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Quantitative evaluation of tracers for quantification of wastewater contamination of potable water sources

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Quantitative criteria for selection of tracers for determination of mixing of wastewater and pristine water are proposed and evaluated for (i) leakage from a wastewater effluents recharge system to nearby pristine water wells and (ii) the dilution of the reclaimed effluents by pristine water from the surrounding aquifer.

Two molecular tracers were compared: Carbamazepine, CBZ an organic drug whose refractory behavior was evaluated on-site, and chloride which is widely used as a wastewater tracer due to salination of tap water by domestic activities. Different approaches for the estimation of the background level of the tracer were evaluated for particular test-sites, water wells in the vicinity of a water recharge system.

We begin by qualitative description of the preferred attributes of good wastewater tracer. Tracer specificity, abundance at the source, constant source level, background level, conservative behavior, mobility and the analytical method requirements will be briefly discussed.

Then the mixing ratios and the corresponding uncertainty levels in their calculation will be quantitatively evaluated for the two tracers using actual field data. Uncertainty level analysis illuminates the effects of the analytical errors in the determination of trace ng/L level micropollutants on the one hand, and the high level of chloride in the background on the other. Uncertainty level calculations revealed that chloride is a somewhat better tracer for the estimation of the dilution of wastewater by flow from a pristine aquifer, whereas carbamazepine is a much better tracer for the calculation of wastewater contamination of nearby drinking water wells. This is a general tendency which holds true as long as aquifer salination (e.g. by overpumping) does not take place. Our quantitative analysis shows that even when carbamazepine degrades to a large and unknown extent, it can still be used to estimate accurately the probability that a site is contaminated by a wastewater stream.

The approach is then extended to the quantitative use of the micropollutant tracer for the evaluation of dynamic leakage from the water recharge area . The quantitative use (and the uncertainty level associated with such estimate) of the proposed wastewater tracer for wastewater effluents – pristine water mixing estimate by non specific domestic wastewater sources will be demonstrated.

We shall conclude by quantification of each of the qualitative criteria for good tracer that were presented at the beginning of the talk.

Reference
Some of the work was presented in G. Gasser, M. Rona, A. Voloshenko, R.Shelkov, N. Tal, I. Pankratov, S. Elhanany, O. Lev Quantitative evaluation of tracers for quantification of wastewater contamination of potable water sources, Environmental Science and Technology, 44, 3919-3925 (2010)