Measuring Geodiversity

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Why Measure Geodiversity?

Why Measure Geodiversity?

- To assess losses over time?
- To assess relationships with measured biodiversity?
- As a tool for land management and planning?

Literature

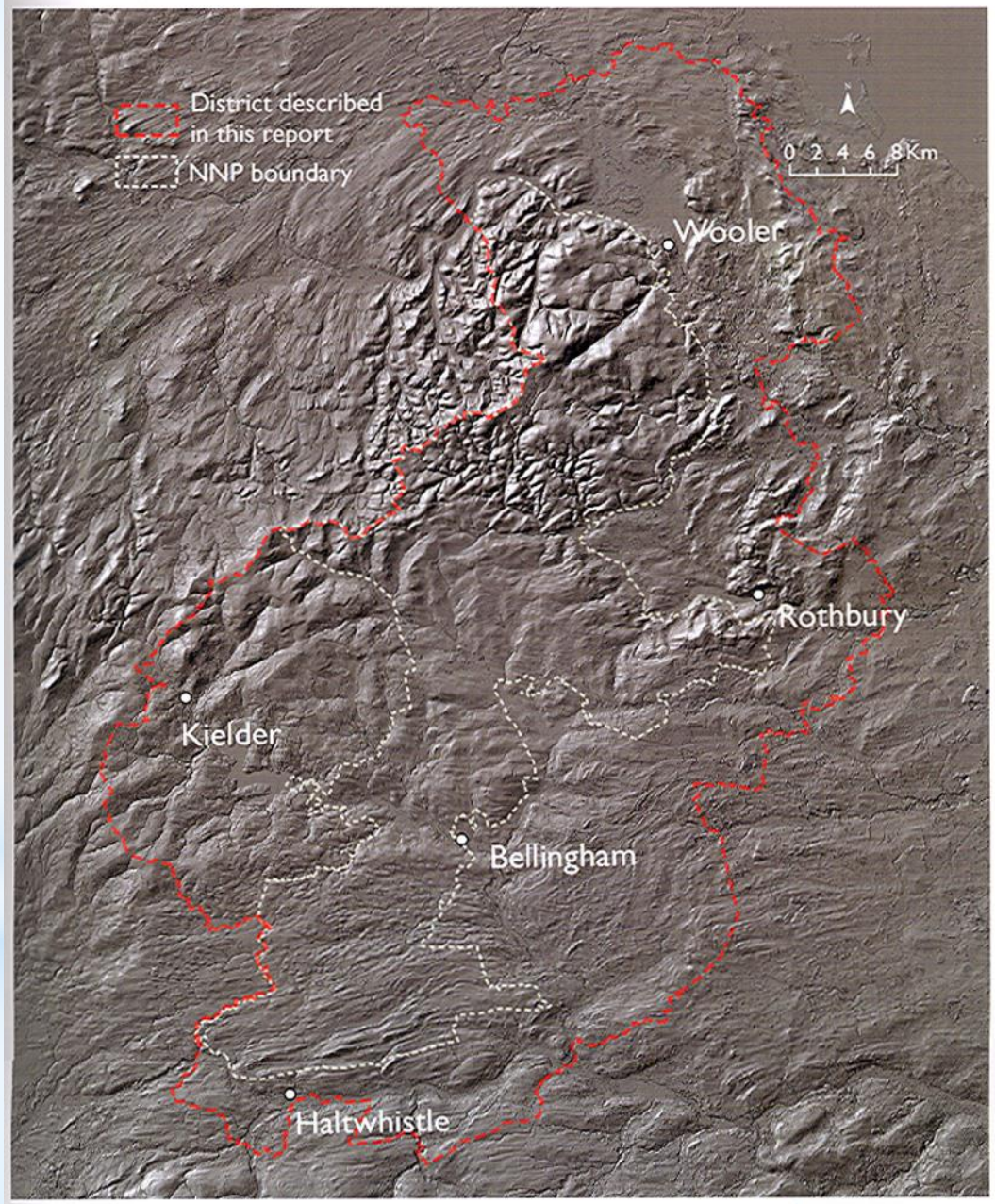
- Several papers in the last few years have tried to measure by using maps and/or satellite imagery (e.g. Hjort & Luoto, 2012; Pereira *et a*l., 2013; Pellitero *et al*., 2014; Santos et al. 2017);
- These studies have generated quantitative data that has then been used to illustrate spatial variations in "the geodiversity of a country/area";
- In turn, it has been suggested by some that areas with the highest geodiversity should be a priority for geoconservation;
- This talk aims to assess the validity of this approach, i.e.
  - (1) can geodiversity be assessed from maps and/or space?
  - (2) can this data be used as the basis for a geoconservation strategy?

What is Geodiversity?

- Before we can measure geodiversity we need to know what geodiversity is;
- "Geodiversity: the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (landforms, topography, physical processes), soil and hydrological features. It includes their assemblages, structures, systems and contributions to landscapes" (Gray, 2013);
- So can we identify all these elements of geodiversity from maps and satellite imagery?
- Different countries have different map/satellite imagery availability.

Meall Ruadh
325
Lochan na Cruaich
Goirtean a' Chladaich
Meall an Doire Dhuinn
Doire Donn
MS
A 82 (T)
Druimarbin
Motel
287
109
Glengour
Beinn Riabhach
Bidein Bad na h-Iolaire
Limestone Group
d2c
Limestone Coal Group
d2b
Lower Limestone Group
d2a
Limestone
Oil-shale
d1
Conformable on c3
al & Oil-shale crops
mestone crops
c3
Cornstone
nconformable on c1
onglomerate
c1
47
46
45
44
43
55°42'
55°41'
55°40'
vBd1
Bd1
c3
d1
vwD
Tc1
Black Mount
Walston
W A L S T O N
Ac1
Ac1 & Bc1
pAc1
c1

A photorealistic hillshade model of the region, derived from the NEXTMap® digital elevation model (© Intermap Technologies Inc.) based on low-level radar survey of the ground surface



What is Geodiversity?

* For me, geodiversity is about the full range of abiotic diversity at all scales….
* …so can the diversity already identified on this photo be assessed from maps or space?

* I've compiled the diversity criteria within each of the geodiversity elements in my book and analysed whether these criteria can be assessed from maps or space.

*Minerals

	Space		Maps
*Mineral type	)		
*Crystal size	)		
*Crystal form & habit	)		
*Hardness	)		
*Cleavage	)	—	—
*Fracture	)		
*Lustre	)		
*Colour & streak	)		
*Internal features	)		
*Chemical properties	)		
*Economic minerals		✓	

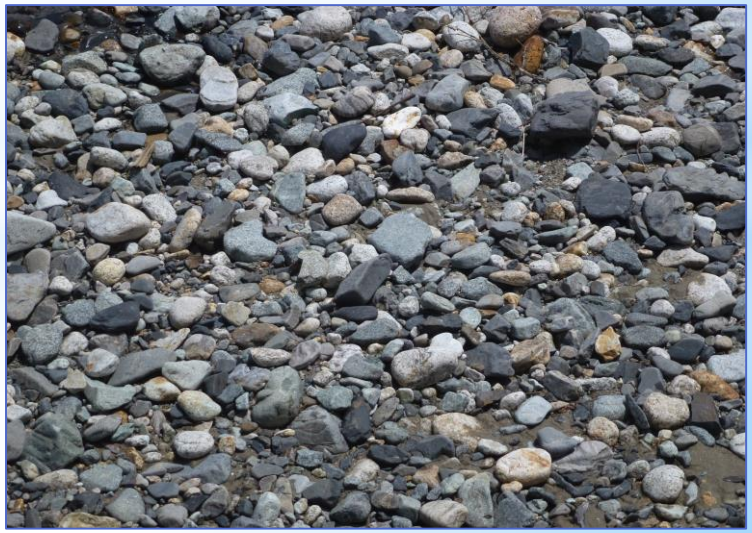
Igneous rocks

	Maps	Space
Rock type	✓✓	—
Rock sub-type	✓	—
Texture	—	—
Chemical & Mineral composition	—	—

Volcaniclastic & sub-aqueous rocks
Ebisujiwa Island, Japan

Sedimentary rocks & sediments

	Maps	Space
Rock type	✓✓	—
Rock sub-type	✓	—
Particle size distribution & sorting	—	—
Particle composition	—	—
Particle shape	—	
Colour	—	
Micromorphology	—	



50 shades of grey!

*Metamorphic rocks

	Maps	Space
*Rock type	✓✓	—
*Rock sub-type	✓	—
*Cleavage & schistosity	—	—
*Banding	—	—
*Shear textures	—	—

Gneiss,
Terras de Cavalieros Geopark,
Portugal

*Structures

	Maps	Space
*Major faults and folds	✓✓	✓✓
*Minor faults, folds and other structures	__	__

Folding,
Algarve, Portugal

Fossils

	Maps	Space
Fossil species	___	___
Fossil assemblages	___	___

*Soils

	Maps	Space
*Soil type	✓✓	—
*Soil sub-type	✓	—
*Colour	—	—
*Particle size distribution	—	—
*Structure & horizonation	—	—
*Density	—	—
*Pore spaces	—	—
*Micromorphology	—	—

Hydrological features

	Maps	Space
Ice sheets, glaciers, etc.	✓✓	✓✓
Snowbeds	—	✓✓
Sea ice/ice bergs	—	✓✓
Streams and rivers	✓✓	✓✓
Springs	✓	✓
Rills	—	—
Ponds	✓	✓
Lakes	✓✓	✓✓
Waterfalls & rapids	✓	✓✓

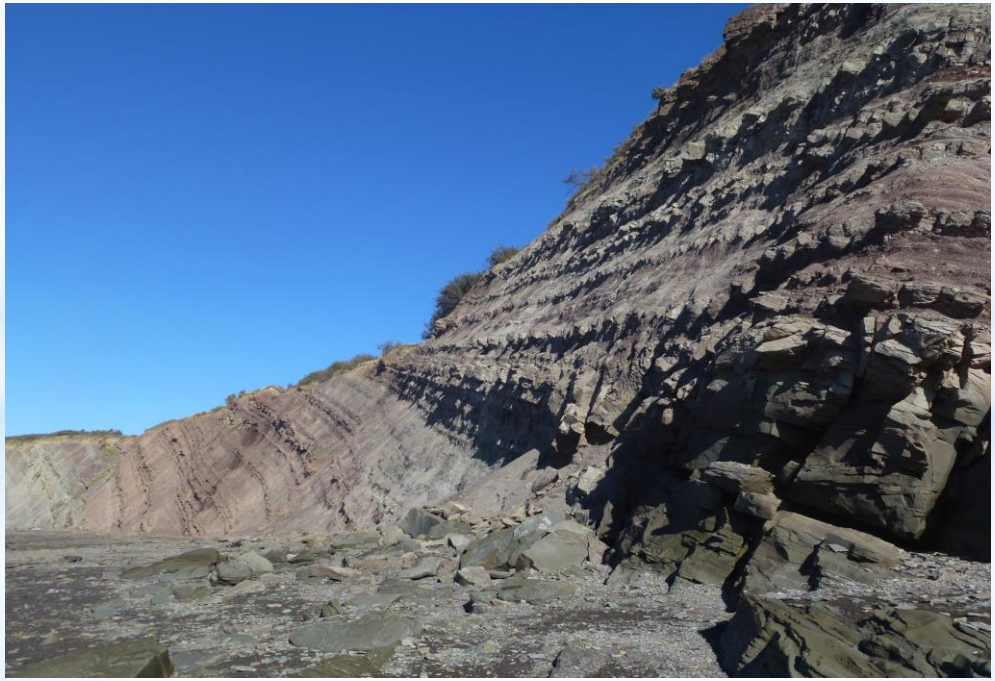
Landforms & topography (summary)

	Maps	Space
Large-scale	✓✓	✓✓
Meso-scale	✓	✓✓
Micro-scale	—	—

South China Karst, Yangshuan

Physical processes (summary)

	Maps	Space
Physical processes	✓	✓



Coastal erosion,
Joggins,
Nova Scotia,
Canada

Conclusions to Q.1

- Some macro- and meso-scale elements of geodiversity are discernible from maps and (less so) from space;
- But most micro-scale geodiversity cannot be assessed by these methods;
- Geodiversity assessments based on maps and/or satellite imagery should make clear that they are only partial assessments of the geodiversity of their areas of study, as assessed from easily available data sources;
- Total geodiversity is rather more complex.

Measuring Geodiversity

* Many have implied or suggested that the areas with the highest geodiversity are the most worthy of geoconservation.
* Is this a valid approach?

Conclusions to Q.2

- A main aim of geoconservation is to protect important geoheritage sites;
- High quality geosites may occur in areas with low geodiversity;
- And high geodiversity areas may have no high quality geoheritage sites.
- So I suggest that this approach should be used with care and in association with the geosite approach.