The Water Cycle – flows & temporary stores

1. Precipitation
2. Infiltration/Runoff
3. Percolation/Recharge
4. Evaporation
5. Condensation
Nutrients follow the water
Springs:

Infiltration

Water table

Permeable

Impermeable

Wet ground

No Infiltration
Sink hole, sinking stream

https://www.pahaspagrotto.org/what-is-karst.html
Mean Annual Precipitation (mm)

More rainfall over time in summer months
Infiltration into soil

Gravel: 2 minutes
Sand: 2 hours
Silt: 200 days
Clay: 200 years

Based on well known figure, constructed using Powerpoint Art.
Infiltration vs. Runoff

Well drained

Poorly Drained

Photos from Irish Soil Information System Archive
Fast Infiltration System?

Soil & Subsoil: Well drained

Rock: Karst Limestone or productive bedrock

Runoff: Low, no in-field drains, no ditches
Dominant pathway: Groundwater
Roadway Network Density: Low
Nutrients Lost: Nitrate, Phosphorus

Mitigation: Source and mobilisation control important
Slow Infiltration System?

**Soil & Subsoil:**
Poorly drained mineral or peaty soils

**Rock:**
Underlain by a poorly productive bedrock

**Runoff:** High, in-field drains, ditches

**Dominant pathway:** surface

**Roadway Network Density:** High

**Surface Nutrient:** Phosphorus (particulate and dissolved)

**Subsurface nutrient:** Ammonium

**Mitigation:**
Need to break the pathway
How long does it take for the mitigation measures to have an effect on water quality?

At meso-catchment scale (up to 100 km²) – 25 studies found worldwide
- Positive effects were found in 17 of the 25 studies
- It took 1-10 years for positive response to show up in monitoring
- Longer times were connected with scale
- Response time increased as the transport pathway increased

Also time lags associated with implementation of measures (0.5 – 14 years)
SLOW INFILTRATION
Time Lag: weeks to months
Intercept Surface Pathways
Find those pinch points

FAST INFILTRATION:
Time Lag: months to decades
Programmes of Measures
Manage expectations

Biogeochemical time lags

Fields
Drainage
Roadways

Diffuse
On Farm Land Drainage -

Shallow high intensity systems - target rainfall

Deep groundwater systems - target groundwater & rainfall

Sediment
Carbon
Phosphorus
Ammonium
We need to avoid land drainage mistakes….. Need to slow the flow

Going forward:
• Focus on mineral and not peat soils
• Avoid floodplains

Break connectivity of drainage network with:
• Farmyards
• Roadways
• Surface Water

Always back fill top soil on top of stone
Diffuse Critical Source Areas
Slow Infiltration Systems

Small OR Large Pollutant Source

High Mobilisation Risk

Hydrologically Sensitive Areas

Lots of Runoff Connectivity & Delivery

Need to break the pathway

Concept developed by Ian Thomas with ACP programme. Thomas et al. (2017-2019)
New Pathway - Farm Roadways

*Research shows annual load of phosphorus and sediment are low: Farm Scale: ~1% of all losses Catchment Scale: ~10 % of all losses

But, but, but……. Compared with field runoff, roadway runoff occurs all year round

Reacts quicker (hard surfaces, less infiltration)

Can connect directly to ditches and surface water

Especially in Summer months: Contributes much higher proportions to catchment load (4-76%)

Find sections
Intercept Pathway
Break the pathway

Roadway, open ditch and in-field options must be explored.

(A) Subsurface artificial drainage network

(B) Roadway

(C) Open ditch