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NATURAL ENVIRONMENT RESEARCH COUNCIL

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# ***An assessment of Pant-y-Llyn, Wales' only turlough and comparison to Irish sites***

Gareth Farr<sup>1</sup>, Owen Naughton<sup>2</sup>, Tristan Hatton-Ellis<sup>3</sup>, and Jamie Bevan<sup>4</sup>

<sup>1</sup> British Geological Survey, Columbus House, Tongwynlais, Cardiff, CF15 7NE

<sup>2</sup> Department of Civil, Structural and Environmental Engineering, University of Dublin Trinity College, Ireland

<sup>3</sup> Countryside Council for Wales, Maes-y-Ffynnon, Ffordd Penrhos, Bangor, Gwynedd LL57 2DW

<sup>4</sup> Countryside Council for Wales, Maes Newydd, Llandarcy, Neath SA10 6JQ



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## **Introduction**

This project was mainly driven by Environment Agency Wales (EAW) and was also largely funded by EAW. Close co operation with specialists at the Countryside Council for Wales (CCW) was vital . From April 1<sup>st</sup> 2013 EAW , CCW and the Forestry Commission will join in Wales and become a single regulatory body called ' Natural Resources Wales'.

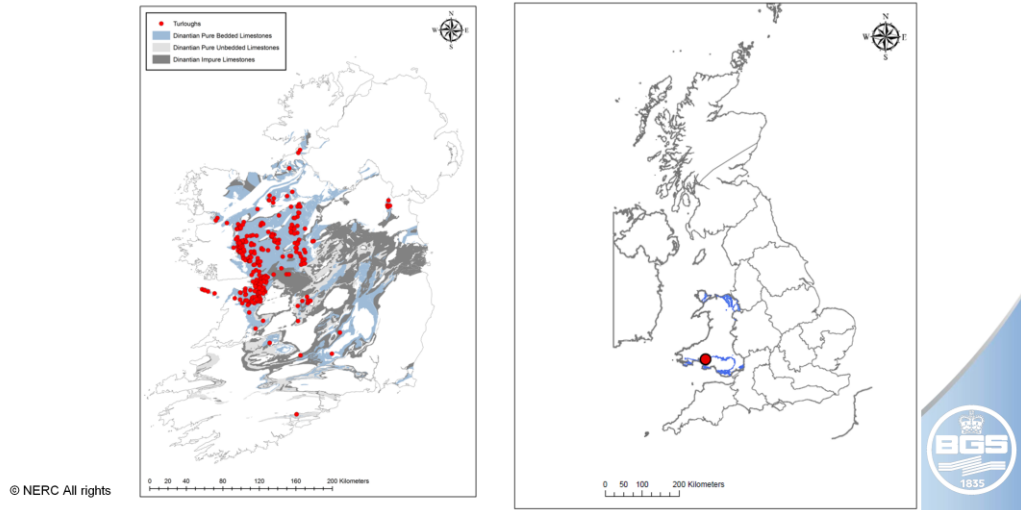
The work aimed to assess the condition of PYL for the Habitats Directive (HD) and Water Framework Directive (WFD). Prior to the study it was classified as being in unfavourable condition.

## **The study aimed to:**

- Improve the hydrogeological conceptual understanding
- Review the water chemistry of Pant-y-Llyn and the surrounding groundwater
- Use existing data back model the turlough hydrograph
- Compare the hydrological of Pant-y-Llyn with that of recorded Irish turloughs
- Provide evidence to confirm its status for the Habitats Directive

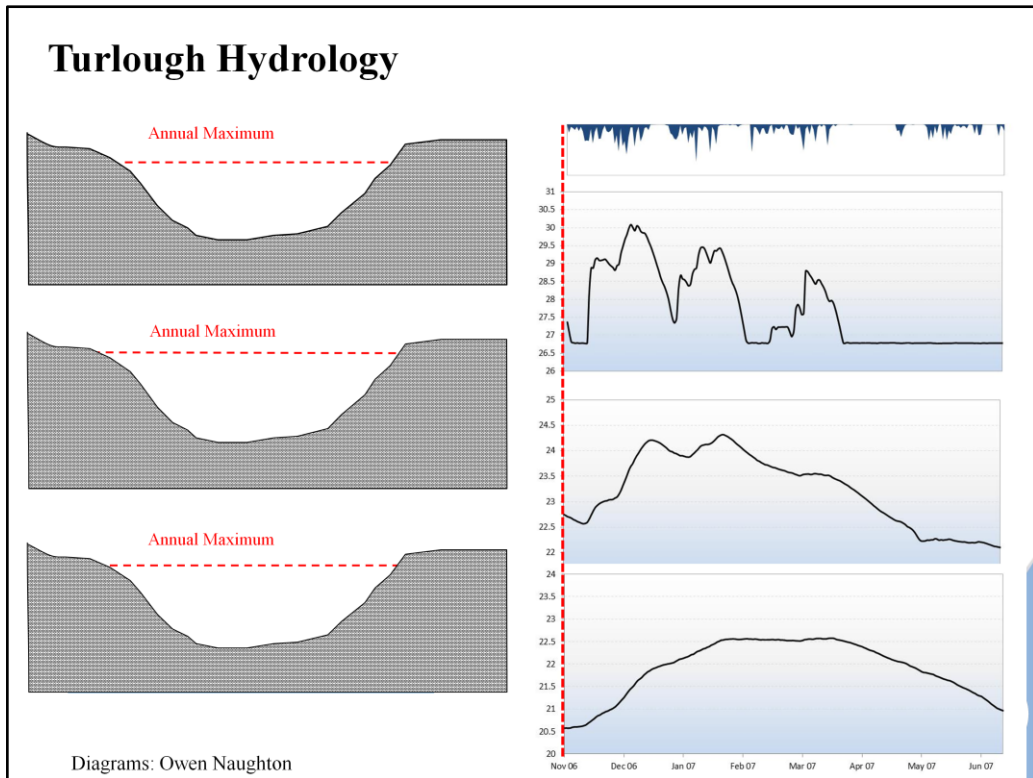
**“A topographic depression in karst which is intermittently inundated on an annual basis, mainly from groundwater, and which has a substrate and/or ecological communities characteristic of wetlands”**

Tynan *et al* 2007



Turloughs.....

- Occur in karst areas
  - Predominantly groundwater fed
  - Occur in high rainfall/water table conditions
  - Are a characteristic feature of Irish karst (>400 examples)
- 
- One recorded example in mainland UK – Pant y Llyn (Campbell, Gunn and Hardwick 1992)



The timing and extent of the annual groundwater flooding can vary significantly between turloughs.

You can see the range of behaviours in the hydrographs from:

Simple

- 1) can respond quickly or slowly to recharge
- 2) can have anything from short distinct flood events to a more seasonal flood
- 3) can peak at different times of the year even if same receiving same rainfall

Detail

- 1) Rapid filling and emptying in response to rainfall events shows a number of distinct flood events, with the annual maximum early in the flood
- 2) The middle turlough shows some peaks superimposed on a seasonal flood pattern, with the annual maximum in mid flood season
- 3) more seasonal flooding pattern at the bottom with poor definition of peaks and a late annual maximum

## Ecological Conservation

Many floral and faunal species of national and international importance

Protected under EU legislation

- Habitats Directive – Priority Habitat
- Water Framework Directive



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This variation in flooding makes turloughs a unique groundwater dependent ecosystem.

They are a habitat for many plant and animal communities of both national and international importance, including a number of rare species such as mudwort and fen violet.

Because of this, turloughs have been designated a priority habitat under Habitats directive, and many turlough sites are classified as Special Areas of Conservation and protected under EU legislation.

In the Irish context, turloughs are one of the two most common groundwater dependent ecosystems in Ireland however on main land UK they are extremely rare.

Photo Credits : Owen Naughton and Gareth Farr



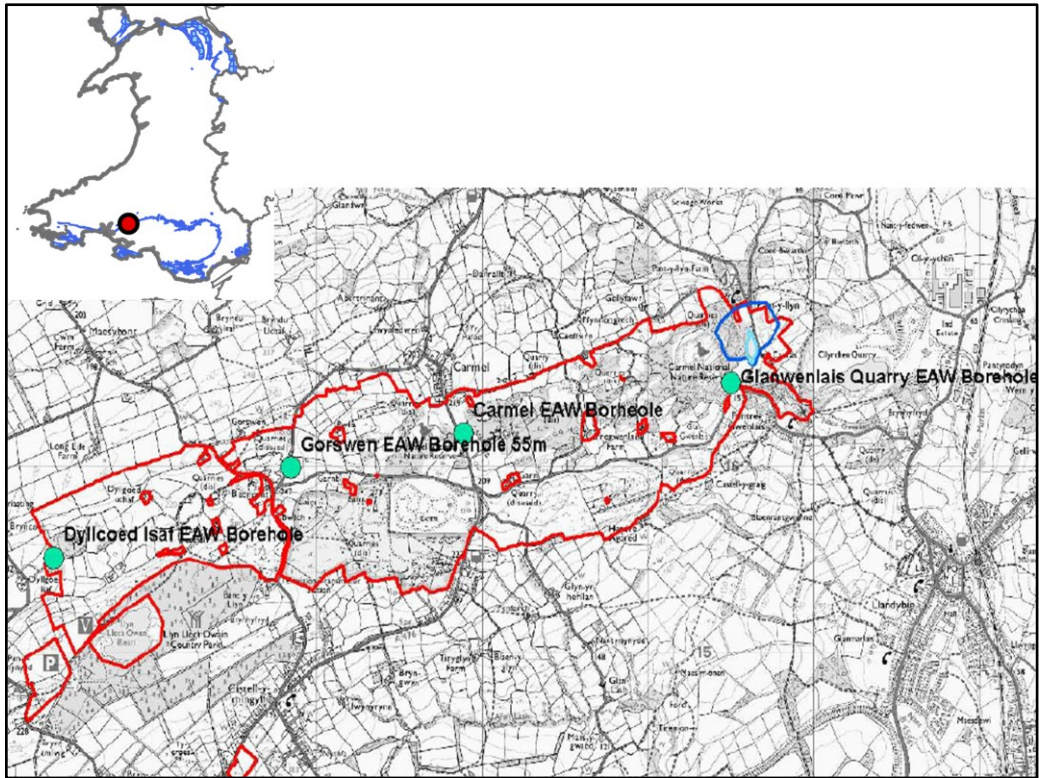
To give an example of groundwater flooding this is Blackrock Turlough, Co. Galway during a dry period.

Photo Credits : Owen Naughton



Blackrock Turlough, Co. Galway during a flood period.

Photo Credits: Owen Naughton

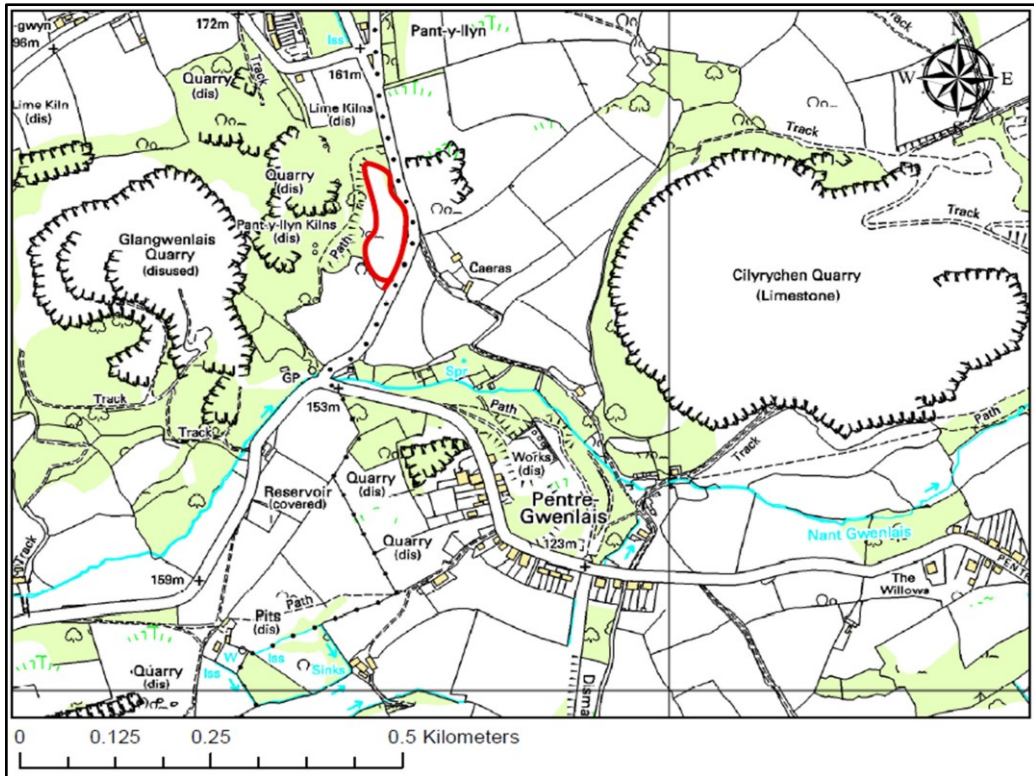


Now returning to Wales, UK.

Pant-y-Llyn is set within an area of Carboniferous Limestone that runs NE/SW.

There are 4 EAW boreholes located across the Carboniferous Limestone outcrop, they are shown with green dots on the map.

There are also lots of closed and mothballed quarries here however one quarry has put in applications to re open.

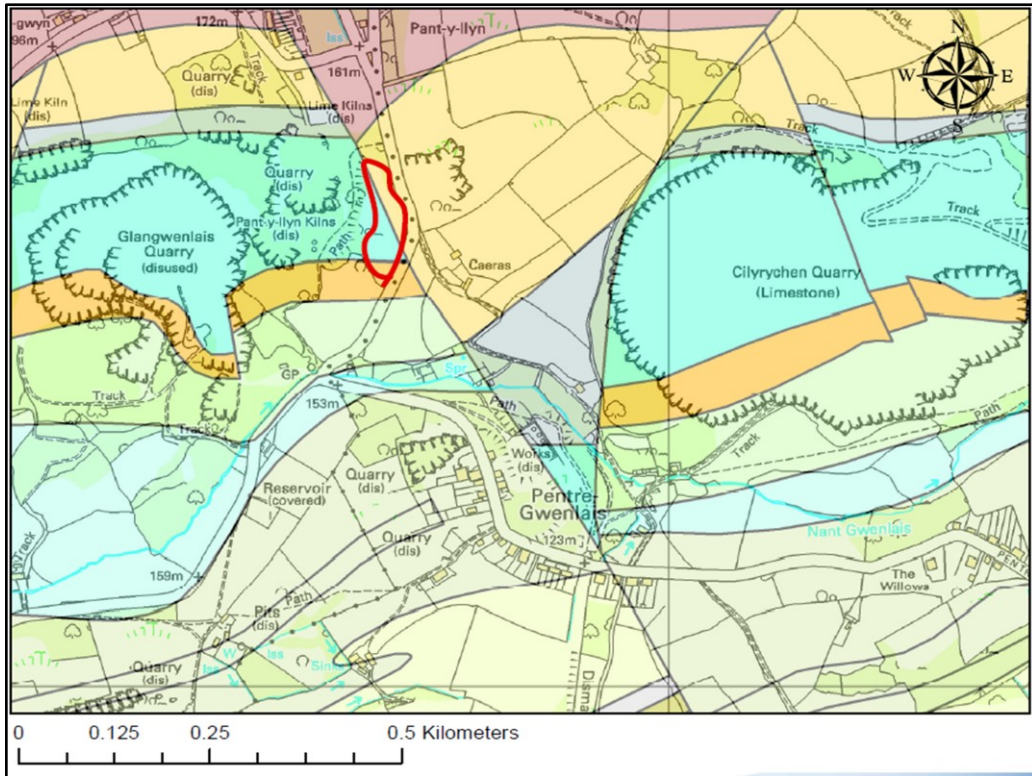


Pan-y-Llyn is highlighted in red.

You can see there are extensive quarrying operations in the area. Some are historic and others are ‘mothballed’

Turn to next slide...



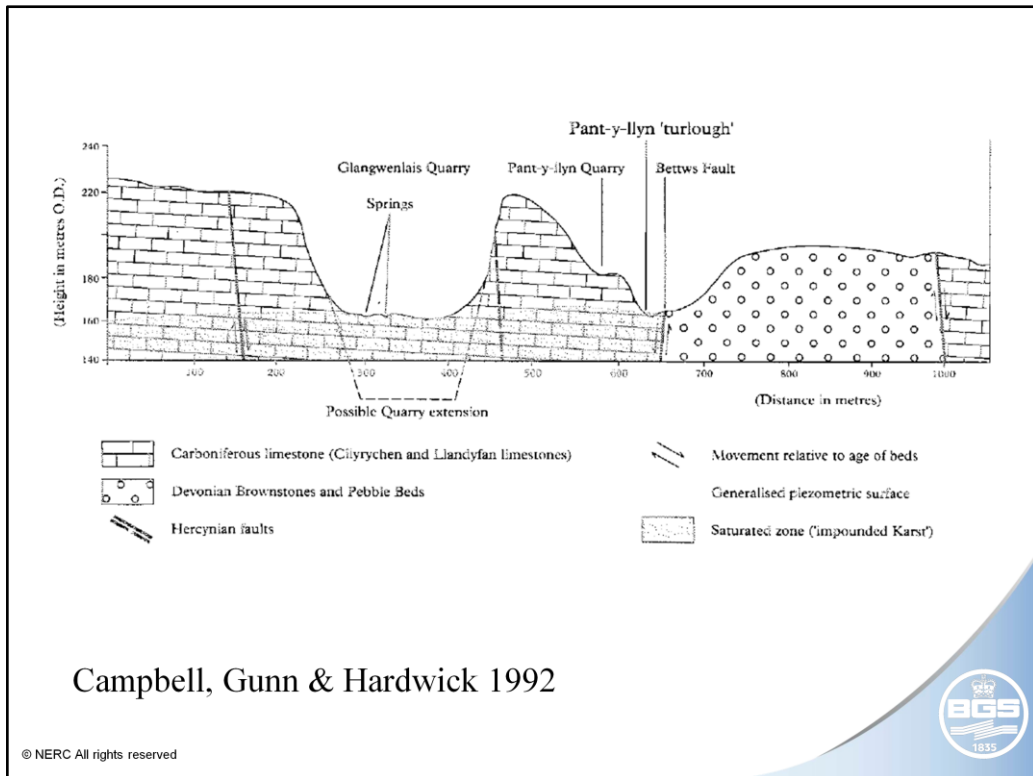


The quarrying is of Carboniferous Limestone (blue) upon which PYL sits.

Quarrying and its potential to change groundwater flow regimes in the limestone was one of the major concerns for this site.

Since then the closest quarry Glangwenlais has been closed and is now a nature reserve...however other quarries in the area are 'mothballed' so not officially closed and could re open.

This enforces the need to understand the baseline hydrogeological condition at PYL



This cross section from Campbell, Gunn and Hardwick shows quite nicely the geological section across PYL.

- The Carboniferous Limestone is faulted against Devonian Sandstones
- The depth of the nearby (although now closed) Glanwenlais Quarry is at or very close to the depth of PYL.



Pant y Llyn 17<sup>th</sup> August 2010

- Much smaller than many Irish examples
- You can see the estavelle in the midground

Photo Credits : Gareth Farr



Pant y Llyn 3<sup>rd</sup> June 2010

Photo Credits : Gareth Farr



Pant y Llyn 15<sup>th</sup> April 2010

n.B we acknowledge the photographs are not in chronological order. They are displayed like this to best show the filling of PYL.

Photo Credits : Gareth Farr

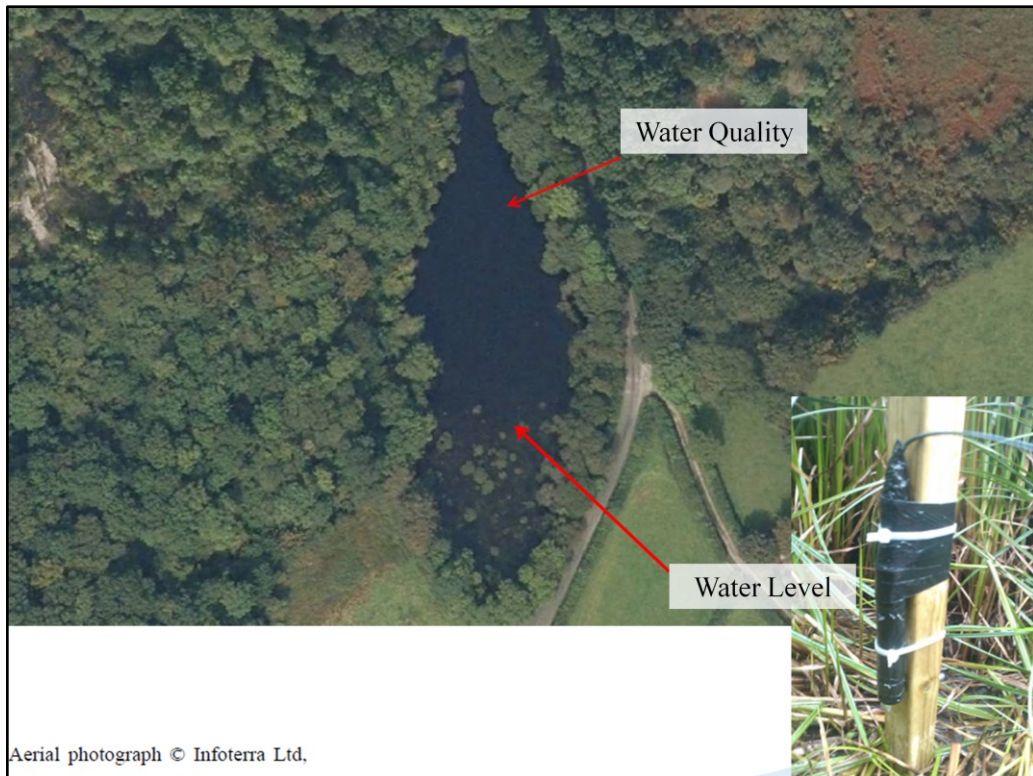


Estavelle – acts as both spring and sink

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Photo Credits: David A Jones / Gareth Farr



Aerial photograph © Infoterra Ltd.

## Water Quality

- Samples as close to the estavelle as possible
- suite of inorganic parameters were reported
- Monthly samples were taken over the period of one year.

## Water level

- Southern part of lake due to exposed nature of the northern part
- problem as the southern part is shallow and the northern part is deepest
- We were aware from the outset that part of our hydrograph would be missing and that some modelling was required to complete this.

We made this decision with some discussion and decided some data was better than no data !

# Water quality

Low N & P

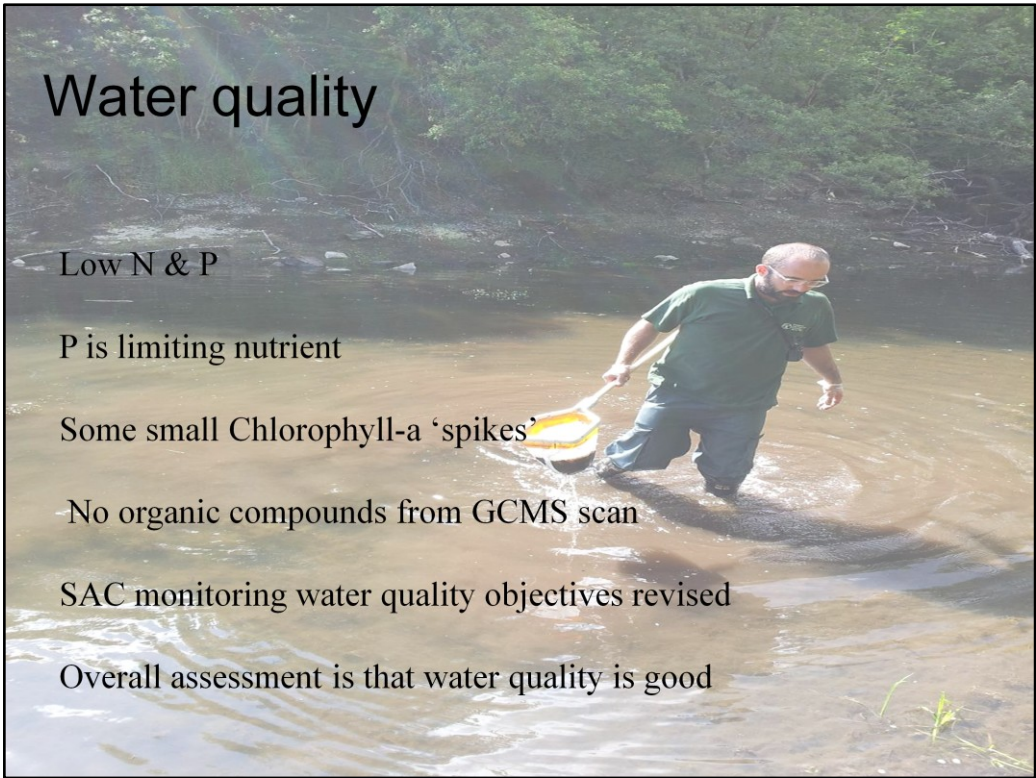
P is limiting nutrient

Some small Chlorophyll-a 'spikes'

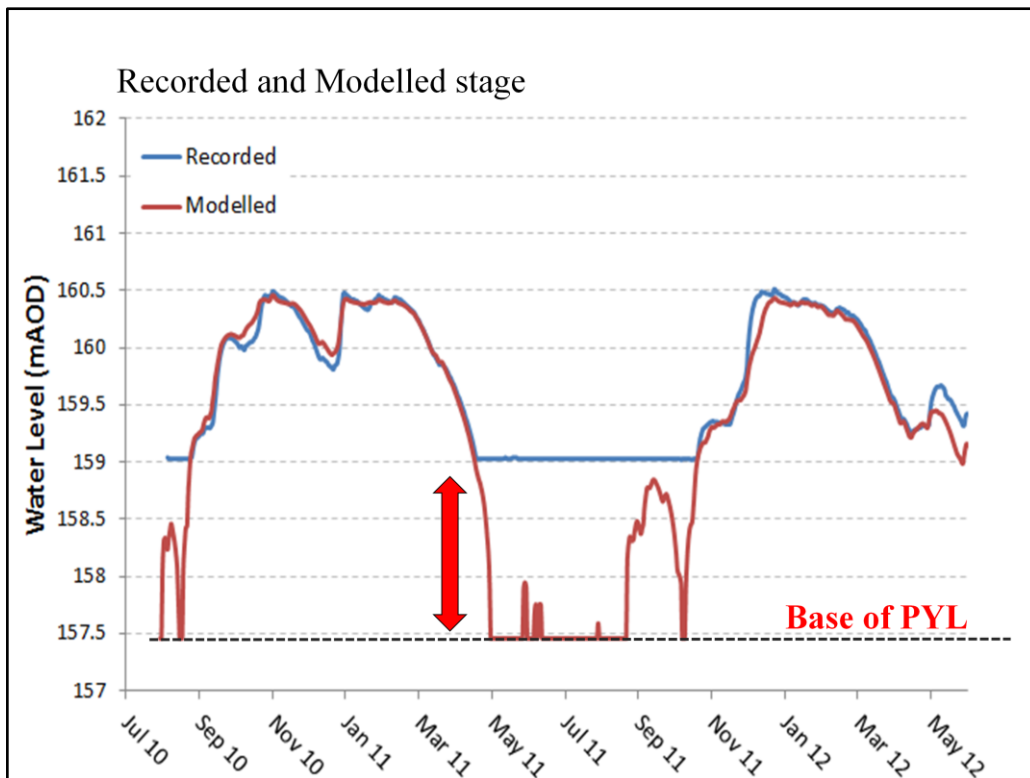
No organic compounds from GCMS scan

SAC monitoring water quality objectives revised

Overall assessment is that water quality is good







Here recorded data for almost 2 years is shown (blue) with modelled data (red) on top. You can clearly see the gap in recorded/modelled data (red arrow).

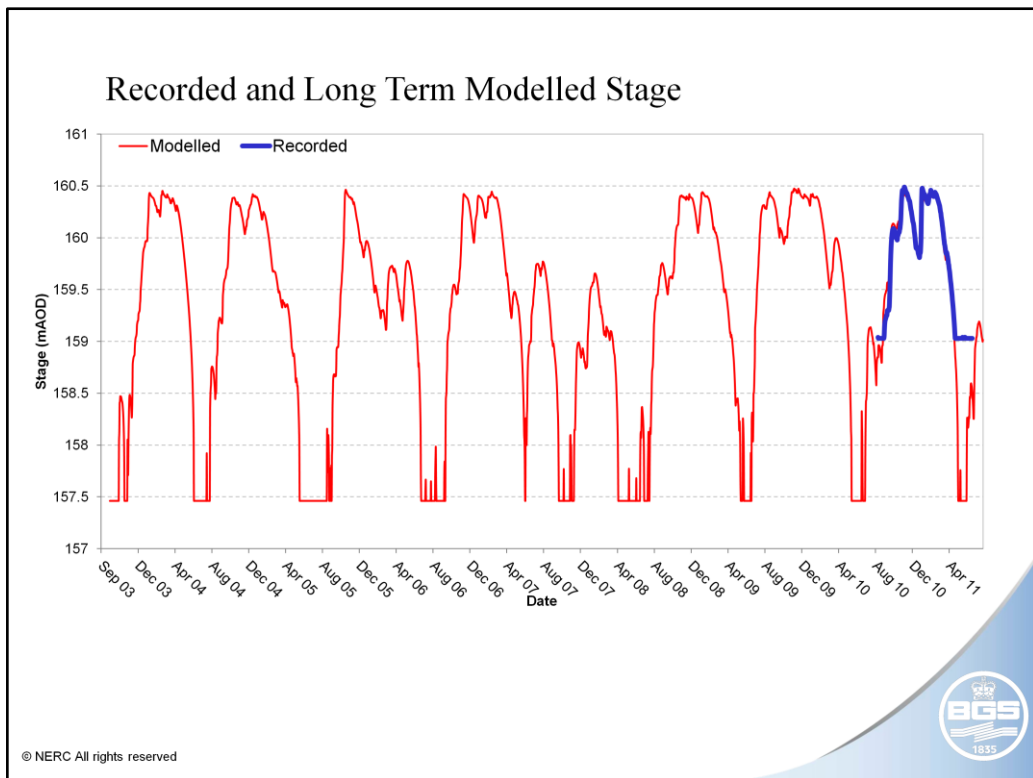
### Model

Developed by Owen Naughton and previously used for modelling Irish turloughs. It is a reservoir 'storage release model' and predicts volume and water level using:

- DTM
- hydrographs
- daily rainfall and evapotranspiration

Model allows us to '**fill in the gaps**' which are created by having to install the data logger in a more shallow part of the lake.

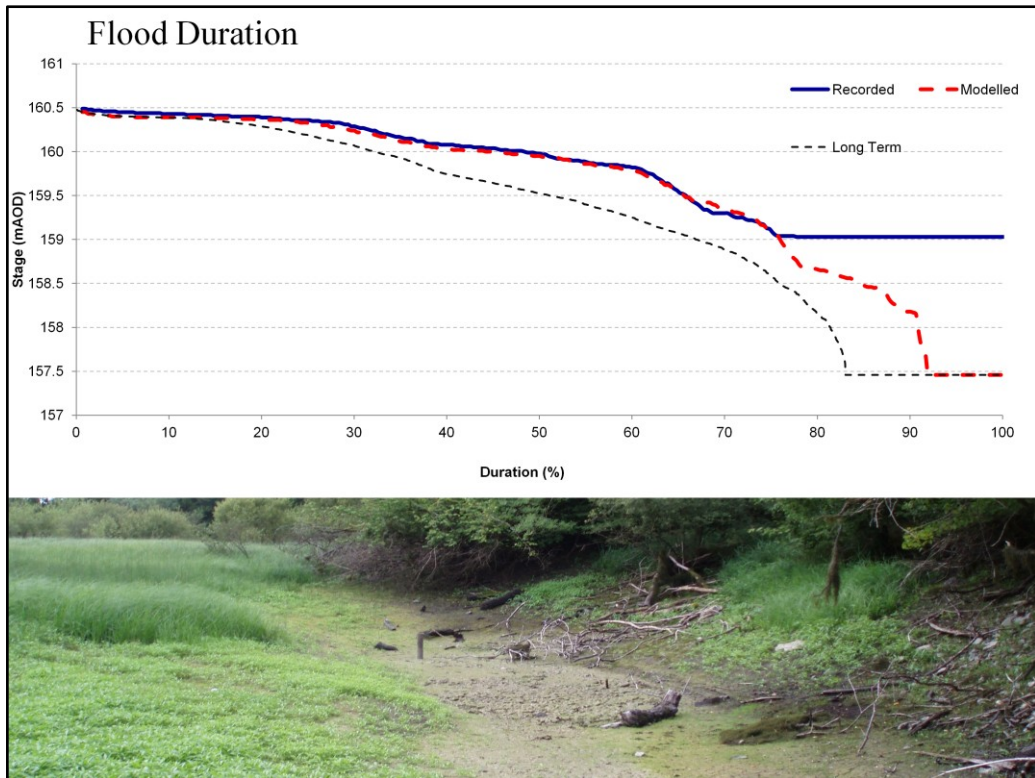
However it assumes constant drainage rate with depth however PYL probably drains slower



## Modelling

Using the Groundwater Level and Rainfall data PYL was back-modelled to 2003

This is important as it allows us for the first time to gain an understanding of relatively long time water levels at PYL.



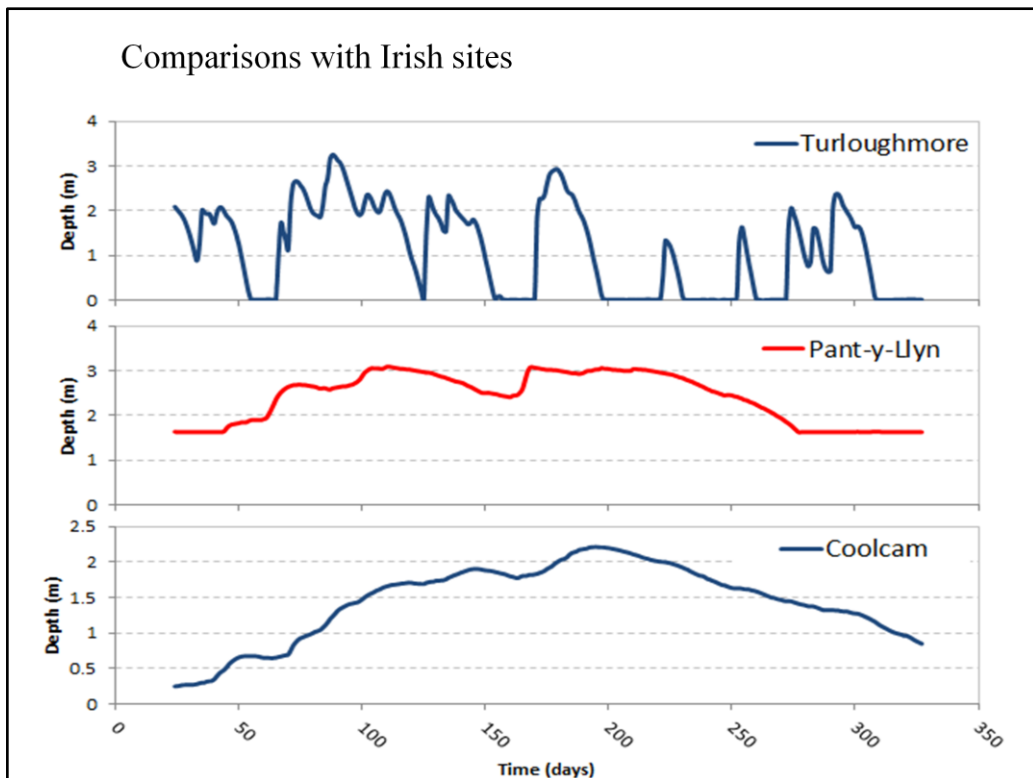
## Flood Duration

The duration that a turlough is flooded has a direct effect on the types of plants that occur within and on the more transitional margins of the turlough.

Now we have measured and modelled the flood duration at PYL we can relate this directly to the vegetation.

This will give us a better understanding for the requirements / tolerances of plant species for flooding.

(Photo; G. Farr. Shows changes of vegetation across the western margin of PYL). The deeper parts are mostly devoid of significant vegetation.



Comparison of Pant-y-Llyn hydrograph with Turloughmore (Co. Clare, Ireland) and Coolcam (Co. Galway, Ireland) (adapted from Naughton, 2011)

**A turlough continuum based on hydrology**

hydrology of turloughs does not naturally group into distinct types.

Range from:

Short duration/rapid response to rainfall --long duration /longer response to rainfall

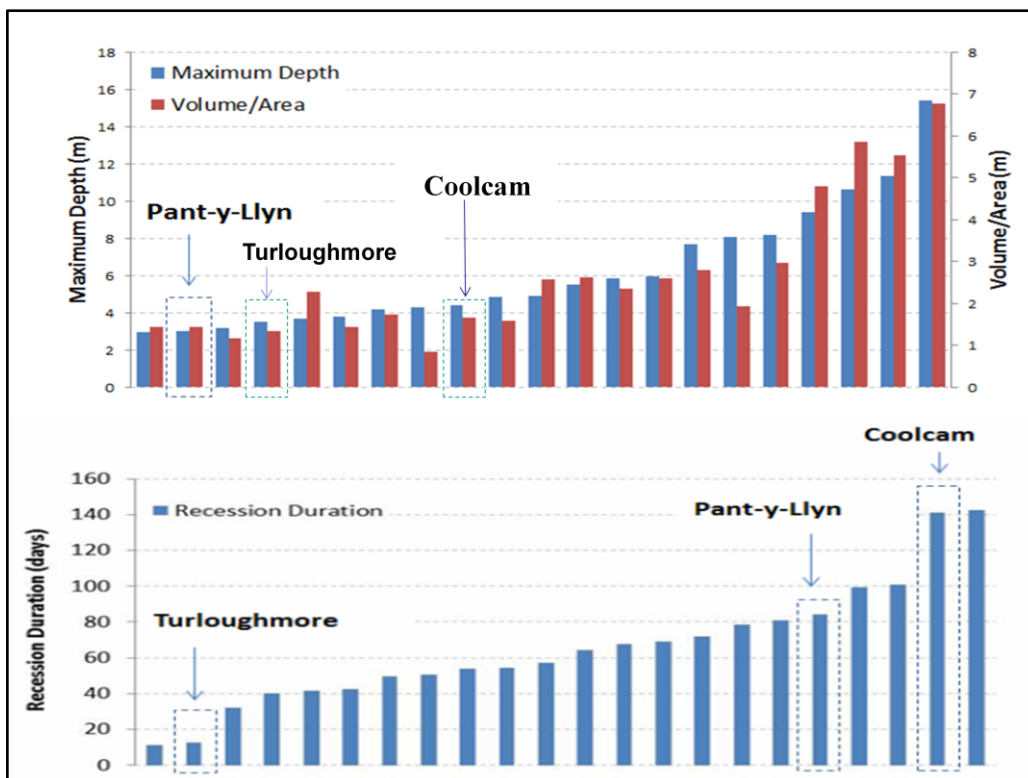
**Two key differences with PYL v Irish sites**

**Size**

PYL is very small. At least an order of magnitude smaller than many Irish sites

**Elevation**

PYL is higher than most if not all Irish turloughs = upland karst turlough. In Ireland 90% are below 150mAOD.



Comparison continued

### Flood Depth

3m depth is very shallow. Irish sites range from 3.0 – 15.4m

### Flood Duration

has slow duration flooding events

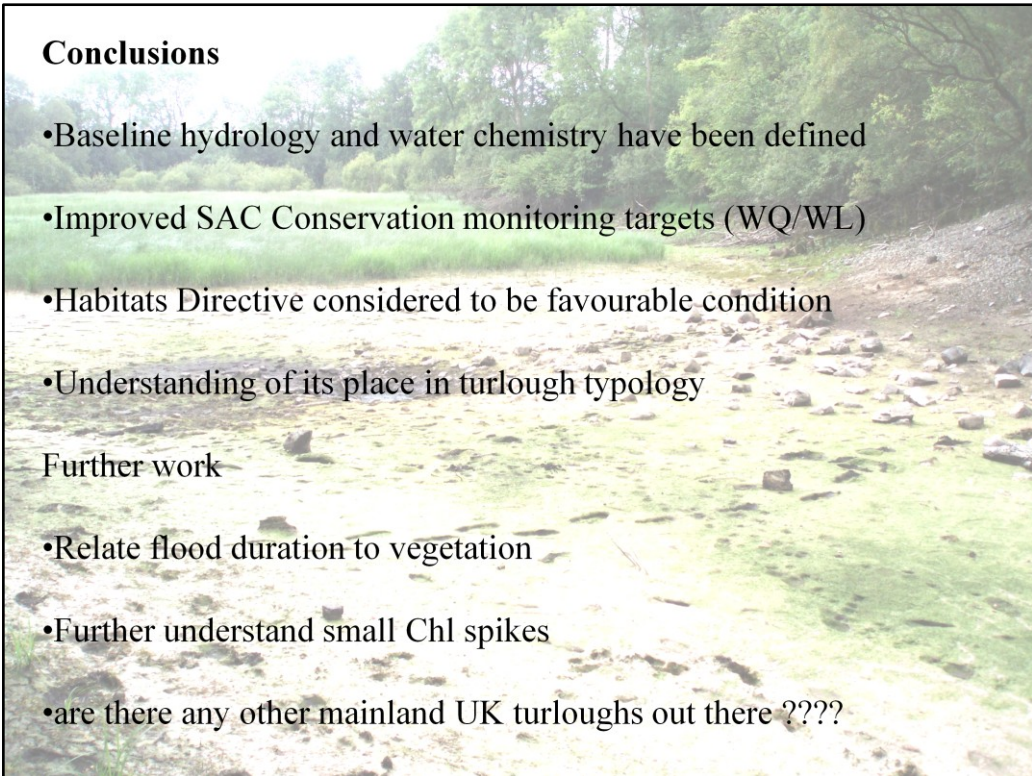
This comparison shows that PYL lies towards the small slow recession end of turlough continuum. Characterised by a slower response to rainfall, smaller size and more shallow depth, when compared to the sites in ON work.

## Conclusions

- Baseline hydrology and water chemistry have been defined
- Improved SAC Conservation monitoring targets (WQ/WL)
- Habitats Directive considered to be favourable condition
- Understanding of its place in turlough typology

## Further work

- Relate flood duration to vegetation
- Further understand small Chl spikes
- are there any other mainland UK turloughs out there ????





**Acknowledgments**

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**Gareth Farr**  
[garethf@bgs.ac.uk](mailto:garethf@bgs.ac.uk)



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See:

Farr, G. Hatton-Ellis, T, Jones D.A, Lambourne, C Bevan, J & Naughton O. 2012. Hydrogeology, Water Quality and Condition of Pant y Llyn – Wales’ only turlough. CCW Science Report No. 12/8/1