Science tools to help get the right measures in the right place

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November, 2019

epaCatchments
Healthy • Resilient • Productive
Valued water resources supporting vibrant communities

EPA Catchment Tools

- Aiming to
  1. provide evidence needed to target measures on the ground – sources of pollution and CSAs
  2. evaluate existing and proposed measures to inform policy to get the best environmental outcomes for stakeholders
  3. support collaboration in Irish catchment science research through a geospatial modelling framework
- National models are built on your catchment science research (with a time lag…)
- Not aiming for “one model to answer all questions”
- Simple models that capture the key environmental processes can be effective

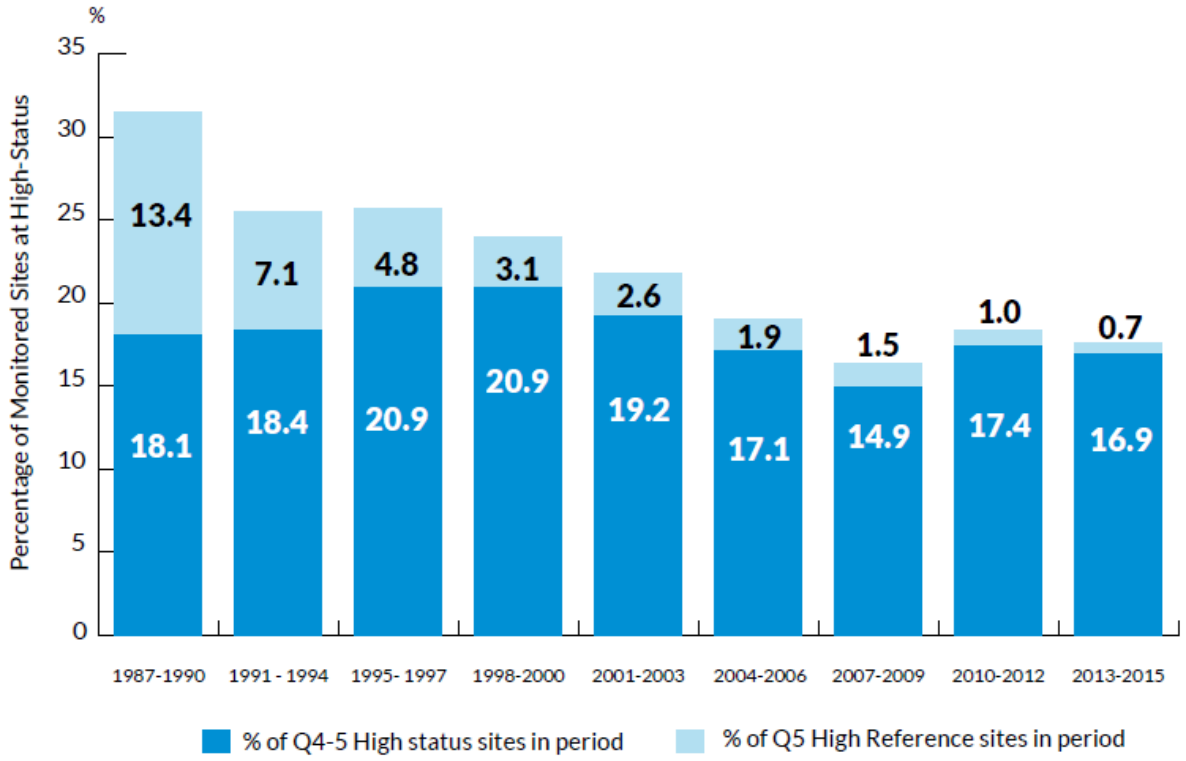
Tools

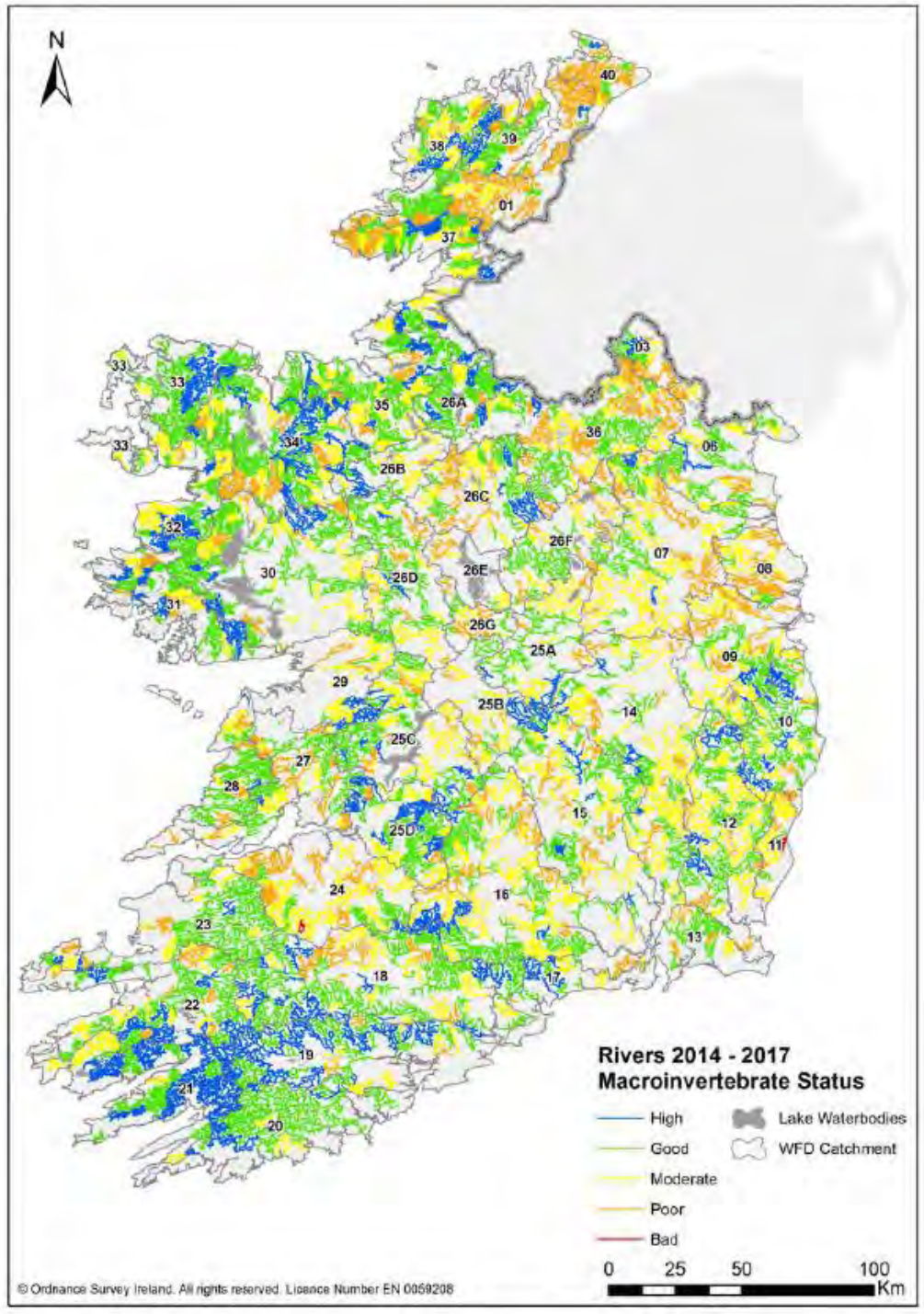
1. Pollutant Impact Potential (PIP) Maps
2. SANICOSE Model for septic tanks
3. Source Load Apportionment Model (SLAM)
4. Dynamic Catchment Modelling Tool (CMT)
5. Morphological Quality Index for Ireland (MQI-Ireland)

Others:
Estuary models, SCIMAP

Water Quality in Ireland

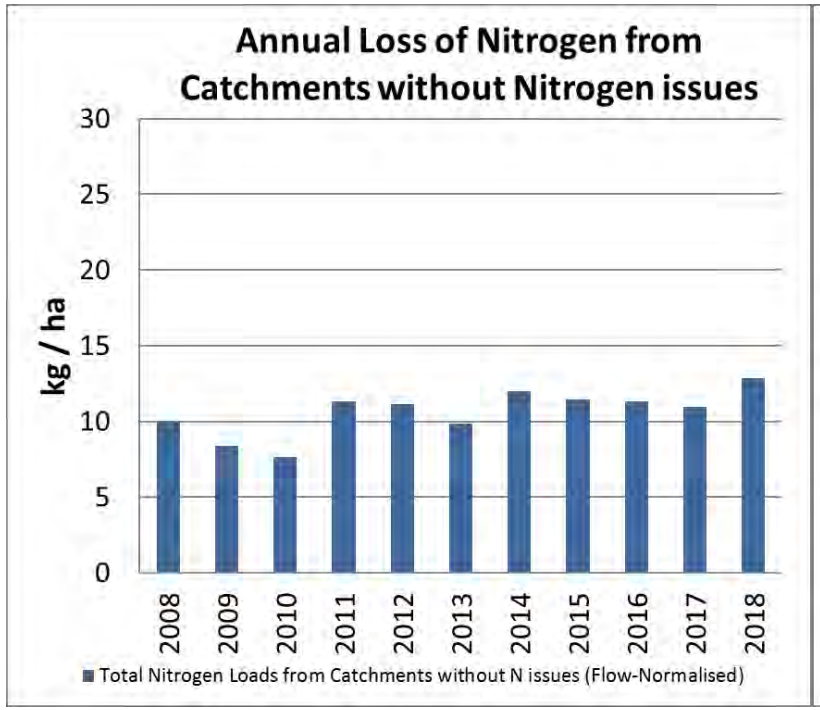
- Half of surface waters are not meeting their water quality targets
- Water quality is declining since 2013
- The loss of high quality biological sites (Q5 and Q4-5) seen since the late 1980s shows no sign of recovery.

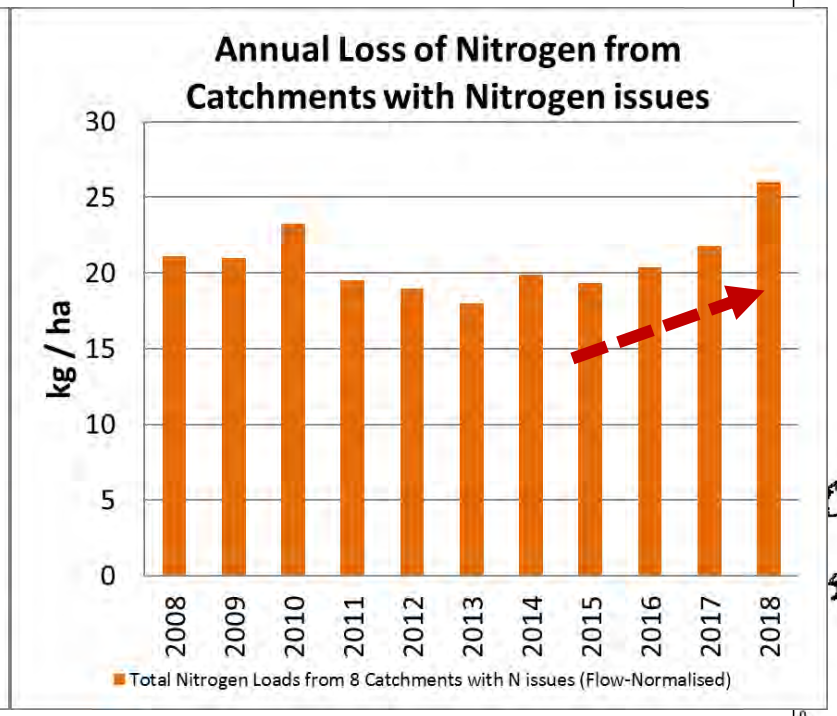


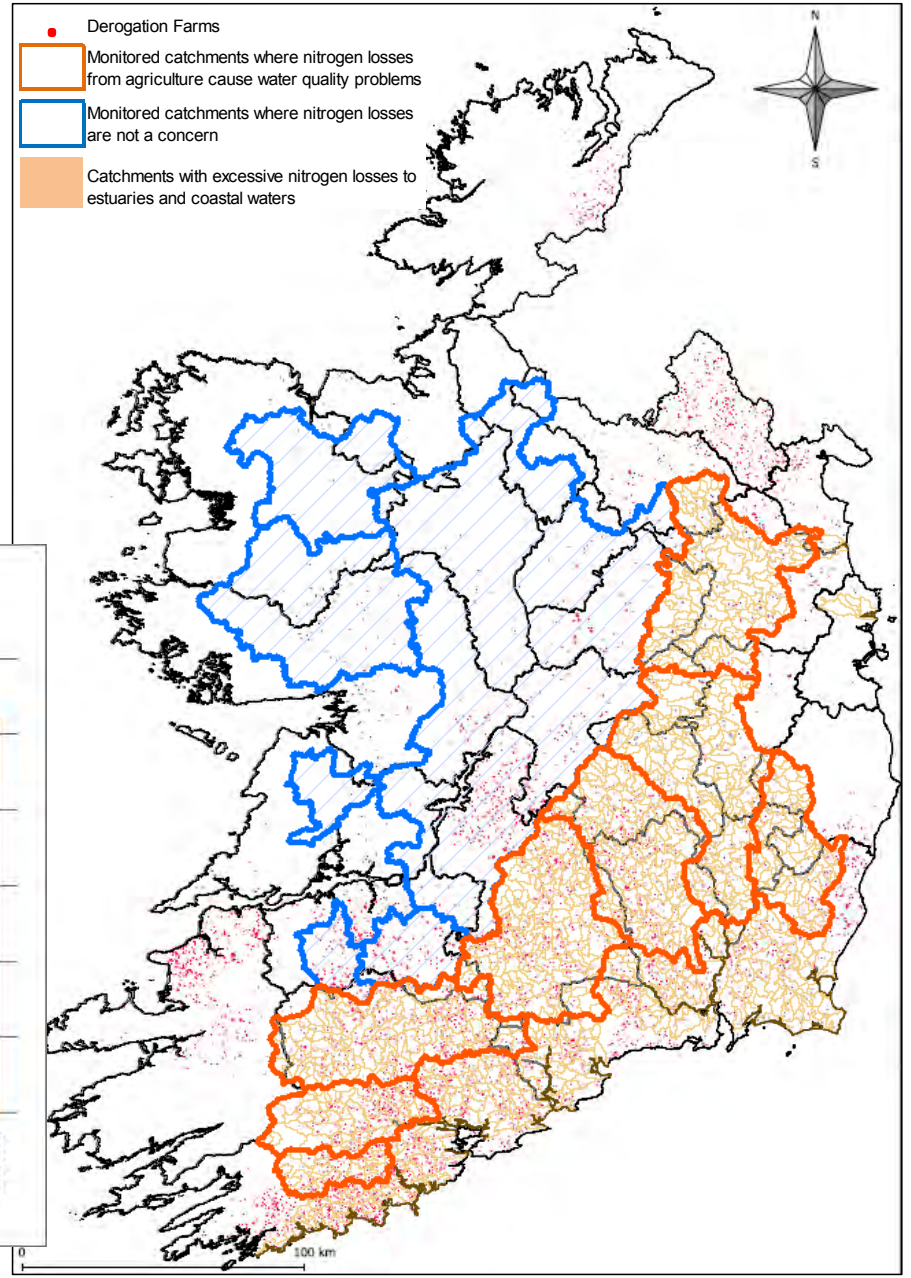


Regional Nitrogen Issues

- Excess nitrogen loads from agriculture is the most significant issue affecting estuaries.
- In the freely draining catchments in the south east, nitrogen losses continue to rise and are over double the annual losses from the west.
- Diffuse sources of N are difficult to mitigate and will need to be managed at catchment-scale.

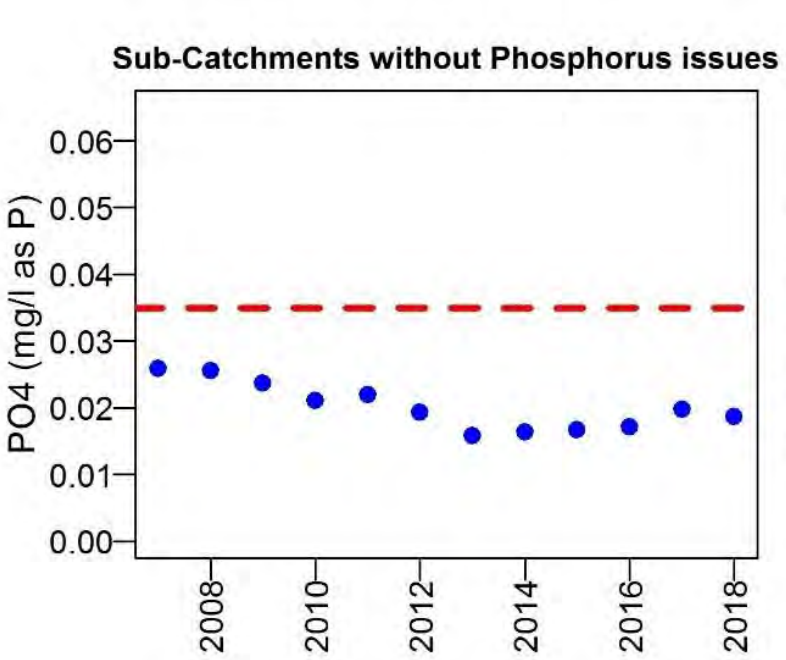


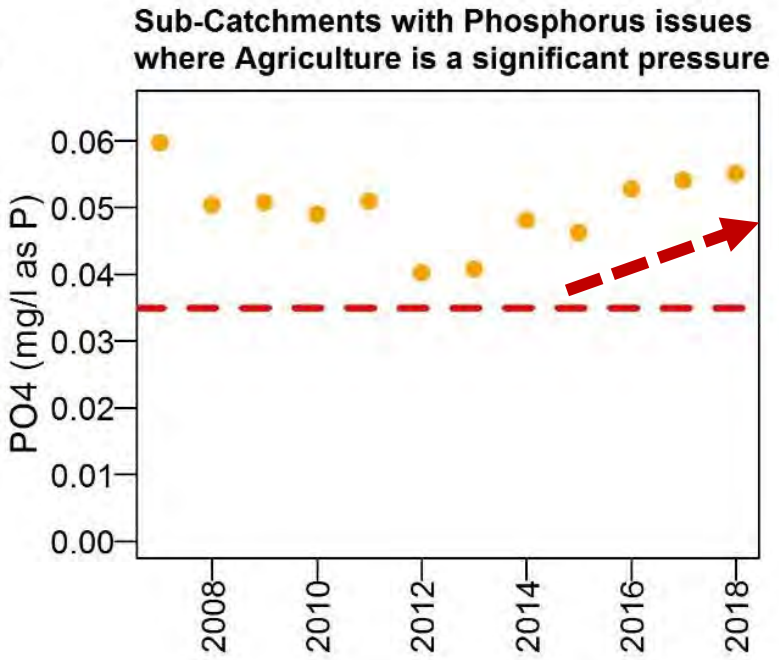


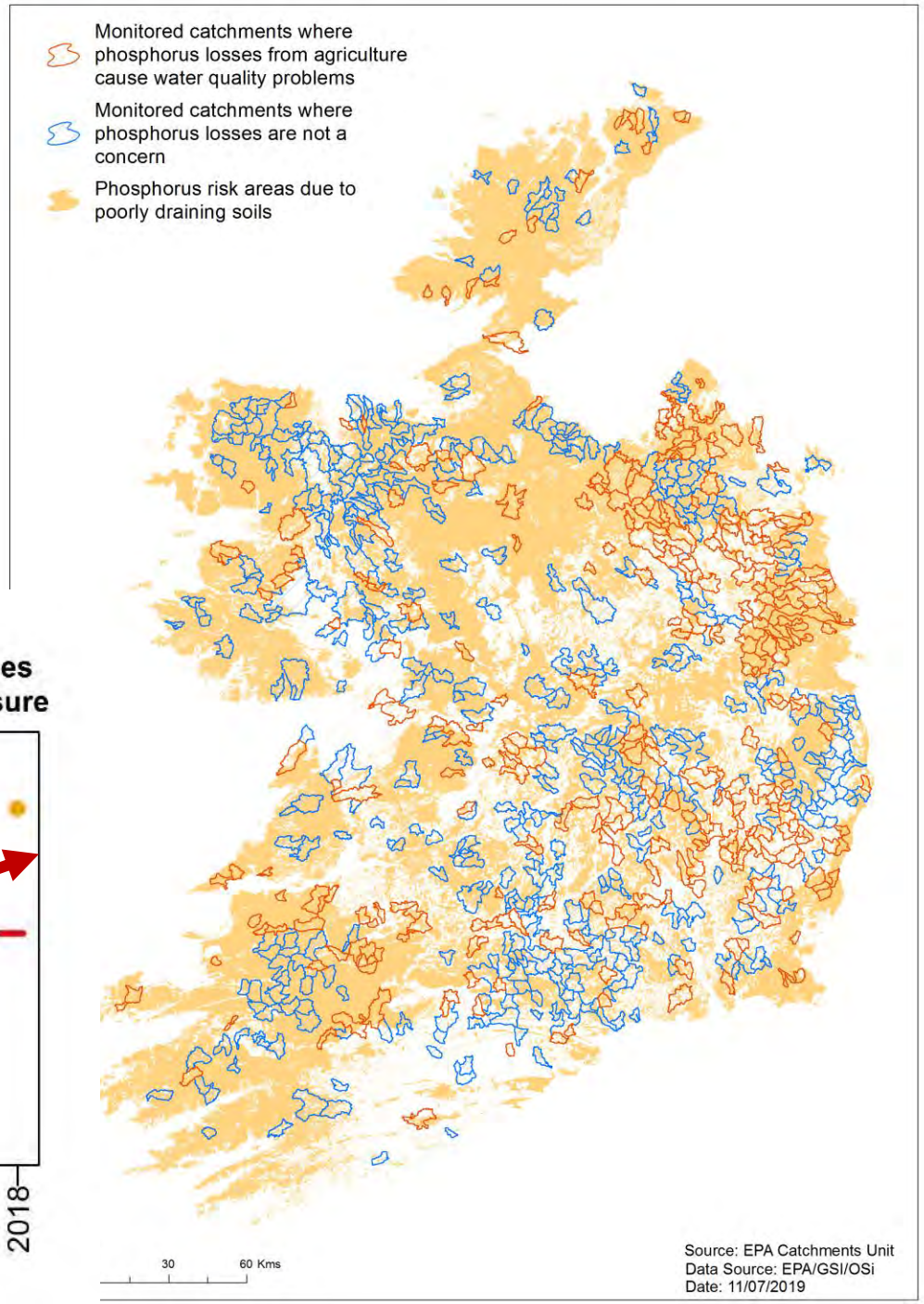


Regional Phosphorus Issues

- Concentrations of phosphorus in rivers have been increasing in recent years in *At Risk* agricultural areas with heavy soils.
- Losses often occur from critical source areas - targeting measures that break the pathway between farm runoff and the receiving waters are most likely to be effective → advisory services







Catchment Permeability → Water Quality Model Structures

P and sediment issues impacting on water quality in rivers and lakes

Break the pathway

Nutrient efficiency alone will not suffice!

Connectivity / Elevation Models are key

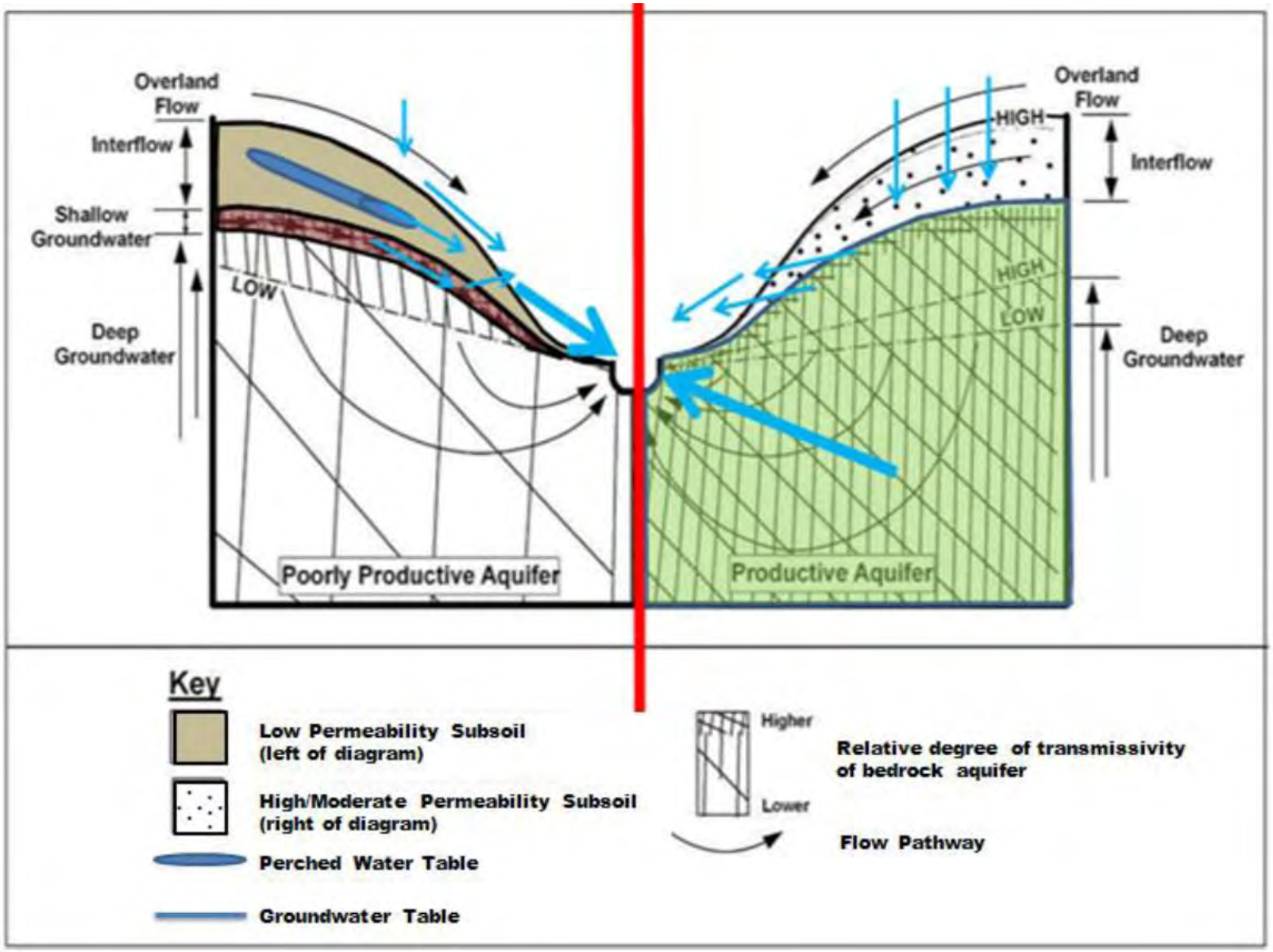


Figure 1.1. Pathways present in poorly productive aquifers (left) and productive aquifers (right) (J. Deakin: after N. Hunter-Williams and D. Daly).

Nitrate impacting on downstream estuaries, and sometimes on drinking water quality

Identify Nitrate CSAs and the measures required to reduce losses to improve estuarine ecological status.

Farm-level management data is essential - issues with data sharing agreements

The Catchment Characterisation Tool (CCT)

Tool 1

- Annual average export coefficient model → Pollutant Impact Potential (PIP) maps
- Coefficients developed during the Pathways Project (2009-2015) incorporating Irish and international research and tested with EPA and ACP monitoring data.
- Two Pathways: Near Surface & Subsurface – coefficients weighted by the proportion of annual flow attributed to each pathway, based on recharge capacity

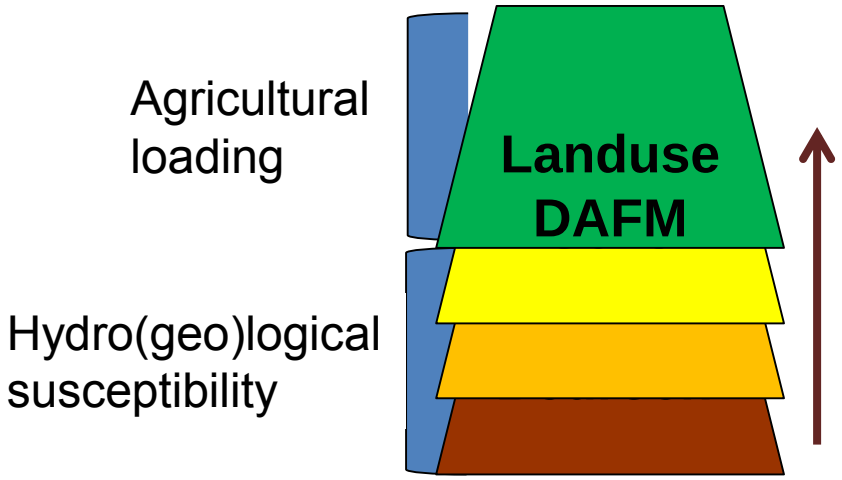


Table A2. Phosphorus near surface pathway factors.

Soil type	P Near Surface Factor
Clayey soil classified as Wet	0.4
Sandy Soil classified as Dry	0.2
Peat	0.4
Drain flow	0.7

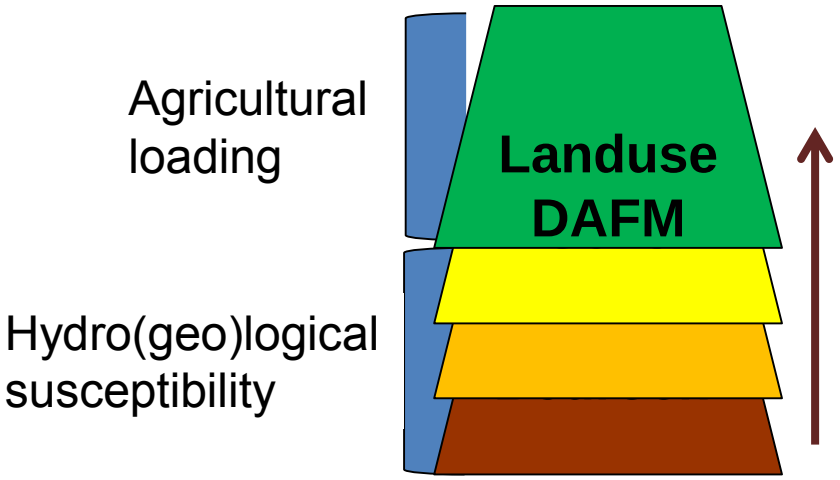
Table A4. Phosphorus groundwater pathway factors.

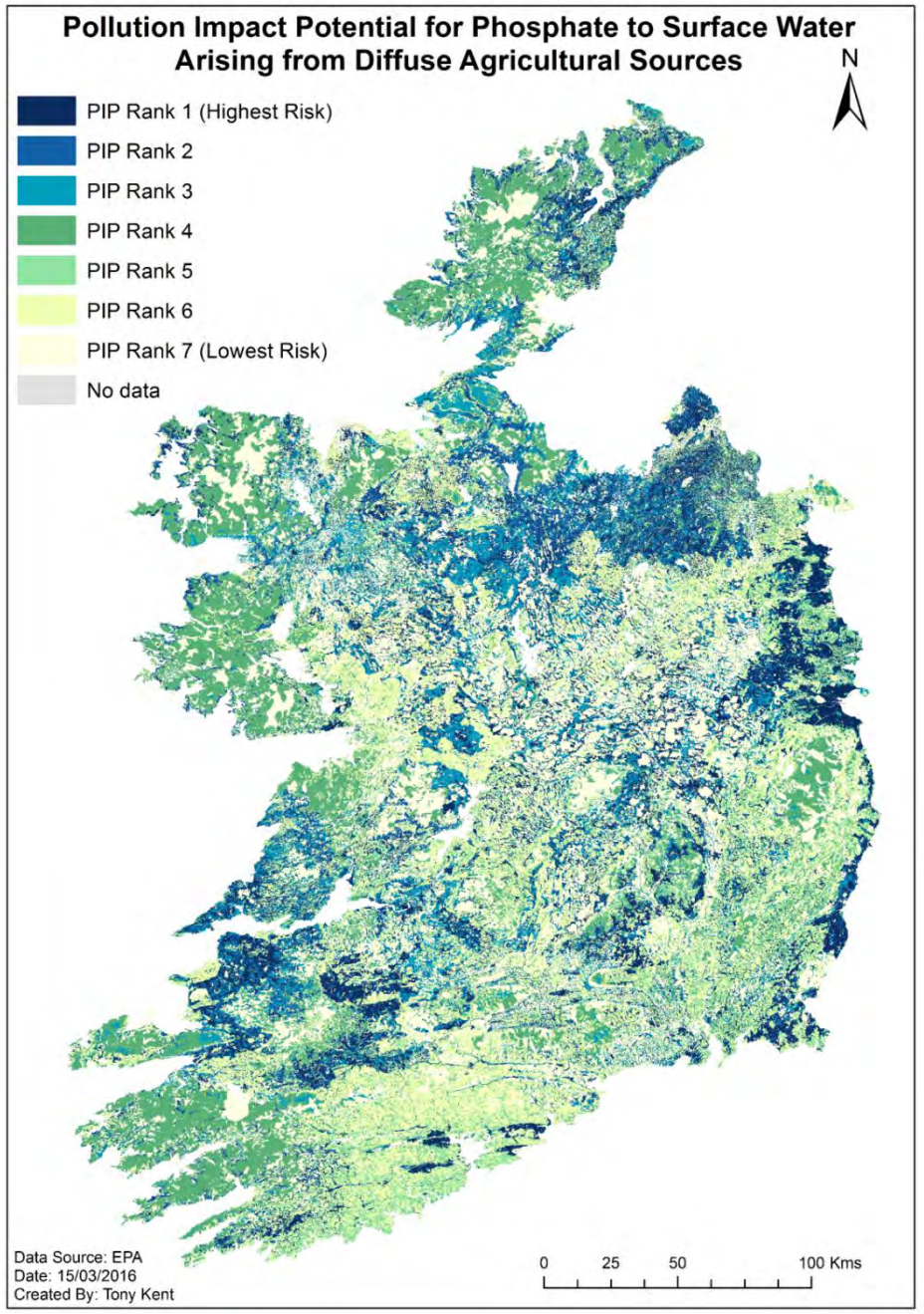
Depth to bedrock	P Subsoil Factors
X Extreme (0-1m and near Karst features)*	0.4
E Extreme (1-3m)*	0.15
3-5m*	0.05
5 – 10m*	0.02
>10 m*	0.01
*Exception Peat subsoils	0.9

Tool 1

Pollution Impact Potential maps

- Map of relative risk of transport of diffuse phosphorus from agriculture to rivers
- Critical Source Areas delineated → Not field scale
- Field scale 'local catchment assessments' are now underway





Septic Tank Systems: SANICOSE Model

Tool 2

Source Apportionment of Nutrients in Irish Catchments for On-Site Effluent (SANICOSE) model

Pathway 1- inadequate percolation i.e. surface pathway direct to water (SW)

Pathway 2 - near surface (subsoils) pathway to surface water (SW)

Pathway 3 - groundwater (GW)

Loads modelled for each septic tank location

Annual N & P loads aggregated for each water body or sub-catchment - incorporated into SLAM.

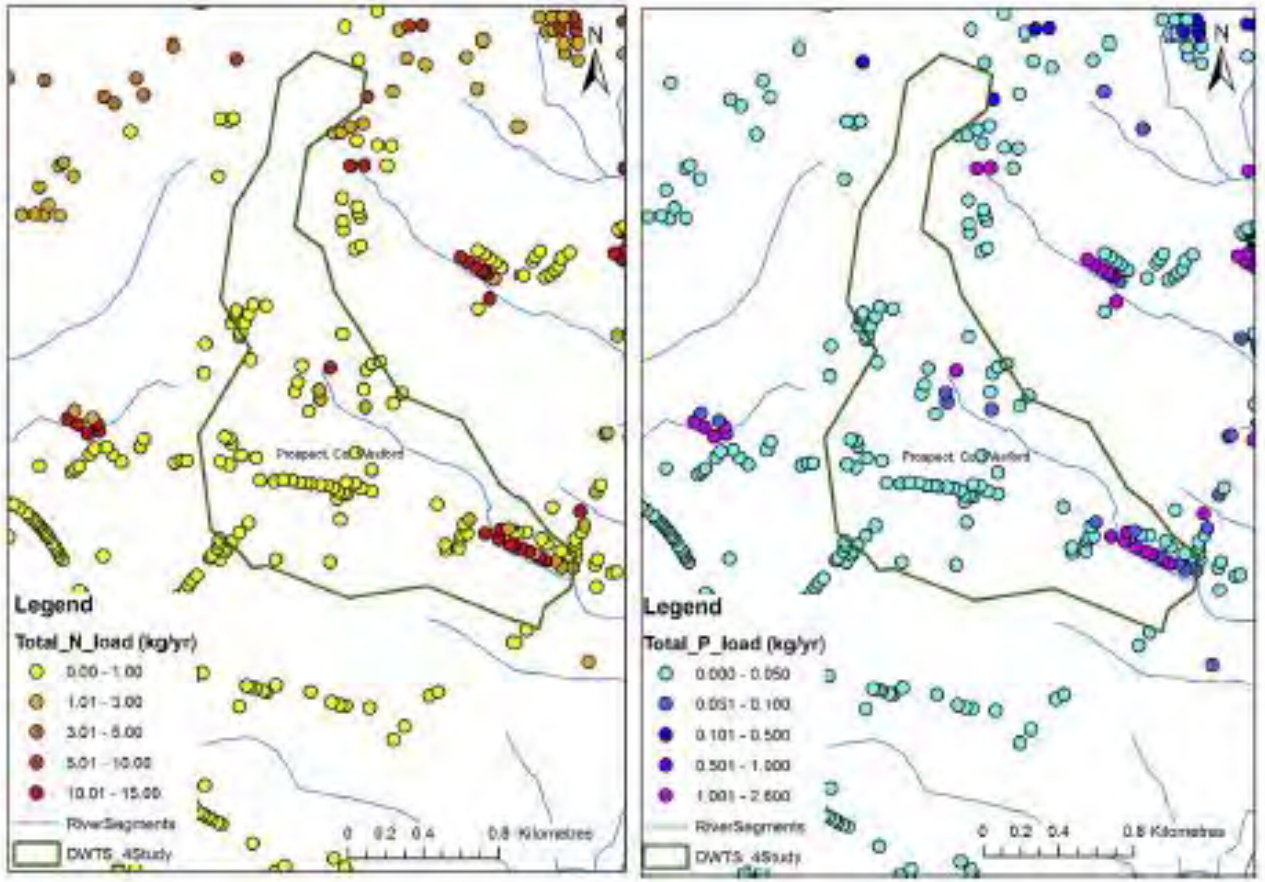


Fig. 5. Net N and P contributions to surface water from individual DWTS – Prospect (Wexford).

Gill, L.W. & Mockler, E.M. (2016) Modeling the pathways and attenuation of nutrients from domestic wastewater treatment systems at a catchment scale. Environmental Modelling & Software 84 363-377. http://dx.doi.org/10.1016/j.envsoft.2016.07.006

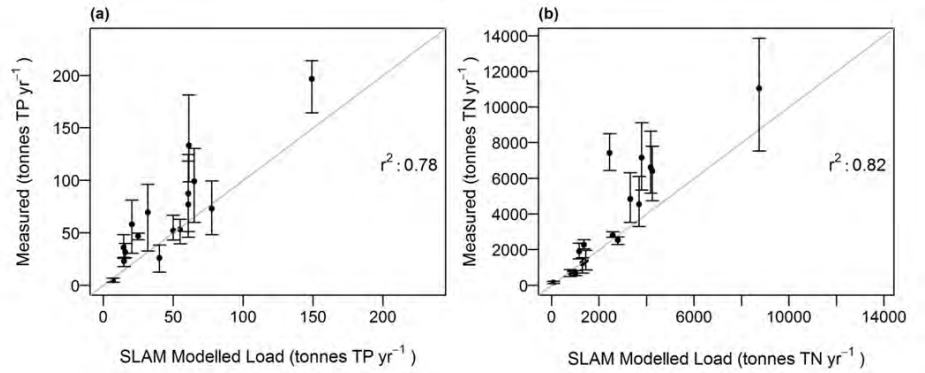
Source Load apportionment Model (SLAM)

Tool 3

- Estimate available load from licences (for point sources), land cover mapping, census data and regulations (diffuse sources)
- Reduce this load by a factor to represent treatment or natural attenuation – factors are determined from environmental reporting/ data/ research / models
  - ArcGIS framework with 9 source sub-models
  - Data for over 1,000 wastewater discharges
  - Geospatial models for diffuse sources using data for 130,000 herds from Dept. of Agriculture
- Compared with 2012 – 2014 annual TP and TN loads

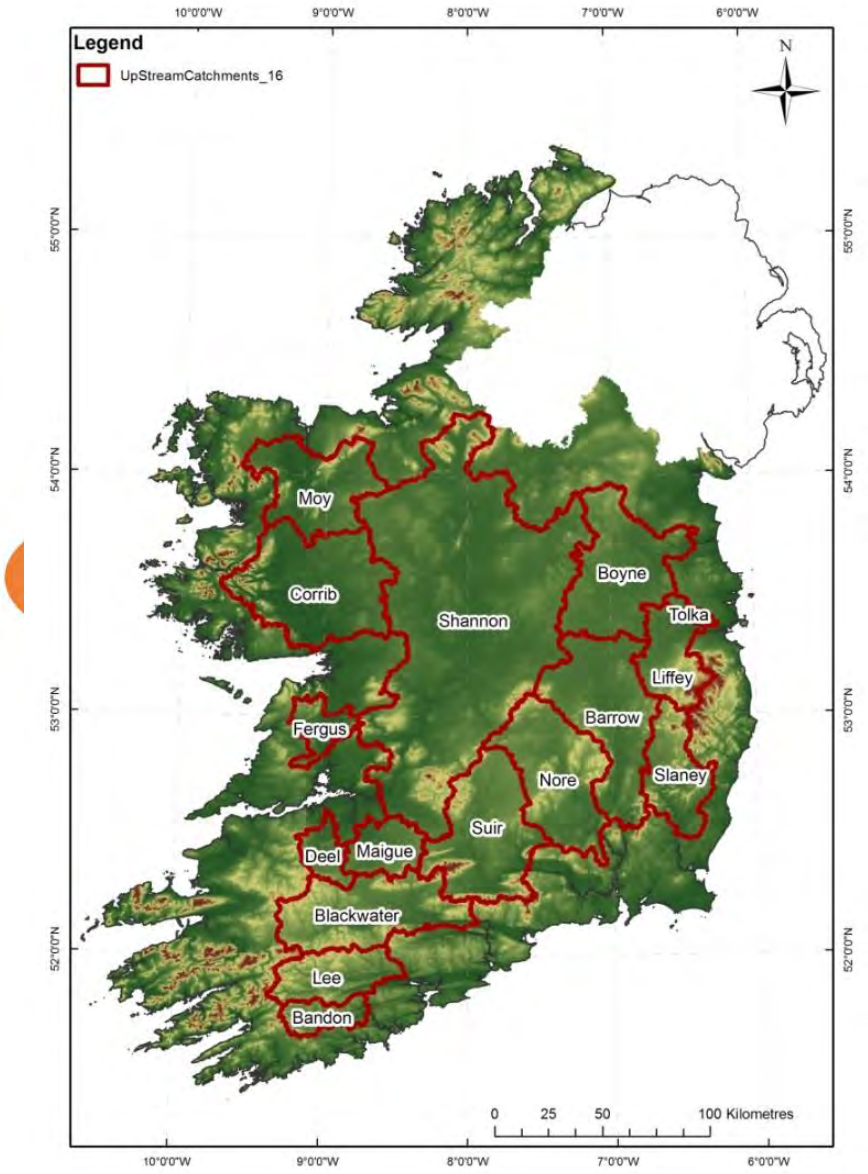
P

$r^2 = 0.78$



N

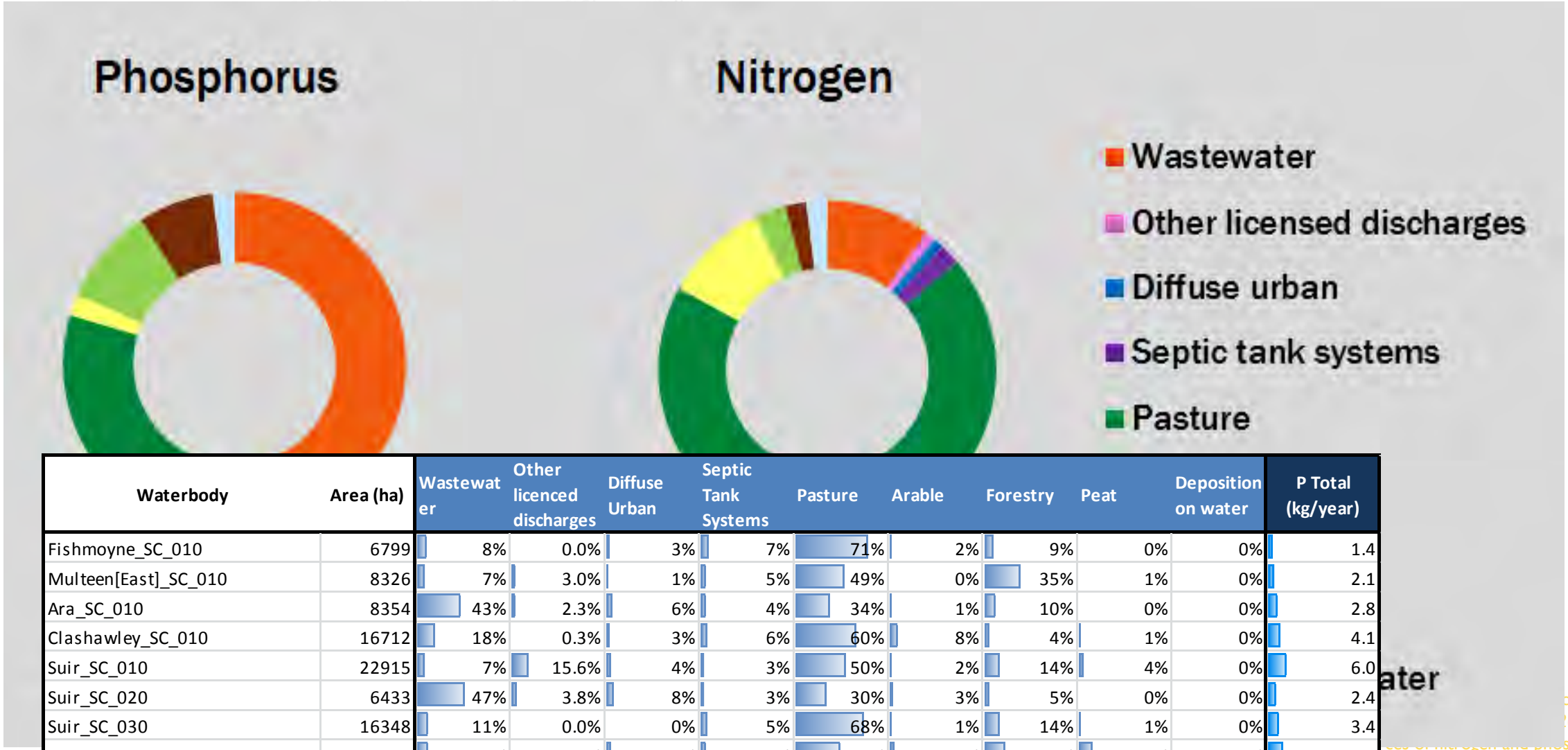
$r^2 = 0.82$



Locations of 16 catchments with monitored TN and TP emissions to water.

Tool 3

National/Regional/Local Source Apportionment Results



Waterbody	Area (ha)	Wastewater	Other licenced discharges	Diffuse Urban	Septic Tank Systems	Pasture	Arable	Forestry	Peat	Deposition on water	P Total (kg/year)
Fishmoyne_SC_010	6799	8%	0.0%	3%	7%	71%	2%	9%	0%	0%	1.4
Multeen[East]_SC_010	8326	7%	3.0%	1%	5%	49%	0%	35%	1%	0%	2.1
Ara_SC_010	8354	43%	2.3%	6%	4%	34%	1%	10%	0%	0%	2.8
Clashawley_SC_010	16712	18%	0.3%	3%	6%	60%	8%	4%	1%	0%	4.1
Suir_SC_010	22915	7%	15.6%	4%	3%	50%	2%	14%	4%	0%	6.0
Suir_SC_020	6433	47%	3.8%	8%	3%	30%	3%	5%	0%	0%	2.4
Suir_SC_030	16348	11%	0.0%	0%	5%	68%	1%	14%	1%	0%	3.4
Suir_SC_040	21027	11%	0.0%	4%	4%	44%	4%	20%	13%	0%	4.9
Suir_											
Suir_											
Suir_											

- Results were considered alongside monitoring data and local knowledge
- Reduced the time required and increase the consistency of the water body assessments

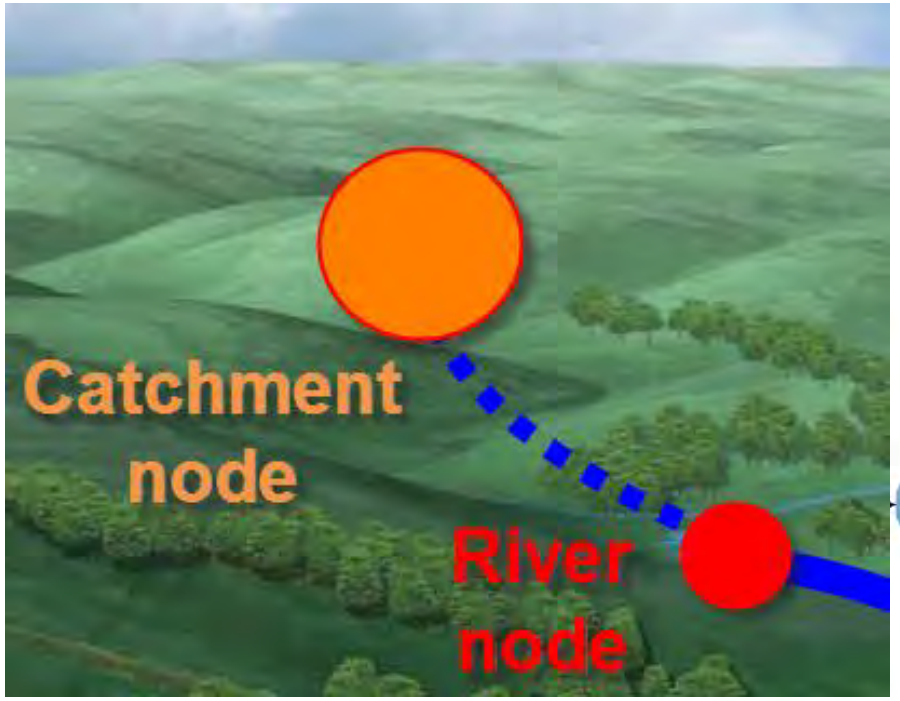
ater

chbold, 2017. es of nitrogen and phosphorus to Irish rivers and coastal timates from a nutrient load nent framework. Science of Environment.

Tool 4

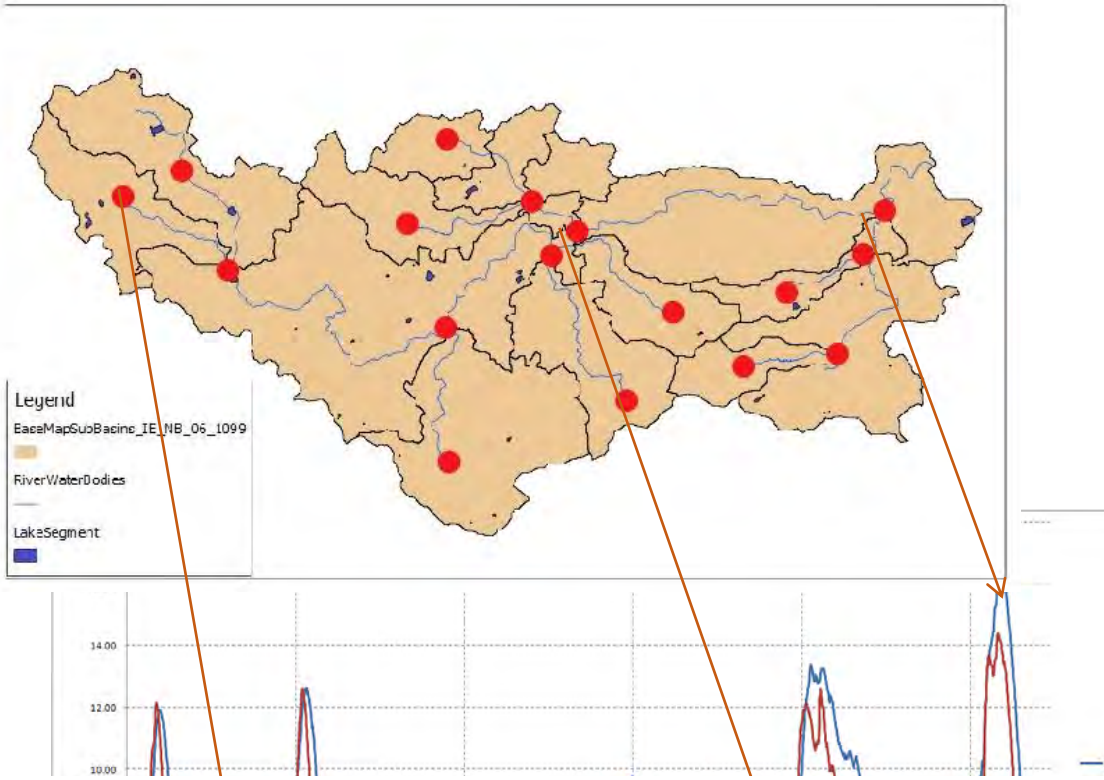
Dynamic Catchment Modelling Tool

- …advantages of dynamic models to explore how the stream might respond to changes in climate, land management
- SMART model simulates overland, interflow, shallow & deep groundwater at sub-daily time steps
- INCA N and P equations with loadings from SLAM
- Python tool on GitHub



Discharge

RK → Q



Calibration of hydrological models for ecologically-relevant streamflow predictions: a trade-off between performance and consistency

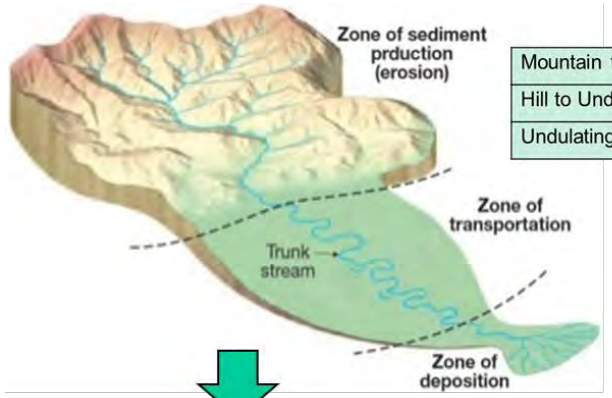
Thibault Hallouin, Michael Bruen, and Fiachra E. O'Loughlin
UCD Dooge Centre for Water Resources Research, University College Dublin, Ireland

Review status
This discussion paper is a preprint. It is a manuscript under review for the journal Hydrology and Earth System Sciences (HESS).

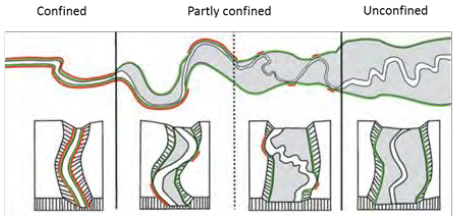
Received: 10 Apr 2019 – Accepted for review: 06 May 2019 – Discussion started: 06 May 2019

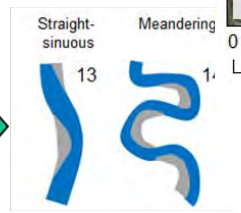
River Hymo Tool: MQI-Ireland

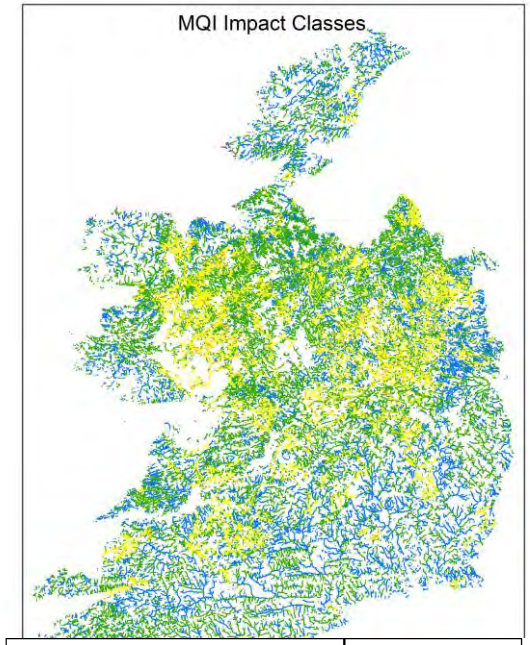
Tool 5



Mountain to Hill	
Hill to Undulating	
Undulating to Flat	







Morphological quality class	MQI score (%)
High	80 - 100
Good	60 - <80
Moderate	40 - <60
Poor	20 - <40
Bad	0 - <20

Segmentation → | Data Capture → | Indicators → | MQI Score

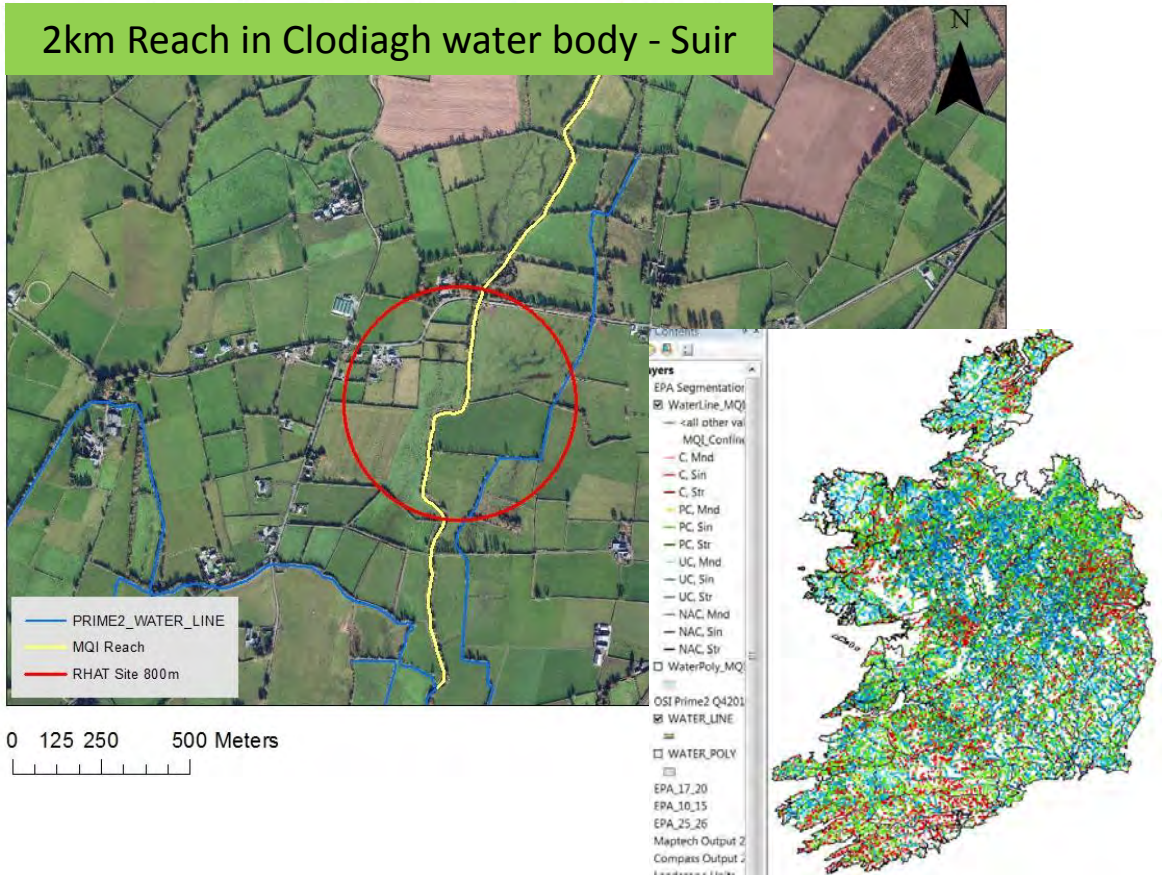
Channel by Landscape Unit → Floodplain extent → Confinement → Channel pattern (sinuosity) → Final Reach Output → Collect/ digitise / process pressure data → Connectivity Indicators → Channel Modification Indicators → Riparian Condition Indicators → Calculate MQI Score & assign Class

River Hymo Tool: MQI-Ireland

Tool 5

MQI Indicator group	Pressure/ measure examples	MQI *results*	MQI *results* *Post Measure*
Longitudinal Connectivity	Weir and bridge	Low impact	Low impact
Lateral Connectivity	Development in the floodplain	Low impact	Low impact
Channel Morphology	Drainage Scheme →Ensure best practice in channel drainage maintenance	High impact	Medium Impact
Riparian Condition	Removal of riparian vegetation →Prevent removal of vegetation on the bank	Medium Impact	Low impact
Hydromorphological quality class		**Moderate**	Good

2km Reach in Clodiagh water body - Suir



Next Steps

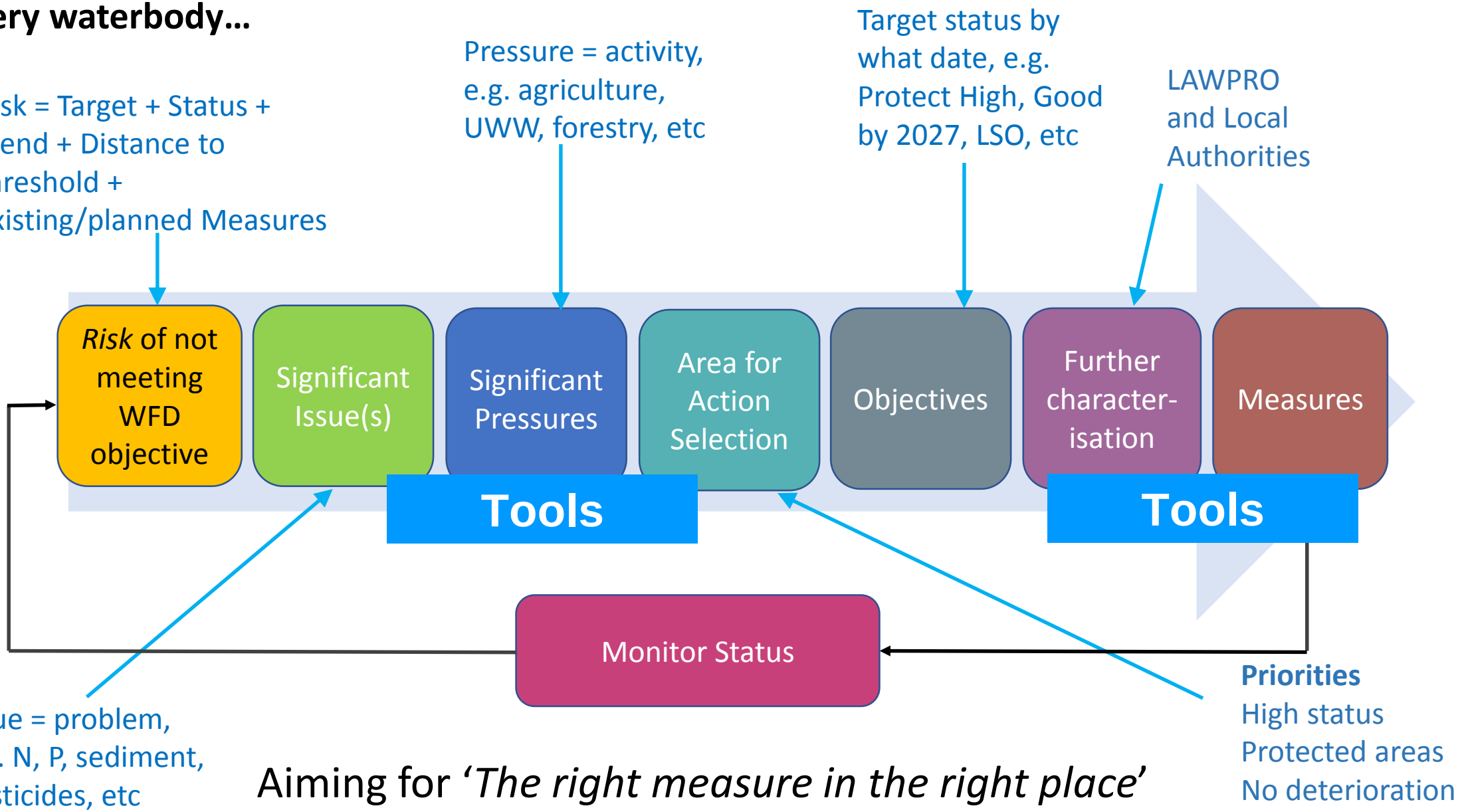
→Support river restoration programmes to focus on the specific conditions that need to be restored to support holistic healthy aquatic habitat conditions.

→Inform the review of HMWB.

→Inform Hymo-Eco links.

Water Framework Directive 2nd Cycle Characterisation

For every waterbody…

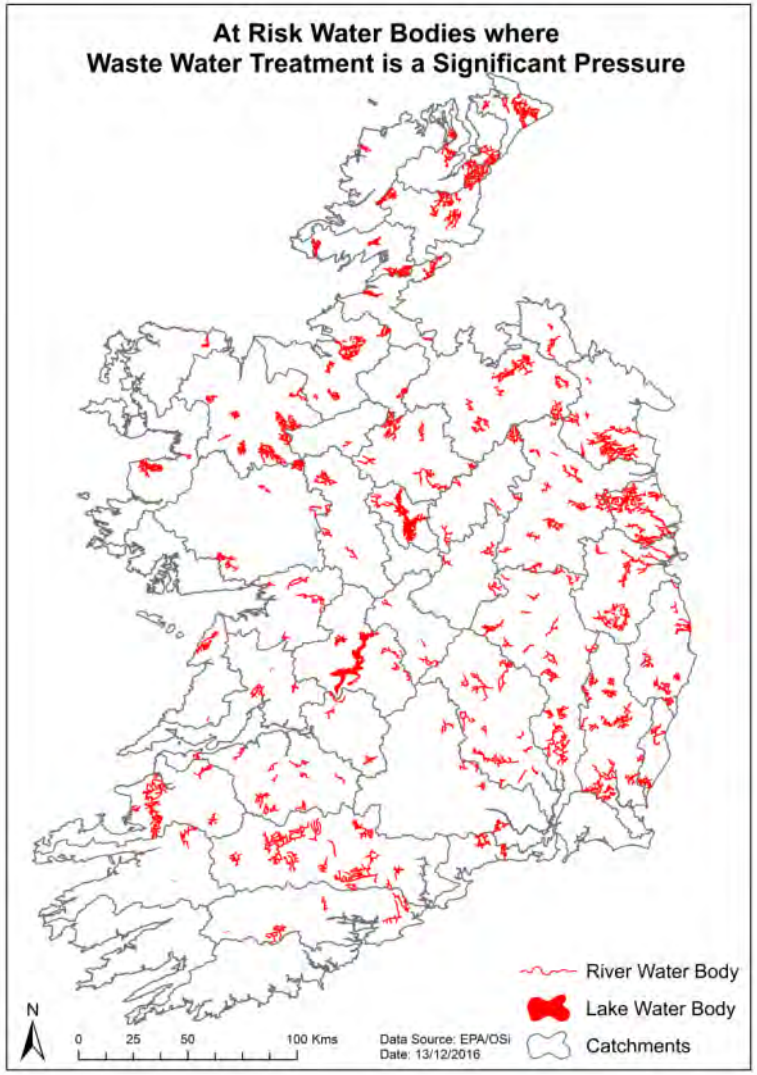


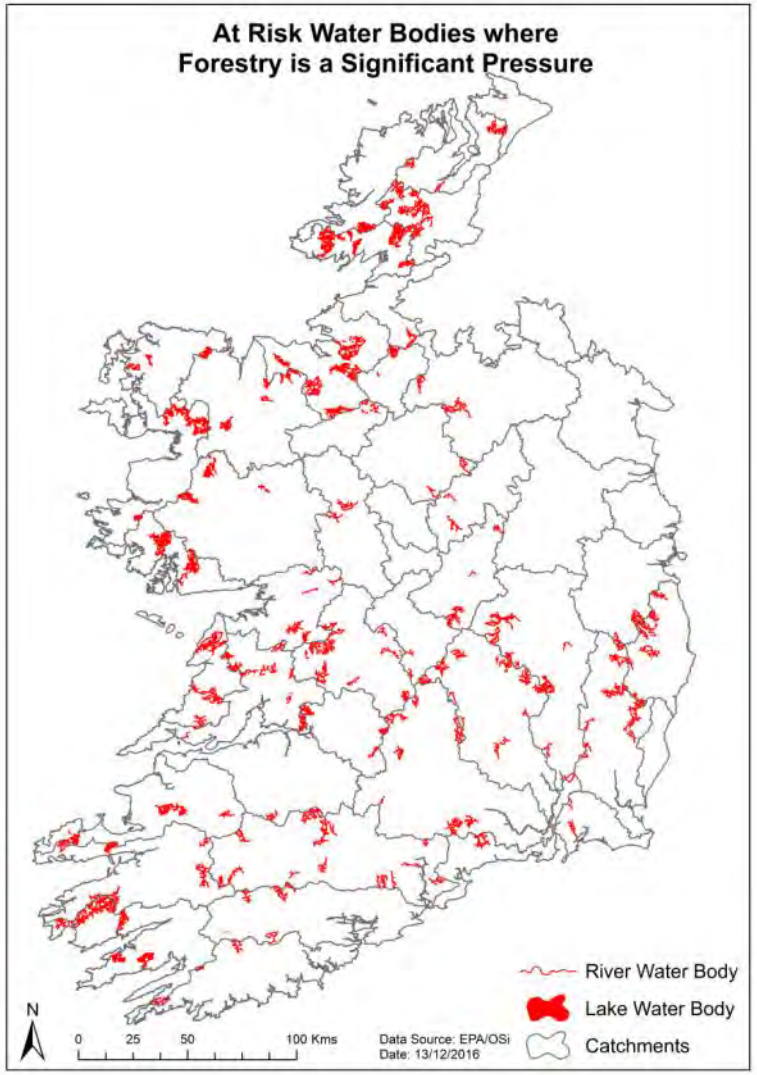
Aiming for '*The right measure in the right place*'

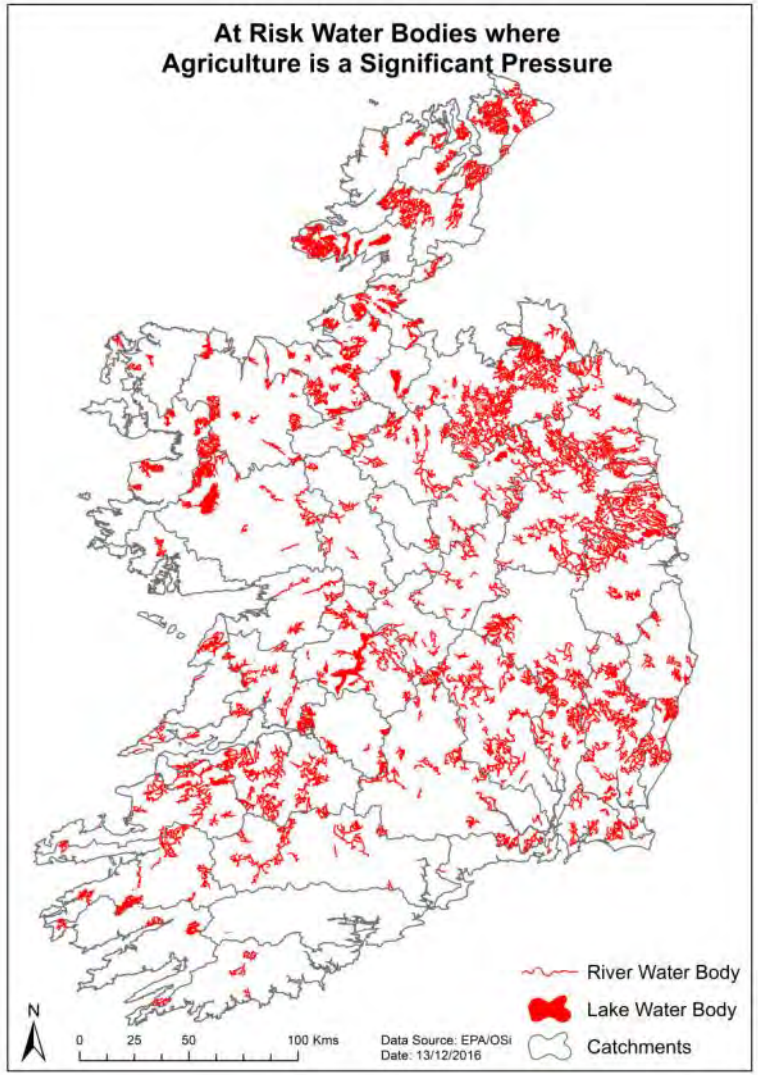
800

700

Significant Pressures : 2nd Cycle Plan







River Lake Coastal Transitional Groundwater

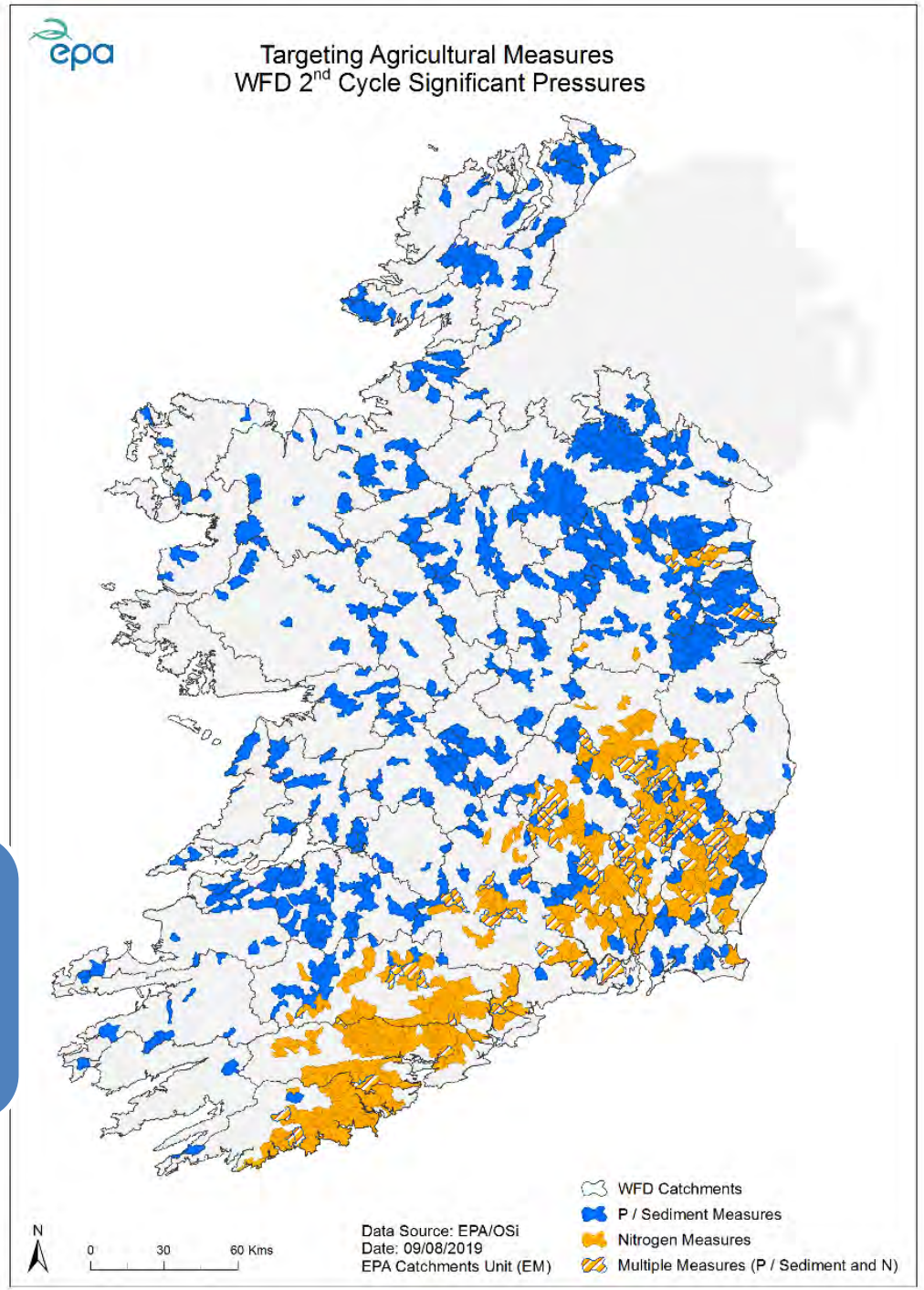
Targeted Agriculture Measures for Water Quality

- ***Catchments Newsletter – www.catchments.ie***
- **Measures to reduce phosphorus and sediment loss** from poorly draining soils - break the pathway between farm runoff and the receiving waters are most likely to be effective in these areas.
- **Measures to reduce nitrogen losses** based on characterisation, chemistry data and the CCT model.
- Although getting the right agricultural measure in the right place requires working at a farm scale, this national overview map can facilitate discussions around the continued move from one size fits all measures to more localised action.

Contribute to **characterisation** alongside monitoring data, local knowledge...

Analyse trends in pressures and water quality to **improve evidence and knowledge**

Assess whether **proposed measures** are future proofed




“By working together,
we will achieve more”
EPA Catchments Unit motto