Holding Water: concepts

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The James Hutton Institute
A loss of water holding capacity in our landscapes

• Water moves faster through drainage systems as they have been "improved" increasing peak flow

• Moving water off land faster is seen as better (e.g. by farmers and developers), but the water has to go somewhere

• There are implications for:
  - Sediment dynamics
  - Ecological habitat, both physical and chemical
  - Flood response speed
  - Riparian connectivity

Our starting premise....

We must maintain a productive landscape....
....but we have lost the landscape’s water holding capacity, so an interventionist catchment engineering approach must be adopted to offset this with space for water holding features.

Policy must be simplified and work more effectively....
....then interventions are best done by local practitioners.

Simple water retention measures can provide cost-effective and least disruptive options for medium flood and drought events....
....but may need to be backed up by harder engineered features downstream.
The case for resilient landscapes: either too little, or too much rainfall...

2011... and ...2012
Future water demands
– projected changes in prime agricultural land

- Irrigation needs & impacts
- Water-use efficiency

Contact: David.Miller@hutton.ac.uk
The case of buffer strips

- Making buffers work in landscapes: Their potential, issues and approaches for ‘eco-engineered’ features
Riparian benefits for water quality

3 aspects to benefiting water quality

• Runoff control of sediments and associated contaminants
• Within soil nutrient processes
• Beneficial interactions between terrestrial biodiversity, aquatic ecosystems and nutrient processing

http://www.extension.iastate.edu/Publications/PM1626B.pdf
The science: can you model and predict effectiveness from the evidence base?

- Literature database developed of buffer width vs effectiveness (60 studies, 300+ observations, 20 countries)
- Studies were either hydrologically based, or soil science based, few reported both sets of crucial parameters

\[
\text{Sed} = 7.4 \ln(\text{width}) + 62.4 \\
R^2 = 0.16
\]

Park et al. (2008). Development of a web GIS based VFSDM system
Buffering in the Tarland catchment
Signs of improvement? Stream chemistry

Sediment concentrations were reduced through the years of restoration, when observed at the whole catchment scale.

But evidence was not clear at tributary scales and subtle effects of buffering were masked by point source measures.

Contentious Danish buffer zones!

- In Denmark long term 2 m stream buffer uprated to mandatory fixed 10 m buffers brought in against all crop land
- Danish buffer zone act 2012 highly contentious:
  - *Government stealing land*
  - *Didn’t want public access*
  - *No reliable watercourse maps*
  - *No science for effectiveness for N, P*
  - *No sense for flat, sandy soils*
- In Feb 2014 softened act back to 2m, with additional 8m in protected areas (25 000 ha of prime land taken out of buffers)
- Buffers must be managed for grass, trees not currently allowed
<table>
<thead>
<tr>
<th>Functions</th>
<th>Issues</th>
<th>Benefits</th>
<th>Evidence base</th>
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</thead>
</table>
| **Controlling diffuse pollution transport** | Site specific soil and flowpath factors  
Insufficient knowledge of catchment scale effectiveness  
Long term P storage, GHG trade-offs. | Sediment:  
Bank stabilisation  
N  
$P_{tot}$  
$P_{diss}$  
Pesticides  
Pathogens | ++  
+  
++  
+  
+  
- |
| **Habitat and ecological connectivity** | Conflict with nutrient retention, best as part of combined in-field and edge of field conservation measures. | Aquatic  
Terrestrial | +  
+ |
| **Stream shading** | Should be broad leaved trees. Protects watercourse from temperature extremes. Increases woody debris and C inputs. | Temp. regulation  
Woody debris | +  
+ |
| **Hydrological connectivity** | Conflicts with soil drained for farming. Wetlands are effective bioreactors for N. Stores flood peak flow. | Wetlands | ++ |
| **Carbon sequestration** | Interaction with DOC, N, P leaching and GHG emissions. | Carbon | - |
| **Biomass production** | Timber or biofuel production may offset lost income. Need appropriate harvesting methods. | Biomass | - |
| **Cultural services** | Habitat for hunting (fishing, deer, game birds), public access, recreation and education, crop pests issues. | Cultural services | - |

*Stutter et al. (2012) Riparian buffer strips as a multifunctional management tool in agricultural landscapes: Introduction. JEQ, 41, 297-303*
Potential landscape management of nutrients

Biomass Cut and used for Green Manure of Silage and manure returned to Arable Land

Nutrients Intercepted and accumulated

N and P Movement Overland Flow and Subsurface Flow
BufferTECH collaboration: Denmark, Scotland

http://www.buffertech.dk/

Zoned buffer, Denmark, photos Ben Christen
System with designed buffer strip and biomass transfer

- Eutrophication Reduced
- GHG emission reduced
- Run-off Reduced
- Nutrient Interception
- Water Quality Enhanced
- Leaching Reduced
- Enhanced Acquisition
- Nutrient pools
- Crop
- Biomass Transfer
- Reduced Inputs
- Fert

Enhanced Acquisition

Nutrient pools
**Rural SuDs**

*Individual, or multiple linked component structures replicating natural processes, designed to attenuate water flow by collecting, storing and improving the quality of run-off water within rural catchments*

- Should be: low energy input; zero or only positive environmental impact; low capital and running costs; with multiple benefits

- Currently being embedded into the new SRDP scheme.

- Conceptual step forwards: multiple, small, unobtrusive measures as part of a ‘treatment-train’ approach

- Needs: landscape planning, demonstration & shared learning
### Rural SuDs Component

<table>
<thead>
<tr>
<th>Rural SuDS Component (results for basic version of system)</th>
<th>Multiple Benefits</th>
<th>Performance</th>
<th>Costs</th>
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<td>Flow</td>
<td>Water Quality</td>
<td>Biodiversity</td>
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<td>In-ditch options</td>
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<td>Swales</td>
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<td>Infiltration trench</td>
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<td>Filter/French drains</td>
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<td>Banners &amp; traps (basic)</td>
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<td>Wetland</td>
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<td>Ponds*</td>
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<td>Retention</td>
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<td>Woodland/Forestry</td>
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<td>Woodland shelter belts</td>
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<td>Buffer strip/headland technology</td>
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<td>New hedges/dry stone dyke</td>
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<td>Dry grass filter strips</td>
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<td>Buffer strip (cry)</td>
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<td>Filters Berm</td>
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<td>Wetland</td>
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<td>Artificial/restored wetland</td>
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<td>Biobeds</td>
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<td>Farm buildings</td>
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<td>Rainwater harvesting</td>
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<td>Cross-drains</td>
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<td>Green roofs</td>
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<td>Sediment trap</td>
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<td>Sedimentation box</td>
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<td>Soak away</td>
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<td>Gully (gully) blocking</td>
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Avery et al. 2012. Report for the EA *(commissioned by J. Letts)*