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METHOD FOR PLANNING WATER PROTECTION OF FORESTRY ON WATERSHED LEVEL

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SUMMARY

Forested headwater catchments need to be analysed to control the leaching of substances from forestry to watercourses. The COFORLO tool was developed for that purpose. The COFORLO is a practical application that makes use of recent scientific findings. The tool is an Excel spreadsheet application that simulates the source, transport, retention and discharge of load from forestry to watercourses. COFORLO calculations provide estimates of the combined load from ditch network maintenance, forest regeneration, and fertilisation of peatland stands. Iterative calculations can help determine the right balance between forestry activities, water protection measures, and the water environment.

KEY WORDS: water protection, forestry, load, watershed, calculation tool

INTRODUCTION

Forests and sustainable forestry are important components of the Finnish economy. Therefore peatland forests have traditionally been drained and fertilised to increase forest growth and the growing stock. The maintenance of deteriorated old ditch systems is now the main type of drainage activity. Ditching of pristine peatland has virtually ceased in Finland.

Forest management procedures, such as drain maintenance, fertilisation, felling and soil preparation, increase leaching of substances into the watercourses. The harmful changes mainly include the eutrophication of waters, increased levels of silting and reduced biological diversity. In Finland the implementation of the European Union Water Framework Directive necessitates the reduction of the export loads of solids and dissolved nutrients.

An analysis and comparison of catchments make it possible to identify the catchments with considerable potential for increasing the performance of water protection, by accommodating forestry to aquatic requirements. Prioritising catchments makes it possible to target detailed planning activities appropriately. Moreover, within one catchment, an acceptably effective and cost-efficient scenario can be selected, by generating alternative combinations of forestry operations, water protection measures, and ensuing load.

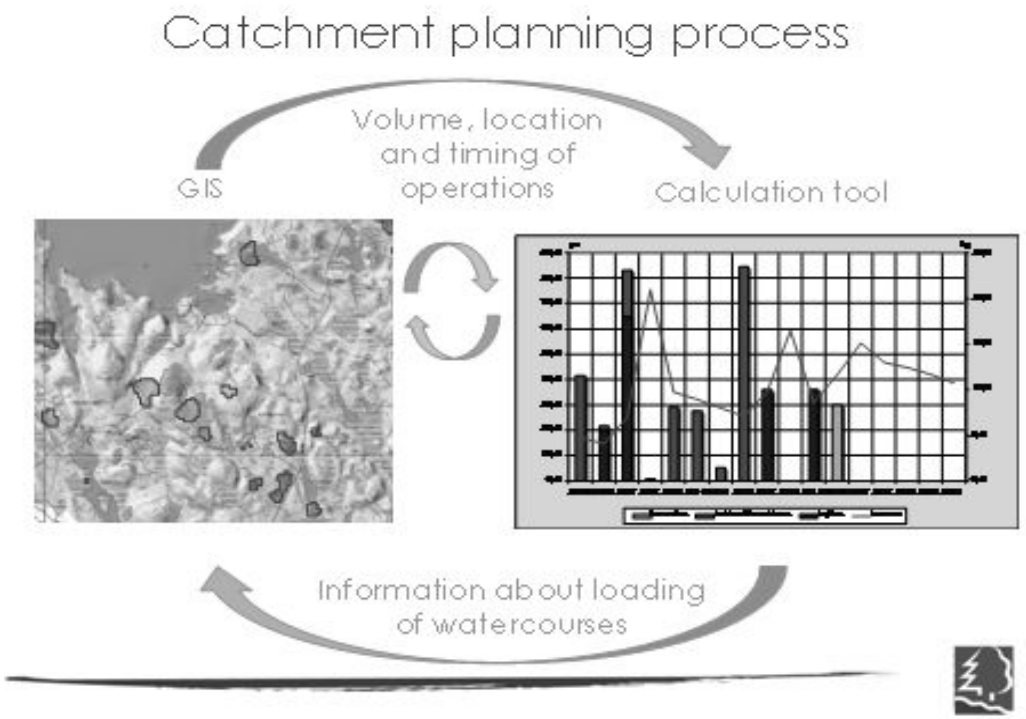


Fig. 1. The iterative interaction between the geographic information system and the prediction of load. The estimates may suggest that plans need to be revised.

The environmental effects of forestry operations in Finland have been assessed separately. From 2010 to 2011 the COFORLO (control of forest loads) tool was developed to allow catchment level calculations in forestry. The objective of this project was not to devise a fully scientific method, but rather to introduce a new way of thinking among forestry practitioners. The tool was most of all designed to promote the adoption of the watershed approach.

THE COMPOSITION OF THE COFORLO TOOL

The COFORLO tool is an Excel spreadsheet application that simulates the source, transport, retention and discharge of load from forestry to watercourses. The initial input data for the calculations is retrieved from GIS systems. The COFORLO calculations provide estimates of the combined load from forest drainage, forest regeneration (harvesting and site preparation), and the fertilisation of peatland stands. For simplicity, merely the total phosphorus discharge is addressed. Nevertheless, the solid particle load is calculated as an interim result.

The COFORLO makes use of recent scientific findings. The algorithms include specific load values presented by Finér et. al. (2010) for forest regeneration on mineral soil and peatland, forest fertilisation and ditch maintenance. The specific load figures are based on the assumption that all the regular water protection measures have been implemented: e.g. the establishment of buffer zones along the edges of watercourses in connection with clear cutting, and the establishment of sedimentation ponds in connection with ditch maintenance. The calculation method takes into account the fact that forestry operations have a long-term impact that eventually fades over time.

Specific load values represent the average of all cases. The COFORLO allows the adjustment of specific load figures to individual local conditions. Explanatory variables have input values that together determine the value of the output variable, i.e. the total phosphorus. The input variables were selected separately for drainage, regeneration and fertilisation (Fig. 2).

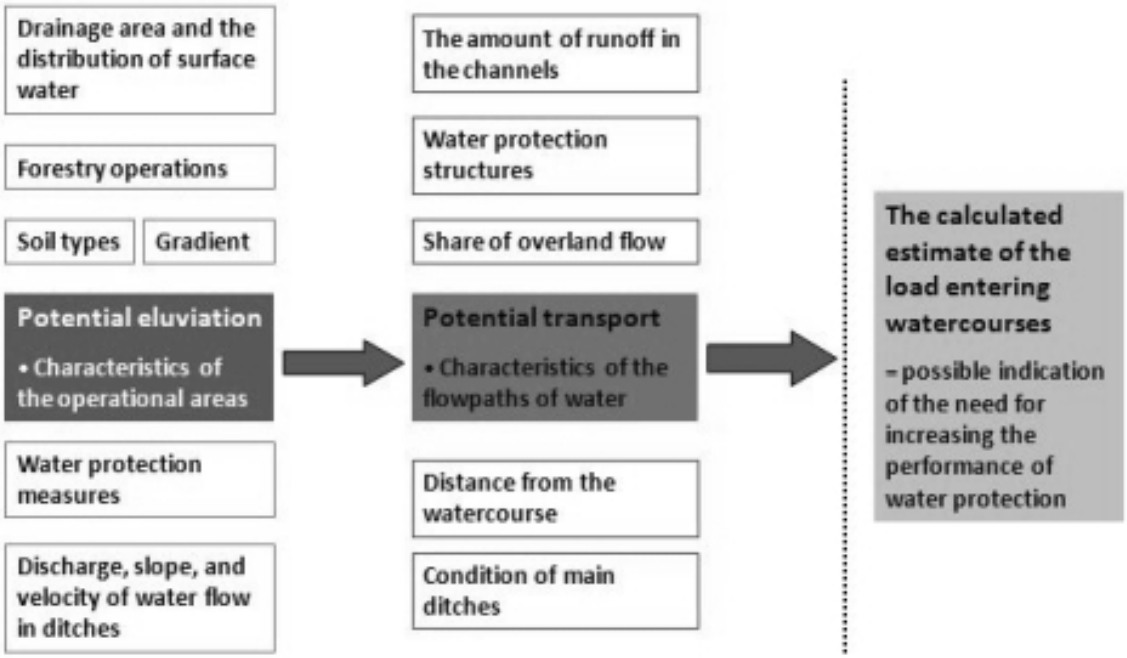


Fig. 2. Variables that explain potential eluviation and transport of load to a given watercourse.

The COFORLO algorithms can utilise some results of elevation model analyses (RLGis).

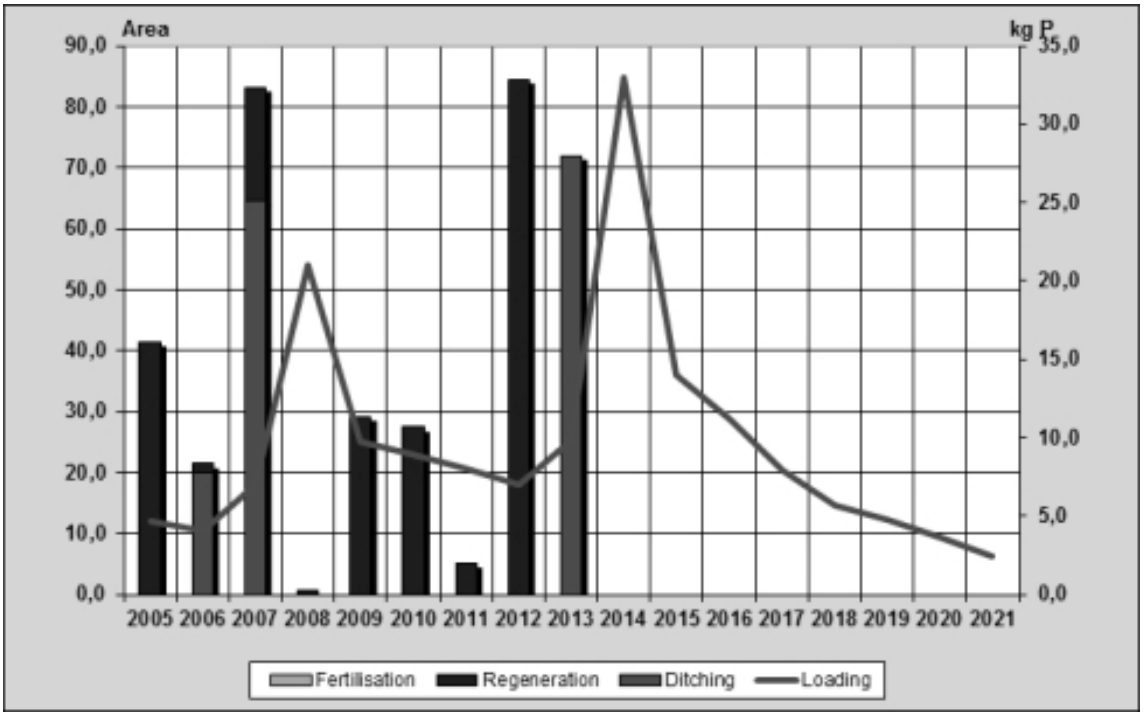
The prediction of the export loads of suspended solids from ditch maintenance at the outlet of the ditch network is largely based on the regression equation that Joensuu (2002) presented. His finding was that soil types primarily explain the load, in addition to the volume and time of the operations.

Until now, science has not provided estimates of the settling and filtration capacity of uncleared over-grown main ditches that conduct water from the area dug to a watercourse. The COFORLO's incomplete scientific basis was supplemented with assumptions. Likewise, in the absence of a model that would state the effects of terrain inclination and soil type on erosion in a regeneration area, the required equations were devised without empirical grounds.

THE OUTCOME OF COFORLO CALCULATIONS

The main output of a COFORLO calculation is a simple line graph that demonstrates the total phosphorus load from forestry to watercourses. The time span covers the past six years and the next ten years.

The calculated load to watercourses can be cut down in two ways. Firstly, the quantity and timing of the activity that causes the erosion or leaching of soluble compounds can be modified; and secondly, water protection measures (e.g. a sedimentation pond) can be used. Figure 3 displays a forestry operations scenario of a headwater catchment before cutting a peak of calculated loading.



Fig, 3**.** The bars indicate the annual volumes of forestry operations in a 2500-ha headwater catchment. The graph demonstrates the ensuing phosphorus load.

Figure 4 displays another scenario after adjustments to the plans. Ditching of 32 hectares was postponed from 2013 to 2015. Overland flow and peak runoff control dams were added. As a result, the calculated peak load dropped so dramatically that 30 ha of peatland fertilisation could be added to the scenario, without jeopardising the standard of water protection. In this case, 16 kg of P annually was considered to be the highest acceptable load.

CONCLUSIONS AND DISCUSSION

Pilot studies have indicated that the COFORLO is a functional tool. The differences between feasible scenarios have repeatedly proved to be surprisingly pronounced, thus suggesting that the application of this method has considerable potential benefits to yield. Iterative COFORLO calculations can help find the right balance between forestry and the water environment. The COFORLO method can be applied to headwater catchments or individual drainage, fertilisation or regeneration plans. However, due to data retrieval problems, the tool may be less convenient for entire river basins.

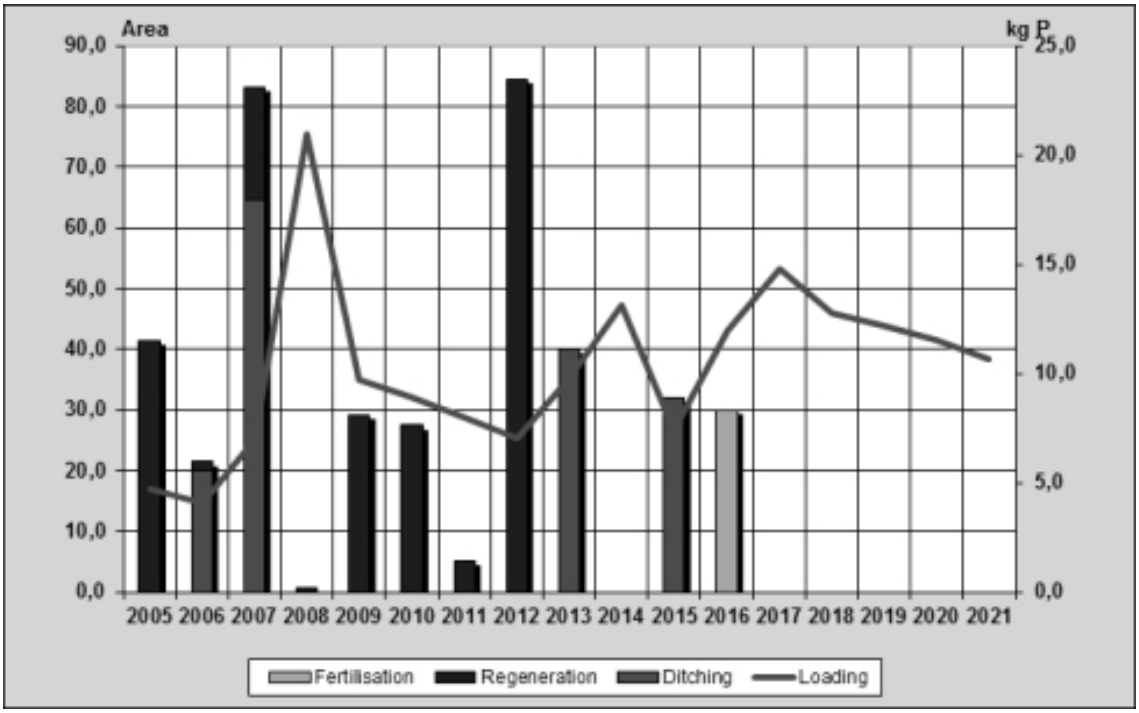


Fig. 4. The loading history and the future scenario of the 2500-ha catchment after adjustment of plans.

In the longer term, the planning of water protection needs to be largely automated and integrated into the information systems of forestry. The inadequacy of the scientific grounds of the COFORLO calculations calls for research. Knowledge of the load-retaining capacity of different kinds of flowpaths would be particularly significant.

ACKNOWLEDGEMENTS

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