5 SOILS AND THEIR GEOGRAPHY

H. de Bakker
Soil Survey Institute
Wageningen, The Netherlands

5.1 Introduction

A series of factors, mainly dealt with in the other papers, are responsible for the complicate soil pattern found in the western part of the Netherlands. This area is roughly situated between Amsterdam, The Hague, Rotterdam and Utrecht (see Van der Linden's Figure 1). It is a quiet, predominantly rural and, for Dutch circumstances, little urbanised area, it is popularly known as "The Green Heart of Holland". Agricultural activities are mainly dairying, further arable on the calcareous soils of the drained lakes, flower bulbs on the excavated dune sands in the west, flowers in greenhouses both on the peat lands and on the calcareous soils of the drained lakes, and ornamental shrubs on the peat lands of Boskoop. Catchwords summarising items discussed in the other papers are: deposition of marine sediments four to five meters below todays sea level, gradual rising of the sea level, nearly closing of the coastal barriers, paludification of the enclosed lagoon, upward growth of the peat, differentiation in big islands of raised bogs surrounded by wood peats with peat streams draining into a lower branch of the Rhine, the Big Reclamation, drainage by gravity, subsidence, drainage by pumping (windmills), development of Drainage Boards, peat cutting, man-made lakes, draining of the lakes. The Figures 1, 2 and 3 are another attempt to elucidate the natural and human activities which made western Holland.
The topic of this paper is to describe the soils and their geography, which properties can only be comprehended if their intricate history is known.

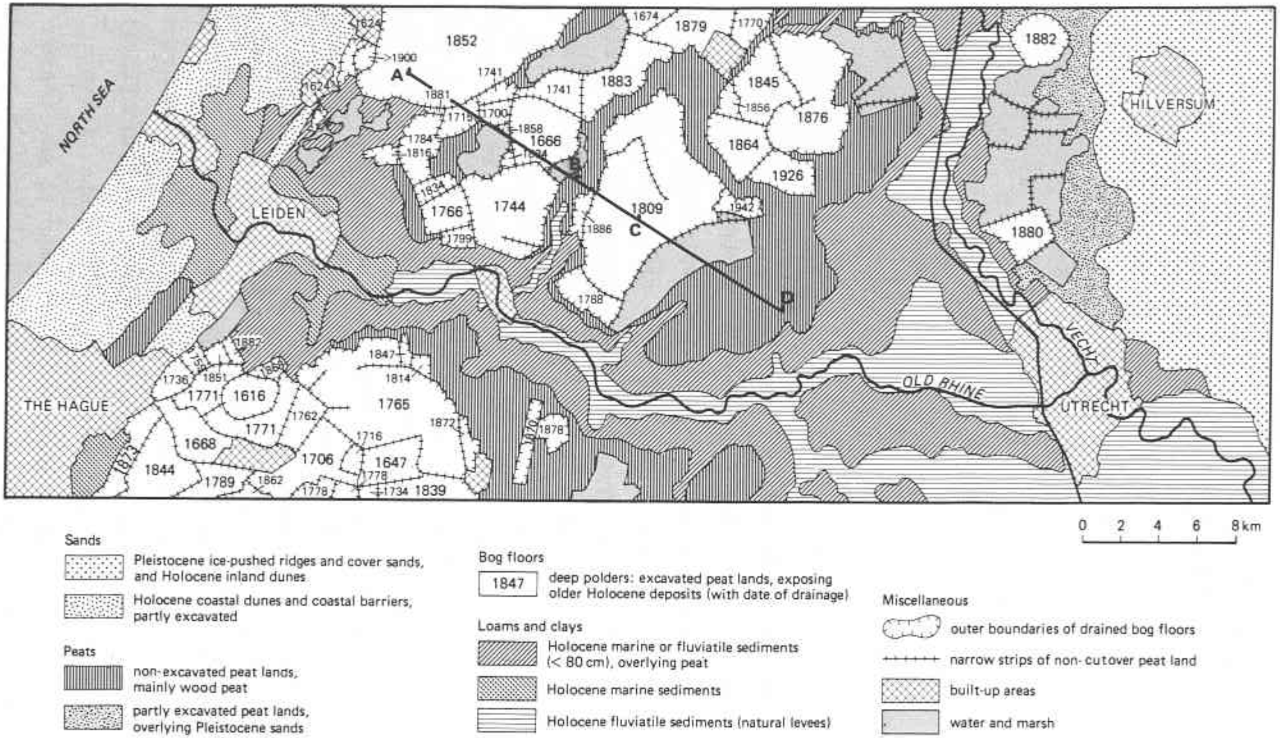


Figure 1 The main area of the drained bog floors and the remaining non-cut over peat areas between The Hague and Utrecht; Amsterdam is just north and Rotterdam further south of this area. A-D indicates the location of the transect from Figure 2, and B-C could be the location of the story given in Figure 3. This rough physiographical map is generalised from the Soil Map of the Netherlands, scale 1 : 50 000, sheets 30 E, 31 W and E, and 32 W.

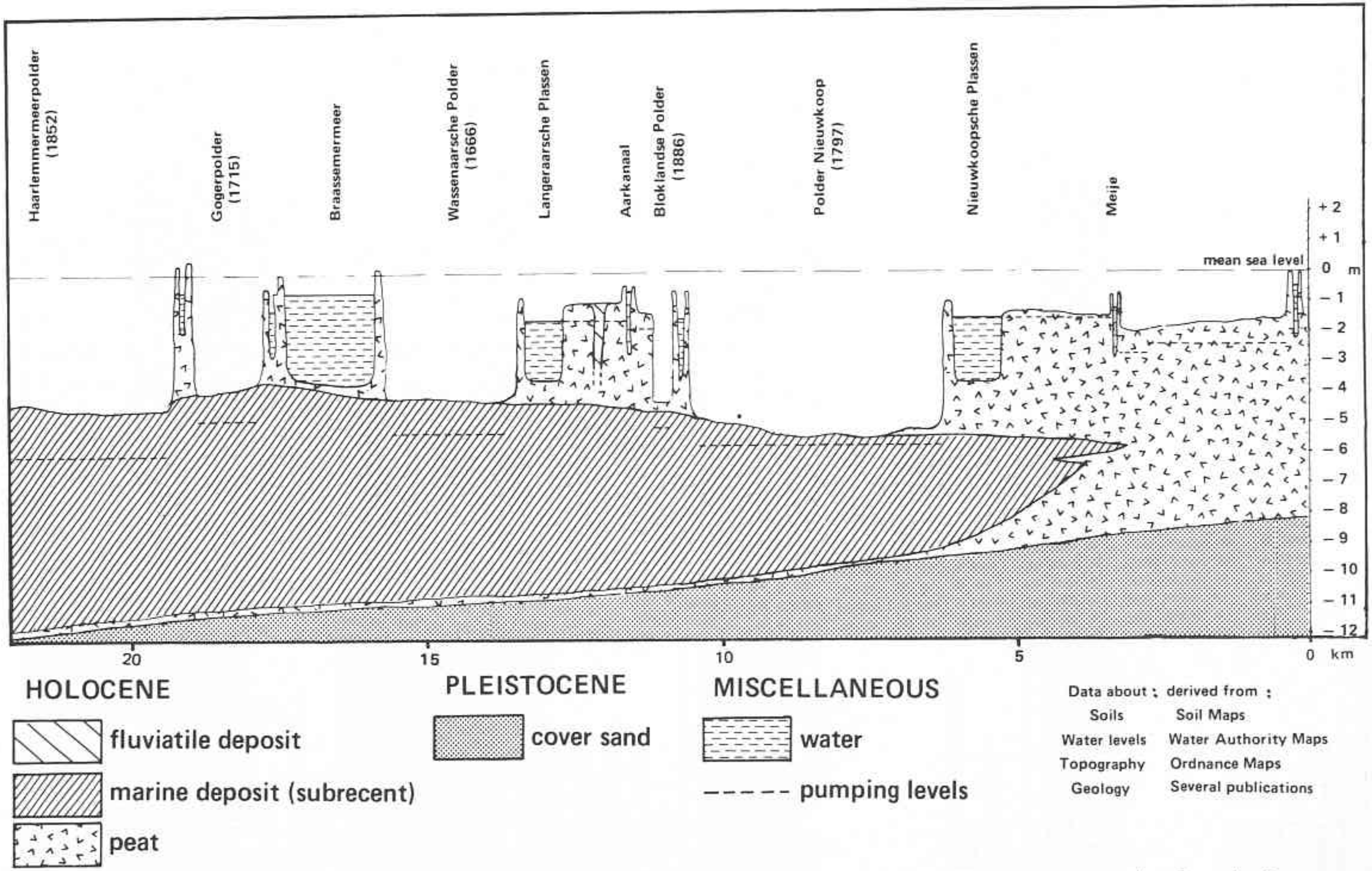
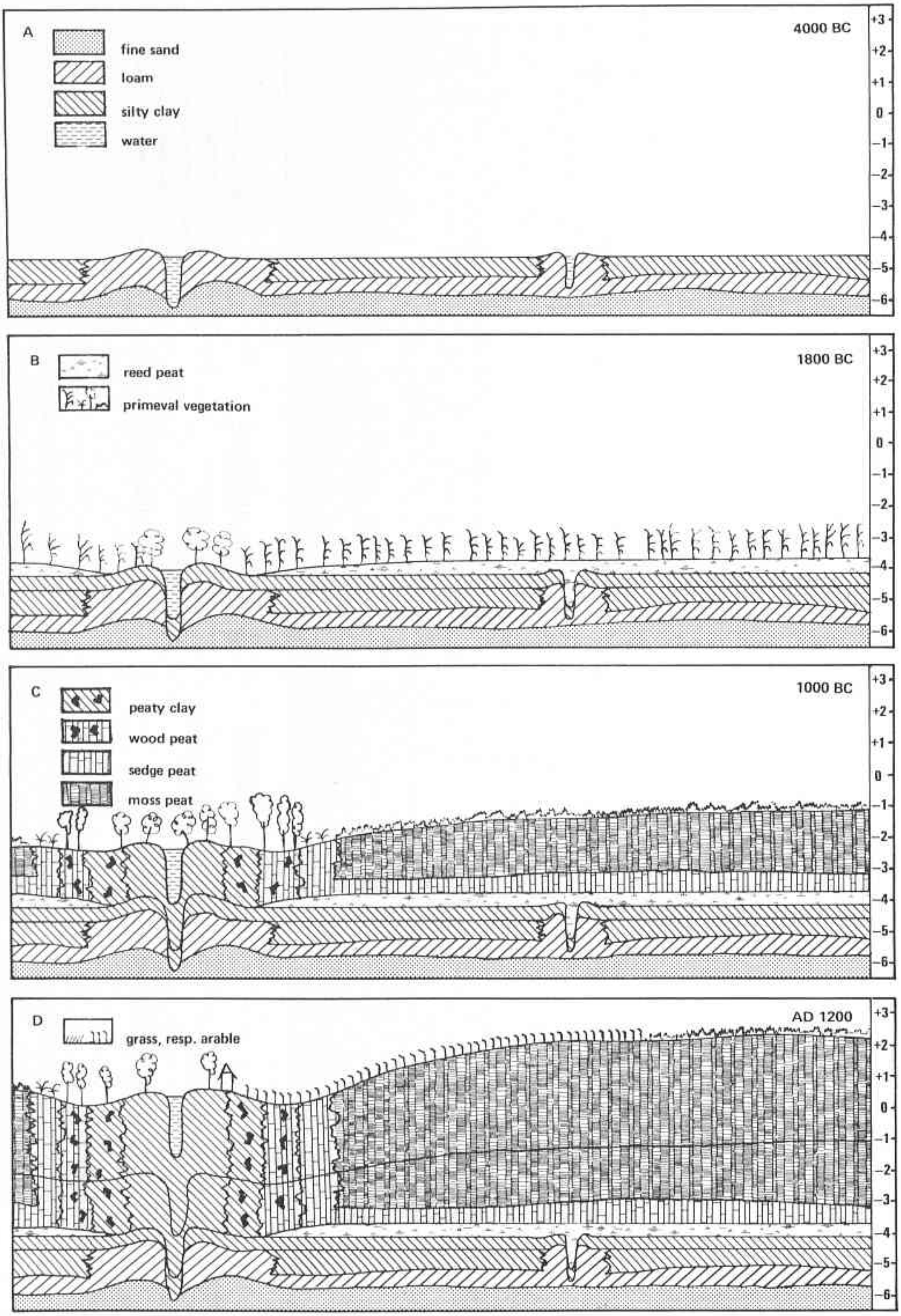


Figure 2 Transect indicating the elevation of the pumping levels, of the non-cut over peat lands and of some reclaimed bog floors and their reclamation dates (cf. Figure 1).


A
4000 BC
fine sand
loam
silty clay
water
B
1800 BC
reed peat
primeval vegetation
C
1000 BC
peaty clay
wood peat
sedge peat
moss peat
D
AD 1200
grass, resp. arable
+3
+2
+1
0
–1
–2
–3
–4
–5
–6

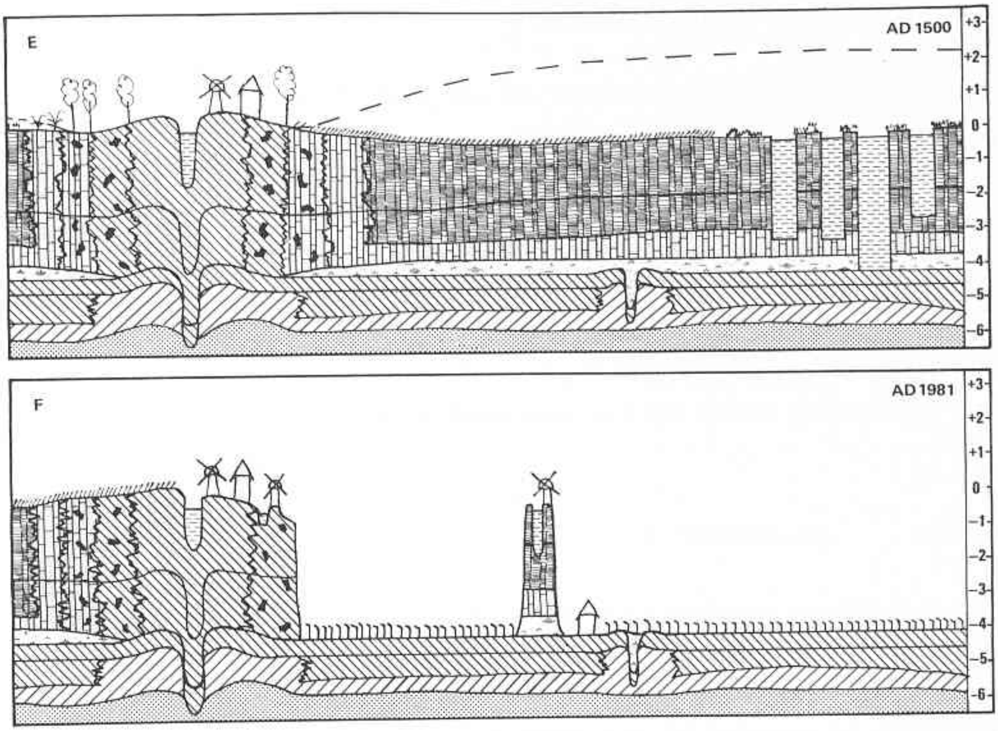


Figure 3 Sketch of the genesis of the area of Figure 1. The elevation is indicated in metres plus or minus todays sea level.

A. Calais deposits (cf. Bijlsma, Table 2) with tidal creeks.

B. the sea retreats, reed peat blankets the flats and many small creeks, the bigger ones drain the bogs into the Rhine.

C. the fens change into raised bogs, eutrophic river influence alongside the peat drains, which are laterally filled in with fine-textured sediments during high discharge of the Rhine, their upward growth keeping pace with the raising bogs.

D. the beginning of the Big Reclamation (cf. Van der Linden's paper): peat streams fringed by gallery forests act as starting lines for the settlers, the higher situated raised bogs could be easily drained by gravity and reclaimed as arable lands.

E. due to subsidence (cf. Schothorst's paper) drainage detiorates, introduction of pumping (cf. Van der Molen's paper), arable land changes into grassland, starting of peat cutting.

F. todays situation: the ash-poor peat has been cut for fuel De Zeeuw, 1978), the resulting lakes are drained and reclaimed.

5.2 General soil conditions

The area of Figure 1 has roughly six soil-landscapes:

a. the Pleistocene area in the east,
b. the coastal-dune area in the west,
c. the estuarine soils in the mouth of the Old Rhine,
d. the riverine soils of the Old Rhine and the Vecht,
e. the non-cut over peat lands, and
f. the area of the deep polders.

The first four areas will be dealt with cursorily, the peat lands and the drained bog floors will be discussed in more details in next chapter.

5.2.1 Pleistocene

The Pleistocene deposits (all sands) in the east dip below the Holocene deposits at about todays sea level, they slope gently to the west (Fig. 2), and pass the coast at about 18 m below sea level (cf. Bijlsma's Fig. 2). Hilversum is situated on an outcrop of preglacial river sediments, pushed up into low hills by the Saale ice (20 m above sea level). The footslope of these hills and all pleistocene sands below the Holocene deposits on Figure 1 consist of cover sands, a fine aeolian sand.
The soils are podzols (spodosols). As far as the ground water is deep, land use is mostly pine forest and some heath land, as far as the ground water is shallower, these podzols are in arable and grass. Locally the cover sand is eroded and blown into inland dunes.

5.2.2 The coastal dune area

On the inner side of the beach there is a narrower or wider strip of coastal dunes, rising locally to 30 m above sea level. In most coastal areas sea defences are artificial (dikes or sea walls), but the Green Heart of Holland is safeguarded by these dunes. Except some roads and footpaths it is forbidden area. The still moving outer dunes are more or less fixed with marram grass (Ammophila arenaria) which can stand, even needs, shifting sands; the inner dunes carry a natural vegetation, diffe-

rentiated after lime content exposition etc.
The inner dunes are much lower, often superficially decalcified. These dunes and also older coastal barriers not or hardly covered with dunes, are mostly excavated down to about half a metre above the everywhere present fixed boezem level (which is 60 cm below sea level). There is a continuing need for sand in urban areas (road building, sand-lime bricks) but it was also used on dairy farms in the stables (see below).
These excavated humus-poor sands are excellently suited for bulb-growing, and the famous colourful Dutch bulb fields are nearly exclusively situated on these soils. The intermediate beach plains between the excavated dune ridges are often peaty or covered with thin estuarine sediments from the mouth of the Old Rhine, and used for dairying.

5.2.3 The estuarine soils

These are situated around Leiden, the upper part of the parent material was deposited in the few ages before the clogging of this Rhine mouth in the middle of the twelfth century (cf. Van der Linden's paper), so it belongs to the Dunkerque III Deposits (Table 2 in Bijlsma's paper). Locally this material was used for firing tiles and bricks in brick kilns. The area northwest of Leiden is raised with dune sand mixed with mud and manure thus improving drainage and texture for horticultural purposes. Land use is mainly grass, some arable and on the above-mentioned improved soils horticulture (flowers, both in the open and in greenhouses).

5.2.4 The riverine soils

The rivers Old Rhine and Vecht (Fig. 1) originally were lower branches of the Rhine (today the Rhine water reaches the North Sea 50 km more south). Both have narrow levees with brown medium- and mottled grey fine-textured soils overlying coarse riversands. Laterally these soils grade into shallow silty clays overlying wood peat. On most places alongside these rivers this levee belt between the clay-over-peat soils is only 500 m wide. In the eastern part of Figure 1 the levee of the Old Rhine is excavated over a relatively large area to a depth of about 1 m, the

material was used in brick kilns.
Most of the soils are used for dairying, some for horticulture. The excavated soils are drained and used for orchards, there are some problems with magnesium because of the high lime content (up to 20%).

5.3 The peat lands and the drained bog floors

The area of Figure 1 encloses about 150 000 ha of land. Roughly 20 000 ha is urban area, originally nearly all on either the inner coastal barriers, or on the levees of the Old Rhine and the Vecht, or on the Pleistocene sands. The more recent urban developments spread over the clay-over-peat and the peat areas with all their problems (cf. Van den Kerkhoff's paper). About 15 000 ha is non-excavated peat lands, mainly wood peat and another 25 000 ha has a peat subsoil within 80 cm depth of marine or fluviatile upper sediments, and about 30 000 ha of Figure 1 consists of drained and reclaimed bog floors. Some data about the reclamation history of all reclaimed inland lakes (either caused by peat cutting or by peat erosion) are given in Table 1.

Table 1 Polders reclaimed from shallow lakes (bog floors) in the provinces Noordholland, Zuid-Holland and Utrecht (excluding polders in the former Zuyder Zee). After De Bakker, 1979

Enclosure between:	1500 – 1550	1550 – 1600	1600 – 1650	1650 – 1700	1700 – 1750	1750 – 1800	1800 – 1850	1850 – 1900	1900 – present[4]
Acreage (ha)	82	2228	26985	1495	3456	21882	9585	42007	1648
Number of polders	2	17	48	4	7	24	1	68	8
Average acreage[1] per polder (ha)	-	147	688	374	494	912	682	735[2]	206
Largest polder (ha)	65	620	7100	960	1125	3975	4355	18100[3]	50
Smallest polder (ha)	17	5	6	170	270	85	5	4	34

1) Excluding polders less than 25 ha.

2) Average acreage excluding the polder of 18100 ha: 425 ha.

3) Second largest polder: 3015 ha.

4) Last polder was reclaimed in 1942.

5.3.1 The non-excavated peat lands

As is stated earlier in this paper and also in the other papers, the ash-poor moss peat and also nearly all sedge peat has been excavated for fuel (see also De Zeeuw, 1978). The non-cut over peat that is left, is nearly exclusively the clayey wood peat. The hundreds of years drainage (although shallow, cf. Schothorst's Introduction), the manuring, liming and fertilisation, have changed the upper part of the soil considerably.
This process has been called "earthifying" (= to change into earth) by the Dutch, and it is comparable with what the Poles call moorsh- or muck-forming process (Kowalinski, 1964; Okruszko, 1972).
The Dutch never did investigate this process chemically, but did a lot of micromorphological work (e.g. Jongerius und Pons, 1962). A peat soil is called an "earthy peat soil" in the Dutch soil classification system when the A1 horizon is thicker than 15 cm and has hardly recognizable peat structure (De Bakker en Schelling, 1966).
A second process on these earthy wood peat soils in this part of the Netherlands is a manuring practice (now obsolete). Sand from the excavated dunes was used in the stables and mixed with mud and manure spread over the land, was caused a higher sand content in the topsoil (the left soil from Fig. 4 and the first soil in Table 2).
From the 15000 ha of peat soils on Figure 1 12000 ha have this sandy-mucky man-made topsoil.
In a small (500 ha) horticultural area west of the lake which is situated south of the large polder reclaimed in 1852, the soils have a topsoil thicker than 50 cm without recognizable peat structure. Under intensive horticulture using all kinds of compost, manure, sand and organic mud dredged from the ditches a thick sandy-mucky (25% o.m., 15% clay, 50% sand) layer was made on top of the original carex-phragmites peat.
These peat lands are mainly used as grassland for dairying. There are a few horticultural centres where flowers in greenhouses are grown (carnations, roses and chrysanthemums) and also vegetables. An important crop near Aalsmeer are lilacs, and in Boskoop ornamental shrubs.

5.3.2 The reclaimed bog floors

From the about 100 000 ha of reclaimed bog floors (Table 1) 30 000 ha occur on Figure 1. From this area 20 000 ha are mineral soils developed in Calais deposits, 500 ha have less than 40 cm peat and 500 ha have more than 40 cm peat, left behind by the peat cutters in the deeper sites of the former tidal flats. The mineral soils mostly have a dark humose topsoil and the texture varies between sandy loam and silty clay. The shallow peaty soils often overly a silty clay which is very acid. Two soils (Fig. 4 and Table 2) will be discussed shortly.

Table 2 Some analytical data from the soils from Figure 4 (De Bakker, 1979).

	org.m. %	C/N	pH-KCl	$CaCO_3$ %	clay %	silt %	sand %
Peat soil							
topsoil	45.3	13	5.2	n.d.	33	42	25
subsurface	23.1	10	5.2	n.d.	54	31	15
subsoil	67.4	20	5.8	n.d.	46	49	5
Acid sulphate soil on bog floor							
topsoil	22.0	12.6	5.6	0.3	43	50	7
subsurface	8.8	n.d.	3.4	0.1	56	43	1
subsoil	6.8	n.d.	3.7	0.2	57	43	0
loamy calcareous soil on bog floor							
topsoil	7.5	11	7.0	1.8	23	36	41
subsurface	4.0	10	7.1	7.9	23	41	36
subsoil	1.1	n.d.	7.4	13.0	10	19	71

The middle soil from Figure 4 is an acid sulphate soil, soils discussed at length during a congres in Wageningen (Drost, 1973). Below a thin layer of peaty clayey material, a limnic deposit dating from the lake-stage (after peat cutting and before drainage) often a remnant of peat (mostly reed peat) is present, overlying a mineral subsoil. The upper part is

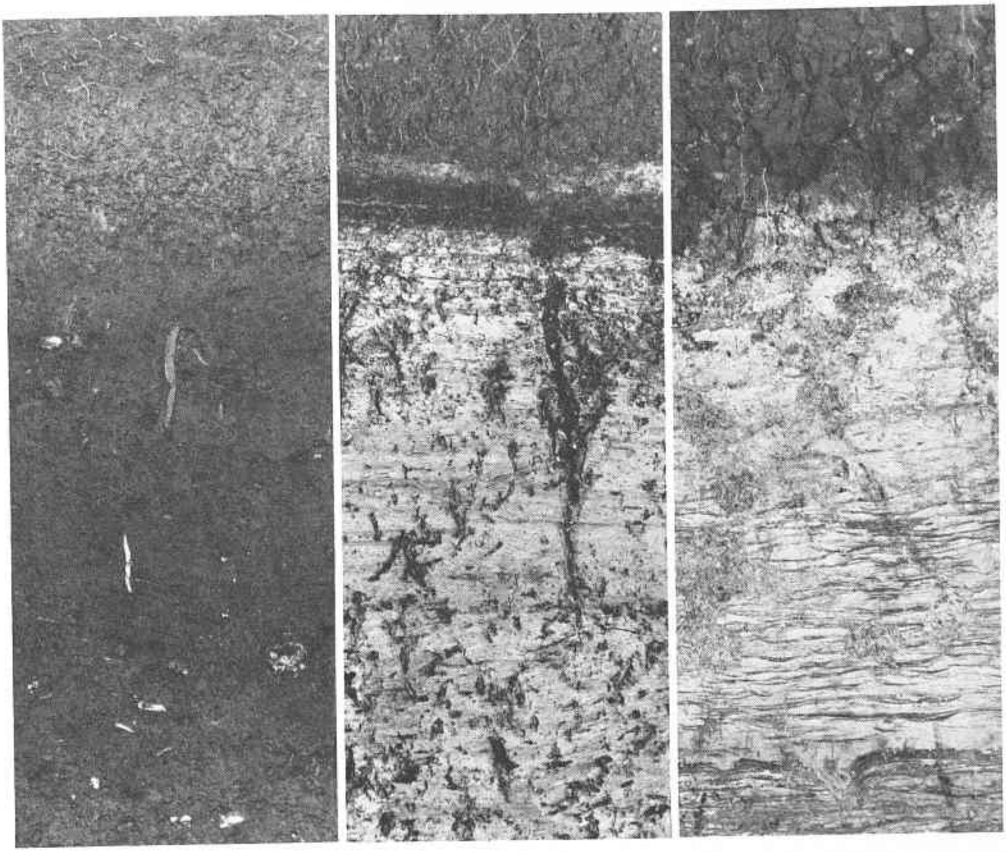


Fig. 4 Three soils (depth 1.20 m) from the area of Figure 1.
Left: a non-cut over wood peat soil, with a sandy man-made topsoil, a clayey mucky subsurface layer overlying wood peat, oxidised to a depth of 65 cm.
The other two soils are from the bog floors, the drained cutover moss peat areas. They are developed from marine sediments deposited 4000 to 5000 years ago.
Middle: an acid sulphate soil, with a topsoil derived from peaty lake mud overlying a thin remnant of peat, on a very acid, partly oxidised silty clay (cat-clay) rich in sulphates with a non-oxidised soft subsoil rich in sulphides.
Right: a loamy soil, with a mixture of marine calcareous loam and peaty lake mud on top, and a loamy calcareous stratified subsoil. (Photos Soil Survey Institute R29-20, -6 and -5).

oxidised, and the sulphides present in the old marine silty clay oxidised into jarosite and sulphuric acid, thus producing an acid layer, called cat-clay by the Dutch farmers. Still deeper the subsoil is still unripened (soft, water rich and non-oxidised) a potential cat-clay.
Such soils are used exclusively as grassland, in the last decades these topsoils have been considerably improved by liming, their subsoils still being acid (Table 2).
The non-acid soils partly are calcareous and medium-textured, like the third soil from Figure 4 and Table 2. The upper part consists of lake mud mixed by ploughing with the calcareous subsoil. This is finely stratified, and often highly calcareous. However they have a different genesis, these soils in some properties are comparable with hydromorphic chernozemic soils: base-saturated, loess-like in texture, dark humose topsoil, low C/N ratio, krotowinas in the subsurface soil.
These soils are all tile-drained and excellently suited and used for a wide range of crops: wheat, potatoes, sugarbeet, barley, colza, peas and in the last decade an important crop is maize for silage. They are also first-rate grassland soils. As Hidding states in his paper some rose growers have moved from the peat lands to these drained bog floors, also other horticultural crops are grown on these calcareous soils.

5.4 Literature

De Bakker, H., 1979. Major soils and soil regions in the Netherlands. Junk-The Hague, Boston, London/Pudoc, Wageningen.

De Bakker, H. en J. Schelling, 1966. Systeem voor bodemclassificatie voor Nederland, de hogere niveaus (with English summary). Pudoc, Wageningen.

De Zeeuw, J.W., 1978. Peat and the Dutch golden age, the historical meaning of energy-attainability. In: A.A.G. Bijdragen 21, 3-37.

Dost, H. (ed.), 1973. Acid sulphate soils; proceedings of the International Symposium on Acid Sulphate Soils, 13-20 August 1972, Wageningen, The Netherlands, ILRI-Publication 18, vol. I and II.

Jongerius, A. und L.J. Pons, 1962. Einige mikromorphologische Bemerkungen über den Vererdungsvorgang im niederländischen Moor. Zeitschr. Pfl., Dü., Bodenk. 97 (142), 243-255. Weinheim.

Kowalinski, S., 1964. Gleby murszowe i ich przeobraženia pod wplywem uprawy pluznej. Wroclaw.

Lambert, Audrey M., 1971. The making of the Dutch landscape, an historical geography of the Netherlands. Seminar Press, London/New York.

Okruszko, H., 1968. Soil-forming processes in drained peatland. Trans. 2d Int. Peat Congr., Vol. I, 189-197. Ed. R.A. Robertson, Edinburgh.

Pons, L.J. and I.S. Zonneveld, 1965. Soil ripening and soil classification; initial soil formation of alluvial deposits with a classification of the resulting soils. ILRI-Publication 13, Wageningen.

Van Heuveln, B. and H. de Bakker, 1972. Soil forming processes in Dutch peat soils with special reference to humus-illuviation. Proceedings 4th Int. Peat Congr. Vol. I, 289-297. Helsinki.

6 REVIEW OF CHAPTER 5

H. Okruszko
Institute for Land Reclamation and
Grassland Farming
Falenty, Poland

The review of the paper was based on the following assumptions:

1) Soils of the Netherlands' region in question belong to those utilized at the longest and most intensively in Europe. They occur in areas subjected to various forms of a strong anthropogenization.
2) Soils developed from peat are very labile and undergo far advanced transformations under the effect of various human activity forms in the natural environment.
3) Peat soils characterized in the paper represent the types which are developing and will develop on peatlands in consequence of different kinds of human activity.
4) Recognition of these soils, their classification and evaluation are of significant importance from the viewpoint of forecasting conditions for agricultural or horticultural production on peatlands in the future.

The author of the paper reviewed distinguishes in the area in question two groups of soils. They are:

a) soils of non-excavated peatlands,
b) soils of the reclaimed bog floors.

He distinguishes with in the first group:

- peat soils transformed by a natural soil process, stimulated by their agricultural utilization,
- peat soils transformed both by the soil process an by different materials added to them, first of all, manure with sand.

In the second group the author distinguishes:

- soils formed from the mineral substrate rich in humus, but without any peat admixture,

- soils formed from the mineral substrate and remnants of peat as well as from mud from the lake formed after peat cutting.

Soils of this group differentiate into types depending on the kind of mineral substrate, on which they developed. There are quite different soils formed from oxidised and silty clay, known as cat-clay, as well as those formed from a calcareous, medium-textured material, which with regard to their properties approximate hydromorphic chernozemic soils (named also black soils).

Comments to the soils presented in the paper are as follows:

First of all, it is to stress that among classifications of peat soils applied in the world only two classifications - Dutch and Polish - distinguish, formally since many years, two main types (Okruszko and Piaścik, 1979):

- soils of undrained peats, being in the peat accumulation phase,
- soils of drained peats subjected to oxidation, in which drying up and disappearance of the organic matter of peat is taking place (decession phase in the peatland evolution).

Similar view as regards the classification principles of peat soils, although formulated still too generally, is represented recently in British, Soviet, GDR and Hungarian classifications.

This question is of significant scientific and practical importance and requires an explicit formulation, particularly in view of assuming by particular countries the classification after the USA Soil Taxonomy. The basis of the USA classification is, besides geographic situation, the peat mass humification state in the subsurface tier at the depth of 30-90 cm (in sphagnum peats 60-120 cm) and in the bottom tier (90-130 cm or 120-160 cm) taking into account to a quite little extent the topsoil tier (0-30 cm) character. However, the properties of the latter determine the root growth conditions, and consequently the level of crop yields, as well as tillage and utilization conditions of these soils. This problem was discussed in detail by Dinç, Miedema, Bal and Pons (1976), who stated: 'we consider the classification system of the Soil Taxonomy for the Histosols very unsatisfactory' (page 262). I support this opinion. I regard as indispensable to take into account in the classification of peat soils the soil process running in them and transforming these labile soils since the moment of their first drainage.

It is also necessary to determine in detail the kind of soil material occurring in the topsoil tier.

Investigations of peat soils in the aspect of the process occurring in them after drainage, defined by us as 'moorsh-forming' soil process, are carried out in Poland intensively for 30 years.

Results of these investigations prove distinctly the purposefulness of taking into account in the classification:

1) soil transformation state under the effect of moorsh-forming process, what is expressed by the thickness and character of the peat mass and its transformation state in the topsoil layer; this is correlated with the kind of peat, from which the soil is developed, first of all with its decomposition degree and with the drainage depth of the given peatland,
2) occurrence in the topsoil layer of soil material other than peat, formed in consequence of natural phenomena (e.g. inundation) or under the human activity effect (adding sand to the topsoil, manuring, spreading of mud, etc.),
3) magnitude of the fresh humus influx (from decomposition of plant matter, mainly roots of plants), which determines the soil structure and air-water conditions in soil connected therewith.

The soil process running in the drained peat soil changes its physical properties (Table 1) and chemical composition (Tables 2, 3), mainly in the topsoil layer.

Table 1. Characteristics of physical properties of moorsh-peat soils

Soil		Layer in cm	Ash content %	Bulk density g/cm^3	Total porosity % of volume	Volume of pores		
						macro	meso	micro
Weakly moorshed soil from		0- 30	18.2	0.200	88.0	15.1	53.1	19.8
fibric peat	Mt I aa	30- 80	8.1	0.122	92.3	25.4	55.5	11.4
Typic Medifibrist	n = 4	80-130	10.1	0.119	92.4	25.8	53.7	12.9
Weakly moorshed soil from		0- 30	17.5	0.201	88.0	16.7	49.0	23.3
medium decomposed peat	Mt I bb	30- 80	10.5	0.135	91.4	23.6	53.4	14.4
Typic Medihemist	n = 4	80-130	11.2	0.128	92.0	26.0	50.4	15.6
Medium moorshed soil from		0- 30	20.4	0.237	86.2	14.5	47.0	24.7
medium decomposed peat	Mt II bb	30- 80	11.6	0.156	90.3	18.9	52.9	18.5
Typic Medihemist	n = 5	80-130	10.7	0.134	91.6	23.0	49.8	18.8
Medium moorshed soil from		0- 30	15.5	0.220	86.8	19.3	39.9	27.6
strongly decomposed peat	Mt II cc	30- 80	13.1	0.155	90.5	21.7	46.7	22.1
Typic Medisaprist	n = 6	80-130	19.3	0.164	90.4	21.1	49.4	19.9
Strongly moorshed soil from		0- 30	17.6	0.304	81.8	23.9	24.7	33.2
strongly decomposed peat on		30- 80	12.4	0.179	89.0	23.0	39.8	26.2
medium decomposed peat	Mt III cb	80-130	8.3	0.107	93.1	21.1	59.9	12.1
Hemic Medisaprist	n = 5							

Table 2. Mineral elements enrichment or impoverishment coefficients of the 0-5 cm soil layer in relation to the layer on the depth 45-50 cm as a result of moorsh process in peat soil (Sapek, Gotkiewicz 1977)

Element	Peatland utilization			
	Grassland		Arable land	Forest
	not fertilized	fertilized	fertilized	not fertilized
Ash	1.31	1.11	1.08	1.56
K	3.39	2.62	3.33	3.50
Mg	1.06	0.93	0.65	1.30
Ca	0.59	0.48	0.40	0.71
Fe	1.30	1.17	1.24	1.65
Al	5.00	3.90	3.20	3.68
P	3.70	3.55	2.66	3.90
Cr	1.70	1.70	1.14	1.84
Mn	2.20	1.65	2.24	3.40
Zn	4.15	2.65	1.60	6.00
Cu	1.40	1.04	4.20	0.89
Co	2.50	7.50	3.50	7.70
Ni	0.91	0.96	0.72	1.57
Pb	35.5	80.0	10.90	31.8
Cd	64.0	91.0	6.75	28.6

Table 3. Characteristics of humus compounds in the profiles of moorsh-peat soils (Okruszko, Kozakiewicz 1973)

Compounds		Layers in the soil profiles				
		0-10	10-20	20-30	50-60	80-90
Fulvic acids in % of C:						
in weakly moorshed soils	n=7	15.3	11.8	9.2	9.3	8.4
in strongly moorshed soils	n=3	15.3	17.5	17.6	18.4	13.2
Humic acids in % of C:						
in weakly moorshed soils	n=4	39.9	39.4	40.1	36.7	34.7
in strongly moorshed soils	n=3	44.5	48.4	52.8	55.2	53.2
Ratio of humic to fulvic acids in soils:						
weakly moorshed		2.3	3.2	3.4	3.5	3.6
strongly moorshed		2.6	2.7	3.0	2.9	4.0
Hymatomelanic acids in % of D.M.	n=3	0.0	0.35	1.14	3.13	3.92
Total N content in % of D.M.	n=7	4.84	4.41	4.29	3.88	3.75
C: N in soils	n=7	11.8	13.2	14.2	16.0	17.2
in humic acids	n=9	11.8	12.1	12.5	13.2	13.2

n=number of samples

A very important factor in the differentiation of peat soils is the peat thickness reduction as a natural process connected with subsidence or caused by man (peat excavation), or other phenomena, as fires, eolian erosion, etc. They lead eventually to developing soils formed from peat and mineral substrate. The area of such soils is widening proportionally to the utilization time of peatlands.

Results of the Polish investigations in this field approximate those presented by De Bakker in the paper reviewed. We have found the formation of kinds of black soil (hydromorphic chernozemis soils) on mineral loamy substrates rich in $CaCO_3$. They are very fertile soils, of a high value for agriculture. In case of sandy substrate poor in lutum, soils defined in Poland as "moorshy" or mucky-like ones, composed of sand and humus, are forming. The humus content in such soils amounts to 10-20%. This amount of the organic matter gives them other properties than those characteristic for humic sandy soils with a humus content of 5-10%. In Dutch literature (De Bakker 1966) such soil materials are defined as peaty sands. Humus of the soils is liable to drying up and after drying it can be separated on sieves from sand. They do not form any complex compounds with mineral part of the soil. They can undergo irreversible dehydration. These soils, when intensively manured and utilized, can give high yields, on the necessary condition of application of organic fertilizers or green manures, increasing the fresh humus amount in them. This kind of soils is not mentioned in the paper by De Bakker. It can be presumed that they would occur on reclaimed bog floors on sand.

The question of the mud participation in the formation of organic soils deserves attention. Mud is formed on the area of cut-over bogs occupied by marshes. This soil formation differs from peat with regard to genesis, character of its mass and properties. There are hitherto only few data in the literature concerning mud, what was stressed in our previous works (Okruszko 1979, 1980). Mud is not of a fibrous structure typical for peat; it is formed in a hydrous medium with humified organic matter mixed with mineral sediments. Hence it is rich in complex organic-mineral compounds, and thus resistant, contrary to decomposed peat, to irreversible dehydration.

Organic soils presented in the paper by the reviewed author (and in his other works), formed under conditions of a long-term and differentiated utilization of peatlands, allow to conclude that the question of their classification would require to be worked out on an international scale. It is necessary to establish the criteria of characteristics and classification of organic soil materials. It concerns basic initial homogenic materials, such as peat, mud, gyttja, as well as heterogenic ones, consisting of the mixture of basic soil materials. Also secondary soil materials can occur in consequence of transformation of the initial materials in the system of soil processes and under the human activity effect. Also definition and characterization of soil processes occurring in organic soils and leading to their modification, being of importance for properties of soils and productive value, are necessary. It is the task, which should be undertaken by the IPS jointly with the International Soil Science Society.

Literature

De Bakker, H., J. Schelling 1966. System of soil classification for The Netherlands. The higher levels. Pudoc, Wageningen.

De Bakker, H. 1979. Major soils and soil regions in The Netherlands. Junk, The Hague, Boston/London, Pudoc, Wageningen.

Dinç, U., R. Miedema, L. Bal, L.J. Pons 1976. Morphological and physicochemical aspects of three soils developed in peat in The Netherlands and their classification. Neth. J. Agric. Sci. 24. p. 247-265.

Okruszko, H. 1979. Wetlands and their classification in Poland. 'Classification of peat and peatlands' - Proc. IPS Hyytiala. p. 221-226.

Okruszko, H. 1980. Klassifizierung von Feuchtgebieten auf der Grundlage der in ihnen entstehenden hydromorphen Bodensubstrate. Telma. B. 10. S. 17-24.

Okruszko, H., A. Kozakiewicz 1976. Humification and mineralization as mucking process elements in peat soils. Zesz. probl. Post. Nauk rol. Z. 146 p. 63-76 (in Polish with English summary).

Okruszko H., H. Piaścik 1979. Comparative characteristics of the organic soil classifications. Polish Soil Science Society (in Polish).

Sapek, A., J. Gotkiewicz 1977. Utilization and fertilization effect on the content of mineral elements in profiles of peat soil from Kuwasy fen. Rocz. Nauk Roln. Polish Agric. Annual F-79-3. p. 113-132 (in Polish with English summary).