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MAPPING IN PHYSICAL GEOGRAPHY, THREE MAPS OF A FORMERLY GLACIATED LOWLAND[1]

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ABSTRACT

Van Dorsser, H. J. & A. I. Salomé 1983 Mapping in physical geography, three maps of a formerly glaciated lowland. In: J. H. J. Terwindt & H. Van Steijn (eds): Developments in physical geography – a tribute to J. I. S. Zonneveld – Geol. Mijnbouw 62: 605-610.

Three mapping systems are applied to an area of the North German Lowland, on a scale 1:25 000. The Dutch and German systems have been developed for geomorphological mapping of those particular countries. The Polish map is a more general environmental map. The mapped area comprises an ice-pushed ridge and a river valley. Large parts of the area are overlain by coversand. Human activity changed the physiognomic appearance of the landscape.

The mapping systems are introduced and the maps are compared. The two geomorphological maps contain much information for the professional geomorphologist. The maps are not intended for the general public. The accessibility for application purposes, e.g. in environmental planning, is restricted. With the data contained in the geomorphological maps it was easy to construct a physico-geographical map according to the Polish system. This map gives less information on the morphogenesis of the area but is more suitable for environmental planning.

INTRODUCTION

During the last 15 years many efforts were made to produce geomorphological maps, which are applicable in areas with low relief. In The Netherlands, where the local relief nowhere exceeds 200 m, systematic surveys have been made since 1966 (MAARLEVELD ET AL., 1974). This led to the start of the publication of the Geomorphological Map of The Netherlands scale 1:50000.

At the same time in the Federal Republic of Germany geomorphological mapping on a scale 1:25000 (GMK 25) has been undertaken within a programme supported by the Deutsche Forschungsgemeinschaft (STÄBLEIN, 1978; BARSCH & LIEDTKE, 1980a; 1980b; 1980c). The legend for the geomorphological map of The Netherlands (MAARLEVELD ET AL.,1977; TEN CATE & MAARLEVELD, 1977) was especially developed for the Dutch lowland, while the legend of the German mapping system (LESER & STÄBLEIN, 1975; 1978) was developed for the whole area of the Federal Republic of Germany, which comprises all kinds of landscapes, varying from alpine mountains to coastal plains. Several sheets of lowland areas have been published in the last few years (GEOMORPHOLOGISCHE KARTE DER BUNDESREPUBLIK DEUTSCHLAND, 1980; 1981).

GALON (1976) stressed the importance of the trends in Polish geography to map various aspects of the physical environment as a physiogeographical map. A fragment of such a map on a scale 1:50000 of a part of the Polish lowland was added to that publication. Using the three mapping systems mentioned, maps of areas, formerly covered by inland-ice, were recently published. To test the three systems we have chosen a small part of the northern German lowland, where an ice-pushed ridge and a river valley show enough difference in geomorphological appearance. The area mapped comprises a part of Emsland and consists of the ice-pushed ridge of Emsbüren, which rises more than 30 m above its surroundings, and of the valley of the river Ems with its terraces. In earlier publications we compared geomorphological maps according to different systems on a scale 1:25000 (VAN DORSSER & SALOMÉ, 1973; 1974) of a dissected peneplain area with terraces, covered by loess and on a scale 1:50000 (SALOMÉ & VAN DORSSER, 1982) of a slope of a Hercynian massif in a hardrock area. From these studies we know that most systems for detailed geomorphological mapping are equally suited for both scales. Therefore we

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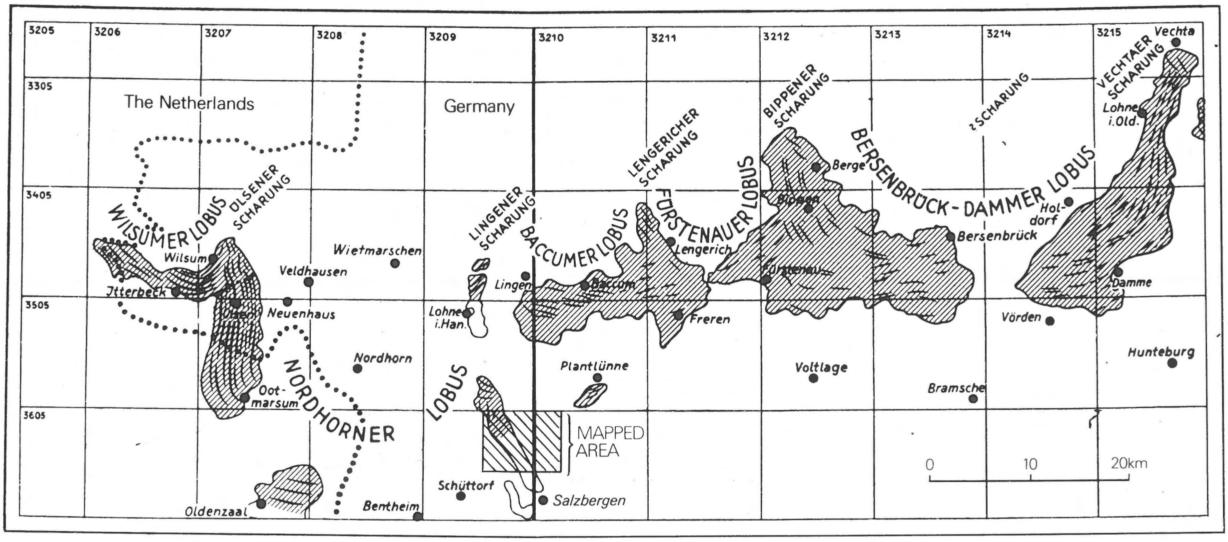

Fig. 1
Position of the inland-ice lobes during the Drenthian stage of the Saalian glaciation. The squares are those of the topographic map 1:25000 (after RICHTER ET AL., 1951).

decided to map the small area in the German lowland on a scale 1:25000 which is also used for the geomorphological map of the Federal Republic of Germany.

GENESIS OF THE LANDSCAPE OF THE AREA CONCERNED

During the Drenthian stage of the Saalian glaciation the Fennoscandian inland ice advanced southward in a number of lobes, by which the several ice-pushed ridges in the southern part of the North German lowland were formed (Fig. 1). The northern part of the Emsbürener ridge on our map consists mainly of sand and gravel, deposited by rivers in the Middle Pleistocene. More to the south the ridge is formed by sand and clay and covered by till. Since the sand and gravel of fluvial or glacio-fluvial origin below the clay show a gradual transition to the clay, it is most probable that the clay south of Emsbüren dates from the Pleistocene (S. BIJLSMA, pers. comm., 1982).

The W-E incision in the ridge was probably formed by ice-meltwater during the Drenthian stage. After the retreat of the inland-ice the area was subject to periglacial processes. This was repeated during the Weichselian. Then incision by snow-meltwater was an active process as was mass wasting of the slopes by gelifluction. By these processes the (now dry) valleys on both sides of the ridge and the deposits at the base of the ridge were formed. In this period the Ems transported a rapidly changing amount of water as a braiding river and deposited much material, partly rather silty sand (Fig. 2, samples 5 and 8). These deposits coalesced with the material moved by gelifluction.

In the Late Glacial the wind was an active agent in the areas with a sparse vegetation. Coversand was deposited in the North German lowland. We observed that much of the surface material around the Emsbürener ridge are sands with an aeolian character. The cumulative frequency curves of the samples 1, 2, 3, 7 and 9 are comparable to those of the Younger Coversands in The Netherlands (VAN DE MEENE, 1977; Fig. 2). East of Emsbüren lies a coversand ridge parallel to the ice-pushed ridge.

Further to the east a plain is present which has been influenced more by fluvial transport of the Ems and less by periglacial slope transport. Possibly this plain can be related to the Upper low terrace which has been found upstream of this area, along the Ems (HESEMANN, 1950; HEMPEL, 1963; WEIN, 1969). From the limited area we mapped it is not possible to conclude the exact age of the plain, but a Weichselian age is most probable.

Later in the Weichselian the Ems lost its braiding character and river incision of about 2 m started. In the Early Holocene, after a renewed incision, the Lower low terrace was established. Later in the same period the meandering Ems once

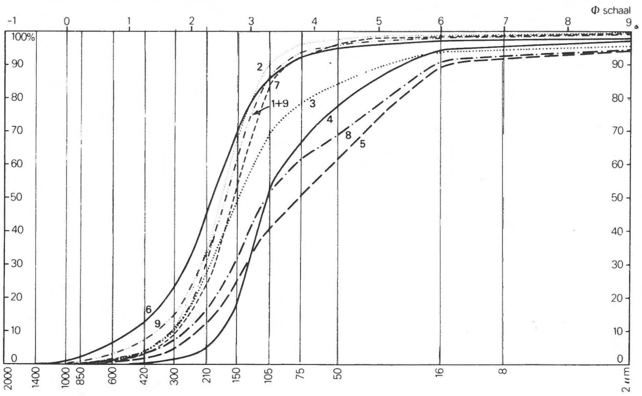

Fig. 2
Cumulative frequency curves of the samples, as indicated on the map according to the GMK 25 system (sampling depth 70-80 cm).

more incised the river-floor by 2 m, forming the Island terrace, which lies about 2 m above the present floodplain. The position of these terraces has been derived from the GEOLOGISCHE KARTE VON NIEDERSACHSEN 1:25 000, Blatt Salzbergen (1980) and MEYER ET AL. (1977). Along the stream in some places small recent natural levees are formed.

Coversand is present on the older terraces (the Upper and the Lower low terrace). It is not present on the Island terrace.

In historical times the natural vegetation was destroyed by man, causing wind erosion. Part of the Late Pleistocene and Early Holocene coversands were windblown and thus inland dunes were formed. Another influence of man is the formation of plaggensoil. Especially around the settlements plaggensoil, caused by agricultural exploitation over several centuries, reaches thicknesses of 50-90 cm.

Recently large tracts of land have been planed by ploughing and bulldozing, especially after the large scale re-allotment by which most of the typical hedges were eliminated. Thus the amount of arable land was augmented at the cost of the noncultivated areas. The physiognomic appearance therefore changed from a closed-hedge landscape into a more monotonous open landscape (WEIN, 1969).

THE MAPPING SYSTEMS

The Dutch system

This system is described by TEN CATE (1983) in this same volume. The legend is an example of a coherent systematic design. By a far-reaching subdivision in form units all kinds of genetic backgrounds can be included. Each unit is precisely defined by its code. The complete legend (MAARLEVELD ET AL., 1977) contains 19 pages. On the published sheets of the geomorphological map of The Netherlands only those units that occur on the particular sheet are depicted in its legend. We followed this practice. Therefore a large number of codes has been omitted as can be seen from the order in the legend of the accompanying map.

In spite of the fact that the basic criteria used for the representation of the geomorphology in this system are the relief and the terrainforms, the map shows primarily the morphogenetic origin of the landforms, since morphogenetic criteria determine the choice of the main colours.

The German (GMK 25) system

From the legends published (LESER & STÄBLEIN, 1975; 1978) and the printing of sample maps (BARSCH ET AL., 1978) it is apparent that small adaptations and alterations are still continuously carried out. To take into account the most recent developments, we used the symbols and colours according to the sheets 5 Damme (1980) and 8 Bordesholm (1981), GMK 25. In this system the following main information is given: slope angle, morphography, surface material, morphogenesis and hydrography. In the legend this information is grouped in no less than 14 subjects:

a. Slope angles (1).
Since the legend has been developed for the whole area of the Federal Republic of Germany, where areas may vary from sea-bordered flatlands to high alpine mountains, three types of slope classification have been proposed, one for the lowland, one for the upland areas with moderate relief, and one for the high mountains.
b. Morphography (2-6).
This subject has been subdivided into:
2) axes of curved slope,
3) segments, curvatures (domes and depressions),
4) steps and breaks in slopes,
5) valleys and small drainage ways,
6) minor landforms and roughness.
c. Surface material (8-11).
The subsidivision here is in:
8) composition of clastic material, defined by particle size, and of type of organic material,
9) bedding characteristics,
10) layering of the (sub)surface material,
11) composition of hardrock.
d. Morphogenesis (7, 12, 13).
Here a differentiation is made between:
7) traces of former processes,
12) traces of present processes,
13) the areal extent of morphogenetic units.
e. Hydrography (14).

Besides the 14 subjects mentioned supplementary information such as pits, sample-points etc., can be added (15).

In the legend of the map each subdivision consists of elements which are, for each map, succesively numbered. All the information is represented on a grey print of the 1:25 000 topographic map. The screens for the slope-classes are also printed in grey. The symbols used for indicating the morphography are printed in black as are the indications of the traces of former processes and the supplementary information. The surface material and its layering are printed in brown-red screens, hydrography is given in blue.

The main use of colours is reserved to depict the areal extent of the morphogenetic units. The shades of the colours may indicate the chronology of the sub-units, slight genetic differences, structural differences etc. Traces of present processes can be added by symbols in orange.

Screens which indicate the layering of the (sub)surface material are printed over the colours of the genetic units. For anthropogenic accumulation grey should be used. Other anthropogenic influences, such as built-up and excavated areas, should be indicated by a screen of grey crossed lines. On the sheet Damme (1980) this screen is widely used, which obscured too much of underlaying indications. We therefore did not follow this addition in the legend (LESER & STÄBLEIN, 1978).

On the map-sheets that are published according to the GMK 25 a small generalised physiographic map is added that depicts a larger area of the particular sheet and its surroundings. It is printed in colour on scales of 1:300 000 to 1:500 000. Because of the limited space in the map published here, it was not possible to follow this practice, but Fig. 1 provides some extra information of the adjacent area of our map.

To each sheet of the GMK 25 an explanatory note has been added.

The Polish system

In Poland physico-geographical or environmental maps have been developed which combine important components of the geographical environment to landscape units. 'These maps must give a spatial presentation of the more important characteristic elements and features of the geographical environment, and an immediate analysis of spatial landscape structure' (GALON, 1976). In the map of part of the Polish lowland belonging to this article the following elements of the landscape are indicated: landforms, lithology of the surface sediments, hydrographic pattern, and forest cover.

The landforms are given in colour and subdivided by shades of the colour. The colours are used for the most important landforms and take into account the origin and the morphographic features. Lithology is marked by symbols and hachures in red, hydrography in blue, and forest in green.

As GALON (1976) pointed out, the making of a map with complex units demands the preparation of a number of component maps. This can only be avoided when dealing with a small area. GALON's (1976) map is only a sample map. It is clear that every author has to compose a legend which is adapted to the particular area and that he has to restrict his choice to the most representative environmental elements.

For our map we have chosen for a close relation with the legend of the Polish map and we distinguish the following elements: the ice-pushed ridge, the coversand area, the dune area, and the valley. This implies that in our map the region outside the ice-pushed ridge of Emsbüren and outside the valley of the Ems is indicated as one coversand area. This in spite of the fact that the coversand overlays different geomorphogenetic units. (cf. Fig. 3) The visible landscape shows the same features, it is a slightly undulating area of arable land with local small forested parcels. Differences in relief between the Upper and Lower low terrace, with its coversand layer, are limited. Distinct boundaries are lacking. Moreover, most of the area is flattened by reallotment activities.

TECHNICAL REMARKS ON THE MAPS

For all three maps a simplified base-map 1:25 000 in grey is used and the built-up areas are also marked as grey blocks. The colours which are used for the units in the different systems, are printed on top of this and that contrasts with the common Dutch system and sometimes with the German one. The maps are printed in six runs. The three main colours: cyan (blue), yellow, and magenta (red) are used to compose the colours of the planes in the map. Cyan is also used to print the symbols for the hydrography and these have been printed in the same way on all three maps, in spite of the fact that each system prescribes the detailed hydrographic symbols in its own way. These symbols, however, differ only slightly in the three systems. To limit draughting time and to economize on space in the legends, the hydrography is printed only once.

Because of the use of fine line and point symbols in the Dutch map a separate print run in brown was necessary. This was also the case for the red which we used for the arrow, indicating the ice-meltwater valley in the Dutch map. This red was also used for the symbols indicating the lithology in the German map. The GMK 25 legend prescribes the colour redbrown. In the published German maps this colour approaches the red colour in our map.

To restrict the number of print runs to six all grey is printed as a screened black. For the same reason the forest symbols on the Polish map are printed in black instead of green.

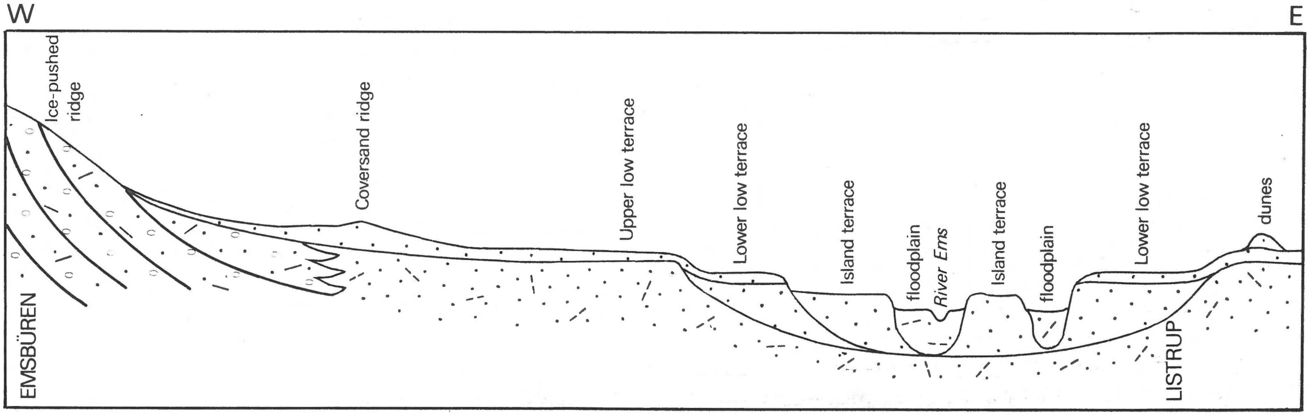

Fig. 3
Schematic W-E cross-section of the mapped area. For the lithology see Legend map 2: 8. surface materials.

A general problem in geomorphological mapping is the indication of the limits of small valleys. The width of the small valleys in the area mapped here has been determined by the location of the inflection lines on the slopes. In doing so it was necessary to augment the width of the small valleys as indicated on the GMK 25 map from 100 to 200 m.

Since the mapped area is so much influenced by human activities we didn't find it practicable to indicate the recent planation, as well as the traces of present processes.

COMPARISON OF THE MAPS

All three maps give a good impression of the variety in this formerly glaciated lowland area. As two of the maps are geomorphological ones we start with a comparison of the Dutch and the German map.

In the Dutch map the surface and subsurface material, the geomorphogenetic sequences and a number of human influences are present in the separate coded units. These units all differ from each other by colour shades in combination with other symbols.

In the German map the surface and subsurface material is indicated by a red screen, printed over the whole map. Layering of the (sub)surface material is represented by printing the symbols of the lithology in a horizontal stripe pattern. The overlying deposit is indicated in the narrow stripes, the underlying one in the wide stripe. Since there exists a genetic difference between the two deposits the sequence of morphogenetic processes is shown in the different colours of the stripes. In practice, this means that the colour of the wider stripes indicates the major morphogenetic process which has determined the landscape form. The colour in the narrow stripes than indicates the additional process which has been responsible for the less dominant landscape forms. For the sake of clarity we printed in the legend of the German map the red screen of the lithology over the colours of the morphogenetic units, as was done on the sheet Damme (1980).

In the Dutch map small dune forms, which rise more than 1,5 m above the surrounding area, can be included in several units. The indication of those dune forms on the German map poses a problem, because the symbolic character of the stripe pattern interferes with the occurence of the individual forms in the overlying sand. Glacial push can be indicated in both maps: in the Dutch map with large lines over the ice pushed ridge; in the GMK 25 map by small symbols belonging to the traces of former processes.

Both geomorphological maps give extensive information on the genesis of the terrain forms, for professionals. At first sight the general impression of the terrain is clear in both maps. The morphogenetic development is better seen in the GMK 25 map. In the Dutch map this information is somewhat hidden in the detailed units. It is an advantage and an absolute necessity that the codes are printed in every unit in the map.

The practical use of these maps by scientists other than geomorphologists is hampered by the large amount of information. Therefore it is necessary to simplify the maps. This can be done by the construction of derivative maps. In fact the Polish map is an example of such a map-type. In a broad sense the origin of the landforms is indicated. This together with the morphography defines the landscape units. In doing so larger, directly visible, landscape units can be discerned more easily. This makes the map more applicable, especially for regional planning, conservation and for other purposes.

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