Fact sheet: The dNmark landscape model – a tool for dialog-based Nitrogen management

dNmark research alliance

Summary

The dNmark landscape model is developed to enable local stakeholders (e.g. farmers) to engage directly in developing landscape scenarios in the context of nitrogen management. The model allows the users to visualize the landscape impacts of suggested improvements of e.g. future land use, crop rotations, and fertilizer application through a geographical interface, and to calculate estimations of the associated changes in the nitrogen leaching. Excess nitrogen is a key threat to ecosystem functioning, impacting the ability of landscapes to provide ecosystem services such as clean water, biodiversity, and healthy living environments to society. Yet nitrogen also represents a key resource for society to assure growth in efficiency and profitability in the agricultural sector. The dNmark landscape model contains detailed information of the most important landscape characteristics (in relation to nitrogen leaching) e.g. soil type, hydrology, and nitrogen retention. Taking the variation of the landscape and the interests of local stakeholders into account in future nitrogen management solutions should ideally allow both a better protection of the environment and a more efficient food production.

Main characteristics of the landscape model

General aspects:

- Model Architecture: a series of Python scripts integrated within an ESRI ArcGIS interface in which data on landscape characteristics and agricultural practices are integrated in 20x20m grid cells:
  - Baseline data can be edited to fit actual conditions and plans for future land use.
  - The N-LES$_4$ model is used for leaching calculations.
- Model input: Crops grown, land use, irrigation, soil data, clay and organic content, precipitation, N application, drainage, retention.
- Model output: Average yearly leaching over a five year period at grid cell level.

Innovative aspects:

- Process focus: Shifting the focus from a hostile relationship between farmers and regulators to a dialogue about locally situated solutions of relevance both at local and national scales:
  - The model can repeat the process steps until the wanted data input and effects are demonstrated.
- Local data input: Improved precision and relevance of estimates due to integration of local scale knowledge.
- Scenario setup: The model is intended to support a process of knowledge integration and accumulation regarding solutions for the future

Landscape model overview

In the landscape model the total land area is divided into four land use categories (rotational crops, permanent crops, permanent land cover, other areas). Depending on land use type different modelling steps and estimations on retentions and leaching applies (fig. 1).

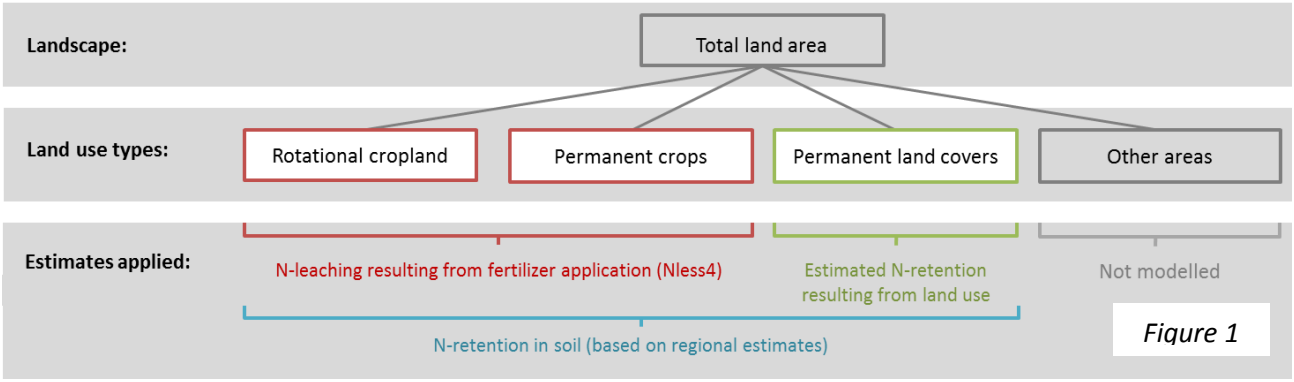

Figure 1

The landscape model consists of five modules: Preprocessing, Calculation, Interface, Recalculation, and Comparison (fig. 2).

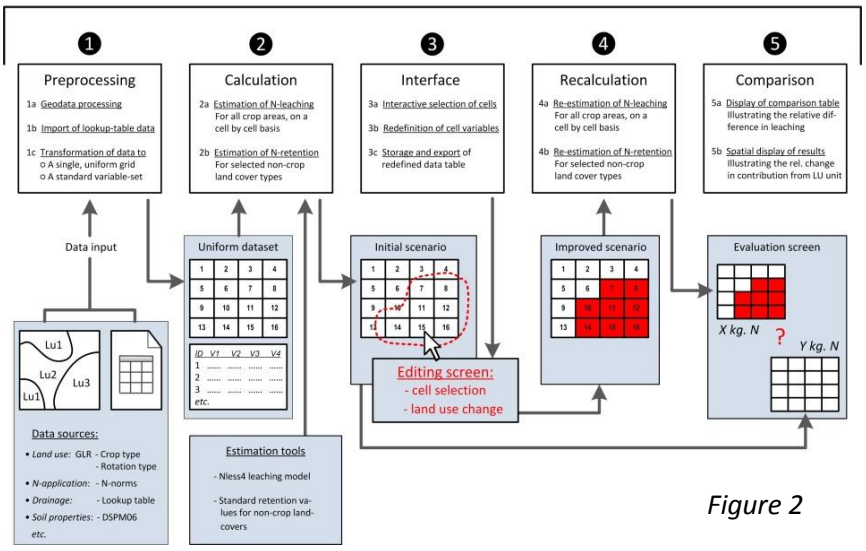

Figure 2

Current model limitations:

- Estimations on N leaching and retention related to permanent land covers are very general.
- Location of drain pipes on agricultural fields is not taken into account.

Future model improvements:

- Integration of difference in manure fertilizer and commercial fertilizer
- Integration of Nitrogen point source data.
- Introduction of larger variety in the possible crop types.

Policy recommendations

- Policies targeting nitrous fertilizer use in Denmark are currently based on broad scale national regulation instruments. It has been suggested to replace this general regulation with a targeted regulation that takes landscape-scale variations in leaching and retention of nitrogen into account. Users of the dNmark landscape model can generate dialogue-based scenarios that seek to solve the challenge of targeted land use management.

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