

# Evaluating the critical source area concept of phosphorus loss from soils to water bodies in agricultural catchments

## Key messages

- This study investigated whether transport metrics alone provide better estimates of phosphorus (P) concentrations and loads from agricultural basins than critical source area metrics which combine source factors as well.
- Relative P losses between basins did not reflect trends in predicted critical source area risk
- Relative P losses between hydrologically *contrasting* basins were primarily hydrologically controlled.
- Relative P losses between hydrologically *contrasting* basins could be predicted using static transport metrics
- Relative P losses between hydrologically *similar* basins were highly variable

## Background

Studies of source and transport controls on P loss in runoff or stream flow can be separated into three types: 1) Those linking P losses primarily to source factors (e.g. soil P, organic P loadings) 2) Those linking P losses primarily to critical source areas (CSAs), i.e. where high-P sources coincide with high P transport risk and 3) Those linking P losses primarily to transport factors (e.g. surface runoff)

Type 1 studies supported the rationale for focusing NAP measures on soil P availability, however were mainly conducted at lab/field scales where hydrological variability was very small. Type 2 studies provided the rationale for the P index used in the U.S.A. and elsewhere. Many studies are now suggesting that a CSA approach might be an appropriate policy tool to manage diffuse P pollution in Europe. Type 3 studies are still emerging and highlight the complexity of hydrological processes across landscapes, scales and storms.

Recent studies have demonstrated that hydrological factors were more important than source factors in determining P loss at particular sites. However, more information is needed on whether transport metrics alone provide better estimates of P loss than CSA metrics which combine source factors as well, thus was the objective of this study. Understanding the importance of hydrological controls on P loss at catchment scales is important for achieving Water Framework Directive objectives.

## Methods

Six basins located across two hydrologically contrasting agricultural catchments were selected for this study (Fig. 1). The Arable catchment is predominantly well-drained and the Grassland catchment is predominantly poorly-drained.

Concentrations and loads of P in surface runoff (or more precisely quickflow) were measured at basin outlets during four storm events and were compared with dynamic (quickflow magnitude) and static (extent of highly-connected, poorly-drained soils) transport metrics and a CSA metric (extent of highly-connected, poorly-drained soils with excess plant-available P).

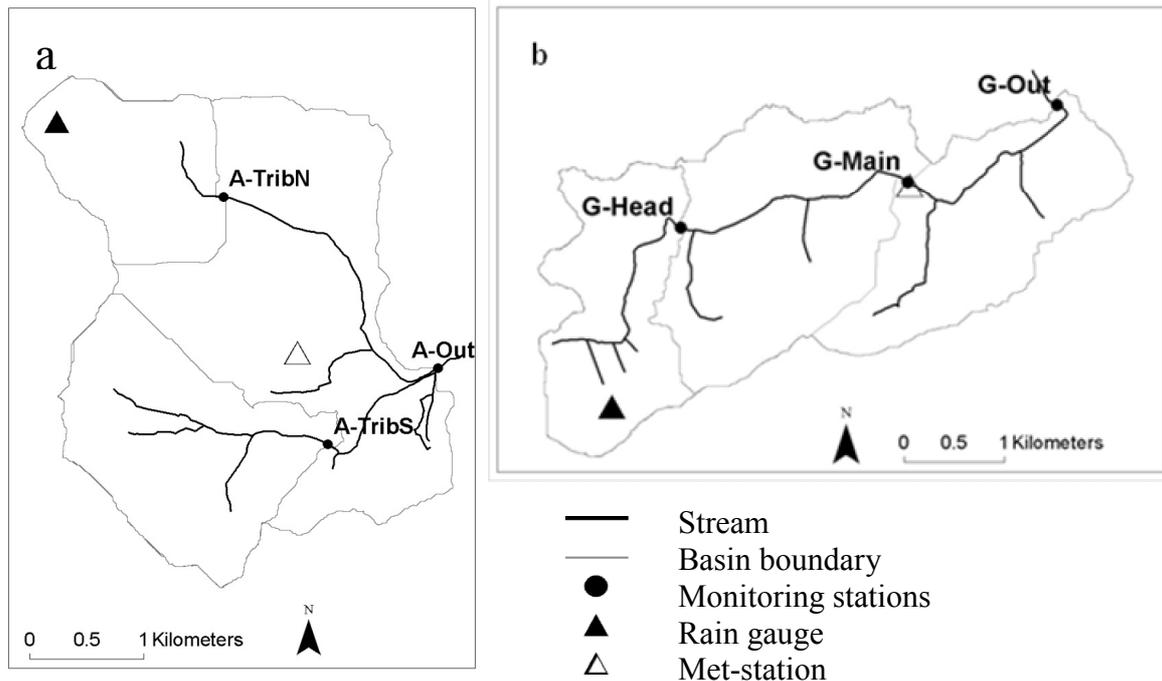


Figure 1. Location and overview of the study basins for a) the Arable catchment and b) the Grassland catchment.

## Results

- Where differences in P transport risk were large, reactive P concentrations and loads were well differentiated by dynamic or static transport metrics alone, regardless of differences in soil P.
- Where P transport risks were similar, non-static transport metrics and P source information additional to soil P, may be required to predict trends in reactive P concentrations and loads between these basins.
- Regardless of differences in P transport risk, information on land use and management, such as time of ploughing, may be required to predict trends in particulate P concentrations between these basins.

## Implications for Policy

- A CSA approach will undoubtedly be better for reducing P losses than the more traditional source-focused approach that is still currently used in many countries (including Ireland). Additionally, limiting P sources in areas with a high P transport potential will also likely reduce the magnitude of P losses.
- However, it is likely that approaches focused primarily at managing the transport potential of P will be the most effective strategy for reducing P losses in the study catchments and other similar catchments.
- Phosphorus loss mitigation efforts could be greatly enhanced by managing the surface runoff in basins where hydrological transfers of P are greatest.
- Such highly-connected basins, and their field scale components, could be identified using the Network Index.