Nutrient release from coniferous woodland stimulated by changes in forest management: A new nitrate time bomb?

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Nitrogen (N) pollution of rivers and groundwater costs billions of pounds per year globally in water treatment and environmental damage from eutrophication. Deep water tables and slow transport of nitrate through unsaturated rocks has resulted in large quantities of nitrate stored in rocks above the water table. Release of this store – "the nitrate timebomb" – to groundwater represents a highly significant risk to water quality. In some areas, due to release of nitrate stored in unsaturated zone, groundwater nitrate concentrations have increased, despite reductions in N leaching.

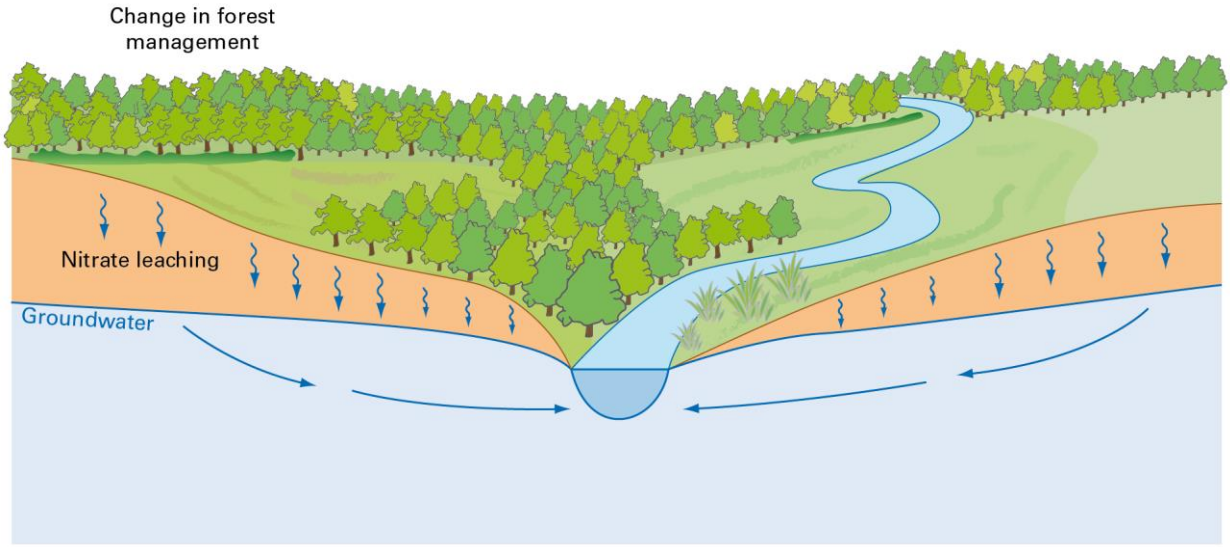
In addition to N stored in the unsaturated zone, there is now extensive evidence for N accumulation in forest soils. Nitrogen stored in forest soils presents a risk to water quality if N stores are mineralized and released, for example as a result of changes in forest management. Despite this risk, the potential impact of changes in forest management on N leaching from forests to groundwater and surface water is poorly understood. Current UK government policy proposes changes to forest management associated with afforestation and conversion of conifer to broadleaf systems. Consequently, we are expecting significant change of forest cover which is likely to alter established N leaching regimes which we know little about, thus creating a major research need.

Will changes in forest management practices result in a new nitrate timebomb? This project will unravel the missing link between N accumulation in forests and its potential for release and to quantify the risks to water quality. A range of monitoring and modelling approaches will be used to quantify N fluxes to groundwater and surface water systems. The project will benefit from a vast array of datasets, from point to national scale covering a range of disciplines including soil science, biogeochemistry and hydrogeology. Long term (>15 years) soil monitoring data at 10 Forest Research monitoring sites across the UK will be analysed in conjunction with novel field measurements to develop conceptual and process-based models of N leaching. The results of this research will be upscaled to the national scale and future scenarios of forest management will be explored.

This research addresses a real-world problem for environmental managers. Results of the PhD will support measures to meet the Water Framework Directive and the Kyoto Protocol. The outcomes will also benefit practitioners and industry (e.g. forest managers, consultants, timber processors) who will receive improved guidance, evidence and tools to support sustainable forest management.

This research is multi-disciplinary, covering soil biogeochemistry, forest management and hydrogeology. The project is a unique integration of world class monitoring platforms, data sets,

instrumentation, modelling within a supportive, dynamic research environment. The student will benefit from training to develop a wide range of technical (modelling, data driven and mathematical approaches, multi-disciplinarity, fieldwork and lab skills), applied, transferable and communication skills, all of which are highly valued by employers. The student will also gain a strong network of both researchers and practitioners working in forestry, soil science and hydrogeology.



Conceptual model of nitrate leaching to groundwater

Training opportunities:

The student will benefit from interdisciplinary training programmes at Forest Research, the University of Reading Graduate School, the School of Agriculture, Policy and Development and SCENARIO DTP. Programmes include formal courses covering a wide range of transferable skills including science, writing, communication or personal development skills. There will also be significant "on the job training" through presentations at annual research conferences and workshops, and collaboration with scientists with expertise in soil science, biogeochemistry, hydrology, modelling, fieldwork, data management and research translation.

The student will benefit from working at BGS offices for 3 months, where they will gain hands-on training in the development and application of groundwater models. They will also have access to BGS High Performance Computing cluster and training in Linux. As needed they will also benefit from training in advanced lab methods to understand N process dynamics.

Student profile:

This project would suit a student with a degree in quantitative environmental sciences. Students with knowledge of N biogeochemistry, soil science and hydrogeology would be particularly well placed.

Funding particulars:

This project has CASE funding from Forest Research and funding from the BGS University Funding Initiative (BUFI).

http://www.reading.ac.uk/nercdtp