Applicability of mitigation measures for surface water in Italy: the case study of the Lombardy Region.

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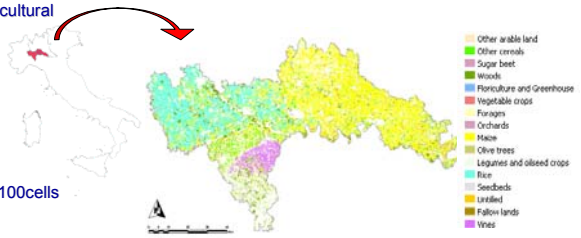
ABSTRACT

In the authorization process of plant protection products (PPP), the evaluation of the impact of PPPs on surface water quality and on aquatic ecosystems is a crucial point.
If the results of the risk assessment suggest an unacceptable risk for aquatic systems, after the pesticide application according the intended uses, mitigation measures have to be applied to reduce the concentration of PPPs which can reach water bodies. In this way the exposure of aquatic organisms is kept at acceptable level allowing a safe use for pesticides useful for crop protection but potentially dangerous for aquatic ecosystem.
This study addresses the applicability of mitigation measures in a selected area of the Lombardy Region (LR) characterised by high density of water bodies. A multivariate analysis based on geo-pedological soil conditions, slope, distance between field and water bodies, considered representative of the Regional arable lands, was performed to evaluate mitigation measures applicability.

MATERIALS AND METHODS

The agricultural districts of Lodi, Cremona and Pavia were identified and selected for the analysis due to data availability of agricultural datasets describing crop spatial variability within the arable land and due to computational limits.
Rice, Orchards, Vines, Vegetables crops and Maize, were selected as the most representative crops where different pesticide applications have to be considered (application methods, pesticide loads, different type/functional class of pesticides).



SIARL

GIS layers:
> Irrigation network 1:10.000 of the LR (db Prior).
> Informative Regional basis of the LR (District and Regional boundaries).
> Digital Elevation Model (DEM) of the LR – 20×20cells grid.
> Geo-Pedological soil characteristics such as Clay and Sand Content (average content within the first 1 meter top soil) – 100×100cells grids.
> Agricultural distribution and statistics 1:10.000 of the LR (SIARL: LR Agricultural Informative System).
The irrigation canals/rivers neighbouring areas were delimited by means of GIS (ESRI ArcGIS 9.2) (3 buffer areas of 5, 10 and 20 meters). The resulting areas were converted into a 5 × 5 meter cells grid and intersected with GIS layers representing crop, clay, sand and slope (derived from DEM). The average of each cell values, aggregated by crop, was calculated for 5, 10 and 20 meter buffer areas.
The principal component analysis was performed considering the average values of clay, sand and the average slope of the arable land within a distance of 5 m, and 20 m from water bodies.
To assess the applicability of the mitigation measures, the distribution of cells within 5, 10 and 20 meters, aggregated by crops, was considered.

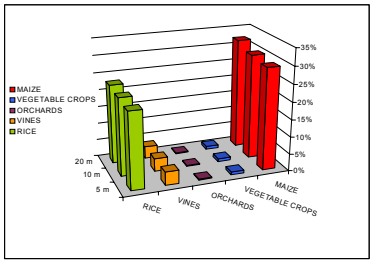
RESULTS AND DISCUSSION

GIS Analysis

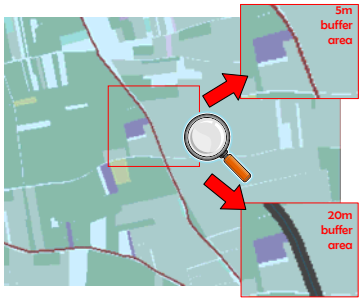
The percentage distribution of cells of all the considered crops, shows that a 5 meter buffer zone, can be considered an acceptable mitigation measure for all crops in the considered area : a reduction of 0.9% of the total area available for maize, 1.1% for rice, 0.2% for vines, 1.6% for orchards and 0.65% for vegetables is expected.
An increase of the buffer width is no more applicable for MAIZE and RICE since this would bring to a reduction up to 7000 ha and 5000 ha for the two crops respectively.
Therefore, a combination of different mitigation measures (i.e. combination of buffer strips and low-drift nozzles) is mandatory for these crops to reduce the contamination of surface water bodies.
A wider buffer (10, 20 meters), on the contrary, seems more applicable on vegetable crops, orchard and vines considering their spatial distribution with respect to the irrigation network: a 20 metres buffer will reduce the area of 3.4% for vegetables, 7% for orchards and 6% for vines. Nevertheless, also for these crops, a combination of different mitigation measures is strongly recommended to avoid unacceptable loss of agricultural yield.

	5 m		10 m		20 m		whole area
	% (*)	ha	% (*)	ha	% (*)	ha	ha
MAIZE	29.6%	1358.0	30.4%	2933.5	32.2%	6952.9	150635.6
VEGETABLE CROPS	0.8%	38.0	0.9%	82.9	0.9%	198.6	5874.1
ORCHARDS	0.3%	12.1	0.3%	24.8	0.2%	53.7	755.7
VINES	3.9%	179.1	3.8%	364.0	3.5%	756.0	13484.0
RICE	22.2%	1018.4	22.6%	2175.8	23.1%	4990.0	89695.3

(*) % based on all arable land statistics within the buffer area

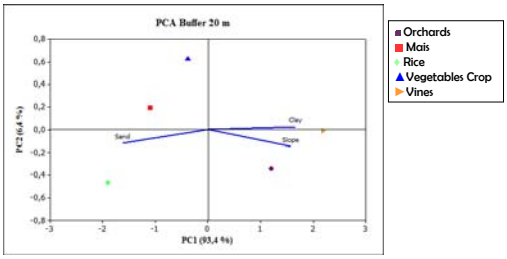


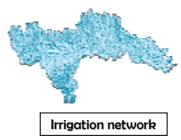
% distribution of cells by crops within buffer areas

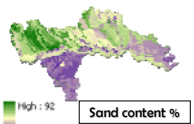


Principal Component Analisys (PCA)

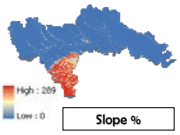
The analysis showed:
- Vegetables, maize and rice grows mainly on flat areas (slopes <4%), in soils with a high sand content and low clay content. Consequently, drift is expected to be the major route of surface water contamination.
- Vines and orchards appear to be primarily cultivated in soils characterized by high slopes (> 4%) and by a high clay content and low sand content. So, water bodies in these areas are expected to be mainly affected by both drift and runoff events..



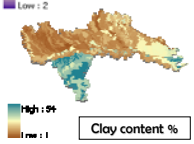

Irrigation network



Sand content %



Slope %



Clay content %

CONCLUSIONS

The application of proper mitigation measures requires the knowledge of the local agricultural landscape. In this work, the contribution of dataset such as agricultural, soil and landscape characteristics such as irrigation network, was used to address the applicability of mitigation measures at different crops.
In the area considered, maize and rice were identified as the most problematic crops: the high sensitivity of river network exclude the possibility to use just distance as a mitigation measure; other instruments have to be used in combination to properly protect surface water. On the other hand, vegetated buffers up to 20 metres seems to be more acceptable for other crops like orchards, vines and vegetables even if a combination of different mitigation measures is strongly recommended to avoid unacceptable loss of agricultural yield Results of this study provide a starting point for the investigation of real applicability of "standard" mitigation measures at local level. Improvements of data availability at National level, would allow the application of this work to the entire Italian agricultural landscape.

References

-ESRI ARCGIS 9.2 Software
-Carthographic data ESRI Coverage or Shape file format
-Regional Datasets (DG Agricolture Lombardy Region)
-Misure di mitigazione del rischio per la riduzione della contaminazione dei corpi idrici superficiali da deriva e ruscellamento – CCPF 2009