Detecting the blue shoots of recovery in agricultural catchments

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Scope

• Impacts of *agricultural* land management practices on *surface* water quality
• Meso-catchment scale (1-100 km²)
• Chemical and biological water quality indicators
• 30 studies
• Europe, North America, Brazil and New Zealand

*Melland AR and Jordan P. A review of monitoring approaches and outcomes of surface water quality mitigation measures in meso-scale agricultural catchments (in preparation)*
Approaches

Number of studies

Time series analysis
- Before and after .................................................. 13
- Gradual change .................................................. 6
- Baseline .......................................................... 3

Spatial comparisons
- Paired .......................................................... 7
- Gradient across multiple ....................................... 5
- Nested up and downstream .................................... 4

Cause and effect
- Drivers, Pressures, State, Impact, Response ........ 6
- Materials transfer continuum ............................ 2

Approaches usually combined
Types and timeframes of change

**Implementation lag**
- Years between initiation and achievement of practice change

**Response occurred**
- Years post full/threshold practice implementation for WQ response to occur

**Response measured**
- Years taken to measure WQ response
50% of the reviewed studies demonstrated positive effects on one or more water quality indicators.

Years taken to measure BMP effect.
Positive effects of measures

Response and measurement times increased with catchment size

Measurement $R^2 = 0.44$
(super fast outlier removed)

Response $R^2 = 0.45$
(super slow outlier removed)
Positive effects of measures

Other factors affecting response and measurement times

- pathway affected by BMP (overland quickflow vs sub-surface delayed flow)
- climate
- implementation rate (area, magnitude, time, threshold?)

Positive effects of measures

Published examples in Ireland of positive trajectories

O’Dwyer et al., 2013 – P response within ten years in 3km²

Murphy et al., 2015 – reduced P pressure four years at 7km²

Ní Longphuirt et al., 2015 – reduced P load ten years at 3,100km²

Reflective of hydrological (overland vs sub-surface) typologies and/or threshold implementation rates?
Implementation lag

Number of years between initiation and achievement of practice change
No clear relationship with implementation approach
Not measurable, negative or no effect

- **Limitations of the monitoring method**
  - Insufficient stormflow sampling to measure BMP impact on P
  - Uncertainty in nutrient flux estimations
  - Nested scales of monitoring needed
  - Insufficient management/pressures information
  - Step changes in effect potentially occurring before monitoring begins

- **Time-frame of monitoring too short

- **Impact of counteracting processes large compared with impact of BMP**
• Practices were ineffective for the water quality indicator measured (or vice-versa)
  – e.g. surface erosion control measures implemented not affecting tile drainage pathway (Lemke et al. 2011)

• Implementation rates too low against background pressure
  – e.g. sprinkler irrigation technology introduced but swamped by effects of remaining furrow irrigation (Bjorneberg et al. 2008)
Learnings for policy makers

• Positive effects often associated with constraints to agricultural source pressure ± resilience measures
• ‘No measurable effect’ is common
• Manageable limitations are time scales, insufficient ‘source’ information
• Evidence that measures ineffective = learning cycle (the ‘response’ in the DPSIR). Modify expectations
• Threshold BMP rates not always discerned or articulated
Learnings for catchment scientists

- Account for long lag times, from four to 19 years, when designing measurement programs
- Analyse response and measurement times (requires practice information)
- Predict
  - cases of ineffective measures
  - degree of effectiveness (enough to meet targets?)
  - where and when water quality will improve
  - potential for pollution swapping
- Measure cause and effects AND
  - calculate costs of implementing measures
  - estimate ratio of costs to benefits of implementing measures
• Positive effects of agricultural practice change on surface water quality took four to 19 years to measure in meso-catchments across the world

• Time lags of 1.5 to 10 years for policies to have a measurable effect on water quality explain why positive effects aren’t always evident within governance cycles