A CATCHMENT APPROACH TO EVALUATE THE NITRATES DIRECTIVE NATIONAL ACTION PROGRAMME IN IRELAND

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Introduction
To support competitive farming and promote environmental protection in Ireland, Teagasc, the Irish Agriculture and Food Development Authority, is undertaking an Agricultural Catchments Programme to evaluate the effectiveness of the Nitrates Directive National Action Programme. The Agricultural Catchments Programme is undertaking intensive monitoring work in catchments dominated by agriculture to measure field and farmyard nutrient sources, identify pathways of nutrient movement and measure mass flux delivery of nutrients to streams. The biophysical monitoring is being supported by advice to farmers and farm-level socio-economics monitoring. This paper describes the procedure and outcomes of the geographic information systems (GIS) approach used to select representative and physically appropriate catchments.

Materials and Methods
The legislation underpinning the establishment of the Agricultural Catchments Programme required that the selected catchments would be representative of the enterprise types and intensities across Irish agriculture. Detailed stakeholder engagement, in the form of meetings with farmers' organisations, expert groups and individuals helped to develop and refine the catchment selection criteria. From these interactions some key principles were identified as having high priority in the selection process. For example, the dominant landuse in the catchments should be agriculture; both arable and grassland enterprises are sufficiently important to warrant independent selection; the lower intensity of agriculture on peat soils reduced their priority. Candidate catchments of between 4 and 12 km^2 in size that contained streams from headwaters to stream order 3 were identified, classified and ranked using a GIS-based multi-criteria decision analysis (MCDA) by maximising the proportion and intensity of arable or livestock enterprises (source factors), and minimising the occurrence of non-agricultural areas, density of housing, the occurrence of forestry and proportion of peat soils. A specific subset was developed for catchments underlain predominantly by limestone.

Detailed maps of susceptibility for both nitrogen (N) and phosphorus (P) transfer to ground and surface waters were also built following the protocols devised by the national agencies responsible for risk mapping under Article 5 obligations of the Water Framework Directive (Anon. 2005) and used to identify catchments considered to be at possible risk of high nutrient transfers. This was largely based on soil type and permeability (transport factors). A final screening excluded catchments that were under consideration for a range of activities such as road building that might substantially alter the catchment characteristics. Catchments identified as suitable using the MCDA analysis were then inspected for practical considerations such as the suitability of catchments for hydrometric research and general access.

Results
Six catchments were selected from 1300 candidates, with four on grasslands of varying risk of P transfer (ie variable agricultural intensity and soil type) and two with catchments comprising more than 50% arable land. A further two catchments will be selected in regions overlying karst limestone; the selection criteria proved restrictive for identifying potential limestone catchments because most of these hydrogeological regions occupy low-lying rather than headwater parts of larger catchments and in the west of Ireland, support generally lower

intensity agriculture. In general, however, the GIS-MCDA approach (e.g. Malczewski, 2006) was highly efficient in handling both the large number of input datasets and attribute ranges used to classify the catchments for selection.

Validating the N and P risk vulnerability mapping was also a useful component of the selection procedure. For example, one of the selected catchments, Castledockerell, Co. Wexford, comprises 54% tillage and 90% of the soils are deep, well drained sandy loams over gravel. The risk assessment procedure predicted this catchment to therefore have high and extreme risks of N transfer from land to groundwater-dependant streams. A concomitant lower risk of P transfers was predicted. In contrast, another selected catchment, Ballycanew, also in Co. Wexford, was predicted to have predominantly low risk of N delivery via groundwater (and high risk of P transfers via overland flow) to surface water outlets due mostly to the low permeability of lowland soils and high grazing pressures. These N and P risk trends were supported by preliminary water quality data collected at the catchment outlets during winter flow conditions (Fig. 1). The risk mapping procedure was likely strengthened by livestock density data being made available to this project at the smallest administrative level in Ireland.
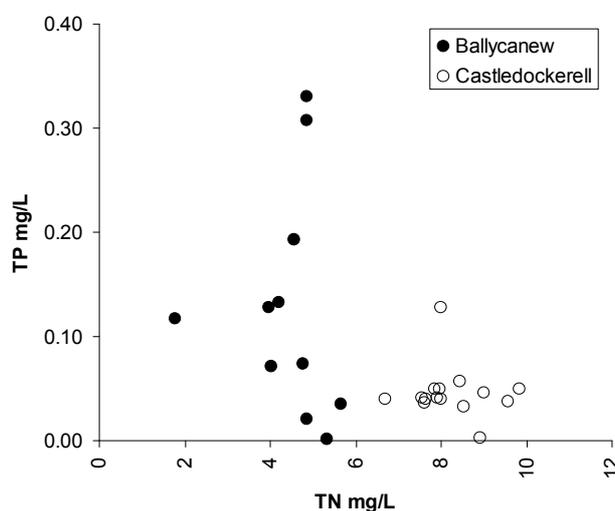

Fig. 1. Total phosphorus and total nitrogen concentrations in a series of preliminary validation water samples from outlets of the Castledockerell (predicted as highly susceptible to N transfer) and Ballycanew catchments (predicted as highly susceptible to P transfer).

Conclusions
The top-down, GIS-MCDA procedure provided an objective, comprehensive and efficient approach for selecting candidate catchments. The ranked assessment of 1300 candidates at the scale required provided six suitable study catchments. Preliminary water quality data indicate that the mapping procedures are useful indicators of the risk of N and P loss at the catchment scale.

References
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