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The use of Geothermal Energy Resources in the Tourism Industry of Vojvodina (Northern Serbia)

¹ Nemanja Tomić² Rastislav Stojsavljević³ Igor Stamenković⁴ Dejan Berić¹ University of Novi Sad, Serbia

Faculty of Science, Department of Geography, Tourism and Hotel management, Trg Dositeja

Obradovića 3, 21 000 Novi Sad

E-mail: airtomic@gmail.com

² University of Novi Sad, Serbia

Faculty of Science, Department of Geography, Tourism and Hotel management, Trg Dositeja

Obradovića 3, 21 000 Novi Sad

E-mail: ralegeo87@yahoo.com

³ University of Novi Sad, Serbia

Faculty of Science, Department of Geography, Tourism and Hotel management, Trg Dositeja

Obradovića 3, 21 000 Novi Sad

E-mail: igor.stamenkovic@dgt.uns.ac.rs

⁴ University of Novi Sad, Serbia

Faculty of Science, Department of Geography, Tourism and Hotel management, Trg Dositeja

Obradovića 3, 21 000 Novi Sad

E-mail: bericdejan@gmail.com

Abstract. Exploitation of geothermal energy in Vojvodina is still at an unjustly low level taking into account the abundance of resource locations, some of which are ranked among the most affluent in Europe. Moreover, development of geothermal exploitation started in Serbia at about the same time as in other countries whose geothermal energy facilities are now at the highest technological level and which are leaders in this field. The largest use of geothermal energy in Vojvodina is present in the non-energetic area, especially in spas and sports–recreational centers. Other, seasonal consumers of geothermal energy are from the field of industry and agricultural production where the energy is used for heating of cattle and poultry farms, greenhouses and other facilities. However these consumers use only a small portion of available geothermal resources. The main users are those from the tourism industry. The goal of this paper is to give an overview and an analysis of the use of geothermal energy resources, mainly geothermal waters, in the tourism industry of Vojvodina. It shows how these resources are used and also for what are they used by the tourism industry. The paper covers only geothermal resources that are currently being used by the tourism industry. The potential for future usage in this area is also briefly discussed.

Keywords: Geothermal energy; Thermo-mineral waters; Spa tourism; Vojvodina; Serbia.

1. Introduction

The combined effect of the widespread depletion of fossil fuels and the gradually emerging consciousness about environmental degradation has given priority to the use of conventional and renewable alternative energy sources such as geothermal, wind, hydro, solar and bioenergy sources [1].

Energy sources can be split into three categories: fossil fuels, renewable sources, and nuclear sources [1]. The focus of this paper will be on renewable sources, specifically geothermal energy in the Vojvodina region of northern Serbia. In this paper, an energy resource is considered as renewable if it has two distinctive qualifications. It has to be carbon neutral and it has to be derived from those natural, mechanical, thermal and growth processes that repeat themselves within our lifetime. According to this definition, renewable energy resources include wind, hydro, solar, bioenergy and geothermal energy sources.

Geothermal energy is a domestic resource which contributes to energy security and decreases the trade deficit by displacing imported fuels. It is also environmentally advantageous energy source which produces far less air pollution than fossil-fuel sources. The life of a geothermal resource may be prolonged by re-injecting the waste fluid which is the most common method of disposal [2].

It has been proved that solar thermal and geothermal energy are the strong candidates for future expansions in the hotel sector. Solar PV energy is rather important, while biomass energy presents a poor profile [3].

The last two decades have been characterized by an increased worldwide interest in geothermal energy, the use of which may bring about important savings of other conventional energy resources [4]. About one-third of the geothermal potential of Vojvodina has been exploited. Deep and high-capacity boreholes producing hot waters can be used to provide heat or generate electricity and thus avoid the use of conventional fuels. Currently, however geothermal waters are utilized mostly for other purposes (spas and baths 43.6%; space heating 38.8%; process heating 11.5%; and covered swimming pools 6.1%) [5].

2. Materials and methods

In order to determine the geothermal resource potential in Vojvodina, we relied on a study conducted by the Faculty of Technical Science in Novi Sad along with other expert literature from this area of research. As a main source of data, literature concerning the exploitation of geothermal energy resources in Vojvodina was also used. Based on this data and data that was collected in the field through interviews with spa managers, we were able to present the current state of geothermal energy usage in the tourism industry of Vojvodina. This field base analysis shows the amount of geothermal energy resources that are mostly used by the spa tourism industry of Vojvodina. It also shows for what they are being used as well as the possibilities for future usage.

This research covered only geothermal energy resources in Vojvodina that are currently used in any way by the tourism industry. The research was supposed to determine how are geothermal energy resources currently being used by the tourism industry and which have the largest potential to be taken into account while planning future tourism development. One of the aims is to also show how and for what can these resources be used in the tourism industry by fully exploiting their potential and values, particularly geothermal waters, which represent a very important resource, especially for the spa tourism industry where they can be used as a renewable resource in several ways.

3. Regional settings

The Autonomous Province of Vojvodina is located in the northern part of Serbia, in the Pannonian plain, containing about 27% of its total population according to the 2011 Census. Being an energy-deficient province with limited indigenous reserves of oil and gas, it is heavily dependent on the import of oil which is a serious strain on its economy. This dependence on fossil fuels needs to be addressed in the future because the energetic security of the region hangs on the fragile supply of imported oil that is subject to disruptions and price volatility [6–8]. Hydropower, biomass, biogas, biofuels, wind power, solar energy and geothermal energy are the major resources to provide Vojvodina with most of its renewable energy in the future [9–13].

Serbia has good investment potentials in renewable energy sources such as solar energy, wind and geothermal energy or the hydro-potential of small water courses. The largest reserves perhaps lie in the enormous potential of geothermal resources, biomass and biogas. However, the awareness about this is still not sufficiently developed, and there is an insufficient amount of investment funds to launch an investment cycle in this field, even though, at the same time large foreign currency funds are being spent on imports of the lacking energy [14].

4. Geothermal energy resources in Vojvodina and their exploitation

The territory of Vojvodina is a part of the Pannonian Basin and as such it belongs to the large European geothermal zone which has favourable conditions for research and utilization in the field of geothermal energy. For the time being, hydrothermal energy is being researched and utilized. This concerns thermal waters of natural springs and waters in rocky masses which can be accessed by drilling. In Vojvodina, four hydro geological systems are recognized and classified. Their basic

characteristic are investigated and defined: lithological composition, stratigraphic references, type and quality of rock collectors, temperature and hydro dynamic features, physical and chemical features of thermal and thermo-mineral waters and accompanying released gases [15-17].

The geothermal waters of Vojvodina are rich in gases, mainly methane, which could potentially lead to explosive conditions during their extraction and utilization. The source of the dissolved and freemethane in the Pannonian hotwaters is biogenic, and the gas occurrence is closely related to the geology, the chemical composition and other physicochemical parameters of these waters [18-20]. Since the mixture of methane in air in a confined area may result in an explosion (the explosive range is 5.35–14.90% methane-in air), it is necessary to reduce the methane content to a safe level using an appropriate degasification system before the waters can be utilized [5].

So far, research has been provided at 73 geothermal drills, the deepest was at 2520 m, and the shallowest at 305 m. Some relevant characteristics of geothermal waters in Serbia are:

- drills are mainly self-outflow operated and most frequent water profusion is 10–20 l/s;
- most frequent outflow temperature is 40–60 °C;
- geothermal gradients are 4.5 °C/100 m to 7.5 °C/100 m;
- nearly all waters contain certain quantities of gases, mostly methane;
- waters contain dissolved minerals in the range 0.42–13.94 g/l;
- mineral contents in drills bored for oil and gas are 0.40–40.18 g/l.

Overall heat energy of hydrothermal drills with water cooling up to 15 °C according to information from the year 1997 which included 65 drills was 85,605 kW. Overall heat energy of hydrothermal drills with water cooling to 15 °C which included 65 drills was 85,605 kW. Only 23 of them have been triggered for the production of heat energy [17]. The balneological composition and some physical and chemical characteristics of thermo-mineral waters in Vojvodina are shown in tables 1,2 and 3 [21].

Table 1

Balneological composition of active components of thermo-mineral waters in Vojvodina

Site	Content of balneologically active components (mg/l)					Purpose
	<i>J</i>	<i>Br</i>	<i>F</i>	<i>HBO₂</i>	<i>H₂SiO₃+SiO₂</i>	
Spa Junakovic	6.5	8.1	3.3	60	95	balneo-therapy, heating rooms or greenhouses, sports and recreation, sanitary hot water
Spa Stari Slankamen	2.7	-	-	-	40	balneo-therapy
Spa Vrdnik	-	-	2.5	-	23	balneo-therapy
Spa Rusanda	-	-	-	-	31	balneo-therapy
Spa Kanjiza	0.9	5.1	6.0	47	-	balneo-therapy, heating rooms or greenhouses, sanitary hot water
Iodine Spa Bezdán	<0.1	-	-	-	-	balneo-therapy
Iodine Spa Bečej	-	-	-	42	38	balneo-therapy, sports and recreation
Spa Temerin	-	-	-	-	-	balneo-therapy, sports and recreation

Table 2

Physical and chemical characteristics of thermo-mineral waters in Vojvodina					
Site	Total mineralization (g/l)	Type of water	pH value	Gas composition	Free H ₂ S (mg/l)
Spa Junakovic	6.5	Cl-HCO ₃ -Na	7.4	CH ₄	1.2
Spa Stari Slankamen	6.6	Cl-Na	7.4	N ₂	
Spa Vrdnik	0.9	HCO ₃ -Na-SO ₄	7.5	N ₂	1.4
Spa Rusanda	2.0	HCO ₃ -Na	7.8	CO ₂	
Spa Kanjiza	4.0	HCO ₃ -Na	8.1	CH ₄	6.3
Iodine Spa Bezdán	2.5	HCO ₃ -Na-Cl	7.3	N ₂	
Iodine Spa Bečej	4.7	Cl-HCO ₃ -Na	7.5	CH ₄	1.4
Spa Temerin	3.6	HCO ₃ -Cl-Na	7.8	CH ₄	

Table 3

Physical and chemical characteristics of thermo-mineral waters in Vojvodina					
Site	Drill mark	Water-bearing horizon (m)	Year of drilling	Spring flow (l/s)	Water temperature (°C)
Spa Junakovic	Pb-1/H	596-701	1981	36.6	54
Spa Stari Slankamen	Natural spring	3.5	1876	0.5	19
Spa Vrdnik	Mining shaft	265	1971	22	33
Spa Rusanda	Me-1/H	445-560	1977	10.3	28
Spa Kanjiza	Kz-3/H	1008-1085	1996	16.7	72
Iodine Spa Bezdán	Well	223-301	>1945	1.5	23
Iodine Spa Bečej	Bc-2/H	890-971	1985	15	60
Spa Temerin	Te-1/H	483-603	1984	20	41

The largest use of geothermal energy in Vojvodina is present in the non-energetic area, especially in spas and sports–recreational centres. Other, seasonal consumers of geothermal energy are from the field of industry and agricultural production where the energy is used for heating of cattle and poultry farms, greenhouses and other facilities. However these consumers use only a small portion of available geothermal resources. The main users are those from the tourism industry. According to foreign and domestic experience, it is estimated that the geothermal resources in Vojvodina could also be used for heating of towns and for supplying the population with sanitary warm water. This, however, remains to be done in the future [22,23].

5. The use of geothermal energy in the tourism industry of Vojvodina

As we saw in the previous chapter, the tourism industry is the most common user of geothermal energy in Vojvodina. This energy is most often used in spas, for healing treatments, recreational purposes and for the heating of facilities. The use of geothermal energy for heating hotels, housing or other structures is in the initial stages and very modest considering the availability of resources.

The most important and the largest consumers of energy provided by hydrothermal drills are two spas, "Junakovic" (cca 150,000 m³/a) in Apatin and Spa "Kanjiza" (cca 110,000 m³/a) in Kanjiza. These two spas are the the most popular among tourists in Vojvodina.

In this chapter we will analyze the current use of geothermal resources by the tourism industry. As it was said earlier, spas are the largest consumers of geothermal energy so each spa will be analyzed and discussed along with other locations that possess geothermal energy resources but do not use them to their fullest potential.

5.1 Spa “Kanjiza”

Spa “Kanjiza” is located in the northern part of the Backa region in Vojvodina, near the Tisa River, only 15 km from the border with Hungary. It is one of the largest and most visited spa centres in the region. The healing properties of waters from these parts were known since 1903. The first chemical analyses was done in 1910. By 1913, the city council of Kanjiza founded the spa that still exists today. Today, the healing water is exploited from three artesian wells. Two wells have alkaline waters with a temperature range from 27 °C to 51 °C. The waters of the third well are rich in sodium, hydrocarbonate and sulfide with temperatures from 64 °C to 78 °C. The most important medicinal components in these waters are hydrogen-sulphide (H₂S), carbon-dioxide (CO₂), iodine (J) and flour (F). The waters in this spa are used for the heating of facilities in installations with low temperature regime of work, for balneo-therapy, recreational purposes in swimming pools and for the treatment of rheumatic diseases, diseases and injuries of bones and joints, muscles and nerves. Thermal water has also been installed as sanitary warm disposable water in all rooms used by guests. The total heat power of bores amounts around 2934 t of crude oil. These energy resources are used during the whole year [21, 24].

Because of its special composition, mud (peloid) is also used for healing purposes. Balneo-therapy and thermo-therapy treatments include mineral baths, hydrogalvanic baths, Hauffe baths and mud baths. Also, this spa is the only one in the country that specialises in the method of underwater extension of the spinal column [23].

Other modern therapies like electro-therapy, kinesi-therapy and magneto-therapy are also used, but since they are not mainly based on geothermal resources we will not be discussing them in this paper.

As we can see, geothermal energy resources in Kanjiza are mostly used for healing and recreational purposes and not so much for the heating of facilities. Some spa buildings are heated by thermal water at the moment, but further investments are needed so that all the buildings can be heated this way. The existing three bores give enough amounts of warm water for heating, therapies, bathing and sanitary water in all rooms but their full potential still remains to be completely exploited.

Almost all tourism activity in Kanjiza and the surrounding area is mainly based on geothermal resources. Without them, there would certainly be much less visitors to this area every year. These resources attract tourists and provide the local people with jobs in the tourism industry which is a vital part of the economy in Kanjiza. There are also other attractions in the area so most tourists that come to Kanjiza for treatments, later end up visiting other places in the vicinity therefore having a significant impact on their economy also.

5.2 Spa “Junakovic”

Spa “Junakovic” is a health resort and a sports-recreational centre in the south-west of Vojvodina, 4 km away from Apatin. Thermo-mineral waters in this area have been used since 1913, but the first detailed analysis of the water’s properties was done in 1923. Afterwards, it was established that the waters from these artesian wells belong to the same category as the ones in well known spas, such as Harkany (Hungary), Karlovy Vary (Czech Republic) and Lipik (Croatia).

The alkaline muriatic and iodine waters (34 °C – 60 °C) are used for bathing and healing of the injured and for recreational use by the healthy. From 1977 to 1985 several new wells with thermo-mineral water were drilled. The main well that supplies the spa with its water today is at a depth of 700 meters with a flow of 3000 l/min and water temperature of 51 °C [23,24].

This spa started being widely used after the construction of a modern spa centre in 1983 when the first patients were admitted. Later, in 2000, the new part of the centre was built and it is still used today.

The medical therapies involve healing rheumatism of different origins, orthopedics and neurology diseases, gynecology diseases and diseases of the respiratory tract. Among the complex

of 10 outdoor pools with hot mineral water, a bowling alley and four tennis courts, there is also an indoor therapy pool, two Finnish saunas and a gym. Some of these facilities are still mostly used for healing purposes and treatments but some of them are more and more often used for recreational purposes. The vicinity of the Danube and a few hunting grounds makes this spa also suitable for hunters, fishermen or those that like watersports.

In the last three years an increase in tourists has been noticed. Most of them are families that come with children on weekends during summer months. Most of those families come from other towns that do not have swimming pools or other facilities for recreation so this spa presents their only solution. This is of course beneficial for the local community mainly from the economic point of view. It is easy to conclude that geothermal resources are once again the main base for tourism development in this area. However they are still not used to their full potential. Only a few spa facilities are currently heated by geothermal energy. In the future, this energy could also be used for the heating of hotels like in Kanjiza, but further research and investments are required.

5.3 Spa "Stari Slankamen"

This spa is one of the oldest in Vojvodina. It is located in the southeastern part of the Srem region at the foothills of Fruska Gora Mountain, 55 km from Belgrade. Historic records indicate that the water from this spa was used by Turks during the time of their rule in these parts. After the Turks left, the spa was abandoned until the end of the nineteenth century. The first water analysis was done in 1876, and the first healing centre was built in 1906. The modern era of this spa begins in 1964 with the construction of several buildings [25].

The spa has natural springs with a water temperature of 18.4 °C and it is one of the few places in Vojvodina with salty water. The water from this spa is used for the treatment of central and peripheral nervous system diseases, loco-motor system diseases after injuries or surgery, rheumatic and gynecological illnesses. The use of these waters is limited to healing treatments and recreation since they have lower temperatures and are not suitable for heating [25].

General conditions for the development of spa tourism are good, but a modernization and construction of new facilities is necessary. Since it is right next to the Danube and close to Fruska Gora Mountain, it offers a wide range of other complementary activities for tourists such as boat rides, watersports, fishing, tours of Novi Sad or Sremski Karlovci, tours of Fruska Gora monasteries and tours of the loess-palaeosol sequences which are considered to be among the best in Europe.

5.4 Spa "Vrdnik"

Spa "Vrdnik" is located in the central part of the Srem region in Vojvodina, at the foothills of Fruska Gora Mountain, 210 meters above sea level. It has a moderate continental climate with warm, sunny days. Because of its excellent exposition, Vrdnik has 2200 hours of sunshine annually.

The most important event for the development of this spa was the discovery of coal in these parts and the beginning of its exploitation in 1804. By mid-nineteenth century, the coal mine was expanded and modernised. This started to attract a larger work force from various parts of Europe which helped the further development of the town.

The beginning of healing activities in this area can be traced back to the 1930s when thermal water from beneath the ground penetrated the southern shaft of the mine. The miners soon noticed that longer exposure to these waters has a favorable effect on bone ache and injured tissue so they dug up three small pools and used them as healing baths [25].

The water from this spa belongs to the group of hypothermal waters with a wide range of effects on the human body. It has a constant temperature of 32.5 °C. Pure, unpolluted air with a large quantity of ozone puts this spa in the category of aerial spas as well.

Spa "Vrdnik" is recommended for all forms of rheumatic illnesses, post-operative and post-rheumatic conditions of the locomotive apparatus and the spine, diseases of the peripheral central motor neuron, various painful syndromes, convalescent states, respiratory and gynaecological illnesses, migraines, deformities of the spine and joints, sport injuries, recreation and for the general well-being of the body [26].

Spa visitors can spend their time in an outdoor Olympic-sized swimming pool, indoor swimming pools and saunas, as well as several courts ideal for sports training.

The water in this spa is still mainly used for healing and recreational purposes at the moment. Further studies on other possible uses are needed in the future.

5.5 Spa "Rusanda"

Spa "Rusanda" is the only active spa rehabilitation resort in the region of Banat. It is located on the northern shore of lake Rusanda, in the town of Melenci. Ever since it was founded in 1867, the spa has had the history of rehabilitation based on the healing properties of the mineral peloid (mud), extracted from the lake, being one of the best in the country for its healing properties. The bottom of the lake is covered in an extremely pure, non-organic mud, the scent of which resembles sulphore-hydrate. The lake's water is similar to sea water – it's high in salt and alkaline. There is also a thermo-mineral water well in the spa with a water temperature of 32 °C. The thermo-mineral water, belonging to the category of sodium hydro-carbonate sulphide hemotherms, is used for hydro-therapeutic purposes.

During the 1930s, when it underwent its tourist expansion, the Spa had five hotels and a considerable number of private home accommodation, a well-built infrastructure, a leisure facility and other. In a season which lasted from May until late September, the spa hosted up to 2500 guests. Since then, the spa has been in constant reconstruction and development and has grown into a leading institution in the field of physical medicine and rehabilitation. Its own specialty is the mineral peloid treatment which is, along with thermo-mineral water treatment, successfully used for healing a number of diseases [27, 28].

This spa offers medical treatments of rheumatoid arthritis, degenerative rheumatism (arthritis and spondylosis), extra-articular and metabolic rheumatism (fibrositis, panniculitis and myositis), intervertebral disc conditions and lumbar ischialgia, after-effects of trauma and conditions after bone breakages and bone and joint surgery, skin diseases (psoriasis and chronic eczema) and chronic non-specific gynaecological diseases and infertility.

The rehabilitation process involves the use of different diagnostic and therapeutic procedures, such as kinesiotherapy, hydro-kinesiotherapy, underwater massage, galvanic bath, four cell baths, localised and alternating mineral water baths, occupational therapy, electrotherapy, phototherapy, ultrasound therapy, paraffin therapy, peloidotherapy, neuropsychological rehabilitation, acupuncture and laser and magnetic therapy [28].

The spa is located on flat terrain and is surrounded by a lake, vineyards and a large green belt of parks and forests. Walking paths crisscross the park and there is a complex of sports grounds for football, tennis and small-scale sports nearby. Guests can also visit Bečej and its famous stud farm, the Carska Bara wetlands and the village of Ečka, known for its fishing and hunting grounds.

5.6 Spa "Bezdan"

Bezdan is located on the left bank of the Danube, six kilometres from the Croatian border and 10 kilometres from the Hungarian. The healing effects of water from these parts were discovered in 1912 during the drilling of a local well. Further analysis has shown that the water belongs to the category of alkaline sodium hydro-carbonate waters rich in iodine with temperatures of up to 37 °C. After this discovery, construction lasted for a few decades until finally, it was proclaimed as a natural spa in 1954. Since then, it has been reconstructed a few times and several new buildings were added.

This spa treats all post-traumatic conditions followed by the locomotor system deficiency, conditions after central and peripheral motor neuron lesions, arthritis in rheumatoid stage, functional disorders of joints, joint arthritis, discopathy, spinal disk herniation, post-op and pre-op conditions and radiculopathy [15,29].

The present spa facilities are not meeting the current demand as more and more people visit it every year. Because of this, many patients choose to stay in private homes of the local people therefore stimulating the local tourism industry.

5.7 Spa "Becej"

This spa is located in the town of Becej near the Tisa River. It is well-known for its thermal springs that have been used since 1904 when a famous well driller named Karoly Sos drilled the first geothermal well and built a bath. Analyses performed at that time confirmed that it was a

healing water with iodine, also known as “yellow water”, and the bath was later renamed to Iodine Spa.

Several facilities nearby use the hydro-thermal resources of this spa for different purposes. Together they use a total of cca 100,000 m³ of thermal waters annually for treatments, therapies, recreational purposes and heating.

The spa offers medical treatments of degenerative rheumatism, skin, liver and spleen diseases as well as most stomach related conditions [24].

A new well has been recently drilled and the first results of the water quality tests are excellent. The water temperature is 67 °C, and its quality has also been confirmed by institutes in Sokobanja and Belgrade. The geothermal water from the new well has characteristics that are suitable for the treatment of post-traumatic and rheumatic conditions and skin diseases, psoriasis in particular [17,29].

Future plans for this spa include the construction of a new hotel, wellness and spa center that will employ about 200 people. This complex is expected to be a flywheel for the development of the whole municipality. New guests could be attracted by stories of wells with “yellow water”, which represent one of the greatest symbols of the town and a tourist attraction because of a legend about travelers who stayed forever in Becej after drinking the first glass of “yellow water”.

5.8 Spa “Iodine Spa – Novi Sad”

The waters of Iodine Spa in Novi Sad were discovered in 1897 in the process of drilling an artesian well for the town water supply in the Futoska forest. The drilling process led to the discovery of warm mineral water (24,6 °C) containing iodine. Its beneficial effects were later analyzed and confirmed. This spa is an organized health institution since 1910, when it received the status of a Health Spa. The main secession-style building was constructed upon the initiative of a medical doctor and balneologist, Wilhelm Wilt [30]. The Spa had a permanently employed medical doctor, a specialist in balneology who was also the first manager of the spa, doctor Wilhelm Wilt (1875-1939). At that time, many bathtubs and showers, as well as three pools with hot and cold water were in use. Various therapeutic procedures were employed at the department for physical therapy: electro-therapy, phototherapy, criotherapy, heliotherapy, fungo therapy, as well as massage. Different therapeutic baths were also used: salt-bath, sulphuric bath, carbon and acidic baths, bathing in lather and dry air baths. Today, the spa is visited by patients suffering from rheumatic diseases, neuralgias, painful and swollen rheumatic or traumatized joints, acute and chronic gastric or intestinal catarrh, patients with inflammation of kidneys and patients suffering from obesity related diseases.

5.9 Temerin swimming pools

Temerin has a long tradition of thermo-mineral water use for medicinal purposes. The first well with thermo-mineral water was drilled in 1907. The water from this well was used for healing treatments when the owner of the well turned his own house into the first bathhouse in the area. In 1978, it was closed down because it was considered a fire hazard due to the presence of methane in the water. In 1983, with the initiative of the local population, it was fully reconstructed and renovated with the addition of the swimming pools that are still in use today.

The waters from this area are mildly alkaline and fall within the category of hydrocarbonate-chloride waters with a temperature of 41 °C. These waters are good for treatment of chronic rheumatism, bone injuries and fractures and diseases of the peripheral and central nervous system. They are currently used for bathing and recreation in swimming pools. According to their properties, these waters can be used for sports and recreation, balneological purposes and for heating of buildings within the area [24,29].

Even though the waters of this area are currently mainly used in swimming pools, there is potential for further development. Temerin and its surroundings offer a wide range of tourist attractions and possible activities like hunting and fishing on the Jegricka River. By fully using the geothermal potential of the area, Temerin could develop into a medium-size spa centre in the future.

5.10 Palic swimming pools

The forerunner of spa Palic was a settlement called Palegyhaza, mentioned for the first time in 1462 and later in some Turkish documents in 1582. This place is known as "Spa Palic" since 1782. The first steam bath and hotel were built in 1852. The lake water and mineral waters of this spa were used for healing since 1920s, after the discovery of the waters healing effects on human skin diseases. The possibility of bathing, sunbathing, swimming, rowing, sailing and skating on the frozen lake in winter really transformed this place into a resort and a well known tourist destination. The development of this spa was continued with the construction of a large public bath, sports center, weekend resort, a few big parks and afforestation of the area. After World War I, the big "Men's Beach" was constructed. It was the largest building of its type in former Yugoslavia. In 1950, the famous summer theater was built and the Palic Zoo was also opened. During the 1960s, a sports center with courts for soccer, basketball, volleyball and handball was built.

However, constantly dropping water levels, heat waves and the drainage of sewage from the nearby town of Subotica into the lake, led more and more often to algae proliferation which culminated in 1970. The pollution level was too high and the algae proliferation was uncontrollable which led to oxygen deprivation and the extinction of almost all life in the lake. In 1971, the lake was fully drained and all the polluted mud was removed. A filter for sewage water was constructed in 1976 and the lake was filled with fresh water from the Tisa river.

In 1978, the first thermo-mineral bore was drilled and in 1984 the first thermal swimming pool was opened. The water belongs to the category of sodium, hydrocarbonate, iodine, fluoride, borate and sulphide mineral waters with a temperature of 47.5 °C at the surface and around 63.0 °C at the bottom. The water is medicinal and it affects a wide range of diseases. It can be easily used by drinking where considerable amounts of iodine and fluoride are fully expressed.

Unfortunately, nowadays this spa is very far from being a popular tourism destination as it was in the past when it was among the best spas in the region and it was visited by tourists from entire Europe. The spa lacks modern infrastructure which is strongly needed in order to regain its old glory and status. Currently, the thermo-mineral water is only being used in two thermal pools for bathing during the summer [23, 29, 31].

A spatial plan for the tourism development of this area was made in 2006 but not much has been done to implement it. Some infrastructure has been renovated and a few new objects have been built. One of the main problems is the pollution of the nearby Palic Lake which constantly turns away potential investors. Some action has been taken to clean the lake but it is a very time consuming process with unpredictable results.

One of the main attractions of this area is the electronic music festival "Summer3p" which takes place at the aforementioned thermal swimming pools every year in July. In a visitor survey conducted by the festival staff (2009), the thermal water is one of the main reasons for visiting this event. More than 30% of surveyed visitors said that the unique ambience and the possibility to enjoy the festival programme from the thermal pools both during the day and night is the main reason for visiting this unique event [31].

This spa has much bigger potential and its geothermal resources could very easily be used for heating in already existing hotels and in new hotels that should be built according to the spatial plan. The plan also suggests the construction of a brand new aquapark in the recent future where this water could also be utilized for several purposes. The water boreholes are not very far from these sites and with reasonable investments and some support from the government this water could be used for much more than it is currently.

Bearing in mind the number and capacity of thermo-mineral springs in Vojvodina, as well as the chemical and mineral structure of the water, it can be concluded that the thermo-mineral waters of Vojvodina are not sufficiently exploited. The water could be used for medicinal purposes in a wider scope and in a better way than it has been until now. However, in order to achieve better results, it is necessary to build modern, well equipped spa tourism centers and employ highly professional staff. Thermal water could also be used for sports and recreational tourism activities. This way, spas would also appeal to the younger population and not only the elderly as it is mostly the case today. A larger number of indoor pools and aquaparks would attract numerous young people from the whole country. This idea is supported by several facts. Firstly, the seaside is too far

and too expensive for the majority of the population, while the rivers, lakes and canals are polluted to a considerable extent. Secondly, sports and recreational activities could be performed during the whole year, regardless of the weather, in suitable buildings with thermo-mineral water. Finally, Vojvodina is very well connected by roads and highways with other parts of Serbia and with neighbouring countries which are also potentially big source markets for the spa tourism of Vojvodina.

6. Conclusions

Modern views towards the use of geothermal potentials show an increase in favoring the use of all renewable energy sources, including geothermal waters but they also recognize the need for stricter environmental policies for their utilization.

The final conclusion is that the territory of Vojvodina has geothermal potentials which are respectable from the standpoint of small and medium size consumers. These are not energy sources of great importance for the Province which could have considerable effects on overall energy supply. This does not mean that the Province should not be involved in their inclusion into regular exploitation. On the contrary, each envisaged project of this type should be supported by low interest rates the same as it is done in developed countries for all cases of utilizing so called "green energy".

Unfavorable trends for geothermal energy use are the strict policies regarding the deposition of used geothermal waters. In EU countries, reinjecting the water is regulated by laws and only waters of certain quality can be discharged in rivers or streams. This has already led to certain problems in some countries where farms and greenhouses are put into a difficult position because of this rule. However, the use of geothermal water for several purposes in spa tourism is still able to keep up with the more and more harsh environment protection measures [17].

With a large number of thermo-mineral springs in Vojvodina, the spa tourism industry could become one of the leading income sources for the region, economically benefiting both the public and private sector through tourism. A large part of thermo-mineral resources in Vojvodina is still not used to its full potential from the aspect of the tourism industry. Spa tourism is somewhat developed in Apatin and Kanjiza but it is still far from spas with similar resources located in Hungary and other neighbouring countries. The thermo-mineral waters of Vojvodina offer much possibilities for further development of existing spas and for the development of new spas. The average age limit of the population of Serbia and also other European countries is getting higher and higher. This means that the market demand for spas has been increasing and it will probably continue to increase throughout the future. This is good news for spa tourism which could become one of the leading tourism types in Vojvodina. Such destinations like Palic could restore its forgotten fame and once again attract a large number of tourists from entire Europe. However, this is not easy to do. Much has to be done in the future. With more investments in the spa infrastructure, with better marketing activities and training of highly qualified staff, this type of tourism could largely benefit the economy of the Vojvodina Province and also the economy of the whole country. The natural resources needed for this type of tourism already exist. It is up to the people that manage them to use them in the right way.

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УДК 38

**Использование геотермальных энергетических ресурсов в индустрии туризма
Воеводины (Северная Сербия)**¹ Неманья Томич² Растислав Стойсавльевич³ Игорь Стаменкович⁴ Деян Берич

¹ Университет города Нови Сад, Сербия
2, Трг Доситея Обрабовича, 21 000 Нови Сад
E-mail: airtomic@gmail.com

² Университет города Нови Сад, Сербия
2, Трг Доситея Обрабовича, 21 000 Нови Сад
E-mail: ralegeo87@yahoo.com

³ Университет города Нови Сад, Сербия
2, Трг Доситея Обрабовича, 21 000 Нови Сад
E-mail: igor.stamenkovic@dgt.uns.ac.rs

⁴ Университет города Нови Сад, Сербия
2, Трг Доситея Обрабовича, 21 000 Нови Сад
E-mail: bericdejan@gmail.com

Аннотация. Использование геотермальной энергии в Воеводине все еще находится на незаслуженно низком уровне с учетом изобилия ресурсов местях, некоторые из которых входят в число самых богатых в Европе. Кроме того, развитие геотермальной эксплуатации началась в Сербии примерно в то же время, как в других странах, в которых геотермальные энергетические объекты сейчас находятся на самом высоком технологическом уровне и которые являются лидерами в этой области. Использование геотермальной энергии в Воеводине присутствует и в неэнергетической области, особенно в санаториях и спортивно-оздоровительных центрах. Другие, сезонные потребители геотермальной энергии из области промышленности и сельскохозяйственного производства, где энергия используется для отопления крупного рогатого скота и птицеводческих ферм, теплиц и других сооружений. Однако эти потребители используют лишь малую часть имеющихся геотермальных ресурсов. Основными пользователями являются те, от индустрии туризма. Целью этой статьи является обзор и анализ использования геотермальных источников энергии, в основном, геотермальных вод, в индустрии туризма Воеводина. Он показывает, как эти ресурсы используются и для чего они используются в индустрии туризма. Документ охватывает только геотермальные ресурсы, которые в настоящее время используются в индустрии туризма. Потенциал для дальнейшего использования в этой области также кратко обсуждается.

Ключевые слова: геотермальная энергия; термо-минеральных вод; СПА туризм; Воеводина; Сербия.