E. Turtola & W.J. Chardon (2012) 21: 204–205

Preface

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In many intensively cultivated areas, surface and ground waters suffer from eutrophication and deterioration of the water quality. To improve the environmental protection actions of agriculture, EU countries have adopted common legislation, such as the Nitrate Directive and the Water Framework Directive, which set limits to the use of manure and nitrogen fertilizers and aim at good ecological state of waters by 2015, respectively. Moreover, different voluntary measures and environmental schemes are being supported financially by EU and national governments to reduce agricultural nutrient loading and eutrophication, for instance by optimizing fertilization and controlling erosion by grass cover and buffer zones. Potential of the above mentioned traditional methods will be marked if environmental programs and technological development support the targets as well.

Yet, in many agriculturally loaded water bodies good ecological state appears to be unattainable in the near future. Former accumulation of phosphorus (P) in soils and sediments retards the recovery of waters, implementation of environmentally friendly measures may be inadequate, or some of the current measures themselves are inefficient. However, it has been estimated that in Finland dissolved P losses could be reduced by one third if P inputs to the soil were in accordance with the plant need on every field. Starting now would mean that we could reach the estimated reduction in twenty years. Yet, at the moment we are still overusing P and the re-arrangement of nutrient flows in agriculture requires fundamental technological changes in the management and use of livestock manure. Moreover, in Finland as well as in the other Nordic countries around the Baltic Sea, global change with increasing rainfall and unpredictable fluctuations in temperature probably brings about heavy challenges for erosion control and maintaining or improving soil structure.

There is an obvious need for novel methods and new techniques for speeding up the load reduction that could be easily adopted by farmers or put into practice by other stakeholders in the river basins.

The novel methods preventing P to enter vulnerable water bodies may include:
- chemical amendments to reduce soil loss;
- chemical amendments to immobilize P in soils, paddocks or in wetlands;
- filter systems to remove P from field runoff;
- sediment traps or filter systems in main ditches and channels.

Targeted and cost-effective use of such methods requires that we recognise the sources and transport routes of nutrients, critical steps in the load generating processes and the magnitude of responses in the rivers, lakes and coastal waters suffering from eutrophication. Moreover, the limitations, possible risks and side-effects must be evaluated.

This special issue of AFS gathers current Finnish research on novel methods for reducing agricultural nutrient losses to water bodies. The review of Klimeski et al. presents principles of dissolved P trapping from runoff with different types of materials and methodological aspects to be considered while estimating their potential. Uusitalo et al. examined the use of one industrial material, Ca-Fe oxide granules, for dissolved P removal from agricultural runoff. In laboratory, Ca-Fe oxide granules showed high P sorption capacity that was also evaluated by desorption tests under different environmental conditions. Different new filtering methods have been put in practice and monitored in some channels in south-western Finland as described by Kirkkala et al., with up to 40% reductions in P load. The paper of Uusi-Kämppä et al. includes promising results of experiments aiming to P and microbe trapping with various amendments mixed in the footing material of horse paddocks. For gypsum amendment (3 and 6 ton ha^{-1}) of clayey soils, rainfall simulations of Uusitalo et al. gave reductions for both dissolved and particulate P, reaching up to 50-70% in percolation water through undisturbed soil monoliths. Ekholm et al. monitored effects of gypsum amendment (4 ton ha^{-1}) on a small catchment with 30-60% reductions in dissolved and particulate P losses, respectively. Based on the empirical studies above, Jaakkola et al. included gypsum effects on P losses as part of ICECREAM model. Field application of gypsum was further investigated for the economic aspects of its use, as compared with other P mitigation measures, by Iho and Laukkanen. Four out of the eight studies included in this issue were presented during a workshop of COST Action 869 (Mitigation options for nutrient reduction in surface water and ground waters) held in Jokioinen, Finland in June 2010[1]. This meeting inspired us to compose this special issue on novel technologies.

The challenges of water protection vary around the Baltic Sea due to differences in natural conditions, agricultural practices and their intensity, economic situation or, in the present context, in the availability of potential materials for P trapping. Obviously the most intensive and expensive methods would be targeted only in the most problematic fields or watersheds. On the other hand, new innovations and method development may produce practical and cheap solutions that can be applied widely. We hope that the special issue of AFS will succeed in triggering scientific interest on the development, needs, application, limitations and mechanisms of new methods directed towards P mitigation from the areas responsible for the highest environmental risks. Ideally, adaptation of such measures, together with traditional water protection, would speed up the recovery of waters and allow better recycling of nutrients in the agricultural system. Although the main purpose of novel methods is to reach good ecological status in the receiving water bodies, the ultimate aim should be to recycle the captured nutrients, e.g. by returning them to the soil for use by crops. The option of using amendments to promote a good soil structure on agricultural soils with a poor structural quality remains an important research question as well.

[1]see http://www.cost869.alterra.nl/COST869.htm#Fin10