

Catchment-scale modelling of flow and nitrate transport in the Chalk

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Chalk: a “nutrient timebomb?”

- Rising nitrate levels have been observed in UK Chalk catchments in recent decades,
- Concentrations are now approaching or exceeding legislated maximum values in many areas.
- There is increasing consensus that Chalk systems can retard decades of prior nitrate loading within their deep unsaturated zones.
- Current concentrations may not fully reflect the long-term impact of present-day practices,
- Stringent land management controls may not be enough to avert further medium-term rises.

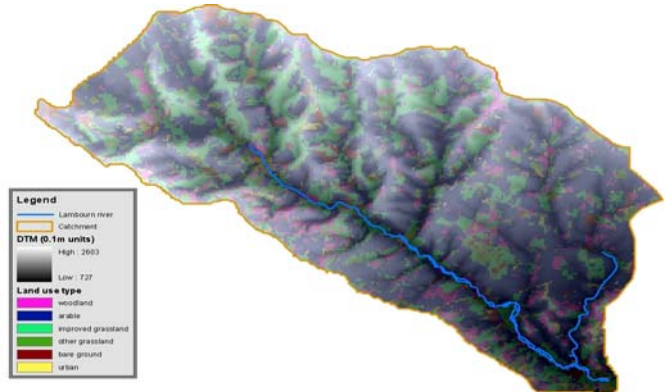


Fig 2: Topography and current-day land use within the Lambourn catchment

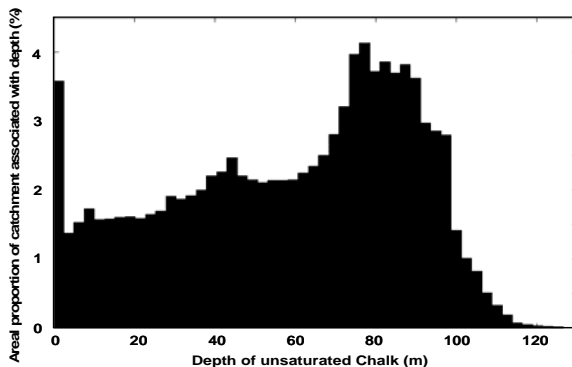


Fig 1: unsaturated zone depth distribution within the Lambourn catchment

INCA-Chalk development

Data analysis and physically based modelling were used to identify dominant responses of nutrients in Chalk systems.

The response of the water table is strongly correlated to major infiltration episodes, with a low lag time (of the order of days).

Slow travel times ($< 1\text{ m year}^{-1}$) and spatial variation in vertical distance of the unsaturated zones (Fig 1), result in water exiting from the unsaturated zone of varying age. Nutrient loading history is correspondingly mixed

Extensions to an existing model (INCA) were made to account for this mixed history. The resultant model (INCA-Chalk) has been used to investigate long term impacts of different land use management practices within the Lambourn catchment in Southern England (Fig 2) in the context of the EU Water Framework Directive.

Real data from 1920 to 2003 was compiled and extended from 2003 to 2100 through the use of climate change scenarios and two fertiliser application scenarios; the first with current-day practices continuing until 2100, and the second with all agricultural nitrate loading cut from 2003.

Future outlook for water quality

- Results (e.g. Fig 3) imply that timelines demanded by the Water Framework directive are not realistic for Chalk catchments.
- Groundwater concentrations will not reduce for several decades, and short-term increases due to historical loading are inevitable.
- In-river improvements are possible, but in the medium term, an increase in groundwater concentration may reverse such improvements.
- If changes to land management practices do not occur, substantial increases in both groundwater and in-river concentration levels within the next decades are inevitable.
- The effects of climate change appear to impact towards the end of this century.

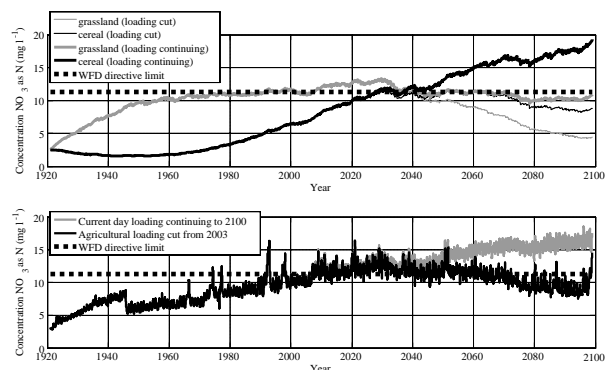


Fig 3: INCA-Chalk historical and predicted nitrate concentrations

Find out more...

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