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New monitoring system for real time continuous measurement of nitrate concentration in unsaturated soils

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Over the past few decades, a clear trend of rising nitrate concentration in groundwater had been observed in aquifers all around the globe. Numerous studies had linked the growing concentration of nitrate in groundwater to agriculture activity and excess use of fertilizers. Up-to-date fertilizer application in agriculture relay primarily of farmers experience, expert's recommendation and sporadic soil testing. All of which do not provide information that is in line with the time scale of N-fertilizers mobilization, consumption and transformation dynamics in the soil. As such in-situ continuous measurement of nitrates in the soil is essential for maximizing the crop yield and at the same time to reduce potential contamination of groundwater.

In this talk, we present a newly developed monitoring system for continuous measurement of nitrate concentration in unsaturated soil. The monitoring system consists of a suction lysimeter coupled to a custom-made optical flow cell. The system was designed for real-time measurement of nitrate concentration in soil's porewater based on absorption spectroscopy methods that is applied through optical fibers technology. Additionally, a special adaptive algorithm was developed in order to optimize the measurement accuracy. Furthermore, the algorithm cancels interference and masking caused by different chemical constituents present in the porewater sample by signal processing for the optical domain.

Preliminary measurement performed on soil column exhibit high accuracy of nitrate over large a concentration range between tens to hundreds ppm. Comparing between the nitrate concentrations in acquired water samples from suction lysimeter, to concentration values attained by the monitoring system, gave an adequate correlation of R2=0.89. Moreover, the system provided a first-time outstanding explicit data on the complexity of the temporal variation of nitrate concentration in the soil during the irrigation cycles. Accurate online nitrate measurements in the root zone can be valuable to farmers as a report of the current nutrient ability to crops, and in turn, can reduce the potential of groundwater pollution by nitrate leaching under cultivated land.