



## **Modeling soilwater and nitrogen balances in the Emilia-Romagna plain**

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The presented project is based on the certainty that the analysis of soil water and nitrogen balance represents a useful tool in assessing the vulnerability of an area and in defining Action Programs, as required by national and European legislation.

The research project was carried out by the Geological Service of the Regione Emilia Romagna and the Environmental Sciences Department of Milano-Bicocca University, in order to evaluate the soil attenuation capacity on the basis of soilwater and nitrogen balance. The study area is the Reggio Emilia plain, which is characterized by high pressure on water resources most linked to the use of liquid manure (Beckwith *et al.*, 2002).

The soil attenuation capacity has been defined according to the Regione Emilia Romagna methodology produced within previous projects (SINA “National Informatical Environmental System”, GeTraMiN – “Control of the Genesis, Transformation and Migration of Nitrates from the Soil to Surface Water and Groundwater”). This approach defines attenuation capacity classes on the basis of simulation models outputs. The MACRO and SOILN coupled models have been used: the dual-porosity model MACRO (Jarvis, 1994) simulates water flow on a field scale, while the SOIL model (Johnsson *et al.* 1987, Eckersten *et al.*, 1996; Larsson *et al.*, 1999) describes turnover and leaching of nitrogen under specified management practices.

Pedotransfer functions, calibrated and validated for the regional soils, allowed to calculate soil hydraulic parameters, which are the principal model inputs (Calzolari *et al.*,

2001; Ungaro e Calzolari, 2001; Ungaro et al., 2005).

In the area of the Reggio Emilia plain simulations were performed with several sceneries representative of the typical agroclimatic zones and of the different agronomic practises, also with the aim of evaluating the sustainability of agronomic practises in terms of nitrate leaching risk.

The sceneries have been defined by analyzing specific data in order to choose the area representative soil profiles (n.39) and the climatic simulation period (1991-2000). Concerning the agronomical practice, maize was considered as reference cultivation and irrigation was applied when required, as a function of climate and soil typology.

Four fertilization sceneries were defined, variable for timing, typology and quantity of nitrate applications. The first one suits with the Code of Good Agricultural Practice (Ministry of Agriculture decree nr. 86/99) introduced in Italy as a consequence of the implementation of European Nitrate Directive 91/676, and involves a mineral application of 200-230 kgN/ha when maize is growing in springtime. The second scenery involves the use of mineral fertilization (50 kgN/ha) and of liquid manure (340 kgN/ha) when maize is growing, the third one involves the use of mineral fertilization (100 kgN/ha) and of liquid manure (340 kgN/ha) with medium-low efficiency (170 kgN/ha of liquid manure used on bare soil in autumn). The fourth scenery involves the use of liquid manure only (500 kgN/ha) with medium-low efficiency (250 kgN/ha of liquid manure used on bare soil in autumn)

MACRO and SOILN simulation were made for each soil and each scenery, and spatial and temporal distribution of the results concerning soil water and nitrate leaching in the Reggio Emilia plain were analyzed in order to identify critical elements concerning soil and climatic characteristics and the different agronomical practices.

For each soil, intrinsic vulnerability was evaluated on the basis of water leaching and the risk of each agronomic practice was evaluated on the basis of nitrate leaching. This evaluation allows to evaluate the best agronomical practise for each area and to provide information to improve environmental management by using suitable Action Programs for each different soil typology.

The results of the analysis will be linked with groundwater hydro-geological analysis, in order to produce a groundwater vulnerability map explicitly taking into account the hydraulic soil characteristics. Such map, which is presently being drawn in cooperation by the Geological Service of the Regione Emilia Romagna, the Provincia of Reggio Emilia, the ENiA water agency and the Research Centre on Animal Production will contribute to better evaluate the supportability of agronomic practices in terms of groundwater nitrate pollution and will also be used for integrating water monitoring

programs and for setting up a specific soil monitoring network.