

ژئودایورسیتی

* ژئودایورسیتی (تنوع زمین شناختی) (سنگها، کانی ها و فسیلها) و ژئومورفولوژیکی (اشکال ناهمواری و فرایندها) و پدیده های خاک)

شبهاتها، روابط، ویژگیها، تفاسیر و سیستمها

* ژئودایورسیتی به عنوان یک پارادایم نوپا

«یک چارچوب فلسفی و نظری از یک رشته یا مکتب علمی در کنار نظریه ها، قوانین، کلیات و تجربیات به دست آمده که قاعده مند شده اند»

* ژئودایورسیتی و بیودایورسیتی

وجود تنوع، ارزشمندی آن، در معرض خطر بودن و نهایتا نیاز به حفاظت

وجود ۵۰۰۰ نوع کانی، هزاران فسیل و فقط ۱۹۰۰۰ نوع خاک در ایالات متحده آمریکا

وجود فرایندها گوناگون مثل فرایندهای رودخانه ای، ساحلی، یخچالی، پریکلاسیری، دامنه ای، بادی، هیدرولوژیکی، آتشفشانی، تکتونیکی و ...

وجود طیف گسترده ای از ناهمواری و عناصر چشم انداز

* تجدید ناپذیری

* مهمترین عوامل ایجاد کننده ژئودایورسیتی در منظومه شمسی

تکتونیک صفحه ای

تغییرات اقلیمی در ابعاد زمانی و مکانی

تکامل و انقراض

* نقاط داغ ژئودایورسیتی

۱) نواحی با تاریخچه زمین شناختی پیچیده و طولانی

۲) حواشی صفحات بویژه صفحات همگرا

۳) نواحی با توپوگرافی مرتفع

۴) سواحل

* ژئودایورسیتی اساس ژئوتوریسم و ژئوپارک

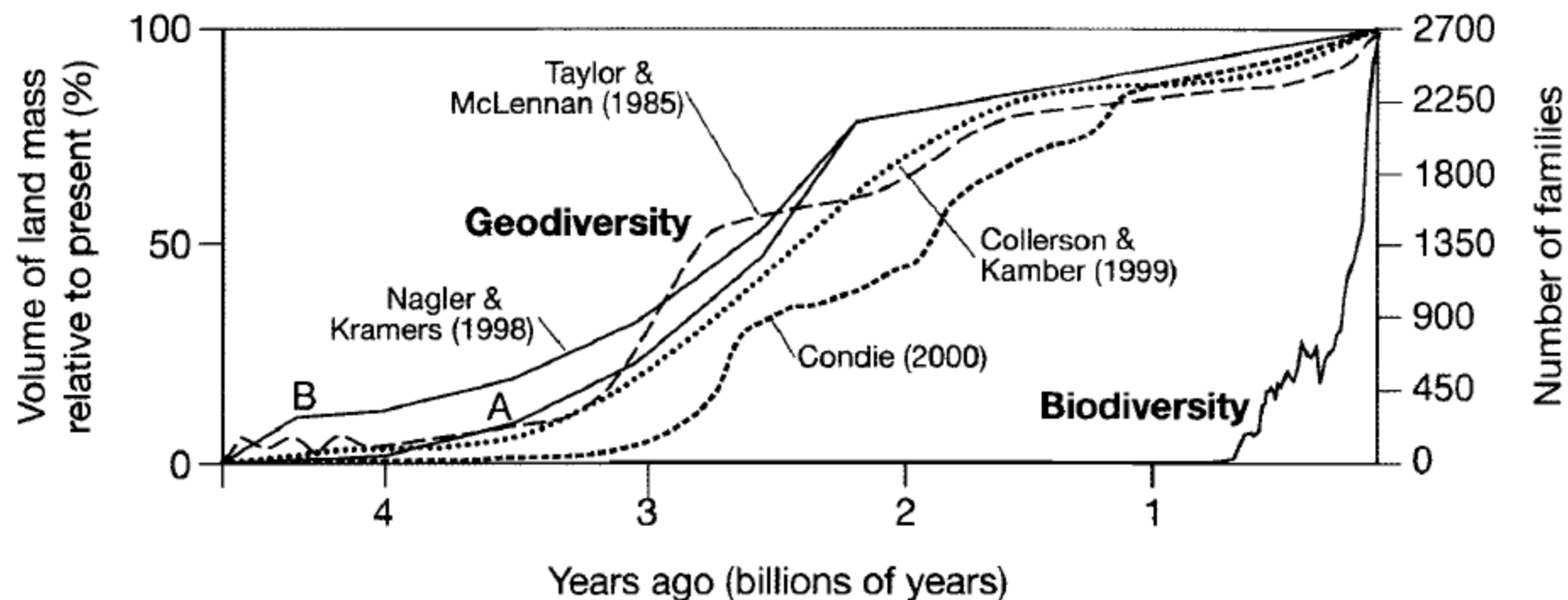
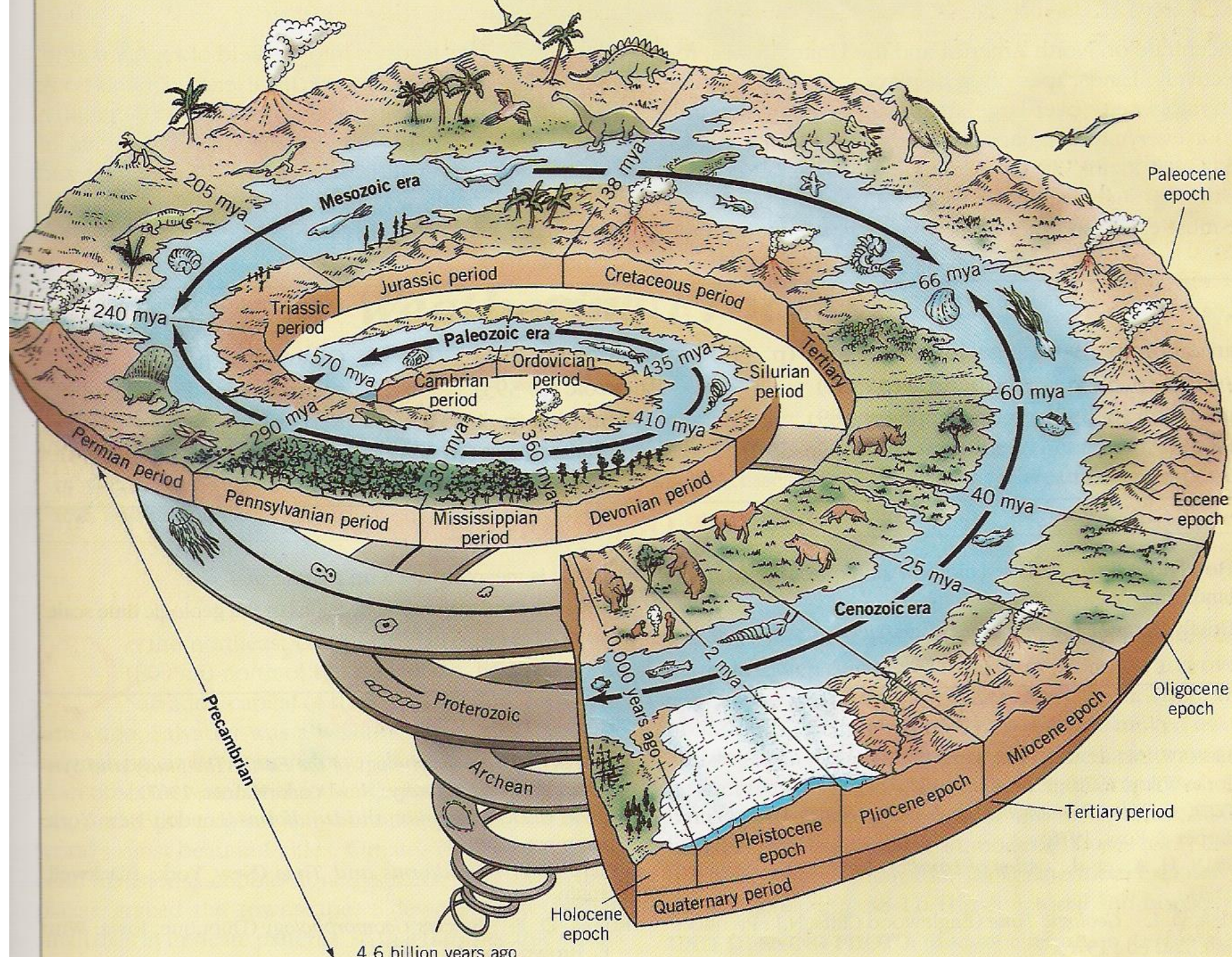
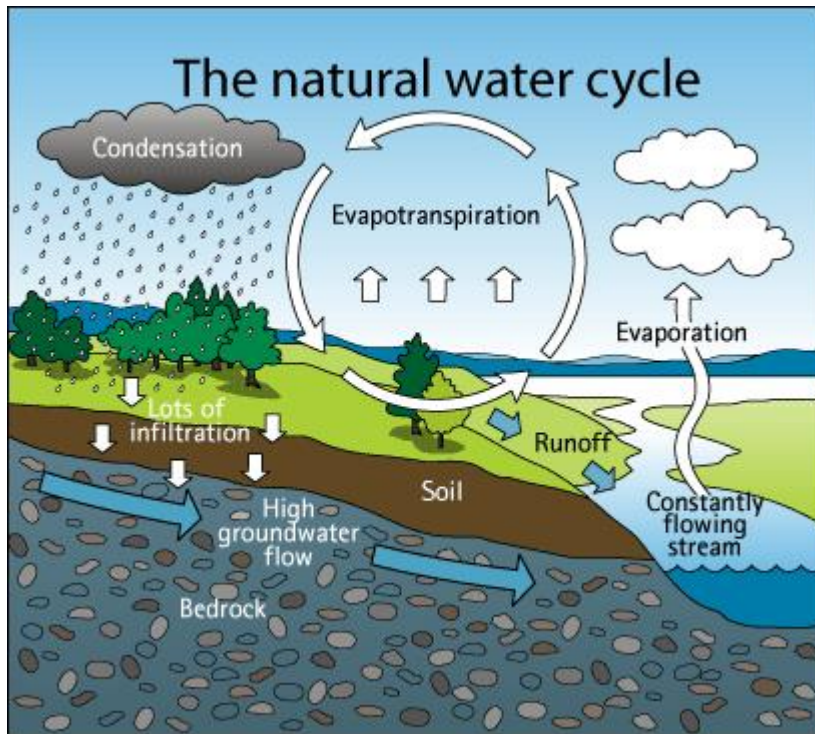


Fig. 1. The evolution of biodiversity (after Benton & Harper, 1997) and suggested S-curves for the evolution of geodiversity based on several author's proposals for the development of the continental crust with acceleration about three billion years ago.



Explain each of these cycles or subsystems

The hydrologic cycle



The rock cycle

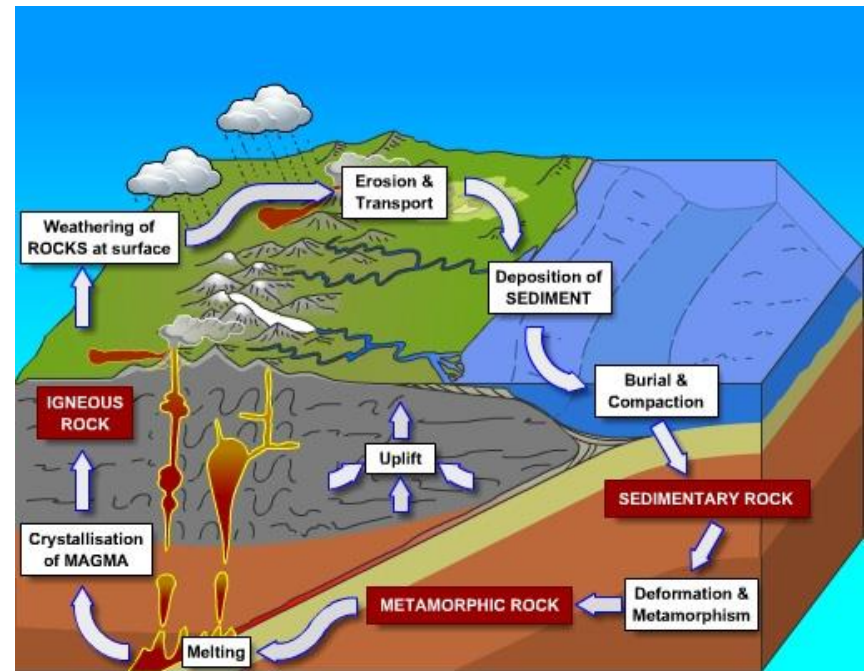
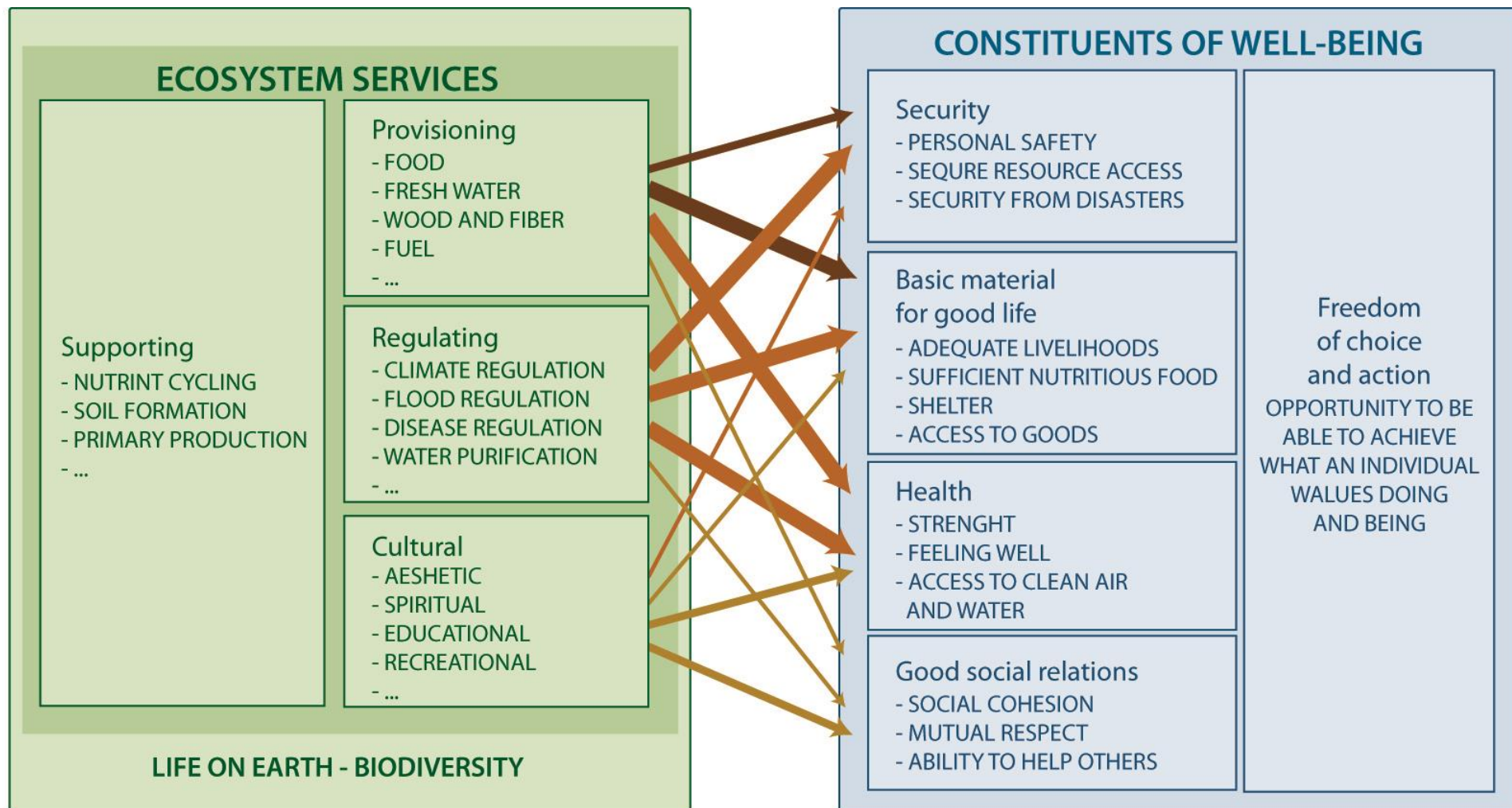


Table 1. Proposed management aims for different elements of geodiversity.

Element of geodiversity	Rare or common	Management aims
Rocks & minerals	Rare Common	Maintain integrity of outcrop and subcrop. Remove samples for curation Maintain exposure and encourage responsible collecting. Encourage sustainable use. Value historical and modern uses of geomaterials
Fossils	Rare Common	Wherever possible, preserve <i>in situ</i> . Otherwise remove for curation Encourage responsible collecting and curation
Topography/Landform		Maintain integrity of topography/landform. Encourage authentic contouring in restoration work and new landscaping schemes
Landscape		Maintain contribution of natural landform, rock outcrops and active processes to landscape. Encourage geomorphologically authentic design in restoration work and new landscaping schemes
Processes		Maintain dynamics and integrity of operation. Encourage restoration of process and form using geomorphologically authentic design principles
Soil		Maintain soil quality, quantity and function



Arrow's color
potential for mediation by socioeconomic factors

High
Medium
Low

Arrow's width
intensity of linkages between ecosystem services and human well-being

Strong
Medium
Weak

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).

Generic Threats to Geodiversity

- Complete loss of site/geological extinction;
- Partial loss/physical damage/resource depletion;
- Fragmentation of interest;
- Loss of visibility or intervisibility;
- Loss of access;
- Interruption of natural processes;
- Off-site impacts;
- Pollution;
- Visual impacts

Specific threats

- Mineral extraction - loss of natural landforms
- Landfill - loss of visibility
- Land development - loss of materials, landforms, visibility, fragmentation of interest;
- River/coastal/natural hazard management - interruption of processes, loss of landforms & visibility
- Forestry - loss of visibility
- Agriculture - partial loss/physical damage, pollution
- Recreation - partial loss/physical damage
- Over-collecting - loss of minerals and fossils
- Ignorance - the biggest threat of all?

Pico, Azores, Portugal



3. Geodiversity & Geoconservation

The Conservation Equation:

Value + Threat = Conservation Need

Fatalistic Approach

- 🏠 Russian roulette - an optimistic approach
- 🏠 Some communities would go as far as to say that hazards are 'God's will'.
- 🏠 Populations take direct action that is concerned with safety.
- 🏠 Losses are accepted as inevitable.
- 🏠 People may remain where they are.
- 🏠 Lack of alternatives - due economic reasons.

Acceptance Approach

- 🏠 Accept the risks that the hazards present because the advantages are greater.
- 🏠 Costs versus benefits.
- 🏠 Tourism.
- 🏠 Energy generation.
- 🏠 Opportunity for intensive agriculture.
- 🏠 Mineral extraction.

Adaption Approach

- 🏠 People see that they can prepare for, and therefore survive, the hazard.
- 🏠 Prediction.
- 🏠 Prevention.
- 🏠 Protection.

Geodiversity & Geoconservation

- So Geodiversity provides a key basis for selecting geoconservation sites at both the international and national levels.....

...and is also the basis for developing geoconservation management aims...

Element of Geodiversity	Rare or Common	Management aims
Rocks & Minerals	Rare	Maintain integrity of outcrop and subcrop. Remove samples for curation.
	Common	Maintain exposure and encourage responsible collecting. Encourage sustainable use. Value historical and modern uses of geomaterials.
Fossils	Rare	Wherever possible, preserve <i>in situ</i> . Otherwise remove for curation.
	Common	Encourage responsible collecting and curation.
Topography/Land form		Maintain integrity of topography/land form. Encourage authentic contouring in restoration work and new landscaping schemes.
Landscape		Maintain contribution of natural land form, rock outcrops and active processes to landscape. Encourage geomorphologically authentic design in restoration work and new landscaping schemes.
Processes		Maintain dynamics and integrity of operation. Encourage restoration of process and form using geomorphologically authentic design principles.
Soil		Maintain soil quality, quantity and function.

and geoconservation methods

Geoconservation Method	Sub-Method	Element of Geodiversity						
		Rocks	Minerals	Fossils	Landforms	Landscapes	Processes	Soils
Site Management	Secrecy	x	x	xx	x			
	Signage	x	x	x	x		x	
	Physical Barriers	x	x	xx	xx		xx	
	Reburial			xx				
	Site Clearance	xx	x	xx				
Curation			x	xx				
Licensing		x	x	xx	x			
Supervision	Static/Mobile Rangers			x	x			
	Remote				x			
	Local Residents			x				
Benevolent Ownership		xx	xx	xx	xx	xx	xx	xx
Restoration					xx	xx	xx	
Legislation	Nature Conservation (Statutory Sites)	xx	xx	xx	xx	xx	xx	xx
	Planning	xx	xx	xx	xx	xx	xx	xx
	Environmental				x	xx	xx	xx
Policy	Non-Statutory Sites (eg WHS, Geoparks, Local Sites)	xx	xx	xx	xx	xx	xx	x
	Management Plans	xx	xx	xx	xx	xx	xx	xx
	Policies/Position Statements	xx	xx	xx	xx	xx	xx	xx
	Codes of Conduct	x	xx	xx	x			
Education	Visitor Centres & Museums	xx	xx	xx	xx	xx	xx	x
	Publications	xx	xx	xx	xx	xx	xx	xx
	Panels	xx	xx	xx	xx	xx	xx	x
	Activities & Clubs	xx	xx	xx	x			
	TV Programmes	xx	x	xx	x		xx	
	Training & CPD	xx	xx	xx	x		x	
	Other							

Table 2. A provisional classification of geoconservation methods and their use for different elements of geodiversity.

Geoconservation method	Element of geodiversity						
	Rocks	Minerals	Fossils	Landforms	Landscapes	Processes	Soils
Secrecy	x	xx	xx	x			
Signage	x	x	x	x		x	
Physical restraint	xx	xx	xx	x		xx	
Reburial	x	x	xx				
Excavation/curation		x	xx				
Permitting/licensing	x	x	x	x			
Supervision			x				
Benevolent ownership	xx	xx	xx	xx	xx	xx	xx
Legislation	xx	xx	xx	xx	xx	xx	xx
Policy	xx	xx	xx	xx	xx	xx	xx
Site management	xx	xx	xx	xx	xx	xx	xx
Education	xx	xx	xx	xx	xx	xx	xx

xx, major method; x, minor method

A thematic approach?

- According to Dingwall et al. (2005), UNESCO is also looking at establishing a list of 13 geothemes to help in assessing for various applications and identifying possible gaps:

- Tectonic & structural features	3
- Volcanoes/volcanic features	13
- Mountain systems	11
- Stratigraphic sites	2
- Fossil sites	11
- Fluvial & lacustrine systems & landscapes	10
- Caves & karst	7
- Coastal development	8
- Reefs, atolls & oceanic island	1
- Glaciers & ice caps	6
- Ice Ages	7
- Arid & Semi-arid landforms & landscapes	4
- Meteorite impact	1

4. Geodiversity & Geoparks

- Geoparks have 3 aims:
 - conservation of geoheritage;
 - geological education for the wider public;
 - sustainable socio-economic development mainly through geotourism.



Arouca Geopark, Portugal

“Extreme geodiversity in a old rifted continent”

- “Textbook examples can be found in almost any field of geology”:
 - Deep orogenic environments
 - Rift environments
 - Ductile deformation: folds and mylonites
 - Faults and fractures
 - Sediments of highly different origins
 - Glacial deposits and glacial features
 - Volcanics, plutons, dykes, sills, laccoliths, pegmatites
 - Metamorphic rocks in orogens and contact aureoles
 - Metasomatic rocks and hydrothermal vein deposits
 - Weathering and soils

5. Geodiversity, Geotourism & Recreation

- “Madame, we do not go there as to paradise. We go to see something different from that we are accustomed to”.

(James Boswell to his wife, 1773)

- So Tourism is based on the diversity of places;
- Geotourism is based on the diversity of geological places;
- Many countries use their geodiversity to promote tourism;

Sport & Leisure activities where topographic diversity is valued

- Skiing (downhill & cross-country);
- Snowmobiling;
- Rock climbing (also values rock diversity);
- Hill walking;
- Running (cross-country);
- Motor cycle scrambling;
- Mountain biking;
- Endurance road cycling (e.g. Tour de France);
- Off-road driving;
- Whitewater rafting;
- Whitewater canoeing/kayaking;
- Canyoning;
- Caving/potholing;
- Golf.

However, other sports, e.g. football, need a “level playing field”

St Andrews, Scotland



Scotland's “links” golf courses like St Andrews are constructed on Holocene raised beach deposits whose surfaces have been modified by wind-blown sand dunes and stabilised by vegetation.

Conclusions

- Geodiversity is the abiotic equivalent of biodiversity and can be assessed in a similar way;
- The Earth's geodiversity brings a huge range of goods and services of benefit to modern society, couldn't live without it;
- Geoconservation should be based on geodiversity, i.e. the fundamental aim of geoconservation should be to protect the geodiversity of a country, region, geopark etc.;
- Geodiversity is also an important basis for geotourism, geoparks and many leisure activities.