The agricultural impact on the vadose zone of the karst aquifer

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The whole Croatian south part of the country belongs to the area of the classical karst. That area is mainly composed of strongly krastified carbonate rocks and there is lack of the large areas with overlying deposits. Nevertheless, karst poljes and some depressions may have thick covers.

Such example is the catchments area of the spring Turanjsko lake in the Vransko polje (*Figure 1*). The Vransko polje is situated in the region Ravni Kotari - north Dalmatia. That polje is a typical karst polje with the thick Quaternary pond and lacustrine deposits. Thickness of those deposits in the middle of the polje is about 7-9 m and on the edge of the polje deposits thickness is thinner. The hinterland of the Vransko polje consists of Upper Cretaceous, Paleocene and Eocene carbonate rocks (mainly limestones) and Eocene flysh sediments. The bedrock of the polje is the well-karstified Upper Cretaceous and Eocene limestones and in them is the main karst aquifer. In the center of the Vransko polje is situated the spring Turanjsko lake, which is today used for the water supply of the town Biograd and its surroundings. Before the tapping it had the shape of the small lake and it was used for the irrigation. The climate in that area is mild and it is suitable for the people to do agricultural operations during the whole year. In those agricultural operations are used fertilizers and/or manure and also pesticides.

During the hydrogeological study of the area, were taken samples of water from springs: Turanjsko lake, Kutijin stan, Biba, Begovaca and channel Kotarka. Also, were taken samples of soil through the profiles at the five locations around the water supply pumping station Turanjsko lake. In all those samples were measured next geochemical indicators: NO_3-N, NH_3-N, PO_4^{3-}, SO_4^{2-}, Cl^-, major ions Ca, Mg, Na, K and heavy metals such as Cu, Mo, Pb, Zn, Cd, As etc.

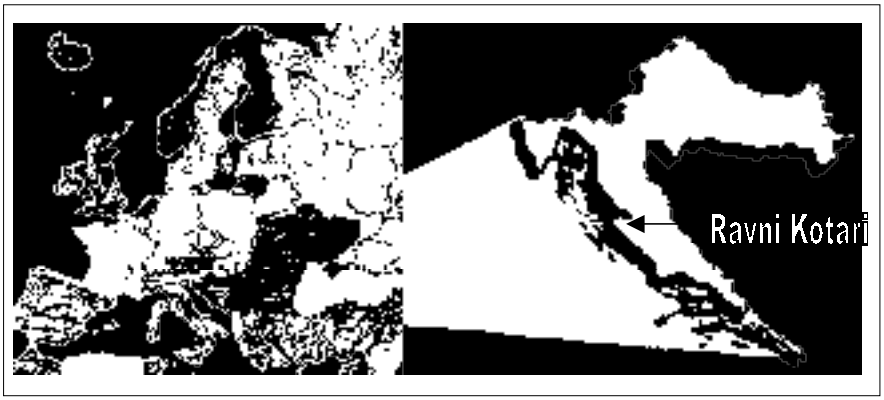

Figure 1: **The position of RavniKotari in the Croatia.**

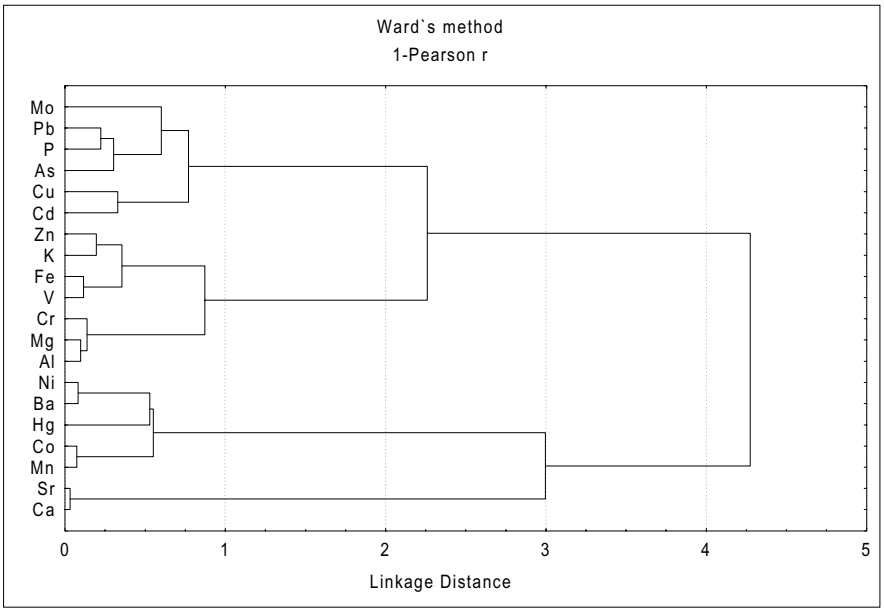

Figure 2: **Dendrogram of the geochemical affinity of the elements in the soil samples.**

For better understanding the distribution of the geochemical indicators in the groundwater and the distribution of the same indicators through the profiles of the overlying deposits and the relationship between them, it was done R - cluster multivariate statistical analysis. The result of that analysis was dendogram of indicators connections with the similar geochemical behavior. The result of the R-cluster analysis shows that there are few groups of elements with the similar distribution (*Figure 2*).

The first group of elements makes: Cu, Mo, Pb, Cd, As and P. They are accumulated in the vadose zone because of agricultural practice (commercial fertilizes and/or manure, and pesticides). The second group is the elements that their distributions are in the connec-

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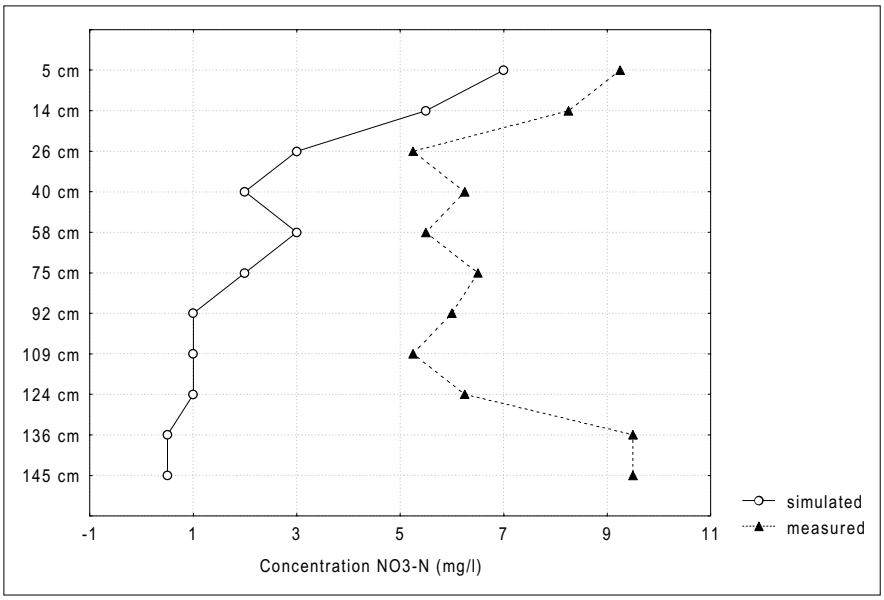

Figure 3: **A comparison of the simulated and measured NO_3-N concentrations.**

tion with the fate of Fe and Mn hydroxides. And the third group is Ca and Sr. The distribution of the third group of elements is controlled by carbonate behaviour (decalcification process).

Also, because of the interest in the behaviour and the effectiveness of agricultural chemicals (fertilizers and pesticides) on the quality of the vadose zone (water and soil) and possible contamination of the karst groundwater, it was done the solute transport model of a chosen geochemical indicator. The chosen geochemical indicator was nitrate-nitrogen (NO_3-N). Also, as a model it was used VS2DT model. VS2DT is a well-tested USGS finite difference model for simulating steady-state or transient groundwater flow and solute transport in the unsaturated zone. The model is based on the solution of Richard's equation. The result of the simulation is showed at the *Figure 3*.

The fitting between simulated curve and measured curve was not as it was expected. That was the consequences of many factors as: were the right infiltration and/or percolation conditions, very high vertical and lateral heterogeneity of the porous media (overlying deposits), soil properties, were all biochemical and chemical processes included etc.

But what is for sure in that area is not big agricultural impact on the quality of the vadose zone (water and soil). And in the future people must use the optimal quantity of the commercial fertilizes and/or manure as well as pesticides.

Literature

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