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Evolution of groundwater composition in the depression cone of Riga region

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Riga is the capital of Latvia with around 0.9 million inhabitants where the main water supply is centralised and decentralised, mostly from groundwater sources, that is from the the Arukilas-Amatas multi-aquifer system, which consists of sandstones and siltstone. These rocks belong to the middle and upper Devonian and have good properties for groundwater extraction: they have high permeability and are widely spread. Below this system lies the middle Devonian Narvas aquitard, that consists of marl and clay. But in the southern and western part of Riga this system covers the upper Devonian Salaspils formation which consists of marl and gypsum.
In the second half of the 20th century an intensive groundwater extraction from the Arukilas-Amtas multi-aquifer system took place in Riga, causing sharp and significant lowering of piezometric surfaces. The maximal decline of groundwater level was observed in 1972, when it was 16 m lower than the average. From the end of 80's started a regeneration of water table, when the volume of water usage began to decrease. Nowadays piezometric surface in the Arukilas-Amatas multi-aquifer system is being renewed and fluctuations are insignificant. The territory, where natural regime of groundwater has changed and that is induced by antropogenic effect is called „Large Riga".
To track chemical changes and evolution in the Arukila-Amata multi-aquifer system long – term monitoring data is used. Data on major ions and piezometric surfaces from 45 monitoring wells that groups in 17 monitoring stations is being analysed. The area is dived into three zones – central, middle and periphery, which differ from each other by the volume of the groundwater level decline. These zones are determined from maps, that shows the piezometric surface difference between two periods: 1949-1951, that describes the natural situation, and 1970-1972, where the minimal groundwater level in the Gauja aquifer was observed. On this basis it was studied how rapidly water chemistry change in aquifers shows up and how these trends change.
It was found out that the sources of water with high SO42- which worsen the quality of water in deeper aquifers, are from the Salaspils aquifer, because the first signs were observed in aquifers, that lie below the Salaspils formation. The same water composition changes in deeper aquifers with a time lag.
When piezometric surface rised up, the mixing from different aquifers ended, that can be clearly observed in the upper Devonian Plavinu aquifer where, in the latest samples, is an increasing concentration of HCO_3- ion. These are the first signs that the situation in this multi-aquifer system begins to return into natural conditions.
Despite that Riga is lying near the sea, the lowering of water table in the Arukilas-Amatas multi-aquifer system hasn't induced intensive intrusion of sea water. This process is observed only in some areas, where intrusion occurs through the bed of river Daugava where the Plavinas aquifer dolomites are situated.
The significant water composition changes are observed in the central part, where the greatest piezometric surface lowering is, which was sufficient enough to cause stronger downward flow from upper aquifers, that induced the mixing water from different aquifers in this territory. As a result, in this zone there are great water composition changes. Also the first signs about water composition changes show up very quickly, but the return to the natural situation is relatively slow.
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