Flow accretion profiling as a method of hydrological characterisation of wetlands in permeable catchments

Heather Musgrave (now at Entec),
Mike Acreman (CEH Wallingford),
Andy Binley (Lancaster University)

Aim

- To develop or improve methods of wetland characterisation, in order to ensure that hydrological processes and functions in wetlands are correctly represented;
- To improve the catchment-scale conceptualisation of wetlands
Assessing impacts of abstractions on wetlands

Ecological status of groundwater bodies affected by condition of GWDTEs

**Wetlands**

- Restoring Sustainable Abstraction Programme
- Habitats Directive
- Water Framework Directive

**Wetland Characterisation**

- Lots of wetlands for which we need to know...
- How they interact with their surroundings and how dependent they are on groundwater
- How can we get an idea of the interactions between wetlands and groundwater for a large number of wetlands?
For floodplain wetlands, there is a continuum between sites;

Common factor of being located in the same catchment, on the same river;

So by looking at the catchment scale, get an initial idea of how wetlands on the floodplain interact with surroundings and compare to each other.

Surface-groundwater interactions

Catchment hydrogeological studies consider spatial distribution of groundwater-surface water interactions;

Carry out incremental flow surveys along a river, looking at accretion between points;

Generally focuses on emergence of groundwater in rivers (passage through floodplain is incidental).
Floodplain-groundwater interactions

- Extend the methodology to see if groundwater interactions with wetlands also occur in the same parts of the catchment as those where the river is accreting;
- This would give an initial idea of which parts of the floodplain had the most groundwater connectivity, and where surface water contributions were more important.

Lambourn Catchment

- Flow surveys along River Lambourn to develop accretion profiles;
- Detailed studies in three wetlands to understand water sources and processes.
LOCAR flow accretion surveys

- Showed where areas of most interaction between river and groundwater occurred

---

Wetland Studies

- Three sites selected for further research

---
Within- Wetland Studies

- Each wetland study included:
  - Geophysical surveys;
  - Groundwater and river level monitoring;
  - River flow surveys;
  - Hydrochemistry surveys; and
  - Vegetation surveys.

For Example…Hunts Green

Entec
Creating the environment for business
Comparison of “groundwater dominance” between sites

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Hunts Green</th>
<th>Boxford</th>
<th>Weston</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water table depth</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Vertical head gradients</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Correlation between surface and groundwater time series</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Groundwater temperature</td>
<td>3</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Mn and Fe concentrations</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Ratios of Mg, Sr and Ca</td>
<td>3</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Other chemistry</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Ellenberg scores</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>20</strong></td>
<td><strong>40</strong></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>

Weston: High accretion
Localised but significant groundwater upwelling. River levels also exert control on wetland water levels.

Boxford: Medium-high accretion
 Significant groundwater upwelling. River levels also affect wetland water levels.

Hunts Green: Low accretion
Little direct interaction with Chalk groundwater. Lateral flow through gravels is significant, but little interaction with river.
Complications…

- Chalk is overlain on the floodplain by a flint gravel layer
  - Acts as extension of the river, with shallow lateral flow occurring
  - So other areas of floodplain still receive some “groundwater” contributions, but not directly from the Chalk

- Flow accretion surveys affected by scale
  - Apparent accretion can vary depending on how long a reach is used
  - Springs (point sources) can affect values

Reminder: Flow Accretion Reaches

![Graph showing flow accretion reaches](image)
Conclusions

- Understanding river flow accretion is a useful tool for providing initial characterisation of wetlands throughout a catchment;
- Does not give absolute answers, but provides relative comparisons along the floodplain;
- Allows identification of wetlands most dependent on groundwater, and prioritisation of most vulnerable sites for further investigation.
Thanks…

- My PhD supervisors Jim Griffiths, David Gowing and Andy Binley
- Mike Acreman and Andy Young, CEH
- Jenny Covey, Environment Agency
- Dave Gasca-Tucker, Helen Gavin and Emma Everrard, Atkins
- Landowners and river keepers at Weston, Boxford and Hunts Green