Hydrology & Bog-Pool Dynamics Wind-Farm Infrastructure Impacts

Workshop Overview

Objectives

Assess effects of tracks/turbines on water table & **bog pool hydrodynamics**; evaluate monitoring & mitigation.

Specifically dense bog pool area (eg. Dubh lochans)

Buffers/Impact zones on the bog pools

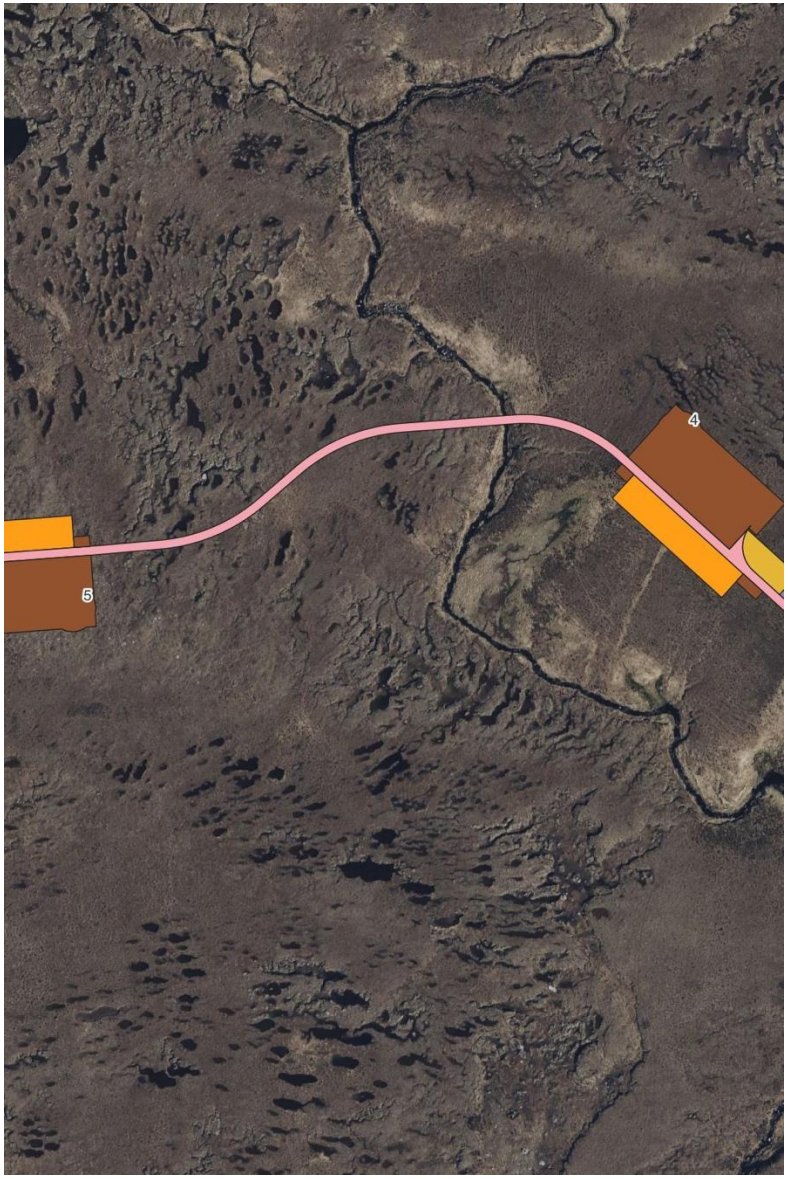
*Not all ecologists have the use of a **model**.*

Assess the production of a model that is practical, where input of data is in simplified steps?

(example Biodiversity Metric!!) produce an excel file with all maths within it, place data into model for result)

Discussion Questions

- *How might the construction and operation of turbines, infrastructure and access tracks on peatland with multiple bog pools (dubh lochans) and lochs affect peat hydrology, bog pool dynamics, and peat stability over the 30-year lifespan (?) of the wind farm?*



- *In what ways could turbine foundations and track development alter the hydrological functioning of bog pools and lochs in peatland, and what long-term consequences might this have for peat formation and carbon storage over the 30-year operational period, (and beyond)?*

- *What are the likely cumulative impacts of 30 years of wind farm operation on peatland bog pools and lochs in terms of hydrology, peat integrity, and greenhouse gas balance?*

- *What monitoring approaches and mitigation strategies could be used to detect, manage, and minimise these impacts over the life of the development?”*

Key Mechanisms

- Drainage and water-table drawdown
- Peat compaction and reduced storage
- New flowpaths altering pool hydrodynamics
- Changes in pool connectivity and persistence

- ***Brief – expand***
- ***Bog pool observations? Participant experience.***

Monitoring Essentials

- Water-table dataloggers (WT), piezometers
- Pool stage sensors (pressure transducers)
- UAV photogrammetry & aerial mapping
- LiDAR for microtopography & pool mapping
- SAR (Sentinel-1) for wetness time-series

- ***Brief – expand on other monitoring data***

Modelling Options (types)

- **Conceptual / bucket mass-balance**
- **Distributed hydrological models**
- **Groundwater / peat flow models**
- **Ecohydrological / peat-process models**

Quick Actions

- Map pool basins with LiDAR
- Install 3 paired piezometers (impact/control)
- Run 12-month baseline monitoring
- Pilot alternative track design in model

- ***Summarised approach***
- ***Expand – Which combination of hydrological, geomechanical, and carbon models are most appropriate to quantify WF infrastructure impacts on bog-pool water levels, peat stability, and greenhouse-gas balance—and what monitoring data are essential to calibrate and validate them?”***

Hydrology & Bog-pool Dynamics

- **Physically based, distributed flow models (2D/3D)**
- **Use for**: Water-table response to foundations/tracks, drainage impact, pool water-level dynamics, GW–SW exchange, culvert spacing scenarios.

- **Inputs**: High-res LiDAR DEM, peat stratigraphy & K/van Genuchten curves, drainage layout, rainfall, boundary heads/lochs; continuous logger data for calibration

- **Overland/shallow flow & barrier effects:**
- **Use for**: How tracks/berms alter surface routing, ponding and connectivity between pools; culvert placement optimisation.

- **Inputs**: Sub-meter DEM, roughness maps (Sphagnum/ericoids/open water), rainfall hyetographs; water-level recorders in representative pools.

- **Catchment-scale conceptual screening:**
  - **Use for:** Rapid “what-if” testing of cumulative hydrologic change and seasonal drawdown risk.
  - **Inputs:** Rain, simple soil/land-cover classes; calibrate to loch outflows and dipwell networks.

- **Peatland-specific eco-hydrological structure:** *DigiBog* (and similar cellular/catenary peat models)

- **Use for**: Long-term pool–ridge water-table behaviour and feedbacks between hydrology and peat accumulation at site scale.

- **Inputs**: Microtopography, acrotelm/catotelm properties, net primary production/decay parameters; decades-scale water-table series helpful

Bog Pool Connectivity & Landscape Change

- **Graph/percolation & cellular automata from LiDAR**:

- **Use for**: How small elevation changes or barriers fragment pool networks and alter hydroperiods; thresholds for loss of connectivity.

- **Inputs**: Sub-meter DEM, mapped pools, seasonal water-level envelopes.

- **Sediment/DOC export to lochs:**
  - **Use for:** Changes in colour/DOC and fine sediment delivery from disturbed corridors.
  - **Inputs:** Flow paths, soil C pools, event sampling of DOC/TSS.

Monitoring that “unlocks” these models (brief)

- **Hydrology**: Nested dipwells (acrotelm/catotelm) at pool–hummock–track transects; pressure transducers; culvert flows; loch stage.
- **Geomechanics**: Settlement plates, extensometers, vibrating-wire piezos; periodic LiDAR/RTK; InSAR for site-wide mm-scale motion.
- **Carbon**: Eddy-covariance tower if feasible; chamber flux grids along disturbance gradients; DOC/TSS at loch inflows/outflows.
- **Remote sensing**: Annual UAV photogrammetry & thermal for pool mapping; hyperspectral for Sphagnum condition.

Next Steps