

GROWTH OF THE SUBURBAN AREAS DUE TO THE UNFAVORABLE CONDITIONS IN THE CITY - CASE STUDY THE CITY OF BIJELJINA

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Abstract: This research includes several aspects of relocation of people from urban to suburban and rural areas. Those include the growth of population in the city which leads to massive construction, increased number of vehicles, converting of green areas to residential, one floor houses to multi floor buildings, etc. All mentioned led to the increase of temperature in city itself and made Bijeljina a heat island. The analyzed parameters in this research were number of inhabitants, land use of the area and thermal comfort for the period of 19 years (2005–2023) for the summer period when the temperatures are the highest. Obtained results show the three directions of suburban growth, and allocation of the population to the neighboring settlements. All three directions record intense growth of the population in its areas, with also the increase of business facilities, while still the agriculture being the dominant as the population income in most of the settlements.

Key words: urban, rural, population influx, thermal comfort, WBGT.

1. INTRODUCTION

Population migrations in these areas have been present for a long period of time. There are many reasons, but most of them relate to the political situation and employment. Bosnia and Herzegovina as a country records a decrease in population. The population distribution within the country is uneven. The population goes to the cities in search of work, leaving the villages empty.

A detailed analysis of the Population Census from 2013 [1] shows that almost all villages in Bosnia and Herzegovina (except those that have since acquired the status of suburban settlements) have a decrease in the number of inhabitants. In contrast, the City of Bijeljina represents a rare example, which, despite the decrease in the number of inhabitants at the level of Bosnia and Herzegovina, and even the entity of Republika Srpska itself, records the growth

of the population, especially in the urban area but also in many of its rural settlements [2].

Many cities have higher temperatures than the environment due to the level of urbanization that modifies land use, creating a specific phenomenon, urban heat islands [3,4]. According to the audit of the world perspective of urbanization from 2018, 68% of the population will live in urban areas by 2050 [4,5]. The quality of urban living conditions often depends on the thermal comfort of the open urban spaces, which are used on a daily basis [6,7].

Bijeljina is a characteristic example of heat island in Bosnia and Herzegovina [7,8,9,10]. The influx of population to Bijeljina, which has been going on since the beginning of the 21st century, has led to changes in the appearance and functioning of the city itself. The needs of the population for housing, education and work have imposed a rapid construction process,

which often does not follow spatial norms. Omissions such as the proximity of buildings to the street or any other object, the absence of trees or their replacement with lawns and buildings, overload of some streets with multi-story buildings, insufficient parking spaces and many others created overcrowding and led to discomfort in people, which in combination with high temperatures is manifested by the appearance of mild or severe health problems [8,9]. In addition to the change of the space in the form of constructing multi-story buildings, natural climate elements also affect the creation of discomfort in the population [9].

As the conditions in the urban environment in the City of Bijeljina become more and more difficult, due to crowds, high temperatures and concrete with lack of green areas, people tend to, if possible, move to rural areas again. However, as the population is mostly employed in the city, the settlements to which they move are located in the immediate vicinity, which leads to the expansion of the city. Bijeljina, as a city in the plain, has good predispositions for expansion and growth, without natural obstacles.

2. METHODOLOGY

2.1. Location and population

Settlement Bijeljina city is located in the northeast part of Bosnia and Herzegovina. Territory of the City borders the Republic of Serbia to the east, the Republic of Croatia to the north, Brčko District to the west and the municipalities of Lopare and Ugljevik and the City of Zvornik to the south. It is characterized by a favorable geographical position at the crossroads between Serbia, Croatia, Brčko District and the Federation of BiH (figure 1).

Its position is one of the main reasons for its fast urban development, that started during the nineties of the 20th century, after the civil war in Bosnia and Herzegovina. In addition to good connections with other countries and with places from the inner, central part of the country, the researched area is rich in fertile soil and is crossed by surface and underground watercourses, the largest of which are the Drina and Sava rivers.



Figure 1. The position of the City of Bijeljina in Bosnia and Herzegovina [9]

A total of 107,715 inhabitants live in the City of Bijeljina, in 67 settlements (table 1). According to the last Census in 2013, the total population of the city is 42 278 [1], which is 16.1% higher than in 1991 [2,10,11]. The population density is 1 497 inhabitants per km², which is much higher than the population density of Bosnia and Herzegovina which is 68.9 inhabitants per km² [11] and the population density of Europe in general which is 188 inhabitants per km² [2,9,12].

Table 1 Number of inhabitants in the settlements of the City of Bijeljina, according to the 1991 and 2013 censuses [11]

No	Name	1991	2013	pp/km ²	Growth
1	Amajlije	1 110	1 131	87.3	↑
2	Balatun	1 305	1 286	81.7	
3	Banjica	406	281	42.4	
4	Batar	382	229	46.1	
5	Batkovic	3 118	2 566	66.8	
6	Bijeljina	36 414	42 278	1497.1	↑
7	Bjelosevac	639	467	60.7	
8	Brijesnica	195	174	48.7	
9	Brodac Gornji	866	789	50.7	
10	Brodac Donji	735	686	35.7	
11	Bukovica Gornja	574	343	54.1	
12	Bukovica Donja	794	576	42.9	
13	Velika Obarska	3 549	3 942	103.9	↑
14	Velino Selo	451	349	29.2	
15	Vrsani	960	635	59.3	
16	Glavice	1 293	1 089	82.6	
17	Glavicorak	359	175	68.6	
18	Glogovac	436	414	68.5	
19	Gojsovac	475	713	260.2	↑
20	Golo Brdo	198	382	77.2	↑
21	Gradac - Stupanj	789	522	45.4	
22	Dazdarevo	435	526	98.3	↑
23	Dvorovi	1 587	4 873	330.8	↑
24	Dijelovi	227	679	363.1	↑
25	Donji Zagoni	391	312	56.5	
26	Dragaljevac Gornji	603	426	36.2	
27	Dragaljevac Donji	463	348	58.8	
28	Dragaljevac Srednji	1 041	755	46.3	
29	Zagoni	851	642	48.2	
30	Janja	10 458	11 710	288.8	↑
31	Johovac	338	287	54.8	
32	Kacevac	351	276	39.5	
33	Kovanluk	158	521	178.4	↑
34	Kovacici	524	411	37.2	
35	Kojcinovac	726	832	165.4	↑

No	Name	1991	2013	pp/km ²	Growth
36	Kriva Bara	255	349	152.4	↑
37	Ljeljenca	967	939	65.9	
38	Ljeskovac	483	1 009	174.2	↑
39	Magnojević Gornji	665	341	53.3	
40	Magnojević Donji	613	456	59.4	
41	Magnojević Srednji	332	334	42.2	↑
42	Mala Obarska	365	315	112.0	
43	Medjasi	896	876	66.4	
44	Modran	1 411	1 044	63.2	
45	Novi	289	187	29.7	
46	Novo Naselje	1 290	853	677.0	
47	Novo Selo	122	1 177	134.8	↑
48	Obrijez	218	190	66.9	
49	Ostojicevo	595	454	32.0	
50	Patkovaca	646	2 619	1019.0	↑
51	Piperci	386	196	33.6	
52	Popovi	1 134	1 257	98.2	↑
53	Pucile	769	2 126	206.2	↑
54	Ruhotina	446	277	50.4	
55	Slobomir ¹	0	6	13.3	↑
56	Suho Polje	1 503	1 194	44.1	
57	Trijesnica	290	509	158.6	↑
58	Trnjaci	639	1 087	203.2	↑
59	Cipirovine	274	660	569.0	↑
60	Hase	341	956	194.0	↑
61	Crnjelovo Gornje	1 840	1 347	55.2	
62	Crnjelovo Donje	2 963	2 078	54.5	
63	Cadjavica Gornja	973	716	52.5	
64	Cadjavica Donja	735	590	39.6	
65	Cadjavica Srednja	693	544	42.9	
66	Cardacine	370	509	126.9	↑
67	Cengic	1 284	895	55.6	

2.2 Land use

The researched area belongs to the southern part and the rim of the Pannonian basin. All settlements are formed on a plain, with an average altitude of around 120 m above sea level [13]. As such, there is room for its expansion in all directions. Altitude increases from north to south and southwest. The lowest altitude is about 70 m at the confluence of the Drina and Sava [2].

Of the natural elements, fertile soil and water are the most important factors. Most of the area

¹ New settlement, formed in 1996

is covered with cultivated land, then other forms of agricultural land such as orchards, meadows and pastures, combined cultures and plot systems and agricultural land in general. With the increase of altitude, cultures change in favor of fruits.

The whole area is intersected with surface and underground waters. Besides rivers Sava and Drina that are the largest, the area is rich with many flows that are important for the agricultural land. Green areas are rare and are presented with deciduous forests, mix forests and forest bush ecosystems. A rare natural feature is present in the northern part of the City, the area of Gromizelj swamp, which represents an oasis of peace and is a protected natural area by law [14]. Swamps are also present near the Drina river.

Artificial elements are largely present in a form of built in terrains. The area is crossed by main, regional and local roads, and a highway whose construction is not finished, and is planned in the near future, which will increase the number of people working in this area. The urbanization of the whole

area is mostly present around the city and along the main roads. The land use of the whole area of the City of Bijeljina is shown in figure 2.

2.3. Thermal comfort

The city is characterized by high temperatures during a large part of the year, with the warmest months being June, July and August, followed by a lack of wind and often higher humidity. This affects overall people's thermal comfort which is defined as a condition of mind which expresses satisfaction with the surrounding environment [15]. As previously mentioned, the city represents a heat island, that due to the lack of green areas and increased construction has a higher temperature than the surrounding areas. As such it has a negative effect on human health. The health problems associated with heat thermal discomfort are numerous: heat rush, heat exhaustion, rhabdomyolysis, heat syncope, heat cramps and heat stroke [16].

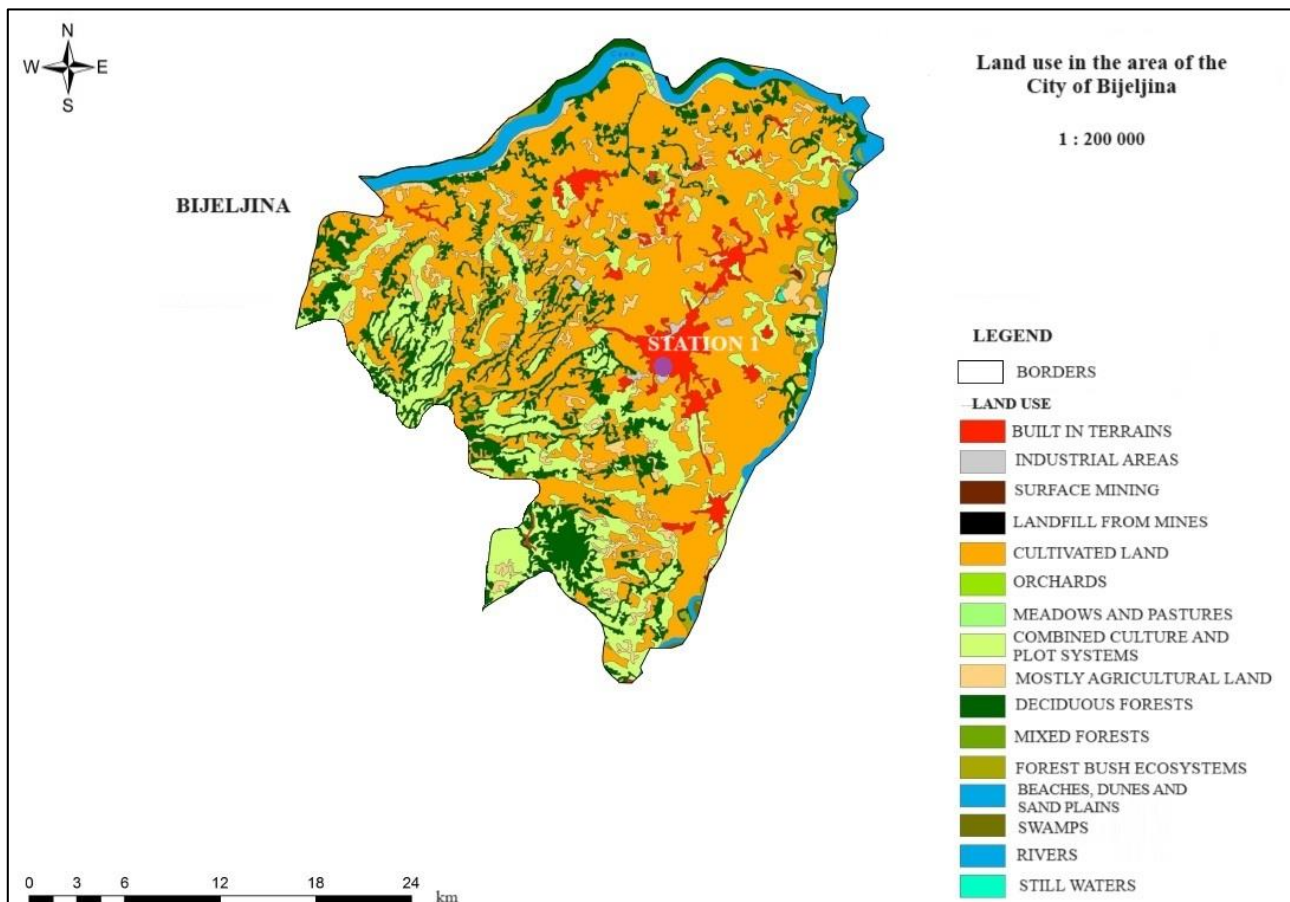


Figure 2 Land use in the area of the City of Bijeljina [2]

Table 2 Recommendations for outdoor activities for wet bulb globe temperature (WBGT) values

	VALUE	DESCRIPTION
Unlimited	< 18	Unlimited
Possible heat stress	18 – 23	Keep alert for possible increases in the index and for symptoms of heat stress
Heat stroke at unacclimated	23 – 28	Active exercise for unacclimatized persons should be limited
Heat stroke at acclimated	28 – 30	Active exercise for all but the well-acclimated should be limited
Activity should be stopped	≥30	All training should be stopped

In this research bioclimatic index Wet bulb globe temperature (WBGT) was used for the presentation of thermal comfort of the area of Bijeljina city. According to National weather service [17] WBGT is a measure of heat stress in direct sunlight, which takes into account: temperature, humidity, wind speed, sun angle and cloud cover (solar radiation). WBGT is commonly used index of heat stress today, especially by military, universities and sports organizations. One of its purposes is to keep people safe while performing outdoor activities at high temperatures.

The period of 19 years, from 2005 to 2023, was analyzed. The weather station from which the data were obtained is located about 1.5 km by air from the city center, at the altitude of around 90 meters [18]. The calculation of this index was done through the program BioKlima 2.6 [19]. This bioclimatic index has 5 categories, divided by the numerical values. The range of all categories, values and recommendations for outdoor activities are presented in table 2 [20].

4. RESULTS

In table 1 are shown all settlements in the City of Bijeljina, their number of inhabitants for the last two Censuses, in 1991 and 2013, and density. In relation to 1991, 24 settlements have higher number of inhabitants, which is a rare example in Bosnia and Herzegovina. Those are: Amajlije, Bijeljina, Velika Obarska, Gojsovac, Golo Brdo, Dazdarevo, Dvorovi, Dijelovi, Janja, Kovanluk, Kojcinovac, Kriva Bara, Ljeskovac, Magnojevic Srednji, Novo Selo, Patkovaca, Popovi, Pucile, Trijesnica, Trnjaci, Cipirovine, Hase i Cardacine. Settlement Slobomir was established in 1996, as a new settlement that according to the last census has 6 inhabitants [1]. The expansion of the settlement is combined with the use value of

the land. On figure 2, it can be seen that cultivated lands are mostly dominant around settlements that record an increase in population

All non-urban settlements, except villages Velika Obarska, that has 393 inhabitants increase and Magnojevic Srednji, that has only 2 inhabitants increase, are located along the main roads. Three directions of urbanization that begin from the Bijeljina settlement, as the central and the biggest one, are present. Those are: Bijeljina – Slobomir, Bijeljina, Dvorovi and Bijeljina – Janja (figure 3).

Bijeljina - Slobomir direction of suburban settlements increase includes: Novo Selo, Dijelovi, Kovanluk, Popovi, Amajlije and Slobomir. Historically, this direction was not attractive before the establishment of the Slobomir settlement, and the connection with Serbia via the Pavlovica bridge, although the villages of Popovi and Amajlije had the status of the wealthiest in Semberija before. Today, here, in addition to numerous business facilities, from megamarkets to universities, there are also refugee settlements in the form of high-rise buildings and apartment blocks. Agriculture continues to play a major role in the development of these places. Tourism also has a major role in the development of this direction. Novo Selo is slowly moving into the suburbs of the city of Bijeljina, where the highest population is inhabited precisely in the part along the border with the city. The transition between the city and other settlements on this path is visible, as there are still many uninhabited parts. This area is not densely populated.

Bijeljina – Dvorovi direction includes the following settlements: Gojsovac, Dvorovi, Dazdarevo, Trnjaci, Kriva Bara and Trijesnica. Dvorovi is one of the richest villages of Semberija, where the Dvorovi Spa complex is located, widely known for its medicinal properties and mineral water [21]. As a settlement today, it consists mostly of house complexes, but also multi-story residential buildings and

numerous business buildings. It is located less than 5 km from the city of Bijeljina and represents one of the settlements that marks the urban development and influx of population from the Bijeljina city. This direction continues towards the border crossing to Serbia, towards Raca border, where the villages of Trijesnica, Dazdarevo, Kriva Bara and Trnjaci connect to Dvorovi. The transition between the city of Bijeljina and the village of Dvorovi is very mild, and there are no uninhabited areas along the main road. As the previous area, this one is still an agricultural area, and also its urbanization is tightly connected with tourism. This area is densely populated.

Bijeljina - Janja direction of suburban settlements increase includes: Patkovaca, Pucile, Ciprovine, Golo brdo, Kovanluk, Ljeskovac, Cardacine, Kojcinovac and Janja. It spreads from the city of Bijeljina to the town of Janja, the only other urban settlement in the researched area. This direction, like the previous one, also represents the common road from the people of the city and their moving to the surrounding areas. The area has a high number of business objects, houses and also multi-story residen-

tial objects. The distance between Bijeljina city and Janja is around 10 km. This direction goes towards the city of Zvornik, however, only part between the Bijeljina city and Janja is densely populated. There is no transition between these two settlements, as all settlements in between are highly populated. This is also an agricultural area, as the previous two, but its population influx is not connected to tourism development.

Unfavorable temperature conditions and the lack of green areas, which lead to unfavorable thermal comfort, affect people's decisions to migrate to suburban and rural settlements. Based on the analysis of meteorological parameters in this area [22], from the station in the Bijeljina city, through the bioclimatic index Wet bulb globe temperature (WBGT), it can be seen that the thermal comfort is unfavorable for the population (figure 4). With the increase in temperature and the passing of winter, the conditions in the city become difficult due to the excessive concentration of concrete in a small area, a large number of vehicles and a lack of greenery. All this leads to the fact that the city itself, and its central core, have a higher tem-

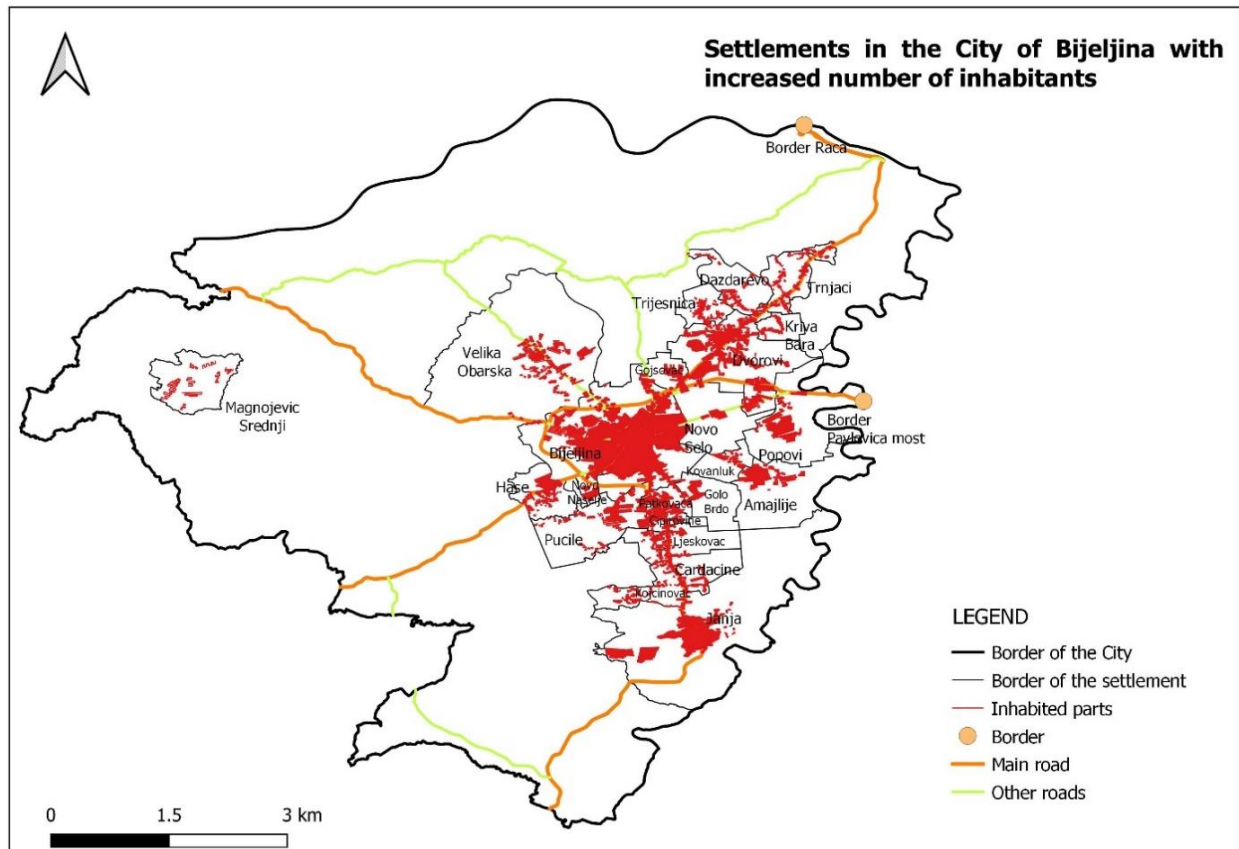


Figure 3 Settlements in the City of Bijeljina with the increased number of inhabitants

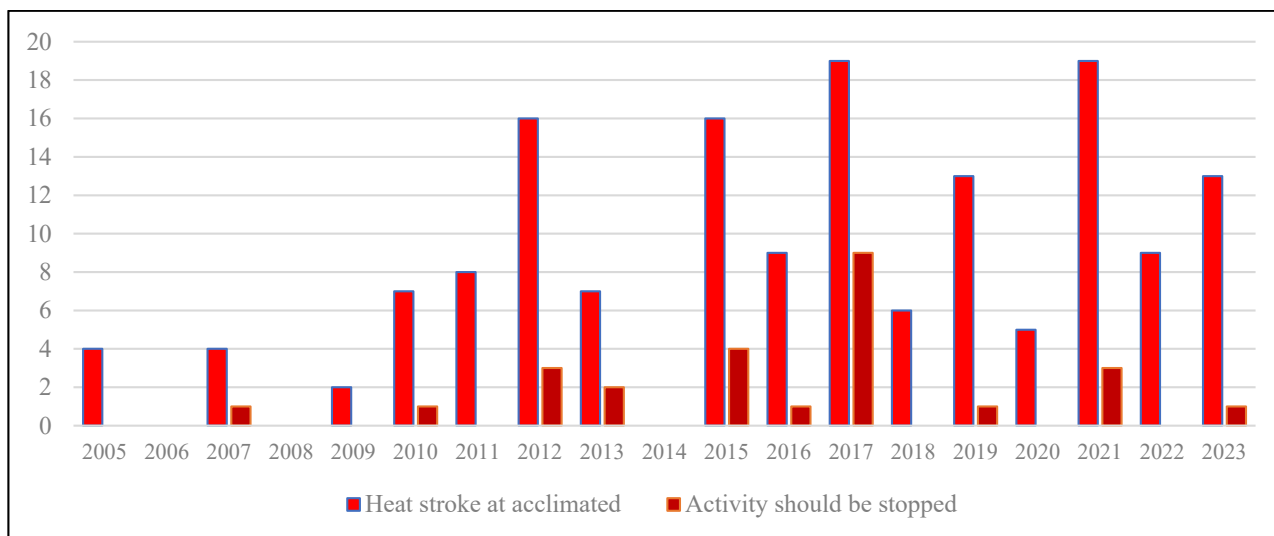


Figure 4 Number of days for the categories Heat stroke at acclimated and Activity should be stopped during months June, July and August for the period 2005 – 2023

perature compared to the surroundings, and due to the lack of vegetation, they have no possibility of cooling down or lowering the temperature, which makes this area scorching during the summer months.

In figure 4 are shown the results, i.e. the number of days within two most dangerous categories for human body, Heat stroke at acclimated and Activity should be stopped. Since 2012 almost every year has a double-digit number of days for both categories together. Number of days in the category Unlimited, which is the most favorable category for thermal comfort and human organism, during summer months in the area of Semberija does not exceed 5 days at best. The exception is the year 2006, for the observed period which had 10 days within this category. Many years had no days in this category. According to this results, Bijeljina city has very unfavorable thermal characteristics that create an unpleasant feeling in human organism and lead to many diseases.

5. CONCLUSION

In this paper are presented settlements that have an increased number of inhabitants, the allocation and migration of inhabitants from urban to suburban and rural settlements and some of the factors that affect this type of change. The factors included are growth of population in Bijeljina city, unfavorable thermal characteristics and use of the land. In addition to the above, numerous other factors have

an impact on the expansion of the city itself, but also the transition from the city to the surrounding areas, especially social elements. However, in this paper, only above mentioned elements are shown, which are the result of the change in natural conditions and the androgenization of space.

People find living in city very hard due to poor natural elements and existing of concrete jungle. Has the modern way of life in urban areas become too difficult for a person, mentally and physically? It is a fact that more and more people are trying to avoid urban areas, retreating to surrounding places that are within reach of the city, that is, their work. In this way, according to new information and trends, people do not have to leave their jobs, and they can live healthier. This is the case with the research area, where people tend to “escape” to surrounding suburban or rural settlements in order to be closer to nature and have a more pleasant environment, but still be close to work.

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РАСТ ПРИГРАДСКИХ ПОВРШИНА ЗБОГ НЕПОВОЉНИХ УСЛОВА У ГРАДУ - СТУДИЈА СЛУЧАЈА ГРАД БИЈЕЉИНА

Сажетак: Ово истраживање обухвата неколико аспеката пресељења становништва из урбаних у приградска и рурална подручја. То укључује пораст становништва у граду што доводи до масовне изградње, повећања броја возила, претварања зелених површина у стамбене, једносратних кућа у вишеспратнице итд. Све наведено је довело до повећања температуре у самом граду и учинило Бијељина је топло острво. Анализирани параметри у овом истраживању били су број становника, коришћење земљишта и топлотни комфор за период од 19 година (2005 – 2023) за летњи период када су температуре највише кроз биоклиматски индекс WBGT. Добијени резултати показују три правца приградског раста и распореда становништва у суседна села. Сва три правца бележе интензиван раст становништва на својим подручјима, уз повећање пословних објеката, док је пољопривреда и даље доминантна као приход становништва у већини села.

Кључне ријечи: урбано, рурално, прилив становништва, термални комфор, WBGT.

Paper received: 3 May 2024

Paper accepted: 17 June 2024



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