Appendix 5: Physiographic Model Methodology

SPECIFICATION FOR PREPARING A PHYSIOGRAPHIC MODEL OF THE COUNTY OF NORTHUMBERLAND

1. INTRODUCTION

1.1 Northamptonshire Archaeology has been commissioned by Northumberland County Council to prepare a physiographic model of the county of Northumberland.

1.2 The model will be used in order to provide the background for other characterisation and related strategic work being undertaken by the Council.

2. OBJECTIVES

2.1 The work will seek to describe the physiography of the county by delineating areas that are defined by a common series of natural attributes. The analysis aims to be as objective as possible and work to a transparent methodology.

2.2 The model will be created digitally and be capable of interrogation through use of a computerised Geographical Information System (GIS).

3. RATIONALE

3.1 The physiography of any landscape is made up of two primary groups of influences, geology and topography. Together, details of these two groups combine to describe the basis of a landscape which has shaped, and is shaped by, all activities in that landscape, be they historic, modern or natural in origin.

3.2 In forming the physiographic model for a landscape the two key considerations are what weight of importance to give between the two primary groups of influences and also between the individual sets of data that form those groups.

Geological Influences

3.3 Geological influences can be broken down into three data sets:

Solid Geology
Drift Geology
Soils

These data are listed in the above order as each derives from the preceding item.

3.4 The solid geology data set describes the underlying rock formations that provide the basis upon which all landscape sits. The drift geology data set describes the overlying soil and rock formations that are derived in the UK primarily from glacial and fluvial action. These deposits generally take their form from the underlying solid geology, or that of the surrounding area, though glacial and fluvio-glacial influences may bring deposits from further afield. The soils data set derives its basic form directly from the drift and solid geology, but represents the manner in which the basic underlying sub-soil has been modified by recent (in geological terms) activities including farming and other forms of land use.

3.5 Having established the link between, and the primary order of the three main geological data sets a decision will need to be taken concerning the weighting given to the individual data sets in the creation of the physiographic model. While the soils data describe the immediate interface with the landscape usage, they are at least in part formed and influenced by the drift and solid geologies. The solid, and to a lesser extent the drift geologies, also have a major influence over some of the topographic data sets. This is because they provide the basic building blocks that have been shaped to form the topographic landscape, and have also influenced the shaping of that landscape by their nature and form.

Topographic Influences

3.6 Three main topographic data sets that have been identified as of potential relevance:

Altitude or Elevation
Angle or Slope gradient
Aspect or Attitude

3.7 Unlike the geological data sets, which are inherently descriptive unless codified, the topographic data sets are based on empirical data. In many ways this makes them considerably easier to handle than the geological data sets. It is likely that Attitude can only be usefully coded at a micro level (possibly within individual land parcels) and therefore may not be useable at the more generalised level required for the physiographic model.

Other influences

3.8 There are other geological data sets that may be useful in formulating the physiographic model for example, ground water data set, which describes the depth and fluctuations of the water table along with data about the ground water's chemical make–up. If available, such data sets will be assessed during the evaluation phase.

Conclusion

3.9 Primacy will be given to the underlying rock formations since it is from these that soils are derived and the topography formed. It is considered that in each case the surface geology is the most significant to understanding physiographic form and so no attempt will be made to factor in the deeply stratified geological deposits.

4. METHODOLOGY

4.1 The method for forming the model comprises assembling the data sets corresponding to the geological and topographic influences and then using MapInfo GIS system to map areas based upon pre-determined combinations and weightings of these data.

4.2 The process will have five stages:

1) Data preparation and evaluation.
2) Formulating descriptions of the physiography based upon those data.
3) Using the query functions of MapInfo to map the areas.
4) Testing the model
5) Reporting and archive

Data preparation and evaluation

4.3 An evaluation will be made of all data sources available. This will include digital, analogue and written sources. Where data is only available in analogue form, it will need to be digitised.

4.4 Separate MapInfo tables will be compiled for each data source. These will be either primary or derived data. Proposed examples are presented below.

<u>Primary data</u>

Geology — Geology data will be based upon the British Geological Survey's mapping of Solid and Drift deposits. Ideally this will be taken from DigMapGB-50, the Geological Survey's new 1:50000 digital series.

Soils — Soil data will be based upon the Soil survey of England and Wales, 1:250000 (or more detailed) mapping.

Altitude — Information will be based upon available Ordnance Survey contour data sets. If available, DTM data such as produced by ifSAR will also be used.

Derived Data

Gradient — A generalised map of gradient will be formed using the altitude data set(s). A regular grid will be placed across the county and a measure of gradient assigned to each grid-square.

A generalised measure of ground 'undulation' may also be attempted, if relevant, using the same grid employed for gradient.

Aspect — If evaluation considers it relevant, measures of aspect will be derived from available DTM data.

Formulation of descriptions

4.5 After the data sets have been assembled and edited so that they can be used effectively within MapInfo, descriptions of areas based upon those data will be formulated. Firstly a hierarchy of physiographic areas will be compiled. These areas will then be defined in terms of the existing data sets and finally, 'queries' will be devised that can be used within MapInfo GIS.

4.6 The process will entail breaking down the physiography of the county into component parts and then re-assembling those elements into the physiographic areas. This has the advantage that if different criteria are introduced or different weightings applied to the data in the future, the basic building blocks can be re-assembled in different ways. In this respect the modelling will form a 'repeatable' process.

Mapping areas

4.7 Running the MapInfo queries will produce a table of MapInfo polygons. The boundary to each polygon will be that of the data set which has the dominant weighting. However, this raises two potential issues. Firstly, these divisions may 'sharp' whilst in reality areas tend to merge, one with another. Secondly, some of the polygons will be deemed 'outliers' of the principal physiographic areas.

4.8 Depending upon the results of the mapping and the uses to which the model will be put, it may be considered necessary to introduce a generalising process to blur distinctions between boundaries. In addition, limits to the scale at which the mapping can be used will also be decided.

4.9 With regard to outlying polygons, it will be necessary to formulate a set of rules to exclude or merge unrepresentative areas. Criteria will thus be specified for such measures as size and extent which would then be employed to rationalise the model.

Testing the model

4.10 The provisional model will be sent to interested parties for comments. Where relevant, these comments and suggestions will be incorporated into the final model. Field visits may be needed in order to verify the accuracy of the model.

Reporting and archive

4.11 Once testing of the model is complete a written report will be produced to serve as a guide to using the digital model. It will include:
1) Background to the project
2) Description of the data employed
3) Methodology
4) Description of the results

4.12 Up to five paper copies of the report will be produced, accompanied by digital versions in Microsoft Word and Adobe PDF formats.

4.13 The digital model will comprise MapInfo tables for each physiographic area. These will also be translated into ESRI ArcView shapefiles. Metadata will be created in accordance with any appropriate Northumberland County Council standards and procedures.

5. RESOURCES

5.1 The project will be managed by Steve Parry MA FSA MIFA, Principal Archaeologist, Northamptonshire Archaeology.

5.2 The work will be undertaken by Mark Holmes MA, Senior Project Officer Northamptonshire Archaeology. Mark produced the physiographic model for Northamptonshire on behalf of Northamptonshire County Council and is undertaking the Historic Landscape Characterisation Project for the Council and English Heritage.

5.3 The work will be undertaken principally using the MapInfo v6.0 computer program. The results will be made available in both MapInfo and ESRI ArcView (shapefile) formats. Other computer programs such as ER Mapper may also be used to process and analyse the data.

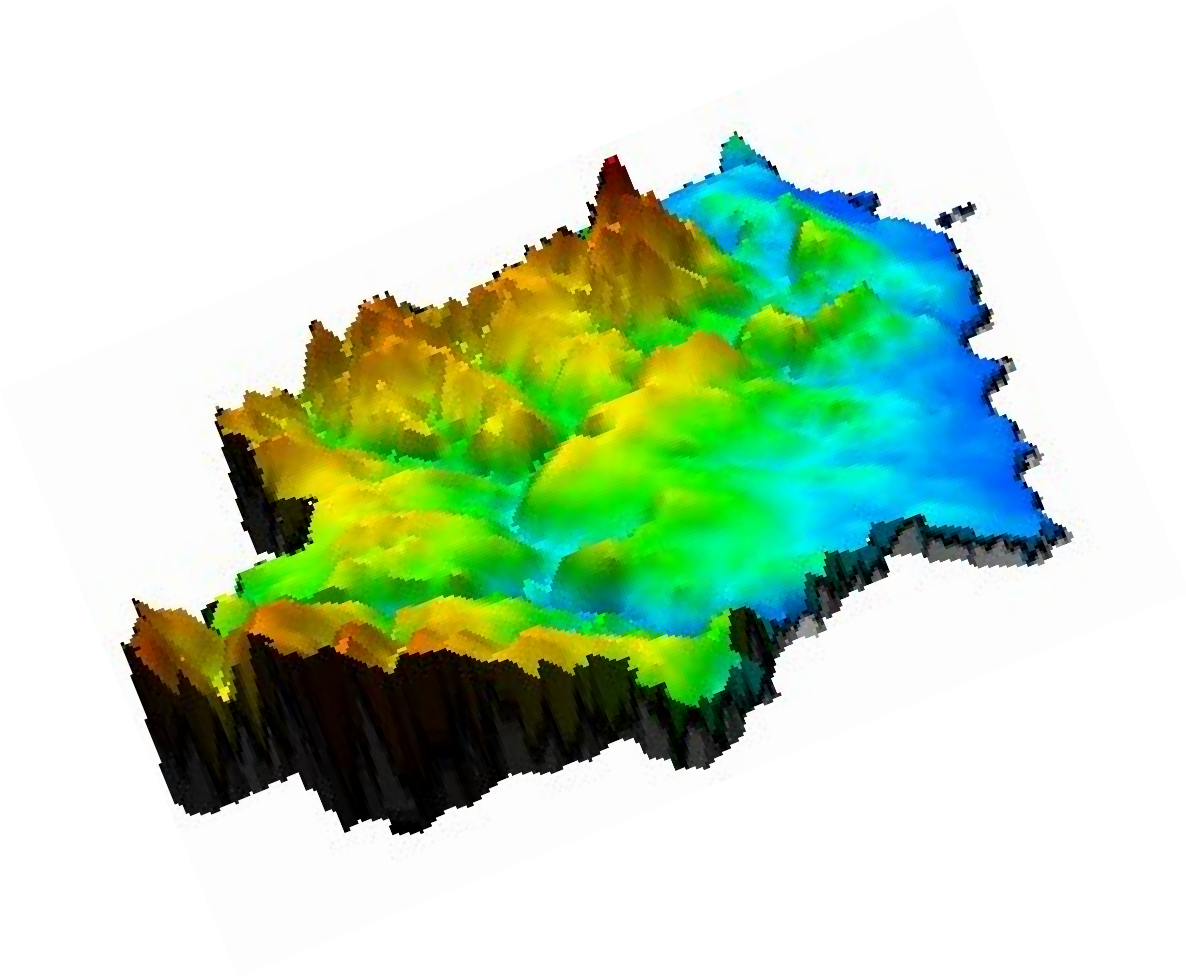
5.4 All works will be undertaken in accordance with Northamptonshire Council's Health and Safety policy.

Northamptonshire Archaeology
A service of Northamptonshire County Council 13 July 2006

Northumberland

Physiographic Model

Methodology



Prepared on behalf of Northumberland County Council and Northumberland National Park
Historic Landscape Characterisation Project by Northamptonshire Archaeology
Funded by the Northumberland Coast Area of Outstanding Natural Beauty

March 2007

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Approved by	S PARRY		02/03/07

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MARCH 2007

1 INTRODUCTION

Northamptonshire Archaeology has been commissioned by Northumberland County Council to prepare a physiographic model of the county of Northumberland. The model will be used in order to provide the background for other characterisation and related strategic work being undertaken by the Council.

This report details the methodology and results of that work and forms an accompaniment to the GIS data sets that make up the physiographic model. The modelling was carried out between November 2006 and February 2007 working to a methodological statement issued by Northamptonshire Archaeology in July 2006.

2 OBJECTIVES AND METHODOLOGY

The work sought to describe the physiography of Northumberland by delineating areas that were defined by a common series of natural attributes. The analysis aimed to be as objective as possible and work to a transparent methodology.

Geology and Topography were considered to be the two main influences on the physiographic character of the county. The weighting to be given to these influences and their component parts were outlined and the following order advanced:

GEOLOGY	*TOPOGRAPHY*
Solid Geology	Gradient
Drift Geology	Altitude
Soils	Aspect

Although, in theory, primacy belongs to the underlying solid rock formations since it is from these that soils were derived and the topography formed, it was considered that in each case the surface geology was the most significant to understanding of the current physiographic form and so the superficial drift geology took precedence where present.

The method for forming the model comprised assembling the data sets corresponding to the geological and topographic influences and then using MapInfo GIS system to map areas based upon pre-determined combinations and weightings of these data.

In practice the process has four stages:

6) Data preparation and evaluation.
7) Formulating descriptions of the physiography based upon those data.
8) Using the query functions of MapInfo to map the areas.
9) Testing the model

Data Preparation and Evaluation

Geology — Geology data were largely taken from the British Geological Survey's DigMapGB-50 1:50000 digital series. One area, Hexham (EW019) has no currently available data for the superficial geology.

Soils — Generally speaking, the soils throughout the county directly reflect the underlying geology. Where they do not, it is usually as a result of modern man-made activity and land-form alterations. As such, although they formed a useful test and corroboration for the physiographic areas it was not felt necessary to use them directly in the formulation of the descriptions. Consequently only a paper copy

	of the 1:250000 Soil map was referenced (Soil survey of England and Wales, 1983).
Altitude	Information was taken from the IFSAR data set which provides a digital terrain model (DTM) from data taken at 5m intervals (Fig 1). Added to this, the Ordnance Survey Contour data set were also used. These line data were transformed into closed polygons and divided into separate tables in order to make selection and queries possible in the MapInfo GIS..
Gradient	A generalised map of gradient was formed using the OS contour data (Fig 2). A grid comprising 1km grid-squares was placed across the county and the number of 25m contour bands that crossed each grid-square was counted. Each band was only counted once within each grid-square. The resulting table produced a measure of steepness ranging from 1 (flat) to 15 (steep).
Aspect	A map aspect for the county was derived from the DTM using the GRASS 6.0.2 GIS. However, it was considered too generalised to be of use at a county scale.

Formulation of Descriptions

After the data sets had been assembled and edited so that they could be used affectively within MapInfo, it was necessary to formulate descriptions of areas based upon those data. Firstly a hierarchy of physiographic areas was compiled. These areas were then defined in terms of the existing data sets and finally ‘queries’ were devised that could be used within MapInfo GIS.

The process entailed breaking down the physiography of the county into component parts and then re-assembling those elements into the physiographic areas. This had the advantage that if different criteria were introduced or different weightings applied to the data the basic building blocks could be re-assembled in different ways. In this respect the modelling formed an attempt to make it a ‘repeatable’ process.

As a start, it was taken that the county could be divided into five basic areas: the coastal areas, the river valleys, the flat plains, raised ground and the higher upper ground. These main terrain types were then subdivided. The river valleys were divided based upon their altitude, whilst the upper ground, lower ground, coastal area and the plains were subdivided according to geological type. Further sub-divisions were possible based upon contour heights. The outlying islands were simply grouped together, since they were considered too small to be analysed using the same criteria as the rest of the county.

The following broad criteria were used:

Coastal

Generally low lying flat areas with sand or other beach deposits

Gradient	< 3
Geology	Beach Deposits
Altitude <25m	

Plains

Plains were principally defined as continuous areas of flat ground. They were then defined in terms of their deposits, which primarily comprised either Boulder Clay or other glacial deposits.

Gradient:	Steepness< = 3
Geology:	Boulder Clay OR Glacial gravels
Altitude:	< 100m

River Valleys
The valley bases were defines as areas of ground, containing the river itself and composed of Alluvium and river terrace gravels. The valley sides were defined in terms of the break of slope. Within River Valleys, two areas comprising lakes were differentiated.

Gradient:	N/A
Geology:	Alluvium OR Terrace Gravels.
Altitude:	(100m contour bands used to subdivide the valleys)

Lower Ground
Areas of lower ground were primarily defined in terms of their gradient. They are distinguished from the plains by exhibiting areas of steeper slopes and higher altitude.

Gradient:	3 - 6
Geology:	Various
Altitude:	> 100m <400m

Upper Ground
The upper ground generally described areas equating to the hill regions of the county

Gradient:	>4
Geology:	Various
Altitude:	> 300m

Since geology was considered the dominant influence on the physiography, it was decided that geological divisions would form the boundaries to each area. The exceptions to this were the river valleys where contour heights were used to create the divisions. This was done because if based solely upon their geology all river valleys would be single, continuous entities and different sections could not be defined.

Because geologies often form large blocks of ground that extend through more than one area often with smaller outcrops of other exposed rock formations it was necessary to define divisions within these larger areas. Since characterisation is a generalising process it was necessary to exclude or merge unrepresentative areas and thus only the dominant geology was considered in the queries. Boundaries in large, otherwise undifferentiated areas of geology were then defined by other natural features such as the river valleys.

3. RESULTS

The coastal Areas (Fig 3)
Four separate coastal areas were defined. They were separated on the basis of their visible and underlying geology. CS1 and CS2 occupy the northern part of the county's coastline and overlie limestone geologies. CS3 and CS4 are located at the south of the county's coastline. Beach deposits here overlie the Stainmore mudstones and Penine coal measures, respectively.

The plains (Fig 4)
The plain areas are principally defined by their flat aspect. In effect this describes an area at the east of the county, bordering the coastline, which is generally covered by glacial till deposits (CP1 to CP5). At the north of the county two further flat areas lying to the east and west of the river Till display slightly differing geologies with outcrops of glacial gravels and volcanic andenite (GP3) and fell sandstone and the Scremeston coal group (CP7) outcropping amidst the glacial Boulder Clay. Further plains of glacial gravels occur at the south of Kielder Water (GP 1 and GP2). These

latter plain areas have been designated with a GP prefix to differentiate them from the clay plains as the gravel geology appears to predominate over the Boulder Clay

The lower ground (Fig 5)
The lower ground is defined by its gradient and altitude (LG1 – LG8). Occupying a midpoint between the high hill areas with their exposed solid geologies and the coastal plains covered by glacial deposits, the lower ground forms a north-east to south-west band through the centre of the county. These undulating areas are generally covered with glacial till but have various outcroppings of other geologies such as sandstones and limestones exposed.

The upper ground (Fig 6)
The areas of upper ground are defined by their altitude and steep gradient. Effectively they represent hilly areas located at the west and south of the county and are characterised by their geologies. UG1 represents the areas of the Cheviots and comprises volcanic formations of granite and andesite. Areas of superficial peat at UG2 and UG7 are separated from UG1 by sandstones and mudstones (UG6). At the south of the county UG8 has a further superficial covering of peat whilst UG9 is covered with Boulder Clay and outcrops of mudstones. In the centre of the county, high areas of fell sandstones form UG3 to UG 5.

The river valleys (Fig 7)
The river valleys form an extensive network, generally running from the high ground in the west directly out across the plain areas to the coast. The exception is the Tyne and its tributaries whose watershed skirts to the south of LG5 before running out to sea. The majority of the river valleys are relatively narrow cuts through the glacial deposits making it difficult to define separate valley sides using the geological and topological criteria employed for the rest of the model. Consequently, the river valleys are an amalgam of both the valley floor and the valley sides. The division of the valleys by altitude produces a four part system (RV 1 – RV4). The highest of these, RV4, only represents the small parts of the upper river valleys, with the majority of the watercourses being represented by RV 1 – 3.

4. CONCLUSION

The project methodology produced a physiographic map of the county which illustrated general areas of similar topography (Fig 8). The extensive distribution of glacial till, however, created some problems in defining boundaries between these separate physiographic areas. Consequently, it should be emphasised that these boundaries should not be seen as ‘sharp’ but rather should refer to broad areas of change in the landscape.

Northamptonshire Archaeology
A Service of Northamptonshire County Council 2 March 2007

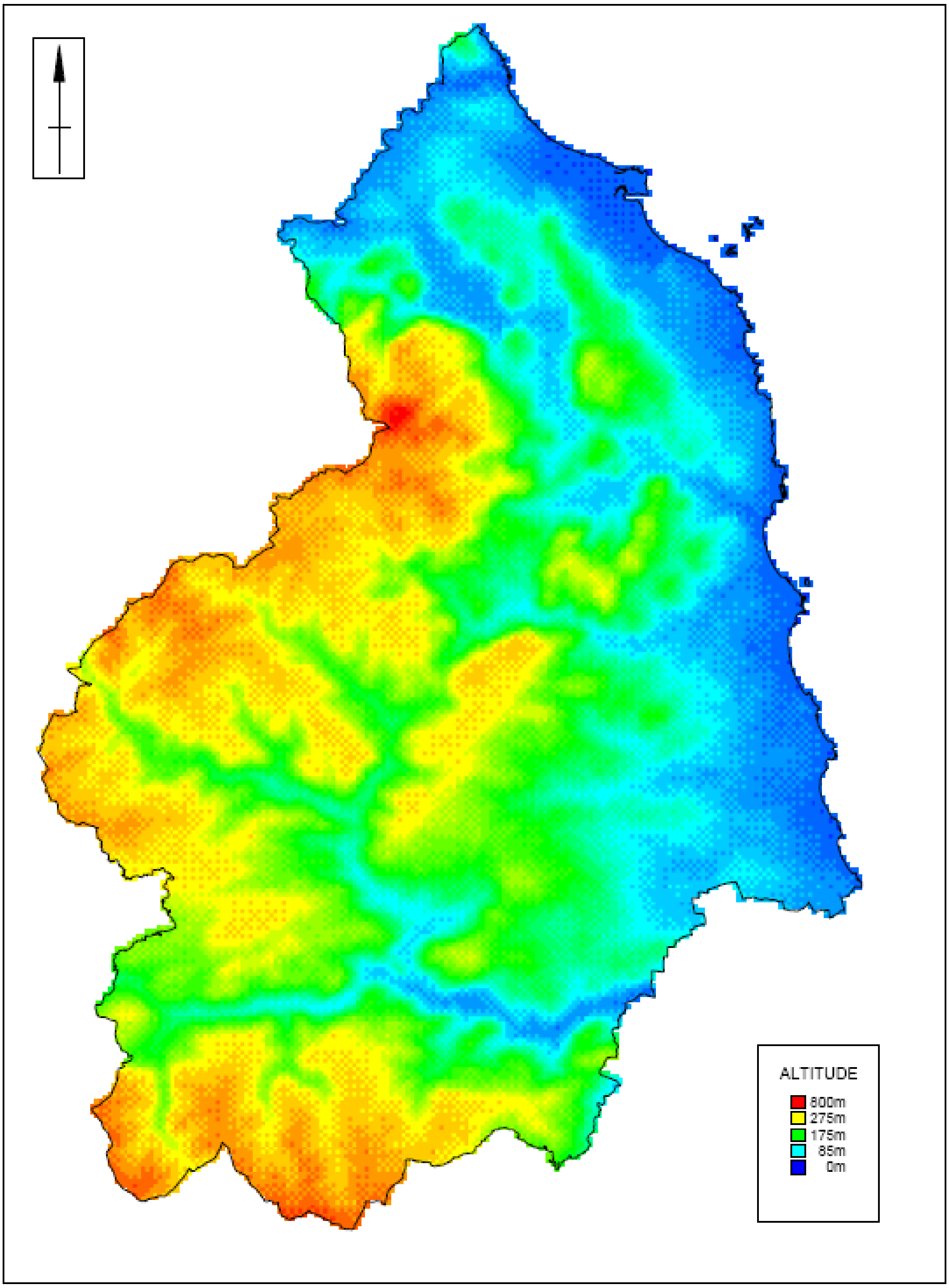

Fig 1: Altitude

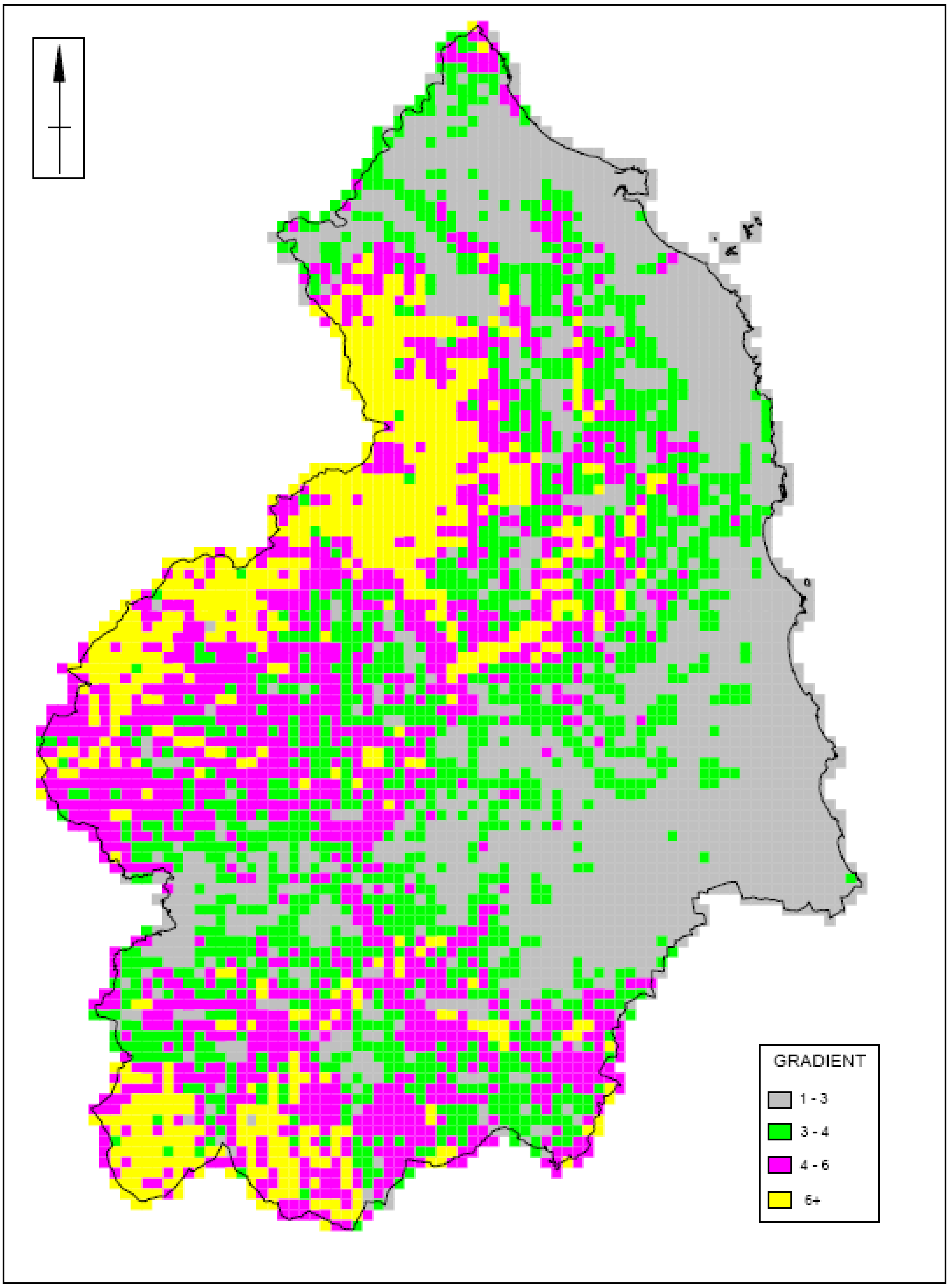

Fig 2: Gradient

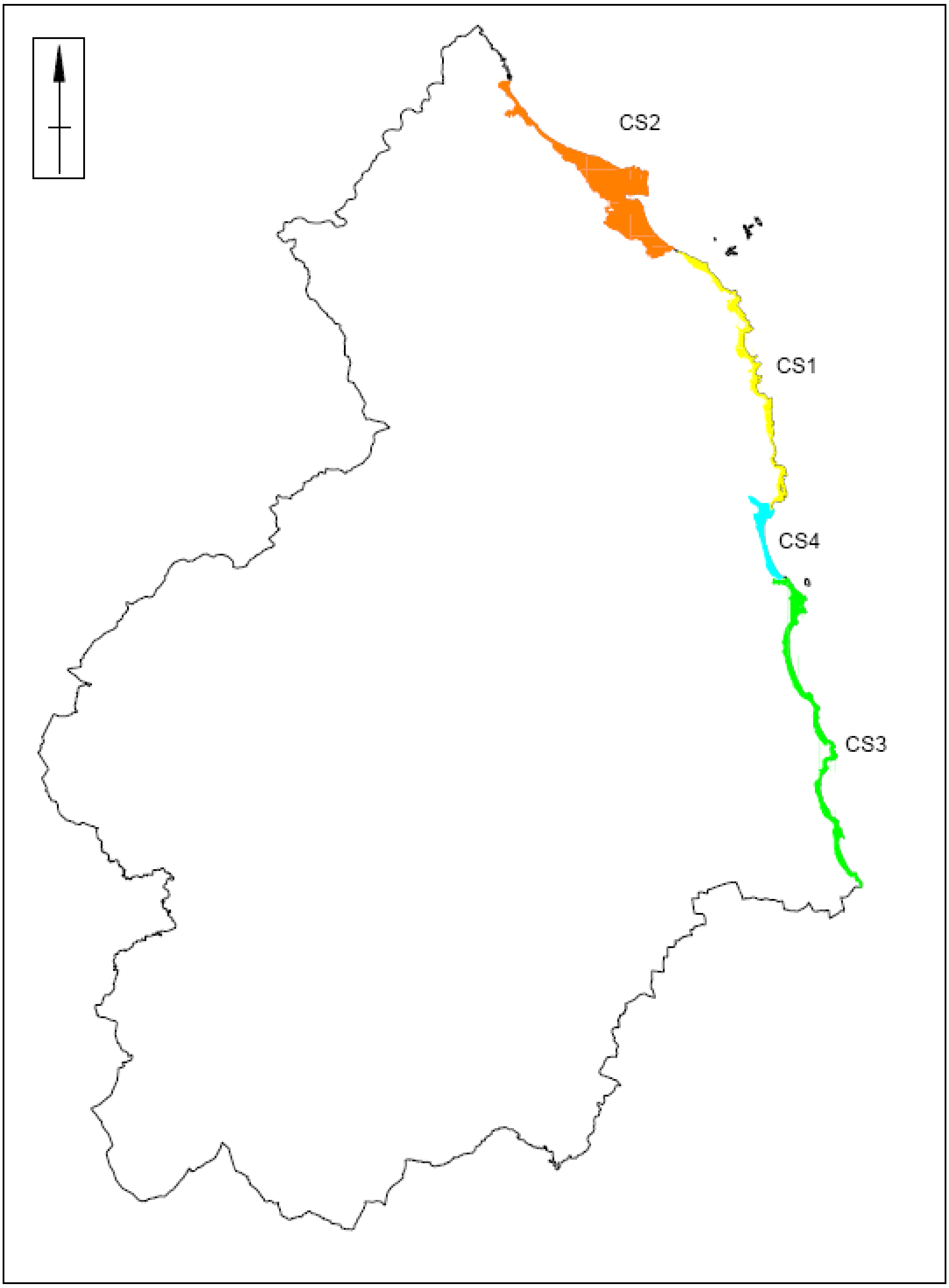

Fig 3: Coastal

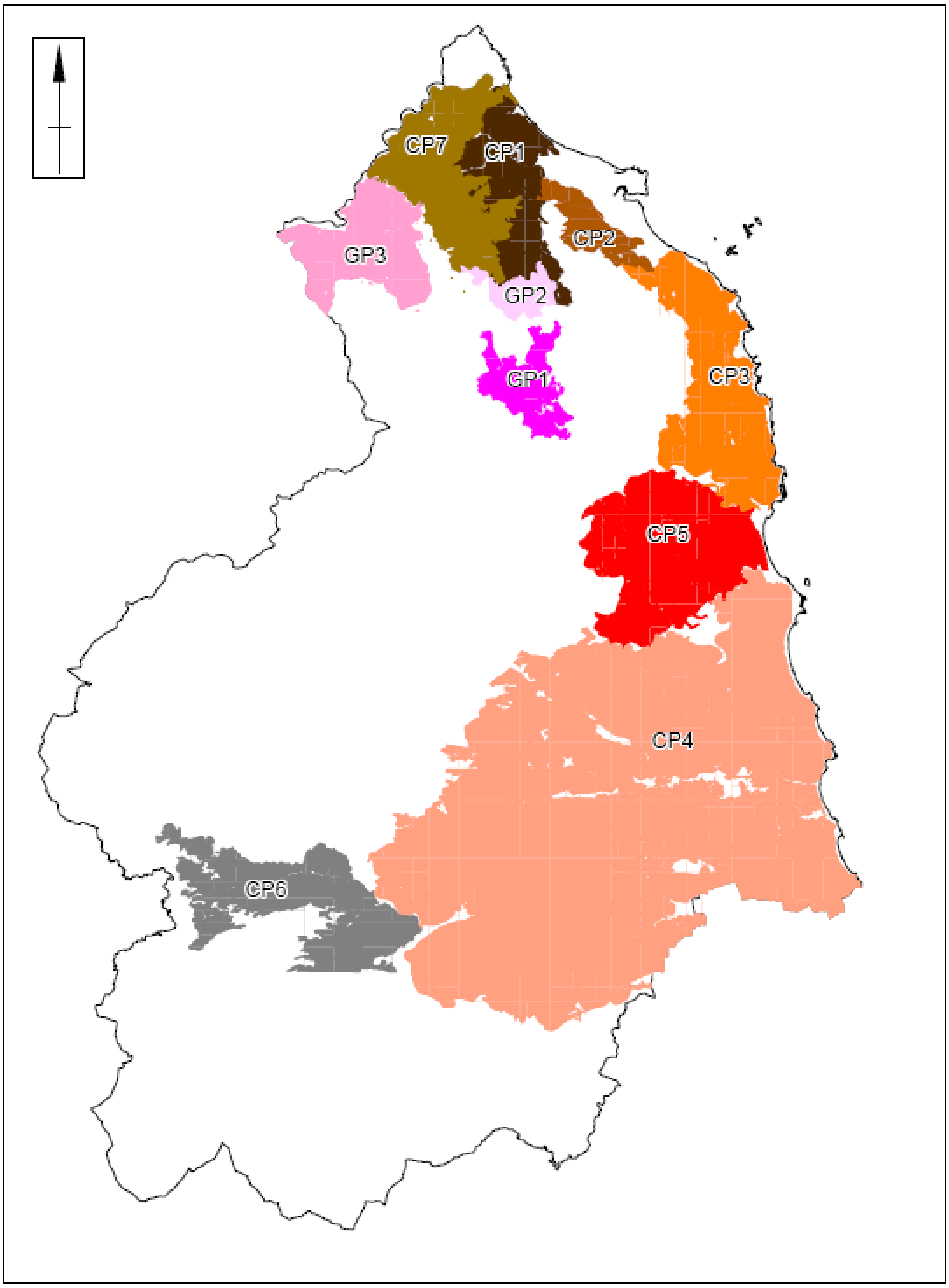

Fig 4: Planes

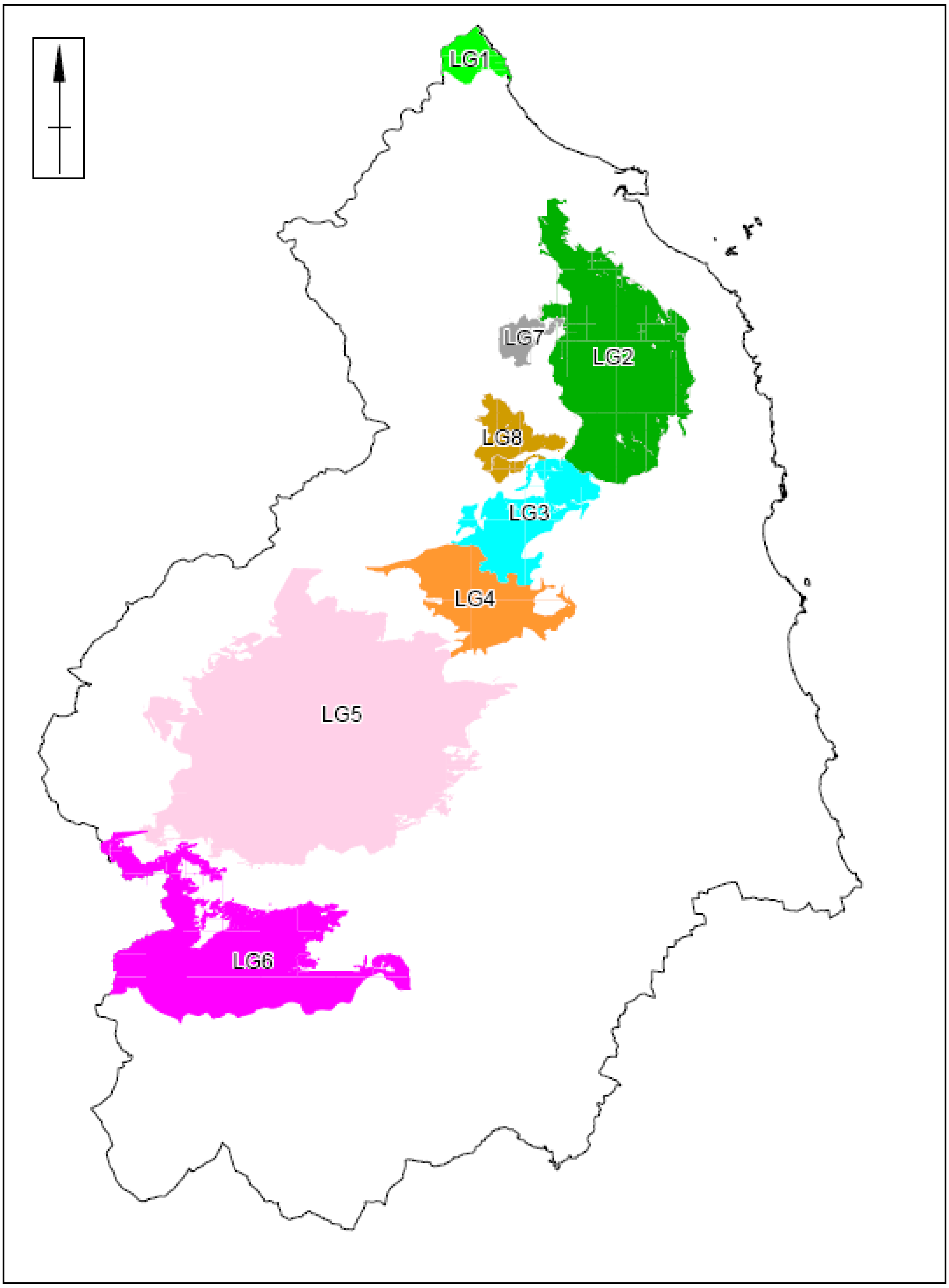

Fig 5: Lower Ground

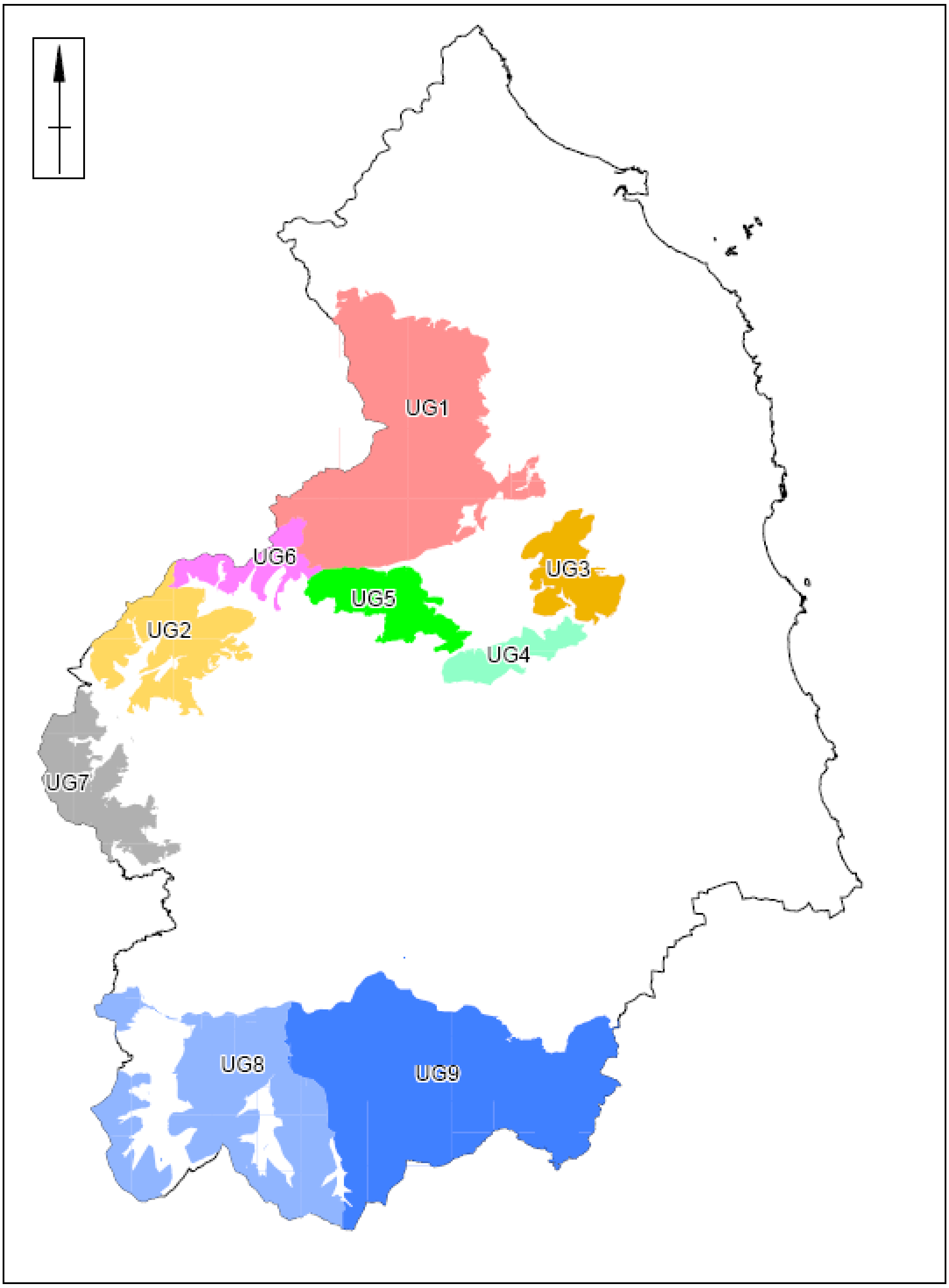

Fig 6: Upper Ground

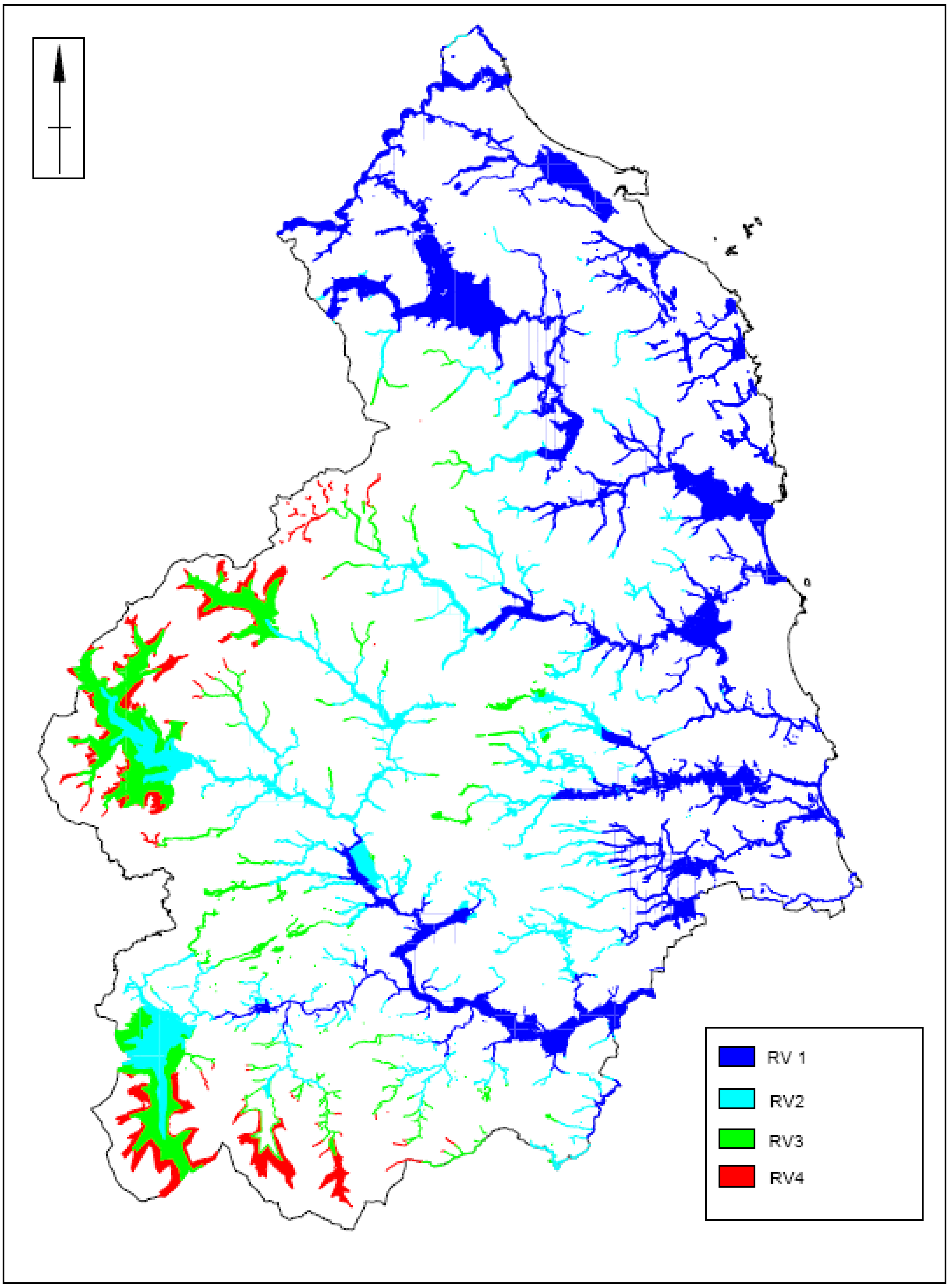

Fig 7: River Valleys

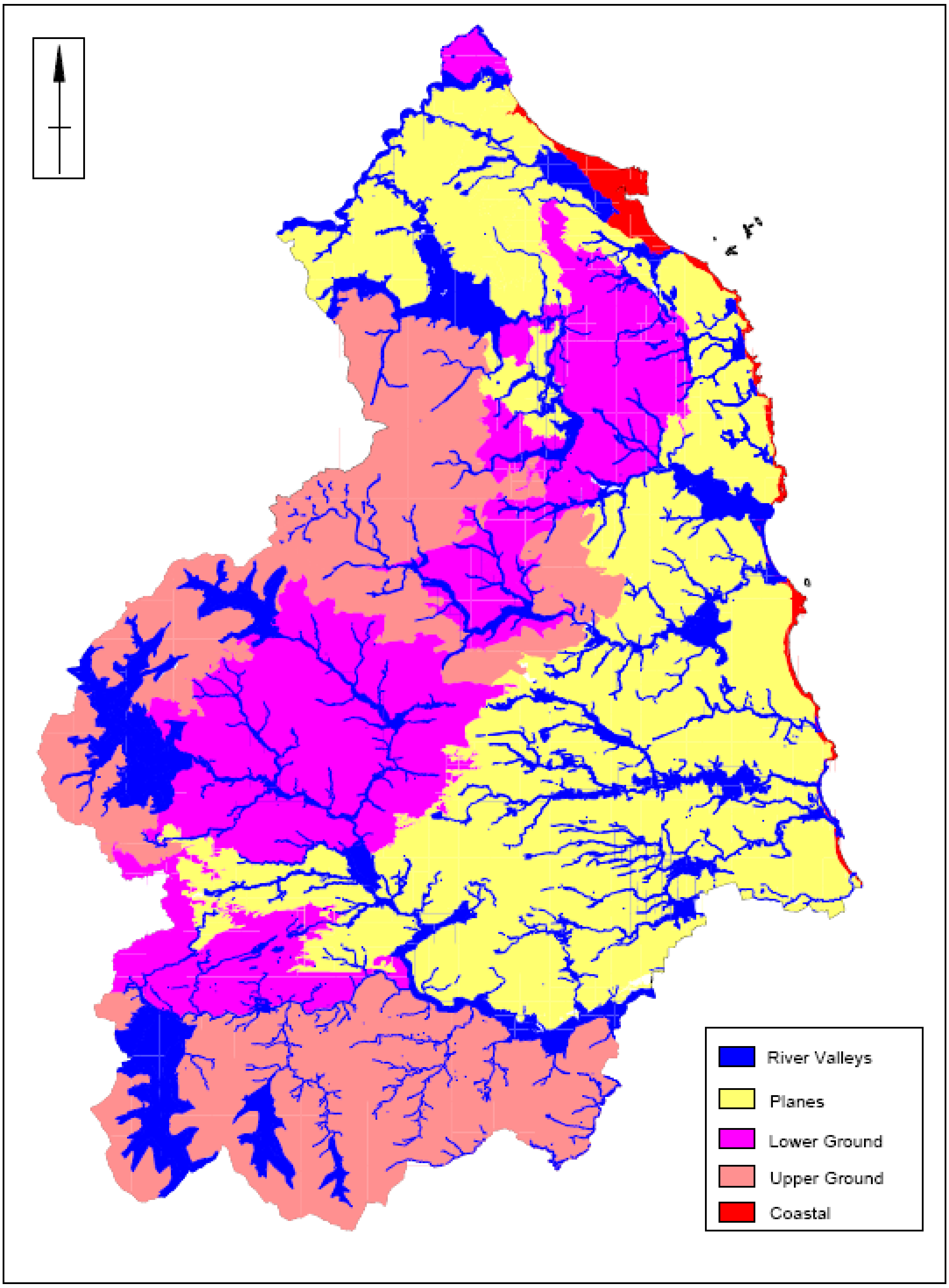

Fig 8: Physiographic Areas