GOSPODARKA SUROWCAMI MINERALNYMI – MINERAL RESOURCES MANAGEMENT
2021 Volume 37 Issue 2 Pages 103–124
DOI: 10.24425/gsm.2021.137565

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Review of Polish spas using thermal waters in balneotherapy and healing purposes

Introduction

The use of thermal waters for healing purposes around the world is related to ancient Greek, Roman, Chinese and Middle East cultures. All these cultures recognized thermal waters as a source of health, fitness and strength. Their properties were the subject of research by Aristotle and Hippocrates. Great rulers such as Emperor Hadrian and the Chinese Ming Dynasty used thermal baths to gain power and maintain youthfulness. The history of balneotherapy in Europe is much shorter and dates back to the 14th century, when healing facilities in Italy, Germany and France were constructed. Poland was also at that time famous for spas in Lądek, Cieplice and Iwonicz (Kiełczawa 2016).

Lund and Toth (Lund and Toth 2020) reported that all over the world, total installed capacity of systems using thermal waters for bathing and swimming (including balneotherapy) is approx. 12253 MWt (a 35.1% increase over 2015) and the energy use is approx. 18407 TJ/yr (a 53.9% increase over 2015). However, they underline that not every country collects this

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kind of data and the results can vary up to 20%. The highest usage of energy for recreational and healing purposes were reported in China, Japan, Turkey, Brazil and Mexico (Lund and Toth 2020). Table 1 shows capacity and energy usage of selected European systems using thermal waters for recreation and balneotherapy.

Table 1. Capacity and energy usage of selected European systems using thermal waters for bathing and swimming/recreation (including balneotherapy)

Tabela 1. Łączna moc osiągalna oraz zużycie energii wybranych systemów w Europie, wykorzystujących wody termalne na cele kąpieli i rekreacji (w tym balneoterapii)

Country	Total capacity (MWt)	Energy usage (TJ/yr)	Source
Austria	12.09	316.35	Goldbrunner 2020
Bulgaria	65.69	993.98	Hristov et al. 2020
Czech Republic	4.5	90	Dědeček et al. 2020
France	20.5	187.2	Boissavy 2020
Germany	56.8	1708.56	Weber et al. 2020
Hungary	249	3684	Toth 2020
Iceland	210	3232	Ragnarsson et al. 2020
Italy	456	3501	Bargiacchi et al. 2020
Poland	17.03	137.17	Kępińska 2020
Slovakia	127	1325	Fričovský et al. 2020
Spain	3.8	92	Arrizabalaga et al. 2020
United Kingdom	1	34	Batchelor et al. 2020

Geological and Mining Law (GML 2011) defines term of healing water:

"Article 5

2. Water:
   1) of curative properties means underground water containing no chemical or micro-biological pollutants and having naturally changeable physical and chemical properties, and:
      a) dissolved solid mineral components – not less than 1000 mg/dm^3 or
      b) ferrous ions – not less than 10 mg/dm^3 (ferruginous water), or
      c) fluoride ions – not less than 2 mg/dm^3 (fluoride-containing water), or
      d) iodide ions – not less than 1 mg/dm^3 (iodide-containing water), or
      e) bivalent sulphur – not less than 1mg/dm^3 (sulphur-containing water), or
      f) metasilicic acid – not less than 70 mg/dm^3 (silica-containing water), or
      g) radon – not less than 74 Bq/dm^3 (radon-containing water), or

h) free carbon dioxide – not less than 250 mg/dm^3, provided that from 250 to 1000 mg/dm^3 means carbonic acid-containing water and above 1000 mg/dm^3 acidulous water;

2) of thermal properties means underground water, which is at least 20°C warm at the outlet of the intake."

Thermal waters in Poland have several applications: space heating, bathing and swimming (including balneotherapy), aquaculture and agriculture, geothermal heat pumps. There are six geothermal space heating plants operationg in Poland: the Podhale region, Mszczonów, Poddębice, Pyrzyce, Stargard, Uniejów (Kępińska 2020). Bathing and swimming is another application widely used by spas and recreational centers, which are the subject of this paper. Water for healing purposes is used by some spas as a base for production of natural cosmetics and healing salts (Gargała-Polar et al. 2018). The remaining applications for thermal waters in Poland are: atlantic salmon farm in Janowo (Świątek 2017), experimental algae cultivation in Poddębice, wood drying in MEERI PAS installation in Podhale region (Kępińska 2020), football pitch and walking paths heating in Uniejów (Tyszer et al. 2020).

In order to prove the positive effect of thermal waters on health, different studies are conducted. Rapoliene and Gedrime (2019) carried out a study on 250 volunteers, who took part in hydrotherapy for 2 weeks, in Na-Cl type waters with a temperature of 36°C and mineralization: 20 g/dm^3, 40 g/dm^3, 60 g/dm^3 and tap water. Medical analyses confirmed the positive effect of the treatments on the immune, circulation, digestion systems and fatigue, where the most significant effect was caused by 40 g/dm^3 water, and the longest lasting by 60 g/dm^3 water (Rapoliene and Gedrime 2019).

Thermal waters in Poland occur in the area of four main hydrogeothermal provinces: the Polish Lowlands, the Carpathians, the Carpathian Foredeep and the Sudetes. Thermal water resources in all these zones are highly diversified due to the fact that three large tectonic structures are connected in Poland: the Eastern European Platform (Pre-Cambrian), the Palaeozoic Platform and the Alpine fold zone of southern Europe (Górecki and Hajto ed. 2006a; Kępińska ed. 2017).

The Polish Lowlands is the largest hydrogeothermal province in Poland, and the geothermal resources in its area are found within the Mesozoic formations. The most interesting reservoirs are the Lower Jurassic and the Lower Cretaceous, built of sandstone formations. They are also characterized by parameters that are very favorable for operation. Thermal waters are also found here in the Upper and Lower Jurassic as well as Upper and Lower Triassic; water with lower temperatures but high mineralization also occurs in Devonian and Carboniferous reservoirs (Górecki and Hajto ed. 2006b; Górecki et al. 2014). The most common temperature values range from 20°C to 40°C, in places they are raised to 50°C, while the highest temperatures were tested in the Konin area – they reach 90°C there. Mineralization of the thermal resources of the Lower Cretaceous formations in the Polish Lowlands is highly variable. An increasing trend was observed with increasing depth. The mineralization values range from 1 g/dm^3 to over 100 g/dm^3 (area of the Szczecin basin). Estimated capacities of potential wells may range from below 25 m^3/h to over 300 m^3/h (local).

However, the Podhale Basin presents highest capacity of geothermal wells in Poland and presents a wide usage of thermal water, especially for district heating and recreation (Górecki and Hajto ed. 2006b; Kępińska ed. 2017; Bundschuh and Tomaszewska ed. 2018). Taking Polish experiences of the use of thermal water in spas and as a medicine source into account, the Sudetes region presents especial role. From the geological point of view, it is built by the fractured, crystalline rocks (Dowgiałło 2000a).

When it comes to spas, the current epidemic situation in the world is not without significance. These are facilities whose functioning depends on the number of people suffering from COVID-19 in the country. After the outbreak of the pandemic in Poland, a regulation was issued in March prohibiting the operation of spas (Regulation of HM 2020). In May of the same year, it was replaced with a new one, allowing spas to accept patients who tested negative for COVID-19 (Regulation of CM 2020a). In October 2020, these facilities were closed again (Regulation of CM 2020b), opened in March 2021 again for patients with negative COVID-19 test results (Regulation of CM 2020c) and the current (April 2021), dynamic situation does not make it possible to predict how the spas will operate in the near future.

The paper presents review of the use of thermal waters in different locations for healing purposes in locations with spa status in Poland. For each of the 12 locations, climate, intakes, water parameters and main treatment profiles are described. Information, whether the spa uses thermal healing water for additional purposes, such as supplying graduation towers, crenotherapy or cosmetics production is included. Locations with water parameters suitable for balneology and therapeutic purposes, but without spa status are also pointed.

1. Healing waters resources in Poland

The regionalization of healing waters in Poland relates to the general division of the underground hydrosphere. The very determination of their places of occurrence is not easy, because they are not separated by clear boundaries and can be found in regions that differ from each other in geology. According to Dowgiałło and Paczyński (Dowgiałło and Paczyński 2002), the regional systematics of mineral and healing waters in Poland lists the division into provinces, regions, subregions and areas. The provinces are units of the highest rank and they are: the Precambrian Platform Province, Palaeozoic Platform Province, Sudeten Province, Carpathian Province.

The Precambrian Platform Province contains the least amount of healing, mineral and thermal waters. According to Dowgiałło (Dowgiałło 2007a), the most common are chloride waters, and their mineralization is dependent on the depth of their occurrence and isolation from upper-lying structures.

The Palaeozoic Platform Province's range covers central and north-western Poland, on the western side of the Teisseyre-Tornquist line. As Dowgiałło (Dowgiałło 2007b) states, the current underground waters composition is related to the accumulation of marine sediments. This province is characterized by the presence of saline Zechstein deposits of considerable

thickness. The Mesozoic Lower Cretaceous and Jurassic formations are the main aquifers for mineral and thermal waters. Palaeozoic formations have much weaker reservoir properties. The largest group of mineral and thermal waters are Na-Cl and Na-Ca-Cl waters. Sulphated waters containing H_2S are also among them, but this is the case only under specific lithological conditions, where gypsum and anhydrites are present.

In the Sudeten Province, the tectonic zones in which the groundwater flows have a very important role. It is composed of many dislocated crystalline rocks. As Dowgiałło and Fistek (Dowgiałło and Fistek 2007) state, the characteristic feature here is the almost complete absence of chloride waters and the dominance of the area by thermal and acidulous waters. As Ciężkowski et al. (Ciężkowski et al. 2016) state, due to the construction of the province, it happens that specific mineral waters become contaminated as a result of mixing with non-mineral waters.

Chowaniec et al. (Chowaniec et al. 2007) say that the Carpathian Province consists of three regions where chloride waters are predominant, and there are carbonic, sulphide and thermal waters locally. Difficulties in managing water resources are caused by the coexistence of mineral and non-thermal waters.

2. The use of geothermal waters for healing and balneotherapy purposes in Polish spas

There are 12 locations in Poland where healing thermal waters are used for balneotherapy purposes (Figure 1).

2.1. Busko-Zdrój

Busko-Zdrój is located in the Świętokrzyskie Province. This localization is very advantageous, due to the lack of industrial facilities in the area up to 50 km. The climate of the spa is described as lowland, little stimulus (Kozłowska-Szczęsna et al. 2002). The origins of the spa are related to the 18th century, when the existence of salty and bitter waters was discovered near Busko while searching for rock salt deposits (Gonda-Soroczyńska 2012). The spa developed over the centuries and in 2009, a geothermal well Busko C-1 "Grzegorz" was created to exploit sulphide waters. The Busko C1 borehole is 663 m deep. It extracts water from the Upper Cretaceous deposits (Gała 2013). These are Na-Cl,S,I type waters with a temperature of 25°C and mineralization of approx. 12,4 g/dm^3. The Busko-Północ field is capable of extracting 6 m^3/h of water (Gała 2011; Dendys 2018).

The basic application of healing water from Busko C-1 intake is balneotherapy. It contains iodine, thanks to which water can be used in treatment of respiratory diseases. In addition to the C-1 intake, the spa also uses healing waters from other seven, non-thermal intakes: B-4b, B-8b, B-13, B-16a, B-17, B-20 and B-21 (Lisik and Szczepański 2018).

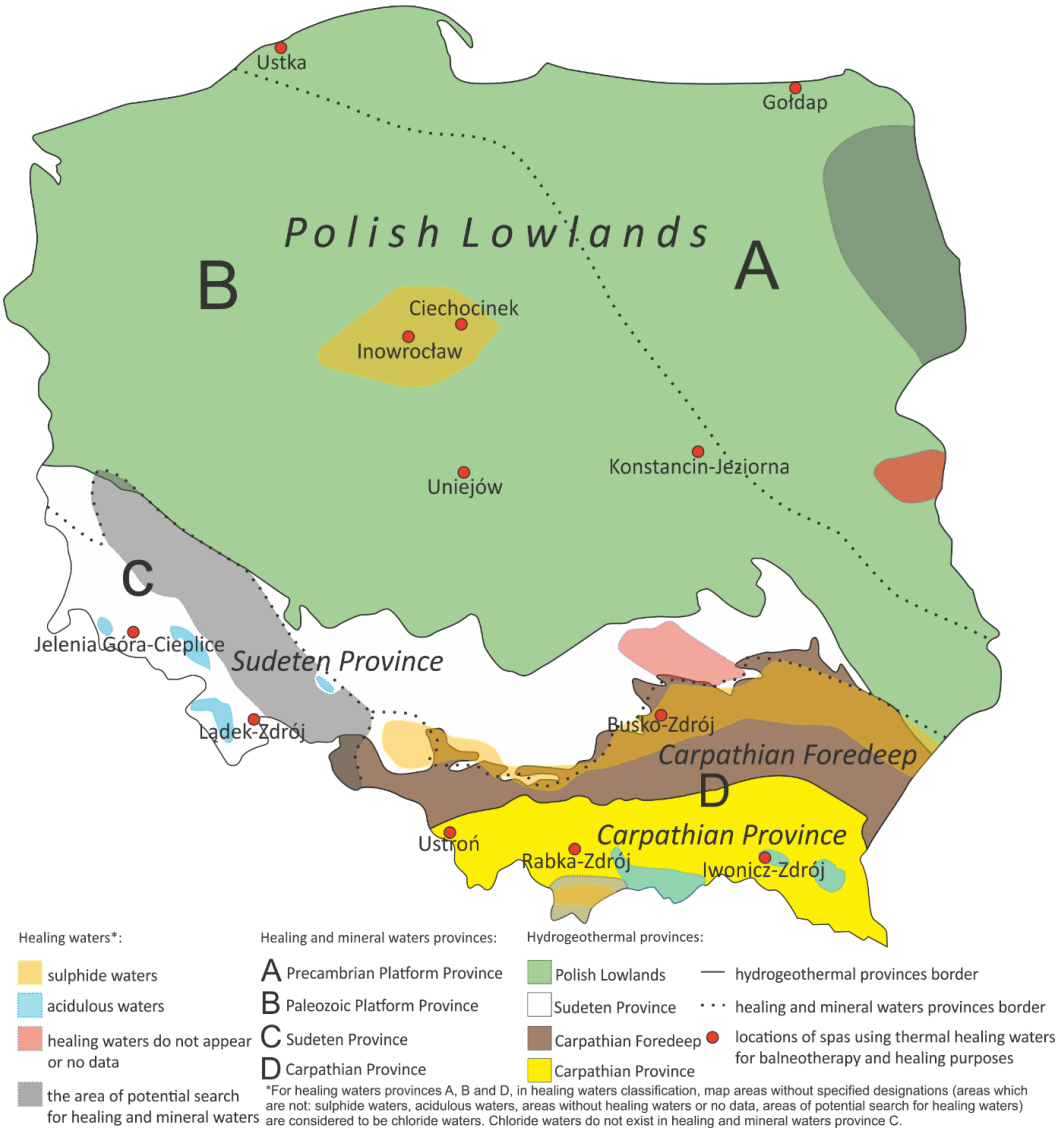

Fig. 1. Map of spas using thermal healing waters for balneotherapy and healing purposes in Poland (based on Dowgiałło and Paczyński 2002; Kępińska ed. 2017)

Rys. 1. Mapa uzdrowisk wykorzystujących termalne wody lecznicze na cele balneoterapii i lecznictwa w Polsce

The main treatment profiles of the Busko-Zdrój health resort are: orthopedic and traumatic diseases, diseases of the nervous system, rheumatology, cardiologal diseases and hypertension, osteoporosis, skin diseases (Barcicki et al. 2017).

2.2. Ciechocinek

Ciechocinek is a town located in the Kuyavian-Pomeranian Province. The climate in Ciechocinek is typically lowland, and the number of days with rainfall or wind is small. Graduation towers, producing a microclimate similar to the sea are characteristic for this spa (Ponikowska and Ferson 2009). Table 2 presents detailed information on the parameters of thermal water intakes in Ciechocinek.

Table 2. Data of thermal water intakes and parameters of thermal waters in Ciechocinek

Tabela 2. Dane dotyczące ujęć wód termalnych oraz parametry wód termalnych w Ciechocinku

Name	Year of production	Depth (m)	Water type	Temperature (°C)	Capacity (m^3/h)	Mineralization (g/dm^3)
Terma 14	1932	757	Na-Cl, I, S	26–28	135	43.5
Terma 16	1952	1 365	Na-Cl, I, Fe	28–32	70	53.4

Source: NIPH-NIH 2008a; Krawiec 2009.

Ciechocinek uses two additional, non-thermal intakes: nr 11 (“Grzybek”) and nr 19a (“Krystynka”) (Krawiec 2009). Therapeutic thermal waters from Ciechocinek are widely used in the treatment of many diseases. According to Felter et al. 2019, the main treatment profiles of this spa are: orthopedic and traumatic diseases, diseases of the nervous system, rheumatology, cardiological diseases and hypertension, diseases of peripheral vessels, upper respiratory tract diseases, diabetes, obesity, osteoporosis, female diseases (treatment of adults and children). In addition to bathing treatments, inhalations (also with a graduation tower) and crenotherapy are also held here. Sludges from the graduation tower are also used for healing purposes (Igliński et al. 2012).

2.3. Gołdap

The relatively young spa of Gołdap (functioning since 2000) is located in Warmian-Masurian Province and its climate is described as lowland and forest (IMWM-SRI 2018). Gołdap Zdrój GZ-1 and Gołdap Zdrój GZ-2 wells were made in 2010, but only GZ-1 contains thermal water with a temperature of 22°C (Felter et al. 2019), total mineralization of 6.3 g/dm^3 and Na-Cl,F type (IMWM-SRI 2018), which is collected from the Middle and Upper Jurassic (646 m deep). The basic application of the GZ-1 water is balneotherapy, it is also used by the graduation tower, thanks to presence of iodine and bromine. GZ-2 intake exploits non-thermal waters from Upper Cretaceous (426 m deep), Na-Cl-HCO_3,F type, with mineralization of 1.4 g/dm^3. Due to lower temperature and mineralization, water from GZ-2

is used as drinking water (GTH 2013; WSCG 2015). The total capacity of both boreholes is 22 m^3/h (SRI-SGI 2019).

The main treatment profiles of this spa are: orthopedic and traumatic diseases, diseases of the nervous system, lower respiratory tract, digestive system, female diseases, rheumatology, cardiologal diseases and hypertension (IMWM-SRI 2018).

2.4. Inowrocław

Inowrocław is located in Kuyavian-Pomeranian Province and its climate is described as lowland. This spa started its activity in the 19th century (Lewandowski 2012). In 2010, the IL-1 Źródło Solankowe intake was created, which extracts water from Jurassic formations from a depth of 495 m. The water is Na-Cl,S type, with mineralization of 13 g/dm^3 and temperature of 23.5°C. In addition to bathing, it is used in graduation towers located in the Inowroclaw Brine Park, due to the presence of iodine (Felter et al. 2019).

The main treatment profiles of this spa are: orthopedic and traumatic diseases, diseases of the nervous system, rheumatology, cardiology and hypertension, diseases of peripheral vessels and the digestive system (ITH 2018).

2.5. Iwonicz-Zdrój

Iwonicz-Zdrój is located in the Podkarpackie Province and its climate is described as sub-mountain (Kalda and Lalicka 2014). Iwonicz-Zdrój exploits two intakes from Lubatówka, which were originally oil wells: Lubatówka 12 with a depth of 1151.5 m and Lubatówka 14, which is 820 m deep. Both intakes contain Na-Cl-HCO_3,I type waters, with mineralization of 17.5–17.7 g/dm^3 (Rajchel et al. 2011) and a temperature of 21–25°C from Eocene sandstones (Chowaniec 2005). A detailed mineral composition of waters from Lubatówka is shown in Table 3. The Iwonicz-Zdrój spa also uses 6 other healing water intakes, but they are not thermal waters (Chowaniec et al. 2016). Waters from Lubatówka 12 and Lubatówka 14 are also used for the production of healing salts and crenotherapy (Kozak 2016; Gargała-Polar et al. 2018).

Table 3. Selected physicochemical parameters of water from the Lubatówka intakes

Tabela 3. Wybrane parametry fizykochemiczne wód z ujęć z Lubatówki

Name	CO_2	Na^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	HCO_3^-	Br^-	I^-
Lubatówka 12	611	6 200	62.8	70.0	7456	0.7	3 428	38.7	16.9
Lubatówka 14	250	6 244	51.7	51.8	7569	1.7	3 364	39.4	18.3

Source: Rajchel et al. 2011.

According to Satora et al. (Satora et al. 2010), the main treatment profiles of this spa are: orthopedic and traumatic diseases, nervous system, rheumatological diseases, diseases of the upper respiratory tract, digestive system, skin diseases, female diseases, obesity, osteoporosis. Additionally, waters from the Iwonicz-Zdrój spa are a base for cosmetics production.

2.6. Jelenia Góra-Cieplice

Jelenia Góra-Cieplice is located in Lower Silesia and its climate is described as sub-mountain (Ponikowska and Ferson 2009). It is considered to be one of the oldest Polish spas, as its history dates back to the 13th century (Jabłonowska and Cieplik 2016). 7 out of 8 intakes exploits low mineral geothermal waters of the Na-Ca-SO_4-HCO_3,F,(Si) type (Kiełczawa and Liber-Makowska 2018). Currently, the exploitation of healing waters is carried out with 5 intakes: C1, C2, Sobieski, Marysieńka, Nowe. The total capacity of Jelenia Góra-Cieplice intakes with healing waters is 56.5 m^3/h (Felter et al. 2019). Table 4. Shows detailed information about the intakes.

Table 4. Data of thermal water intakes and parameters of thermal waters in Jelenia Góra-Cieplice

Tabela 4. Dane dotyczące ujęć wód termalnych oraz parametry wód termalnych w Jeleniej Górze-Cieplicach

Name	Type of intake	Number of intakes	Year of opening	Temperature (°C)	Mineralization (mg/dm^3)
Marysieńka	Well Borehole	1 1	1880/82	21.7	550
Sobieski	Bell-type	1	1929/30	22.2	465
Nowe	Bell-type Borehole	4 1	1929/30	33.3	517
Basenowe Damskie	Bell-type	2	1929/30	40.8	537
Basenowe Męskie	Bell-type	1	1929/30	39.7	538
C-1	Borehole	1	1971/98	86.7	–
C-2	Borehole	1	1972	59.5	535

Source: Igliński et al. 2012.

The C-1 borehole was deepened to 2002.5 m in 1997 (previously it was closed). Its resources and potential were not used for a long time, despite the water temperature of 86.7°C (Dowgiałło 2000b) and the artesian spring with a capacity of 45 m^3/h. Currently, its water is used for bathing and balneotherapy. The thermal spa provides many types of services, including bath tubs, pool baths, inhalations, crenotherapy and eyes rinsing. The main

treatment profiles of this spa are: orthopedic and traumatic diseases, diseases of the nervous system, rheumatology, osteoporosis, diseases of the kidneys and urinary tract, eye and eye appendages (treatment of adults and children) (Grabowska-Szaniec et al. 2018).

2.7. Konstancin-Jeziorna

Konstancin-Jeziorna is located in Masovian Province and its climate is described as lowland (Ponikowska and Ferson 2009). In 1964, Warszawa IG-1 research borehole was created (Areń 1965). Later, it began to be exploited by Uzdrowisko Konstancin-Zdrój. Warszawa IG-1 water is described as Na-Cl, I, Fe type and is extracted from a depth of 1750 m from Lower and Middle Jurassic formations, with temperature of 35°C (Socha et al. 2016; Sowińska ed. 2018) and a mineralization of approx. 75 g/dm^3. According to Barbacki and Bujakowski (Barbacki and Bujakowski 2010), the total capacity of the Warszawa IG-1 intake is 10 m^3/h.

The water from Warszawa IG-1 are supplying the graduation tower and brine pools in Kontancin-Jeziorna (Sowińska ed. 2018). The main treatment profiles of this spa are: nervous and cardiological diseases, hypertension, diseases of the upper respiratory tract (CSO 2011).

2.8. Lądek-Zdrój

The oldest spa in Poland, Lądek-Zdrój, is located in Lower Silesia and its climate is described as mountain (Ponikowska and Ferson 2009). According to Liber 2007, it exploits healing waters from seven intakes: Jerzy, Wojciech, Skłodowska-Curie, Dąbrówka, Chrobry, Stare and L-2 "Zdzisław". The temperature of the waters from these intakes varies from slightly above 20°C in Dąbrówka to 44°C in L-2 "Zdzisław" (Liber-Makowska and Kiełczawa 2017). The total capacity of the intakes is approx. 58 m^3/h (Igliński et al. 2012). Waters from Lądek-Zdrój are low-mineralized, Na-HCO_3,F,Rn,S type, and they contain 7–13 mg/dm^3 of fluoride ion, >1 mg/dm^3 of divalent sulfur and 122–1214 Bq/l of radon (Liber-Makowska and Kiełczawa 2017).

The only application of waters from Lądek-Zdrój is balneotherapy, due to its low temperature. The spa offers a wide range of balneotherapy treatments, such as baths, crenotherapy, mud treatments and radon treatments (Liber 2009). According to information given by CSO 2011, the main treatment profiles of this spa are: orthopedic and traumatic diseases, diseases of the nervous system, rheumatology, peripheral vascular diseases, skin diseases, female diseases, osteoporosis.

2.9. Rabka-Zdrój

Rabka-Zdrój is located in Lesser Poland Province and its climate is described as mountain and semi-mountain (Tokarczyk and Nowak 2013). It is primarily aimed at treating children diseases. It exploits type Na-Cl, I waters from 9 intakes, but only one, Rabka IG-2 contains thermal waters from Upper Cretaceous formations with a temperature of 28°C and mineralization of 26 g/dm^3. It was created in 1981, but began to be used in 2007. The total capacity of all the intakes is approx. 6.47 m^3/h, of which about 4.5 m^3/h is Rabka IG-2's capacity (Rajchel 2009).

Water from the Rabka IG-2 intake is mixed with waters from other intakes. Due to its higher temperature and capacity, it significantly reduces energy usage for heating. Mixed water is used for balneotherapy (baths, inhalations, crenotherapy) and supplying a small graduation tower (Rajchel 2009). It is also used as a base for natural cosmetics production. The main treatment profiles of this spa are: orthopedic and traumatic diseases, rheumatology, cardiology and hypertension, diseases of the upper respiratory tract, lower respiratory tract, skin diseases, diabetes, obesity (treatment of adults and children) (RZTH 2018).

2.10. Uniejów

The youngest of presented spas (got spa town status in 2012), Uniejów, is located in Łódzkie Province. The Uniejów IGH-1 borehole was created in 1978, and in 1990–1991 the PIG/AGH-1 and PIG/AGH-2 boreholes were created as a geothermal doublet. At present, PIG/AGH-2 is an exploitation well, while IGH-1 and PIG/AGH-1 are injection wells. The detailed mineral composition of PIG/AGH-2 water is shown in Table 5 (Latour and Smętkiewicz 2012). Water from PIG/AGH-2 has a temperature of 67°C, a mineralization of approx. 8 g/dm^3 and a capacity of 120 m^3/h. This Na-Cl type water is exploited from approx. 2000 m from the Lower Cretaceous formations (Kurpik 2009).

Since 2001, waters from Uniejów are used for heating purposes in a cascade system. Due to their mineral composition and healing properties, they are also used for healing and balneotherapy purposes in baths and inhalations. In addition, they are a base for the production of hypoallergenic cosmetics (Kaczmarek and Smętkiewicz 2013). The main treatment profiles for this spa are: orthopedic and traumatic diseases, nervous system diseases, rheumatological diseases, peripheral vascular diseases, skin diseases (Sapińska-Śliwa and Kurpik 2011).

2.11. Ustka

Ustka is located in the Pomeranian Province and its climate is described as seaside (Ponikowska and Ferson 2009). In 1979, the Ustka IGH-1 borehole with a depth of 730 m was created (Walkowiak et al. 2017). It extracts Na-Cl, I water with a mineralization of 34 g/dm^3

Table 5. Mineral composition of the PIG/AGH-2 intake water

Tabela 5. Skład mineralny wód z ujęcia PIG/AGH-2

Component	Content (mg/dm^3)	Component	Content (mg/dm^3)
Cations		Anions	
Na^+	2 300	Cl^-	3 686.8
Ca^{2+}	70.14	HCO^{3-}	140.50
Mg^{2+}	25.52	SO_4^{2-}	5.18
K^+	21	F^-	0.65
Sr^{2+}	3.92	J^-	0.42
Li^+	0.201	Br^-	1.8
Fe^{2+}	0.45		
Mn^{2+}	0.05		
Ba^{2+}	0.115		
NH_4^+	0.05		

Source: Latour and Smętkiewicz 2012.

(NIPH-NIH 2008b) and a temperature of 21°C from Permian sandstones and conglomerates. The capacity of this intake is approx. 31 m^3/h (UTH 2019).

Treatments consist of baths and inhalations and the main treatment profiles for this spa are: orthopedic and traumatic diseases, diseases of the nervous system, rheumatology, cardiology and hypertension, diseases of the upper and lower respiratory tract, endocrine diseases, osteoporosis (UTH 2020).

2.12. Ustroń

Ustroń is located in Silesian Province and its climate is described as sub-mountain (Petryszyn and Zuzańska-Żyśko 2009). In 1971–1972, the Ustroń IG-3 (currently named Ustroń U-3) exploration and exploitation well was created. After that, exploration well Ustroń U-3A was created as well. Both the Ustroń U-3 and Ustroń U-3A wells are currently exploring Na-Ca-Cl, I, type waters, with a mineralization of 110–135 g/dm^3 and a temperature varying in range from 18–22°C (it is dependent directly on current exploitation capacity) from Devonian formations lying at a depth of 1320 m. The exploitation of the deposit is carried out at the capacity of 0.6 to 1.2 m^3/h (Rajchel et al. 2007). Those waters contain a large amount of iodine (17–19.9 mg/dm^3 according to Rajchel and Dobrzyński 2017).

The only application for waters from Ustroń is balneotherapy in baths. After using them for healing purposes, they are bacteriologically cleansed and pumped into the Cl injection well (Waligóra and Sołtysiak 2011). The main treatment profiles for this spa are: orthopedic and traumatic diseases, diseases of the nervous system, rheumatology, cardiology and hypertension, diseases of the peripheral vessels, upper and lower respiratory tract, diabetes, obesity, osteoporosis (Gonda and Soroczyńska 2013).

Prospects for the development of balneotherapy and the use of healing properties of thermal waters in other regions of the country

The towns with the greatest potential for the development of treatment with the use of thermal waters, which do not have spa status, are shown in Table 6.

Table 6. Towns with greatest potential for the development of balneotherapy in Poland

Tabela 6. Miejscowości z największym potencjałem rozwoju balneoterapii w Polsce

Town	Temperature (°C)	Mineralization (g/dm^3)	Capacity (m^3/h)	Water type
Celejów	29	45	28	Na-Cl
Cudzynowice	28	15	82	Na-Cl, S, I
Grudziądz	40.5	77.7	20	Na-Cl, I, Fe
Konin	92	150	114	Na-Cl
Koszuty	41	8.2	40	Na-Cl, S
Lidzbark Warmiński	21	21	120	Na-Cl
Pyrzyce	62	116	340	Na-Cl, Fe, I
Skierniewice	57	103	87	Na-Cl, Fe, I, F
Stargard	69	120	200	Na-Cl, I
Tarnowo Podgórne	43	81	225	Na-Cl
Toruń	60	120	320	Na-Cl
Trzęsacz	25	13.5	180	Na-Cl
Zawadka	65	96	60	Na-Cl, I

Source: own study based on (Felter et al. 2019).

The explanatory text to the Map of the underground waters classified as minerals 2018 (Felter et al. 2019) accurately describe the parameters of the intakes in individual cities in Poland. It focuses on information such as temperature, mineralization, water type and well performance, which allows to identify potential places for the development of balneotherapy with the use of thermal waters in Poland. It also gives additional information, such as the current use of these waters. For example, Stargard and Pyrzyce use geothermal water and

energy in a cascade systems. Waters exploited by them have parameters sufficient for use in balneotherapy and healing purposes such as baths and inhalations. The emerging and developing geothermal heat plants in Toruń and Konin also have great potential to use the water for therapeutic purposes in a cascade system (Kępińska 2018; Felter et al. 2019). Grudziądz does not have the status of a spa town, but provides numerous services in the field of balneotherapy, due to great water parameters. It is used to treat skin diseases, musculoskeletal system, respiratory system, and thyroid diseases (Leszczyński ed. 2011).

Conclusions

Thermal waters healing is a piece of Polish culture and history, as the oldest spas such as Lądek-Zdrój, Jelenia Góra-Cieplice and Iwonicz-Zdrój date back to the 14th century and developed alongside spas in other European countries. Since then, balneotherapy was used by magnates, nobility and aristocrats to bring relief of pain, maintain good health and improve mental condition. Over the centuries, healing baths have become widely available for many different social groups. Nowadays, people use them for the same purposes as their ancestors, knowing that balneotherapy is recommended by medicine in the treatment of many diseases and ailments. The awareness that balneotherapy is a fully-fledged branch of medicine reaches an increasing number of people. This is related to the growing popularity of natural healing, which is based only on natural means and methods. Changing eating habits of people is also observed, and more attention is paid to consuming water in its natural form. A healthy, natural lifestyle becomes everyday life, not a compulsion, thanks to which the society is more willing to apply prophylaxis, which can also include balneotherapy treatments. Many spas have modern equipment, allowing for the treatment of early stages of eye diseases, hypertension, locomotor system diseases, post-traumatic rehabilitation and digestive system diseases in a non-invasive way with thermal waters.

New investments in the geothermal energy sector in Poland may bring about the creation of new spas, e.g. in Toruń or Konin, which could be a part of the cascade systems. It is possible that towns such as Skierniewice or Grudziądz will receive the status of spa towns in the near future, thanks to which they will gain more public attention, thus it would be a great development opportunity for them.

When thinking about the development of balneotherapy and the use of thermal waters for therapeutic purposes, one should take the current global (also in Poland) situation related to the COVID-19 pandemic into account. A very dynamically changing situation, constantly changing recommendations and restrictions make normal work impossible for many industries, including spas and recreational facilities. Maintaining and preparing for the opening of this type of facility is very costly, but it is impossible to predict whether it will need to be closed a week later. In addition, the fight against the pandemic consumes huge amounts of public funds that could normally be used for the development of new and already operating facilities. However, there is a possibility that after the pandemic and its consequences have

been mitigated, the spa centers will experience a renaissance caused by the influx of people who are eager for rest and respite.

Part of this study was funded by the Polish National Centre for Research and Development, grant number POLTUR3/Geo4Food/4/2019.

REFERENCES

Areń, B. 1965. Results of Warszawa IG-1 borehole drilling (Wyniki wiercenia Warszawa IG-1). *Przegląd Geologiczny, Geochemia, mineralogia, petrologia* 13(9), pp. 369–372 (*in Polish*).

Arrizabalaga et al. 2020 – Arrizabalaga, I., de Gregorio, M., de Santiago, C., de la Noceda, C., Perez, P. and Urchueguia, J.F. 2020. *Country Update for the Spanish Geothermal Sector, Proceedings, World Geothermal Congress 2020*, Reykjavik, Iceland, 12 p.

Barbacki, A. and Bujakowski, W. 2010. Preliminary identification of thermal water in Warszawa region (*Wstępne rozpoznanie wód termalnych w rejonie Warszawy*) *Technika Poszukiwań Geologicznych, Geotermia, Zrównoważony Rozwój* 1–2, pp. 5–14 (*in Polish*).

Barcicki et al. 2017 – Barcicki, M., Gałuszka, G., Kamińska, W. and Wilk-Grzywna, M. 2017. The functioning and scope of spatial interaction of the „Świętokrzyskie Health-Resorts Cluster" (*Funkcjonowanie i zasięg oddziaływania przestrzennego klastra „Uzdrowiska Świętokrzyskie"*). *Komitet Przestrzennego Zagospodarowania Kraju Polskiej Akademii Nauk* 267, pp. 133–162 (*in Polish*).

Bargiacchi et al. 2020 – Bargiacchi, E., Conti, P., Manzella, A., Vaccaro, M., Cerutti, P. and Cesari, G. 2020. Thermal Uses of Geothermal Energy, Country Update for Italy, Proceedings, *World Geothermal Congress 2020*, Reykjavik, Iceland, 15 p.

Batchelor et al. 2020 – Batchelor, T., Curtis, R. and Busby, J. 2020. Geothermal Energy Use, Country Update for United Kingdom, Proceedings, *World Geothermal Congress 2020*, Reykjavik, Iceland, 10 p.

Boissavy et al. 2020 – Boissavy, C., Schmidlé-Bloch, V., Pomart, A. and Lahlou, R. 2020. France Country Update, Proceedings, *World Geothermal Congress 2020*, Reykjavik, Iceland, 19 p.

Bundschuh, J. and Tomaszewska, B. ed. 2018. Geothermal Water Management, CRC Press/Balkema, Taylor & Francis Group, Boca Raton.

Chowaniec, J. 2005. Groundwater in the south-eastern part of the Podkarpackie Province (*Wody podziemne południowo-wschodniej części województwa podkarpackiego*). *II Konferencja Naukowo-Techniczna „Błękitny San"*, pp. 95–106 (*in Polish*).

Chowaniec et al. 2001 – Chowaniec, J., Poprawa, D. and Witek, K. 2001. Occurrence of thermal waters in the Polish Carpathians (Southern Poland) (*Występowanie wód geotermalnych w polskiej części Karpat*). *Przegląd Geologiczny* 49(8), pp. 734–742 (*in Polish*).

Chowaniec et al. 2007 – Chowaniec, J., Zuber, A. and Ciężkowski, W. 2007. *Carpathian province* (*Prowincja karpacka*) [In:] Paczyński and Sadurski ed. 2007: *Regional hydrogeology of Poland, vol. II, Mineral, healing, thermal and mine waters* (*Hydrogeologia regionalna Polski, tom II, Wody mineralne, lecznicze i termalne oraz kopalniane*). Warszawa: PIG (*in Polish*).

Chowaniec et al. 2016 – Chowaniec, J., Gągulski, T., Gorczyca, G. and Operacz, T. 2016. New data on hydrochemical and isotopic composition of the therapeutic water in the Iwonicz-Zdrój–Rudawka Rymanowska Anticlin (*Nowe dane dotyczące składu fizykochemicznego i izotopowego wód leczniczych antykliny Iwonicza-Zdroju–Rudawki Rymanowskiej*). *Biuletyn Państwowego Instytutu Geologicznego* 466, pp. 43–50 (*in Polish*).

Ciężkowski et al. 2016 – Ciężkowski, W., Kiełczawa, B., Liber-Makowska, E., Przylibski, T. and Żak, S. 2016. Mineral waters of the Sudetic region (SW Poland) – selected problems (*Wody lecznicze regionu sudeckiego – wybrane problemy*). *Przegląd Geologiczny* 64(9), pp. 671–682 (*in Polish*).

CSO 2011 – *Central Statistical Office* (*Główny Urząd Statystyczny*) 2011. *Spa Treatment in Poland in 2000–2010* (*Lecznictwo uzdrowiskowe w Polsce w latach 2000–2010*). Kraków (*in Polish*).

Dědeček et al. 2020 – Dědeček, P., Šafand, J., Tym, A. and Holeček, J. 2020. Czech Republic Country Update 2018, Proceedings, *World Geothermal Congress 2020*, Reykjavik, Iceland, 6 p.

Dendys, M. 2018. *Hydrodynamic conditions of the circulation of thermal and therapeuticgroundwaters in the Cenomanian of the Miechów Troughand the central part of the Carpathian Foredeep* (*Hydrodynamiczne uwarunkowania krążenia wód termalnych i leczniczych w utworach cenomanu Niecki Miechowskiej i środkowej części Zapadliska Przedkarpackiego*). Kraków: MEERI PAS (*in Polish*).

Dowgiałło, J. 2000a. The Sudetic geothermal region of Poland – new findings and further prospects. *Proceedings World Geothermal Congress 2000*, Kyushu–Tohoku, Japan, May 28–June 10, pp. 1089–1094.

Dowgiałło, J. 2000b. Thermal water prospecting results at Jelenia Góra-Cieplice (Sudetes, Poland) versus geothermometric forecasts. *International Journal of Geosciences, Environmental Geology* 39(5).

Dowgiałło, J. 2007a. *Precambrian platform province* (*Prowincja platformy prekambryjskiej*) [In:] Paczyński and Sadurski ed. 2007. *Regional hydrogeology of Poland, vol. II, Mineral, healing, thermal and mine waters* (*Hydrogeologia regionalna Polski, tom II, Wody mineralne, lecznicze i termalne oraz kopalniane*). Warszawa: PIG (*in Polish*).

Dowgiałło, J. 2007b. *Paleozoic platform province* (*Prowincja platformy paleozoicznej*) [In:] Paczyński and Sadurski ed. 2007. *Regional hydrogeology of Poland, vol. II, Mineral, healing, thermal and mine waters* (*Hydrogeologia regionalna Polski, tom II, Wody mineralne, lecznicze i termalne oraz kopalniane*). Warszawa: PIG (*in Polish*).

Dowgiałło, J. and Fistek, J. 2007. *Sudeten province* (*Platforma sudecka*) [In:] Paczyński and Sadurski ed. 2007. *Regional hydrogeology of Poland, vol. II, Mineral, healing, thermal and mine waters* (*Hydrogeologia regionalna Polski, tom II, Wody mineralne, lecznicze i termalne oraz kopalniane*). Warszawa: PIG (*in Polish*).

Dowgiałło, J. and Paczyński, B. 2002. *Regional division of Polish medicinal waters* (*Podział regionalny wód leczniczych Polski*) [In:] *Assessment of available resources of potentially curative waters. Medical handbook* (*Ocena zasobów dyspozycyjnych wód potencjalnie leczniczych. Poradnik medyczny*) (Paczyński B. ed.), Warszawa: PIG, pp. 16–24.

Felter et al. 2019 – Felter, A., Skrzypczyk, L., Socha, M., Sokołowski, J., Sosnowska, M., Stożek, J., Gryszkiewicz, I. and Wrzosek, A. 2019. *Map of underground waters classified as minerals 2018 – explanatory text* (*Mapa Zagospodarowania Wód Podziemnych Zaliczonych do Kopalin 2018 – tekst objaśniający*). Warszawa: PIG-PIB (*in Polish*).

Fričovský et al. 2020 – Fričovský, B., Černák, R., Marcin, D., Blanárová, V., Benková, K., Pelech, O., Fordinál, K., Bodiš, D. and Fendek, M. 2020. Geothermal Energy Use – Country Update for Slovakia, Proceedings, *World Geothermal Congress 2020*, Reykjavik, Iceland, 19 p.

Gała, I. 2011. The preliminary diagnosis and characteristic of thermal sulphide waters in the Busko C-1 borehole (*Wstępne rozpoznanie i charakterystyka siarczkowych wód termalnych w otworze Busko C-1*). *Technika Poszukiwań Geologicznych, Geotermia, Zrównoważony Rozwój* 1–2, pp. 339–347 (*in Polish*).

Gała, I. 2013. Hydrochemical characteristics of sulphide thermal waters in the Busko C-1 borehole (*Charakterystyka hydrochemiczna siarczkowych wód termalnych w otworze Busko C-1*). *Technika Poszukiwań Geologicznych, Geotermia, Zrównoważony Rozwój* 2, pp. 117–125 (*in Polish*).

Gargała-Polar et al. 2018 – Gargała-Polar, M., Pisarek, M., Lichołai, L. and Farajewicz, M., 2018. Land development of the Iwonicz Zdroj spa in tourists and patients‟ opinions, TOPIARIUS. *Landscape studies* 6, pp. 65–79.

GML 2011 – Act of June 9, 2011, Geological and Mining Law (Ustawa z dnia 9 czerwca 2011 r. Prawo geologiczne i górnicze). *Journal of Laws 2011.63.981, as amended* (*in Polish*).

Goldbrunner, J. 2020. Austria – Country Update, Proceedings, *World Geothermal Congress 2020*. Reykjavik, Iceland, 19 p.

Gonda-Soroczyńska, E. 2012. Spa function of a small town on an example of Busko-Zdrój (*Funkcja uzdrowiskowa małego miasta na przykładzie Buska-Zdroju*). *Infrastructure And Ecology Of Rural Areas, Polish Academy of Sciences* 2, pp. 5–16 (*in Polish*).

Gonda-Soroczyńska, E. 2013. The uncommon combination of the curative function with the industrial functions exemplified by the Ustroń Spa (*Nietypowe połączenie funkcji uzdrowiskowej z funkcją przemysłową na przykładzie uzdrowiska Ustroń*). *Infrastructure And Ecology Of Rural Areas* Nr 3/II/2013, pp. 31–46 (*in Polish*).

Górecki, W. and Hajto, M. ed. 2006a. *Atlas of geothermal resources of Paleozoic formations in the Polish Lowlands* (*Atlas zasobów geotermalnych formacji paleozoicznej na Niżu Polskim*). Kraków: WGGiOŚ AGH (*in Polish*).

Górecki, W. and Hajto, M. ed. 2006b. *Atlas of geothermal resources of mesozoic formations in the Polish Lowlands* (*Atlas zasobów geotermalnych formacji mezozoicznej na Niżu Polskim*). Kraków: WGGiOŚ AGH (*in Polish*).

Górecki et al. 2014 – Górecki, W., Sowiżdżał, A., Hajto, M. and Wachowicz-Pyzik, A. 2014. Atlases of geothermal waters and energy resources in Poland. *Environmental Earth Sciences* 74(12).

Grabowska-Szaniec et al. 2018 – Grabowska-Szaniec, A., Walkowiak, K. and Smakulski, J. 2018. Spa survey for the Cieplice Health Resort (*Operat uzdrowiskowy dla Uzdrowiska Cieplice*). Poznań: Eko-log (*in Polish*).

GTH 2013 – Gołdap Town Hall (Urząd Miasta Gołdap). 2013. *Report on the environmental impact of the investment "Exploration and recognition of oil and gas deposits within the Gołdap license"* (*Raport o oddziaływaniu inwestycji na środowisko "Poszukiwanie i rozpoznawanie złóż ropy naftowej i gazu w granicach koncesji Gołdap"*). [Online] http://bip.goldap.pl/files/fck/69/Goldap_raport_tekst.pdf [Accessed: 2021-04-07] (*in Polish*).

Hristov et al. 2020 – Hristov, V., Benderev, A., Stoyanov, N., Antonov, D., Trayanova, M. and Kolev, S. 2020. Geothermal Update for Bulgaria (2014–2018), Proceeding, *World Geothermal Congress 2020*, Reykjavik, Iceland, 11 p.

Igliński et al. 2012 – Igliński, B., Buczkowski, R., Kujawski, W., Cichosz, M. and Piechota, G. 2012. Geoenergy in Poland. *Renewable and Sustainable Energy Reviews* 16, pp. 2545–2557.

IMWM-SRI 2018 – *Institute of Meterology and Water Management – State Research Institute (IMGW-PIB), 2018, Conducting the necessary tests to determine the healing properties of the climate and issuing a certificate confirming the healing properties of the climate for the purposes of preparing a spa survey for the spa in Gołdap* (*Przeprowadzenie niezbędnych badań do ustalenia właściwości leczniczych klimatu oraz wydanie świadectwa potwierdzającego właściwości lecznicze klimatu dla potrzeb sporządzenia operatu uzdrowiskowego dla Uzdrowiska w Gołdapi*). [Online] http://bip.goldap.pl/files/files/operat%20uzdrowiskowy%20cz.3.pdf [Accessed: 2021-03-02] (*in Polish*).

ITH 2018 – Inowrocław Town Hall (Urząd Miasta Inowrocław) 2008. *Spa operator of Inowrocław health resort* (*Operat uzdrowiskowy Uzdrowiska Inowrocław*) (*in Polish*).

Jabłonowska, J.B. and Cieplik, J. 2016. Tourist potential of Cieplice Śląskie-Zdrój health resort in the opinion of foreign patients (*Potencjał turystyczny Uzdrowiska Cieplice Śląskie-Zdrój w ocenie kuracjuszy zagranicznych*), *Europa Regionum* 28.

Kaczmarek, J. and Smętkiewicz, K. 2013. Potential use of geothermal water on the example of Uniejów health-resort (*Potencjał wykorzystania wód termalnych na przykładzie uzdrowiska Uniejów*). *Zeszyty Naukowe. Cieplne Maszyny Przepływowe – Turbomachinery / Politechnika Łódzka* 143, pp. 73–83 (*in Polish*).

Kanda, G. and Lalicka, M. 2014. Resort resources condition and their growth perspectives in Poland (*Stan i perspektywy rozwoju bazy uzdrowiskowej w Polsce*). *Journal of Civil Engineering, Environment and Architecture* 31(61), pp. 85–100 (*in Polish*).

Kępińska, B. ed. 2017. *Geothermal energy – a basis for low-emission heating improving living conditions and sustainable development – preliminary studies for selected areas in Poland* (*Energia geotermalna – podstawa niskoemisyjnego ciepłownictwa, poprawy warunków życia i zrównoważonego rozwoju – wstępne studia możliwości dla wybranych obszarów w Polsce. Raport z wizyt studyjnych*) (*in Polish*).

Kępińska, B. 2018. *A review of geothermal energy uses in Poland in 2016–2018* (*Przegląd stanu wykorzystania energii geotermalnej w Polsce w latach 2016–2018*). *Technika poszukiwań Geologicznych, Geotermia, Zrównoważony Rozwój* 57(1), pp. 11–27 (*in Polish*).

Kępińska, B. 2020. Geothermal Energy Country Update Report from Poland, 2015–2019, Proceedings, *World Geothermal Congress 2020*, Reykjavik, Iceland, 13 p.

Kiełczawa, B. 2016. *Outline of balneotherapeutic use of thermal waters* (*Zarys balneoterapeutycznego zastosowania wód geotermalnych*). Wrocław: WGGiG, Politechnika Wrocławska (*in Polish*).

Kiełczawa, B. and Liber-Makowska, E. 2018. Variability of selected deposit parameters of thermal curative waters from Cieplice (*Zmienność wybranych parametrów ilościowych i jakościowych termalnych wód leczniczych Cieplic*). *Technika poszukiwań Geologicznych, Geotermia, Zrównoważony Rozwój* 57(1), pp. 61–71 (*in Polish*).

Kozak, E. 2016. *Sources of mineral and ordinary waters in the Podkarpackie Province* (*Źródła wód mineralnych i zwykłych w województwie podkarpackim*). Rzeszów: WIOŚ (*in Polish*).

Kozłowska-Szczęsna et al. 2002 – Kozłowska-Szczęsna, T., Błażejczyk, K., Krawczyk, B. and Limanówka, D. 2002. *Bioclimate of polish spas and possibilities of using for healing purposes* (*Bioklimat uzdrowisk polskich i możliwości jego wykorzystania w lecznictwie*). Warszawa: PAN, pp. 45–59 (*in Polish*).

Krawiec, A. 2009. Thermal waters in the vicinity of Grudziądz (*Wody geotermalne w rejonie Grudziądza*). *Technika poszukiwań Geologicznych, Geotermia, Zrównoważony Rozwój* 48(2), pp. 81–88

Kurpik, J. 2009. Use of thermal waters on example of Uniejów (*Wykorzystanie wód geotermalnych na przykładzie Geotermii Uniejów*). *Przegląd Geologiczny* 57(8), pp. 654 (*in Polish*).

Latour, T. and Smętkiewicz, K. 2012. Physical and chemical properties of geothermal waters and their use in medicine with particular focus on well PIG/AGH-2 in Uniejów (*Właściwości fizykochemiczne i chemiczne wód geotermalnych i ich zastosowanie lecznicze ze szczególnym uwzględnieniem wody z odwiertu PIG/AGH-2 W Uniejowie*). *Biuletyn Uniejowski* 1, pp. 79–93 (*in Polish*).

Leszczyński, K. ed. 2011. *Grudziądz IG 1, Profiles of Deep Drilling Holes* (*Grudziądz IG 1, Profile Głebokich Otworów Wiertniczych*). PIG-PIB v. 129 (*in Polish*).

Lewandowski, Ł. 2012. Gardens of the Pontyficial as a complement to the health resort Inowrocław (*Ogrody Papieskie jako dopełnienie programu uzdrowiskowego Inowrocławia*). *Technical Transactions, Architecture* 6-A(19) (*in Polish*).

Liber, E. 2007. Relationships of Lądek Zdrój thermal waters springs (*Współdziałanie pomiędzy źródłami wód termalnych w Lądku Zdroju*). *Prace Naukowe Instytutu Górnictwa Politechniki Wrocławskiej* 33(118), pp. 81–88 (*in Polish*).

Liber, E. 2009. Dewatering characterization of a deep circulation fissure water reservoir exemplified by thermal water deposit in Lądek spa (*Charakterystyka opróżniania zbiornika wód szczelinowych głębokiego krążenia na przykładzie złoża wód termalnych Lądka-Zdroju*). *Biuletyn Państwowego Instytutu Geologicznego* 436, pp. 317–322 (*in Polish*).

Liber-Makowska, E. and Kiełczawa, B. 2017. Characteristics of selected deposit parameters of thermal medicinal waters in Lądek-Zdrój (*Charakterystyka wybranych parametrów złożowych termalnych wód leczniczych Lądka-Zdroju*). *Technika Poszukiwań Geologicznych, Geotermia, Zrównoważony Rozwój* 2, pp. 117–129 (*in Polish*).

Lisik, R. and Szczepański, A. 2018. *Sulphurous therapeutic groundwaters in the part of the Carpathian Foredeep* (*Siarczkowe wody lecznicze w części zapadliska przedkarpackiego cz. 2*). Hydrogeotechnika, Kielce, Kraków (*in Polish*).

Lund, J.W. and Toth, A.N. 2020. Direct Utilization of Geothermal Energy 2020 Worldwide Review, Proceedings *World Geothermal Congress 2020 Reykjavik*, Iceland, April 26–May 2, 2020, pp. 1–39.

NIPH-NIH 2008a – *National Institute of Public Health – National Institute of Hygiene, 2008. CCHP – Certificate confirming healing properties of waters Ciechocinek 14.* [Online] http://www.sanatoriumchemik.pl/solanka.html [Accessed: 2021-03-02] (*in Polish*).

NIPH-NIH 2008b – *National Institute of Public Health – National Institute of Hygiene, 2008. CCHP – Certificate confirming healing properties of waters Ustka IGH-1.* [Online] https://www.ustka.pl/uploads/files/RIE/10_O_Swiadectwo-solanka.pdf [Accessed: 2021-03-02] (*in Polish*).

Paczyński, B. and Sadurski, A. ed. 2007. *Regional hydrogeology of Poland, vol. II, Mineral, healing, thermal and mine waters* (*Hydrogeologia regionalna Polski, tom II, Wody mineralne, lecznicze i termalne oraz kopalniane*). Warszawa: PIG (*in Polish*).

Petryszyn, J. and Zuzańska-Żyśko, E. 2009. Stages of economic and spatial development in Ustroń (*Etapy rozwoju gospodarczego i przestrzennego Ustronia*). *Geographia. Studia et Dissertationes* 31, pp. 127–145 (*in Polish*).

Ponikowska, I. and Ferson, D. 2009. Modern spa medicine (*Nowoczesna medycyna uzdrowiskowa*). Warszawa: MediPress (*in Polish*).

Ragnarsson et al. 2020 – Ragnarsson, A., Steingrímsson, B. and Thorhallsson, S. 2020. Geothermal Development in Iceland 2015–2019, Proceeding, *World Geothermal Congress 2020*, Reykjavik, Iceland, 14 p.

Rajchel, L. 2009. Occurrences and utilization of chloride waters in Rabka-Zdrój (*Występowanie i wykorzystanie wód chlorkowych Rabki-Zdroju*). *Geologia* 35(2/1), pp. 271–278 (*in Polish*).

Rajchel, L. and Dobrzyński, D. 2017. Iodide waters of the polish Carpathians (*Wody jodkowe Karpat polskich*). *Acta Balneol* 4(150), pp. 354–359 (*in Polish*).

Rajchel et al. 2007 – Rajchel, L., Śliwa, T. and Waligóra, J. 2007. Remarks about Mecidinal Waters of Ustroń (*Uwagi o wodach leczniczych Ustronia*). *WPH* 13 (*in Polish*).

Rajchel et al. 2011 – Rajchel, L., Czop, M., Motyka, J. and Rajchel, J. 2011. Chemistry of the mineral and therapeutic waterfrom Iwonicz–Rymanow region (Carpathian Mountains, south Poland) (*Skład chemiczny wód mineralnych i leczniczych rejonu Iwonicza i Rymanowa*). *Biuletyn Państwowego Instytutu Geologicznego* 445, pp. 549–560 (*in Polish*).

Rapoliene, L. and Gedrime, L. 2019. Geothermal water for health state improvement: randomised controlled study. *Balneo Research Journal* 10(2).

Regulation of CM 2020a – *Regulation of the Council of Ministers of May 29, 2020 on the establishment of certain restrictions, orders and bans in connection with an epidemic (Journal of Laws 2020.964)* (*Rozporządzenie Rady Ministrów z dnia 29 maja 2020 r. w sprawie ustanowienia określonych ograniczeń, nakazów i zakazów w związku z wystąpieniem stanu epidemii (Dz.U. 2020 poz. 964)*). [Online] https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20200000964/O/D20200964.pdf [Accessed: 2021-04-07] (*in Polish*).

Regulation of CM 2020b – *Regulation of the Council of Ministers of October 23, 2020 amending the regulation on the establishment of certain restrictions, orders and bans in connection with an epidemic (Journal of Laws 2020.491)* (*Rozporządzenie Rady Ministrów z dnia 23 października 2020 r. zmieniające rozporządzenie w sprawie ustanowienia określonych ograniczeń, nakazów i zakazów w związku z wystąpieniem stanu epidemii (Dz.U. 2020 poz. 1871)*). [Online] https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20200001871/O/D20201871.pdf [Accessed: 2021-04-07] (*in Polish*).

Regulation of CM 2020c – *Regulation of the Council of Ministers of February 11, 2021 amending the regulation on the establishment of certain restrictions, orders and bans in connection with an epidemic (Journal of Laws 2021.267)* (*Rozporządzenie Rady Ministrów z dnia 11 lutego 2021 r. zmieniające rozporządzenie w sprawie ustanowienia określonych ograniczeń, nakazów i zakazów w związku z wystąpieniem stanu epidemii (Dz.U. 2021 poz. 267)*). [Online] https://dziennikustaw.gov.pl/D2021000026701.pdf [Accessed: 2021-04-07] (*in Polish*).

Regulation of HM 2020 – *Regulation of the Minister of Health of March 20, 2020 on announcement the state of epidemic within the Republic of Poland (Journal of Laws 2020.491)* (*Rozporządzenie Ministra Zdrowia z dnia 20 marca 2020 r. w sprawie ogłoszenia na obszarze Rzeczypospolitej Polskiej stanu epidemii*). [Online] https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20200000491/O/D20200491.pdf [Accessed: 2021-04-07] (*in Polish*).

RZTH 2018 – *Rabka-Zdrój Town Hall* (*Urząd Miasta Rabka-Zdrój*), 2018. *Development plan of Rabka-Zdrój spa for 2016–2023* (*Plan rozwoju uzdrowiska Rabka-Zdrój na lata 2016–2023*). Kraków: Pro Regio Consulting (*in Polish*).

Sapińska-Śliwa, A. and Kurpik, J. 2011. Current management of water and geothermal heating Uniejów (*Aktualne zagospodarowania wody i ciepła geotermalnego w Uniejowie*). *Technika Poszukiwań Geologicznych, Geotermia, Zrównoważony Rozwój* 1–2, pp. 225–234 (*in Polish*).

Satora et al. 2010 – Satora, S., Chmielowski, K. and Wałęga, A. 2010. Balneological usage of the groundwater in the selected regions of South Poland (*Balneologiczne wykorzystanie wód podziemnych w wybranych rejonach Polski południowej*). *Acta Scientarium Polonorum, Formatio Circumiectus* 9(4), pp. 43–53 (*in Polish*).

Socha et al. 2016 – Socha, M., Skołowski, J., Felter, A. and Stożek, J. 2016. Occurrence of thermal waters in the area of Warsaw agglomeration with a preliminary assessment of the possibility of their management (*Charakterystyka występowania wód geotermalnych w rejonie aglomeracji warszawskiej oraz wstępna ocena możliwości ich zagospodarowania*). *Technika Poszukiwań Geologicznych, Geotermia, Zrównoważony rozwój* 2, pp. 17–30 (*in Polish*).

Sowińska, M. ed. 2018. Our spas. The magazine of Polish spas (*Nasze zdroje. Magazyn uzdrowisk polskich*). *Zakład Leczniczy „Uzdrowisko Nałęczów" SA*. [Online] https://uzdrowisko-konstancin.pl/nasze-zdroje/nr1.pdf [Accessed: 2021-03-02] (*in Polish*).

SRI-SGI 2019 – Balance of mineral deposit resources at 31 December 2019 (*Bilans zasobów złóż kopalin w Polsce wg stanu na 31 XII 2019 r.*), Warszawa: PIB-PIG (*in Polish*).

Świątek, L. 2017. The City Aquaculture – capital and knowledge integration model in municipal development – Nature 4.0 (*Akwakultura Miejska – model integracji kapitału i wiedzy w przestrzeni komunalnej – Natura 4.0*). *Przestrzeń – Urbanistyka – Architektura*, pp. 318–327 (*in Polish*).

Tokarczyk, N. and Nowak, A. 2013. Evaluation of the balneological potential of selected health resorts in Polish Carpathians (*Ocena potencjału balneologicznego wybranych uzdrowisk Polskich Karpat*). *Problemy Ekologii Krajobrazu, Rekreacja w krajobrazach o wysokim potencjale* 34, pp. 231–237 (*in Polish*).

Toth, A.N. 2020. Country Update for Hungary, Proceedings, *World Geothermal Congress 2020*, Reykjavik, Iceland, 10 p.

Tyszer et al. 2020 – Tyszer, M., Bujakowski, W., Tomaszewska, B. and Bielec, B. 2020. Geothermal Water Management Using the Example of the Polish Lowland (Poland) – Key Aspects Related to Co-Management of Drinking and Geothermal Water, MDPI, *Energies* 13, 2412.

UTH 2019 – Environmental Protection Program for the Municipality of the City of Ustka for 2019–2022 with a view to 2026 (*Program Ochrony Środowiska dla Gminy Miasto Ustka na lata 2019–2022 z uwzględnieniem perspektywy do 2026 roku*). Ustroń: Eko-precyzja (*in Polish*).

UTH 2020 – *Ustka Town Hall* (*Ustka Spa (Uzdrowisko Ustka).* [Online] https://visit.ustka.pl/wp-content/uploads/2020/04/UZDROWISKA-online.pdf [Accessed: 2021-03-02] (*in Polish*).

Waligóra, J. and Sołtysiak, M. 2011. Subsurface injection of waste-water into devonian carbonate formation in the health resort Ustroń (*Zatłaczanie wód pozabiegowych w utwory serii węglanowej dewonu w uzdrowisku Ustroń*). *Biuletyn Państwowego Instytutu Geologicznego, Hydrogeologia* 445(12/2), pp. 701–708 (*in Polish*).

Walkowiak et al. 2017 – Walkowiak, K., Grabowska-Szaniec, A. and Smakulski, J. 2017. *Spa operat. Spa or health resort protection area of Rowy* (*Operat Uzdrowiskowy. Uzdrowisko lub obszar ochrony uzdrowiskowej Rowy*). Poznań: Ekolog Sp. z o.o. [Online] https://www.ustka.ug.gov.pl/pliki/konsultacje_uzdrowisko_rowy/operat_uzdrowiskowy.pdf [Accessed: 2021-03-02] (*in Polish*).

Weber et al. 2020 – Weber, J., Born, H., Pester, S. and Moeck, I. 2020. Geothermal Energy Use in Germany, Country Update 2015–2019, *Proceedings,World Geothermal Congress 2020*, Reykjavik, Iceland, 15 p.

WSCG 2015 – Water and Sewage Company in Gołdap (PWIK – Przedsiębiorstwo Wodociągów i Kanalizacji Gołdap), 2015. *Mineral Water Pump Room and Masurian Brine Graduation Towers* (*Pijalnia Wód Mineralnych I Mazurskie Tężnie Solankowe*), promotion materials. [Online] https://pwik.goldap.pl/sites/pwik.goldap.pl/files/pliki/pijalnia_ulotka.pdf [Accessed: 2021-04-07] (*in Polish*).

REVIEW OF POLISH SPAS USING THERMAL WATERS IN BALNEOTHERAPY AND HEALING PURPOSES

Keywords

spa treatment, spas, balneotherapy, healing thermal waters, potentially curative towns

Abstract

Thermal waters have been recognized as a source of health and energy since ancient times, and today there is still interest in balneotherapy as a method of treating various diseases, rehabilitation and prevention. In Poland, as many as 12 spa towns use healing thermal waters in their activities. They include: Busko-Zdrój, Ciechocinek, Jelenia Góra-Cieplice, Gołdap, Inowrocław, Iwonicz-Zdrój, Konstancin-Jeziorna, Lądek-Zdrój, Rabka-Zdrój, Uniejów, Ustka and Ustroń. Healing thermal waters are not only used there for medical treatments, because they also supply the brine graduation towers, are the base for the production of cosmetics and are also used in drinking treatments. Uniejów spa is a part of the cascade system, so the healing waters of higher temperature are also used for heating apartments. Depending on the mineral composition of the waters, they can be used in the treatment of, among others: diseases of the musculoskeletal system, rheumatology, osteoporosis, skin diseases,

diseases of the upper and lower respiratory tract, cardiological diseases, diseases of the digestive system, hypertension, obesity, diabetes. All treatments are non-invasive, because the vast majority of them are carried out in the form of bathing, irrigation, inhalation or drinking treatments. The paper also shows the most promising towns in terms of the development of balneotherapy, including Stargard, Pyrzyce, Toruń, Konin and Grudziądz. Balneotherapy in Poland is currently at a difficult time, which is related to the inability to function of many facilities due to the COVID-19 pandemic. However, there is a possibility that when the pandemic and its effects are eliminated, balneotherapy and spa treatment will experience a renaissance.

PRZEGLĄD POLSKICH UZDROWISK WYKORZYSTUJĄCYCH WODY TERMALNE NA CELE BALNEOTERAPII I LECZNICTWA

Słowa kluczowe

uzdrowiska, balneoterapia, lecznictwo uzdrowiskowe,
termalne wody lecznicze, potencjalne miasta uzdrowiskowe

Streszczenie

Wody termalne są uznawane za źródło zdrowia i energii od czasów starożytnych, a w czasach dzisiejszych nadal obserwuje się zainteresowanie balneoterapią, jako metodą leczenia różnorodnych chorób, rehabilitacji oraz profilaktyki. W Polsce, aż 12 miast uzdrowiskowych wykorzystuje w swojej działalności lecznicze wody termalne. Są wśród nich: Busko-Zdrój, Ciechocinek, Jelenia Góra-Cieplice, Gołdap, Inowrocław, Iwonicz-Zdrój, Konstancin-Jeziorna, Lądek-Zdrój, Rabka-Zdrój, Uniejów, Ustka oraz Ustroń. Lecznicze wody termalne nie są wykorzystywane tam jedynie w zabiegach medycznych, ponieważ stanowią także zasilanie tężni solankowych, bazę do produkcji kosmetyków, korzysta się z nich także w kuracjach pitnych. Uzdrowisko Uniejów jest częścią systemu kaskadowego, a więc tamtejsze wody wykorzystywane są także na cele ogrzewania mieszkań. W zależności od składu mineralnego wód, mogą one być stosowane w leczeniu m.in.: chorób układu ruchu, reumatologicznych, osteoporozy, chorób skóry, chorób górnych i dolnych dróg oddechowych, chorób kardiologicznych, chorób układu pokarmowego i układu trawienia, nadciśnienia, otyłości, cukrzycy. Wszystkie zabiegi łączy bezinwazyjność, ponieważ ich zdecydowaną większość prowadzi się w postaci kąpieli, irygacji, inhalacji lub kuracji pitnych. Wyszczególnione zostały perspektywiczne pod względem rozwoju balneoterapii miejscowości, wśród których są Stargard, Pyrzyce, Toruń, Konin oraz Grudziądz. Balneoterapia w Polsce znajduje się obecnie w trudnym momencie, co jest związane z brakiem możliwości funkcjonowania wielu obiektów z powodu pandemii COVID-19. Istnieje jednak możliwość, że kiedy pandemia i jej skutki zostaną zniwelowane, balneoterapia i lecznictwo uzdrowiskowe przeżywać będą renesans.