Comments from the coal face: implementing models to explore changing ecosystem outcomes

LAND UTILISATION & CAPABILITY INDICATOR

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Figure 1 from Bagstad et al. (2013)

Ecosystem Services

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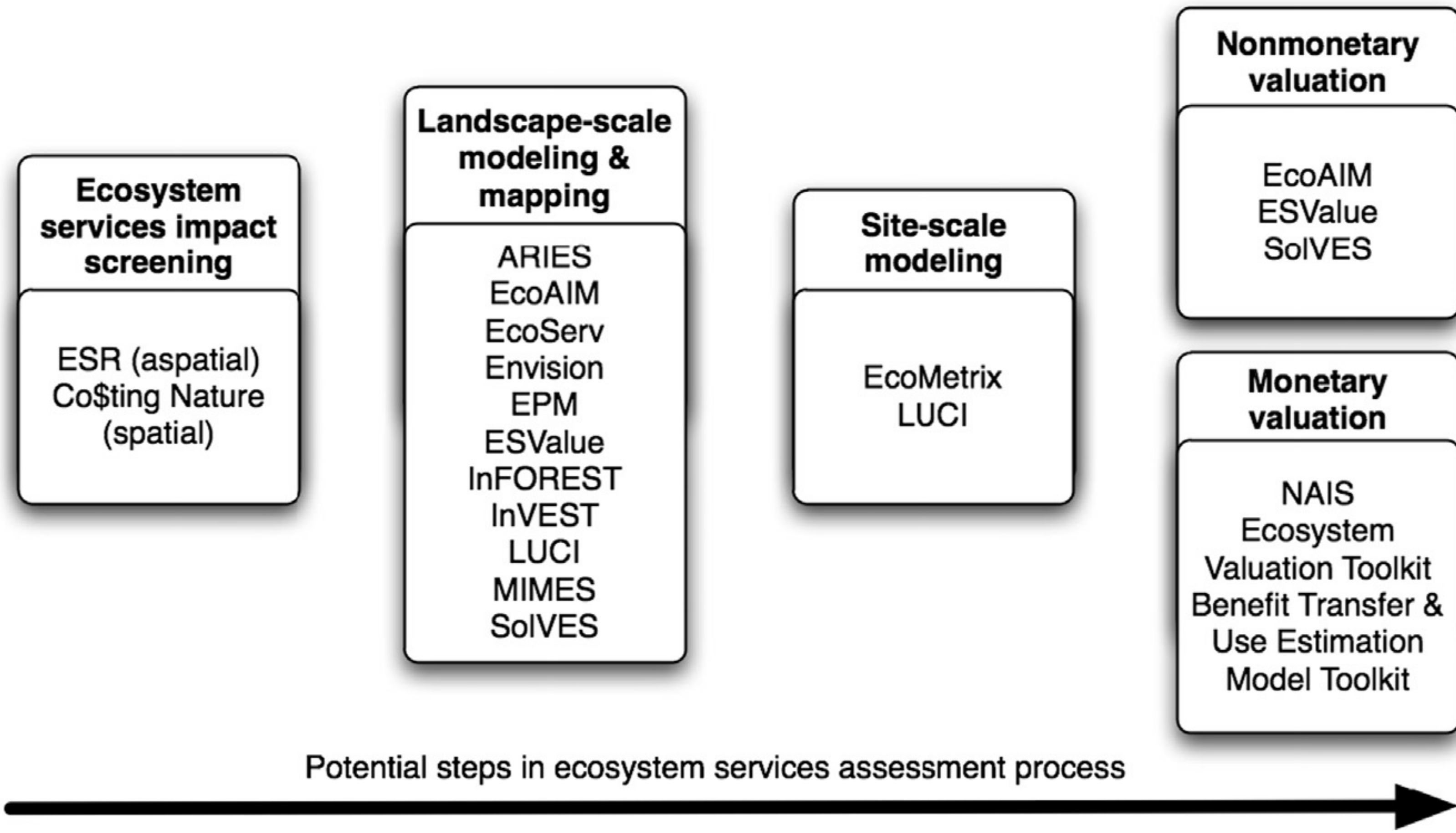
A comparative assessment of decision-support tools for ecosystem services quantification and valuation

Kenneth J. Bagstad[a], Darius J. Semmens[a], Sissel Waage[b], Robert Winthrop[c]



“Mature” services supported by LUCI

Service	Method
Production	Based on slope, fertility, drainage, aspect, climate
C stock/emissions	**IPCC Tier 1 compatible – based on soil & vegetation**
CH_4/N_2O emissions	IPCC Tier 1 compatible– soils, veg, stocking rate, fertiliser
Water supply and floods/ droughts	**Topographical routing of water accounting for storage and infiltration capacity as function of soil & land use.**
Erosion	Slope, curvature, contributing area, land use, soil type
Sediment delivery	Erosion combined with detailed topographical routing
Water quality	**Export coefficients (land cover, farm type, fertiliser, stocking rate info) combined with water and sediment delivery models**
Habitat Approaches	**1) Cost-distance approach: dispersal, fragmentation, connectivity.** **2) Identification of priority habitat by biophysical requirements e.g. wet grassland** **3) Measures of habitat richness, evenness, patch size etc**
Coast/ floodplain inundation risk	Based on topography and input height of storm surge/long term rise etc: surface and groundwater impacts estimated
Tradeoffs/synergy identification	Various layering options with categorised service maps; e.g. Boolean, conservative, weighted arithmetic, distribution plots

Underlying principles:

Practical

1) Can be run using just 3 *nationally* available datasets and be enhanced with local data if available
2) Modular – can embed external models & export aspects to other models
3) Fast running, enabling interactive scenario exploration

Conceptual

1) Operates at a spatial scale *relevant for field and sub-field level management decisions*
2) “Values” features and potential interventions by area affected, not just area directly modified
3) Addresses spatial tradeoffs & searches for “win-win” solutions

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2) Modular – can embed external models & export aspects to other models
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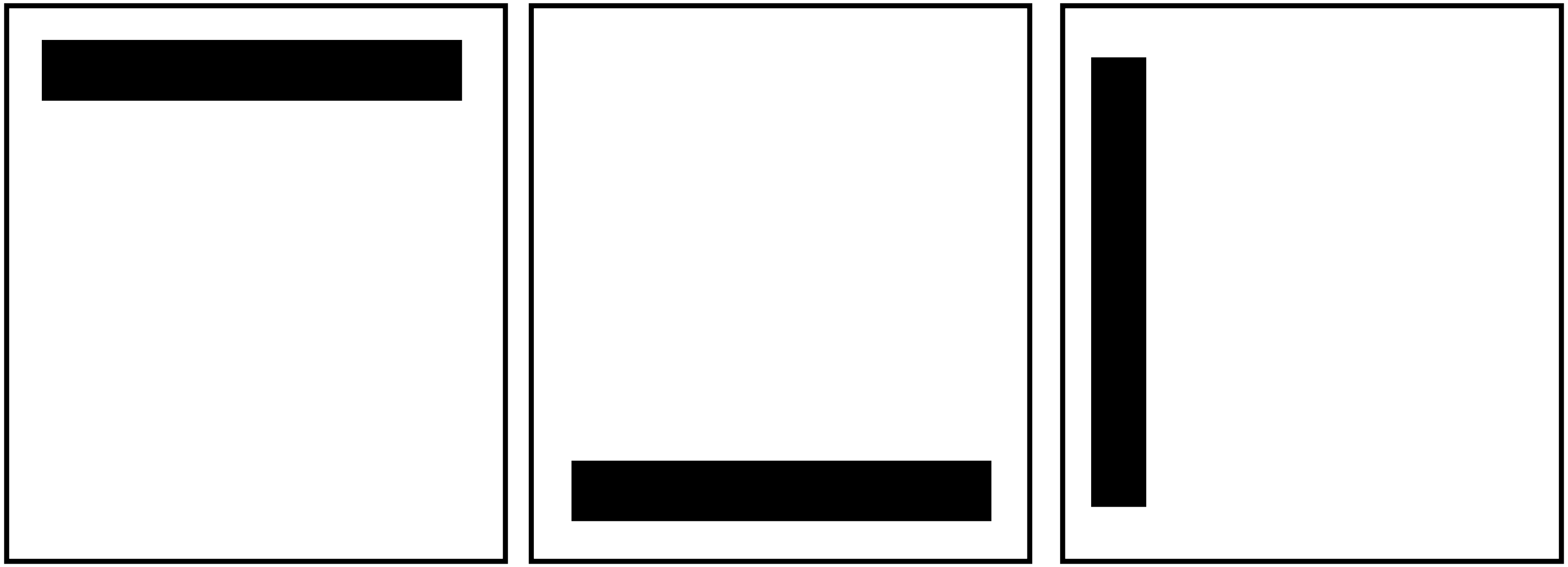
Importance of landscape *organisation*

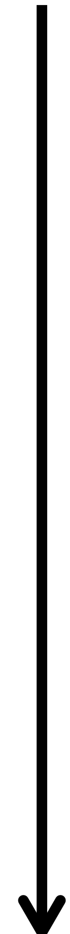


a) Permeable strip near top of slope ("High shelter belt")

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

c) Permeable strip against slope ("Shelter belt 90^{o} to contour")

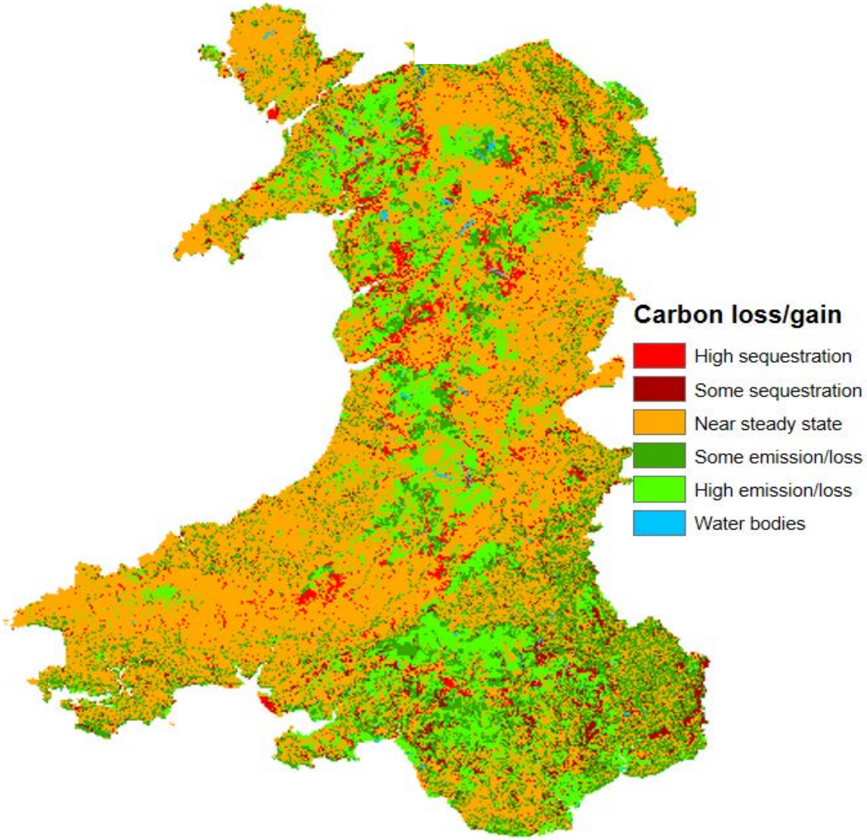
- Fine resolution detail rarely represented in catchment models
- Issue for prediction – and also for derivation and use of model parameters e.g. hydraulic conductivity, nitrogen export, etc…



Direction of down-slope movement

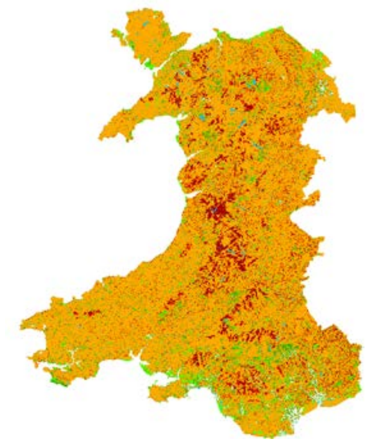
Mapping Wales (21,000 km2) at 5mx5m scale: ~800 million elements *per service*

Carbon emissions

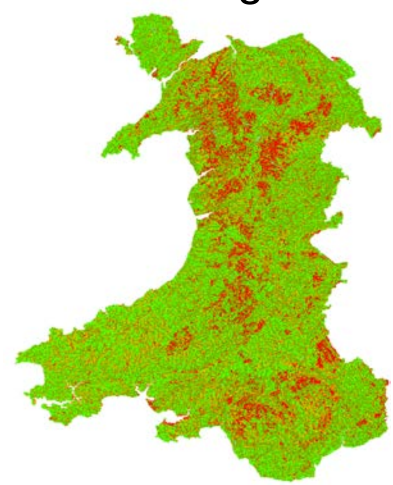


Nitrate in rivers

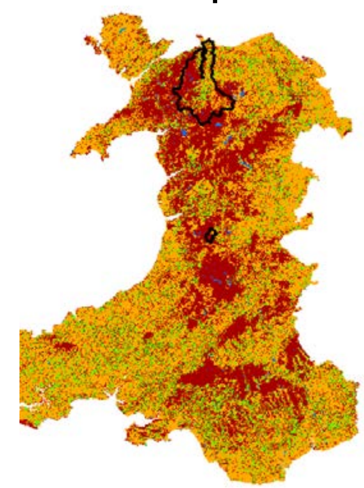
Agricultural use



Flood mitigation



Woodland priorities



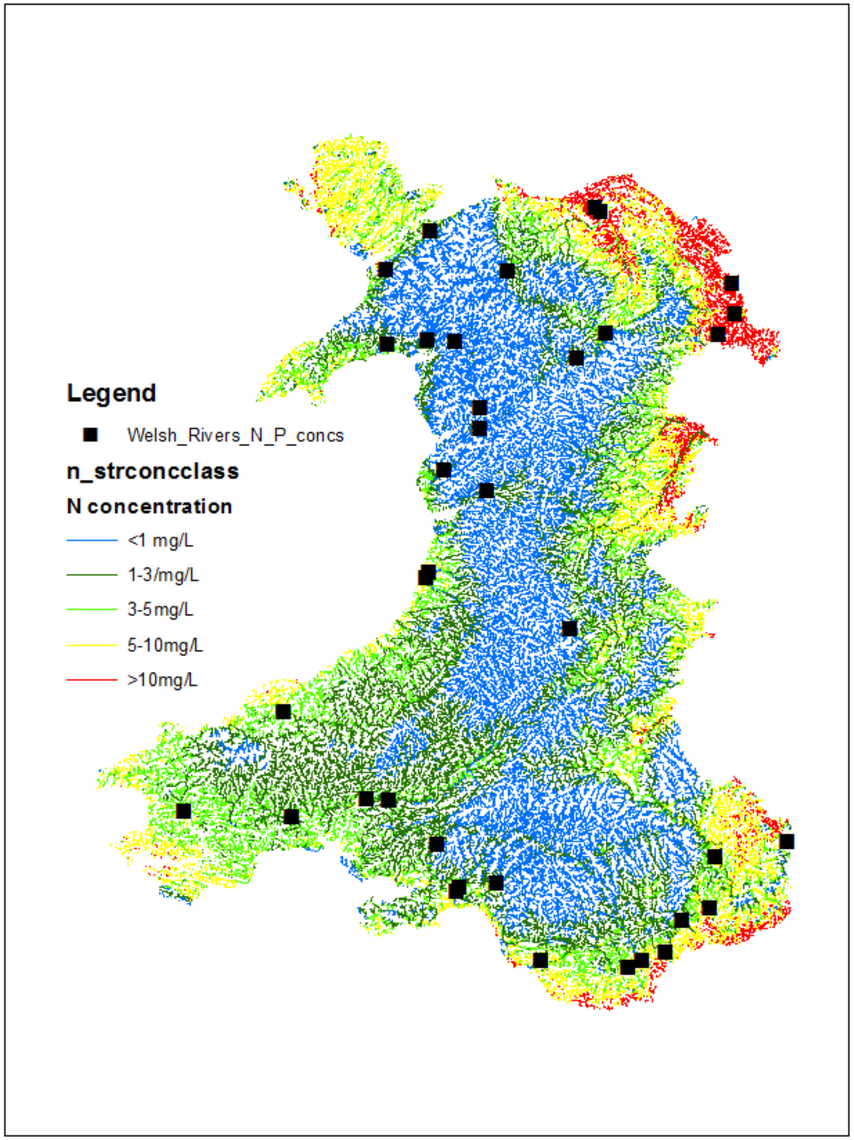
Feasibility of global application?

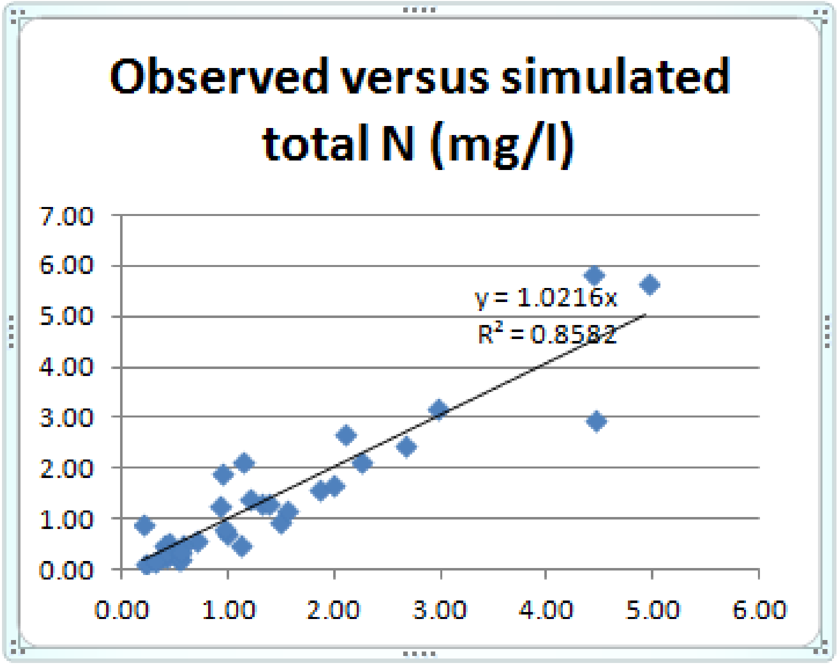
- 1.5 days on 1 PC to run LUCI at 5 by 5m over all of Wales *for all services*
- *Server enabling speeds this 100-fold+*

Coverage	Resolution	Area (sq km)	No. pixels	"Home PC" time
Wales	5m x 5m	2.1×10^4	0.84×10^9	1.5 days
New Zealand	15m x 15m	2.7×10^5	1.2×10^9	2.1 days
World (SRTM)	90m x 90m	1.5×10^8	18.5×10^9	33 days
World (ASTER GDEM)	30m x 30m	1.5×10^8	167×10^9	298 days

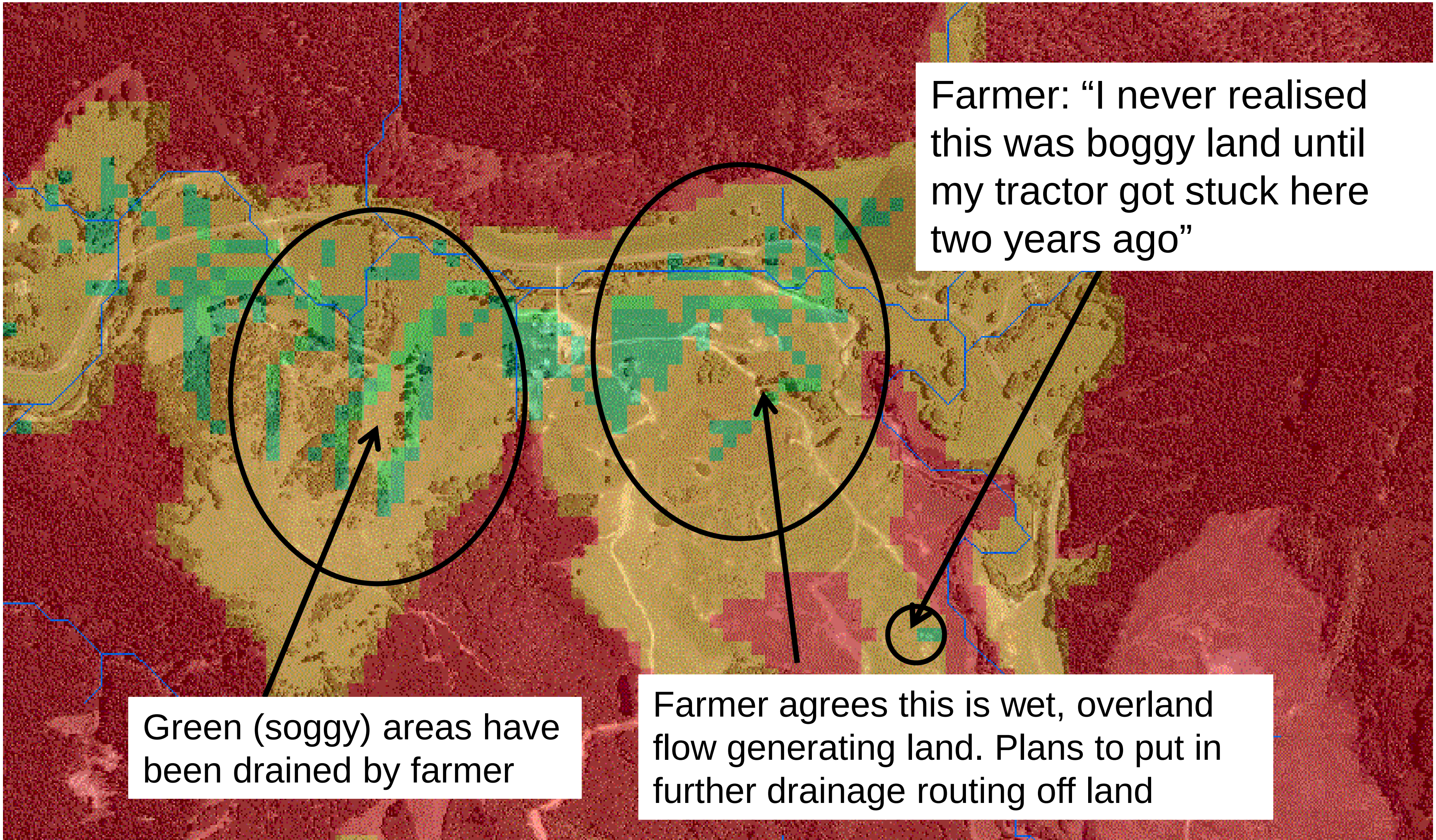
But won't make sense everywhere: most mature in NZ and the UK. Applications with "groundtruthing" now starting in the Philipinnes and Australia, and about to start in Samoa and Vietnam

Evaluating LUCI output e.g. Water quality

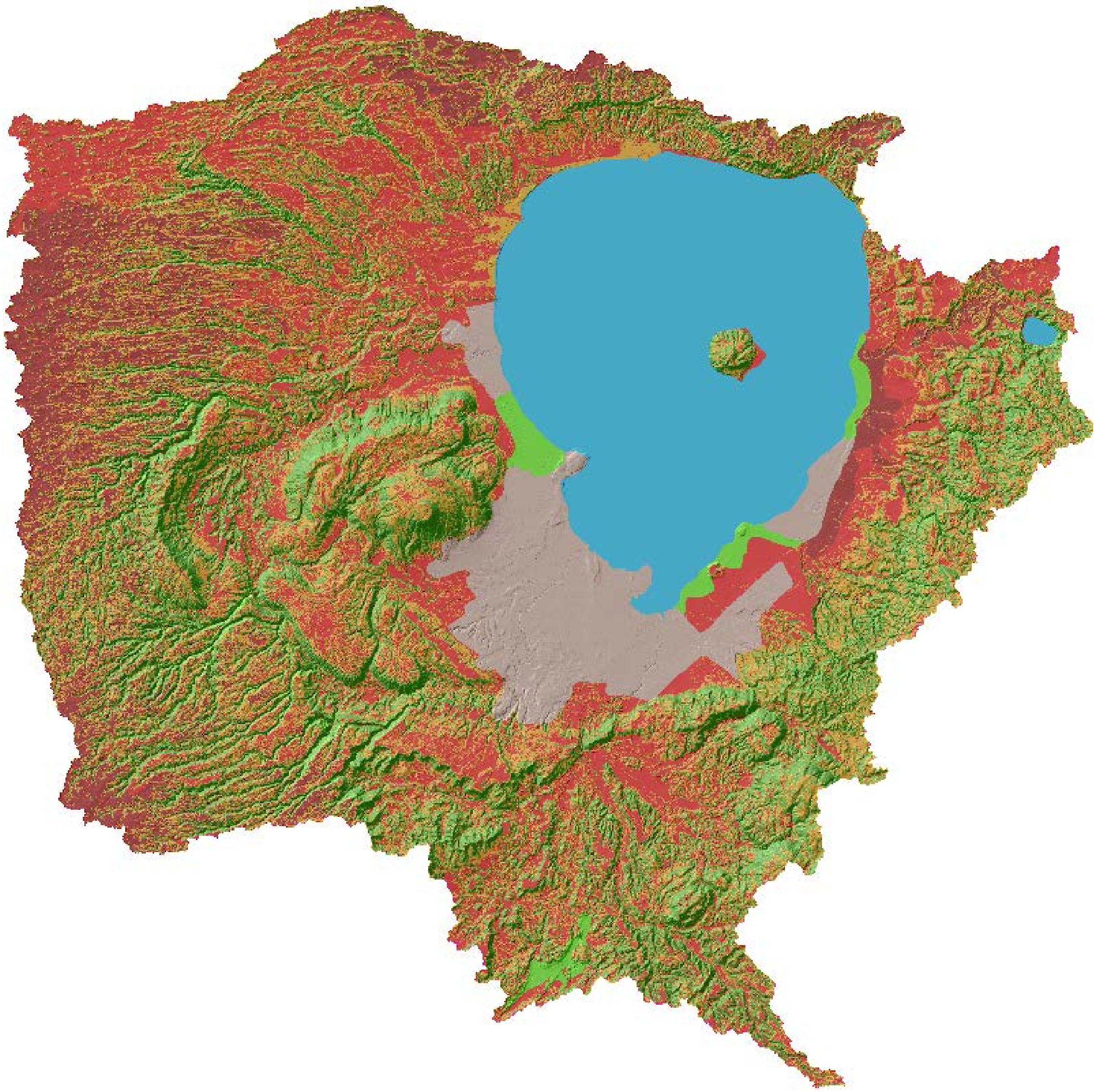




Groundtruthing at local scale (Uawa, NZ)



Framework naturally considers capacity



Predictions of areas with high agricultural production capability-

Predicted optimal agricultural utilisation

- Very high production capacity
- High production capacity
- Moderate production capacity
- Marginal production capacity
- Negligible production capacity
- Water bodies
- "Urban mapped" soils

And is beginning to account for condition

Master_codes_Vegmgt_Mar2015 - Excel

LUCI type	LUCI Code	LUCI Condition Type	LUCI Condition Code	LCM2007 BH Subclass Description	LCM2007 BH Subclass Code	LCM2007 Class
Red text means I have made some kind of judgement call that needs reviewing: e.g. LCM 2007 recent = <10 years, recent in LUCI needs defining by cover type.						
Woodland						
Broadleaved decidious	101	Average (or unknown/assumed average)	1	Deciduous	D	1
			8	Recent deciduous (<10 years)	Dn	1
Broadleaved evergreen	102	Average (or unknown/assumed average)	1			
Coniferous decidious	103	Average (or unknown/assumed average)	1	Larch	Cl	2
Coniferous evergreen	104	Average (or unknown/assumed average)	1	Conifer	C	2
		Recently planted	8	Recent coniferous (<10 years)	Cn	2
		Average (or unknown/assumed average)	1	Evergreen	E	2
Mixed forest	105	Average (or unknown/assumed average)	1	Mixed	M	1
		Felled	7	Felled	Fd	2
Scrub, heath, other inland veg						
Scrub/shrub generic	201	Average (or unknown/assumed average)	1	Scrub	Sc	1
		Average (or unknown/assumed average)	1	Gorse	Hg	10
Dwarf scrub/shrub generic	202	Average (or unknown/assumed average)	1			
Heathland and dwarf shrub	206	Average (or unknown/assumed average)	1	Heather & dwarf shrub	H	10
		Average (or unknown/assumed average)	1	Dry heath	Hd	10
Heathland and grass	207	Burnt	5	Burnt heather	Hb	10
		Average (or unknown/assumed average)	1	Heather grass	Hga	11
		Average (or unknown/assumed average)	1	Montane habitats	Z	13

LUCI Code system | LUCI to UK | LUCI to EUROPE_US | LUCI to NZ LCBD | LUCI to NZ Land Use 2011 | LUCI to BoPRC Land Use | Sheet2 | Wales Phase I | UK LC ...

Final points

- “Naively”; easy to link up biophysical outcomes from models with fine resolution to any of the proposed “ecosystem accounting units”
- Should some ecosystem accounting units screen for configuration where they lose spatial connections (e.g. reporting against land cover, other “point” information) to avoid perverse outcomes?
- “Origin” of service entering spatial system may not be the best start point or boundary
- We have a system that already considers condition and capacity naturally; and can report in any unit . We and other groups are already formalising this conceptually; while also looking to this group and others to evolve for multiple needs going forward
- Consider what is needed for data and models to not only support countries providing ecosystem accounts, but also understand how different futures might change those accounts (scenario reporting)