MAINTAIN AND /OR MANAGE RIPARIAN WETLANDS

Final draft April 14, 2008 Authors C. Gascuel-Odoux & J.M. Dorioz

Description

Small riparian wetlands inserted in agricultural landscapes are often neglected in national and regional wetland inventories. These areas are small, located in the bottomlands of the headwater catchments, scattered in the rural landscape. They are often considered as controversial wetlands. They are the inescapable interfaces between groundwater-of which they are the diffuse outlet - and the superficial water body of river systems. They are also in these agricultural landscapes, the interface between the cultivated hillslopes and plateaux and the river system.

The awareness of the wetlands functional role is increasing in parallel with their progressive disappearing in intensive farming landscapes. The difficulty with integrating wetlands in management is exemplified with the European Water Framework Directive (EU, 2000), where wetlands are not recognised as water bodies, but have to be included either in the groundwater bodies or in the surface water bodies (WFD, 2003).

These wetlands may be seen as areas buffering the water quality against the degradation due to diffuse source pollutions (Viaud et al., 2004). They are key areas for environmental challenges related to water protection (Blackwell et al., 2002). It is precisely because they are scattered in the landscapes and thus with a maximised length of contact with the agricultural zones producing the diffuse pollution, that they are able to play with efficiency this buffer function.

Rationale, mechanism of action

Their narrow width is moreover completely adapted to a function of biogeochemical buffer (Mitsch and Gosselink, 1993): Sabater et al. (2003) and Beaujouan et al. (2002) demonstrate for nitrogen that the length of contact between the wet zone and the zone of contribution of nitrate (the cultivated hillslope) -and not the surface of the wetland- is the factor driving the efficiency of the wetland buffer for nitrogen abatement.

The water feeding the wetlands comes from hillslope and ground water which are often rich in nitrate. Three conditions are required for the denitrification: income nitrate fluxes; availability of C (heterotrophic activity of the bacteria); anoxic conditions; biological activity of specific bacteria regarding to the denitrification processes. Other factors are involved: temp > 4°; a little acidic pH. These conditions depend on the season and the hillslope conditions as well micro-local conditions. These conditions are better in the first meter of the wetland, in the few 20- 40 cm in depth (organic matter).

The N removal can also be due to the N uptake from the vegetation, therefore the management of the riparian wetland. The decrease in N concentration is also due to the dilution (no fertilization, surface runoff).

The situation is different for phosphorus. Individual wetlands may me source or sinks for P. Generally wetlands are sinks for particulate P but tend to release some dissolved P and the balance input-ouput depend on their characteristics, shapes, landscape positions etc. Some of them are saturated. At the landscape level, natural wetlands seem to be globally a significant sink for total-phosphorus from land surfaces. Effect seems to be related to their number and total surface area. Consequently the really narrow riparian wetlands may not be good sinks.

Applicability

Management could be recommended to improve these conditions: increase direct incoming fluxes from the hillslope to the wetlands (i.e. redirect drainage water for example); control stream water discharge to increase residence time, decrease spatial variability of the fluxes and decrease flow velocity within the wetlands (i.e. stream management).

See also factsheet : "constructed wetlands" *(categorie : "measures in surface water" reference UK44 Establish and maintain artificial (constructed) wetlands)*

Effectiveness, including uncertainties

Despite a real denitrification in riparian wetlands, their effect on N removal remains low and highly variable, and is limited to medium events which allow sufficient residence time for denitrification; boundaries of the wetland; high heterogeneity of water flow in wetlands which avoid the site where denitrification could be increase.

The processes described for field margin *(factsheets 7.4)* can also act in riparian wetlands. But due to anoxic conditions which tend to increase organic matter mineralization, uncertainties exist on P, metals, and pesticide becoming. P, Cu, Zn can be released. Whatever they are P transformers. The biotransformations of pesticides can be stopped.

Thus, if the preservation of the wetlands is positive anyway and act as buffer, their management and the changes of state due to the practices applied have to consider these uncertainties.

Time frame

Time is due to their inventory and assessment of their function. Numerous papers describe how to do that (see Merot et al. (2006) for a review).

Environmental side-effects / pollution swapping, e.g.

The major pollution swapping is on atmosphere. The denitrification can increase N oxide gas emission, due to an incomplete denitrification process. The N oxide gas emissions in catchments are mainly due to the bottom wetness domain in the catchment. Therefore, management or practices applied can have side-effects. It has been mentioned that high inputs of NO_3 can increase P release from wetlands.

Otherwise wetlands present a specific wildlife, a heritage value which is may conflict with the change of state related to their management as buffers.

Relevance, potential for targeting, administrative handling, control

Delineation is easy, both DEM or remote sensing can be used.

Costs: investment, labor

1. Inventory requires a moderate investment (DEM, soil mapping and field survey)
2. Management (stream discharge control, etc.) requires a moderate investment.
3. Protection from livestock can require some investments *(cf factsheets 7.2)*

References

Baudry, J. and Thenail, C., 2004. Interaction between farming systems, riparian zones, and landscape patterns: a case study in western France. Landscape and Urban Planning, 67(1-4): 121-129.

Beaujouan, V., Durand, P., Ruiz, L., Aurousseau, P. and Cotteret, G., 2002. A hydrological model dedicated to topography-based simulation of nitrogen transfer and transformation: rationale and application to the geomorphology-denitrification relationship. Hydrological Processes 16: 493-507.

Blackwell, M.S.A., Hogan, D.V. and Maltby, E., 2002. Wetlands as regulator of pollutant transport. In: P.M. Haygarth and S.C. Jarvis (eds), Agriculture, Hydrology and Water quality. CAB Int. Publishing, pp. 321-339.
Bullock, A. and Acreman, M., 2003. The role of wetlands in the hydrological cycle. Hydrology and Earth System Sciences 7: 358-389.
Chaplot, V., Walter, C. and Curmi, P., 2000. Improving soil hydromorphic prediction according to DEM resolution and available pedological data. Geoderma 97: 405-422.
Crave, A. and Gascuel-Odoux, C., 1997. The influence of topography on time and space distribution of soil surface water content. Hydrological Processes 11: 203-210.
Curmi, P. et al., 1998. Hydromorphic soils, hydrology and water quality : spatial distribution and functional modelling at different scale. Nutr. Cycl. Agroecosyst. 50: 127-142.
Franks, S.W., Gineste, P., K.J., B. and P., M., 1998. On constraining the predictions of a distributed model : the incorporation of fuzzy estimates of saturated areas into the calibration process. Water Resources Research 34: 787-797.
Gineste, P., Puech, C. and Merot, P., 1998. Radar remote sensing of the source areas from the Coët-Dan catchment. Hydrological Processes, 12: 267-284.
Güntner, A., Uhlenbrook, S., Seibert, J. and Leibundgut, C., 1999. Estimation of saturation excess overland flow areas - comparison of topographic index calculations with field mapping. In: B. Diekkrüger, M. Kirkby and S. U. (Editors), Regionalization in Hydrology. IAHS, Oxfordshire, UK, pp. 203-210.
Maltby, E., Hogan, D., Immirzi, C.P., Tellam, J.H. and Van Der Peijl, M., 1994. Building a new approach to the investigation and assessment of wetland ecosystem functioning. In: W.J.Mitsch (Editor), Global Wetlands : Old World and New. Elsevier Science B.V., pp. 637-658.
Maltby, E., Hogan, D.V. and Mc Inness, R.J., 1996. Functional analysis of European wetland ecosystems - Phase 1 (FAEWE). Office for Official Publication of the EC, Luxembourg.
Merot, P. et al., 2003. Testing a climato-topographic index for predicting wetlands distribution along an European climate gradient. Ecological Modelling 163(1-2): 51-71.
Merot, P., Hubert-Moy, L., Gascuel-Odoux, C., Clément, B., Durand, P., Baudry, J., Thenail, C. 2006. Environmental assessment. A method for improving the management of controversial wetland. Environmental Management 37, 258-270.
National Research Council, 1995. Wetlands : Characteristics and boundaries. National Academic Press, Washington DC, 444 pp.
O'Loughlin, E.M., 1986. Prediction of surface saturation zones in natural catchments by topographic analysis. Water Resource Research 22, 794 - 804.
Sabater, S. et al., 2003. Nitrogen removal by riparian buffers along a European climatic gradient: Patterns and factors of variation. Ecosystems 6(1): 20-30.
WFD, 2003. Common Implementation Strategy. Guidance document n°2. Identification of water bodies, European Communities, Luxembourg.
Wang D., Dorioz J.-M., Trevisan D., Braun D.C., Windhausen L.J., Vansteelant J.-Y., 2004 – Using a landscape approach to interpret diffuse phosphorus pollution and assist with water quality management in the Basins of lake Champlain (Vermont) and lake Léman (France). In : Lake Champlain : partnership and research in the New Millenium. Manley T. and all Eds. Kluwer Acad. 2004 ; p. 159-189. (827)