The role of groundwater in supporting eco system and cultural services in North West England

https://www.liverpoolecho.co.uk/news/local-news/gallery/merseyside-air-2010-pics-colin-3247504

Dr Derek Clarke, University of Southampton, UK

UNIVERSITY OF Southampton

https://iah2019.adabyron.uma.es/event/1/contributions/674/

22-27 September 2019
Trade Fairs and Congress Center (FYCMA)
Europe/Madrid timezone

The role of groundwater in supporting eco system and cultural services in North West England

27 Sep 2019, 11:45

Oral | Topic 6 - Groundwater,... | Parallel

Speaker

Dr Derek Clarke (University of Southa...)

Description

This paper describes the importance of groundwater to the coastal habitats of the sand dunes in North West England. The sand dunes support an aquifer that extends for 20km between Liverpool and Southport. They provide a range of natural habitats, sites of special scientific interest and a number of nature reserves (https://www.sefton.gov.uk/around-sefton/coast-countryside.aspx). It also supports cultural services (landscape, tourism, art) and international quality recreation facilities such as the famous Royal Birkdale Golf Club and others. Groundwater levels in the sand dunes have been monitored monthly since 1972 and at 30 minute intervals since 2010. Seasonal changes in recharge cause groundwater levels to rise and fall 0.5-1.0m between winter and summer. The long term observations suggest a gradual lowering of water levels of 0.15m over the last 45 years, despite the sea level boundary rising by 0.1m over the same period (https://www.ntslf.org/products/sea-level-trends).

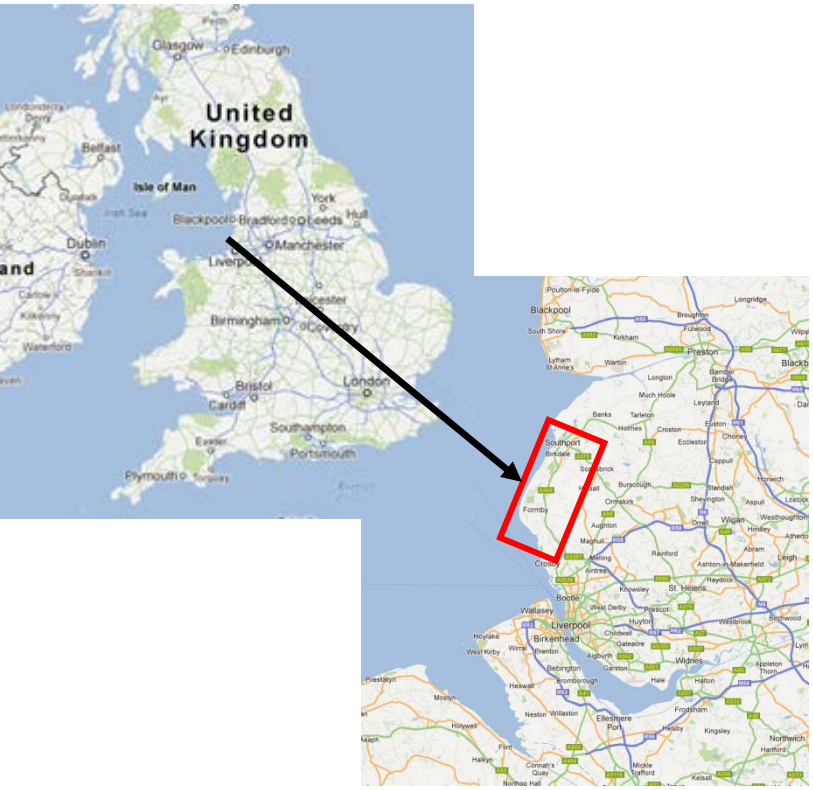
The importance of groundwater in the various nature reserves is demonstrated by the emergence of fresh water ponds each winter. These areas are extremely biodiverse, supporting up to 100 plant species per square meter (Houston, 2008, Natural England, 2014) together with IUCN Red List species (www.iucnredlist.org/) such as the Natterjack Toad (Epidalea calamita).

Concerns have been raised that climatic change and human actions such as agricultural drainage in the adjacent areas may adversely affect the groundwater levels which in turn may cause breeding ponds to dry up and the loss of biodiversity (Curreli et. al., 2013). Another impact is a reduction in the natural sub irrigation of the fairways and greens of the numerous golf courses in the area.

Various 1D and 2D groundwater models have been developed to explain the annual and long-term changes in ground water levels (Clarke and Sanitwong, 2009, Abesser et. al., 2017). These have been tested against the 45+ years of monitoring data. Information from this modelling work is enabling conservation planners to identify areas of the dune system that will be of concern to managers. Coastal processes are creating new land that will become suitable for the creation of new nature reserves. A new approach to conservation may become necessary, where ecosystems relocate spatially, and conservation management will have to become more dynamic.

Abesser, C., Clarke, D., Hughes, A. G., & Robins, N. S. (2017). DOI: 10.1007/s11852-017-0525-5
Clarke, D. and Sanitwong Na Ayuttaya (2009). DOI:10.1007/s11852-009-0066-7
Curreli, A., Wallace, H., Freeman, C., Hollingham, M., Stratford, C., Johnson, H. and Jones, L. (2013). DOI: 10.1016/j.scitotenv.2012.11.035
Houston, J. A. (2008). Management of Natura 2000 habitats. 2190 Humid dune slacks. European Commission.
Natural England (2014). Survey and analysis of vegetation and hydrological change in English dune slack habitats. Annex 2 - Site report for Sefton Coast: Ainsdale NNR, Ainsdale LNR, Birkdale Hills LNR. publications.naturalengland.org.uk/file/6635636215775232

Ainsdale location map



25km x 5km coastal zone of sand dunes

Unconfined aquifer resting on clay

Sand dune ridges up to 25m high with wet depressions

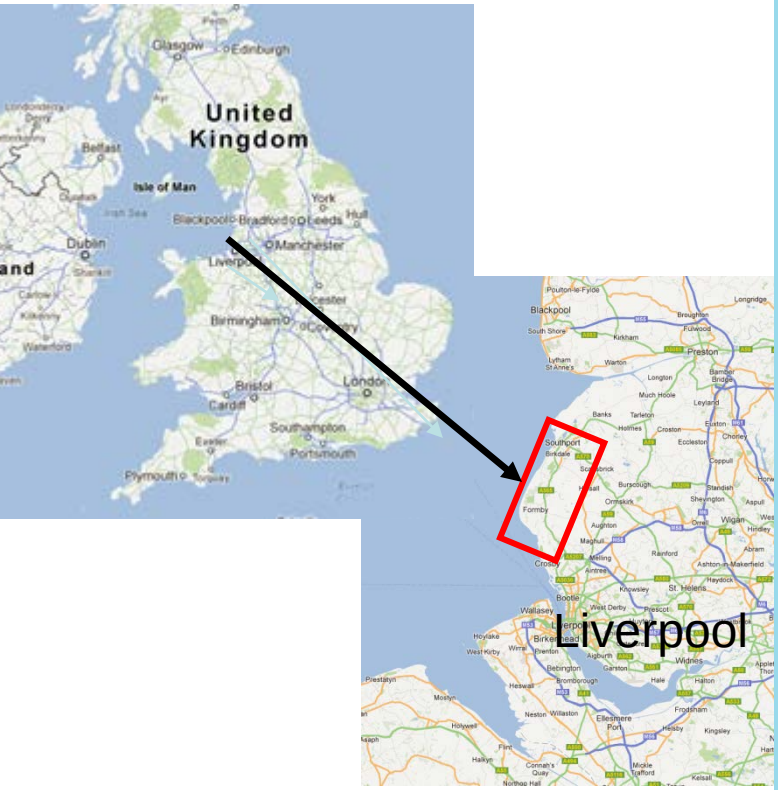
High biodiversity - 10 SSSI's and 4 Nature Reserves

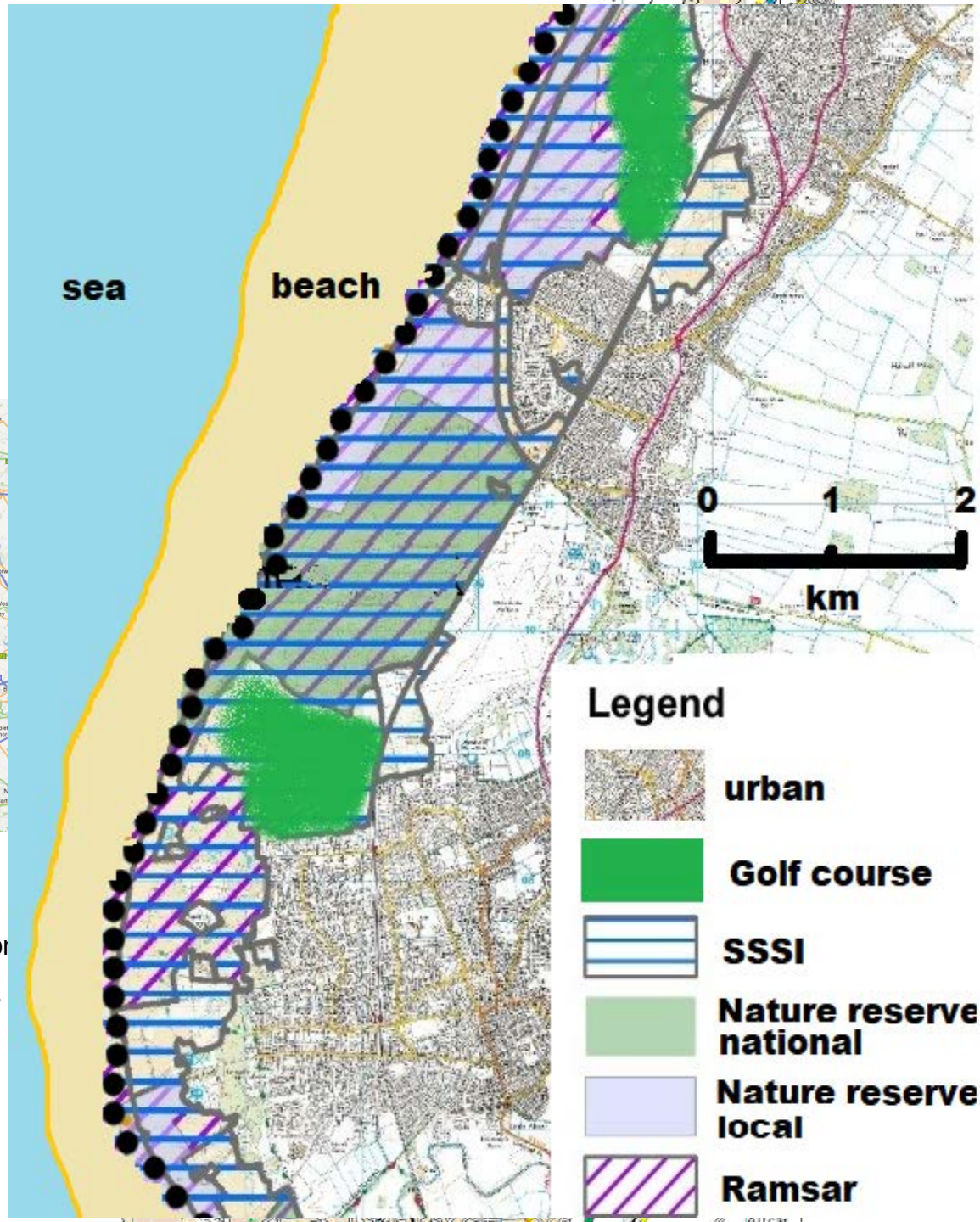
Drier areas are used for Golf courses, urbanisation.

Heavy pressure on land use.

Coastline is eroding 10-15m/year

Ainsdale location map





25km x 5km coastal zone of sand dunes

Unconfined aquifer resting on clay

Sand dune ridges up to 25m high with wet depressio

High biodiversity - 10 SSSI's and 4 Nature Reserves

Drier areas are used for Golf courses, urbanisation.

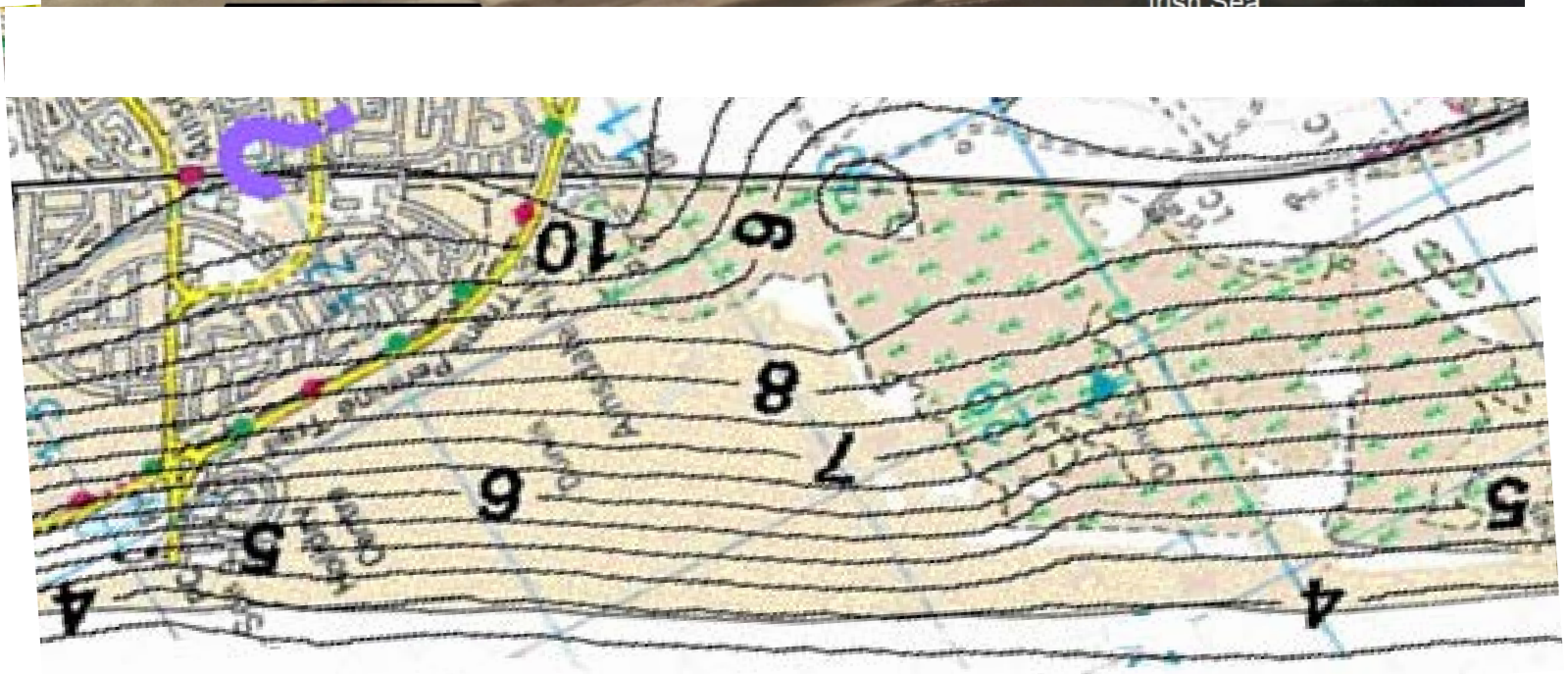
Heavy pressure on land use.

Coastline is eroding 10-15m/year

Damp Dune slacks – high biodiversity

over 100 plant species per sq.metre

Water table monitoring points and contour map



Annual Rainfall 840mm

Annual PET 750mm

Annual AET 450-600 mm

GW recharge ~300mm


Image Landsat / Copernicus

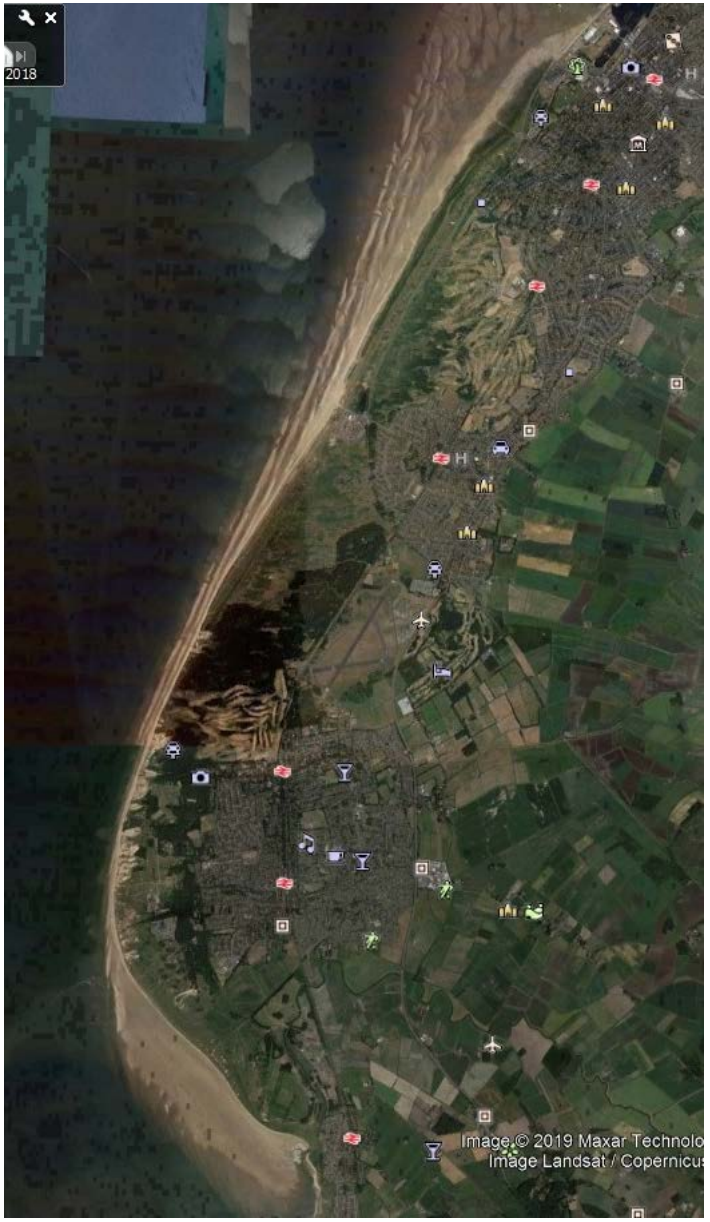
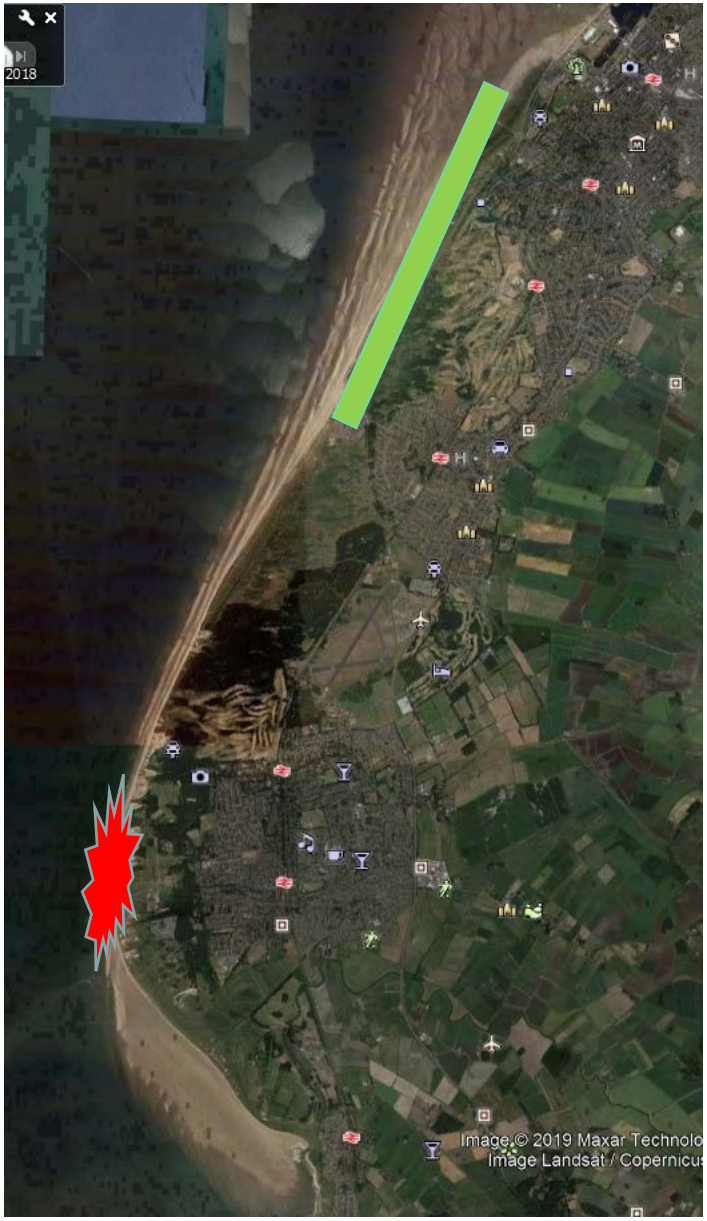
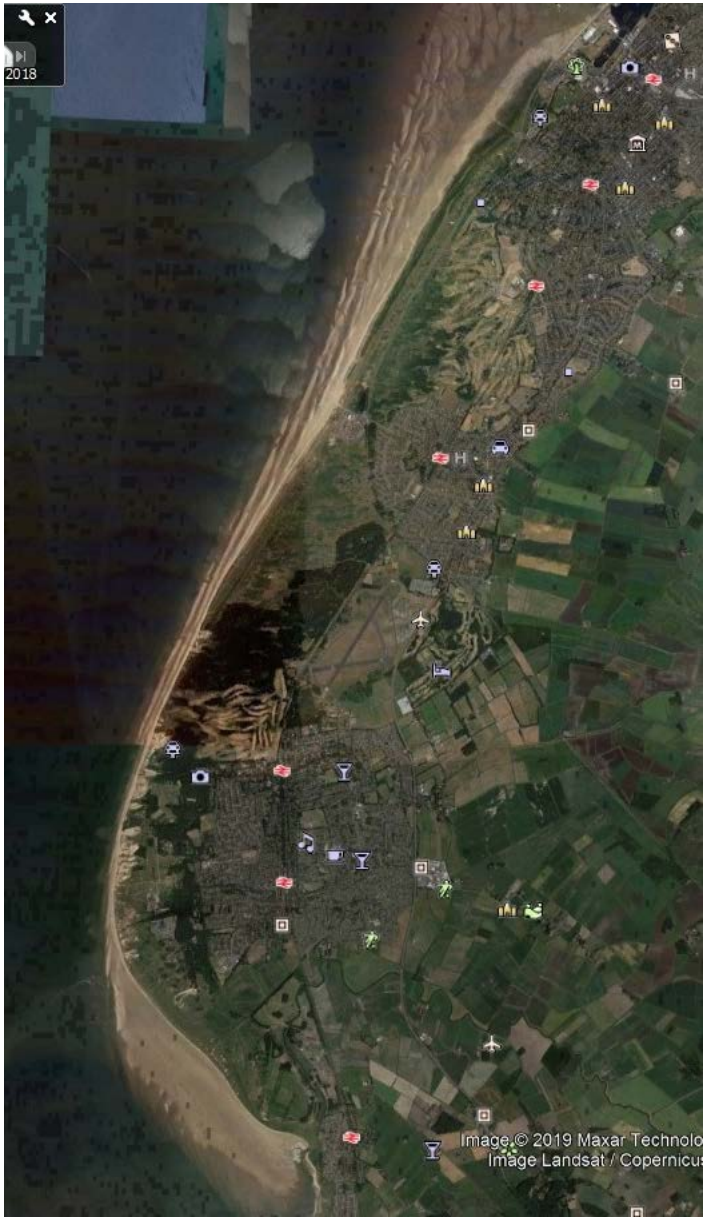
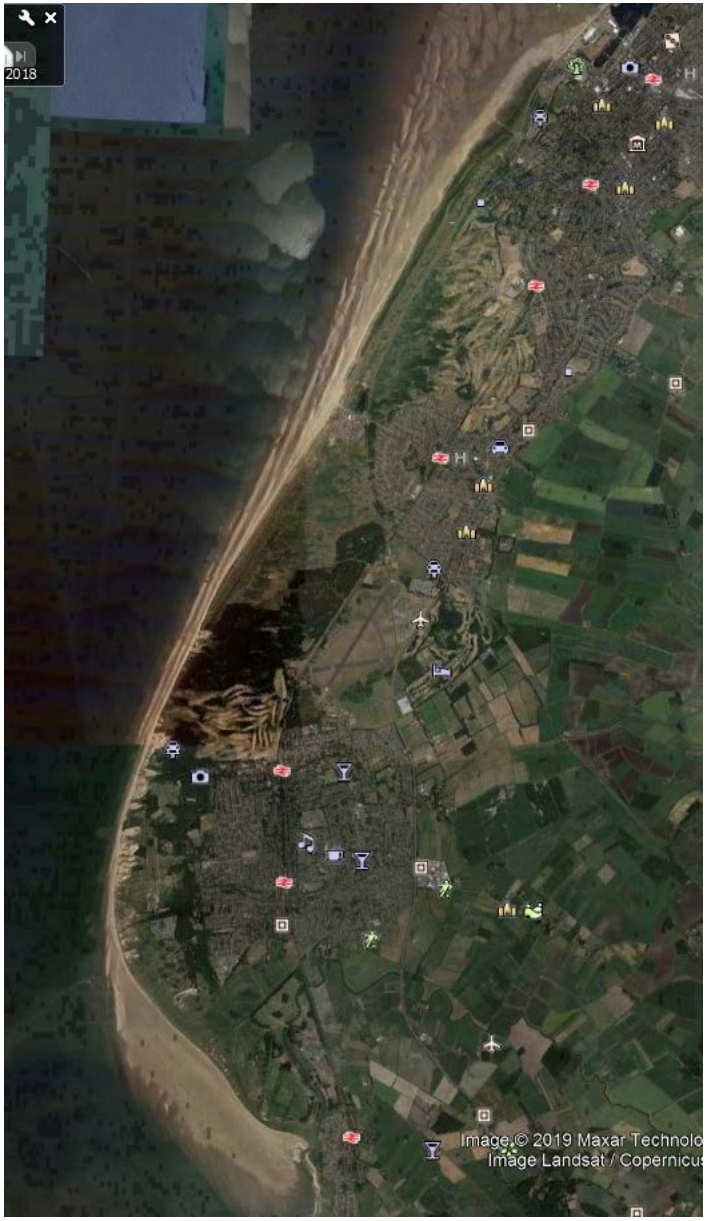

2018
Image © 2019 Maxar Technolo
Image Landsat / Copernicus


Image Landsat / Copernicus

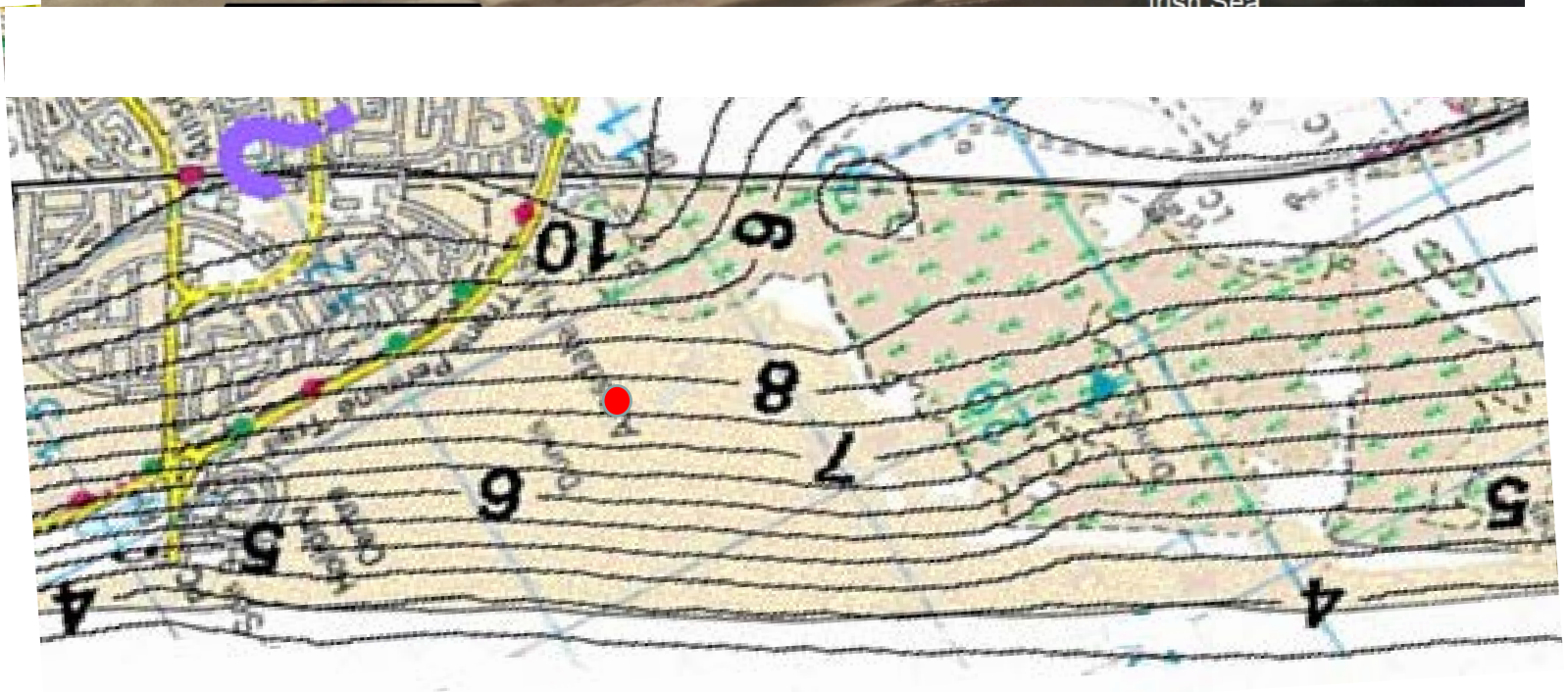

2018
Image © 2019 Maxar Technolo
Image Landsat / Copernicus


2018
Image © 2019 Maxar Technolo
Image Landsat / Copernicus


2018
Image © 2019 Maxar Technolo
Image Landsat / Copernicus


2018
Image © 2019 Maxar Technolo
Image Landsat / Copernicus

Water table monitoring points and contour map



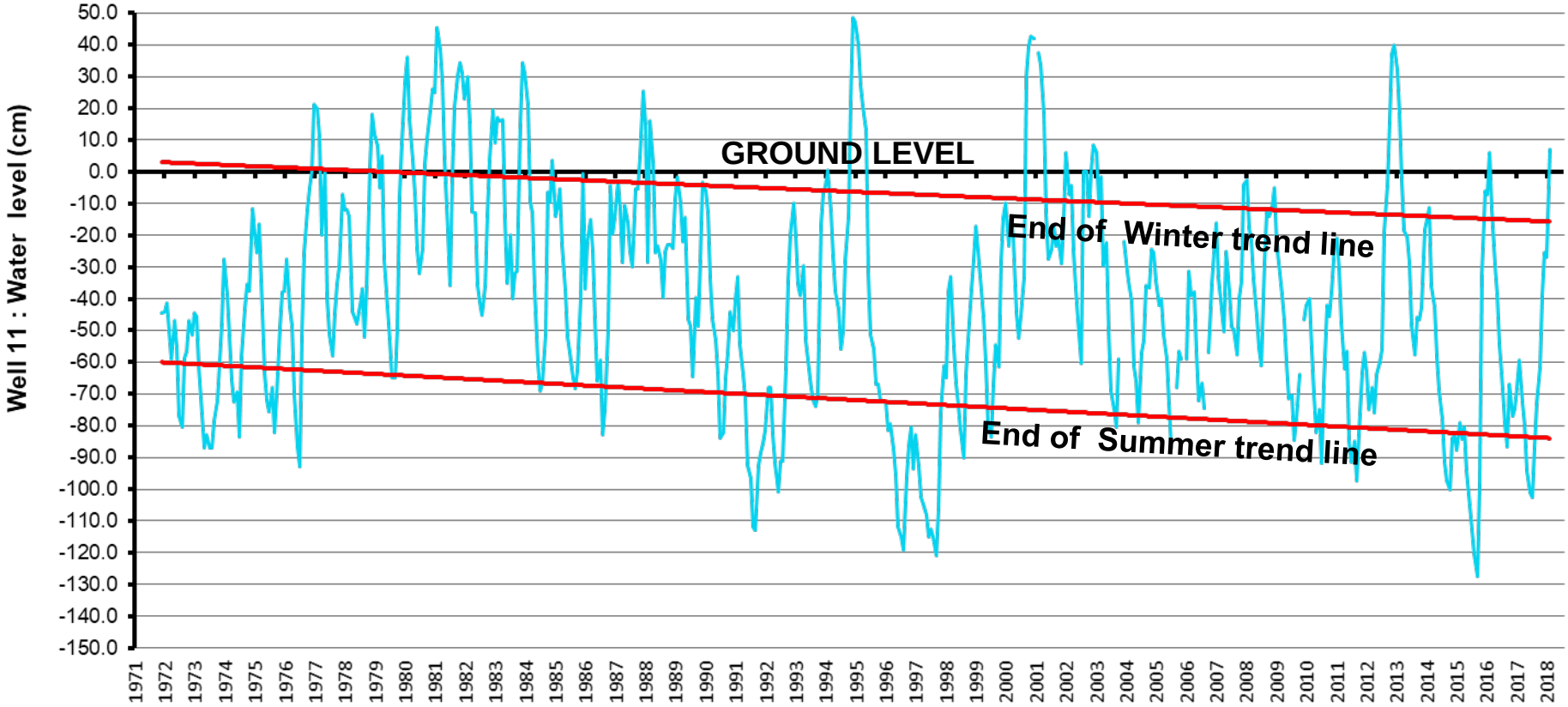
Annual Rainfall 840mm

Annual PET 750mm

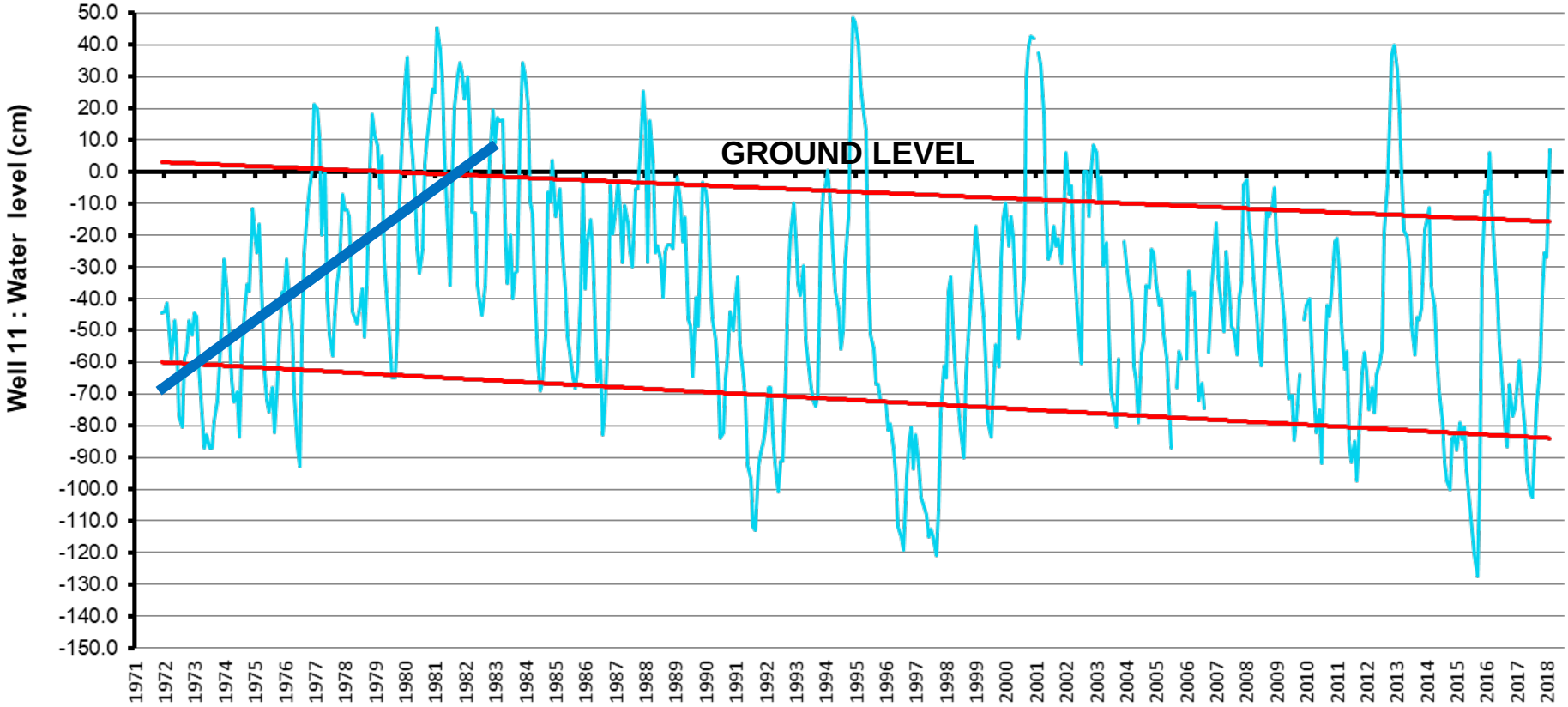
Annual AET 450-600 mm

GW recharge ~300mm

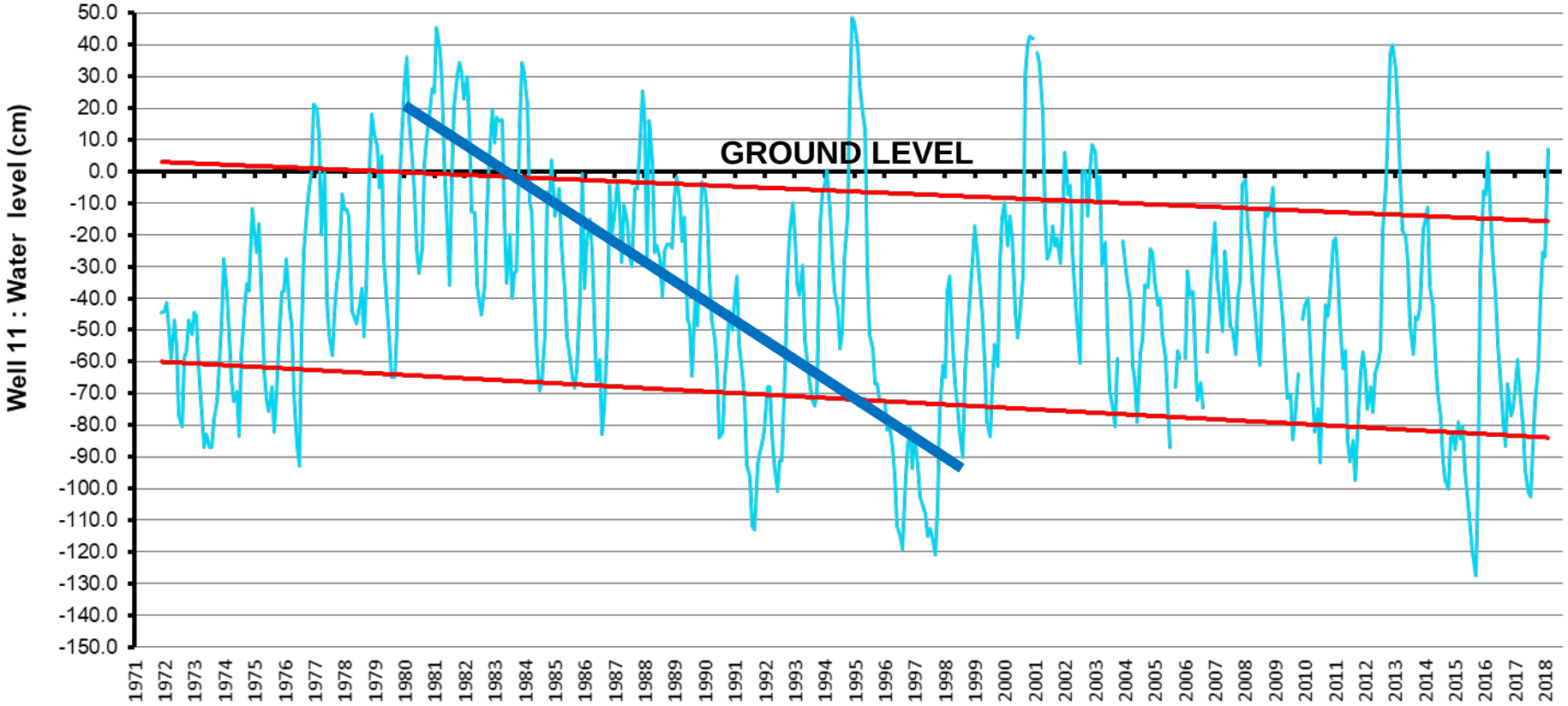
Groundwater level monitoring started in 1972



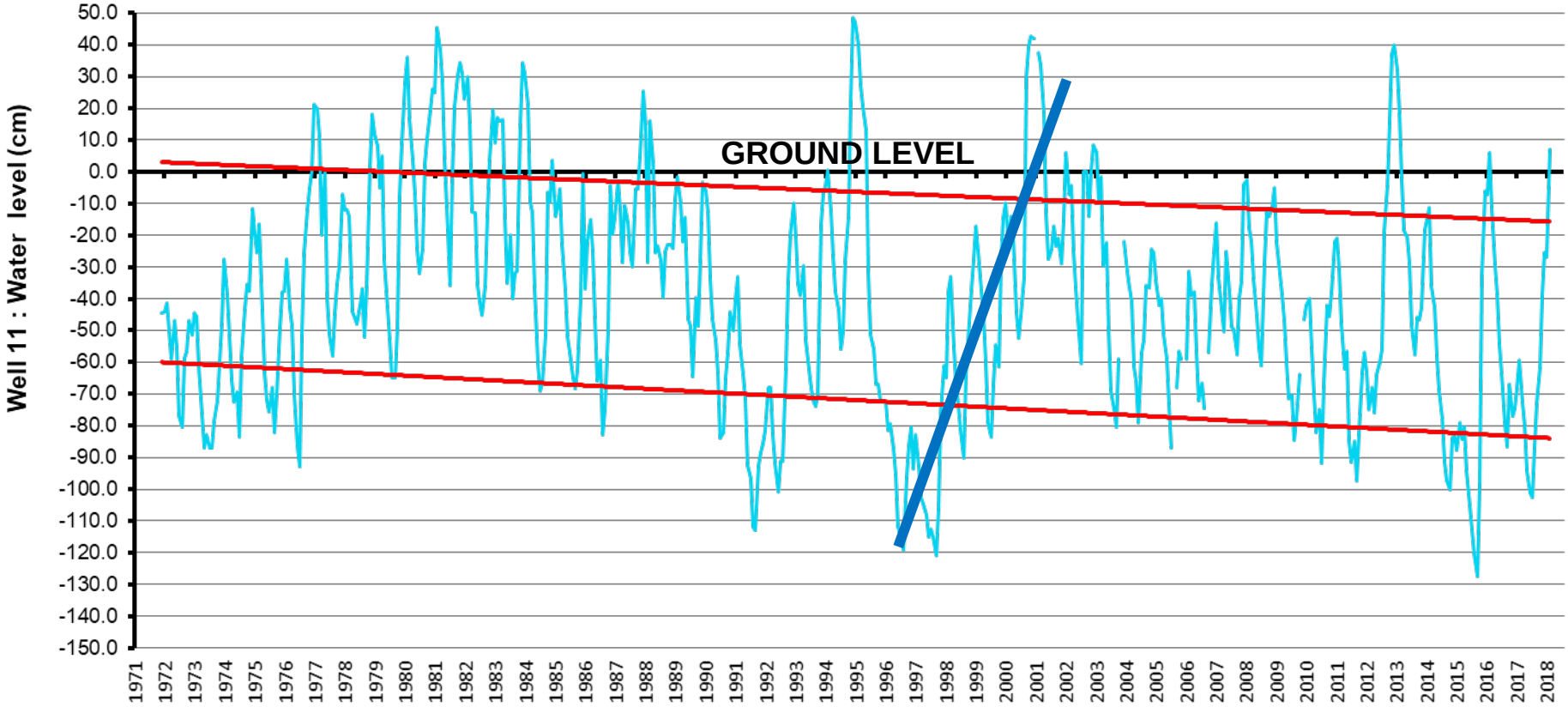
Groundwater level monitoring started in 1972



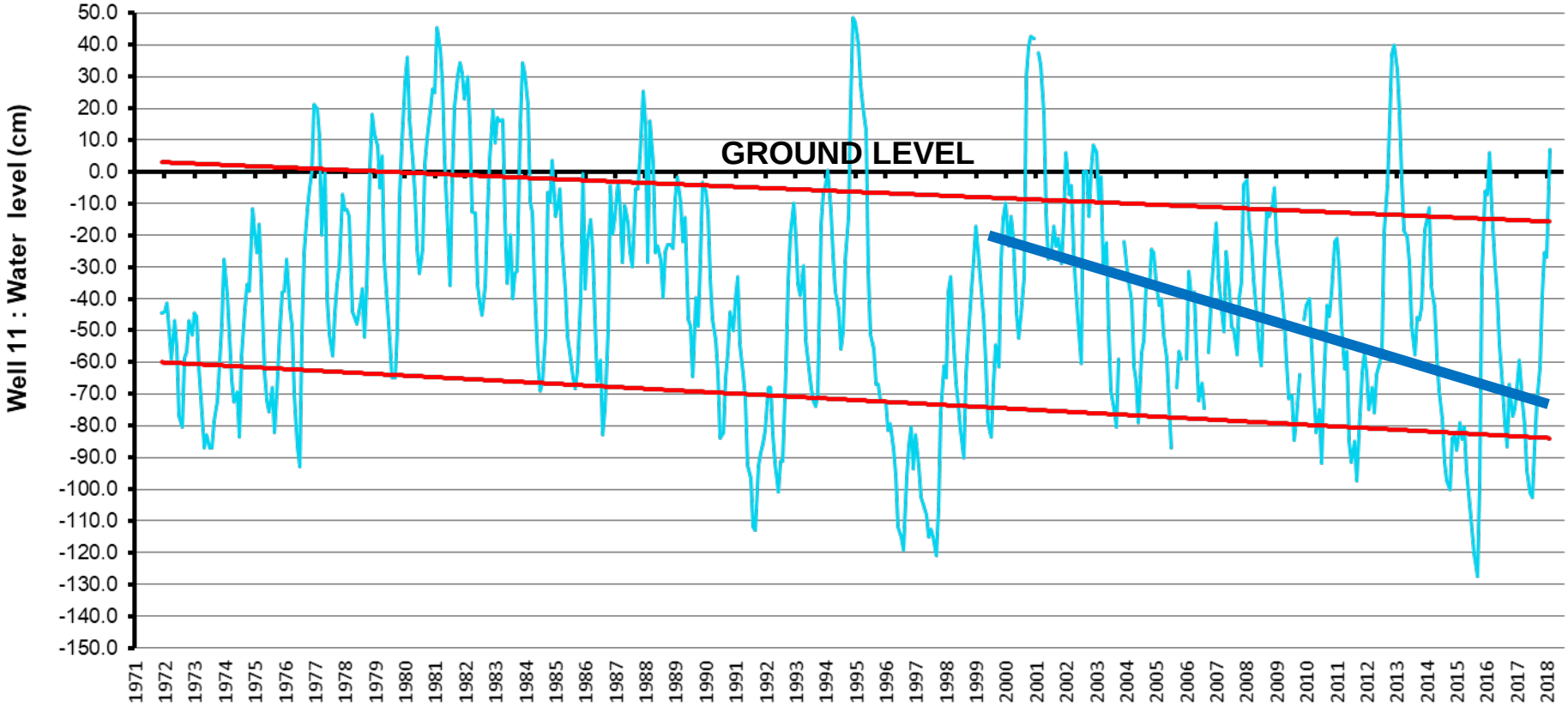
Groundwater level monitoring started in 1972



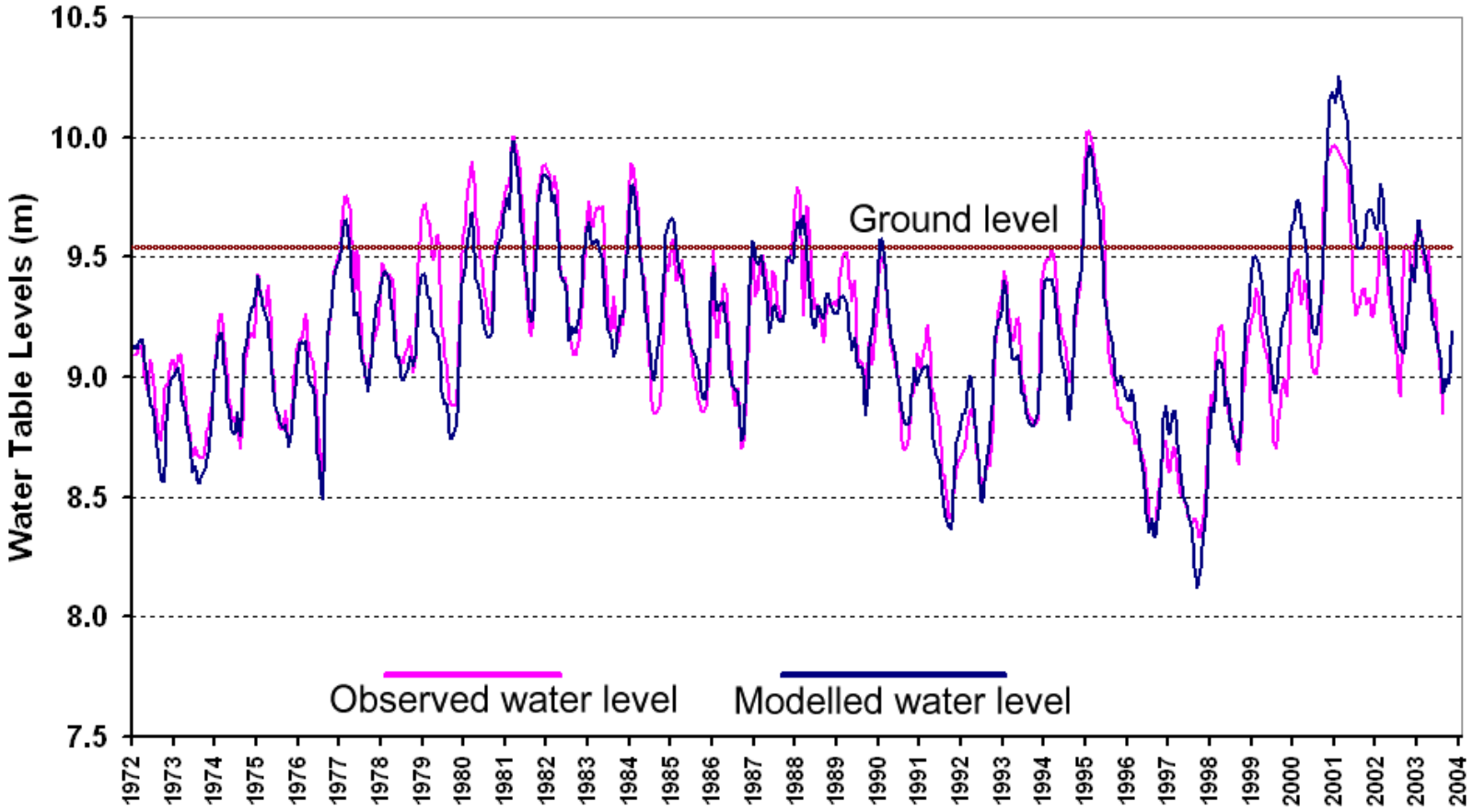
Groundwater level monitoring started in 1972



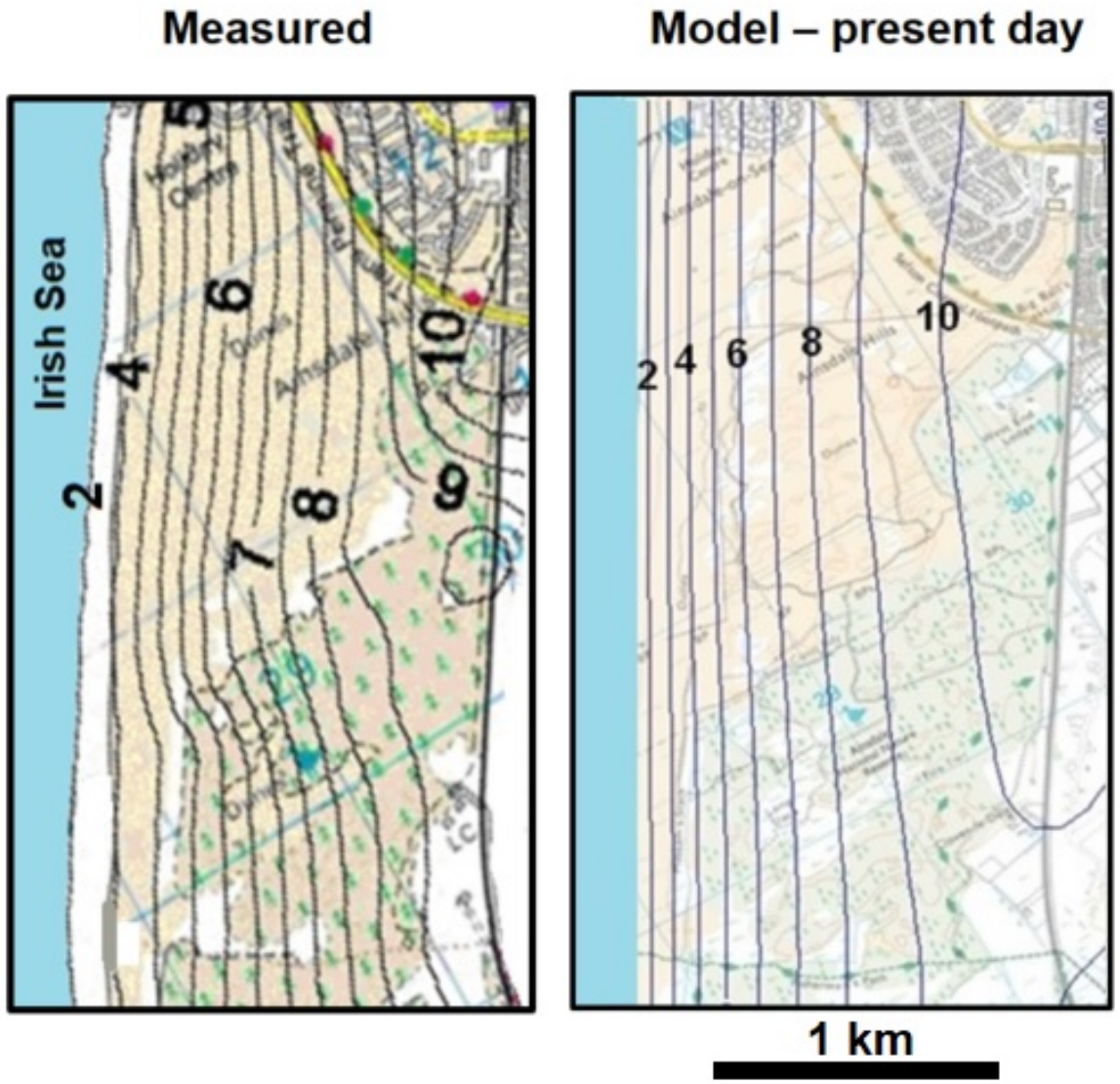
Groundwater level monitoring started in 1972



Water balance simulation model in open dunes (Clarke and Sanitwong, 2010)

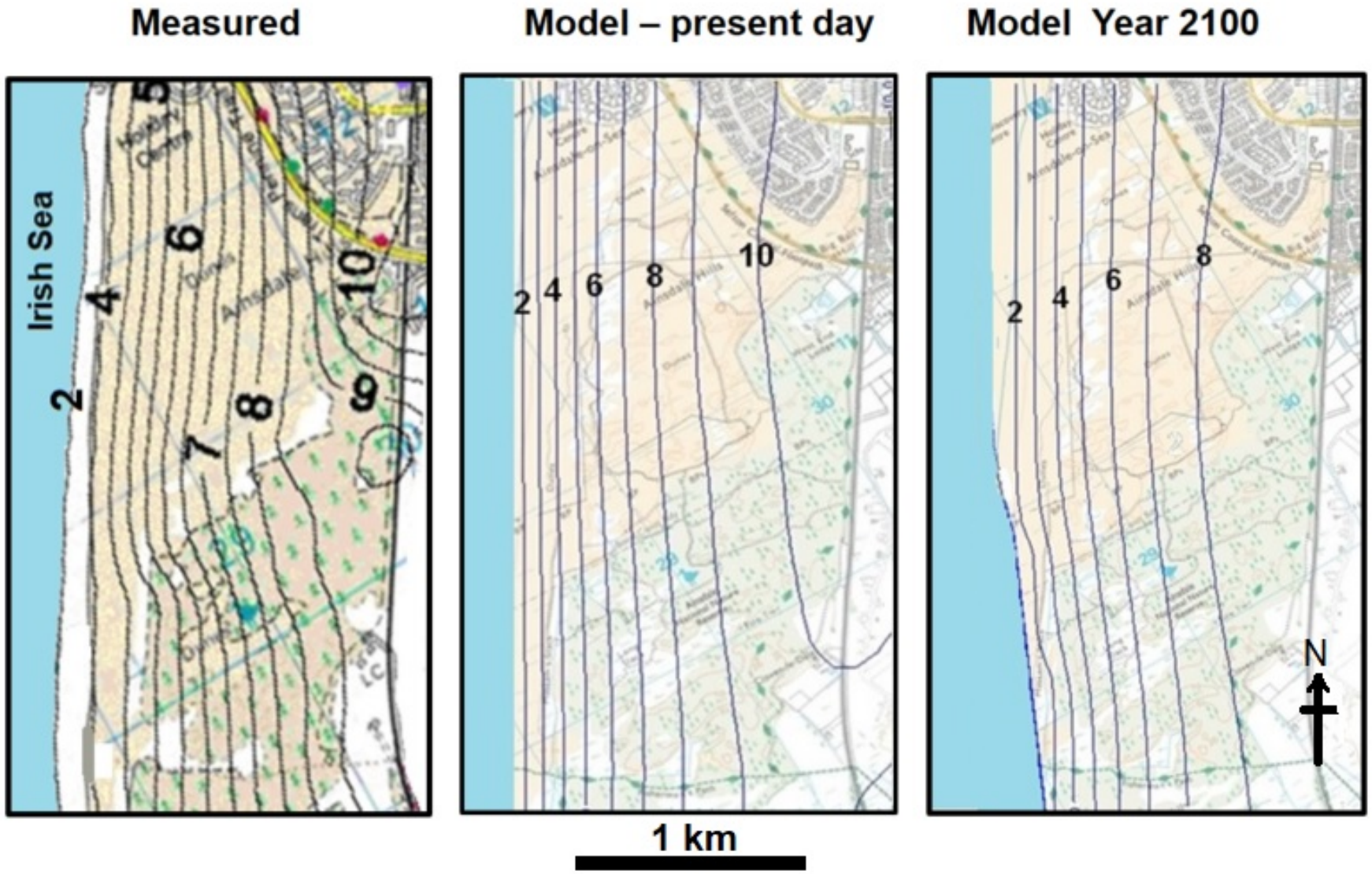


MODFLOW simulations
using recharge model for present day

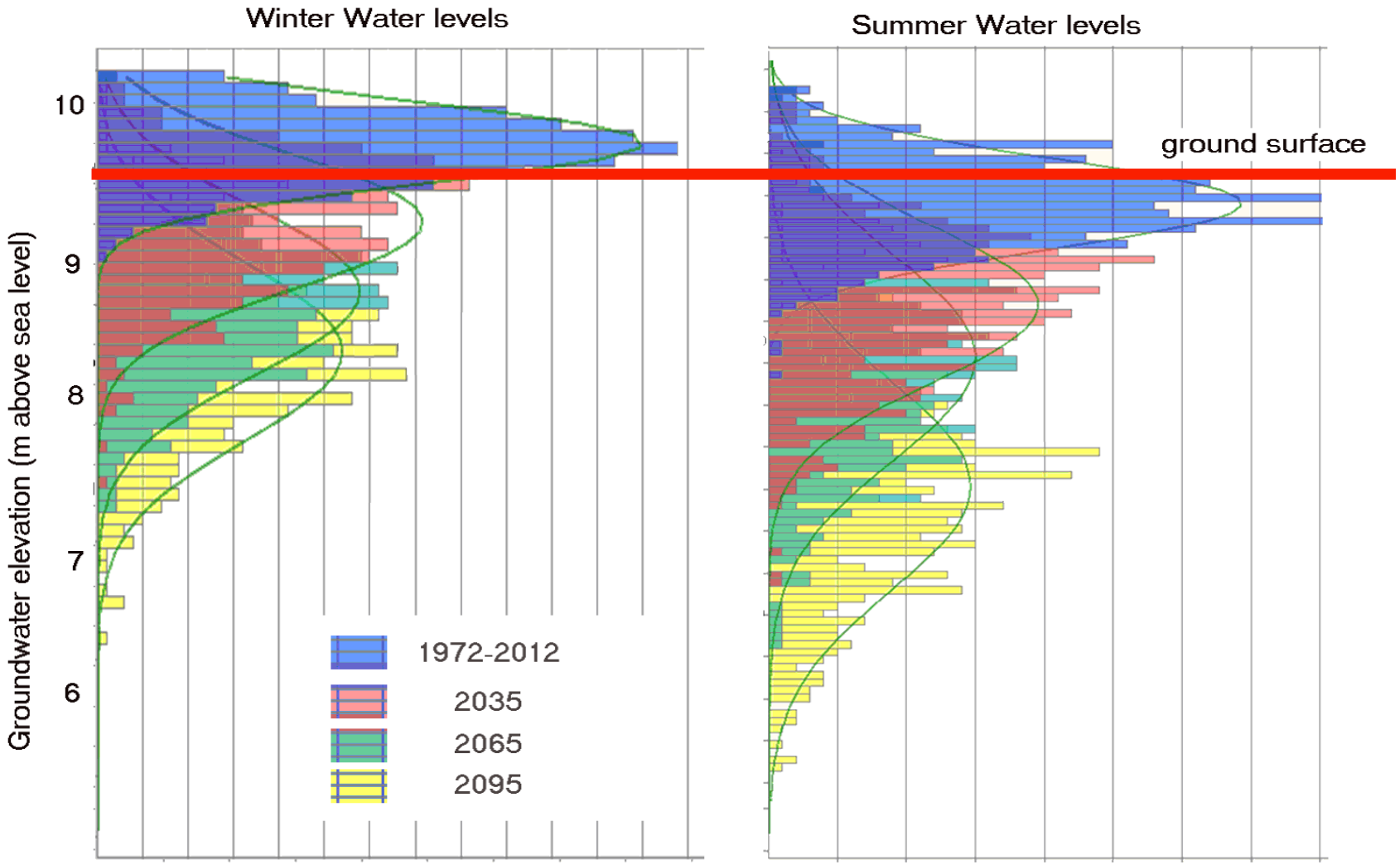


MODFLOW simulations

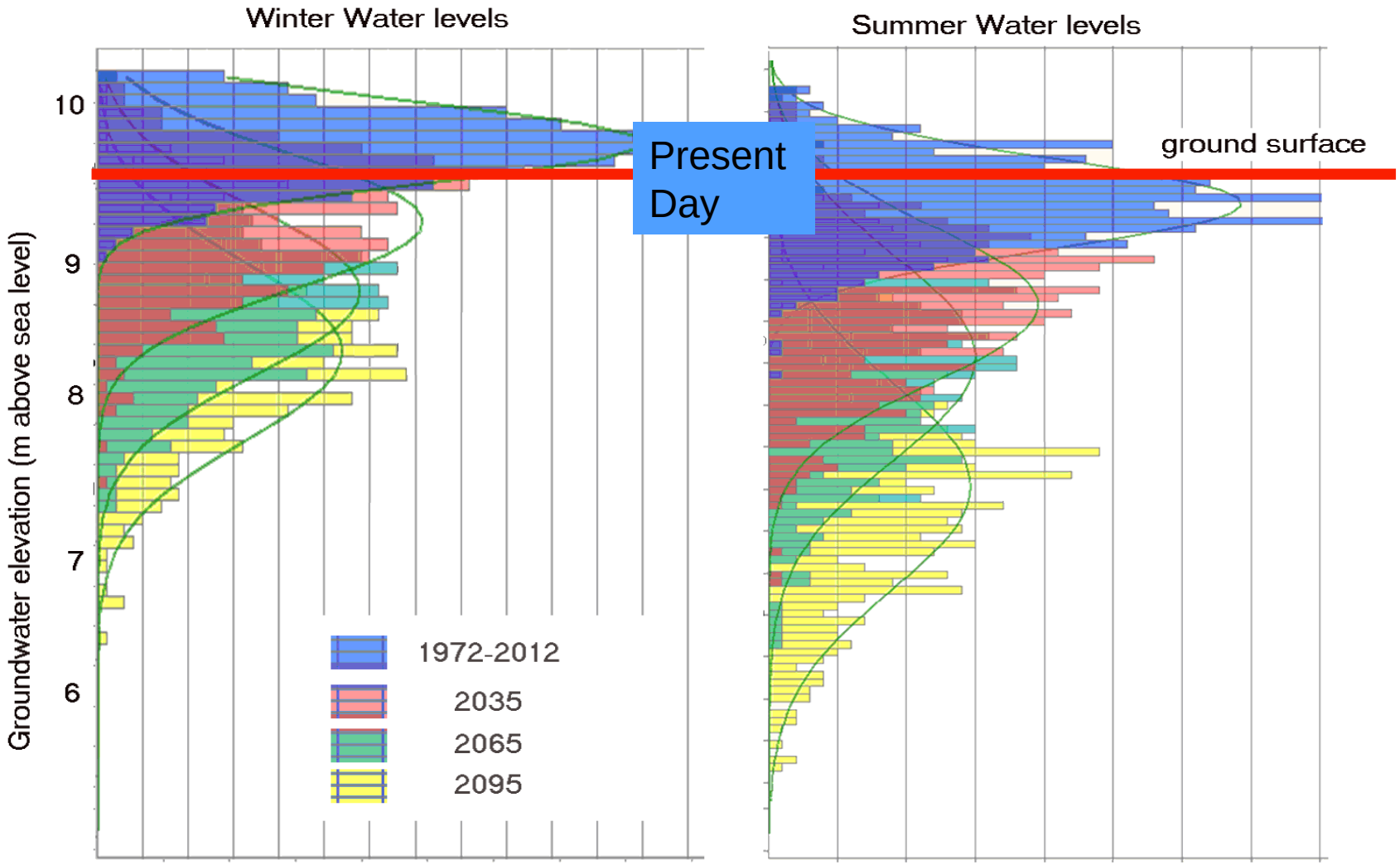
Annual rainfall -5%
Temperature +3.5°C
Drier summers



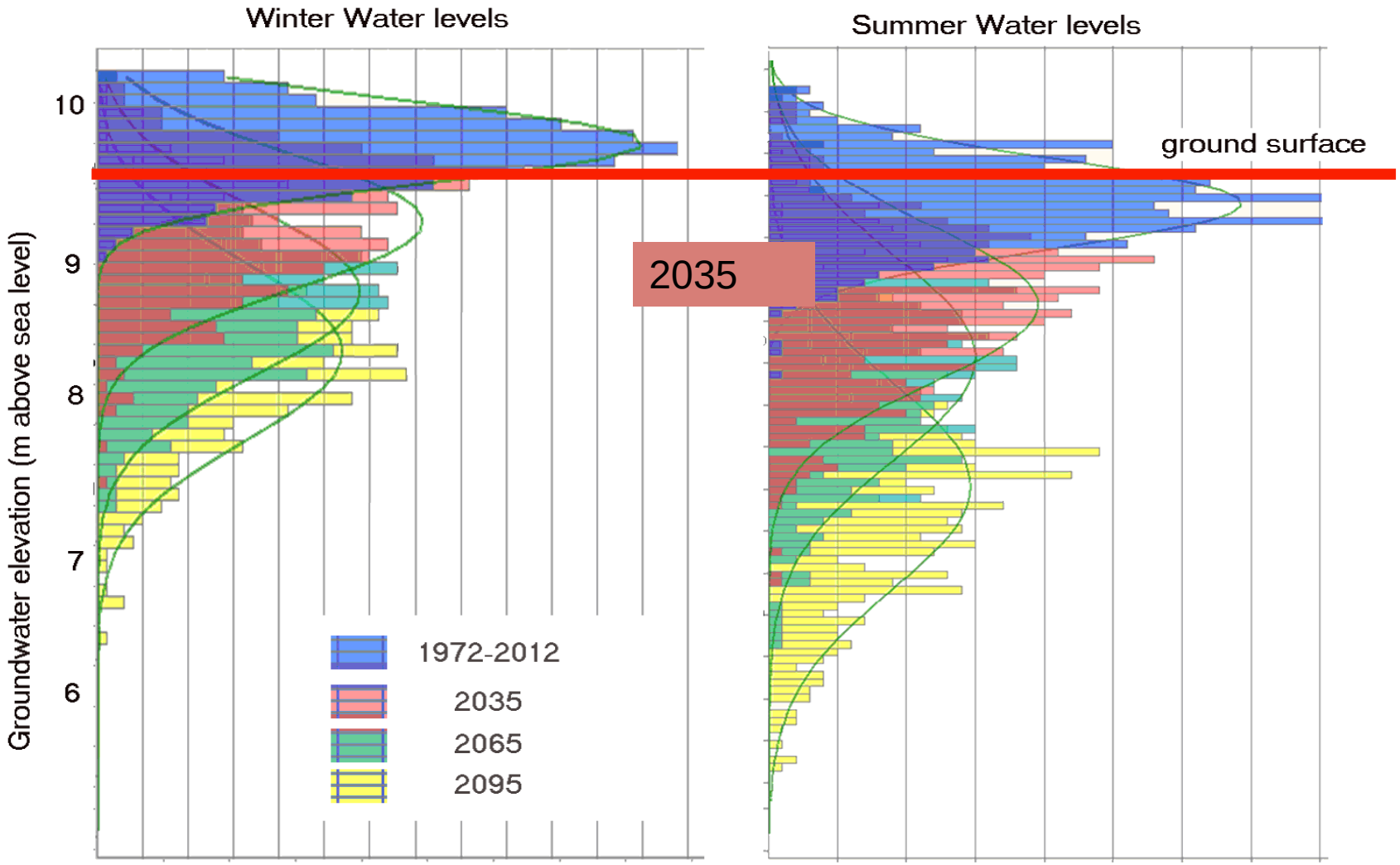
Winter and summer groundwater level simulation using recharge data for present day and end of century climate



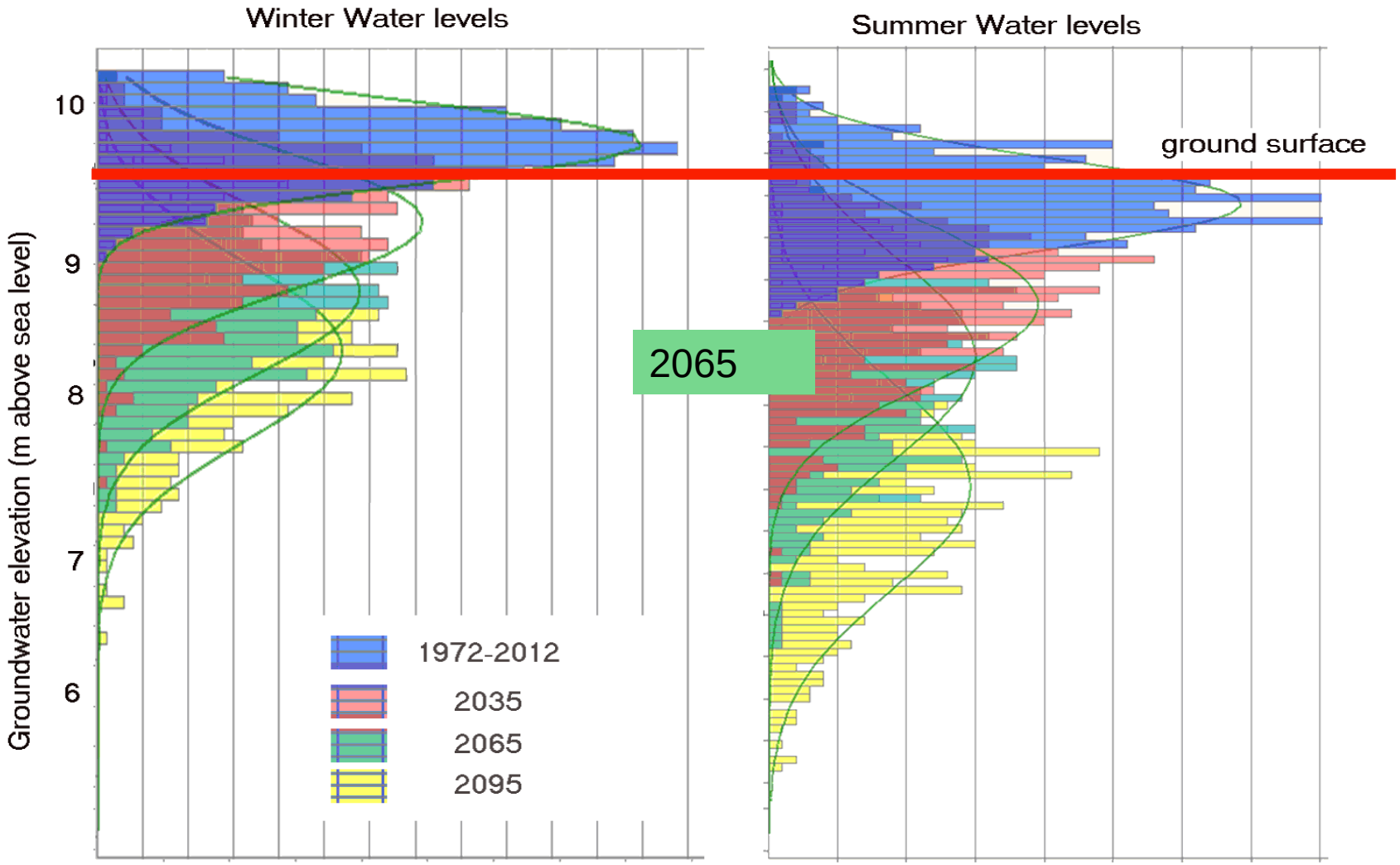
Winter and summer groundwater level simulation using recharge data for present day and end of century climate



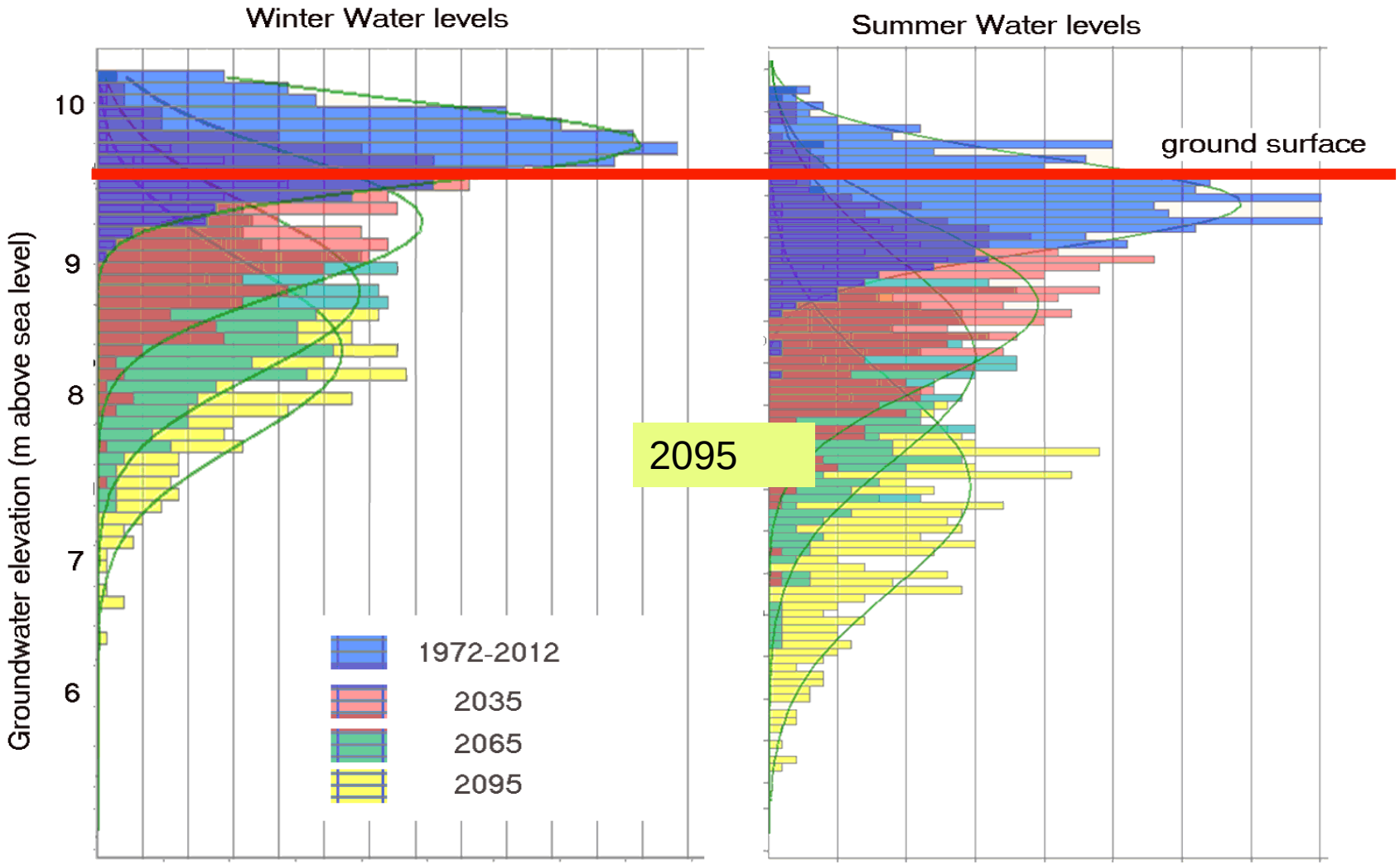
Winter and summer groundwater level simulation using recharge data for present day and end of century climate



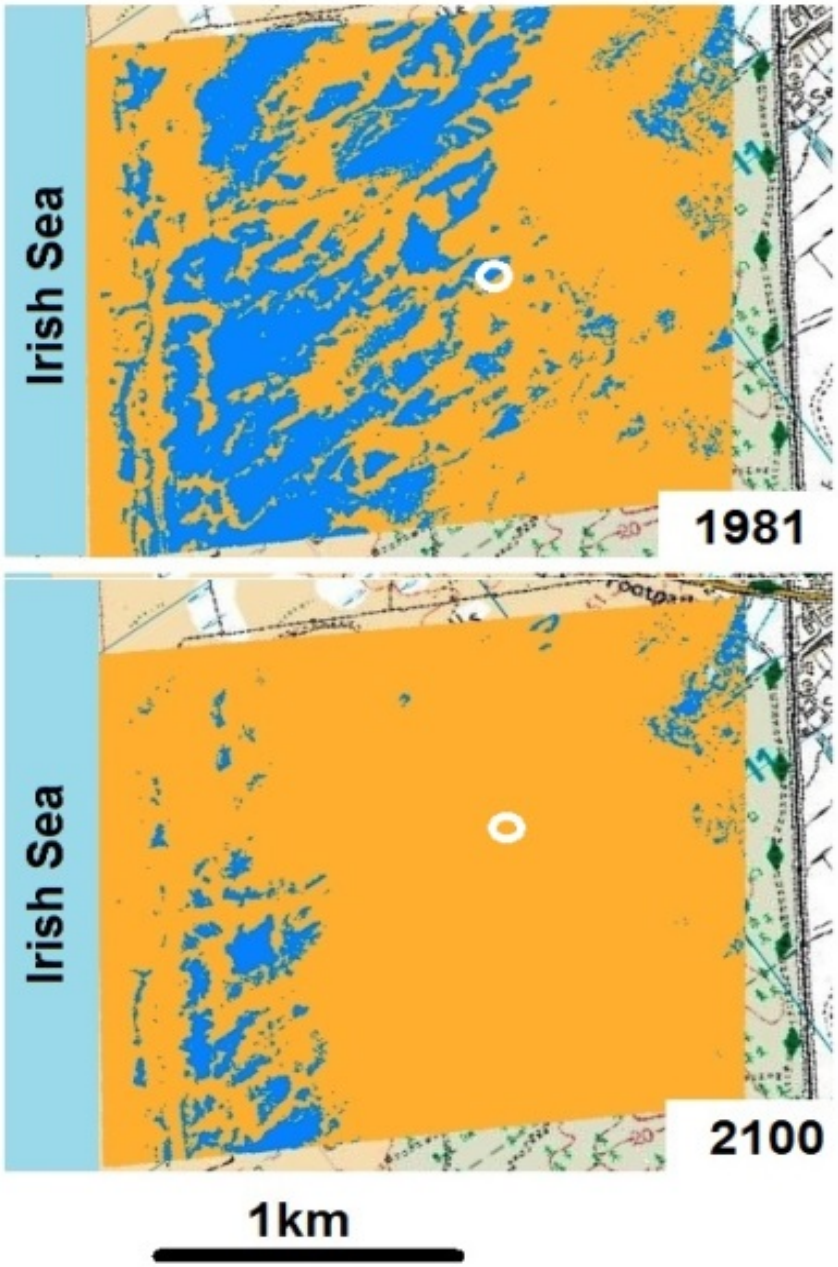
Winter and summer groundwater level simulation using recharge data for present day and end of century climate



Winter and summer groundwater level simulation using recharge data for present day and end of century climate



Maximum wet winter ponded areas



- Expectations of climate change will lower groundwater levels by about 1m on average by the end of the century.
- This has serious implications for managing threatened species which are dependent on freshwater

Summary

- Expectations of climate change will lower groundwater levels by about 1m on average by the end of the century.
- The most significant natural threat to groundwater levels (and the nature reserve itself) will be coastal erosion. The sand is moving north and creating new dunes.
- Simple land use planning is no longer sufficient. New sites have to be identified to establish new conservation areas.

Acknowledgements

- **Natural England**
- **Staff of Ainsdale Sand Dunes National Nature Reserve**
- **UK Climate Impacts Programme**
- **Research students, University of Southampton :-**
  - **Fatemeh Rahimi**
  - **Sarinya Sanitwong Na Ayuttaya**

Contact details

Dr Derek Clarke
Faculty of Engineering & the Environment
University of Southampton, SO17 1BJ

Email **DC@soton.ac.uk**
Phone 02380 593 573
Web http://www.southampton.ac.uk/engineering/about/staff/dc.page

Useful paper :

Clarke D., Sanitwong Na Ayuttaya S, (2009).

"Predicted effects of climate change, vegetation and tree cover on dune slack habitats at Ainsdale on the Sefton Coast, UK."

Journal of Coastal Conservation DOI: 10.1007/s11852-009-0066-7

UNIVERSITY OF Southampton