

CONFERENCE  
PROCEEDINGS

**3<sup>RD</sup> INTERNATIONAL  
ACADEMIC CONFERENCE ON  
PLACES AND TECHNOLOGIES**

EDITORS  
EVA VANIŠTA LAZAREVIĆ  
MILENA VUKMIROVIĆ  
ALEKSANDRA KRSTIĆ-FURUNDŽIĆ  
AND ALEKSANDRA ĐUKIĆ

CONFERENCE  
PROCEEDINGS

**3<sup>RD</sup> INTERNATIONAL  
ACADEMIC CONFERENCE ON  
PLACES AND TECHNOLOGIES**

EDITORS  
EVA VANIŠTA LAZAREVIĆ  
MILENA VUKMIROVIĆ  
ALEKSANDRA KRSTIĆ-FURUNDŽIĆ  
AND ALEKSANDRA ĐUKIĆ

**PLACES AND TECHNOLOGIES 2016**

**CONFERENCE PROCEEDINGS OF THE 3<sup>RD</sup> INTERNATIONAL ACADEMIC CONFERENCE ON  
PLACES AND TECHNOLOGIES**

EDITORS:

Eva VaništaLazarević, Milena Vukmirović, Aleksandra Krstić-Furundžić, Aleksandra Đukić

FOR PUBLISHER: Vladan Đokić

PUBLISHER: University of Belgrade – Faculty of Architecture

DESIGN: Stanislav Mirković

TECHNICAL SUPPORT: Jasna Marićević

PLACE AND YEAR: Belgrade 2016

ISBN: 978-86-7924-161-0

## ORGANIZERS



University of Belgrade |  
Faculty of Architecture

**URBANLAB**<sup>®</sup>  
PROFESSIONAL ASSOCIATION URBAN LABORATORY

## MAIN CONFERENCE SUPPORT



Република Србија  
МИНИСТАРСТВО ПРОСВЕТЕ,  
НАУКЕ И ТЕХНОЛОШКОГ РАЗВОЈА



ИНЖЕЊЕРСКА  
КОМОРА  
СРБИЈЕ



## CONFERENCE SUPPORT

Arhi.pro



**magna COOP** - Pančevo  
APSOLOTNO IZOLOVANO!  
[www.magnacoop.com](http://www.magnacoop.com) [office@magnacoop.com](mailto:office@magnacoop.com)



[www.insomnia.rs](http://www.insomnia.rs)



## **PLACES AND TECHNOLOGIES 2016**

KEEPING UP WITH TECHNOLOGIES TO CREATE COGNITIVE CITY  
BY HIGHLIGHTING ITS SAFETY, SUSTAINABILITY, EFFICIENCY,  
IMAGEABILITY AND LIVEABILITY

## **CONFERENCE PROCEEDINGS OF THE 3<sup>RD</sup> INTERNATIONAL ACADEMIC CONFERENCE ON PLACES AND TECHNOLOGIES**

### **CONFERENCE ORGANISERS**

University of Belgrade – Faculty of Architecture and  
Professional Association Urban Laboratory

### **ORGANIZING COMMITTEE**

#### **Founding members of the Organizing committee**

**Dr Eva Vaništa Lazarević**

Conference Director, University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Milena Vukmirović**

Conference Executive Coordinator, University of Belgrade, Faculty of Architecture and Urban  
Laboratory, Belgrade, Serbia

**Dr Aleksandra Krstić Furundžić**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Aleksandra Đukić**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

#### **Associate members of the Organising committee**

**Jelena Samardžić**

Faculty of Information Technology Belgrade Metropolitan University, Belgrade, Serbia

### **TECHNICAL COMMITTEE**

**Dr Milena Vukmirović**

Conference Executive Coordinator, University of Belgrade, Faculty of Architecture and Urban  
Laboratory, Belgrade, Serbia

**Branislav Antonić**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

## SCIENTIFIC COMMITTEE

In Alphabetical order

**Dr Laura Aelenei,**

National Energy and Geology Laboratory (LNEG), Lisbon, Portugal

**Dr Ivan Aleksić,**

University of Belgrade, Faculty of Civil Engineering, Department of Geodesy and Geoinformatics, Belgrade, Serbia

**Dr Evangelina Athanassiou,**

Aristotle University of Thessaloniki School of Architecture, Thessaloniki, Greece

**Dr Milica Bajić Brković,**

ISOCARP - The International Society of City and Regional Planners, The Hague, Netherlands

**Dr Ljiljana Blagojević,**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Ružica Božović Stamenović,**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia and National University of Singapore, Singapore

**Dr Olja Čokorilo,**

University of Belgrade, Faculty of Transport and Traffic Engineering, Belgrade, Serbia

**Dr Grygor Doytchinov,**

Institute for Urban Design, Technical University of Graz, Austria

**Dr Nataša Danilović Hristić,**

Urban Planning Institute of Belgrade, Belgrade, Serbia

**Dr Vladan Đokić,**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Aleksandra Đukić,**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Alenka Fikfak,**

University of Ljubljana, Faculty of Architecture, Ljubljana, Slovenia

**Dr Dejan Filipović,**

University of Belgrade, Faculty of Geography, Belgrade, Serbia

**Dr Darija Gajić,**

University of Banja Luka, Faculty of Architecture and Civil Engineering, Banja Luka, Republic of Srpska, Bosnia and Herzegovina

**Dr Bob Giddings,**

Northumbria University, Faculty of Engineering and Environment, Newcastle, United Kingdom

**Dr Jelena Ivanović Šekularac,**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Vlatko Korobar,**

St. Cyril and Methodius University, Faculty of Architecture, Skopje, FYR Macedonia

**Dr Saja Kosanović,**

University of Priština, Faculty of Technical Sciences, Department of Architecture,  
Kosovska Mitrovica, Serbia

**Dr Aleksandra Krstić-Furundžić,**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Višnja Kukoč,**

University of Split, Faculty of Civil Engineering, Architecture and Geodesy, Split, Croatia

**Dr Piotr Lorens,**

Gdansk University of Technology, Faculty of Architecture, Gdansk, Poland

**Dr Lucia Martincigh,**

University of Roma Tre, Faculty of Architecture, Rome, Italy

**Prof. Ljubomir Mišević,**

University of Zagreb, Faculty of Architecture, Zagreb, Croatia

**Acad. Branislav Mitrović,**

University of Belgrade - Faculty of Architecture, Belgrade, Serbia

**Dr Juan Luis Rivas Navarro,**

University of Granada, Department of Urban and Regional Planning, Granada, Spain

**Dr Grzegorz Peczek,**

Sopot University of Applied Science, Sopot, Poland

**Dr Lea Petrović Krajnik,**

University of Zagreb, Faculty of Architecture, Zagreb, Croatia

**Dr Miroslava Raspopović,**

Faculty of Information Technology, Belgrade Metropolitan University, Belgrade, Serbia

**Dr Ralf Risser,**

Research Institute FACTUM, Vienna, Austria

**Dr Lina Seduikyte,**

Kaunas University of Technology, Faculty of Civil Engineering and Architecture, Kaunas,  
Lithuania

**Manfred Schrenk,**

CORP - Competence Center for Urban and Regional Planning, Vienna, Austria

**Dr Jasmina Siljanoska,**

St. Cyril and Methodius University, Faculty of Architecture, Skopje, FYR Macedonia

**Dr Metka Sitar,**

University of Maribor, Faculty of Civil Engineering, Traffic Engineering and Architecture, Maribor,  
Slovenia

**Dr Predrag Šidanin,**

University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia

**Dr Ljupko Šimunović,**

University of Zagreb Faculty of Transport and Traffic Sciences, Zagreb, Croatia

**Dr Stefan van der Spek,**

Delft University of Technology, Faculty of Architecture and Built Environment, Delft, Netherlands

**Dr Svetlana Stanarević,**

University of Belgrade, Faculty of Security Studies, Belgrade, Serbia

**Dr Milena Stavrić,**

Graz University of Technology, Faculty of Architecture, Institute of Architecture and Media, Graz, Austria

**Dr Aleksandra Stupar,**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Eva Vaništa Lazarević,**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Milena Vukmirović,**

University of Belgrade, Faculty of Architecture and Urban Laboratory, Belgrade, Serbia

**Dr Salih Yilmaz,**

Izmir KatibCelebi University, Department of Engineering and Architecture, Izmir, Turkey



## REGIONAL AND GUEST DEANS COMMITTEE

In Alphabetical order

**Dr Bálint Bachmann,**

University of Pécs, Pollack Mihály Faculty of Engineering and Information Technology, Pécs,  
Hungary

**Dr Dženana Bijedić,**

Vice-dean), University of Sarajevo, Faculty for Architecture, Sarajevo, Bosnia and Herzegovina

**MSc Peter Gabrijelčič,**

University of Ljubljana, Faculty of Architecture, Ljubljana, Slovenia

**MSc Boris Koružnjak,**

University of Zagreb, Faculty of Architecture, Zagreb, Croatia

**Dr Florian Nepravishta,**

(Department department), Polytechnic University of Tirana, Department of Architecture, Tirana,  
Albania

**Dr Svetislav Popović,**

University of Montenegro, Faculty of Architecture, Podgorica, Montenegro

**Dr Milenko Stanković,**

University of Banja Luka, Faculty of Architecture and Civil Engineering, Banja Luka, Republic of  
Srpska, Bosnia and Herzegovina

## REVIEWERS

**Dr Evangelina Athanassiou,**

Aristotle University of Thessaloniki School of Architecture, Thessaloniki, Greece

**Dr Ljiljana Blagojević,**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Ružica Božović Stamenović,**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia and National University of Singapore, Singapore

**Dr Olja Čokorilo,**

University of Belgrade, Faculty of Transport and Traffic Engineering, Belgrade, Serbia

**Dr Grygor Doytchinov,**

Institute for Urban Design, Technical University of Graz, Austria

**Dr Nataša Danilović Hristić,**

Urban Planning Institute of Belgrade, Belgrade, Serbia

**Dr Aleksandra Đukić,**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Alenka Fikfak,**

University of Ljubljana, Faculty of Architecture, Ljubljana, Slovenia

**Dr Darija Gajić,**

University of Banja Luka, Faculty of Architecture and Civil Engineering, Banja Luka, Republic of Srpska, Bosnia and Herzegovina

**Dr Bob Giddings,**

Northumbria University, Faculty of Engineering and Environment, Newcastle, United Kingdom

**Dr Jelena Ivanović Šekularac,**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Vlatko Korobar,**

St. Cyril and Methodius University, Faculty of Architecture, Skopje, FYR Macedonia

**Dr Saja Kosanović,**

University of Priština, Faculty of Technical Sciences, Department of Architecture, Kosovska Mitrovica, Serbia

**Dr Aleksandra Krstić-Furundžić,**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Višnja Kukoč,**

University of Split, Faculty of Civil Engineering, Architecture and Geodesy, Split, Croatia

**Dr Lucia Martincigh,**

University of Roma Tre, Faculty of Architecture, Rome, Italy

**Dr Juan Luis Rivas Navarro,**

University of Granada, Department of Urban and Regional Planning, Granada, Spain

**Dr Grzegorz Peczek,**

Sopot University of Applied Science, Sopot, Poland

**Dr Lea Petrović Krajnik,**

University of Zagreb, Faculty of Architecture, Zagreb, Croatia

**Dr Miroslava Raspopović,**

Faculty of Information Technology, Belgrade Metropolitan University, Belgrade, Serbia

**Dr Ralf Risser,**

Research Institute FACTUM, Vienna, Austria

**Dr Metka Sitar,**

University of Maribor, Faculty of Civil Engineering, Traffic Engineering and Architecture, Maribor, Slovenia

**Dr Predrag Šiđanin,**

University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia

**Dr Ljupko Šimunović,**

University of Zagreb Faculty of Transport and Traffic Sciences, Zagreb, Croatia

**Dr Stefan van der Spek,**

Delft University of Technology, Faculty of Architecture and Built Environment, Delft, Netherlands

**Dr Svetlana Stanarević,**

University of Belgrade, Faculty of Security Studies, Belgrade, Serbia

**Dr Aleksandra Stupar,**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Eva Vaništa Lazarević,**

University of Belgrade, Faculty of Architecture, Belgrade, Serbia

**Dr Milena Vukmirović,**

University of Belgrade, Faculty of Architecture and Urban Laboratory, Belgrade, Serbia

## TABLE OF CONTENTS

### ARCHITECTURAL TECHNOLOGIES I – ENERGY ISSUES

DETERMINATION OF ENERGY CHARACTERISTICS OF TRANSPARENT ELEMENTS OF ENVELOPE OF RESIDENTIAL BUILDINGS IN BOSNIA AND HERZEGOVINA Darija Gajić	3
ECO-ENERGETIC RECONSTRUCTION OF ARCHITECTURAL STRUCTURES BY APPLYING MODERN FACADE TECHNOLOGIES Olja Joksimović, Katarina Vukosavljević	11
MODERNIZATION OF EXISTING GLASS FACADES IN ORDER TO IMPLEMENT ENERGY EFFICIENCY AND MEDIA CONTENT Jasna Čikić Tovarović, Jelena Ivanović Šekularac, Nenad Šekularac	19
EFFECTS OF WINDOW REPLACEMENT ON ENERGY RENOVATION OF RESIDENTIAL BUILDINGS – CASE OF THE SERBIAN BUILDING PRACTICE Ana Radivojević, Aleksandar Rajčić, Ljiljana Đukanović	27
GREEN ROOF RETROFIT POTENTIAL IN A DENSELY POPULATED BELGRADE MUNICIPALITY Katarina Vukosavljević, Olja Joksimović, Stevan Vukadinović	35
ENERGY REFURBISHMENT OF PUBLIC BUILDINGS IN SERBIA Milica Jovanović Popović, Miloš Nedić, Ljiljana Djukanović	43
PROBLEM OF PROTECTION OF ORIGINAL APPEARANCE OF PREFABRICATED CONCRETE FACADES AND ENERGY IMPROVEMENT MEASURES – EXAMPLE OF NEW BELGRADE Nikola Macut, Ana Radivojević	51
SUNLIGHTING: A BRIGHT LIGHT SOURCE FOR MULTI-STORY BUILDING CORES Liliana Beltran	59

### ARCHITECTURAL TECHNOLOGIES II - INNOVATIVE METHODS, SOFTWARE AND TOOLS

BIM AND GREEN BUILDING DESIGN: EXPECTATIONS, REALITY AND PERSPECTIVES Igor Svetel, Marko Jarić, Nikola Budimir	69
UNDER THE SKIN - DETERMINING ELECTRICAL APPLIANCES FROM SURFACE 3D SCANS Ulrich Krispel, Torsten Ullrich, Martin Tamke	77
ARCHITECTURAL DIAGRAM OF A CITY Olivera Dulić, Viktorija Aladžić	85
DIGITAL TOOLS - BASED PERFORMANCE EVALUATION OF THE ADAPTIVE BUILDING ENVELOPE IN THE EARLY PHASE OF DESIGN Komnen Žižić, Aleksandra Krstić-Furundžić	93

INCREASING QUALITY OF PLACE BY USERS VALUE ORIENTATION Alenka Temeljotov Salaj, Svein Bjorberg, Nikolaj Salaj	101
COMFORT QUALITY IN THE ARCHITECTURAL TRANSFORMATION OF EXISTING FACILITIES Saša B. Čvoro, Malina B. Čvoro, Una Umićević	109
<b>BUILDING STRUCTURES AND MATERIALS</b>	
CONCEPTUAL STRUCTURAL DESIGN STRATEGIES FOR REDUCING ENERGY CONSUMPTION IN BUILDINGS Aleksandra Nenadović, Žikica Tekić	119
COMPARISON OF THE SUSTAINABILITY OF DIFFERENT TECHNIQUES FOR THE STRENGTHENING OF REINFORCED CONCRETE COLUMNS Tanya Chardakova, Marina Traykova	125
THE ARCHITECTURAL ASPECT OF DESIGNING THE OFFICE ENVIRONMENT IN THE MULTIFUNCTIONAL BUILDING IN THE CITY CENTRE Anna Rynkowska-Sachse	133
MITIGATE THE HOUSING DEPRIVATION IN THE INFORMAL CITIES: MODULAR, FLEXIBLE AND PREFAB HOUSES Frabrizio Finucci, Adolfo Barrata, Laura Calcagnini, Antonio Magaro, Ottavio Minnella, Juan Martin Piaggio	141
AN EXAMPLE OF USING RECYCLED CRUSHED CLAY BRICK AGGREGATE: A PREFABRICATED COMPOSITE FAÇADE PANEL WITH THE FACE OF STONE Tijana Vojinović Čalić, Dragica Jevtić, Aleksandra Krstić-Furundžić	149
<b>CLIMATE CHANGE I – ENERGY ISSUES</b>	
ENERGY MAP OF KRAGUJEVAC AS AN INTRODUCTION TO THE ANALYSIS OF NECESSARY INTERVENTION MEASURES ON BUILDINGS IN ORDER TO ADAPT TO CLIMATE CHANGE Iva Poskurica Glišović	159
THE IMPACT OF CLIMATE CHANGE ON THE ENERGY PERFORMANCE OF HISTORICAL BUILDINGS Alexandra Keller, Cristian Petrus, Marius Mosoarca	167
INFLUENCE OF DIFFERENT PAVEMENT MATERIALS ON WARMING UP OF PEDESTRIAN AREAS IN SUMMER SEASON Jelena Đekić, Petar Đekić, Milena Dinić Branković, Mihailo Mitković	175
ANALYSIS OF ELECTRICITY GENERATION RESULTS OF FIRST MINI SOLAR POWER PLANTS IN THE SOUTH OF SERBIA WITH VARYING INCLINATION OF PHOTOVOLTAIC PANELS AND DIFFERENT ENVIRONMENTAL CONDITIONS Mihailo Mitković, Jelena Đekić, Petar Mitković, Milica Igić	183
EDUCATION NEEDS AND INFLUENTIAL FACTORS ON ENVIRONMENTAL PROTECTION IN FUNCTION OF SUSTAINABLE DEVELOPMENT AT HIGHER EDUCATION INSTITUTIONS Marijola Božović, Milan Mišić, Zorica Bogićević, Danijela Zubac	191

**BUILDING CLIMATE CHANGE II –  
STRATEGIES, PROTECTION AND FLOODS**

EVALUATING THE CO-BENEFITS OF FLOOD MITIGATION MEASURE – A CASE STUDY OF SOUTHERN YUNLIN COUNTY IN TAIWAN Yi-Hsuan Lin	201
FLOODING RISK ASSESSMENT IN MOUNTAIN VILLAGES—A CASE STUDY OF KAOHSIUNG CITY Ting-Chi Hsu, Han-Liang Lin	209
SPATIAL PLANNING IN VIEW OF FLOOD PROTECTION-METHODOLOGICAL FRAMEWORK FOR THE BALCAN COUNTRIES Brankica Milojević	217
CLIMATE WARS AND REFUGEES: HUMAN SECURITY AS A PATHWAY TOWARDS THE POLITICAL? Thomas Schad	225
LOW-IMPACT DEVELOPMENT STRATEGIES ASSESSMENT FOR URBAN DESIGN Yu-Shan Lin, Han-Liang Lin	235

**SUSTAINABLE COMMUNITIES AND PARTICIPATION I –  
PLANNING ISSUES**

THE POSSIBILITIES OF SURVEY AS A METHOD TO COLLECT AND THE DERIVE MICRO-URBAN DATA ABOUT NEW COLLECTIVE HOUSING IN SERBIA Branislav Antić	247
POSITION OF THE SOCIAL HOUSING ACCORDING TO THE URBAN PLANNING REGULATION OF THE CITY OF NIS – DO THEY PROMOTE THE INCLUSION? Nataša Petković Grozdanović, Branislava Stoiljkovic, Goran Jovanović	255
INFLUENCE OF DIFFERENT APPROACHES IN DEVELOPMENT OF LOCAL RESIDENTIAL BUILDING TYPOLOGIES FOR ESTIMATION OF BUILDING STOCK ENERGY PERFORMANCE Milica Jovanović Popović, Dušan Ignjatović, Bojana Stanković	263
TOWARDS A LOW-CARBON FUTURE? CONSTRUCTION OF DWELLINGS AND ITS IMMEDIATE INFRASTRUCTURE IN CITY OF SPLIT Višnja Kukoč	271
SCENARIOS IN URBAN PLANNING AND THE MULTI-CRITERIA METHOD. A MEANINGFUL EXPERIENCE IN ITALY: PIANO IDEA IMPLEMENTED IN JESI AN,2004 Giovanni Sergi, Paolo Rosasco	279
THE PUBLIC INSIGHT AND INCLUSIVITY IN THE PLANNING PROCESS Nataša Danilović Hristić, Nebojša Stefanović	287
TOWARD THE SUSTAINABLE CITY – COMMUNITY AND CITIZENS INCLUSION IN URBAN PLANNING AND DESIGN OF URBAN GREEN SPACES: A REVIEW OF SKOPJE Divna Penčić, Snezhana Domazetovska, Stefanka Hadji Pecova	295

## **SUSTAINABLE COMMUNITIES AND PARTICIPATION II – CONCEPTS, METHODS AND COMMUNITY**

HOW TO DEVELOP AND DESIGN HEALTHY URBAN ENVIRONMENT? Sanja Štimac, Anja Jutraž	305
SUSTAINABILITY AND BROWNFIELD REGENERATION Kristina Azarić	313
THE SOCIAL DIMENSION OF A SUSTAINABLE COMMUNITY: UNDERSTANDING OF THE EXISTING SPACE Silvia Grion, Elisabeth Antonaglia, Barbara Chiarelli	319
HOW TO UNDERSTAND THE GLOBAL PHENOMENON OF URBAN SHRINKAGE AT LOCAL LEVEL? COMPARISON OF URBAN AREAS IN ROMANIA AND SERBIA Mihai-Ionut Danciu, Branislav Antonić, Smaranda Maria Bica	327
SPATIAL PATTERNS OF SERBIAN MIGRANTS IN VIENNA AND IN THE SETTLEMENTS OF THEIR ORIGIN IN EASTERN SERBIA Branislav Antonić, Tamara Brajović	335
KEEPING THE CITY LIVEABLE FOR INHABITANTS AND EFFICIENT FOR TOURISTS: THE PILGRIMAGE ROUTES Lucia Martincigh, Renata Bizzotto, Raffaella Seghetti, Marina Di Gauda, Giovanni Perrucci	347
ENVIRONMENTAL PROBLEMS AND CITIZEN PARTICIPATION IN MEDIUM-SIZED TOWNS OF SERBIA Anđelka Mirkov	355
URBAN PROBLEMS OF HILLY AND MOUNTAINOUS RURAL SETTLEMENTS IN NIŠ MUNICIPALITY Milica Igić, Petar Mitković, Jelena Đekić, Milena Dinić Branković	361

## **IMAGE, IDENTITY AND QUALITY OF PLACE I – PLANNING ISSUES**

THE STRATEGIES OF PLACE-MAKING. SOME ASPECTS OF MANIFESTATIONS OF POSTMODERN IDEAS IN LITHUANIAN ARCHITECTURE Martynas Mankus	373
DESIGNING CENTERS OF SUBURBAN SETTLEMENTS IN THE POST-SOCIALIST CITY – NIŠ CASE STUDY Milena Dinić Branković, Jelena Đekić, Petar Mitković, Milica Igić	381
TRANSITION AND THE CITY: TRANSFORMATION OF URBAN STRUCTURE DURING THE POST-SOCIALIST PERIOD Dejana Nedučin, Milena Krklješ	389
POST INDUSTRIAL CITIES: CREATIVE PLAY - FAST FORWARD BELGRADE 2016 Eva Vaništa Lazarević, Marija Cvetković, Uroš Stojadinović	395
THE FUTURE OF OLD INDUSTRIAL AREAS - SUSTAINABLE APPROACH Anica Tufegdžić, Maria Siladji	405

CREATING IDENTITY AND CHARACTER OF NEW SETTLEMENT FORMED DUE TO GROWTH OF THE CITY- ON THE EXAMPLE OF PODGORICA Ema Alihodžić Jašarović, Edin Jašarović	413
SPINUT-POLJUD RESIDENTIAL AREA IN SPLIT, CROATIA Vesna Perković Jović	421
IMAGE, IDENTITY AND QUALITY OF ZAPRUĐE HOUSING DEVELOPMENT IN NOVI ZAGREB Ivan Milnar, Lea Petrović Krajnik, Damir Krajnik	429
URBAN IDENTITY OF BORDER SPACES. CONSTRUCTING A PLACE IN THE BORDER CROSSING BETWEEN SPAIN AND MOROCCO IN CEUTA Belen Bravo Rodriguez, Juan Luis Rivas Navarro, Alicia Jiménez Jiménez	435
ZEITGEIST & GENIUS LOCI: TRADE VALUE AESTHETIC AND WEAKNESS OF AUTHOR'S IDENTITY IN RECENT SERBIAN ARCHITECTURE Aleksandar Kadijević	445
 <b>IMAGE, IDENTITY AND QUALITY OF PLACE II – PUBLIC SPACES</b>	
PRESERVING PLACE MEANING IN FUNCTION OF TRANSFORMATION OF OPEN PUBLIC SPACES Ana Špirić, Sanja Trivić	455
STREET LIFE DIVERSITY AND PLANNING THE URBAN ENVIRONMENT. COMPARATIVE STUDY OF SOFIA AND MELBOURNE Silvia Chakarova	463
TRANSFORMATIONS AND PERMANENCE OF REPUBLIC SQUARE Stefan Škorić, Milena Krklješ, Dijana Brkljač, Aleksandra Milinković	473
THE IMAGE OF THE CITY VS. SEMI-PUBLIC SPACES OF SHOPPING MALLS: CASE STUDY OF BELGRADE Marija Cvetković, Eva Vaništa Lazarević	481
THE MARKET HALL OF PÉCS Balazs Kokas, Hutter Ákos, Veres Gábor, Engert Andrea, Greg András, Sike Ildikó, Alexandra Pető	489
INNOVATIVE PUBLIC SPACE REHABILITATION MODELS TO CREATE CONDITIONS FOR COGNITIVE - CULTURAL URBAN ECONOMY IN THE AGE OF MASS INDIVIDUALISATION Katarzyna Bartoszewicz, Piotr Lorens	497
ILLUMINATION OF FACADES OF PUBLIC BUILDINGS IN NOVI SAD AND ITS IMPACT ON SPATIAL PERCEPTION Dijana Brkljač, Milena Krklješ, Aleksandra Milinković, Stefan Škorić	507
COGNITIVE PERFORMANCES OF PEDESTRIAN SPACES Milena Vukmirović, Branislav Folić	515



### **IMAGE, IDENTITY AND QUALITY OF PLACE III – CONCEPT, METHODS, EDUCATION**

THE CRIMINAL CITY: URBAN RESET AFTER "COLECTIV" Agelica Stan	527
TOWARD THE ULTIMATE SHAPE-SHIFTER: TESTING THE OMNIPOTENCE OF DIGITAL CITY Aleksandra Stupar, Tatjana Mrđenović	535
MANAGEMENT OF URBAN IMAGE AS A TOOL FOR PLANNING. THE CASE OF THESSALONIKI Kleoniki Gkioufi, Eleni Gavra	541
VISIBLE AND INVISIBLE PROCESSES AND FLOWS OF TIME-SPACE OF ARCHITECTURAL AND URBAN CONTINUITY OF THE CITY Velimir Stojanović	549
FORMS OF CONTINUITY IN ARCHITECTURAL SPACE Petar Cigić, Milena Kordić	555
URBAN DESIGN EDUCATION FOR PLACEMAKING: BETWEEN COGNITION AND EMOTION Jelena Živković, Zoran Đukanović, Uroš Radosavljević	565
SKETCHBOOK AS AN ARCHITECTURAL DESIGN INSTRUMENT OF THE COGNITIVE CREATION PROCESS FOR THE QUALITY OF PLACE Igor Rajković, Uroš Radosavljević, Ana Zorić	573
THE MUSICALITY OF UNDULATING GLASS PANES IN THE CONVENT OF LA TOURETTE Marko Slaviček, Anja Kostanjšak	581
THE ROUTES OF DIGITALIZATION – FROM REAL TO VIRTUAL CITY AND VICE VERSA Miodrag Ralević, Tatjana Mrđenović	587
<b>RESILIENCE OF PLACES</b>	
A SHRED OF PLACE IN A DIGITAL ERA HUMANITARIAN DISASTER Pavlos Lefas, Nora Lefa	599
URBAN SPACES MORPHOLOGY AND MICROCLIMATE CONDITIONS: A STUDY FOR A TYPICAL DISTRICT IN THESSALONIKI Stella Tsoka, Katerina Tsikaloudaki, Theodoros Theodosiou	605
SPONTANEOUS DEVELOPMENT AND RESILIENCE PLACES – A CASE STUDY OF ELECTRONIC INDUSTRY NIS (SERBIA) Liljana Jevremović, Branko Turnsek, Aleksandar Milojkovic, Milanka Vasic, Marina Jordanovic	613
SUSTAINABLE MODEL FOR REGIONAL HOSPITALS IN HUMID TROPICAL CLIMATE Nataša Čuković Ignjatović, Dušan Ignjatović, Dejan Vasović	621

MATERIAL AND COGNITIVE STRUCTURES OF BUILDINGS AND PLACES AS INTEGRATED PATTERNS OF PAST, PRESENT AND FUTURE Dženana Bijedić, Rada Cahtarevic, Mevludin Zecević, Senaida Halilović	627
BOOSTING THE RESILIENCE OF THE HEALTHCARE SYSTEM IN BELGRADE: THE ROLE OF ICT NETWORKS Jelena Marić, Aleksandra Stupar	635
INTERCONNECTION OF ARCHITECTURE AND NEUROSCIENCE - RESHAPING OUR BRAINS THROUGH PHYSICAL STRUCTURES Morana Pap, Mislav Pap, Mia Pap	645
THE POTENTIAL OF URBAN AGRICULTURE IN REVITALIZATION OF A METROPOLIS Gabriela Rembarz	651
 <b>ADAPTIVE REUSE</b>	
IMPROVING STRATEGIES FOR FUNCTIONAL UPGRADE FOR AN "INTEGRATED REHABILITATION" Francesca Guidolin	661
ADAPTIVE REUSE AND SOCIAL SUSTAINABILITY IN THE REGENERATION PROCESSES OF INDUSTRIAL HERITAGE SITES Sonja Ifko, Ana Martinović	669
REVEALING THE MONTENEGRIN KATUN AS A PLACE OF REUSABLE COGNITIVE TECHNOLOGIES Edin Jašarović, Ema Alihodžić Jašarović	683
INTERSECTIONS OF NOW AND THEN; IMPLEMENTATION OF ADAPTIVE REUSE AS CATALYST OF SPACE TRANSFORMATION Anja Kostanjšak, Nikola Filipovic	691
MULTIFAMILY HOUSING IN BELGRADE – ENERGY PERFORMANCE IMPROVING POTENTIAL AND ARCHITECTURAL CHALLENGES Nataša Ćuković Ignjatović, Dusan Ignjatovic, Bojana Stankovic	699
SPATIAL STRUCTURE OF THE SUBURBAN ZONES IN SELECTED ENTREPRENEURSHIPS NESTS OF THE TRICITY METROPOLITAN AREA Grzegorz Pęczek, Justyna Martyniuk-Pęczek	707
 <b>INNOVATIVE METHODS AND APPLICATIONS FOR SMART(ER) CITIES</b>	
TECHNOLOGY AS A MEDIATOR BETWEEN MAN AND CITY IN THE CONTEXT OF CONTEMPORARY CHALLENGES Katarina Stojanović	725
CITY INTELLIGENCE INFORMATION MODELING Alice Pasquinelli, Silvia Mastrolembro, Franco Guzzeti, Angelo Ciribini	731
AN INTRODUCTION TO THE PHYSICAL PLANNING INFORMATION SYSTEM OF CROATIA AND NEW GENERATION OF SPATIAL PLANS Sunčana Habrun, Lidija Škec, Danijel Meštrić	739

THE CONCEPT OF SMART ARCHITECTURE IN SERBIA – ONE BELGRADE EXPERIENCE Dragan Marčetić, Andrej Josifovski	747
THE IDEA OF COGNITIVE CITY - A CHALLENGE FOR NEW TECHNOLOGY TO PROMOTE HEALTH Aleksandra Krstić Furundžić, Nikola Z. Furundzić, Dijana P. Furundzić	755
MIXED REALITY ENVIRONMENT AND OPEN PUBLIC SPACE DESIGN Aleksandra Đukić, Dubravko Aleksić	761
VULNERABILITY OF PUBLIC SPACE AND THE ROLE OF SOCIAL NETWORKS IN THE CRISIS Milena Vukmirović, Miroslava Raspopović	769
NEUTRAL GROUNDING POINTS WITHIN THE GENERAL DISTRIBUTION SYSTEM AS AN ELEMENT OF ENVIRONMENTAL PROTECTION Zorica Bogičević, Slobodan Bjelić, Bojan Jovanović, Milan Misic	779
THE ROLE OF COGNITIVE – CULTURAL ECONOMY IN CITY’S GLOBAL POSITIONING Sanja Simeunčević Radulović, Biserka Mitrović	789
<b>URBAN MOBILITY, TRANSPORT AND TRAFFIC SOLUTIONS</b>	
THE CONTRIBUTION OF ITS TO THE SAFETY IMPROVEMENT OF VULNERABLE ROAD USERS Bia Mandžuka, Ljupko Šimunović, Pero Škorput	799
BUILDING ENVIRONMENTAL PERSPECTIVE OF AIRCRAFT OPERATIONS AROUND BELGRADE NIKOLA TESLA AIRPORT Olja Čokorilo, Ivana Čavka	805
TRANSPORT PROJECTS AND PUBLIC PARTICIPATION Davor Brčić, Stjepan Kelcec-Suhovec	813
DISLOCATION OF THE EXISTING RAILWAY AND BUS STATION IN THE CITY OF KUMANOVO AND THEIR INTEGRATION INTO A TRANSPORT HUB WITH ADJOINING CONTENTS Mihajlo Zinoski, Medarski Igor, Stefani Solarska	817
THE IMPACTS OF TRANSPORT INFRASTRUCTURES ON URBAN GEOGRAPHY Federico Andrea Innarone	825
LIQUID LIFE: A RELATIONSHIP BETWEEN VULNERABILITY AND MOBILITY – THE CONSEQUENCES FOR A SUSTAINABLE CITY, StevanTatalović	831

## **INFLUENCE OF DIFFERENT APPROACHES IN DEVELOPMENT OF LOCAL RESIDENTIAL BUILDING TYPOLOGIES FOR ESTIMATION OF BUILDING STOCK ENERGY PERFORMANCE**

**Milica Jovanović Popović<sup>1</sup>**

Professor, Faculty of Architecture University of Belgrade, Bulevar Kralja Aleksandra 73/II  
milicajp@arh.bg.ac.rs

**Dušan Ignjatović**

Assistant Professor, Faculty of Architecture University of Belgrade, Bulevar Kralja Aleksandra  
73/II, ignjatovic.dusan@arh.bg.ac.rs

**Bojana Stanković**

Teaching Assistant, Faculty of Architecture University of Belgrade, Bulevar Kralja Aleksandra 73/II  
bojana@arh.bg.ac.rs

### **ABSTRACT**

Focus on structuring and evaluation of existing building stock, its characteristics and improvement potential represents the first step towards its refurbishment. After development of National residential building typology, further steps include its application for planning activities both on national and local level. As a result of adoption of recent regulatory acts in the field of energy efficiency improvement, local governments have an obligation in formulating Local Energy Action Plans (LEAPs) with estimations of savings potentials and related costs. These action plans need to address building stock energy efficiency, where residential buildings have a significant impact on the overall energy performance. In order to properly assess energy savings and investment costs the actual residential building stock characteristics and energy performance levels need to be investigated. Although National typology of residential buildings represents the basis for estimation of local building stock and formulation of local building typology, different approaches for its application on local level are possible.

Two different approaches have been tested through a case study in municipality of Vršac: a top-down and a bottom-up method. Main characteristic of the top-down approach is that it mostly relies of data gathered for the purpose of National typology, while in the bottom-up method a local survey is conducted providing some new data which are then used in adjusting National typology to local conditions. While both methods result in a relevant local typology, their applicability and accuracy of final results depend on municipality characteristics. Results of energy performance calculations are derived and compared for both methods and application guidelines for both methods are defined, which will enable local authorities to properly address this issue in the process of preparation of local energy action plans and support decision making related to investment cost and generated savings.

**Keywords:** building typology, energy performance, energy efficiency, decision making, local energy action plans

---

<sup>1</sup> Corresponding author

## INTRODUCTION

It is impossible to introduce a sustainable strategy for energy efficiency, regardless of the level of the plan, without adequate treatment of building stock. At the same time, every strategic decision must be based on assessment of relevant information on the actual characteristics of the building stock, its specific characteristics and modalities of improvement that include elements of thermal envelope and the systems installed in the building itself. This is why focus on structuring and evaluation of existing building stock, its characteristics and improvement potential represents the first step in its refurbishment. First steps towards this action are being taken through several research activities.

After formulating National residential building typology [Jovanović Popović et al., 2013] according to TABULA project principles, Serbia has joined its follow up project, EPISCOPE, as an associated partner. TABULA project methodology has been widely acclaimed as valid for assessing refurbishment potential of residential buildings stock Use of building typologies in assessing refurbishment potential has been [Ballarini et al., 2014; Dascalaki et al., 2011]. Following the development of residential building typology, further steps include its application for planning activities both on national and local level. As a result of adoption of recent regulatory acts [Law on efficient use of energy, 2013] in the field of energy efficiency improvement, local governments have an obligation in formulating Local Energy Action Plans (LEAPs) with estimations of savings potentials and related costs. These action plans need to address building stock energy efficiency, where residential buildings have a significant impact on the overall energy performance. In order to properly assess energy savings and investment costs the actual residential building stock characteristics and energy performance levels need to be investigated. Although National typology of residential buildings represents the basis for estimation of local building stock and formulation of local building typology, different approaches for its application on local level are possible.

In order to investigate possibility of application of National typology for this purpose, Serbian pilot action in EPISCOPE project has focused on local level, namely, municipality of Vršac in Vojvodina region. Two options for local typology application have been envisioned: a *top-down* approach, which mostly relies of data gathered in the process of development of National typology, and a *bottom-up* method, which is based on data gathered through a local survey. Both approaches were tested in the conducted pilot project, and their results were analysed and compared. From the conclusions of these analyses a common methodology for development of local building typologies for the purpose of Local Action Plans definition has been established.

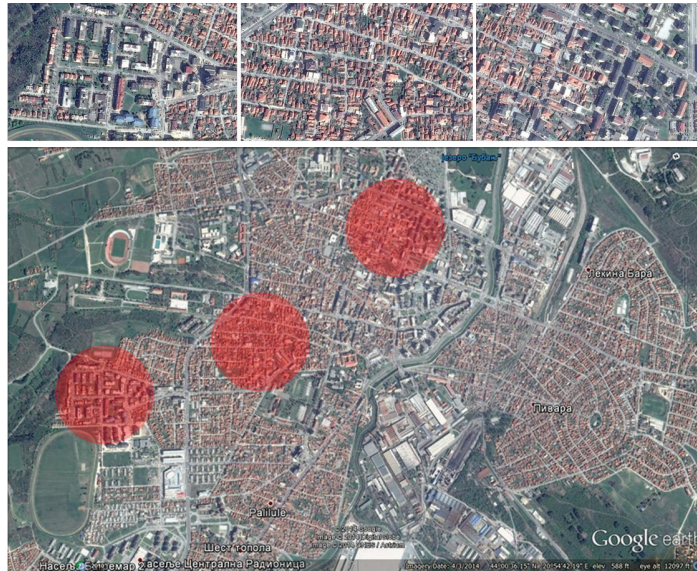
Top-down approach was the first tested method. Local sample for the analysis of building characteristics was derived from the sample based on which National typology was developed. However, in order to formulate benchmarks for energy reduction, and compare results and targets of refurbishment actions in the future, some parameters such as relevant local renovation rates had to be defined. These could be properly determined on a local level, but only by new detail inquiry of the building stock, as part of the new local survey. These actions are conducted as part of the bottom-up method, for which purpose a new survey was designed, with a new, modified questionnaire for building inquiry.

### Local typology of building stock

Need for formulation of local typologies of building stock has been emphasized by obligations of local authorities in term of planning of activities and investments in energy efficiency, set by the legal framework. The Law on efficient use of energy defines the legal framework for the level of the Republic of Serbia, but also at the level of smaller spatial entities - local governments, ordering the formulation of the Local Energy Efficiency Plans. More specifically, Article 10 defines that each local government, as the organizer of local energy management, is required to bring their own energy efficiency in line with the Strategy and Action Plan adopted at the level of Serbia.

The content of the program includes a number of different activities: the need for a review and assessment of the annual energy needs of local government as a whole, including the assessment of the energy performance of buildings, as well as need to propose measures and activities which will ensure efficient use of energy in the overall energy sector. This law defines also the introduction of energy management services (Article 19) as obligatory for all municipalities with more than 20,000 inhabitants. The energy manager, among other, has an obligation to collect and analyse data on energy use, prepare appropriate programs and plans, proposes measures that contributes to efficient use of energy and to control their implementation. Construction of energy managers service, understood in this way, to a great extent depend on the possession of information on the structure of energy consumption in local government, its carriers, characteristics, as well as the principles and modalities of achieving a higher degree of efficiency.

Although National typology can be used as a mean of efficient planning tool on the level of whole Serbia, its application on local level needs to be analysed. Analysing the diversity of the structure of settlement in Serbia, their size, the spatial distribution of the building stock and forms of building it is obvious that it is necessary to develop a methodological approach for local application of typologies, and the principles by which it is possible to form local matrices. Any methodology developed for the local level, must primarily take into account the existence of specific local features: uneven development, different densities within a very small space frame and typological diversity. An example of the variety of different forms of building stock in the context of their spatial distribution can best be seen in Figure 1. Looking at the physical structure shown in the illustration, through the basic analysis of urban matrix, the diversity of forms can be determined, with the logic of spatial distribution that is extremely inconsistent and not related to the basic city zoning. Historically the development of cities in Serbia is largely characterized by different trends of development that manifest in varied scope, type, method and distribution of the construction process. The boundaries of planning zones are often extremely deterministic without "soft" connections with the environment which often results in stark contrast to the built structure. The result of these activities is the phenomena of collective building blocks situated at the ends of the urban fabric surrounded by individual housing.



**Figure 1. The diversity of forms of building stock within the structure of the city**

While working on the further implementation of the National methodology, observed characteristics have led to the development of two potential approaches for development of the matrix of local residential buildings. These two approaches are fundamentally different in the way of data collection that is forming a base and partly by way of data processing. Professionally, these approaches can be characterized as: **TOP-DOWN** (top to bottom) and **BOTTOM-UP** (bottom to top) method, and each has its own peculiarities, certain advantages and, of course, limits of the application, which will be further analysed and presented.

### **Top-down method**

Top-down approach is characterized by the process of forming typology which is based on data from a broader spatial framework (National typology) as well as other data available for the analysis of the local level. The quality of the results depends largely on the availability of data. As a starting point, database established during the creation of the National typology of residential buildings, or other larger scale survey is used. In addition to these data, it is preferable to use and all other data that are available both at the national and local level:

- census of population and housing, data on the number of dwellings by municipalities, time periods, and the size of dwellings [Statistical Office of Republic of Serbia. 2013];
- statistics on buildings constructed by municipalities (Statistical yearbooks);
- statistics on housing built from 1994 to 2008 (Statistical yearbooks);

or other data that may exist at the local level:

- data from the cadastre;
- data from public companies for heat supply;
- data from public companies for gas supply;
- information from public companies for maintenance of residential buildings.

The development of methodology must represent teamwork with a defined manager of overall survey (local energy manager) and with the participation of a large number of professionals like statistical experts, experts on building typologies, local consultants with expertise in the field of construction and energy efficiency and researchers in the field (optional, but highly desirable).

The procedure of forming the typology starts similarly as the procedure used in formulating national typology in Serbia [Jovanović Popović, Radivojević, 2012]: analysis of the available data and implementation of the cluster analysis method applied to the local level. As the result, a new definition of representative types is possible and different, local typology formulated. In the process of forming the matrix, degree of relevance is very important, because experience has shown that adjusting the national matrix usually involves reduction (in some cases, drastically) of the number of types, thus determination of threshold (statistical representation of the type) is a basic generating parameter. By defining a new, statistically defined matrix, it is necessary to identify the material characteristic of buildings in order to access the identification of the model building and in the next step of real building as its representative. Representative buildings are identified in the field or in the available database. After formulation of local building typology, energy performance characteristics of new types are calculated according to national regulations and building sector energy characteristics on municipal level are summarized. Thus, matrix forming based on a top-down method is largely based on expert evaluation of existing data. In the example of the municipality of Vršac, which was used as a test case, there was an insufficient number of analysed buildings in the data base used in the process of forming of National typology, that served as a starting point, as well as the uneven distribution of the sample. The methodology of the national typology was carried out through two independent census cycles based on different statistical approaches. In Vršac municipality only 44 buildings of 6696 in the first and 176 of a total of 17,502 in the second survey are listed. This number of listed buildings does not represent valid statistical sample for municipality of Vršac.

### Bottom-up method

Bottom-up methodology can be characterized as a method for forming typology based on the data collected in accordance with predefined statistical principles and according to the adopted questionnaires, through direct research in the field, or the process of surveying a particular, predefined sample. The quality of the results is directly dependent on the sample definition, its size and quality of the data collected. As in the top-down approach, but even more important is to engage team of experts with specialties in defined areas. Due to this methodological approach, the relevance of the results is directly dependent on the principles and the implementation of a local survey, and thus special attention must be paid to the definition of type and size of the survey, which determines the manner and scope of research that is directly proportional to the size of the analysed unit. Type of the survey defines whether it is only one or a two-stage survey, and the percentage of buildings to be analysed in the second round. For the town of Vršac sample size was defined with 1300 buildings plus 144 stratums (total fund) of multi-family buildings for a total of 1,444 buildings in the sample, partly on the basis of the defined principles but primarily due to the funding limitations. The creation of the sample is one of the most important steps in the implementation of this methodology. A methodology of forming a sample is developed by connecting statistical principles of numerical relevance with urban and architectural characteristics of the buildings. The method is based on the principle of zoning of the research area, on the macro and micro zones (Figure 2.). Macro zones are parts of the territory (urban structure) with relatively homogenous characteristics according to the basic parameters (age, type of construction), while the micro-zones form their substructure. The number of macro zones can vary depending on the complexity of the physical structure of a specific urban territory. In the case of Vršac (Figure 5.) the territory was divided in 18 macro zones. After the sampling the procedure of selection of building representatives through cluster analysis is same as in National Typology and top-down model, resulting in more accurate data on building types.



**Figure 2: Map of Vršac divided into macro and micro zones for the purpose of bottom-up sample gathering**



### Comparison of two methodologies

The difference between the two approaches can be presented by direct comparison of the results, on a finalized local matrix, which is generated by overlapping national and developed matrixes for Vršac (Figure 3.). Building types that have shown significant local relevance are shown in colour, while others are overtaken from National typology. Data for all the buildings are either calculated again (local reference buildings) or downloaded from the National typology (for all other buildings). In the case of Vršac, in the final matrix almost all buildings appear, which may not be the case in the smaller municipality. In that case, some fields can be empty and filled neither with local representatives nor types form national typology.

TYPE	Family housing		Multi family housing	
	1 detached	2 row house	3 detached	4 Apartment block
A Before 1945				
	8.85 % 3.67 % 6.30 % 3.62 %	6.10 % 4.57 %	0.12 % 0.55 % 0.06 % 0.31 %	0.04 % 0.19 %
B 1946-1960				
	10.05 % 4.21 % 6.61 % 3.85 %	4.34 % 1.95 %	0.25 % 1.32 % 0.02 % 0.04 %	0.01 % 0.06 %
C 1961-1970				
	13.08 % 5.15 % 9.08 % 5.31 %	1.09 % 0.43 % 6.34 % 3.35 %	0.73 % 5.99 % 0.20 % 1.61 %	0.06 % 1.18 % 0.06 % 0.49 %
D 1971-1980				
	19.48 % 11.96 % 13.80 % 10.57 %	1.42 % 0.89 % 6.73 % 5.76 %	2.01 % 16.30 % 0.30 % 4.23 %	0.11 % 2.59 % 0.09 % 1.09 %
E 1981-1990				
	19.55 % 10.96 % 17.50 % 21.07 %	1.58 % 0.99 % 6.66 % 8.12 %	1.39 % 11.80 % 0.07 % 0.72 %	0.05 % 1.35 % 0.05 % 0.34 %
F 1991-2011				
	17.36 % 10.69 % 12.74 % 17.07 %	1.68 % 1.32 % 2.61 % 3.16 %	1.11 % 8.08 % 0.24 % 1.93 %	0.03 % 0.60 % 0.06 % 0.58 %

Figure 1: Building typology matrix for the municipality of Vršac. (top – down data in white cells: left – percentage by number of buildings, right – percentage by area / bottom-up data in grey cells: left – percentage by number, right –percentage by area)

At first glance, the imprecision of top-down methods can be seen, and its dependence on the available data do not always provide a realistic picture of the situation on the ground. Some types that exist in the matrix, in this methodology, do not at all appear as relevant in the bottom-up approach (C4, D4, E4, F4, A3, B3). For those types, where a large sample is available, all the data are almost identical, which only confirms the methodological characteristics and accuracy of both approaches. On the other hand, some types are represented in a similar manner in both methodologies (C1, D1, E1). For these types, which have great both local and national representativeness, some more complex improvement scenarios should also be investigated, taking into account their more detailed characteristics.

## CONCLUSIONS

In summary, it can be said, that in order to obtain more accurate results, which can be considered as a basis for strategic decision-making, more applicable is bottom-up methodology, while the top-down method can be used when a basic picture of the status of the building stock in a particular local government is needed.

## REFERENCES

- Ballarini, I., Corgnati, S. P., Corrado, V. 2014. "Use of reference buildings to assess the energy saving potentials of the residential building stock: The experience of TABULA project." *Energy Policy* 68: 273-284. doi:10.1016/j.enpol.2014.01.027
- Dascalaki, E.G., Droutsas, K.G., Balaras, C.A., Kontoyiannidis, S. 2011. "Building typologies as a tool for assessing the energy performance of residential buildings – a case study for the Hellenic building stock." *Energy and Buildings* 43: 3400–3409. doi:10.1016/j.enbuild.2011.09.002
- Jovanović Popović, M., Ignjatović, D., Radivojević, A., Rajčić, A., Đukanović, Lj., Čuković Ignjatović, N., Nedić, M. 2013. *Nacionalna tipologija stambenih zgrada Srbije/National typology of residential buildings in Serbia*. Belgrade, Faculty of Architecture University of Belgrade, GlZ.
- Jovanović Popović M. and Radivojević A. 2012. "National typology of residential buildings in Serbia: design structures and principles." In *Housing development in Serbia in the context of globalization and integrations, Volume I, Experiences and approaches*, edited by Mako V., Lojanica V., Božović Stamenović R., 169-189. Beograd: Arhitektonski fakultet Univerziteta u Beogradu.
- Ministry of Energy and Mining of Republic of Serbia. 2013. *Law on efficient use of energy*. The Official Gazette of Republic of Serbia No. 25/2013.
- Statistical Office of Republic of Serbia. 2013. *2011 Census of Population, Households and Dwellings in the Republic of Serbia, Book 22: Number and the floor space of housing units*, Belgrade.
- Statistical Office of Republic of Serbia. 2013. *2011 Census of Population, Households and Dwellings in the Republic of Serbia, Book 20: Comparative overview of the number of population, data by settlements*. Belgrade.
- TABULA/EPISCOPE. European Projects TABULA & EPISCOPE. <http://episcopo.eu/welcome/>