent forecasting results. To perform calibration for TELUM-EMP it is necessary to have employment data by employment type and by zone for two time points five years apart. It is common practice to set a typical census year as 'current' time, such as 2011 (for Greece), and a 'lag' time point five years earlier, i.e. 2006. It should be noted that the employment data is the only data required in two time points.

For TELUM-RES it is necessary to have population data for one time point that will match TELUM-EMP 'current year'. Population data are usually households by type (4 to 8 categories of household types i.e. by income category) for each analysis zone, derived most of the times from the decennial population census. TELUM-RES allows the use of lagged household variables, which require household data for a prior time period, normally five years earlier. The use of lag household data significantly increases the accuracy of the calibration results.

Regarding land use data, it is considered to be

the most difficult data to obtain. A data set of different land use categories for each zone in 'current year' is required. The categories are shown below:

- Total zonal area
- Residential area (by household type)
- Commercial area (used for commercial and third sector employment)
- Industrial area
- Unusable area (e.g. water, environmentally sensitive lands, land with developmental constraints)
- Vacant developable area.

Despite the fact that it seems quite straightforward what type of land uses these categories may contain, questions often arise in determining where to place certain categories that may have been defined differently in the original data. Most of the time problems tend to arise in determining what constitutes vacant usable or developable land area. TELUM treats this category as developable land, or land that can be used for residential, industrial, or commercial purposes. How agricultural land, parkland, streets and highways, and wetlands are to be treated is a matter for decision by the user of the model.

APPLICATION OF TELUM IN THESSALONIKI, GREECE

Study Area Profile

Thessaloniki is the second largest city in Greece (after Athens), and one of the largest urban centers in the Balkans area. Since the early 1980s the greater area of Thessaloniki experienced tremendous changes in terms of its morphological and functional organization. Key features in these developments were urban expansion and the formation of a 'new city' that lacked defined boundaries and dominant center(s). New high speed highways (in conjunction with no investments in public transit), shopping centers, R&D facilities and companies' headquarters seem to be scattered in the peri-urban area. Suburban housing became accessible and affordable to middle and low income classes, increasing suburban housing demand and therefore becoming the main form of residential development.

Population distribution of the study area over the last 40 years comes to confirm all of the above, since the compact urban area of Thessaloniki the 'Urban Agglomeration of Thessaloniki-UATh', lost population to its surroundings (Map 1). More specifically during 1991-2001, UATh experienced only a 7% increase in population

numbers, a percentage that was not even close to the increase that the greater area of Thessaloniki experienced (32%). Dispersion of population to the outskirts of the compact center became even more obvious in the next decade (2001-2011) when UATh showed, for the first time in its urban history, a 2% decrease, while its peri-urban area (GATh) experienced a 23% increase (Yiannakou, 2012).

Data availability and acquisition

The most challenging issue in applying a LUTIM is acquiring the appropriate data. Data required for TELUM and for the purposes of calibrating the model(s), is presented above. The first issue that had to be addressed was the spatial analysis unit. When dealing with socio-economic data it is common that spatial unit of analysis is the census tract level (or its disaggregation), as defined by the Hellenic Census Bureau. The use of census tract as spatial analysis unit has many advantages, including the greater flexibility in defining the boundaries of our study area and the fact that we can work with actual (and not estimated) data recorded every decade (1991, 2001, 2011, etc.).

Despite the fact that census tracts might be the best spatial analysis unit, it was imperative to take into account the spatial unit for which transportation data was collected and which is available to us. It has been mentioned that in the process of modeling and mostly during forecasting procedure, it is required to have a computation of zone-to-zone travel time and travel cost on various modes. A relative search in regard to transportation data availability showed that for our study area there has been only one transportation study (TS) that was conducted back in 1997. The study defined 316 transportation analysis zones (TAZ), that most of the times were disaggregation of the corresponding census tracts. Map 2 shows the total area that transportation study covers and its relation to the UATh and GATh.

Despite the fact that the traffic study is outdated, it still remains the only source for transportation data and therefore it becomes essential that we use the same spatial analysis unit. It should be noted that definitions of TAZs were the result of an extended analysis of traffic patterns in the area of Thessaloniki. Therefore, any future efforts to update transportation data will most probably use the same zonal system.

The inevitable selection of TAZ's as TELUMs analysis zone created several spatial and temporal inconsistencies. As far as spatial inconsistencies, the first issue that arose was

Pref. Kilkis

Pref. Pella

Pref. Thessaloniki

Pref. Imathia

Thermaikos Gulf

Pref. Pieria

Pref. Chalkidiki

0   10   20
Kilometers

Urban Aglomeration of Thessaloniki (UATh)   Prefecture of Thessaloniki
Greater Area of Thessaloniki (GATh)   Other Prefecture's Boundaries
Build Areas (Corine 2006)   National Road Network
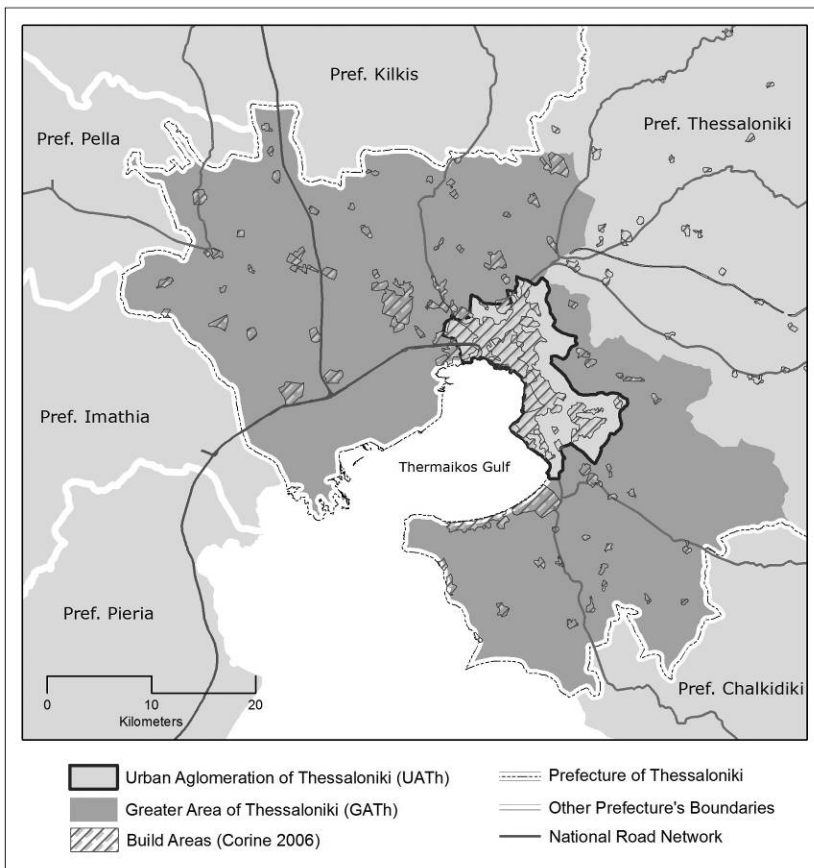
Map 1. Thessaloniki: Urban Aglomeration and Greater Area

that the study area of 316 zones as defined at the time that the transportation study was conducted (1997) includes the functional area of Thessaloniki as in 1997. Besides, as indicated in Map 2, the TS area covers mainly UATh and only a small part of GATh, when GATh, as explained earlier, experienced dramatic changes over the last decade (2001-2011). Therefore, the 1997 definition of the study area becomes obsolete for the use in TELUM. An addition of several zones that would incorporate GATh into the existing zonal system would be an appropriate solution, but the lack of past and present transportation data for these zones makes it practically useless.

Another quite trivial issue was to find appropriate land use data and to create the categories required by the model. TS provided us with some land use data, but the way it was recorded was not suitable for use by TELUM. For this reason a calculation of land use categories that were missing was conducted. In more detail, TS recorded land uses as total build area occupied by each activity (i.e. residential, commercial, etc.). Essentially, total build area is the actual land area multiplied by the corresponding floor area ratio (FAR). For instance, in a zone of 108 acres there were 267 acres build up area. A simple division will give us a FAR of 2.4, which happens to be the statutory FAR for this zone. This led us to the conclusion that there is no available 'land' for further development. If the statutory FAR was higher than 2.4, then there would have been vacant land available for development in the zone. Under the same notion we were able to calculate the acres for each one of the categories needed.

In terms of data's temporal reference, it is predetermined that since we have transportation data only for 1997, this will be set as the 'current year' for the calibration and forecasting process. Therefore, 1991, which is the immediately preceding census year, becomes the 'lag year'. This makes it a six-year increment, which is close enough to the five-year ideal time increment. Fortunately, employment, household and land use data for 1997 are available by TS itself. Table 1 summarizes data requirements and sources for the use in TELUM.

Last but not least, one cannot ignore the quite old time reference of the input data. Actually, the issue that arises here does not have to do with the time reference of the data per se, but with the fact that both employment and household 'reality' has radically changed over the last 4 years. It is well known that Greece experienced (and still does) a major economic crisis that led to financial support from the International Monetary Fund in 2010. This fact completely changed the market behavior
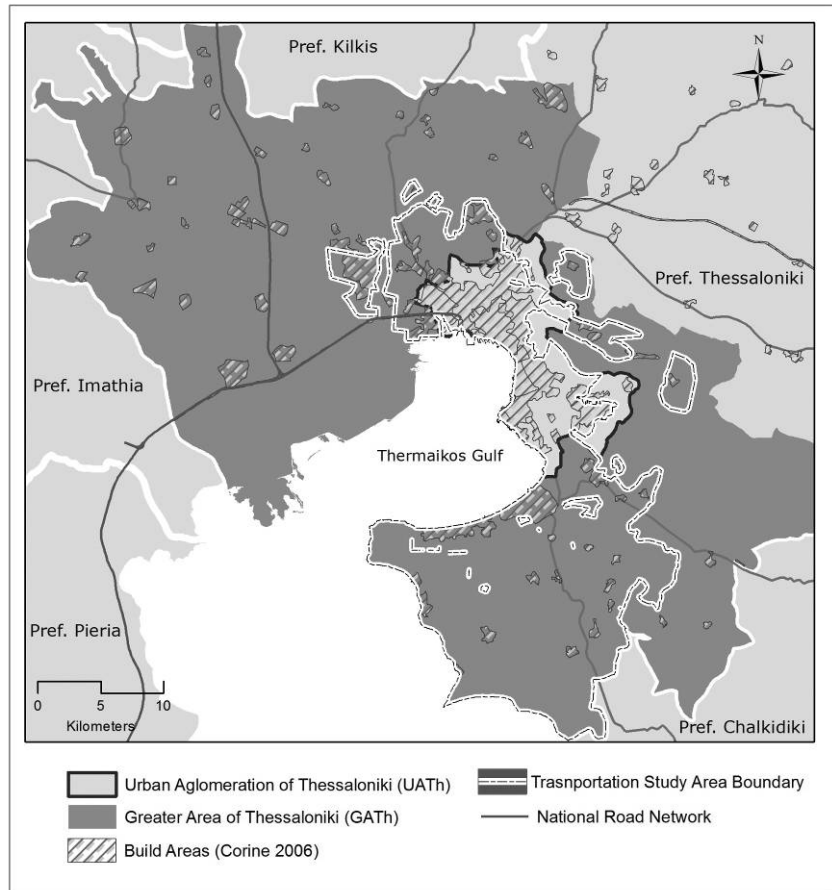
Map 2. Transportation Study Area Boundary

Table 1. TELUM Data Requirements and Sources

Type of Data	Spatial Reference	Temporal Reference	Source
Population Control Totals	Regional	Lag, 1991	Census
Employment Control Totals by sector	Regional	Lag, 1991	Census
Households by Income	TAZ	Current,1997	TS
Employment by Sector	TAZ	Current,1997	TS
Interzonal Travel Cost	TAZ	Current,1997	TS
Land Use (Total and by type)	TAZ	Current,1997	TS
Average number of employees by household type	TAZ	Current,1997	Unavailable*
Households (by income) per Employees (by sector)	TAZ	Current,1997	Unavailable*
Regional Rate of Employee Commutation	Regional	Current,1997	TELUM default value

We can assume uniform distribution of employees across household types

for both businesses and households due to reductions in income, unemployment and the undermining of public services and infrastructure (Thoidou, 2013). One of the most evident effects was on the housing construction sector where hundreds of new homes in the suburbs still remain unsold. The construction sector decline led to a great loss of construction jobs that were mainly occupied by immigrants. In turn, immigrants, who mostly lived in the city center, abandoned the city in order to find jobs in more prosperous countries. This created 'new' housing stock within UAth. In general, economic crisis

brought several effects that the city experienced for the first time, like high vacancy rates in commercial properties both in the city center and suburbs, reduced use of cars due to high gasoline price, and return of inhabitants in the city center due to lower rents.

The effects of economic crisis are in many ways related to the calibration of the model. As mentioned earlier calibration process adapts the model to the input data and determines the values for α, β, λ, a, b and all other related parameters. Essentially, the calculated values

for these parameters incorporate the future behavior for each locator type for employment and households. Therefore, if we calibrate the model with the 1997 data we implicitly assume that past urban development trends will continue to occur.

In a scenario where Greece did not experience economic crisis this data, even if a bit outdated, would have been appropriate for model calibration. This is because in such a scenario we assume that the development trends will continue, until full capacity of transportation and land use system occurred, or until certain governmental policies suspend or restrict market trends. When extreme and unexpected events occur (i.e. stock market crash), LUTIM, or any model for that matter, cannot automatically adapt to the new situation, unless we calibrate the model to the new 'facts'. In the case of Thessaloniki the most recent socioeconomic data available is the latest national Census (2011), which still does not capture the effects of the ongoing economic crisis. Even so, if we decided to use 2011 data inputs, the fact that there is no recent transportation data would make it impossible to calibrate the model.

It is obvious that the calibration process and the modeling process in general is a data intensive procedure. Even if the researcher decides to make certain concessions with the quality of data used, requirements can still be high enough to make its application impossible. At this point it should be noted that the choice of model(s) used here (TELUM) was not random. Actually, the option of using other LUTIMs were examined but the highly aggregated data required by TELUM in comparison to the refined data required by other models (i.e. UrbanSim) was the determinant factor in making the final decision. Nevertheless, the weakness of acquiring the appropriate data even for TELUM, has highlighted important issues related to data availability, organization and standardization.

As a result a reorientation of the course of the project was considered. The main research target from now on will be to find, organize and standardize the appropriate data. For example, land use data will most probably result from General Urban Plans that each municipality has, where existing land uses are recorded. This is not an unproblematic solution since it could be quite time consuming (GATh has 13 municipalities and several sub-municipalities each) and with several inconsistencies (General Plans have been conducted roughly from 2000 till today and have different land use codification). As far as transportation data, a

research field is required, in combination with data that could be purchased, in crude form, from the Hellenic Transport Institute. Finally, for the socioeconomic data, a research team is still on quest finding out how data that will encompass 'new' locating behavior for households and businesses, will be acquired.

CONCLUDING THOUGHTS

Implementation of LUTIMs requires access to combination, consolidation, display and exploitation of data from a variety of sources. It also requires efficient processing mechanisms that can handle large amounts of different data like topographic, cadastral, land cover and use, transportation, employment, building information, etc. (Joksic and Bajat 2004). Last but not least, they require both data at different scales to denote the functional and morphological characteristics of a city, and data over several years to identify evolution patterns.

An attempt to apply a relatively simple, in terms of its data requirements, LUTIM brings up important issues of data availability and data standardization. In a world where software vendors have implemented products tailored to the needs of specific research goals, communities and customers, standardization of data becomes a necessity in order for the interoperability of different systems to succeed (Hamilton *et al.*, 2005). There is an extended bibliography in relation to integration and interoperability strategies for urban data. There are also several conceptual urban data models developed to accommodate datasets relevant to different aspects of urban modeling and city planning in general. In an effort to underline the significance of having extensive and consistent spatial data the EU adopted the INSPIRE Directive in 2007, an infrastructure system for spatial information in the European Community. The main goal of the system was to make more and better spatial data available for the preparation and implementation of environmentally (and not only) related issues.

The final point that this paper wants to stress out is the significance of finding the appropriate data to make use of any LUTIM. It is a common misconception amongst the modeling scientific community that advancements in LUTI modeling (and urban modeling in general) has to do with two factors. The first is the refinement in the model packages, aiming to increase the percent of explained variation or, in other words, increase the predictability of the model. The second is the refinement of the spatial level of analysis, by increasing the disaggregation of the models originally developed in the 'first generation' of operational models. Indisputably,

these two factors are significant to advancement of modeling per se, but the last 15 years the usability of models has also become a major determinant of their practical value in planning. The usability of models in planning practice is determined by various factors, availability of data being a significant one (Pozoukidou, 2008, Putman, 2010). Therefore, less sophisticated models that require few data could have better utilization prospects and consequently more practical value in the planning practice.

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SPATIAL AND SECTORAL PLANNING SUPPORT TO SUSTAINABLE TERRITORIAL AND TOURISM DEVELOPMENT OF PROTECTED MOUNTAIN AREAS IN SERBIA

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The starting point for easier resolution of conflicts between conservation and development should be the application of the concept of protected areas of natural heritage as social-ecological systems. This is also the precondition for attainment of strategic planning coordination for protected mountain areas (PMA). The objective of the paper is to provide the insight into the effectiveness of strategic planning support – spatial and sectoral planning – to sustainable territorial and tourism development of PMA in Serbia. The study area comprises Kopaonik and Đerdap National Parks, and Stara Planina Nature Park. This paper evaluates the effectiveness of strategic planning for PMA by means of analysis and evaluation of spatial plans, Strategic Environmental Assessment (SEA) and sector plans in tourism for the study area. The effectiveness of spatial planning is checked based on the analysis and evaluation of sustainability of zoning and land-use regimes, and of tourism development proposed by spatial plans for the study area. The conclusion is that it is necessary to apply holistic approach to sector planning for nature conservation and tourism development, and to apply SEA for tourism planning as well. Reduction of the spatial coverage of PMA and spatial differentiation of protected zones from the ones planned for intensive development is recommended.

Key words: spatial and sectoral planning, protected mountain areas, sustainable territorial and tourism development, zoning and land-use regimes, evaluation.

INTRODUCTION

The objective of the paper is to provide the insight into the effectiveness of strategic planning support, namely of spatial and sectoral planning to sustainable territorial and tourism development of protected mountain areas with natural heritage (PMA) in Serbia.

Protected areas of natural heritage in Serbia currently cover 5,221 km^2 (i.e. 5.9% of its territory) with the tendency of increasing up to 12% of its territory by 2020. So far, the greatest efforts in Serbia have been brought together in the formal declaration of the protection status for protected areas, while very few efforts have been made regarding the effectiveness of planning

and management for protection and development of these areas. Significant part of these areas consists of protected mountain areas (PMA), as mountain areas in Serbia (above the height of 600 m) cover 34% of its territory (i.e. approximately 29,850 km^2). Prevailing part of high mountains (elevations over 1,500 m with surrounding areas above 1,000 m account for only about 11% of Serbian territory, i.e. 9,680 km^2), as well as part of semi-high and low mountains, have been declared protected areas with different status of protection (Milijić *et al.*, 2013). The most attractive PMA are identified by the Spatial Plan of the Republic of Serbia (1996, 2010) as tourism destinations. Only a few of these PMA tourism destinations are developed or have been in the initial stage of development (Maksin and Milijić, 2013).

One of the critical issues is the need to balance

the economic, environmental and social dimensions of sustainable development and heritage protection. This balance is the basis of the new concept of biodiversity and protected areas of natural heritage as social-ecological systems (Tschanz *et al.*, 2013). These concepts should represent the starting point for easier resolution of conflicts between conservation and development in strategic planning and management of PMA.

The coordination between tourism, spatial and environmental planning is a crucial issue aiming at realizing an integrated strategic planning for

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sustainable territorial development of PMA. In this context, Peano (Peano *et al.*, 2013) points out that the general question is: 'Which missions can be assigned to planning, with the aim of a more effective integration of conservation policies into the overall territorial policies?' The next question concerns how effective strategic planning is as support to sustainable PMA management. This paper evaluates effectiveness of strategic planning for PMA in Serbia by means of analysis and evaluation of spatial plans for PMA and mutual-feedback coordination with Strategic Environmental Assessment and sector plans in tourism.

The first hypothesis is that the key precondition for achieving sustainable development and management of PMA – the coordination of strategic planning (spatial, sector and environmental) in Serbia has not been fulfilled yet. Spatial planning in Serbia establishes the main planning framework for sustainable territorial development. The *Spatial Plan of the Republic of Serbia* (SPRS, 1996, 2010) represents planning framework for coordinating strategic planning of a more balanced territorial development of Serbia on the state level, as well as on the level of PMA. The holistic approach to PMA as socio-ecological systems (SES) is applied only to spatial planning. The following limitations affect the effectiveness of strategic planning support to sustainable development of PMA: prevailing sector approach in PMA protection (ecological approach) and tourism development (economic approach); consequently, there is insufficient relativization of conflicts between natural heritage protection, tourism development and sustainable development of local communities; the coordination of sector planning in tourism with spatial planning is inadequate, as well as the application of SEA for assessment of tourism impact on the environment (Maksin, Milijić, 2010).

The second hypothesis is that the sustainability of the natural heritage protection, sustainable tourism development and sustainable development of local communities can be achieved in the spatial planning for PMA. Coverage of Serbian territory with spatial plans for special-purpose areas (SPSPA) provides a sound spatial planning framework for the coordination and integration of strategic planning and management of PMA sustainable development. The effectiveness of spatial planning will be checked based on the analysis and evaluation of sustainability of zoning and land-use regimes and of tourism development proposed by spatial plans for these areas. For PMA, spatial zoning and land-use regimes for

the nature protection, natural resources use, tourism development and development of settlements are established. Conservation policy in Serbia is based exclusively on the goals of the natural heritage and biodiversity protection, which is not in accordance with the new concept of biodiversity and PMA as SES. It is rooted in restrictions rather than in possibility and creativity for new development, similar to planning policy for England National Parks (Thompson *et al.*, 2013). Therefore, the zoning and land-use regimes for the nature protection are restrictive. Only controlled tourist visits are allowed in the first-degree protection zone, while the second-degree protection zone permits recreation of tourists and limited development of tourism and other types of infrastructure. The third-degree protection zone is permitted to have settlements, where the selective and limited development of tourist resorts and tourism infrastructure is also allowed. The land-use regime for the third-degree protection zone has similarities with buffer zones, as defined by Wild and Mutebi (Ebregt & De Greve, 2000). A buffer zone, as defined in Serbian legislation, surrounds the protected area, similarly as the transition area defined in UNESCO's Man and Biosphere Program, but there is no obligation for this zone to be established. Adaptations of conservation policy for protected areas are realized in the process of spatial planning, primarily regarding the spatial coverage of these areas, protection zones and land-use regimes, by means of which partial relativization of conflicts between conservation and development is achieved. PMA management programs (PMAMP) are prepared based on SPSPA for PMA.

Research focus in this paper is on: the coordination of the spatial and sectoral planning for PMA, the sustainability and conflicts of the zoning and land-use regimes in spatial plans for PMA; and the sustainability of the proposed tourism development for PMA.

MATERIALS AND METHODS

Study area

The study area comprises the following PMA (Figures 1, 2) for which spatial plans for special purpose areas (SPSPA) and tourism master plans (TMP) were adopted: high mountains (Kopaonik National Park – Kopaonik and Stara Planina Nature Park – Stara Planina) and low mountains along the Danube river bank (Đerdap National Park – Đerdap).

Stara Ianina occupies the area of 1,143 km², with 55 rural settlements. It is situated in the eastern part of Serbia, on the borderline between the Republic of Serbia and the Republic of Bulgaria. The Nature Park is designated as IBA and IPA area. This is an area with pronounced potential for the development of the all-year-round tourism offer. However, tourism is only in the initial phase of development.

Kopaonik occupies the area of 121 km², with tourist resorts (partly within the National Park) and with few hamlets, but without urban or rural settlements. It is situated in the central part of Serbia. This area is developing the all-year-round tourism offer. The buffer zone is established in the SPSPA of the Kopaonik National Park.
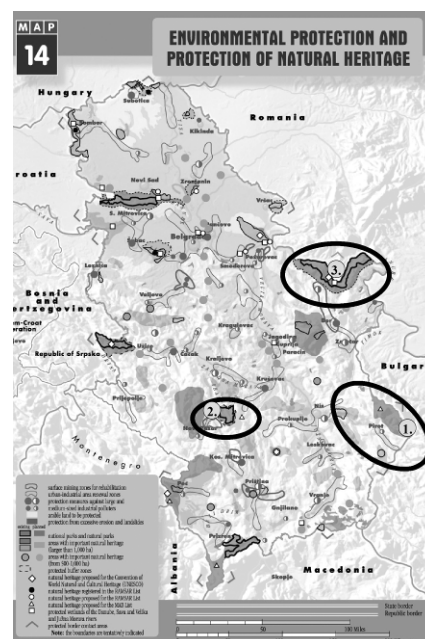

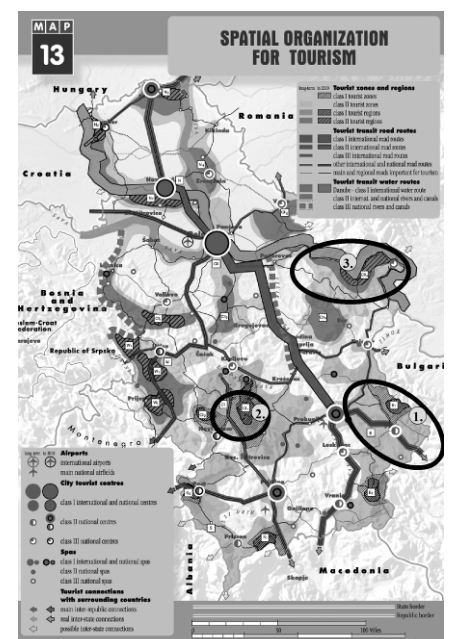*Figure 1. PMA within protected areas in Serbia*

Figure 2. PMA as tourism destinations in Serbia

In terms of tourism, the most attractive part of the Danube flow through Serbia is Đerdap. It covers the area of 637 km², with 27 rural and small urban settlements. Đerdap is declared IBA, IPA and PBA area. The area is on the list of the Carphatian areas, with its tourism still being in the initial phase of development.

Materials and methods

This qualitative research is based on documentation study (SPSPA and TMP for the study area), field work and stakeholder involvement during the preparation of SPSPA (information feedback – briefs, focus groups and consultation, and joint planning – mediation and negotiation).

Starting from the chosen research focus and conducted qualitative research, the study procedure included three steps. In every step the evaluation criteria were proposed. Based on evaluation criteria and comparative analysis of SPSPA and TMP for the study area, the effectiveness of strategic planning coordination for sustainable territorial development of PMA in Serbia was carried out. Based on evaluation criteria and comparative analysis of spatial plans for the study area, the sustainability assessment of the zoning and land-use regimes, as well as of the proposed tourism development were carried out.

Evaluation was carried out by five professional planners involved in the preparation of SPSPA and average score for each criterion was calculated. Evaluation results were checked during public consultations and confirmed through the discussions and joint planning with stakeholders involved in the preparation of spatial plans.

RESULTS

Coordination of the strategic planning for PMA

The following evaluation criteria for the coordination (C) of the strategic planning are proposed for PMA (modified based on Maksin, 2012):

- C1 – Planned PMA development (proposed plans: SPSPA, PMAMP and TMP) – *high* (1) SPSPA, PMAMP and TMP are adopted; *medium* (2) one of the proposed plans is adopted, or two plans have been elaborated, but not adopted; *low* (3) none of the proposed plans is elaborated;
- C2 – Coordination of the strategic plans for PMA (coordination of TMP with the SPSPA and PMAMP, as coordination of SPSPA with TMP and PMAMP with SPSPA is obligatory) – *high* (1) TMP is elaborated and adopted in

compliance with SPSPA and PMAMP; *medium* (2) TMP is elaborated and adopted partly in compliance with SPSPA and PMAMP; *low* (3) TMP is not elaborated and adopted in compliance with SPSPA and PMAMP;

- C3 – Controlled impacts of the strategic plans for PMA on the environment (Strategic Environmental Impact Assessment – SEA) – *high* (1) SEA is carried out for SPSPA and for TMP, and SPSPA and TMP are elaborated in compliance with SEA; *medium* (2) SEA is carried out only for SPSPA, and TMP is elaborated in compliance with SPSPA and SEA for SPSPA; *low* (3) SEA is carried out only for SPSPA, but TMP is not elaborated in compliance with SPSPA and SEA for SPSPA;
- C4 – Participation of local stakeholders in the strategic planning for PMA (SPSPA, PMAMP, TMP, SEA) – *high* (1) Participation of local stakeholders is accomplished in the process of SPSPA, PMAMP, TMP and SEA elaboration; *medium* (2) Participation of local stakeholders is accomplished only in the process of SPSPA elaboration; *low* (3) Participation of local stakeholders is reduced on public review or consultations of draft versions of SPSPA, SEA, TMP and/or PMAMP.

Sustainability of the zoning and land-use regimes (Figure 3)

The evaluation was carried out on the basis of the following criteria for the sustainability of the zoning and land-use regimes (ZL) proposed in SPSPA for PMA:

- ZL1 – Coordination of zoning with land-use regimes for nature protection with available resources for the implementation of land-use regimes and adequate compensations for the limitations in land use – *high* (1) for zoning in

accordance with available resources, with adequate compensations; *medium* (2) for zoning partially in accordance with available resources, with limited compensations for the limitations in land use; *low* (3) for zoning not in accordance with available resources;

- ZL2 – Coordination of zoning with land-use regimes for nature protection with sustainable development of involved local communities (development of traditional and new activities) and settlements – *high* (1) for zoning which enables sustainable development of local communities and settlements, *medium* (2) for zoning witch limits development of new activities and settlements, *low* (3) for zoning which limits further development of all activities and existing settlements;
- ZL3 – Coordination of zoning with land-use regimes for tourism development with zoning for nature protection – *high* (1) for zoning which is in complete accordance with zoning for nature protection, *medium* (2) for zoning which is not in accordance with zones of nature protection in less than 10% of the mentioned zones, *low* (3) for zoning which is not in accordance with zones of nature protection in 10-20% of the mentioned zones;
- ZL4 – Coordination of zoning with land-use regimes for tourism development with zoning of natural resources (agricultural land, forest and water) and settlements – *high* (1) for zoning which is in full accordance with zoning of natural resources and settlements; *medium* (2) for zoning which is not in accordance with zoning of natural resources and settlements in less than 20% of the mentioned zones, *low* (3) for zoning which is not in accordance with zoning of natural resources and settlements in more than 20% of the mentioned zones.

Table 1. Evaluation of coordination of the strategic planning for PMA

Evaluation Criteria	1. Kopaonik	2. Đerdap	3. Stara Planina
C1	1	1	1
C2	3	1	3
C3	3	2	3
C4	2	2	2
Average	2.25	1.5	2.25

Table 2. Sustainability evaluation of the zoning and land-use regimes in SPSPAs for PMA

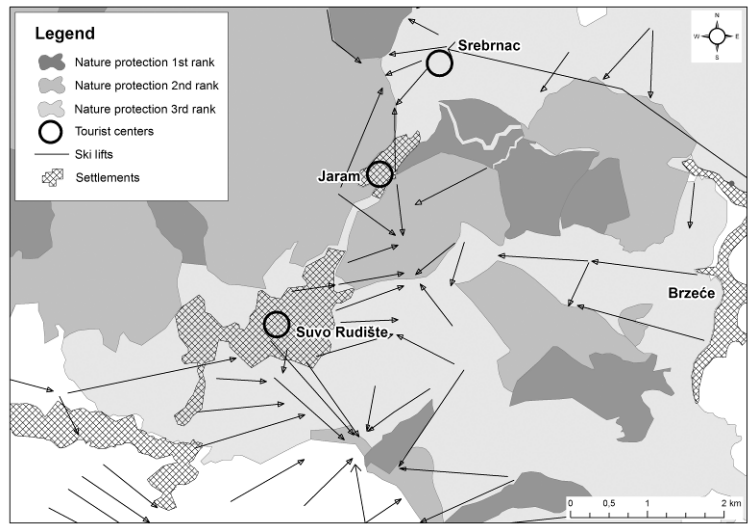| Evaluation Criteria	1. Kopaonik	2. Đerdap	3. Stara Planina
ZL1	2	2	2
ZL2	2	2	2
ZL3	2	1	3
ZL4	1	1	2
Average	1.75	1.5	2.25

Figure 3a. Kopaonik
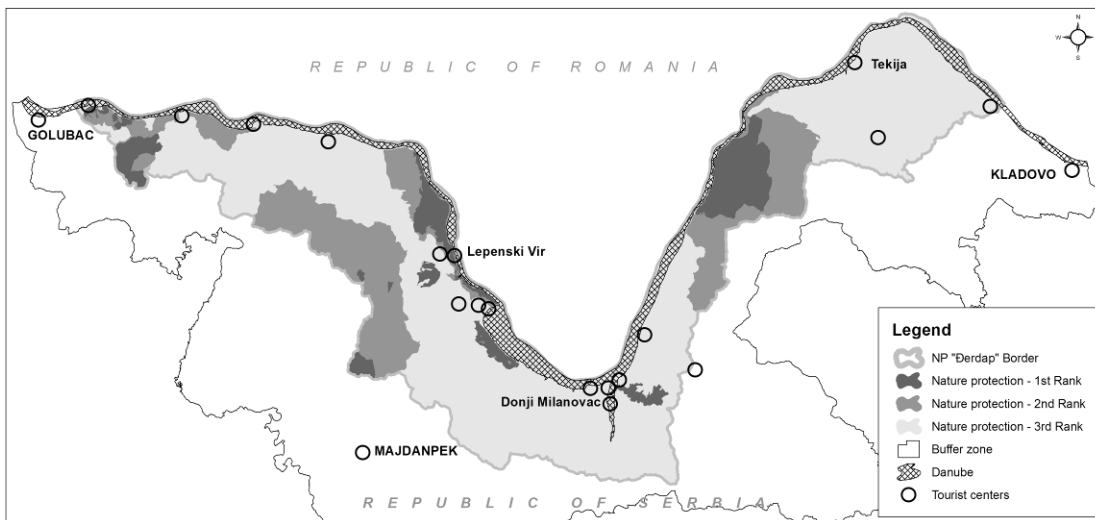*Source: Spatial Plan of Kopaonik National Park, 2009*

Figure 3b. Đerdap;
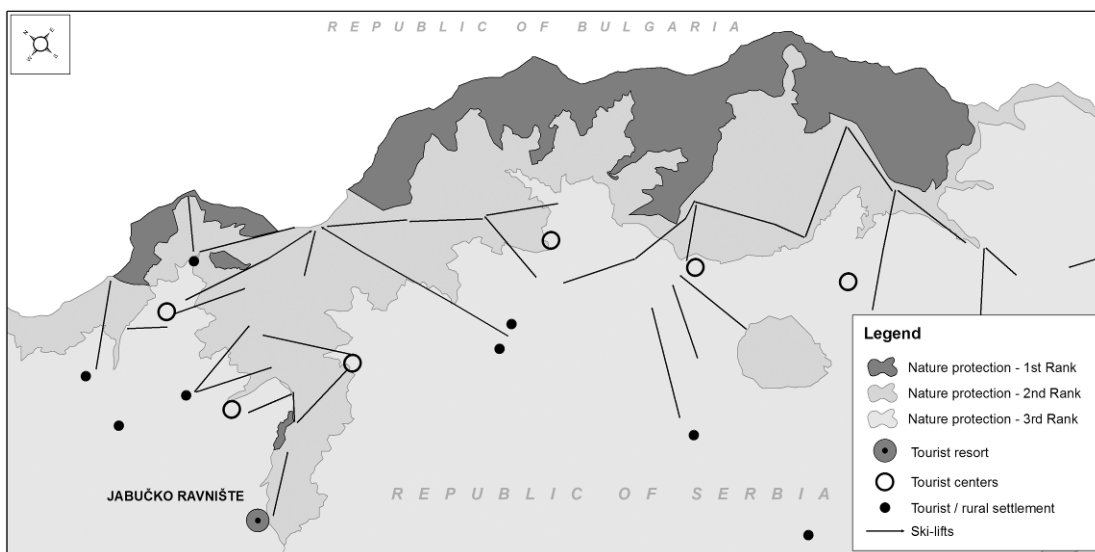*Source: Spatial Plan of Đerdap National park, 2013*

Figure 3c. Stara planina.
Source: Spatial Plan of Nature Park and Touris Area of Stara Planina, 2008

Figure 3. Zoning of nature protection and tourism development in SPSPA for PMA

Sustainability of the proposed territorial development of tourism

The evaluation was carried out on the basis of the following evaluation criteria for sustainability of the territorial development of tourism (SPT) proposed in SPSPA for PMA:

- S-SPT 1 – Sustainability of the proposed territorial development of tourism for the core area of natural heritage (first-degree and second-degree protection zones) – *high* (1) proposed spatial development of tourism has no negative impacts on the core area; *medium* (2) proposed spatial development of tourism has no negative impacts on the first-degree protection zones and has limited negative impacts in less than 10% of the second-degree protection zones, which can be controlled; *low* (3) proposed spatial development of tourism has limited negative impacts on the core area which are difficult to control;

- S-SPT 2 – Sustainability of the proposed territorial development of tourism for the third-degree protection zones and sustainable development of the buffer zone – *high* (1) proposed spatial development of tourism has no negative impacts on the third-degree protection zones and enables sustainable development of the buffer zone; *medium* (2) proposed spatial development of tourism has limited negative impacts in less than 20% of the third-degree protection zones and buffer zone, which can be controlled; *low* (3) proposed spatial development of tourism has limited negative impacts on the third-degree protection zones and buffer zone which are difficult to control;

- S-SPT 3 – Sustainability of the proposed territorial development of tourism for the sustainable natural resources use (agricultural land, forests and water) – *high* (1) proposed territorial development of tourism has no negative impacts on sustainable natural resources use; *medium* (2) proposed territorial development of tourism has limited negative impacts on less than 10% of available natural resources, which can be controlled; *low* (3) proposed territorial development of tourism has negative impacts on the protection and use on more than 10% of available natural resources, which are difficult to control;

- S-SPT 4 – Sustainability of the proposed territorial development of tourism for the sustainable development of local communities (local job creation, improved quality of life, development of traditional activities and settlements) – *high* (1) proposed territorial development of tourism has overall positive impacts on sustainable development of local communities; *medium* (2) proposed

Table 3. Sustainability evaluation of the proposed territorial development of tourism in SPSPAs for PMA

Evaluation Criteria	1. Kopaonik	2. Đerdap	3. Stara Planina
S-SPT 1	3	1	3
S-SPT 2	3	1	2
S-SPT 3	2	1	3
S-SPT 4	2	2	3
Average	2.5	1.2	2.75

territorial development of tourism has limited positive impacts on sustainable development of local communities; *low* (3) proposed territorial development of tourism has limited negative impacts on sustainable development of local communities.

DISCUSSION

Coordination of the strategic planning for PMA

According to the first criterion, high level of strategic planning is achieved for all PMA.

According to all other criteria, mutual-feedback coordination of strategic plans for PMA was not applied consequently due to sector planning in tourism for two out of three study areas. The elaboration of TMP was conducted before the elaboration of SPSPA for Đerdap, while for the other two study areas the elaboration of SPSPA was conducted before the elaboration of TMP.

According to the second and third criterion, a high level of non-coordination of strategic planning is identified for both high-mountain PMA, and a higher level of coordination for low-mountain PMA. The application of market-driven approach in sector planning in tourism, as well as the obligation to implement TMP in the elaboration of SPSPA (proposed by the Law on Tourism, 2009) and reduced public participation in tourism planning process cause difficulties in the coordination of strategic planning for PMA. The obligation to consult TMP in the elaboration of SPSPA should be established, as well as the obligation to control the spatial, environmental and social impacts of tourism development proposed by TMP through the spatial planning process and SEA process. Non-implementation of SEA for tourism sector plans might jeopardize the realization of the integrative role played by spatial planning in directing and managing sustainable territorial and tourism development of PMA, namely in the case of the most attractive PMA for winter tourism. Despite this, the implementation of SEA in spatial plans contributed to achieving a certain balance between tourism development and protection for PMA. The implementation of SEA enabled in SPSPA for Stara Planina compromise solution with the tourist resort Jabučko ravnište

whose capacities are reduced to medium-size (6,000 beds) instead of a mega-tourist resort.

An inadequate involvement of local communities and local stakeholders in the decision-making process during the elaboration of TMP and PMAMP is another weak point in the coordination of strategic planning for all PMA.

Sustainability of the zoning and land-use regimes

Sustainability evaluation of the zoning and land-use regimes in SPSPA shows lower level in the two analyzed high-mountain PMA, than in the case of low-mountain PMA.

According to the first and second criterion, the planning solutions of the SPSPA are equally suitable for all PMA. The problem partially lies in the topicality and viability of established protection zones, since they are not established on available financial resources for the application of land-use regimes, and adequate compensations for limitations in the land use. According to the third criterion, the planning solutions are lower for high-mountain PMA, but for different reasons. Relative to its altitude, the core area of the Kopaonik National Park is located below the zone of intensive winter tourism development (tourist resorts and ski zones), thereby exposed to direct negative effects of unpurified wastewater from tourist centers, polluted runoff from roads, traffic-derived air pollution, air pollution from heating of accommodation facilities, etc. In a part of the Stara Planina Nature Park, due to inadequately located Jabučko ravnište ski-resort (in relation to the core area and main ski zones), the problem of anthropogenic impacts on the environment jeopardizing the natural resources is pronounced. According to the fourth criterion, the planning solutions of the SPSPA of the Kopaonik and Đerdap National Parks are more favorable than those of the SPSPSA of the Stara Planina Nature Park. In spatial planning the model of 'concentrated dispersion' for spatial development of tourism offer is implemented in all SPSPAs. The problems were caused by planning solutions for the Jabučko ravnište mega-tourist resort (23,000 beds) and ski zones covered by the

Stara Planina Resort Area Master Plan (Stara planina TMP, 2007). The conflicts were resolved and compromise solutions achieved through joint planning – mediation and negotiations in the process of SPSPSA and SEA elaboration.

Sustainability of the proposed territorial development of tourism

The evaluation of the proposed territorial development of tourism shows lower level of sustainability in the high-mountain PMA, as well as higher level in the low-mountain PMA than the evaluation of the zoning and land-use regimes for tourism development in SPSPA.

According to results for the first and second criterion, the zoning and land-use regimes proposed by SPSPA for high-mountains PMA should be questioned. Are there problems associated with the zoning and land-use regimes which have not been appropriately addressed in the spatial planning and in the evaluation of their sustainability? Zoning and land-use regimes for tourism development are principal methods to deploy visitors, and hence it is critical in achieving the appropriate combination of concentration and dispersion of tourism offer, and degree of the impact which a type of tourism causes (Eagles *et al.*, 2002). One of the problems includes altitudinal zoning and overlapping of protection zones with zones of tourism development. In the Kopaonik National Park, the problem of altitudinal zoning is more pronounced. In a part of the Stara Planina Nature Park (Jabučko ravnište-Babin zub), the problem of overlapping of protection zones with zones of tourism development is pronounced. There is a pronounced problem of degradation and erosion of Babin zub natural landscape – the main tourist attraction in summer, due to inadequately located Jabučko ravnište ski-resort with ski connections on the slopes (according to the Stara Planina TMP).

According to the third criterion, the lowest level of sustainability is assessed for Stara planina. The development of accommodation capacities is over-dimensioned in relation to possibilities for their rational water supply (according to the Stara Planina TMP), contrary to solutions proposed in the SPSPA (2008). This conflict was partially resolved in the process of spatial planning and carrying out of SEA for SPSPA.

According to the forth criterion, the proposed tourism development might have limited positive impacts on sustainable local community development, because the tourism management has so far failed to give the adequate support to the development of local

agriculture and inclusion of rural settlements in tourism development. In the past 25 years, out of 16 planned settlements in the buffer zone of the Kopaonik National Park, only the settlement of Brzeće was included in the tourism offer. The engagement of human resources from surrounding areas of PMA for tourism development was proposed by Stara Planina TMP, without creating local jobs, improving the quality of life of local communities, etc.

CONCLUSION

Sustainable territorial and tourism development of PMA requires the establishment of coordination and integration of strategic planning and improvement of its implementation. In order for spatial planning for PMA to fulfill its role of coordination and integration, it is necessary to enhance sector planning for protection of natural heritage and tourism development by application of holistic approach.

SEA is an important control instrument for the support to coordination and integration of strategic planning with a view of achieving sustainable territorial development. The integration of the SEA into spatial plans for PMA in Serbia has given positive results in the evaluation of different territorial development solutions, and has also contributed to the improvement of natural heritage protection and sustainability of planned development. A precondition for SEA to have a controlling and coordinating role is to initiate their application in tourism planning, using experiences related to SEA implementation and integration into the spatial planning process as the starting basis, as well as to enable their adequate integration into the strategic planning process – from preparation to implementation, monitoring and auditing.

One of the key issues of strategic planning for PMA as SES should be the achievement of higher quality of life and prosperity of local communities within PMA. For this reason we propose application of the Social Impact Assessment (SIA) process in strategic planning for PMA, as a part of SEA or separate process.

It is also of key importance to: improve governance support to the implementation of strategic planning for PMA; establish information and monitoring systems for spatial, tourism and natural heritage planning and management; provide an adequate involvement of local communities and local stakeholders in the decision-making process with respect to tourism development and conservation of natural heritage; etc.

The achieved sustainability of zoning in SPSPA is conditioned by restrictions and inadequate

performance of conservation policy and market-driven approach to tourism planning. In the case study of the Kopaonik National Park, the impact of tourism development on the core area will lead to lowering of the level and category of the natural heritage protection (nature park, landscapes of outstanding beauty), as well as to a reduction in its coverage. Based on the experiences of Alpine countries, prevention and relativization of these conflicts can be obtained by means of spatial differentiation of protected zones from the ones planned for intensive development. This proposal is similar to the spatial differentiation of European protected areas and MAB Biosphere Reserves on the Core, Buffer and Development zones (Köck *et al.*, 2009). For the case studies of the Stara Planina Nature Park and Đerdap National Park, the differentiation between core areas and tourism development zones is possible.

A trade-off can be achieved by reconsidering and reducing the spatial coverage of PMA and zones of natural heritage protection, as well as by spatial differentiation between development zones or multiple-use zones. e.g. for tourism, settlements, MSE, infrastructural corridors, and core zones (Naughton-Treves *et al.*, 2005). The core zones can be interconnected through ecological corridors and buffer zones, thus forming an ecological network. Development or multiple-use zones imply their sustainable spatial development and should be a part of sustainable-use area and buffer zones (Bennett & Mulongoy, 2006). They should form a sustainable development network for tourism and local communities. The authors of this paper believe that protected areas with sustainable use of natural resources will interweave with buffer zones, taking into account the following functions of buffer zones: support to sustainable development; sustainable livelihoods and community benefits as an adequate compensation for more restrictive land uses in the protected area; provision of ecosystem services to the community (e.g. clean water); etc. (Martin & Piatti, 2009). It is necessary to provide a coordination of zoning with available financial resources for the implementation of land-use regimes and with adequate compensations to landowners and land users for the limitations in the land use (Milijić *et al.*, 2013).

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LAND USE REGULATION AND PROPERTY RIGHTS REGIME OVER LAND IN SERBIA

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Starting from the fact that land use regulations can directly affect assignment and reassignment of property rights over land, the authors examine the link between land use regulation and property rights in Serbia by analyzing relevant literature, as well as legislation and regulations. Current legal framework that regulates property rights over land is inconsistent in many parts, while the effects of land use regulations are very dependent on structural institutional transformations and interdependent on property rights. In this regard, the paper gives a critical overview of framework of property rights regime over land and urban construction and agricultural land regulation in Serbia. After reviewing existing literature, legislation and institutional regulation on the main issues of land use regulations and property rights, the authors discuss in particular redefinition of property rights over land, processes of privatization and restitution of land. The authors indicate that resolving property rights over land is very important both for social issues and for economy and regarding this, land restitution, supported by efficient land administration, is the precondition for successful privatization process.

Key words: land rights, land use regulation, property rights, land policy, Serbia.

INTRODUCTION

As a multiple resource land is managed trough *land policy*, concerning key issues regarding sustainable *use* (land administration, land management), *regulation* (land use planning), security and equitable distribution of *land rights* and *access to land*, including the forms of *tenure* under which it is held (EC, 2004). Information on land and property rights over land are fundamental to effective land administration. Land is a specific type of property (e.g. real property) and Norton and Bieri (2014) consider a 'property' as particular human institutionalization of 'land' (i.e., the attributes of land-as-nature that make it useful to us). *Property rights* have central place in every legal system. Regardless of the legal traditions (either civil or common law), diverse bundle of rights are related to property. Property rights consider formal and informal institutions and arrangements that govern access to land and

other resources, as well as the resulting claims that individuals hold on those resources and on the benefits they generate (Bromley, 1997 and McElfish, 1994 quoted in: Wiebe and Meinzen-Dick, 1998:205).

Property rights refer to *economic* (property) rights and *legal* (property) rights. Economic property rights (the ability to derive direct or indirect income or welfare from a resource or attribute of a resource) are the end-result, whereas legal rights are the means to achieve the end (van der Krabben, 2009). Hence, land use can be regarded as both an object of deliberation and subsequent intervention with modifying (prescriptive) laws and an asset that generated codification (description) of how people handle property rights (van Dijk and Beunen, 2009). Thereby, clarification and security of land rights are essential for the success of integrated planning and management of land resources, which reduces conflicts between stakeholders, increases the confidence required for sustainable land use practices by the actual land cultivators or protectors, determines the respective

responsibilities, and provides the basis for a fair and environmentally-sound allocation of incentives, subsidies or taxes (FAO, 1995).

Applying property rights theory to the field of spatial planning suggests that land use planning must focus on improving efficiency by changing the property rights regime. While traditional regulatory planning systems restricted certain developments in certain locations because of the negative external effects, land use planning based on property rights theory would assign property rights over the negative external effects that are now left in the public domain (van der Krabben, 2009). Some studies find planning approaches rooted in the activities of making, implementing and enforcing legal rules for property rights over land and building.

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Such 'planning by law and property rights' (Hartmann and Needham, 2012) is seen as unavoidable and indispensable in a society with a rule of law.

The paper gives a critical overview of framework of property rights regime over land, as an integral system of legal and conventional rules concerning property rights, and urban construction and agricultural land regulation in Serbia, created in specific, post-socialist, environment. The paper discusses /questions how land issues are positioned within property rights regime and how property rights to land are treated within land (planning) regulation. In this regard, the authors discuss in particular redefinition of property rights over land, processes of privatization and restitution of land.

THE LAND USE REGULATIONS AND PROPERTY RIGHTS REGIME IN THE POST-SOCIALIST DISCOURSE: A BRIEF OVERVIEW

In the past two and a half decades, the region of Central and Eastern Europe was marked by multiple structural transformations, which have been analyzed widely, with a prominent focus on political and spatial restructuring and economic development (Andrusz, 1996; Tosics, 2006), institutional and spatial (and urban form) changes (Taşan-Kok, 2006; Tsenkova, 2006; Stanilov, 2007; Nedovic-Budic *et al.*, 2012), land privatization and restitution (Savas, 1992; Sutela, 1998; Heller and Serkin, 1999; Karadjova, 2004, Murie *et al.*, 2005), socio-economic changes (Vujošević and Nedović-Budić, 2006), etc.

In socialism, both urban and agricultural land was subject to strict state control, with limited or non-existent free market, while land policy was driven by: an ideological belief in the common or social ownership of property; the allocation of resources according to centralized planning including state intervention processes; and the associated suppression of the individual private ownership rights in property (Dale and Baldwin, 2000).

Due to changing of land policies, deregulation, privatization and restitution processes, redefinition of land property rights became very prominent in the post-socialist discourse and influenced land planning and management. The focus was on land use regulation as a key component of free market economy, whereby urban land has major role, and the transfer of real estate from the public to private sector, which caused new environments for land markets and land development processes in the countries in transition. Regarding essential role of land in agriculture, property rights in

this area are very important and often are a source of tension among various stakeholders. Without a developed land market for and the rights to long-term land lease, it is not possible to create conditions for the development of more efficient agricultural production (Popović *et al.*, 2011).

Research on post-socialist transition in Serbia was mainly focused on key macro-economic imbalances and political environments (Mijatović, 2008), theoretical approaches to planning in transition (Vujošević, 2002; Vujošević, 2003), planning of territorial capital (Vujošević *et al.*, 2010), actors in urban development processes (Vujović and Petrović, 2007; Petovar, 2010) and on urban land issues (Mijatović, 2008; Zeković, 2008; Nedovic-Budic *et al.*, 2012). This paper aims to give a contribution to land issues (urban and agricultural) in post-socialist context with special reference to property rights aspects.

PROPERTY RIGHTS REGIME OVER LAND IN SERBIA

The primary property right is the right to ownership, the highest entitlement that provides its holder the right to use, enjoy and dispose of his right.

Our legislation recognizes the rule *superficies solo cedit*, which means that object constructed on land succeed property rights of that land and belong to the owner of the land. The *Law on Basis of Ownership and Proprietary Relations* stipulates the *acquisition of property rights* based on: the law, a legal transaction, inheritance and government's decision. On the basis of the law, the property right is acquired by creating new things, by building on another's land, acquiring ownership from a non-owner, by occupation and in other cases specified by law. Thus, owners of buildings that were built on publicly owned land maintained the right to use the land on which the building was constructed and the land that served for regular use of the building. The *Law on Real Estate Transfer* prescribes that the transfer of ownership of the building also implies the transfer of ownership of the land under the building and on the land needed for its regular use. In this manner, the building and land are a unique legal object, so property right to building and property right to land are inseparable.

According to the *Constitution*, the right to use and dispose of the land (agricultural, forest and urban construction land) in **private property** is free (Art. 88). Still, although all property rights are legally protected, such rights may be revoked or limited:

- in order to eliminate the risk of harm to the environment or to prevent violations of rights and legally based interests of the others,
- in the public interest, or the law may restrict the *manner of property use*.

Public interest is determined in accordance with the *Law on Expropriation*, as a legal way of acquiring state assets[2], which provides adequate compensation for expropriated agricultural arable land by giving in ownership other suitable land of the same type and quality, or the corresponding values in the nearby area. If the user of expropriation is not able to offer a suitable agricultural land, compensation is determined in adequate value of the land in the given area. However, in accordance with the *Law on Agricultural Land – LAL*, agricultural land used for the exploitation of mineral resources or for other purposes that do not have a permanent character (i.e., in cases where land use change is made for the specified time, until the end of the exploitation period) is coming to an appropriate use, respectively, to habilitate for agricultural production according to recultivation project. The new holder of entitlement can use the land obtained by expropriation only for public purposes, and expropriated property can be returned to the former owner.

There are controversies in *agricultural land disposition* between the provisions of the Constitution (Art. 85) and the *Law on Privatization* (Art. 12), which allow foreign physical and legal subjects to acquire the real property, and the LAL, as law *sui generis*, which forbids foreign citizens and companies to have ownership over agricultural land in Serbia.

The Stabilization and Association Agreement (SAA) also implies the obligation of the Republic of Serbia to enable EU citizens to acquire property rights to real property, including agricultural land, by 2017[3]. According to the SAA provisions, within four years from the entry into force of this Agreement, Serbia shall progressively adjust its legislation concerning the acquisition of real estate in its territory by nationals of the Member States of the European Union to ensure the same treatment as compared to its own nationals (Art. 63.3). Also, subsidiaries of

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[2] In former (real) socialist states public interest was an instrument for enabling various activities, and carriers of those rights were clearly defined – only actors from the state/common sector could be the beneficiaries of public interest (Petovar and Jokić, 2011).

[3] It should be pointed out here that some EU countries (e.g., Hungary, Lithuania, Slovakia) are making great efforts to delay the entry into force of the SAA provisions regarding enabling foreigners to acquire agricultural land, in order to prevent the misuse of agricultural land (Živanović Miljković, 2014).

Community companies shall, from the entry into force of this Agreement, have the right to acquire and enjoy ownership rights over real property as Serbian companies and as regards public goods/goods of common interest, the same rights as enjoyed by Serbian companies respectively where these rights are necessary for the conduct of the economic activities for which they are established (Art. 53.5b).

As it is certain that it is impossible to change the SAA provisions subsequently, the amendments to the provisions to domestic laws which regulate this area should be considered, in the direction of tightening the conditions for obtaining and disposing of agricultural land. Along with the Law on Agricultural Land, issues related to the acquisition and disposal of agricultural land are also regulated by other regulations concerning inheritance, concessions, privatization and others.

As Holden and Otsuka (2014) stated, more secure property rights and removal of restrictions on land markets have the potential to create both efficiency and equity benefits, but there are high risks of elite capture of large land areas with inefficient and inequitable outcomes.

Foreign as well as Serbian investors are interested primarily in large agricultural parcels. The state owns more than half of the parcels larger than 50 hectares, and, according to the assurances of the officials from the Ministry of Agriculture, they will not be subject to sale. In addition, the new Draft of the Law on Agricultural Land, whose adoption is expected by early 2015, will enable farmers, physical persons, to have a right of pre-emption of land, with the requirement that they should be residents in the territory in which the land is located (Nova Ekonomija, 2014).

CHANGES IN PROPERTY RIGHTS REGIME OVER LAND IN SERBIA AND ITS EFFECTS

Transitional period in Serbia enacted many changes and challenges very important for land property right regime. Unresolved property rights are permanent problem, particularly for objects constructed on land over which other owners or holders held rights (Popović and Živanović Miljković, 2013). Accordingly, illegal construction has begun in completely disordered circumstances of inefficient cadastre and land registry, unresolved property issues, undefined status of construction land, etc. (Živanović Miljković and Popović, 2014). However, direct effects on land property rights regime have the following changes, characteristic for transitional period:

• **redefinition of property rights**,

• **land privatization**, and
• **land restitution** issues.

Redefinition of property rights. Redefinition of property rights in Serbia was introduced by the *Constitution* in 2006, which recognized three forms of ownership – *private*, *public* (i.e. state property, the property of the autonomous province and local government property) and *cooperative*, and abolished *social property*, thus such property became private property under the terms, on manner and within the time limits prescribed by law.

As mentioned above, the right to use and dispose of the **agricultural land in private property** is free. **Agricultural land in state ownership** is not a commodity and despite such clear legal provision derived from the LAL, agricultural land fund (and the whole sector) suffered trough transition period due to numerous irregularities, primarily related to privatization process.

Agricultural state owned land can be leased to individuals and legal entities with the compensation in the double-round public auction, including preferential right to lease, for a term of one to 20 years (40 years for fishponds and vineyards). Agricultural state owned land, which was evidenced for restitution according to the *Law on Registration and Evidence of Deducted Property*, may be leased for a period of three years at most. The new law on agricultural land is expected to define further the area of the lease of state land in order to improve its legal protection. The Ministry of Agriculture announced numerous changes related to the consolidation, land use and tender for the lease of the land, including the concessions, as a form of leasing of the state-owned land[4].

Unresolved property rights over land that was formerly in the **cooperative ownership**, precluded the access to capital markets and budget support to cooperatives[5], thus slowing down their restructuring. As stated in the *Strategy of Agriculture and Rural Development of the Republic of Serbia 2014-2020*, the identity of cooperative ownership and confidence in the cooperative system are lost.

Property rights over construction land have been changing over the past decades, too, but quite differently. During the socialist period, construction land has been in the

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[4] About 10,000 farmers cultivate around 300,000 ha of state owned land and based on lease, in 2013 around 60 million euros were paid to the budget of Serbia (Radio-televizija Vojvodine, 2014).
[5] Not until 2013 the cooperatives were able to use direct incentives for registered cooperative property (OG RS, No. 85/2014).

legally very complex, economically inefficient system of *social property*, which did not allow a rational use of construction land, by excluding such land from economic transactions. *The Law on Construction Land* (1995) provided *state ownership* over public construction land, which also could not be a commodity. Since 2003, the *Law on Planning and Construction* has regulated construction land use and regulation. Apart from public construction land, this Law introduced the category of *other construction land*, which could be in all forms of property rights and is considered as a commodity.

The *Law on Planning and Construction – LPC* (2009) prescribed construction land as land provided for construction and for regular use of constructed objects, and the land on which buildings are constructed in accordance with the law and the land used for regular use of constructed objects. It may be in all forms of ownership[6] and it is a commodity. Nevertheless, many conflicting, and hence non-applicable provisions, caused numerous changes and amendments to the Law. The LPC stipulates the framework for main issues on planning and construction (e.g. urban planning and construction permitting procedures), but also for some other important land policy issues, for which it is not *sui generis* (Nedovic-Budic *et al.*, 2012; Živanović Miljković and Popović, 2014).

Privatization. Although privatization had strong economic and political motives and was mostly seen as a step in the process of transition to market economy in all post-socialist environments[7], various privatization laws presented during the last two decades in Serbia gave poor results in privatization process and reasons for that are numerous. Very specific economic system and property regime of social property and residuals of the old system of self-management hampered this process, while conflicting interests led to frequent amendments to the regulations in this domain, stagnation and the wrong order in their adoption and impulsive steps in practice, resulting in compromising privatization as a process and also causing irreparable harm to Serbian economy (Popov, 2013).

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[6] The Republic of Serbia, autonomous provinces and local government have property rights to construction land in public ownership.
[7] At contrast, according to Havel (2014), Bromley (1992, 2000) argues that privatization is neither *necessary* (because many agricultural problems were unrelated to the ownership structure of land) nor *sufficient* (because in the absence of coherent factor and product markets, incentive structures would be flawed, new owners would be deprived of needed inputs, and their output would languish in fields and storage facilities).

Implemented with low legitimacy (for more details cf. the Anti-Corruption Council reports for the years 2003 and 2012), privatization of **agricultural land** caused many dilemmas within scientific community (for detailed discussion cf. Pejanović *et al.*, 2011) and besides that, in numerous cases it resulted in termination of the privatization process of socially-owned enterprises (SOEs), restructuring of socially-owned enterprises and nationalization and resale, especially in the agricultural sector. The untimely adoption of the *Law on Public Property* and non-regulation of the status of cooperative land caused the privatization of many enterprises without previously solving ownership rights to the land and made the implementation of the Law on Restitution difficult (Popović and Živanović Miljković, 2013).

Adopting the LPC 2009, local governments became the owners of the **construction land**, which they could sell to private persons or give long-term leases on it. The Law prescribes this should be done in a competitive process (trough standard models, by the price which cannot be lower than the market price), but only for construction purposes and based on the planning documentation which regulates location permission.

The LPC provided for the privatization of construction land by *conversion of the right to use into ownership* in two ways:

– **free of charge** – for the Republic of Serbia, autonomous provinces, local governments and legal subjects established by the Republic of Serbia, autonomous provinces and local governments – the holders of the right to use over built and unbuilt state owned land; persons registered as holders of rights to use over built and unbuilt state owned land in the public book of the real estate records and the owners of physical parts in condominiums; and for the owners of buildings constructed on building land in public ownership for which the lease contract for construction has been concluded in accordance with previous laws on planning and construction, if the full amount of rent was paid for the period stipulated in the lease contract; and

– **with the compensation** – on built and unbuilt construction land over which business entities and other legal subjects to which are applicable provisions of the Law on Privatization and bankruptcy and enforcement proceedings, and their legal followers, have the right to use; for the holders of rights to use acquired by a purchase from a business entity or other legal entity which has been subject to privatization, bankruptcy or enforcement proceedings; for the

holders of rights to use of unbuilt construction land in state ownership which has been acquired for the construction, in accordance with laws in force before 2003, and which was not used for stipulated purposes; for the subjects which have acquired the right to long-term lease on unbuilt other construction land in state ownership; and for the business and other legal entities, holders of rights to use of built and unbuilt construction land, to which are applicable provisions of the regulations of the Republic of Serbia and bilateral international agreements, for which the restitution procedure ends. This compensation means *the market value of the construction land at the moment of land rights conversion, reduced for the costs of obtaining the right to use on this construction land.*

Although provisions regarding the privatization of public construction land by conversion of the right to use into ownership caused numerous changes and amendments to the Law, as well as to the Constitutional Court Decisions, this issue is still controversial in the new Draft Law on Amendments to the Law on Planning and Construction (2014) (The Ministry of Construction, Transportation and Infrastructure of the Republic of Serbia, 2014a). It retains the same provisions for the privatization of construction land by conversion of the right to use into ownership *without compensation*, and provides for the privatization of construction land by conversion of the right to use into ownership *with the compensation* for: companies in restructuring; sport societies and citizens' societies; persons who have acquired the construction land which was part of the property over which the holders of the right of use are companies and other legal entities to which were applied provisions of the law regulating privatization; and persons who have acquired the right to use the unbuilt construction land owned by the state for construction, in accordance with previous laws that regulated construction land until adoption of the Law on Planning and Construction (2003) or upon the decision of the competent authority, where the land was without function and was applied for conversion within the statutory deadline. The compensation represents *the market value of the construction land at the time of the submission of the application.*

These issues in the Draft did not accomplish the agreement between stakeholders[8]. In the next

period, a new law on planning is expected to be adopted which would not contain provisions related to the conversion, but these issues would be regulated by a special law on property transactions after a detailed analysis of the possible effects (The Ministry of Construction, Transportation and Infrastructure, 2014b).

Restitution. Problems regarding property rights over land multiply because restitution did not come prior to the privatization process, although that should be the case[9]. After World War II, agricultural and construction land in private ownership were nationalized, confiscated and expropriated (mostly free of charge) based on a set of laws.

Although the ownership is normally protected with revindication, in our practice the *Law on Property Restitution and Compensation*, which proclaims the principle of priority of restitution in kind, was not adopted until 2011. Nevertheless, this principle is significantly narrowed by numerous exceptions. Hence, the subject of the restitution in kind cannot be land that was meanwhile privatized, given to the long-term leasing, built and reserved by planning regulation for the construction of objects of public interest and objects used for the implementation of economic development projects, land for regular use of the objects that are in the process of legalization, etc.

For the former owners, restitution in kind can be conducted for agricultural state-owned land and the limited fund of the state bonds as compensation. In addition, the Law does not allow return of the right of ownership over real property that is sold or acquired in the privatization process as assets or equity entities of privatization, in accordance with the Law on Privatization. However, significant number of exceptions from restitution in kind enjoy a serious lack of adequate public interest, which would justify its existence (Samardžić, 2012).

Under the provisions of this Law, about 1,930 hectares of agricultural land[10] and about 76 ha of unbuilt urban construction land in Serbia have been restituted so far, with 63 ha of unbuilt urban construction land only in Belgrade (The Agency for Restitution of the Republic of Serbia, 2014).

The LPC stipulates paying an amount of 50% of financial means provided on the basis of the conversion of rights of use into ownership into special fund for restitution. Nevertheless, the

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[8] According to the relevant Minister, the Republic of Serbia has the obligation to harmonize these provisions with the EU legislation, according to which all must pay for the conversion, but there are also opposing efforts on the part of the investors (The Ministry of Construction, Transportation and Infrastructure of the Republic of Serbia, 2014b).

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[9] In some countries (e.g. Hungary, Slovenia) was introduced type of privatization, which happened along with restitution (Murie *et al.*, 2005).

[10] Part of confiscated agricultural land fund (about 200,00 ha) has been already restituted in previous period.

manner of conversion of rights to use into ownership over construction land provided by the LPC directly prejudice the provisions of the Law on Restitution and definitely preclude the enforcement of restitution in kind and fair compensation for the owners of land that was meanwhile constructed.

Generally, full property rights on construction land are accepted basis for all kinds of partnerships, especially if they open up the possibility for greater involvement of private funds in the financing of public utilities and other activities (e.g. joint investment in equipping the land). In order to achieve public-private partnerships, the LPC stipulates that unbuilt construction land in public ownership may be included as a founding stake in the company's initial capital and that the owner of construction land in public ownership may conclude a contract on joint construction of one or more objects with physical or legal subjects. Such provisions are supported by the Law on Public Ownership, but this Law also stipulates that public company which has acquired ownership over construction land in such cases cannot sell it or give it for a long-term lease without the prior consent of the public company founders, whereas selling or long-term leasing has to be done by the procedure prescribed by the LPC.

FINAL REMARKS

With the adoption of laws and by-laws, the institutional and regulatory framework for agricultural and urban land in Serbia was created, but overall conclusion is that planning instruments and management of land are not harmonized with transition reforms.

The paper shows that changes in property rights regime over land in Serbia have numerous negative effects. The process of restitution is yet to be conducted, while possibilities for restitution in kind are very limited. The conversion of land that is not subject to restitution reduces state property without providing the income based on adequate market price. Any reduction of state property permanently eliminates the income on the basis of the use of such property, which should be the budget revenues (Bušatlija *et al.*, 2012). Thereby, resolving property rights over land is very important both for social issues and for the economy (it affects the investor's decisions, budget revenues, etc.). As the success of privatization depends on the implementation of restitution, that process should be obligatory. In that regard, strengthening of land administration (registration and titling property rights, with

resolution of land disputes) should follow these processes.

Developed land rental and land sale markets are necessary preconditions for land use efficiency in agriculture. In doing so, the preservation of national interests, especially the interests of family farms, which represent a backbone of sustainable agriculture and rural development of the country, by relevant, well-tailored, national legislation must be taken into account.

Since by-laws and other regulations have not had productive effects on assessment or appraisal of the market value of construction land (Zeković, 2014), this issue is further coupled with land conversion, compensation issues, restitution, etc. Accordingly, the property rights over land and its proper involvement in land use regulations and, hence, overall land policy, are yet to be done, which is supported by the urgency of mutual harmonization of documents in this area (the LPC, the LAL), which should correct – if not preclude – often bypassing the regulations and laws in the past period.

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THE GEOMETRY OF TRIFOCAL CURVES WITH APPLICATIONS IN ARCHITECTURE, URBAN AND SPATIAL PLANNING

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In this paper we consider historical genesis of trifocal curve as an optimal curve for solving the Fermat's problem (minimizing the sum of distance of one point to three given points in the plane). Trifocal curves are basic plane geometric forms which appear in location problems. We also analyze algebraic equation of these curves and some of their applications in architecture, urbanism and spatial planning. The area and perimeter of trifocal curves are calculated using a Java application. The Java applet is developed for determining numerical value for the Fermat-Torricelli-Weber point and optimal curve with three foci, when starting points are given on an urban map. We also present an application of trifocal curves through the analysis of one specific solution in South Stream gas pipeline project.

Key words: *Fermat-Torricelli-Weber point, trifocal curve, Java applet.*

HISTORICAL CONCERNS OF OPTIMAL LOCATION

The Fermat problem is given in original Latin as (Fermat, 1679): *'datis tribus punctis, quartum reperire, a quo si ducantur tres rectae ad data puncta, summa trium harum rectarum sit minima quantitas'* or in the English translation 'for three given points, the fourth is to be found, from which if three straight lines are drawn to the given points, the sum of the three lengths is minimum' (Brazil *et al.*, 2013). French mathematician Pierre de Fermat in XVII century in a private letter to Italian physicist and mathematician Evangelista Torricelli (Torricelli *et al.*, 1919) stated a problem of finding a point with following property: the sum of distances from one point to the vertices of a given triangle is minimal. The first solution of this problem was given by Torricelli with three equilateral triangles over the sides of the initial triangle and three circumcircles of equilateral triangles. Then the point of intersection of these circumcircles is solution of Fermat problem and it's called Fermat-Torricelli point *F* (Figure 1). This point in literature is known as the fifth significant point of the triangle

(Mladenović, 2004) and this point is said to be the first triangle center discovered after ancient Greek times (Volek, 2006).

Next step in the research of Fermat's problem was given by Bonaventura Cavalieri. He proved that three line segments from vertex of the triangle through the Fermat-Torricelli point (short dash line on Figure 1) determined angles of 120° (Kirszenblat, 2011).

Vincenzo Viviani, the pupil of Torricelli and disciple of Galileo, had published Torricelli's solution (Pérgamo and Viviano, 1695), which in modern terminology was given by Heinrich (1965):

1. If all angles in *ΔABC* are less than 120°, the point *F* that minimizes the sum of its distances from vertices *A, B, C* is the that point inside *ΔABC* at which ∠*AFB* = ∠*BFC* = ∠*CFA* = 120°.

2. If some angle of *ΔABC* is 120° or more, say the angle at *C*, then *F=C*.

One century later, English mathematician Thomas Simpson in his paper *Doctrine and Application of Fluxions* (Simpson, 1750) simplified the previous Torricelli construction. He connected the outside vertices *A₁*, *B₁*, and *C₁* of equilateral triangles with appropriate vertices of the initial triangle *ΔABC* (long

dashed line on Figure 1). The point of intersection of Simpson's lines is the Fermat-Torricelli point *F* (Kirszenblat, 2011).

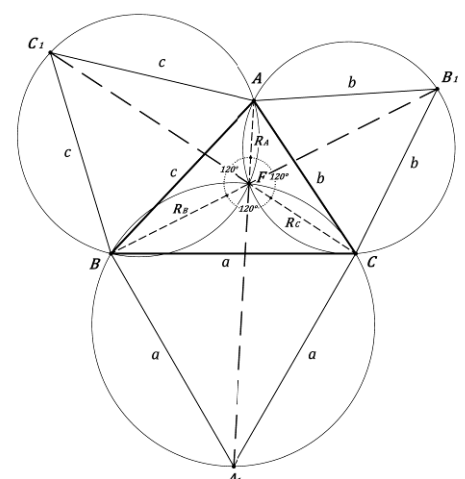One upper bound of the sum of distance from the interior points to the vertices of initial

Figure 1. The Torricelli construction of Fermat's point

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triangle is given with the following inequality:

$R_A + R_B + R_C < max\{a+b, b+c, c+a\}.$

This inequality was given by Dutch mathematician Visschers (Crux, 1997) and it is proved by Romanian mathematician József Sándor (Sándor, 2005).

The Fermat-Torricelli point is the default point for optimal location in sense of the minimal sum equal weight distance from the point to vertices of triangle as considered by Austrian economist Alfred Weber (Weber, 1929). Weber's problem was later expanded on weighted problem with three points: find the location for factory such that transport costs to the factory from three resource suppliers are minimized, provided that the appropriate distances are multiplied by weight factors of objects that signify their importance to production process.

LOCATION PROBLEMS

These fundamentals of optimization problems of Fermat-Torricelli-Weber type are a good foundation for location analysis. Let us emphasize that Location analysis, Graph theory, Mathematical programming, Game theory and others belong to the area of Operational research. Location problems themselves have great application in Urbanism, Architecture, Traffic, Industry (Boltyanski *et al.*, 1999, Drezner and Hamacher, 2002, Volek, 2006, Teodorović, 2009, Watanabe *et al.*, 2009). Current division of location problems to continuous, discrete and network (Mladenović, 2004) was based on the idea where to locate objects; if they are in the plane; what number of objects are serviced; in what way to allocate clients who demand service in objects, etc. If it is possible to locate object in any point of considered region than the problem in question is continuous location problem. With discrete location problem object location is possible only in the predetermined set of points. With network model of the location problem, field of possible new location is anywhere on the given network; set of vertices on it is finite, and the set of arcs that connect vertices is continuum.

Classification of location problems (Teodorović, 2009) is also possible based on characteristics of certain location problems toward:

- Number of objects on network (one or more objects);
- Allowed places for object location (continuous or discrete location problems);
- Type of objects on network (medians, centers or objects with predefined system performance);
- Type of algorithm used for solving location problem (exact or heuristic algorithm);
- Number of criteria functions on which object locations are based (one or more criteria function).

METRIC IN LOCATION PROBLEMS

Choice of a metric for measuring distance is of fundamental importance for solving location problems. Metric is defined by nature of the problem. Most common metric for solving location problems is Euclidean distance, and often that is the Euclidean distance with correction factor. Statistically it has been shown that measuring distances by roads gives 10-30% longer distances than corresponding Euclidean distance (Teodorović, 2009). If location problem in question is of urban nature and streets of the considered city are perpendicular to each other, than the distance is best determined by taxicab metric (Farahani and Hekmatflar, 2009). Location problems are most commonly connected to the plane. Still, as Earth's surface can be approximated by plane only in small dimensions, it is only logical that instead of Euclidean geometry, Riemann geometry is used. In that case, the shortest distance between two cities (objects) is given by geodesic line. These lines are curves whose geodesic curvature is equal to zero in any point. On the sphere, geodesic line is great circle or orthodrome. Loxodrome is another geodesic line which is used for determining the distance between two points on sphere. Sea lines of communication are mostly loxodromic, so solving location problems in waterway traffic is conditioned also by loxodromic distance.

Let us note that Minkowski distance of the order p:

$$d_p = \left(\left| x_A - x_B \right|^p + \left| y_A - y_B \right|^p \right)^{\frac{1}{p}}$$

for two observed points $A(x_A, y_A)$ and $B(x_B, y_B)$ is considered for value of parameter $p \geq 1$ (Farahani and Hekmatflar, 2009). Especially for value of $p=1$, Minkowski distance determines Manhattan, or the city block distance (short/long dashed lines on Figure 2), while for $p=2$ Minkowski distance determines Euclidian distance (continuous line on Figure 2).

Naturally, the term 'distance' can also consider time distance, cost of travel or any other variable relative for location problem.

TRIFOCAL CURVE AS MODEL FOR SOLVING LOCATION PROBLEMS

Scottish physicist and mathematician James Clerk Maxwell wrote his first scientific paper (Maxwell, 1847) in area of mechanical meaning of drawing mathematical curves (Harman, 1990): ellipse – curve with two focuses
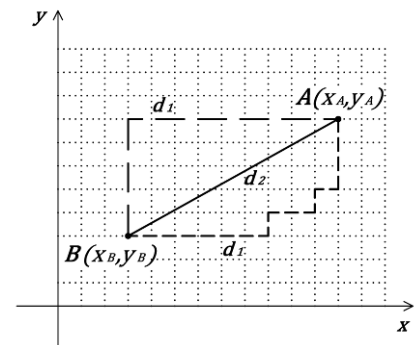
Figure 2. Distances between two points

and curves with more than two focuses.

Standard definition of trifocal ellipse is given by the following equation:

$$R_A + R_B + R_C = S \qquad (1)$$

where:

$$R_A = \sqrt{(x - x_A)^2 + (y - y_A)^2},$$
$$R_B = \sqrt{(x - x_B)^2 + (y - y_B)^2},$$
$$R_C = \sqrt{(x - x_C)^2 + (y - y_C)^2}$$

Euclidean distances of the point $M(x,y)$ to three foci $A(x_A, y_A)$, $B(x_B, y_B)$, $C(x_C, y_C)$ and for given parameter $S>0$. The Fermat-Torricelli point determines the minimal value of parameter $S=S_0$. If $0<S<S_0$ then trifocal ellipse doesn't exist, and for $S>S_0$ trifocal ellipse is a non-degenerated egg curve. In that case, the following names are applied for curve: egglipse, trisoid, polyellipse, trifocal ellipse, 3-ellipse, multifocal ellipse, etc. (Sahadevan, 1974, 1987; Melzak and Forsyth, 1977; Erdös and Vincze, 1982; Sekino, 1999; Khilji, 2004).

These curves have oval shape and their construction is well known even from seventeenth century, but only in relation to Descartes construction of multifocal curves (Descartes, 1638). Maxwell construction has given certain simplifications (Mahon, 2003).

Weber's expansion of Fermat-Torricelli point takes in consideration the following equation

$$w_A R_A + w_B R_B + w_C R_C = S$$

where w_A, w_B and w_C are positive real values, weight factors.

Let us notice that research of egg curves in engineering and their constructive geometrical solving are very contemporary because of ergonomics of their ovoid, bionic form (Rosin, 2000, 2004, Petrović, 2010, Barrallo, 2011). Also, the application of these curves on different problems of Fermat-Torricelli-Weber type are given in papers from theory of optimization (Soothill, 2010, Kupitz *et al.*, 2013).

P.V. Sahadevan was the first to introduce the term egglipse – a new curve with three focal points (Sahadevan, 1987). Sahadevan also introduced a classification of trifocal ellipses with collinear focuses in two categories. Trifocal ellipse is considered abnormal if focus F_3 is located at the middle of segment formed by F_1 and F_2, and if not, it is considered as normal (Sahadevan, 1974). By analyzing normal trifocal ellipse Sahadevan had found parametric equation of this curve and calculated area, using elliptic integral of first order. Varga and Vincze had also given similar parameterization of trifocal ellipse (1), (Varga and Vincze, 2008). The area of this closed curve was also determined using program package Maple. In literature we couldn't find procedure for finding perimeter and area of trifocal curve for non-collinear foci (Figure 3) so special subroutine was developed in Java applet for calculation of their approximate numerical value.
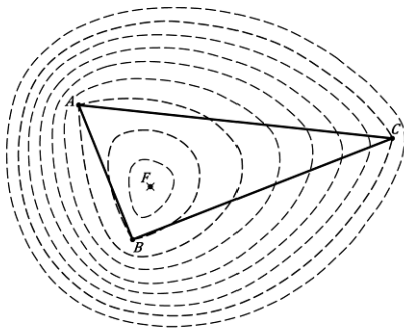
Figure 3. Trifocal ellipses with non-collinear foci

Subject of this paper is the trifocal ellipse (1). Let there be given expressions:

$Q_1=(x-x_A)^2+(y-y_A)^2$,
$Q_2=(x-x_B)^2+(y-y_B)^2$,
$Q_3=(x-x_C)^2+(y-y_C)^2$, and
$S=const, S>S_0$.

Let us consider the following algebraic transformations of equation (1):

$$\sqrt{Q_1} + \sqrt{Q_2} + \sqrt{Q_3} = S,$$
$$\sqrt{Q_1} + \sqrt{Q_2} = S - \sqrt{Q_3},$$

by first squaring we obtain

$$\left(\sqrt{Q_1} + \sqrt{Q_2}\right)^2 = \left(S - \sqrt{Q_3}\right)^2,$$
$$Q_1 + 2\sqrt{Q_1}\sqrt{Q_2} + Q_2 = S^2 - 2S\sqrt{Q_3} + Q_3,$$
$$2\sqrt{Q_1}\sqrt{Q_2} + 2S\sqrt{Q_3} = S^2 + Q_3 - Q_2 - Q_1,$$

by second squaring we obtain

$$\left(2\sqrt{Q_1}\sqrt{Q_2} + 2S\sqrt{Q_3}\right)^2 = \left(S^2 + Q_3 - Q_2 - Q_1\right)^2,$$

$$8S\sqrt{Q_1}\sqrt{Q_2}\sqrt{Q_3} = S^4 - 2S^2Q_3 - 2S^2Q_2 - 2S^2Q_1$$
$$-2Q_3Q_2 - 2Q_3Q_1 - 2Q_1Q_2 + Q_1^2 + Q_2^2 + Q_3^2,$$

and by third squaring we finally obtain

$$\left(8S\sqrt{Q_1}\sqrt{Q_2}\sqrt{Q_3}\right)^2 = \left(S^4 - 2S^2Q_3 - 2S^2Q_2 - 2S^2Q_1\right.$$
$$\left.-2Q_3Q_2 - 2Q_3Q_1 - 2Q_1Q_2 + Q_1^2 + Q_2^2 + Q_3^2\right)^2,$$

which in the end determines algebraic curve of eight order:

$$64 S^2 Q_1 Q_2 Q_3 = \left(\left(S^2 + Q_3 - Q_2 - Q_1\right)^2\right.$$
$$\left. - 4Q_1Q_2 - 4S^2Q_3\right)^2 .$$

The trifocal ellipse is one part of the previous curve, which is presented by Nie *et al.* (2008) using representation by the appropriate determinant. Analog conclusion also derives when considering Weber weighted variant of Fermat-Torricelli point. Let us emphasize that trifocal curves have natural application in multiple optimization problems. In the interior of trifocal curve of level S we obtained the following inequality:

$$S \geq w_A R_A + w_B R_B + w_C R_C \geq S_0 .$$

In the case $S=S_0$, we obtained Fermat-Torricelli-Weber point. If this point has inconvenient position in the sense of urban and spatial planning, then we determine the whole interior of trifocal curve as an appropriate solution for the point for which the sum of weighted distances is under or equal to the value of S.

JAVA APPLICATION FOR VISUAL REPRESENTATION OF TRIFOCAL CURVES

In this paper we describe the application which was developed in programming language Java, whose purpose is to determine weighted Fermat-Torricelli point based on image input in application. Our application was developed in programming language Java since it was intended to be available over the internet. One of the basic goals of this project was for the application to be available for all researchers in this field, which asked for platform independent programming language, such as Java, to circumvent a need for several separate distributions of the application. Because the application was developed as an applet, and has a wide spectrum of functionalities, as well as new changes that company Oracle has introduced to runtime environment of programming language Java about digitally signing all files, when application is run, security question pops up which has to be answered confirmatively. As the application was intended to be available free of charge, no digital key from certified organization was available. Internet application is

available as 3-Ellipses software on webpage http://symbolicalgebra.etf.bg.ac.rs/Java-Applications/3-Ellipses/index.html.

While developing Java applet, two types of graphical representations were implemented. The first type of graphical representation defines the interior of trifocal ellipse for the given triangle of foci and parameter S, as well as area and perimeter of region defined by it. Calculation of the area and the perimeter was determined by approximating graphical-numerical methods. Also, accuracy estimate of considered calculation was determined. For higher precision it is necessary to use Calculus by computer algebra systems as Maple (Zuber and Štulić, 2006) or Mathematica (Groß and Strempel, 1998, Petruševski *et al.*, 2010). The second type of graphical representation defines trifocal isolines under condition $d_1+d_2+d_3=S$ $(S \geq S_0)$, which are represented in a graphic box. Parameter $S=S_0$ is value for which trifocal curve degenerates into Fermat-Torricelli point. Isolines are calculated only in defined rectangular region (graphic box), in which we also calculate points where the value of sum $d_1+d_2+d_3$ is minimal and maximal.

For any initial values of coordinates of the points A, B and C, the lengths d_1, d_2 and d_3 are modified into weighted lengths $w_A \cdot d_1$, $w_B \cdot d_2$, $w_C \cdot d_3$ by use of sliders where w_A, w_B, w_C which have the range of decimal values from 0 to 10. Sliders w_A, w_B, w_C have default value of 1 and are positioned in the right corner of the application main window. If graphical representation of curve is active, one additional slider is present for parameter S, which can have a decimal value from 0 to 2000.

In the applications menu bar several sections of program options are located. In section labeled Mode, users can select option Curve for graphical representation of trifocal ellipse or by selecting option Color mapping transfer to isolines representation (Figure 4a).

In menu labeled Opacity users can select a level of the opacity of graphical representations. Offered options are 20%, 40%, 60%, 80%, 100% and the custom level of the opacity where users are prompted in a dialog to input decimal value ranging from 0 to 100 (Figure 4b).

One of functionalities that was developed in the application is setting of the background map to graphical representation. In the menu labeled Background, users can select from several predefined maps for background, remove background image, or input background image of their choosing (Figure 4c).
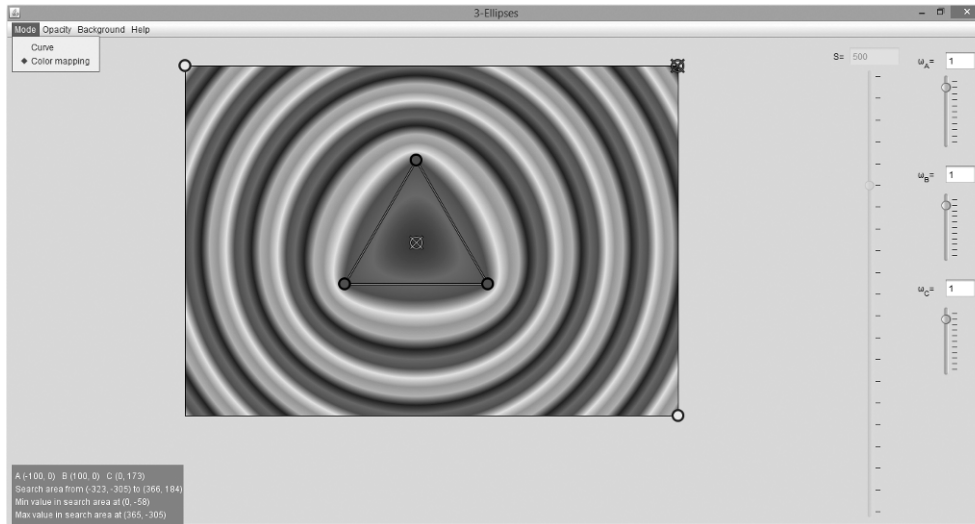
a) Mode users
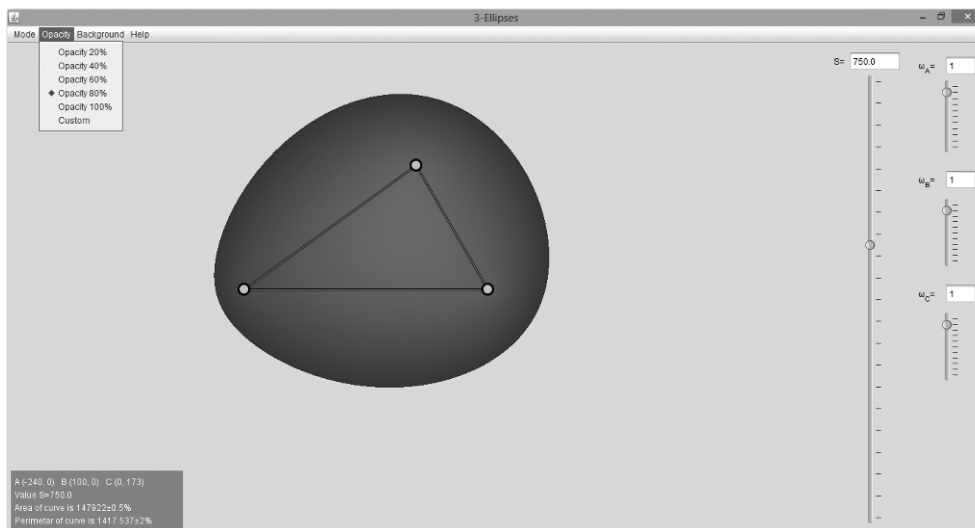
b) Opacity
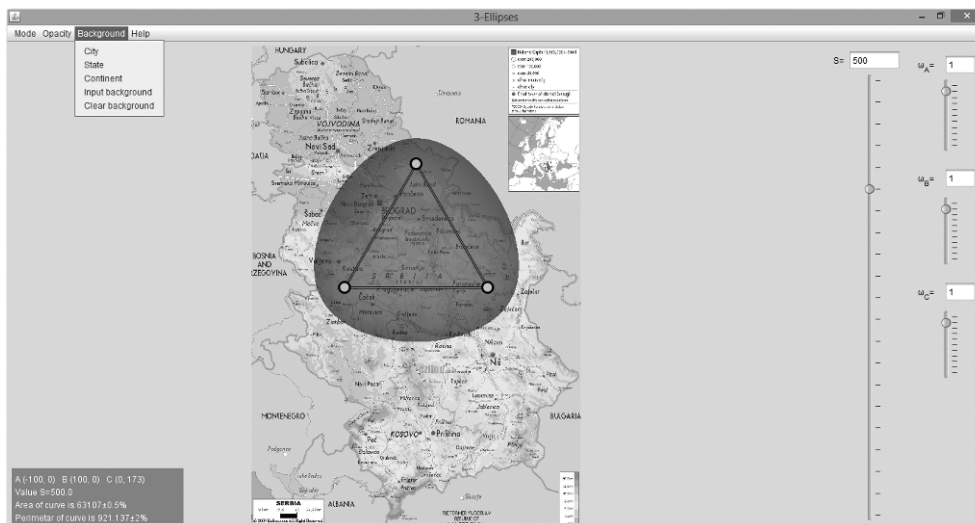
c) Background

Figure 4. Java applet labels

EXAMPLES OF APPLICATION OF JAVA APPLET IN URBAN AND SPATIAL PLANNING

In this part of the paper we shall conduct the analysis of application of Fermat-Torricelli point for three given points, i.e. locations/cities in whose near proximity South Stream pipeline is located.

Gas lines start from southern part of Russia, close to Beregovaya city at the bottom of the Black Sea, to Varna city in Bulgaria. The total length of the Black Sea section will exceed 900 km. The onshore section in Europe will be 1,455 km long (Figure 5).

Near Pleven city in Bulgaria was planned that the pipeline would split in two ways. One part would run from Bulgaria, over the Greece, and under the sea to Italy, and other would go accross Serbia and Hungary to Austria. South Stream will enter Serbia from Bulgaria near Zaječar, eastern Serbia, and exit near Subotica, northern Serbia.

If three given locations of Beregaya (Russia), Thessaloniki (Greece) and Subotica (Serbia) are observed, Fermat-Torricelli point would be near Pleven in Bulgaria (Figure 6a – see small trifocal curve around Pleven). On Figure 6b near Fermat-Torricelli point isolines which are trifocal ellipses can be seen. Selecting Varna (Bulgaria) instead of the location Beregaya (Russia), the developed application determines that Fermat-Torricelli point also stays near city Pleven (Figure 6c). Let us notice that the optimal point in proximity of city Pleven is acquired with values of weight factors of one in this application. It infers that both sides of the pipelines to Thessaloniki and Subotica are equally important. Graphical representation of trifocal curve, calculation of its area and perimeter for set value of $S > S_0$ is available in the application. Let us note that similar web-based support of spatial planning in Serbia was considered by Bazik and Dželebdžić (2012).

CONCLUSION

The application of trifocal curves through analysis of one specific solution in urban and spatial planning was presented in this paper. The developed Java applet for plotting of these curves had enabled visual representation of optimal solution as well as fast calculation of numerical value of parameter S (that is minimum sum of distances). The area and perimeter of trifocal curve for any initial values of coordinates of points A, B, C, parameter S, and weight factors w_A, w_B, w_C were also developed.

Our research of optimal curves will further
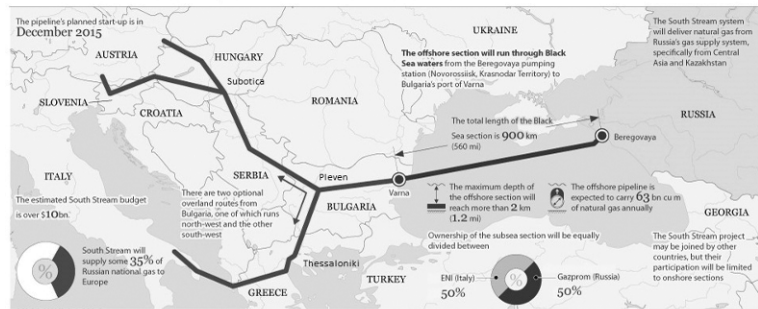
Figure 5. South Stream gas pipeline project (Oikonomia, 2013)
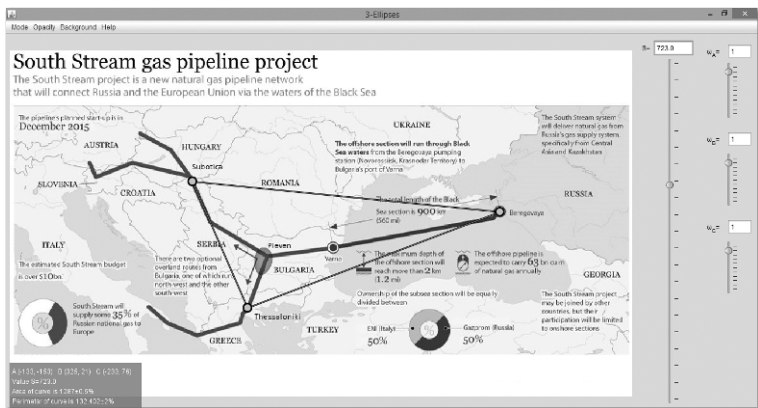
a)
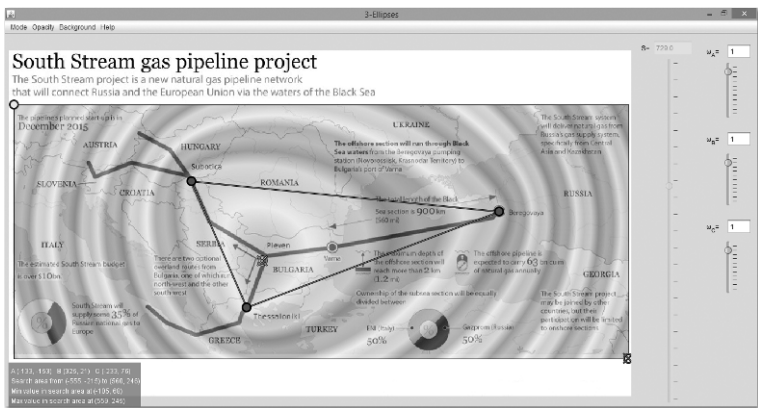
b)
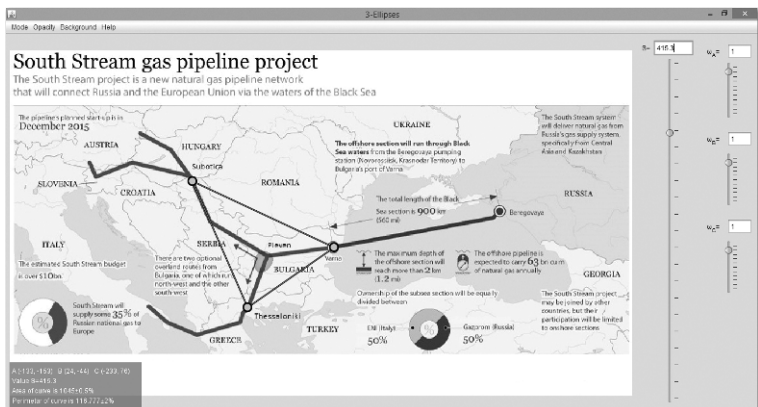
c)

Figure 6. Application of Java applet

consider curves based on *n* input points (where *n≥4*). The analytic and algebraic representation of these *n*-focal curves will also be considered. A similar line of research is also visual representation of these curves for other types of metric (Manhattan, Riemann or corrected Euclidean distance).

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BIM: PROMISES AND REALITY

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The building information modeling – BIM is a technology developed toward creation of computer based information model that encompasses whole building lifecycle. Toward that goal a number of information technology standards have been developed that enable different professions in AEC to cooperatively develop electronic building model. The paper gives overview of essential technologies, discusses their intended purpose, and gives outline of the currently achieved functionality.

Key words: Building information modeling, BIM, Open Standards, intelligent parametric elements, building energy simulation.

INTRODUCTION

Building information modeling – BIM is a collection of computer based technologies developed to support creation of electronic building model that contains definitions of all physical and functional features and required performances of building's elements and ensembles. The model includes information describing whole building lifecycle from conception, through design and construction, to facility management. The BIM is not conceived as a single monolith data repository; instead, it includes variety of programs and associated data representations relating to different disciplines, comprising architectural, engineering and construction (AEC) industry. The buildingSMART international alliance was conceived as a driving force in the development and proliferation of open interoperability standards that will provide seamless transfer of information among BIM applications. Up to now, three standards have been developed: Industry Foundation Classes – IFC, BuildingSMART Data Dictionary – bSDD (previously International Framework for Dictionaries – IFD), and Information Delivery Manual – IDM. Together with existing commercial BIM applications these technologies aim to replace traditional architectural and construction paper documentation with the computer based information model. The paper gives overview of essential technologies, discusses their intended purpose, and gives outline of the currently achieved functionality.

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BUILDING INFORMATION MODELING

The term Building information modeling (BIM) denotes a process of using information technology (IT) to model and manage data encompassing whole lifecycle of the facility (Lee *et al.*, 2006). The technology is inspired by years of research on a general data model for AEC (Eastman *et al.*, 1991; Björk, 1989), but does not follow established principles rigorously. The BIM design process means to build a facility virtually, prior to constructing it physically, in order to simulate and analyze potential impacts and work out possible problems. It is easier to fix a problem by moving element with a mouse on a computer than to demolish and rebuild elements on a construction site.

On the surface, all BIM applications implement same process. The designer selects building elements from the library of parametric three-dimensional (3D) components. The BIM components are based on principles of parametric geometry modeling (Petruševski *et al.*, 2010) with further advancements beyond mere geometric construction. Each component contains parameters describing its geometry and all intrinsic physical and functional properties. Additionally, each component contains rules that describe constraints, behavior, and relations to other objects. The BIM modeling process starts with the selection of appropriate parameter values that describe actual design situation and continues with the selection of appropriate location of the element

in the building model. Finally, according to defined rules, the element is integrated in the model (same materials in the joint elements are merged, parts of the element that become surplus in the model are trimmed, etc.). The reliance on the element libraries is the main characteristic of the BIM software. Before any actual modeling is initiated the designer is forced to think about required elements. Thus, the greatest burden in the process is shifted toward initial design phases and to the preparation of necessary information required to define building elements. That way system prevents inclusion of undefined elements in the model and prevents unforeseen work and costs that in traditional practice can often be detected only during construction phase. The elements also prevent information redundancy in the model. Once an element becomes a part of the building model all future operations refer to that unique data structure. All graphical representations (layouts, sections, perspective view or virtual reality walkthrough), project schedules or simulations use that single data structure to create required representation.

Unfortunately, this basic operation mode is all that is common to commercial BIM applications. The actual functioning depends on the core mechanism that each particular application

uses. The ArchiCAD is the oldest BIM implementation that appeared in 1987 and proclaimed the 'Virtual Building' concept. The core mechanism of the ArchiCAD is based on procedural modeling language – GDL (Geometric Description Language). Each element is defined as the GDL script that identifies 3D geometry, ways that 3D model maps to 2D representations, user interface display, behavior and listing quantities. The language is flexible and enables definition of any conceivable building element. On the other hand, the language does not provide any constraints, so each element can have its peculiar modeling process and user interface forcing a designer to learn to use each particular element from the library correctly. The Revit is the newer application that has in its core the parametric change management engine. The mechanism updates whole building model on each modification according to inter-element relationships. The elements are classified in predefined families. Each family has user selectable predefined rules that define how the element in the family relates to other elements. According to those rules each change in the element is propagated to other elements, and all related data are updated to appropriate values. A new element in the library can be created only by modifying existing families. That limits the scope of geometric forms that can be used in the model, but provides consistent behavior and user interface to all new elements reducing the need for learning how to use them. The characteristic that each Revit element belongs to a predefined family enables management of data both on element and class levels, enabling the user to change parameters belonging to all elements belonging to the same element class rapidly.

Based on these core mechanisms software manufacturers have developed a range of applications that cover different AEC fields. The MEP Modeler from Graphisoft is the ArchiCAD plug-in that enables model-based MEP networks (ductwork, pipework and cabling) design. The EcoDesigner is the built-in building energy modeling application that calculates building's yearly energy consumption by sources and targets, CO_2 emission, and monthly energy balance. The Autodesk offers Revit as the single application that incorporates features for architectural design, MEP, and structural engineering and construction from the version 2013. The range of cloud services offers further analysis of basic Revit models, like Energy Analysis for Revit and Green Building Studio for energy analysis and Structural Analysis for Revit. Both software manufactures offer different partner solutions that cover a broad range of AEC applications compatible with basic modeling applications.

OPEN BIM STANDARDS

The commercial BIM applications use proprietary data formats to represent building models, thus keeping all information locked in distinct software. The proliferation of BIM technologies has raised question of interoperability and public availability of BIM models. This objective is covered by the development of open BIM standards.

The largest open BIM regulatory body is the BuildingSMART, a neutral, international and not-for-profit organization supporting open BIM. Under their supervision three open standards are developed: the Industry Foundation Classes (IFC) data model, the Information Delivery Manual (IDM) data exchange protocols, and the buildingSMART Data Dictionary (bSDD). IFC is an object oriented data model under development since 1996 with the aim to attain highest level of interoperability in AEC industry on the level of data exchange. The currently available version is 4 (IFC, 2013), registered as the ISO 16739:2013 standard (ISO, 2013). The IFC comprises of class definitions representing not only physical components of the building, but also actors and their roles, time, price, approval, etc. The standard provides data interchange without information loss among all AEC applications, unified model-based description of all building components and relationships with other components, information on the graphical representation of components, link to property and classification data, and access to external libraries. Currently, all BIM applications support import and export of their models using the IFC standard format. Since the IFC includes all conceivable building data, and often provides different representations for the same data, it is necessary to define when and what amount of data is necessary to establish effective communication among different participants in the design and construction process. The IDM standard is developed to achieve that goal. It is registered as the ISO 29481-1:2010 standard (ISO, 2010). The IDM provides the reference for process and data requirements in BIM by identifying the distinct procedures undertaken within AEC processes, the information required for their execution, the results of that activity, and how the information should be supported by software solutions. The first result is the IFC2x3 Coordination View Version 2.0 Certification process (buildingSMART, 2010) that strictly defines the scope of IFC data needed to establish seamless exchange of the coordination model among BIM applications. The certification process is accepted by all major BIM software developers and in the 2013

BIM applications received first certifications. The bSDD standard (formerly International Framework for Dictionaries – IFD) is the classification system for all information in the AEC/FM field. It is an object-oriented framework that defines objects, collections and their relationships. The standard is registered as the ISO 12006-3:2007 standard (ISO, 2007). It is intended to work as the overarching structure that will provide support for the development of the unified AEC/FM vocabularies at the national, regional or domain levels. Since all share the same structure it will be possible to translate terms between languages and domains, preferably using automated software agents. The bSDD standard provides the capability to define context within which a concept is going to be used. Each object can have multiple names providing for the definition of synonyms or usage in different languages.

The second type of AEC interoperability formats has been developed based on the free open standards eXtensible Markup Language (XML) (Harold and Means, 2004). The XML enables the structured representation of any kind of information by the insertion of tags in the traditional text, but does not provide any mechanism to infer the meaning of the terms used in tags. One approach to the definition of a tag's meaning is the XML schema. It is a language that provides a description of a type of XML document, usually articulated in terms of constraints on the structure and content of related XML documents. Many schemas have been developed for the AEC/FM field. The gbXML (Green Building XML) schema is used for describing data relating to the building energy efficiency and its impact on the environment. The aecXML schema is used for depicting all building data in design, engineering and construction disciplines, and the CityGML schema is used for geo-spatial data representation. Also, the IFC data can be represented with the ifcXML schema. The commercial BIM applications support most XML schemas, but without strict import/export functionality examination.

BUILDING MODELING

The current BIM technology is based on implementations that use diverse core mechanisms and intrinsic element libraries. The ArchiCAD uses mechanism oriented toward geometry, while Revit is built around change management engine. Despite some differences in the basic geometry modeling algorithms it is possible to transfer any geometry between applications. But since two applications differ in the ways geometric

relations are implemented, elements often lose some of the modeling capabilities when exported to another application. Also, ArchiCAD lacks most of the inter-element relations that Revit implements. For that reason, the ArchiCAD and Revit element libraries are incompatible. This fact causes many discrepancies in the basic modeling process when using different BIM applications.

Because ArchiCAD uses GDL scripts to represent library elements it is easy to generate object's geometry on the fly and to illustrate each change of the object's parameters. That makes ArchiCAD's interface user friendly and supports effortless learning how parameter's change affects object's shape. The drawback is that object's level of modeling detail and amount of supporting information depends on the effort that programmer put in the development of the GDL script. On the other hand, the objects in the Revit are completely constructed only after their location in the model and propagation of all inter-object dependencies. For that reason, the Revit's user interface shows only basic object's representation and the designer can understand how parameter's change affects whole object only after actual location in the model. That makes Revit difficult to learn and requires experience with objects and their parameters for masterful modeling. But once learned, the same principles apply to all new objects.

The Revit has predetermined modeling sequence that depends on predefined relations among families of elements. For example, floor can not be constructed before surrounding walls are created. That means that the designer should learn the whole modeling process before starting actual modeling. The ArchiCAD does not impose any modeling sequence enabling learning by doing and facilitates experimentation in the modeling process. The modeling rigidity of the Revit has its advantages in the design modification. All relations established during model creation will be preserved during modification. For example, if the wall is moved, all connected walls will adjust their lengths to preserve established connections, and all appliances connected to the wall will be moved together with the wall. The staircase will automatically change number of steps and their dimensions to suit new floor height. The ArchiCAD will move only imbedded objects, like doors and windows, together with walls, while all other necessary modifications require user intervention (Figure 1).
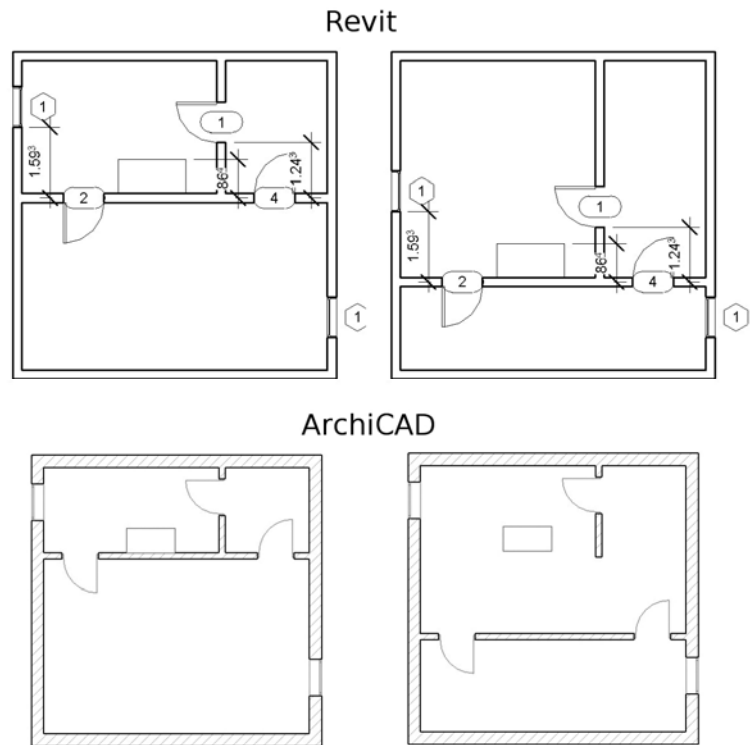
Figure 1. Example of automatic preservation of relationships among building objects in Revit and ArchiCAD

BUILDING SIMULATION

Prior to the development of BIM technology, the building simulation was considered as extremely information demanding and time consuming process reserved for outstanding buildings. Today, when models created with BIM applications contain geometric and parameter representation necessary for simulations, it looks like BIM technology is natural companion to building simulation applications. Among different simulation disciplines the design of sustainable buildings and building energy simulation gain most interest.

A lot of commercial and free energy simulation applications are available on the market (Jarić *et al.*, 2013). They can be divided in three groups: energy analysis engines, energy analysis environments, and built-in analysis applications. The energy analysis engines are oldest developed applications and contain basic computer implementations of the energy analysis algorithms. They read input information and write results in the form of the custom formatted text files. The main concern in their development is the accuracy of the implemented algorithms. The prominent engines are DOE-2 and EnergyPlus, both freeware applications. The energy analysis environments are developed to offer user friendly interface to the energy analysis engines. They enable the designer to

graphically construct building model or to use standard interoperability formats to import models from BIM applications. Some also enable export of files for further analysis. The well-known free energy analysis environment is eQUEST and among commercial applications the notable are Green Building Studio, Ecotect Analysis, Virtual Environment (IES-VE), IDA Indoor Climate and Energy, RIUSKA, etc. The built-in analysis applications are developed for the use inside the existing BIM applications with the intention to provide instant energy analysis. The whole process of transferring data from the BIM model to the energy simulation is hidden from the user and only final results are provided. Two existing built-in applications are Energy Evaluation in ArchiCAD and Conceptual Energy Analysis Tool in Revit.

The major weakness of the current energy simulation applications is that they were developed before BIM technology, when computer based information about building was scarce. Each simulation has developed simplified building representation to cope with the lack of data and whole computation algorithms are based on those energy models. Today, when BIM applications offer detailed computer based building information, it is necessary to translate this detailed model to the simplified energy model. Often, dimensional accuracy required in the BIM model for construction purposes is too complex for

analytical purposes, and adjustments are necessary to produce simplified analytical model. Also, terms of nomenclature and the definition of various parameters differ among BIM applications and analytical software. Neutral file formats like IFC and gbXML enable transfer of the data between applications but the content of the data depends on the actual simulation applications. Each application requires distinct set of data, and still there are no attempts to define standard set of data for all simulation applications. Also, there are no predefined criteria on the material and section profile names in the BIM libraries, and in the case of ArchiCAD they can vary between different implementations of the same building elements.

The results of building energy simulation applications include yearly energy consumption by sources and targets, CO_2 emission, monthly energy balance, etc. Often, simulation results are represented as charts or tables (Figure 2). Most applications aim to provide precise prediction of energy consumption and building's environmental impact in accordance with recent regulations (Pucar and Nenković-Riznić, 2007). This information is valuable for investors and regulation bodies, but has little impact on design process. The information how to build

sustainable building is still based on the designer's knowledge, not on the results of the simulation software.

CONCLUSIONS

Most commercial brochures and a lot of research papers describe BIM technology as the compact activity with common practices. The research and educational communities recognized potential of BIM technologies to unite AEC stakeholders around unified building information model (Aranda-Mena *et al.*, 2008). Based on this recognition, researchers attempted to define how the IFC can be used as the unified nonproprietary format that provides seamless interchange of the building model among AEC professions and to define what kind of paradigm shift is needed in the AEC business processes for the full BIM adoption among practitioners (Arayici and Aouad, 2010). But AEC industry remained insensitive to BIM promises mainly because neither IFC nor other BIM formats provided mechanism for the identification of information authorship, and consequently responsibility for validity of information in BIM models.

The still dominant view of the BIM as the cohesive technology gives the idea that choice between competing commercial applications is

the only concern of the future BIM user. This may be true in some distant future, but recently the BIM technology is a set of diverse and sometimes even incompatible software solutions. Also, on the current level of development, BIM is more appropriate for large companies that have architectural, engineering and construction teams, and internal IT departments. Medium and small architectural companies have more difficulties in adopting BIM technology (Coates *et al.*, 2010) and since they don't represent majority of BIM technology users, the new BIM development is directed toward large AEC companies and professional BIM services.

To use BIM technology properly on the current level of development, the designer needs to have good knowledge how the functioning of commercial BIM application fits actual design processes in the bureau (Arayici *et al.*, 2011). It is necessary to test how libraries of building elements and procedures for the creation of new elements fit actual components used in the everyday design. Furthermore, it is important to establish if the design process involves more creation of the new building components, or the modification of the existing ones. The best way is by conducting pilot projects with actual designs and different BIM applications. The
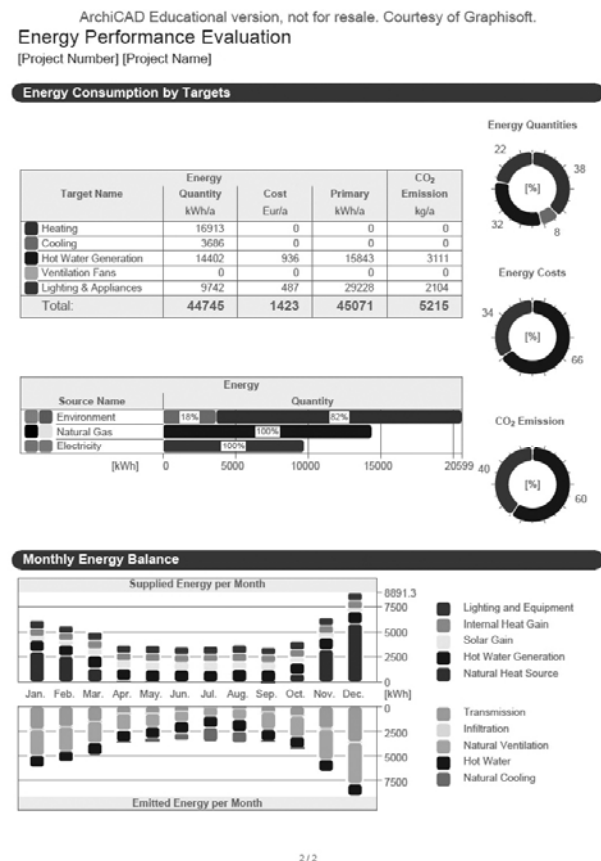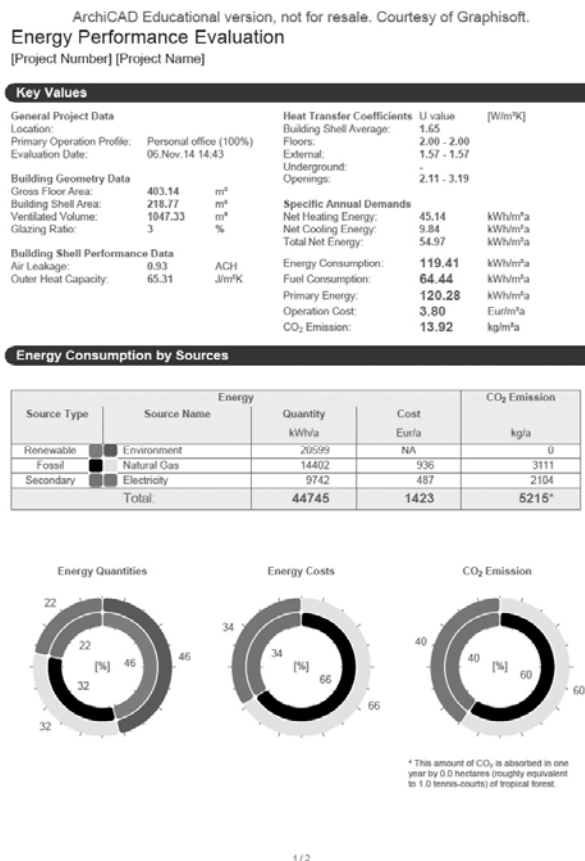
Figure 2. Example of typical results obtained by building energy simulation applications

decision on proper BIM technology also depends on other stakeholders in the design, engineering and construction process, and the tools they use in their business. It is not enough to determine that different applications import and export same data formats, but to understand the actual implementations.

On the recent level of development, the BIM technology is not a miraculous tool that solves all problems in the AEC industry. This is not the reason to reject this technology and to wait until it reaches levels of greater maturity. It should be adopted with the understanding of current limitations, and only when more designers start to require increased functionality from the existing BIM applications can we expect that developers will provide better software.

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COMPLEX URBARCHITECTONIC STRUCTURES

OF PRIŠTINA AND NOVI PAZAR CITIES

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Contemporary urban development has changed the traditional cities all over the world. In our region, the typical Balkan cities of oriental origin, structure and outlook were almost totally transformed in the second half of the 20th century. Modern movement brought new models of urban organization, different communication concepts and a variety of concepts of modern buildings. Among others, the idea of complex urbarchitectonic structures in urban tissue spread under specific influences and models. After a short review of modern urban development and the idea of complex urban structures, this paper explores urban transformation of less researched cities such as Priština and Novi Pazar. The focus is on the phenomenon of complex urbarchitectonic structures built in related cities in a short period from 1969-1989.

Four complex urbarchitectonic structures will be presented: Kičma and complex in JNA Street in Priština and Lučne buildings and Jezero buildings in Novi Pazar.

Key words: Priština, Novi Pazar, complex urbarchitectonic structure.

INTRODUCTION: MODERN MOVEMENT IN URBAN DEVELOPMENT - THE IDEA OF COMPLEX URBARCHITECTONIC STRUCTURES

Modern movement in urban development of European cities was the result of the many urban problems in the late 19th and early 20th centuries. Industrial revolution and industrialization caused sudden urbanization of existing cities and resulted in massive building density inside existing traditional cities and extensive growth of suburbs. Overpopulation and dense construction caused traffic congestion, very poor sanitary conditions, and communication problems in a new era of motor vehicles. New requirements for immediate interventions led to development of a variety of modern urban concepts, starting with ideal cities: Ledoux's Ideal city of Chaux, 'new ideal world' of Robert Owen, and ideal community 'phalange' to live in 'phalansteres' of Charles Fourier. Models for early concepts of the ideal city originated from royal palaces, from Diocletian's palace in Split, to Versailles in Paris, where unique building included different functions and represented a self-sufficient concept - an entire city or

community in one building. New building materials and technologies at the end of the 19th century enabled the covering of lit, vast spaces, first presented in the Crystal Palace for the Great Exhibition in London in 1851. The new palace emerged in metal and glass construction. It also influenced covering of entire streets, such as shopping street in Milan, Italy – The Galleria Vittorio Emanuele designed by Giuseppe Mengoni in 1865 (Barnett, 1987). Further development of modern urban idea produced different models of urban growth: interconnecting structures of a linear city (Soria Y Mata), modern Industrial City of Tony Garnier and futurist drawing of new structures of *Citta Nuova* by Antonio Sant'Elia.

Swiss architect Le Corbusier, in his rich opus, offered different urban concepts and modern architectural structures from 1920s to 1950s, where he combined his own admiration for engineering exactitude and aesthetic, his extensive research of vernacular architecture and his valorization of nature and its 'essential joys' sun, space and green. He started his urban studies with the City on Columns (*Ville Pilotis*), and then developed the idea of a modern city in the Contemporary City (*Ville Contemporaine*) for three million inhabitants, where a dense city was elevated above the surface of continuous park. The radical cuts were presented in *Plan Voisin* for Paris where he overwrote existing city tissue with

modern structures (Beganović, 2013). It culminated with the Radiant City (*Ville Radieuse*) where urban functions were strictly divided into parallel belts, adopted as the Functionalist City by the 11th CIAM (International Congress of Modern Architecture - *Congress Internationaux d'Architecture Moderne*) in 1933 (Božić, 2002). Some of the conceptual, functional, structural and aesthetic principles presented in the mentioned projects were elaborated in his complex urbarchitectonic structure of dwelling unity - *Unité d'Habitation*. With an extensive program, many functions were concentrated within one unique building containing different functional belts deployed in height. The idea was a self-contained community with 337 dwellings, shopping street on the sixth floor and variety of other functions that made it 'as much 'social condenser' as Soviet commune blocks of 1920s. This total integration of community services recalled the 19th century model of Fourier's *phalanstery*, not only through its size but also in its isolation from immediate environment' (Frampton, 1985). Unity hosted 23 types of dwellings and 26 different communal services including a hotel, a kindergarten and a swimming pool on the top of the building. (Dženks, 1982). First built in Marseille (1947-1952), and later in a few other cities, 'designed as prototype, but proved too expensive and idiosyncratic to become government policy'

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(Barnett, 1987), it had a great influence on modern architecture.

The idea of complex buildings elaborated as 'Megastructures: the City as a Building' was the 'idea of an urban area as a large, interconnected building' (Barnett, 1987) usually consisting of covered streets or bridges, plazas and various buildings connected within one structure. In the early 1950s, the influence of science fiction and comic books led to different concepts of Archigram's plug-in, or walking cities and structures in Great Britain. In Japan, the Metabolists developed the idea of enabling the addition of units to the basic structures in a variety of projects such as Kenzo Tange's projects for Tokyo Bay. These ideas spread worldwide in a short period in the 1960s and 1970s. They had a great influence on the architecture of the time: Rudolph's project of enclosure to the Lower Manhattan Expressway, Alison and Peter Smithson's Golden Lane in Coventry, Lynn's and Smith's Park Hill in Sheffield, Bakema's and Van den Broek's superblocks in the project for Tel Aviv 1963 and many more (Frampton, 1986).

Modern architecture spread in former Yugoslavia too, and variety of new complex urbarchitectonic structures were built in large urban centers from Ljubljana (Edvard Ravnikar's Residential Area Ferant Gardens from 1966), Split (Frane Gotovac's Apartment Buildings S3-1 from 1974) to Belgrade (to mention only Mihajlo Mitrović's Western Gate of Belgrade – Residential and Business Center 'Genex' from 1980)(Štraus,1991). In the southern part of the country, close to observed cities, most radical changes were done after International competition for reconstruction of the city of Skopje in 1965, following the devastating earthquake in 1963. The proposal of the Master plan of the metabolist Kenzo Tange won the competition. The project 'was structured around two concepts: the 'City Gate', which was the hub of entry into the capital, comprising all transportation systems, and the 'City Wall', consisting of apartment buildings, simulating a medieval wall, which would incorporate housing to downtown' (The Metabolist Movement, 2011).

URBAN DEVELOPMENT OF PRIŠTINA AND NOVI PAZAR CITIES

Priština and Novi Pazar are examples of oriental cities developed in the Balkan Peninsula during a long period. Theoretically, the term Balkan city best describes urban settlements developed or upgraded from existing settlements during a longer period

under the influence of different cultures, but with a final stamp of oriental, or precisely, Turkish period (Kojić, 1976). During five centuries of Ottoman rule, both cities had significant administrative roles in certain periods as regional centers, and then downsized roles in periods of regress such as after war, fire and other disasters. After liberation from the Turks, these cities remained in an undeveloped part of the country, and kept their inherited oriental structure: city center - čaršija with manufacture, trade and most important religious and public buildings, surrounded by neighborhoods – mahalas, long after. In the beginning of the 20th century, introduction of modern ideas of European architecture in urban structures of these cities was modest: some modern buildings were built mostly in city centers, but the overall urban structure remained preserved even after the period of reconstruction of the war-damaged country after World War II. In the new Yugoslavia, Priština became the capital of the Autonomous Province of Kosovo and Metohija, which influenced its rapid growth, more extensive than in Novi Pazar. New architecture followed new social order: modest in the beginning, it offered more complex and creative solutions later on. Even though, a few specific, complex urbarchitectonic structures that will be presented in this paper were built in both cities between 1970s and 1990s.

Urban development of Priština

Traces of settlement in the area of Priština date from prehistoric times, antique Roman times (urban center Ulpiana, reestablished in the 6th century as Iustiniana Secunda) and medieval times (as the capital of Serbian sovereign families Nemanjić and Branković).

The Turks conquered Priština in 1439 and the city kept 'leading trade and administrative role as emperors *has* - center of *Sandžakat* or center of *Vilajet* (region) (Костић, 1922). After *Defter* (Turkish tax book) for 1486/7, the city had 392 houses in 10 *mahalas* (GUP Priština 2000, 1988). In the mid-17th century, Priština was visited by Evlija Čelebi who described it as a pleasant city with 2060 houses, religious and public buildings and *čaršija* of 300 stores (Čelebi, 1967). From the beginning of the 20th century, slow process of modernization started with building of several modern buildings for Turkish administration, followed by regulation of main streets and uncovering of covered *čaršija* in 1930s.

After World War II and recovering and reconstruction of war damages, first Master plan was produced in 1950s. Two trends in urban changes took place simultaneously: reconstructions and transformations within

existing urban tissue, and outspreading the city and occupation of free spaces with newly designed modern settlements. Transformation of central parts of the city destroyed existing oriental structures of *čaršija*. New city center was based on design of Nikola Dobrović from 1954 (Stojkov, 1996). The rows of uniform apartment buildings along central streets with shops formed stronger block structures alternated with a unique freestanding public building. Whilst the city center was primary scene for modern public buildings, novelties in residential architecture were best represented in new settlements built in the southern part of the city. After application new modern ideas in architecture in the first new settlement Ulpijana (designed by architects Milutin Glavički, Branislav Jovin, Stojan Maksimović and Jovan Mišković in 1964) the further development was directed towards urban aspects of dwelling through relation with surroundings and traffic, as in new settlements Dardanija and Sunny Hill (designed by architects Josip Hitil, Dražen Janković, Darko Kozjak, Miro Pak and Miljenka Stanković-Fischer in 1976 and 1986 (Beganović, 1997).

Urban development of Novi Pazar

Medieval Serbian settlement Ras with marketplace called Pazarište, 11 km away from Novi Pazar, was the first Serbian State capital of the Nemanjić dynasty.

After the Turkish conquest in 1455, a new settlement developed in the valley of the Raška River. It was first mentioned in 1461 as *Yeni Bazar*, meaning New Market, or Novi Pazar. As Evlija Čelebi stated, the founder of Novi Pazar was Isa Beg Ishaković who transformed church on the grain market into a mosque named after him (Kurtović-Folić, 2000, Nešković *et al.*, 1988, and Čelebi, 1967). This suggests the existence of earlier settlement on the site of today's city. According to Evlija Čelebi, in the 17th century, Novi Pazar was *šeher*, i.e. higher level or urban settlement with 3,000 houses in forty to fifty *mahalas*. It comprised various and rich public buildings and *čaršija* of 1,110 stores/shops/manufactures/workshops as one of the largest cities in the Balkans. In the 18th century a stone fortification replaced prior wooden-earth one. From 1877 Novi Pazar became a center of *Novopazarski sandžak* (Sanjak of Novi Pazar), up to 1912. Later, Novi Pazar lost its leading role in the region after a new road was built leading from north to east, away from it (Novi Pazar - Istorija, 2014).

Novi Pazar, with its central, well-developed čaršija and surrounding mahalas, preserved parts of its original oriental structure and outlook until now. Industrialization and

migration to Novi Pazar caused city expansion along rivers and accessing roads. Apartment buildings were built along main central street with stores on the ground floor. Two young, educated local architects, Tomislav Milovanović and Amir Ćorović, were responsible for most of modern developments of Novi Pazar from 1960s onward. After visiting different regional centers of former Yugoslavia, in 1968 they designed the first plan of regulation of central zone with modern vision (Figure 1). They situated a new center on the site of the existing one, preserving only sacral buildings. Analyzing the existing traffic in Novi Pazar, they decided to introduce a concentric street, with wide profile that should unburden the new center of traffic, thus leaving entire central area to pedestrians. Perimeter of the new street was 300 meters and centered on the bastion of city fortress across the Raška River. The center included variety of city squares for main, newly designed public, administrative and service buildings. High residential buildings were punctually spread in the center or linearly interconnected, making a curved frame with covered pedestrian flows. (Milovanović and Ćorović, 1968). The project for the city center has been partially realized, still waiting for its completion.

COMPLEX URBARCHITECTONIC STRUCTURES IN PRIŠTINA AND NOVI PAZAR

The complex urbarchitectonic structure is outlined in the first paragraph. Amongst the first modern structures in the observed cities, the ones that meet the following criteria will be presented:

- to be a composite structure comprising many urban and architectonic elements: more building with different functions and shapes (residential, business, trade, services, etc.) interconnected in one structure together with streets, pedestrian areas, walkways, *piazzettas*, playgrounds, parking lots, garages;

- to be a large structure by its volume and by number of comprising units, that distinguishes it from its surroundings, visible in the city tissue;

- to have a specific architectural design and outlook that makes it unique;

- to have a strong overall identity recognizable as city landmarks.

Two of the most significant complex structures by these criteria in Priština are *Kičma* and the Complex in JNA Street (Figure 2). Best representatives meeting criteria in Novi Pazar are *Lučne* and *Jezero* buildings (Figure 3).
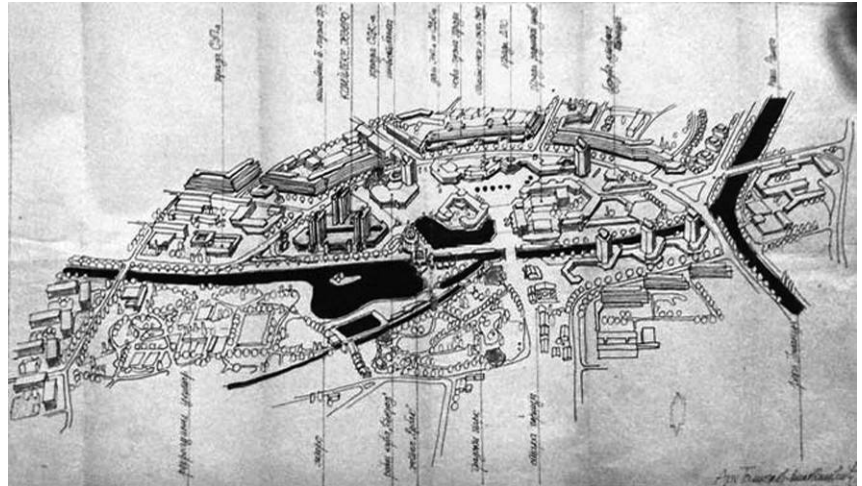
Figure 1. The Plan of modern regulation of the central zone in Novi Pazar (1968) (courtesy of T.Milovanović)

Figure 2. Kičma (down) and Complex in JNA Street (up) in the urban tissue of Priština
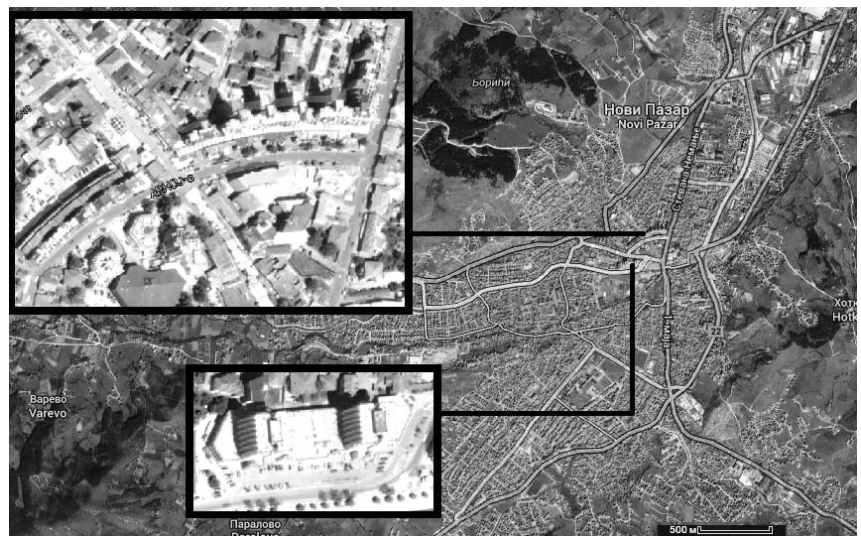
Figure 3. Lučne (up) and Jezero (down) buildings in the urban tissue of Novi Pazar today

Kičma complex

Kičma is a part of newly designed Dardanija settlement. *Trougao* (Triangle) competition was organized in 1972 and five of the most appreciated Yugoslav institutions for urban design were invited to participate. The design of the APZ (Architectural Design Institution) Plan from Zagreb won the competition. The design was finished in 1976, and the first building started in 1974-1977 (Beganović, 1997). The Triangle united two settlements with necessary services and central functions for entire new southern district of Priština (Beganović, 1989).

Architect Dražen Janković from Zagreb designed *Kičma* complex (Spine or *Kurriz* in the Albanian language) in 1983, and the building was completed in 1986 (Figure 4).

The core of the entire design of Dardanija settlement is a complex urbarchitectonic structure, spreading as a spine through the center of triangle-shaped settlement. It connects two centers set on peripheral streets, local center on one side, and district center on the other. Along two intersected axes, a row of nine high buildings (6-17 floors) is set on one side, and six lower (4-6 floors) on the other side of the street.

The position and importance of the location, as well as a dense row of high-rise dwellings allowed more investment in this structure. Two parallel flows are combined on the ground floor: a street with parking lots and the shopping street *Bazar*. Both are covered with the main pedestrian area elevated on the first floor. Elongated pedestrian area is enriched with small *piazzettas*, fountains and variety of urban furniture and revived with stores on the first floor of the high-rises along one side of the street. Lower floors of the high-rises are extended and enriched with balconies, and form covered walkways along the street. The entire walkway is paved in a combination of stone and glass cubes to provide daylight to the ground floor street and *Bazar* (Figure 5).

Lower residential buildings contain multi-story dwellings (not practiced in prior apartment buildings in Priština). Towards settlement, they are enriched with terraces all along the street, but towards pedestrian area, they have accessing galleries on every other floor, (the same concept as on the back of the high-rises). These were the first gallery accesses used in residential architecture of Priština.

The access of the pedestrian street and entrances to Bazar are carefully designed. An access from the northwest side to the pedestrian street is a slight pedestrian ramp combined with stairs forming an elevated
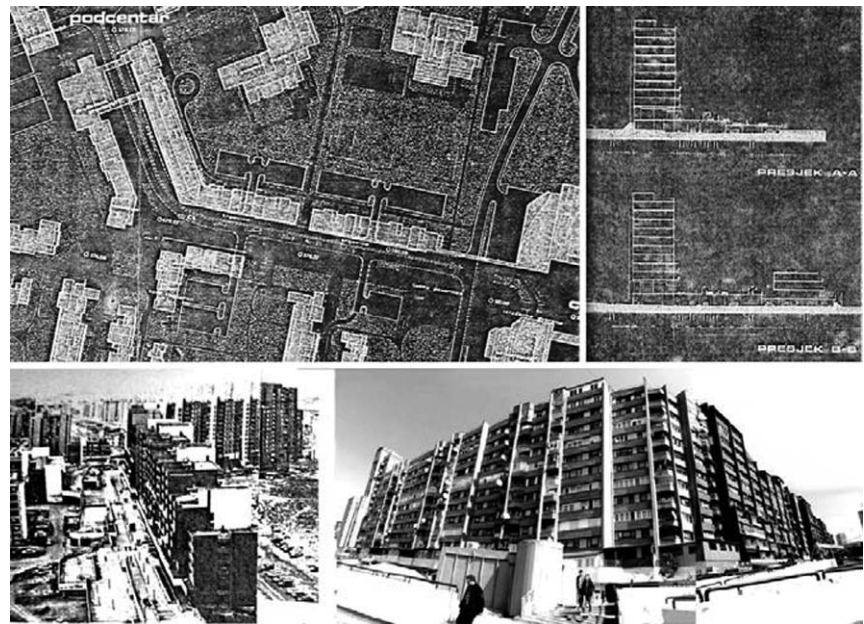
Figure 4. *Kičma – original design of the complex structure: plan and cross-sections from 1976, aerial view from 1988, and actual view of row of high buildings.*

Figure 5. *Features of Kičma: access from the east, pedestrian area, back of high buildings with accessing galleries (first row), access from the north-west and covered street (middle row) and Bazar (down)*

gallery over motorcar street and creating the bridge to the side buildings. The entrance to *Bazar* is emphasized with a large city clock on the gallery. The eastern access, adjusted to topography, merges with terrain and naturally descends with rows of stairways from the district center directly onto pedestrian street, flying over ground floor street.

Bazar, carefully and richly decorated with marble floor and glass ceiling, emphasizes the curved layout of the complex. Entrances to *Bazar* on both sides are gradual – one side covering shopping parts opens to the settlement and leads to dual-side shopping in the central part of *Bazar*. Middle access to the settlement is surrounded with opulent composition of

stairways enriched with modern fountains.

The high buildings rise gradually, which, together with position of the whole structure, gives dynamic to the whole complex. Facades are finalized in green, with yellow paint and red brick details.

In time, different changes were made to the buildings, from enclosing the balconies, transforming the accessing galleries into individual entrances and adding one or two-floor apartments on top of the buildings, to installing gable roofs on the flat-roof buildings.

The complex urbarchitectonic structure of *Kičma* comprises 494 dwelling units, 36-102 sqm large, with total of 29,580 sqm, approximately 200 shops/services/other premises, 15-60 sqm large, with total of 7,905 sqm, 2,015 sqm of storage space, and 63 parking lots. The street for motor vehicles is separated from the elevated pedestrian walkway and covered shopping street.

Complex in JNA Street

The complex in JNA Street was completed in 1989 (Figure 6). As it was constructed not much later than *Kičma* complex, it was popularly named *Qafa* (only in Albanian language), which means Neck. The simple association with the name of *Kičma* (Spine), the name *Qafa* is now widely recognized and used by the citizens of Priština.

The complex in JNA Street was built in one of the oldest parts of the city, in the central zone. It was designed by architectural office Osnova from Belgrade, on limited area, provided by displacement of the JNA street residents into newly built Dardanija settlement. It is situated in one of the oldest streets in Priština known under its Turkish name *Divan - jol* (Talk Street). The new complex replaced existing traditional houses with yards, which occupied expensive site in the city center and were already surrounded with higher buildings from different periods of urban development of Priština. Lack of ambiental and structural values in the existing settlement, united with the changing socio-economic circumstances of market economy required intervention and led to this project.

The expensive and limited location demanded rational planning of high-rises and almost total occupation of the site with building. The complex includes two 13-storey and one 7-storey apartment buildings atop a shopping center and one underground floor designed for garages. The structure of the shopping center is a combination of simple square shapes adopted to available site, and repeated on the first floor. Premises of the ground floor are orientated towards walking terrace, elevated a
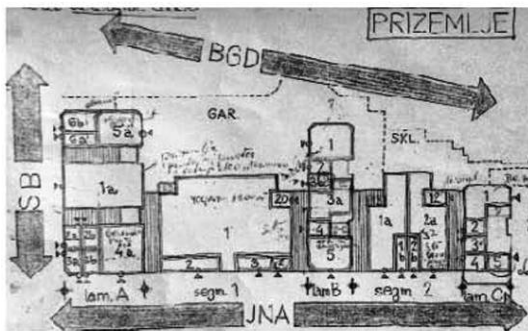
Figure 6. The complex in JNA Street: side view of the complex, scheme of ground floor of shopping center, view and access to upper shopping floor (middle row), front view, external shops and detail of facade (down)

few steps from pavement of JNA Street. Communication between JNA Street and back yard/parking place on the ground floor is enabled through four transverse passages. The first floor, accessed by stairways from passages, is organized around central shopping street. Premises are different sizes to adopt a variety of functions – from business to restaurants, shops and services. Residential buildings emerge from this structure as cuboid volumes with edged corners.

Designed and built in the period of lower

housing funding than in the previous decade, it is simpler in program and outlook. Residential buildings, as vertical elements of the complex, are covered with beige bricks and brown colored walls, decorated with horizontal lines; simple architecture without many details and elaboration. In contrast, the shopping mall as a horizontal element of the complex is in glass towards main streets. The access to parking lots and underground parking garages is on the backside, very simple in beige bricks.

Plain architecture allowed only minor changes such as enclosing the balconies. Service floor with storage premises is adapted for residing. Curtain wall is installed on one part of the upper floor of the shopping center.

The whole structure comprises 266 dwelling units, 16-104 sqm large, with a total of 15,744 sqm, and 132 shops/services/other premises, 15-600 sqm large, parking floor with 269 individual garages, open shopping walkway and covered shopping street.

Lučne (Curved) Buildings

Architect Tomislav Milovanović designed *Lučne* (Curved) buildings as a complex of 3 buildings along new street, framing the city center. Only two of them have been built so far, named Old and New. Long, slightly curved, the buildings cut existing city tissue, introducing geometry in originally organic street and plot pattern. Imitating a fortress wall, by framing center, they divide new center from the rest of the original residential area. This is even more emphasized since the center is not completed and some parts of the existing city tissue remained on both sides of *Lučne* buildings.

Lučne buildings were supposed to provide covered walkway from one side of the center to another. Not physically connected, they are united by their position, form, proximity, continuity and outlook. New promenade should continue trade tradition of Novi Pazar's *čaršija* with modern shops and other premises on the first two floors (Figure 7).

Old *Lučna* building was first completed in 1969. It consists of a row of five buildings, three floors high above two floors of the shopping premises. The complex structure of two concentric tracts with semi-floors is emphasized with playful facade coated with pearly pebbles from the Danube River. Both sides are decorated with rows of curved balconies, as the author says, one kilometer of the facade flowerpots was installed on the building to compensate for lost gardens.

The ground floor is drawn inside the building and supported by columns narrowed at the bottom, thus forming pedestrian shopping street with luxury large duplex shops. Windows and entrances to shops and apartments are processed with specific angular frames (Figure 8).

New *Lučna* building comprising nine residential buildings and two rows of shops was completed ten years later (1979). Larger than the old one, it has radial annexes on the back of the main structure and an angular addition along side street. Some structures are higher than the others, and reminiscent of

Figure 7. Lučne Buildings – Outlook and original site drawing (courtesy of T.Milovanović)

Figure 8. Old Lučna building: outlook, side view showing double tract, back of buildings and shopping street

fortress bastions. Elaborate concrete structures are designed as specific building decorations forming a gallery of original details. Angular parts and rows of shops exposed to streets are specially designed in concrete, thus forming various urban spaces.

The front of New *Lučna* Building is elaborate as the front of the old one, while the back looks very different covered with red bricks and yellow painted details. Concrete arches support radial tracts over supplying backstreet.

Here, the shopping street supported on rows of shops exposed to the front and side streets, is added to the front all along the main building. The shopping street is also a frequent walkway where transparent cover provides daily light (Figure 9).

In time, many changes were made on the building – from enclosing the balconies, changing details of shops, to addition of entirely new apartments as additional floors on the top of buildings.

Old *Lučna* Building consists of 102 dwelling units, 17 luxury shops and covered semi-open shopping street. New *Lučna* building houses 230 dwelling units, 63 shopping/ restaurant/ service/ administrative premises, and closed covered shopping street.

Jezero complex

Jezero (Lake) complex is designed by Sandžakprojekt Novi Pazar, by architect Tomislav Milovanović, as a complex of 3 towers over doubled shopping center above the internal street but in 1986 only the first stage was completed: two southern residential buildings over the shopping center. It is situated by the Raška River beside the planned, but never realized, artificial lake and was named after it.

In this complex, the shopping center is organized in a hexagonal elongated shape on two floors, surrounded by accessing galleries on both floors. In the middle of the structure, there is a pedestrian cross-link. Two residential high-rises are in the form of cell structure inscribed in squares – a simple basic shape but very expressive in outlook. Final treatment in concrete, colored balconies fences and glass adds to the final composition, visually connects the buildings with the *Vrbak* hotel. Cylindrical concrete details of spiral stairways break emphasized horizontality and get along with cylindrical structures of the high-rises (Figure 10).

The shopping center contains shops, restaurants, services, offices, agencies, but also some school premises, medical services

Figure 9. Features of New Lučna building: outlook, front and side view (middle), back of the building and shopping street (down)
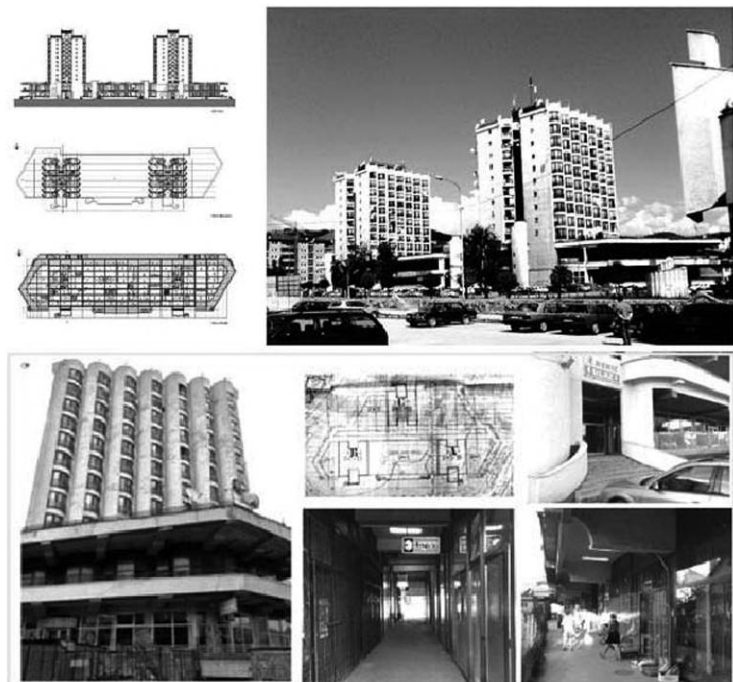

Figure 10. Jezero buildings complex: ground and typical floor, southern elevation (up left), outlook (right), side view (down left), (courtesy for CAD drawing arch. E.Hamidović), original concept (middle), (courtesy of T. Milovanović), entrance and views of shopping center (down and right).

and children's playrooms. Flexible places enable different possibilities for the use of the premises. Only minor changes were made on this complex.

Jezero complex consists of 120 dwelling units in both high-rises, 90 premises for different functions on two floors of the shopping center with surrounding galleries.

CONCLUSION

The influence of Modern movement in architecture and urban planning spread all around the world, transforming cities, removing differences, and creating universal values. In our region traditional Balkan cities of oriental origin embraced changes and created specific urbarchitectonic complexes that became examples of tradition of modern architecture. Along with modern influences on their design, from *Unité d'Habitation*, Lijnbaan Street (designed by Van den Broek and Bakema in 1953), Galleria Vittorio Emanuele, Belgrade Palace (by .Pešić in 1974) and many more, some local traditions were applied, like city walls, covered trade streets of *čaršija*, connection with nature in dwelling units etc., whose presence is more evident in concepts than in outlooks, universally adoptable, and transformed in universal architectural language of modern architecture. In a limited number of presented complexes in observed cities, some similarity can be found distinguishing two basic types: linear, elongated street-like forms of *Kičma* and *Lučna*, being walls or spines, and compact form of complexes in JNA Street and *Jezero* – with residential buildings over shopping centers with similar contents and even more similar building concept. Undoubtedly, all of them are complexes with different contents, multifunctional, larger than surrounding ones, with specific, various architectural articulation and strong individuality and identity. Their relation with history is also specific, not only regarding applied concepts, reminders or resemblances, but also regarding the size of the settlements. For example, *Kičma* has more dwellings in comparison with the number of houses in the 15th century Priština; a single building is larger than the entire town was. Furthermore, it has almost a quarter of the number of dwellings and 2/3 of the number of shops of the 17th century Priština. With its size and contents, it is almost a self-sufficient entity, but still open to surroundings and flows of communication. Even though *Lučna* building might look overdesigned in its dimension and appearance in the city today, in figurative sense it witnesses magnitude of famous ancient Novi Pazar.

Whether designed by Yugoslav architects in Priština, or local architects, as in Novi Pazar, these complexes became an essential part of the images of these cities. Despite strong individuality and identity, which characterize these significant landmarks of both cities, many connections with the mentioned complexes can be found in the region and farther, which confirms universality of modern architecture.

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SOCIAL SPACE AS THE SUBJECT

OF SCIENTIFIC RESEARCH – SPATIUM

Milorad Macura

Overview

Among the processes with which one could measure the intense development of civilization are the essential changes in the structure and content of humanity's living space, something which society at large is as of yet unaware.

Man's understanding of the world, which had a totalizing aspect in the ancient past, has gradually changed into scientific knowledge, based on defining and classifying all the phenomena that comprise the world. The rise of science, accompanied for centuries by the differentiation of sciences and establishment of barriers between particular scientific branches, is today also characterized by a process of reintegration of scientific fields. In this regard, particularly prominent are the humanities and biology, in which ecology has developed as a new scientific discipline.

Parallel to this, we see the first signs of the reintegration of social space, whose development throughout history had been characterized by a differentiation and isolation of each individual spatial unit from the others.

Research activities in the domain of social space, divided currently into regional, urban, architectural and interior, demands the construction of a unified scientific system which would encompass all the elements and phenomena, and observe the corresponding patterns.

We consider the subject matter of this field of study to be <u>human living space, created, organized and furnished through social labor – spatium.</u>

Spatium, which is at once the expression and the precondition of humanity's existence, has specific characteristics. These are: a) functionality, b) spatial phenomena and relations, and c) the process of creation of spatial units.

In the domain of <u>functionality</u> we can differentiate 1) functional processes, as the spatial aspect of social activities, and 2) functional attributes, which define the particularities of spatial units conditioned by functional processes.

Functionality is the basis for the categorization and division of spatial units, which are themselves a reflection of the organizational structure of social activities, into categories and regions.

<u>Spatial phenomena and relations</u>, expressed in various forms, can be defined as the subject matter of our research. In the course of the systematization of this subject matter, the following determinants are applicable: 1) the constitution of spatial units, 2) their gradation, and 3) relations that exist in spatium.

Within the constitution of spatium, we differentiate: a given social community, spatial units and spatial elements. The constitution determines the level of compactness of spatium, which in turn expresses its constitutional development. This development is the initial move towards the reintegration of spatium.

<u>Gradation</u> in spatium – conditioned by social factors, the attributes of spatium, natural phenomena, etc. – is expressed as the relation of one spatial unit a) to a higher gradation unit, b) a lower gradation unit, and c) and units of the same gradation.

<u>Relations</u> in spatium depend on the function, constitution and gradation of spatial units. We can differentiate them as functional (immediate, mediated and spontaneous), structural (conditional, spatial and technical), and compositional, which elicit a certain aesthetic experience, influence man's mental formation, and stimulate appropriate social reactions in human communities.

Introduction

The topic of this text, a presentation of a work in progress, extends beyond the limits of questions set by the main conference papers. However, it seemed to the members of the Committee for Regional Studies, Planning and Design of our Institute, as well as some members of the organizational committee, that it ought to be presented at the conference, even if it would not be the subject of special consideration.

Our wish was to place the sketched out problems and phenomena in the context of our discussion regarding the given conference topics, because they permeate the contemporary scientific atmosphere much the way the Earth's atmosphere is suffused with water vapor, which can condense to become fruitful rain, or hale, or a snowy cover, or frost.

Defining the problem of social space

Today, when human knowledge penetrates into the atom as well as the galaxies, when technology allows for flights into the cosmos, when the number of people inhabiting this planet is growing at a striking rate, all the while torn by contradictory questions regarding humanity's self-destruction, its struggle against starvation and for housing on finite continents, when the natural conditions for the life of man as a natural being are devalued through

technical interventions, when space produced with technical means renders humans worthless both as individuals and members of a social community, alienated in overpopulated cities, with a feeling of boundless loneliness – today, in such a day and age, we, the experts who deal with the living space of humanity, see our social role and its meaning in new proportions, with new contents and new properties.

Society as a whole is still unaware of the revolutionary events that are shaking the tectonic framework of the spatial structure of its very existence. The numerous negative effects are still thought of as results of mistakes and incompetence, and not as certain systemic regularities emerging from a developmental evolution. There is still a belief that with routine or expert intervention into a perceived problem – seen as a phenomenon unto itself, in isolation from the whole to which it belongs – there could be an integral solution. And even though they are treating novel spatial elements and processes, both the lay person and the expert still use terms and criteria rendered obsolete by progress.

There is a gradual and ever more noticeable awareness in society of the essential change of understanding of the space in which human life unfolds. This change has required setting up solutions to certain problems in accordance with new tools and laws, and sought through new conceptions and principles.

To this end, our country has seen the founding of several institutions with the goal of studying phenomena and establishing the laws that govern the existence and appearance of built space, as well as the mutual influence of man, the social community and their space.

THE EVOLUTION OF SPACE AND SCIENTIFIC THOUGHT

Scientific currents

After millennia of understanding the world in a totalizing fashion, in the last few centuries, human thought has arrived at the knowledge that it can learn about and understand the world only through the phenomena in which it is expressed. Defining and classifying these phenomena, from the most general to its most elementary, allowed for the discoveries of laws according to which these phenomena appear the way they do. This allowed for the creation of science. The more knowledge expanded, the more science branched out and developed barriers between individual branches; this also meant the loss of an idea of the whole. Each scientific researcher, shut in his own scientific system, acquired the elements of his own system only. Other areas of science were foreign to him.

Parallel with this development, another current has developed as of a few decades ago. It is the idea that the studied and classified phenomena do not exist each for itself, but that they represent constituents that bind together to form larger units within which there are important inter-field influences. Any single phenomenon cannot be entirely understood if it is seen only through the prism of a single discipline, but rather must be looked at from various points of view. This has led to the dissolution of the barriers between individual scientific fields and the process of scientific reintegration.

Begun within the humanities, encompassing nearly all human knowledge, this process is particularly advanced in the area of biology. Ecology, as a new scientific discipline, has changed our understanding of nature and life, offering colorful and exciting validation of Marx's dialectic, so often rendered simplistic and mechanical.

We can also point to an adequate development in the concept of social space – in the area of architecture and urbanism.

Devaluing space

For thousands of years humanity sought an effective isolation of concrete space. Walls grew around homesteads, castles and cities. Street facades of buildings were closed and fortified, and their field of view reduced to the yard. The difference between the village and city, between the agrarian landscape and virgin nature, was intensified.

Analogous to this, building, as a specifically human expression of creativity, branched out into urbanism, architecture, interior design, horticulture. With each offshoot there was further disintegration and devaluing of space, to the point of reducing architecture to the outward shaping of facades.

Industrialization of production and new social relations have turned this tendency on its head. Along with the process of reintegration of science, there has been a spontaneous movement towards the reintegration of space.

City walls have already disappeared. Building openings are becoming bigger. The dominant tendency is to fuse, in a functional and visual sense, the interior and exterior space. Cities penetrate landscapes and dissolve into them. The difference between villages and towns is falling away. Tourist houses and bungalows are popping up in previously inaccessible forests, and transmission lines and highways cross erstwhile unassailable mountains. Distances are no longer measured in days and weeks, but in hours and minutes, and the telephone, radio and television have almost negated them completely. Thus contemporary man, seeking peace, traverses tens of kilometers to get away from his workplace.

Agrarian areas are shrinking because of the expansion of cities, industrial complexes and water reservoirs. Forests are retreating, and due to the control of flooding and river beds, underground waters are drained from the soil. Entire areas are left without water, and what little still flows into our rivers is polluted by settlements, factories, mine waste. The air too is polluted with various vapors that ruin the flora and cause pathological growths in the human body.

Various means of transportation, with their flattering efficiency, take more lives than the bloodiest of old wars. Still, humanity is oppressed by austerity of dwelling, schools, hospitals and other kinds of architectural space – the precondition of humanity's existence.

The required funds for the construction of such a space are ever increasing since the bare minimum of their services and technical readiness grows in step with the growth of density of population of an urban unit. Such are the biological and psychological demands of human life, and the fact that frugality in the domain of the urban is achieved by skimping on the architectural.

Here, today

In this country, we are, thanks to being relatively undeveloped, still far from the dispiriting state of Borinage, or the area surrounding Liege, or some other areas of Western Europe and America. But we ought not forget that forty years ago Yugoslavia had a population of 11.5 million. Soon it will have double that, and those additional people have to be provided food and shelter on land of the same size. Agriculture can only support up to seven or eight million people, whereas the rest will have to be employed in activities belonging to an urban framework.

Methods thus far used in solving these problems have proven insufficiently efficient. The reality of other countries, even technologically highly developed ones, confirms this observation.

The reason for this – among others – is that the building of urban and architectural space has no unified and integrated scientific basis. Aside from results of individual and partial studies, such building relies on fragments of legacies of numerous scientific areas, which are not necessarily in accordance with one another, and are often even in contradiction.

Thus we are faced with the need to establish an integrated scientific research system. Within it, each phenomenon will have its proper place, each relation clearly defined, along with their mutual influence on one another and on society at large.

The barriers established in theory and practice between regions, cities, buildings and rooms should be eliminated, as should the processes of their emergence; rather, they ought to be thought of as components of a single, more general category. This need exists in our individual consciousnesses as a certain notion, but it has neither been defined nor studied on the scale of society as a whole.

SPATIUM

Nature is not the simple totality of all phenomena created through elemental development on this planet. Nor is it simply a resource of means for the sustaining of life on it. It is also the space in which that life unfolds.

Natural and social space – spatium

Humanity acts within the confines of natural space, and by adapting certain aspects to its needs, has changed their content and their attributes. Where humanity acted exclusively as exploiter, natural space was devalued and transformed into wasteland. In other places, where such action was planned and permanent, directed at creating new values, we saw the emergence of fields, along with roads, houses, villages and cities.

Thus emerges – initially in rare enclaves dispersed through endless natural space, and then larger, more purposeful and complex – THE SPACE OF HUMAN LIFE, FORMED, ORGANIZED AND FURNISHED THROUGH LABOR. To differentiate this space from any natural, cosmic, abstract, or other kind of space, let us call it, analogously to 'the urban' and 'the region' – 'SPATIUM'.

Thus we introduce a term that encompasses the region, the city, the building, the room – all the categories of space in which human life takes place, whether individual or public, in all its manifestations and forms, as well as aspects of social activity.

The characteristics of spatium

Spatium, in its most general description, is the expression and precondition of the existence of a social community. The community determines its content and attributes, and, to a great extent, spatium predetermines the community's conditions and ways of life and work.

The entire production base and social superstructure is reflected in spatium in multiple ways. This gives spatial units the unique particularity of representing the materialized imprint of human life, revealing it in the way that fossils reveal prehistoric life.

Of all the products of human labor, spatium and spatial elements are distinguished by some particularities. We consider the following most prominent and noteworthy: <u>functionality, spatial phenomena and relations within spatium, and the process of emergence of spatial units</u>. The definition and establishment of laws according to which these attributes are expressed, allow us to more easily and efficiently solve certain problems, the essence of which we have not been able to grasp until now.

FUNCTIONALITY

Nearly all forms of social activity are defined in part by their spatial aspect, technically called its <u>functional process</u>. It does not encompass the meaning, content or any other characteristic of labor, but rather only the phenomena expressed by the position and movement of certain people and objects within a given space – in short, spatial activities.

The functional process predetermines important attributes and particularities of each spatial unit: its dimension, layout of its constituents, conception, realization, finishing and equipment, the biological and psychological conditions of life and work within it, as well as others – all of which make up its <u>functional attributes</u>.

Function and purpose

Functional processes and attributes are summed up in <u>functionality</u>, the primary reason for the creation and existence of spatium and spatial units. These aspects distinguish spatium from other human products, defined by their purpose.

Purpose is inextricably tied to its corresponding object. It is a property of the object, at once predetermined by and predetermining the object. Purpose is always simple, changeable only according to certain characteristics, such as capacity, quality, and the like.

Functionality is conditioned by a given human activity – that is, its spatial manifestations – and the primary attributes of the object: spatial, physical, and others. It is, therefore, complex, and in any given case defined in a specific way. The function of the existing spatial unit can be adapted within certain limits to other social needs with smaller or greater alteration, which is impossible in the case of its purpose.

If we consider a given area of activity in its context, as a category in a system of general social activity, and follow it through the various gradations of the network of all relevant institutions, as well as those institutions' constituents, to the workplace and the individual who ensures the social impact of his working activity, we will notice certain phenomena and relations that converge into a certain order expressed in organizational-work units.

We are used to seeing the whole system as permanent and unchangeable because it is made concrete through certain organizational and spatial units that have become notions, which are at once the subject and means of thought.

The evolution of function

However, within each of the social activities that are tightly bound into a whole, there is constant change, the cumulative result of which is humanity's progress. The changes appear as a consequence of development of the appropriate scientific basis, technical means with which activities are carried out, experience consistently accumulated, and everyday practice. At the same time, the significance of each social activity constantly changes for society as a whole, for the individual unit, and for the individual himself. As do the relations within which certain needs are fulfilled by that activity, and the conditions under which this is done.

Given that in relation to such events spatium generally develops quantitatively, whereas qualitative changes of spatial units are rare and limited, as an important contributing factor, spatium mostly retards progressive movement. However, under certain conditions, when the realization of a certain spatial unit or system of units is conceived in a comprehensive, creative and technical procedure inspired by new discoveries and understandings, it acts as a powerful and efficient stimulant of future progress.

The goal of research in this area is to study and define, in concert with other experts and scientists, the changes that take place in each and every social activity. It is to understand and establish their spatial aspects, and based on a comprehensive approach from the most general to the most particular functional processes, to conceive the appropriate system of their spatial units and functional attributes.

Categorization and zoning – the region

This means that we need to establish a purposeful categorization and classification of institutions – that is, spatial units – in accordance and parallel with their spatial distribution, such that they form the most encompassing functional unit.

This process produces zones for specific social activities, which in further spatial arrangement defines the region as the highest category of spatial unit.

Within zones, which encompass both the region and the settlement, each institution radiates its influence on other institutions, a consequence of their arrangement into gradations. Any given institution serves a portion of a region or settlement, according to its characteristics and function gradation, and the radiating of the highest gradation institution participates in the definition of the limits of the region or the size of the settlement.

If the distribution and building programs of individual architectural objects – representing nothing other than the spatial aspect of the organization and labor of the corresponding institution – are defined within this system, according to which the more complex functions are compressed into higher gradation units, we achieve significant advantages. This would establish closer contact of recipient of activity with the most commonly used and least complex institutions. Further, it would allow for more integrated, rational, and higher quality work within these institutions, as well as in those of the higher gradation. It would reduce necessary investment, and increase the possibilities for the advancement and improvement of the activities themselves.

This applies to all contemporary forms of social activity: the economy, culture, child care, health care, etc.

SPATIAL PHENOMENA AND RELATIONS

We have already mentioned that spatium – as the space of human life, formed, organized, and furnished through labor – is the expression and precondition of the existence of humanity.

Due to our contemporary social community being structurally differentiated and its life and work characterized by a wealth of material and forms, spatium is, therefore, one of its most complex phenomena. The reason for this is that among the numerous and differing spatial units and elements, there are appropriate connections, and complex inter-influences.

The analysis conducted thus far has led us to the conclusion that although they are expressed in various ways, all the phenomena and relations within spatium can be defined and arranged as subject matter for scientific research. To that end, the applied criteria are:

- Constitution of spatial units: determined by appropriate functional systems and the intensity of eco-technical development of space;
- Gradation – the entirety of gradations of spatial units – appearing as a consequence of the organic division of spatium, dependent on the structure of the social community and forms of its activity; and
- Relation between spatial units conditioned by the coexistence and active inter-influence of a multitude of units in spatium.

The constitution of spatium

Based on their constitution, we differentiate spatial units of the landscape, the urban, the architectural, and the intramural. Since the particularities and problems emerging from each of these are generally well known, we will not deal with them individually. Rather, we will sketch some of their general characteristics.

The constituents of spatium

Each spatial unit forms a complete system with a set of laws governing the relations among its own constituents, grouped in the following way:

– specific social community – a developed social body or part of body: commune, a family, the entirety of a company's personnel, etc.

– spatial units of lower gradation: cities in a region, zones in a city, rooms in an apartment, etc.

– spatial elements: buildings, groups of buildings, and accompanying phenomena.

Within these we differentiate: elements of anorganic nature, whether appearing through natural forces or produced through a technological process; elements of organic nature formed either through spontaneous development or cultivated and distributed through human labor; and events appearing as universal or regular phenomena of which some are natural and some caused by human activity.

Each of these elements of spatium influences the human on his life path either directly or indirectly. Assessing their action through the prism of human interest, understood in its broadest sense, we can regard them as either positive or negative. However, careful consideration indicates that it is nearly always both positive and negative, either in reality or only potentially.

Here we meet one of the most interesting tasks for the researcher of spatium, the planner of spatial development, or creator of spatial units.

How can we reduce the negative phenomena of spatium to a minimum? How transform their influence on human life and render them compatible with human wants and needs? Perhaps we ought to change, develop, or even incite completely novel desires!

Did not man acquire fire from lightning? Did he not palliate himself with water unsuitable for drinking and washing? Did not the Nile's floods ensure food for the Egyptians? Is not winter today a great source of joy and health? Lest we forget, man, nature's most sublime creature, emerged out of the Ice Age, which forced him to dwell in caves, build a hearth, organize his life based on the division of labor.

From the moment people pushed the first rock onto the mouth of the cave to thwart beasts from entering and shield from the icy wind, the barriers of spatium grew, strengthened and were built gradationally. The tendency towards total isolation of the spatial unit from external space as a means of personal and social safety was, for millennia, the primary motivator for building.

Constitutional development of spatium

Within the framework of those barriers, space has been used ever more intensely. Continuous building has lowered the ratio of external to internal space – intensifying the shrinkage of spatium. This has been the expression of spatium's constitutional development for centuries, with corresponding consequences. On the one side, we have the rising level of its exploitation; on the other, the reduced quality of attributes composing the conditions for a harmonious life. The latter lead to the degeneration of man as a physical, psychological and social being.

We have already mentioned that an aspect of the contemporary development of civilization has been the growing awareness of the changes to space. As a reaction to a specific state of affairs, man has developed an urge for free space and isolation, not from external space, but within it.

This need, along with the fantastic progress of technology, stimulates the integration of the previously atomized spatium.

Reintegration of spatium

We have again touched upon one of the primary tasks of the researcher of spatium. How to understand, how direct, with what spatial unit and element express the reintegration of spatium? We know that the current manifestation of that process – covering huge areas of rural land with family gardens and glass houses – is not compatible with general interest. Nor do we feel particular affinity towards ideas of spatium conceived as a termite tower, since we base our conception on a certain understanding of man, which stands in opposition to such a construct. We are convinced of one thing only: that we ought to research, study, experiment, and that guided development – through a synthesis of scientific thought and spatial creation – will reach solutions that will satisfy both the individual and the community.

Gradation in spatium

Doubtlessly, among the components of this development is the gradual transformation of dominant systems of gradation of spatial units.

Means of organization of space

Gradation is an expression of organic partition of spatium into its constitutive parts, conditioned by the multidirectional and multilevel division of the social community, as well as the essential properties of spatium itself. It represents one of the primary means of organization of space. Thanks to this gradation, the amorphous set of units is given the form of a definite system or a higher gradation organism.

Gradation represents a significant phase in the defining of the content and character of a spatial unit, and thus its purpose, effectiveness, and quality. Pointing in opposing directions, it currently manifests either as a shrinking – fusion – or else as dissolution – fission – of spatial units, in which certain functional processes take place. For this reason it is the subject of considerable dilemmas, often not entirely resolved. These dilemmas in fact cannot be resolved if we use quotidian and pedestrian logic, instead of a method based on certain laws emerging from longterm research effort.

Conditions of gradations

By studying the phenomena of gradation as such in spatium, we have established that they are differentiated by factors that cause them. These factors

are categorized into three basic groups, according to which we differentiate three types of gradation:

– gradations conditioned by social factors;

– gradations conditioned by natural phenomena, development of science and technology,

– historical events and other factors.

Each type represents one of the ordinates that defines the very phenomenon of gradation. Each type is insufficient on its own, nor can any type be omitted.

Phenomena of gradation

The phenomenon of gradation is expressed in spatium through various gradations and in multiple branches, that is, as:

- the relation of the spatial unit to a higher gradation unit (example: zone to region, city to region),

- the relation of the spatial unit to lower gradation units (city to city quarter, to city hubs and buildings, and to suburban settlements etc.),

- the relation of the spatial unit to units of the same gradation, which, although not an expression of pure gradation, very often serves to define certain gradation phenomena and attributes (residential area to industrial sector or city center, etc.).

If we attempted to conduct a spectral analysis of any given urban plan in our country, broken down through the prism of gradation, we would see in it multiple voids and absences. Among these, the ones that create the conditions for basic weaknesses of building and development of our cities, creating obstacles that cannot be dislodged without great effort, and with which we struggle, to great sacrifice and often with little result.

Relations within spatium

Through coexistence and active mutual influence, multiple spatial units on a single territory start creating appropriate mutual relations. These relations are, among other, dependent on function, consistency and the gradation of those units.

Relations of spatial units are all the more complex and important if the density of spatium is higher. Since we assume, as was previously noted, that the increase in density of spatium will be one of the main characteristics of its future development, it is obvious that we must give some attention to this issue.

Through analysis and classification of various relations and connections observed in spatium, we can conclude that it is possible to identify three types of relations: functional, structural and compositional. The first is a reflection of the relations in space of various social activities and types of activity, understood not simply through their corresponding functional assessments, but comprehensively. The second type, structural, follow from the fact that each spatial unit or element without exception represents a physical or spatial constituent of another unit or element. The third, compositional, emerges from the visual effect of spatium based on the artistic appearance of its constituents and their mutual compositional relations.

Functional relations

However many and various they may be, functional relations can be categorized into three basic groups: direct, indirect and spontaneous.

Direct relations appear where there is a complementarity to social activities or a mutual negation of basic functional conditions. They occur, that is, where the effect of human labor in one domain directly depends on the effect of labor in another domain, and where this effect can be predetermined in spatial relations. As an illustrative example we can take an industrial complex of a steel mill, whose production and economic viability are dependent on railway traffic, whereas the viability of the investment into the railway extension is dependent on the capacity of the steel mill and its distance from the classification yard. Or else when instead of a playground, a football stadium is built next to an elementary school, resulting in the noise from the stadium disturbing the peace and quiet pupils and teachers need to concentrate.

Indirect relations appear when a connection emerges between two spatial units in the form of a third spatial unit or element. For example, when an unsatisfactory solution to a system of transportation, such as a poor connection from a residential area to a factory, results in a shrinking of labor productivity. When industrial drainage pollutes a river, destroying a settlement's water supply. Or when an ice factory is located near a small stadium, and the connection of the two leads to an ice rink.

Spontaneous relations are the expression of extraordinary sets of events, whether accidental or foreseen. These relations are outside the standard set of problems of space and often their effect, positive or negative, is very pronounced. If a bank-side reservoir is constructed in a beautiful landscape that also features a road, this will allow for the establishment of recreational centers. However, the building and inevitable expansion of a viscose factory on a given territory poses a threat to the operation of the renowned and once sufficiently secluded sanatorium.

Direct relations are obvious and clear. As a rule, they are taken into account by any expert in the course of his work, such that mistakes made in this area really can be considered as wrongdoing and culpability. However, indirect, and especially spontaneous relations, with either positive or negative consequences, ought to be the object of special study. It is necessary to note these phenomena, analyze and classify them, and establish, to the extent possible, the regularity of their manifestation, and then use the results of such studies in practice with the aim of raising the quality of our built space.

Structural relations

The physical connection between spatial units and elements in a given space is a common phenomenon. However, the importance and role of its expression vary from case to case. Sometimes it is inconspicuous, only to burst suddenly into our main focus of interest and concern, leaving behind all other factors and problems. Considering that these relations appear always as part of a given whole, comprised of units or elements, we have designated this type of relation as structural.

According to the attributes and nature of these relations, we differentiate among them as conditional, spatial and compositional.

Structural-conditional relations emerge between units and elements that are as spatial phenomena mutually conditioned and spatially connected through all their attributes. Two units in this relation are conditioned one upon the other to such an extent that without one another, they lose all meaning.

As an illustration, we can offer the relation of docks and navigable rivers; mining towns, the mine and the ore deposits; industrial complex and access roads; or even an elementary school and a residential area.

The essence of the task in this area of work is the coordinating of attributes and capacities of correlative units. Rather than a definition of general laws, as the object of study in this case we see the establishment of certain regulations.

Structural-spatial relations appear when special elements – or in rare cases units as well – are inevitably set one towards the other in a given space. Their mutual connectedness is pronounced here more than anywhere else. This produces the main difficulties in solving concrete tasks. Whether these elements are acquired through the convergence of natural and technical means (such as a canyon, river, railway, road), or whether they are planned (for example: city, railway facility, city traffic), or even if they are a consequence of a city development boom (for example: reconstruction of urban traffic networks in built up zones), in each case the task presents a new problem that cannot be resolved by applying a universal solution, since none exists.

These phenomena ought to be noted, analyzed, and compared, with the aim of establishing the purpose and value of particular solutions. Results of those studies could be used to avoid mistakes from the past, and to direct and assess proposed solutions by comparison.

Structural-technical relations appear mostly between spatial elements built in space, when certain elements represent higher order constituent elements. The most prominent examples are bridges and tunnels as integral parts of roads and railways. These also include the relation of a dam to a water reservoir, electrical facility to a transmission line.

The relation of a railway station to the railway, garages and depots to city traffic lines, service stations to the highway – although seemingly falling into this category, should be placed in structural-conditional. We hold this opinion due to the fact that these elements – although technical, functionally and spatially connected – are not predetermined in space by a higher gradation element solution.

Their attributes and role ought to be separately established.

In structurally-technical relations, all spatial questions, with very rare exceptions, are solved at the same time for all correlative elements. Therefore it seems they do not need to be individually treated.

Compositional relations

Compositional relations have a special role and importance. While all previously considered phenomena are intimately connected to specific human and social interest – understood here in the broadest sense, since those words define many conditions and aspects of human life – this type of relation, through which spatium affects human psyche, are only indirectly connected to those interests. Still, the connection is important, since they can expand or shrink labor productivity, speed up or slow down the restoration of a person's health, increase or lower the concentration levels of a student.

Man reacts to compositional attributes of spatial units and elements, whether wishing to or not, whether aware or not. This reaction is based not only on the attributes of spatium, but also on the education and habits of man. For that reason the reaction of various people to a given spatial phenomenon is not the same, much like its aesthetic valorization. Regardless, although they change through time, the compositional attributes of spatium are based on very clear laws and criteria.

The influence of spatium on human psyche is manifested in inducing a certain aesthetic feeling. This affects the formation or transformation of human mentality, which in turn produces certain social reactions in groups of people who live in a given spatium.

The aesthetic feeling appears – at the moment when man experiences the compositional effect of a given spatium – as a very complex phenomenon. It ranges from conscious attraction based on a positive critique of a work whose composition is in accordance with established norms, through the excitement over a new creation that surpasses the norms and criteria of a given moment, to the subconscious submission to an atmosphere exuded by the space itself.

Accordingly, when it comes to the aesthetic feeling produced in man by spatial phenomena, we can distinguish two layers.

The lower layer encompasses all forms of subconscious reactions caused by feeling: size, proportion and distribution of space, elements of formal structure, basic and complementary colors, level of saturation of space with elements and people, the intensity of lighting, character and volume of sound, as well as other factors – all of which affect man's subconscious, causing a certain mood.

The upper layer is expressed in the conscious zone. Here, the classical sense of the beautiful reigns, based on certain generally accepted laws and principles. They are not universal or permanent, since they depend on the territory, level of general social development, the unit, class relations, as well as other factors, and as such, these laws and principles change through time. In the process, contemporary criteria, through the process of creation and criticism, and after triaging and objectivization, transform into historical criteria.

In accordance with the level of education and cultural engagement of a given person, these criteria appear – along with appropriate adjustments – as particular reactions of an individual. For that reason, the study of these phenomena takes multiple directions. Some of them are mostly psychological. In others, the social component is dominant. Others still have a pronounced theoretical importance.

In concert with other actors – above all, the appropriate part of the social community – spatium contributes to the mental formation or transformation

of man. Together, these factors constitute the surroundings. It is not necessary to emphasize that we are speaking of permanent influence, according to which there are even negative consequences in a certain period. But it is not possible to avoid this influence, so long as it is sufficiently intense and lasting.

This phenomenon is more easily understood through the process of transformation of the mentality of man, than in the process of his primary formation.

Sociologists have established that there are certain connections between spatium, child delinquency, and crime in general. In addition to which, there are connections between spatium and many mental deformities, even those bordering on psychopathological phenomena.

This influence is of the utmost importance for us due to the massive shift of population caused by the development of industrial production and the mechanization of agriculture, which has had equally positive and negative consequences on mental formation.

Research in this area leads us to conclude that the shock caused by a sudden move from rural to urban settlements can be mitigated by the construction of purposefully conceived semi-urban settlements. This idea is also attractive because the expenditure necessary for the design of an architectural-urban space in such settlements is significantly lower than investments in highly urbanized units.

Psychology and sociology can define such problems. But the solution to these problems can only be found through the study of appropriate spatial units, with the goal of establishing new properties and principles according to which the design of the units can be executed.

Social reactions to the compositional attributes of spatium appear through the social integration of aesthetic and mental effects on the individual. In the local context, as an excellent example, one still insufficiently sociologically and psychologically studied, we can cite the effect produced in man's psyche by the relations produced by sharing a dwelling. This relationship, more than others, shows the disharmony between the composition of a given apartment, its size, and the composition of its inhabitants.

A similar example is provided by an event in the first years upon the end of World War II. When the shacks from Belgrade's 'Prokop' were razed, and their tenants moved to multistoried buildings, it seemed that a large problem had been solved. However, the entanglement resurfaced when the building inspection discovered that new shacks popped up in 'Prokop', and that their previous tenants had returned, resolutely refusing to move to their assigned 'modern' apartments.

A positive counterexample was an interesting response of the citizens of Titovo Užice to the recently built central square. The reaction was particularly noted in the youth, more easily susceptible to the influence of spatium than the older generations. The changes in mentality of the people that had already been underway due to general social development were given a new forceful surge with the appearance of this new urban phenomenon, which intensely radiates dignity, self-respect, and respect for others throughout its entire creation.

All the instances of influence of compositional relations in spatium ought to be studied synchronically from two points of view. On the one hand, there is spatium and its compositional attributes, on the other, man and society, that is, their reactions. Throughout this endeavor, just as in other areas of research of spatium, there ought to be cooperation between researchers from all branches of science interested in these questions – above all architects, who remain insufficiently engaged.

The aim of this work is to eliminate the impersonal, sterile, disheartening space from the field of architecture and urban studies, which has contributed to man's feeling of loneliness, oppression and spiritual emptiness; on the contrary, we wish for man's joy and excitement about his city to embed him ever deeper into the fabric of its social community, and thus into his homeland.

The limitations of this paper do not allow for the sketching out of the full complexity of the problem of spatium.

The very important and complex phenomenon of the emergence of spatial units has been left out. We have left the categorization of spatium and corresponding units and elements insufficiently treated. It is not possible to properly frame the necessary systematization of areas and aspects of research of spatium. For the same reason, we have left out the presentation of appropriate understandings of mutual relations between social and economic development, and the appearance and formation of spatium, the planning of that appearance and its connection with social planning, as well as many other questions that follow one from another, or else each from the previous question's solution.

Still, we have been able to show a few important phenomena in spatium that can serve as the determinants of a given system of research in the area of urban studies and architecture. We have seen that functionality, spatial phenomena, and relations permeate the entire subject matter, as does – something not treated in this paper – the specificity of the emergence of spatial units. These are the general attributes of spatium that can be seen throughout the gradations of its system and categories of its appearance.

This should be enough to consider the problems of urban studies, architecture and construction in a new light, to be able to grasp, without wishing to leave out special and fragmentary research, the plan and design of research in spatium as a whole. That is, to grasp it as an entire system in which each problem or undertaking has an allocated place, relations to other elements of the system, and significance.

We would thus define a new area of research, thus far only hinted at and present in our consciousness, but insufficiently formulated and treated. It is as significant for the life of man and the community as other scientific branches. With permanent, purposeful, and systematic work in this field, other spatial sciences will emerge, as a general theoretical and scientific base of construction and constituent part of any future social space.

STRUCTURAL CHART OF THE MAIN TYPES OF SOCIAL ACTIVITY AND RELATED PHENOMENA

NATURE

MATERIAL BASE — SOCIAL COMMUNITY — SOCIAL SUPERSTRUCTURE

HISTORICAL HERITAGE

CONSTRUCTION — SPATIUM — ARCHITECTURE

SCIENCE

| INDUSTRY | AGRICULTURE / MINING | PRODUCTION | SOCIAL SYSTEM | CULTURE | PHILOSOPHY / PRACTICES | ART |

TRANSPORTATION — TRAFFIC — TELECOMMUNICATIONS

HOUSING
FAMILY
MAN
AND CHILD

| STORAGE | TRADE / SERVICES / HOSPITALITY | RECREATION / LEISURE / GYMNASTICS | SOCIAL LIFE |

CHILD CARE
EDUCATION
SOCIAL SERVICES

HEALTH CARE

TOURISM

SYSTEMATIZATION OF SCIENTIFIC RESEARCH IN THE AREA OF URBANISM AND ARCHITECTURE

NATURE

PHILOSOPHY

HISTORY

SOCIAL NEEDS → LINES OF SPATIAL RESEARCH ← SOCIAL MEANS

1   3

FUNCTIONALITY			PROCESS OF EMERGENCE		
social activities	higher spatial unit		indirect	direct	
FUNCTIONAL PROCESSES	SPATIAL ACTIVITIES	FUNCTIONAL ATTRIBUTES	PROGRAMMING AND PLANNING	CREATION AND DESIGN	MATERIAL AND EXECUTION
simple	technological	spatial	need	program	industry
complex	physical and mechanical	physical	capacity	preliminary sketch	technical sciences
co-functional	human reactions	furnished	means	technical study	building

2

SPATIAL PHENOMENA AND RELATIONS

social structure	natural and spatial phenomena	
CONSTITUTION	GRADATION	RELATION
landscape units	higher gradation units	functional
urban units	same gradation units	structural
architectural units	lower gradation units	compositional

PURPOSE   QUALITY   RATIONALITY

SPECIFIC SPATIAL UNITS

SAVREMENE URBANISTIČKE TEME 2

PRILOZI III KONGRESU URBANISTA JUGOSLAVIJE

Prof. arh. Branislav Kojić: **Neki problemi u regionalnoj sistematizaciji naselja na teritoriji Srbije** ◆ Prof. dr Branko Maksimović: **Planska organizacija prigradske zone kao sredstvo za ograničenje porasta krupnih gradova** ◆ arh. Milorad Macura: **Društveni prostor kao predmet naučno-istraživačkog rada — Spacium** ◆ arh. Branislav Mirković: **Faktori prostornog oblikovanja** ◆ arh. Ranko Radović: **Sklop gradova u regionu**

IAUS

INSTITUT ZA ARHITEKTURU I URBANIZAM SRBIJE
ИНСТИТУТ ЗА АРХИТЕКТУРУ И УРБАНИЗАМ СРБИЈЕ

Arh. Milorad Macura

DRUŠTVENI PROSTOR KAO PREDMET NAUČNO-ISTRAŽIVAČKOG RADA — SPACIUM

DRUŠTVENI PROSTOR KAO PREDMET NAUČNO-ISTRAŽIVAČKOG RADA — SPACIUM

SADRŽAJ

Intenzivan razvoj civilizacije sem drugim procesima manifestuje se i suštinskim promenama u strukturi i sadržaju prostora ljudskog života, kojih društvo kao celina još nije svesno.

Čovekovo shvatanje sveta, u davnoj prošlosti totalističko, postupno se menjalo u naučno saznanje, zasnovano na definisanju i klasifikaciji svih pojava iz kojih se taj svet sastoji. Razvoj nauke, vekovima praćen diferencijacijom saznanja i porastom barijera između pojedinih naučnih grana, danas se odlikuje i procesom njene reintegracije. Ona je naročito izražena u nauci o društvu i u biologiji, u čijem okviru se razvila ekologija kao nova naučna disciplina.

Uporedno sa tim javljaju se i početne manifestacije reintegracije društvenog prostora, prostora čiji se razvoj kroz čitavu istoriju odlikovao rasčlanjavanjem i izolacijom svake od drugih prostornih jedinica.

Istraživačka aktivnost u oblasti društvenog prostora, danas podeljnog na regionalni, urbanistički, arhitektonski i enterijerni, zahteva izgradnju jednog celovitog naučnog sistema, koji će obuhvatiti sve elemente i pojave, i definisati odgovarajuće zakonitosti.

Kao materiju istraživanja u toj oblasti vidimo prostor ljudskog života društvenim radom formiran, organizovan i opremljen — spacium.

Spacium, koji je istovremeno izraz i preduslov egzistencije čovečanstva, odlikuje se svojim specifičnim svojstvima. To su: a/ funkcionalitet, b/ spacijalne pojave i odnosi, i c/ proces nastajanja spacijalnih jedinica.

U oblasti funkcionaliteta razlikuju se: 1/ funkcionalni procesi, kao prostorni aspekt društvenih aktivnosti, i 2/ funkcionalna svojstva, koja definišu osobenosti spacijalne jedinice uslovljene funkcionalnim procesom.

Funkcionalitet je osnov za kategorizaciju i rejonizaciju spacijalnih jedinica, koje su odraz organizacione strukture društvenih aktivnosti.

Spacijalne pojave i odnosi, izraženi u različitim vidovima mogu se definisati kao materija istraživačkog rada pri čijoj sistematizaciji su primenjene kao determinante: 1/ konstitucija spacijalnih jedinica, 2/ njihova gradacija, i 3/ relacije koje u spacijumu postoje.

U okviru konstitucije spaciuma razlikujemo određenu društvenu zajednicu, spacijalne jedinice i spacijalne elemente. Ona definiše stepen stisnjenosti spacijuma kojim se pak manifestuje njegov konstitucioni razvoj, a koji počinje da se usmerava na reintegraciju spaciuma.

Gradacija u spacijumu — uslovljena društvenim faktorima, svojstvima spacijuma i prirodnim i drugim pojavama — manifestuje se kao odnos jedne spacijalne jedinice: a/ prema jedinici višeg stepena, b/ prema jedinicama nižeg stepena i c/ prema istostepenim jedinicama.

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Relacije u spacijumu su zavisne od funkcije, konstitucije, i gradacije spacijalnih jedinica. Razlikujemo ih kao funkcionalne /neposredne i spontane/, strukturalne /uslovne, prostorne i tehničke/, i kompozicione, koje izazivaju u čoveku određeno estetsko osećanje, utiču na mentalno formiranje čoveka, i potstiču odgovarajuće socijalne reakcije ljudskih zajednica.

Ovde nije obrađena specifičnost nastajanja spacijalnih jedinica ni druge pojave i kategorije u spacijumu. Svrha prikazanog rada je da se u do sada amorfnoj materiji urbanizma i arhitekture definišu, klasificiraju i sistematizuju opšte pojave i pojmovi, da bi se moglo pristupiti programiranju i planiranju naučnoistraživačke aktivnosti u oblasti specijalnih nauka.

Uvod

Tema ovog spisa, datog kao prethodno saopštenje o jednom redu u toku, izlazi iz kruga pitanja omeđjenog glavnim kongresnim referatima. Ipak se činilo članovima Komisije za regionalne studije, planiranje i projektovanje u našem Institutu, i nekim članovima Organizacionog odbora, da je treba izneti pred Kongres mada neće biti predmet posebnog razmatranja.

Želja je da se ocrtani problemi i pojave budu u kontekstu naše diskusije o utvrđjenim kongresnim temama. Jer je njima prosuknuta atmosfera naše sadašnjice kao zemaljska vodenom parom koja, kondenzovana, može da bude i plodonosna kiša, i grad, i snežni pokrivač, i slana.

Problematika društvenog prostora

Danas - kada ljudsko saznanje prodire u atom i galaksije, kada tehnika omogućava letove u kosmos; kada broj ljudi koji nastanjuju ovu planetu raste fantastičnom brzinom; ka da nas razdiru kontrapozirana pitanja samouništenja ljudskog roda, i njegove ishrane i smeštaja na fizički omeđjenim kontinentima; kada se prirodni uslovi života čoveka kao prirodnog bića obezvređjuju tehničkim intervencijama, a tehničkim sredstvima sazdan prostor obezvređjuje čoveka kao ličnost i kao člana društvene zajednice, otuđjenog u prenaseljenim gradovima osećanjem beskrajne usamljenosti - danas mi stručnjaci, koji se bavimo prostorom u ljudskog života, vidimo svoju društvenu ulogu i njen smisao i novim razmerama, sa novim sadržajem i novim svojstvima.

Društvo kao celina još nije svesno revolucionarnih zbivanja koja razaraju tektonski sklop prostornog okvira njegove egzistencije. Još uvek se misli da su brojne negativne pojave posledica grešaka i krivaca, a ne određjenih zakonomernih promena, uslovljenih opštim razvojem. Još je ono ubeđjenje da će običnim ili stručnjačkim logiciziranjem o registrovanom problemu - sagledanom kao fenomen sam po sebi, izolovan od celine čiji je sastavni deo - uspeti da nađje celishodno rešenje. I danas laik i stručnjak služe se razvojem prevazidjenim pojmovima i merilima. Mada tretiraju nove prostorne elemente i procese, i nove odnose.

Postupno, ali sve izrazitije, manifestuje se u našem društvu saznanje da se suštinski menja problematika prostora

u kome se odvija ljudski život. Da treba zadatke kojima se ona rešava postavljati u skladu sa novim sačiniteljima i zakonitostima, i tražiti im rešenje po novim koncepcijama i principima.

Zato je u našoj zemlji osnovano nekoliko institucija čiji je zadatak da proučavaju pojave i otkrivaju zakonitosti nastajanja i egzistencije izgrađjenog prostora, i međjusobnih uticaja: čoveka, društvene zajednice i tog prostora.

EVOLUCIJA NAUČNE MISLI I PROSTORA

Tokovi nauke

Posle milenijuma tetalističkog shvatanja sveta, ljudska misao je tokom poslednjih stoleća došla do saznanja da ga može upoznati i shvatiti jedino ako ga sagleda kroz pojave kojima se on manifestuje. Definisanje i klasificiranje tih pojava od opštih do najelementarnijih, omogućilo je da se otkriju zakoni prema kojima se one manifestuju. Time je nastala nauka. I ukoliko se širio obim saznanja utoliko se nauka više granala, rasle su barijere između pojedinih njenih oblasti, nestajala je predstava o celini. Svaki od naučnih radnika, zatvoren u svoj naučni sistem, poznavao je samo elemente tog sistema. Drugi su za njega predstavljali nepoznata područja.

Od pre nekoliko decenija uporedno sa ocrtanim razvojem javlja se novo strujanje. Ono je zasnovano na saznanju da proučene i klasificirane pojave ne egzistiraju same za sebe, već da predstavljaju sačinitelje viših celina, u okviru kojih se zakonito, javljaju medjuuticaji primarnog značaja. I da jedna pojava može da bude celovito shvaćena pod uslovom da je ne vidimo samo kroz prizmu jedne naučne discipline, već da je posmatramo sa više aspekata. To je dovelo do probijanja palisada izmedju pojedinih oblasti nauke, i do procesa njene reintegracije.

Započet u okviru društvenih nauka, obuhvativši skoro celokupno ljudsko saznanje, taj proces je naročito izražen u oblasti biologije. Ekologija, kao nova naučna disciplina, menja dotadašnja shvatanja o prirodi i životu, potvrdjujući slikovito i uzbudljivo ispravnost Marksove dijalektike, inače često simplificirane i mehanizovane.

Adekvatan razvoj evidentiramo u koncepciji društvenog prostora, - u oblasti arhitekture i urbanizma.

Obezvredjiva-nje prostora

Hiljadama godina težilo se što efikasnijoj izolaciji konkretnog prostora. Rasle su zidine oko majura, dvorova i gradova. Zatvarane i jačane su ulične fasade zgrada, čiji je vidokrug aveden na dvorište. Intenzivirana je razlika izmedju grada i sela, agrarnog pejzaža i devičanske prirode.

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Analogo tome neimarstvo kao specifičan izraz ljudskog stvaralaštva rasčlanjevalo se na urbanizam, arhitekturu, enterijer i hortikulturu, čije osamostaljivanje je izraženo dezintegracijom i devalorizacijom prostora. U jednom času stiglo se dotle, da se pod arhitekturom podrazumevalo samo likovno oblikovanje fasade.

Industrijalizacija proizvodnje i novi društveni odnosi usmeravaju ovo kretanje u suprotnom pravcu. Uporedno sa procesom reintegracije nauke, javlja se spontana težnja ka reintegraciji prostora.

Gradske zidine su već nestale. Otvori na zgradama su sve veći. Teži se funkcionalnom i vizuelnom spajanju unutrašnjeg i spoljnjeg prostora. Gradovi prodiru u pejzaž i rasplinjavaju se u njemu. Razlika između sela i grada opada. Turistički domovi i bungalovi niču u ranije nepristupačnim šumama, a dalekovodi i autostrade prelaze preko planina nekada neprohodnih. Distance se ne mere danima i nedeljama već satima i minutima, sada ih telefon, radio i televizor skoro negiraju. Zato se savremeni čovek tražeći odmor u miru, udaljuje od svog mesta rada, i prelazi svakodnevno desetine kilometara.

Agrarne površine se smanjuju zbog ekspanzije gradova, industrijskih kompleksa i hidroakumulacija. Šume se povlače, a regulacijom bujica i reka drenira se vodonosno podzemlje. Čitave oblasti ostaju bez vode, a ono malo što još uvek protiče našim rekama zagadjuje se odlivima iz naselja, fabrika i rudnika. Zagadjuje se i vazduh raznim isparenjima, koja degenerišu floru i izazivaju patološke pojave u ljudskom organizmu.

Saobraćajna sredstva, čija efikasnost nam imponuje, odnose više žrtava nego nekada najkrvaviji ratovi. Pa ipak čovečanstvo tišti oskudica u stambenom, školskom, bolničkom i drugim kategorijama arhitektonskog prostora, koji je preduslov njegove egzistencije.

Potrebna sredstva za izgradnju tog prostora permanentno se povećavaju, jer neophodni minimum njegovih svojstava i tehničke opremljenosti raste uporedno sa porastom gustine nastanjenosti odredjene urbane jedinice. To iziskuju psihobiološki uslovi ljudskog života, i činjenica da se ekonomika u oblasti urbanističkog prostora ostvaruje arhitektonskom.

Mi smo, blagodareći našoj relativnoj nerazvijenosti, još daleko od obezhrabrujućeg stanja Borinaža, regiona Liježa, ili nekih drugih oblasti zapadne Evrope i Amerike. Ali ne treba zaboraviti da je Jugoslavija pre četrdesetak godina imala jedanaest i po miliona stanovnika, i.da će ih uskoro imati dvaput više. Da treba na skoro istoj površini obezbediti im i ishranu. Da poljoprivredi može da zasniva svoju egzistenciju najviše sedam do osam miliona ljudi, dok će ostatak morati da bude angažovan urbanim delatnostima, u urbanom okviru.

Metodi kojima smo se do sada služili pri rešavanju ovih problema pokazali su se nedovoljno efikasnim. I praksa u drugim, pa i tehnički visoko razvijenim zemljama,potvrdjuje ovu konstataciju.

Razlog tome je - pored ostalog - što izgradnja urbanistič kog i arhitektonskog prostora nema jedinstvenu i sveobuhvatnu naučnu bazu na kojoj bi se zasnivala.Za nju se, pored rezultata pojedinačnih i parcijalnih istraživanja, koriste fragmenti iz tekovina brojnih naučnih oblasti, izmedju kojih nisu uspostavljeni potrebni harmonijski odnosi. Koji su u izvesnim slučajevima čak i kontradiktorni.

Zato se nameće kao potreba uspostavljanje jednog celovitog naučno istraživačkog sistema. U kome će svaka pojava dobiti odredjeno mesto, s tim da budu jasno definisane njene veze i medjusobni uticaji sa korelativnim joj i opšte društvenim pojavama.

Treba eliminisati praksom i teorijom ustanovljenje pregrade izmedju regiona, grada, zgrade i prostorije, i procesa njihovih nastajanja, i sagledati ih kao organske sačinitelje jedne opšte kategorije. O kojoj u našoj individualnoj svesti postoji odredjena predstava, ali koja još uvek nije u društvenim razmerama ni definisana ni proučena.

SPACIUM

Priroda nije samo jedinstvo svih pojava stihijnim razvojem nastalih na ovoj planeti. Ni samo izvor sredstava za održavanje života na njoj. Ona je i prostor u kome se taj život odvija.

U okvirima prirodnog prostora ljudski rod je dejstvovao, i prilagodjavajući pojedine njegove delove svojim potrebama menjao im je sadržaj i svojstva. Tamo gde je njegovo dejstvo bilo isključivo eksploatatorskog karaktera, prirodni prostor je devaloziran i pretvoren u pustoš. Na drugim mestima, gde je ono bilo smišljeno i trajno,usmereno na stvaranje novih vrednosti, nastala su polja, put, kuća, selo ili grad.

Tako se razvija - u početku kao retke enklave u beskrajnom prirodnom prostoru a kasnije sve širi, celovitiji i složeniji - PROSTOR LJUDSKOG ŽIVOTA DJUŠTVENIM RADOM FORMIRAN, ORGANIZOVAN I OPREMLJEN. Radi razlikovanja od prirodnog, kosmičkog, apstraktnog ili bilo kog drugog prostora, nazovimo ga analogo "urbanizmu" i "regionu" - "SPACIUM".

Time je nastao pojam koji obuhvata i region i grad i zgradu i prostoriju - sve kategorije prostora u kome se odvija ljudski život. Individualni i društveni, sa svim njihovim manifestacijama i oblicima i sektorima društvenih delatnosti.

Opšta je karakteristika spaciuma da je on izraz i preduslov egzistencije društvene zajednice; da mu zajednica odredjuje sadržaj i svojstva; i da joj on u značajnoj meri predodredjuje uslove i način života i rada.

Celokupna privredna baza i društvena nadgradnja odražavaju se višestruko u spaciumu.Otuda isključiva osobenost spacijalnih jedinica da predstavljaju materijalizovani otisak ljudskog života, iz koga se taj život može da upozna kao praistorija iz otkrivenih fosila.

Medju svim produktima ljudskog rada spaciuma i spacialni e lementi odlikuju se nekim specifičnim svojstvima.Kao najiz razitija i najopštija vidimo: funkcionalitet, spacijalne pojave i odnose u spaciumu, i proces nastajanja spacijalnih jedinica. Definicije i utvrdjivanje zakonitosti, prema kojima se ta svojstva izražavaju, omogućiće nam da lakše ili efiksanije rešimo neke probleme, čiju suštinu nismo uspeli do sada da sagledamo.

FUNKCIONALITET

Bezmalo svi vidovi društvene aktivnosti definisani su i svojim prostornim aspektom, u struci nazvani funkcionalni proces. Njime nisu obuhvaćeni smisao i sadržaj rada i njegove druge karakteristike, već samo njegove izražene položajem i kretanjima odredjenih ljudi i predmeta u odgovarajućem prostoru - prostornim zbivanjima.

Funkcionalni proces predodredjuje bitne osobine i osobenosti svake spacijalne jedinice. Njene dimenzije, raspored njenih sačinitelja, koncepciju, realizaciju,obradu i opremu, psihobiološke uslove života i rada u njoj,i druge, koji svi skupa čine njena funkcionalna svojstva.

Funkcionalni procesi i svojstva sažimaju se u funkcionalnosti, koja je primarni razlog nastajanja i postojanja spacijuma i spacijalnih jedinica. Njome se oni odlikuju od drugih proizvoda ljudskog rada, definisanih namenom.

Namena je nerazlučivo spojena sa odgovarajućim joj predmetom. Ona je svojstvo predmeta, predodredjeno predmetom,koji je istovremeno njome predodredjen. Namena je uvek jednostavna, promenljiva samo po odredjenim karakteristikama kao: kapacitet, kvalitet i sl.

Funkcionalnost je uslovljena odredjenom ljudskom aktivnošću - odnosno njenim prostornim manifestacijama - i primarnim svojstvima objekta: prostornim, fizičkim i drugim. Zato je ona složena i u svakom konkretnom slučaju na specifičan način definisana. Funkciju postojeće spacijalne jedinice može se u odredjenim granicama prilagoditi drugim društvenim potrebama uz manju ili obimniju adaptaciju, što je sa namenom nemoguće.

Ako jedan domen delatnosti sagledamo u njegovom integralnom vidu, kao kategoriju u sistemu opšte društvene aktivnosti, pa ga stepenovanjem pratimo preko mreže svih angažovanih institucija i njihove sačinitelje, do radnog mesta i pojedinca koji svojim radom obezbedjuje efekat te delatnosti, uočićemo izvesne pojave i odnose koji se sažimaju u odredjenu organizaciju izraženu organizacionim - radnim jedinicama.

Navikli smo da ceo taj sistem vidimo kao stalan i nepromenljiv. S razloga što se on konkretizuje odredjenim organizacionim i spacijalnim jedinicama, koje su postale pojam. A pojmovi su istovremeno i predmet i sredstvo našeg mišljenja.

Medjutim u okviru svake od društvenih aktivnosti, koje su medjusobno čvrsto povezane u jednu celinu, zbivaju se bez prekida promene čija sveukupnost čini progres čovečanstva. One nastaju kao posledice razvoja odgovarajuće naučne baze, tehničkih sredstava kojima se aktivnost obavlja, iskustva koje se permanentno akumulira,i svakodnevne prakse. Istovremeno se menja i značaj te aktivnosti za društvo kao celfnu, za pojedine njegove jedinice i za pojedinca. Menjaju se i odnosi u okviru kojih se tom aktivnošću zadovoljavaju odgovarajuće potrebe, i uslovi pod kojima se to dogadja.

Budući da se razvoj spaciuma manifestuje u odnosu na ova zbivanja uglavnom kvantitativno, dok su kvalitativne promene postojećih spacijalnih jedinica ograničene i retke,on kao značajan uticajni činilac najčešće usporava progresivno kretanje. Ali pod odredjenim uslovima kada je realizacija neke spacijalne jedinice ili sistema jedinica kon cipirana na studijskom, kreativnom i tehničkom zahvatu inspirisanom novim saznanjima i shvatanjima, oni dejstvuju kao snažan i efikasan stimulans budućeg napretka.

Cilj istraživačkog rada u ovoj oblasti je da u saradnji sa drugim stručnjacima i naučnim radnicima proučimo i definišemo promene koje se zbivaju u okviru svih i svake društvene aktivnosti. Da sagledamo i utvrdimo njihove prostorne aspekte, i na osnovu celovitog obuhvata funkcionalnih procesa, od najopštijih do pojedinačnih, da koncipiramo odgovarajući im sistem spacijalnih jedinica i njihova funkcionalna svojstva.

To znači da treba uspostaviti celishodnu kategorizaciju i klasifikaciju institucija, - odnosno spacijalnih jedinica - u skladu i istovremeno sa njihovim prostornim razmeštajem, tako da one čine najopštiju funkcionalnu celinu.

Time nastaju rejoni odredjenih društvenih aktivnosti koji naknadnim prostornim usklađivanjem definišu regione kao najvišu kategoriju spacijalnih jedinica.

U okviru rejona, koji zahvata i region i naselje, svaka institucija zrači svojim uticajem na druge institucije,što je uslovljeno njihovim stepenovanjem. I svaka opslužuje jedan deo regiona ili naselja, prema svojim karakteristikema i stepenu funkcije, pri čemu ona najvišeg stepena svojim zračenjem sudeluje u definiciji granica regiona ili veličine naselja.

Ako razmeštaj i programi izgradnje pojedinih arhitektonskih objekata – koji ne predstavljaju ništa drugo do prostorni aspekt organizacije i rada odgovarajuće institucije – budu definisani u okviru ovakvog sistema,po kome se složenije funkcije sažimaju u jedinice višeg stepena, postigle bi se značajne prednosti. Uspostavilo bi se prisniji kontakt korisnika delatnosti sa najfrekventnijim i najjednostavnijim institucijama, omogućilo bi se celishodniji, racionalniji i kvalitetniji rad u njima,i u onim višeg stepena, smanjile bi se neophodne investicije, i bile bi povećane mogućnosti za unapređenje i usavršavanje samih aktivnosti.

To se odnosi na svaki od savremenih vidova društvene aktivnosti. Na privredu, na kulturnu delatnost, staranje o detetu, zdravstvenu zaštitu i sve druge.

SPACIJALNE POJAVE I ODNOSI

Rekli smo da je spacijum – kao prostor ljudskog života društvenim radom formiran, organizovan i opremljen – izraz i preduslov egzistencije čovečanstva.

Budući da je savremena društvena zajednica strukturalno raščlanjena i da se njen život i rad odlikuju bogatstvom sadržaja i oblika, spacijum je jedna od najsloženijih pojava ovog sveta. Razlog tome je što između brojnih i raznovrsnih spacijalnih pojava i elemenata postoje odgovarajuće veze, i složeni međusobni uticaji.

Analiza koju smo obavili dovodi do zaključka da se sve pojave i odnosi u spacijumu, koji su izraženi u različitim vidovima, mogu da definišu i srede kao materija naučno istraživačkog rada. Pri tome su kao determinante primenjene:

– **Konstitucija** spacijalnih jedinica, određena odgovarajućim funkcionalnim sistemima i intenzitetom ekotehničke izgrađenosti prostora;

– **Gradacija** – stepenovanje spacijalnih jedinica – koja se javlja kao posledica organske raščlanjenosti spacijuma, zavisne od strukture društvene zajednice i vidova njene aktivnosti; i

– **Relacija** između spacijalnih jedinica uslovljene koegzistencijom i aktivnim međusobnim uticajem većeg broja jedinica u spacijumu.

| Konstitucionalni razvoj spacijuma |

Od časa, kada su ljudi navalili prvu stenu na grlo pećine da bi onemogućili ulaz zverima i zaustavili ledenu struju vazduha, jačale su, rasle i stepenovale se barijere u spacijumu. Težnja za totalnom izolacijom spacijalne jedinice od spoljnjeg prostora, kao sredstvom lične i društvene bez bednosti,bila je milenijumima primarni podsticaj građenja.

| Konstitucionalni razvoj spacijuma |

U okvirima tih barijera prostor je sve intenzivnije korišćen. Stalnom izgradnjom smanjivao se odnos spoljnjeg prema unutarnjem prostoru – jačala je **stišnjenost spacijuma**. Time se manifestovao njegov konstitucionalni razvoj praćen kroz vekove recipročnim posledicama. Na jednoj strani raste stepen njegove eksploatacije; na drugoj smanjivan mu je kvalitet svojstava koja sačinjavaju osnovne uslove harmoničnog života ljudi, što je vodilo ka degeneraciji čoveka kao fizičkog, psihičkog i društvenog bića.

Rekli smo da se u okviru savremenog razvoja civilizacije shvatanje prostora menja. U čoveku je izbila, kao reakcija na određeno stanje, nagonska težnja za slobodnim prostorom, za izolacijom od spoljnjeg prostora, već u tom prostoru.

Ta težnja, uz fantastičan progres tehnike, podstiče reintegraciju ranije atomiziranog spacijuma.

| Reintegracija spacijuma |

Dotakli smo se opet jednog od primarnih zadataka istraživanja u spacijumu. Kako shvatiti, kuda usmeriti, kakvim prostornim jedinicama i elementima izraziti reintegraciju spacijuma? Znamo da trenutna manifestacija tog procesa – pokrivanje ogromnih površina agrarnog zemljišta porodičnim vrtovima i kućama od stakla – nije u skladu sa opštim interesom. Nisu nam bliske ni ideje o spacijumu tipa termitnjaka, jer svoju misao zasnivamo na određenom shvatanju čoveka, suprotnom takvoj zamisli. Ubeđeni smo samo u jedno; da treba istraživati, proučavati, eksperimentisati i da će se kroz usmeravani razvoj – sintezom naučne misli i prostorne kreacije – doći do solucije kojima će i pojedinac i zajednica biti zadovoljni.

| Gradacija u spacijumu |

Među komponentama tog kretanja nesumljivo će biti i postupna transformacije preovladjujućih sistema gradacije spacijalnih jedinica.

| Sredstvo organizacije prostora |

Gradacija je izraz organske raščlanjenosti spacijuma, uslovljene više smernom i višestepenom raščlanjenošću društvene zajednice, i suštinskim svojstvima samog spacijuma. Ona predstavlja jedno od primarnih sredstava organizacije prostora. Pomoću nje amorfni skup jedinica uobličava se u određeni sistem, ili organizam višeg reda.

Značajnu fazu pri definisanju sadržaja i svojstava spacijalne jedinice a time i njene svrsishodnosti, racionalnosti i kvaliteta, predstavlja gradacija. Upravljena u dva

| Konstitucija spacijuma |

Na osnovu konstitucije vidimo spacijalne jedinice kao pejzažne, urbane arhitektonske i enterijerne. Pošto su njihove osobenosti i problemi koji iz njih nastaju uglavnom poznati, nećemo ih u ovom prilikom pojedinačno da tretiramo. Ocrtaćemo samo neke opšte pojave.

| Sačinitelji spacijuma |

Svaka spacijalna jedinica čini celovit sistem unutar koga su izraženi zakonomerni odnosi između njenih sačinitelja koje možemo grupisati kao:

– određena društvena zajednica – razvijeni socijalni organizam ili deo tog organizma: komuna, kolektiv jednog preduzeća, porodica i dr.

– spacijalne jedinice nižeg stepena: gradovi u regionu, zone u gradu, sobe u stanu i sl.

– spacijalni elementi: objekti, grupe objekata i odgovarajuće pojave.

Među njima razlikujemo: elemente anorganske prirode, bilo da su nastali dejstvom prirodnih stihija ili da su izvedeni tehničkim postupkom; elementi organske prirode koji se formiraju ili spontanom razvojem, ili ljudskim radom kultivisani i rasprostranjeni; i određena zbivanja, kao redovne i zakonite pojave od kojih su neke prirodne, a neke izazvane ljudskom aktivnošću.

Svaki od elemenata spacijuma neposredno ili posredno utiče na čoveka ili njegov životni tok.Njihovo dejstvo, posmatrano kroz prizmu ljudskog interesa sagledanog u najširem dijapazonu, ocenjujemo kao pozitivno ili negativno. Medjutim pažljivo razmatranje ukazuje na činjenicu da je ono bezmalo u svim slučajevima i pozitivno i negativno, bilo da se ono takvim javlja,bilo da zato postoji potencijalni uslov.

Susreli smo se sa jednim od najinteresantnijih zadataka istraživača spacijuma, planera spacijalnog razvoja, ili kreatora spacijalnih jedinica.

Kako negativne pojave u spacijumu redukovati na minimum? Kako njihov uticaj na čoveka i njegov život transformirati, da bi se uskladile sa njegovim htenjima i potrebama? Možda i želje treba razvijati, menjati ili potpuno nove izazivati!

Zar čovek nije od groma dobio vatru? Zar se još od davnina nije lečio vodom mrgođdnom za piće i pranje? Zar nisu poplave Nila obesbedjivale hranu Egipćanima? Zar zima danas nije izvor radosti i zdravlja? Setimo se, da čovek nastaje kao vrhunsko biće prirode u ledeno doba, koje ga je prinudilo svojom stihijom da se nastani u pećinama, da u njima ustanovi ognjište, i da organizuje svoj život zasnovan na podeli rada.

suprotna smera ona se danas manifestuje ili kao sažimanje – fuzija – ili kao razlaganje – fisija – spacijalnih jedinica, u kojima se odvijaju određeni funkcionalni procesi. Zato je ona predmet mnogih dilema koje nisu uvek celishodno rešene. Koje se i ne mogu razrešiti ako se pri tome služimo svakidašnjem ljudskom logikom, umesto postupkom zasnovanim na poznavanju određenih zakonitosti kao tekovini odgovarajućeg istraživačkog rada.

| Uslovi gradacija |

Proučavanjem pojava gradacije u spacijumu kao takvih, ustanovljeno je da se one diferenciraju prema činiocima koji ih izazivaju. Ti činioci su svrstani u tri osnovne grupe, prema kojima razlikujemo tri vida gradacije:

– gradacije uslovljene društvenim faktorima;

– gradacije uslovljene svojstvima spacijuma;

– gradacije uslovljene prirodnim pojavama, razvojem nauke i tehnike, istorijskim zbivanjima i drugim činiocima.

Svaki od navedenih vidova predstavlja jednu od ordinata kojima je definisana sama pojava gradacije.Nijedna od njih nije sama po sebi dovoljna, a isto tako nijedna se ne može zanemariti.

| Pojave gradacije |

U spacijumu pojava gradacija se manifestuje stepenovanjem i grananjem, i to kao:

– odnos spacijalne jedinice prema jedinici višeg stepena /primeri: rejon prema regionu, grad prema regionu/;

– odnos spacijalne jedinice prema jedinicama nižeg stepena /grad prema gradskim zonama, opšte gradskim centrima i objektima, prigradskim naseljima i dr./;

– odnos spacijalne jedinice prema jedinicama istog stepena, koji mada ima izraz čiste gradacije, veoma često služi da se definišu neke gradacione pojave i svojstva /stambena zona prema industrijskoj zoni, gradskom centru i dr./

Kada bismo pokušali da izvršimo spektralnu analizu nekog našeg urbanističkog plana razloženog kroz prizmu gradacije,otkrili bismo u njemu brojne šupljine i nedostatke. Među njima i one koji uslovljavaju osnovne slabosti izgradnje i razvoja naših gradova, stvarajući prepreke koje se ne mogu bez velikih napora da uklone. A sa kojima se mi danas, uz znatne žrtve i često bezuspešno,nosimo i borimo.

| Relacije u spacijumu |

Koegzistencijom i aktivnim međusobnim uticajem više spacijalnih jedinica na određenoj teritoriji nastaju među njima odgovarajuće relacije. One su – pored ostalog – zavisne od funkcija, konzistencije i gradacija tih jedinica.

Relacije spacijalnih jedinica su utoliko složenije i značajnije, ukoliko je stišnjenost spacijuma viša. Pošto pred

postavljamo, kao što je ranije naznačeno, da će poras stišnjenosti spacijuma biti jedna od glavnih karakteristika njegovog budućeg razvoja, očigledno je da im moramo posvetiti puno pažnje.

Analizom i klasifikacijom raznovrsnih odnosa i veza registrovanih u spacijumu, došlo se do zaključka da možemo identifikovati tri vrste relacija: funkcionalne, strukturalne i kompozicione. Prve su odraz odnosa u prostoru raznih društvenih aktivnosti i vrsta aktivnosti, i to celovito shvaćenih, a ne samo odgovarajućih im funkcionalnih procesa. Druge proizilaze iz činjenice da svaka spacijalna jedinica ili element bez izuzetka predstavljaju fizički ili prostorni sačinitelj druge jedinice ili elementa. A treće nastaju iz vizuelnog efekta spacijuma zasnovanog na likovnim svojstvima njegovih sačinitelja, i na njihovim medjusobnim harmonijskim odnosima.

Funkcionalne relacije

Ma koliko bile brojne i različite funkcionalne relacije, one se mogu svrstati u tri osnovne grupe: neposredne, posredne i spontane.

Neposredne relacije javljaju se tamo gde postoji komplementiranje društvenih aktivnosti ili uzajamno negiranje osnovnih funkcionalnih uslova. Tamo gde efekat ljudskog rada u jednom domenu neposredno zavisi od efekta rada u drugom, a da to bude odnosima u prostoru predodredjeno. Kao ilustrativni primer sredjemo industrijski kompleks jedne želazare, čija produkcija i ekonomičnost su zavisni od željezničkog saobraćaja, a rentabilnost investicija u željeznički priključak od kapaciteta želazare i njene udaljenosti od renžirne stanice. Ili kada je kraj osnovne škole umesto igrališta sagradjen fudbalski stadion sa kojeg galama remeti mir i moć koncentracije i djeka i nastavnika.

Posredne relacije nastaju kada se izmedju dve jedinice kao uticajna veza javi treća spacijalna jedinica ili element. Kada je na primer, usled necelishodno rešenog sistema saobraćajnica zametna veza izmedju stambenog naselja i fabrike, što dovodi do smanjenja njene produktivnosti rada. Kada industrijski odliv zagadjuje reku, tako da je onemoguće no snabdevanje naselja vodom. Ili kada je fabrika leda locirana blizu malog stadiona, pa se njihovim povezivanjem došlo do sportskog klizališta.

Spontane relacije su izraz vanrednog sticaja okolnosti.Bilo slučajnog bilo predvidjenog. One su izvan okvira standardne problematike prostora i često je njihov efekat, i kad je pozitivan i kad je negativan, veoma naglašen. Ako se protočna hidroakumulacija realizuje u lepom pejsažu kroz koji prolazi put, tu će se formirati rekreativni centar. Medjutim izgradnjom fabrike viskoze na odredjenom terenu i njenom neminovnom ekspanzijom doveden je u pitanje opstanak poznatog lečilišta, koje je u početku bilo dovolj no .izolovano.

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Neposredne relacije su očigledne i jasne. Njih po pravilu uzima u obzir pri radu svaki stručnjak, tako da se greške uočene kod nas u ovoj oblasti zaista mogu smatrati kao prestupi i krivice. Ali već posredne, a naročito spontane relacije treba da budu predmet posebnog izučavanja. I one pozitivne, i negativne. Potrebno je registrovati pojave, analizirati i klasificirati ih, ustanoviti koliko god je moguće zakonitosti po kojima se one manifestuju, i rezultate tog rada koristiti u praksi sa ciljem da se uzdigne kvalitet našeg izgradjenog prostora.

Strukturalne relacije

Fizička veza izmedju spacijalnih jedinica i elemenata u odredjenom prostoru je redovna pojava.Medjutim njen značaj i uloga nisu uvek podjednako izraženi. U pojedinim slučajevima su skoro neutralni, da bi odjednom izbili u prvi plan naših interesa i staranja, zasenjujući sve druge faktore i probleme. Budući da se ti odnosi javljaju uvek u okviru odredjene celine, u kojoj sve jedinice ili elementi predstavljaju delove iz kojih je ona sazdana, obeležili smo ovu vrstu relacija kao strukturalne.
Prema svojstvima i prirodi tih odnosa mi ih razlikujemo kao: uslovne, prostorne i kompozicione.

Strukturalno-uslovne relacije registrujemo izmedju jedinica i elemenata koji su kao spacijalne pojave svim svojim svojstvima medjusobno uslovljeni i prostorno povezani. Ta uslovljenost je toliko izrazita, da jedna pojava bez druge gubi egzistencijalni smisao.

Kao ilustracija mogu da posluže odnosi pristaništa i plovne reke; rudarskog naselja, rudnika i rudnih naslaga; industrijskog kompleksa i pristupnih komunikacija; ili osnovne škole i stambenog naselja.

Suštinu zadatka u ovoj oblasti rada predstavlja usklaadjivanje svojstava i kapaciteta korelativnih jedinica,pri čemu kao predmet istraživanja vidimo pre ustenovljenje odredjenih normativa, nego definiciju opštih zakonitosti.

Strukturalno-prostorne relacije nastaju kada su spacijalni elementi - ili u retkim slučajevima i jedinice - neumitno postavljeni jedan prema drugom u odredjenom prostoru. Medjusobna uslovljenost izmedju njih u ovom slučaju je izrazitija više no ikad. Iz toga nastaju glavne teškoće pri rešavanju konkretnog zadatka. Bilo da se ti elementi sustiču sticajem prirodnih i tehničkih činilaca /kao na primer: klisura - reka - željeznička pruga - drum/, bilo da je to nastalo planski /primer; gred - željeznička postrojenja - gradjaki saobraćaj/ ili kao posledica stihijnog razvoja grada /primer: izgradjeni rejoni - rekonstrukcija saobraćajne mreže/ u svakom slučaju zadatak predstavlja nov problem koji se ne može rešiti korišćenjem opštevažećih obrazaca, jer oni ne postoje.

Ove pojave treba registrovati, analizirati i uporedjivati, sa ciljem da se utvrdi celishodnost i vrednost konkretnih

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rešenja. Rezultati tog rada koristiće da se izbegnu jednom već učinjene greške, i da se analogijom usmeri i oceni predloženo rešenje.

Strukturalno-tehničke relacije javljaju se uglavnom izmedju spacijalnih elemenata sagradjenih u prostoru, kada neki elementi predstavljaju sačinitelje elemenata višeg stepena. Najizrazitiji primeri su mostovi i tuneli kao sastav ni delovi željezničke pruge ili kolskih puteva. Medju njih spada i odnos hidrobrane prema akumulacionom jezeru, transformatorskog postrojenja prema dalekovodu i sl.

Odnos željezničke stanice prema željezničkoj pruzi; garaže i depoa, prema linijama gradskog saobraćaja; servisnih sta nica prema autoputu - mada prividno spada u ovu kategoriju relacija - treba shvatiti kao strukturalno uslovne.

Na to nas navodi činjenica što ovi elementi - mada tehnički, funkcionalno i prostorno povezani - nisu predodredjeni u prostoru rešenjem višestepenog elementa.

Njihova svojstva i položaj treba posebno utvrditi.

Kod strukturalno-tehničkih relacija sva spacijalna pitanja, sem kod retkih izuzetaka, rešena su istovremeno za sve korelativne elemente. Zato izgleda da ih sa ovog aspekta ne treba pojedinačno tertirati.

Kompozicione relacije

Posebnu ulogu i značaj imaju kompozicione relacije. Dok su sve ranije posmatrane pojave prisno vezane za konkretan čovečiji i društveni interes - shvaćen u najširem smislu tih reči, jer definišu mnoge uslove i vidove ljudskog života - dotle ova vrsta relacija, kojima spacijum utiče na psihu čoveka, sa tim interesom je samo u posrednoj vezi. Pa ipak, veoma značajno. Jer one mogu da povećaju ili umanje proizvodnost rada, da ubrzaju ili uspore proces ozdravljenja bolesnika,da povećaju ili smanje koncentraciju pažnje učenika.

Čovek reaguje na kompoziciona svojstva spacijalnih jedinica i elemenata hteo to. ili ne hteo; bio toga svestan ili ne. Ta reakcija uslovljena je ne samo svojstvima spacijumma već i obrazovanjem i navikama čoveka. Zato reakcija raz nih ljudi na jedan spacijalni fenomen nisu iste, kao ni ocene njegove estetske vrednosti. I pored toga kompoziciona svojstva spacijuma zasnivaju se na veoma jasnim, mada kroz vreme promenljivim, zakonima i merilima.

Uticaj spacijuma na psihu čoveka manifestuje se time što izaziva u njemu odredjeno estetsko osećanje; što utiče na formiranje ili transformiranje mentaliteta čoveka; i što izaziva odredjene socijelne reakcije grupa ljudi koji žive u odredjenom spacijumu.

Estetsko osećanje javlja se - u času kada čovek doživljava kompozicioni efekt odredjenog spacijuma - kao veoma složena pojava. Ono .se proteže od svesnog dopadanja zasnovanog

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na povoljnoj kritičkoj oceni dela čije kompozicija je uskladjena sa usvojenim normama, preko ushićenja novom kreacijom koja probija nivo dotadašnjih shvatanja i merila, do podsvesnog podavanja atmosferi kojom taj prostor sam po sebi zrači.

Prema tome kod estetskog osećanja koja u čoveku izazivaju spacijalne pojave možemo razlikovati dva sloja.

Donji obuhvata sve vidove podsvesnih reakcija izazvanih osećanjem: veličine, proporcija i razudjenosti prostora, elementa kojima je on formiran, osnovnih i komplementarnih mu boja,stepena zasićenosti prostora elementima i ljudima, intenziteta osvetljaja, svojstava i jačine zvuka i drugih faktora u njemu, koji delujući na podsvest čoveka izazivaju odredjeno raspoloženje.

Gornji sloj je izražen u zoni svesti. Tu vrhuni klasično osećanje lepog, zasnovano na odredjenim opšteusvojenim za konima i principima. Oni nisu jedinstveni i stalni, jer zavise od podneblja, stepena opštedruštvenog razvoja odredjene jedinice, od klasnih odnosa i drugih činilaca, i kao takvi menjaju se kroz vreme. Pri tome se savremena merila, definisana stvaralaštvom i kritikom, postupnim trijažiranjem i objektivizacijom pretvaraju u istorijska.

U skladu sa stepenom obrazovanja i kulturnog angažovanja odredjene ličnosti, ova merila se manifestuju - uz odgovarajuće prilagodjavanje - kao konkretna reakcija te ličnosti. Zato je izučavanje ovih pojava usmereno u više pravaca. Neka od njih su pretežno psihološkog karaktera, u drugima preovladjuje socijalna komponenta, dok su treća izrazito teorijskog značaja.

Mentalnom formiranju odnosno transformiranju čoveka spacijum doprinosi kroz sadejstvo sa drugim činiocima - prvenstveno sa odgovarajućim delom društvene zajednice - koji avi skupa čine ambijent. Ne treba naglašavati da se tu radi o trajnom uticaju, prema kome čak u jednom razdoblju po stoji i negativna reakcija. Ali koji, ako je dovoljno intenzivan i trajan, nije moguće izbeći.

Ovu pojavu je lakše sagledati kroz proces transformacije mentaliteta čoveka, nego u procesu njegove primarne formacije.

Sociolozi su utvrdili da postoje odredjene veze izmedju spacijuma i dečjeg kriminala, i kriminala uopšte. Da postoje veze izmedju spacijuma i mnogih mentalnih deformacija.Čak i onih koje se graniče sa psihopatološkim pojavama.

Za nas je taj uticaj od izuzetnog značaja zbog intenzivnog strujanja stanovništva izazvanog razvojem industrijske proizvodnje i mehanizacija poljoprivrede, koja se u oblasti formacije mentaliteta odražava koliko pozitivnim toliko i negativnim pojavama.

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Istraživački rad u toj oblasti dovodi nas do zaključka da se šokovi izazvani naglim prelaskom iz ruralnog u urbani ambijent mogu ublažiti izgradnjom celishodno koncipiranih naselja sem i urbanog tipa. Ova ideja je privlačna i zbog toga što su izdaci za neophodan arhitektonsko-urbanistički prostor u takvim naseljima znatno niži od investicija u visoko urbaniziranim jedinicama.

Psihologija i sociologija mogu da definišu ovakve probleme. Ali njegovo rešenje može se naći samo proučavanjem odgovarajućih spacijalnih jedinica, sa ciljem da se utvrde njihova nova svojstva i novi principi po kojima će one biti realizovane.

Socijalne reakcije na kompoziciona svojstva spacijuma nastaju društvenom integracijom estetskih i mentalnih uticaja na pojedinca. Kao specifično naš primer, još uvek nedovoljno sociološki i psihološki proučen, možemo navesti efekt koji u psihi čoveka izazivaju sustanarski odnosi. Tu se naročito manifestuje disharmonija između kompozicionih svojstava određenog stana, i veličine i sastava grupe ljudi koje u njemu žive.

Sličan primer pretstavlja jedan događaj iz prvih godina po Oslobodjenju. Kada su udžerice u beogradskom "Prokopu" porušene, i njihovi stanovnici bili preseljeni u višespratne zgrade, izgledalo je da je rešen jedan krupan problem. Ali problem je postao još zamršeniji kada je građevinska inspekcija otkrila da su u "Prokopu" sagrađene nove udžerice, i da u njima žive stari stanari koji su odlučno odbili da se vrate u dodeljene im "moderne" stanove.

Zanimljivo je, kao pozitivna pojava, reagovanje građana Titovog Užica na nedavno izgrađeni centralni trg. Ono je naročito zapaženo kod mlađih generacija koje su podložnije dejstvu spacijuma nego starije. Promene u mentalitetu stanovništva izazvane opštedruštvenim razvojem dobile su snažan podsticaj novim urbanim fenomenom, koji intenzivno zrači na celu aglomeraciju dostojanstvom, samo štovanjem i poštovanjem drugog čoveka.

Sve pojave uticaja kompozicionih relacija u spacijumu treba dvostrano ali sinhrono proučavati. Na jednoj strani spacijum i njegova kompoziciona svojstva, na drugoj čoveka i društvo, odnosno njihove reakcije. U tom radu, kao i u drugim oblastima istraživanja spacijuma, treba ostvariti punu saradnju između radnika iz svih grana nauke zainteresovanih ovim pitanjima. Sa arhitektima, koji su do sada bili neangažovani, na prvom mestu.

Cilj toga rada je da iz naše arhitektonske i urbanističke kreacije eliminišemo onaj bezlični, sterilni i obeshrabrujući prostor koji doprinosi osećanju čovekove usamljenosti, potištenosti i duhovne praznine. Da čovek kroz oduševljenje koje u njemu izaziva lepota i osobenost njegovog grada postane još više privržen svom gradu kao društvenoj zajednici, a preko njega i svojoj domovini.

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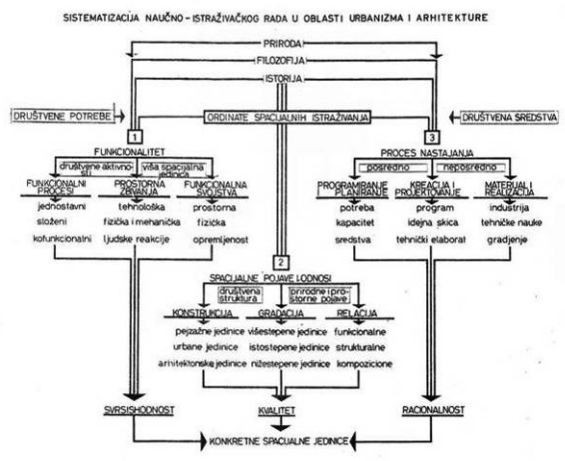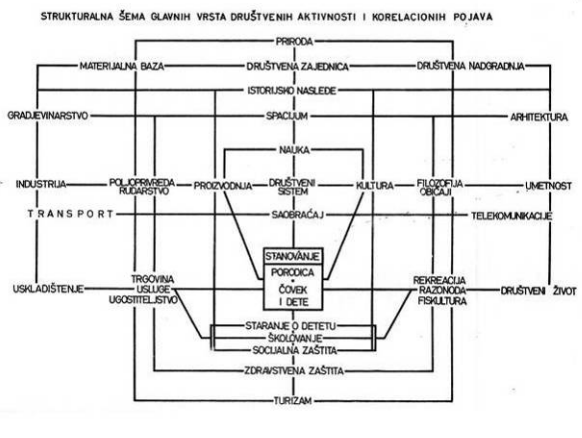Ograničeno vreme ne dopušta da se ovim radom skicira kompleksna problematika spacijuma.

Izostaje veoma značajna i složena pojava nastajanja spacijalnih jedinica; ostaje neobrađena kategorizacija spacijuma i pripadajućih mu jedinica i elemenata; nije moguće ocrtati pretpostavljenu sistematizaciju oblasti i vidova istraživačkog rada u spacijumu. Iz istog razloga izostavljen je i prikaz odgovarajućih shvatanja uzajamnih odnosa između društveno - ekonomskog razvoja, i nastajanja i formiranja spacijuma; planiranje tog nastajanja i njegova veza sa društvenim planiranjem; i mnoga druga pitanja koja izviru jedno iz drugog, ili drugo iz rešenja prvog.

Ipak se uspelo da prikaže nekoliko bitnih pojava u spacijumu, koje služe kao determinante određenog sistema istraživačkog rada u oblasti urbanizma i arhitekture. Videli smo da se kroz celokupnu materiju protežu funkcionalnost, prostorne pojave i odnosi, i - u ovom radu neobrađena - specifičnost nastajanja spacijalnih jedinica, kao opšta svojstva spacijuma. Registrovana na bilo kom sistemu njegove gradacije, u bilo kojoj kategoriji pojava.

To je dovoljno da problematiku urbanizma, arhitekture i izgradnje sagledamo u novom svetlu. Da - ne zapostavljajući i posebna i fragmentarna istraživanja - možemo sagledati program i plan istraživačkog rada u spacijumu kao celinu. Kao određeni sistem u kome svaki problem ili zahvat ima tačno određeno mesto, odnose prema drugim elementima sistema, i značaj.

Time bi bila definisana i jedna nova oblast istraživanja, do sada samo naslućena i prisutna u našoj svesti, ali nedovoljno sagledana i obrađena. Za život čoveka i zajednice značajna toliko isto, koliko i druge naučne grane. A trajnim, celishodnim i sistematskim radom u toj oblasti nastale bi kroz vreme spacijalne nauke, kao opšta teoretska i naučna baza izgradnje i svojstava našeg budućeg društvenog prostora.

arh. Milorad Macura

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STRUKTURALNA ŠEMA GLAVNIH VRSTA DRUŠTVENIH AKTIVNOSTI I KORELACIONIH POJAVA

SISTEMATIZACIJA NAUČNO - ISTRAŽIVAČKOG RADA U OBLASTI URBANIZMA I ARHITEKTURE

SPATIUM *International Review*
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References

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