

ECONOMIC ASPECTS OF GROUND WATER USE

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ABSTRACT

From the view-point of economic geology ground water is a mineral resource of prime importance. Its use and economic value is steadily growing all over the world. The activity of the ground water industry is nowadays on the focus of the public interest. Economic and financial factors can greatly improve the performance and efficiency of ground water industry. The utilization of ground water resources is characterized by a great variety. All welfare and social programs are highly affected by the hydroeconomics and by water supply economics. Some examples of special ground water use in Hungary and their economic importance.

1 INTRODUCTION

It is well known that ground water supplies are of great economic value all over the world. From the point of view of economic geology ground water is a mineral resource of prime importance. Meinzer, O.E., the distinguished American Hydrogeologist, told already a half century ago that one of the great achievements of civilized man has been the ability to provide adequate and reliable supplies of good water in those parts of the earth where surface waters are lacking or unusable. The use of ground water is steadily growing and became highly diversified. Its economic value is also gradually increasing and for this reason the activity of the ground water industry is nowadays on the focus of the public interest and social welfare. As a result, hydroeconomics is presently an important and effective tool for the economic evaluation and assessment of ground water production, distribution and use. Economic and financial factors can greatly improve the performance and efficiency of the ground water indus-

try. Consequently, all welfare and social programs are highly affected by water supply economics and by the hydroeconomics. We are aware of the fact that many things can be done to enhance and to improve ground water-use efficiency.

2 UTILIZATION OF GROUND WATER RESOURCES

2.1 General aspects

The utilization of ground water resources is characterized by a great variety. Apart from ground water withdrawals for public supplies for municipalities and rural communities, the largest consumptive use is represented by irrigation. It was reported that in the third World about 250 billion US \$ have already been invested in irrigation and the World Bank devoted about 30 per cent of all agricultural lending to irrigation. Moreover, it was predicted that about 100 billion US \$ more will be spent before the year 2000 to create greater capacity. At the same time revenues collected from farmers cover only 10 to 20 per cent of the cost of building and operating the system.

It must be noted that a considerable part of the water supply for irrigation purposes is stemming nowadays from subsurface aquifers. Agricultural engineers, especially in highly developed countries, have worked out methods which utilize the timing, frequency and uniformity of watering systems to maximize efficiency and reduce waste and operating costs. Such advancements in irrigation technology help farmers to curb operating costs. It is noteworthy that U.S. agriculture is using ground water to irrigate about 9.8 million ha. All kinds of economic and financial incentives and means can greatly improve the performance of irrigation systems, especially public systems.

Proper economic consideration has to be paid to ground water withdrawals for drinking purposes and for other public

supplies. Due to the ever growing demand of these supplies an intense effort must be made to meet and satisfy them. The cost of ground water extraction and distribution is differing from place to place. Recently a great attention is paid on ground water quality too. For protecting drinking water resources and supplies a comprehensive water-quality planning and preventive control is needed which means, of course, considerable extra costs. In addition, however, all branches of ground water use /agricultural, industrial, rural, domestic, stock supplies/ will be more and more expensive due to increased costs of aquifer development, well construction, equipments, distribution facilities, quality controls, monitoring, etc./.

It is widely and generally experienced that regional public water supply and the centralized rural water system is usually more economical than the individual scattered water supply system due to the reduced operating costs. More recently electronics telecommunication and automation is playing a very important role in the cost-effective operation of modern Water Works.

2.2 Some examples of special ground water use in Hungary

In many parts of the world great volumes of ground water have to be pumped to make access to underground ore and mineral deposits. It is usually an expensive, time-consuming, costly operation. Many cubic meters of ground water have to be removed for each ton of minerals or ores.

A remarkable and instructive example of this kind of ground water withdrawal activity is underway in Hungary. Here in the Transdanubian Middle Range territory more than $11.2 \text{ m}^3/\text{s}$ karstic water extraction is needed through great diameter shaft-wells for the interest of underground brown coal and bauxite mining because these mineral deposits occur below the static karstic

water level. Earlier the cost of karstic water pumping was put on the production cost of the mineral mining. Later the increased volume of water extraction made the pumping rather expensive. The price of the water withdrawal is changing according to the given geographical site. The cost of water production is composed of

- depreciation
- energy
- materials
- transport
- maintenance

Under certain circumstances the operation of a coal-mine may be uneconomical due to the great costs of dewatering activity. Generally the cost of pumped karstic water is changing from a few cents to 25 cents per m³.

Since the extracted karstic water has an excellent quality and suitable for drinking purposes, it is sold by the mining company to the District Water Works and is distributed through pipeline-system to the consumers. This activity represents an economic, cost-saving operation because it reduces the karstic water withdrawal expenses. It must be noted, however, that for the time being, only 30 per cent of the totally extracted water is getting into the drinking water distributory system. Therefore, the greater part of the pumped water is getting lost.

A special and unique ground water use is developed in Hungary in the form of thermal water utilization. It has a considerable socio-economic benefits. Hungary as a typical intermontane sedimentary basin is characterized by favorable geothermal conditions and as a consequence, great thermal water resources, that is, rich low enthalpy geothermal resources are available. The thermal water-bearing formations are occurring at a depth interval from a few hundred to 2500 meters or even deeper. The geothermal wells

are supplying hot waters with a well-head temperature of 30 up to 100 degrees Celsius while the average yield of an individual well amounts 10-20 litres/s. For the time being, there are about 600 operating thermal wells in the country.

The utilization of thermal water is widespread and diversified. The main branches of utilization are, as follows,

- balneological-terapeutical,
- agricultural-horticultural heating,
- district and space heating,
- drinking and domestic water supply,
- industrial,
- mineral water bottling.

The use of thermal water for balneological and therapeutical purposes has an old tradition and has a favorable impact and benefit on the national health conditions and made possible to build a modern infrastructure of balneotherapeutical stations and facilities, bathing resorts and centers of thermal tourism. Especially the thermal tourism is recently a flourishing branch with great economic advantages. For the time being, a total of 145 thermal baths are operating in Hungary.

A very efficient use of thermal water with low-enthalpy geothermal energy content is the heating of glasshouses, greenhouses, plastic tents and tunnels and soil-heating. The geothermal capacity of a normal average thermal well amounts about 3 to 5 MW. Actual annual average use of geothermal energy in 1986 amounted to 330 MW. Glasshouses totalling about 700.000 m², while plastic tent-tunnel systems of about 1.200.000 m² are heated by thermal water, that is, by geothermal energy, these facilities are producing tomato, paprika, cucumber and other vegetables, further carnation, roses and hortensias. Cow stalls, pigsties, chicken houses are also heated by thermal water. Some geothermal drying

and one cooling plant are used for conservation of grains, fruits and vegetables. In addition, some fish ponds are supplied by thermal water. Relatively low temperature water of 35 to 45 °C is used for soil heating.

The estimated total heat production referred to + 15 °C in the field of agricultural utilization is about $1'55 \times 10^{16}$ J/year (500 MWt).

10 district and space heating plants provide heating and warm water supply for about 3500 flats with more than 700.000 m³ heated space.

The estimated calorific value of the geothermal energy used for district and apartment heating is about $1'25 \times 10^{14}$ J/year (4 MWt).

In certain parts of the country thermal waters even up to 60 °C are suitable for drinking purposes and as domestic water due to their good quality.

There are 11 thermal wells which supply water of 40 to 50 centigrades for hemp-processing plants.

A very efficient and cost-effective way is the multipurpose utilization of the thermal water which eliminates any wasting of the available thermal water resources. A remarkable example of the multipurpose utilization of the thermal water is the municipal hospital of Szentes in the southern part of the Great Hungarian Plain. The hospital was heated and supplied with domestic water of 79 °C, while the nearby municipal bath and swimming pool as well as the neighbouring greenhouse complex were supplied by the same thermal water. The multipurpose utilization of the thermal water is a highly desirable objective which was realized in many parts of Hungary, especially in the southern part of the country which is the most favorable region for the multipurpose utilization.

The exploitation and utilization of thermal waters, especially

those of above 60 degrees Celsius, is a viable and feasible operation under present economic conditions regarding the capital cost and all relevant costs, such as, drilling, well construction and operation, installation, equipments, instrumentation, housing for pumps, maintenance, labor and material costs, piping and used water disposal. It was generally experienced in the last two or three decades that the cost of geothermal heating of agricultural facilities as well as the district and space heating could be significantly reduced below the cost of conventional heating with fossil fuels. For the users of thermal water /mostly cooperatives, state farms, municipalities, hospitals and schools/ subsidy or long-term loans were granted by the state. In addition, especially in the agricultural sector, there is no obligation of any charge or fee for using thermal water.

The present economic structure of Hungary makes it impossible to compare costs relevant to the thermal water development and utilization with countries of different conditions. Increasing energy prices and the swiftly changing economic scene prevent any definite statement to be made everywhere.

There is a special case for selling thermal water in a highly frequented bathing resort, Hajdusoboszló, in East-Hungary.

The water prospecting and drilling company of VIKUV has here 3 thermal wells yielding hot water of 75 centigrades Celsius temperature. This valuable and curative thermal water is collected in tanks from where it is pumped to the bathing facilities in a quantity of more than 1 million m³ per year for about 25 cent per m³. This thermal water production and selling activity is very economical for the company VIKUV.

Another remarkable example of utilization of thermal water can be quoted from South-Hungary near the city of Szeged where a successful and profitable secondary oil recovery is taking place

in the Algyó-oil field by the partial use of thermal water. The thermal ground water is extracted from Pliocene multi-layer sand formation at a depth interval from 1000 to 1500 meters through 12 thermal wells. The produced thermal water is of good quality and has a well-head flowing temperature of 50 to 60 °C. These thermal wells are yielding a total of 10.000 m³ water per day and the water is injected continually through special intake wells located at the periphery of the oil field into the oil producing formation. By this water-drive and water-flooding operation additional oil production can be obtained with considerable economic benefits. The recoverable oil reserves by primary recovery were estimated as much as 20 to 25 per cent which can be increased by the use of secondary recovery as much as 45 per cent. It means a much higher ultimate oil recovery with all its economic advantages.