Geographical targeted landscape management for reduced N pollution from agriculture

Tommy Dalgaard[1], Esben Auken[2], Christen D. Børgesen[1], Gitte Blicher-Mathiesen[3], Klaus Butterbach-Bahl[4], Morten Graversgaard[1], Birgitte Hansen[5], Brian H. Jacobsen[6], Jørgen E. Olesen[1], Finn Plauborg[1], Stefan Schaper[7], Irene Wiborg[8] *et al.*

[1] Department of Agroecology, Aarhus University, Research Centre Foulum, Tjele, Denmark
[2] Department of Geology, Aarhus University, Aarhus, Denmark
[3] Department of Bioscience, Aarhus University, Silkeborg, Denmark
[4] Karlsruhe Institute of Technology (KIT), Garmisch-Partenkirchen, Germany
[5] Geological Survey of Denmark and Greenland (GEUS), Copenhagen and Aarhus, Denmark
[6] Department of Food and Resource Economics, University of Copenhagen, Frederiksberg, Denmark
[7] Department of Department of Management, Aarhus University, Aarhus, Denmark
[8] SEGES, Knowledge Centre for Agriculture, Aarhus, Denmark

E-mail: tommy.dalgaard@agro.au.dk

Abstract

This paper argues that geographically targeted management of agricultural landscapes is key to achieve ambitious reduction targets for water, air and climate pollution in combination with a socio-economically sustainable food production, while simultaneously offering a significant potential for multiple other ecosystem services.
Guiding principles for the sequential implementation of various types of landscape-scale measures are provided and exemplified for Denmark, where a new paradigm for a more geographically targeted nitrogen regulation is implemented. It is concluded, that further development of landscape management measures hold a very large potential.

Keywords: agricultural production, landscape management, nitrogen pollution, targeted regulation

1. Introduction

One of the largest global challenges is to combine the development of a sustainable food production with the urgent needs to reduce environmental pollution and climate effects from agriculture.
This paper argues, that geographically targeted management of measures to reduce pollution from agricultural production landscapes provides important new solutions to this challenge. Recently, the European Commission initiated the development of both farmer and policy maker guidance on how to implement environmental measures to obtain a more sustainable agricultural production with combined water, air and climate benefits, including a review of land use and landcape management measures (Dalgaard and Butterbach-Bahl 2019). The present paper draws on these results, in particular in relation to the extensive challenges related to the implementation of the EU Water Framework Directive and points to potentials for landscape-based solutions.
This will be illustrated for the case of Denmark where the government promotes a paradigm shift towards a more targeted regulation to supplement the existing general regulation of nitrogen use and management (Dalgaard et al. 2014).

2. Materials and methods

The basis for the present paper is results from the www.mapfield.dk Innovationfund Denmark project and the related study landscapes that cover a series of small agricultural watersheds in Denmark. Detailed land use and field-based agricultural management information has been

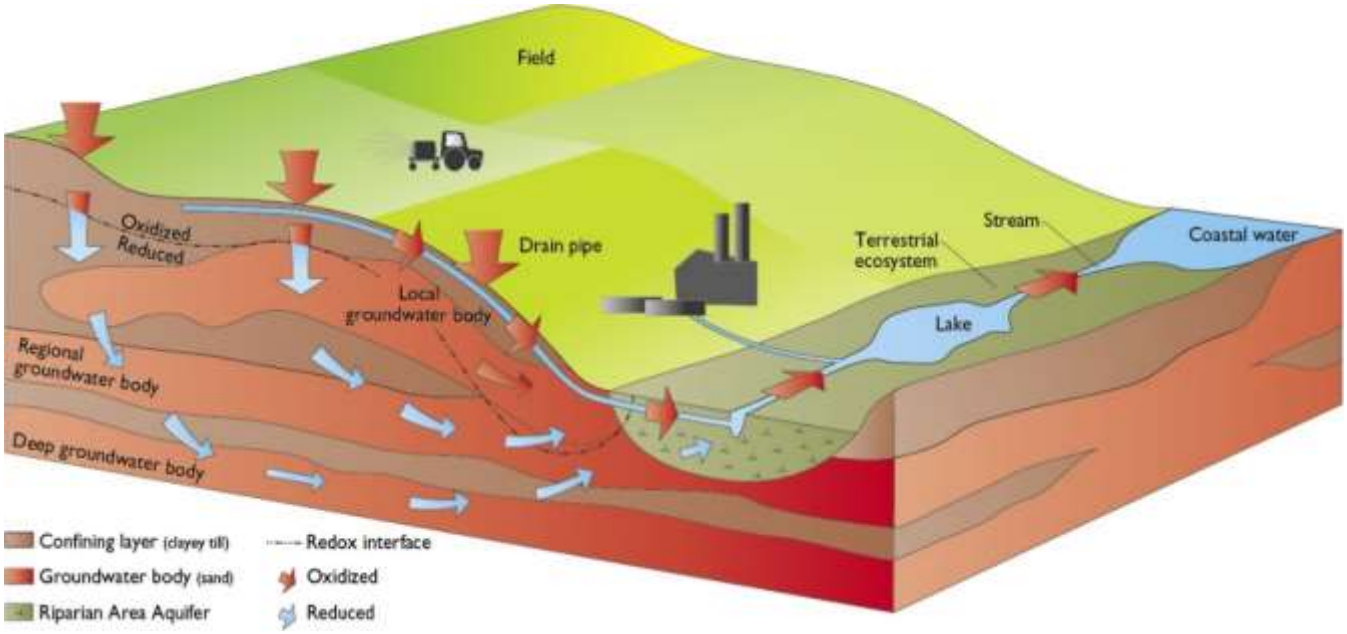

Fig. 1: Conceptual model of the landscape water flows (Hinsby et al. 2008).

collected, and the soils and geology of each landscape are mapped in 3D using newly developed high resolution electromagnetic methods, and detailed information about geochemical N reduction processes and location of subsurface redox zones. Thereby, landscape-scale water and nitrogen flow models are set up, and using the conceptual model in Fig. 1, the effects of geographically targeted measures can be assessed by farmers and other key stakeholders to design solution scenarios to reach defined N pollution reductions targets.

3. Resulting sequence of measures studied

As a result of an expert workshop in Brussels, a series of relevant landscape measures have been identified (Dalgaard and Butterbach-Bahl 2019), including the following general types of measures whose potential implementation in the concrete landscapes is suggested to be assessed in sequence with the aim to establish local targets for reduction of N losses:

1) Changed crops and crop rotations dependent on landscape properties.
2) Better distribution of livestock manure and fodder production and assessment of the potential for more mixed farming and agroforestry systems.
3) Hot spot management of livestock facilities.
4) Introduction of new biotopes for reduced pollution from agriculture in the landscape (buffer strips, hedgerows, wetlands, mini-wetlands, afforestation and set-aside land).

4. Discussion and conclusions

Geographically targeted landscape management to reduce N pollution has been discussed for many years (Hutchings et al. 2004). However, this aspect has gained greatly in importance with the development of new 3D digital mapping and modelling techniques, and examplae of which will be given. Moreover, in countries like Denmark, the low hanging fruits from more general types of measures introduced to reduce N pollution have been plucked and implemented to a degree where further implementation will be very costly (Dalgaard et al. 2014). Additional measures are therefore urgently needed to meet the enhanced policy targets of reduced pollution, not only for water but also regarding air, climate and biodiversity impacts. Moreover, such an approach provides oppertunities for a continued development of more enviromental friendly food production systems.

Acknowledgements

Thank you to the EU Commission for expert panel support and Innovationfund Denmark for www.mapfield.dk.

References

Dalgaard T and Butterbach-Bahl K 2019. Land use and landscape management. http://www.clrtap-tfrn.org/.

Dalgaard T et al. 2014. Policies for agricultural nitrogen management… *Environ. Res. Lett.* 9, 115002.

Hinsby K et al. 2008. European case studies supporting the derivation of natural background levels and groundwater threshold values... *Sci. Tot. Env.* 401, p. 1–20.

Hutchings et al. 2004. Watershed N modelling. *Wageningen Academic Publishers.* ISBN 90-7699-984-34. p. 47-53.