Valuing Abiotic Nature

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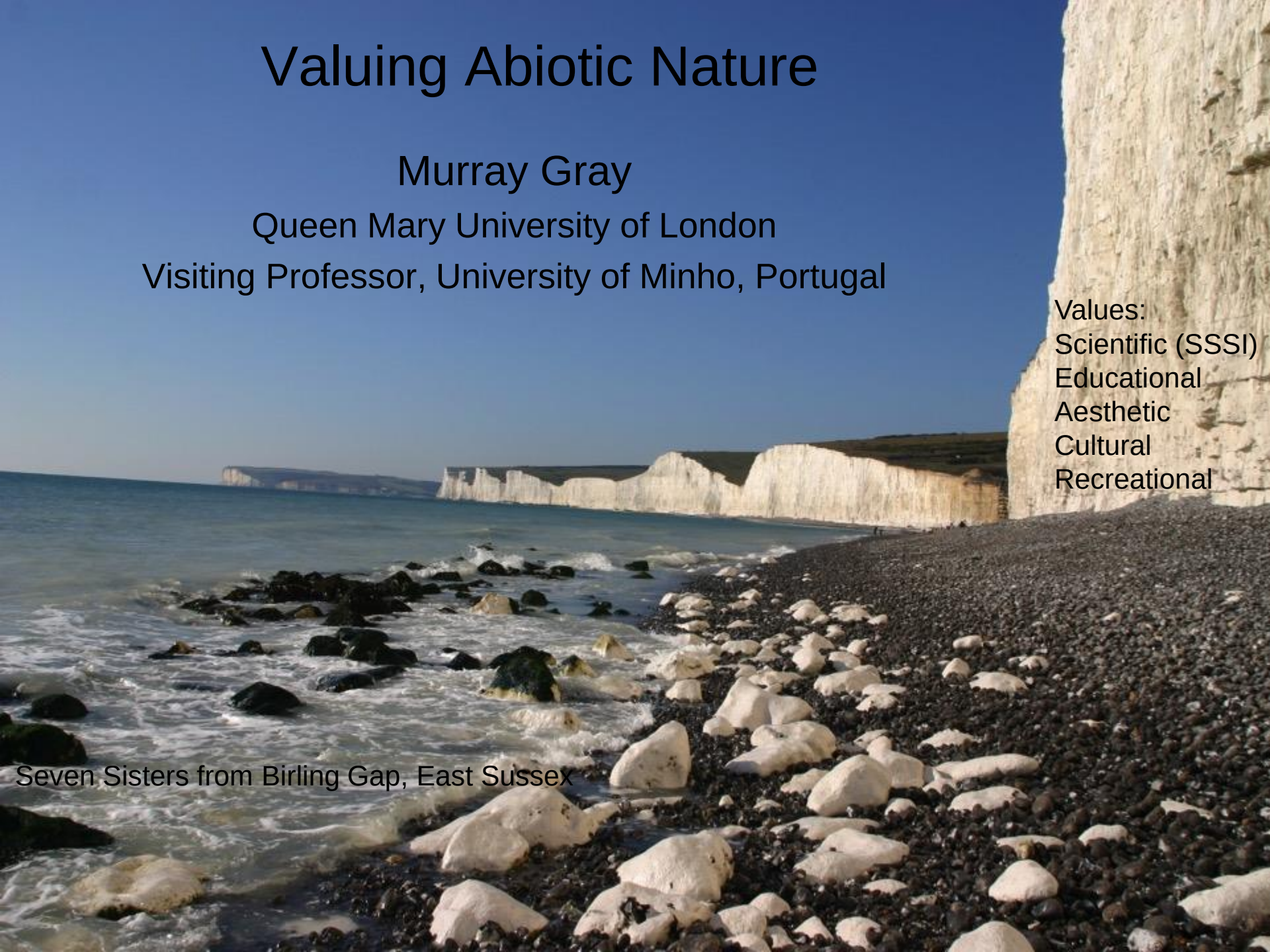
Values:
Scientific (SSSI)
Educational
Aesthetic
Cultural
Recreational



Seven Sisters from Birling Gap, East Sussex

As well as biodiversity, we live on a geodiverse planet

Sculpture: “Knowledge”

@ Queen Mary University of London

Planet Earth represented as a smooth, steel sphere

= no geodiversity

“Geodiversity: the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (landforms, topography, physical processes), soil and hydrological features”

(Gray, 2013)

Above Grasmere, Lake District NP

Geodiversity

Fortunately, the world is not a perfect sphere composed of a single rock type. It is highly diverse in terms of its:

- geological materials,
- topographic variation, and
- physical processes.

Valuing abiotic nature ought to recognise these 3 characteristics of geodiversity -

material

form

process

Natural Capital

- The *World Forum on Natural Capital* defines natural capital as:

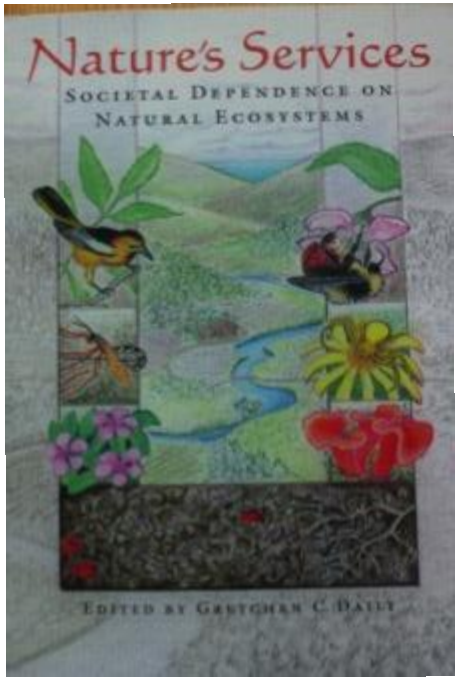
  "the world's stocks of natural assets which include geology, soil, air, water and all living things"

- So includes both abiotic and biotic nature;
- Definition repeated by many UK organisations including:

  - *Natural Environment Research Council*,
  - *Scottish Forum on Natural Capital*,
  - *Marine Ecosystems Research Programme*,
  - *The Biodiversity Consultancy*

Natural Capital & Ecosystem Services

- These Natural Capital assets, then lead to goods and services that benefit human society;
- Gretchen Daily's (1997), seminal book on this subject that cemented this approach, is entitled "Nature's services: societal dependence on natural ecosystems";
- But unfortunately, the approach has become generally known not as "natural or nature's services" but as "ecosystem services" (ES);
- This is not helpful for a holistic approach to nature, because "ecosystems" are mainly or often regarded as biological.

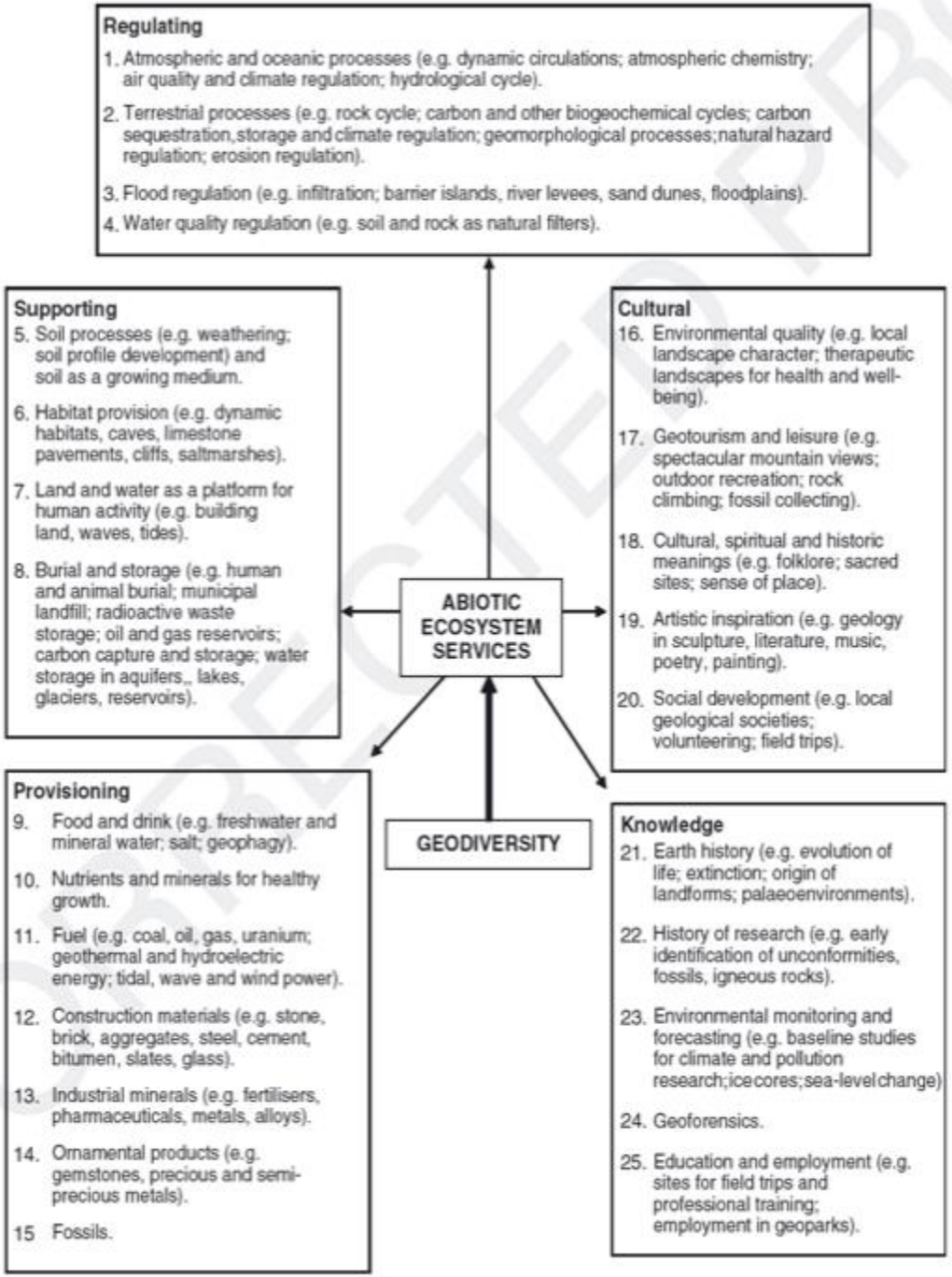


Natural Capital & Ecosystem Services

- So, *the World Forum on Natural Capital* is leading the way in promoting "natural capital" as including geology, but the "ecosystem services" approach is generally excluding it, sometimes consciously. For example:
- Costanza *et al.* (1997, p.253), in attempting to quantify the global value of ecosystem services stated that "We included only renewable ecosystem services, excluding non-renewable fuels and minerals…".
- Milton (2002, p.115) stated that "diversity in nature is usually taken to mean diversity of living nature".
- Diaz *et al.* (2015) state that "Non-living natural resources…are considered as part of nature, but their direct benefits are not the focus of IPBES" (*Intergovernmental Platform on Biodiversity and Ecosystem Services*);
- And Brown *et al.* (2011) state that *the UK National Ecosystem Assessment* "does not provide an assessment of 'environmental services' that may be purely abiotic in origin…".

ES and Geodiversity

- The Millennium Ecosystem Assessment (MEA) is also very biologically based;
- Because of this deficiency, I have used the MEA classification of ecosystem services as a basis for showing the goods and services related to geodiversity;
- But I have separated out a 5th category of “Knowledge Services”, part of “Cultural Services” in the MEA classification.
- This is because of the importance of geodiversity in providing evidence for the history of Planet Earth and the evolution of life.


Regulating
1. Atmospheric and oceanic processes (e.g. dynamic circulations; atmospheric chemistry; air quality and climate regulation; hydrological cycle).
2. Terrestrial processes (e.g. rock cycle; carbon and other biogeochemical cycles; carbon sequestration, storage and climate regulation; geomorphological processes; natural hazard regulation; erosion regulation).
3. Flood regulation (e.g. infiltration; barrier islands, river levees, sand dunes, floodplains).
4. Water quality regulation (e.g. soil and rock as natural filters).
Supporting
5. Soil processes (e.g. weathering; soil profile development) and soil as a growing medium.
6. Habitat provision (e.g. dynamic habitats, caves, limestone pavements, cliffs, saltmarshes).
7. Land and water as a platform for human activity (e.g. building land, waves, tides).
8. Burial and storage (e.g. human and animal burial; municipal landfill; radioactive waste storage; oil and gas reservoirs; carbon capture and storage; water storage in aquifers,, lakes, glaciers, reservoirs).
Cultural
16. Environmental quality (e.g. local landscape character; therapeutic landscapes for health and well-being).
17. Geotourism and leisure (e.g. spectacular mountain views; outdoor recreation; rock climbing; fossil collecting).
18. Cultural, spiritual and historic meanings (e.g. folklore; sacred sites; sense of place).
19. Artistic inspiration (e.g. geology in sculpture, literature, music, poetry, painting).
20. Social development (e.g. local geological societies; volunteering; field trips).
ABIOTIC ECOSYSTEM SERVICES
Provisioning
9. Food and drink (e.g. freshwater and mineral water; salt; geophagy).
10. Nutrients and minerals for healthy growth.
11. Fuel (e.g. coal, oil, gas, uranium; geothermal and hydroelectric energy; tidal, wave and wind power).
12. Construction materials (e.g. stone, brick, aggregates, steel, cement, bitumen, slates, glass).
13. Industrial minerals (e.g. fertilisers, pharmaceuticals, metals, alloys).
14. Ornamental products (e.g. gemstones, precious and semi-precious metals).
15 Fossils.
GEODIVERSITY
Knowledge
21. Earth history (e.g. evolution of life; extinction; origin of landforms; palaeoenvironments).
22. History of research (e.g. early identification of unconformities, fossils, igneous rocks).
23. Environmental monitoring and forecasting (e.g. baseline studies for climate and pollution research; ice cores; sea-level change)
24. Geoforensics.
25. Education and employment (e.g. sites for field trips and professional training; employment in geoparks).

Abiotic Ecosystem Services

Regulating services

1. Atmospheric & oceanic processes;
2. Terrestrial processes;
3. Flood regulation;
4. Water quality regulation;

Supporting Services

5. Soil processes;
6. Habitat provision;
7. Platforms for human activity;
8. Burial and storage;

Provisioning services

9. Food & drink;
10. Nutrients & minerals;
11. Energy sources;
12. Construction materials;
13. Metals & industrial minerals;
14. Ornamental products;
15. Fossils;

Cultural services

16. Environmental quality;
17. Geotourism and leisure;
18. Cultural, spiritual and historic meanings;
19. Artistic inspiration;
20. Social development;

Knowledge services

21. Earth history;
22. History of research;
23. Environmental monitoring/forecasting;
24. Geoforensics;
25. Education & employment.

ELEMENTS OF A SMARTPHONE

ELEMENTS COLOUR KEY: ALKALI METAL | ALKALINE EARTH METAL | TRANSITION METAL | GROUP 13 | GROUP 14 | GROUP 15 | GROUP 16 | HALOGEN | LANTHANIDE

SCREEN

49 In Indium
8 O Oxygen
50 Sn Tin

Indium tin oxide is a mixture of indium oxide and tin oxide, used in a transparent film in the screen that conducts electricity. This allows the screen to function as a touch screen.

13 Al Aluminium
14 Si Silicon
8 O Oxygen
19 K Potassium

The glass used on the majority of smartphones is an aluminosilicate glass, composed of a mix of alumina (Al_2O_3) and silica (SiO_2). This glass also contains potassium ions, which help to strengthen it.

39 Y Yttrium
57 La Lanthanum
65 Tb Terbium
59 Pr Praseodymium
63 Eu Europium
66 Dy Dysprosium
64 Gd Gadolinium

A variety of Rare Earth Element compounds are used in small quantities to produce the colours in the smartphone's screen. Some compounds are also used to reduce UV light penetration into the phone.

ELECTRONICS

Copper is used for wiring in the phone, whilst copper, gold and silver are the major metals from which microelectrical components are fashioned. Tantalum is the major component of micro-capacitors.

29 Cu Copper
47 Ag Silver
79 Au Gold
73 Ta Tantalum

Nickel is used in the microphone as well as for other electrical connections. Alloys including the elements praseodymium, gadolinium and neodymium are used in the magnets in the speaker and microphone. Neodymium, terbium and dysprosium are used in the vibration unit.

28 Ni Nickel
66 Dy Dysprosium
59 Pr Praseodymium
65 Tb Terbium
60 Nd Neodymium
64 Gd Gadolinium

Pure silicon is used to manufacture the chip in the phone. It is oxidised to produce non-conducting regions, then other elements are added in order to allow the chip to conduct electricity.

14 Si Silicon
8 O Oxygen
51 Sb Antimony
33 As Arsenic
15 P Phosphorus
31 Ga Gallium

Tin & lead are used to solder electronics in the phone. Newer lead-free solders use a mix of tin, copper and silver.

50 Sn Tin
82 Pb Lead

BATTERY

3 Li Lithium
27 Co Cobalt
8 O Oxygen
6 C Carbon
13 Al Aluminium

The majority of phones use lithium ion batteries, which are composed of lithium cobalt oxide as a positive electrode and graphite (carbon) as the negative electrode. Some batteries use other metals, such as manganese, in place of cobalt. The battery's casing is made of aluminium.

CASING

Magnesium compounds are alloyed to make some phone cases, whilst many are made of plastics. Plastics will also include flame retardant compounds, some of which contain bromine, whilst nickel can be included to reduce electromagnetic interference.

6 C Carbon
12 Mg Magnesium
35 Br Bromine
28 Ni Nickel

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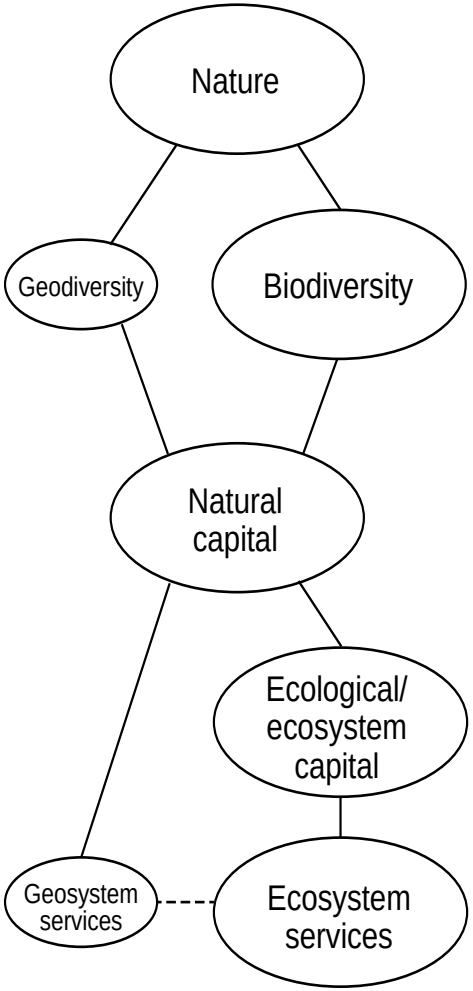
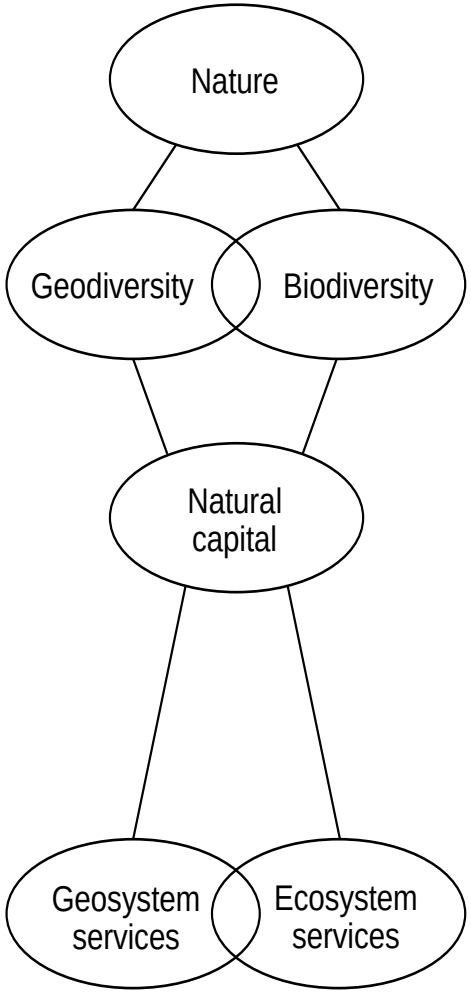
A Current

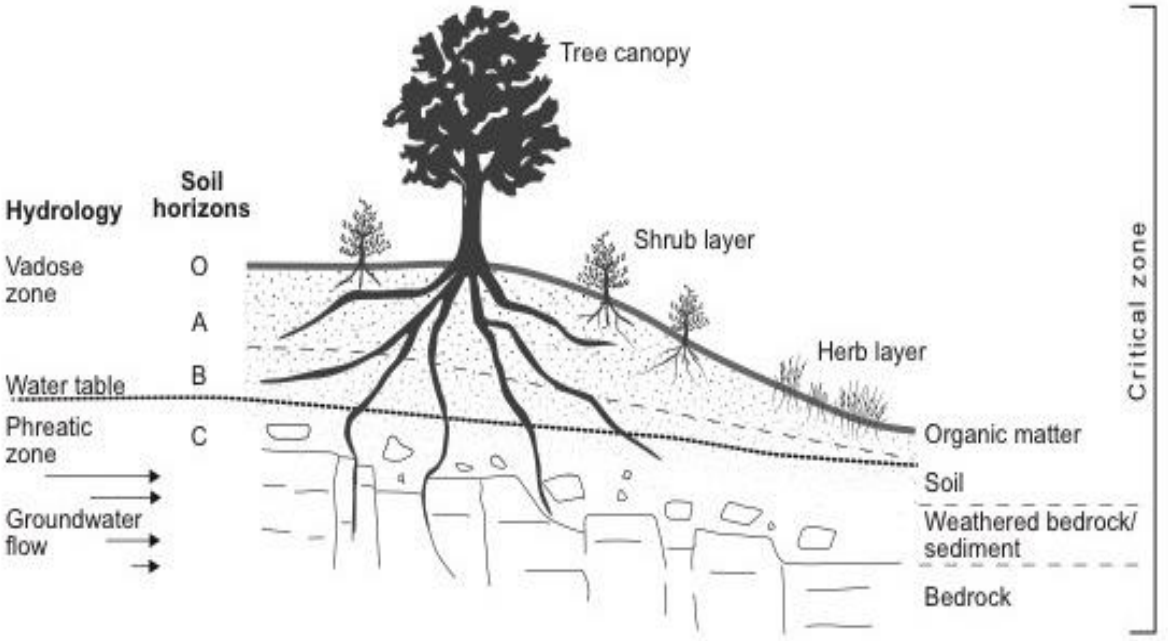


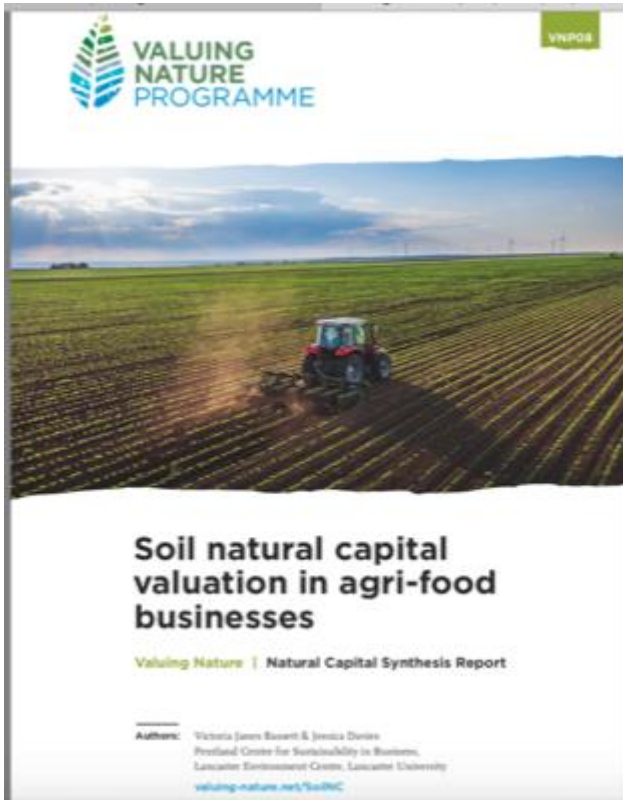
B Proposed



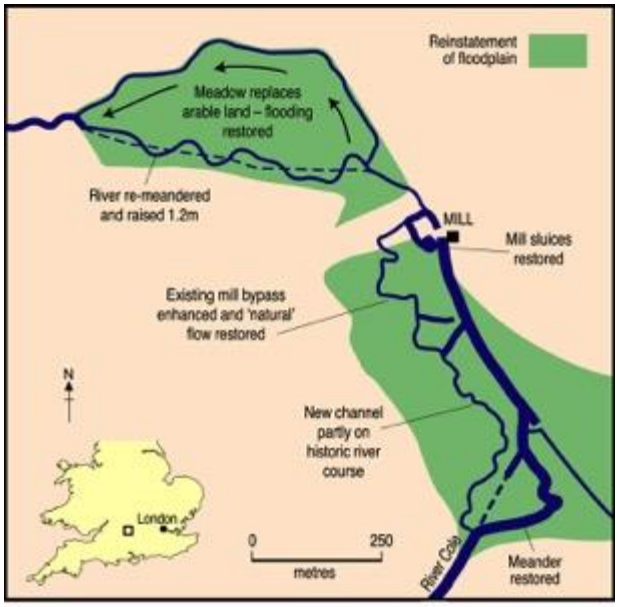
NB - Geodiversity and Biodiversity treated as equals.

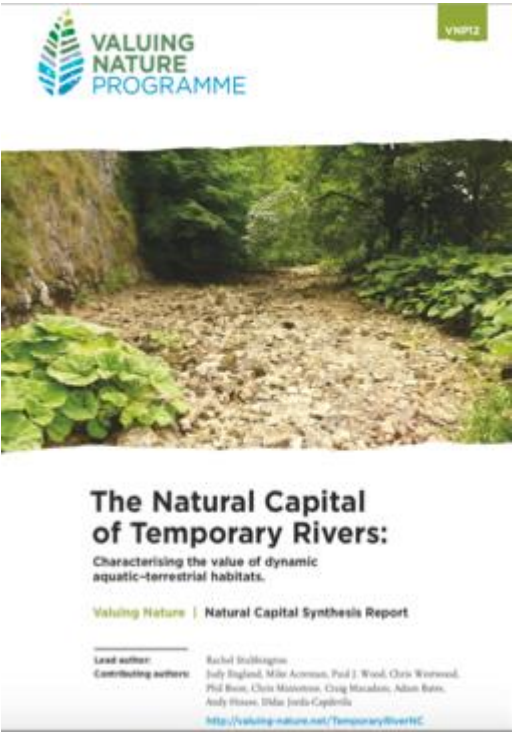
Land, Soil and the "Critical Zone"



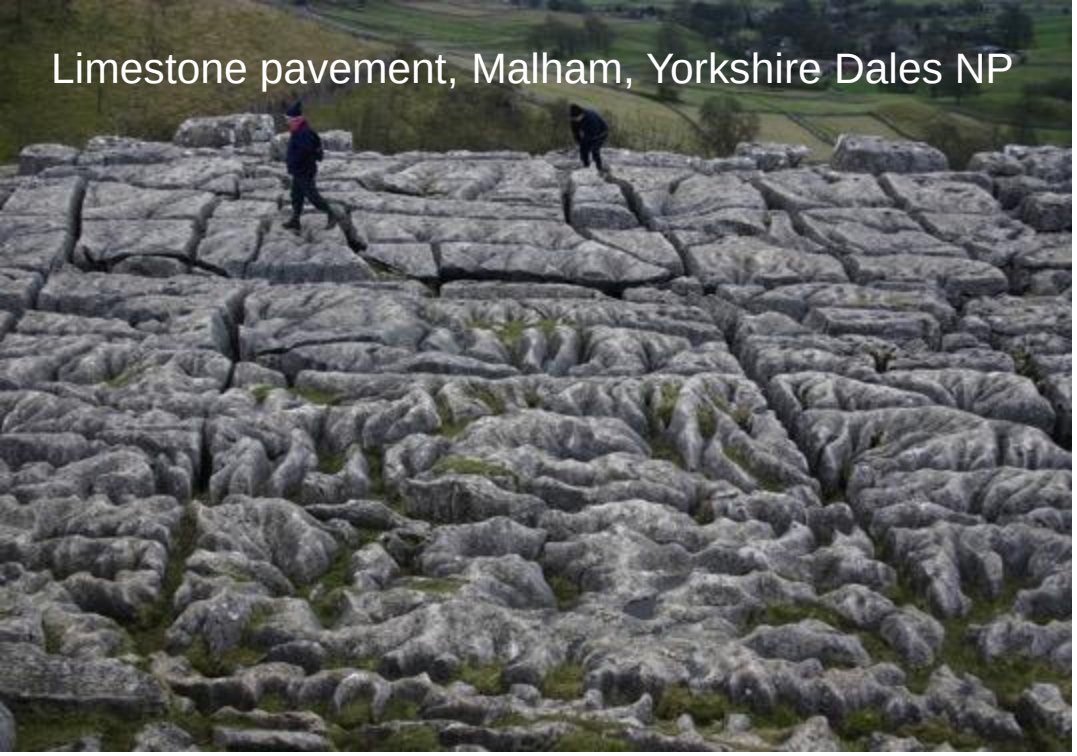


Natural capital is a way of accounting for the amount of a resource we have (stocks), and the services that arise from these stocks (flows). These flows are either ecosystem services produced by living systems, such as crops and woodland, or abiotic services arising from geological processes such as water filtration and sediment capture. The value of an asset is a function of the benefits it provides, which can often be difficult to express in financial terms.





River/Flood Management & Restoration



Limestone pavement, Malham, Yorkshire Dales NP

Intertidal rock outcrops, Algarve, Portugal

geodiverse

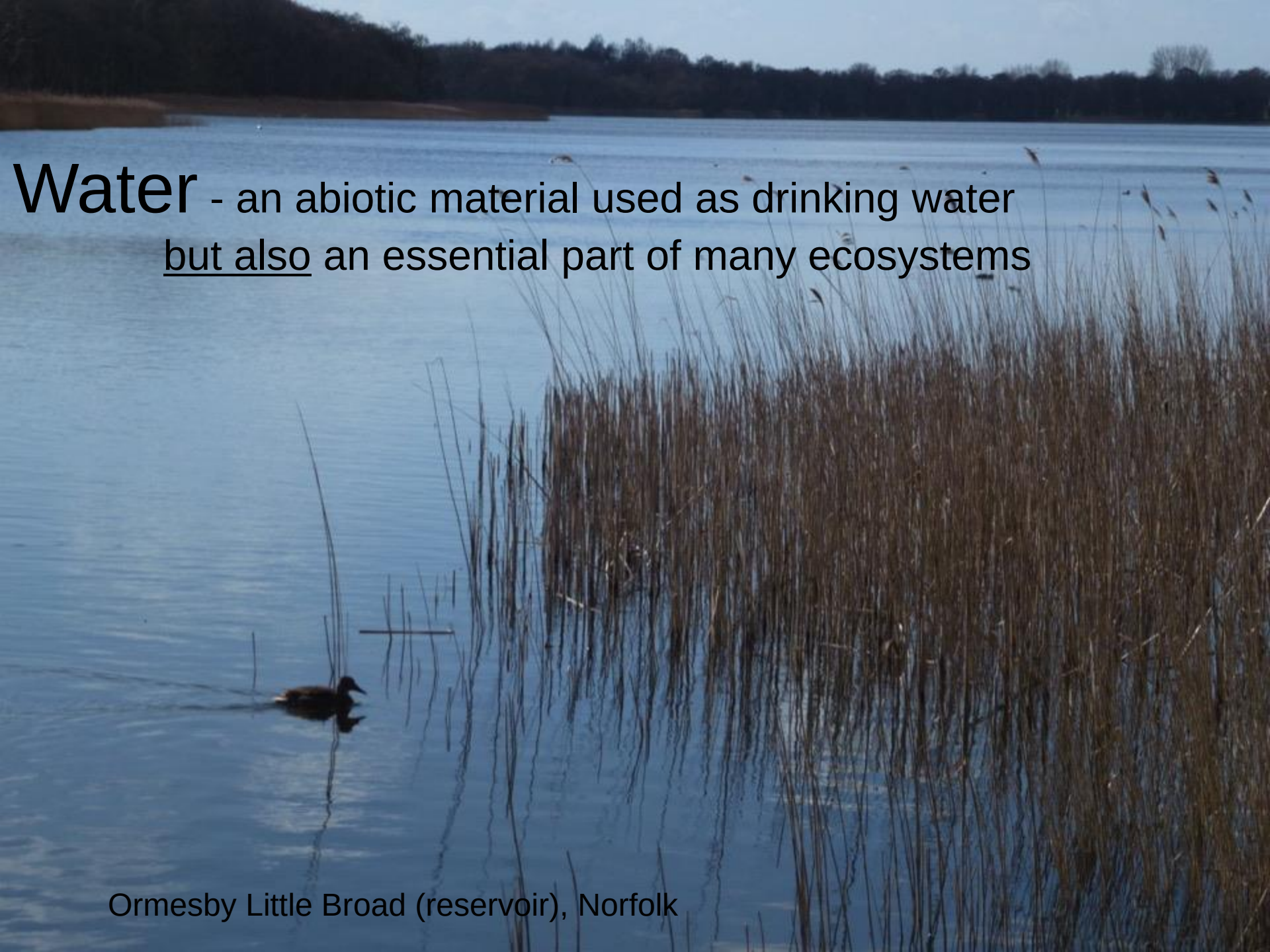
Habitats –

↓

Biodiversity

↓

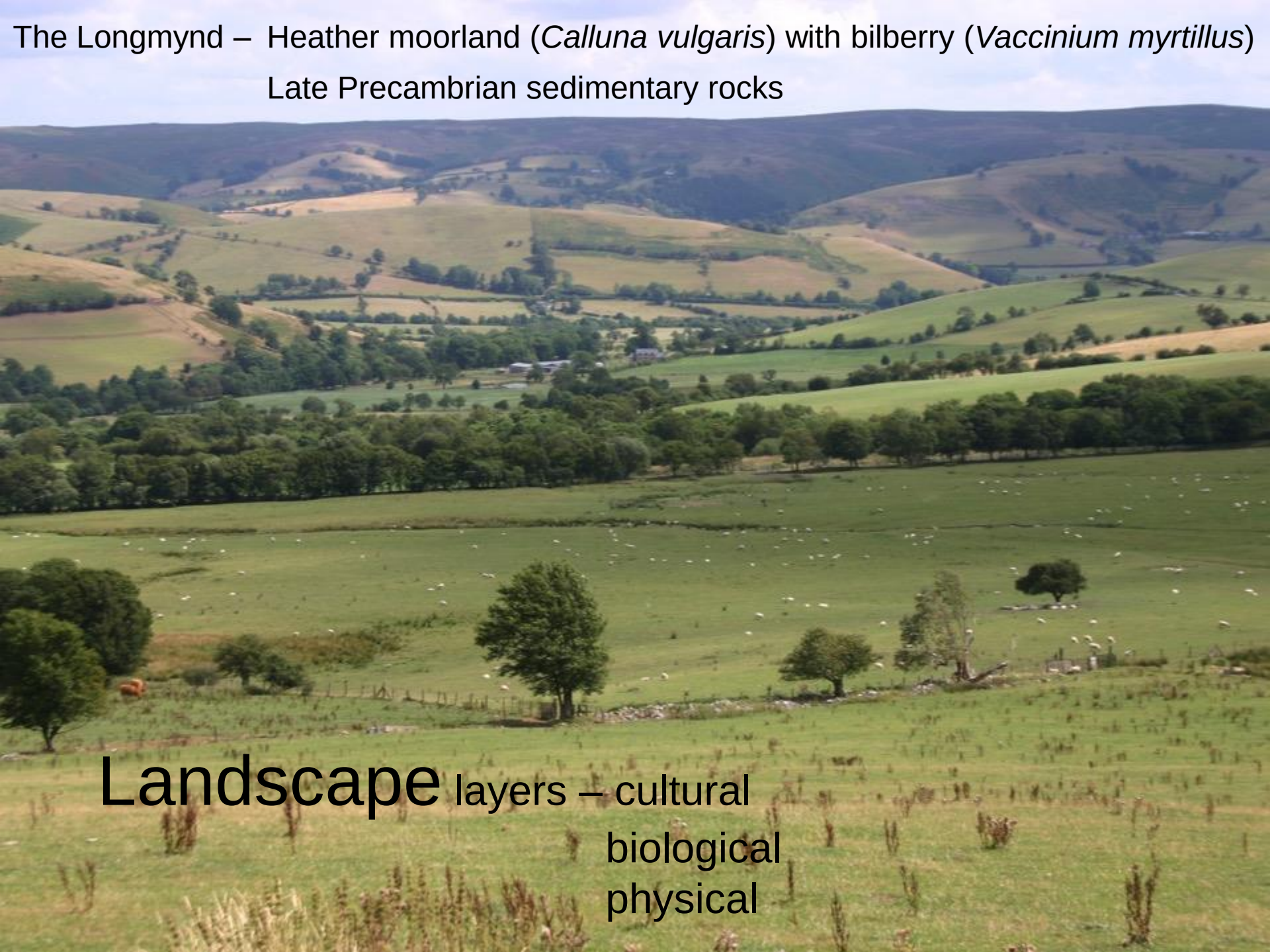
Conserving Nature's Stage (CNS)



Water - an abiotic material used as drinking water

but also an essential part of many ecosystems

Ormesby Little Broad (reservoir), Norfolk


The Longmynd – Heather moorland (*Calluna vulgaris*) with bilberry (*Vaccinium myrtillus*)
Late Precambrian sedimentary rocks
Landscape layers – cultural
biological
physical

Natural History Museum, Vienna

Peat bog sediment core, Scotland

Fossils –
animal <u>and</u> mineral

Palaeontology & Palynology

Changing

climate,
processes,
sediments
vegetation
ecosystems

Conclusions

- The current position of geology/geodiversity within the natural capital and ecosystem services approaches is complex, confused and inconsistent:
- This means that decision-makers are undervaluing the benefits that the whole of nature brings to society and are therefore failing to promote a comprehensive and integrated approach to valuing nature and nature conservation;
- The geodiversity of our planet provides a huge variety of materials, processes and forms that have been brilliantly exploited by human societies over the millennia, from the Stone Age and Iron Age to the Oil Age and Silicon Age;
- Today, our modern society simply could not exist without this geodiversity:
- Value geodiversity every day!

Thank You…

Want to know more?

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