



CONDITIONS OF ARTESIAN AQUIFER TRANSFORMATION INTO SUB-ARTESIAN IN VOJVODINA PART OF PANNONIAN BASIN

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Abstract

As a consequence of an intensive exploitation of ground waters to provide drinking and industrial water supply the artesian waters in the region of Vojvodina. Accumulated in the sand strata at a depth of 60.0-140.0 m, have been transformed into subartesian ones, with a tendency of a further slow decrease of their static level.

Keywords: *Intensive exploitation, drinking water, hydroisolines*

1. INTRODUCTION

Numerous artesian wells in the territory of Vojvodina (Northern Serbia, Yugoslavia) reduce artesian aquifers only small part of that amount is used for drinking, while greatest part disappears forever, forming marshes in depression. Drilling is carried out without any control, particularly by private contractors, producing undesired consequences. Case of artesian well in the northern side of Fruska gora mountain, where huge eruption of artesian aquifer happened, causing occurrence of landslide, which was hardly reclaimed, warns us. There are no regulations to protect so significant source of unpolluted groundwater. The resources are not inexhaustible, which is documented through decrease of piezometric pressure and self-discharge of some artesian wells in the settlements. Self-discharge prevention is possible by some technical procedures, which should be regulated. But, it is much more difficult problem of concentrated exploitation of a great number of wells supplying towns in Vojvodina and produced ecological consequences. Through the example of Becej town water supply, it is shown in this paper.

2. PRESURE LOWERING BECAUSE OF SELF-DISHARGE

Pressure measuring-piezometric levels and capacities of self-dishrag of artesian wells were made periodically, with continual three-five years period. Unfortunately, there are no continual observations for longer period. They were impossible to be made because of lack of financial resources.

Analysis of acquired data presented that, within edge parts of large Pannonian basin (including Macva, part of Srem and SE Banat, near to Yugoslav - Romanian border), static reserves are restorable. Dynamic reserves are reflected by increase or decrease of pressure and self-discharge capacity in dependence of time, closeness of recharge zone and precipitation regime.

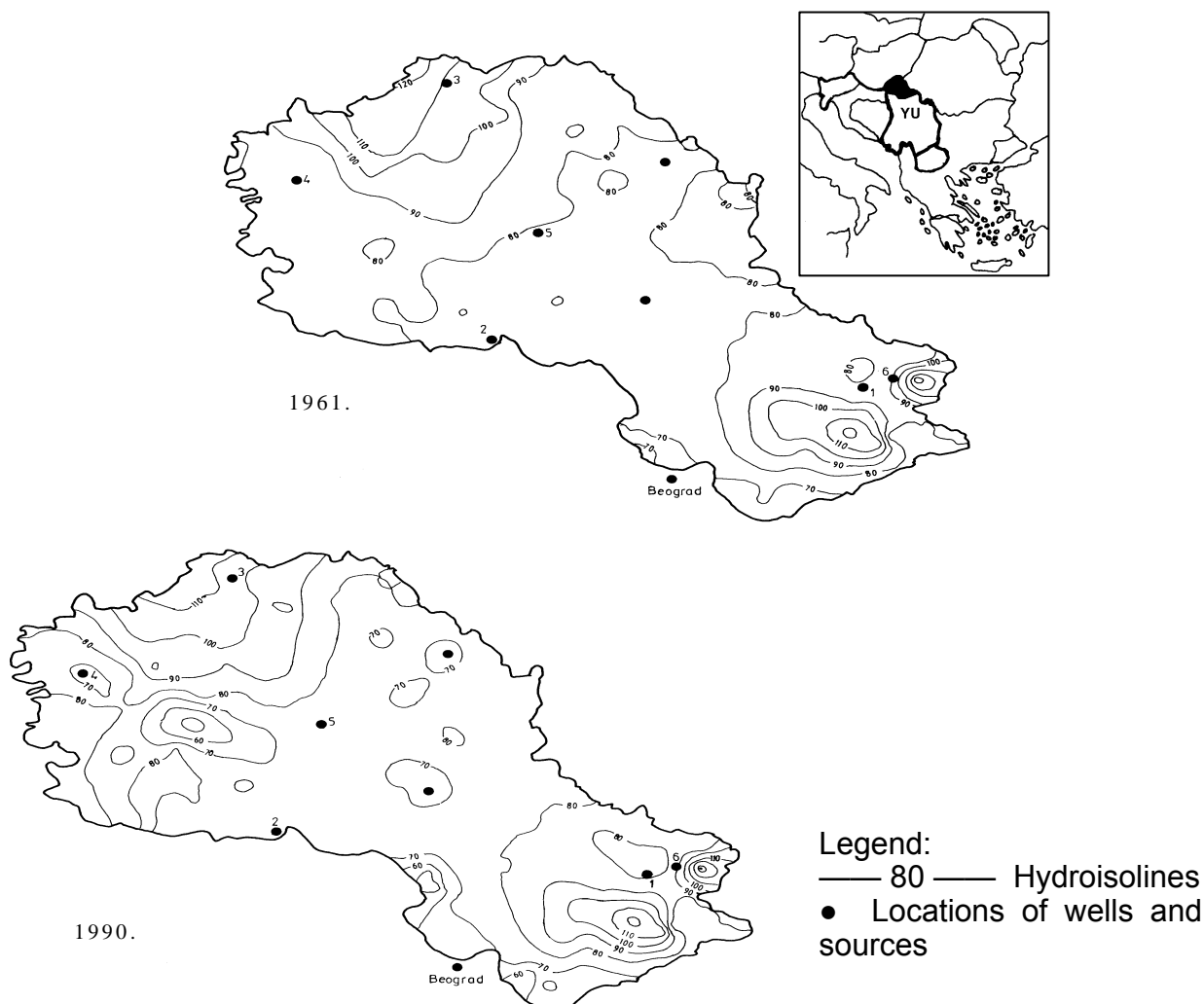
Artesian aquifers are not endangered by artesian wells self-dishrag. However, it doesn't mean that they should not be protected against useless consumption by uncontrolled outflow (Stojsic 1988).

In the major part of large Vojvodina plain, resources of artesian aquifers are almost unrestorable. During exploitation, static reserves are consumed, which is noticeable at each well in the area. In dependence of locality, distribution of artesian wells or closeness of the source where the same aquifers are exploited, trend of pressure lowering and self-discharge capacity is different, but with constant decrease.

In order to illustrate the decrease, on well in endangered zones in the territory of Vojvodina (Table 1) in presented.

Table 1. Changes of piezometric pressure at artesian wells

Location	Year	Capacity Q (l/s)	Piezometric WTL (m)
Vlajkovac (1)	1985	-	+ 0,70
	1986	0,423	+ 0,60
	1987	0,348	+ 0,40
	1988	0,276	+ 0,38
Novi Sad (2)	1986	0,875	+ 0,69
	1987	0,820	+ 0,63
	1988	0,770	+ 0,51



Artesian wells working in zones with settlements far from centralized sources where the same caught aquifers are exploited.

Lowering of pressure and outflow capacity of some artesian wells in the settlements far from the edge of Panonian basin is noticeable. With time, trend of lowering increases, by transforming artesian pressure into subartesian and tendency of further decrease. There are several examples that several wells have become dry by stopping of self-discharge, although it was caused particularly because of intensive exploitation of present sources in these towns, because of uncontrolled long-term self-discharge.

Protection measures of artesian aquifers

Uncontrolled useless discharge of artesian aquifers over wells self-discharge should be stopped. Problem is not easy to be solved, because it is impossible to close easily and to regulative the self-discharge.

It is known that during pressure measuring by the manometer and self-discharge closing, capacity decrease, even outflow stopping, occurred. By closing, contra-pressures balance at contact of screen envelope and caught sand layers was disturbed. The envelope is caving, filling with fine grains, causing self-discharge capacity decrease. In Banovo Polje village (Macva), after measuring with manometer and self-discharge closing, outflow was permanently reduced from 0.6 to 0.15 l/s.

Self-discharge can be similarly controlled if piezometric levels-pressures are 3-4 m. that height is possible for mounting pipes $\varnothing 128$ mm over the well, fixing by concrete. One meter over the terrain surface, drainpipe with valve is put, so-by closing opening, level in the pipe $\varnothing 128$ mm oscillates freely.

For higher pressure, a technical solution should be found. Regarding a number of artesian wells in the territory of Vojvodina, by measures of self-discharge control, part of static reserves. Will be protected (Stojiljkovic 1997).

3. CONSEQUENCES OF INTENSIVE EXPLOITATION OF ARTESIAN AQIFERS

By urbanization of towns in Vojvodina and development of industry, needs for water increased from year to years. Present sources for water supply were enlarged by drilling new wells or forming new ones. But, it was not taken care of potential of caught aquifers. Consequences of irrational water consumption and more intensive exploitation had influence onto: pressure lowering (piezometric level), water quality changes, changes within aquifers, which was noticed during the last decade at the territory of Vojvodina (Fig. 1, Table 2).

However, thanks to hydrogeological conditions, Becej is famous after the solution of water supply of industry and irrigation systems separated from water supply of settlements and part of food industry.

Area of the town and vicinity is made of Quaternary and Neogene sediments.

Quaternary sediments, 30-40 m thick are presented by loam, sand dust, clay and sand. Fine-grain to medium-grain sand thick 5.0-14.0 m occur at the terrain surface along left coast of the Tisa river, and, at the right one, under Varoska Terase to 30 m depth.

In sands, accumulated groundwater is with double hydraulic mechanism - unconfined and subartesian. Content of ammonia and iron is higher than permitted (according to regulation for drinking water), but they can be eliminated by aeration and activated charcoal. By groundwater catchig in Quaternary sands for irrigation systems and industrial water supply, intensity of exploitation at Becej plumbing source. Neogene sediments to 140 m depth are made of clay with sand intervals:

58.0 - 64.0 m	94.0 - 103.0 m
69.0 - 74.0 m	112.0 - 136.0 m.

Table 2. Level changes of artesian aquifer caused by exploitation at greater sources

Location Depth wells (m)	Year	Pumping rate in the course of year Q (m ³ /s)	Piezometric level STL (m)
Subotica (3) 130.00	1958	0.010	- 1.04
	1962	0.015	- 2.20
	1967	0.068	- 2.90
	1968	0.110	- 4.30
	1972	0.140	- 8.60
	1975	0.186	- 1.53
	1977	0.186	- 15.40
	1980	0.235	- 19.50
	1995	0.438	- 30.00
Sombor (4) 160.00	1957	0.005	- 1.16
	1963	0.010	- 2.50
	1965	0.015	- 3.43
	1968	0.020	- 6.15
	1975	0.030	- 8.30
	1977	0.040	- 12.00
	1980	0.040	- 14.03
	1995	0.240	- 38.00
Becej (5) 80.00	1955	0.007	- 1.05
	1963	0.010	- 0.80
	1965	0.010	- 1.50
	1968	0.015	- 3.07
	1970	0.020	- 4.20
	1975	0.025	- 6.50
	1980	0.030	- 7.80
	1995	0.145	-15.05
Vrsac (6) 65,00	1961	-	+ 2.85
	1993	0.021	- 3.90
	1997	0.021	- 5.10
	1998	0.021	- 8.00

Fine-grained to coarse-grained sand change grain-size characteristics in horizontal and vertical direction. From place to place, there is more or less clay content. Loosing characteristics of aquifer.

Calculated filtration coefficient are 3.1×10^{-5} - 2.7×10^{-4} m/s. from fifties, aquifers were caught by all drilled wells in depth range 50.0 - 140.0 m. long-term, particularly perforated exploitation of the aquifer caused undesirable consequences.

Consequence of pressure drop is end of self-discharge of artesian wells in becej, used as public drinking fountains.

During the end of sixties, old source was formed in the town, by drilling several wells. From 1975, in the town and in vicinity, 30 exploitation wells are existent.

Small number of exploitation artesian wells drilled before sixties for supply of industry, at first, became "dry", transforming artesian aquifer into the subartesian, and titen, caused level drop: 1,5 m under the terrain surface. Between 1960 and 1975, by exploitation of 30 wells, statistic level droppes: from 3.20 to 4.50 m.

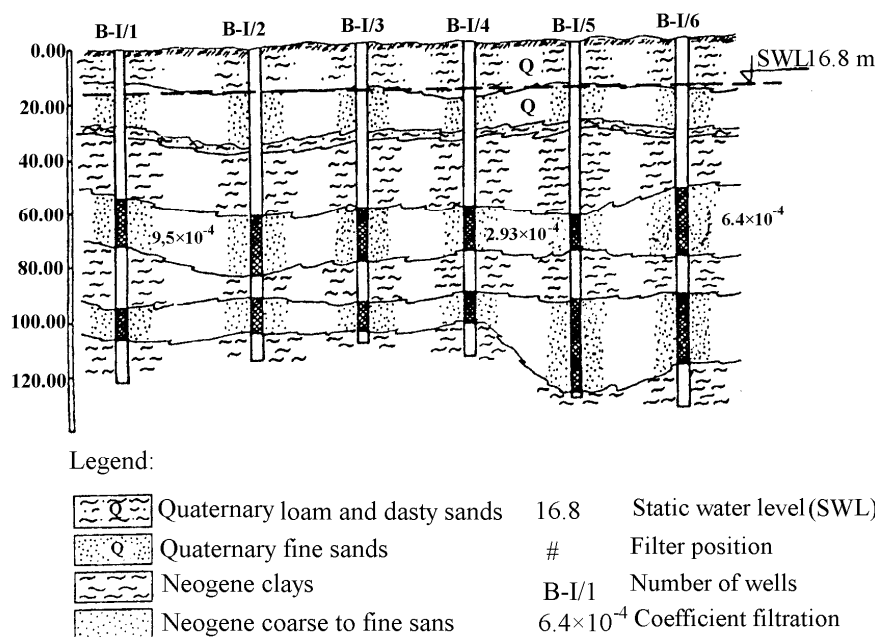


Figure 2. Hydrogeological profile along of the trace of exploitation wells (water-supply source of Becej)

Old source in the town was not sufficient for the requirements of the town and industry. From 1980, hydrogeological exploitation of the area right from Becej - Srbobran way (Fig.2), started. Just five years later, level in the exploratory boreholes was: 4.17-7.00 m.

Between 1980 and 1990, at the new source, 15 exploitation wells were made. Because of perforated exploitation, static level became to drop more intensively, and from 1995 it was: 11.4-16.8 m.

This trend of dropping worries us, because it is consequence of the well exploitation at the source with total capacity: $\square Q = 135$ l/s.

With planned increase of capacity in 2000. to over 200 l/s, trend of dropping will be more drastic. Ecological consequences are difficult to be predicted, because they are present even now (Stojiljkovic & Pavlovic 1997).

4. CONCLUSION

Discharge of groundwater resources over the self-discharge of artesian wells should be prevented by piezometric level stabilizing over the terrain surface in $\varnothing 128$ mm pipe, with mounted valve for closing. However, it is much more difficult to solve problem of pressure drop by static reserves total consuming because of intensive exploitation. At the territory of Vojvodina, it is necessary to carry out integrated groundwater resources management, control of well drilling and constructing industry with high water consumption.

Besides, some parts of industry can use water of the first aquifer formed in Quaternary sands water from water flows which could be conditioned. By this, exploitation at sources of greater towns could be rationalized and negative effects as a consequence of perforated well pumping, prevented. First of all, slowing down of global trend in piezometric pressure drop, but also water quality aggravating, degradation of caught aquifers by iron and manganese depositing, and short life of the well.

REFERENCES / BIBLIOGRAPHY

- [1.] STOJILJKOVIC, D. & PAVLOVIC, P. 1997. *The consequence of intensive exploitation of groundwaters in the region of Becej. 100 years of hydrogeology in Yugoslavia, Belgrade. 275-280, Univ. of Belgrade, Yugoslavia.*
- [2.] STOJILJKOVIC, D. et all. 1997. *Danger presence of methane in water supply system of Backa Proc. 100 years of hydrogeology in Yugoslavia, Belgrade. 353-359, Univ. of Belgrade, Yugoslavia.*
- [3.] STOJSIC, M. & STOJILJKOVIC, D. 1988. *Pijezometarski nivoi i hemizam podzemnih voda dubljih izdani u uslovima dugotrajne eksploatacije na teritoriji SAP Vojvodine. Vode Vojvodine J. 16, 95-107, Novi Sad, Yugoslavia, (in Serbian).*