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VEGETATION, SOIL, HYDROLOGY AND MANAGEMENT IN A DRENTHIAN BROOKLAND (THE NETHERLANDS)

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SUMMARY

The relation is discussed between vegetation, soil, hydrology and management in a characteristic lower course of a Drenthian brook. Vegetation and soil were compared by overlaying vegetation and soil maps. The resulting soil spectra were compared with the land use before acquirement by the State. The plant communities were characterized by phreatophytic spectra and groundwater fluctuations. Relations between plant communities and soil units were described. In the wettest areas the hydrology seems to determine the plant communities; not only mean highest and mean lowest groundwater level, but also regarding height of inundation and water quality. The somewhat drier communities appear to be determined by (i) earlier manuring, (ii) changes in the vegetation due to recent nature management practices and (iii) changes in the vegetation due to possible draining towards agricultural areas outside the study area.

1. INTRODUCTION

Dutch phytosociological research resulted in a survey of plant communities in The Netherlands (WESTHOFF & DEN HELD 1969). The study of the important soil conditions also led to a soil classification for The Netherlands (DE BAKKER & SCHELLING 1966). Both systems, however, are not interrelated. Generally, the synecological description of plant communities is very rough and an indication of the soil units is lacking. Some studies, however, concerned the relation between vegetation and soil especially. In a freshwater tidal-area ZONNEVELD (1958) found a good correlation between soil units and plant communities. OTTO (1959) found a high correlation between the occurrence of moist grassland communities on sandy soils under agricultural practices and the prevailing groundwater patterns. A correlation between groundwater tables and gleying had been found earlier (VAN DER SCHANS 1957). ZONNEVELD (1965) demonstrated a high correlation between the occurrence of some heathland communities and their soil units. In communities of semi-natural woodlands VAN DEN BROEK & DIEMONT (1966) found a fairly good correlation between some vegetation types and soil units, whereas other communities occurred on various soil units. GROOT OBBINK & BUITENHUIS (1972) observed in a peaty area a good fit of vegetation boundaries and soil boundaries. MEISEL (1956) made the first quantitative comparison of soil and vegetation by comparing a vegetation map and a soil map of semi-natural grassland communities, resulting in soil spectra of the occurring vegetation types. BANNINK, LEYS & ZONNEVELD (1973, 1974) compared vegetation maps and soil maps quantitatively for conifer woodlands and weeds, respectively, by making vegetation and soil spectra. KRAAK (1974) did the same for grassland communities under agricultural practices. Most of the above authors suggest that apart from the soil unit itself the hydrology plays an important role in the relation soil-vegetation. However, publications on groundwater levels that were actually observed are relatively scarce (TÜXEN & GROOTJANS 1978, GROOTJANS 1980b).

The authors of the above mentioned studies try to demonstrate the positive correlation between soil units and plant communities. However, the discrepancies between both soil maps and vegetation maps could be even more interesting, pointing to historical events or indicating human interference. Thus a combination of the soil, vegetation, and management maps could provide new explanations of ecological phenomena (ZONNEVELD 1959).

In this study the relation is described between the semi-natural (WESTHOFF 1971) plant communities, soil units, hydrology and management in a characteristic lower course area of a Drenthian brook.

2. MATERIALS AND METHODS

The study area is situated south of Groningen (53°08'NL 6°37'EL) along the Drentsche A, a catchment area draining 30.000 ha of a Pleistocene landscape.

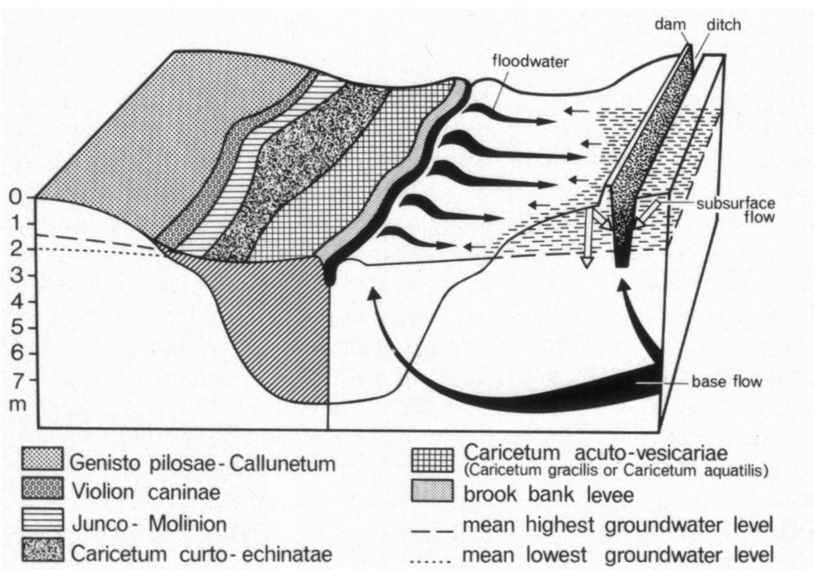

Fig. 1. Schematical cross-section of the lower course situation of the Drentsche A. After GROOTJANS 1980a.

This brook valley developed during the Holocene in a much broader and deeper incision in older glacial deposits. The boulder clay deposits were eroded in the valleys but are generally present in the banks. In the subsequent Würm glacial coversands built up some sand-ridges. In the Holocene peat accumulated in the valley, its basis consisting of the remnants of an Alder carr overlain by sedge-peat and reed-peat deposits. The reed-peat has probably been formed under brackish circumstances prevailing in a period of transgression, because two km north of the study area marine clay covers the peat (STICHTING VOOR BODEMKARTERING 1973). Within the Pleistocene landscape a Drenthian brook can be divided into source area, upper course, middle course and lower course (SCHIMMEL 1955, GROOTJANS 1980a). The study area (27 ha) represents a lower course situation. Its hydrology is predominantly governed by flood water from the brook and to a lesser extent by slowly discharging deep groundwater seepage (*fig. 1*). Only the 15–80 cm higher sand-ridges do not become inundated.

The area was in agricultural use at least from the year 1650 onwards. The lower parts probably being used for hay-making, the drier parts for grazing. Information about agricultural practices between 1930 and 1966 was gathered from former owners. In 1966 and 1967 the State Forestry Service acquired the area and started management practices aiming at the preservation and restoration of species rich grasslands by yearly hay-making in the second half of June and in September, without manuring.

The soil was systematically investigated by means of 100 cores.ha^{-1}, being a reliable number (VAN HOLST & VLEESHOUWER 1970) for detailed surveys. Often local differences forced to enlarge the sample numbers. Core depth was 120 cm, several characters of the various horizons were described viz. thickness, colour, rust, reduction, admixture of silt and sand, to enable grouping into the system of soil classification for The Netherlands (DE BAKKER & SCHELLING 1966).

The ground water table was measured at a number of places from April-December 1975; the measurements give a detailed picture for a short period. The hydrology of a relatively long previous period is probably reflected in the zone in which rust occurs and in the phreatophytic spectra according to LONDO (1976).

To characterize the different plant communities 101 relevés were made according to the Braun-Blanquet approach. The relevés were arranged in a synoptic table by hand sorting. Species occurring in three relevés or less are not included.

The nomenclature of the Phanerogams follows HEUKELS & VAN OOSTSTROOM (1975), that of the Bryophytes MARGADANT (1959) and LANDWEHR & BARKMAN (1974).

The vegetation map (1:2000) and the soil map (1:2000) were compared by overlaying. By means of a dot grid with a dot spacing of 1 cm the distribution of plant communities and soil units was worked out for each separate point. The occurrence of vegetation types for each soil unit has been quantified as vegetation spectra and on an analogous way soil spectra have been made (BANNINK, LEYS & ZONNEVELD 1973).

3. RESULTS

3.1. Soil

The three peat soils present (*fig. 2*) are characterized by a layer of peat with a

Fig. 2. Soil map of a lower course area of the Drentsche A.

minimum height of 40 cm within 80 cm below the surface. The "Vliet" peat soils, marking an old meander of the brook, are on the boundary between soil and water. They have a ripened topsoil layer, less than 20 cm, consisting of the roots and debris of sedges and grasses. The "Vlier" peat soils have a firm, ripened, but still unmoulded topsoil layer of over 20 cm. Because of frequent inundations this topsoil contains silt and sometimes rust in the top 15 cm layer. The "Made" peat soils are the least wet. Due to drainage and activity of soil fauna the topsoil is moulded and rust occurs deeper than 15 cm. The topsoil contains some silt.

The two peaty soils are characterized by a peaty topsoil layer of 10–40 cm containing some silt. In the "Broek" earth soils very little vertical downward transport of humus occurs, due to permanently high groundwater tables and seepage. In the drier "Moer" podzol soils, a clear alluvial humus horizon can be distinguished.

In the coversand sediments percolation of rainwater enabled the vertical translocation of humus developing the "Veld" podzol soils with a clear B-horizon.

3.2. Vegetation, hydrology and management

The relevés have been classified and mapped in *fig. 3*. The local vegetation types are summarized in *table 1*, and their resemblance with the syntaxa described by WESTHOFF & DEN HELD (1969) is indicated below. Moreover an example of their groundwater table (*fig. 4*), phreatophytic spectrum (*table 2*) and former land use is given.

1. Community dominated by *Glyceria maxima*, representing the sociation of *Glyceria maxima* of the alliance *Phragmition*, ground water type A, earlier grazed and manured.
2. Community dominated by *Carex hudsonii*, representing the *Caricetum hudsonii* of the alliance *Magnocaricion*, ground water type B, earlier abandoned or mown twice a year, in general not manured.
3. Communities dominated by *Carex acuta* or *Carex aquatilis*, representing the *Caricetum acuto-vesicariae* (*Caricetum gracilis* (Graebner & Hueck 1931, Tüxen 1937)) and *Caricetum aquatilis* (EVERTS & DE VRIES, in prep.), respectively of the alliance *Magnocaricion*, groundwater type B, earlier abandoned or mown twice a year, not manured. This community is the most characteristic one in this marshland (SCHIMMEL 1955). *Table 3* illustrates the composition in detail, revealing two variants. The relevés 1, 2 and 3 represent a variant inops (i.e. a subassociation poorer in species than the other subassociations, but without own differential taxa, WESTHOFF & DEN HELD 1969), whereas the relevés 4 and 5 illustrate the variant with the differential species *Potentilla palustris*, *Menyanthes trifoliata* and *Carex rostrata*. The relevés 6 and 7 will be discussed below.
4. Community dominated by *Carex disticha*, ground water type B, earlier abandoned or mown twice a year, not manured, but locally grazed and manured. Both structure and floristic composition resemble those of the communities 2 and 3. Therefore this community represents the *Caricetum distichae* of the alliance *Magnocaricion* and not the *Senecioni-Brometum racemosi* of the alliance

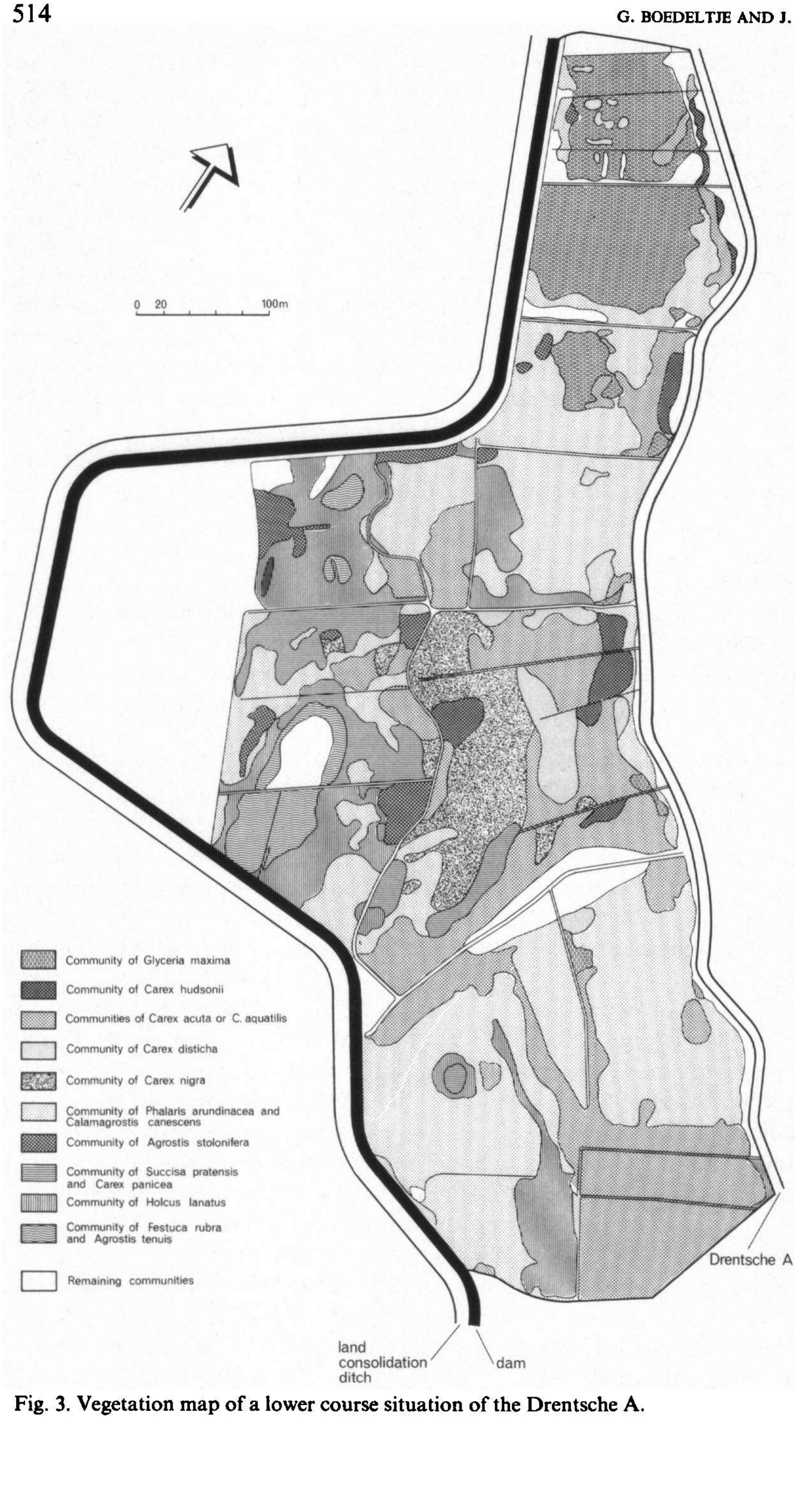

Fig. 3. Vegetation map of a lower course situation of the Drentsche A.

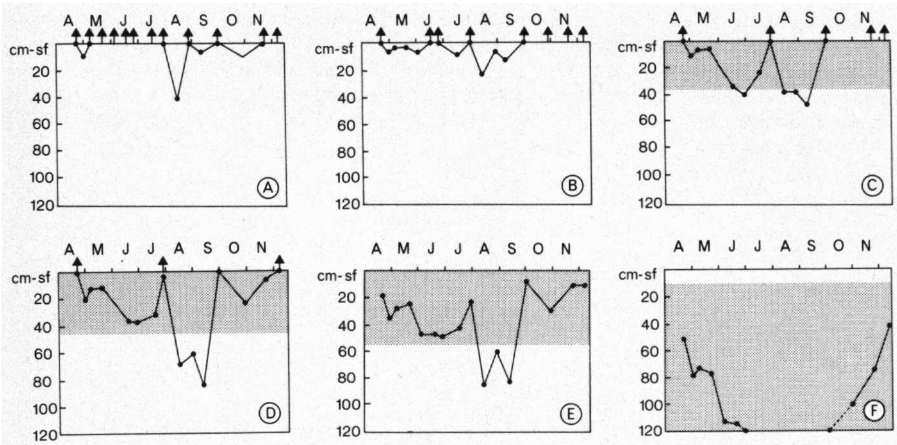

Fig. 4. Ground water fluctuations in 1975 under different plant communities in a lower course situation of the Drentsche A.
A: Community of *Glyceria maxima*, B: Communities of *Carex hudsonii*, of *Carex acuta* or *Carex aquatilis*, of *Carex disticha*, of *Carex nigra*, C: Community of *Phalaris arundinacea* and *Calamagrostis canescens*, D: Community of *Agrostis stolonifera*, E: Communities of *Succisa pratensis* and *Carex panicea* and of *Holcus lanatus*, F: Community of *Festuca rubra* and *Agrostis tenuis*. Hatched area: zone of rust.

Calthion palustris (WESTHOFF & DEN HELD 1969).

5. Community dominated by *Phalaris arundinacea* and/or *Calamagrostis canescens*, representing the sociation of *Phalaris arundinacea* of the alliance *Magnocaricion*, ground water type C, abandoned or mown twice a year, locally manured.
6. Community dominated by *Carex nigra*, with the differential species *Pedicularis palustris*, representing the *Caricetum curto-echinatae* of the alliance *Caricion curto-nigrae*, ground water type B, mown twice a year, not manured. This community has the highest number of species of the study area.
7. Community of *Agrostis stolonifera*, ground water type D, in general grazed and manured. This community can be assigned to the alliance *Agropyro-Rumicion crispi* (cf. ELLENBERG 1978). Representatives of this alliance occur inconspicuously in other communities. Locally one or more of these species come to dominance viz. *Agrostis stolonifera*, *A. canina*, *Alopecurus geniculatus* and *Poa trivialis*.
8. Community of *Succisa pratensis* and *Carex panicea* comprising elements of various syntaxa of which the *Junco-Molinion* should be mentioned, ground water type E, mown twice a year, locally grazed in late summer, not manured.
9. Community dominated by *Holcus lanatus*, a poorly developed *Molinio - Arrhenatheretea* community, ground water type E, in general grazed and manured.
10. Community of *Festuca rubra* and *Agrostis tenuis*, a poorly developed *Molinio-Arrhenatheretea* community, groundwater type F, in general gra-

Table 1. Synoptic table of plant communities of a lower course situation of the Drentsche A. Pe: Phragmitetea, NG: *Nasturtio-Glycerietalia*, Pa: *Phragmitetalia*, M: *Magnocaricetalia*, P: *Parvocaricetea*, M: *Molinio-Arrhenatheretea*, C: *Calthion palustris*, F: *Filipendulion*, JM: *Junco-Molinion*, A: *Arrhenatherion elatioris*, ARc: *Agropyro-Rumicion crispi*, Rs: Remaining species.
* mean cover over 25%. Presence; I: 1–20%, II: 21–40%, III: 41–60%, IV: 61–80%, V: 81–100%.

		Community of Glyceria maxima	Community of Carex hudsonii	Communities of Carex acuta or Carex aquatilis	Community of Carex disticha	Community of Phalaris arundinaceae and Calamagrostis canescens	Community of Carex nigra	Community of Agrostis stolonifera	Community of Succisa pratensis and Carex panicea	Community of Holcus lanatus	Community of Festuca rubra and Agrostis tenuis
	mean cover herb layer (%)	50	60	65	55	70	55	70	80	90	85
	mean cover bryophytes (%)	0	12	6	8	2	30	10	35	2	4
	mean number of species	7	20	16	18	15	31	13	27	14	16
	number of relevés	11	8	23	9	17	6	9	8	6	4
Pe	Phragmites australis	.	I	.	.	.	.	.	.	.	.
	Rumex hydrolapathum	II	III	I	.	.	.	.	.	.	.
	Lycopus europaeus	II	II	I	.	I	.	.	.	.	.
	Glyceria maxima	V*	IV	IV	V	IV	I	III	.	I	.
	Rorippa amphibia	III	III	I	II	I	.	I	.	.	.
	Equisetum fluviatile	IV	V	IV	IV	II	V	I	II	.	.
	Iris pseudacorus	I	I	I	.	.	I	I	II	.	.
NG	Myosotis scorpioides	.	II	III	IV	I	I	.	.	.	.
	Cicuta virosa	.	III	I	.	.	.	.	.	.	.
	Sparganium erectum	I	II	.	.	I	.	.	.	.	.
Pa	Typha latifolia	III	.	I	.	.	.	.	.	.	.
M	Carex acuta	I	.	II	I	.	.	.	.	.	.
	Carex aquatilis	I	V	V*	IV	IV	V	III	.	I	.
	Lysimachia thyrsiflora	.	II	I	I	.	.	.	.	.	.
	Galium palustre	I	IV	IV	IV	IV	V	II	.	.	.
	Poa palustris	.	IV	.	III	I	III	.	.	.	.
	Carex hudsonii	I	V*	II	I	I	III	.	.	.	.
P	Pedicularis palustris	.	I	I	I	.	V	.	.	.	.
	Stellaria palustris	.	II	.	II	.	IV	.	.	.	.
	Potentilla palustris	I	I	II	II	I	III	II	IV	.	.
	Hydrocotyle vulgare	.	I	.	.	.	IV	.	.	.	.
	Calliergon cordifolium	.	III	IV	IV	III	V*	III	I	I	.
	Carex nigra	.	II	II	III	II	V*	III	IV	II	.
	Ranunculus flammula	.	II	II	II	III	V	IV	II	.	.
	Viola palustris	.	.	.	.	.	II	.	IV	I	.
M	Holcus lanatus	.	.	I	I	III	I	IV	V*	V*	V*
	Rumex acetosa	.	I	II	III	IV	V	III	V	V	V
	Cerastium holosteoides	.	.	.	.	.	.	I	.	.	IV
	Cardamine pratensis	.	III	IV	IV	IV	V	III	V	IV	IV
	Plantago lanceolata	.	.	.	.	.	.	.	V	.	III
	Rhytidiadelphis squarrosa	.	.	.	.	I	.	I	V*	.	III
	Climacium dendroides	.	.	I	I	II	V	II	IV	II	.
	Deschampsia caespitosa	.	.	.	.	.	.	.	III	.	II
	Angelica sylvestris	.	.	I	.	.	.	.	II	.	.
	Achillea ptarmica	.	.	I	.	.	.	.	I	.	III
	Valeriana dioica	.	.	I	I	I	II	.	V	.	.
C	Lychnis flos-cuculi	.	I	I	III	I	V	.	.	.	.
	Caltha palustris	I	IV	IV	IV	III	III	.	II	.	.
	Lotus uliginosus	.	.	I	.	I	.	.	V	.	II
	Carex disticha	.	I	I	V*	I	.	.	I	.	.
	Juncus acutiflorus	.	.	.	.	.	.	.	III	.	II
	Senecio aquaticus	.	.	I	.	I	.	.	II	.	.
F	Lythrum salicaria	I	II	II	II	III	V	I	.	.	.
	Stachys palustris	I	II	I	.	.	.	.	.	.	.
	Valeriana officinalis	.	I	I	.	.	.	.	I	.	.
	Filipendula ulmaria	.	III	II	III	II	III	.	IV	II	II
JM	Succisa pratensis	.	.	.	.	.	.	.	V	.	.
	Carex panicea	.	.	.	.	.	.	.	IV	.	.
A	Festuca pratensis	.	.	I	.	II	.	.	III	III	II
	Alopecurus pratensis	.	.	.	I	I	.	.	.	I	.
	Ranunculus acris	.	.	I	I	I	.	I	V	I	V
ARc	Agrostis stolonifera	.	II	II	III	III	V	V*	III	II	.
	Ranunculus repens	.	II	III	IV	IV	V	III	V	IV	V
	Leontodon autumnalis	.	.	.	I	I	I	I	IV	.	.
	Rumex crispus	.	.	.	.	I	.	II	.	.	.
	Eleocharis palustris ssp. uniglumis	.	.	I	II	.	III	I	.	I	.
	Juncus effusus	.	.	.	.	I	I	II	IV	II	.
	Alopecurus geniculatus	.	.	I	.	I	.	IV	.	.	.
	Lysimachia nummularia	.	I	I	I	I	II	.	.	.	.
	Poa trivialis	I	II	III	IV	IV	V	III	.	IV	.
	Poa pratensis	.	.	I	.	I	.	I	II	IV	III
	Trifolium repens	.	I	.	II	.	V	.	II	.	II
Rs	Urtica dioica	I	I	.	.	I	.	.	.	.	.
	Solanum dulcamara	II	.	I	.	.	.	.	.	.	.
	Epilobium hirsutum	.	II	I	.	.	.	.	.	.	.
	Leptodyctium riparium	.	II	I	.	.	.	.	.	.	.
	Phalaris arundinacea	I	IV	V	V	V*	V	V	IV	V	.
	Calamagrostis canescens	I	V	IV	III	V*	V	II	IV	III	.
	Carex rostrata	.	II	I	I	.	III	.	.	.	.
	Menyanthes trifoliata	.	II	II	.	.	III	.	.	.	.
	Agrostis canina	.	.	.	I	II	III	III	III	.	.
	Mentha aquatica	II	IV	II	I	I	V	.	.	.	.
	Eurynchium praelongum	.	I	.	.	I	.	.	.	I	III
	Eriophorum angustifolium	.	I	.	I	I	I	II	I	.	.
	Anthoxanthum odoratum	.	.	I	I	II	II	II	V	II	V
	Agrostis tenuis	.	.	.	.	.	.	.	II	.	V*
	Festuca rubra	.	I	I	II	II	V	II	IV	III	V*
	Calliergonella cuspidata	.	II	II	III	IV	V	II	I	.	.
	Mnium affine s.l.	.	II	II	II	I	III	I	I	I	.
	Leptodyctium kochii	I	I	I	.	.	.	.	.	.	.
	Drepanocladus aduncus	.	.	I	II	.	.	.	I	.	.
	Brachythecium rutabulum	.	.	I	.	I	.	I	IV	II	IV

Table 2. Phreatophytic spectra of communities derived from *table 1* taking into account the class of presence of each phanerogamic species. W: species requiring for at least part of the year a (ground) water level above or at the soil surface (strict phreatophytes), F: species growing exclusively within the sphere of influence of the phreatic level, which is generally below the surface (strict phreatophyte), f: species growing mainly or nearly exclusively within the sphere of influence of the phreatic level, which is generally below the surface (not strict phreatophyte), A: species not bound by the sphere of influence of the phreatic level (aphreatophytes).

	W	F	f	A
	%	%	%	%
Community of Glyceria maxima	76	8	11	5
Community of Carex hudsonii	65	13	12	10
Communities of Carex acuta or C. aquatilis	53	12	18	17
Community of Carex disticha	53	13	12	22
Community of Carex nigra	46	18	12	24
Community of Phalaris arundinacea and Calamagrostis canescens	39	11	20	30
Community of Agrostis stolonifera	31	6	30	33
Community of Succisa pratensis and Carex panicea	20	11	31	38
Community of Holcus lanatus	12	7	29	52
Community of Festuca rubra and Agrostis tenuis	3	8	20	69

zed and manured.

4. DISCUSSION

The soil spectra for each plant community are shown in *table 4*. Without discussing all details it can be stated that some communities are strongly related to a single soil unit e.g. the community of *Festuca rubra* and *Agrostis tenuis*, whereas others are not e.g. the community of *Phalaris arundinaceae* and/or *Calamagrostis canescens*. Despite their differences in soil spectra the communities of *Carex hudsonii*, of *Carex acuta* or *Carex aquatilis*, of *Carex disticha* and of *Carex nigra* can be compared very well with respect to their ground water fluctuations (*fig. 4*) and the latter three according to their phreatophytic spectra (*table 2*), too. Because of the short period of observation the ground water fluctuations should be regarded as an illustration of the phreatophytic spectra. The lower percentage of strict phreatophytes in the community of *Phalaris arundinacea* and/or *Calamagrostis canescens* than those of the marshy communities agrees with BALÁTOVA-TULÁČKOVÁ (1968); the *Phalaridetum arundinaceae* should make higher demands upon oxygen supply in the soil than the *Caricetum gracilis*. MEISEL (1956) found under the *Glycerietum maximae*, the *Caricetum gracilis* and the *Juncus filiformis-Pedicularis palustris* association the same soil unit. The hydrology, however, should determine the differences in the vegetation. The obvious conclusion that phreatic level is a master factor in determining the occurrence of plant communities, however, should not be drawn too easily. The community of *Carex nigra* and of *Carex acuta* or *Carex aquatilis* are not comparable due to the lack of measurements of water levels above soil surface

Table 3. Communities of *Carex acuta* or *Carex aquatilis*. Ca: *Caricetum acuto-vesicariae*, M: *Magnocaricion*, P: *Phragmitetea*, M/Cc: Magnocaricion/Caricion curto-nigrae, Cc: *Caricion curto-nigrae*, Rs: Remaining species.
* Relevés made by SCHIMMEL (1955). – absent, r 1–2 individuals, +: 3–20 individuals, 1: 21–100 individuals, cover <5%, 2: any number of individuals, cover 5–25% or more than 100 individuals, cover <5%, 3: any number, cover 25–50%, 4: cover 50–75%, 5: cover 75–100%.

	Relevé number	1	2	3	4	5	6*	7*
	Date	29–5	29–5	27–5	26–5	28–5	28–5	31–8
	Quadrat size (m^2)	4	4	4	4	4	100	100
	Cover herb layer (%)	100	50	30	70	80	?	90
	Species number	4	9	15	19	20	12	19
Ca	Carex acuta	5	–	3	–	4	5	5
	Carex aquatilis	–	3	1	3	1	1	1
M	Poa palustris	1	1	–	+	2	–	1
	Galium palustre	–	–	2	2	2	1	1
	Scutellaria galericulata	–	–	–	–	–	1	–
P	Glyceria maxima	–	+	+	1	1	–	–
	Myositis scorpioides	–	+	+	+	1	+	–
	Equisetum fluviatile	–	+	+	1	1	–	+
	Rumex hydrolapathum	–	–	–	–	–	+	–
	Phragmites australis	–	–	–	–	–	+	+
M/Cc	Potentilla palustris	–	–	–	2	1	–	1
	Menyanthes trifoliata	–	–	–	+	2	–	1
	Carex rostrata	–	–	–	+	–	1	1
Cc	Calliergon cordifolium	–	–	1	2	2	–	–
Rs	Phalaris arundinacea	2	1	1	–	r	1	2
	Calamagrostis canescens	1	–	1	1	2	–	–
	Cardamine pratensis	–	r	+	1	+	–	1
	Calliergonella cuspidata	–	–	2	+	–	–	–
	Ranunculus repens	–	–	+	–	1	–	–
	Ranunculus flammula	–	–	r	–	+	–	–
	Caltha palustris	–	–	r	r	+	–	+
	Mentha aquatica	–	–	–	+	+	–	2
	Lythrum salicaria	–	–	–	+	–	–	+
	Filipendula ulmaria	–	–	–	–	–	2	1

Addenda: (2) *Epilobium hirsutum* +; *Ranunculus sceleratus* r; (3) *Lysimachia nummularia* +; (4) *Agrostis stolonifera* 1; *Carex hudsonii* +; *Eleocharis palustris* +; (5) *Mnium affine* s.l. 1; *Poa trivialis* 1; *Rumex acetosa* +; (6) *Lychnis flos-cuculi* 2; *Valeriana dioica* 1; (7) *Climacium dendroides* 4; *Mnium spec.* 2; *Ranunculus spec.* +; *Valeriana officinalis* 1.

(BALÁTOVA-TULÁČKOVÁ 1968, ELLENBERG 1978, GROOTJANS 1980a, 1980b). For agricultural purposes and demonstration of the relation soil-vegetation always mean highest and mean lowest groundwater levels are used (VAN DER SCHANS 1957, OTTO 1959, KRAAK 1974), but these proved to be insufficient to describe ground water characteristics of semi-natural communities (GROOTJANS 1980b). Apart from the height of water above soil surface the quality possibly plays an

Table 4. Soil spectra of the different plant communities of a lower course area of the Drentsche A. Percentage of correlation points where the community was present. –: absent, n = number of correlation points.

	Community of Carex hudsonii	Community of Glyceria maxima	Community of Carex disticha	Communities of Carex acuta or Carex aquatilis	Community of Phalaris arundinacea and Calamagrostis canescens	Community of Carex nigra	Community of Agrostis stolonifera	Community of Succisa pratensis and Carex panicea	Community of Holcus lanatus	Community of Festuca rubra and Agrostis tenuis	n
"Vliet" peat soil	83	40	–	8	5	–	–	–	–	–	24
"Vlier" peat soil	17	60	89	61	27	43	–	–	–	–	102
"Made" peat soil	–	–	11	22	46	5	27	–	15	–	86
"Broek" earth soil	–	–	–	4	11	43	–	22	7	–	33
"Moer" podzol soil	–	–	–	5	9	9	64	61	22	–	44
"Veld" podzol soil	–	–	–	–	2	–	9	17	56	100	38
n	12	5	9	76	126	21	11	18	41	8	327

important role. The community of *Carex nigra* and the variant with *Potentilla palustris* of the community of *Carex acuta* or *Carex aquatilis* (*table 3*) could be influenced by discharging rain water and seepage in contrast to the *Phragmitetea* communities which are influenced predominantly by eutrophic, silt containing brook water as depicted in *fig. 1* (cf. BALÁTOVA-TULÁČKOVÁ 1968). This seems in accordance with far lower "nitrogen figures" (ELLENBERG 1974) (indicating the occurrence of species in relation to the ammonia or nitrate supply) for *Parvocaricetea* species than for *Phragmitetea* species.

Starting from the soil units vegetation spectra have been worked out (*table 5*), showing only little relations at first sight. With respect to the unmanured situation, however, fairly good relations between "Vliet" peat soil and the community of *Carex hudsonii*, between "Vlier" peat soil and the communities of *Carex acuta* or *Carex aquatilis*, between "Broek" earth soil and the community of *Carex nigra* and, to a lesser extent, between "Moer" podzol soil and the community of *Succisa pratensis* and *Carex panicea* can be observed, which is in accordance with the soil spectra for each plant community (*table 4*). For the "Moer" podzol soil and the "Veld" podzol soil, relations with plant communities are obscured by earlier manuring. Moreover the community of *Holcus lanatus* probably is a transition due to the nature management practices (BAKKER 1976, 1980, OOMES 1977). The community of *Phalaris arundinacea* and/or *Calamagrostis canescens* is apparently indifferent with respect to the soil units. The area covered by this community increases, since SCHIMMEL (1955) does not mention it (cf. *table 3*). This could be due to a lowering of the summer ground water level during the last 25 years, caused by the construction of a deep drain ditch (80–100 cm below soil surface) for the adjacent land consolidation (*fig. 2*), followed by a change of groundwater type B into C (*fig. 4*) and a resulting decrease in the percentage of strict phreatophytes (*Table 2*). The occurrence of

Table 5. Vegetation spectra of the different soil units of a lower course area of the Drentsche A. Figures and symbols as in *table 4*.
In bold type: earlier manured; * both earlier manured and unmanured.

	"Vliet" peat soil	"Vlier" peat soil	"Made" peat soil	"Broek" earth soil	"Moer" podzol soil	"Veld" podzol soil	n
Community of Carex hudsonii	42	2	–	–	–	–	12
Community of Glyceria maxima	8	3	–	–	–	–	5
Community of Carex disticha	–	8	1	–	–	–	9
Communities of Carex acuta or Carex aquatilis	**25**	45	20	9	9	–	76
Community of Phalaris arundinacea and Calamagrostis canescens	25	**33**	**68***	**42**	**25**	8	126
Community of	–	9	1	28	5	–	21
Community of Agrostis stolonifera	–	–	3	–	**16**	3	11
Community of Succica pratensis and Carex panicea	–	–	–	12	25	8	18
Community of Holcus lanatus	–	–	7	9	**20**	**60**	41
Community of Festuca rubra and Agrostis tenuis	–	–	–	–	–	**21**	8
n	24	102	86	33	44	38	327

summer ground water levels below the lower limit of rust (*fig. 4*) also points to this direction. The communities of *Carex acuta* or *Carex aquatilis* can change into the community of *Phalaris arundinacea* and/or *Calamagrostis canescens* due to lowering of the summer ground water level (EVERTS & DE VRIES in prep.). The occurrence of the community of *Carex nigra* both at "Vlier" peat soils and "Broek" earth soils, can not be explained.

Summarizing it can be concluded that in the wettest areas fairly good relations can be found between plant communities and soil units; the hydrology being a master factor not only with respect to mean highest and mean lowest ground water level, but also regarding the height of inundation and water quality. In the drier areas little relations between plant communities and soil units can be found; plant communities appear to be determined by (i) earlier manuring, (ii) changes in the vegetation due to recent nature management practices and (iii) changes in the vegetation due to possible draining towards agricultural areas adjacent to the study area. The relation between plant communities and soil units apparently can be worked out better by detailed hydrological research and by describing plant communities at the level of subassociations and variants (NIE-

MANN 1973). The use of single values seems the next step (VAN HEUVELN 1980), but when used on their own, their interpretation is difficult, because the influence of a certain character (e.g. a single nutrient) depends on the combination with other characters (e.g. pH) (ZONNEVELD 1959). However, studying e.g. which ground water data represent the whole hydrology or which nitrogen determination represents the nitrogen supply to the plant communities is probably useful.

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