

CONFERENCE
PROCEEDINGS

**3RD INTERNATIONAL
ACADEMIC CONFERENCE ON
PLACES AND TECHNOLOGIES**

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

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

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PLACES AND TECHNOLOGIES 2016

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

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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
BUILDING STRUCTURES AND MATERIALS	
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
CLIMATE CHANGE I – ENERGY ISSUES	
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
IMAGE, IDENTITY AND QUALITY OF PLACE II – PUBLIC SPACES	
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
RESILIENCE OF PLACES	
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
ADAPTIVE REUSE	
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
INNOVATIVE METHODS AND APPLICATIONS FOR SMART(ER) CITIES	
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
URBAN MOBILITY, TRANSPORT AND TRAFFIC SOLUTIONS	
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

SUSTAINABLE MODEL FOR REGIONAL HOSPITALS IN HUMID TROPICAL CLIMATE

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ABSTRACT

Developing countries are facing numerous challenges in the process of providing adequate health care to often deprived and diminished social groups. In countries and regions with poor road infrastructure, this often means that the population outside major urban centres is even physically incapable of getting some sort of health aid in a timely manner. Being a country made up of a mainland territory and five islands in Gulf of Guinea, almost entirely covered by tropical rainforest, Equatorial Guinea is a showcase of various obstructions in developing effective health care system.

The sustainable primary, secondary and tertiary health care assumes good accessibility as well as proper understanding of local conditions. The paper presents a model for sustainable health care building – a local hospital capable of providing all basic types of health service while retaining a high level of technical independence. The architectural design for a regional hospital was developed aiming to maximize the use of natural ventilation, daylight and rainwater management, leaving the operation block, laboratory and intensive care unit practically the only parts of the structure that would need mechanical air conditioning. The layout was designed having in mind local culture and customs, thus offering a possibility of strong integration with local community, and the building technology was thought over to enable efficient and cost-effective construction and proper resilience for tropical rainforest environment. The result is a structure providing for contemporary, high quality medical service, interpreting local climatic and cultural contextual premises through modern architectural expression. Some design features developed for regional hospital were also explored in somewhat different conditions – a major clinical centre (in Malabo, the capital) and a local health centre with the basic services for the most remote areas.

Keywords: Sustainable architecture, Tropical climate, Health care, Hospitals

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INTRODUCTION

Developing countries are facing numerous challenges related to providing adequate health care to often deprived and diminished social groups. Apart from well-known medical issues (insufficient personal, professional, financial and pharmaceutical support), infrastructure and communal services also play a very important role in many African countries. Lack of paved roads often means that the population outside major urban centres is even physically incapable of getting some sort of health aid in a timely manner. Power supply, potable water supply and instable communication services yield for sustainable solutions that could become reliable sector of social services and healthcare provisions. The aim of this paper is to explore the options for sustainable architectural design that could encompass various aspects in healthcare buildings in this specific climatic and social context.

Basic postulates for the development of the concept were derived from the experience of visiting a local hospital near Lambarene. Established in 1913 by Albert Schweitzer, the Nobel Prize laureate, and in operation ever since, it successfully integrates local building tradition with western medical approaches and proves the principle of cross-cultural partnership to be a valid one. It has to be noted that main goal of the design process was to create a modern, self sustained structure that can adopt to different programmes, various location specificities and that could be easily managed by the local workforce.

Local community

Local community is strongly intertwined with formal and traditional institutions. Republic of Equatorial Guinea consists of 7 administrative provinces (3 in Insular Region and 2 in Continental region), 18 districts, 12 towns, 827 village councils and 163 neighbourhood communities. Traditional tribal chiefs and councils still play important role in everyday life. Respectively, according to World Health Organisation (WHO), at the moment there are 18 public hospitals (2 regional), 42 centres for public health and 161 medical posts, but they are not all functional.

It is quite common for family members to accompany patient for consultations, check-ups, and stay with them even while hospitalised. For this reason, special attention has been dedicated when accommodating different functional parts, especially waiting rooms and common areas where visitors can stay with the patient.

DESIGN CONTEXT AND CORRESPONDING STRATEGIES

Idea behind the design can be explained through the analysis of the major influencing parameters that are of the different origin, ranging from climatic to technological and traditional. Programme for the particular project consists of primary health care unit with examination rooms, laboratory, maternity and surgery wards with patient and staff rooms located on the first floor. All functional parts have been designed as separate elements grouped in two major and a smaller rectangular building, connected together by the elliptic based volume serving as a centre of the composition. Form of the complex, as illustrated on Figure 1, has been divided in various segments enabling independent usage and access, as well as multi-phased construction process. Also, subdivision of programme through construction of separate buildings organized on identical design principle allows for accommodation of different size units, ranging from local healthcare units to larger hospitals, keeping the recognizable architectural language that can be symbolically identified with the primary function. In this way, the proposed design can be considered as a model, setting the ground for different developments.

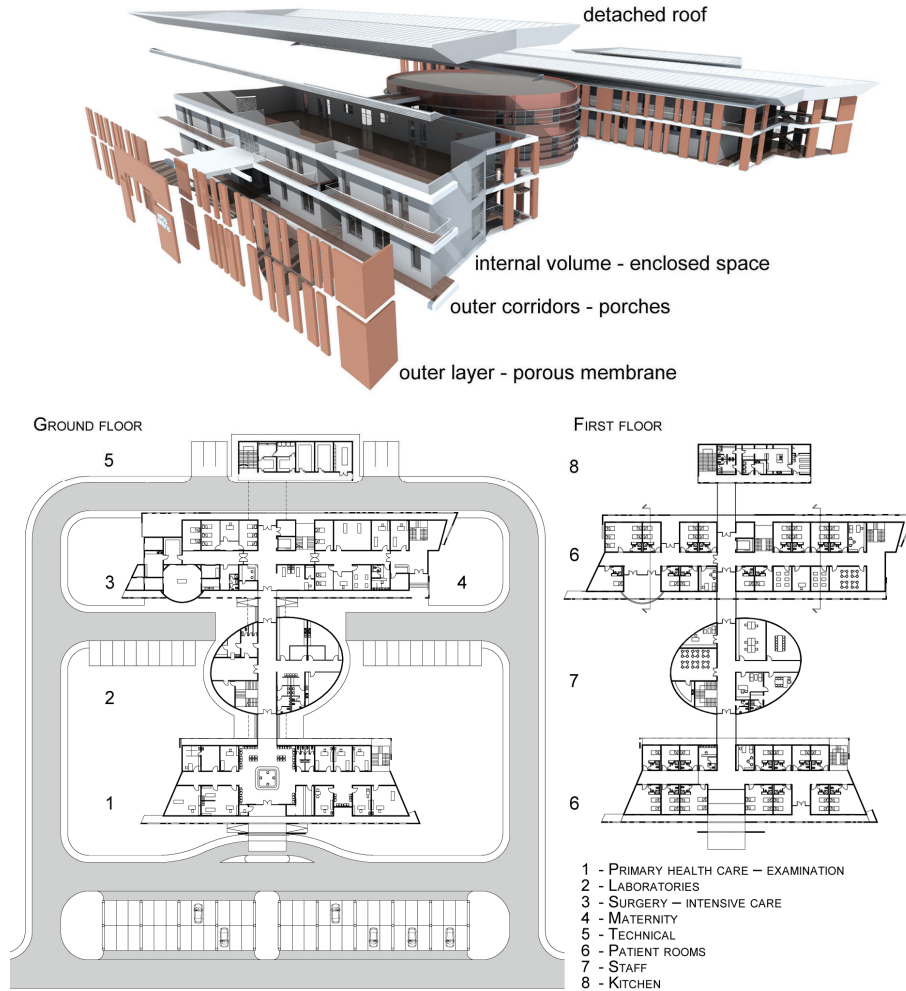


Figure 1 “Exploded perspective” of the Hospital building (top) and floor plans (bottom)

Climate

The climate in Equatorial Guinea is predominantly tropical-monsoon (*Am* by Köppen Climate Classification System) and tropical-wet (*Af* by Köppen Climate Classification System) in some areas. This means that the average temperatures are rather constant throughout the year, the precipitation level is high with some minor seasonal variations and the relative humidity also high throughout the year, as shown in Figure 2. Being close to the Equator, the number of daylight hours is approximately 12 throughout the year, but regular clouds reduce the number of sunlight hours to 3-5 per day². Low wind speeds (daily mean 2-3m/s)³ are also typical for this area, with

² Climate data from: <http://www.equatorial-guinea.climateemps.com>, accessed April 2015.

³ Wind speed data from: <https://weatherspark.com/averages/29071/Malabo-Bioko-Norte-Equatorial-Guinea>, accessed April 2015.

predominant wind direction depending on geographical position. Climatic context can be translated to the following design considerations:

- Thermal comfort,
- Ventilation and moisture control
- Daylighting and Sun control, and
- Rainwater management.

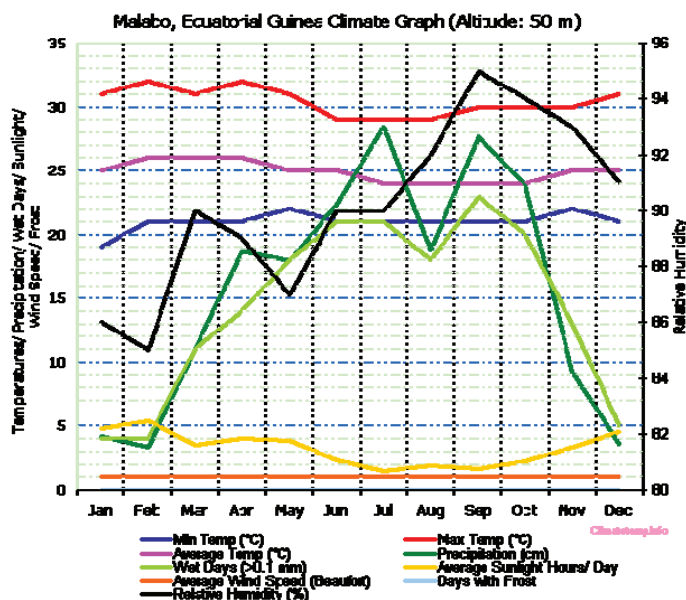


Figure 2 Climate graph for Malabo, the capital of Equatorial Guinea (source: <http://www.equatorial-guinea.climateemps.com>, accessed April 2015.)

a. Thermal comfort: Temperature is constant, averaging around 25°C, with average minimum temperature never below 19-20°C (annual: 21°C) and average maximum temperature never above 31-32°C (annual: 30°C). This means that only some basic cooling should be provided for the hottest days and that no heating is needed. Good bioclimatic design should provide adequate thermal comfort with basic passive design strategies. Unlike construction process in moderate or cold climates, where the main goal is to prevent buildings from losing energy, design challenge in tropical climate is to protect buildings from overheating and enable easy cooling when needed. For this reason, building concept is based on segregation of thermal mass by creation of porous external envelope composed of the alternating wall parts and voids and massive internal sections. By applying the concept of two outer layers, it was possible to create different thermal building zones: internal zone that is fully enclosed and which can be, if necessary, easily conditioned and outer, semi-enclosed zone that reinterprets the traditional porch, and prevents from overheating. For this reason, the roof has been designed with large overhangs, providing sufficient shade for the most of the day.

b. Ventilation and moisture control: High humidity presents a special design challenge, where much attention should be dedicated to providing adequate ventilation. Standard (contemporary) building practice in Equatorial Guinea includes use of variety of mechanical systems, from split-system air conditioning units to complex HVAC systems, but one of our design goals was to

minimise the need for use of such systems in order to provide climate-responsive architectural design that would be less dependent on external power supply, taking advantage of natural ventilation.

In order to provide for natural ventilation, the building was composed of several volumes arranged in parallel manner, with enclosed intermediate green areas. In this way, surface to envelope area ratio has been significantly increased, with large openings on all sides, thus maximizing the ventilation potential. Also, the green areas between the built sections are designed as a tool for minimizing the heat island effect and reduction of the albedo effect that would have been much more influential if paved surfaces were to be applied. External corridors are practically open, enclosed only by mosquito nets in the form of sliding panels. They are, through the voids in internal mass that are serving as waiting rooms or meeting places, connected to the internal corridors, enabling the cross ventilation throughout the building. For this reason, doors and windows are equipped with the "grille" systems that can be, if needed, efficiently closed. In this way, we are actually creating another envelope that is permeable to air but closed for the insects and other pests.

The large roof has been designed detached from the mass of the buildings and it has been separated from the main volume by cross-ventilated area, minimizing the secondary radiation coming from the metal sheeting. Space beneath the roof covering has been planned as the technical area, designated for placement of external units of split systems and other auxiliary items.

c. Daylighting and Sun control: Permanent 12 hours of daylight throughout the year offer good starting point for extensive use of natural daylight, but the fact that is often cloudy has to be taken into consideration. Dominant strategy was to use the building form as the controlling mechanism and to avoid any sophisticated technical solutions that are in need of expert maintenance. Double-layered outer facade with external corridors and balconies and large roof overhang were designed to provide sufficient shading, having in mind the trajectory of the Sun. Fixed Sun louvres systems were only applied in central oval area that has standard flat roof without overhangs. All floor areas were designed in the form of paved, white, surfaces symbolically emphasizing the cleanness of the hospital, but, at the same time, providing enough reflected daylight for users.

d. Rainwater management: Very high precipitation rates could strongly influence architectural design in terms of form, materials and rainwater management. Since the infrastructure is poor, rainwater collection would provide for higher level of independence. One of the main components of the design - the large roof - has been used for protection from heavy rainfall as well as for rainwater collection. Storage has been placed in the technical area between the roof and upper level, making the use of the collected water possible just by gravitational flow. By implementation of adequate filtering and surplus water evacuation, design has incorporated rainwater management, in the form of technical water for flushing and cleaning purposes, as one of the main strategies. Further use of purified rainwater as potable one is possible, but has not been investigated nor planned due to the lack of adequate systems.

Materials and building technology

Rainforests offer some of the most noble and durable construction wood. Yet, in countries like Equatorial Guinea, wood is not perceived, nor appreciated, as a contemporary building material except for houses or smaller residential buildings. Some explanation might be found in the fact that, despite the abundance of this resource, there are no processing facilities or any type of industrialized production – tropical wood is mainly directly exported as timber or applied in simple way as the sidings. Modern industrial techniques that would provide adequate treatment of wood and its wider application are not available and standard practice can't meet the maintenance standards needed for public buildings. Clay is scarce, leaving concrete and

3rd INTERNATIONAL ACADEMIC CONFERENCE

lightweight concrete blocks as the main construction material. Construction steel can be used as well, but one should keep in mind the necessity of specialized workers and some more demanding engineering related to steel construction. For these reasons, the structure for the proposed hospital is designed as a combination of massive bearing walls and low-tech steel roof construction. Basic idea was to use this development as a training ground for the local work force by introducing them to new, but, at the same time, rather simple building techniques so that they could gain skills needed for future building construction, both public and residential.

Finishings were chosen having in mind extremely high relative humidity and heavy rainfalls, coupled with often-troublesome maintenance. Therefore, durable, low-maintenance finishings were considered: ceramic tiles, composite aluminium panels, sheet metal etc. both for the envelope and internal surfaces. Previous experiences on other projects developed in the same climate have proven this kind of finishings to be adequate for these specific conditions. Use of wood was, for the sake of easy maintenance, restricted only to the elements that are intended for internal use and could be produced locally.

Building size, form and construction technology have been adjusted to the local potential which is rather modest, so planned construction process does not require sophisticated machinery or skills and can be executed with available workforce and minimal training.

Infrastructure

The development has been planned as a self-sufficient complex, so all needed infrastructure has to be provided on site. For this reason, a separate technical building designated to electrical generation and water supply (well) has been designed. Use of renewable power generation in the form of photovoltaic panels has also been planned.

CONCLUSIONS

In order to develop sustainable model for regional hospitals in humid tropical climate, one has to "read" and learn from local customs, building principles and logic but, at the same time, apply a modern architectural language, construction technique and materials. This synergy of tradition and modernity can provide an adequate answer to many of the challenges that are arising from the local environment, resulting in recognizable and adaptable model building.

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