# BALNEOLOGICAL CLASSIFICATION OF THERMOMINERAL, THERMAL AND MINERAL WATERS AT THE REGION OF ILIDZA- SARAJEVO AND ITS IMPACT ON TOURISM

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Abstract: The primary purpose of this study was to identify and evaluate the thermomineral, thermal and mineral water sources in the region llidza-Sarajevo, Bosnia and Herzegovina that are used in balneology. The objectives of this study were to: 1) anaylize specific geographic and tourism features of Sarajevo and the region of lidza; 2) present the genesis of thermomineral, thermal and mineral waters in the region; 3) analyse the content- physical and chemical characteristics of the observed waters; 4) classify medicinal waters according 2 basic balenological indicators: TDS and temperature using the contemporary models; 5) identify the hotels with health spa centres and balneology indications. The study found that llidza region is wealth with thermal, thermal and mineral and mineral waters, while the most valuable is Terma, the highly thermal spring; it's also the hottest spot of thermal water at the national level. Thermal wates while the luxury and superior hotels with spa programs for the hearth tourism. This study provided balneological and tourism value of thermal, thermanl, thermanl and mineral waters and their impact on the destination development.

Keywords: thermomineral, thermal and mineral waters, the content, balneological indicators, health tourism, destination development.

#### **1** Introduction

Thermal, thermineral and mineral waters of Sarajevo have been used in balneology since Roman period in Bosnia and Herzegovina (I cent.). The waters were found at the hydrogeothermal region of Ilidza, which is located at southwest of Sarajevo destination. Sarajevo as a tourism destination can be presented as the area of 5 urban municipalities (Stari Grad, Centar, Novo Sarajevo, Novi Grad, Ilidza) with the majority of tourist infrastructure. The region of Ilidza is famous because of the thermomineral water with the highest temperature in the country. Therefore, Ilidza consist many luxurious and superior hotels with spa program and medical spa centre specialized in balneology. Vukajlija (1980) defines balneology (lat. balneum) as the science of mineral waters that are used for the health program- drink and bath. Balneology is the study of medicinal springs and the therapeutic effects of bathing in them (Oxford). Cvorovic (1976) stated that balenological tourism is one of the oldest in the world. Bathing at thermal and thermomineral water, drinking it or inhaling with its vapour on their sources is the therapeutic method old same as the human civilization. Using the thermomineral water for bathing existing since Roman period in Bosnia and Herzegovina and it resulted in building the first settlement known as "Aqua S" at the region of Ilidza (turkish "iladz": spa, cure), Sarajevo (II cent.). The first medical spa centre (Terma) was created during Ottoman period in Bosnia (XVII cent.; the first written sources of spa centre Ilidza come from 1626 year) and it was renovated during Austro-Hungarian period (XIX-XX cent.) when the balneological tourism was blooming, while it was obstructed during the war (1992-1995), but since 2004 it works with full capacity. Therefore, it was necessary to apply the contemporary models of classification medicinal waters and to present physical and chemical characteristics of specific/ observed waters at Ilidza, as well as its balneological indications. This region is mostly recognized by sulphurous thermomineral waters which smell and vapour give a specific note to the environment. The positive trend in tourism of Sarajevo over the last decade was followed with increased interest in spa hotels, while the region of Ilidza was preceded in the number of arrivals and overnight.

### 2 Methodology

There was used a several classificational models to identify and categorize thermomineral, thermal and mineral waters as medicinal waters used in balneology or the health tourism. Models were mostly based on the physical and chemical indicators: total mineralisation, dominant anion or cation, and the temperature (°C), as well as the contemporary standards for

balneological use and treatment. The criteria of mineralisation and temperature enabled divison of underground waters at 4 sections: thermomineral, mineral, thermal and fresh waters (Skopljak, 2006), while the first 3 was the subject of matter. There were applied 3 different criteria for classification of medicinal waters based on their chemical characteristics: a) physiological (Komatina, 2004), b) total chemicalmineralisation (TDS), and c) mineral content (Jonker, 2016) to identify the type of sources at the observed region. For the classification medicinal waters based on their physical characteristics- temperature, 5 criteria of different authors were introduced and applied (Vintras, 1883; Djerkovic, 1971; Komatina, 2004; Spahic, 2005; Karagüle, 2014) to identify and valorisate balneological value of thermomineral waters. The terrain (Ilidza) was visited to observe the existence of tourism capacities and to identify hotels with the spa program, while the informal interview was conducted between the tourists who had their outdoor activites but they generaly stayed at some of the Ilidza hotels, while there were also helpful the previous related findings of corresponding author (Zunic, 2018). The tourism development of Ilidza was measured thrue the statistical indicators (growth of the number of arrivals and overnight stays), while the analysis of the hotel's program and the Ilidza municipality tourism offer resulted in presenting the correlation of tourist interest and health spa centres.

#### Table 1: Water classification according to Skopljak (2006)

	Mineralisation	Temperature
	(TDS mg/l)	(°C)
Thermomineral water	>1000	>12
Thermal water	<1000	>12
Mineral water	>1000	<12
Fresh water	<1000	<12

(Source: Skopljak, 2006)

Table	e 2:	Chemical	classification	of	medicine	waters	based	on
their	phy	siological	properties acco	ordi	ng to Kom	atina (2	.004)	

Туре	Mineralisation (g/l)	Use
Waters elevated mineralisation	1-5 g/l	Consumed drinking
Waters medium mineralisation	5-15 g/l	Suitable for balneology Take in as medicine
Waters high mineralisation	15-35 g/l	Exclusively for bathing purpose
Brines	35-150 g/l	Exclusively for bathing purpose

(Source: Komatina, 2004)

Table 3: Classification of medicinal waters total mineralization according to Jonker (2016)

Type of water	Total dissolved solids (TDS)
Akrato/ Simple thermal water	<1000 mg/l
Oligo-metalliques	700-1000 mg/l
Highly mineral waters	>1000 mg/l
(Source: Jonker, 2016)	

Table 4: Classification of medicinal waters mineral content according to Jonker (2016)

Туре	Calculated as	Criteria
Alkaline (Na-K- bicarbonated) waters	Concentration g/l	≥ 1 g/l total dissolved solid, dominant anion: HCO3
Alkaline (Ca-Mg- bicarbonated) waters	Concentration g/l	≥ 1 g/l total dissolved solid, dominant cations: Ca, Mg

Carbonate waters	Concentration CO2 g/l	dominant anion: HCO3 Containing total carbonate in excess of 300 mg/1 (0.3 g/1) Water
Chloridated, Saline	Concentration NaCl g/l	containing more than 14 g/l sodium chloride (hypertonic) ≥ 1 g/l total dissolved solid, dominant cation: Na dominant anion: Cl
Sulphurous waters	Concentration SO4 g/l	≥ 1 g/l total dissolved solid, dominant anion: SO4
Waters containing Mg	Contribution %	Mg- an equivalent contribution of at least 20%
Waters containing I	Concentration mg/l	> 1 mg/l iodine
Waters containing F	Concentration mg/l	> 2 mg/l fluoride
Waters containing	Concentration	$\geq 5 \text{ mg/l}$
Br Wetere ereteini	mg/1	bromine
waters containing	Concentration	more than 10
Fe Waters containing	mg/1	mg/1 iron
Si	mg/l	70 mg/l H2SiO3
Waters containing As	Concentration mg/l	0.7 mg/l As
(Source: Jonker, 2016)	Ŭ	

Table 5: Classification of temperature thermal and thermomineral waters (°C) according to 5 different authors from the earlier to the contemporary models

the curner	to the conten	portary mout		
1. Vintras, 1883	2. Djerkovic, 1971	3. Komatina, 2004	4. Spahić, 2005	5. Karagülle, 2014
a) Cold <18 b) Warm 18-28 c) Hot 28-36 d) Very hot >36	a) Cold <20 b) Warm 20-35 c) Hot 35-42 d) Very hot >42	a) Cold <20 b) Warm 20-37 c) Thermal 37-42 d) Highly thermal 42-100 e) Super heated >100	a) Hypothermal 20-34 b) Homeothermal 34-38 c) Hyperthermal >38	a) Cold <25 b) Tepid 25- 34 c) Warm 34- 42 d) Hot >42

(Jonker, 2016; Zunic, 2015. Prepared by Authors)

### **3 Results and Discussion**

# 3.1 Geographical and Tourism features of Sarajevo and its region of Ilidza

Thermal, thermomineral and mineral waters are important resources of Sarajevo, the capital of Bosnia and Herzegovina. Sarajevo is located on the southwest of "Sarajevo-Zenica" tectonic basin. This basin is presented with 2 geomorphologic environments: a) internal flat with the Sarajevo field, and b) the mountain surroundings (Trebević, Jahorina, Igman, Bjelašnica, Treskavica and Romanija- Olympic mountains of Sarajevo which belong to Dinaric Alps Mountain range in Europe). Skopljak (2006) stated that thermomineral waters are found only in the hydrogeologic unit of Sarajevo field which belongs to the Ilidza region near Sarajevo. This terrain is located on the southwest of Sarajevo, between the rivers Zeljeznica and Presjenica (SE) and Lepenica (NW). The border on the southwest is presented with mountain Igman up to contact with

Bjelasnica, and it contains area from the source of Presjenica, over the Ravna vala up to the mouth of Krupa- Zujevina, which makes the border on the northwest. The border on the northeast is the river Zeljeznica up to Vojkovici, Stup and Rajlovac. It contains also the area of Butila, Rakovica and Buhotina when it joins the boundary on the northwest. Total area is 250 square km (Skopljak, 2006). Regional tectonic predisposition participated in the genesis of Sarajevo field, while the Busovaca is the fault of central importance. Mineral, thermal and thermomineral waters of Sarajevo are found along the tectonic faults with 2 directions: Sarajevo-Kiseljak-Busovaca and Knezina-Olovo-Orlje. Geological terrain is mostly composed of sediments and volcanic formations, as well as the mesozoic flysch sediments, and the lake sediments and various kenozoic accumulations. Terrain elevation is presented with the hight range from 500 m at Sarajevo field up to 1647 m on the ridge of mt. Igman. The wider area is fluvially shaped with majority of denudational landforms and the possible presence of karst phenomens (e.g. caves, springs), while the central area of the field is typical by fluvial relief (stream channels, floodplains, alluvial fans, or even the specific forms such as "bigar"- tuff from the thermal waters). Sarajevo has a humid climate with warm summer (Köpen: Cfb), and an average temperature is 9.5°C and 932 mm precipitation per year. Sarajevo field is located in the upper Bosnia river basin with its tributaries Zujevina, Zeljeznica, Dobrinja and Miljacka, and it belongs to the Black sea at the higer level of drainage. Djug et al. (2008) stated that majority of water territory belongs to the river Bosnia system, and it has combined a moderate pluvial-nival river regime. The mountain area belongs to the ecosystem of Fagetum and Abies, while the field area contains hygrophile ecosystems of Alnus, Populus and Salix, as well as the mezophille forests of Quercus and Carpinus (Djug et al., 2008). Sarajevo, as the capital, has a favourable geographic, traffic and tourism position, and it's well connected with Europe and the rest of the World, while it's also the part of a very important European tourism corridor which connects the continental Middle Europe and the Mediterranean Europe. Sarajevo has a positive tourist growth over the last decade, but it's stil counted as a "city break destination" because of the shorter overnight stay (less then 3 days). The region of Ilidza is extremely important as the geotraffical nucleus and terminal, while it's also of a great tourism importance because of the rational exploitation of thermomineral waters for the tourist and resident's purpose, and its general natural and cultural attractiviness. There were built a popular hotels and recreativerehab centres, some of them kept authentical style from Austria-Hungarian period in Bosnia and Herzegovina (e.g. lux hotels Austria and Bosnia). Ilidza is one of 5 urban municipalities of Sarajevo, and it has progressive tourism development over the last decade with the preceding participation in the overall tourism growth of Sarajevo.





Figure 1: Physical map of Sarajevo Canton (Source: L. Zunic- ArcGIS)



Figure 2: Location of Sarajevo and its connections with Europe via corridor  ${\sf V}$ 

(Source: Strategies of the Pan-European Transport Corridors and Transport Areas, 2002)

Table 6: Tourist arrivals in the Sarajevo Canton over the last decade 2007-2017

Municipality:	2007 year	2012 year	2017 year
Stari Grad	24682	55193	123211
Centar/ Centre	41531	28800	99361
Novo Sarajevo	21651	40646	40044
Novi Grad	8158	16945	27072
Ilidza	57075	114947	173105
Vogosca	8225	6878	13503
Hadzici		1575	561
Ilijas			
Trnovo	5871	3516	5637
Total	167193	318032	482494

(Source: Institute for planning development of Sarajevo Canton. Prepared by Authors)

Table 7: Tourist overnight stays in Sarajevo Canton from 2007 to 2017 year

Municipality:	2007 year	2012 year	2017 year
Stari Grad	51143	116826	276346
Centar/ Centre	81940	55917	206368

Novo Sarajevo	38587	69052	81952
Novi Grad	16090	28443	40384
Ilidza	105950	206383	320148
Vogosca	21902	20627	26750
Hadzici		3619	1834
Ilijas			
Trnovo	16110	10890	13590
Total	331772	511757	967372
Source: Institute for	nlanning deve	elonment of Sa	raievo Canton

(Source: Institute for planning development of Sarajevo Canton. Prepared by Authors)

According to the governmental statistics (table 6 and 7), Sarajevo destination has a positive tourism growth over the last decade (2007-2017). There was evident a threefold increase in the number of arrivals from 167193 in 2012 year to 482494 in 2017 year, and in the number of overnight stays as well- from 331772 (2012) to 967372 (2017). Municipality Ilidza, which is also the main hydrogeothermal region at Sarajevo and Bosnia and Herzegovina, has the dominant participation in a tourism growth. Ilidza had also an increase in tourist arrivals and overnight stays by three times, while its share in both categories reaches 33.1-35.9%. International make 89.3% of total overnight stays in the destination. According to the Tourism Association of Sarajevo Canton, Sarajevo had more then 1 million overnight stays in the last year (2018: 1.021.452), while the majority of tourists came from Turkey, Croatia, China, U.A.E., Slovenia, Saudi Arabia, Germany, Serbia, USA and Italy. Ilidza, right after the Stari Grad (21.8%), has the highest growth rate in accommodation (number of beds) 19.9% (Tourism of the Sarajevo Canton, Institute for planning development, 2018). The study of Sarajevo tourism (Zunic, 2018) showed that Ilidza experiences a tourist blooming particulary because of the superior and luxurious hotels with spa programs based on thermal waters, but for the other tourism attractiveness of that area as well. Ilidza is a specific region of Sarajevo wealth in ancient culture (e.g. Butmir neolit culture from the 5-th millenum BC), while the first organized settlement "Aqua S." origins from Roman period (II cent.) in Bosnia and Herzegovina was found in this region. Since then the thermal water have been used for balneology purpose and it is nowdays one of the main reason that many arrivals choose this location for their stay. During informal interview, majority of tourists in Ilidza expressed they preferred hotels there because of the spa and medical program.

Table 8: Hotels with the Spa & Wellness Program at the region of Ilidza-Sarajevo

Hotal Spa Cantra	Category	Facilities,
notei, spa Centre	(Stars)	Balneological offer
		Hydrotherapy and
		physical therapy
		(electro therapy,
		magnetic therapy,
		volcanic mud therapy,
1 Hotel Spa		laser therapy, kinesis
Tormo	4	therapy, lymph
Terme		drainage), wellness,
		two indoor swimming
		pools, fitness, saunas,
		massage salons, beauty
		salons, thermal baths,
		solarium, parking
		Wellness and Spa
		center; two indoor
		swimming pool,
2 Hotel Austria		modern fitness center,
and Bosnia	5	sauna, solarium, hot
and Dosma		tubs with natural
		thermal sulphurous
		water; medical
		treatments
<ol><li>Hotel Crystal</li></ol>	4	Wellness & Spa in the
Deluxe	+	hotel Terme
4. Hotel	4	Wellness & Spa in the
Herzegovina	+	hotel Terme

<ol><li>Hotel Oaza</li></ol>	4	Wellness & Spa in the
Resort	4	hotel Terme
		Jetted tub, Saunas
		(Finnish, infrared,
6 Hotel		infragreen and steam),
U. Hollywood"	4	Turkish hammam,
"nonywoou		Relax room, Salt room,
		Water massage,
		Therapeutic massage
		Outdoor and indoor
	4	pools, fast flowing
7 Hotel Hills"		river, massage seats, jet
7. HOLEI "HIIIS - Thormal Diviora		massage, whirlpools,
Thermal Kiviera		water slides,
		trampoline; the wave
		pool
		Spa, fitness and warm
0 H-4-1 M-1-1-		swimming pool,
o. notel Walak	5	Turkish hammam,
Regency		sauna, spacious pool
		and massages

(Source: Strategy of the Ilidza development in 2014-2020; Website of the hotels; Author's terrain observations & data collected at the area of Ilidza)

The table above shows the identified hotels at the region of Ilidza with the spa and wellness program which is based on the thermal waters. All the hotels are private property. The first 5 hotels belong to the same group- Hotels Ilidza (Austria & Bosnia, Spa Terme, Crystal Deluxe, Hercegovina, Oaza Resort-Villas & Apartments), while the other hotels group is presented with 2 hotels, Hollywood and Hills (the hotels groups are under the same management). Some of the hotels were created during Austria-Hungarian period in Bosnia and they are renovated in 2018. For example, hotel Austria & Bosnia- Hotels Ilidza is designed by Chech architect F. Blazek in 1892 and it was also a residental hotel of Austro-Hungarian archduke Franz Ferdinand. Since May 2018 Austria & Bosna Hotel represents an ultimate 5star luxury hotel with the spa offer in Sarajevo. However, the oldest balneological- medical centre is the part of the hotel Terme, and it's known since Ottoman period as the "Banja Terme Ilidza" (Spa Terme Ilidza). Results from the earlier study (Zunic, 2018) showed that hotels of Ilidza has a positive tourism trend followed by the annual growth rate in overnight stays 10-15%. The longest extended-stay guests at the hotels are arrivals from Arab countries (U.A.E., Kuwait, Saudi Arabia, Oman, etc.), some of them stay up to the expiring date of their tourist visa (3 monthes), while the most often guests at this hotels are arrivals from Turkey and then from the region of SE Europe mostly the neighbouring countries (e.g. Croatia, Slovenia) because the competitive price of Bosnian spa centres (qualitative product for the affordable price between the cheapest in the region of SE Europe). Marketing workers from the hotels of Ilidza confirmed that people fly thousand and thousand kilometres to reach the sulphurous water of Sarajevo, while the tour guides in charge for the group of Arab tourists stated they prefer a health spa program and the green surroundings of Ilidza.



Figure 3: Spatial distribution of spa hotels at Ilidza- Sarajevo (Source: Google Earth Maps, Ortophoto ILIDZA, Satellite Imagery)

# **3.2** Genesis of thermal, thermomineral and mineral waters at the region of Ilidza, Sarajevo

Genesis of thermomineral waters in the Sarajevo field is related with areas composed of Triassic carbonate close to the topographic surface or they are covered with thin quaternary deposits. Thermomineral waters at Ilidza are found in carbonates, mostly dolomitic carbonate, dolomite and carbonate from Midd and Upper Triass. It is assumed they were caused by lateral facies changes, or this structure could be the result of complex tectonic followed by differential motion in the zone of Busovaca fault. Triassic carbonates are covered with the gravel layer which has an average thickness of 3-15 m. The northeast area of Saraievo field, between rivers Bosna and Zujevina, is composed of alluvium 2-10 m, while the area of Blazuj, Mostarsko raskrsce and Rakovica has an Upper Creda flysch layer. The area of Butmir, on the profile of Ilidza-Plandiste up to the mouth of river Miljacka into the Bosna and the Rajlovac surroundings, is composed of lake sediments from the Upper Miocene with visible discordant position. The results of isotopic research thermomineral waters in the area of Blazuj, by the German firm "Hydroisotop GmbH", indicated water occurs from the carbonate aquifer with direct or indirect influx of volcanic CO2, the groundwater system was formed in the Pleistocene 10.000 years ago, there was also found young waters at the age of 40, sulphate of mineral waters comes from gypsum-bearing and anhydrite bedrock, while the low radon content indicates that ground waters don't have a direct contact with deposits enriched with uranium (Heidinger, 2000). The fault of Busovaca and its transversal and diagonal geofractures had the key role for the genesis of thermomineral waters. Descending terrain along this fault resulted in forming the horst structure with Sarajevo-Zenica basin. The fault on the southwest separates Igman from Bjelasnica, while the fault of Spring of Bosna- Krupac, on the northeast of Igman, caused the Sarajevo field elevation downfall of 1.000 m. Thermomineral water temperatures are the result of deep infiltration atmospheric waters and geothermal gradient, static pressure in the lenses of permotrias deposits caused by differential motions in the zone of Busovaca fault and the following dynamic factors and ascendation of thermomineral waters thrue the porous rocks on the long distance under the extremely high pressure. Suphurous spring (Terma) at Ilidza was discovered in May 1893, while in August 1894 Professor E. Ludwig from Vienna researched the balenological parameters of water (chemical content, temperature 56.8-57.5°C and stability of water mineralisation). He stated that the water is good not only for bath but for drink as well, because it contains some hydrogen sulphide and a lot of glauber's salt, chloride, bicarbonate calcium and magnesium. Thermomineral waters were also found in recent wells at Ilidza (PP-1, B-3a, IB-1, IB-2, B-10a, IB-10) and Blazuj (P-1, P-2, B-1, F-1, Mratnjevaca, Aqua Vitae- Plandiste). Those waters are similar physicochemical characteristics as Terma and Slana Bara.

Thermal waters were found at wells in Triassic carbonates of Sarajevo field and Hadzici-Rakovica, and their genesis is similar with thermomineral's.

Mineral water sources were found in the area between Vlahovici, Han Ploce and Buhotina, on the northwest slopes of Igman. This terrain is dissected by Lepenica which flows from the southwest to the northeast in its upper area, then the river meanderings and change her direction to the northwest. Furthermore, Busovaca fault follows the course of this river which gets a several streams (tributaries) flowing from the area of Buhotina, Boljkovici and Azapovici. A several sources of mineral water with the lower yield occur in the terrain composed of layers from lower triass covered with alluvium (Boljkovici, Azapovici) or pliocene deposits (Buhotina) (Skopljak, 2006).



Figure 4: Litostratigraphic distribution of aquifers along deepth, hydrogeothermal regions and perspective geothermal zones of Bosnia and Herzegovina

(Source: Miosic, Samardzic and Hrvatovic, 2015)

# **3.3** Identification and classification of thermomineral, thermal and mineral waters at the region of Ilidza- Sarajevo

According to the criteria of underground water classification (table 1), the following tables (9, 10, 11) show division of identified waters at the region Ilidza-Sarajevo into 3 basic groups: thermomineral, thermal and mineral waters whether they're found as springs, sources or wells. Tables also summarize the physical and chemical characteristics of the presented waters.

Table 9: Physico-chemical characteristics of thermomineral sources/ springs in the Sarajevo field: *Terma- Ilidza* and *Slana Bara- Blazui* according to Cerveniak 1984-1985

Spring:	Na	K	Ca	Mg	HCO <sub>3</sub>	$SO_4$	Cl	TDS (mg/l)	t (°C)	
Terma	260	14	470	79.3	1342	500	320	3057	57.5	
Slana bara	110.7	8.5	370	140	1433	385	124	2596	24	

(Source: Skopljak, 2006. Prepared by authors)

Table 10: Physico-chemical characteristics of thermal waters in the Sarajevo field: IB-7 Butmir, IB-4 Sokolovic kolonija, SG-1 Rakovica, "CC Well" Hadzići according to Geoengineering institute of Bosnia and Herzegovina 1987 and Frescenius Germany, 2003

Well:	Na	K	Ca	Mg	HCO <sub>3</sub>	SO <sub>4</sub>	Cl	TDS (mg/l)	t (°C)
IB-7	1.29	1.35	57.6	9.73	170.8	24.69	14.2	294.9	22
IB-4	3.01	-	72.1	23.2	268.8	51	6	424.2	14
CC Well	1.7	0.6	58.2	28	308	4.8	1.3	407	17.5
SG-1	13	17	68	30.2	346	2.8	2.5	461	13.4

(Source: Skopljak, 2006. Prepared by authors)

Table 11: Physico-chemical characteristics of mineral waters in the Sarajevo field: sources Boljkovici, Azapovici and Buhotina according to Health institute of Sarajevo 1976-1977

Source:	Na	Ca	Mg	HCO <sub>3</sub>	$SO_4$	Cl	TDS (mg/l)	t (°C)
Buhotina	25.7	225	121	1295.3	13.4	16.6	1697	10
Boljkovici	2.2	658	144	539.8	1725	10.6	3083	11.5
Azapovici	2.9	622	78.4	586.6	1332	9.40	2639	11

(Source: Skopljak, 2006. Prepared by authors)

According to the classificational model of medicinal waters suitable for treatment by drinking or bathing (table 2), all thermal, thermomineral and mineral waters at Ilidza-Sarajevo are identified as the water elevated mineralization (total mineralisation 1-5 g/l), while their temperature gives them features of balneological waters (as it's mostly above 18°C).

However, Jonker (2016) stated that curative waters are classified according to total mineralization into 3 groups: akrato/ simple, oligo-metallique and highly mineralized. According to the Jonker's classificational model (table 3) which is current generally accepted mineralization standards use in balneology, the identified sources (whether it's springs or wells) at Ilidza-Sarajevo can be divided into 2 basic groups, while there is no oligo-metallique type of medicinal waters:

- a) Highly mineral waters: Terma, Slana Bara; Buhotina, Boljkovici, Azapovici
- b) Akrato/ Simple thermal waters: IB-7, IB-4, CC Well, SG-1

According to the classificational of medicinal waters mineral content (table 4), waters from the section of "highly mineral waters" (2 thermomineral springs and 3 mineral sources) at llidza-Sarajevo can be classified as it follows:

- a) Alkaline waters: Terma, Slana Bara; Buhotina; this responds to Skopljak (2006) determination of "hydrocarbonated-sulphur-calcic-chloridic" type of thermomineral water (Terma) and "hydrocarbonatedsulphur-calcic-magnesyc" type of thermomineral water (Slana Bara), and alkaline waters (Ca-Mg type) which is equivalent to "hydrocarbonated-calcic" type of mineral water (Buhotina)
- b) Sulphurous waters: Boljkovici, Azapovici; this match with Skopljak (2006) identification of "sulphurhydrocarbonated-calcic-magnesyc" type of mineral water (Boljkovici) and "sulphur-hydrocarbonated-calcic" type of mineral water (Azapovici)

Respecting the classificational model based on the temperature of thermal and thermomineral waters (table 5), all sources of thermomineral, thermal and mineral waters at the region Ilidza-Sarajevo can be classified as it follows:

- According to the criteria of Vintras (1883), Djerkovic (1971) and Komatina (2004), there are 2 different types of thermal waters at Ilidza-Sarajevo:
  - a) Warm (Slana Bara and IB-7)
  - b) Very hot (Terma)
  - c) Cold waters (IB-4, CC Well, SG-1, Buhotina, Boljkovici, Azapovici)
- II. According to the criteria of Spahic (2005), there are 2 types of thermal and thermomineral waters in this region:
  - a) hypothermal (source of Slana Bara and water from well IB-7), and
  - b) hyperthermal (spring of Terma).
- III. But, compared to the contemporary critera of Karagülle (2014), almost all determined springs at the region belong to the cold waters, while the only exception is Terma which is recognized as the main source- hot/ highly thermal spring. This is nowdays counted as the basic balneologic classification for medicinal waters (Karagülle & Karagülle, 2014). Jonker (2016) stated that the indicative water temperature for balneology is 50°C. Zunic (2015) stated that termomineral waters with temperature above 58°C in Sarajevo are used for the balneology and other purposes. Miosic, Samardzic and Hrvatovic (2015) stated the spring with the highest temperature (58°C) in Bosnia and Herzegovina is in Ilidža - Sarajevo with total power of all the wells of this deposit of 50 MWt. It proves the Terma's undeniable geothermal capacity and balneological value at the same time.

# 3.4 Valorisation and balneological indications of Ilidza waters

Thermomineral waters at Ilidza carring a huge geothermal potential (Miosic and Hrvatovic, 1999). Valorisation of this waters resulted in a wide application (warming of objects, balneological- spa centres, heating pumps, conservatories, aquaculture, industry, melting the snow, drying fruits and vegetables, etc.). Thermomineral waters at Blazuj has a balneological use as health waters weather for inhaling or the pools or even a drinking waters. Exploitational reserves of thermomineral waters at Blazuj are used for the production of bottled mineral water under the industrial company "Ilidzanski dijamant/ Ilidza Diamond", and this water supply not only domestic but also foreign market (it's exporting good). Thermal waters of Sarajevo field are used for the water supply, bottling and recreation. Thermal water from IB-4 is used for the pools of Ilidza. According to Lund's natatorium design conditions, the water temperature of a different type of pools (recreational, therapeutic, competition, diving, whirlpool/ spa) have a range from 24 to 40°C (Lund, 1996), which means that thermomineral waters at Ilidza (Terma and Slana bara) have a suitable application for any type of indoor pools, while recently found thermal waters (e.g. IB-7 and CC Well) could be used with a simple adaptation by rational heating. Water from CC-Well can be used in a food or water industry or for some other technological process. Mineral waters are mostly used as drinking waters, while the water from the source of Buhotina has the best quality for that purpose. Thermomineral waters with temperature above 58°C in Sarajevo are used for the electricity production, warming, balneology, agriculture, recreation, etc. (Zunic, 2015). Balneological, chemical and physiotherapeutic research showed that thermomineral sulphurous waters from Ilidza are mostly used to the following balenological indications:

- Rheumatic diseases (inflammatory rheumatic disease, rheumatoid arthritis, ankylosing spondylitis (Bechterew's disease and Marie-Strümpell disease), juvenile arthritis, degenerative rheumatism, osteoarthritis, spondylosis, polyarthrose, gonarthrosis, osteoporosis).
- Neurological disease (a condition after stroke, multiple sclerosis, cerebral palsy, neuralgia, painful syndromes of the neck and back, polyradiculopathies, polyneuropathy, disk herniation, sciatic neuralgia).
- Orthopaedic diseases (conditions after illness, injury and surgery of the locomotor system, the postoperative state on the spinal column, the situation after the operation installing hip and knee arthroplasty, meniscus surgery).
- Dermatological diseases (psoriasis, eczema, seborrhoea, dermatitis and others, allergies, acne).
- Urological disease (urogenital diseases, prostate).
- Gynaecological diseases (sterility and non-specific inflammatory diseases of the urogenital tract).
- Metabolic diseases (diabetes, uric acid (gout), metabolic syndrome (obesity).

Program of physical therapy of prevention, treatment and rehabilitation according to the findings, and program recommended by physiatrist:

- Treatment with sulphuric thermal mineral water and mud (mud wraps, pearl bath, medical bath, underwater massage in a mineral water, galvanic bath, Hubbard bath).
- wide selection of traditional and Α modern physiotherapeutic procedures (thermal, electro, helium, sono-thermal, magnets, hydro).

Balneo-physical program include underwater massage in sulphur water, etc. (Program of Treatment and Rehabilitation, Health Spa Terme, Ilidza, Sarajevo)

# 3.4.1 The Spa Park of Ilidza- Sarajevo

The spa park and architectonic monuments with the luxurious hotels concentrated around the thermomineral sources are respresentative health spa complex at the region of Ilidza. It is located at the left bank of the Zeljeznica river with its total area of 14 ha. The perifer area consist the remains of the Roman settlement "Aqua S.", while its central area is represented with the marble fountain surrounded with promenades and grasslands decorated with seasonal flowers. The horticultural conception was made in the neobarok geometric style with the visual effect of the "green carpets" around the fountain and in the front of the hotels. The spa park of Ilidza is the part of the national protected area- Natural Monument of Vrela Bosne/ Springs of Bosnia (Category III of IUCN categorization of protected areas) and it represents its II buffer zone (Hadzidervisagic, 2014). The springs occurs It's connected to it via Velika aleja/ Big Tree Alley of Platanus and Aesculus/ The Great Avenue (3.5 km), which is also an attractive content of the same buffer zone. This site is located in the distance of only 2 km from Sarajevo International Airport and 8 km from the centre. It reflects a touristically liveliness, but it's also one of the favourite recreational area for the residents



Figure 5: The Spa Park Ilidza/ Spa Resort Ilidza- Sarajevo, Bosnia and Herzegovina (Web Gallery of Hotels Ilidza, Sarajevo)



Figure 6: The luxury spa hotel Austria at Ilidza existing more than a century- since 1892 and it was renovated in 2018; the background is presented with a beautiful mountain surrounding of Igman

(L. Zunic's Private collection)



Figure 7: The Great Avenue is an attractive promenade of endemic platanus which connecting the Spa Park Ilidza with the Springs of Bosnia (L. Zunic's Private collection)

# **4** Conclusion

The results of research reveal balneological classification of thermomineral, thermal and mineral waters at the region of Ilidza- Sarajevo and its impact on the tourism development. Ilidza waters at the contemporary balneological models according their physical and chemical characteristics particulary the temperature and the mineral content and total mineralisation, are recognized as water elevated mineralisation with balneological features, while the most valuable is highly mineralised, alkaline and highly thermal spring- Terma. The study explores balneological indications of presented medicine waters and their valorisation thrue the identified spa hotels at Ilidza which is the competitive product of the Sarajevo destination (health & spa tourism). The genesis of thermal, thermomineral and mineral waters showed their occurrence at the surface as springs or sources, while others were recently found at wells mostly along the tectonic fault of Busovaca, reflecting the undeniable geothermal potential of this region. Majority of waters is enriched with sulphur so the site itself behaves like the spa environment with natural inhalation. This paper will help spatial planners to understand contemporary processes at Sarajevo destination that are related to the tourism impact of balneological waters at Ilidza. Balneological use of thermomineral, thermal and mineral waters particulary by the organized form thrue the luxurious spa hotels contributes a lot in the tourism development of Sarajevo which was confirmed by the preceding number of visitors and overnight stays at the area of Ilidza, as well as by the empirical (terrain) findings. The author's informal interaction with the guests/ tourists explored their huge interest in the spa programs and such accommodation. The future studies could focus on finding new sources of thermomineral water and its balneological- tourism exploitation, or how to valorisate the water from recent wells for this purpose? The paper presented the Spa park of Ilidza as the basic balneological site in Sarajevo that could be a popular health tourism destination in Europe because of existing "medicine" waters and the competitive spa offer. Besides, Sarajevo is gaining more attention day by day not only because of the thermomineral resources but its unique attractiveness as the "European Jerusalem". The Sarajevo as a European tourism destination is interesting because of its unique natural and cultural heritage, while the spa centres with an attractive environment near to the city centre present an invaluable tourist treasure. Therefore, the study should initialize interest of foreign investors for the region of Ilidza. The research should also stimulate new ideas of thermomineral water valorisation in the health tourism thrue the creating a wide spectar of spa products as the wellness (which is the part of the health tourism concept) present the new mode of tourism. It's very important to improve and promote the health and spa programs at the highest level because the therapeutic and rehab programs affect longer overnight stays then the simple/ or usual tourist stay in destination. Up to now, Sarajevo has mostly based its tourism product on the multicultural complexity and the mountain surroundings, but it is stil counted as a "city break destination", while by the highlighting the health and spa products we could potentially extend the tourist stay. This paper should awake the new tips for the marketing of Sarajevo as a European health tourism destination. Therefore, the balneological site of Ilidza could become the potential spa European site of tourist gathering.

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#### Primary Paper Section: D

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