Long-Term Large-Scale Project

Erosion Modelling

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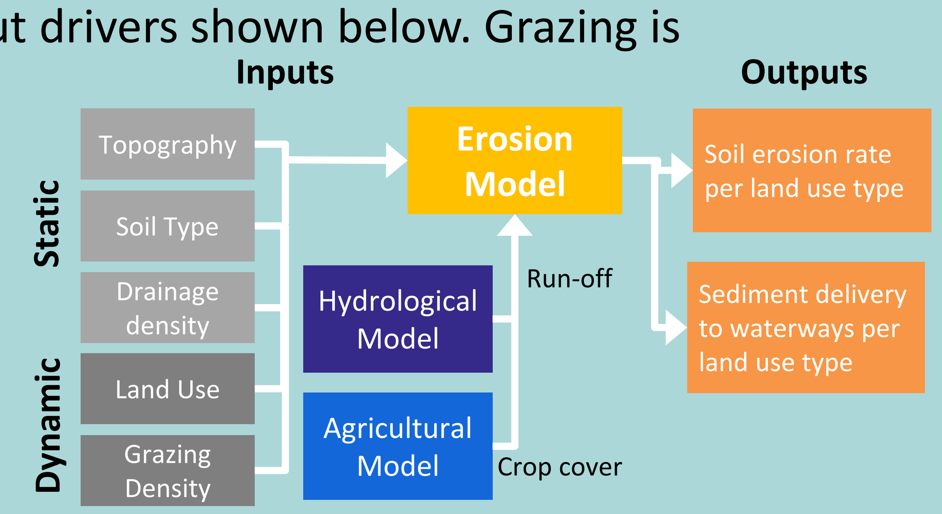
Model Summary

The LTLS erosion model uses a simple semi-empirical energy based approach to calculate erosion rates and sediment delivery to waterways using the input drivers shown below. Grazing is represented by relating plant coverage to stocking density. The model has relatively few parameters which have been set using literature data.



Past Soil Loss to Waterway

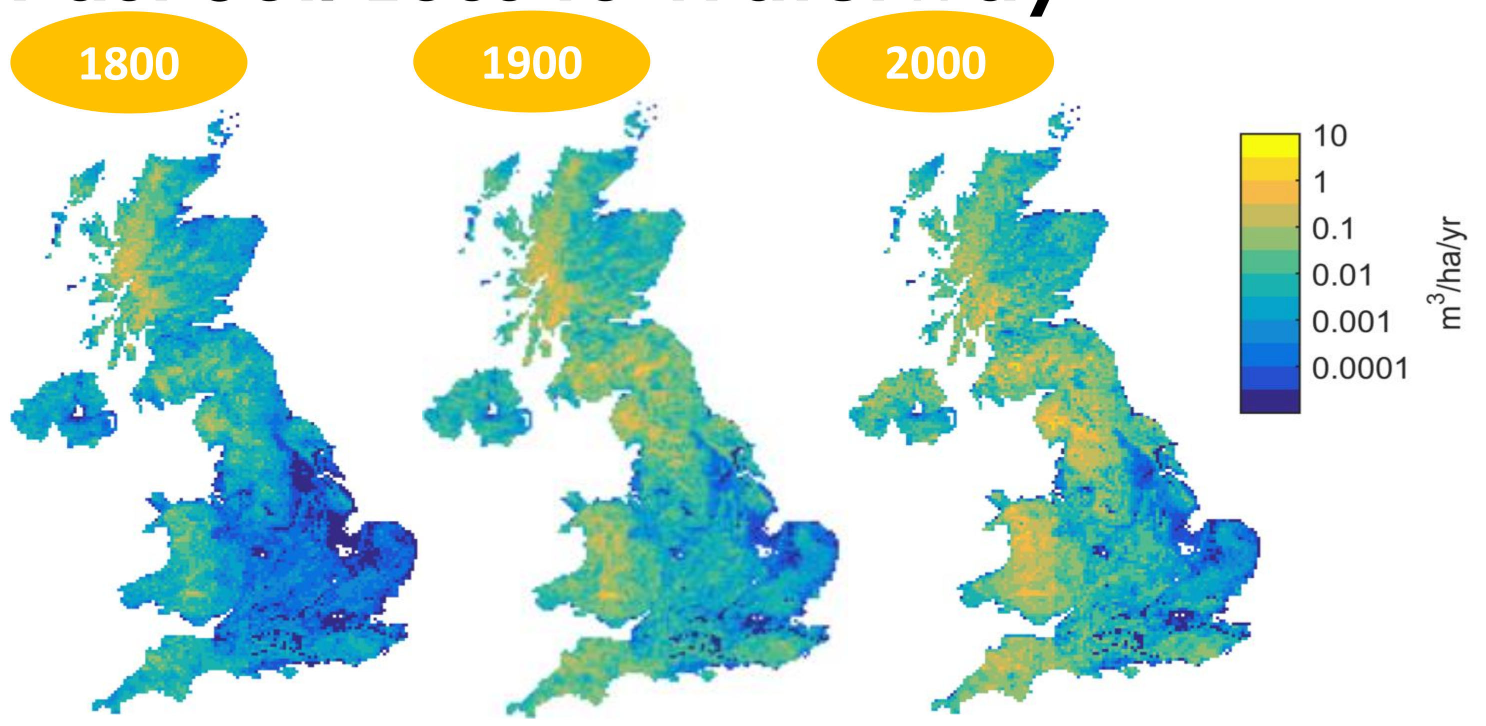


Figure: Past transfer of soil from land to water via erosion. Mean sediment delivery to waterway on a weighted land use basis is mapped on the LTLS 5x5 km grid.

Total UK Erosion

Sediment flux increases between 1800-2000:

- ~8 fold in improved grasslands
- ~6 fold in peatlands
- ~3.5 fold in rough grasslands

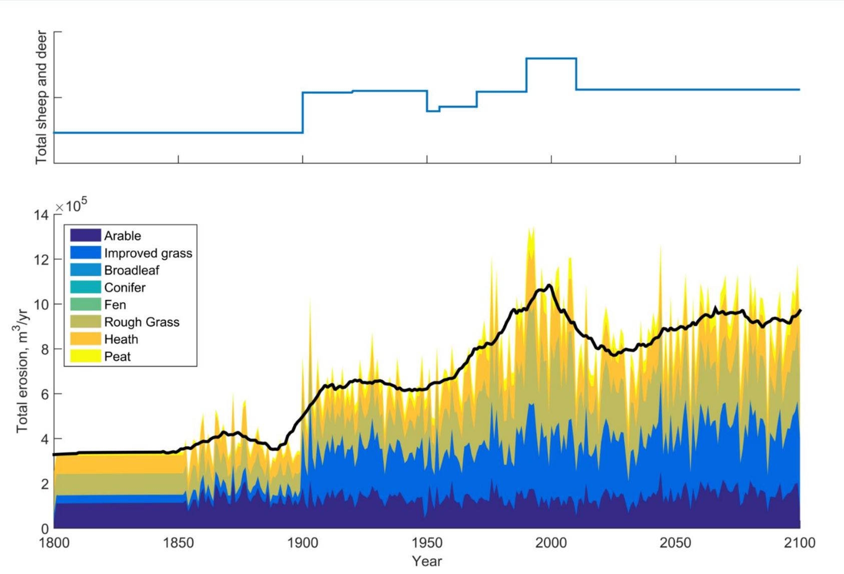


Figure: Total transfer of soil from land to water via erosion for UK 1800-2100 under BAU scenario

The model suggests that:

- Increases in grazing density have significantly increased erosion
- Recent decreases in grazing have reduced present day erosion
- Increases in future run-off may increase erosion by ~30% 2010-2100

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Groundwater

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Phosphate in mains water leakage (MWL)

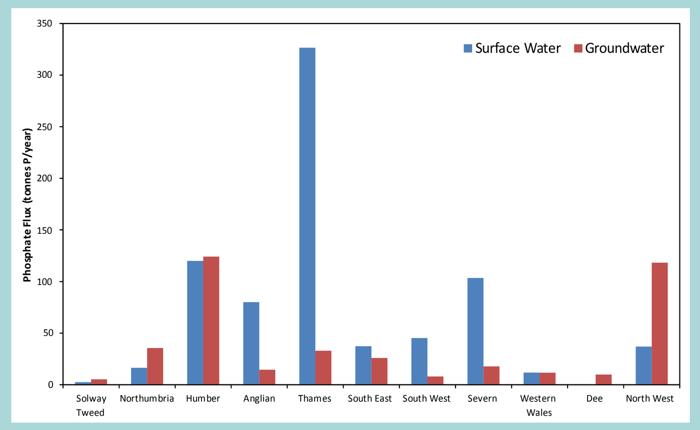
- P (as PO_4) is added to drinking water supplies to control plumbosolvency
- 95% of drinking water in the UK is dosed at c. 1 mg P/L
- Up to 25% of mains supply is lost as MWL
- Understanding sources of P is critical for water and ecological quality management

Leaking water main

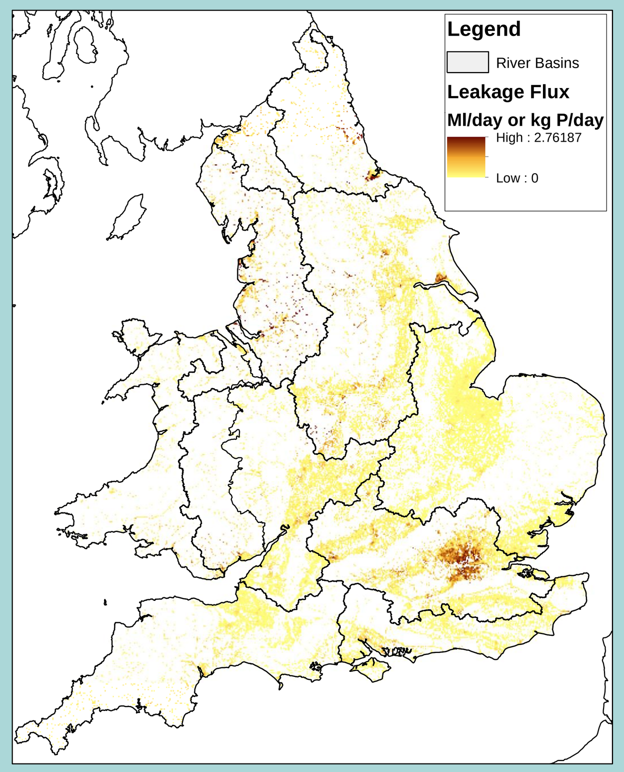
Estimating MWL flux to the environment

Method

- Published water company leakage rates
- Leakage susceptibility mapping
- Road network as a surrogate for water mains
- Aquifer mapping
- WFD river basin districts



Basin-scale MWL P flux estimates



Spatial MWL P flux for England and Wales

- Total leakage for England and Wales = c. 1.2 kt P/year
- Urban areas significant due to high water main density
- Thames Basin has largest flux of >350 t P/year
- High P flux to surface water where pipes are underlain by low permeability bedrocks
- Significant variability between areas in magnitude of flux and split between ground and surface water

Conclusions

- Leakage of phosphate-dosed mains water is likely to be a significant flux of P to the environment
- Should be taken into account in future environmental P flux modelling
- Generic methodology developed which can be applied elsewhere

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Wastewater

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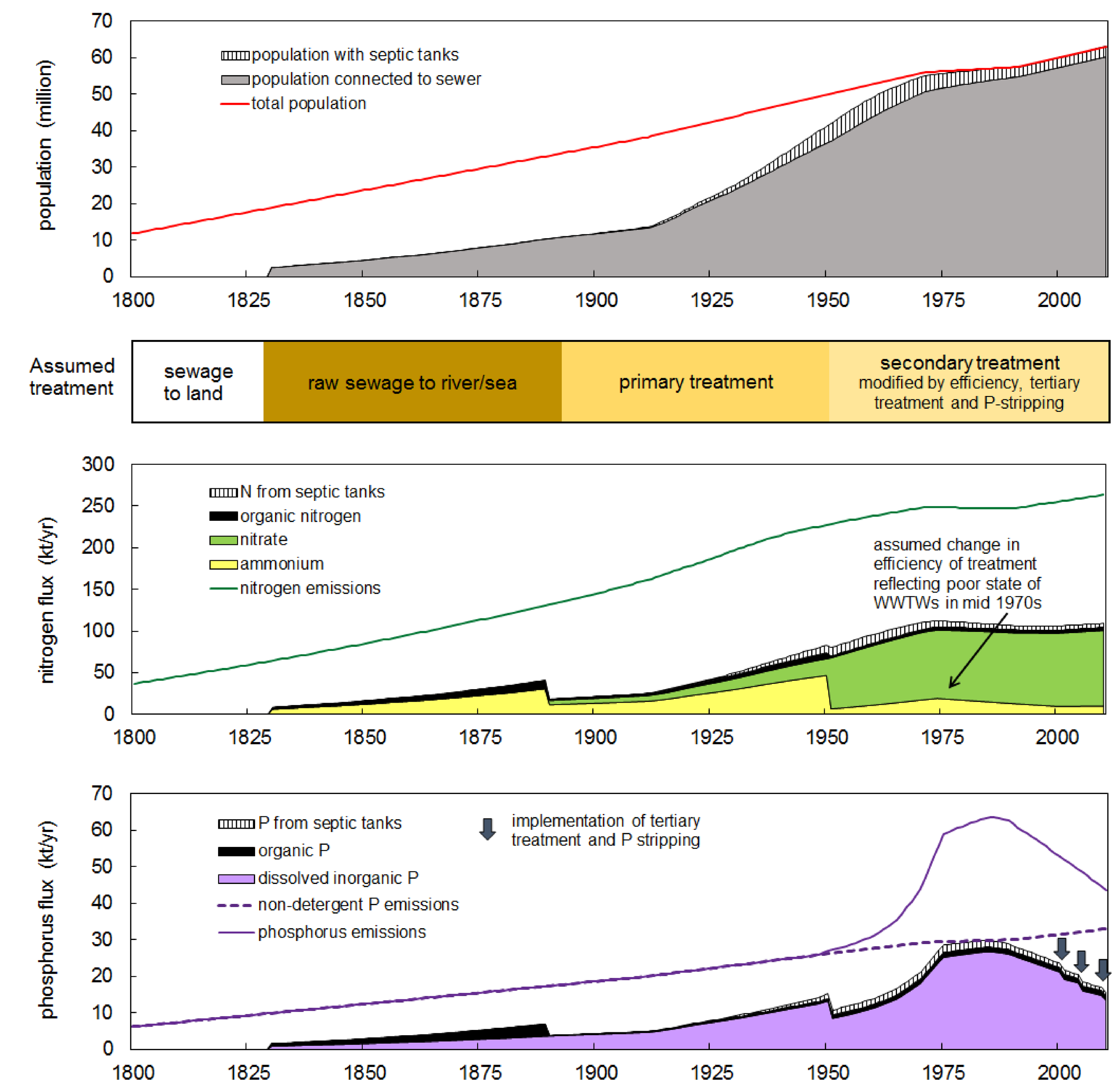
Nutrient fluxes in human waste and wastewater effluent from domestic sources in the UK 1800-2100 have been estimated from

- population data using UK census returns and future projections
- nutrient emissions per person based on published data
- introduction of WCs, septic tanks and likely connection to sewer
- changes in sewage treatment and its removal of nutrients.

The resultant fluxes, expressed on a 5km grid, are one of the input datasets to the LTLS Integrated Model.



Estimated nutrient fluxes from domestic wastewater 1800-2010 using a scenario approach to historical changes in wastewater treatment as indicated. Full details are given in Naden *et al.* (2016) Nutrient fluxes from domestic wastewater: a national-scale historical perspective for the UK 1800-2010. Science of the Total Environment (in press).

The model suggests that

- The most important drivers of change since 1800 are population growth, connection to sewer and use of phosphorus in detergents.
- Fluxes of N from domestic effluent have increased fivefold since 1900.
- Fluxes of P peaked in the 1980s. They are now half this value, mainly due to reduced detergent P, but are still 3.4 times larger than in 1900.
- By 2100, assuming current levels of treatment, N flux from wastewater is estimated to increase by 50% and P flux by 36%.

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