1.1 Orohydrography

The first of the maps in this Atlas is an orohydrographic map of Germany. Starting the Atlas with this map emphasises the fundamental connection that exists between the relief and form of a land surface and its drainage network and hydrological state. Orohydrographic maps are essentially descriptive – the term “orohydrography” is compounded from the terms “orography” and “hydrography” – and the goal of orohydrography is to map together topographic relief and surface-water distribution. By the latter is meant the drainage network, with its flowing-water and standing-water components.

The formation of relief and the development of drainage networks are mutually dependent processes. Every part of the Earth’s land surface is affected to some extent by the sculpting power of surface water. Changes in tectonic situation can result in changed drainage directions; different rock types produce different drainage configurations; changes in climate alter a region’s water cycle and water budget. Present-day landforms and drainage patterns are still partly indicative of past climatic conditions, and the modern drainage network is often still not in equilibrium with the presently existing external controlling factors. Particular combinations of slope and relief conditions produce particular types of drainage forms, and control together flow velocity and the intensity of erosion. These then determine how erosional and depositional landforms are built, how landscapes are fashioned, and how the water budget is developed. The degree of exposure that a place on a land surface has will also have a substantial effect on the water budget and drainage development there.

Additional types of relief representation can be found in the attachments to Chapter 1.0 “Introduction”. These transparent overlays, at scale 1 : 2,000,000, show hill shading, contour lines and spot heights. Used together with the orohydrographic map 1.1, they enable the relief and landforms in Germany to be visualised.

Map Structures

The drainage network and the relief are represented on the orohydrographic map by means of layer shading. All of the maps in the Atlas have the same projection and all use the same drainage-network geometry. This network geometry is derived from the project AKTIS-DLM 1000 (Amtliches Topographisch Kartographisches Informationssystem, Official Topographic Cartographic Information System, Digital Landscape Model 1 : 1,000,000). A thinned-out version of this geometry is used as a basic common orientation basis for the various thematic maps in the Atlas.

Drainage Network

The drainage network used in the orohydrographic map is a higher density version of the basic AKTIS-DLM 1000 network. This higher density network is based on the drainage network database maintained by the Umweltbundesamt (German Federal Environmental Agency, UBA). This database was produced by vectorising the map of drainage density in the Hydrological Atlas of the Federal Republic of Germany (1978); it was then subsequently adjusted to conform to the geometry of the ATKIS-DLM 1000, which is used in this present Atlas generally. The drainage networks of the neighbouring countries of Germany, which are also shown on Map 1.1, are reproduced in a thinned-out form. The rivers on the map are represented by lines of different weight. The line weight corresponding to any given river is approximately proportional to that river’s discharge and importance; however, no quantitative significance should be attached to this relationship.

Relief

There are many methods for representing relief on maps; these methods commonly are combined. One method uses elevation contour lines (isohypses): any such line joins together points of equal elevation above sea level. The vertical separation of contour lines is determined by the scale of the map. If the areas between contour lines are given characteristic colours, then a layer-shaded map is produced. This type of representation is the preferred way of showing relief on small-scale maps, such as those in atlases. The choice of thickness for the individual shaded layers is essentially dependent on the range of elevations on the land surface being represented. On any one map, the thickness of the layers is generally made to increase with increasing elevation. Another method of representing relief, a graphic one, uses hill shading; this can bring out slope and exposure, depending on where the light source used for the hill shading is located. Finally, it is possible also to add spot heights to any map, i.e. points at which the absolute height of the land surface above sea level is given.

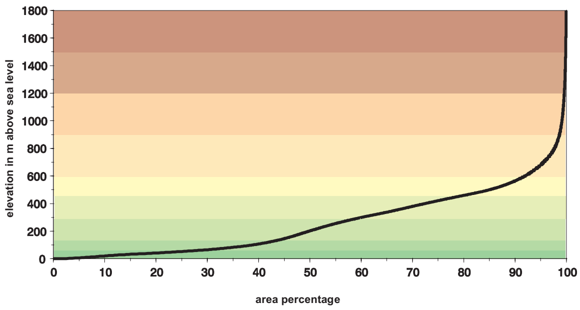

Fig. 1 Hypsographic diagram for the area of Germany

The layer-shaded relief representation used here is based on the global digital elevation model produced by the United States Geological Survey (USGS). This uses a grid cell size of 30 arc-seconds (Global 30 Arc-second Elevation Data Set, GTOPO30), which corresponds in Germany to a spatial resolution of approximately 950 x 600 m, depending on the latitude. The USGS model is in the public domain; it is of about the same quality over the whole of Europe. This model was transformed onto the HAD projection, using a 500 m grid, and contour lines were then obtained automatically from it, using an appropriate smoothing algorithm. The contours were subsequently generalised manually, and were then used to define eleven layers, with elevations ranging from 0 to more than 2100 m above sea level. These layers were coloured systematically: the colours vary from green through yellow to brown, corresponding to the passage from lowlands, through low hilly regions, through uplands, to mountains.

Subdivision of Germany into its Principal Relief Units

Germany contains regions that belong to the three principal relief units of Central Europe – lowlands, uplands, mountains – and these regions will now be described in terms of their characteristic landforms and drainage patterns. The proportions of Germany belonging to the different relief units are shown on the hypsographic diagram (Fig. 1).
The *North German Lowlands* are part of a broad lowland area that reaches from the coast in Flanders to the large East European Plain. Their elevations range from a maximum of between 180 and 200 m down to sea level; parts of the land surface close to the North Sea coast even lie below sea level. The morphological characteristics of the North German Lowlands were produced by glaciation. The North European Inland Ice Sheet had its greatest extent during the Saalian Glacial Stage, when, except in the Lower Rhine Embayment, it reached to the northern margin of the German Uplands. The position of the ice sheet margin during the last Glacial Stage (the Weichselian/Würm) is indicated by the Baltischer Höhenrücken (Baltic Ridge), which can be seen very clearly on overlay 1.0 B as a band of hills running from northwest to southeast across the North German Lowlands.

Fig. 2 Meandring river in the North German Lowlands

The area covered with inland ice during the Weichselian is referred to in Germany as the Jungmoränengebiet. The landscape in this area is undulating, with basin-like to elongated depressions, and with large areas covered by lakes; it is traversed by ridges reaching almost 200 m in height in places, which are the remnants of end moraines. The drainage networks developed in this type of geologically young landscape are termed “immature”.

The northwest part of the North German Lowlands is an area of older moraines (Altmoränengebiet), and is more like a plain in its nature than is the Jungmoränengebiet. The landscape in this northwestern part is characterised by areas of geest and sandur, by boggy depressions, by marshy areas with rivers and lakes, and (at the North Sea coast) by a postglacially developed tidal coastline with marshes and sandflats. The density of drainage channels increases at the coast and in the valleys of the large rivers. The generally northerly drainage of the North German Lowlands was altered during the glaciation due to the extension of the ice sheet, becoming northwesterly and following ice marginally valleys (Urstromtal) towards the North Sea; this is now still the principal drainage direction. Only much further east do rivers – the Oder, for instance, or the Weichsel (Vistula) in the Polish Lowlands – flow directly into the Baltic Sea. Canals and canalised rivers cross the North German Lowlands, joining together rivers and marginal seas; these artificial channels in places follow older lines of natural drainage.

A series of broad embayments – the Lower Rhine Embayment, the Westphalian Embayment, and the Leipzig Embayment – form the southern boundary of the North German Lowlands. To the south are the *German Uplands* (Mittelgebirgsland), a very varied relief unit, with heights ranging from 200-300 m in their northernmost part to the 1493 m of the Feldberg, the highest point in the Hochschwarzwald (High Black Forest), in the south.

Fig. 3 Course of the Middle Rhine

Drainage in the German Uplands tends to follow tectonical structures: particularly impressive examples of this are the courses of the Upper Rhine, and the course of the Leine between Eichsfeld and Hannover. There are also numerous river courses that follow epigenetic valleys, ones that were formed originally on old land surfaces and that have been held to to the present day, often in opposition to the present-day relief. Prime examples are the Mosel and the Middle Rhine as they cross through the Rheinisches Schiefergebirge (Rhine Slate Hills), the Danube in the region of the Fränkische Alb (Franconian Alb), and the Saale in the East Thuringian Uplands.

The capability that a river has to erode and to carry away debris is controlled by the slope of its channel; this is controlled, in turn, by the elevation at which the river lies and by the distance to the point at which the river reaches its erosional baselevel. In the German Uplands, it is the tributaries of the Rhine that have the higher slopes, in contrast to the tributaries of the Danube. The result is that the catchment area of the Rhine is increasing at the expense of that of the Danube, either as a result of river capture at the surface (for instance, the Wutach in the Black Forest) or of underground seepage (for instance, the Danube seepages near Immendingen).

One region that might seem to be assignable to the German Uplands is the *Alpine Foreland*; this has elevations of 500 m and more. This region needs special consideration, however, because its geological and morphological development was characterised by sediment deposition associated with the building of the Alps and with subsequent Alpine glaciations. The basic relief units in this region are the gravel plains in the northwest, the Tertiary hill areas in the northeast, and the glacial landforms in the south. The large rivers draining the Alpine Foreland follow the slope of the glacial depositional surface in the direction of the Danube, primarily northwards and to the northeast. Bogs, lakes and kettle holes are found primarily in the most recently deglaciated areas.

Only a small area of Germany belongs to the *Mountains of the Alps*. The German Alps are a narrow band running from Allgaeu, through part of Bavaria, towards Salzburg. The highest point in the German Alps is the Zugspitze (2963 m). The drainage of the German Alps principally follows geological structures.

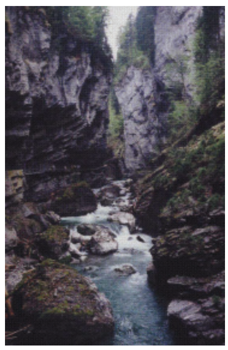

Fig. 4 Alpine Ravine of a Danube tributary