Geomorphological mapping
Case studies in coastal environment (beaches/rock cliffs)

Contents of the presentation

1) Main objectives of geomorphological maps
2) Data to map
3) Rules of mapping
4) General methodology
5) Practical exercise of geomorphological mapping
1) Main objectives of geomorphological maps

**Geomorphological maps**
- The most appropriate and synthetic ways of showing the spatial distribution of:
  - landforms,
  - surface and near-surface deposits
  - processes that act on landforms
  - the time of the action of these processes
  
  ➔ better analysis and understanding of landscape development

- Important products of investigations made by geomorphologists on the territories

  - professionnals dealing with the landscape and landforms
  - engineers
  - urban planners
  - soils, forests scientists
  - land conservationists
  - risks managers
  - etc.

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**Geomorphological maps**
- contain information on the morphology, genesis and age of landforms.
- take into account the topography and the geological structure
- can be enriched in attributes including slope, aspect, soils, climate and vegetation
- try to explain the landforms genesis

But detailed geomorphological maps are frequently considered as a time-consuming and costly activity …

… Even if the accuracy and speed of mapping is continuously being improved by the availability of more sophisticated equipment, in particular, GPS
5 different types of data

i. Morphographic data (purely descriptive: qualitative description or configuration of the landforms)
   1. Landforms correctly identified
   2. Erosion and accumulation landforms

ii. Morphometric data (gives a quantitative description of the shapes of the landforms)
   Slope, difference in altitude (given by contours and spot elevation e.g)

iii. Structural data
   Relation between geological structure and landforms (selection of geological data)
   Distinction between hard and soft rocks, unconsolidated sediments
   Lithology, e.g. to show erosion resistance of the outcroppings

iii. Morphogenetic data (to emphasize processes and conditions of landforms formation)
   -Genetic classification of landforms: Forms of denudational, fluvial, marine, glacial and periglacial, aeolian, and solution (karst) origin, polygenetic landforms
   -Including sometime processes (gravity, main stream, wind direction, anthropological impacts,...)
   -Detailed description of resulting deposits (in particular quaternary deposits often ignored by geological maps)
   -The focus is on the last, or occasionally earlier, process that acted upon the land surface

v. Chronological data
   Reconstruction of the landscape history
   Successive generations of landforms to distinguish inherited and active landforms
3) Rules of mapping

All the rules of mapping must, of course, be respected

The quality that any map should have is the easy readability of relevant information

- A precise title (where, when, what ?)
- A structured legend (themes, sub-themes, etc.)
  - The legend must be clearly **structured** and **logical** to facilitate the overview (there is a need of classification of each data before drawing the map)
  - The number of symbols must be kept low for easy use
  - One geomorphological fact to map = one symbol
- A graphic scale (rather than numerical)
- The orientation (the North and/or geographical coordinates)
  For easy orientation in the field, it is advantageous if the geomorphological map is based upon a geo-referenced topographic map or orthophotograph that shows selected infrastructure and also gives contour lines.
- The references of data
- The author of the map as well as the date of realisation
3) Rules of mapping

A detailed and precise map... but also a work of art.

A structurated legend...
### 3) Rules of mapping

A structurated legend… Example of the French geomorphological map at 1/50 000

<table>
<thead>
<tr>
<th>THEME</th>
<th>SUB-THEMES</th>
<th>MORPHODYNAMIC SYSTEM</th>
<th>PROCESSES</th>
<th>SYMBOLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Morphometric data</td>
<td>Topography</td>
<td></td>
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<tr>
<td></td>
<td>Bedform</td>
<td></td>
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<tr>
<td>II Hydrographic data</td>
<td>Rivers</td>
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<td>Lakes</td>
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<td></td>
<td>Glacial hydrography</td>
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<tr>
<td></td>
<td>Marine hydrography</td>
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</tr>
<tr>
<td>III Geological structures</td>
<td>Lithology</td>
<td>Inherited continental landforms and deposits (polygenic)</td>
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<tr>
<td></td>
<td>Tectonic</td>
<td>Fluvial landforms and deposits Ground-water and karst</td>
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<tr>
<td></td>
<td>Structural landforms</td>
<td>Landforms and deposits</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Continental landforms</td>
<td>Ground-water and karst</td>
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<td></td>
<td>Ground-water and karst</td>
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<tr>
<td>IV Morphogenetic data</td>
<td>Coastal and submarine landforms</td>
<td>Inherited coastal and submarine landforms and accumulations</td>
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<td></td>
<td>Present-day erosional landforms and accumulation features</td>
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<tr>
<td>V Bioconstruction</td>
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<tr>
<td>VI Anthropogenic landforms</td>
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</tbody>
</table>

Colours usually used in the French geomorphological map
3) Rules of mapping

Adaptation of the legend when chronology is the most important fact to better understand the morphology… (river terraces)

Change of the colours to indicate the period

Landforms related to river terraces

Other main information: granulometry and composition of the terrace deposits
3) Rules of mapping

Other example: Ouessant island (western Brittany) → lithology and tectonic

Ouessant
4) General methodology

**Procedure**

- The production of geomorphological maps starts with field survey that could be prepared with a bibliographical work.
- Field observations are recorded on a copy of the topographical map that could be enlarged for the field work.
- Aerial photographs (including satellite imagery) can enable the production of the base map.
4) Methodology

**Field survey**
- Conception of the legend of the map based on field observations and remote sensing of aerial photos
  - Classification of morphological features into themes, sub-themes, etc.
  - Present-day geomorphological processes
  - Lithology
  - Topographical data to map
  - etc.

- Choice of the symbols and colors or black and white to apply

For example, refer to:

**Lab works**

For the legend conception:

L'Île-Tudy
Combrit
A «simplified» way to build the legend of a geomorphological map…

<table>
<thead>
<tr>
<th>Continentale</th>
<th>Continental</th>
<th>Coastal</th>
<th>Sub-marine</th>
<th>Anthropogenetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erosional landforms</td>
<td></td>
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<td></td>
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<tr>
<td>Landforms due to accumulation</td>
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<tr>
<td>Processes</td>
<td></td>
<td></td>
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<tr>
<td>Topometric data</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
4) Methodology

A « simplified » way to build the legend of a geomorphological map...

<table>
<thead>
<tr>
<th>Landforms</th>
<th>Erosional</th>
<th>Old</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<tr>
<td>Deposit</td>
<td>Old</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processes</td>
<td>Specific</td>
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</tr>
<tr>
<td></td>
<td>Not specific</td>
<td>aeolian</td>
<td>periglacial</td>
</tr>
</tbody>
</table>

Topometric data

Lithology

Field survey

Lab works

2d step = Conception of the map based on georeferenced topographical and geological maps, DTM (if existing) and aerial photos.
4) Methodology

2d step = Conception of the map based on georefenced topographical and geological maps, DTM (if existing) and aerial photos.

3rd step = The base map is then "ground truthed" in the field. Ground truthing is an important part of the process to validate the map (small scale features can often be missed, and larger scale features can be misinterpreted).

5) Practical exercise of geomorphological mapping
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1) Identify and list all the facts to map, especially the geomorphological features

- Chalk with flinty beds or nodules
- Surficial accumulation of flinty clay
- Main contours
- Spot elevation
- Bathymetric contours
- Pool of water
- Convex break of slope
- Side of incised valley
- Plateau
- V-shaped hanging valley
- Scar of collapsed mass at the cliff top
- Scree of debris
- Collapsed mass due to rockslide
- Abrasion zone
- Shore platform
- Cliff top
- External cliff of the shore platform
- Tracks of old collapsed mass reshaped by coastal processes
- Pebble beach
- Collapsed mass due to mudslide
- Litoral drift
- Sands and pebbles
- Rannel (locally called "caminaux")
- Shore platform Brown algae zone
- Roads
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- Shore platform Brown algae zone
- Roads

2) List the main topics

- Lithology
- Topographic data
- Hydrography
- Polygenic landforms
  - Polygenic features due to gravity
  - Coastal and submarine landforms

3) Choose the colour
### 5) Practical exercise of geomorphological mapping

1) Identify and list all the facts to map, especially the geomorphological features

- Chalk with flinty beds or nodules
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2) List the main topics

<table>
<thead>
<tr>
<th>Lithology</th>
<th>Chalk with flinty beds or nodules</th>
<th>Surficial accumulation of flinty clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topographic data</td>
<td>Main contours</td>
<td>Spot elevation</td>
</tr>
<tr>
<td>Hydrography</td>
<td>Pool of water</td>
<td></td>
</tr>
</tbody>
</table>

3) Choose the colour

- Polygenic landforms
- Polygenic features due to gravity
- Coastal and submarine landforms

4) Separate erosional features from accumulations

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<thead>
<tr>
<th>Polygenic landforms</th>
<th>Erosional features</th>
<th>Plateau</th>
<th>Convex break of slope</th>
<th>V shaped hanging valley</th>
<th>Side of incised valley</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polygenic features due to gravity</td>
<td>Erosional features</td>
<td>Scar of collapsed mass at the cliff top</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Accumulations</td>
<td>Some of debris</td>
<td>Collapsed mass due to rockslide</td>
<td>Collapsed mass due to rockfall</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coastal and submarine landforms</th>
<th>Coastal erosional features</th>
<th>Cliff top</th>
<th>Shore platform Abraision zone</th>
<th>Shore platform Brown algae zone</th>
<th>External cliff of the shore platform Runnel (locally called &quot;carriaux&quot;) Tracks of old collapsed mass reshaped by coastal processes</th>
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</thead>
<tbody>
<tr>
<td>Coastal accumulations</td>
<td>Lithoral drift</td>
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<td></td>
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<tr>
<td>Main coastal process</td>
<td>Pebble beach</td>
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<td></td>
</tr>
<tr>
<td>Submarine accumulation</td>
<td>Sands and pebbles</td>
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- Roads

2) List the main topics

3) Choose the colour

4) Separate erosional features from accumulations

5) Choose the symbols to draw
5) Practical exercise of geomorphological mapping

Morphological map of the rocky coast near Senneville sur Fécamp
Some references:


- Joly F., Glossaire de géomorphologie, base de données sémiologiques pour la cartographie. Collection U, A. Colin, ppp


http://geographie2001.free.fr/TDgeo.html#f%C3%A9omorphologie