Role of Geotechnics in Peatland Restoration and Management

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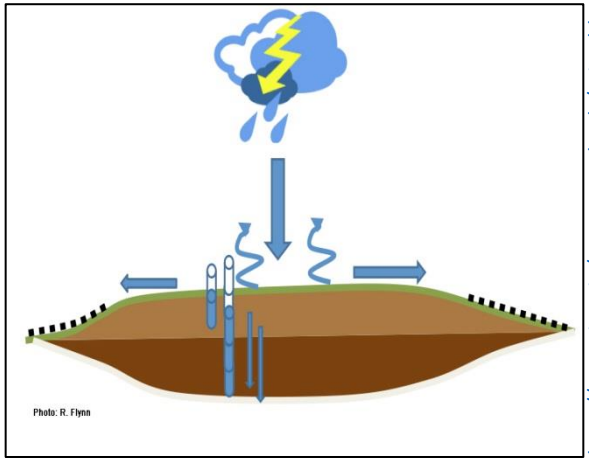
Introduction

http://www.ipcc.ie/a-to-z-peatlands/raised-bogs/

Peatlands encountered in many geographical areas

— fragmented remains of dead plant vegetation that build up over time where there is a persistent presence of water

— dynamic eco-hydrological wetland systems



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Morphology changes annually: in-situ peat absorbs water and swells during wintertime and then releases water (usually through evapotranspiration) during summertime

Peatlands threatened worldwide due to natural and anthropogenic affects


http://www.biodiversityireland.ie/projects/national-vegetation-database/irish-vegetation-classification/explore/bg1a/

Sphagnum mosses, key species in *acrotelm* (upper) layer for active raised bogs →

— health depends on availability of sufficient rainwater
— growth becomes stunted when mean groundwater level drops about 10cm below ground surface and/or surface gradient increases >1:30

- Large-scale drainage and localized turf cutting for fuel, causes subsidence and ecological damage
- Oxidation of organic matter causes permanent material changes

More stringent environmental policy and legislation — EU Habitats and Water Framework Directives

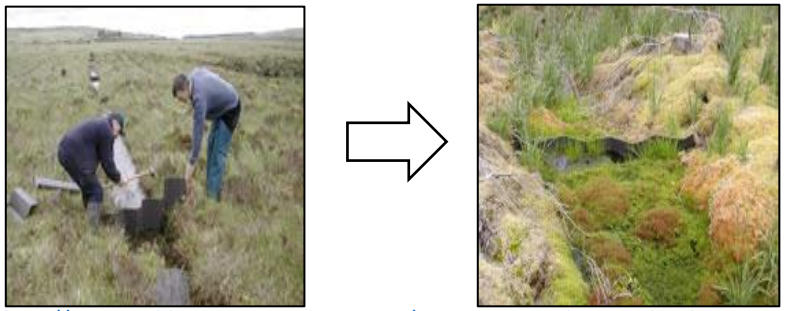
- Conservation, restoration and long-term sustainability of degraded active bog ecosystems

- Careful management of bog hydrology and biodiversity to rebuild fragile remnants of original ecosystems for developing and sustaining the characteristic functions required for transition to pristine fully-functional wetland

- Goals:
  - *Arrest propagation of subsidence trough*
  - *Restore natural groundwater balance*
  - *Create conditions conductive to re-colonization of affected areas by indigenous plants over time*

Various engineering approaches to re-establish natural hydrology and peat-forming vegetation at affected areas

- Blocking existing drains



http://www.irishbogrestorationproject.ie/restoration_techniques.html

- Place hydrological barriers within bog to reduce seepage rates
- Strategically construct peat dams and/or networks of peat bunds at bog margins for collection, storage and controlled release of surface runoff from high bog
- Measures used independently or integrated, depending on site conditions and extent of treatment area

FIELD CASE STUDY — *Raheenmore raised bog, County Offaly, Ireland*

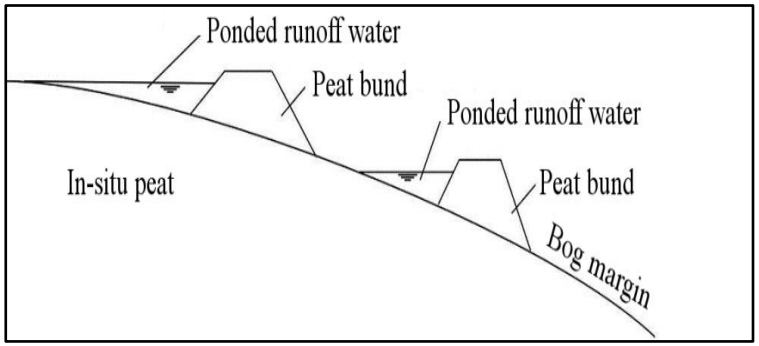
- 162ha active raised bog and designated nature reserve (SAC)
- Characteristic well-developed dome shaped relief (peat depths up to 15m for high bog)
- Margins have been arterially drained and some turf cutting occurred in the past

Initial measures — block existing surface drains at 10m intervals

=> not sufficient to arrest propagation of subsidence trough towards high bog

Treatment Area 1: south-eastern bog margin — slope gradient 1:20

In 1994/95, network of peat bunds constructed using locally sourced air-dried peat



Cascade system

— to replicate hydraulic gradient < 1:30

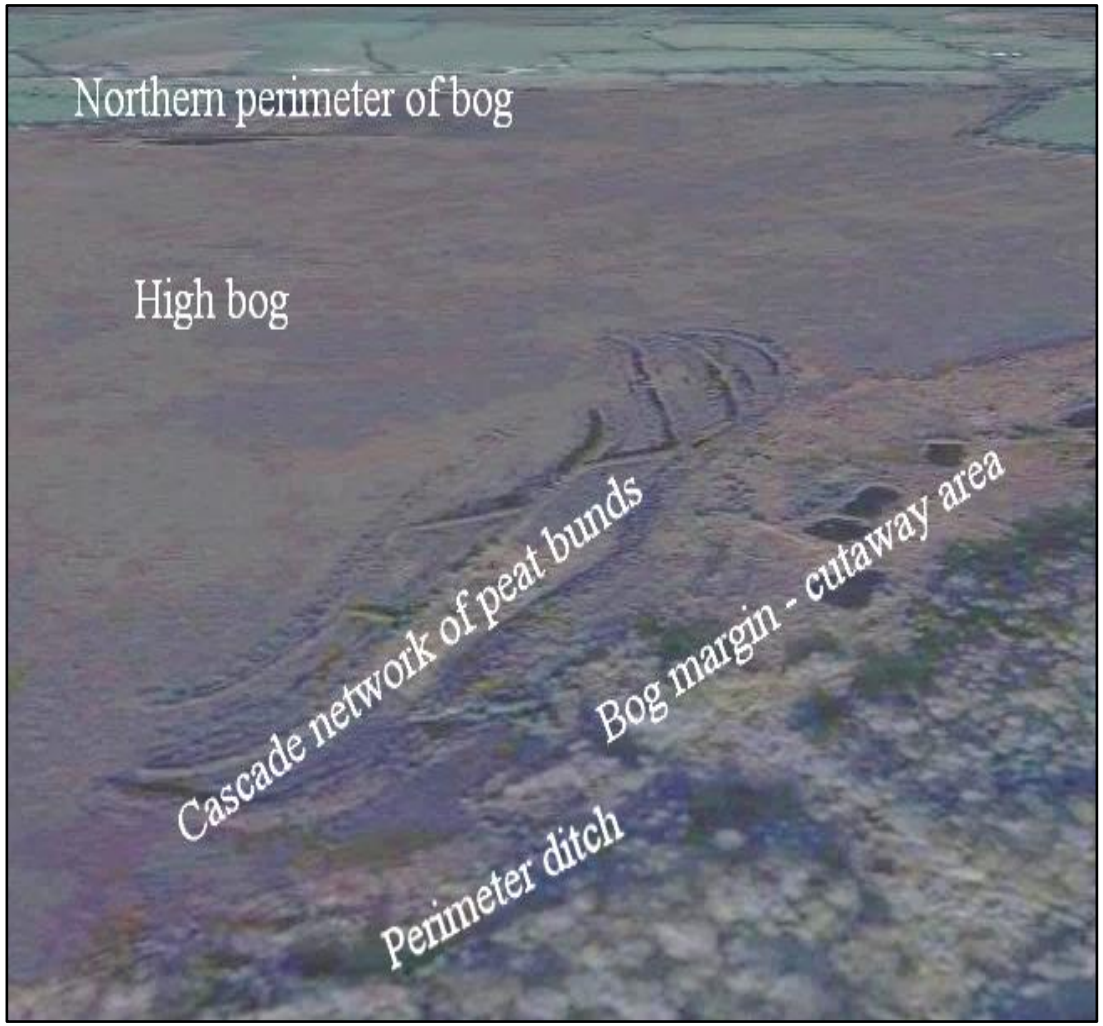
— controlled by horizontal overflow pipe network

— limits lateral and uplift hydraulic pressures acting on bunds, and destabilizing seepage pressures, to acceptably low levels

Individual bunds up to approx. 306m long, 0·5–3m high increasing closer to bog margin, crown widths of 1·5–5m, and 1:1 side slopes

— strengthen by driving wooden poles vertically into them to penetrate in-situ peat

Treatment Area 1 (ctd.)



Google Earth Image

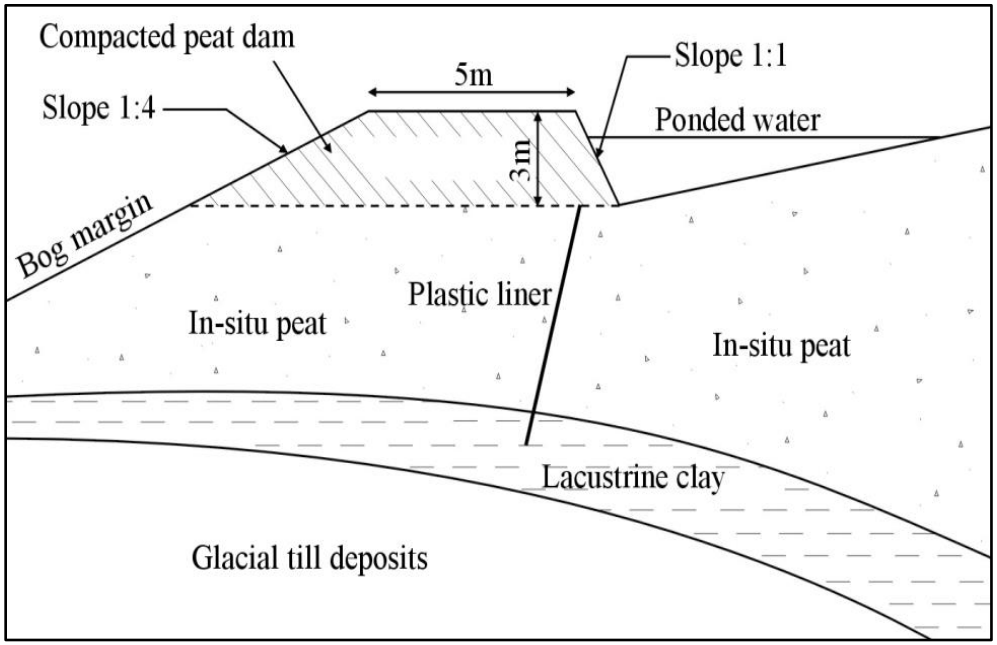
Radial cross-bunds compartmentalized bund network

Maximum retained water depth of 2·5m for outer 3m high bunds

Geotechnical design must consider *drying out of construction peat material* during drought (reduces bund self-weight), combined with *increases in lateral and uplift hydraulic pressures, and seepage pressures* acting beneath bund base, through rising water levels following torrential rainfall

Treatment Area 2: cutaway section near northern perimeter

3m-high peat dam constructed in 1997 retains 2·5m depth of ponded runoff water



Improved geotechnical design:

Reduced gradient of 1:4 for downside slope

High-density plastic membrane running from dam heel and keyed into underlying lacustrine clay layer

Shear key constructed between dam and underlying in-situ peat

Photograph taken from high bog

Field study — Outcome and Summary

Extensive monitoring of morphology and hydrology over many years using GPS surveying and airborne LiDAR

— over six-year period following northern dam construction, affected bog surface had steadily risen by up to 1·0m and natural rejuvenation of indigenous *Sphagnum* mosses had begun to recolonize and infill along edges of ponded water

=> demonstrates effectiveness of constructed peat bunds (dams) in restoring natural hydrology and creating conditions conductive to re-colonization by indigenous plants at affected areas

Thank You!