



Soil carbon: Protecting our assets and developing our stores

Bridget Emmett

NERC's Centre for Ecology and
Hydrology



Outline

- How much is there?
- Where is it?
- What causes it to change?
- Why should we care?
- Can we make a difference?
- Some golden rules.....

How much is there?

Welsh soils store 409 Megatonnes of carbon

= 409 million tonnes of carbon

= £409 million (@ £25/tonne)

= 29 years of Wales CO₂ eq emissions

= 249 years of Welsh agricultural CO₂ eq emissions

11, 000 years to do this so.....

A National Treasure!



What else does the soil do for us?

Water:

Flood and flow regulation

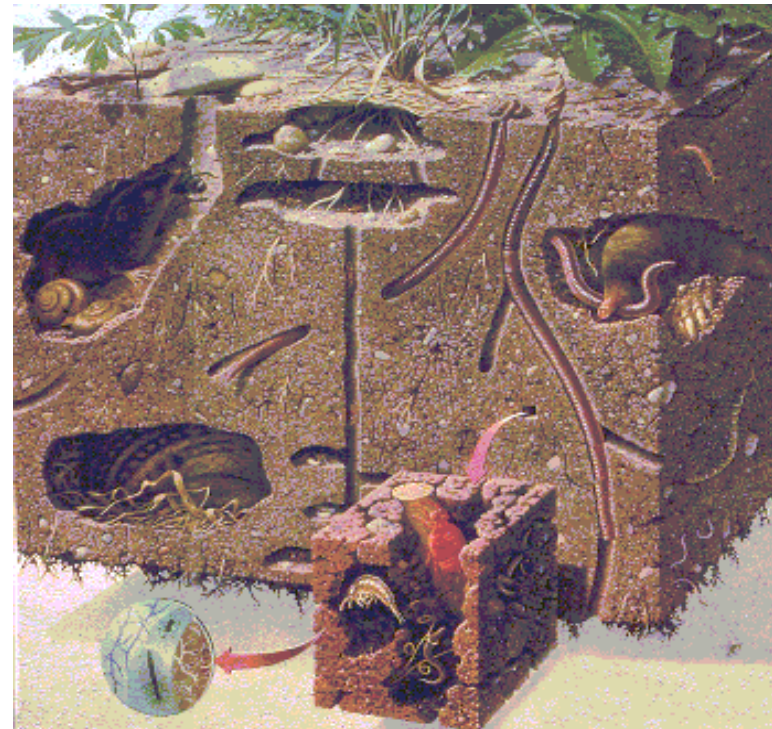
*Filtering of contaminants for fresh-water
and marine systems*

Nutrient cycling:

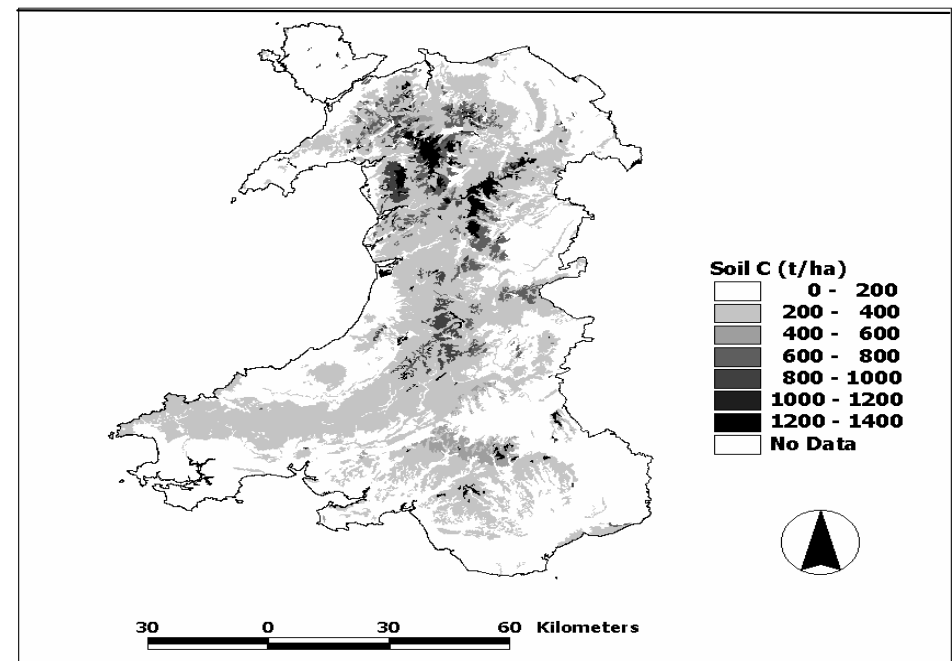
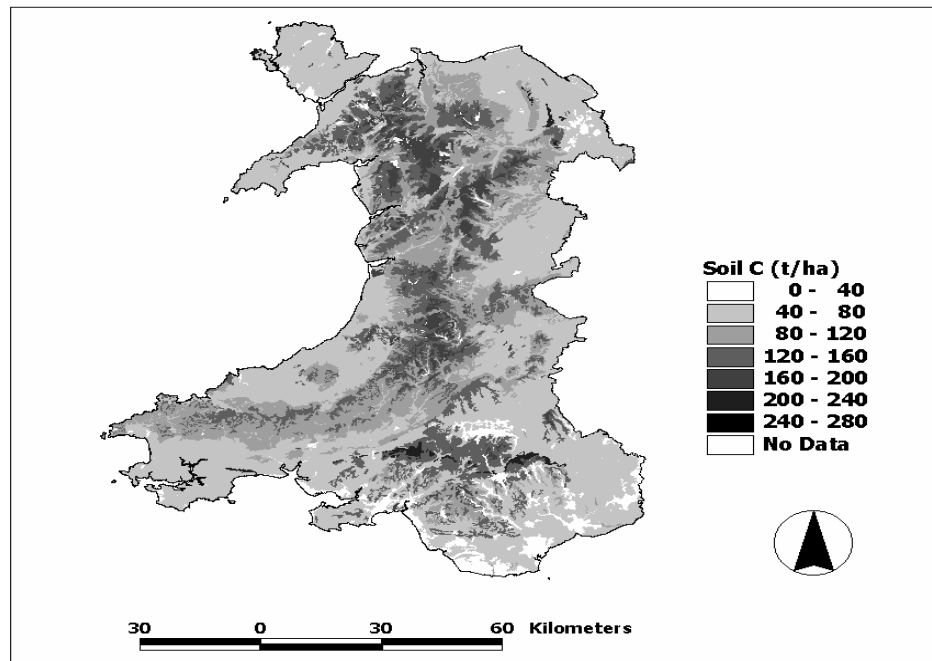
Basic support of food, biomass and fibre

Biodiversity and genetic resources:

*Supports biodiversity above-ground and
huge below-ground biodiversity*



Where is it?

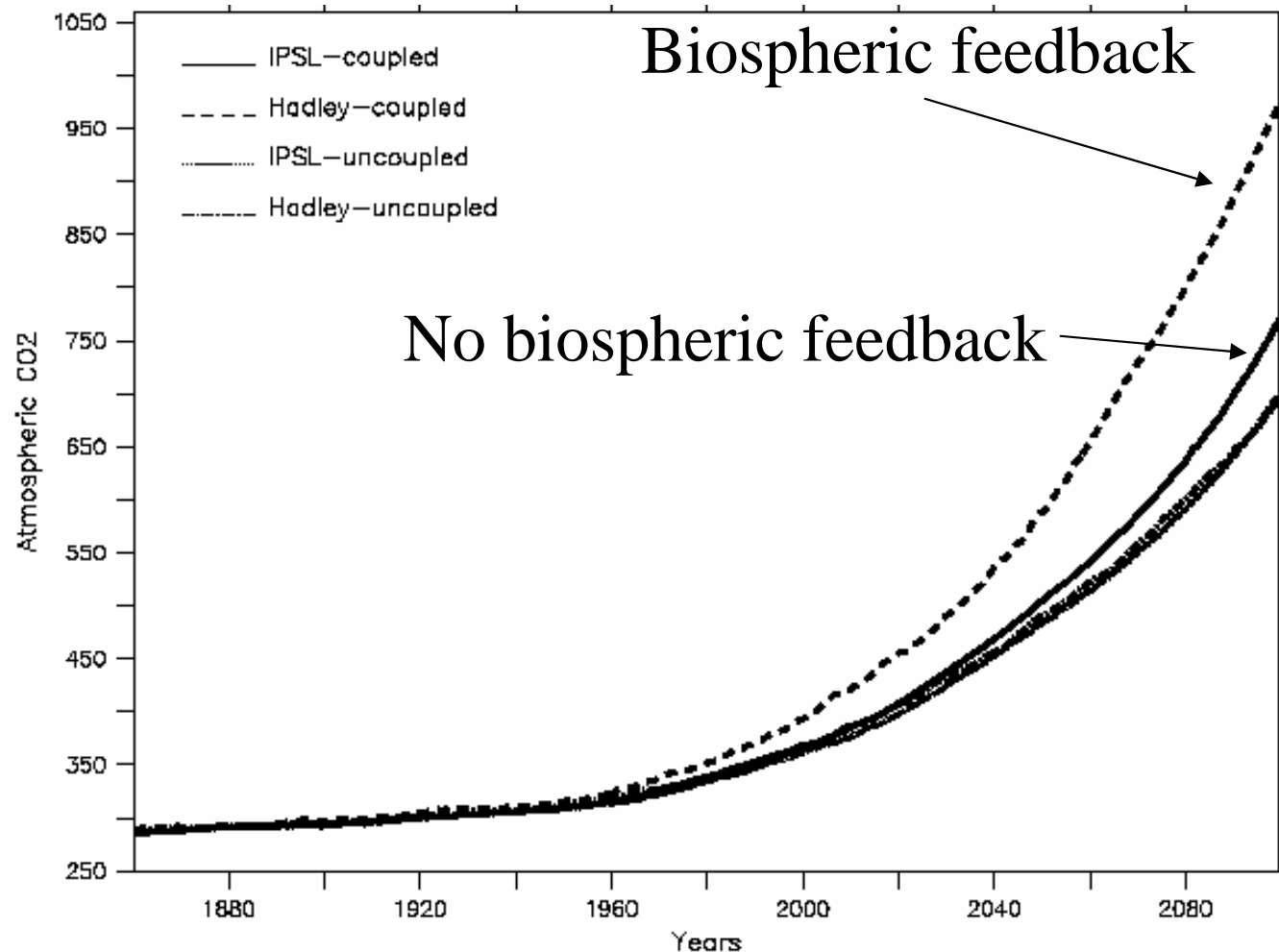


50% of carbon is in 23% of land area = uplands

What causes it to change?

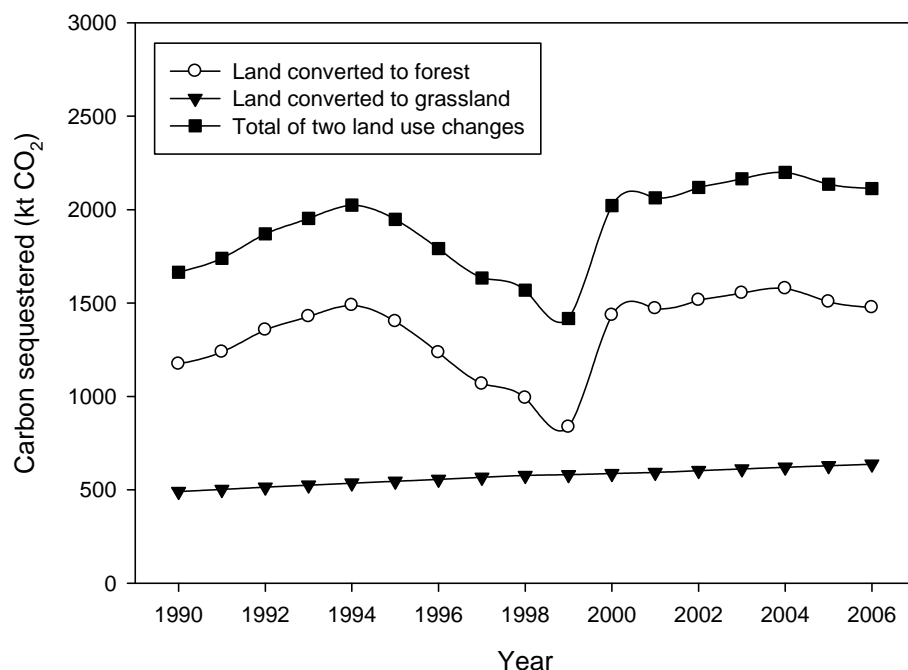
- Changing land cover
 - A switch from a high to low carbon system e.g. woodland to grassland
- Changing land management
 - Anything which causes less carbon to be fixed by plants e.g. ozone
 - Anything which causes more carbon to be lost from soils e.g. liming, drainage
- Climate change
 - Positive feedback with warming and drought of wet soils causing release of GHG from soils

The big worry.....

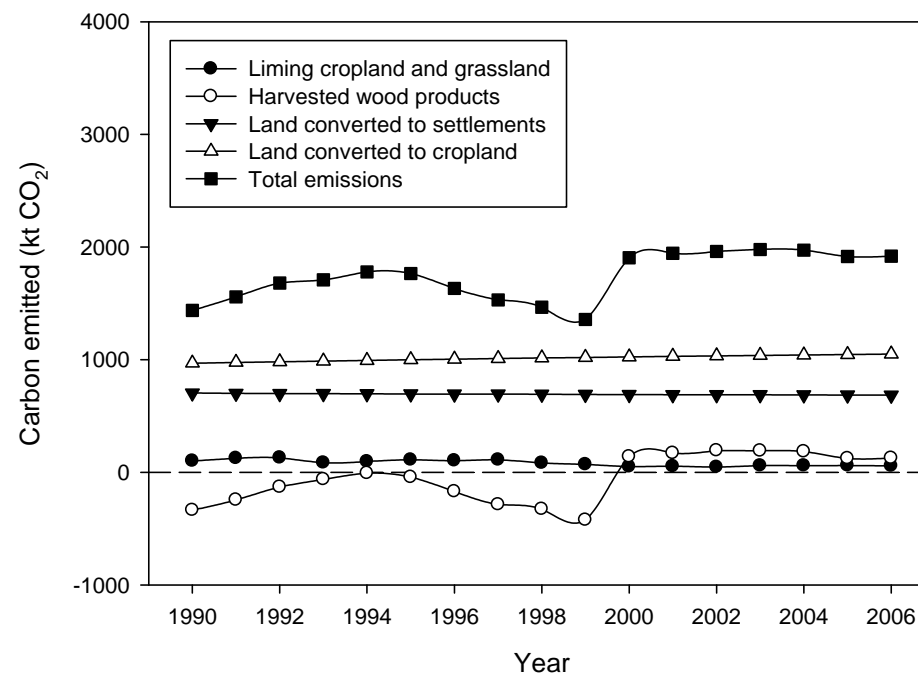


Does land management in Wales result in a source or sink?

Carbon captured by land



Carbon lost by land

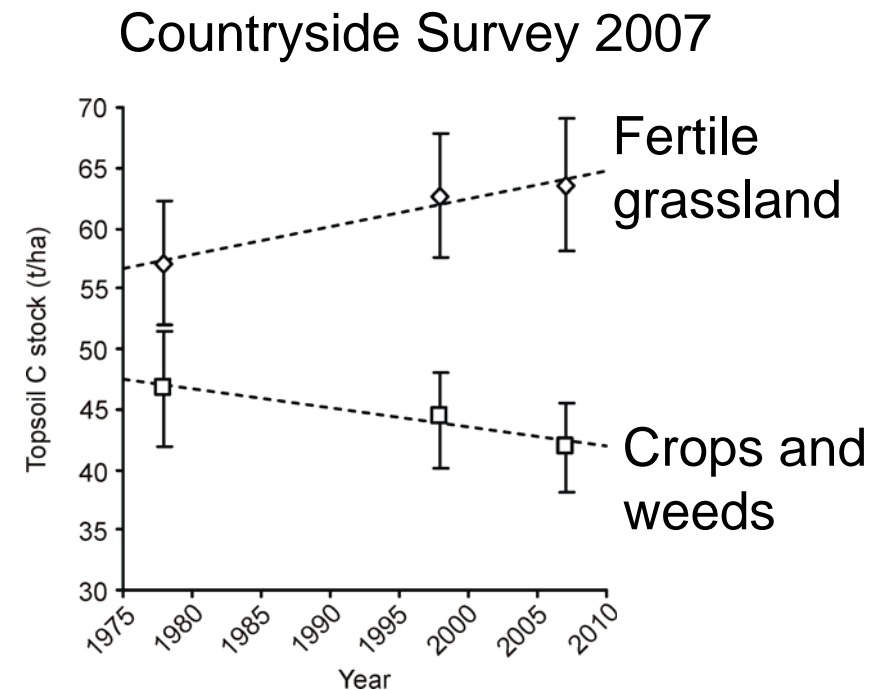


Net sink in 2005 of 248 kt CO₂ eq

But the inventory is quite crude and does not capture all the changes

So can we measure the changes which are due to soil carbon?

- Not very well!
- Problem of resources to detect small but important changes (<8% change) and only topsoil (0-15cm)
- Two national soil monitoring studies of top soil which disagree;
 - National Soil Inventory = Major loss (15% in 25 years Bellamy et al. 2005)
 - Countryside Survey 2007 = No change (Carey et al. 2008; www.countrysidesurvey.org)

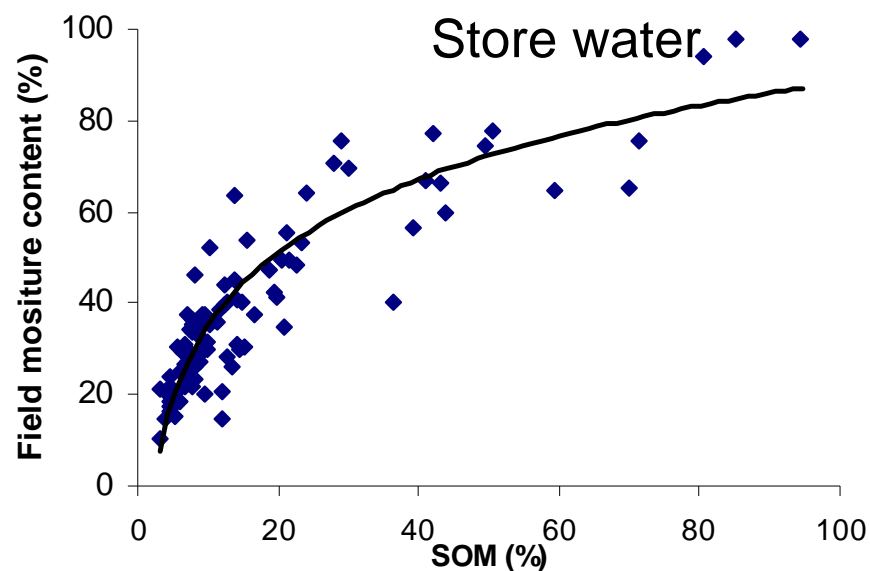
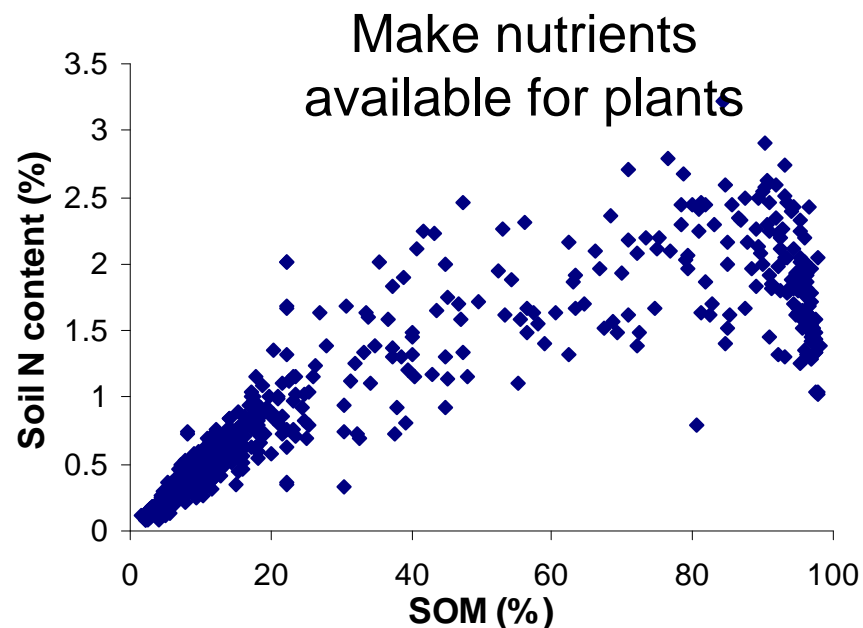
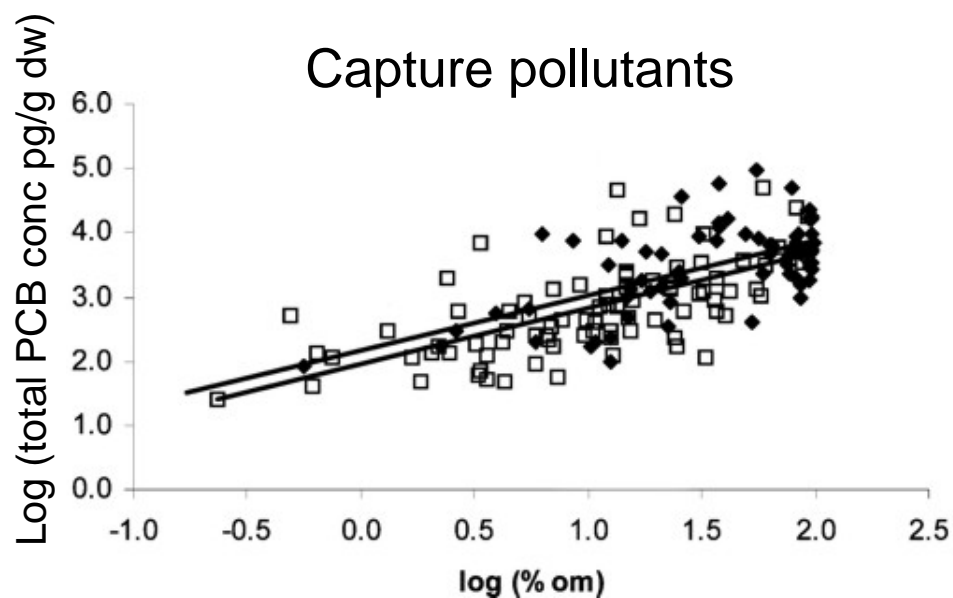


Carey et al. 2008

The 2 teams agree we need an improved national soil monitoring programme to 1m depth. Major under-resourcing compared to monitoring of biodiversity and water

Why should we care?

- Carbon enables soil to.....

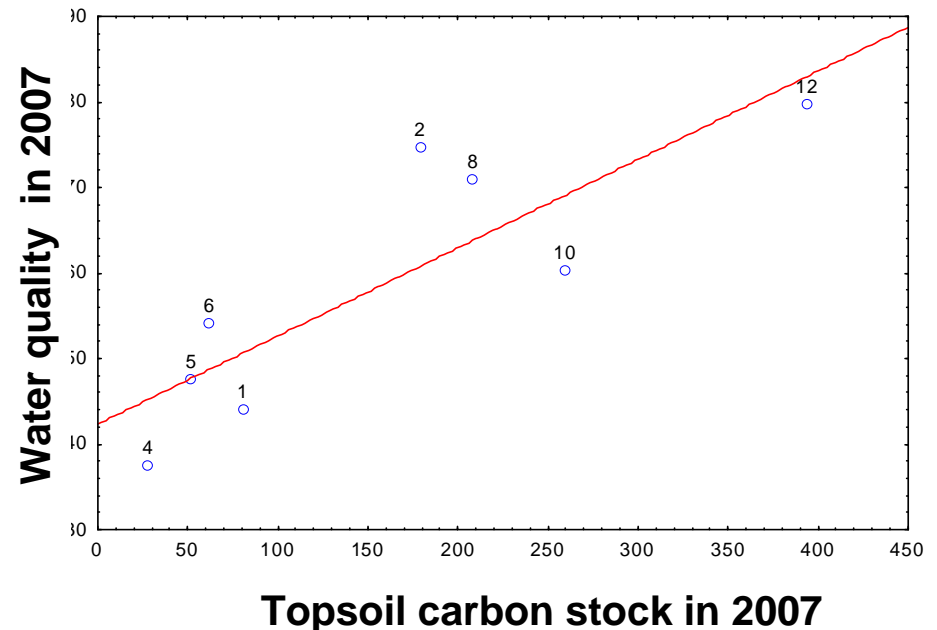


Relationships between soil carbon and other ecosystem services at a national scale

Metrics 2007	Broadleaved	Coniferous	Linear	Arable	Improved Grass	Neutral Grass	Calcareous Grass	Acid Grass	Bracken	DSH	FMS	Bogs
Biodiversity- total taxon rich X plots	20.9	14	15.4	10.2	14.3	20.4	43	19.6	19.3	15.9	21.9	17.2
Topsoil Carbon (0-15cm)	80.7	179.1		27.9	51.7	61.9		208.1	180.7	259.5	208.	393.5
Water quality (taxa no.)	44.0	74.6		37.5	47.5	54.2		71.0		60.3		79.7
Butterfly food plants	3.6	3.2	4.6	4.1	5.4	5.9	11	5.4	4.3	4.3	4.6	4.1
Habitat provision (Area of Broad Habitat 'ooos ha)	1406	1319	496	4608	4494	2176	57	1589	260	1343	392	2232

- Are carbon-rich systems associated with good water quality across Broad Habitats?

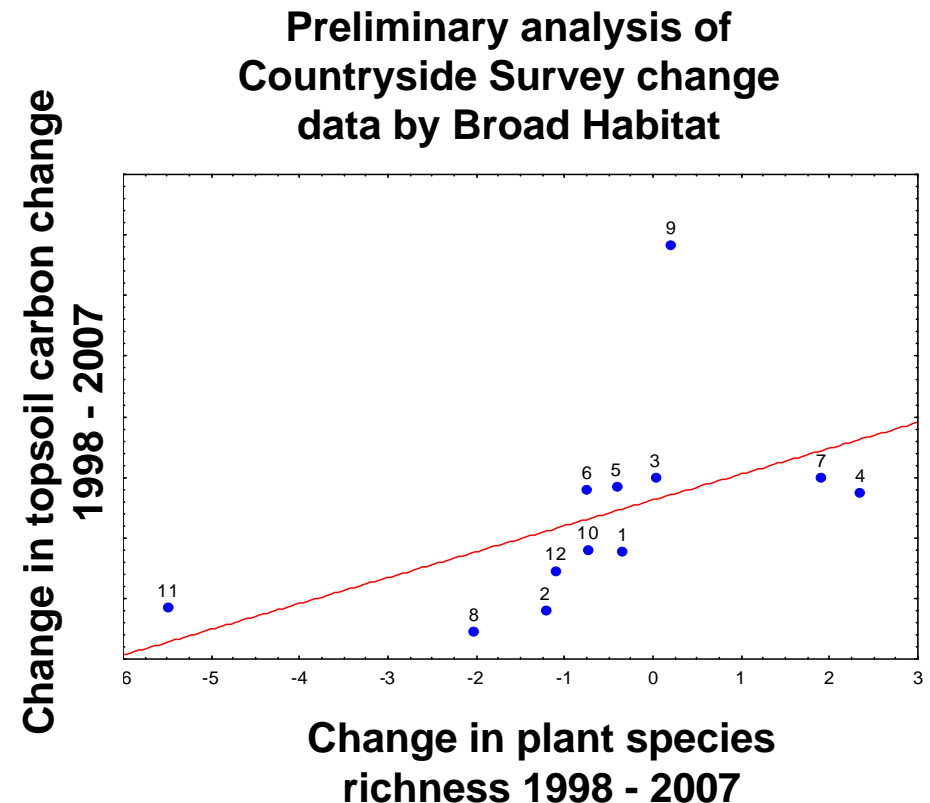
Preliminary analysis of Countryside Survey data by Broad Habitat



If we change soil carbon – is there a benefit elsewhere?

Metrics 2007	Broadleaved	Coniferous	Linear	Arable	Improved Grass	Neutral Grass	Calcareous Grass	Acid Grass	Bracken	DSH	FMS	Bogs
Biodiversity- total taxon rich X plots	20.9	14	15.4	10.2	14.3	20.4	43	19.6	19.3	15.9	21.9	17.2
Topsoil Carbon (0-15cm)	80.7	179.1		27.9	51.7	61.9		208.1	180.7	259.5	208.	393.5
Water quality (taxa no.)	44.0	74.6		37.5	47.5	54.2		71.0		60.3		79.7
Butterfly food plants	3.6	3.2	4.6	4.1	5.4	5.9	11	5.4	4.3	4.3	4.6	4.1
Habitat provision (Area of Broad Habitat 'ooos ha)	1406	1319	496	4608	4494	2176	57	1589	260	1343	392	2232
Change 98-2007												
Biodiversity change	-0.3	-1.2	0.03	2.4	-0.40	-0.7	1.9	-2	0.2	-0.7	-5.5	-1.1
Topsoil Carbon change (0-15cm)	-12.4	-22.1		-2.6	-1.5	-2.2		-25.6	38.2	-12	-21.6	-15.5
Water quality- change	-3.1	-0.5		5.0	2.9	0.4		5.3		-11.3		7.4
Butterfly food plants	0.1	-0.3	0.01	0.6	-0.31	-0.2	1.5	-0.8	-0.1	-0.4	-1.8	-0.3
Change in Area of Habitat	78	-67	-15	-459	243	169	-4	86	-55	44	-34	10

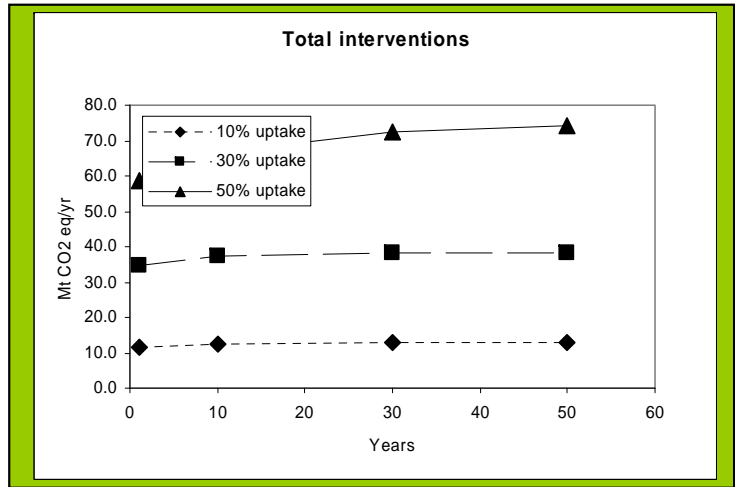
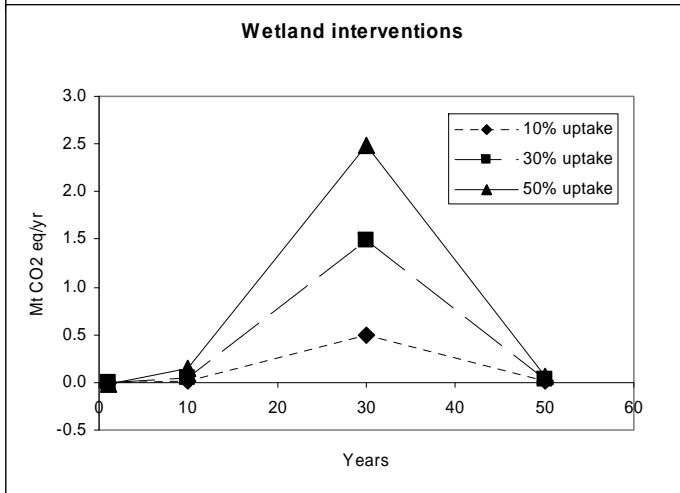
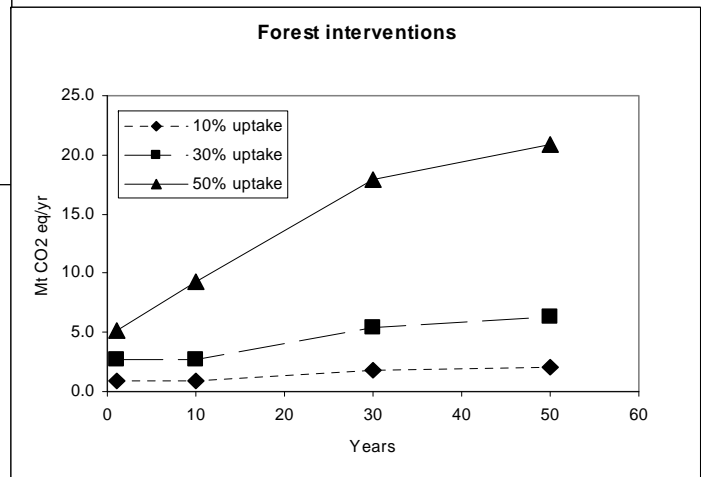
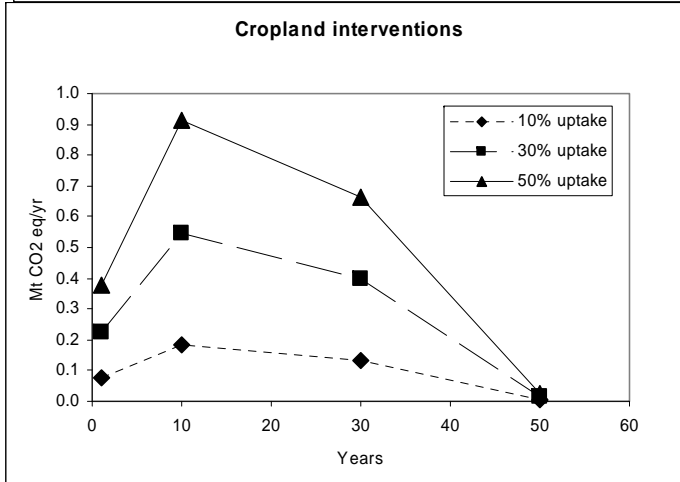
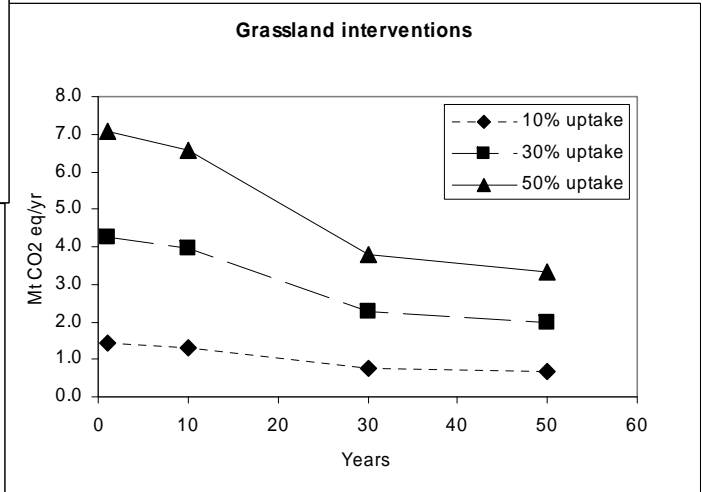
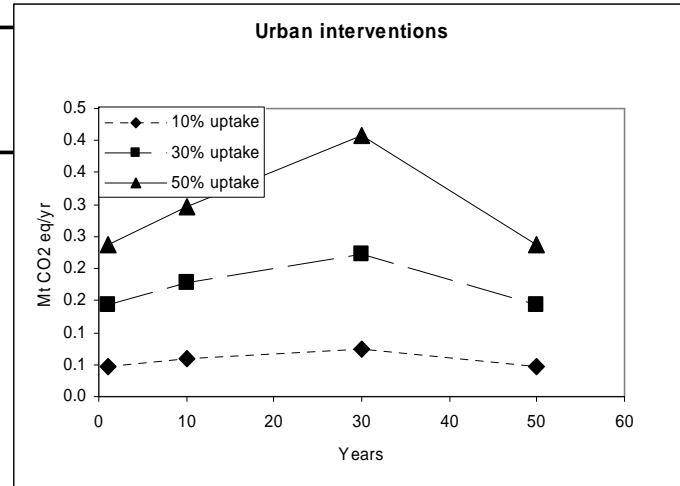
- Is an increase in plant biodiversity associated with an increase in topsoil carbon across Broad Habitats?





Can we really make a difference?

And if so how.....?



Best option in each category combined = 37% CO2 eq of 1990 agricultural emissions reduced



Golden rules

- Increase capture
 - Move to plants which store lots of carbon (i.e. trees but we need to maintain food production)
 - Manage carbon-rich plant better
 - Increase productivity, rotation length, native species
 - Use manures and biosolids to increase soil carbon
 - Research into biochar (pyrolysis of wood, waste, biosolids to form safe for 1000's of years)

Golden rules

- Stop losses
 - Use nitrogen more efficiently (i.e. apply N so crops use most efficiently – saves GHG used in making fertiliser and not lost as N₂O)
 - Rewet peat soils (there may be a trade-off with methane initially)
 - Stop additions which encourage soil microbial activity and thus CO₂ losses e.g. liming
 - Minimise tillage to stop CO₂ loss (but there may be a trade-off in N₂O and CH₄ on some soils)