

# AQUALINC



## Bury your head to see the light!

**Dr John Bright**

Aqualinc Research Ltd

GROUNDWATER

IRRIGATION

RESOURCE CONSENTS

FARM ENVIRONMENT PLANS

EFFLUENT MANAGEMENT

WATER MANAGEMENT

11 April 2018

# Outline



- **Why we have to take groundwater seriously!**
- **An assumption commonly made in regional scale hydrological modelling that we need to drop.**
- **A modelling architecture we should seriously consider as the starting point for a national model.**

# Its all groundwater anyway

(well, almost all!)



- Hydrological research in North Island hill country catchments showed:
  - 70 to 80% of the surface water flow volume per year comes from groundwater.
  - Catchment flow divides don't always coincide with catchment boundaries derived from surface-topography.

# An assumption we should toss



- One of the first steps in constructing a catchment hydrological model is to map surface water flow paths based on surface topography – usually.
- We assume all flow paths follow this pattern.
- But they don't!

# Burying your head to see the light



- Understanding flow paths, and conditions along them, is critical to understanding and managing the effects of land and water use.
- To gain this understanding we need to know what the sub-surface structure is like.
- Need to store data on the 3D structure of a catchment in a way that allows the physics and maths to determine flow paths dynamically.
- That will shed a lot of light on what's *really* going on!

# An architecture for consideration



# LUCI : A tool that models multiple ecosystems services at the farm, catchment, regional and national scales

Bethanna Jackson

School of Geography, Environment and Earth Sciences  
Victoria University of Wellington

Capital thinking. Globally minded.



# Background to



- LUCI **implements & extends** the Polyscape framework described in Jackson et al (2013)\*
- Research in Wales demonstrated strategically planted hedgerows or 'shelter belts' could significantly reduce runoff and sediment movement (flood risk) and, by implication, change water quality.
- Work up-scaling impacts of detailed farm interventions to catchment scale & conversations with farmers and interdisciplinary scientists inspired design criteria.



\*Jackson, B, Pagella, T, Sinclair, F, Orellana, B, Henshaw, A, **McIntyre, N**, Reynolds, B, **Wheater, H**, Eycott, A (2013)

*Polyscape: a GIS mapping toolbox providing efficient and spatially explicit landscape-scale valuation of multiple ecosystem services, Urban and Landscape Planning 112, 74-88.*



## Importance of landscape *organisation*



a. Permeable strip near top of slope ("High shelter belt")

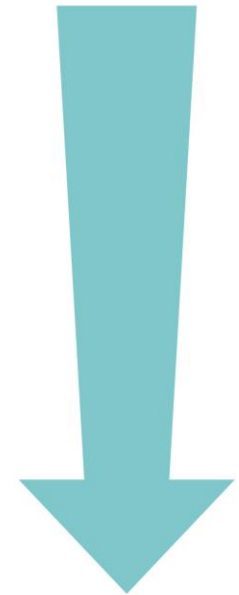


b. Permeable strip near bottom of slope ("Low shelter belt")



c. Permeable strip against slope ("Shelter belt 90° to contour")

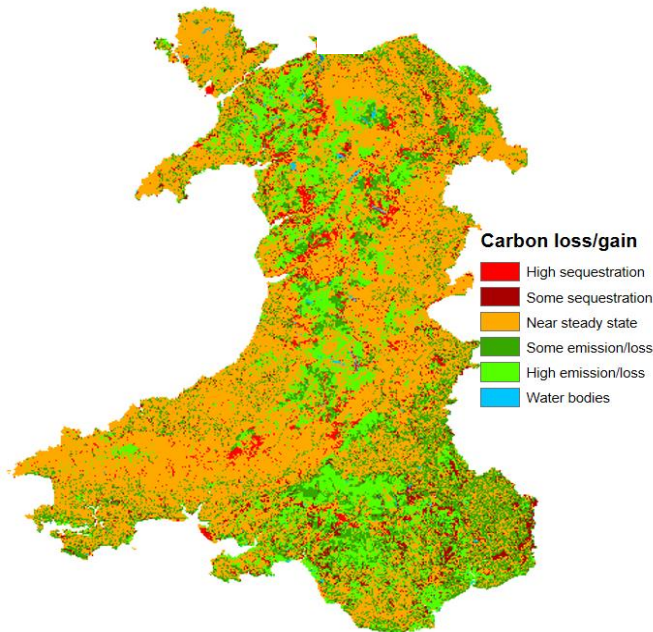
- » Fine resolution detail rarely represented in catchment models
- » Issue for prediction – and also for derivation and use of model parameters e.g. hydraulic conductivity, nitrogen export, etc...



DIRECTION OF  
DOWN-SLOPE  
MOVEMENT

# Mapping Wales (21,000 km<sup>2</sup>) at 5mx5m scale: ~800 million elements *per service*

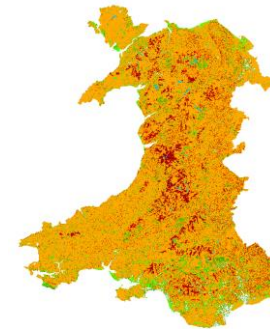
## Carbon emissions



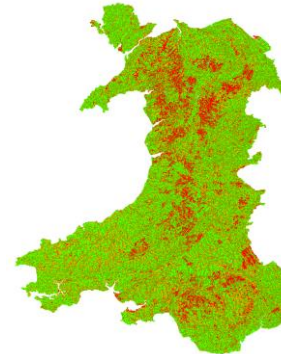
## Nitrate in rivers



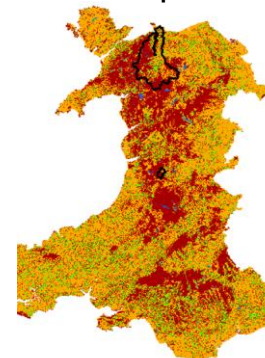
## Agricultural use



## Flood mitigation



## Woodland priorities



# How is LUCI being applied in NZ and internationally?

- Welsh Government and various DEFRA & EA applications
- Vanuatu, Philippines, Bulgaria, Australia (Hunter Valley) applications
- Regional nutrient loading analysis (Env Southland)
- “Farm LUCI” for use by Ravensdown
- B+L project + Ravensdown/GWRC projects looking at collaborative multi-farm catchment scale applications, etc
- Exploring flood mitigation opportunities (e.g. Hutt River)

# Why am I interested in LUCI?



- Operates efficiently across a wide range of scales.
  - Precise representation of land-management activities (such as actions of mitigate NPS pollution).
  - GIS based – fits the normal data work-flow.
  - Modular and extensible.
  - Open source.
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- Groundwater not well modelled yet, BUT
  - Architecture lends itself to allowing the maths to determine groundwater and surface water flow paths.



Thank you for listening!

