Evaluation of the deposition, infiltration and drainage of the atmospheric pollutants in the vadose zone

Marco Masetti[1], *Corrado Camera*[1], *Daniele Pedretti*[1], *Stefania Stevenazzi*[1*]

[1] *Università degli Studi di Milano, Dipartimento di Scienze della Terra "A. Desio", Milano, Italy.*
**Corresponding email: stefania.stevenazzi@unimi.it*

ABSTRACT

In the last decades, a large effort has been carried out to reduce atmospheric pollutant emissions in Europe. However, despite the progresses of the last 30 years (Rogora et al., 2016), water and soil acidification, nutrition unbalance in forest trees, and eutrophication in surface waters are still of great concern.

In particular, nutrients that fall on the ground from the atmosphere represent a minor component of the total nitrogen input to soils, especially when compared to agricultural, civil and industrial inputs (EEA, 2005). Although often underestimated, this source apportionment becomes a part of leaching from the soil to groundwater. Therefore, the overarching goal of this study is to identify anthropogenic background values of pollutants in groundwater, not related to direct sources of contamination (e.g., industrial wastes, leakages from sewage systems, fertilizers).

Keywords: nitrogen cycle, monitoring, unsaturated zone

METHODS

In June 2018, an instrumented field site has been settled to reconstruct the path of nitrogen through: 1) atmospheric emission; 2) wet and dry depositions; 3) infiltration through the ground surface and the vadose zone; 4) addition to groundwater storage.

The field site is located within a well field of the public manager of the integrated water service of the Province of Milan, in northern Italy. The well field is located in the plain, 20 km east from the City of Milan.

The instrumented field site is constituted of a meteorological station, 6 soil moisture sensors, 6 tensiometers and 3 suction cups. Soil moisture sensors, tensiometers and suction cups have been settled at three depths (20 cm, 40 cm, 80 cm) to evaluate the soil characteristics and responses to precipitation events along the soil profile.

The instruments are equipped with a solar panel and a data logger, which allows collecting data every ten minutes. Water in the suction cups is manually collected after each rainfall event.

The field site is located 25 m upgradient respect to a water well monitored in continuum by a multiparameter probe. This probe allows measuring several parameters: groundwater depth, temperature, pH, EC, turbidity, DOC, TOC and nitrate concentration.

RESULTS

In situ tests at the field site allowed evaluating an infiltration rate of 1.5×10^{-4} m/s, which is compatible with a silty sand and gravel deposit. The monitoring campaign allowed calculating an arrival time of rainfall of about 9-13 hours, from the topsoil to groundwater table (about 7 m below ground).

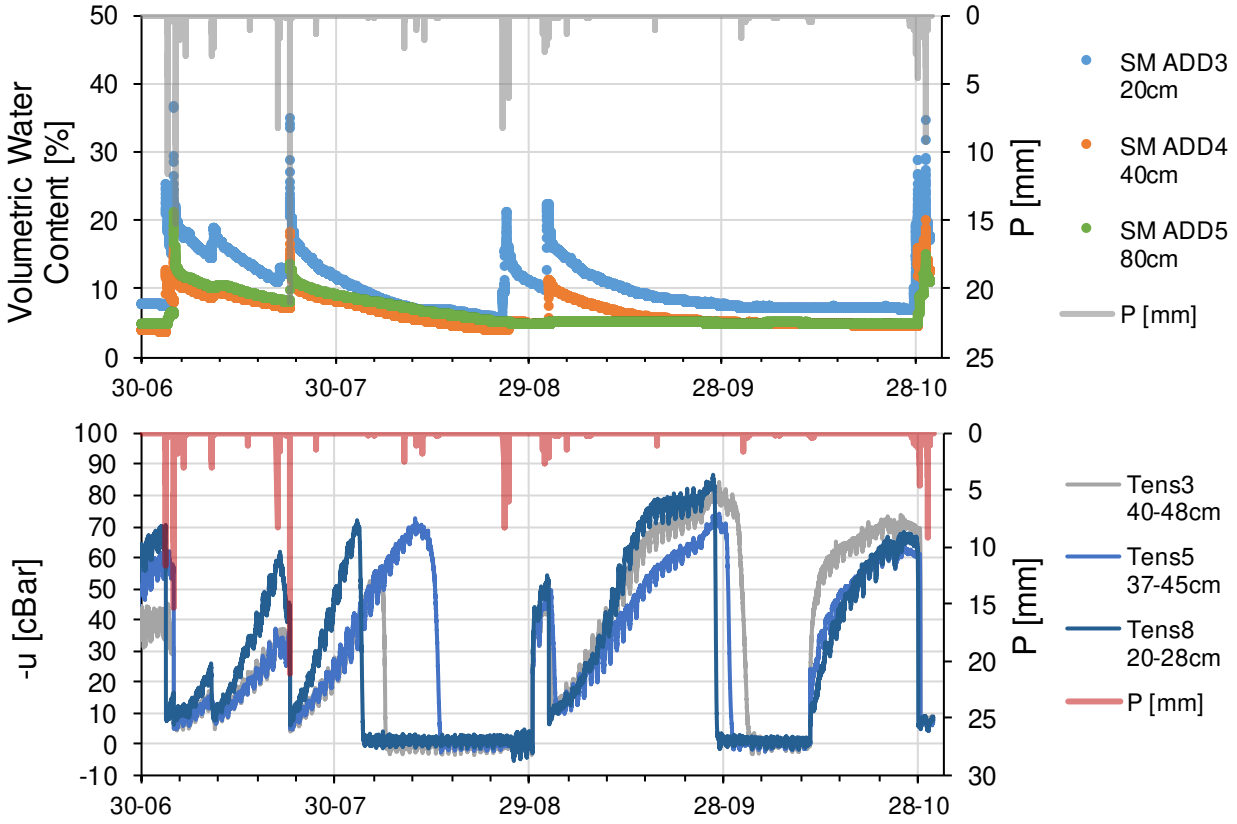

Fig. 2 – Volumetric water content (upper graph) and pore pressure (lower graph). Tensiometers have been restored some times during summer, due to long dry periods.

CONCLUSIONS

Results from the monitoring campaign allows a better understanding of the nitrogen cycle from the atmospheric emissions to rainwater precipitations to soil and groundwater, adding useful information about the amount of nitrogen involved in the process.

Moreover, it will be possible to calibrate a numerical model, which could help in identifying the impacts of atmospheric emissions on groundwater quality in different environmental contexts (e.g., natural, urban and agricultural areas).

References

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