7th Groundwater Symposium of the
International Association for Hydro-Environment Engineering and Research (IAHR)

Application of mathematical models in defining optimal groundwater yield

E. Hadžić[a], N. Lazović[a] and A. Mulaomerović-Šeta[a]*

[a]Faculty of Civil Engineering, University of Sarajevo/ 71000 Sarajevo, Bosnia and Herzegovina

Abstract

In this paper are given the results of ground water mathematical modeling of the source zone Sokolovići in order to define the optimal water exploitation. After processing and analyzing the results of hydrogeological and hydrological research of source of Sarajevsko Polje, boundary conditions are selected, and after that were made calibration of mathematical models for Sokolovići zone.

Given the complexity and importance of groundwater sources Sokolovići, optimization of the results of the mathematical model is also made in this paper. Optimal exploitation (optima yield) of groundwater is selected based on the three criteria: 1st the provision of river inflow in amount of that will not exceed the natural infiltration in accordance with the appropriate geometry and boundary conditions; 2nd ensuring at least minimum required flow to downstream groundwater source, in quantities that exploitation of Sokolovići water well will not compromise, and 3rd preservation of filtration stability of wells in the Sokolovići area.

1. Introduction

Determination of optimal groundwater yield is one of the most complicated hydro-technical problems. The optimum yield may not be equal to the pumping rate of objects for exploitation, [1], nor can it be considered as a quantity that is constant in time. According to its physical essence can be considered as the amount of water that is being renewed and that is dependent of the recharge sources. It means should

* Corresponding author. Tel.: +0-387-33-278-422; fax: +0-387-33-200-158.
E-mail address: ajla.mulaomerovic@gf.unsa.ba

be variable value, which is dependent on the hydrological situation in the catchment area. Especially complex situation can be in the case of the accumulation of groundwater which is situated on a large area, and when the water is exploited in several different locations (source zones), distant to each other by several hundred meters. In this case, the impact that one source has to another zone, among other factors, certainly affects to the selection of optimal water pumping.

There are several approaches to solving these problems. In recent years, with the development of computer technology is an increasingly common application of mathematical modeling. However, only the use of the results of mathematical models quite often cannot be enough to solve this complex problem. There are other factors that limit the pumping rate, such as those that are conditioned by the technical characteristics of the wells, filtration stability in the borehole zone, the natural characteristics of the aquifer, the source management methods, etc. In order to select the optimal solution, it is necessary to observe the source as a whole, to define existing constraints and evaluation criteria, and make the most favorable decision.

2. Characteristics of Groundwater Sources - Sarajevsko Polje

Sarajevsko Polje is, morphologically, alluvial plateau, whose area is about 13 km^2. From the hydrogeological point of view, it makes a huge underground reservoir. In its upper layer, aquifer with free water level is formed. Exploitation is carried out from the upper granular aquifer through 36 vertical wells, located in the three source zones: zone Konaci, zone Bačevo and zone Sokolovići. The thickness of the quaternary sediments varies from 70 meters in the northern part of the area to 30 m or less at the southern part of Sarajevsko Polje. According to the hydrogeological profile (see Fig. 2), the thickness of gravel-sandy sediments in the area Sokolovića is between 15 and 35 meters. At greater depths, after less permeable layers, there is a layer of limestone.

Water regime of the groundwater aquifer in the Sarajevo area is influenced by the flow through its contours: from the west - Bosna River; from north-east to the River Željeznica, from the south to the streams Stojčevac part, and through the boundary contours and the slope of the field from the direction of karst massif Igman - Bjelasnica.

Previous research works, which were carried out in this area, it has been shown that amount of renewable groundwater are between 800 and 1250 l/s, depending on the hydrological situation. It is also shown that the exploitation of this amount does not threaten underground reservoirs, [2]. Overexploitation of groundwater aquifer, which today is from 2500 to 3200 l/s, caused a downfall in water levels, [3]. To minimize the negative effects overexploitation, artificial recharge is applied. By activating the pumping source Sokolovići, 1998th year, the depletion of groundwater sources is continued. But, quantities of water that can be abstracted from this source that does not harm on downstream water sources (Konaci i Bačevo) is remained unknown. Pumping wells, which were carried out after the drilling of wells, are shown that Sokolovići source has a significant impact on other sources (Bačevo, Konaci). However, estimate of this impact was unknown.