

Natural Capital Accounting of the Air Quality Regulating Service of Trees in the UK



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Air pollution and human health

5.5 million deaths globally
40,000 deaths, UK

Which pollutants

PM10

PM2.5

NO2

NH3

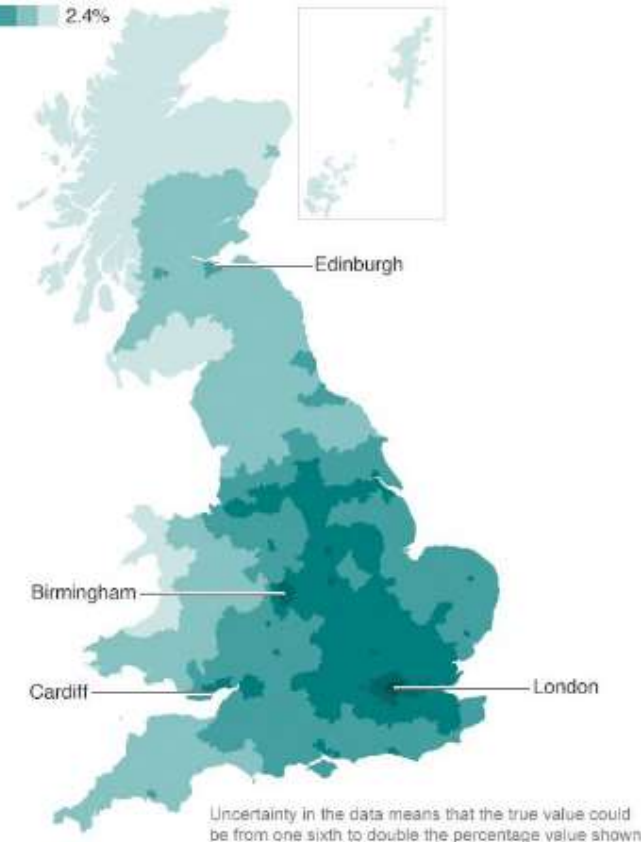
O3

SO2

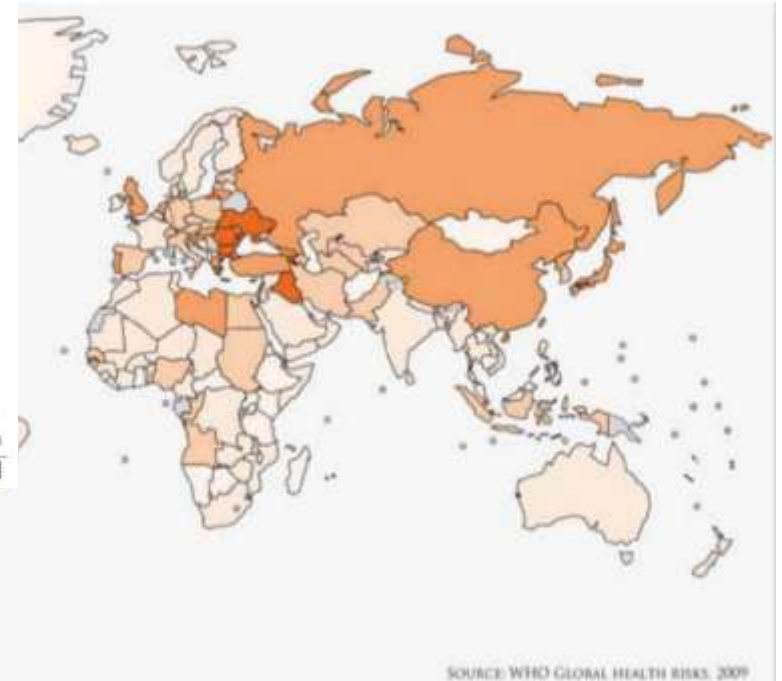
Air pollution deaths

Estimated percentage of adult deaths attributable to PM 2.5 particulate air pollution
Map data does not include other types of air pollution, eg nitrogen dioxide

8.3%  2.4%



Source: Public Health England



Trees remove air pollution

London's trees remove 2.2 kt pollutants (**i-tree Eco**)

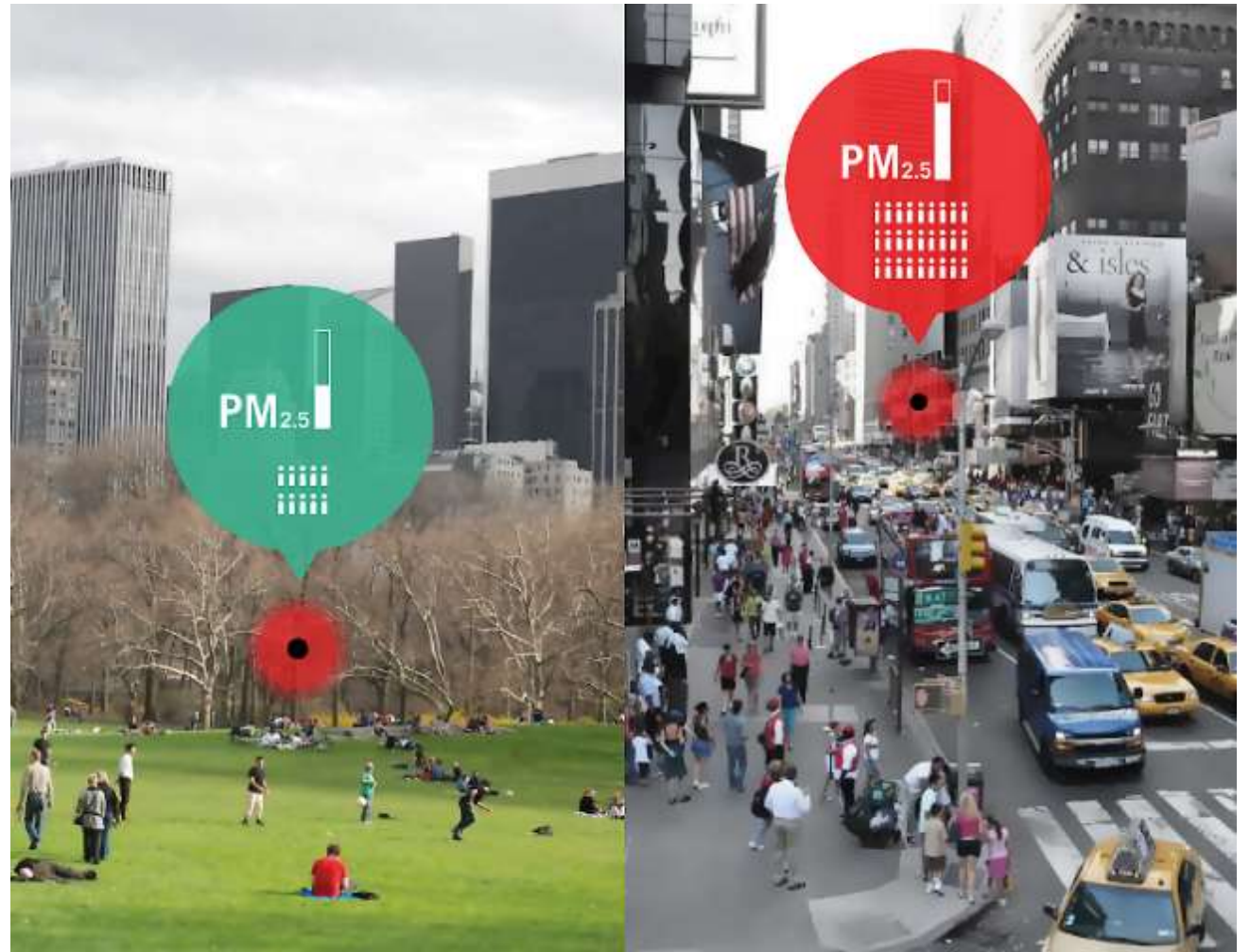
Trees reduce pollutant concentrations by 1 – 10% (**Nowak et al. 2013**)

Rome (**Manes et al., 2012**)

- Ozone ~\$3 million/yr for human health benefits (risk of mortality due to ozone)
- PM₁₀ \$36 million/yr

Case study small area (10 km x 10 km) in London (**Tiwary et al., 2009**)

- PM₁₀ 2 less deaths and 2 less hospital emissions per year.



Nyhan M. 2015, SENSEable City Lab, MIT

Pollution removal by vegetation

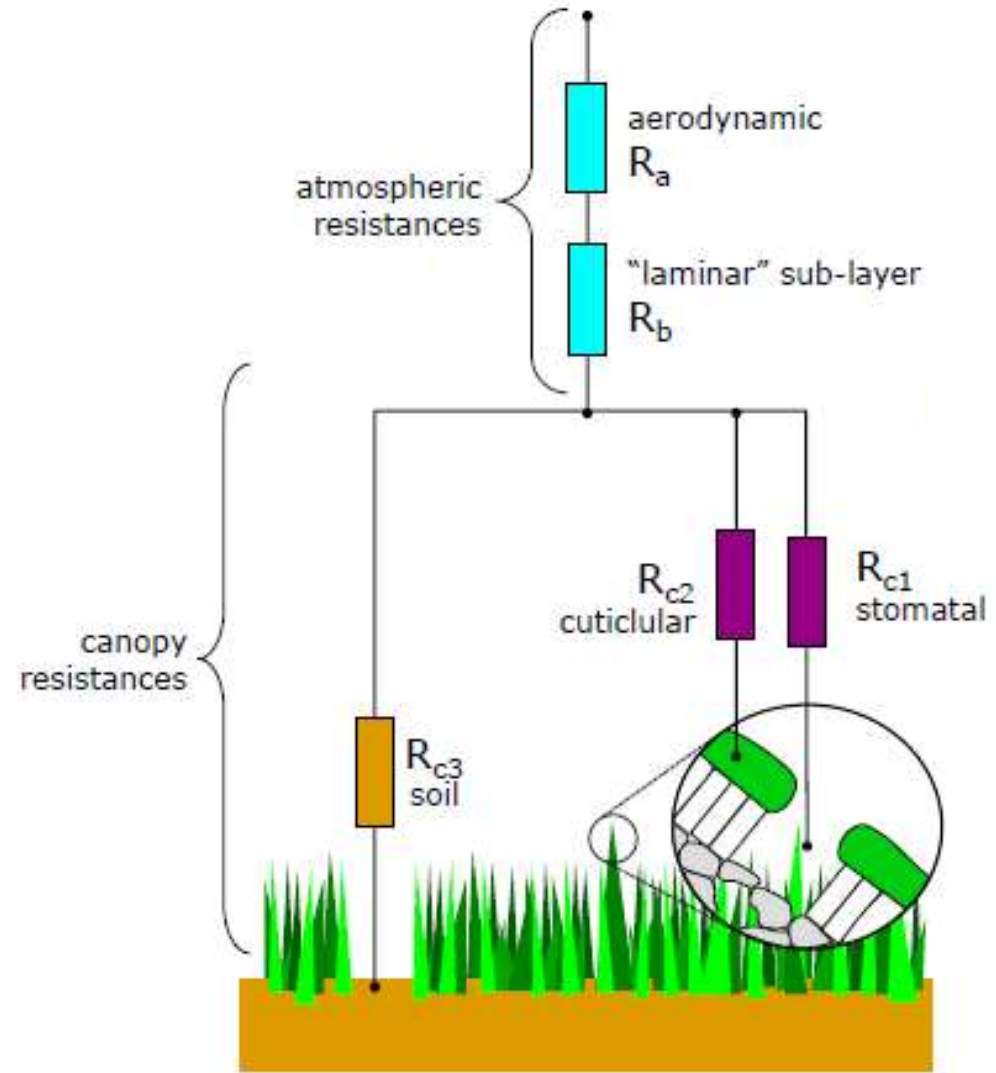
Aerodynamic resistance

Boundary resistance

Canopy resistance

To surface

To stomata

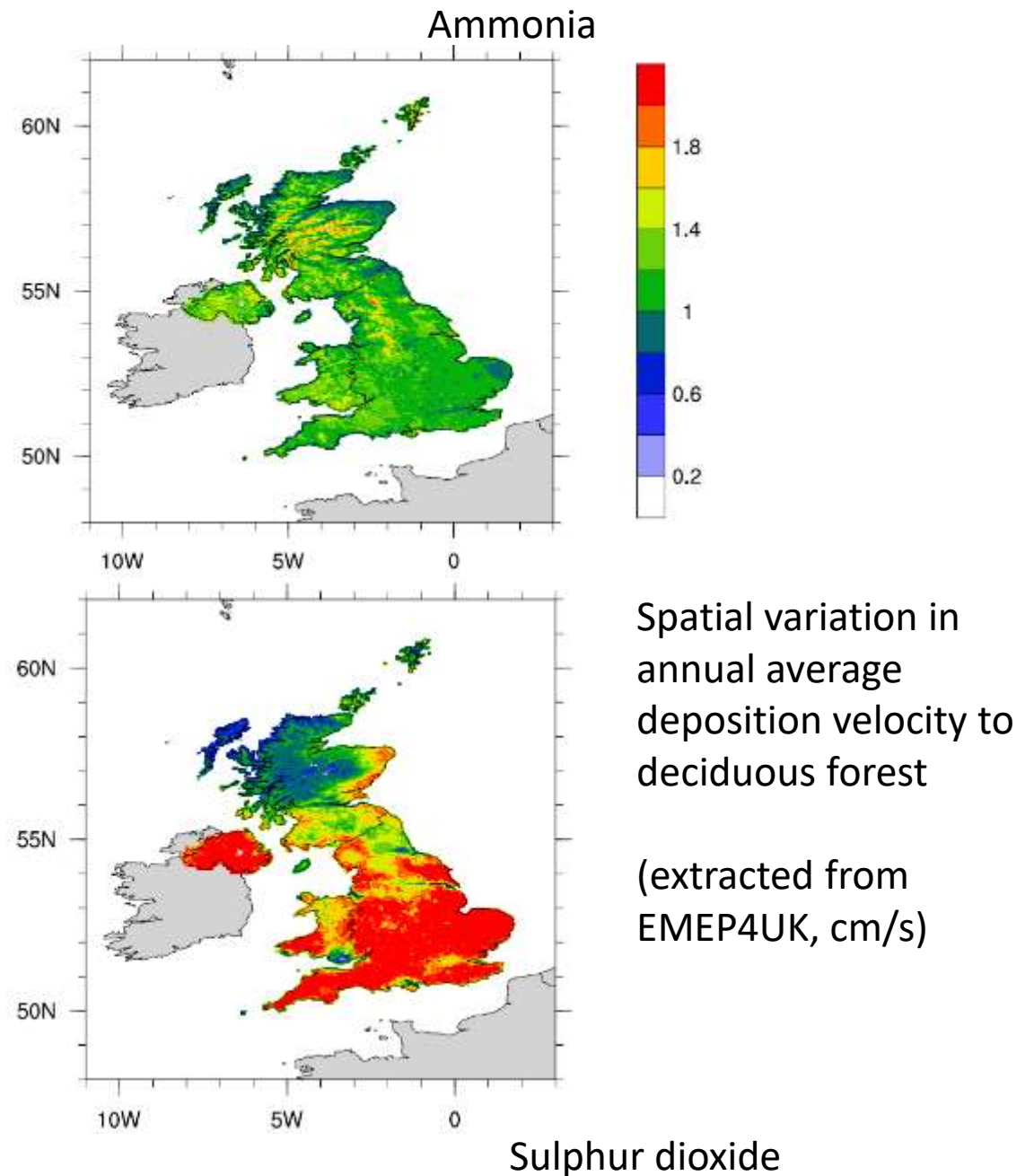


Most similar approaches ...

- Apply a single deposition velocity
 - Adjust for meteorology (dry days per year)
 - Adjust for seasonality (in leaf/off leaf)

Don't consider:

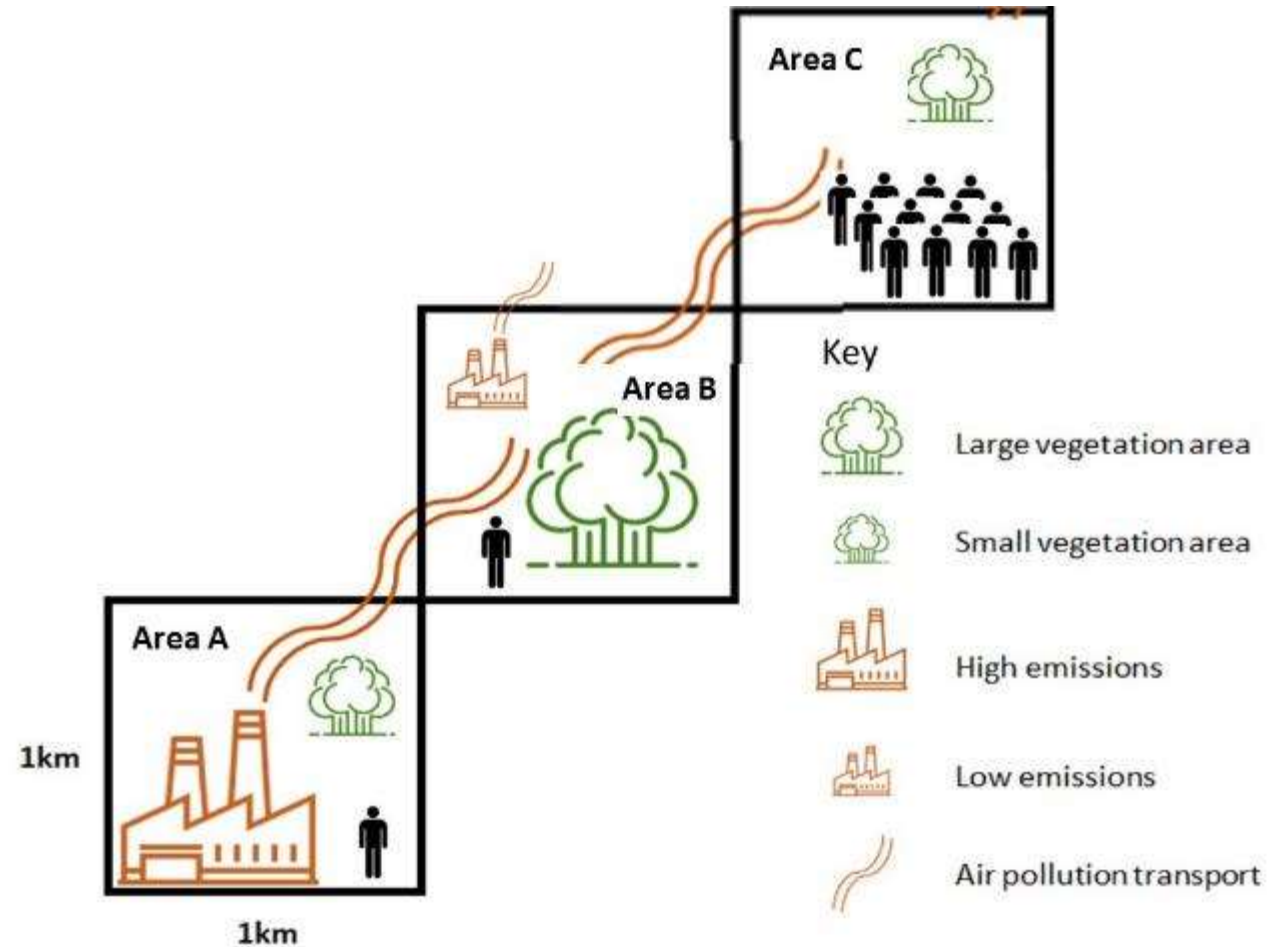
- Pollutant interactions
- Dynamic meteorology
- Transport



Spatial context

Atmospheric transport

Location of beneficiaries



The EMEP4UK
atmospheric chemistry
transport model

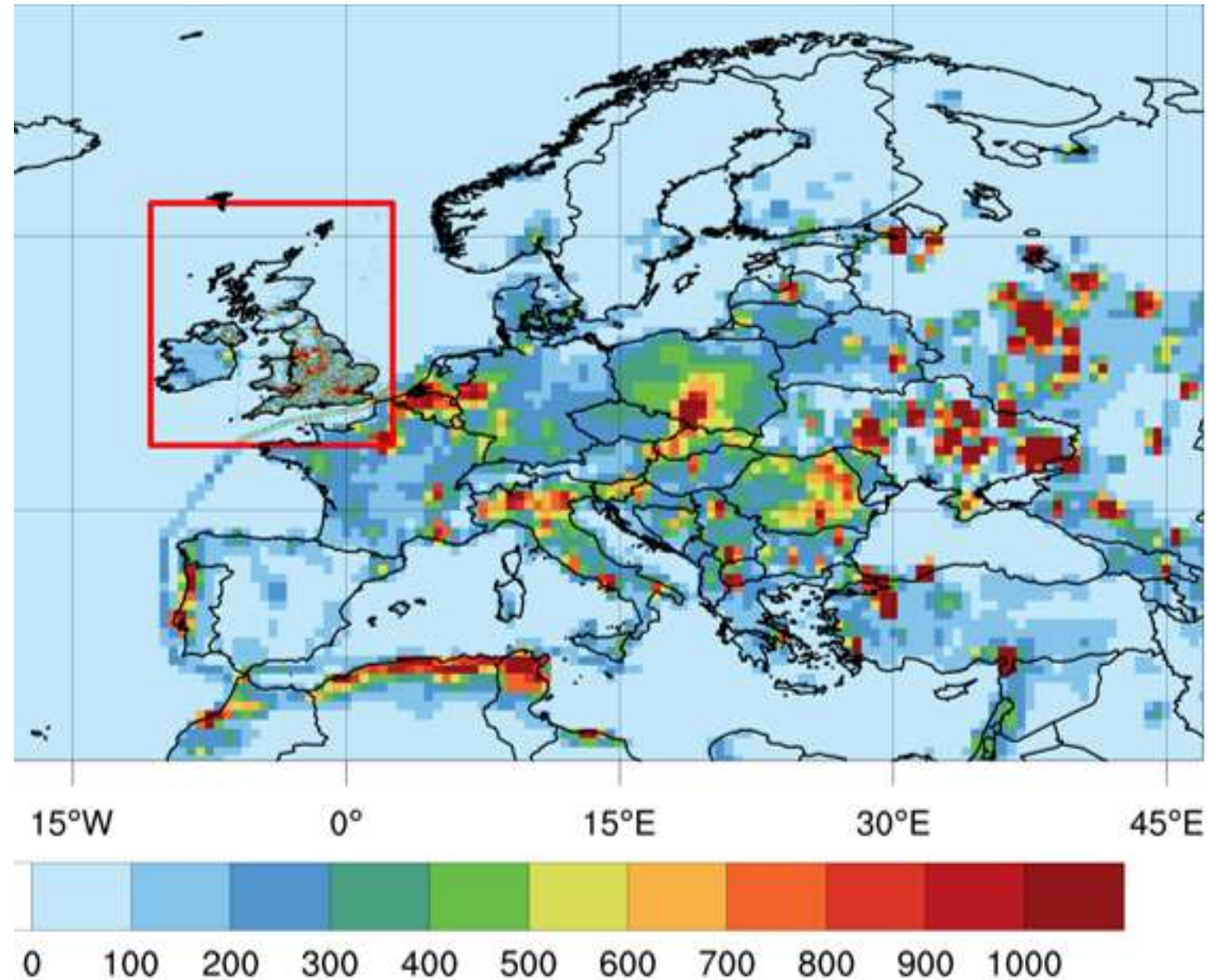
5x5km (~2x2km)

Hourly timestep

Dynamic interactions

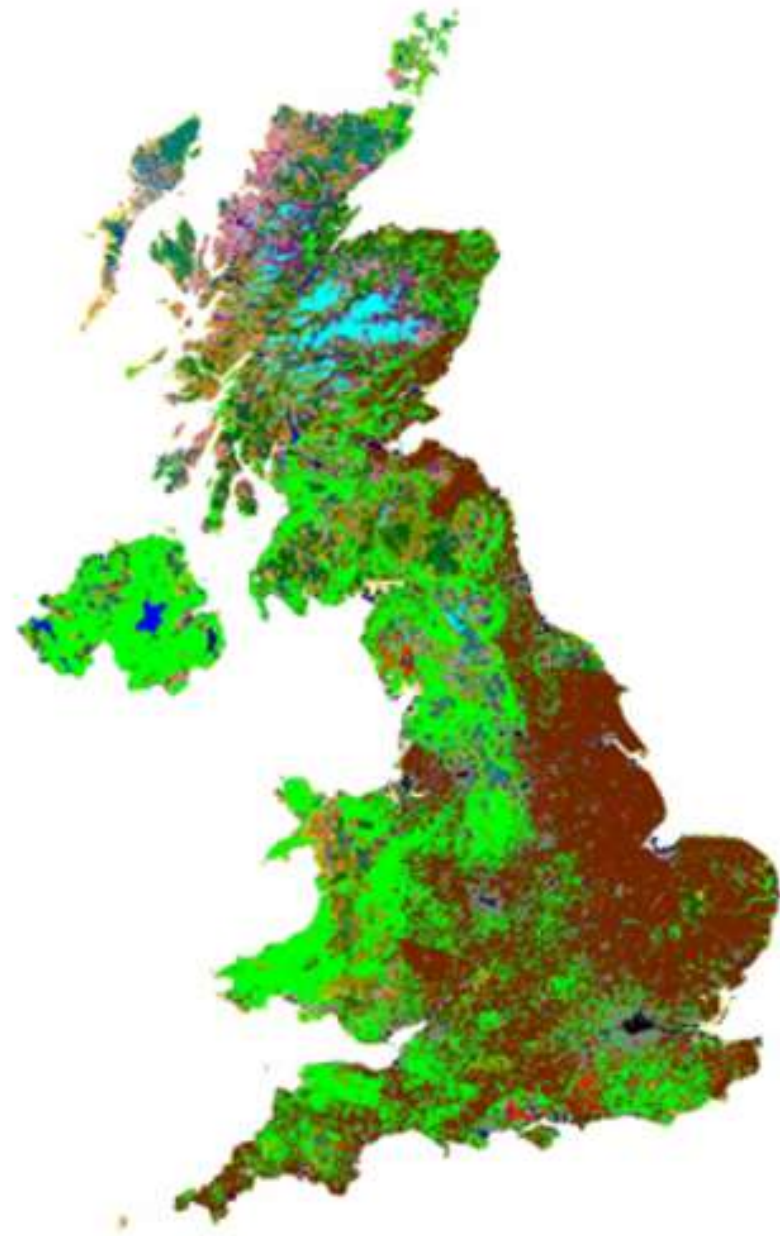
Transport

2015, emissions PM2.5 mg/m²

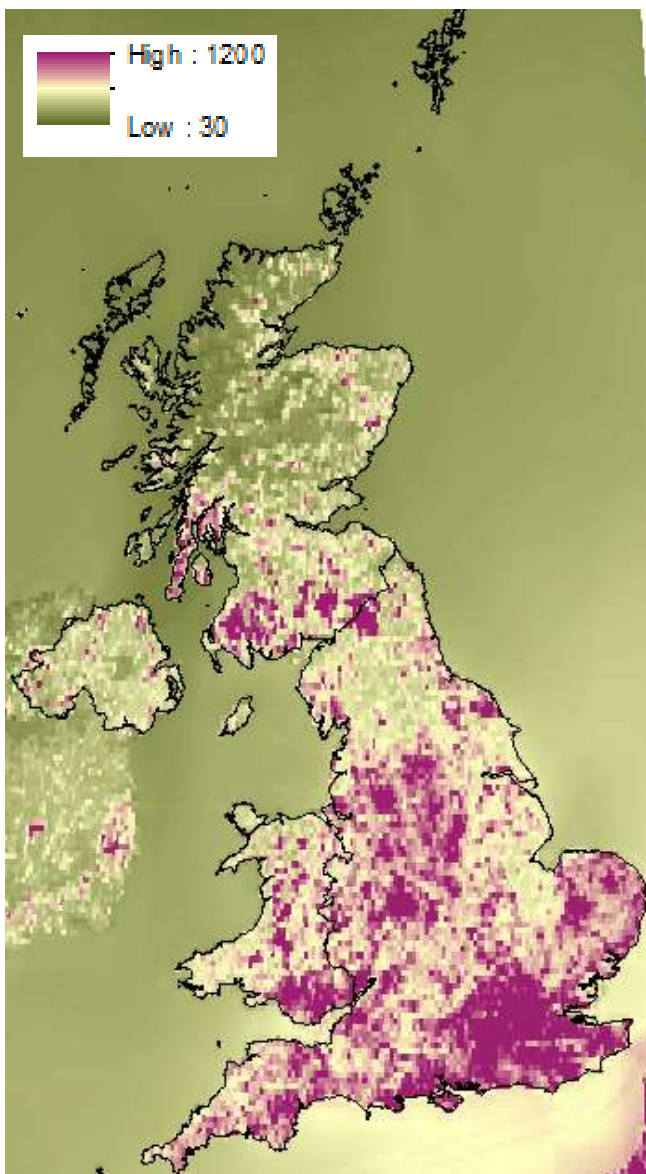


Land cover scenarios

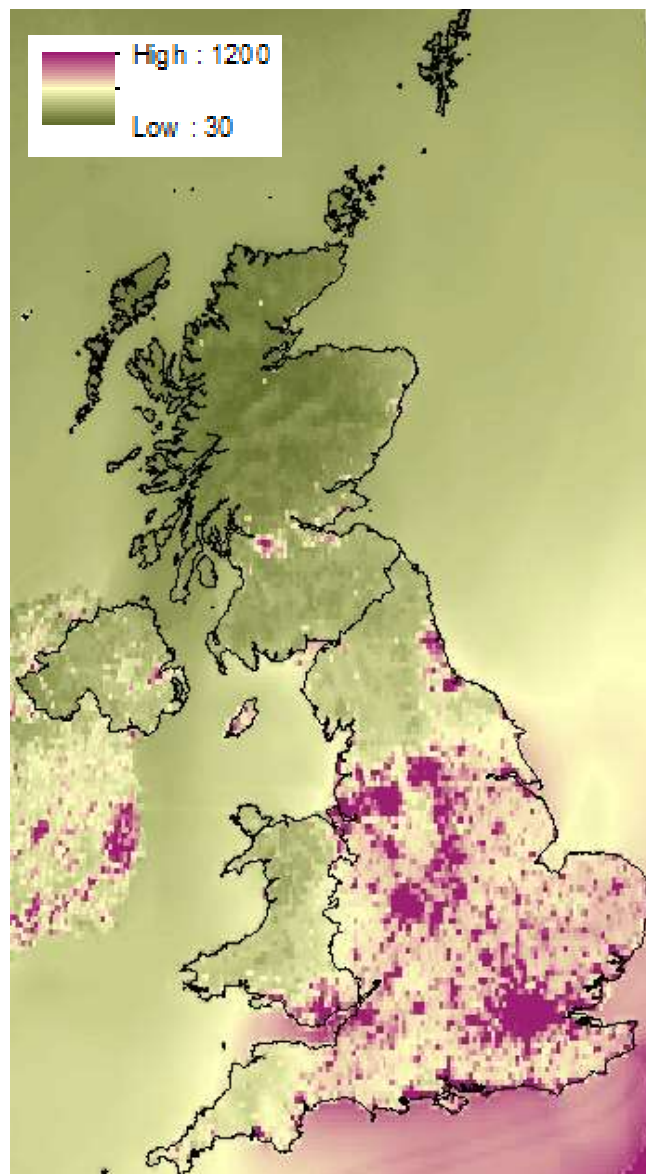
Change all vegetated land cover
to 'neutral'



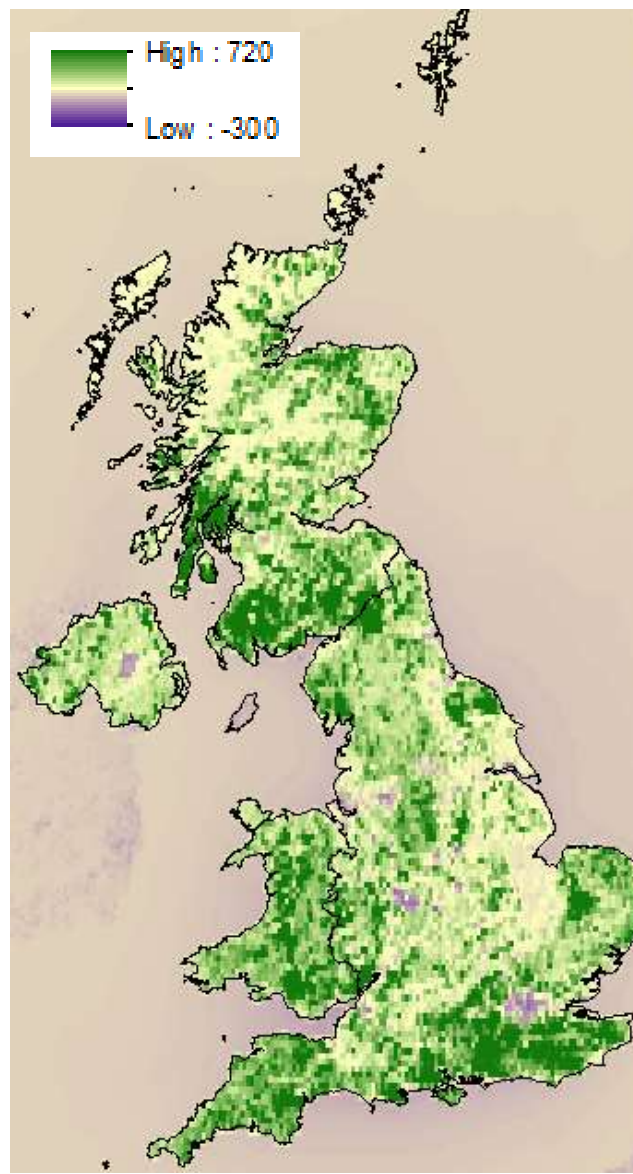
Base map, 2015



No vegetation scenario



Difference map



Quantity of
PM2.5
removed
(mg/m²)

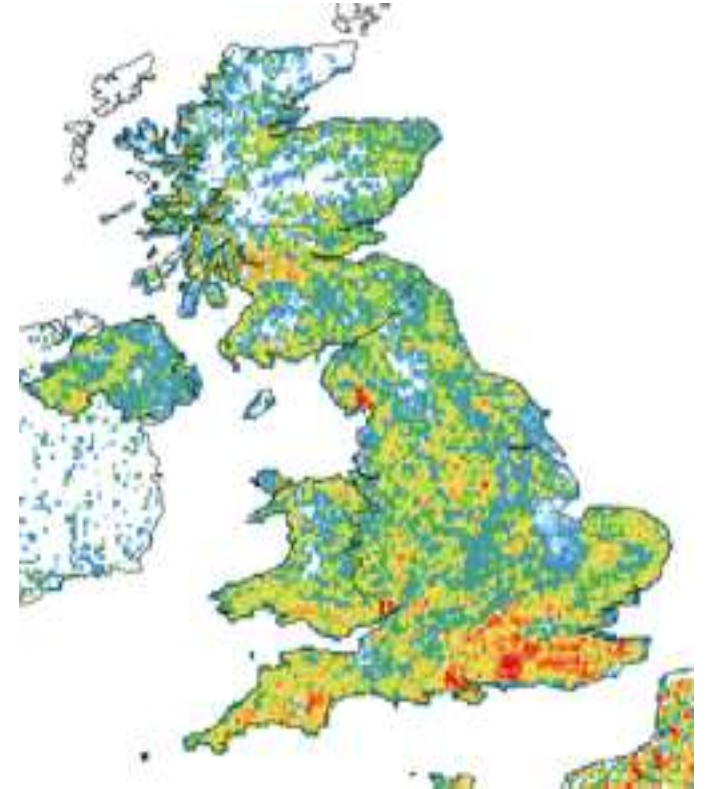
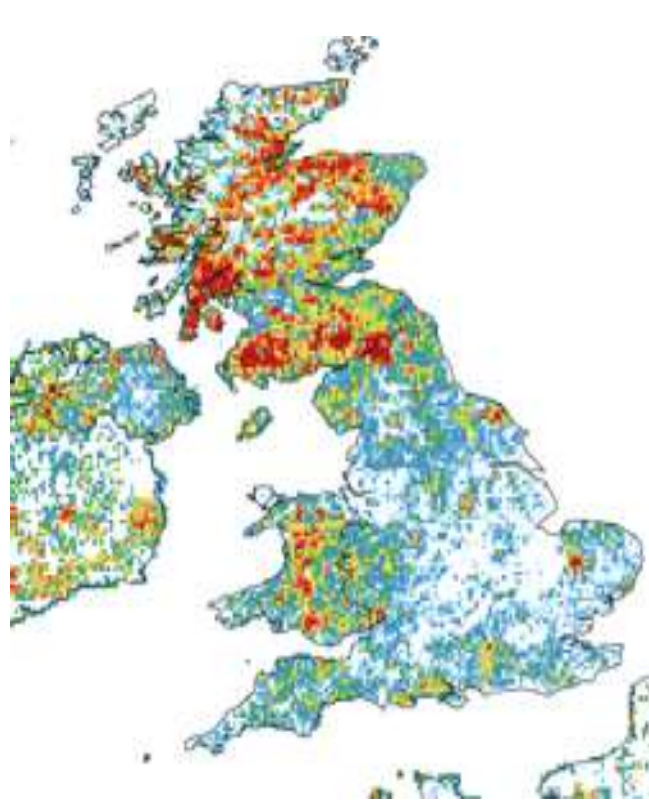
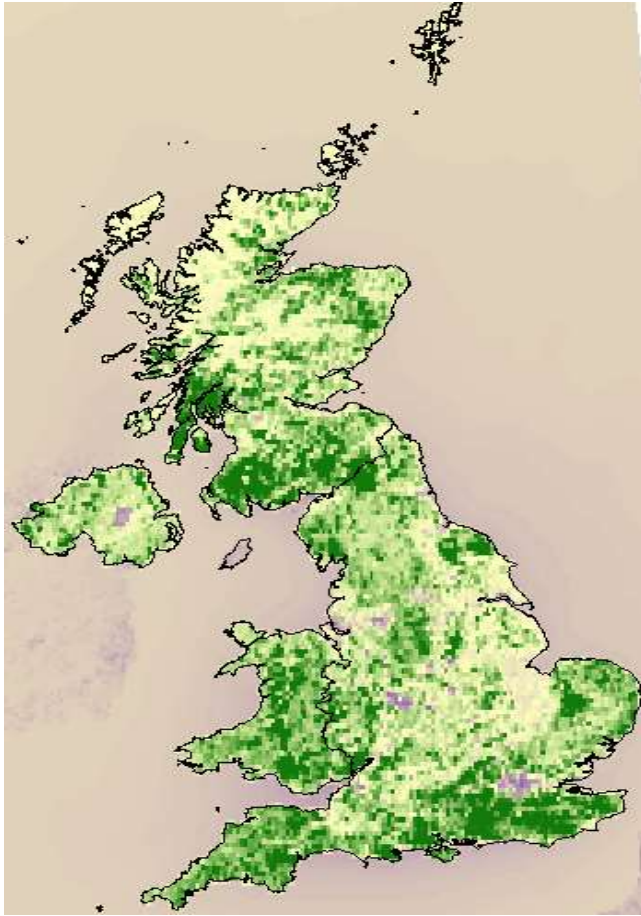
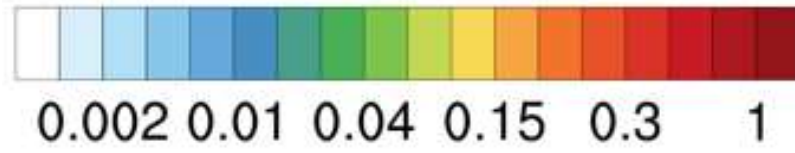
Table of deposition velocities (mm/s)

	Coniferous	Deciduous	Heather & grass	Reference	Crops	Water
				(No vegetation)		
PM ₁₀	7.88	5.31	2.54	2.34	2.35	2.37
PM _{2.5}	5.94	3.71	0.91	0.57	0.66	0.58
SO ₂	17.77	17.68	7.55	1.17	5.45	6.75
NH ₃	12.81	12.52	6.32	1.25	3.33	6.6
NO ₂	1	0.77	0.53	0.05	0.54	0.05
O ₃	4.32	3.83	2.67	0.5	3.51	0.5

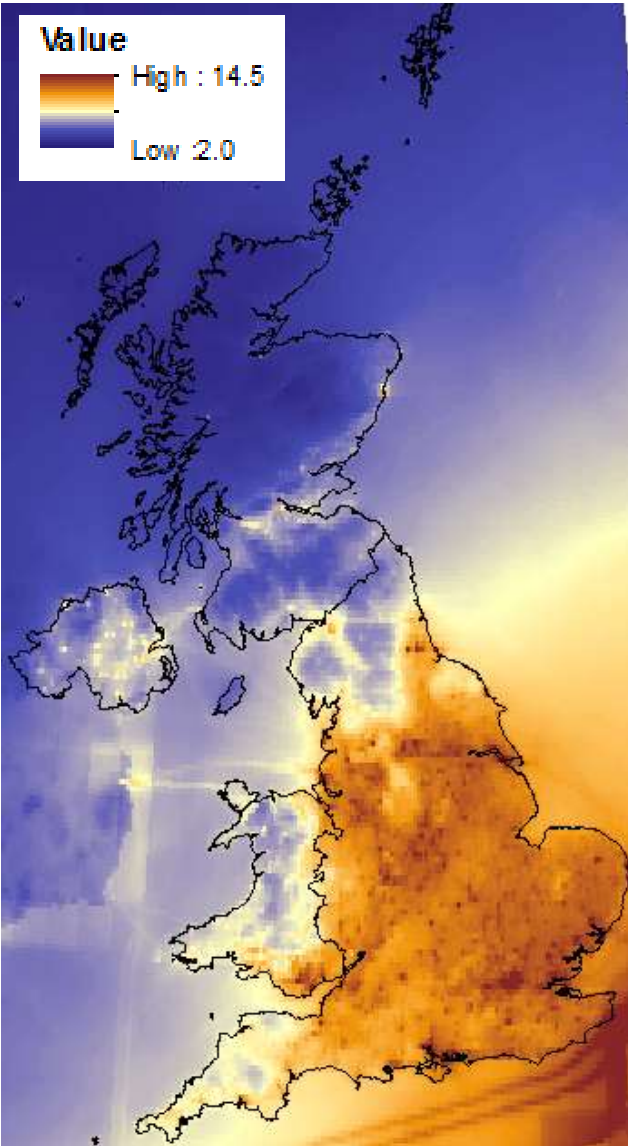
Quantities of pollutant removed (kt/yr)

Habitat	Coniferous woodland	Deciduous woodland	Semi-natural (grassland, moorland)	Crops	Total vegetation	Water / urban / ice (by difference)
Area CEH landcover (km ²)	15,361	13,950	135,909	63,161	228,381	69,106
PM ₁₀	21.3	14	7.7	0	43	-3.9
PM _{2.5}	9.6	8.2	4.5	-0.1	22.2	-2.3
SO ₂	4	7.1	17.7	9.5	38.3	-1.2
NH ₃	4.7	8.4	26.5	7.8	47.4	-4.5
NO ₂	1.6	2.6	10.4	9.1	23.7	-0.2
O ₃	121.6	95.5	597.1	383.9	1198.2	-26.7

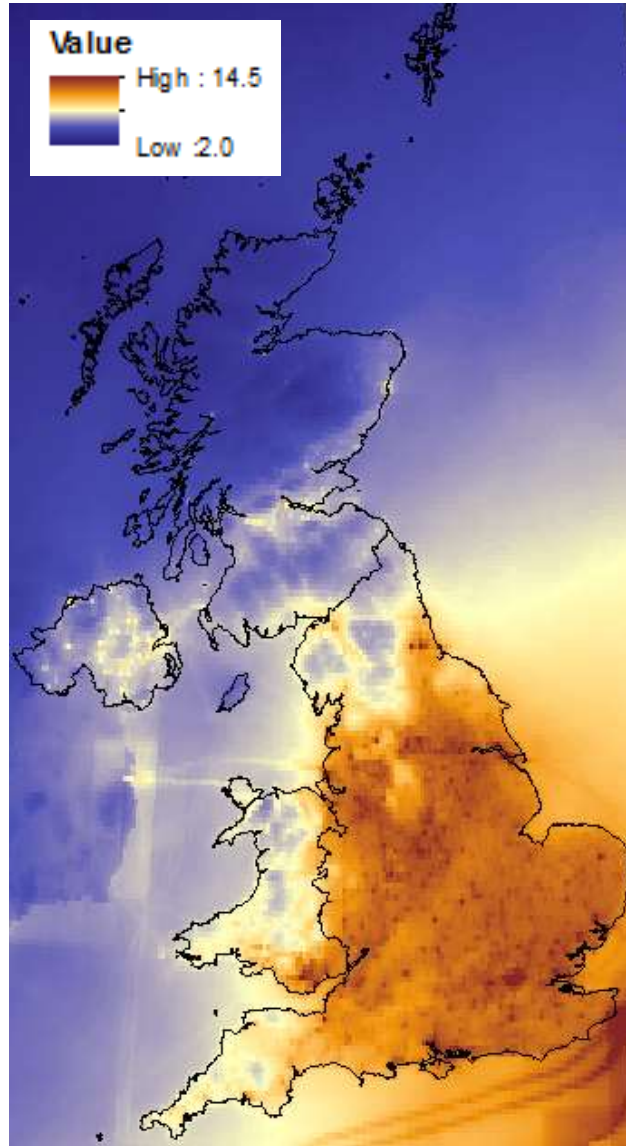
Where is the PM2.5 being removed



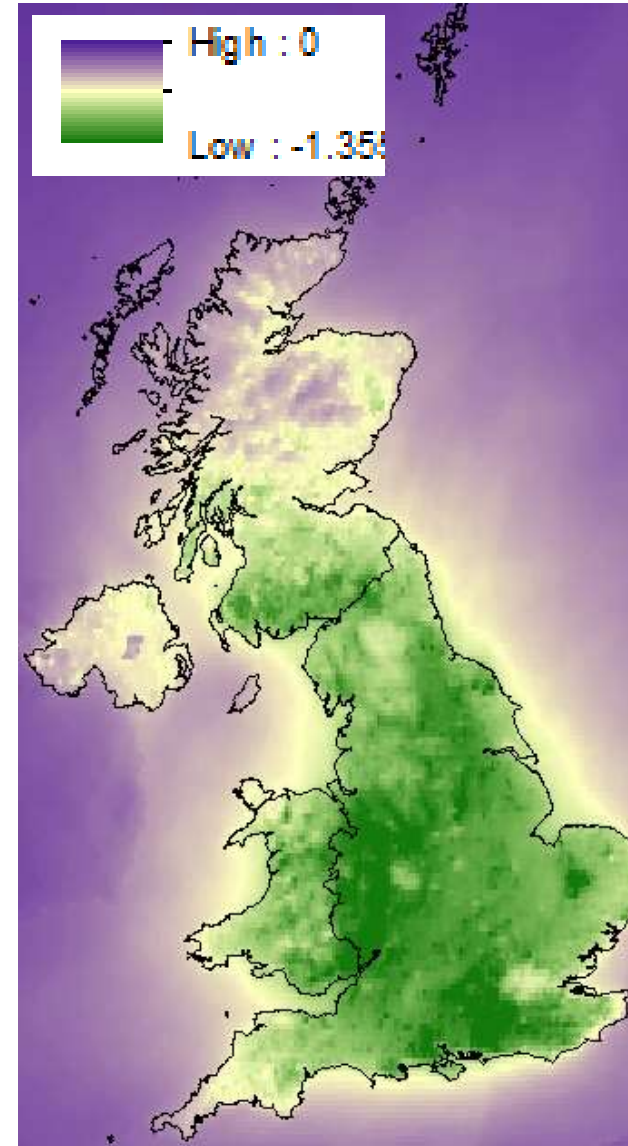
Base map, 2015



No vegetation scenario

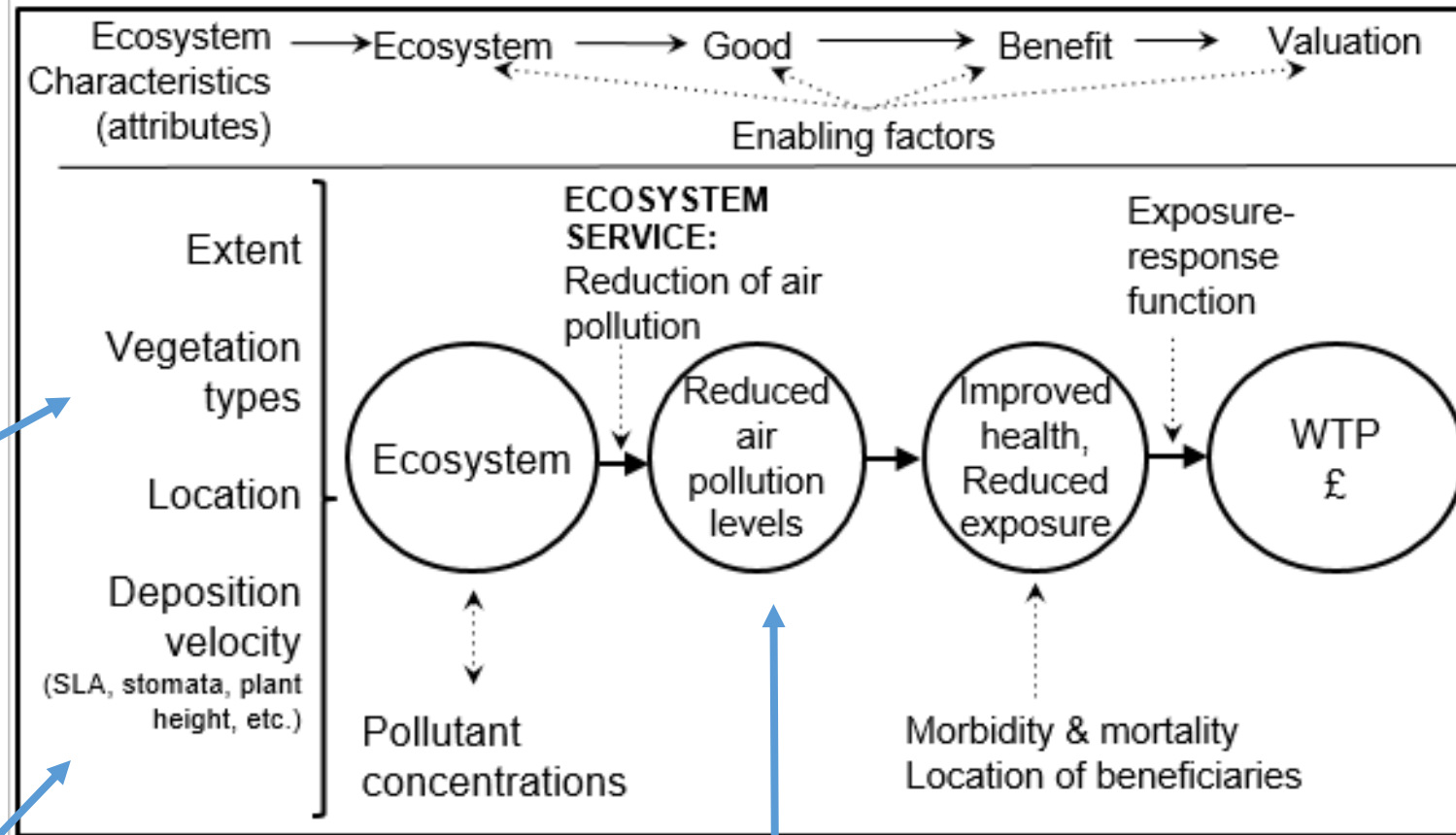
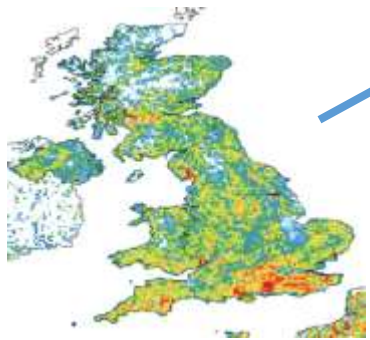


Difference map

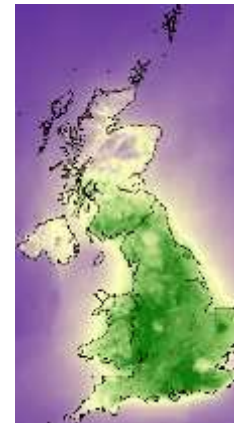


Change in exposure to PM2.5 ($\mu\text{g}/\text{m}^3$)

Natural Capital Accounts



	Coniferous	Deciduous
PM ₁₀	7.88	5.31
PM _{2.5}	5.94	3.71
SO ₂	17.77	17.68
NH ₃	12.81	12.52
NO ₂	1	0.77
O ₃	4.32	3.83



Next steps: Urban only scenario

- Health & economic analysis
- National scope
- Greater Manchester case study
- Finer resolution input data



Any questions

