Provision of ecosystem service information at the local level

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Defra Scoping Study on the Design and Use of Biodiversity Offsets in England

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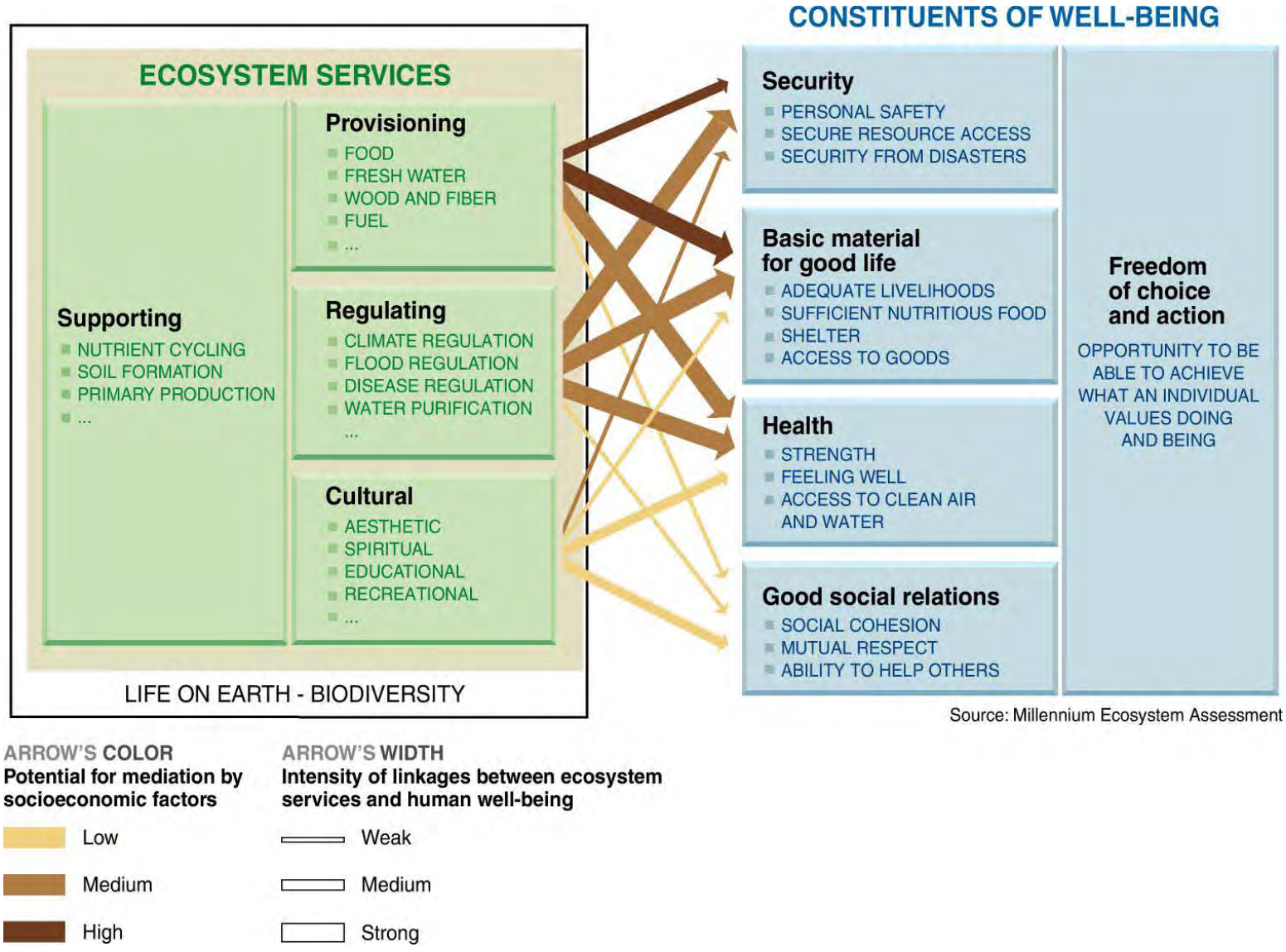
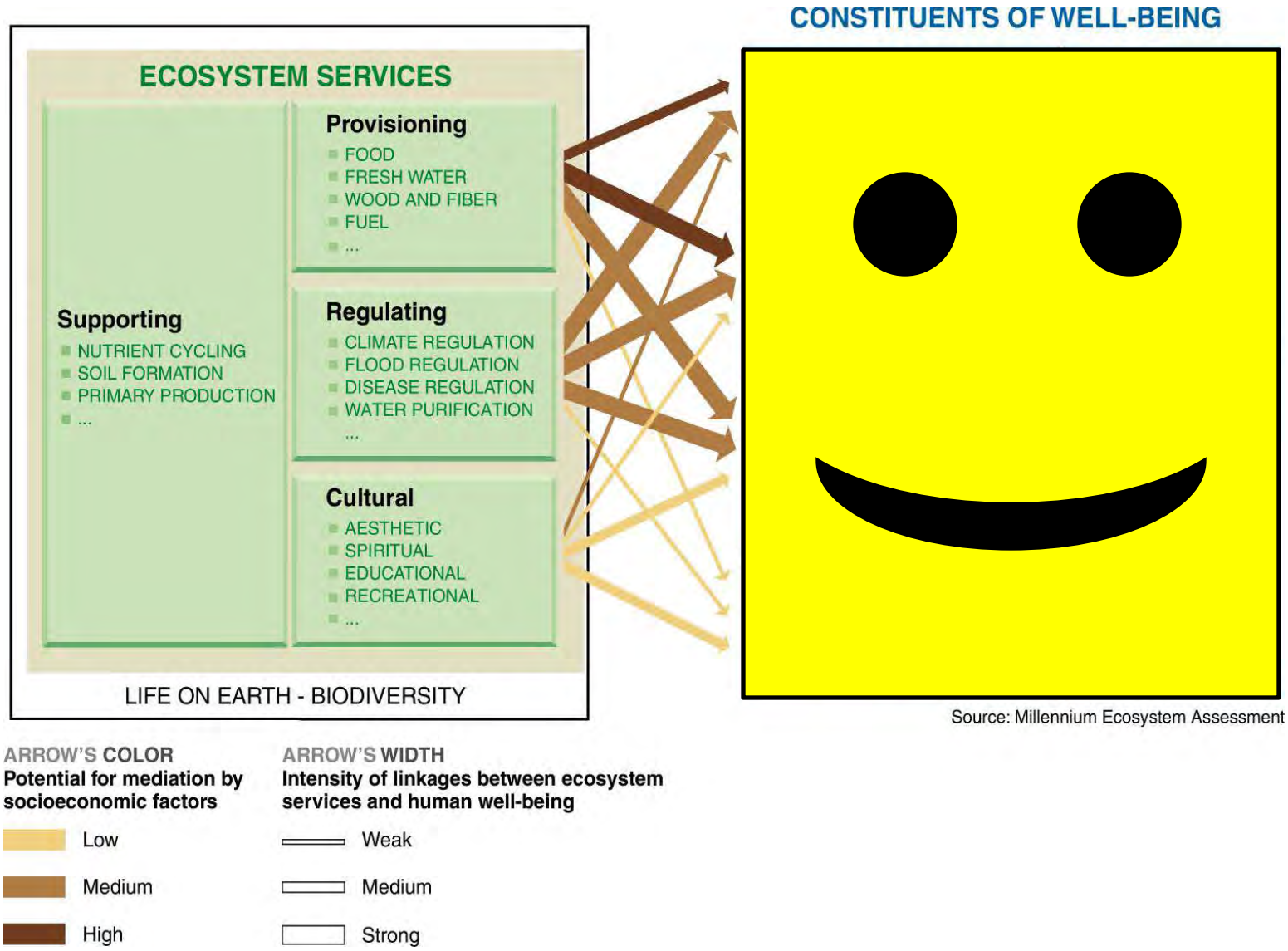
"achieve no net loss and preferably a net gain of biodiversity with respect to species composition, habitat structure and ecosystem services."



Source: Millennium Ecosystem Assessment



Source: Millennium Ecosystem Assessment

DEFRA Ecosystem Approach

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Score	Assessment of effect
++	Potential significant positive effect
+	Potential positive effect
0	Negligible effect
-	Potential negative effect
—	Potential significant negative effect
?	Gaps in evidence

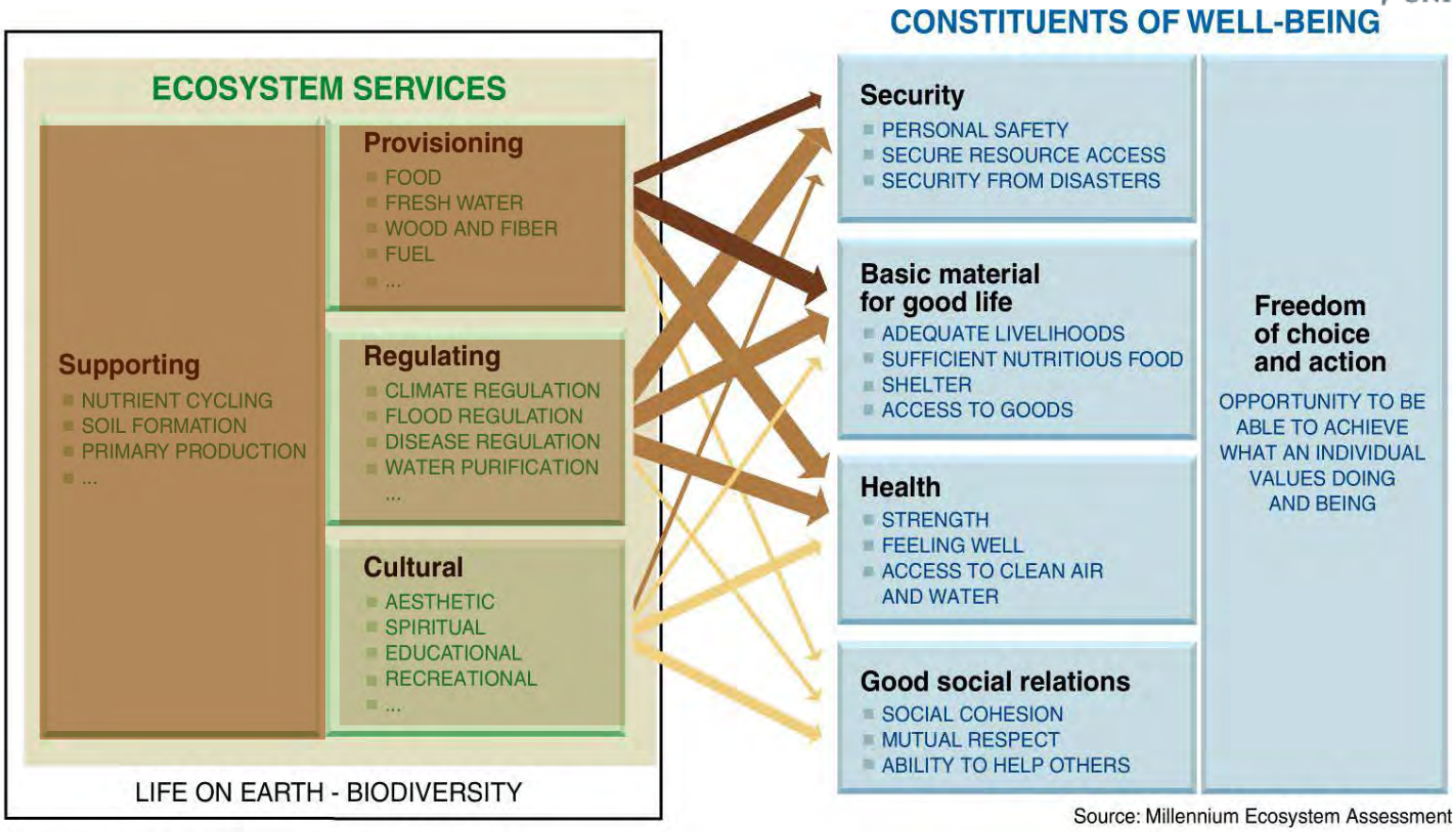
Table 3.1 Initial checklist of ecosystem services for consideration

Category	Baseline/ 'Do nothing' policy option 0	Policy option 1	Policy option 2	Policy option 3
Provisioning services				
Food				
Fibre and Fuel				
Genetic resources				
Biochemicals, natural medicines, pharmaceuticals				
Ornamental resources				
Fresh water				
Regulating services				
Air-quality regulation				
Climate regulation				
Water regulation				
Natural hazard regulation				
Pest regulation				
Disease regulation				
Erosion regulation				
Water purification and waste treatment				
Pollination				
Cultural services				
Cultural heritage				
Recreation & tourism				
Aesthetic value				
Supporting Services				
Soil formation				
Primary production				
Nutrient cycling				
Water cycling				
Photosynthesis				

- To date planners operate without access to detailed, spatially explicit summaries of how land-use change would affect these services, and where best to instate mitigating practices, such as ecological restoration.

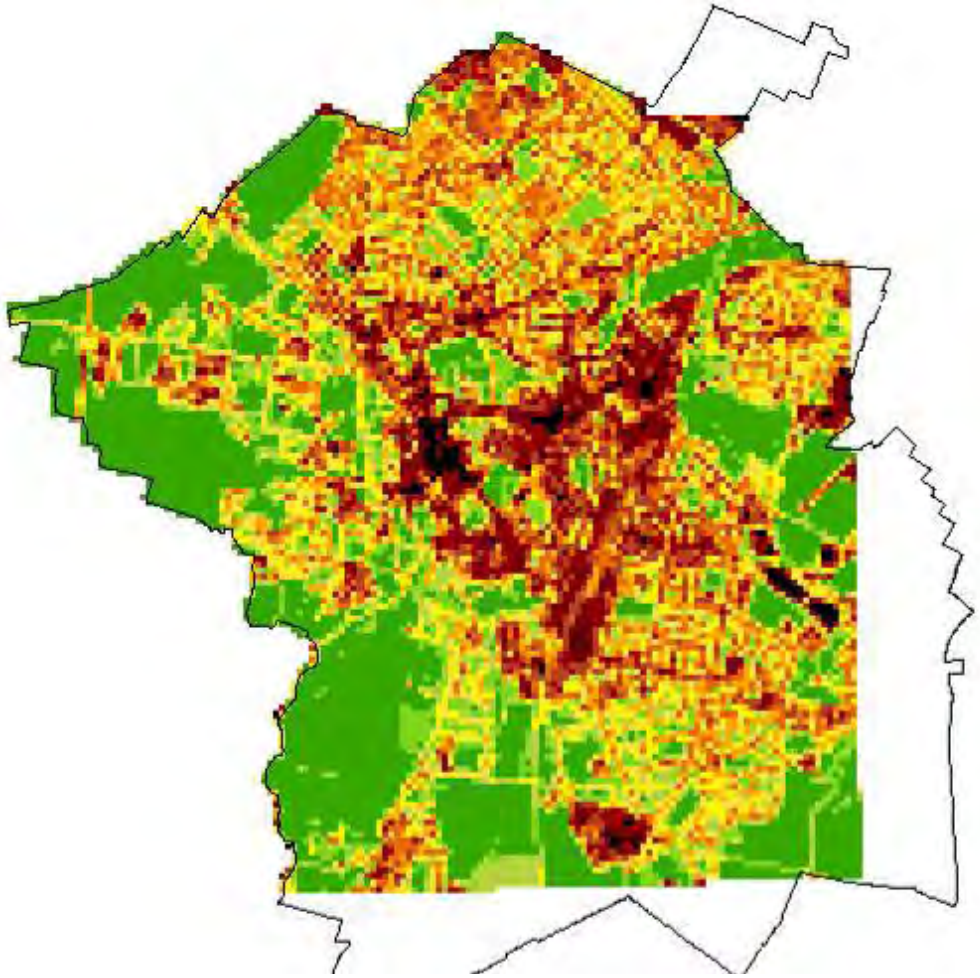
What we need from our planning toolkit: example questions

- "if I put X number of houses here, where, how much, and what type of ecosystem(s) will I have to restore to balance this?"
- "which agricultural areas (place and extent) can be removed from intensive production to ecological restoration to achieve an improvement in water quality of Y, for the lowest cost?"
- "how much retrofitting of green roofs/urban ecosystems/permeable pavements are required to achieve an increase in biodiversity of Z in an extant urban area, and what impact will this have on the quality of life?"

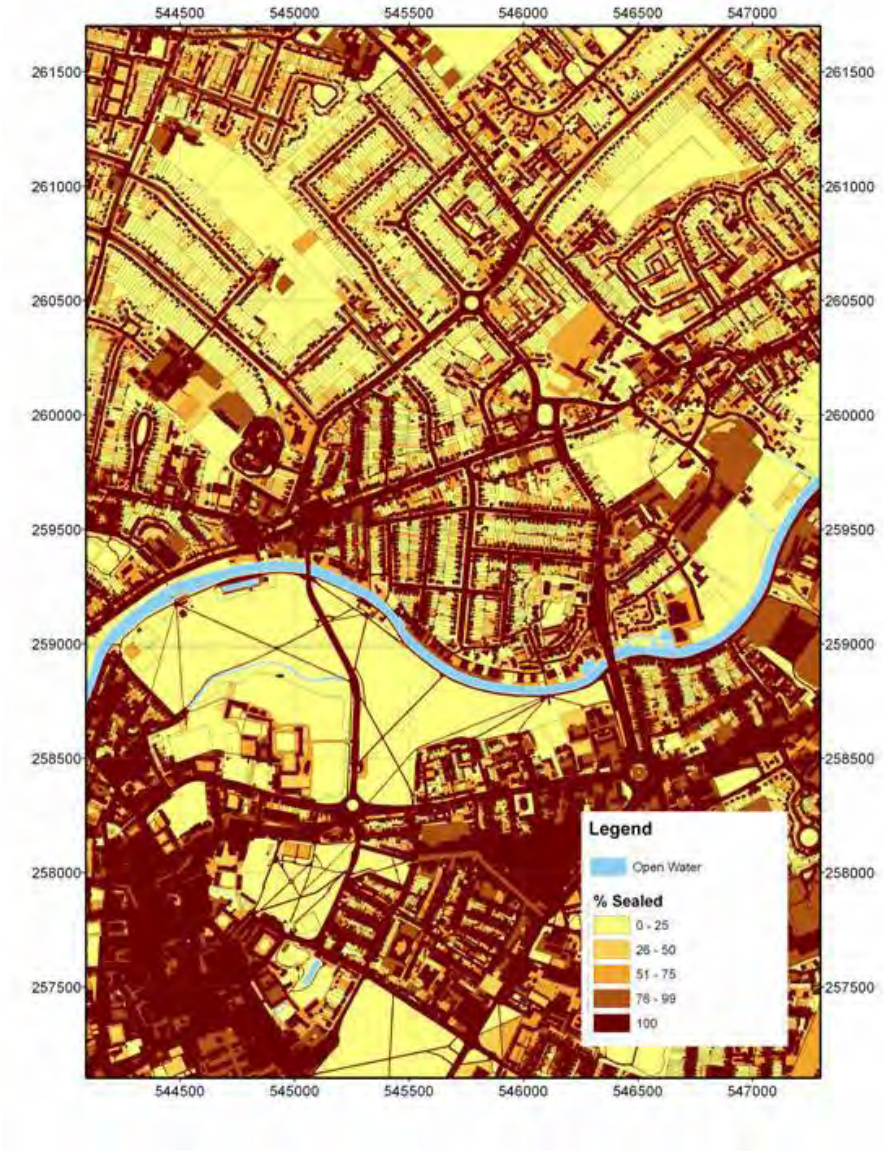


Source: Millennium Ecosystem Assessment

Soil-dependent ecosystem services



Classified map of sealing for Cambridge City district, 2003
(Wood et al, 2006)



Percentage of sealed soil after processing

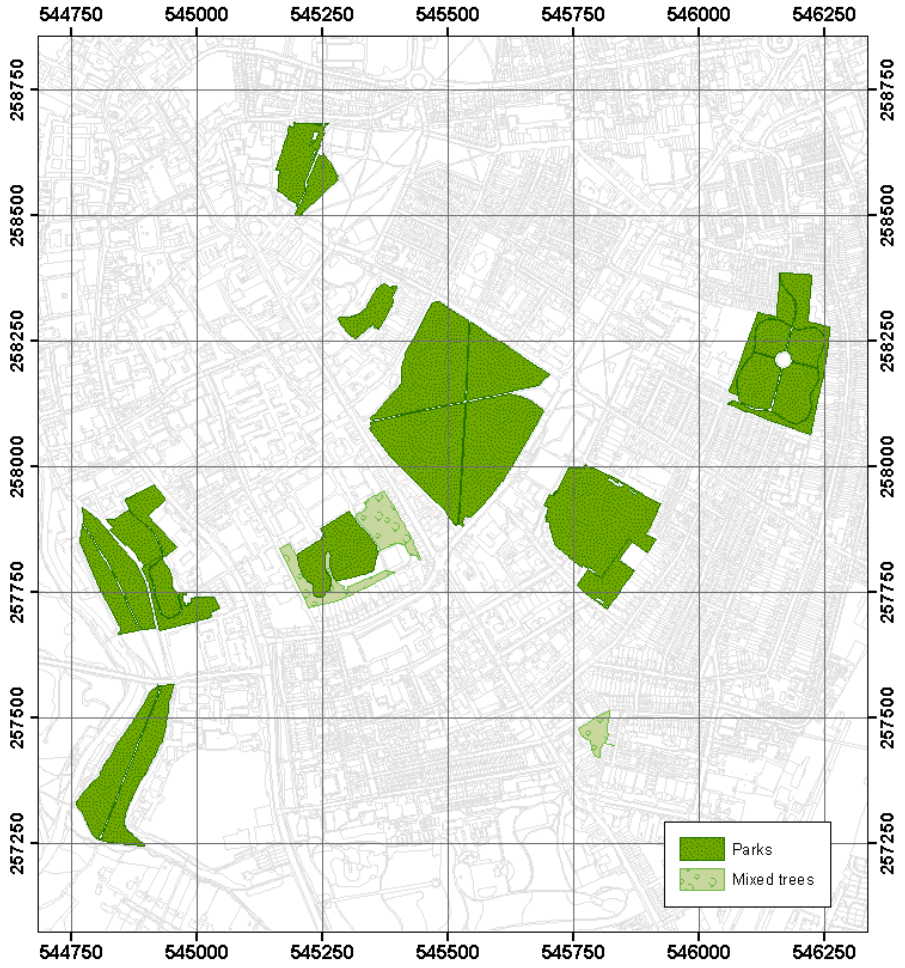


Figure 6.10 Green space in the central area of Cambridge

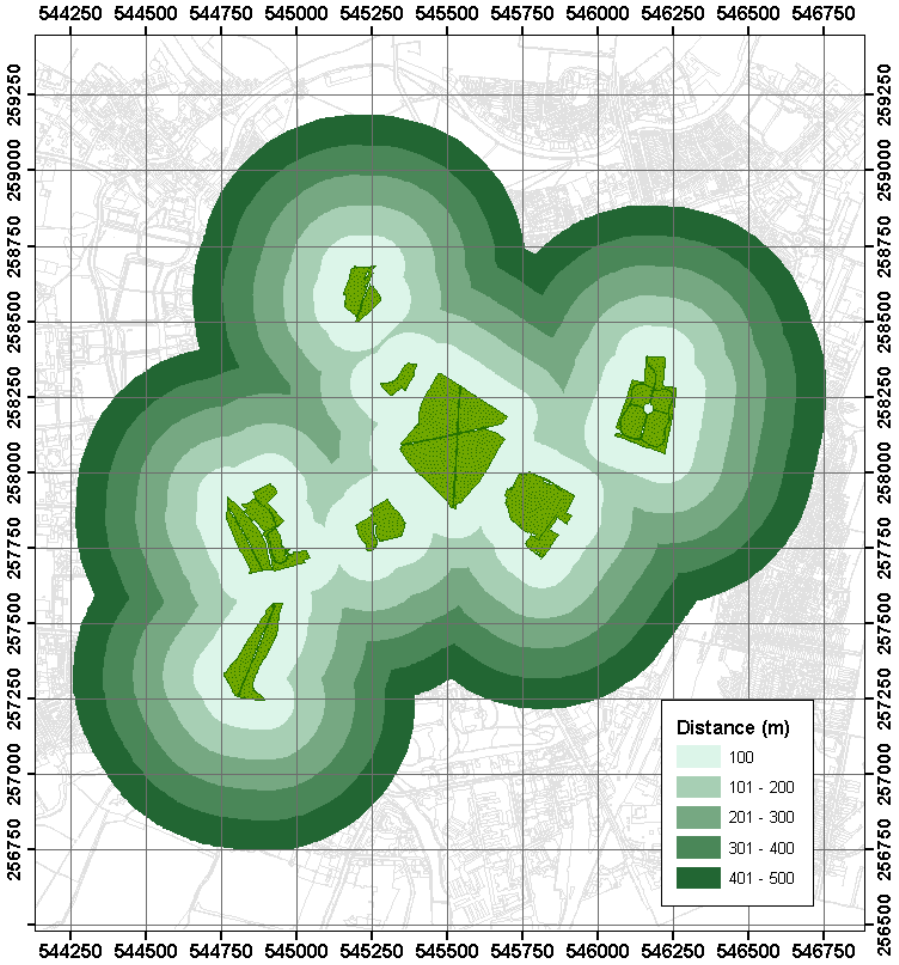


Figure 6.11 Buffer distances from the green parks

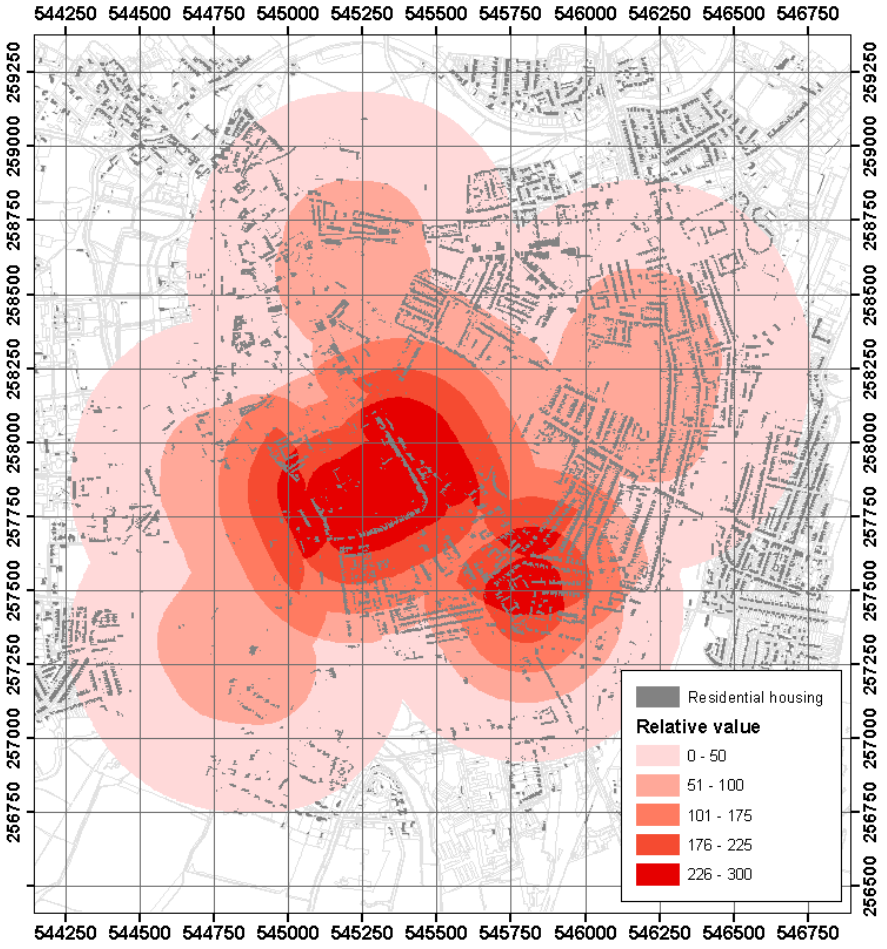


Figure 6.13 Extent of 'relative' value indices around green spaces.

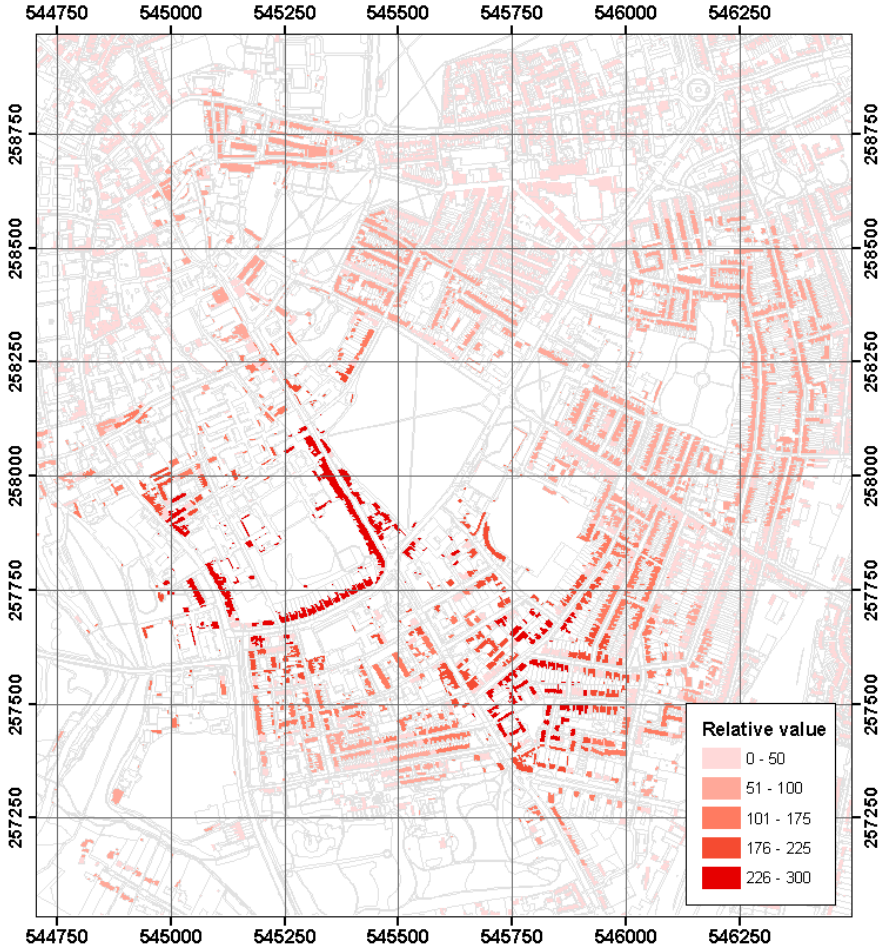
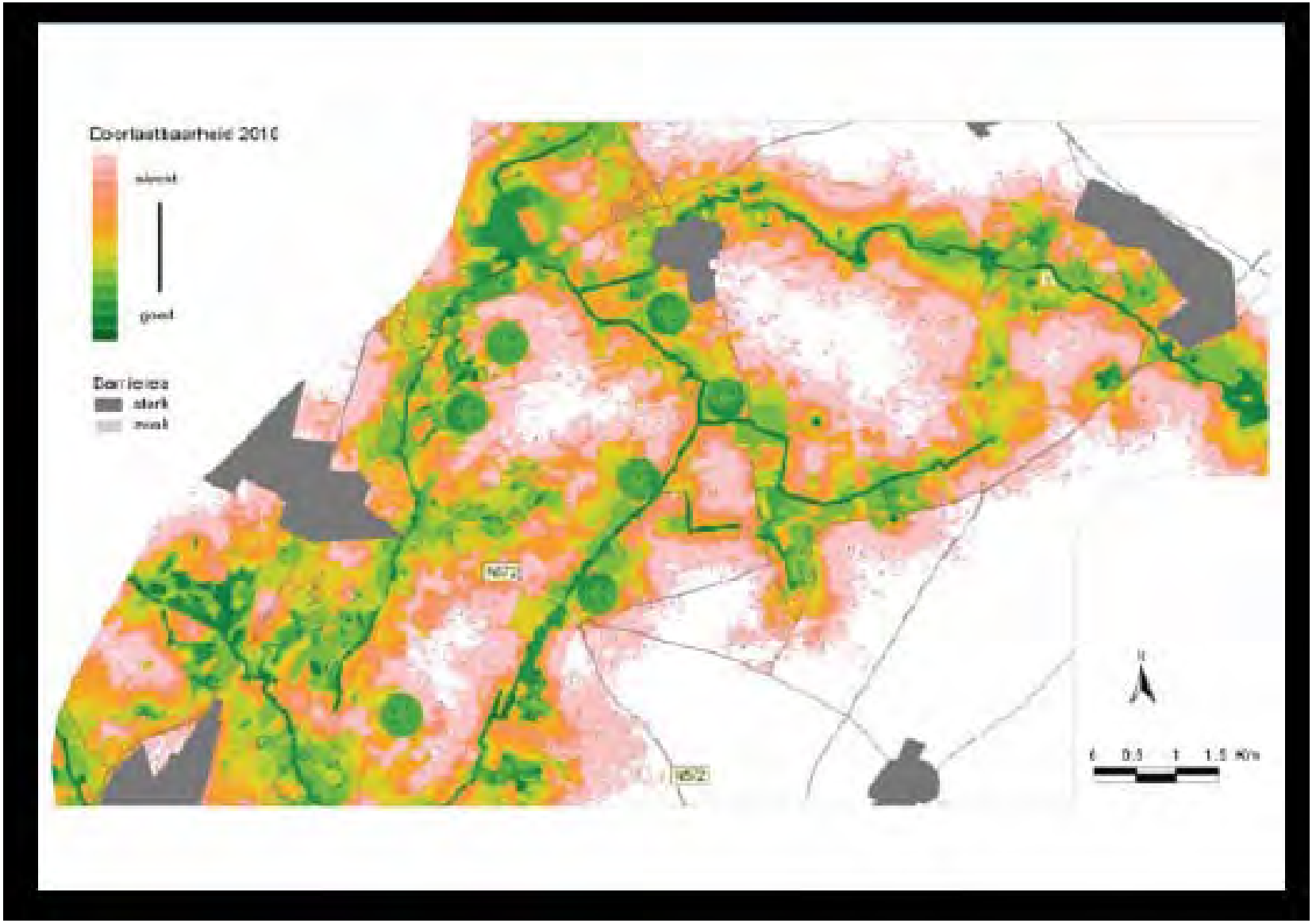


Figure 6.14 Aesthetic 'value' indices (derived from table 6.1) of households within the test area.



Dispersion model Limburg – Tree Frog

Assessment of Plans using Defra's Ecosystem Approach

	Valuating ecosystem services			
		Current	Masterplan	ETC
Provisioning	Food	0	0	+
	Fibre and Fuel	0	+	+
	Genetic resources	-	+	++
	Biochemicals, natural medicines, pharmaceuticals	-	0	+
	Ornamental resources	-	++	++
	Fresh water	0	+	++
Regulating services	Air-quality regulation	0	0	0
	Climate regulation	0	+	+
	Water regulation	-	+	++
	Natural hazard regulation	-	+	++
	Pest regulation	0	0	0
	Erosion regulation	-	+	+
	Water purification and waste treatment	0	+	+
	Pollination	0	0	+
Cultural services	Cultural heritage	++	0	++
	Recreation & tourism	0	+	+
	Aesthetic value	-	+	+
Supporting Services	Soil formation	0	0	0
	Primary production	0	0	+
	Nutrient cycling	-	0	++
	Water cycling	-	0	+
	Photosynthesis	-	+	++

Score	Assessment of effect
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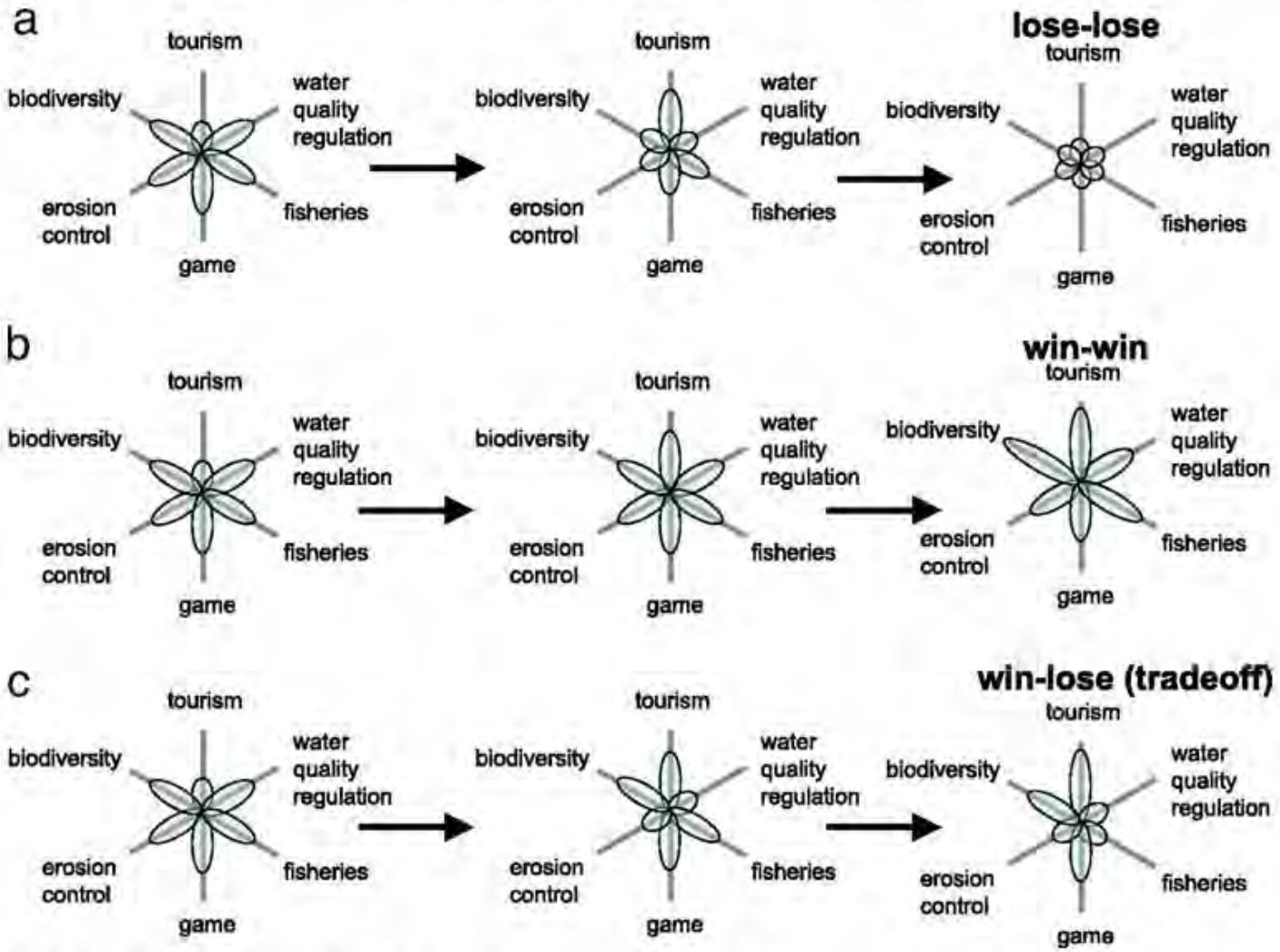
Defra, 2007

"Tradeoff flowers" depicting alternative scenarios for ecotourism projects aimed at biodiversity protection and economic growth

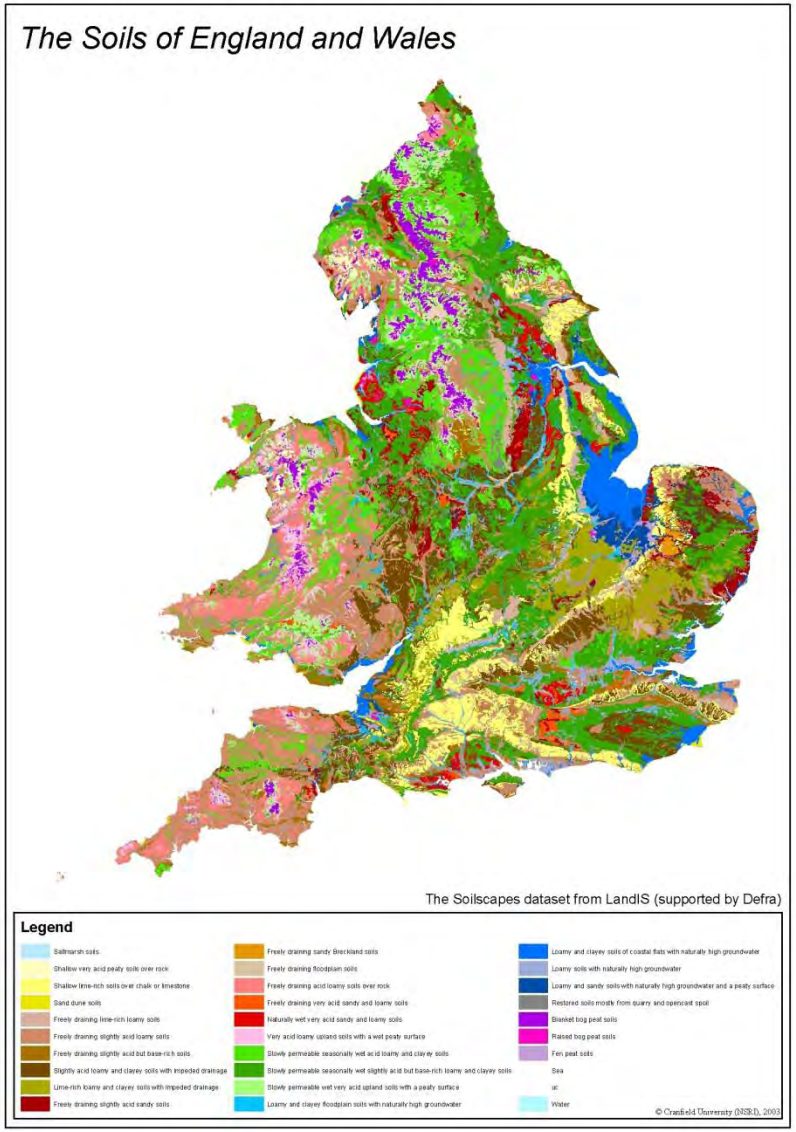


Tallis H. et.al. PNAS 2008;105:9457-9464

Providing a planning decision support tool

A potential methodology

Soilscapes – 27 class national soil data set



Linking soil to vegetation

Unit	General soil conditions	Related habitats (actual and potential)
1	Saltmarsh soils	Coastal salt marsh vegetation subject to tidal flooding
2	Shallow very acid peaty soils over rock	Rugged wet heather and grass moor with bare rock, and bog vegetation in hollows
3	Shallow lime-rich soils over chalk or limestone	Herb-rich Downland and limestone pastures; limestone pavements in the uplands; Beech hangers and other lime-rich woodlands
4	Sand dune soils	Sand dune vegetation ranging from pioneer dune systems through to low shrub
5	Freely draining lime-rich loamy soils	Herb-rich chalk and limestone pastures; lime-rich deciduous woodlands
6	Freely draining slightly acid loamy soils	Neutral and acid pastures and deciduous woodlands; acid communities such as bracken and gorse in the uplands
7	Freely draining slightly acid but base-rich soils	Base-rich pastures and deciduous woodlands
8	Slightly acid loamy and clayey soils with impeded drainage	Wide range of pasture and woodland types
9	Lime-rich loamy and clayey soils with impeded drainage	Base-rich pastures and classic 'chalky boulder clay' ancient woodlands; some wetter areas and lime-rich flush vegetation
10	Freely draining slightly acid sandy soils	Acid dry pastures; acid deciduous and coniferous woodland; potential for lowland heath
11	Freely draining sandy Breckland soils	Characteristic Breckland heathland communities
12	Freely draining floodplain soils	Grassland; wet carr woodlands in old river meanders
13	Freely draining acid loamy soils over rock	Steep acid upland pastures dry heath and moor; bracken gorse and oak woodlands
14	Freely draining very acid sandy and loamy soils	Mostly lowland dry heath communities
15	Naturally wet very acid sandy and loamy soils	Mixed dry and wet lowland heath communities
16	Very acid loamy upland soils with a wet peaty surface	Grass moor and heather moor with flush and bog communities in wetter parts
17	Slowly permeable seasonally wet acid loamy and clayey soils	Seasonally wet pastures and woodlands
18	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	Seasonally wet pastures and woodlands
19	Slowly permeable wet very acid upland soils with a peaty surface	Grass moor and some heather with flush and bog communities in wetter parts
20	Loamy and clayey floodplain soils with naturally high groundwater	Wet flood meadows with wet carr woodlands in old river meanders
21	Loamy and clayey soils of coastal flats with naturally high groundwater	Wet brackish coastal flood meadows
22	Loamy soils with naturally high groundwater	Wet acid meadows and woodland
23	Loamy and sandy soils with naturally high groundwater and a peaty surface	Wet meadows
24	Restored soils, mostly from quarry and opencast spoil	Variable
25	Blanket bog peat soils	Wet heather moor with flush and bog communities
26	Raised bog peat soils	Raised bog communities
27	Fen peat soils	Wet fen and carr woodlands

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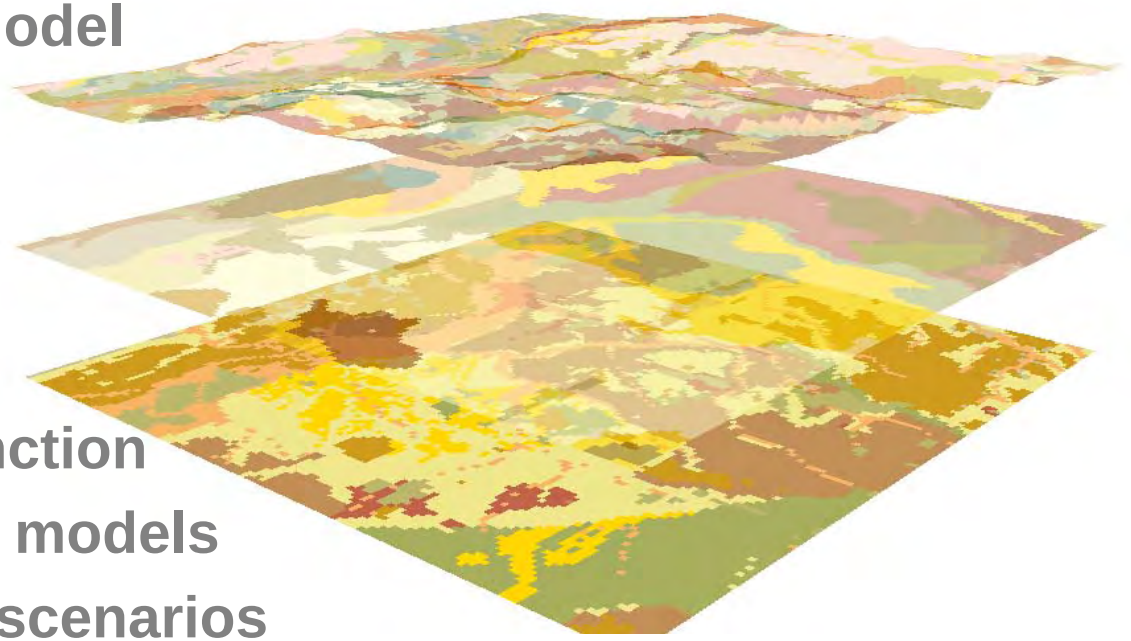
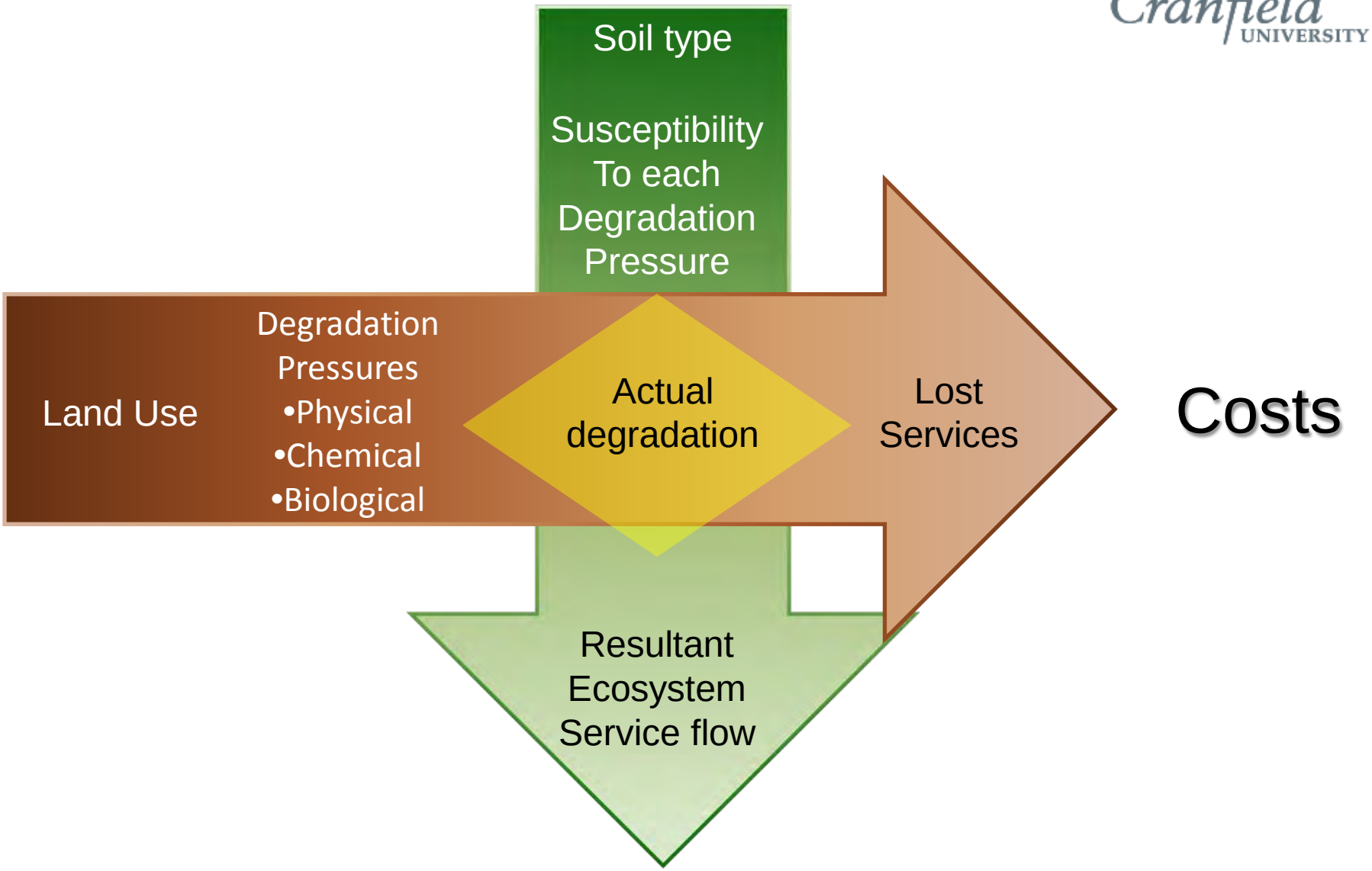
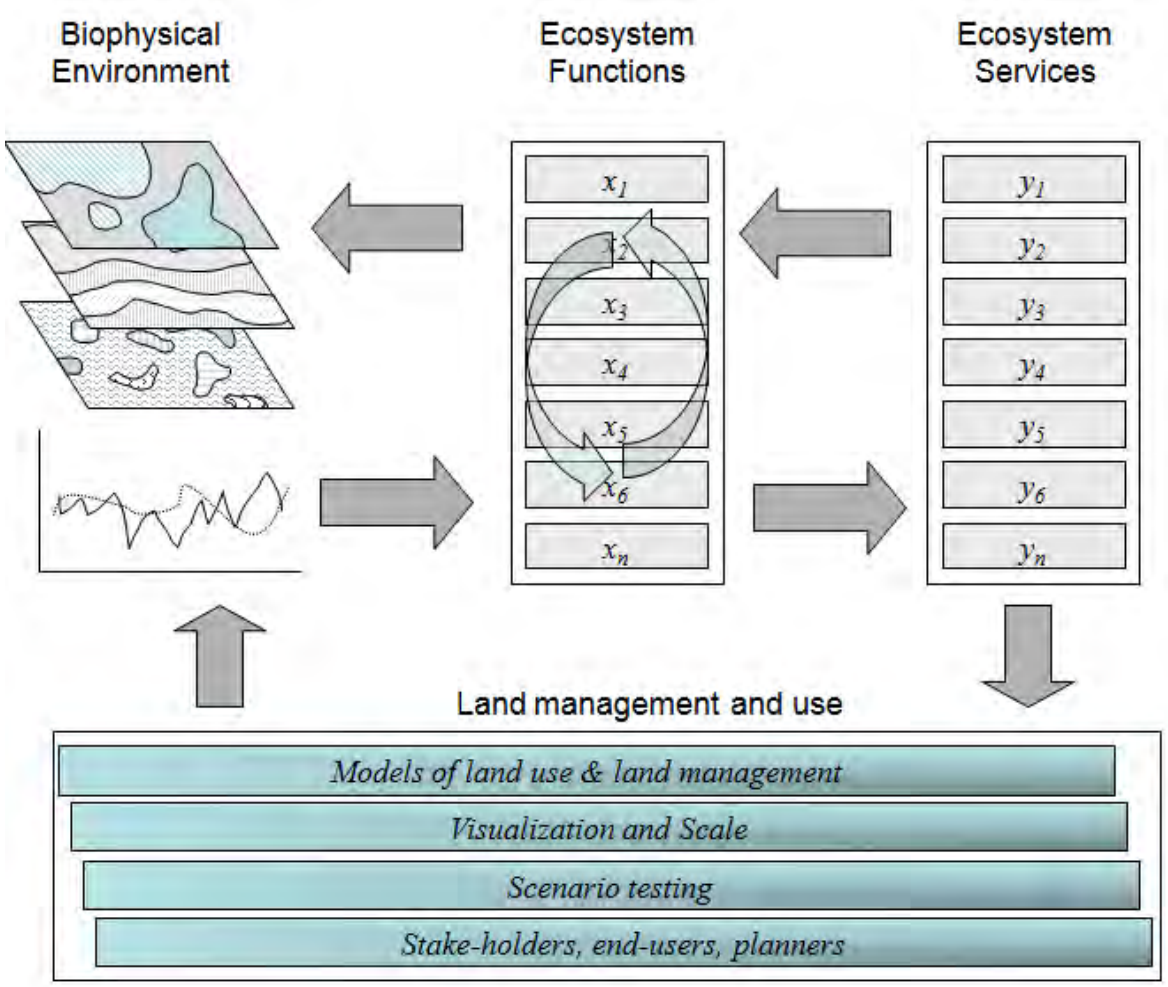
Potential Ecosystem Map

- Digital Terrain Model
- Soil Maps
- Geology Maps
- Climate data
- Land-use data
- Hydrological function
- Socio-economic models
- Climate change scenarios

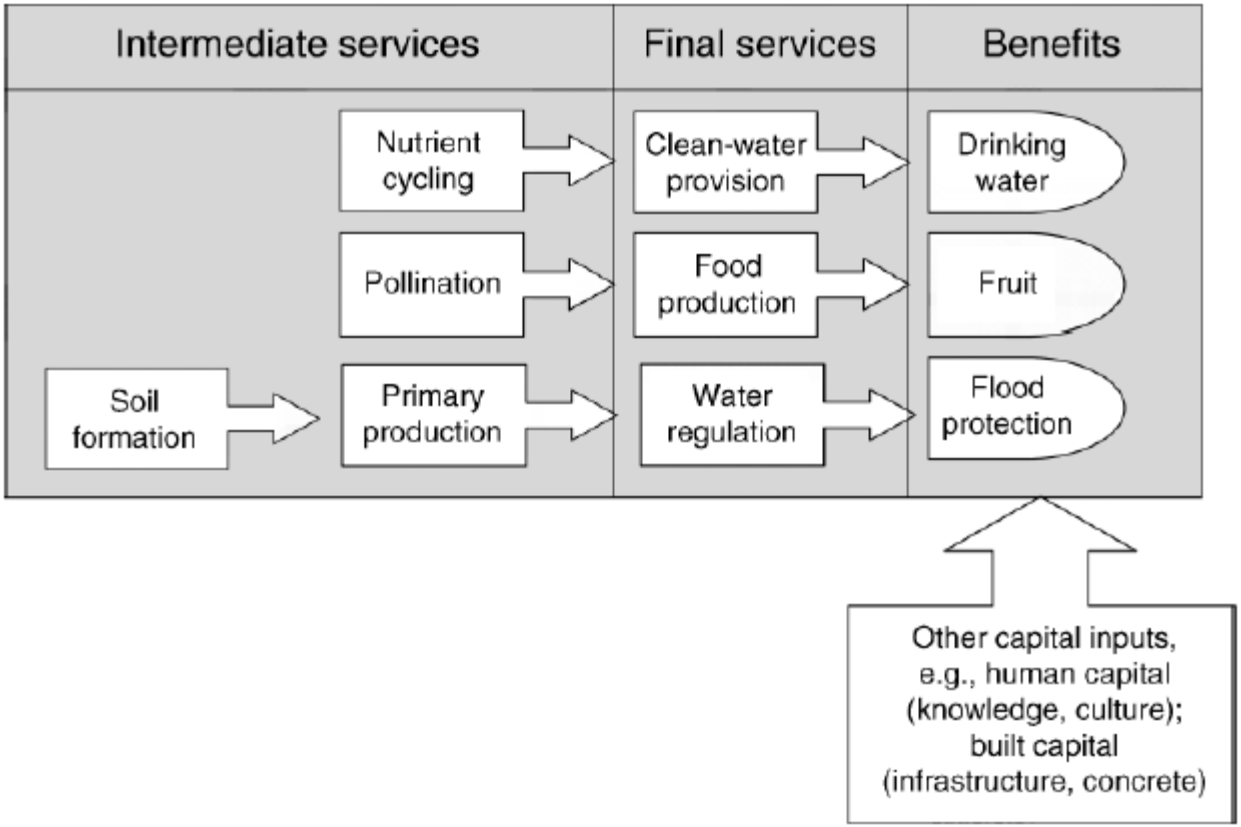



Soil type
Susceptibility To each Degradation Pressure
Land Use
Degradation Pressures
•Physical
•Chemical
•Biological
Actual degradation
Lost Services
Costs
Resultant Ecosystem Service flow
Benefits


Biophysical Environment
Ecosystem Functions
Ecosystem Services
x_1
x_2
x_3
x_4
x_5
x_6
x_n
y_1
y_2
y_3
y_4
y_5
y_6
y_n
Land management and use
Models of land use & land management
Visualization and Scale
Scenario testing
Stake-holders, end-users, planners

Ecosystem service delivery?

ES delivery?

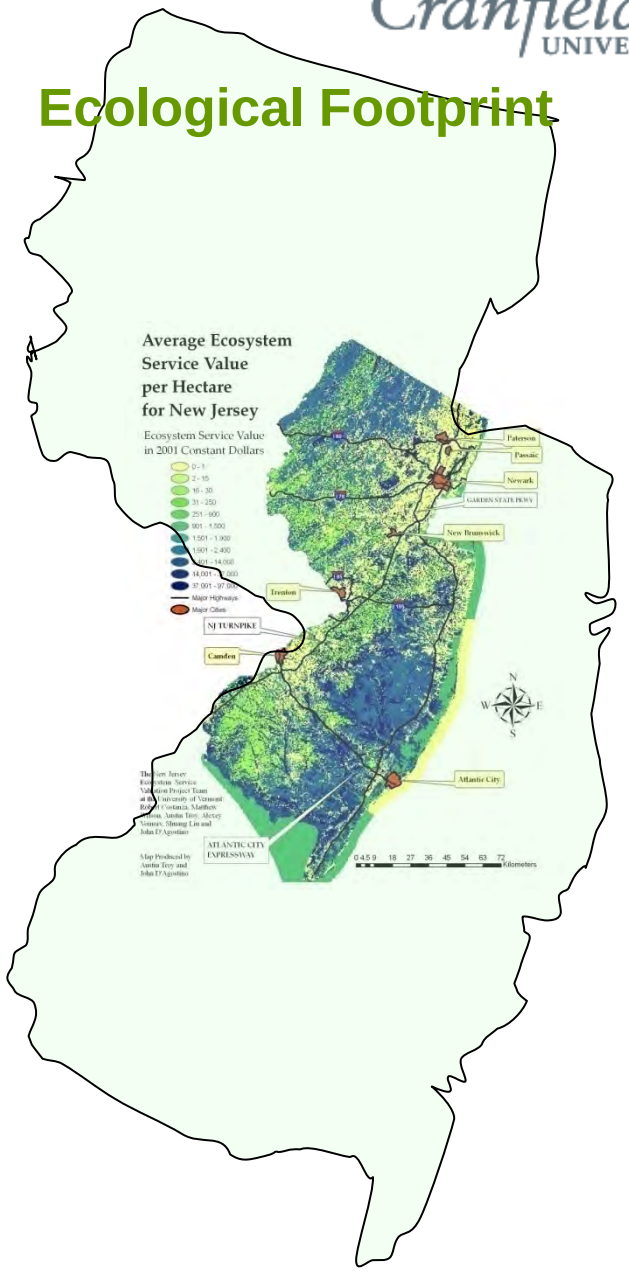


Fisher et al 2008


Average Ecosystem Service Value per Hectare for New Jersey
Ecosystem Service Value in 2001 Constant Dollars
0 - 1
2 - 15
16 - 30
31 - 250
251 - 900
901 - 1,500
1,501 - 1,900
1,901 - 2,400
2,401 - 14,000
14,001 - 37,000
37,001 - 97,000
Major Highways
Major Cities
Paterson
Passaic
Newark
GARDEN STATE PKWY
New Brunswick
Trenton
NJ TURNPIKE
Camden
Atlantic City
ATLANTIC CITY EXPRESSWAY
N
W
E
S
0 4.5 9 18 27 36 45 54 63 72
Kilometers
The New Jersey Ecosystem Service Valuation Project Team at the University of Vermont: Robert Costanza, Matthew Wilson, Austin Troy, Alexey Voinov, Shuang Liu and John D'Agostino
Map Produced by Austin Troy and John D'Agostino

Simple Rules for Planning:

1. Any development increasing the size of the ecological footprint is forbidden;
2. No development is permitted on high value Natural Capital Areas
3. Development on low value Natural Capital Areas must increase their value, thereby shrinking the footprint



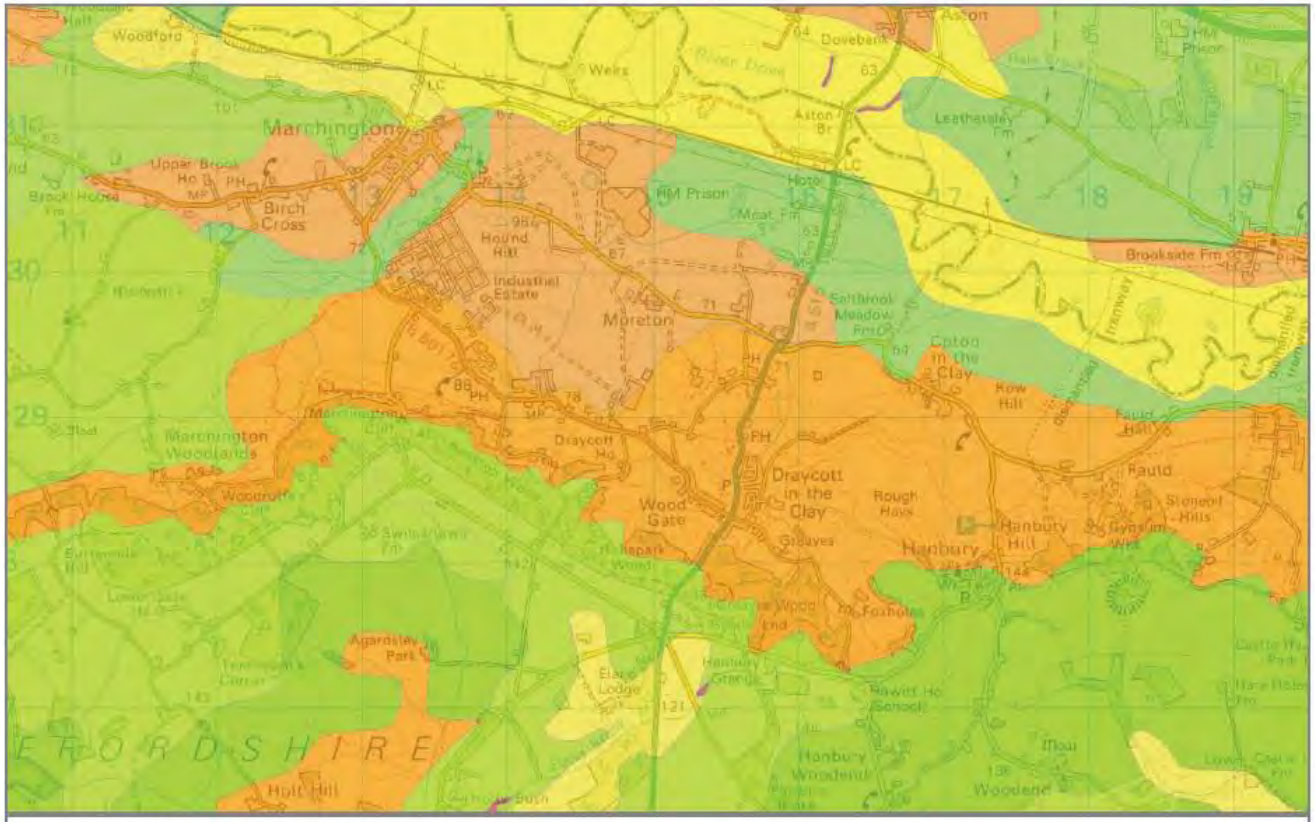
Conceptual plan

Actual Plan

End-product

Natural Capital / Ecosystem Services Value

Ecosystem | Water | Health | Energy | Crime | SSSIs | Food | Economy | Happiness | Regional Effects | Species | Soils



ecosystem service value per hectare

very low | low | moderate | high | very high

current

cultural

provisioning

regulating

The current state of Natural Capital value and the total amount (size of pie above) and the types of ecosystem goods and services delivered (divisions of the pie).

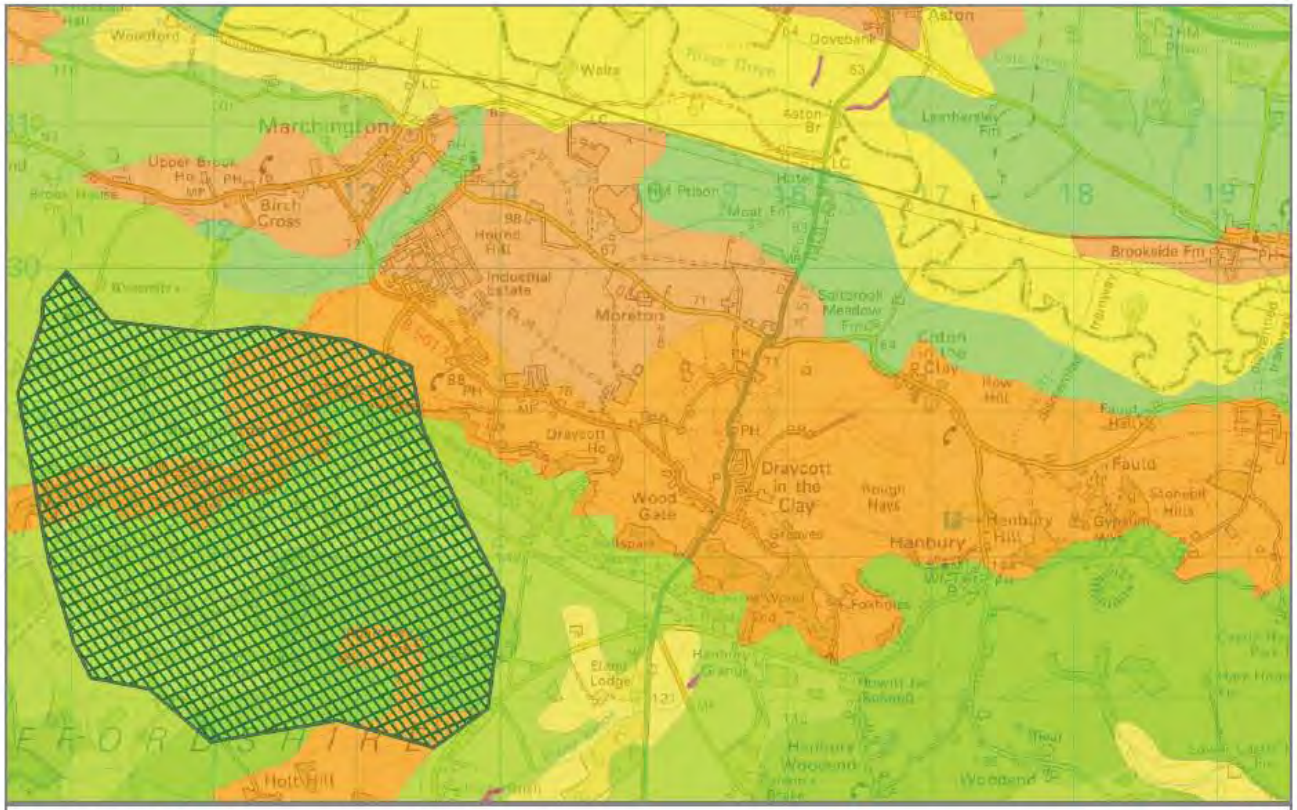
Development proposals should aim to increase the size of the pie, and balance the streams of ecosystem service delivery.

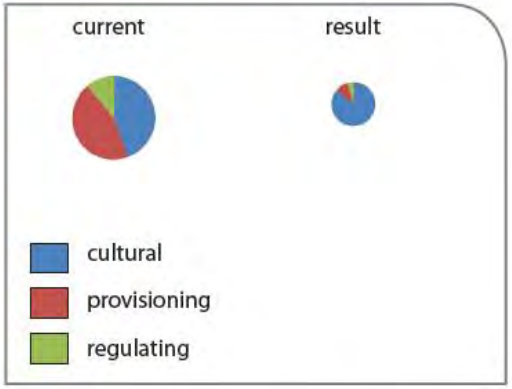
Add new development

current status | urban ecological regeneration proposal | wetland restoration proposal | 8000 new homes proposal

Natural Capital / Ecosystem Services Value

Ecosystem | Water | Health | Energy | Crime | SSSIs | Food | Economy | Happiness | Regional Effects | Species | Soils





A traditional (current) approach to house building on the flood plain.

Hard, disconnected surfaces increase flood risk, reduce biodiversity and deprive both access to green space and food production.

Natural capital shrinks and the regulating and provisioning services almost disappear.

Add new development

current status | urban ecological regeneration proposal | wetland restoration proposal | 8000 new homes proposal

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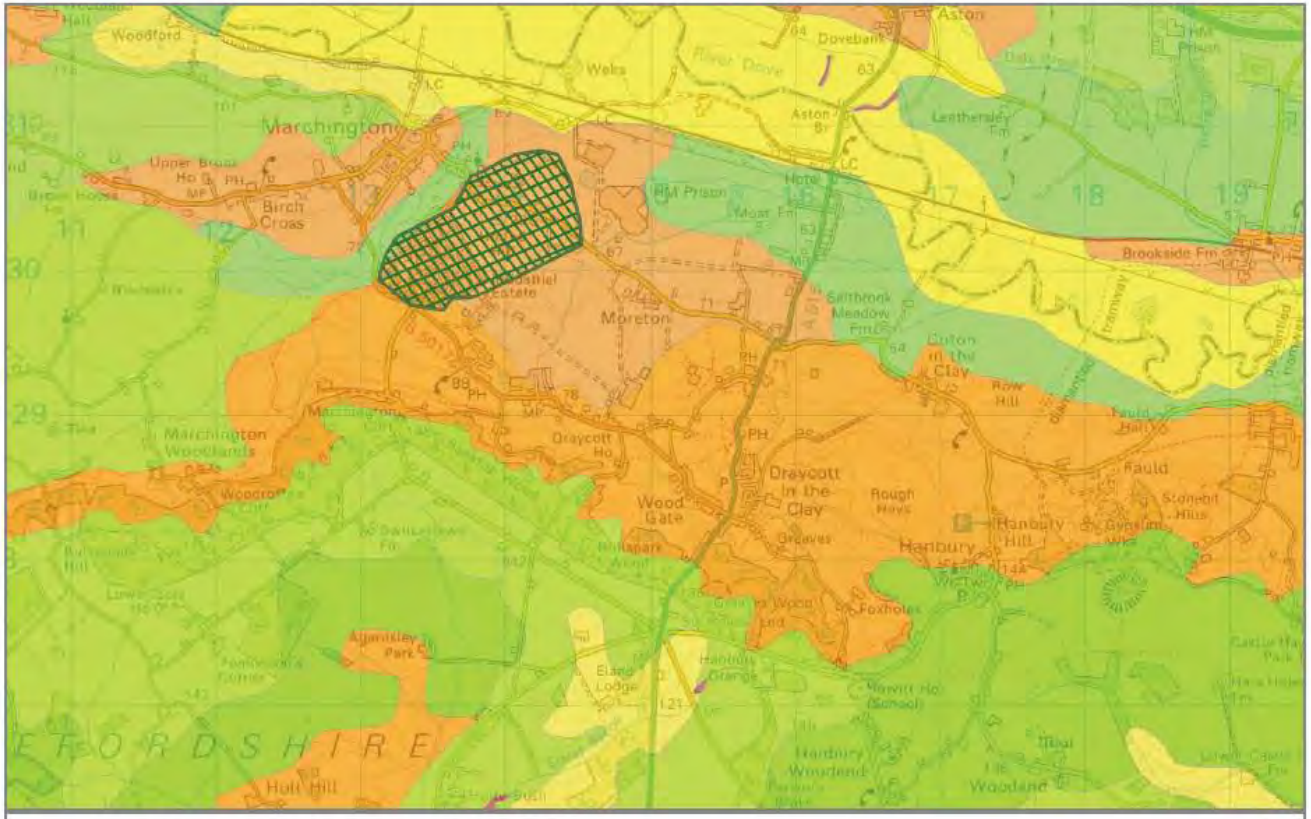
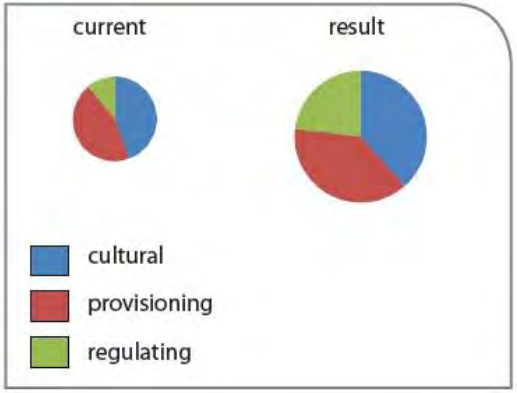


ecosystem service value per hectare

very low | low | moderate | high | very high



Here, the development proposal for an urban regeneration/extension consists of a combination of retrofitting energy efficiency, SUDS and biodiversity corridors, reversing flood risk, increasing carbon sequestration and accessible public open space.

As a consequence the Natural Capital of the area increases (bigger pie) and the ES flows are more balanced.

Add new development

current status | urban ecological regeneration proposal | wetland restoration proposal | 8000 new homes proposal

Natural Capital / Ecosystem Services Value

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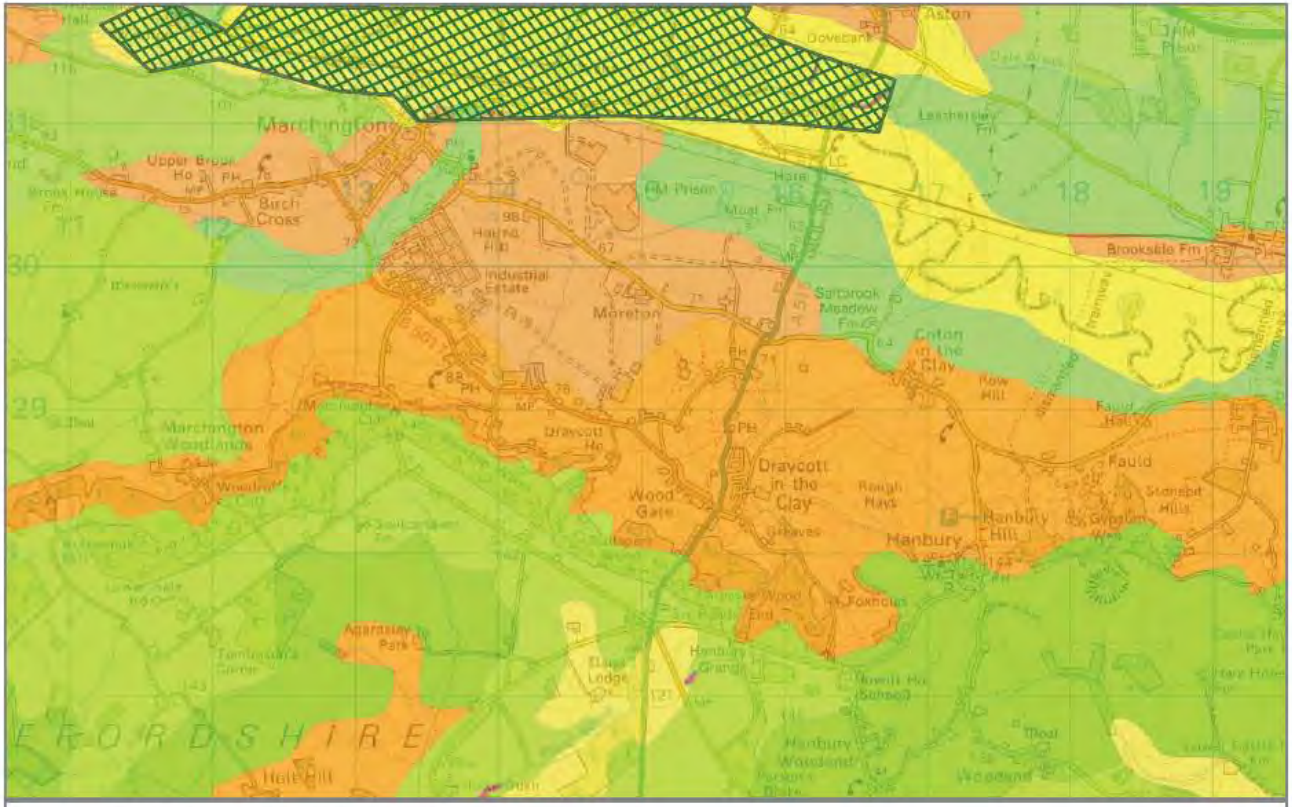

ecosystem service value per hectare

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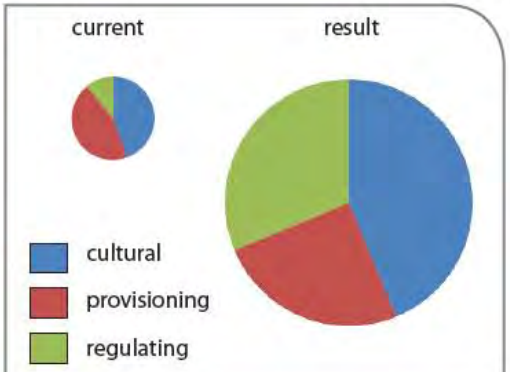

Here, arable land in the floodplain is restored to its former condition by removing berms and re-instating landscape features, allowing the natural floodplain hydrology to restablish, and biodiversity increase – reducing flood risk.

The Natural Capital increases again, with a major increase in regulating and cultural services, with a slight reduction in provisioning service.

Add new development

current status | urban ecological regeneration proposal | wetland restoration proposal | 8000 new homes proposal

Conclusions

- There is a pressing political and technical need to provide a planning tool encompassing bio-physical and socio-economic impact of development, and data to provide this at a local scale
- The precise relationship between ecosystem functions and ecosystem services needs to be elucidated and systematised.
- This will all be in vain unless brought into the planning regime as the first consideration in setting the planning framework

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Questions?