Farm nutrient regulations; contrasting impact on water quality in different catchments

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Irish farm nutrient regulations (National Action Programme)

Limits source of N and P
- Constrains N & P application rates, soil P test
- Caps livestock intensity (170kg organic N/ha)
- Supports a derogation (250kg organic N/ha)

Minimises _temporal_ and _spatial_ interaction of N, P and surplus water
- Closed spreading & ploughing periods
- Manure storage requirements
- Buffers between applications and water bodies
- Separation of clean and dirty water
Two contrasting catchments

**Arable A**

- Spring barley 54%
- 11.2 km²
- well-drained soils
- Slate and siltstone

**Arable B**

- Winter wheat 32%
- 9.5 km²
- poorly-drained soils
- Calc. greywacke & mudstone

The Irish Agriculture and Food Development Authority
Catchment-based experimental design

Sources

Mobilisation

Pathways

Delivery

Impacts

Farm nutrient regulations

WFD standards

Wall et al ES&P 2011
Methods - Sources

• Soil tests every 2 ha
• Farm facilities & nutrient management records
Results - sources

**Arable A**
- 8.5 houses per km²
- 0.014/ha livestock farmyards
- Closed period 15 Sep-12 Jan
- 18% fields soil P > optimum

**Arable B**
- 14.0 houses per km²
- 0.016/ha livestock farmyards
- Closed period 15 Sep-15 Jan
- 19% fields soil P > optimum

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Methods - Delivery

Sub-hourly
Total P
Total reactive P
Nitrate-N
Turbidity
Conductivity
Temperature

Synchronous discharge and chemistry monitoring
Results - Delivery

Total P & total reactive P
$N = 1860\;\text{mo}^{-1}$

Nitrate-N
$N = 4464\;\text{mo}^{-1}$

Discharge
$N = 4464\;\text{mo}^{-1}$
Results - Delivery standards

$n = 86-96\%$ annual record

Total reactive P (mg L$^{-1}$)

Nitrate-N (mg L$^{-1}$)

Arable A well drained
Arable B mod-poorly drained

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Methods - Impacts

Biannual benthic diatom and macro-invertebrate surveys

Once off fish and river habitat survey
Results - Ecology standards

- 2015 ‘good’ status target met only occasionally
- Seasonal variation larger than expected

Benthic diatoms

- Seasonal variation larger than expected

Macro-invertebrates

- 2015 ‘good’ status target met only occasionally
Two questions:
1. Why the difference in TRP response?
   1. Flow volume and pathway
   2. Loading

2. Are the NAP measures likely to result in WFD targets being met?
   1. Requires temporal and spatial connectivity (mobilisation) of sources with stream response
1.1 Delivery - discharge comparison

<table>
<thead>
<tr>
<th></th>
<th>Arable A</th>
<th>Arable B</th>
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</thead>
<tbody>
<tr>
<td>Q(\text{mma}^{-1})</td>
<td>492</td>
<td>393</td>
</tr>
<tr>
<td>Q (%) closed</td>
<td>41</td>
<td>47</td>
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</tbody>
</table>
1.2 Delivery – Seasonality of loads
Delivery – seasonality and loads

![Graph showing delivery of total reactive P for Arable A and B, with open and closed systems, in mg/L and g/ha/hr.]

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Delivery – seasonal connectivity with sources

Higher particulate fractions in winter cf summer – evidence of connectivity of diffuse sources higher in winter than summer

c) Arable A
d) Arable B
Methods - Pathways

Surface water snapshots

Groundwater monitoring
2.1 Source connectivity

Arable A - close stream and groundwater quality link
Arable B - no stream and groundwater quality link
Source connectivity – Arable B baseflow

- Good status P std
- Baseflow Main avg
- Baseflow tribs avg
- Groundwater

n = 5-17 per sample site
Conclusions - Efficacy of measures

Same measures – different catchment responses

Moderate-poorly drained Arable B showed:
• lack of hydrological buffering of nutrient pressures during summer
• exacerbation of nutrient pressures during storms

Lotic ecology poor-good despite Arable A TRP standard met

Lotic ecology better following (winter) period of higher nutrient load rate

Pathways analysis helps identify which and when sources are most connected to stream response
Future challenges

Further (targeted and long term) research into

• seasonal lag effects of storm (diffuse) loads on the range of receiving water body types and

• historical near/in-stream (point) sources on summer concentrations and ecological response
Thank you
www.teagasc.ie/agcatchments

Catchment farmers N = 301
Colleagues N = 24
Funder (DAFM) N = 1
Catchment Science 2011 participants N = c. 200