# Coastal dune wetlands in England and Wales: Understanding rainfed groundwater dependent ecosystems to underpin conservation management

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*BGS and CEH*

**Groundwater Dependent Ecosystems**

**27 February 2013**

**THE TEAM:**

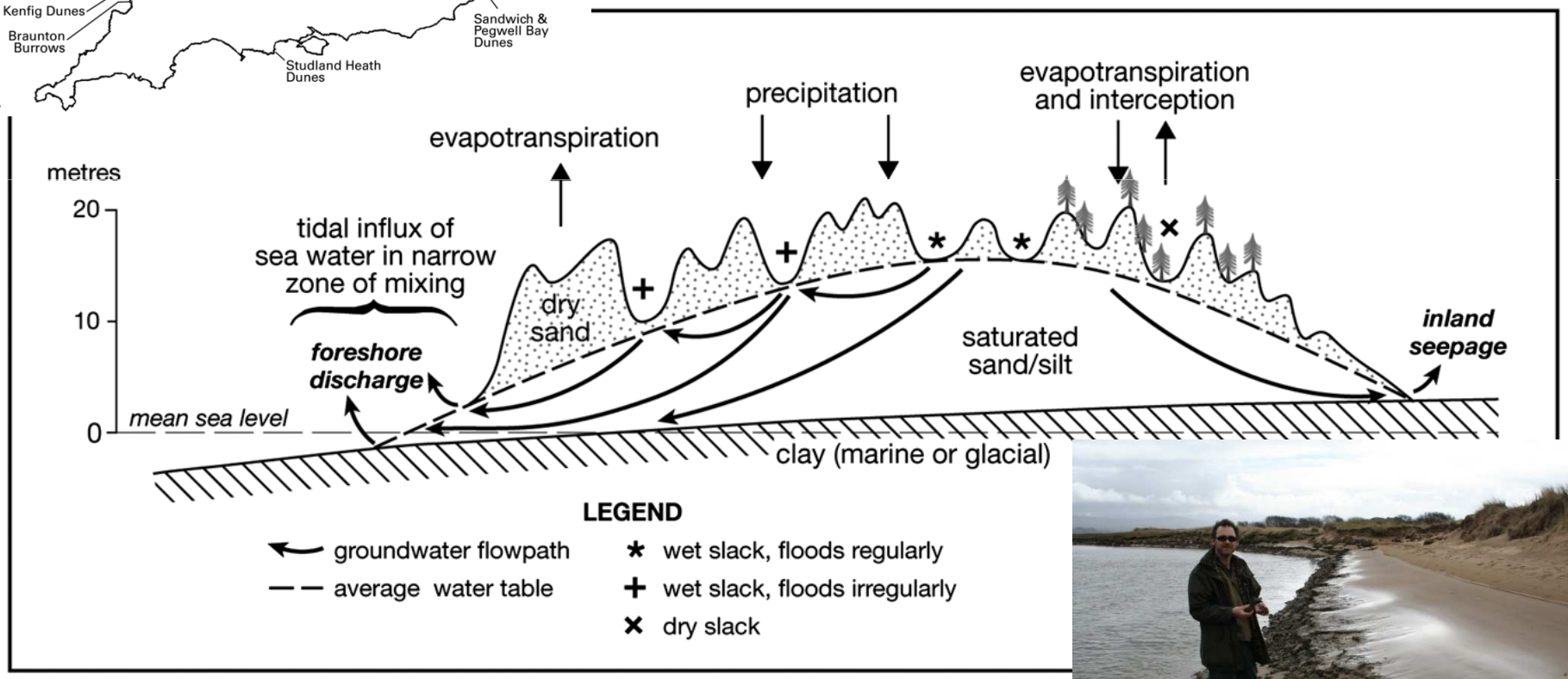
- Centre for Ecology and Hydrology / British Geological Survey
- University of Southampton
- University of Groningen
- Natural England
- Countryside Council for Wales
- Ecological Surveys (Bangor)
- Geological Survey of Northern Ireland
- Sefton Borough Council

**THE COASTAL DUNE WETLANDS:**

- Sandscale – Furness
- Ainsdale – Sefton Coast
- Newborough Warren – Anglesey
- Whiteford Burrows – Gower
- Braunton Burrows – North Devon
- Holme – North Norfolk
- Magilligan – Co. Londonderry

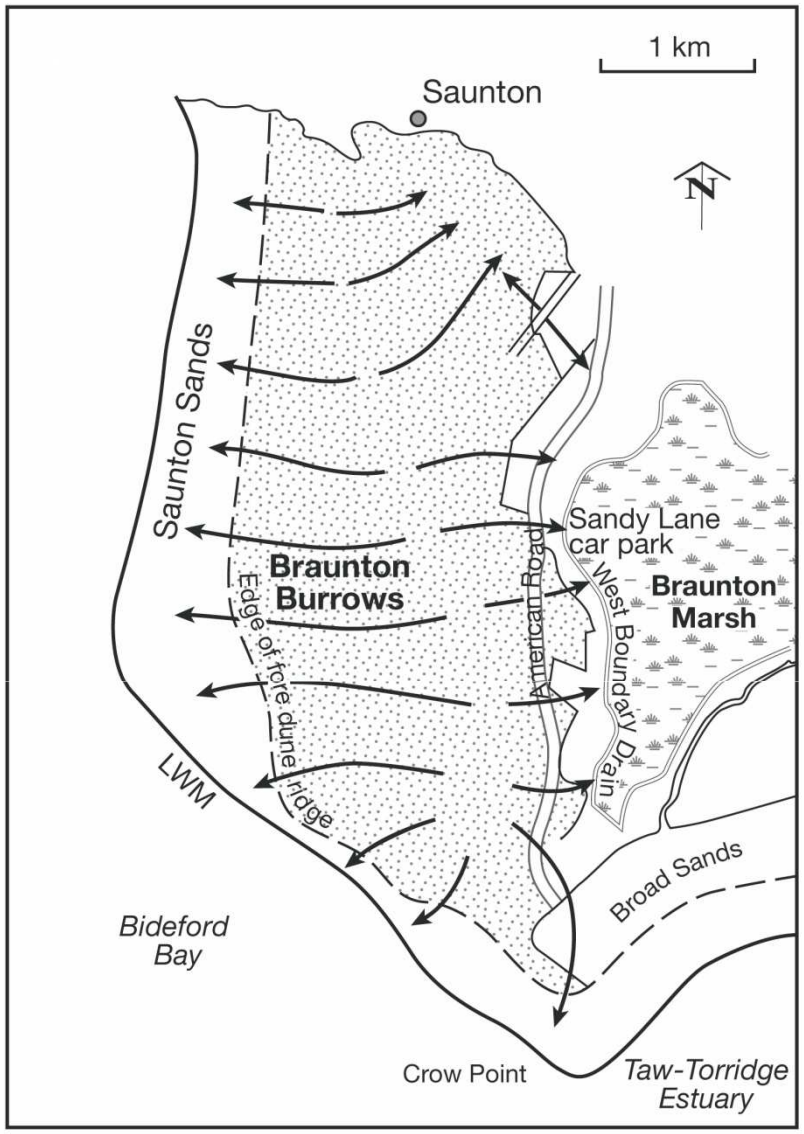
# The coastal dune wetlands of England and Wales

Masters of sand dune hydrology are the Dutch. Their dunes differ in that they are deeper with a saline wedge below and used to filter Rhine water for supply and as coastal defence structures.

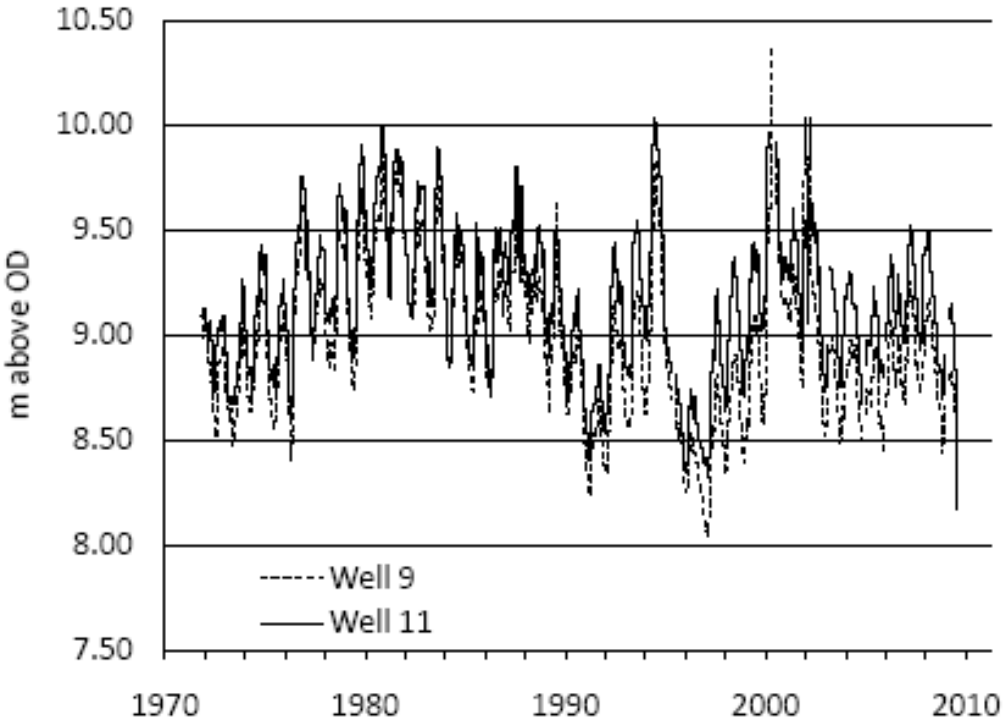

Magilligan is different: thick and very big


I'm not licking any water off this beach!



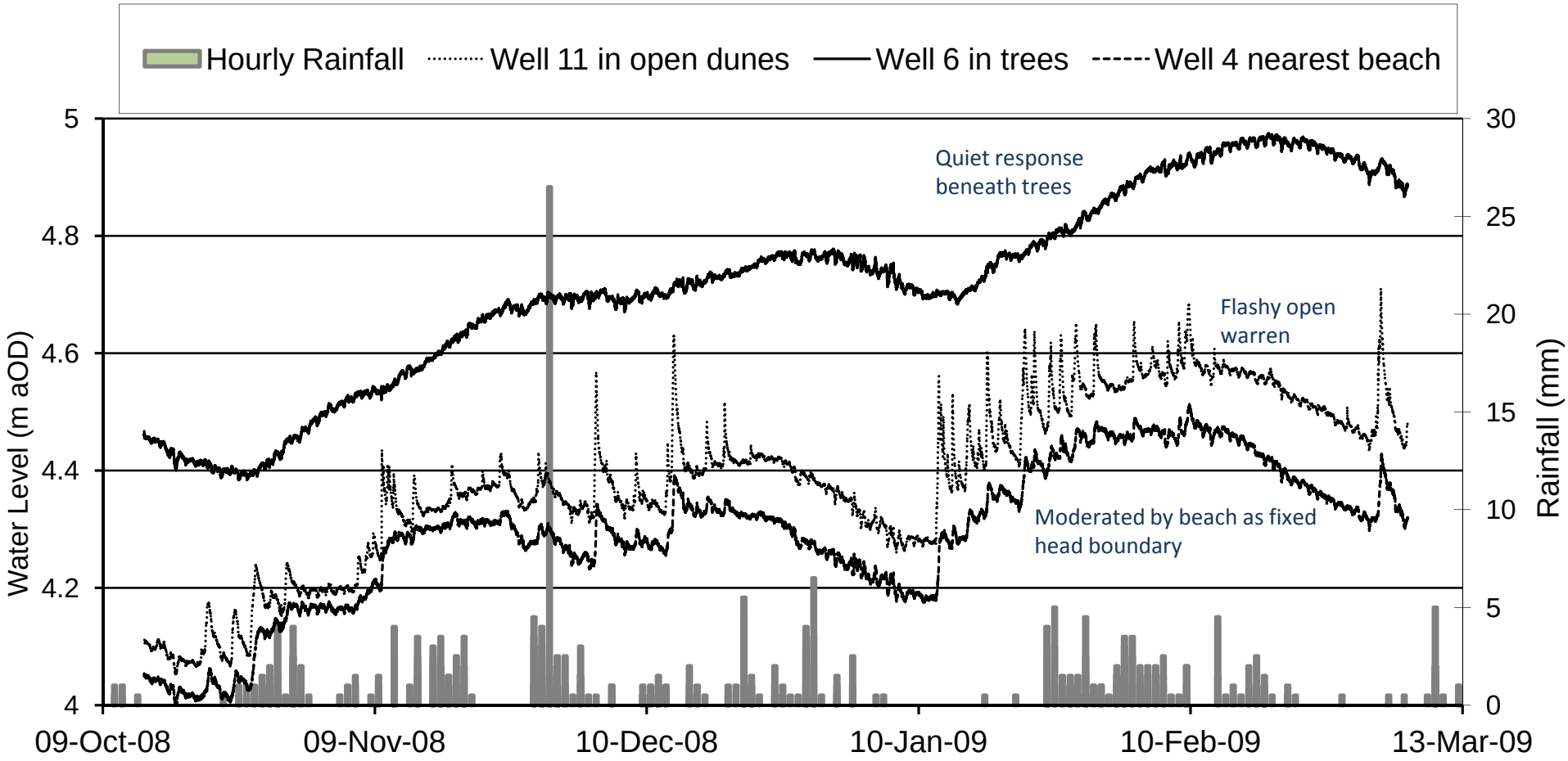

Braunton Burrows coastal dune spit system.
Classic groundwater ridge two thirds way inland towards estuarine marsh at estuary mouth.
Carboniferous Limestone hills to the north...

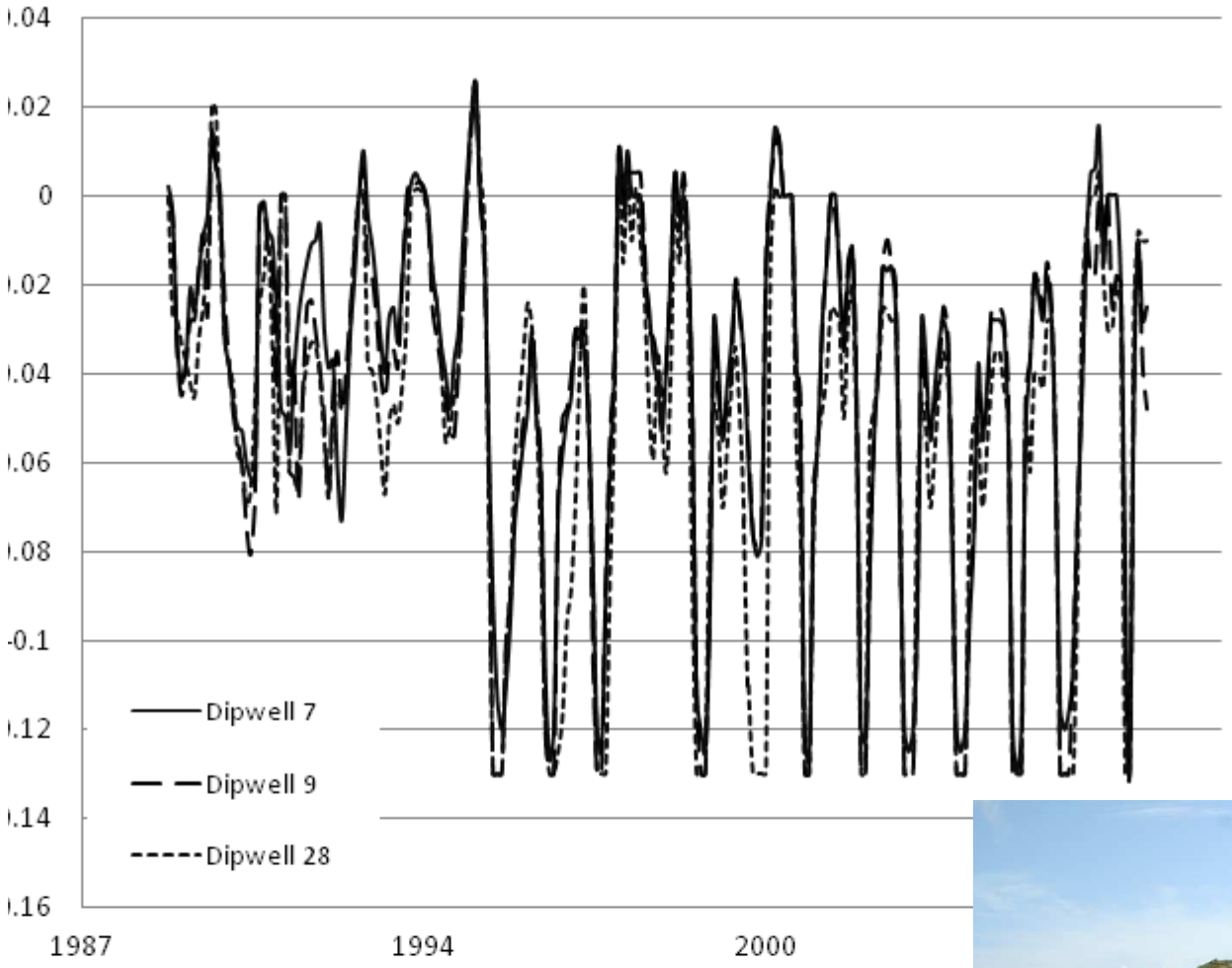
...and a typical long-term dipwell record in dune slacks at Ainsdale, Sefton Coast



**High frequency hydrograph data for Whiteford Burrows, Gower.**

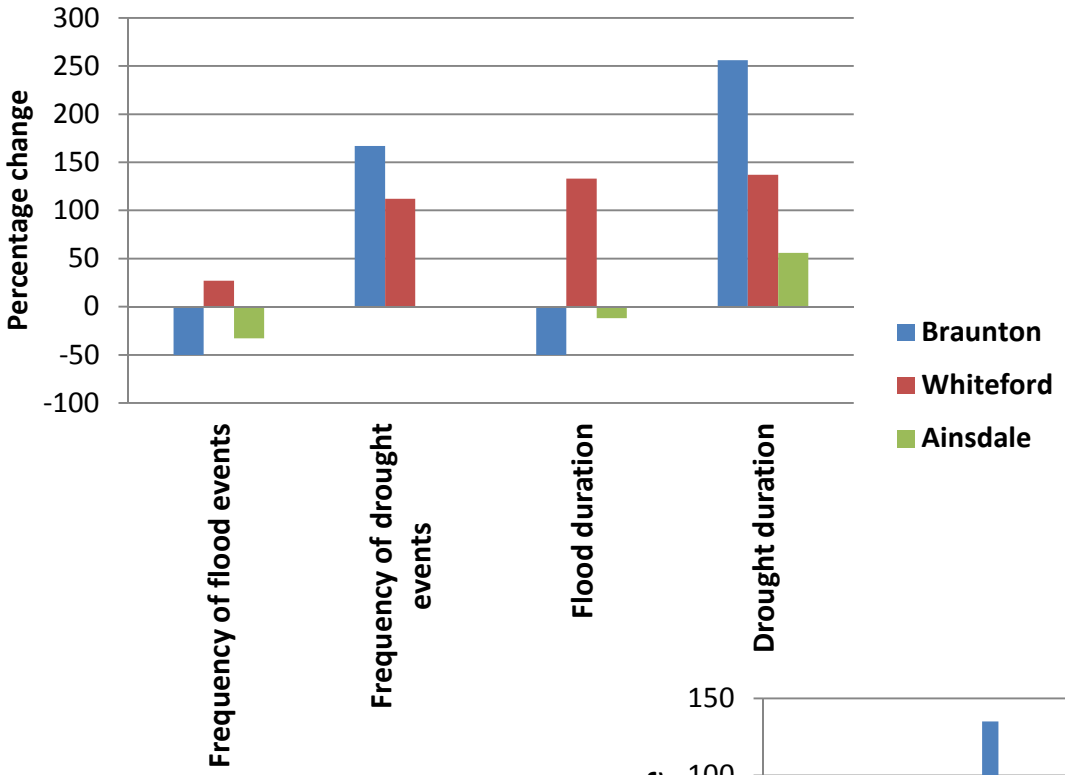
Note the TREES and NOT TREES issue (RED SQUIRRELS or RABBITS?)



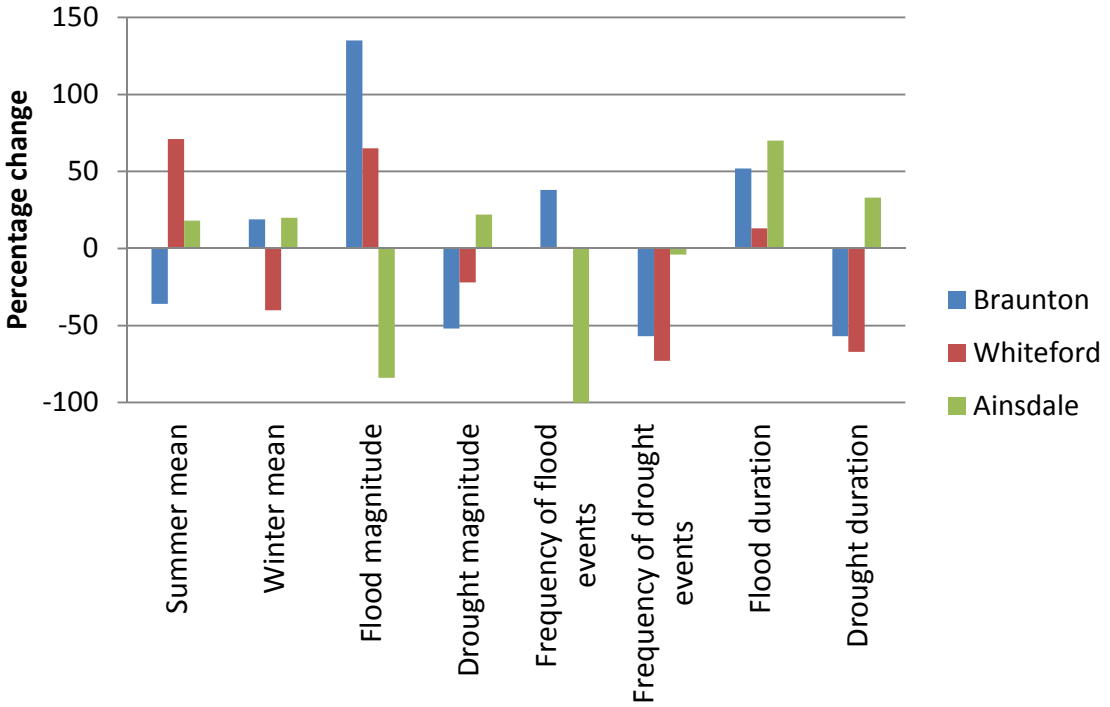


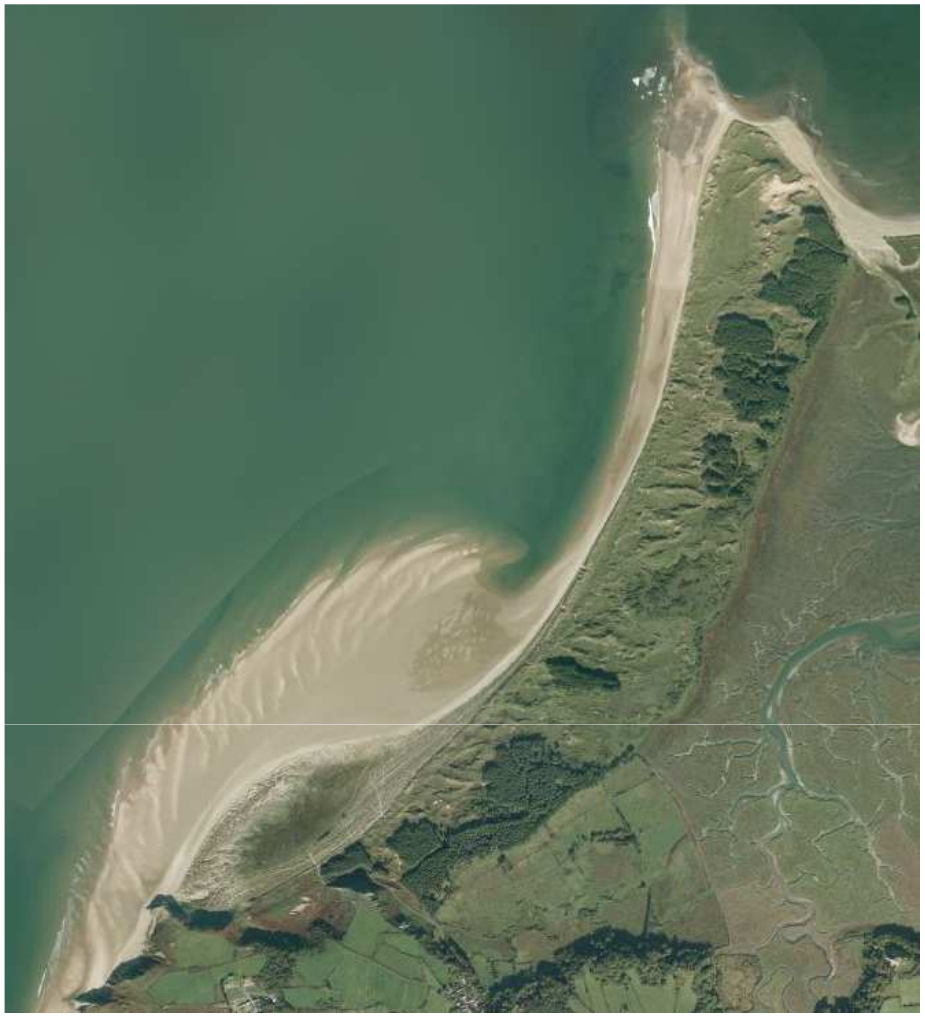

Whiteford Burrows
The great storm of April 1995

# Richter analysis – hydroecological indicators of change

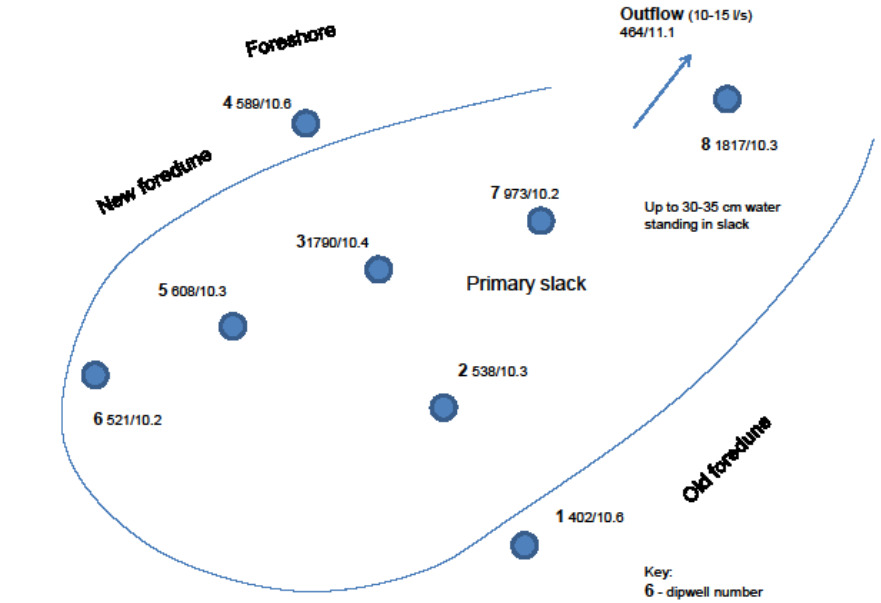



Percentage change due to long term decline in effective rainfall at Braunton Burrows, rapid storm event foreshore erosion at Whiteford Burrows, and long term foreshore erosion at Ainsdale

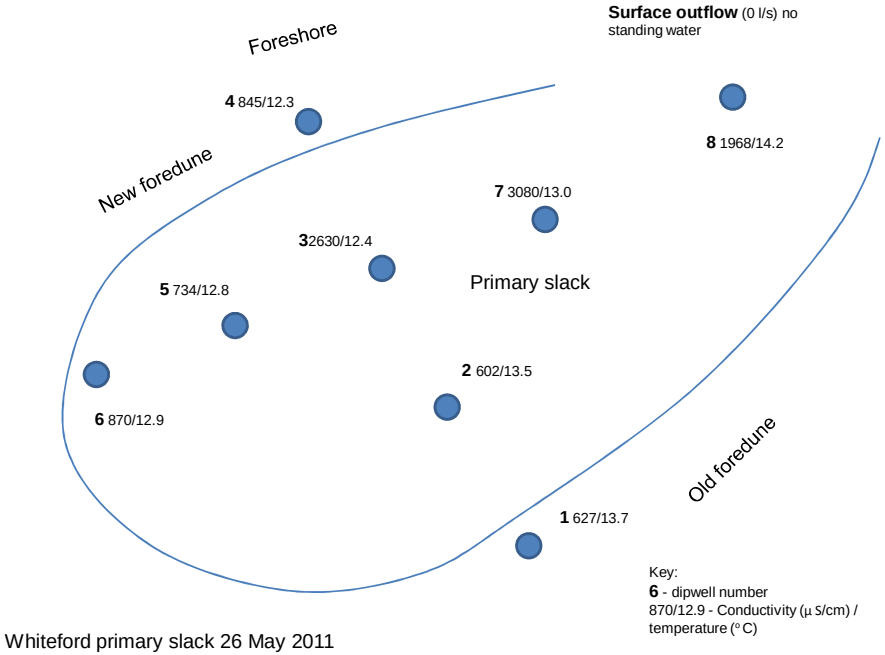




# Whiteford Burrows: monitoring Tors Slack

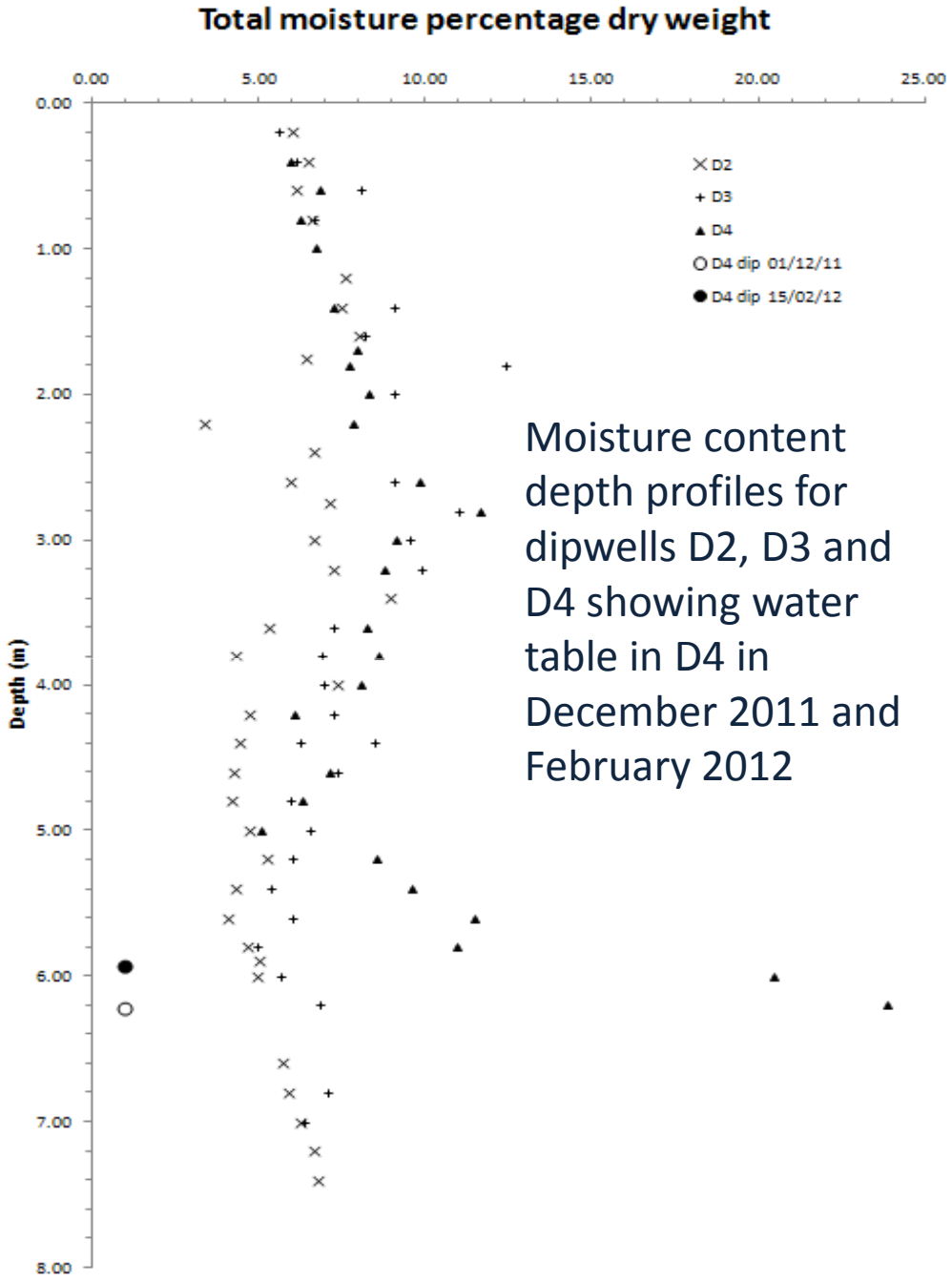



Whiteford primary slack 18 November 2010



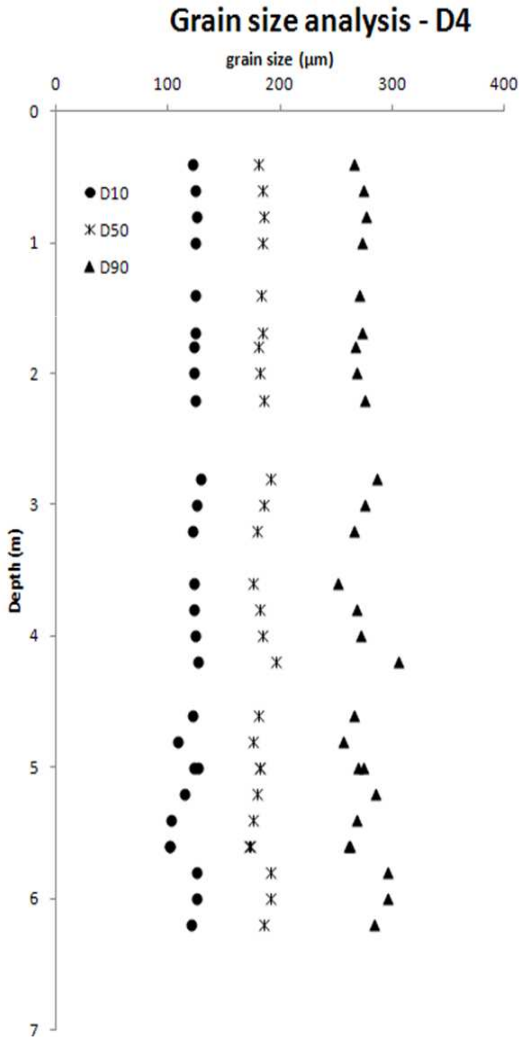

Whiteford primary slack 26 May 2011

# BRAUNTON BURROWS



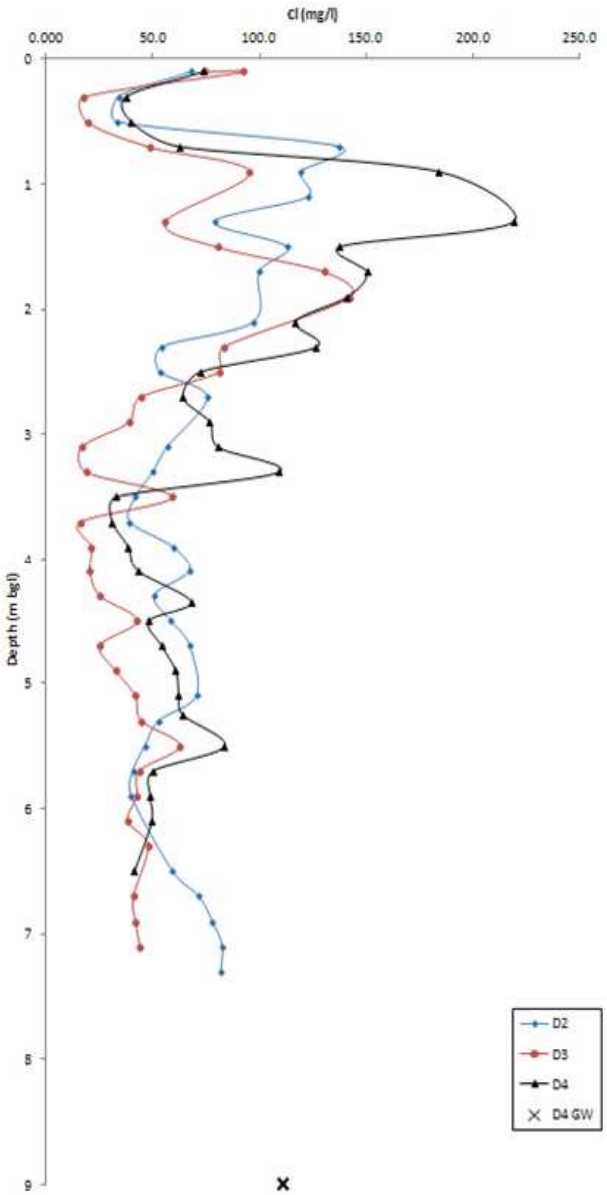

Moisture content depth profiles for dipwells D2, D3 and D4 showing water table in D4 in December 2011 and February 2012

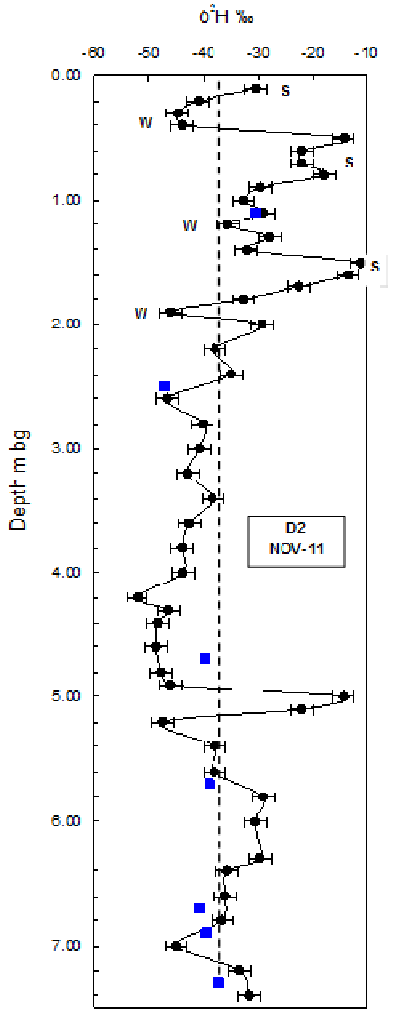
Grain size profile D4. Hazen approximation gives K of ~10 m/d

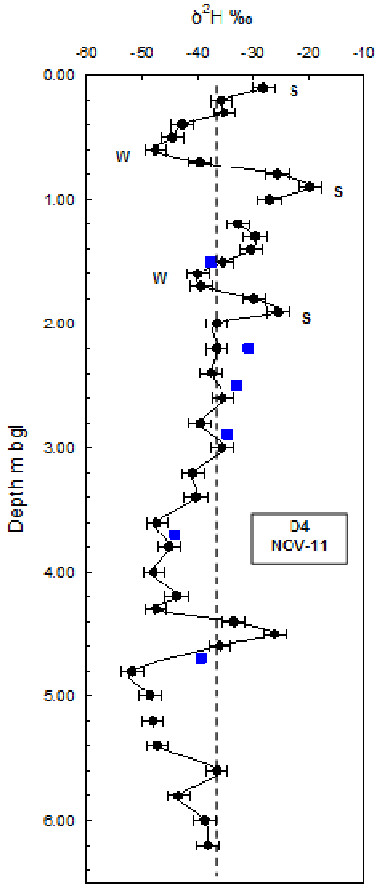


| Site | Date | RWL (mbgl) | Well depth (m bgl) | Temperature (°C) | SEC (µS/cm) | pH | DO (mg/l) | Eh | $HCO_3$ (mg/l) |
|---|---|---|---|---|---|---|---|---|---|
| High dune | | | | | | | | | |
| $D_{new}$ 4 | 15/02/2012 | 5.93 | 9.2 | 10.4 | 804 | 7.9 | 13.4% | 23 | 285 |
| $D_{new}$ 5 | 15/02/2012 | 5.06 | 9.2 | 12.1 | 687 | 8.0 | 6.7% | -107 | 330 |
| Dune slack | | | | | | | | | |
| 1 | 25/02/2010 | top of casing | 1.97 | 7.9 | 719 | 7.3 | 0.4 | 139 | 373 |
| 2 | 25/02/2010 | 0.51 | 1.97 | 8.9 | 597 | 7.5 | 0.23 | 133 | 291 |
| 3 | 25/02/2010 | 0.35 | 1.97 | 8.3 | 835 | 7.7 | 0.15 | 248 | 307 |
| 7 | 15/11/2012 | | | 12.2 | 599 | 7.6 | 0.5 | 148 | 306 |
| Bedrock Borehole (Pilton Mudstone Formation) | | | | | | | | | |
| GC | 14/11/2012 | artesian | 24 and 63 | 12.0 | 877 | 7.2 | 0.9 | 23 | 254 |

Braunton Burrows



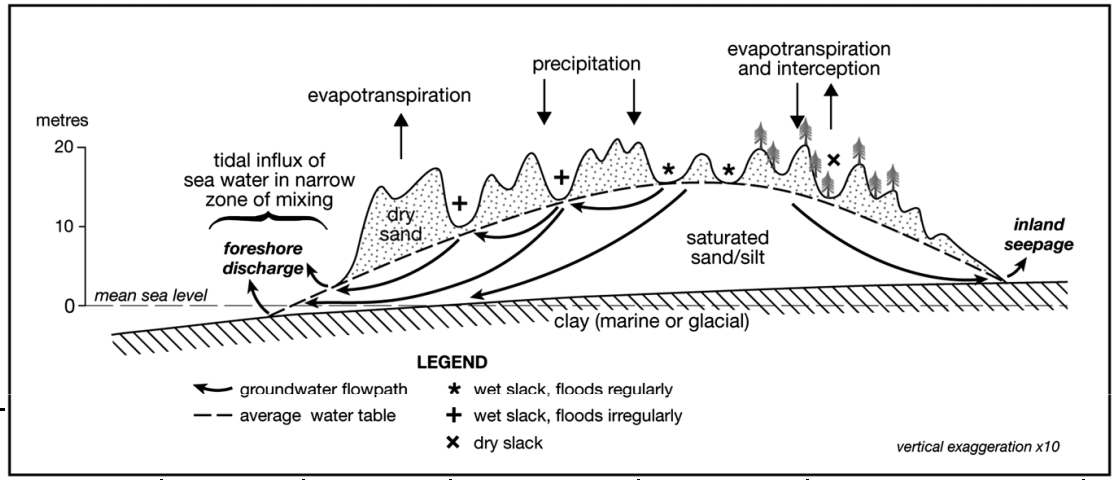




L and $\delta^2H$ profiles. Peaks, if annual, suggest downward piston flow of ~1 m/yr

**Problem:** need downward piston flow of ~2 m/yr to shift all the effective rainfall down the unsaturated zone with porosity of 30% and moisture content of 13%.

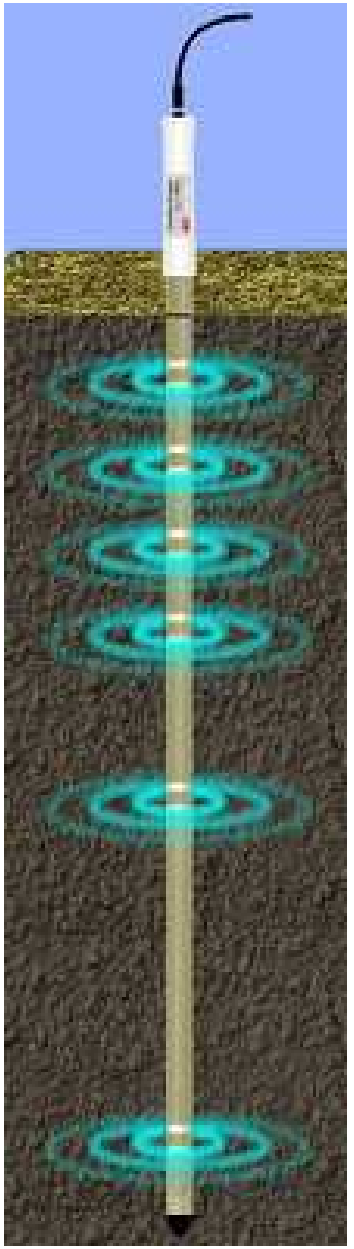
**Cause**: perturbation of climate with wet summers and dry winters.

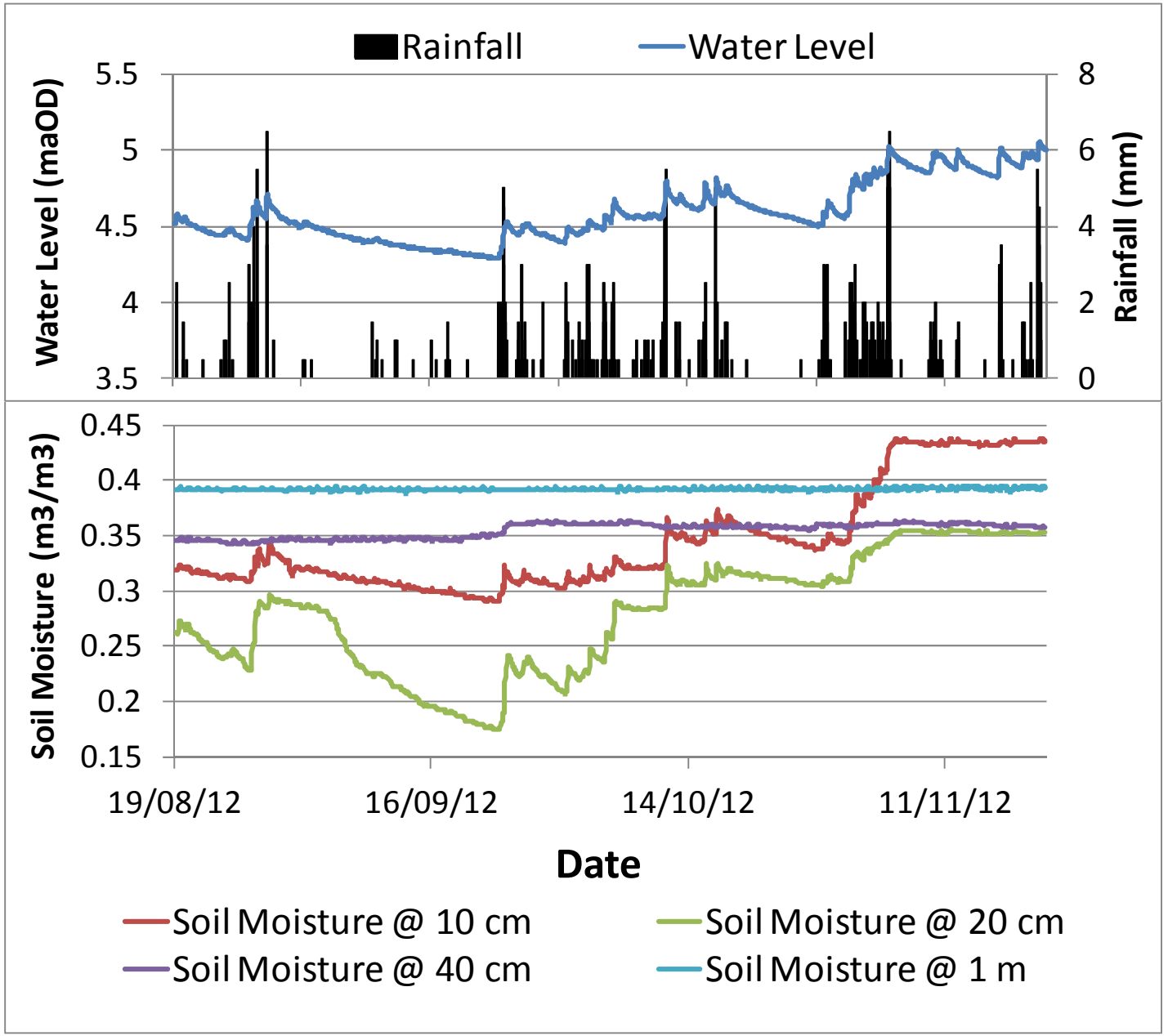



Age dating with SF6. CFC not used as water in vadose and saturated zones tends to be depleted in oxygen and CFC may have become degraded.

| Dipwell | Site | Eastings | Northings | Sampling Date | $SF_6$ (fmol/l) | Mean residence time 1.5 ccSTP/L EA ± 2 years |
|---|---|---|---|---|---|---|
| 1 | Dune slack | 245849 | 135363 | 25/02/2010 | 2.65 | (2004) 6 |
| 2 | Dune slack | 245222 | 135738 | 25/02/2010 | 2.49 | (2003) 7 |
| 3 | Dune slack | 244765 | 135888 | 25/02/2010 | 2.73 | (2005) 5 |
| $D_{new}4$ | High dune | 244902 | 135684 | 15/02/12 | 1.76 | (1996) 16 |
| $D_{new}5$ | High dune | 244760 | 135731 | 15/02/12 | 2.06 | (1999) 13 |
| GC | Bedrock | 24648 | 13748 | 14/11/12 | 1.310 | (1992) 20 |

# Moisture profiling –Braunton Burrows




Rainfall
Water Level
Water Level (maOD)
Rainfall (mm)
5.5
5
4.5
4
3.5
8
6
4
2
0
Soil Moisture (m3/m3)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
19/08/12
16/09/12
14/10/12
11/11/12
Date
Soil Moisture @ 10 cm
Soil Moisture @ 20 cm
Soil Moisture @ 40 cm
Soil Moisture @ 1 m

## So why monitor and measure?

To advise national strategy for conservation management.

## What has it all got to do with the ecology anyway?

Plant species according to pH, depth to water, flooding, nutrient supply etc.

Hydrogeological and hydrological enquiry underpins ecological understanding and informs the managers.