Flood Risk Management Research Consortium - Pontbren

- Research demonstrated that small scale strategically planted hedgerows or ‘shelter belts’ could significantly reduce runoff and sediment movement (flood risk) and water quality.
- Landscape scale ecosystem service provision was emergent
  - but incidental rather then planned
- How do we decide where to place trees (or other features) to enhance ecosystem service provision?
Policy aiming to protect and enhance a broad range of ecosystem services raises the need for:

1. development of **social capital** amongst land users at the landscape scale (rather than farm and field) for management and policy implementation
2. spatially explicit policy implementation
3. integration of policy across sectors (e.g. water, biodiversity, agriculture and forestry)
4. participation (and learning) by many differing stakeholder groups

Initially implemented for spatially explicit evaluation of trade-offs in changing land use on hydrology, productivity and biodiversity – *application at Pontbren explores tree placement*.

- Meets a key need for models and visualisations that can be applied to any landscape with readily available data for parameterisation
Tool specification

• Designed explicitly as a negotiation tool
• Works at landscape scale- resolution appropriate for field decisions but information from small (10km²) to medium (1000km²) catchment scale
• The basic algorithms can be applied using national scale (i.e. widely available) digital elevation data, land use data and soil data
  – Enhanced output where higher resolution data is available
    – e.g. LIDAR, detailed surveys.
• Runs in seconds to minutes- proposed interventions can be immediately evaluated
Current features

Explores impacts of land use or management changes at a landscape scale

Farm impact:
- simple rule set (based on slope, current land use and water regime)

(Forest) habitat connectivity:
- habitat networks
- uses BEETLE - Biological and Environmental Evaluation Tools for Landscape Ecology (Kevin Watts and Amy Eycott from Forest Research)

Flood Mitigation:
- flow accumulation algorithm
- modified by soil type and land cover

Tradeoffs
- Tools explore trade offs, multiple benefits and opportunities for change

POLYSCAPE operates on a traffic light system:

Green  highlights high opportunities for change

Red   highlights existing utility (be wary of change)

Orange either marginal opportunity for service provision (or identifies one or more trade offs between ecosystem services)

Options for 3 and 5 colour displays (+dark red/green)
Initial application: Pontbren
The Pontbren farms (outlined in red) overlaid over the FRMRC monitored catchments
Farm impact Layer for Pontbren

Basic farm productivity layer based on slope and soil type (informed through farmer discussion); this layer will be ‘editable’ by farmers.

Key:
- marginal (either because they are waterlogged or too steep (>15°)
- valuable for production services (i.e. flat and/or dry)
- semi-waterlogged but flat areas
- negotiable

Topsoil characteristics at Pontbren

- Unidentified
- Moderately stony clay loam
- Slightly or moderately stony clay loam
- Slightly stony clay loam
- Slightly stony silty clay loam
- Stoneless clay loam
- Stoneless humified peat
- Stoneless peat
- Stoneless raw peat
Farming impact layer (overlaid over 2006 aerial photograph)  
(Slope thresholds set at 5° & 15°)

This area is already wooded- Remnant tree cover on non-economically viable agricultural land.

Steep field

Dry Field valued by the farmer

Steep field

Key:
- marginal (either because they are waterlogged or too steep (>15°)
- valuable for production services (i.e. flat and/or dry)
- semi-waterlogged but flat areas
- negotiable

Forest habitat connectivity layer

Below output based on Forest Research’s BEETLE- generic algorithm in development

Key:
- Opportunities to expand existing woodland
- Habitat already present
- Low woodland habitat value
**Hydrology layer –**
Based on a flow accumulation algorithm modified by land use

**Flood overlay: half moon field**

Blue=half moon tree belt;
Black=area contributing to half moon belt;
Red areas have low accumulation;
Green areas have high accumulation (highest value accumulates 0.18 hectares of overland flow): optimal for tree planting from flood perspective
Tree area covers 4% of field; provides benefit to approx 30% of field
Half moon field; trees removed

Red areas have low accumulation;
Green areas have high accumulation (highest value accumulates 0.56 hectares of overland flow)
Accumulation values three times higher with tree removed
Optimal placement changes as landscape elements change

Farm impacts, habitat connectivity and flood mitigation traded off using national scale data for Pontbren

Farm vs. Flood

Farm vs. Habitat

Flood vs. habitat

Trade all
Initial findings

– Algorithms perform very well where data is of a sufficient quality
– All identified issues were due to data inconsistencies
– Pontbren Farmers understood the output and engaged with the tool
– In response to this we are developing *interactive land owner preferences* (we found that this is important to ground truth land cover data and capture and engage local stakeholders)
National level data is frequently inaccurate. This example shows CCW’s Phase 1 data overlaid over the 2006 aerial photograph for Pontbren (BEETLE uses CCWs Phase 1 Data)

The figure shows missing data (and ‘simplistic’ characterisations)

See: Eyecott et al 2007
Future plans for Polyscape:

Current focus on: Sediments, Carbon sequestration, Water quality

Research in New Zealand and Ghana

Table 1: Matrix of land use changes and the ecosystem services that provide public goods at Pontbren

<table>
<thead>
<tr>
<th>Major land use interventions at Pontbren</th>
<th>Ecosystem services that provide public goods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Climate regulation</td>
</tr>
<tr>
<td>Shelterbelts</td>
<td>✓</td>
</tr>
<tr>
<td>De-stocking</td>
<td></td>
</tr>
<tr>
<td>Pond Formation</td>
<td>✓</td>
</tr>
<tr>
<td>Native woodland</td>
<td></td>
</tr>
<tr>
<td>Streamside woodland</td>
<td></td>
</tr>
<tr>
<td>Shelterbelts</td>
<td></td>
</tr>
</tbody>
</table>

This figure shows the effect of missing data on the flood mitigation layer; and also it’s utility where data is more representative.
Conclusion

POLYSCAPE provides:

- Ways of valuing existing features and ecosystem service provision on farms and within landscapes.

- Means of targeting and prioritising changes
  - where can small changes have great positive impact &
  - the location of areas of potential synergy?

- A tool for engaging a range of stakeholders in a potentially complex decision making process

End

And the Pontbren farmers
Data required to run the model

- Digital elevation (any resolution; e.g. 10x10m, 5x5m or LIDAR)
- Soil data
- Land use data (For Wales: CCW Phase 1 data, LCM2000 or LCM2007?)
  
  and

- Local knowledge

Need for targeted interventions/valuation

a) Permeable strip near top of slope
b) Permeable strip near bottom of slope
c) Permeable strip against slope
Field overland flow

Impact of tree planting at Pontbren