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Rule-based Handling of Hazardous Nitrogen

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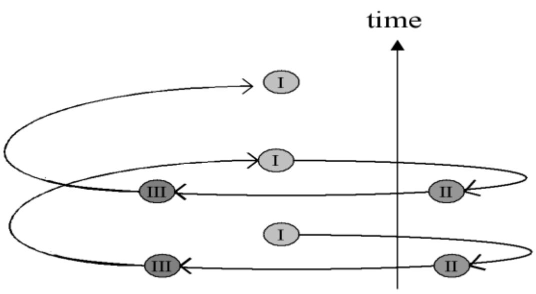

Fig. 1 - The recursive framework (details in the text).

A rule-based, recursive framework is an ideal approach to support the design of cropping systems (CS). A framework of this type was proposed, arranged into three stages (Silvestri and Bellocchi, 2007): (phase I) prior evaluation (technical, problem-solving, farmer-driven stage), (phase II) posterior evaluation (institutional, environmental monitoring implemented when CS response deviates from expected behaviour), and (phase III) managing the change (participatory, dynamic rearrangement of CS). This sequence is meant to evolve and grow over time through reiterations (Fig. 1), allowing for a continuous adaptation of agricultural productions systems as the business environment and society change. The same procedure was applied in this study to assess the behaviour of an array of CS run in the proximity of Lake Massaciuccoli - an area of Central Italy currently defined as "vulnerable area" under EU Directive 676/91 - as part of an action aimed at identifying possible responsibilities of farmers in NO_3 contamination of waters (research developed in 2005-2006 under the Italian Ministry of Education, University and Research).

Methodology

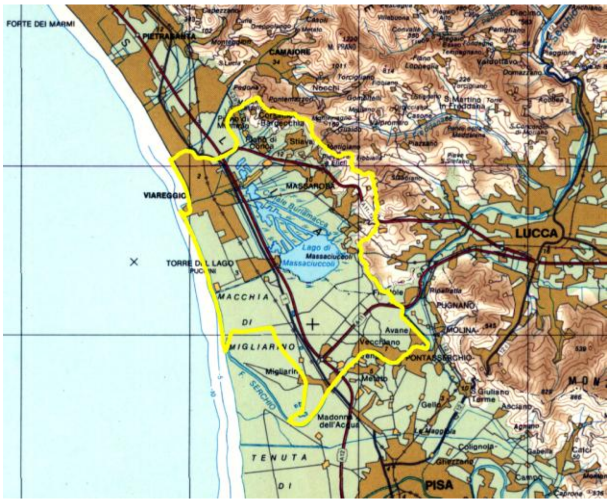

Fig. 2 - Map of the study area.

Study area. Lake Massaciuccoli is a shallow coastal lagoon, located within north-western Tuscany (Italy). It extends over ≈690 ha, with a storage capacity of ≈9 millions m^3 and varying in depth from 1.5 to 2.0 m. Water input to the lake is limited to small rivers draining the hilly region to the east and neighbouring areas (from marshes restored long ago). The vulnerable area (Fig. 2) surrounding the lake covers over 14000 ha (≈50% of which being cultivated).

Phase I. At each site, information was collected from the farmers by using common interview schedule and observational checklist. The aim was to characterize the technical choices of the farms, and to assess the structure and functions of CS. Farmers' behaviour was assessed on a 4-point scale: -2 (very negative), -1 (negative), 0 (standard), +1 (positive), +2 (very positive). Such assessment was based on: mechanization choices, management of irrigation, fertilisation options, composition and sequence of crops. A synthetic index (NSI: Nitrate Sustainability Index) was calculated at each farm to assess the potential hazard of nitrate contamination due to NO_3 escaping from the fields.

Phase II. An environmental monitoring was carried out. Surface water bodies were monitored twice (May and November) for a range of 70 GPS-georeferenced sampling points within the basin. Nitrate level and an array of quality parameters were determined (Silvestri and Gorreri, 2006).

Phase III. Of the farms included in the project, a core sample (>50%) was selected where more detailed information was available. A focus group was created to debate potential changes to the CS management. Patterns and attitudes of sharing and acceptance of solutions were evaluated.

Results

Phase I. In total, 45 farms were assessed covering over 1508 ha of suitable arable area (SAU), corresponding to more than 20% of the vulnerable area covered by farms. The farms extend over flat domains and 62% of businesses are family-runs. Average farm SAU is about 30 ha. The most commonly cultivated crops are cereals (56%), followed by industrial crops (14%), horticultural crops (6%) and woody crops (6%). Maize, with 37% of the cultivated area, is the most widely grown crop. Irrigation is performed over 40% of the SAU. NSI = -0.13 (slightly negative) was computed as weighed average across values from single farms. However, farms were registered with both NSI values largely lower (down to -0.9) and much higher (up to 1.25). NSI values >1 only affect less than 5% of the SAU. Favourable conditions (0 < NSI < 1) were registered on about 20% of the SAU. For the most part (74% of the SAU), the fields are characterized by -1 < NSI < 0 and only on 1% of the SAU was NSI <-1.
Phase II. Results from the environmental monitoring confirmed that contamination of surface waters by nitrates does exist. The phenomenon is less marked in the northern sub-area (less densely and intensively cultivated), where 3% of positive samples (NO_3 concentration >1 mg L^{-1}) were detected (against 68% in the southern sub-area). Timing of sampling is also important: 16 mg L^{-1} on November versus 5 mg L^{-1} on May, as averages of all samples collected.
Phase III. For possible measures to be taken in order to limit agricultural contribution to pollution, farmers expressed their preferential choice (67%) for reduction of fertilisation rates. Splitting of fertiliser applications is also largely shared (54%). The idea of using slow release fertilisers and reducing irrigation usage are less appealing options. Only 1/3 of the farmers gave favourable opinion about a change in the crop patterns (e.g. reduction of the area allocated to maize, introduction of a catch-crop). This generally negative opinion keeps unchanged even in the expectation of compensating financial aids.

Conclusions

Farming practices registered cover a range of diverse behaviours. The latter are in some cases potentially harmful for the water-environment of a vulnerable area. The environmental monitoring confirmed indeed the presence of non-negligible NO_3 levels in surface water bodies, although not generalized over time and space. The management of fertilisation seems not to depart from rational decision-making; this indicates that alternative farming strategies should be based on a modification of crop patterns. Other actions (e.g. introduction of buffer strips) are even less accepted by the farmers.
Data (not shown here) from the agronomic stations placed in the basin, also provided evidence on the peaty nature of some soils and their importance in the release of nitrates from soil organic matter as consequence of natural mineralization. It would guess a critical stance towards the CS proposed and the start of a new evaluation cycle (Fig. 1) for a more advanced definition of sustainable and agreed agricultural strategies.
It is worth mentioning here that the Region Tuscany action program for nitrate vulnerable zones (Decree of the President of Regional Council n. 32/R of the 13/072006) entered into force on March 1, 2007. The plan set out obligations for the farmers to draw up fertilisation plans based on application of detailed N budgets, but it does not directly account for specific edaphic conditions related to the zone of interest. This research goes further to provide a comprehensive assessment about the condition of agricultural soils and farmer preferences in the Massaciuccoli area.

References

Silvestri N., Gorreri L. (Eds), La qualità delle acque superficiali ad uso irriguo nel comprensorio del Massaciuccoli. I risultati di una prima indagine territoriale. 2006. Felici Editore, Pisa, 1-99.
Silvestri N., Bellocchi G., Designing sustainable cropping systems: a general framework, 2007. Proc. Farming Systems Design 2007, Catania, Italy, 2, 119-120.