

REGIONAL AND SECTORAL VARIATIONS IN THE UTILIZATION OF THERMAL WATERS AND GEOTHERMAL POTENTIALS IN NORTHEASTERN HUNGARY

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Abstract. The north-eastern part of Hungary possesses favourable geothermal endowments. There exist various forms of the utilization of thermal waters involving several fields of the economy and public administration. With respect to the existing capacities, the region holds substantial, unutilized reserves of thermal waters and geothermal energies. The broadening of our experience, the changing economic and natural landscape calls for the evaluation of the current situation from time to time, as well as setting new priorities for the fields of utilization. The focal point of this study is the analysis of the north-eastern part of Hungary in terms of economic geography, from the perspective of trends in the utilization of thermal waters and geothermal energy. The area of study is the North Great Plain Region, i.e. Hungary's north-eastern region and it is part of the EU's statistical planning areas statistical planning, which encompasses three counties: Szabolcs-Szatmár-Bereg, Hajdú-Bihar and Jász-Nagykun-Szolnok. Our studies have examined the actual extent of the utilization of geothermal energy, as to which fields of economy and public administration it involves. With these investigations, I have wanted to find out for the satisfaction of what economic demands thermal waters have been established, and how the purpose of utilization has changed in the course of operations, and currently, in 2011 how the sectoral distribution of the utilization of wells looks like. The number of the currently unutilized wells has also been established. These investigations have relied on quantitative and deductive methods, and besides empirical studies have been performed.

Keywords: north-eastern Hungary, North Great Plain Region, thermal water, geothermal energy, renewable energies

1. INTRODUCTION

With the utilization of the available potentials and technologies, geothermal energy may contribute to the reduction of the quantities of the emitted contaminants and greenhouse gases, as well as the development of peripheral regions. Hungary has outstanding opportunities with respect to thermal water and geothermal energy resources, but the rate of their utilization – with respect to the available thermal well capacities – is low. This situation is due to the regulatory requirements posed on operators, the high investment and maintenance costs, the general shortage of funds, the current difficulties of agriculture, industry and local governments, as well as the fact that the solid and liquid potentials lying at depths of several thousand meters, the potential methods and opportunities of exploitation, sustainability are not or just hardly known. Our

studies have examined as for what economic purposes the available thermal water and geothermal facilities have been constructed for, what changes have taken place in their use, and as of 2011 what the volume of the available, but unutilized potentials is.

The geothermal endowments of the area of the North Great Plain Region can be considered to be favourable even in global comparison (Stegana et al., 1975), which – owing to the just 20–25 km thick subgrade of the basin (Molnár, 1984), the porous thermal water-yielding layers up to the thickness of 1,500 meters, the cracked and karstic thermal water storage systems under them down to depths of 4000–4500 meters and 4.5°C/100 m geothermal gradients –, results in a 60 PJ/year geothermal potential (Mádlné, 2008), 90–100 mW/sq m heat flow (Royden et al., 1983; Royden & Dövényi, 1988), 35–130°C temperature values at depths of 500–2000 meters, as well as water yields of 10–100

cc m/h (Dövényi et al., 2001). The majority of the thermal water under the territory of Hungary is of low enthalpy, and therefore their use would allow heat and water utilization at the current state of technology. Waters of the highest temperatures feature 80–90°C, which in communal utility supply would be suitable for satisfying the demands of heating, sanitary hot water, air-conditioning and drinking water supply. Concerning the economic sectors, it can be used in tourism, industry and a broad range of agricultural activities. The most dynamically developing area is balneology, the water supply of bathing places. This tendency is true for both Hungary and the North Great Plain Region. The reason underlying the dynamic development of this method of utilization can be traced back in the priority role of health and adventure tourism in the country's tourism concept, as well as the associated earmarked grants (Csomós & Kulcsár, 2010). With respect to the heating of buildings, this solution can be applied efficiently in settlements where the population lives in a concentrated structure. The increasing energy prices, the financing problems that local governments face, as well as our energy dependence gradually set alternative heat service solutions to top priorities.

The focal point of this study is the analysis of the north-eastern part of Hungary in terms of economic geography, from the perspective of trends in the utilization of thermal waters and geothermal energy. The area of the study is the North Great Plain Region, i.e. Hungary's north-eastern region of statistical planning, which encompasses three counties: Szabolcs-Szatmár-Bereg, Hajdú-Bihar and Jász-Nagykun-Szolnok. My studies have examined the actual extent of the utilization of geothermal energy, as to which fields of economy and public administration it involves. With these investigations, I have wanted to find out for the satisfaction of what economic demands thermal waters have been established, and how the purpose of utilization has changed in the course of operations, and currently, in 2011 how the sectoral distribution of the utilization of wells looks like. The number of the currently wells that are currently out of use as a result of the termination, dissolution of the earlier operator–consumer has also been established. These investigations have relied on quantitative and deductive methods, including the analysis and processing of the data and information that are available at the regional directorates of water management, and besides empirical studies have been performed in the course of which the associated statistical figures have been updated.

2. REGIONAL AND SECTORAL VARIATIONS IN THE UTILIZATION OF THERMAL WATERS IN THE NORTH GREAT PLAIN REGION

The North Great Plain Region has favourable endowments in view of the available geothermal potentials. Due to its northeastern–southwestern orientation, however, considerable differences can be identified. Most of the thermal waters in the region are stored in Upper Pannonian layers, which grow gradually thicker from the feet of the enclosing mountains towards the inner areas of the basin, and tend to lie at increasing depths (Molnár, 1984). Accordingly, the thermal water endowments improve from the northeast to the southwest, the temperature of the exploitable water increases, which is also reflected in the larger number of wells: 34 wells in Szabolcs-Szatmár-Bereg, 94 wells in Hajdú-Bihar, 177 wells in Jász-Nagykun-Szolnok. The utilization of thermal water and the dominance of certain fields of application somewhat contradict the conditions bettering towards the southwest. At the present, thermal waters are just scarcely used for heating, but its volume could be increased by deploying unutilized wells – the largest number of such wells can be found in this region – for production, as well as the multiphase use of the operating wells. The operation, reconstruction of existing, but currently not utilized, closed thermal wells, and the establishment of new wells could satisfy broad-scaling user demands.

2.1. Szabolcs-Szatmár-Bereg County

In the county, all the thermal water wells have been established in the Upper Pannonian sand and sandstone layers. In the Bereg Region bordering on the Northeastern Carpathians and in the surroundings of Nyírlugos, the high-lying Upper Pannonian layers do not bear thermal waters. In comparison with the other areas of the Great Plain, the properties of this region in terms of the hydrogeology of thermal waters are less favourable. From the thermal water reservoirs of the Upper Pannonian layers, thermal waters up to 67°C have been explored in the vicinity of Tiszavasvári, whereas the high-lying, also Upper Pannonian formations around Nyírlugos yields subsurface water of less than 30°C (Lorberer, 2009).

In the county, the first wells were established in 1958, in Nyíregyháza and Kemece. The largest number of drillings was made in the 1960s, and therefore – they have been in use for over 40 years. With respect to the construction of the wells, until

the 1980s a decreasing tendency could be observed, and then it gathered new impetus in the 1990s and after 2000. Today, the oldest wells can be found in the surroundings of Ibrány–Nagyhalászi, as well as in Nyíregyháza and Nyíregyháza–Sóstófürdő.

Seventeen settlements of the county have altogether 34 thermal wells, and with respect to their utilization at the time of their establishment three main areas – bathing, medical and industrial use – can be distinguished (Fig. 1). In addition to balneology, the Upper Pannonian reservoir was also utilized in a subordinated manner, for communal water supply, industrial and agricultural purposes, yet the dominant way of use was the mostly seasonal bathing utilization and drinking water supply. Seventy percent of the wells have been made to supply swimming pools and bathing services with nearly half of them being of medicinal water grade. For use in industry and food processing – covering altogether 15 percent –, thermal wells have been established in four plants: at the bottling plant of Várda Drink Company in Kisvárd, the hemp factory of Nagyhalászi and the tobacco fermentation plant of Nyíregyháza. The newly established well of Cégénydányád was also built for the purpose of mineral water bottling in 2008. Medical utilization is characteristic of three settlements, Nyíregyháza, Nyíregyháza-Sóstófürdő and Fehérgyarmat, and therefore this type of use has 9 percent in overall utilization. Thermal water is used as a source of geothermal energy only in Gemzse. 32 percent of the thermal wells are used in a multiphase and shared manner where bathing, medical and industrial functions are all included in the scope of communal water supply (Fig. 3/a, b). In view of agricultural use, the largest part of the county does not have real prospects, because the water yields of those – wells that can be exploited only with the use of submersible pumps are limited (Lorberer, 2003). Thermal water output arrived at the maximum in 1994, while in the following year consumption dropped by 30% (Lorberer, 2009).

According to a 2011 survey, the utilization profile more or less corresponds to the distribution at the time of establishment, but by today 21 percent of the wells have been put out of use or closed. When these changes are examined with respect to the areas concerned, most of the unused or terminated wells are situated in the Ibrány–Nagyhalászi region, while the operation of single wells have also been stopped in Kisvárd, Nyíregyháza and Gemzse. Such closing of the wells has affected the production of geothermal energy for agriculture, medicine, industry, as well as swimming pool and bathing services. The scope

of the purposes of use at the time of establishment has shrunk primarily due to dissolution of agricultural plants and industrial businesses formerly operating thermal wells, and the shortage of funds available to local governments.

No water is produced from the wells of the former hemp factory of Nagyhalászi, and so far the Local Government of Nagyhalászi having taken the wells over has not been able to find a new operator. The situation is similar in Gemzse, where the greenhouses and plastic tents of the local cooperative used to be heated with thermal water. With the dissolution of this cooperative, only one well having provided heat energy has remained unused. Constructed in 1994 for the bottling of mineral waters, the well of Várda Drink in Kisvárd has not been commissioned due to the subsequent reduction of the product range, and similarly the well built in Csengersima in 1991 has not been in operation since its establishment. On the basis of the above tendency, by today the ratio of thermal wells used for industrial purposes has decreased to 6 percent. Water is taken in the mineral water bottling plant of Cégénydányád and the tobacco fermentation facility of Nyíregyháza, though in this latter part 65 percent of the extracted thermal water is used as sanitary hot water, and just 35 percent is consumed as industrial-technological water. The discontinuation of the utilization of wells for bathing purposes – basically, owing to the large number of the facilities serving these ends – has been less perceivable; in the county, this rate has dropped from 70 to 64 percent. The field of medicine can be characterized by a 30 percent fallback, though the underlying reason has been the replacement of the well in the process of the extension of Jósza András Hospital of Nyíregyháza, and therefore in this respect just a relative decrease can be recorded (Fig. 2 & 3).

When examining these processes, it has also been considered that some of these wells have accomplished their operating lifetimes – such as the wells in the microregion of Ibrány–Nagyhalászi that are over forty years old now –, yet examples to the contrary include the regularly maintained and continuously operated thermal wells of Nyíregyháza and Nyíregyháza–Sóstófürdő. In the light of the data available at the Environmental Protection and Water Management Directorate of the Upper Tisza Region (FETIKÖVIZIG), in Szabolcs-Szatmár-Bereg County only the thermal well of Kisvárd has become fully inoperable and ultimately terminated. The other wells have been closed down, with the exception of the one in Nyíregyháza, for financial reasons.

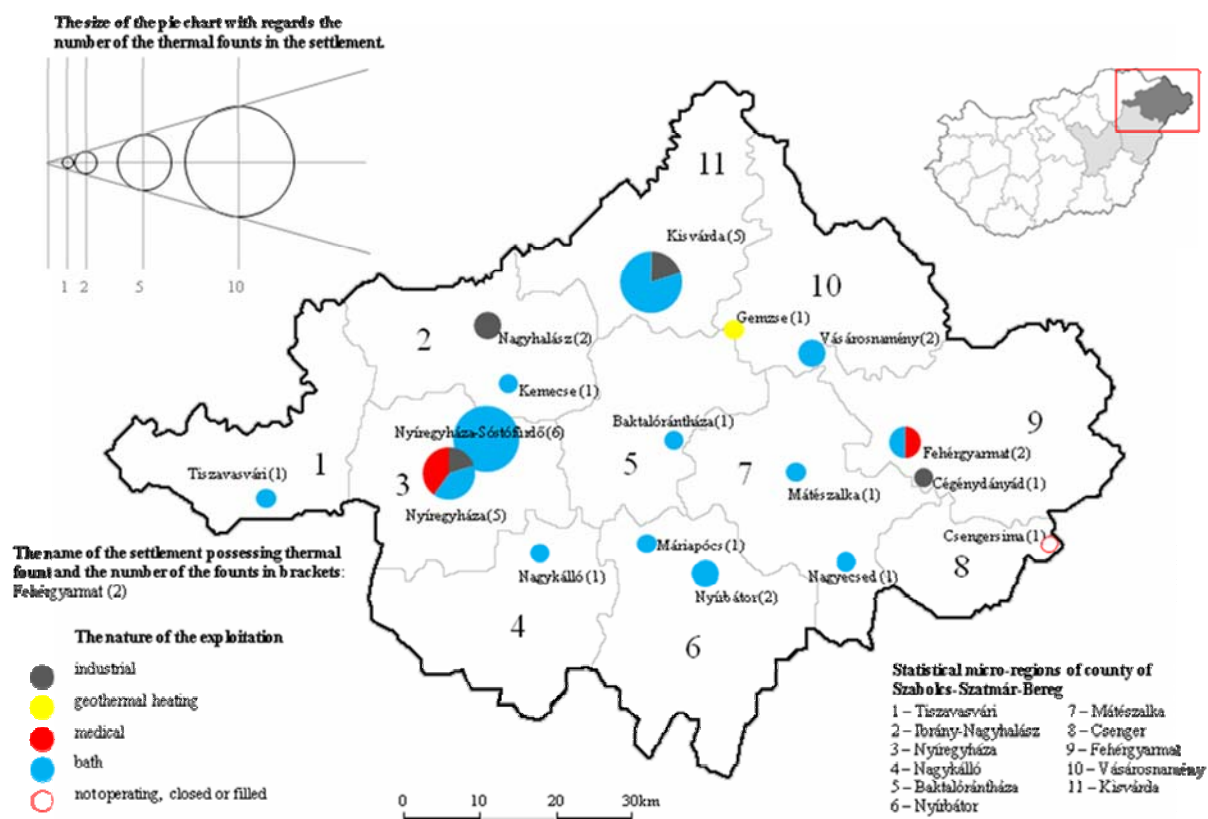


Figure 1. Structure of the utilization of thermal wells in Szabolcs-Szatmár-Bereg County, in the year of establishment (Source: figure created by the author based on data of Upper-Tisza Region Environmental and Water Directorate)

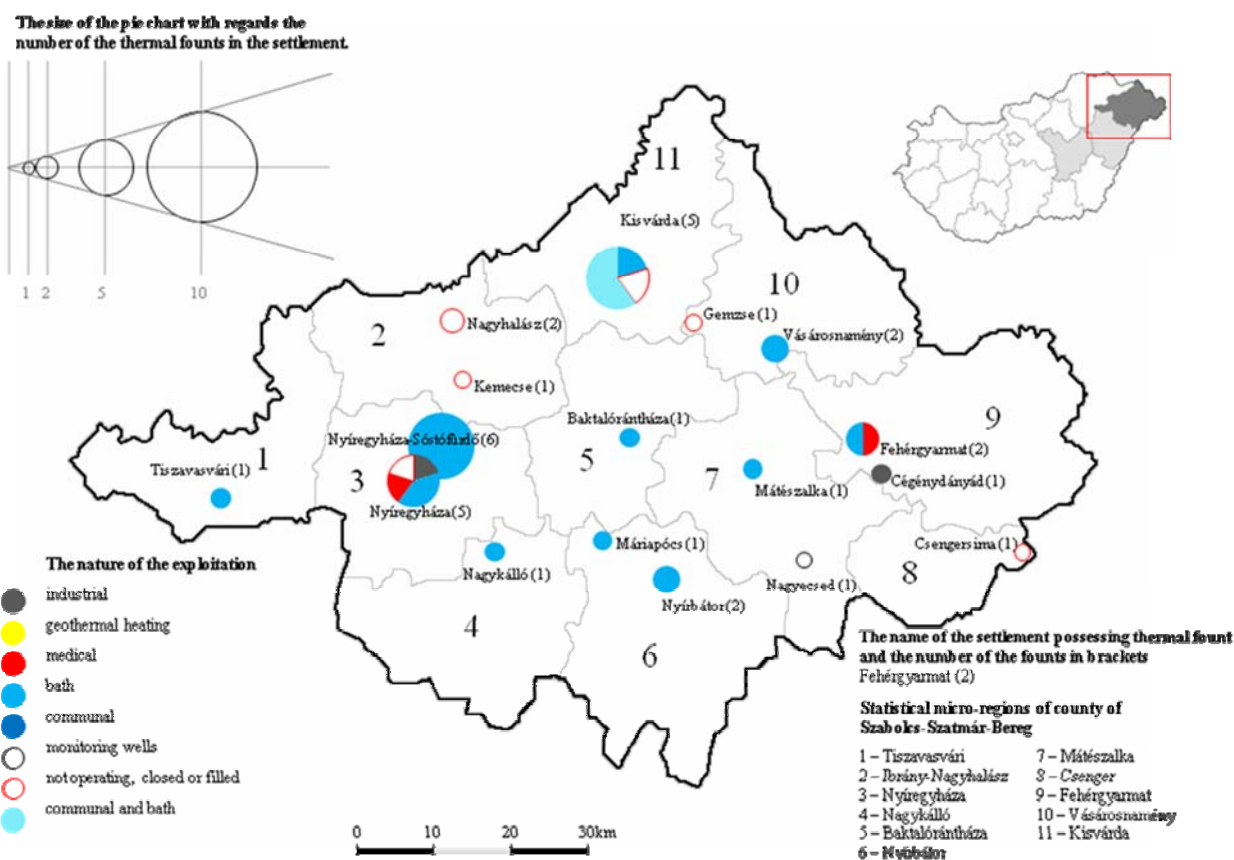


Figure 2. Structure of the utilization of thermal wells in the area of Szabolcs-Szatmár-Bereg County, in 2011 (Source: collected by the author from owners of thermal wells)

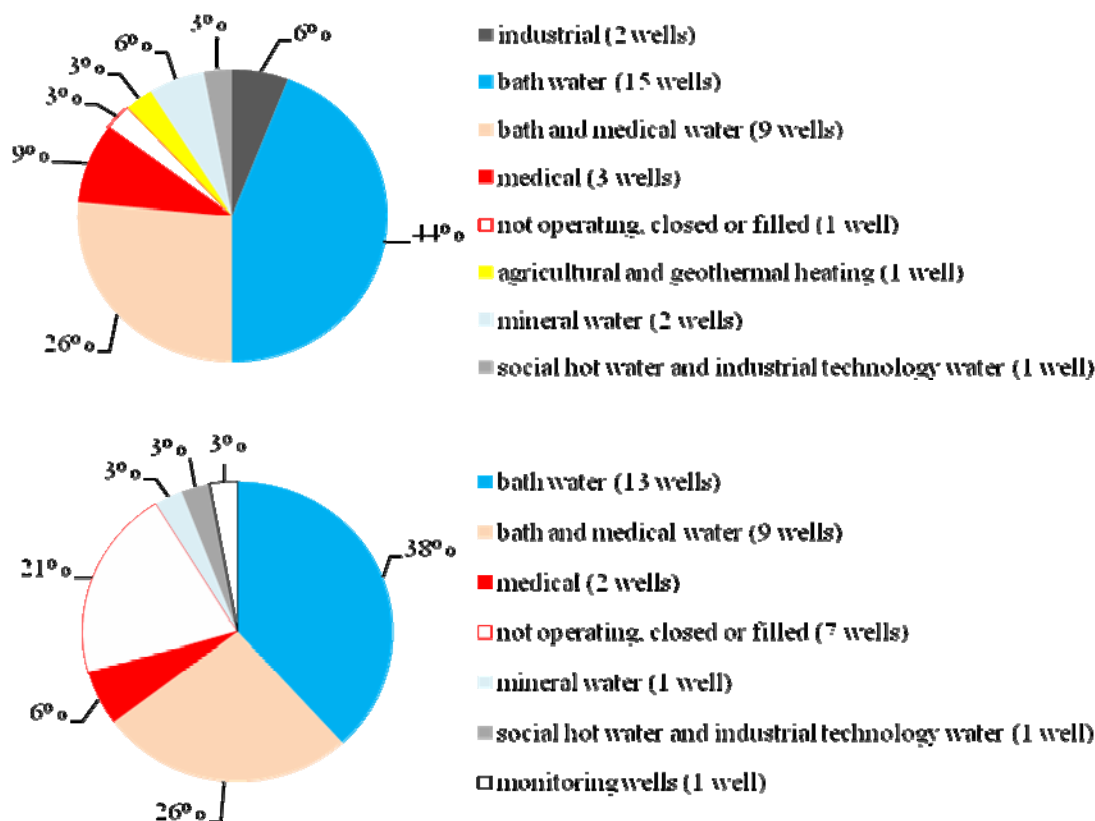


Figure 3/a, b. Distribution of the forms of the utilization of the thermal wells in the area of Szabolcs-Szatmár-Bereg County upon establishment and currently (Source: based on data of Upper-Tisza Region Environmental and Water Directorate and the author, figures created by the author)

2.2. Hajdú-Bihar County

In view of the hydrogeology of thermal waters, the endowments of Hajdú-Bihar County more or less correspond to the average of the Great Plain with the eastern districts being less favourable; from the Upper Pannonian measures, no thermal waters over the temperature of 85°C can be anticipated to be explored. The local thermal wells have been constructed as filtered through porous Upper Pannonian – and sometimes younger Upper Pleistocene and Lower Pleistocene layers. Represented by Hajdúszoboszló and Debrecen, the county is a classic area of the balneologic utilization of the Upper Pannonian thermal water reservoir, upon which most of the thermal wells have in fact been constructed. This is the area with the largest number (14) thermal wells of medicinal water grade. In this county, agricultural use has always been less significant (Lorberer, 2003.), and this tendency still prevails today. Beyond the Upper Pannonian sequence, just single wells are filtered through the Upper Pleistocene (Komádi) and Lower Pleistocene (Berettyóújfalú) layer for use in bathing establishments, while in the part of the region bordering on Békés County a larger number of such wells have been constructed for water supply.

In Hajdú-Bihar County, the first exploratory drilling for thermal water had been performed in 1915 in Balmazújváros, and until the 1950s a relatively small number (16) of drillings with effluent water over 30°C were turned into wells. Most of the thermal wells in the region were drilled from the 1950s to the 1980s, and then the recession of the 1990s set this impetus back.

A new wave of drillings – due to the considerable grants given to bathing developments – came only after 2000, and since then eight such facilities have been opened. The thermal wells located in Hajdú-Bihar County can still be regarded to be rather young. The most recently constructed facilities are the wells in the microregions of Hajdúszoboszló, Debrecen, Hajdúböszörmény – 17–26 years have elapsed since their establishment –, which is due to the relatively large number of wells constructed after the turn of the millennium. The oldest wells can be found in the region of Berettyóújfalú. The thermal well boasting of the highest effluent temperature is operated in Hajdúszoboszló, where thermal water of 78°C is brought to the surface from a depth of 1,621 meters.

Hajdú-Bihar County has 94 thermal wells in altogether 31 settlements. When the regional distribution of the thermal wells is examined, figure 4

reflects that there are no thermal wells in the regions of Derecske–Létavértes and Hajdúhadház. The largest number of wells with effluent temperatures over 30°C have been drilled in the region of Berettyóújfalu, primarily for agricultural and communal water supply purposes. The regions of Hajdúszoboszló and Debrecen also have numerous wells, but in both microregions wells can be found only in the central settlements. As a result of intensive extraction, the depression of the stationary and operating water levels has forced the operators to designate protective zones of significant expanse, and therefore no further drillings can be performed in the other settlements of the region.

Looking at the utilization of thermal wells upon their establishment, water supply to bathing establishments was the dominant purpose with 52 percent, followed by the supply of drinking water with 22 percent, and agricultural use with 15 percent. One-tenth of the wells have been designed for combined use. In line with the existing heat and water demands, the water of eight wells has been dedicated to multiphase bathing and agricultural use, a well in Balmazújváros has been constructed for bathing purposes and communal water supply, whereas a well in Debrecen serves industry and bathing alike. Nevertheless, there is a large number of wells that satisfy only industrial demands – primarily in food processing and light industry –, while 5 percent is represented by the depth monitoring wells of the Geological Institute of Hungary (MÁFI), which is a considerable proportion in comparison with the number of such wells (5) in the other two counties (Fig. 4, 6).

When trends in the thermal water utilization are studied from the establishment of the wells until 2011, the most significant change can be seen in this county, as the general setup of thermal water utilization has undergone major transformation. With 33 percent, the swimming pool and bathing services have remained dominant, but in this area remarkable development has been implemented towards multiphase utilization, i.e. more than half of the waters of these bathing establishments – Debrecen, Hajdúszoboszló, Hajdúböszörmény, Berettyóújfalu, Hajdúnánás and Tiszacsege – is now used in the form of geothermal energy, as well. Geothermal heating is mostly restricted to the buildings of the bathing facilities, catering units in some locations, with the exception of one of the thermal wells of the Berettyóújfalu Baths that serves three functions: geothermal heating, bathing water for the pools, as well as medical purposes at the Rehabilitation Department of the neighbouring Gróf Tisza István Hospital. Two percent is covered by joint operation for bathing and agricultural purposes, while

one percent falls on combined bathing and industrial, as well as bathing and communal water supply utilization. Agricultural utilization is still significant within the use of thermal water in Hajdú-Bihar County with 9 percent, similarly to communal water use with 10 percent.

Within the North Great Plain Region, in 2011 this county has been the area with the largest number of thermal wells out of use – their proportion is 37 percent –, with most of them being serviceable wells that are closed or not operated, while 9 wells have been terminated, filled up. Nearly all the sectors have been hit by considerable fallback; in terms of percentages, industry has suffered the largest loss, as 66 percent of the wells are not utilized. It is followed by agricultural utilization, where the extent of drop has been 45 percent, while in communal thermal water use the corresponding proportion of decrease has been 54 percent. Unfortunately, most of them have not been given new functions as a result of the changed structure of the economy and their location in the outer areas of the settlements. On the other hand, the southern part of the Hajdú-Bihar County has become the region where thermal water is the most extensively used for agricultural purposes.

The situation is similar with the thermal wells drilled for industrial purposes in Debrecen, Berettyóújfalu and Komádi. The leather factory of Debrecen was dissolved in the second half of 1990, while the meat-processing plant was closed down in the summer of 2011, yet its thermal well has been out of use since 2008. In Komádi, it was the hemp factory that used thermal water, but it is not operated any longer. From among the wells drilled for industrial purposes, today only the Metallurgy Company of Berettyóújfalu (Elzett) produces water from its wells. Due to the large number of wells utilized for bathing purposes, the material decrease (19 wells) is less apparent in comparison with other sectors, still it has reached the high 36 percent. In 2011, the largest consumers of thermal water have been the bathing establishments of the settlements, as well as the bathing complex of national and international significance. In the past 20 years, most of these facilities have been converted for winter use, as well, and expanded with a large number of new buildings (Fig. 5–6).

In spite of their theoretical importance, no geothermal systems for the individual settlements – like the ones in Kistelek or Mórahalom – have been constructed, as today there is not a single local government where planning would have been followed by actual implementation. Investments are hindered by the general shortage of resources at the local governments, which situation is not expected to change

even on the medium term with respect to the increasingly more frequent municipal bankruptcies. Consequently, Hajdú-Bihar County has retained utilization for bathing purposes, further increasing the dominance of balneology in the utilization of thermal waters.

2.3. Jász-Nagykun-Szolnok County

In the North Great Plain Region, Jász-Nagykun-Szolnok County has the largest number of thermal water wells. Most of the drillings made in this area can be found in the Jászság region and the surroundings of Szolnok (Fig. 7). In the center of the Pannonian Basin, the sediment sequence are of considerable thickness, yet in certain areas of the county – such as in the Jászság region – the large number of wells are settled on the rather poor water-yielding capacities of shallower layers, and therefore in these areas a large proportion of thermal water use services communal drinking water supply.

Most of the thermal wells were constructed in the 1960s and 1970s, while the subsequent 30 years saw a decreasing number of well drilling. Quite surprisingly, in this period the largest number of thermal wells were built or reconstructed with new drillings in the recession-laden 1990s.

The large majority of those wells in Jász-Nagykun-Szolnok County that feature effluent water over 30°C have been built with reliance on the water well drilling technology, particularly for the withdrawal of water. Similarly, the largest number of unused hydrocarbon drillings has been converted into thermal wells in Szolnok, and besides such wells have been established in Szandaszőlös, Kengyel, Tiszaörs and Karcag. There are several thermal wells operated in the country that are used as depth monitoring wells in addition economic purposes, with the exception of the drilling of Jászladány, that solely serves the former end.

In view of the effluent temperature of the thermal wells, the hottest wells are situated at the edge of the Békés Depression, as well as by River Tisza, with a considerable proportion of them being thermal wells converted from unused hydrocarbon drillings; the highest effluent temperature belongs to the three drillings in Cserkeszőlő – the temperature of the thermal water here is 83°C on the surface, and reaches up to 143°C at a depth of 2311 meters –, and a well in Túrkeve whose temperature is over 80°C. The effluent temperature is higher than 70°C in the case of a well in Karcag, Tiszaföldvár, Törökszentmiklós, Túrkeve, and two thermal wells in Mezőtúr. Besides, in 8 settlements there are altogether 13 thermal wells that yield waters of 60–70°C. The majority of them follow the course of River Tisza.

In Jász-Nagykun-Szolnok County, 177 wells have been drilled in 43 settlements. From among the 7 statistical microregions of the county, the largest number of thermal wells can be found in Jászság (54), and the Szolnok area (43), which also form the surroundings of most of the settlements that have thermal wells. Szolnok has the largest number, i.e. 21 wells, followed by Jászkisér and Jászapáti both with 12 wells.

The fields of the application of the water extracted from the thermal wells of the county – still in view of the forms of utilization upon establishment – seem to be more varied than in the other two counties of the region, primarily in terms of industrial utilization. If the percentage rate of the wells is taken into consideration, the number of wells for communal thermal water supply is the largest, making up some 38 percent of all the wells.

The main water supply is followed by wells for agricultural purposes with 27 percent; in this category, water use for animal farming and thermal wells serving other agricultural functions can be clearly distinguished, and their ratio is 15 to 85 percent. The Jászság area can be characterized by the broad-scaling utilization of thermal water for agricultural purposes, and these wells have been specifically established for the water supply of animal farms, as well as irrigation, greenhouse heating, as well as sanitary use.

Twenty percent of the wells have been constructed for the supply of bathing facilities. With its 11 percent, industrial utilization is also considerable, but it is distributed among a relatively diverse set of sectors. Within the North Great Plain Region, this area shows the highest rate of thermal water utilization for industrial purposes. Most of the 20 industrial thermal wells have been established in Szolnok, Martfű, Mezőtúr, Zagyvarékas, Jászberény and Jászkisér. With respect to the subsectors concerned, particularly the water demands of food processing have been satisfied from these water resources, such as the sugar mill of Szolnok. In terms of volumes, food industry is followed by the thermal wells serving mechanical engineering and public transport companies, the bus and coach depot, the railway station and sports grounds of the Hungarian State Railways (MÁV). In Jászság, the largest thermal water consumers are the Lehel Refrigerator Factory of Jászberény and the Construction Machinery Service Workshop of MÁV. In the field of light industry, the Tisza Footwear Factory of Martfű, while in chemical industry the Chemical Works of Szolnok and the petrochemical company founded for MÁV should be mentioned, where thermal water is used in the form of energy, and additional thermal wells were constructed in 2009 to serve the Industrial Park of Szolnok.

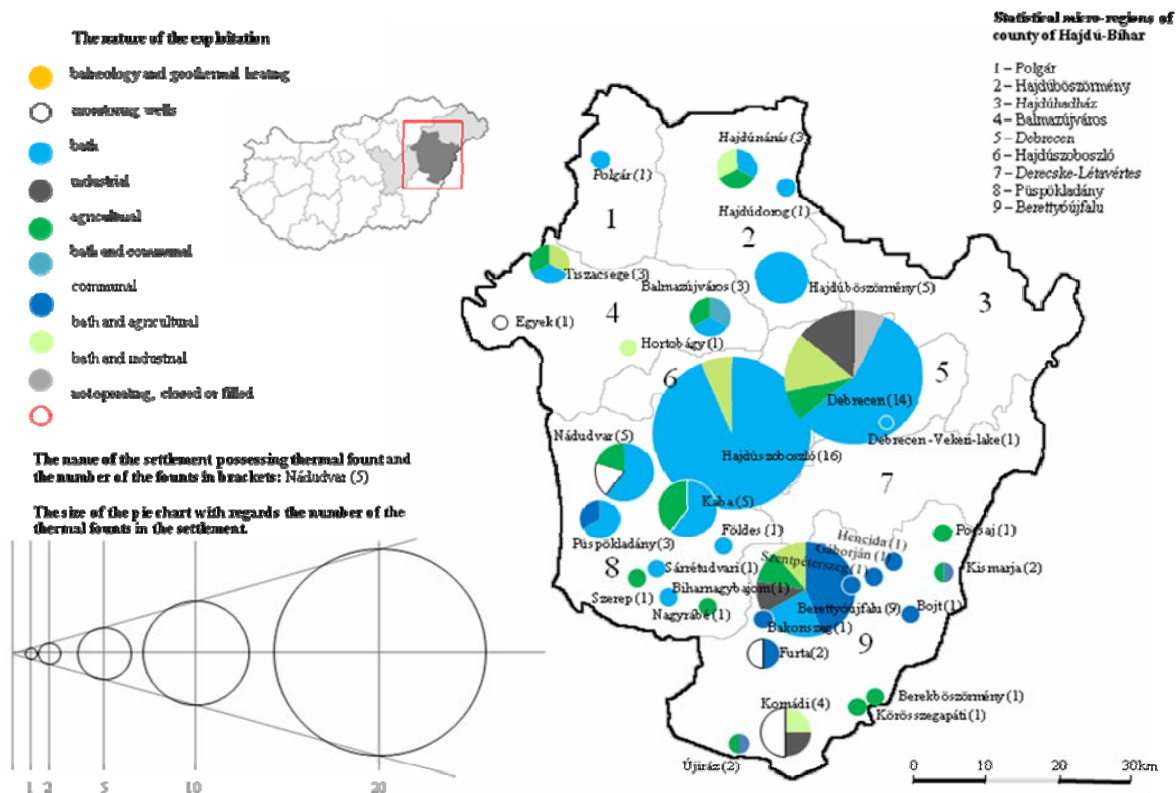


Figure 4. Structure of the utilization of thermal wells in Hajdú-Bihar County, in the year of establishment (Source: figure created by the author based on data of Trans Tisza Region Environmental and Water Directorate)

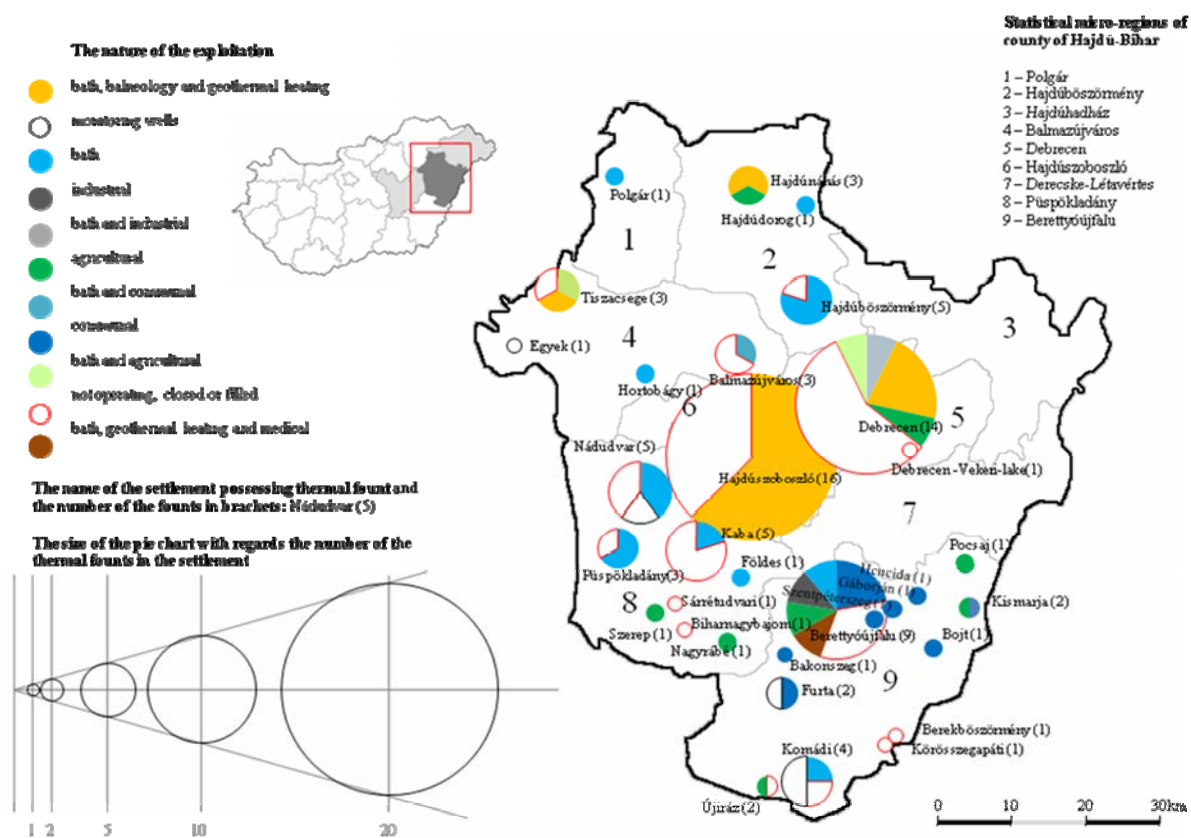


Figure 5. Structure of the utilization of thermal wells in the area of Hajdú-Bihar County, in 2011 (Source: collected by the author from owners of thermal wells)

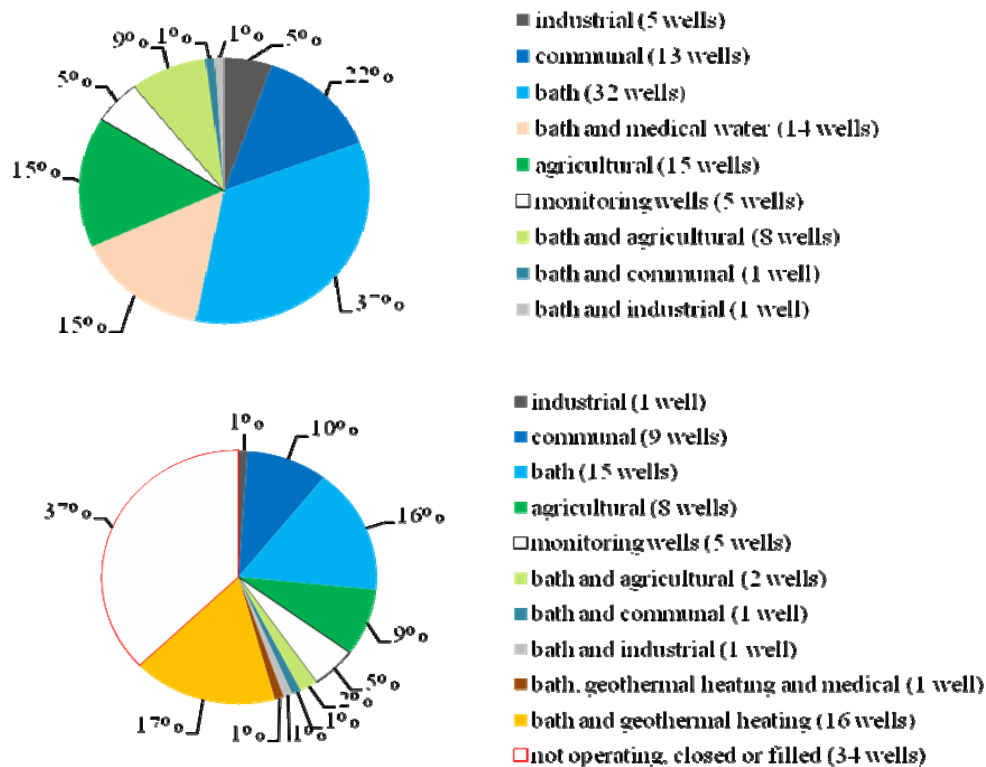


Figure 6/a, b. Distribution of the forms of the utilization of the thermal wells in the area of Hajdú-Bihar County upon establishment and currently (Source: based on data of Trans Tisza Region Environmental and Water Directorate and the author, figures created by the author)

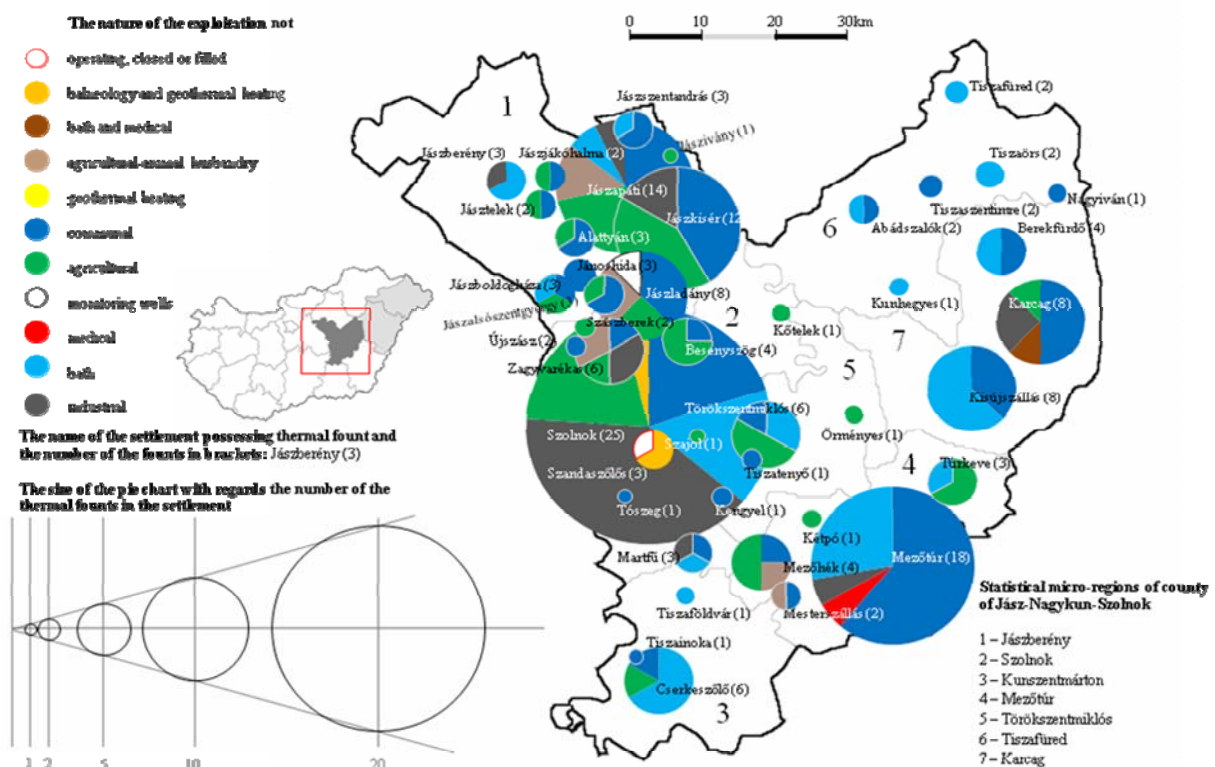


Figure 7. Structure of the utilization of thermal wells in Jász-Nagykun-Szolnok County, in the year of establishment (Source: figure created by the author based on data of Middle-Tisza Region Environmental and Water Directorate)

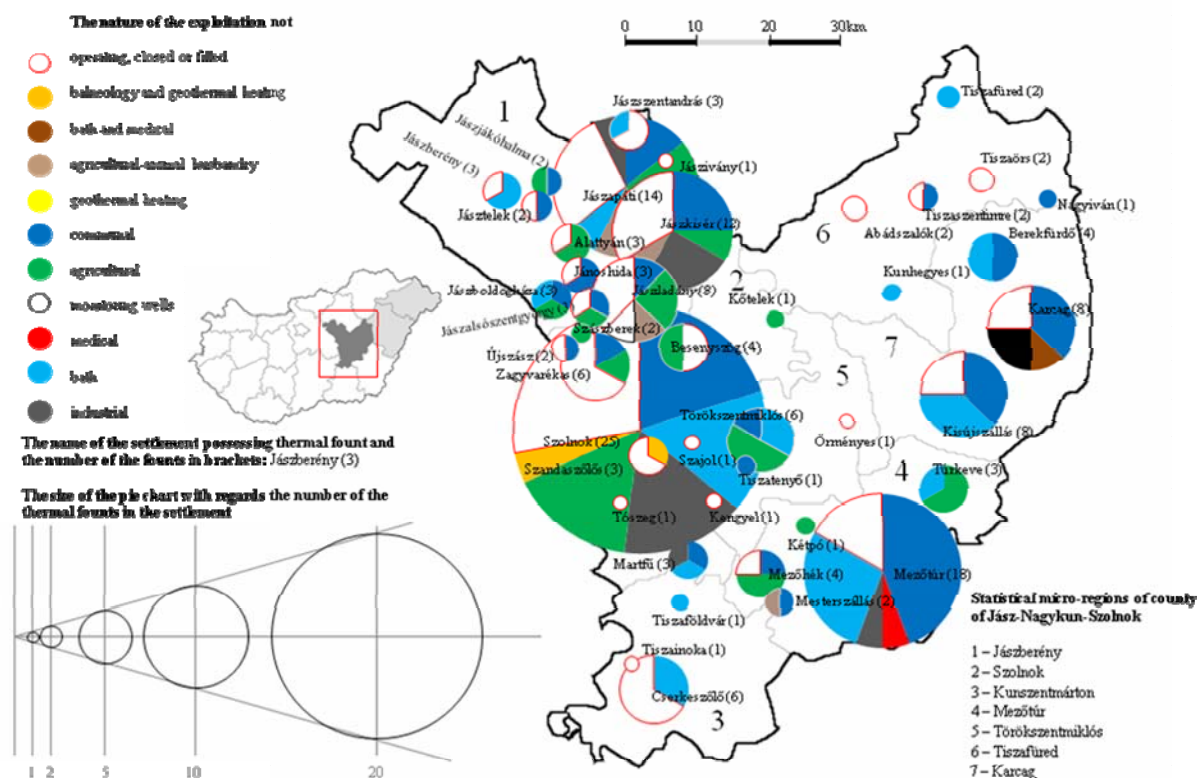


Figure 8. Structure of the utilization of thermal wells in the area of Jász-Nagykun-Szolnok County, in 2011 (Source: collected by the author from owners of thermal wells)

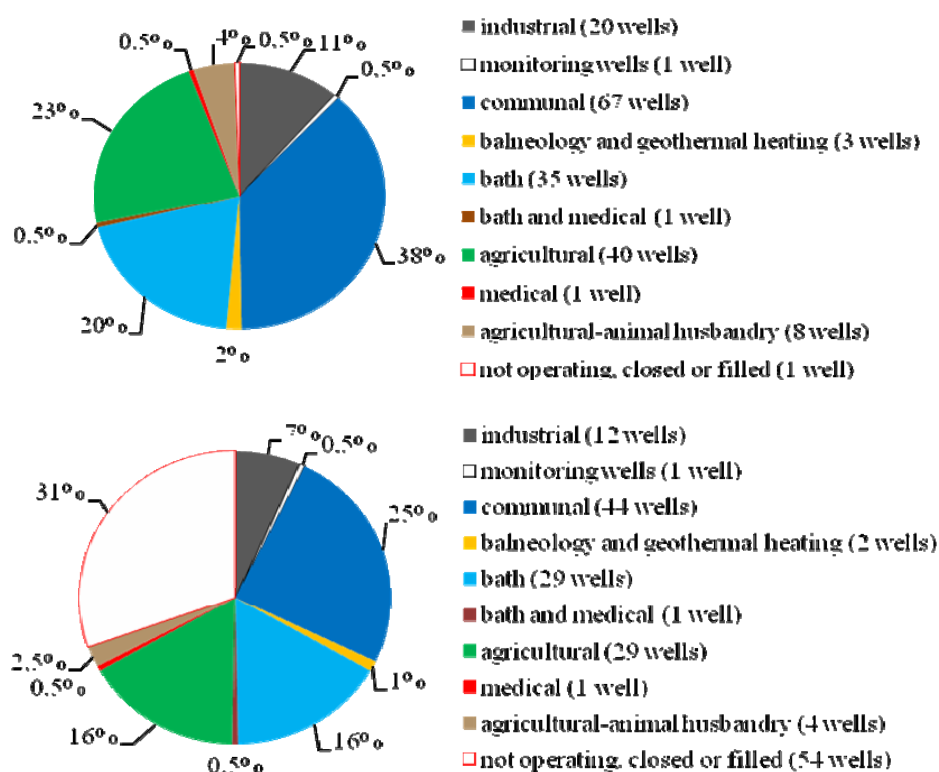


Figure 9/a, b. Distribution of the forms of the utilization of the thermal wells in the area of Jász-Nagykun-Szolnok County upon establishment and currently (Source: based on data of Middle-Tisza Region Environmental and Water Directorate and the author, figures created by the author)

Utilization for medical purposes is implemented in the hospitals of Mezőtúr and Karcag; in this latter institution, thermal water is used jointly with the neighbouring bathing establishment. Thermal water has been used on several occasions as a geothermal energy carrier, especially to supply heating and sanitary hot water to the military establishments of Szandaszőlös, as well as to heat the hospital of Szolnok. There is one thermal well that expressly serves research objectives. It is the thermal well of Jászládány, which has been constructed for the Geological Institute of Hungary (MÁFI) for the purpose of depth monitoring studies. Initially, multiphase and shared use was applied in four wells: the thermal well of Tisza Hotel in Szolnok served balneologic ends and the heating of the building, two wells in Abádszalók were used for communal water supply and the filling of bathing facilities, whereas the thermal well of the hospital of Karcag had medical and water supply tasks to bathing (Fig. 7, 9).

In this county boasting of the best endowments, by 2011 the volume of the use of operating thermal water supply wells for drinking water – otherwise representing the largest number of wells – has decreased by 34.5 percent with one of the indirect causes being the dynamic rise of water tariffs after 1990 and the concurrent drop in the number of consumers. In spite of their outstanding number, their role in water supply is rather insignificant, a large proportion of them is out of use. The only exception is given by certain areas of Jászság, where they take a more weighty part in communal water supply.

It has been followed by drastic fallback in the field of large-scale plant farming and animal breeding, as a result of which 15 wells have discontinued their operations because of the dissolution of cooperatives and state farms similarly to Hajdú-Bihar. These capacities are still available, yet are mostly in unkempt conditions due to the ignorance of the necessary scheduled maintenance and developments. In the light of the current cognitive experience, the current processes among enterprises involved in animal farming tend to channel resources to the production of biogas with the objective to comply with the effective rules of the management of liquid manure [Ministry of National Development, (2009), Decree 59/2008 (Apr 29) of the Ministry of Agriculture and Rural Development, Decree 27/2007 (Apr 17) of the Ministry of Agriculture and Rural Development]. As a consequence, the available thermal water potentials continue to serve the performance of the well-established tasks, while utilization for energy purposes is not anticipated even in the medium-term plans.

The industrial production of the county has fallen victim to the new economic regime. After the

closing of the wells having been used by the dissolved companies, the number of thermal wells serving industrial purposes has dropped by 40 percent. The smallest extent of decrease in the number of operating wells has been witnessed in the field of utilization for bathing purposes, which is attributable to the continuous support granted to this branch of tourism. Thermal wells initially designed for medical purposes, geothermal heating, combined balneologic and the heating of buildings, as well as bathing and medical purposes are mostly still in operation.

It can be ascertained that in Jász-Nagykun-Szolnok County – with the exception of its utilization for bathing purposes serving as the basis of medical and wellness tourism – the sectors deemed to be large thermal water consumers have been hit by a general drop of use, and when the three counties are compared, it can be seen that the largest number of production wells have been terminated and closed in this county (Fig. 8). With respect to the still operating thermal wells, facilities for communal water supply, bathing and swimming pool services, as well as the satisfaction of agricultural demands are associated with most of the operating wells today.

3. CONCLUSIONS

When the geothermal endowments and utilization profiles in the three counties of Northeastern Hungary are compared, it can be found that in the area of Szabolcs-Szatmár-Bereg County the major method of thermal water use is utilization for bathing purposes, subordinately followed by drinking water supply, which corresponds to the poor endowments. Opportunities connected with use for energy purposes may be exploited in agriculture: the heating of stables and other farm buildings. In Hajdú-Bihar County, thermal water use is almost fully focuses on utilization for bathing purposes. The extracted temperature values, however, reflect considerable geothermal capacity reserves that have already been partly utilized. The large number of wells in Jász-Nagykun-Szolnok County – as a result of its favourable endowments, i.e. the layer sequence of good water-yielding capacities – makes communal water use dominant, yet these wells serve as reserve facilities in water supply, and have substantial roles only in certain areas. Therefore, most of the operating wells satisfy the demands of agriculture and bathing establishments. The county operates just a low level of combined use, yet the utilization of thermal water for heating purposes is the most wide-spread here and the bathing towns of the Hajdúság region.

In the light of the foregoing, it can be claimed that with respect to the existing capacities the North

Great Plain Region has considerable unused thermal water and geothermal energy reserves that are present in the thermal wells currently out of operation. On the basis of the practical experience of the users and the characteristics described above, there are two areas that seem to be promising in the use of heat energy. One of them is comprised by small towns and similar settlements, where the given number of inhabitants and businesses ensures such revenues for the local governments that enable them to participate successfully in renewable energy grant applications, and where such a number of institutions are maintained whose heating demands can be covered from the available thermal water capacities.

The other area is agriculture, and in particular cooperatives and joint stock companies that have been able to preserve their farmlands, and operate extensive agricultural profiles including both plant farming and animal breeding. In the process of continuous modernization, these business entities do dedicate resources to the funding of investments based on energy-saving operations and renewable energies, as well as participation in the associated grant applications. Examples from southeastern Hungary – Pálmonostora, Fülöpjakab – show that even on the level of family enterprises there are option to rely on geothermal energy, yet the given business profile should be capable of generating large added values – on the level of the produced food and industrial crops – , and realizing considerable revenues.

No further, extensive bathing developments can be regarded to be feasible, unlike the improvement of the quality of the existing capacities and their multiphase utilization, such as communal heating of households and agricultural use. As a consequence, heat trade would bring additional resources for profitable operation.

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