Aquatic ecosystem shifts in response to early human land-use change in two low-elevation lakes in northwestern Europe

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Context
Eutrophication of (freshwater) aquatic systems calls for management and conservation measures

- Adequate understanding of the causes and consequences of the shifts in nutrient availability
- Proper pre-impact nutrient reference baselines

Location: Sediment cores were obtained from two lakes in northwestern Europe, using a piston corer deployed from a floating platform:

**Llangorse Lake (UK)**
- Lateglacial basin
- Brecon Beacons, Wales
- (Hyper)eutrophic

**Hijkermeer (NL)**
- Pingo-remnant
- Drenthe plateau
- Oligo- to mesotrophic

Coring
- 12 meter sediment
- 7 meter water depth

Figure 1. Topographic setting of Llangorse Lake and Hijkermeer, including bathymetry based on Jones et al. (1985) and Heiri et al. (2007) respectively

**Vegetation** (Human impact) | **Diatoms** | **Trophic state**
--- | --- | ---
Pollen indicate land-use change | Diatoms indicate trophic state (method 1, indicator values; Van Dam et al. 1994) and total phosphorus (method 2, transfer function; Battarbee et al. 2000) | Diatoms indicate biodiversity (rarefaction)

**Llangorse Lake**

<table>
<thead>
<tr>
<th>Vegetation (Human impact)</th>
<th>Nutrients</th>
<th>Biodiversity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals decrease</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>Cereals increase</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Deforestation</td>
<td>-</td>
<td>↓</td>
</tr>
</tbody>
</table>

**Results Llangorse Lake**

Figure 2. Sediment record of Llangorse Lake: Correlated with LOI to radiocarbon ages and summary pollen stratigraphy (Jones et al. 1985), summary diatom stratigraphy, rarefaction diversity, trophic state and LOI reconstructions.

**Hijkermeer**

<table>
<thead>
<tr>
<th>Vegetation (Human impact)</th>
<th>Nutrients</th>
<th>Biodiversity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drop Sphagnum</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Increase aquatic plants</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cereals increase</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Hiatus</td>
<td>↑</td>
<td>-</td>
</tr>
</tbody>
</table>

**Results Hijkermeer**

Figure 3. Sediment record of Hijkermeer: Radiocarbon ages, summary pollen stratigraphy together with Sphagnum and aquatic plants, summary diatom stratigraphy, rarefaction diversity and trophic state.

**Conclusion**

⭐ Anthropogenic impact occurred on lake ecosystems at least 5000 years ago, in the form of deforestation
⭐ Diversity increases with increased nutrients in the oligotrophic lake, and decreases with increased nutrients in the (hyper)eutrophic lake
⭐ Llangorse Lake’s diatom assemblage indicates recovery of the ecosystem after a period of maximum disturbance, highlighting resilience

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References