Room for nutrient improvement: A Field scale audit of P management and soil P trends in two mixed-use catchments

CATCHMENT SCIENCE 2019

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AGRICULTURAL CATCHMENTS PROGRAMME

Teagasc
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Department of Agriculture, Food and the Marine

Background

- Phosphorus (P) is an essential **primary nutrient** needed to sustain and achieve high agricultural output on farms.
- P is also recognised as a **key trophic pressure in waters**, contributing to water quality decline.
- EU Nitrates Directive, (1991)

  National Action Programme (NAP) measures applied on a whole-territory for N and **P** since 2006.
- Measures restrict P applications to the land, according to **agronomic soil test P (STP: Morgan's P mg/l) levels**:
  - **Index 1:very deficient** – 0-3 mg/l

    – crop/animal requirements + build up
  - **Index 2: deficient** – 3.1- 5 mg/l grassland/ 6mg/l Arable

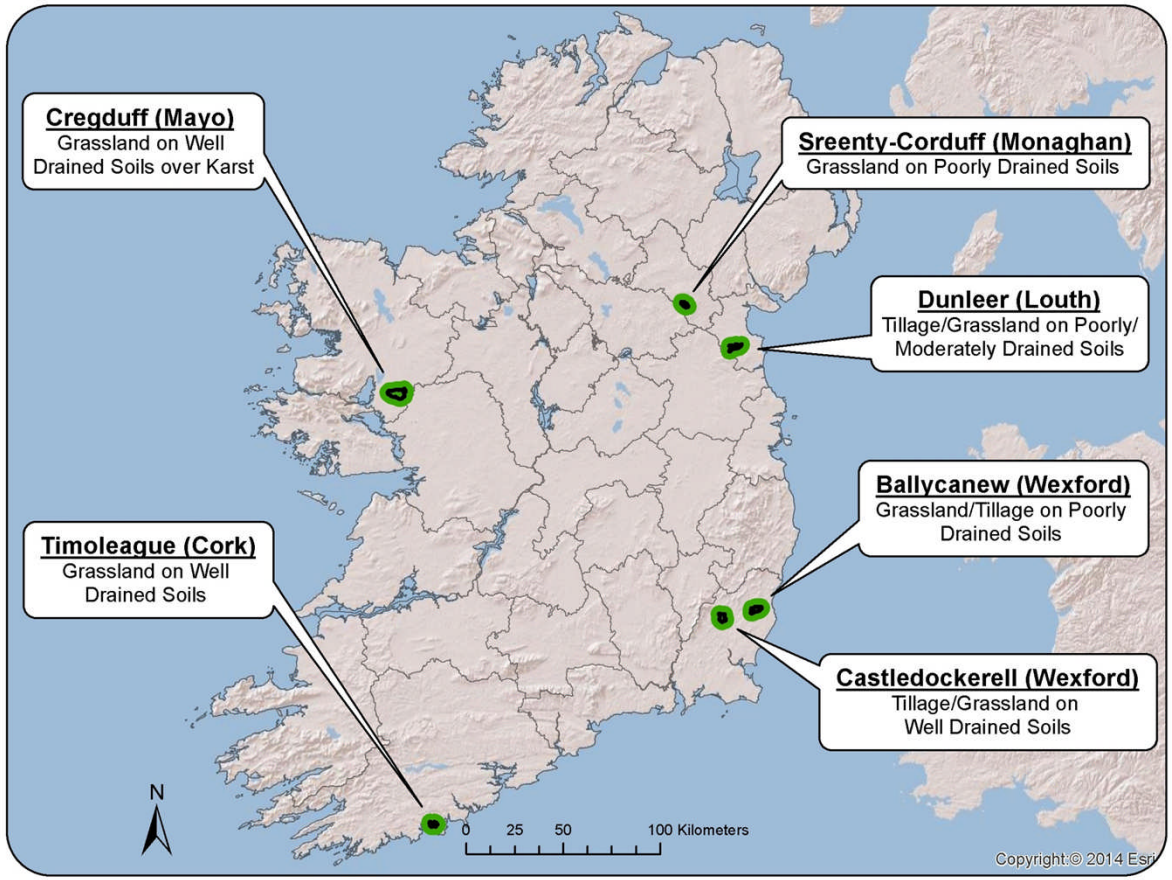
    – crop/animal requirements + build up
  - **Index 3: optimum** –5.1- 8mg/l grassland / 6.1- 10 mg/l Arable

    – maintain crop/animal requirements,
  - **Index 4: excessive** > 8mg/l grassland / 10mg/l Arable

    (levels above crop/animal requirements),

    •Decrease levels (risk to water quality) by P mining

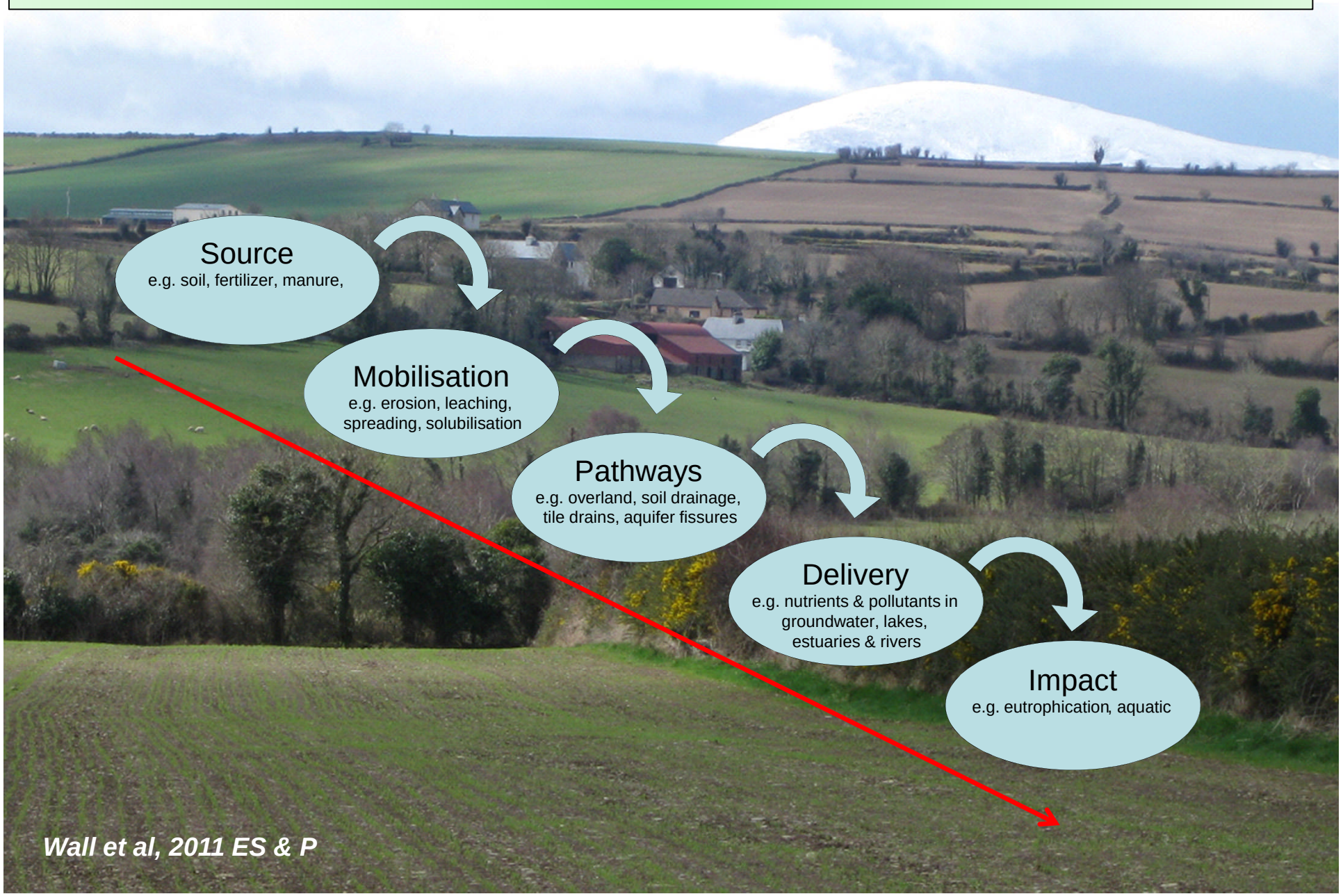
Irish Agricultural Catchments Programme



- Established in 2008
- **Evaluate the environmental & economic effectiveness of NAP measures**
- Across 6 Catchments
- Representing dominant land-types & production systems
- Integrated advisory & research approach
- >320 farmers – individual contact
- Collaborations – national, international

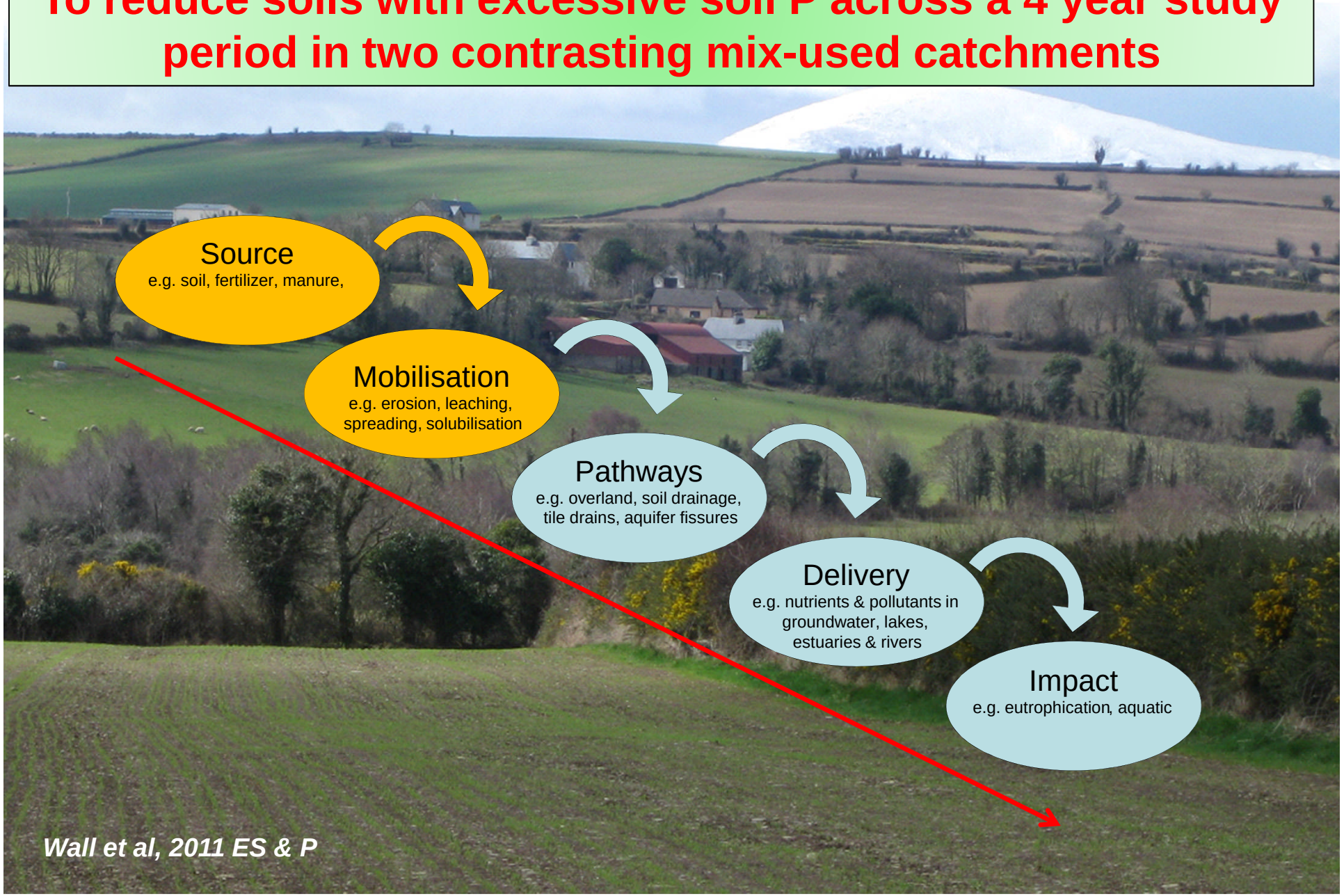
Evaluate the biophysical effectiveness of NAP measures

Observed across the nutrient transfer continuum at catchment scale

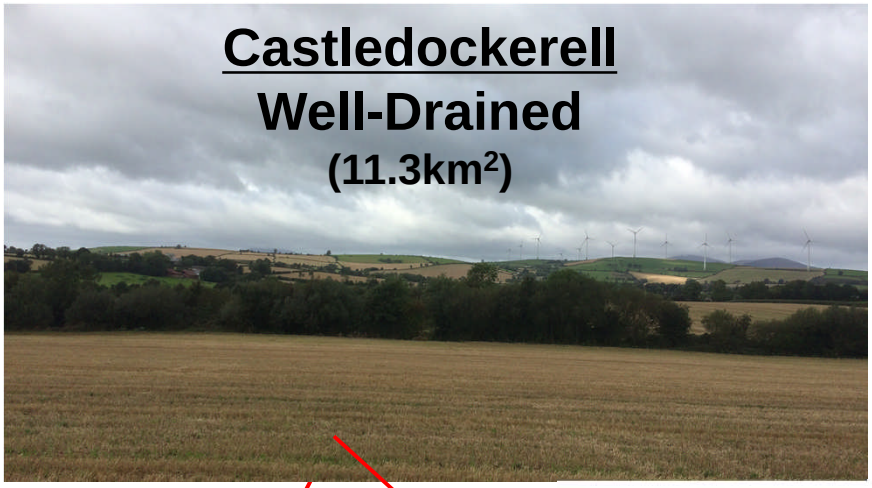


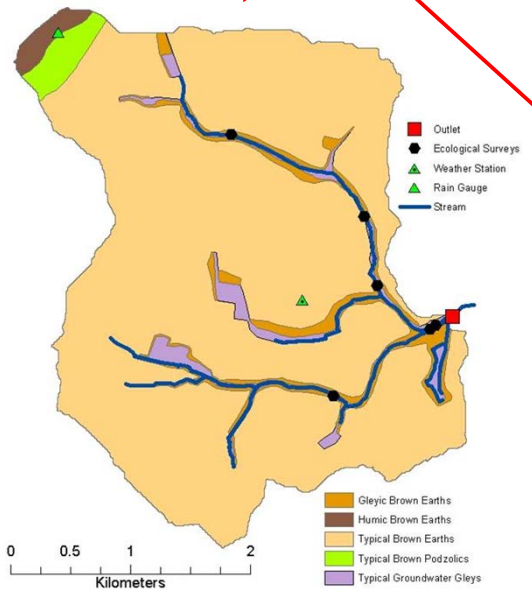
Study Aim: Evaluate the effectiveness of P measures

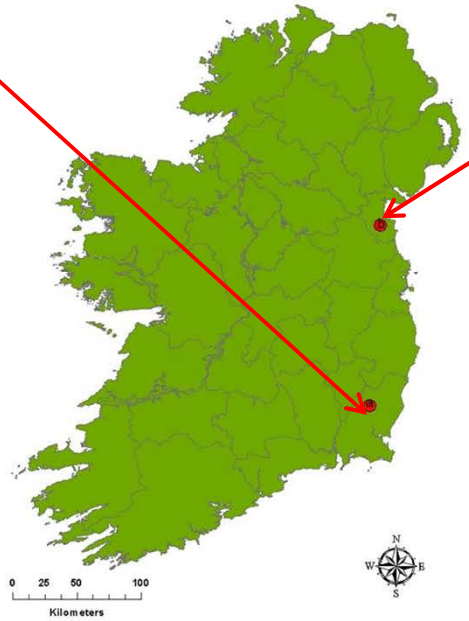
To reduce soils with excessive soil P across a 4 year study period in two contrasting mix-used catchments

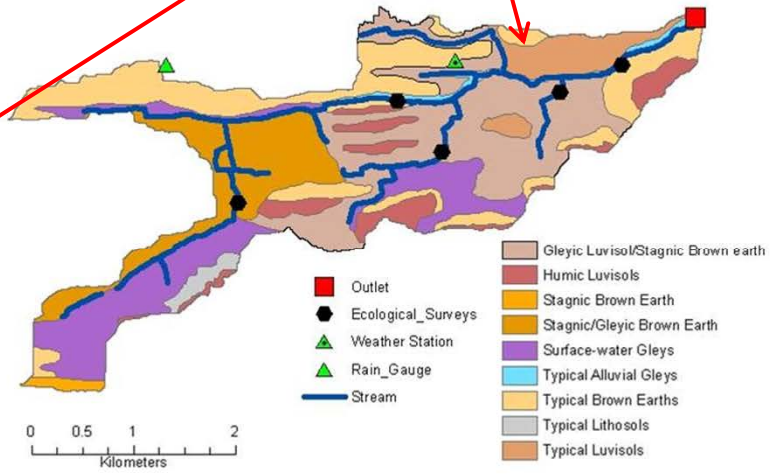


Study Sites



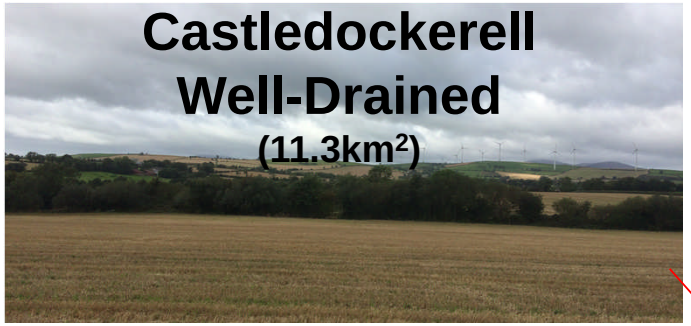






Annual Precipitation: 1017 mm

Annual Precipitation: 934 mm



- **Spring Barley** is the dominant crop type
  - (approx. 563 ha)

other crops; Winter Wheat, oilseed rape

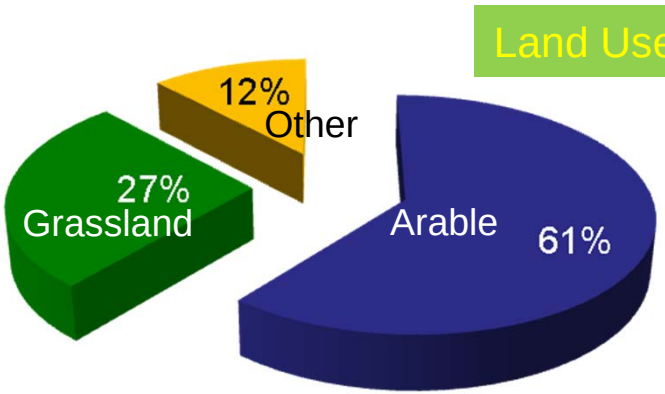
- **Low** catchment **stocking rate**
  - **1.14LU ha^{-1}**
  - **97 kg organic N ha^{-1}**

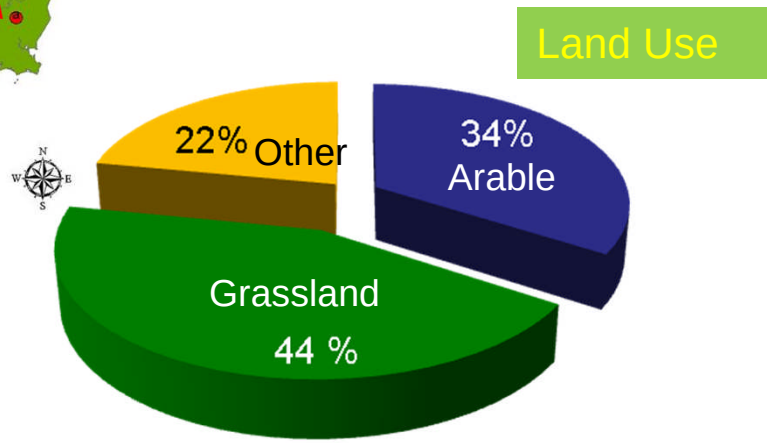
- **Winter Wheat** is the dominant crop type

other crops; Spring barley and potatoes

Moderate catchment stocking rate

- **1.76LU ha^{-1}**
- **149 kg organic N ha^{-1}**





Methodology

Soil census for available P; Soil test P (STP; Morgan's extractable P)

- **Castledockerell**: **2009** (baseline) & **2013** (repeated)
- **Dunleer:** in **2010** (baseline) & **2014** (repeated)
  - < 2 ha (approx. 397-416 samples each year)
  - 10cm depth

2010 to 2013: Field scale records

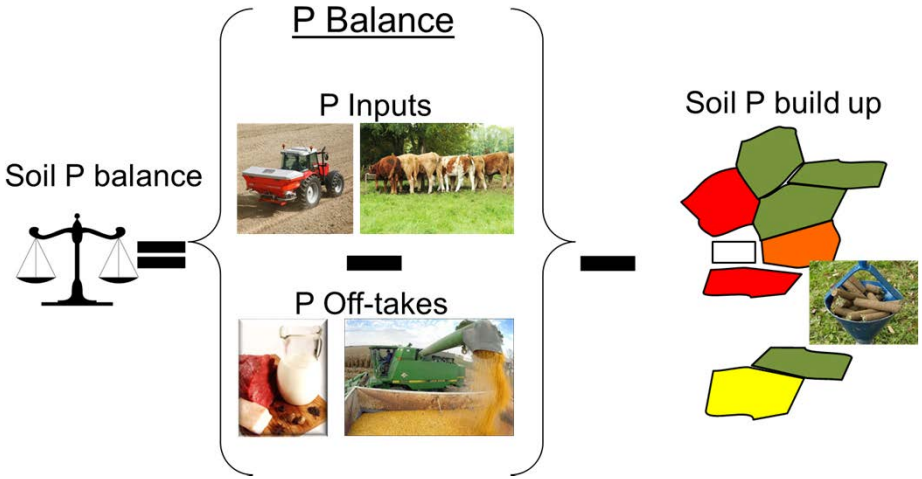
Nutrient input

- Fertilizers (organic + chemical)
- Meal fed at grazing
- Grazing stock

Nutrient off-takes

- Crop (i.e. grain, straw, grass silage)
- Grazing stock (i.e. meat & milk)

Calculate field and soil P balances

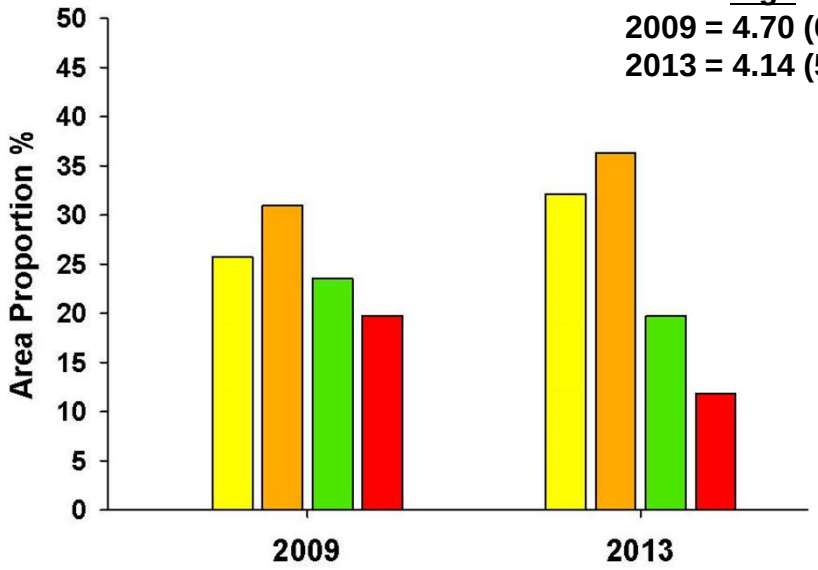


Soil P Trends in Catchment Soils

P Index 1 (Very deficient)
P Index 2 (Deficient)
P Index 3 (Optimum)
P Index 4 (Excessive)

Castledockerell

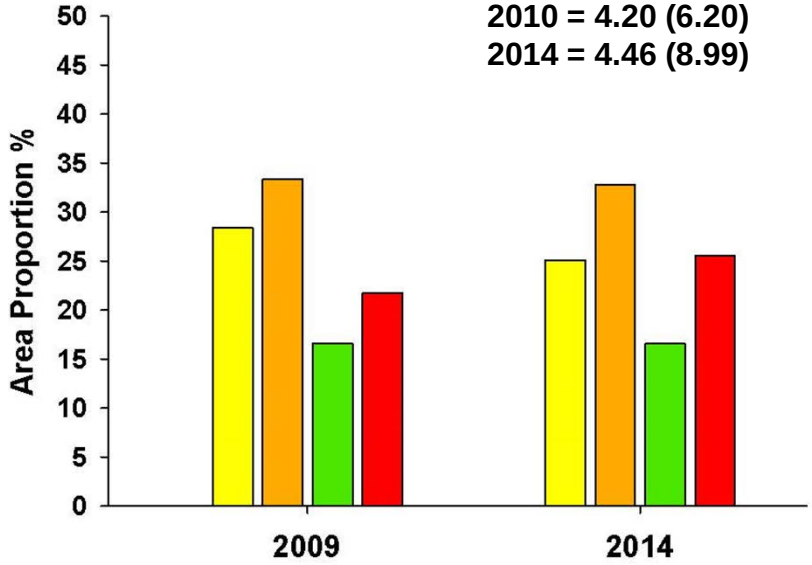
STP Median (Mean)
mg/l
2009 = 4.70 (6.23)
2013 = 4.14 (5.15)



- 4% decline in Index 4 soils
- 3% decline in Index 3 soils
- 7% increase in Index 1 & 2 soils:
  - 2013: 67% of the area

Dunleer

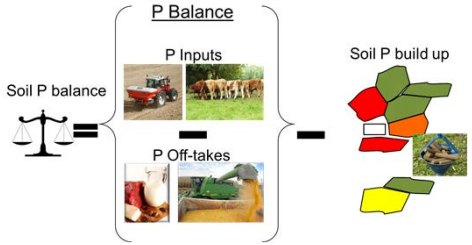
STP Median (Mean)
mg/l
2010 = 4.20 (6.20)
2014 = 4.46 (8.99)



- 4% increase in Index 4 soils
- Index 3 constant at 17%
- 2014: 57% of area in Index 1 & 2 soils

Poor distribution of P across both Catchments

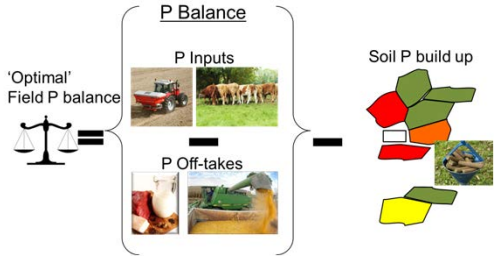
Average Field P Balances
(P inputs, off-takes & soil P build up) 2010-2013



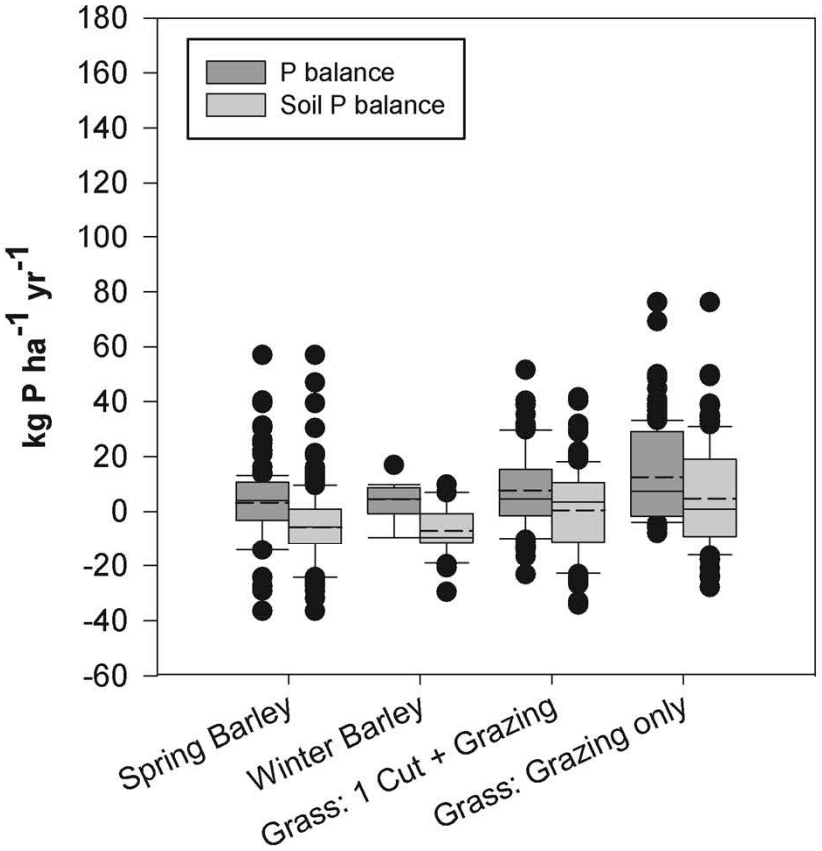
	Castledockerell				Dunleer			
	2010	2011	2012	2013	2010	2011	2012	2013
Phosphorus Inputs	kg/ha/yr							
Total fertilizer P applied	25.0	26.0	28.8	32.2	23.1	33.8	37.5	39.3
Conc. P fed at grazing	2.22	1.09	1.29	1.32	1.61	1.57	1.07	3.39
Phosphorus Off-takes	kg/ha/yr							
Crop P off-take	23.1	24.0	23.3	25.1	24.5	25.3	21.7	24.2
Stocking rate change		-1.2	1.0	0.5		2.7	1.2	3.0
Soil P Build-up required	8.7	8.6	8.6	8.6	9.7	9.5	9.8	9.4
Phosphorus Balances	kg/ha/yr							
P balance	2.7	1.9	6.1	7.5	-0.6	13.9	19.0	25.5
Soil P balance	-6.1	-6.7	-2.5	-1.1	-10	4.4	9.2	16.1

P balance of Main Crop Types

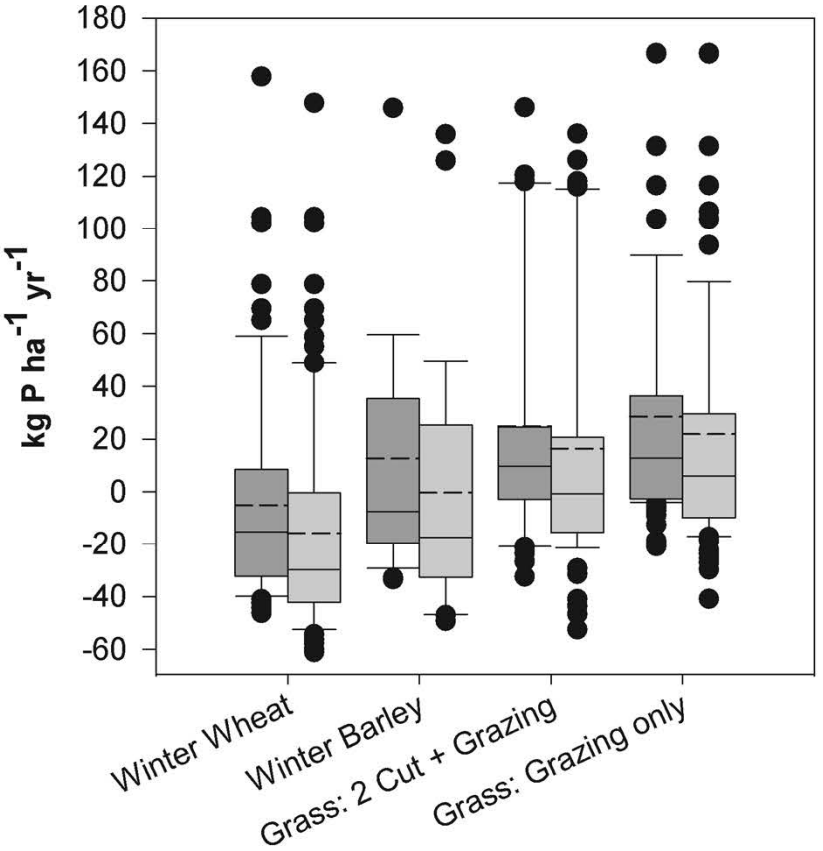
2010-2013



Castledockerell



Dunleer



Large variability of P management within crop types, especially in Dunleer

Summary

- Area of soils with **high P status** and higher P loss risk potential (Index 4)
  - **Castledockerell; decreased** by 4% between 2009-2013
  - **Dunleer; increased** by 4% between 2010-2014
- More than half (>57%) of the area in both catchments had P deficient soils (Index 1 & 2)
- The average nutrient P inputs per ha increased over the study period resulting in positive field P balances in both catchments.
  - Castledockerell: Increase **mineral/ chemical P applications**, but did not fulfil the P build-up requirements
  - Dunleer: Increase **organic P sources (imported pig & poultry manure**)
- P management **within crop types** the main sources of **variance of P balances**
- **Poor P distribution** within catchment farms
  - P inputs often did not match crop and soil P needs at field scale

Conclusions

- Are soil P mitigation measures having the desired effect at Catchment Scale?
  - *Yes* in Castledockerell
  - *No* in Dunleer
- Why Not?
- Poor **nutrient distribution** within and between farms- *in both catchments*
- NAP provisions for **excess manures impeded** chances to **reduce P** in some soils.
- **Lag time to reduce high P soils** (3 to 20+ years-depending on crop & soil type)
- Recommendation
- Soil, farm and catchment **specific nutrient advice** needed for dual agronomic and environmental benefits, with particular attention of **better nutrient distribution**
- **Other Other influences of P loss to water**; i.e. weather, soil type, hydrology and point sources

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Thank You

Farmers, ACP Team, Teagasc Staff

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For more info please see

- TResearch Autumn 2019, pg 12-13

- McDonald, et al (2019) Agriculture, Ecosystems and Environment, 274: 14-23 https://doi.org/10.1016/j.agee.2018.12.014

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