Turkish Journal of Earth Sciences
http://journals.tubitak.gov.tr/earth/
Research Article
Turkish J Earth Sci
(2021) 30: 1162-1185
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doi:10.3906/yer-2105-2

Use of geothermal resources in Konya Plain Project (KOP) Region for tourism, health purposes, agricultural, industrial and distict heating

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Received: 03.05.2021 • **Accepted/Published Online:** 06.10.2021 • **Final Version:** 01.12.2021

Abstract: This study has been prepared in accordance with the objectives of evaluating and developing geothermal resources in order to bring the geothermal resources in the Konya Plain Project (KOP) Region, which includes Aksaray, Kırşehir, Konya, Nevşehir, Niğde and Yozgat provinces, to the country's economy with maximum capacity, and to develop proposals for investments to be made. The number of overnight stays and the number of tourists outside the region should be increased by utilizing alternative tourism opportunities in the region. Their use in terms of geothermal energy, tourism and health has an important investment and income potential for the region. It has been determined by the laboratory results that the contents of thermal waters have inductions against many diseases. New investment projects have been recommended with the strategy of highlighting different practices in different provinces within the KOP Region. In this respect, each province and region within each province were evaluated separately, and suggestions suitable for their strategic positioning were presented. In addition, rather than offering new thermal accommodation facilities, modernization of existing facilities or businesses and infrastructures that offer services that all facilities can benefit from are proposed. However, it was seen that there was a need for accommodation capacity and new business models in some regions and suggestions were made accordingly.

Key words: Konya Plain Region, geothermal energy, tourism and health, agricultural utilization, geothermal greenhouses, district heating

1. Introduction

Among the 8 provinces in the Konya Plain Project (KOP) Region, Aksaray, Kırşehir, Konya, Nevşehir, Niğde and Yozgat provinces are prominent in terms of geothermal resources. In addition, there are more than 50 thermal tourism and health facilities in the region. Nevşehir-Kozaklı has become an important center by accommodating approximately half of this capacity. In addition, Sarıkaya Roman Bath, which shows that thermal balneology culture has been in the region for a long time, has a history that will create a brand in the region. Policies and road maps are needed for the integrated and correct evaluation of the resources in the KOP Region.

This study has been prepared in accordance with the objectives of evaluating and developing geothermal resources in order to bring the geothermal resources in the KOP Region, which includes Aksaray, Kırşehir, Konya, Nevşehir, Niğde and Yozgat provinces, to the country's economy with maximum capacity, and to develop proposals for investments to be made. It has been prepared by considering the final report of the resource evaluation project. In the project of utilization of geothermal resources, the agricultural, tourism, energy and industrial usage areas of the existing geothermal resources in the KOP Region have been investigated. Konya KOP Project Regional Development Administration, Turkey and TÜBİTAK Industrial Management Institute (TÜSSİDE) in cooperation with the Assessment of Geothermal Resources Project has been completed. Within the scope of the project of utilization of geothermal resources, researchers from different disciplines worked together and completed an integrated research project for the KOP Region on more efficient use of geothermal energy. Within the scope of the project, experts in the fields of agriculture, tourism, energy

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and geology/hydrogeology and TÜSSİDE researchers have completed their research activities. The findings obtained as a result of the study were transformed into strategies and action plans after their economic analysis. In this article, the use of geothermal resources in the KOP Region for tourism, health, agricultural, industrial and distinct heating purposes has been evaluated as a result of the project.

2. Geothermal areas in the KOP Region

During the researches conducted within the scope of the study, 265 points with geothermal resources in the region were determined. As a result of the analysis of these points and field investigations, 65 points were reached, and samples were taken by observing these points on site. The locations of the identified and confirmed sources are shown in Figure 1. In addition to these points, 10 geothermal points were communicated by experts in the region and were recorded in the region's geothermal resource inventory.

There are no geothermal resources in the provinces of Kırıkkale and Karaman in the KOP Region, which includes Aksaray, Karaman, Kırıkkale, Kırşehir, Konya, Niğde, Nevşehir and Yozgat provinces. The locations of the geothermal resources in the KOP Region are shown in Figures 1 and 2. According to the written information given by the Special Provincial Administration in the province of Karaman, there are 7 geothermal resource exploration licenses. It has been stated that 6 of these are at the tender stage and no drilling work has been done in one. The geothermal resources in the KOP Region are used in thermal tourism, agriculture and energy sector.

3. Geothermal tourism and health status analysis in KOP Region

3.1. National and regional thermal tourism strategies and plans for the KOP Region

In the 2007–2023 Thermal Tourism Master Plan, while creating thermal tourism regions, geothermal resources and potentials, as well as cultural values of national and international importance, the criteria such as transportation opportunities, natural beauties, climatic conditions and opportunities to be integrated with other alternative tourism types has been taken into account (Aydın, 2014). In addition, special destinations and tour programs have been created with each of them for the Central Anatolia Tourism Region, which has been determined as a priority region to develop.

In the Thermal Tourism Master Plan (2007–2023), 10 priority thermal tourism centers to be developed as Central Anatolia Tourism Center (Aksaray, Kırşehir, Niğde, Nevşehir, Yozgat) are proposed:

1) Aksaray Güzelyurt Ilısu Thermal Tourism Center
2) Kırşehir Çiçekdağı Mahmutlu Thermal Tourism Center
3) Kırşehir Mucur Thermal Tourism Center
4) Kırşehir-Terme-Karakurt Thermal Tourism Center
5) Niğde Aksaray-Narlıgöl Thermal Tourism Center

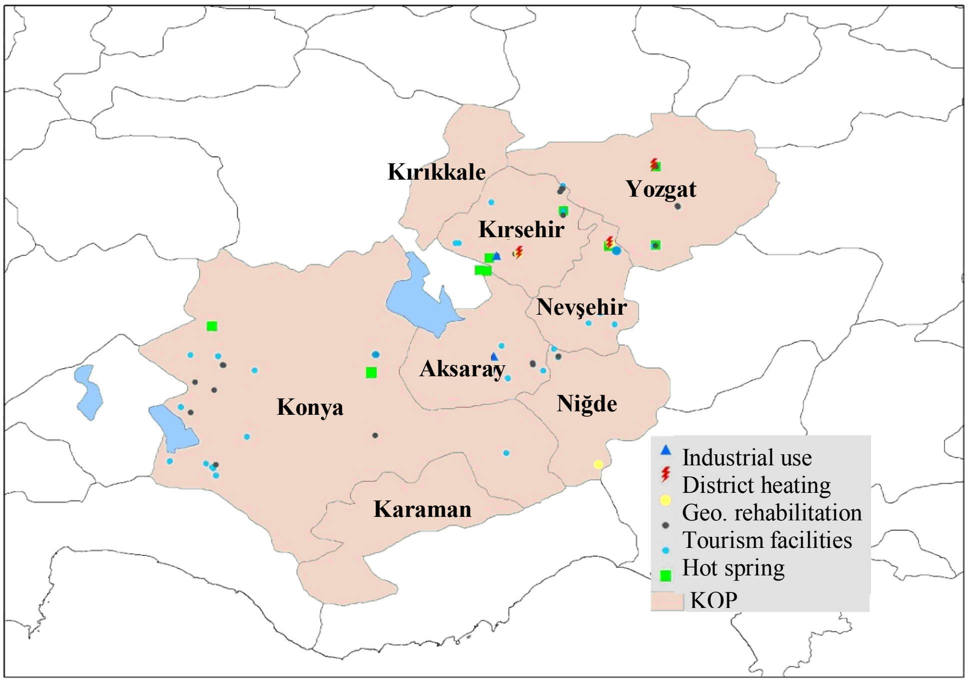

Figure 1. KOP Region geothermal use inventory (JKDP, 2021).

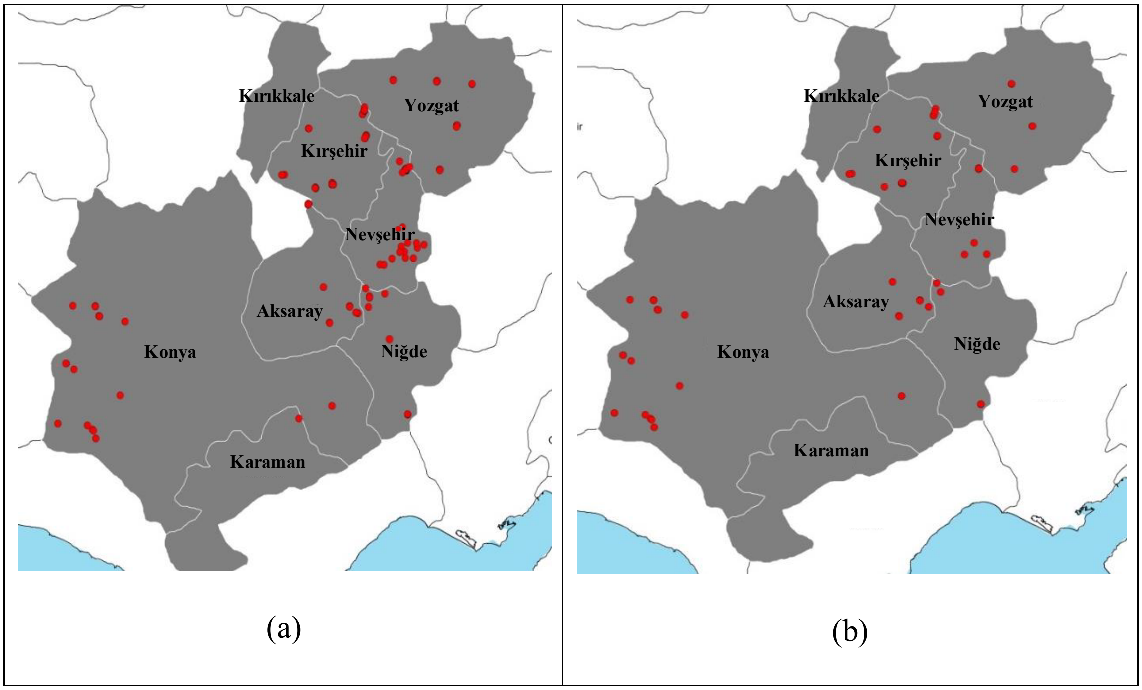

Figure 2. Geothermal resources in KOP Region (a-detected; b-confirmed) (JKDP, 2021).

6) Yozgat Akdağmadeni Karadikmen Thermal Tourism Center

7) Yozgat Boğazlıyan Bahariye Thermal Tourism Center

8) Yozgat Sarıkaya Thermal Tourism Center

9) Yozgat Sorgun Thermal Tourism Center

10) Yozgat Yerköy Güven-Kırşehir Çiçekdağı Bulamaçlı Tourism Center

Local actors in the region, on the other hand, carried out studies at basin, province or IMM 2 level for thermal tourism. In this respect, besides the KOP Administration, the studies of Development Agencies come to the fore. In the KOP Region Tourism Master Plan prepared by the KOP Regional Development Administration (RDA) in 2016, thermal tourism centers were envisaged for Konya, Aksaray and Niğde provinces. In this context, suggestions and plans were presented in Niğde (Narlıgöl and Çiftehan), Aksaray (Ziga, Narlıgöl and Ilısu), Konya (Ilgın, Akşehir, Kadıhanı, Tuzlukçu, Hüyük - Köşk, Karatay-İsmil, Seydişehir, Ereğli-Akhüyük).

In the KOP Region Integrated Tourism Master Plan prepared by the KOP RDA in 2018, Terme, Karakurt and Çiçekdağı, Bulamaçlı in Kırşehir, Kozaklı in Nevşehir, Sorgun in Yozgat, Sarıkaya, Yerköy and Boğazlıyan were highlighted as thermal tourism centers and Kozaklı district has been determined as a 'thermal tourism center and tourism center'. In the plan decisions, recommendations and plans were presented at these locations.

In the macro-based regional plan prepared by Mevlana Development Agency (MEVKA) for Konya and Karaman provinces in 2017, strategies and implementation projects were prepared for the use of thermal waters for tourism purposes. Suggestions have been made to increase interaction with other regions and a study has been conducted for the cluster model. It has been suggested to establish a health and SPA city within the application projects, and as an alternative, Ilgın, Köşk and İsmil spa resorts have been brought to the fore. Kulu and Cihanbeyli were stated as alternatives for the establishment of a salt, health and antiaging center.

Yozgat has been comprehensively addressed in the 2021–2024 strategic plan of the ORAN Development Agency. In this respect, taking into account the historical Hittite civilization of the region, Boğazlıyan, Sarıkaya, Yerköy and Sorgun districts were defined as tourism protection and development areas in the incentive system. In the regional plan, it has been predicted that Yozgat thermal resources will be promoted and economic growth will be around 14%, especially with the opening of the Ankara - Sivas high speed train line. A comprehensive geothermal road map for the districts of Yozgat has been prepared.

In the regional plan prepared by Ahiler Development Agency in 2014, Kırşehir-Center, Nevşehir-Kozaklı, Avanos, Ürgüp, Aksaray-Güzelyurt, Gülağaç and Niğde-Ulukışla were specified in the focus of thermal tourism. Targets and strategies have been established for the development of thermal tourism.

3.2. Health services availability of geothermal resources

Chemical analysis results of 70 water samples taken from geothermal springs in Aksaray, Konya, Kırşehir, Niğde, Nevşehir and Yozgat provinces within the scope of KOP Region Geothermal Resources Assessment Project were classified according to the criteria used in special waters and drinking cures used in the classification of thermal and/or mineral water resources. When the contents of the waters analyzed in the KOP Region are examined, the healing properties for the following disease groups have been determined. According to this classification, Turkey is assessed based resource availability can be used as a supporting treatment of certain diseases that are determined by different research made worldwide. While evaluating the resources, the diseases were collected in 8 groups. These disease groups are:

1) Gynecological Diseases
2) Kidney and Urinary Tract Diseases
3) Skin Diseases
4) Digestive System (Stomach and Intestinal Metabolism Diseases)
5) Respiratory System Diseases
6) Heart and Circulatory System Diseases
7) Neurological Diseases
8) Locomotor System Diseases

From this point of view, geothermal water resources that are effective against diseases on the basis of provinces are given in Table 1. KOP Region has rich contents of geothermal resources with different indications. Maps for the curative use of water from springs on the basis of disease groups are given in Figures 3 and 4. The dots indicated in the form of a large circle indicate that the content of water taken from that point is good for the disease in question. The small circle indicates that water is not an indication for related diseases.

3.3 Evaluation of geothermal tourism and health enterprises in KOP Region

An inventory study has been carried out for geothermal tourism and health enterprises located in the KOP Region. For the needs analysis made for the field of geothermal tourism, some of the facilities were visited and information was obtained from them through different communication channels.

In the inventory study conducted for geothermal health and tourism enterprises in the KOP Region, a total of 42 enterprises were reached. The provinces where these enterprises are located are given in Table 2. However, it should be noted that the statistics in question are only from the businesses that can be reached and the inventory is actually larger.

The total bed capacity of 42 enterprises in the KOP Region is 7947. The total number of rooms is 3243. Nevşehir is the most prominent province in terms of the number of enterprises, and it is seen that Kozaklı district covers this whole. 45% of the enterprises are located in Nevşehir. In this respect, it can be stated that Nevşehir-Kozaklı region is an important region in terms of geothermal health and tourism.

The distribution of 45 enterprises that can be reached in the KOP Region is given in Table 3.

When the total capacity of the enterprises is examined in terms of the number of rooms and beds on a provincial basis, it is seen that Nevşehir has almost half of the total capacity. Niğde, Yozgat, Kırşehir, Konya and Aksaray follow Nevşehir respectively. Considering the average size of the enterprises in terms of beds, it is seen that there are 189 beds per enterprise. However, it is understood that the number of beds per enterprise is 370 in Niğde, well above the regional average, on the other hand, Yozgat and Konya are below the average with values below 140 beds.

Table 1. Health availability of geothermal resources (JKDP, 2021).

Diseases/illness	**Provinces (number of geographical points)**						
	Konya (24)	**Kırşehir (22)**	**Nevşehir (6)**	**Niğde (4)**	**Aksaray (7)**	**Yozgat (6)**	**Toplam (69)**
Gynecological diseases	3	0	0	0	0	0	**3**
Kidney and urinary tract diseases	9	0	3	3	3	0	**18**
Skin diseases	7	2	0	0	3	0	**12**
Digestive system diseases	6	0	3	4	3	2	**18**
Respiratory diseases	0	0	0	1	1	1	**3**
Heart and circulatory system diseases	3	0	0	2	0	0	**5**
Neurological diseases	14	20	3	0	3	4	**43**
Locomotor system siseases	17	22	6	4	6	6	**61**
Total	**59**	**44**	**15**	**14**	**18**	**13**	**163**

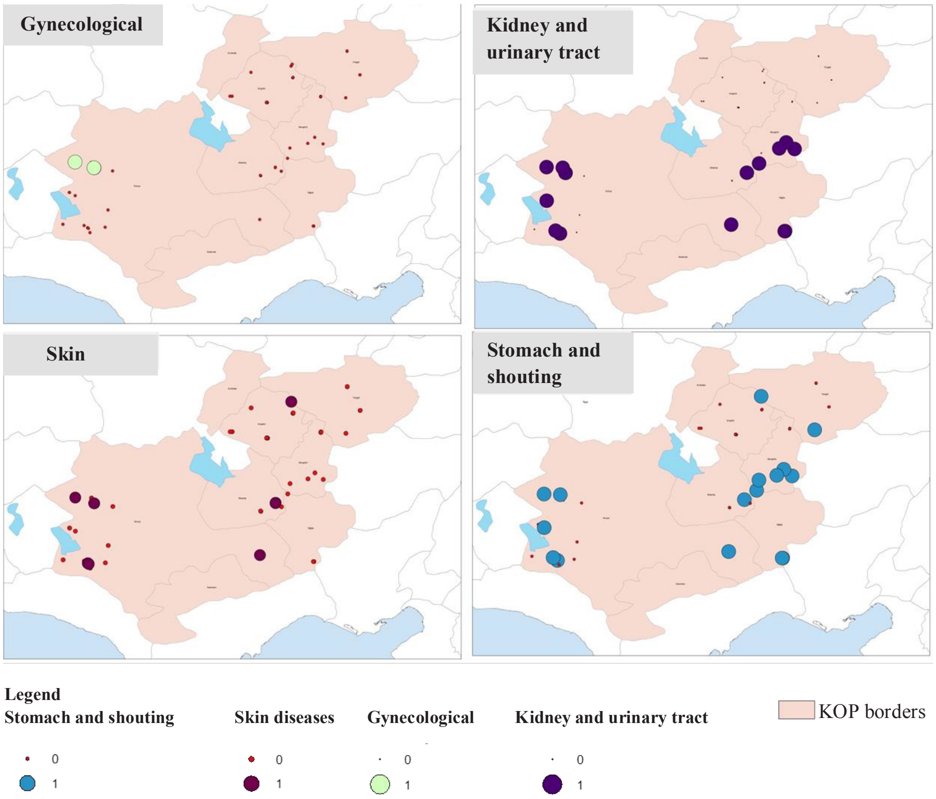

Figure 3. Display of disease inductions on the basis of provinces (JKDP, 2021).

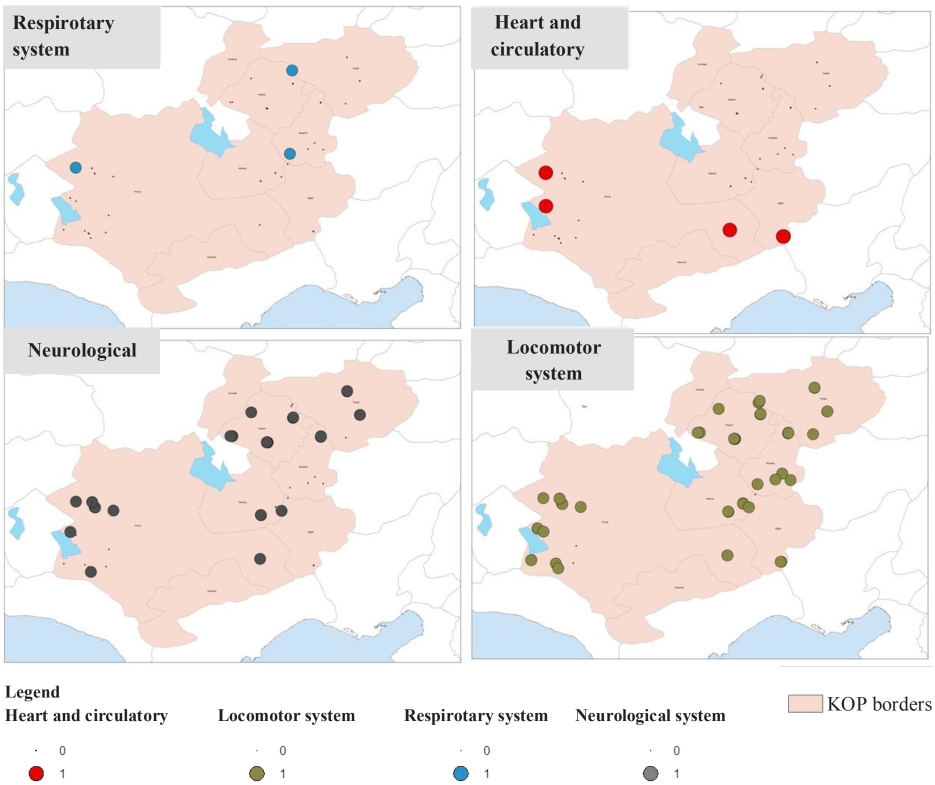

Figure 4. Display of disease inductions on the basis of provinces (JKDP, 2021).

Table 2. Geographic distribution of geothermal health and tourism enterprises in the KOP Region (JKDP, 2021).

Quantity	Number of facility in KOP provinces						
	Konya	**Kırşehir**	**Nevşehir**	**Niğde**	**Aksaray**	**Yozgat**	**Total**
Number of facility	6	4	19	3	2	8	42
Ratio (%)	14	10	45	7	5	19	100

Table 3. Classification of geothermal health and tourism enterprises in the KOP Region (JKDP, 2021).

	Conventional			**Improved**	
Provinces	**Thermal**	**Bath**	**Drinking**	**Scientific Spa**	**Total**
Aksaray	2				2
Kırşehir	4	1			5
Konya	6	1	1		8
Nevşehir	16			3	19
Niğde	4				4
Yozgat	7			1	8
Total	39	2	1	4	46

The highest and lowest occupancy rates of enterprises on provincial basis are given in Table 4. The number of beds and occupancy rates of some enterprises could not be reached.

Occupancy rates of geothermal tourism and health enterprises in the KOP Region are given in Table 5 on provincial basis. Information on occupancy rate of some of the facilities in Konya, Nevşehir and Yozgat provinces is not available. Therefore, the number of businesses given in the previous sections differ. Information on occupancy rates of one facility in Konya, two facilities in Nevşehir and three facilities in Yozgat is not available. The occupancy rates were divided into 20% pieces and ranges were created. In order to show the average occupancy better, the weighted average occupancy rates are determined by taking the weighted average according to the bed capacity. Aksaray is the best among provinces in terms of occupancy. The provinces where the enterprises have the lowest occupancy on average are Konya and Yozgat. From the point of view of the KOP Region, the occupancy rate of hotels weighted according to the number of beds is 65%.

The existence of enterprises operating as scientific spas under the operating permit of the Ministry of Health is an important criterion in terms of showing the level of infrastructure in terms of thermal health tourism. Therefore, an inventory has been taken in the KOP Region for the enterprises with this permission. There are a total of 26 hot springs in the Central Anatolian Thermal Tourism cities region, which includes Aksaray, Kırşehir, Nevşehir, Niğde and Yozgat provinces in the KOP Region. In addition to these, there are three hot springs in Ilgın and Karatay in Konya, which are not included in the thermal tourism cities plan. With the addition of the facilities in Konya, the total number of hot springs in the KOP Region reaches 29. These hot springs and other hot springs in the region are given in Table 6. Sixteen of the 29 hot springs in the KOP Region are located in Nevşehir Kozaklı. While Nevşehir is followed by Kırşehir with 4 facilities, there are 3 hot springs in Konya and 2 in Aksaray and Yozgat provinces.

4. Agricultural and industrial applications of geothermal resources in the KOP Region

Regarding the agricultural applications of thermal resources in the KOP Region, different applications were visited on site and information on agricultural enterprises using thermal resources was collected. In addition, interviews were conducted with business owners to identify different applications, opportunities and threats related to businesses. Thus, the general situation of geothermal enterprises in the KOP Region has been revealed.

4.1. Agricultural applications of geothermal energy and greenhouse inventory in KOP Region

The main usage area of geothermal resources in KOP Region is geothermal greenhouse cultivation. Within

Table 4. Tourism and health enterprises in KOP provinces (JKDP, 2021).

Quantity	Number of facility in KOP provinces						
	Konya (6)	**Kırşehir (4)**	**Nevşehir (19)**	**Niğde (3)**	**Aksaray (2)**	**Yozgat (8)**	**Total (42)**
Number of rooms	338	434	1546	354	156	415	3243
Number of rooms (%)	10	13	48	11	5	13	100
Number of beds	821	845	3734	1,110	416	1021	7947
Number of beds (%)	10	11	47	14	5	13	100
Number of tack per business	137	211	197	370	208	128	189
The lowest occupancy (%)	40	40	30	30	60	25	25
Highest occupancy (%)	100	85	85	80	95	70	100

Table 5. Occupancy rates on the basis of provinces in the KOP Region (JKDP, 2021).

Occupancy	Provinces (number of facility)						
	Konya (4)	**Kırşehir (4)**	**Nevşehir (17)**	**Niğde (4)**	**Aksaray (2)**	**Yozgat (5)**	**Total**
80% and above	1	1	3	1	1	0	7
60%-79%	1	2	4	2	1	2	12
40%-59%	2	1	8	0	0	2	13
40% below	0	0	2	1	0	1	4
Average occupancy (%) (arithmetic)	58	66	56	64	78	54	59
Average occupancy (weighted)	60	71	63	72	77	64	65

Table 6. The number of spas with ministry operating certificate in the provinces of KOP Region (JKDP, 2021).

Province	District	Number of Spas
Aksaray	Güzelyurt	2
Kırşehir	Merkez	4
Konya	Ilgın	2
	Karatay	1
Nevşehir	Kozaklı	16
Niğde	Ulukışla	2
Yozgat	Sarıkaya	1
	Sorgun	1
Total		29

Table 7. Agricultural greenhouse areas in KOP Region (JKDP, 2021).

Provinces	Number of businesses	Greenhouse area (da)
Konya	2	150
Nevşehir	2	59
Aksaray	2	77
Yozgat	2	80
Kırşehir	2	226
Total	10	592

the scope of the current situation analysis, there are geothermal greenhouses in 5 provinces in the KOP Region. Some summary information of the existing geothermal greenhouses on the basis of provinces is given in Table 7. Detailed information about the enterprises is given in Table 8. It is observed that vegetables, mostly tomatoes, are produced in geothermal greenhouses, except for the rose greenhouse in Kozaklı. Existing geothermal greenhouses are concentrated in the north-east of the region.

Apart from the existing enterprises, it is planned to establish a 30 decare geothermal greenhouse in Nevşehir Kozaklı. This enterprise aims to increase the greenhouse area to 50 decares later. In addition, there are two greenhouse complexes currently under construction in Yozgat-Sorgun and Boğazlıyan districts. With these three

Table 8. Current geothermal greenhouses and their features in the KOP Region (JKDP, 2021).

0.1. Companies	BAŞYAZICIOĞLU		İLKSER	FARMCO	TUTKU	MİLKAR	DODOMATES	ERKBY	ŞTİ	KOZAKLI ROSE
1.2. Provinces	Nevşehir	Yozgat	Yozgat	Kırşehir	Aksaray	Aksaray	Konya	Konya	Kırşehir	Nevşehir
1.3. District	Kozaklı	Boğazlıyan	Sorgun	Çiçekdağ	Sarıyahşi	Sarıyahşi	Tuzlukçu	Cihanbeyli	Karakurt	Kozaklı
1.4. Altitude	1000–1100m	1000–1100m	1200 m	1300 m			979 m	973 m	1080 m	1050 m
2. Geothermal resources										
2.1. Geothermal well		Bahariye		Farmco	Bekdik 2-3, Tutku 1		Buhar 1- 2-3-4 ve KT 1			
2.2. License	NEVJET	City administrations	City administrations	Farmco	Tutku	Milkar	Buhar Energy	Erkby	ŞTİ	Kozaklı Rose
2.3. Well deep				250 m, 1300 m 800 m			215–350 m	468 m		55 m
2.4. Fluid temperature	90–95 °C	55–60 °C		80 °C	51-52 °C, 58-61 °C	71 °C	50 – 55 °C	48 °C	70 °C	85 °C
3. Greenhouse structural features										
3.1. Greenhouse area	56-60 da	55 da	25 da	100 da	40 da	37 da	50 da	100 da	126 da	4 da
3.2. Greenhouse dimensions	120 × 190 m	240 × 230 m	80 × 124 56 × 100 100 × 104				240 × 202 m			90 × 45 m
3.3. Greenhouse height	7–9 m	7–9 m	7 m	4.5 m	7.6 m	7.6 m	7.5 m	7 m	7 m	4.5 m
4. Greenhouse heating systems										
4.1. Heat exchanger location	Water is distributed through the valve system. It circulates from the ground at a height of 20 cm from the ground.	Water is distributed through the valve system. It circulates from the ground at a height of 20 cm from the ground.	With steel pipes under the gutter and above the growing box	Rail system is used. With steel pipes under the gutter and above the growing box	Rail system is used. With steel pipes under the gutter and above the growing box	Rail system is used. With steel pipes under the gutter and above the growing box	Rail system is used.	Rail system is used. With steel pipes under the gutter and above the growing box	Rail system is used. With steel pipes under the gutter and above the growing box	Rail system is used. With steel pipes under the gutter and above the growing box
4.2. Fluid inlet temperature	70–75°C	40–45°C	78–80 °C	70 °C	51 °C	51 °C	50-55 °C	43 °C	55 °C	85 °C
4.3. Fluid outlet temperature	55–60°C	25–30°C	28–30 °C		38 °C	38 °C	35 °C	23 °C	35 °C	
4.4. Fluid flow rate	30 l/s	50 l/s	11–12 l/s		30 l/s	30 l/s	120 l/s	200 l/s		10 l/s
4.5. Use of inhibitors	The municipality uses it itself.	It is used from time to time because it is sulphurous water.	No	Yes	Yes Ca ve Mg 10 ton/year 35 000/year	Yes Ca ve Mg 10 ton/year 35 000/year	Lime is used because of its high water feature.	Yes	No	Yes

Table 8. ‘Continued).

4.6. Energy/fuel cost	55 thousand TL water price 60 thousand TL electricity fee	1% of the revenue is paid to the special provincial administration for rent and water. Electricity cost 65 thousand TL	Spring water 20 thousand TL/ month 15 thousand TL electricity	100 thousand TL/month			In addition to geothermal energy, a natural gas system has also been established. However, its use was not deemed necessary.			
5. Cultivation systems										
5.1. Growing period and period	9 months of the year, cultivation and product harvest is carried out.	9 months of the year, cultivation and product harvest is carried out.	8 months of the year, cultivation and product harvest is carried out.	Summer season: 1.5 months Winter season: 3-4 months			Summer season: 2 months Winter season: 2.5 months	3 months	3 months	
6. Product features										
6.1. Grown product type	Frenzo	Frenzo	Altes	Sranzo, Gülköy, Climbo, Aroma, Bombelo	Climbo	Climbo	Cluster	Gülköy, Cluster Cherry	Cluster	
6.2. Number of plants :	160,000 (3 thousand ton)	142,000 (3 thousand ton)	60 thousand roots	3.75 plant (with hill)/m^2	3.6 plant (with hill)/m^2	3.6 plant (with hill)/m^2	130,000			15.000 pieces/da
6.3. Crop yield			30–35 ton/da 13 kg per root	30 ton/da	40 ton/da Yearly 1500 ton	40 ton/da	45–50 ton/da	60 ton/da	50 ton/da	60.000 pieces/da
7. Greenhouse Ventilation system										
7.1. Total clearance area	1 m	Between both glasses 3 m					1 m			
7.2. Number of dans	150	150	NO				48			
8. Energy savıng measures and automatıc control in greenhouse										
8.1. Frost protection	Coal heating system	Coal heating system	Natural gas backup boiler	No	No	No	No	Backup boiler, Buffer tank	Backup boiler, Buffer tank	No

greenhouses to be established, it will contribute to the increase of the geothermal greenhouse area in the region.

In recent years, two newly opened greenhouse enterprises stated that they want to increase the total greenhouse area to 500 decares in the coming years. The data on the greenhouse areas were compiled taking into account the statements of the companies as a result of the interviews. Therefore, there may be incompatibilities regarding the geothermal area specified in the license obtained.

Enterprises engaged in geothermal heated greenhouses in the KOP Region; It is located in Sarıyahşi (Aksaray), Çiçekdağı (Kırşehir), Cihanbeyli and Tuzlukçu (Konya), Kozaklı (Nevşehir), Boğazlıyan (Yozgat), and Sorgun (Yozgat). The altitude of the settlements where greenhouse businesses are located varies between 900 and 1300 m. The licenses of the geothermal resources used for heating purposes in the greenhouses where geothermally heated tomatoes are produced in Kozaklı (Nevşehir), Boğazlıyan (Yozgat) and Sorgun (Yozgat) districts belong to the Special Provincial Administrations. The licenses of the geothermal resources used by the greenhouse enterprises in Sarıyahşi (Aksaray), Çiçekdağı (Kırşehir), Karakurt (Kırşehir), Cihanbeyli (Konya) and Tuzlukçu (Konya) belong to the companies themselves.

If the main characteristics of the greenhouse are examined in the interviews made with the geothermal greenhouse operators in the KOP Region, it is seen that the greenhouse ceiling structures are generally designed with polyethylene (PE) plastic cover, and the sides of the greenhouse are designed with polycarbonate (PC) plastic. Except for the greenhouses in Nevşehir Kozaklı, Yozgat Boğazlıyan and Sorgun, other greenhouse structures are located east-west. The other three facilities are located in the north-south direction. In greenhouse heating systems, generally 51 mm diameter steel pipe systems are used, while 38 mm diameter plastic pipes are used for plant heating.

Soilless agriculture is carried out in the greenhouses and cocopite is used as the growing medium. Plant nutrients are provided by applying it to irrigation water. Bumblebees are used in tomato cultivation in other greenhouses in the region other than the greenhouse where roses are grown in Nevşehir Kozaklı.

In all of the greenhouses, geothermal water is not sent directly to the greenhouse, but is used in the heating of clean water. After the geothermal water is taken from the well with the pump, it is heated with a heat exchanger system. Clean water heated by the method of heat transfer between fluids is transported into the greenhouse with the help of pipes.

Natural ventilation system is applied in all existing greenhouses. Cooling and humidification systems are provided by fogging method in all greenhouses other than the Ilkser greenhouse in Yozgat and the rose greenhouse in Nevşehir Kozaklı. Again, with the exception of Nevşehir Gül greenhouse, shading and screening applications are made in other greenhouses. It is possible to say that fully automatic control systems are used in greenhouses except Kozaklı rose greenhouse for energy and heat saving measures in greenhouses. Automatic control systems regularly check the greenhouse climate data every hour and give warnings against emerging sudden situations. With these systems, products are prevented from being damaged.

4.2. Use of geothermal energy in drying plant

The geothermal fruit drying facility is located in Karakurt, about 20 km from Kırşehir city center. The drying facility was built with the partnership of Kırşehir Special Provincial Administration and Kırşehir Municipality with a grant from Ahiler Development Agency. The facility, which has existed for approximately ten years, has been operated by Kırşehir Chamber of Craftsmen and Craftsmen Gıda for the last 5 years. Geothermal is the first public fruit and vegetable drying plant started up in Turkey. fruit and vegetable drying plant in Turkey, which is generally operated with a high cost of coal and natural gas. The biggest advantage of geothermal drying over other drying methods is that it does not leave any residue on the product. This feature is an important preference for geothermal drying. In this sense, with the renovation of the idle school buildings with the public initiative, the said facility was put into operation at a distance of approximately 500 m from the geothermal water well. The indoor area of the facility established on a total area of 20 decares is approximately 200 m^2. There are 1 food engineer and 2 personnel working seasonally in the facility.

The thermal energy required for the drying of the products in the facility is obtained from the Karakurt1 (K1) well at 147 m depth, which has a flow rate of 15 l/s and a temperature of 52 °C. The thermal water, which is transported to the heat center by means of pipes, heats the network water through exchangers. The heated mains water comes to the air handling unit, which has a flow rate of 15,000 m^3/h, 7.5 kW motor power and 146,200 kcal/h heating capacity, and from here blows hot air to the drying oven (Boyacı et al., 2018). Products coming to the facility are stored in a cold storage at +4/6 °C until they reach a certain maturity level. The product to be produced in the facility becomes ready for packaging after the stages of washing, chopping and passing through the drying tunnel. Since the packaging process is also carried out in-house, fresh fruit is taken out of the facility as packed and dried one day after entering the facility. Geothermal energy is used in the drying tunnel during the effect of water vapor on the product. Drying times vary according to the type of product, and the drying process is completed in 8 h or 1 day.

The facility, where different products are dried, from watermelon to apple, tropical fruits such as pineapple, kiwi to anchovies and mushrooms, makes production according to orders. Within the scope of the cooperation with Kırşehir Ahi Evran University, anchovy drying has also been made, and services can be provided for different orders.

The most important problem in the business is the insufficient capacity. Although orders are received from different provinces for drying of various fruits, the demands cannot be answered due to the low capacity. As a solution to the problem of insufficient capacity at the facility, a project with a budget of 485 thousand liras named Capacity Increase in Dried Food was implemented in the social and environmental investment programs of the Trans Anatolian Natural Gas Pipeline (TANAP). In the project in question, a capacity increase was made with a 95% grant, and the machines that can currently dry 400 kg of products at the same time have been able to receive up to 2000 tons of products (Boyacı et al., 2018).

In addition, the said drying facility has developed a joint project with the Ministry of National Education. In this cooperation planned within the scope of safe food, it was aimed to distribute dried fruit to primary school students. An agreement was reached with an exporter company for the sale of the manufactured products abroad. In this context, it is planned to ship products to Kuwait and Qatar markets. It is considered that the products produced for export can easily be found in buyers, but the exporters and the relevant department of the Chamber of Tradesmen and Craftsmen, market research and price analysis cannot be opened to the foreign market due to the need for development in areas that require marketing expertise.

The drying facility has problems with increasing costs due to the seasonal increase in fruit prices. Another factor that increases the cost of the product produced is the high electricity costs of the facility. In geothermal drying, electrical power is used to drive the fan and pumps. The cost of the dried product on a monthly basis is approximately 2 times the cost of electricity, the facility with an electricity cost of 20 thousand lira, declares that the operating costs will be significantly reduced and costs will be reduced in case of electricity generation.

It is possible to prevent waste and the damage of greenhouse businesses by drying the products that cannot be sold periodically in the greenhouses in the drying facility with the cooperation between the fruit drying facility and greenhouses. Especially, tomato growing greenhouses located in Kırşehir may be considered to be sold to Eastern Anatolia and Southeastern Anatolia regions, where this product is consumed intensively, by drying tomatoes in periods when the products cannot be sold. In addition, the fact that companies producing products such as instant soups and pasta sauce intensively purchase dried tomatoes reveals that sales can also be made in this area (Boyacı et al., 2018).

4.3. Products that can be produced in the greenhouse and dried fruit industry

When the vegetables, fruits and plants that are widely produced in greenhouses are examined, many factors from the climatic conditions of the region to the marketing possibilities are effective in the selection of the product to be grown. For this reason, these factors should be analyzed in detail when investing in greenhouses. However, according to the production statistics of the KOP Region, the most vegetables for table tomatoes, carrots and tomato paste are produced in the region. In fruit production, it is seen that apple production is significantly higher than other fruits. While table and tomato paste is produced mostly in Konya, Karaman and Aksaray provinces, carrots in Konya and apples in Karaman are produced. When considered in terms of export markets on the other hand, the leader of Turkey's advantageous geographical position allows it to export tomatoes seems to be a country. The focus of geothermal greenhouses in the KOP Region on tomato production is the size of the added value obtained from exports. For this reason, it is thought that it would be more economical for greenhouses to continue export-oriented tomato production. In the negotiations with companies, tomatoes are preferred primarily because of the fact that there is no problem in the export market, it is very advantageous to Northern European countries in terms of climate zone and solar radiation, and the region is suitable for tomato production both in summer and winter. When asked about their opinions on different products, they stated that a product other than tomatoes is not as open as tomatoes in export and national markets. In addition, tomato production is preferred because it allows for approximately 11 months. At this point, businesses have strategically prioritized turning to new export markets and diversifying their existing markets without changing products.

It is important for the industry of the region to produce value-added products by utilizing geothermal energy in industrial applications and thus increasing the benefit to be obtained. When we look at the dried fruit industry, the product range includes fruits such as dried apple, strawberry, pineapple, kiwi, persimmon, orange, watermelon, quince, pear, plum, peach, tangerine, melon, apricot and fig. It is possible to come across applications in which the variety of products is increased by drying vegetables such as tomatoes, onions and herbal teas.

Products are not only sourced from the region, but can also be purchased from surrounding provinces and other regions. In the present case, as the drying plant products in the KOP received from producers in the province, by supplying from various regions of Turkey also serves fruit and vegetable drying.

As in the selection of the product to be produced in the greenhouse, climate conditions, supply and marketing opportunities analysis are important factors here. When these analyzes are considered as a prerequisite before such investments, it is considered that among the products that can be dried in the region, tomatoes, melon, watermelon and grapes can be considered among the products that can be dried in the region and it is not suitable for the region due to the high prices of strawberries in today's conditions. In this context, it is considered that tomatoes, beans, green peppers and strawberries can be evaluated if they are found suitable for the region by researching investment opportunities in terms of products that can be produced in greenhouses.

It is expected to increase both in Turkey and in the world of dried fruit and vegetable consumption. World production and trade of dried fruits Turkey ranks first. Included in the fruit group are hard-shelled fruits such as hazelnuts and peanuts. Turkey, 36% of the world production of raisins, and dried figs meets alone in 40%. Looking at the production of the KOP Region, the most striking product is apple with 1.2 million tons of production. When looking at the price changes of apple, it can be seen that it varies between 0.7 and 1.5 TL, and it can generally be supplied for 1 TL. Therefore, drying the apple is considered beneficial for the region (JKDP, 2021).

Melon and watermelon production is also available in the region. Approximately 480 thousand tons of these products are produced and the sales prices are between 0.3 and 0.5 TL in the spring and summer months (between the 5th and the 10th month). It is seen that these products also have drying potential. In the fruit category, apple production is followed by grape production with 309 thousand tons. 115 thousand tons of these grapes are for drying. Grapes also emerge as candidates for drying between 6 and 8 months with a value of 1 TL (JKDP, 2021).

Along with the high demand in the region, tomatoes also have a production of over 790 thousand tons. Looking at the market prices, it is possible to find products for 0.5 TL (JKDP, 2021). Therefore, tomato drying should also be taken into account. At this point, it is recommended to dry the tomato coming from the field due to the high production costs in the greenhouse and the high quality of the tomato produced. Products such as cherries and sour cherries are also produced in the region. However, these products emerge as qualified and value-added products sold to foreign markets. Therefore, these products do not seem possible to be dried. However, if the market is not found, these products can be dried. One of the most important evaluation topics regarding the products to be dried is the initial and final moisture rates. These ratios refer to the weight to be lost during the drying of a product.

5. Heat capacities of geothermal resources in KOP Region

In this section, the temperature and capacity relationships of geothermal resources in the provinces and districts of the Konya Plain Project (KOP) Region have been examined. Data were evaluated on geothermal fields located in Konya, Aksaray, Niğde, Nevşehir, Kırşehir and Yozgat provinces in the KOP region. From these data, heat capacity in MWt were calculated by using the flow rates and temperature values of the wells. Thermal capacity was calculated equation is given in the below.

$$\textit{heat capacity} = w \times (T - 20) \times 0{,}004184 \qquad (1)$$

where w (kg/s) and T (°C) represents mass flow rate and geothermal fluid temperature, respectively.

The heat capacity obtained is in units of MWt. Power calculation was made with the assumption that the return temperature of the geothermal source with T temperature decreased by 20 °C.

Heat capacity analysis was made according to the provinces in the KOP Region. Results depicted in Table 9 and Figure 5. As seen in Table 9, some statistical data are given by provinces. This study consists of 65 data in total. Accordingly, the most data belong to Konya. This is followed by Kırşehir province. The highest temperature observed in a well belonging to the Special Provincial Administration in Kozaklı district of Nevşehir province. In the light of current data, the highest capacity is realized in Kırşehir. Provinces where district heating can be realized are Kırşehir, Nevşehir and Yozgat.

Heat capacities with the information about all the wells are calculated for the evaluation of the geothermal possibilities of the Konya Plain (Table 9). The heat capacity values are based on the current temperature and flow rate values. Flow rates can change over time. If additional wells drill within the scope of the project in any region, the flow rate production and heat capacity will increase.

6. Results and discussion

6.1. Thermal tourism for the KOP Region

When the provinces in the KOP Region are evaluated in terms of thermal tourism potential, Kozaklı district of Nevşehir province stands out. It can be shown as an example of good practice in the region because it is the province with the highest number of facilities in the region and is an important source of income and employment for the district. While evaluating geothermal tourism suggestions, stakeholder opinions and information obtained from field studies, geological, geographical and historical structure of the region were taken into consideration. Tourism sector

Table 9. Distribution of heat capacity according to provinces in the KOP Region (JKDP, 2021).

Province	Number of Data	T_{min} (°C)	T_{max} (°C)	Capacity (MW_t)	%
Aksaray	7	28.4	56.20	29.93	13
Kırşehir	18	30.8	78.30	68.94	30
Konya	29	18.3	60.00	60.09	26
Nevşehir	6	43.5	105.50	33.28	14
Niğde	4	32.2	60.10	6.77	3
Yozgat	6	40.6	79.40	33.73	14
KOP Region	**70**	**18.3**	**105.5**	**232.73**	**100**

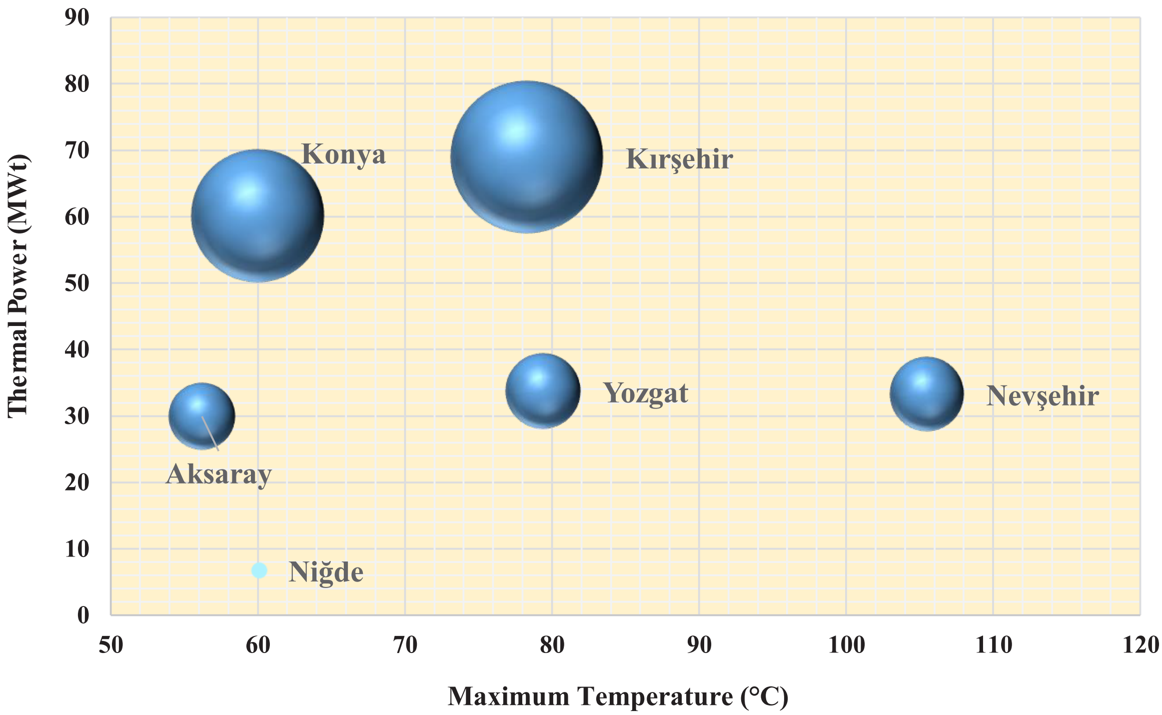

Figure 5. Distribution of the relationship between heat capacity and maximum temperature by provinces (JKDP, 2021).

investment proposals were made for the provinces and districts of Aksaray, Kırşehir, Konya, Nevşehir, Niğde and Yozgat.

6.1.1. Investment recommendations for the tourism sector in KOP Region Provinces

When geothermal resources are evaluated in terms of tourism in Aksaray province, it is seen that the districts of Gülağaç and Güzelyurt stand out. There is a need for a 5-star facility for business purposes in the city center. However, it was concluded that the possible new facility could not meet the demand for a thermal hotel.

When the geothermal resources in Kırşehir are evaluated in terms of tourism, the provincial center, Akpınar, Çiçekdağı and Kaman districts stand out. Due to the fact that it is a destination in the central region and the demands for accommodation are intense, a hotel with a tourism operation certificate has been proposed. In Akpınar district, it was proposed to renew the existing thermal pool and make it suitable for use. In Çiçekdağı, a modernization proposal has been made due to the fact that the current facility needs maintenance. Considering the tourist potential of the dam beach in Kaman district, it has been evaluated that the creation of a thermal pool and additional service areas will contribute to the development of the region.

Within the scope of the evaluation of geothermal resources in Konya, suggestions were made for Akşehir, Ereğli, Hüyük, Ilgın and Seydişehir districts. While a proposal was made to build a tourism-operated boutique hotel in Akşehir district, it was proposed to build a touristic pool in Ereğli to utilize the thermal potential. According to the results of thermal water analysis in Hüyük district, it has been observed that it benefits digestive, cardiovascular, locomotor and kidney-urinary tract diseases. Modernizing the Köşk Hot Spring in the district and making it usable with integrated tourism activities will also be appropriate in terms of utilizing the tourism potential in the district. In Ilgın, it is seen that the capacities of the existing facilities are sufficient and the current situation of the district will improve if they are evaluated as a destination together with Akşehir. A capacity increase proposal was made in the Seydişehir district.

In the current situation in Nevşehir, Kozaklı and Ürgüp districts stand out in terms of utilizing thermal resources in the tourism sector. In order to evaluate the potential of Kozakli, creating a holistic visiting area with landscaping was evaluated, while a proposal was made for the construction of a thermal pool and a hotel with tourism operation certificate for the Mustafapaşa region for Ürgüp.

Nigde has the characteristic of being a region where visitors come from different points due to its geographical location and being located between important connection roads. For this reason, the advantage of Ulukışla as a special region where forest, nature, thermal water and historical places are located together was also evaluated and a revision of existing facilities was proposed.

Within the scope of utilizing geothermal resources in the tourism sector in Yozgat, suggestions have been made for the districts of Sarıkaya, Sorgun, Yerköy. Considering the cultural value of the historical Roman Bath in Sarıkaya and the potential of the district, two different proposals have been made, one with a tourism operation certificate and a special certificate. While evaluating the proposal for revisions of the existing investments in Sorgun district, it was thought that modernization and making it suitable for use for the facility in Yerköy will have a positive effect on the region.

6.2. Determination of potentials for agricultural and industrial applications in the KOP Region

6.2.1. Potential areas for geothermal heating greenhouse cultivation

As a result of the field studies, water temperature and flow rate data of 65 springs were obtained. In addition, data of 75 wells in total were taken from 10 sources from provincial special administrations and local governments. In the calculations, thermal water resources below 45 °C were excluded from the scope of the calculation, taking into account the current applications. As a result of this criterion, potential greenhouse area calculations were made for 33 wells above 45 °C. Although there are differences between provinces in terms of the lowest temperatures and possible height of the greenhouse above sea level, the outside temperature was taken into account as –15 °C in the construction of greenhouses. In the interviews with the current greenhouse owners, it was understood that the area calculation was made according to the situation where the outside temperature is –15 °C. It has been stated that temperatures below –15 °C are unusual during the winter months and is recorded for a short time. In addition, greenhouse investors use fossil fuel-fired boiler units and large-capacity balancing tanks against unusually low temperatures, instead of reducing the greenhouse area by taking the external temperature lower. In Table 10, the distribution of potential greenhouse areas on the basis of provinces is given. The calculations made may vary by ±10% according to detailed studies in the location of the geothermal well.

The potential emerging in the calculation of potential greenhouse areas was evaluated with 3 distinctions. It is divided into those over 25 decares, those between 25 and 18 decares, and those below 18 decares. This distinction has been created according to the sustainable area approach for businesses that are generally accepted in the sector. According to the values taken from 33 wells, the total heatable greenhouse area was determined as 663,229 da. 459,661 decares of this part belongs to the wells that promise more than 25 decares of potential.

On the basis of provinces, the highest potential belongs to Kırşehir with 218,916 decares. The thermal spring in Mahmutlu village of Kırşehir Çiçekdağı district, one of the wells with a potential of over 25 decares, is used by FARMCO for greenhouse heating. The resource in Karakurt, Kırşehir, is used in a 100 decare greenhouse belonging to ŞTİ. The potential that emerges in Aksaray-Sarıyahşi is utilized in greenhouse cultivation by MİLKAR and TUTKU. The potential of the well in Konya - Cihanbeyli is used by ERKBY as of 2019. The water of 60 decares greenhouse owned by Başyazıoğlu company in Kozaklı is supplied by NEVJET public company. The water of İLKSER's greenhouse in Sorgun is provided by the Special Provincial Administration. There is a greenhouse potential of 22.5 decares in Konya Tuzlukçu. Currently, this resource is used by a tomato greenhouse and it has established a greenhouse area of 50 decares with 4 new wells it opened.

When the existing and potential greenhouse areas are evaluated together, it is thought that the capacity used for residential heating in Kozaklı will open new areas for greenhouse cultivation. In addition, in Ziga, located in the district of Güzelyurt in Aksaray province, the existing potential is high and there is no greenhouse investment yet in that location. It is seen that the potential greenhouse heating capacity calculations calculated by taking into

Table 10. Potential Greenhouse Areas in KOP Region Provinces.

Province	Decares (25 da and above)	Decares (between 18 and 25 da)	Decares (below 18 da)	Total greenhouse decares
Aksaray	115,329 (3)	-	12,540 (2)	**127,868 (5)**
Kırşehir	135,728 (3)	64,224 (3)	19,182 (6)	**218,916 (11)**
Konya	30,360 (1)	22,489 (1)	2,052 (1)	**54,902 (3)**
Nevşehir	96,067 (1)	18,333 (1)	20,765 (3)	**135,165 (5)**
Niğde	-	-	17,343 (3)	**17,243 (3)**
Yozgat	82,177 (2)	21,389 (1)	5,567 (2)	**109,133 (5)**
Total	**459,661 (10)**	**126,435 (6)**	**77,133 (16)**	**663,229 (32)**

account the data of the sampled wells are made with only a limited number of wells and more greenhouse areas can be heated with thermal resources to be determined with new drillings. As a matter of fact, the installed capacity of the company operating in Cihanbeyli has reached 100 decares with the new wells it opened (potential 30 da).

Within the scope of the study, some standards regarding greenhouse production have been determined in order to ensure qualified production and to prevent incorrect investments. In this context, the technical characteristics of the greenhouse in an area of 10 decares. The greenhouse area taken as basis in technical feasibility studies is approximately 25 decares. It has been determined that the payback period of these investments is 4.5 years and the benefit/cost ratio is 1.29.

6.2.2. Use of geothermal energy in animal shelters in the KOP Region

In low ambient temperatures, animals spend a significant portion of the feed they consume to keep their body temperature constant. As a result, the rate of utilization from feed decreases. Feed consumption of animals decreases in hot climatic conditions. In this case, a decrease in their development and productivity is observed. The most suitable environmental conditions as comfort zones for farm animals are defined as climatic conditions in which they can maintain their productivity and body temperature without any difficulty. Under these conditions, air temperature values vary between 13 and 15 °C, air relative humidity values 60–70% and wind speed values between 5 and 8 km/h. However, due to some of their characteristics, livestock are capable of sustaining beyond these temperature ranges over a much wider range without significant reduction in productivity. This zone, defined as the appropriate temperature zone, is located between −5 °C and +25 °C. The temperature values that farm animals cannot compensate for the decline in their productivity and begin to be damaged are called lower and upper critical temperature values. Animal age, nutritional level, etc. In addition to factors such as humidity, wind speed, the lower value is −18 °C and the upper value is +27 °C for these critical temperature values (Akman, 1998). While factors such as the breed, age, condition and production level of the animal play an important role in the level of being affected by these adverse conditions, there are also individual differences.

There are many heating methods using different energy sources to create a suitable environment for animal shelters in cold winter conditions. Among these methods, heating applications with hot water from conventional heating boilers are widely used. In the application of using the geothermal resource made here, the hot water coming from the heating boilers is replaced by the hot fluid from the geothermal source. At low temperatures in animal shelters, the ambient air can be kept within certain limits with the energy to be gained from the geothermal source. In case geothermal energy is used to meet the heating needs of the animal shelter; the benefits to be achieved in terms of energy conservation, economic gains and environmental protection should be determined in detail. For example, an evaluation has been made for the use of geothermal resource in a poultry farm.

As an example of the use of geothermal energy resources in the KOP Region for the conditioning of animal shelters, the technical, economic and environmental gains that will be provided in case of heating a chicken coop with a base area of 480 m^2 in Nevşehir province with geothermal fluid in winter have been evaluated. For this purpose, a standard chicken coop with a length of 40 m, a width of 12 m and a height of 2.5 m, with a capacity of 4320 chickens was taken into consideration (JKDP, 2021).

The most suitable indoor air temperature for adult chickens has been considered as 22 °C. The total heat losses related to the different structural components of the standard house considered were determined. The annual maximum heat load for the house has been calculated as Q_t = 353.09 kW. Considering the lowest physical properties (lowest temperature T_{geo} = 30 °C and lowest flow m_{geo} = 40 m^3/h) for geothermal resources suitable for poultry heating in the KOP Region, the amount of heat to be gained from the geothermal fluid to the poultry environment has been calculated. Since the amount of heat energy gained to the poultry house with geothermal fluid (Q_{geo} = 375.06 kW) is higher (Q_{geo} > Qt) than the total heat losses (Q_t = 353,09 kW) from the house, it has been determined that it can be used for house heating with geothermal fluid (JKDP, 2021).

If the poultry house under consideration is heated with geothermal energy, a total of 106,694.4 kg of fuel will be saved annually from LPG consumption and 99,705.4 kg from diesel fuel consumption. If diesel or LGP fuel is used for poultry heating purposes instead of geothermal fluid, the annual total fuel cost will be 632,263 TL for LPG and 648,970 TL for diesel use. If the house under consideration is heated with geothermal energy, annual total greenhouse gas emissions will be 316,225.4 kg $CO_{2\text{-eq}}$ compared to the use of 323,284 kg $CO_{2\text{-eq}}$ diesel compared to LPG usage (JKDP, 2021).

6.2.3. Use of geothermal energy in aquaculture in the KOP Region

Cultural aquaculture is in a rapid development as it facilitates breeding studies and enables planning in accordance with market demands. Therefore, geothermal fluid can be used in aquaculture. Geothermal fluid with a high mineral content can be utilized by using a heat exchanger after chemical precipitation processes. Many fish species can be raised with geothermal energy in a shorter time. The use of geothermal energy in fish farming depends on the temperature of the fluid. Ambient temperature is very important for aquatic and terrestrial animals. The temperature at which aquatic species such as shrimp and catfish develop best is limited to about 30 °C. However, fish species such as trout and salmon can be grown at low temperatures not higher than 15 °C. When the water temperature drops below optimal limits, the fish lose their nutritional abilities as their basic body metabolism is affected. Due to its constant temperature, geothermal resources can be utilized to provide a natural temperate environment for fish. Although the application temperature in fish farming varies depending on the fish species, low temperature geothermal resources such as 21–27 °C can be used in fisheries enterprises (Öztürk, 2004).

Geothermal energy can be used in the cultivation of Tilapia (Israel Chip), a fish of tropical origin. These types of fish living in warm and hot waters show the best development at water temperatures above 20 °C and in the range of 26–30 °C. When the water temperature drops between 7 and 13 °C, tilapia fish begin to die. The lowest oxygen level they could live was recorded as 0.1 mg/L It is stated that tilapia can withstand pH values between 5 and 11 (Tekelioğlu, 1996).

Within the scope of the project, a type feasibility study was prepared to set an example for investors for the use of geothermal energy resources and the production of fresh water bream. Within the scope of this study, the technical requirements needed for the investment were determined and the economic analysis of the project was made. Geothermal resources are used in the production of freshwater bream to bring the pool to the required temperature level and to keep it at this level and to keep energy costs at competitive levels. According to the evaluations, there is a need for broodstock, fry and egg, pool need, water need and feed for the production of freshwater sea bream. In this context, an evaluation was made based on 2019 sales values. As a result of the evaluation made under the determined acceptances, it has been determined that the profitability margin will be high and the investment can pay itself around 2.8 years. Calculations show that, at the end of 32 months in a 100 tons/year capacity enterprise, when approximately 22 tons of fish are sold, a profit starts to be made. However, the land expense is not taken into account in the calculations as it will vary according to the investment location.

6.2.4. Use of geothermal energy for product drying in the KOP Region and tomato drying facility investment analysis with geothermal energy

Many food and agricultural industries utilize thermal drying processes to ensure long-term use of food. In industrialized countries, the amount of energy consumed in drying processes constitutes 7%–15% of the total industrial energy consumption. However, their thermal efficiency was at the level of 25%–50% and remained partially low. In some highly industrialized countries, drying processes account for more than a third of basic energy consumption (Chou et al., 2021). Therefore, it is necessary to reduce energy consumption by using efficient energy resources for agricultural drying. The most effective applications for this are to utilize low and medium enthalpy geothermal resources. For the drying process, it can use geothermal hot water or steam, or heat energy from waste heat recovered from a geothermal plant.

Drying of agricultural products is a very important process in preventing waste and ensuring the consumption of nutritious foods throughout the year and in drought. Low and medium-enthalpy geothermal sources with a temperature lower than 150 °C are widely used because they have an important potential for agricultural drying applications. Heat energy to be used for drying can be obtained from hot water or steam in geothermal wells or by recovering waste heat from a geothermal facility. There are many advantages to using geothermal energy instead of oil and electricity in food processing. The cost of using hot water or steam is much lower.

Since tomatoes are among the most demanded dry products in the world markets, the semidried tomatoes, which are expected to have the fastest return on investment, were analyzed within the scope of the study.

Production processes in semidried tomato production are as follows. Sufficient amount of tomatoes of suitable quality are taken from the fields on a daily basis throughout the season. Tomatoes brought to the facility are cleaned and taken into the facility after quality selection. Tomatoes are cut by machines and placed on trays. The trays are placed in the oven carts. The trays are kept in the oven for 3.5 h and the moisture of the tomatoes is reduced to the appropriate level. Then, a short rest is made in the corridor or waiting area, and the tomatoes that are taken out of the oven at 60 °C are expected to reach 30 °C. Tomatoes with a temperature of 30 °C are taken to the precooling room and cooled down to 4 °C in 1 h. Tomatoes that come out of precooling with a temperature of 4 °C are taken into the shock chamber at –40 °C. Shocked tomatoes are placed in storage chambers at –18 °C after a simple prepackaging. With the order, the products taken out of the frozen storage room are taken to the packing room and shipped with freezing cased frigo trucks (JKDP, 2021).

In the planned 400 ton capacity semidried tomato plant, the facility will employ 70 seasonal workers per shift. The drying oven will operate at least 3 times a day and 6 tons of semidried products will be produced. The facility will operate for approximately 70 days and will have produced at least 400 tons of products at the end of the season. The quenching system will shock 6 tons of products per day and the cold rooms will have the capacity to stock 400 tons of products in total.

It has been calculated that there will be approximately 6.7 million TL investment cost for the said semidried tomato plant investment. In addition to the investment cost, the operating cost will also be incurred in the facility to be established. It has been calculated that this cost will be approximately 3.2 million TL. If this facility is planned as a 400 tons/year semidried tomato plant and 175 tons/year fruit drying facility, it has been calculated that the investment cost will be around 8.5 million TL and the operating cost will be approximately 6.3 million TL per year. It has been calculated that if this facility has a 400 tons/year semidried tomato plant and a 175 tons/year fruit drying facility and a 90 tons/year dried apricot production facility, an investment cost of 8.8 million TL and an operating cost of 7.5 million TL/year will occur (JKDP, 2021).

6.3. Determination of district heating potentials of geothermal resources in KOP Region

Lindal diagram calculation principles have been used in order to reveal the disrict heating potential of the KOP Region. When sources above 50 °C are taken into account as potential, areas that can be heated have been determined as in Figure 5. In this context, provinces that create potential are evaluated as Kırşehir, Nevşehir and Yozgat.

Assuming that 20% energy loss during the distribution of the fluid for district heating, the amount of potential area (m^2) that can be heated has been calculated. Assuming that the size of a dwelling is 100 m^2, the number of dwellings that can be heated has been calculated and the results are given in Table 11. Number of dwellings that can be heated in the KOP Region is theoretically determined as 11,452 units. Sources below 50 °C are not included in the calculations as they are not economical for district heating. At this stage, the total heatable equivalent district has decreased to 11000. Cumulative values were obtained by combining well technical properties where calculations were made. Based on these values, only 9 points were evaluated because it is difficult the resources below 300 dwellings to meet the initial investment cost. In the calculations, the return temperature has been taken between 38 and 45 °C, and it varies according to the silicification feature of the water.

When the existing potential points are evaluated, considering their distance to the city, it is seen that three points may be suitable for the use of district heating. The relevant evaluation is shown in Table 12. The source located in Kozaklı, Nevşehir which is the first point to be seen as potential, is currently being used for district heating. Similarly, district heating is available in Kırşehir Center and Sorgun, which have emerged as feasible. Therefore, it is not possible to develop a proposal for district heating in addition to the existing resources in the KOP Region.

The analysis of the results, the relations between heat capacity and temperature are given in Figure 6. It is possible to divide the sources into two different sections as 50 °C below and 50 °C above according to their temperature. Sources with temperatures above 50 °C are available for district heating. There are approximately 28 sources according to this. Sources with temperatures below 50 °C are suitable for other direct uses such as greenhouse cultivation, tourism and health. Sources shown in green are currently used in greenhouse cultivation, while those shown in red are used in residential heating.

7. Recommendations

7.1. Geothermal health tourism in KOP Region

There are 7 geothermal water sources in total in the province with report numbers ML-S-19-090, 91, 92, 93, 96, 97, 98. Since the source with report number ML-S-19-091 in the center contains bicarbonate, sodium, chloride thermo-mineral water, it can be used in public and private hospitals established for treatment purposes. According to the lists published on the website of the Ministry of Health,

Table 11. Heatable area and district equivalent based on geothermal wells in KOP Region (JKDP, 2021).

No	Province	District	Well Name	Flow Rate (l/s)	Temp. (°C)	Area (m^2)	District Equivalent	Return Temp. (°C)
1	Nevşehir	Kozaklı	Nevşehir İl Özel İdaresi (Nevjet A.Ş.) – Sanıtaş Kuyusu (Ö-1)	60	105.5	163350	1.634	45
2	Nevşehir	Kozaklı	Nevşehir İl Özel İdaresi (Nevjet A.Ş.) – Kostuntaş Kuyusu (K-1)	11	91.5	23018	230	45
3	Nevşehir	Kozaklı	Kozaklı Belediyesi Yukarı Hamam Kuyusu	15	90	30375	304	45
4	Yozgat	Sorgun	Yozgat İl Özel İdaresi-SG-4	32	79.4	49536	495	45
5	Kırşehir	Çiçekdağ - Mahmutlu	Kırşehir İl Özel İdaresi (Farmco Tarım İşl.) / ÇM-4 Kuyusu (Artezyen)	35	78.3	52448	524	45
6	Yozgat	Sorgun	Yozgat İl Özel İdaresi-SG-2	55	78.2	82170	822	45
7	Kırşehir	Çiçekdağ - Mahmutlu	Kırşehir İl Özel İdaresi (Farmco Tarım İşl.) – ÇM-2 Kuyusu	80	76.1	111960	1.120	45
8	Kırşehir	Çiçekdağ - Mahmutlu	Kırşehir İl Özel İdaresi (Farmco Tarım İşl.) / ÇM-1 Kuyusu (Artezyen)	40	73.1	50580	506	45
9	Kırşehir	Merkez	Kırşehir İl Özel İdaresi (Kırşehir Jeotermal A.Ş.) – T-1 Kuyusu	4,2	66.3	4026	40	45
10	Aksaray	Sariyahşi	Bekdik-2	80	62	61200	612	45
11	Kırşehir	Karakurt	Kırşehir İl Özel İdaresi – Karakurt Sera Tesisleri SSK-1 Kuyusu	40	61.3	29340	293	45
12	Aksaray	Sariyahşi	Bekdik-1	80	61	57600	576	45
13	Yozgat	Sarikaya	Yozgat İl Özel İdaresi-SK-6	10	60.2	6840	68	45
14	Niğde	Narligöl	Narlıgöl	20	60.1	13590	136	45
15	Konya	Tuzlukçu	MTA KT-1	46	60	31050	311	45
16	Kırşehir	Merkez	Kırşehir İl Özel İdaresi / T-4 (T-3 Yeni İsmi) 1993	53,1	58.3	48507	485	38
17	Nevşehir	Ürgüp	Nevşehir İl Özel İdaresi Mustafapaşa MTA Kuyusu	13	58	11700	117	38
18	Kırşehir	Merkez	Kırşehir İl Özel İdaresi / T-9 (T-6 Yeni İsmi)	49	56.4	40572	406	38
19	Kırşehir	Merkez	Kırşehir İl Özel İdaresi (Kırşehir Jeotermal A.Ş.) – T-11 (Yeni İsmi T-8)	26,7	56.3	21987	220	38
20	Aksaray	Gülağaç	Kapadokya Kent Otel – SK-1	5	56.2	4095	41	38
21	Niğde	Çiftehan/ Ulukışla	Bulur Kaynak	4	55.1	3078	31	38
22	Aksaray	Güzelyurt	Aksaray İl Özel İdaresi – Ziga-2	90	54.2	65610	656	38
23	Kırşehir	Merkez	Kırşehir İl Özel İdaresi (Kırşehir Jeotermal A.Ş.) – T-10 (T-7 Yeni İsim)	12,3	54.2	8967	90	38
24	Niğde	Çiftehan/ Ulukışla	Niğde İl Özel İdare/ÇF-2	18	53.5	12555	126	38
25	Yozgat	Bahariye	Yozgat İl Özel İdaresi-BG-2	70	52.5	45675	457	38
26	Kırşehir	Merkez	Kırşehir İl Özel İdaresi (Kırşehir Jeotermal A.Ş.) T-3 (T-2 Yeni İsmi)	0,8	51.1	472	5	38
27	Yozgat	Yerköy	Yozgat İl Özel İdaresi-Uyuz Hamamı Kaynağı	2,5	50.3	1384	14	38

Table 11. ‘Continued).

No	Province	District	Well Name	Flow Rate (l/s)	Temp. (°C)	Area (m^2)	District Equivalent	Return Temp. (°C)
28	Konya	Cihanbeyli	Erkby	138	49	68310	683	38
29	Konya	Akşehir	Akşehir Gözpınarı – Gözpınarı Kuyu	21	44	5670	57	
30	Kırşehir	Çiçekdağ	Kırşehir İl Özel İdaresi (ÇB-1 Kuyusu ve Bulamaçlı Kaynak-1 Karışım)	8	43.7	2052	21	
31	Kırşehir	Çiçekdağ	Kırşehir İl Özel İdaresi / ÇB-1 Kuyusu	7	43.7	1796	18	
32	Aksaray	Güzelyurt	Aksaray İl Özel İdaresi – Ziga-1	120	43.6	30240	302	
33	Nevşehir	Merkez	Nevşehir Belediyesi – NİS 2	14	43.5	3465	35	

Table 12. Evaluation of the potential use of geothermal resources in district heating in the KOP Region (JKDP, 2021).

No	Province	Location	Flow Rate (l/s)	Temperature (°C)	Potential (m^2)	No of dwelling	300 dwellings	Inner city	Suitability	Current usage
1	Boğazlıyan	Bahariye	53	70	45,675	457	√			
2	Cihanbeyli	Yapali	49	138	68,310	683	√			
3	Çiçekdağ	Mahmutlu	228	155	214,988	2.150	√			
4	Ulukışla	Çiftehan	109	22	15,633	156				
5	Gülağaç	Narligöl	56	5	4095	41				
6	Güzelyurt	Ziga	54	90	65,610	656	√			
7	Kırşehir	Karakurt	61	40	29,340	293				
8	Kozaklı	Kozaklı	287	86	216,743	2.167	√	√	√	Dwelling heating
9	Kırşehir	Merkez	343	146	124,530	1.245	√	√	√	Dwelling heating
10	Niğde	Narlıgöl	60	20	13,590	136				
11	Sarıkaya	Sarıkaya	111	13	8224	82				
12	Sarıyahşi	Sarıyahşi	123	160	118,800	1.188	√			
13	Sorgun	Sorgun	158	87	131,706	1.317	√	√	√	Dwelling heating
14	Tuzlukçu	Tuzlukçu	60	46	31,050	311	√			
15	Ürgüp	Ürgüp	58	13	11,700	117				

there are 3 private hospitals, 3 private medical centers and 1 private polyclinic throughout the province.

The geothermal source with report number ML-S-19-093 in Gülağaç is a thermo-mineral water with bicarbonate containing boron. This resource can be used in functional diseases of the gastrointestinal (stomach, intestines) system, ulcers, chronic infections of the urinary system (urinary tract and kidney), prevention of urinary stones (uric acid, cystine stones), functional diseases of the digestive system, diabetes and gout.

In the planning phase of health and supportive projects for Aksaray, it should be considered together with Narlıgöl and prioritizing the regions with bed occupancy problems. In private health facilities, it is recommended to encourage businesses that do not have a health tourism authorization certificate to obtain this certificate.

Within the scope of the project, the geology reports of 18 water resources were examined. A total of 4 sources are fluoride thermal water sources in Akpınar, Savcılı and Kaman with report number ML-S-19-121, ML-S-

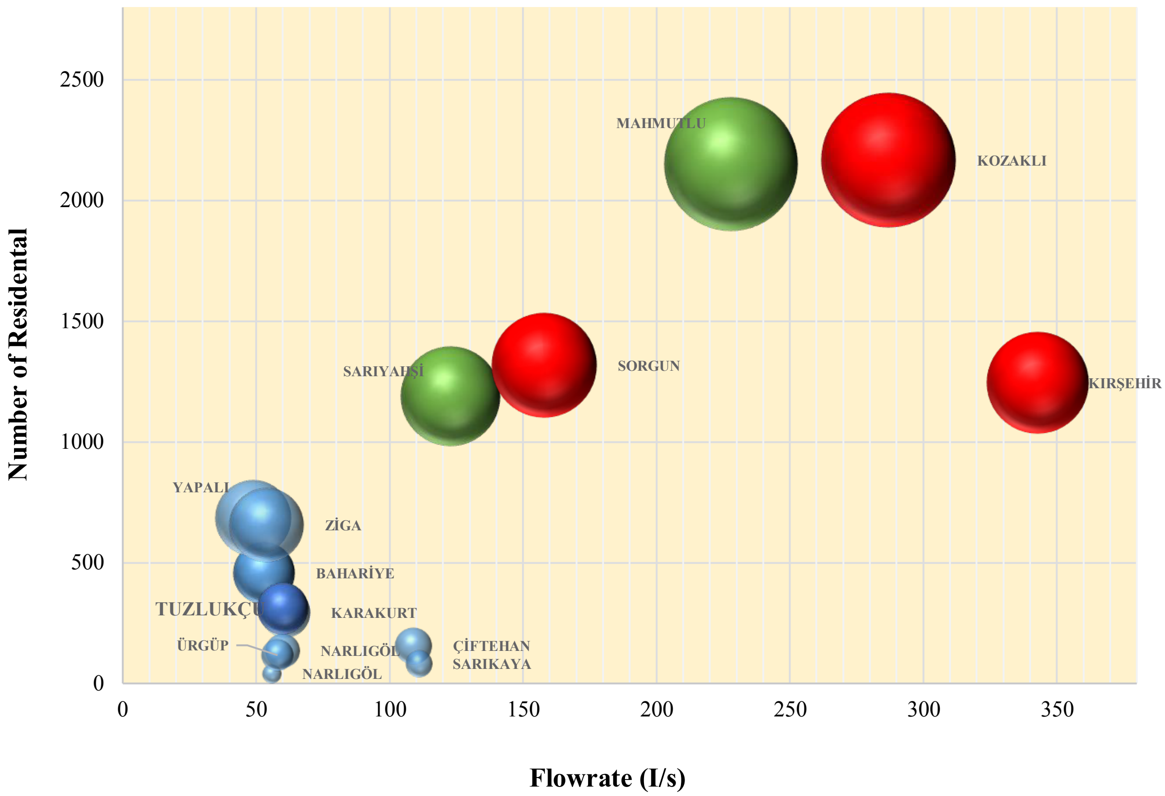

Figure 6. Suitability of geothermal resources for district heating in KOP Region (JKDP, 2021).

19-125, ML-S-19-134, ML-S-19-135. Sources with report number ML-S-19-121 and ML-S-19-134 are also suitable for drinkability. These spring waters can be used in terms of bone and skeletal system diseases, rheumatic diseases, orthopedic, neurological diseases, soft tissue diseases. Since geothermal waters with the same content as these water resources are also located in the center, planning geothermal investments in the center is primarily recommended for the development of Kırşehir with the thermal destination and thermal city theme.

In Karakurt region, there is a fluoridated high temperature thermal water containing iron with report number ML-S-19-141 and a sodium, sulphate, fluoride, chlorinated high temperature thermomineral water source with report number ML-S-19-120 in Mahmutlu region. Since the Karakurt source is close to the center and the Mahmutlu source is close to Çiçekdağı, it is recommended to consider the center and Çiçekdağı regions first in order to ensure efficiency in the investments made. There is one private hospital in the province. This facility should be encouraged to obtain a health tourism license.

Within the scope of the project, a total of 23 resources in 8 different regions in Konya were evaluated according to the balneological evaluation reports made by the geology department. The evaluation was carried out on a regional basis. In the Beyşehir region, there are 2 springs containing fluoridated acratothermal water, and according to reports, there are no facilities in these sources. The spring water with report number ML-S-19-081 is in potable water standards, and should be used in drinking water in terms of fluoride level. This drinkable feature is valuable in the KOP Region. It can be planned as a Thermal Permitted Facility in terms of strengthening the bone and skeletal system, aiming to have the Stork Valley in Beyşehir and to increase the tourism potential of the region. Beyşehir State Hospital is a 200-bed hospital. For the effective use of geothermal waters in the region, a detailed project can be worked on in cooperation with the municipality and the Ministry of Health. Being close to Seydişehir may make the investment to be made risky in Beyşehir.

According to geology reports, Hüyük Region has three water resources that can be used in combination with acrotothermal physical therapy and physical therapy in the treatment of patients due to the heat effect. The source numbered ML-S-19-072 is acratothermal water with sulphate and fluoride content and its temperature is 35 Celsius degrees. It can be used for cleaning the bile ducts, digestive system (stomach, intestine) disorders, urinary system (uric acid, cystine stones) diseases, functional disorders of upper abdominal organs, urinary tract infections, bone and skeletal system diseases. A facility with Spa operation permit that can serve the region can be planned. But as long as it is not accommodated, there may be problems in terms of productivity. Hüyük Municipality is recommended to support the investment.

When Akşehir and Ilgın districts are compared, Ilgın is advantageous due to its thermal investment and Akşehir in terms of tourism and cultural values. Ilgın/Akşehir region Healthcare Basin project should be considered. It can be launched as a holistic city of healthy living. When an integrated assessment is made specifically for these two districts, it is important that they are able to offer different transaction options to their target audiences so that the investments made in these districts do not compete with each other. Although Ilgın and Akşehir project type proposals seem similar, they are segmented and recommended to create a higher model in terms of GETAT applications. When these two districts are considered combined, it should be planned to increase their efficiency by launching them as a holistic wellness center/city. Because both districts are on the Afyon highway and can become important points in the Afyon region in terms of health and thermal tourism.

There are 6 sources in the city with number ML-S-19-103, 104, 105, 106, 107 and 108 report numbers. The source numbered ML-S-19-107 is in the center and it is a water source with arsenic and fluoride thermomineral containing boron. The source numbered ML-S-19-103 is in Ürgüp, it is a boron-containing sodium, bicarbonate, fluoride, chlorinated thermo-mineral water source. The source numbered Ml-S-19-104 is in Göreme, it is a mineral water source with arsenic, fluoride, sodium, bicarbonate, chlorine containing boron and its temperature is low. In terms of arsenic height, a detailed report should also be obtained in drinking use.

Since Nevşehir, Avanos, Ürgüp and Göreme regions are a region where tourism investments are made intensely due to cultural tourism, it is considered that the use of geothermal resources for SPA purposes should be concentrated instead of building new facilities. Investing in the treatment of diseases is not seen as an urgent need in terms of efficient use of resources and achieving the goals of investments in this region. The use of water for health purposes in the region (SPA/wellness uses) and the cultural structure and richness of the cuisine of the region should be brought to the fore (by combining gourmet tourism) and investors should be encouraged. Investments in health tourism for therapeutic purposes will be made more efficient in the Kozaklı region, which also has accommodation investments in Nevşehir province.

There are 4 geothermal resources throughout the province, and the source with report number ML-S-19-102 is located in the Aksaray province Narlıgöl region. There are 2 private health institutions in the province, one is a private hospital and the other is a medical center. Projects focused on Ömer Halis Demir University and Ömer Halis Demir University Boron Physical Therapy and Rehabilitation Hospital should be carried out.

7.2. Agricultural and industrial applications

Based on stakeholder interviews and analyzes regarding the use of geothermal for agricultural purposes and especially in greenhouses. Basically, businesses have explained their assets, profitability and sustainability in five basic axes. In this respect, a regular thermal and irrigation water supply is the most important conditions. The comprehensive planning and feasibility studies of the enterprises affect their success significantly. In addition, access to qualified workforce and information is another important factor for businesses. Finally, national and international market knowledge and participation in networks also significantly affect the business.

In terms of potential greenhouse areas, project proposals were produced with two different approaches. In the first approach, it was assumed that the total greenhouse area could not exceed 500, and individual greenhouse investments were proposed. In the second approach, considering that the total greenhouse potential will be over 500, TDİOSB is suggested. The recommendations also take into account the current uses of geothermal water resources.

Greenhouse investments: Considering the current usage situations and potentials, a new greenhouse investment is suggested as a greenhouse investment in Aksaray Güzelyurt Ziga location. Other sources are currently used for greenhouse or residential heating.

Specialized organized greenhouse zone based on agriculture (TDİOSB): Three regions are proposed as the TDİOSB based on agriculture. Although the existing geothermal water resources are not sufficient for TDİOSB, it is seen that the potential of being TDİOSB has occurred with the new wells opened by the companies using these resources. These regions are Konya Cihanbeyli, Kırşehir Karakurt and Nevşehir Kozaklı.

Four different models have been proposed for the agricultural use of geothermal resources for the KOP Region. These model suggestions are greenhouse, poultry farm, fish farm and vegetable fruit drying plant. As a result of field investigations and interviews, technical improvements that can be applied in greenhouses were determined. The findings and suggestions here are formed by synthesizing the opinions of experts in various fields.

- The greenhouse heat requirement should be accurately determined depending on the climatic conditions of the region and the type of product grown.
- It is important that the heat exchanger elements placed in the greenhouses are selected according to the size of the greenhouse to be used and the geothermal

resource feature. In order to use geothermal energy efficiently and fully benefit from the heat energy carried by the geothermal fluid, properties such as source properties, water temperatures, flow rate of geothermal water should be determined in the selection of heat exchangers. Heat exchanger elements should be selected in sufficient dimensions and technological designs according to these features.

• Before the heating systems are designed, the chemical properties of the geothermal fluid should be determined. Measures should be taken to prevent the chemical content of the fluid from reducing the efficiency of the heating elements. Physical (scaling, settling, etc.) or chemical (inhibitor use) applications should be used to prevent the fluid from clogging by forming deposits and crusts in the heating pipes.

• Minimizing the heat losses to be experienced while transporting the geothermal fluid is very important in order to utilize the energy in the highest efficiency. Therefore, heat losses should be reduced by choosing the right installation. The installation to be used in the transportation of geothermal energy should be developed and renewed, and heat losses should be prevented and geothermal energy should be used with the highest efficiency.

• The power and capacity of the equipment and power-consuming electric motors used in greenhouse air conditioning (heating, ventilation, humidification, CO_2 increase) and lighting systems should be determined correctly.

• In greenhouse air conditioning systems, importance should be given to the use of automatic control systems in order to reduce energy consumption and ensure efficient operation. In addition, by controlling the features such as the flow rate and temperature of the geothermal water, precautions should be taken beforehand against any possible problem that may occur in the heating of the greenhouses.

• Care should be taken to place the heating elements in the indoor environment of the greenhouse on the ground or close to the ground. Heat exchanger surfaces should be clean and there should be enough space around it. Especially the correct placement of the fans is important for the homogeneous distribution of the air in the greenhouse.

• To reduce heating and cooling loads in greenhouse heating and ventilation applications, using curtain systems to reduce heat losses or shading is one of the most important issues for the greenhouse. For this reason, emphasis should be placed on the use of heat curtains in greenhouses.

• Plastic cover materials containing additives effective against ultraviolet (UV) and infrared (IR) radiation should be used in plastic greenhouses in order to reduce heat losses and not to reduce the strength of cover materials with the effect of sunlight.

• Hybrid air conditioning systems including solar energy and geothermal energy should be applied. Solar energy will be an environmentally friendly method that will reduce the usage expenses especially in the electricity generation phase, which is one of the biggest economic expenses of the greenhouse.

• The use of the geothermal resource at the highest efficiency should be ensured by expanding the use of micro-cogeneration applications based on the Organic Rankine cycle.

• After the plant wastes are passed through ozone machines and purified from their harmful substances, they can be brought back to the plant with irrigation water to gain profit from fertilization.

• It may be considered to support the geothermal fluid with supportive boiler systems against unusually cold weather.

7.3. District heating

· In terms of district heating, no alternative zones have been identified except Yozgat-Sorgun and Yerköy, Nevşehir-Kozaklı and Kırşehir-Center, in the region having the district equivalent of 5000. It has been determined that the existing resources are used in either residential heating or greenhouse heating. However, it is considered that this potential will emerge with new thermal sources or wells. District heating potentials in Sarıyahşi and Mahmutlu have not been suggested due to the use of existing resources in greenhouses heating.

· Existing data show that the springs in Kırşehir, Nevşehir and Yozgat are above 60 °C. Considering the temperatures of these resources in these provinces, they can be used in district heating. Therefore, it will be correct to examine and develop the site in detail.

· In April 2017, the temperature was measured as 295 °C at 3816 m depth in Sivrihisar 3 (Bozköy/Nevşehir) exploration well belonging to 3S Kale Energy Production Company. This temperature is a very important value when evaluated at a temperature elevation conditions in Turkey. A detailed study should be carried out on the geothermal potential of this region. Especially due to the high reservoir temperature, it attracts attention as an important field with electricity generation potential in the region. Therefore, it is important for the region to determine and evaluate the energy potential of the field by making new drillings in the area in question.

· In order to provide additional city heating from existing resources in the KOP Region, detailed research including hybrid uses and additional heating costs is required.

Update works related to geothermal energy potential in Turkey is continued by Mining Technical Research (MTA).

Turkey Geothermal Inventory which was published in 2005 by MTA is continuing its importance as a basic resource. However, these resources have emerged after the publication of the related laws and geothermal energy investments in Turkey increased significantly after this date. Therefore, more detailed evaluations are needed. In this respect, it is thought that the geothermal resources of the KOP Region have not been fully discovered yet and there is an important investment requirement. Sarıkaya, where there has been a thermal spa culture in the region for a long time, is located with a thermal culture object. In addition, it is seen that Ulukışla and Narlıgöl are places where natural beauties can come to the fore with their thermal emphasis. In this respect, each province and region within each province were evaluated separately, and suggestions suitable for their strategic positioning were presented.

8. Conclusion

In this study conducted for the evaluation of geothermal resources in the KOP Region, the KOP Region has been evaluated with a holistic perspective. Considering the capacity of geothermal resources in Turkey in this respect, the role of KOP has been clarified and has been linked with the role of field work done in KOP Region. The results of the field studies played an important role in the creation of project proposals for the provinces and holistic action plans that should be implemented for the evaluation of geothermal resources in the KOP Region. In this respect, the outputs of this project have been brought together in a holistic approach at national, regional and local levels. At this point, it has been seen that the measures for better utilization of geothermal resources in the KOP Region require solutions at both local, regional and national levels. From this perspective, actors at different levels should play a role in both the creation and implementation of the necessary actions for the development of geothermal resources.

Although some of these initiatives can be taken at local and regional level, it is considered that many factors affecting the sector from skin should be resolved at national level. It has been evaluated that it would be more appropriate to evaluate the geothermal potential of the region in agricultural applications. Geothermal greenhouse cultivation is growing very rapidly with a geothermal greenhouse area approaching approximately 600 decares. The region has a naturally cool climate, which is necessary for production in summer. As a result of the researches and interviews conducted on the use of geothermal resources, it has been determined that there is a need for improvement in various areas. Suggestions that should be taken into account in the national rather than local framework for the solution of the problems that apply to the region are grouped in the present study.

Turkey has turned to domestic resources in recent years for reasons such as energy independence and ensuring the security of energy supply. For this purpose, some incentives and supports are given to investments for the utilization of geothermal resources, especially for the utilization of renewable energy resources.

Regarding the agricultural applications of thermal resources in the KOP Region, different applications were visited on site and information on agricultural enterprises using thermal resources was collected. In addition, interviews were conducted with business owners to identify different applications, opportunities and threats related to businesses. Thus, the general situation of geothermal enterprises in the KOP Region has been revealed. Geothermal resources provide the opportunity to provide the temperature required by the plant by reducing greenhouse costs. Considering the geothermal resource potential of our country, the use of geothermal resources in greenhouse cultivation significantly reduces operating costs compared to natural gas or other heating methods.

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