Soil Variability Impacting Source Mobility

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Soil Variability Impacting Source Mobility

• Current Irish NAP measures restrict P usage, in one rule applied for all soil types.
  • How do these “measures” measure up?
    ➢ National
    ➢ Agricultural Catchments Programme (ACP)
    ➢ Farm Scale

• Lags in decline of excessive soil P levels
  ➢ Dependent on initial soil P concentrations, soil type and management
    ➢ How does that effect previous predictions?

• Variability in the chemistry of catchment soils
  ➢ How does this effect soils capacity to mobilize nutrients i.e. Phosphorus?

• Conclusions & Implications for policy and expectations
Temporal Phosphorus Supply in Irish Soils

- NAP measures constraint P usage above crop & animal requirement to avoid excessive P in soils (i.e. Index 4).
- Index system (1 to 4) of plant available (Morgan’s P): Soil Test P (STP) is basis of agronomic advice for crop & animal P requirements.

“National” Soil P Trends

average 38,125 samples per year (Teagasc, 2014)

Note: Samples submitted to Teagasc from farmer clients, not a stratified random sample.
How has soil P levels changed the Catchments?

Baseline Soil Census Vs. Repeated Soil Census
Soil P Trends in Catchment Soils

Grassland A

- 8% decline in proportion of Index 4 soils

STP Median (Mean) mg/l
2010 = 5.65 (6.84)
2013 = 5.61 (6.41)

Grassland B

- 3% decline in proportion of Index 4 soils

STP Median (Mean) mg/l
2009 = 4.65 (4.45)
2013 = 3.98 (3.71)

Grassland C

Preliminary soil results

- 3% decline in proportion of Index 4 soils

STP Median (Mean) mg/l
2010 = 4.65 (5.64)
2015 = 3.98 (5.36)
Soil P Trends in Catchment Soils

Arable A

<table>
<thead>
<tr>
<th>Year</th>
<th>STP Median (Mean) mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>4.70 (6.23)</td>
</tr>
<tr>
<td>2013</td>
<td>4.14 (5.15)</td>
</tr>
</tbody>
</table>

- 8% decline in proportion of Index 4 soils

Arable B

<table>
<thead>
<tr>
<th>Year</th>
<th>STP Median (Mean) mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>4.20 (6.20)</td>
</tr>
<tr>
<td>2014</td>
<td>4.46 (8.99)</td>
</tr>
</tbody>
</table>

- 4% increase in proportion of Index 4 soils

The Irish Agriculture and Food Development Authority
Spatial & Temporal Distribution of P

P decline and distribution will vary with changes in farm management & nutrient practices (Wall et al., 2012, ES & P)
Decline in STP in Index 4 Soils

Baseline STP minus re-sampled STP Concentrations

Average Decline in STP (mg l\(^{-1}\))

Index 4 STP thresholds (mg l\(^{-1}\))

- 20+ with \(n = 44\)
- 15 to 20 with \(n = 59\)
- 10 to 15 with \(n = 208\)
- 8 to 10 with \(n = 111\)
Variability of STP decline of Index 4 soils across thresholds, management and soil type

- Arable A field: -13 kg P/ha/yr
- Grassland A field: -29 kg P/ha/yr

Average Decline in STP (mg l⁻¹)

Index 4 STP Thresholds (mg l⁻¹)
Soil test response to soil P draw down (Index 4 soils)

18% P-Index 4 soils in 2009

Soils re-sampled in 2013

Proportion still in P Index 4

Mean P deficit: ~ 12 kg/ha P/yr

12 kg/ha P deficit predicts 20% Index 4

Catchment soils 1st sampled in 2009

Wall et al., 2013, SUM

The Irish Agriculture and Food Development Authority
Variability in soil chemistry:

*P sorption capacity of catchment soils*

- Soils with Mehlich 3 Al/P >11.7; higher P retention & lower P solubility rates (Daly et al., 2015)

\[
Y = -0.4117 + \left(101.48/X\right)
\]

\[ R^2 = 0.77, \quad p<0.001, \quad n = 149 \]
Influence of soil chemistry:

*P sorption capacity of catchment soils*

- Soils with Mehlich 3 Al/P >11.7; high P retention & lower P solubility rates
- 67% of stratified grid sampled ACP soils were > 11.7 for Al/P.
- Soils with a low Al/P ratio mostly fall within Index 4 (i.e. > ~8.26 mg l\(^{-1}\)).

\[
Y = -0.4117 + \left(\frac{101.48}{X}\right)
\]

\(R^2 = 0.77\)

\(p<0.001\)

\(n=149\)
Concluding Remarks

- Catchment soils with high P status (Index 4) have declined in 4 out of 5 catchments; same pattern nationally.
- Index 4 catchment soils with high STP levels were quicker in their decline.
- Decline in STP varies with initial STP concentrations, soil type and management.
- Previous predictions of soil P decline seem to over-estimate the rate of decline for P deficit scenarios.
- Recognising the influence that Al:P levels have on P availability in soils, warrants the inclusion additional testing (i.e. extractable Al) for soil chemical properties.
- Greater consideration of soil type and chemistry could improve agronomic and environmental assessment of P availability on farms.