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# Biourbanism - a solution for mitigation of urban climate. Case study Bucharest city

Gabriela MANEA[1,*], Iuliana VIJULIE[1], Laura TIRLA[1], Elena MATEI[2], Roxana CUCULICI[1], Adrian TIȘCOVSCHI[3], Octavian COCOȘ[4]

[1] University of Bucharest, Faculty of Geography, Department of Regional Geography and Environment, 1 Nicolae Bălcescu Avenue, Bucharest, Romania
[2] University of Bucharest, Faculty of Geography, Department of Human and Economic Geography, 1 Nicolae Bălcescu Avenue, Bucharest, Romania
[3] University of Bucharest, Faculty of Geography, Department of Meteorology and Hidrology, 1 Nicolae Bălcescu Avenue, Bucharest, Romania
[4] University of Bucharest, Faculty of Geography, Department of Geomorphology, Pedology and Geomatics, 1 Nicolae Bălcescu Avenue, Bucharest, Romania
* *Corresponding author*, maneagabriela2002@yahoo.com

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**Abstract**

As a living environment or biotope of the human species, urban structures must meet not only the economic, social and political rights of the people, but also their biological and neurophysiologic requirements. A new scientific approach to urban planning is biourbanism or organic urbanism, which considers the urban environment as being a hyper-complex living thing. From the scientific point of view, this approach opens the way to new scenarios for urban planning research. The aim of the study is to promote this modern concept of urban planning for Bucharest City in the context of its climate vulnerability. The objectives of our investigation are the following: analyzing the dynamic of climate conditions of the city, highlighting the weather risks for the population and devising scenarios for implementing the concept in Bucharest. The research methodology focused on the following: the discussion of conceptual framework based on specialty literature, the calculation of bioclimatic indices in order to assess the city's vulnerability to climate conditions and the presentation of "biourban" improvement models applicable to urban fabric samples. The study reveals the vulnerability of Bucharest City in relation to the specific risks associated to the weather phenomena of the summer season (high temperatures and moisture deficit), as argument in favour of preparing implementation scenarios for biourbanism ideas.

**Keywords:** *city's climate vulnerability, mitigating effect, urban planning, biourbanism, Bucharest*

**Rezumat. Biourbanismul -o soluție pentru ameliorarea climatului urban. Studiu de caz: Municipiul București.**

Ca mediu de viață sau biotop al speciei umane, structurile urbane trebuie să răspundă atât nevoilor economice, sociale și politice ale oamenilor, cât și nevoilor biologice și neuropsihologice ale acestora. În acest sens, o nouă abordare științifică a planificării urbane o reprezintă biourbanismul sau urbanismul organic, care consideră mediul urban ca un organism viu, hiper-complex. Particularitățile potențialului climatic și topoclimatic al municipiului București, densitatea populației, a construcțiilor, a mijloacelor de transport motorizate și ponderea redusă a suprafețelor oxigenate verzi și acvatice, înscriu capitala României în categoria orașelor care reclamă o nouă abordare a planificării urbane, respectiv biourbanismul sau urbanismul organic. Scopul studiului îl reprezintă promovarea argumentată a acestui concept modern de planificare a mediului urban bucureștean, în contextul tendințelor climatice marcate de creșterea frecvenței fenomenelor meteorologice de risc (secete prelungite, temperatura estivale ridicate, vijelii etc.). Obiectivele studiului sunt: analiza contextului climatic al orașului; evidențierea fenomenelor de risc pentru populație și elaborarea unor scenarii de implementare a conceptului în București. Metodologia de cercetare s-a axat pe: discuții asupra cadrului conceptual, pe baza consultării literaturii de specialitate,calcularea indicilor bioclimatici în scopul evaluării vulnerabilității climatice a orașului și prezentarea unor scenarii biourbanistice pe eșantioane de țesut urban. Studiul relevă vulnerabilitatea capitalei în raport cu riscurile asociate fenomenelor climatice din sezonul cald (temperaturi ridicate și deficit de umiditate), ca argument în favoarea implementării biourbanismului sau urbanismului organic.

**Cuvinte-cheie:** *vulnerabilitatea climatică a orașului, efect de atenuare, planificare urbană, București*

## Introduction

The present environment of the big cities is confronted with many urban planning problems generated by a number of factors like climate changes, the increase of urban population, and the growth of its living, transportation and recreation demands, which have a direct impact on the quality of environment and the life of the citizens. Under the circumstances, efforts are being made at international level in order to design and promote new urban development models, ecologically protective, but also sustainable from the economic point of view, meant to bring nature closer to the people even in the most artificialized settlements, as is the case of the capital of Romania.

The urban planning models promoted until recently started from assessments based on obsolete scientific theories that regarded the cities and their features as separate and disconnected parts. But the cities are complex systems and their economic and social components, as well as their

infrastructure, are strongly correlated. Addressing them separately leads to inefficient policy, which most oftenrings about unfortunate, and sometimes disastrous, consequences (Caperna, 2011).

As a living environment and biotope of human species, the urban structures must meet not only the economic, social and political demands of the people, but also their organic, biological and neurophysiological ones (Caperna, 2011). This is the framework that includes all the new urban planning concepts of the 21st century: sustainable urban planning, eco urban design, green urbanism, smart city, biophilic city, biourbanism, organic urbanism.

Sustainable urbanism serves as a fundamental tool for improving the quality of life in the urban environment through the medium of green architecture (Emir, 2011).

Green urbanism is a form of making the urban communities beneficial both for the people and for the environment by minimizing the consumption of materials and energy (Beatley, 2000).

In the smart city, the investments made in socio-human capital, the urban infrastructure, and the rational management of natural resources, encourage a sustainable economic development and promote a high quality of living by participatory actions and the commitment of community members (Caragliu et al., 2009;Păceşilă&Colesca, 2007).

Biophilia describes the bond between humans and nature. Biophilic cities include abundant natural elements and their policy is oriented towards nature protection, conservation and restoring (Wilson, 1984). The biophilic cities start from the premise that nature is indispensable for a healthy, happy and meaningful life. For this reason, they integrate nature in the urban design.

The concepts of biourbanism and organic urbanism are the most recent; they convey the idea of a friendly and healthy urban environment, where nature and city meet, in an effort to restore the lost values and the former balance of the urban ecosystem (Tracada&Caperna, 2012).

It is worth mentioning that in the urban planning field the concepts of biourbanism and organic urbanism are less known and therefore less used.

Biourbanism means more than expansion of green areas and use of renewable energy. It considers that architecture is inextricably linked with biology (Tracada&Caperna, 2012). From the scientific standpoint, this concept opens the way for new research scenarios in the field of urban design.

The aim of biourbanism is to create a living city through adapting the ecosystem to the human needs by optimizing the interaction between the cultural and physical factors. Although this concept may point to a "Gaudi" planning style, inspired by the nature patterns, its real aim is to identify the way in which the natural elements can be connected to the human needs (Salingaros, 2010; Tracada&Caperna, 2013).

Biourbanism admits the "optimum forms" defined at different scales (from the purely psychological to the ecological ones), which, through the medium of morphogenetic processes, ensure the systemic efficiency regarding the quality of living. A project that fails to obey these laws will give rise to artificial and hostile environments, which negatively impact the life of the citizens. One of biourbanism's objectives is to bring its scientific contribution to the identification and updating of environmental progress according to the natural needs of the people and the ecosystem they live in (Caperna et al., 2013).

In Romania, the concept is rather new, which motivated us to approach this issue. At international level, however, we were able to find similar approaches with the present study, pleading in favour of implementing sustainable urbanism models, focused on the climate conditions of the investigated territories (Gomez et al., 2001).

The specific features of the climate and topoclimateof Bucharest City, as well as the relatively low values of green areas per inhabitant, place the Romanian capital among the cities that need to embrace a new interdisciplinary approach of urban planning. Under the circumstances, biourbanism is meant to integrate water surfaces and vegetation into the urban system, because "only interdisciplinary co-planning involving administration, architecture, urban planning, water management, and landscape design will help to integrate water infrastructure as part of multifunctional spaces into the urban fabric" (Ruhnke, 2011).

The purpose of our study is to promote this modern concept of urban planning for Bucharest City, starting from the analysis of its climate conditions, which shows that weather risk phenomena affecting population are on the increase. The most important are the long drought intervals, the increasing number of hot days, the tropical nights, the high insolation levels and the occurrence of dust storms originating from North Sahara Desert, in recent years . These phenomena are amplified by the city, with its densely populated artificial and artificialized areas, characterized by a high coefficient of thermal retention, which during the tropical nights generates intense caloric cross radiation that negatively impacts the urban living comfort.

The study is focused on the following objectives: a) the assessment of climatic vulnerability of Bucharest City from the perspective of urban living conditions, and b) the presentation of selected models for the implementation of biourbanism ideas.

The study area is represented by the Romanian capital, which is situated in the central-eastern part of the Romanian Plain, near the northern limit of the territories affected by aridization (Achim et al., 2012) – fig. 1, 2. From the physiographic point of view, Bucharest lies in the plain bearing the same name, 60 km away from the Danube, in the south, 100 km away from the Carpathians, in the north, and 250 km away from the Black Sea Coast, in the east (Posea&Ștefănescu, 1984).


**Fig. 1: The location of Bucharest City in Romania**

The elevation of Bucharest City ranges from 118 m in the northwest and 50 m in the Dâmbovița floodplain, while the mean altitude is 80 - 85 m. The lithology consists of Quaternary sedimentary deposits (gravel and sands), piled by the Carpathian and Sub-Carpathian rivers, overlain by loess deposits and loose rocks, with high dust content. In summer, this dust is blown away by the wind, which negatively influences the quality of living in the urban environment.

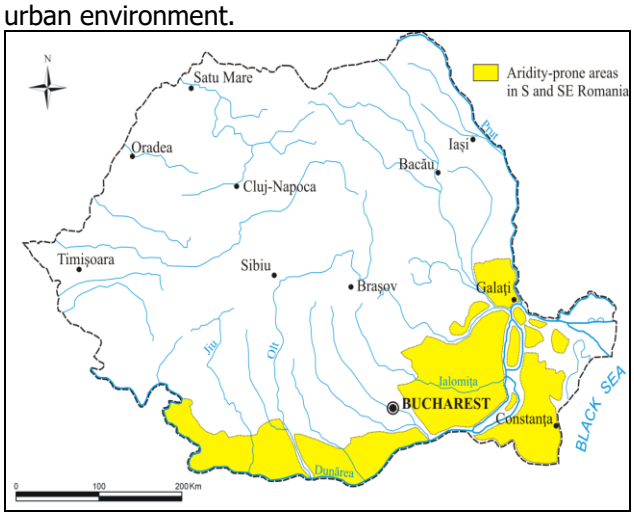


**Fig. 2: The location of Bucharest City within the territories affected by aridization (Source: Achim et al., 2012)**

The climate of Bucharest Plain is dominated by polar maritime and continental air masses, coming from the eastern quadrant (60.3%), followed by tropical maritime and continental ones, which define a continental climate, with slight subtropical influences (Bogdan& Niculescu,1999).

Summer is the warm season, with mean monthly temperatures of 20-230C; now and then, however, thermometer rises to 35-400 C, while the number of tropical days is usually more than 38.

The mean multiannual amount of precipitation is higher in the city centre (613.2 mm at Filaret station) and lower on the outskirts (603.6 mm at Băneasa) (according to ClimaRomâniei, 2008), which is a direct consequence of the big number of aerosols generated by industry and road traffic. In summertime, the heavy rainfalls are sometimes accompanied by hail.

The northeast winds prevail followed by the southwestern ones. Wind direction in the city depends on street orientation, the width of avenues and roads, and the position of the public squares. A specific phenomenon for Bucharest is the urban breeze (ClimaRomâniei, 2008), which originates in the temperature differences between the city and the surrounding areas.

The annual number of foggy days is 40-50, the phenomenon being more common in the vicinity of lakes, reservoirs and rivers. In many instances, fog may combine with urban fog, which makes breathing very difficult. Because of the high amount of pollutants, cloudiness is higher in the city (more than 6 tenths) and lower in its hinterland. The highest cloud cover values (exceeding 6.5 tenths) are common from November till March, while the lowest (less than 4 tenths) are specific for July-September interval (Dumitrescu, 2007).

As a metropolis, Bucharest has the most typical urban climate in Romania, being the biggest "heat island" of the country (Bogdan& Niculescu,1999).

Natural pollution is determined by dust storms, which particularly influence the areas void of vegetation. The suspended dust particles dim the solar light and increase the occurrence of fog, mist, cloudiness and precipitation. Urban atmosphere is purified through the medium of thermal convection, local winds and precipitation.

The features of urban topoclimate may be emphasized by the values of selected bioclimatic indices, which reveal the thermal and hydrological contrast between centre and periphery, depending on the green and blue areas perceived as thermoregulatory factors. Bioclimatic indices capture the spatial and temporal evolution of the climate parameters that play an important part in the economy, the comfort of human communities and the territorial planning (Iojă, 2012).

## Materials and methods

Data collection. Climate data were provided by the National Meteorological Administration (NMA) for Bucharest-Băneasa and Bucharest-Filaret weather stations, based on the recordings made between 1961 and 2000 for temperature and between 1961and 2005 for precipitations. The time interval - the 30-year period from 1961 to 1990 are currently used to define the latest global "Normals" used for climate reference.

The Digital Elevation Models were accomplished starting from the cadastral map of Bucharest, scale 1:2000.

The research methodology was based on bibliographic documentation, field investigations and the computation of representative bioclimatic indices, which are used in many studies accomplished in Romania dealing with the bioclimatic conditions of various regions.

The most representative bioclimatic indices, typically used to assess the environmental potential of a territory, are the following: Mayrtetratherm, which is the ratio between the average temperatures corresponding to the most arid interval of the year and the period of maximum biological activity (Satmari, 2010); De Martonne aridity index, computed as a ratio between annual precipitation and the mean annual temperatures exceeding +100C (Ozenda, 1994; Pătroescu, 1996; Dumitrașcu et al., 2004; Iojă, 2006; Manea, 2009; Vijulie, 2010); Thornthwaite aridity index, expressed with a formula accepted by the United Nations Environment Programme (UNEP); Angot aridity index, which is the ratio between the mean annual precipitation and the monthly precipitation, where subunit values point at the dry months (Satmari, 2010); Siple-Passel index (W/m2), which correlates air temperature and wind velocity, parameters that suffer significant alterations within the urban environment (Besancenot, 1978); Annual Hydric Compensation Index- expressed as ratio between humidity excedent and humidity deficit.(Pătroescu, 1987; Manea, 2009); Gaussen index, expressed as the ratio between the precipitation fallen in summer and the annual amount of precipitation (Ozenda, 1994; Manea, 2011). The same purpose was also served by the Walther-Liethclimogram, also called ombrothermic diagram or Gaussen dual-scale diagram, which allows the estimation of the mean annual or multiannual duration of the dry season in the investigated territory (Gaceu, 2002; Manea, 2011). These indices highlight the drought vulnerability of the urban ecosystem. In our study, were used the following indices: Angot aridity index, Hydric Compensation Index, Gaussen index, MayrTetraterm, De Martonne aridity index, Thornthwaite aridity index.

The observations in the field accomplished during the period July 2012-September 2013 were aimed at identifying the urban fabric samples, whose artificial or artificialized structure was accompanied by specific townscape elements, as well as the urban structures that might be better capitalized through townscape improvement. The digital elevation models of the urban fabric improvement works overlapping the Dâmboviţa corridor and the swampy area of Lake Văcărești were created using ArcGis 10.1. and SketchUp softwares.

## Results

### *Dysfunctions of the climatic and bioclimatic conditions of Bucharest City*

By analyzing the climate data sets and by computing some representative indices, we were able to reveal the features and vulnerabilities of the climate conditions of the Romanian capital. The active surface of Bucharest City, which is mostly built-up, totally differs from the surrounding flatlands. Its complex structure is characterized by a street network of various sizes and orientations, buildings of different heights, street corridors channelling the air masses, factories, water surfaces and green areas, which generate different topoclimates. As far as the values of climate parameters are concerned, these suffer alterations because of the building materials having high coefficients of thermal retention.

The risk phenomena specific for Bucharest City are drought, tempests, dust storms and the high temperatures exceeding the thermal comfort value (>250C). More often, these values occur in summertime, when the capital is under high climatic stress, the living conditions being affected by the high temperatures and the scant precipitation.

During the last century, the temperature gradually rose to the core of the city, as the urban sprawl intensified (Fig. 3).

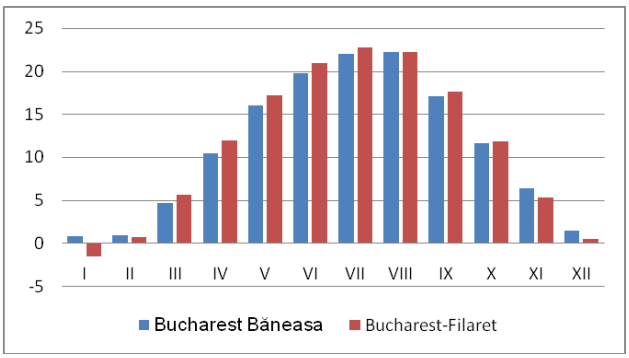


**Fig. 3: Mean multiannual air temperature evolution (°C) at Bucharest-Filaret station (centre of the city) and Bucharest-Băneasa station, in northern part of the city (1961-2000); Source of data: Archives of NMA.**

In consequence, during the summer season Bucharest turns into a hostile environment, which makes its residents temporary migrate towards the hilly and mountainous areas. On the other hand, the people who still remain here are forced to use the air conditioning systems intensively, which increases the electric power consumption.

The processing of climatic data sets gives us a complex image on the capital climatic vulnerability during the summer season, as well as on the mitigating effect of the green areas of the city.

The values of the Mayrtetratherm highlight the amount of necessary heat for vegetation development, the areas prone to thermal discomfort in summertime, and the metropolitan area (urban heat island).

Consequently, at Bucharest-Filaret weather station the Mayrtetratherm value is about 10°C higher than at Bucharest-Băneasa, which lies in the northern part of the city and suffers the influence of Băneasa forest. The moderating effect of the vegetal cover is also emphasized by the comparative analysis of the maximum values of the mean monthly temperatures computed for the interval 1961-2000. The thermal differences between the core of the city (Filaret station) and its northern part (Băneasa station) are given in table 1.

The Gaussen index values (fig. 4) for the period 1961-2000 remain below 0.25 units, placing Bucharest on the limit between the continental climate and the subtropical or Mediterranean one. At the same time, Fig. 4 show a constant increasing trend of the index values for the interval 1961-2000.

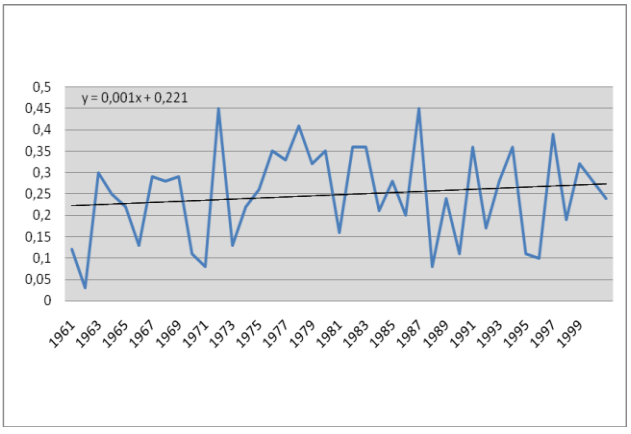


**Fig. 4: The evolution of Gaussen Index values (Source: processed based on the information supplied by NMA)**

The annual values of the De Martonne aridity index exceed 25 units for both weather stations, which places the capital within the forest-steppe semi-humid climate (10-150C) (Table 1). In its turn, the Angot aridity index highlights the climatic features of every month, its subunit values pointing at the dry intervals (from middle of April to the end of August). Figure 5 shows that five months per year, including the period with maximum biological activity (VII-VIII), are confronted with moisture deficit; this fact, together with the highest values of temperature and evapotranspiration, on the one hand, and the prevalence of the areas with high thermal retention coefficient, on the other hand, are responsible for the discomfort felt by the people.

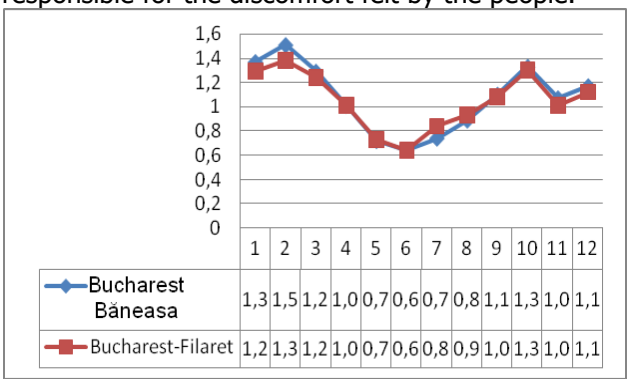


**Fig. 5: The evolution of the mean monthly values of the Angot aridity index (1961 - 2000) (Source: processed based on the information supplied by NMA)**

The moisture deficit is also revealed by the Thornthwaite index (table 1), which shows that water loss through evapotranspiration during the vegetation season cannot be compensated by precipitation.

## *Means of implementing biourbanism or organic urbanism concepts*

The climatic background revealed in the previous subchapter justifies the concern for finding and implementing an eco-protective, functional and aesthetic urban planning model, knowing that Bucharest, more than any other European capital, developed in the 8th and 9th decades a monotonous residential infrastructure, devoid of architectural personality, densely populated and almost totally lacking natural improvements.

Such a model, meant to bring the Bucharest citizens closer to "Paradise lost", may be represented by biourbanism or organic urbanism, a concept of urban planning recently come to the attention of architects, specialists in urban planning and NGO's. Thus, a first step for implementing the biourbanism concept in Bucharest is the launching of "Plug to nature" strategy, aiming at winning back the city. This would imply the improvement of the Dâmboviţa channel and its adjacent areas (Fig. 6, 7), on the reach crossing the city centre (between the National Library and the Unirii Bridge – Fig. 6, 7), so that to turn it into an Eco-Urban Cultural Centre, according to the project proposed by "Ivan Patzaichin-Mila 23" Association.

**Tabel 1 The values of selected bioclimatic indices at Bucharest-Băneasa and Bucharest-Filaret weather stations (1961-2000)**

| Month | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BUCHAREST -BĂNEASA | | | | | | | | | | | | |
| $T^0C$ | -0.77 | 0.85 | 4.60 | 10.44 | 16.02 | 19.7 | 22.01 | 21.21 | 17.2 | 11.6 | 6.37 | 1.45 |
| P (1961 – 2005) | 36.5 | 33.1 | 38.8 | 49.5 | 69.8 | 78.6 | 67.7 | 56.4 | 45.7 | 37.7 | 46.9 | 42.9 |
| ETP | 0.4 | 3.9 | 16.7 | 52.1 | 96.5 | 126.4 | 142.7 | 125.8 | 81.7 | 42.3 | 14.1 | - |
| ΔP = P-ETP | 36.1 | 29.2 | 22.1 | -2.6 | -26.7 | -47.8 | -75 | - 69.4 | -36 | -4.6 | 32.8 | - |
| $I_{pm}$Angot | 1.37 | 1.51 | 1.29 | 1.01 | 0.72 | 0.64 | 0.74 | 0.89 | 1.10 | 1.33 | 1.07 | 1.17 |
| $I_{ar}$deMartonne III-XI | | | 31.89 | 29.06 | 32.19 | 31.75 | 25.37 | 21.68 | 24.13 | 20.94 | 34.37 | |
| $I_{ar}$Thornthwaite (annual): Bucharest- Băneasa -603.6/702.6= 0.859 (0.7 is the transition value to the sub-humid dry climate) | | | | | | | | | | | | |
| $I_{ch}(\sum\Delta P^{+}/\sum\Delta P^{-}) = 0.458(\sum\Delta P^{+} = 120.2; \sum\Delta P^{-} = 262.1)$ | | | | | | | | | | | | |
| $I_{ar}$deMartonne (annual)= 28.89 | | | | | | | | | | | | |
| MayrTetratherm = $( T_V+T_{VI}+T_{VII}+T_{VIII})/4$ =19.73 | | | | | | | | | | | | |
| BUCHAREST - FILARET | | | | | | | | | | | | |
| $T^0C$ | -0.51 | 0.71 | 5.61 | 11.90 | 17.22 | 20.87 | 22.76 | 22.17 | 17.65 | 11.77 | 5.25 | 0.51 |
| P (1961-2005) | 39.4 | 37 | 41 | 50.2 | 69.6 | 78.9 | 60.5 | 54.8 | 47 | 39.2 | 50.1 | 45.5 |
| ETP | 0.7 | 4.1 | 19.3 | 54.3 | 99.0 | 129.3 | 146.4 | 130.4 | 85.7 | 45.6 | 16.2 | - |
| ΔP = P-ETP | 38.7 | 32.9 | 21.7 | -4.09 | -29.4 | -50.4 | -85.9 | -75.6 | -38.7 | -6.4 | 33.9 | - |
| $I_{pm}$Angot | 1.29 | 1.38 | 1.24 | 1.01 | 0.73 | 0.64 | 0.84 | 0.93 | 1.08 | 1.30 | 1.01 | 1.12 |
| $I_{ar}$deMartonne III-IX | | | 31.51 | 27.5 | 30.68 | 30.67 | 22.16 | 20.44 | 20.39 | 21.60 | 39.42 | |
| $I_{ar}$Thornthwaite (annual): Bucharest-Filaret –613.2 /731.2 = 0.838 (0.7 is the transition value to the sub-humid dry climate) | | | | | | | | | | | | |
| $I_{ch}(\sum\Delta P^{+}/\sum\Delta P^{-}) = 0.437(\sum\Delta P^{+} = 127.2; \sum\Delta P^{-} = 290.5)$ | | | | | | | | | | | | |
| $I_{ar}$deMartonne (annual) = 28.76 | | | | | | | | | | | | |
| MayrTetratherm = $( T_V+T_{VI}+T_{VII}+T_{VIII})/4$ =20.75 | | | | | | | | | | | | |

Source of climatic data: NMA

This initiative inspired us to design a model for improving the previously mentioned wetlands, as the central location of this stretch, which is currently dull and inert, presents a good opportunity for the area. Consequently, the cultural and social values, stemming from the presence of one of the most important libraries in Bucharest, may be interconnected with the aesthetic and ecosystemic ones, which are attributes of the blue and green oxygen producing areas belonging to the Dâmboviţa stream and its adjacent improved or improvable areas.


**Fig. 6:** The distribution by sectors (districts) of the present water surfaces and green areas of public interest

As a matter of fact, urban improvements should include the entire reach of the river crossing the Romanian capital (Fig. 6), which from the architectural standpoint might be considered a genuine spinal column of the urban ecosystem,

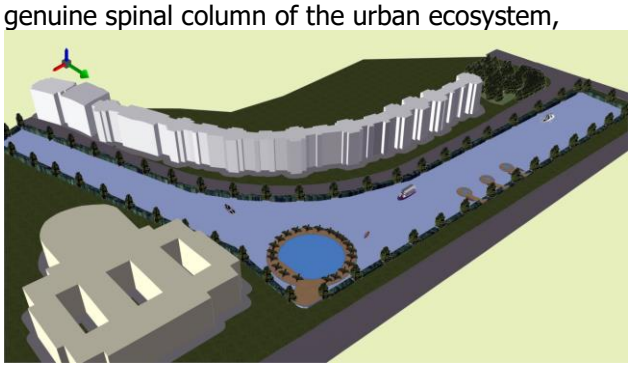

**Fig. 7:** A model of urban improvement of a sample lying along the Dâmboviţa corridor

being flanked by important cultural or research institutions: Polytechnic University, Faculty of Law, Faculty of Biology, Palace of the Romanian Parliament, Palace of Justice, etc.).

Another example worth mentioning in this context is Lake Văcărești wetlands (Fig. 8, 9), lying at the core of a dispute among civil society, political regime and mass media representatives, which might be turned into an urban natural park (Manea et. al., 2013), with improvements inspired from other similar areas in the world. Following the creation of the Văcărești Natural Park, Bucharest would reach half of the necessary green area required by the European norms (40 square meters per inhabitant). At present, the official figure in this respect is about 24 square meters per inhabitant (Cadastrul verde al Bucurestiului, 2011). This green area would be the first urban natural park in

Romania and its ecological and socio-economic benefits would be remarkable.

**Fig. 8:** Current situation of Lake Văcărești wetlands

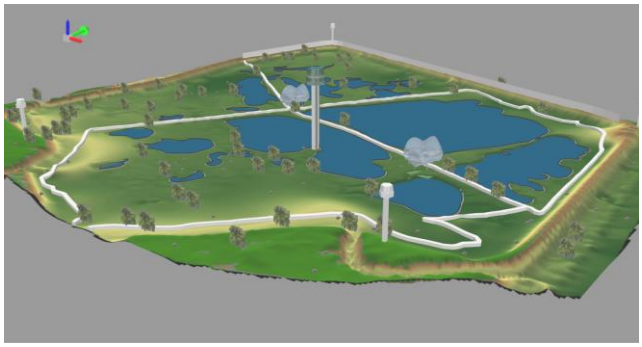

**Fig. 9:** A model of improving Lake Văcărești wetlands

Another project, entitled "Transcentral Urban Bucharest", proposed in 2007 by a team of architects, must also be taken into account in this urban improvement context. Although it has not been implemented yet, it is meant to interconnect the green areas, the water surfaces and the public. The project aims at building a pedestrian and cyclist bridge over the Dâmboviţa River (opposite the Palace of Parliament). This will have several levels covered by vegetation, as a symbol suggesting that the green areas and public squares of the old city are willing to conquer the opposite bank, "in order to civilize the desolate areas surrounding the Palace of Parliament" (Andreșoiu et al., 2007) (Fig. 10).

This type of improvement would bring about an increase of the quality of urban living by facilitating access to leisure and recreation activities and by connecting two types of areas devoid of constructions, which are not fully capitalized, one lying in the old city and the other being the result of the urban planning policies of the former communist regime.

**Fig. 10:** Transcentral Urban Bucharest Project (Source: Andreșoiu et al, 2007; 2010)

The ultimate goal should be the overall landscape improvement and the increase of urban living comfort through the medium of water and green areas.

The idea could be further developed by connecting the entire city to nature, revaluating the natural or semi-natural biotopes, which currently are not properly managed, and turning the water surfaces into topophilic environments, accessible to urban residents. This approach is interdisciplinary or even transdisciplinary, the implementation of ideas being possible only through a process of analysis and co-panning involving the stakeholders' representatives: local authorities, architects, landscape designers, geographers, economists, sociologists, plain citizens and even physicians and psychologists.

A method of urban improvement with positive impact on the aesthetics and the quality of urban living might be the cityregeneration through creative artistic interventions: climbing vegetation on blind walls (Fig. 11), hedgerows around the blocks of

**Fig. 11: Climbing vegetation on blind walls (Original photo)**

flats, green facades, rivers with grassy banks, flower pots on the balconies of the collective dwellings (especially the old blocks in the communist neighbourhoods), green roofs capable of storing

water (Ruhnke, 2011), attractive green areas in place of vacant lands and decommissioned sites, as well as leisure and recreation fields.

## Discussion

International examples are numerous and may serve as models for the 21st-century architecture: Milan (Fig. 12), London, Berlin, Ljubljana, Wroclaw Stockholm, Los Angeles, Buenos Aires etc.

Thus, in the city centre of Milan, the first vertical forest in the world (called "BoscoVerticale") will include two 27-storey towers, which will be coated with about 730 trees, shrubs and flowering plants.

**Fig. 12: The „BoscoVerticale" project in Milan (Photo: damncoolpictures.com)**

We may argue that this type of structures is an ingenious and unique way of blending architecture with ecology; this architectural idea might be a solution to the lack of vegetation in the large cities. The green infrastructure is a fundamental element for territorial planning. It mitigates the thermal discomfort by controlling the sprawl of urban heat island, improves the living conditions (Carreiro&Tripler, 2005), controls the flow of rainfall water, maintains biodiversity, purifies the atmosphere, stores carbon (Chiesura, 2004; Del Saz-Salazar s &Rausell-Koster, 2008; Tyrvainenet al., 2007 ) and provides a pleasant and healthy landscape.

The elements of green infrastructure may preserve and enrich the ecosystems diversity from the point of view of habitats and species (Tzoulas et al., 2007). At the same time, the green infrastructure may counterbalance soil sealing, which is the major consequence of urban development. As part of this green infrastructure, the green roofs (Madre et al., 2014) may diminish some of the negative effects of soil sealing, but they cannot compensate soil function loss. However, they may bring their contribution to some extent in preventing surface flow, as it happens in the centre of Manchester City and in its densely populated suburbs. There, the green roofs have reduced the surface flow triggered by a heavy rainfall of 20 mm even by 20%. This type of reduction may be useful in controlling the floods in urban environments. In addition, the green roofs may become habitats for certain plants and wild animal species, thus exerting a positive effect on microclimate by transpiration (which has a cooling effect), but they can also purify the air by filtering the suspended particles (Siebielec et al., 2010). As far as the costs are concerned, these are somewhat comparable to those of conventional roofs.

The maintenance costs of these improvement works can be minimized if the species will be selected depending on their adaptability to the thermal and precipitation regime of Bucharest City. However, the "greening" of dwellings might be hindered by the difficulties encountered in the management of undesirable organisms: invertebrate animals, rodents, bacteria, fungi, etc. (Ioja, 2012).

At present, the city of Bucharest, urban settlement with multi-secular history marked by urban approaches specific to every historical context (Oriental, Byzantine, Baroque, Eclectic, Neo-Romanian, Art Deco or Streamline Moderne), includes in his architectural mosaic distinctive samples of urban fabric, which resemble independent towns. We can mention in this respect the Primaverii and Floreasca neighbourhoods, situated in the north, the Cotroceni neighbourhood, in the central-western part, and the residential districts adjacent to Dacia Avenue, DumbravaRoşie Street, Polonă Street and Spania Square, lying in the city centre. For the most part, however, Bucharest is dominated by collective dwellings (blocks of flats) with monotonous architecture, where artificial areas prevail, which adversely affect the physical and mental health of the inhabitants. Consequently, a good solution for mitigating the dysfunctions would be the "rebranding" of these dwellings in the spirit

of biourbanism, inspired from the models designed and tested at international level.

## Conclusions

The location of Bucharest City on the edge of the Romanian territories affected by aridization, its present climate conditions marked by aridization tendencies and high temperatures during the summer season, the sprawl of built-up area, and the increasing population density justify the adoption of biourbanism as a new model of development. Consequently, following the example of other European and World cities that have already implemented such strategies, the local authorities will be able to mitigate the climate conditions and to increase the living standards of Bucharest residents.

An important step in promoting biourbanism is to connect the city with nature. This can be done by capitalizing the natural and/or semi-natural biotopes, which at present are not properly managed (the Dâmboviţa River corridor and the wetlands adjacent to Lake Văcărești) and by rethinking the improvements of urban environment making use of creative interventions meant to expand the green areas. The final purpose of biourbanism should be the improvement of urban climate, the overall landscape adjustment and the increase of urban living comfort through the medium of water and green areas.

However, this new type of urban approach might be confronted with a number of constraints, such as the high maintenance costs of the improvements, the low awareness of public opinion regarding the benefits, the diverging interests of real estate market, the disinterest of local authorities, the low financial resources, and the difficulties encountered in the maintenance process. All these could be overcome through a large-scale promotion of the concept, through raising the awareness regarding the usefulness of the ecosystemic services provided, and through a larger involvement of the target groups. Probably the best approach in this respect would be that of the small, but safe, steps. Previous experience in the history of urban planning in Romania (and especially in the communist period) confirms that radical decisions, taken without informing and consulting the stakeholders, may have negative far-reaching effects, both on the territory and on the mental health of the residents.

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