Vegetatio, 37, 3: 163–173, 1978

A VEGETATION MAP OF THE NETHERLANDS, BASED ON THE RELATIONSHIP BETWEEN ECOTOPES AND TYPES OF POTENTIAL NATURAL VEGETATION* **

A.H.P. STUMPEL & J.T.R. KALKHOVEN

Research Institute for Nature Management (RIN), Leersum, The Netherlands
with the co-operation of S.E. Stumpel-Rienks, Leersum, and E. van der Maarel, Division of Geobotany, University of Nijmegen

Keywords: Ecotope, Landscape ecology, Potential natural vegetation, Vegetation complex, Vegetation map, Vegetation series

Introduction

To adjust the physical planning in The Netherlands to new views of this time, including ecological views, the National Physical Planning Agency has started a study in process planning with the natural environment and human society as most important components. Within this framework two additional ecological studies were initiated:
a. The draft of a so-called general ecological model to be used in physical planning (cf. Van der Maarel & Vellema 1975, Van der Maarel 1977, Anon. 1977).
b. The set up of an 'Environmental Survey of The Netherlands' with the aim to typify and evaluate the Dutch natural environment.
This survey that has been finished now (Kalkhoven, Stumpel & Stumpel-Rienks 1976), is an example of the so-called landscape ecological studies, which have been initiated in many parts of our country (Van der Maarel & Stumpel 1975).

As it was impossible to obtain a complete survey of all occurring terrestrial biotic communities and the main species forming part of them in the two years of field work available, we had to confine ourselves almost entirely to a broad survey of the vegetation. The most important considerations to this restriction were on the one hand that vegetation is supposed to reflect the combined action of climate, relief, soil, water and the influence of animals and men, on the other hand that biotic communities are mainly determined by their vegetation, particularly its structure (cf. Westhoff 1955).

The vegetation was characterized in such a way that it was possible to construct a small-scale vegetation map. A scale 1: 200,000 has been chosen for this map because Dutch physical planning on a national level works on the same scale and because this scale leaves sufficient room to express the different characters of the Dutch landscape. With a predominantly agricultural landscape, so strongly scattered as the Dutch one, the actual vegetation is difficult to map on this small scale (cf. Küchler 1973). To solve this problem we have chosen for a method, in which the actual vegetation is described in relation to the potential natural vegetation (Tüxen 1956, Kalkhoven 1974, Stumpel 1974, cf. Westhoff & Van der Maarel 1973).

The vegetation map with explanatory text can be found in the final report of the survey project (Kalkhoven, Stumpel & Stumpel-Rienks 1976). In the present paper some starting points and the method of mapping are discussed.

Potential natural vegetation and vegetation series

For a good understanding of what a potential natural vegetation actually means, it is necessary to go a little further into the term 'natural vegetation'. This is the vegetation which directly relies on the environment of the site,

* Contribution to the Symposium on Plant Species and Plant Communities, held at Nijmegen, 11–12 November 1976, on the occasion of the 60th birthday of Professor Victor Westhoff.
** Nomenclature follows Heukels-van Ooststroom, Flora van Nederland, 18e druk, 1975, Wolters-Noordhoff, Groningen; nomenclature of syntaxa follows Westhoff & den Held (1969)

assuming that it has not been influenced by man (cf. Tüxen 1956). It is the kind of vegetation which develops entirely spontaneously where both the composition of the species and the arrangement of the growing plants are concerned; it is determined by climate, relief, soil character, water regime and the autochtonous fauna, but not by man and his (in)direct influences. When man's influence becomes noticeable, 'natural vegetation' cannot be spoken of anymore. In the Dutch cultural landscape human influence has continuously been exerted nearly everywhere for many centuries. The result is, that natural vegetation is hardly found in this country nowadays.

In relation to the degree of human influence, a number of substitute and companion communities exist in the landscape which, according to the amount of human impact, can be classified into various categories of naturalness. Usually we distinguish between natural, near-natural, semi-natural and hardly natural vegetation or landscape (Westhoff 1968, 1971). Van der Maarel (1975) suggested a six-category system based on Sukopp's (1972) hemerobiotic degrees: natural, near-natural, semi-natural, agricultural, near-cultural; cultural. These categories can be characterized by the spontaneousness of structure and floristic composition as well as the amount of alien species. If human influence would have gone, succession gets started towards the climax stages. This future climax is designated as potential natural vegetation. In view of the planological background of this study some restrictions have been added to the concept of potential natural vegetation. A first restriction concerns the factor time. In his definition of potential natural vegetation, Tüxen (1956) excluded any changes in time by indicating that it should be imagined that the final stage of succession is reached at once. If, however, final stages or interim-stages of succession are to be realized, this will take time. We therefore have coupled the attainment of a (provisional) final stage to a development period of 50 to 150 years because there will likely occur no climatic changes within that period. An additional advantage of taking only a relatively short time into consideration is the avoidance of all uncertenties about the long-term changes in the environment caused by vegetation itself, which we cannot (anymore) deduce from present-day climax vegetation (simply because we do not have such climax vegetation left for most of the forest regions). With this limitation, our concept of potential natural vegetation comes close to Gaussen's (1955) term 'plesioclimax', a developmental stage of succession reached within 100 years after man's disappearance. This needs not always to be the final climax. From a practical point of view it is mainly the direction in which a vegetation will develop, that matters. Our description implies, for instance, that the *Querco roboris-Betuletum* can be considered as a type of potential natural vegetation, though it is still uncertain whether this type of forest is a final stage of succession in our country or whether it will develop in the long run into a *Fago-Quercetum*. Something similar can be said of the *Stellario-Carpinetum* in the South of the province of Limburg, of which Van der Werf (in: Trautmann 1972) supposes that this will become ultimately a *Luzulo-Fagetum* whilst the present form is the result of human exploitation. We see this also as a rather long-term development. A second restriction concerns the extent to which human influence is excluded (Westhoff & Van der Maarel 1973). In the definition of potential natural vegetation only human impact is taken into account, resulting from activities directly affecting a certain site or its immediate surroundings. Such activities like manuring, sprinkling, cutting, mowing, burning and grazing can be stopped immediately and the effects can be turned slowly. However, during the last few centuries, man has also interfered with the landscape as a whole, which has altered the character of many sites irrevocably. For instance in the north-east and south-east of the country extensive bog areas occurred. Owing to reclamation their soil and water regime have completely and irreversibly changed. In these reclamation areas, bog can therefore no longer be considered the potential natural vegetation. Also in the many heath reclamation areas man has, by disturbing the upper soil layer and by manuring, changed the character of the site so much that this influence will continue to be reflected in the vegetation for at least the first 150 years.

Another influence which can hardly be repelled, is the establishment of self-rejuvenating exotic species, such as *Prunus serotina* and *Quercus rubra* in our deciduous woodlands (cf. Sissingh 1976, 1977).

Another form of influence, which may be considered of a permanent character and which will therefore also determine the potential natural vegetation, is the indirect large-scale impact following from 'the making of the Dutch landscape' (Lambert 1971). A large part of the west of The Netherlands lies below sea-level and is protected against the influence of the sea by dunes and dikes, combined with large-scale polder drainage. While estimating the climax vegetation in these areas, we must realize that drainage will not be stopped and that dikes will not be pierced.

In conclusion, the potential natural vegetation of a certain site is defined as the vegetation which would come into existence there within a period of 50 to 150 years when all

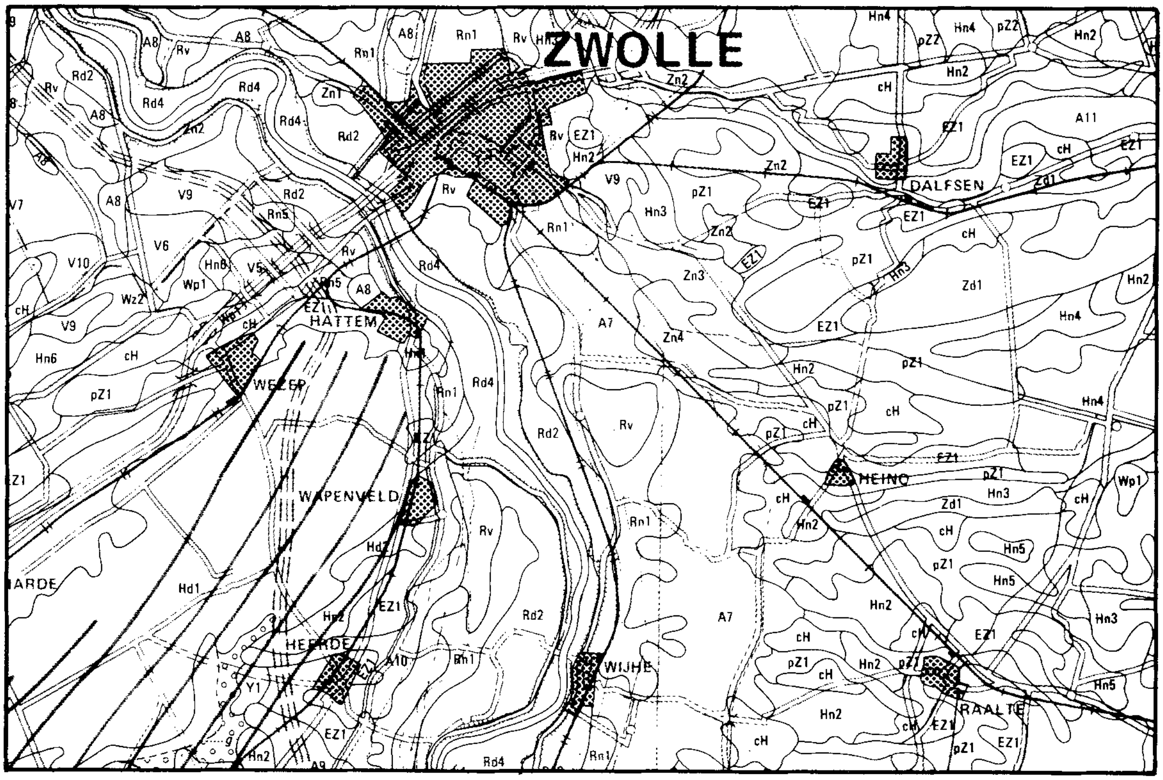

Fig. 1: Part of the soil map.

Legend, shortened, in classic terms:

V	peat soils	Zd	inland dune sand
EZ	plaggen soils	Zn	gley soils
cH	intergrade podzol soils – plaggen soils	Rv	alluvial gley soils overlying peat
Y	brown podzolic soils	Rn	alluvial gley soils
Hd	podzol soils	Rd	brown alluvial gley soils
Hn	hydromorphic podzol soils	A7	Rn + Zn
Wp	peaty podzol soils	A8	sandy 'wash' from scours
Wz	peaty gley soils	A9	EZ + cH
pZ	humic gley soils	A10	Zn + Wz

direct human influence upon the place itself or upon its immediate surroundings would stop.

The type of potential natural vegetation depends mainly on climate (temperature, light), relief, water (ground water, rain water) and nutrients. Data on water and nutrients, and, to a limited extent, on relief, can be taken from soil maps of The Netherlands, scale 1 : 50,000, which are based on the classification system by De Bakker & Schelling (1966). These maps were scaled down and generalized into scale 1 : 200,000. Kloosterhuis & Pape (1976) describe the method and its pedologic consequences. The map, obtained in this way, a fraction of which is shown in Fig. 1, has been used as the basis for mapping the potential natural vegetation.

The actual vegetation was recorded on 600 sites, using Tansley's (1965) 'codom' method, which were distributed representatively over the various soil types distinguished on the 1 : 200,000 soil maps. Relevés were comparatively large, covering at least 300 sqm and representing mainly woodlands, scrubs and semi-natural grasslands. The relevés were interpreted as syntaxonomical units of the Braun-Blanquet system according to Westhoff & Den Held (1969), using the association level as far as possible. The association *Luzulo-Quercetum*, distinguished in South-Limburg, has been adapted from Noirfalise & Sougnez (1956), who described this type from the Belgian Ardennes. At the site

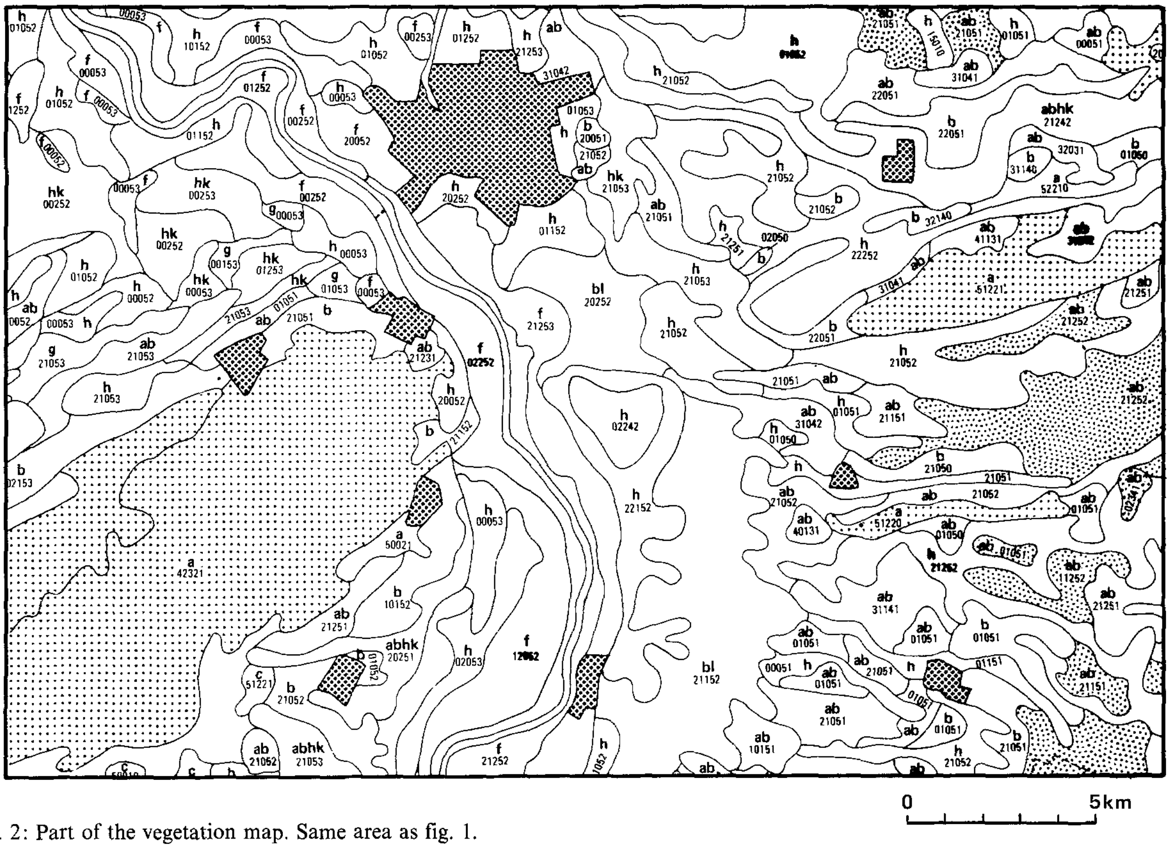

Fig. 2: Part of the vegetation map. Same area as fig. 1.

Legend:

a	*Querco roboris-Betuletum*
ab	Complex of *Querco roboris-Betuletum* and *Fago-Quercetum*
b	*Fago-Quercetum*
bl	Complex of *Fago-Quercetum* and *Alno-Padion*
c	*Fago-Quercetum*, type poor in species
f	*Fraxino-Ulmetum*
g	*Anthrisco-Fraxinetum*
h	*Circaeo-Alnion*
hk	Complex of *Circaeo-Alnion* and *Alnion glutinosae*
abhk	Complex of *Querco roboris-Betuletum*, *Fago-Quercetum*, *Circaeo-Alnion* and *Alnion glutinosae*

predominantly moist and wet vegetation types

predominantly dry vegetation types

urban area

for figures, see text and Fig. 6.

of each relevé a boring was carried out to a depth of 1.20 m, to determine the corresponding soil type and the ground water regime.

Generally a clear correlation between a certain type of vegetation and certain soil units was found. Soil water conditions appeared to play a major differentiating role here. On places with the same soil type but with differences in ground water regime (particularly fluctuations), different vegetation types may occur. On humic gley soil the *Circaeo-Alnion*, the *Fago-Quercetum*, or a complex of both types was found, dependent on the occurring ground water regime. Various soil types show regional variation, which has often been neglected because of the predominant use of the soil classification for agricultural purposes. This variation could be syntaxonomically interpreted, together with regional climatic differences, however only on levels below that of the association. They can not be recognized in a vegetation typology adapted to a mapping scale of 1 : 200,000.

Fig. 2 shows the potential natural vegetation of the area, the soil of which is shown in Fig. 1.

Each potential natural vegetation type is linked with a number of vegetation types which can be considered as substitute and companion communities. All types of vegetation which may develop on the same soil type and therefore belong to the same potential natural vegetation, can be classified into a series the elements of which are arranged according to the kind of human influence. Van Gils & Van der Maarel (in: Werkgroep G.R.I.M. 1974) made a start with the use of vegetation series. This method has been worked out and refined by the authors. Such a vegetation series is similar to, though still distinct from the 'Gesellschaftsring' (community ring) described by Schwickerath (1954, cf. Schmithüsen 1968, Seibert 1968), because 1. within the series not only the climax and substitute communities are involved, but also certain companion communities (forming 'vegetation complexes' with the former ones) that do not form a direct part of that succession series. 2. the idea of ring is not appropriate because it is uncertain that original climax from which the series started and potential natural vegetation to which it develops are identical (Seibert 1968, Werkgroep G.R.I.M. 1974).

The syntaxonomical units arrived in the way described above were first arranged into 38 vegetation complexes, each of them characterized by one or several mosaic-like occurring potential natural vegetation types. These complexes are the mapping units on the 1 : 200,000 vegetation map. The vegetation complexes were again arranged into seven main vegetation series. Within these main series a number of sub-series are distinguished which have the greater part of the units in common with the main series, but differ in their presumed final stage. The main series as well as the sub-series have been called after their final stage of development (= potential natural vegetation). The existing units have been classified both on the alliance and association level (see Fig. 3).

The following main series are distinguished:

I. *Quercion robori-petraeae* series
4 sub-series: a. *Querco roboris-Betuletum*
b. *Fago-Quercetum*
c. *Fago-Quercetum*, type poor in species
d. *Luzulo-Quercetum*

II. *Carpinion betuli* series
This alliance has only 1 association in The Netherlands:
a. *Stellario-Carpinetum*

III. *Alno-Padion* series
5 sub-series: a. *Ulmion carpinifoliae*
b. *Fraxino-Ulmetum*
c. *Anthrisco-Fraxinetum*
d. *Circaeo-Alnion*
e. *Macrophorbio-Alnetum*
a and d have been used in areas where the vegetation could not further be specified.

IV. *Alnion glutinosae* series
no sub-series

V. *Salicion albae* series
Only 1 association in The Netherlands:
a. *Salicetum albo-fragilis*

Fig. 3: Main vegetation series of the Quercion robori-petraeae (simplified from Kalkhoven, Stumpel & Stumpel-Rienks 1976).

A. Forest vegetation	B. Scrub vegetation	C. Semi-natural land vegetation	D. Hardly natural or non-natural land vegetation	E. Water and marsh vegetation
Quercion robori-petraeae	Lonicero-Rubion sylvatici	Nanocyperion flavescentis	Polygono-Chenopodion	Potamion graminei
Querco roboris-Betuletum	Dicrano-Juniperetum	Epilobion angustifolii	Sisymbrion	Littorellion uniflorae
Fago-Quercetum		Spergulo-Corynephorion	Polygono-Coronopion	Bidention
Fago-Quercetum, type poor in species		Thero-Airion	Arnoseridion	Cardaminion
Luzulo-Quercetum		Ericion tetralicis	Aphanion	
Dicrano-Pinion		Violion caninae	Lolio-Plantaginion	
		Calluno-Genistion pilosae	Agropyro-Rumicion crispi	
		Empetrion nigri	Arction	
			Aegopodion podagrariae	
			Arrhenatherion elatioris	

VI. Bog vegetation series

Bog is syntaxonomically characterized as a complex of *Erico-Sphagnion*, *Sphagnion fusci* and *Rhynchosporion albae*, sometimes in combination with *Betulion pubescentis*.

VII. Coastal dune vegetation series

Within the coastal dunes, two separate vegetation complexes are distinguished, namely those of the dunes rich in lime with the sub-series

a. *Convallario-Quercetum dunense*

b. *Crataego-Betuletum*

and those of the dunes poor in lime with a complex of *Empetrion nigri*, *Violo-Corynephoretum* and *Quercion robori-petraeae* (*Violo-Corynephoretum* is the only association of the *Galio-Koelerion* existing within this complex).

The plant communities of salt marshes have been added to this survey as an appendix. Environmental dynamics are so strong here that no higher stages of succession can develop and the proper idea of vegetation series cannot be applied here.

Within every vegetation series, the plant communities have subsequently been divided into five structural groups. This division is similar to that of Rey & Izard (1972). It also resembles the division into degrees of naturalness by Westhoff (1973). For the vegetation series I-V these groups include:

A. Forest vegetation

This group includes all the potential natural forest types. For practical reasons the planted woods have been also included in this group. Especially in the older plantations, the layers of shrubs and herbs correspond with those of the more natural forest.

B. Scrub vegetation

This group includes communities of scrubs, forest margins and hedges. Also single trees and shrubs along the roads and parcels are placed into this group.

C. Semi-natural land vegetation

Vegetation of this type shows a largely spontaneous species composition, but a structure determined by man through a constant or regurlaly returning human influence. Among these are heath lands, extensively used grasslands (particularly hay meadows) and the margin-communities of forests.

D. Hardly natural or non-natural land vegetation

This group includes the communities strongly influenced by man, such as fields, intensively used grasslands, ruderal places, disturbed margins of oligotrophic pools, etc.

E. Water and marsh vegetation.

These are the communities of open water, trembling-bog and the communities of the margins of oligotrophic to eutrophic waters. The swamp vegetations of the peat-moor and peat-bog landscape also belong to this group.

For the vegetation series VI and VII some deviations were necessary. The two first groups of the main series VI have been composed in a different way, namely: A. Bog vegetation, B. Forest and scrub vegetation. Group C of the main series VII deviates from the other series and is called Natural to semi-natural dwarf scrub and herb vegetations.

Fig. 3 gives an example of a simplified description of main series I. In our final report details are included on the correlated soil types and the distribution in The Netherlands of all vegetation complexes occurring in the series. Also guidelines for management are added, which are needed to have a type developed to a further stage of succession or to maintain a substitute community. The sequence from group A to D runs roughly parallel to the sequence in degrees of naturalness mentioned above.

With increasing human impact on vegetation the corresponding plant community types are less typical for particular series. A number of communities from group D are found in nearly all series. An example of this is the *Poo-Lolietum*, the cultivated grassland poor in species which is now found in large parts of The Netherlands on all kinds of soil. Within every group we find a variation in composition of the vegetation complex due to differences in microclimate and mineral richness of the soil. A subsequent classification can thus be made within every group e.g. according to the degree of oligotrophy or the degree of environmental dynamics. This has not yet been worked out further because, in view of the scale of this map, such a classification is not relevant.

Ecotope and ecotope complex

As mentioned above, plant communities in the landscape are found in spatially and functionally coherent vegetation complexes. Such a complex stands for a group of plant communities which can be deduced from one type of potential natural vegetation and which are connected with each other ecologically and physiognomically (cf. Hofmann 1965). Thus a vegetation complex is a characteristic and discernable part of the vegetation with an internal structure and an ecologically interpretable position in the landscape.

This conception of vegetation complex comes close to the 'ecological community complex' in Seibert's (1974) system. Since the term is used in different meanings (e.g. Oberdorfer 1964, Schmithüsen 1968, Tüxen 1973, see Seibert 1974 for a review) it may be useful to avoid the term and to use the term ecotope instead, as is frequently done in landscape ecology. The framework of landscape ecological concepts, mainly developed in physical geography, is appropriate indeed (cf. Van der Maarel & Stumpel 1975, Tjallingii 1976, Anon. 1977). Landscape ecology deals with 'geographic areas' which can be considered as the smallest landscape ecological units. These units are defined with help of environmental factors, such as climate, soil, water and relief, as well as vegetation and fauna, and they form a functional system: an ecosystem (cf. Neef 1970). In natural and near-natural situations, it is relatively difficult to distinguish one ecosystem from another; in the semi-natural and agricultural landscape, this is often less difficult because of the many sharp boundaries induced by man. For such easily recognizable sites with a particular ecosystem the term ecotope was suggested, probably independently by Tansley and Troll in 1938 (cf. Tansley 1965, Troll 1970, see also Schmithüsen 1948, Leser 1976). We consider an ecotope as an ecologically uniform part of the landscape, characterized by one or more interrelated ecosystems, i.e. the entire set of interrelated abiotic and biotic factors.

A vegetation complex, as described above, can be considered as the vegetational component of the local ecotope. It should be noted that the meaning of the term ecotope in the present scope deviates from the meaning attached to it by Whittaker, Levin & Root (1973) who used the term ecotope for the set of environmental factors determining the occurrence of an organism or a biotic community as a whole.

Stumpel-Rienks (1974) published a list of ecotopes on behalf of the environmental survey on which we report here. Most ecotopes of this list comprise a complex of plant communities (on the levels of association and sub- association).

For mapping landscape ecological units on small scales it will be necessary to distinguish complexes of landscape ecological units: ecotope complexes. Heathland and heathpool for instance, are separate ecotopes, but, on a map from scale 1 : 100,000, a heathland with a few scattered pools in it, will have to be represented as an ecotope complex. In the survey below, no further distinction is made between ecotopes and ecotope complexes.

In this stage of research we consider this approach appropriate on scale 1 : 200,000. Further work will have to be directed towards both analytical and synthetic research of landscape ecological units on larger scales.

The list of existing ecotopes and ecotope complexes in the landscape, has been obtained first of all by interpreting topographical maps on scale 1 : 25,000. This interpretation has been supplemented by national inventories of ecotopes which cannot be read off from these maps. They mostly concern rare, small remainders of semi-natural to near-natural ecosystems, such as wells, limestone grasslands, peat-moors etc. Fig. 4 gives an example of ecotopes and ecotope complexes in the mainly agricultural landscape of The Netherlands, arranged according to the groups classified above.

In order to obtain an idea about the distribution of the actual vegetation types, an estimate was made of the size of the areas (or length for linear elements) taken in by the five structural groups distinguished within every vegetation series. This was done for every area on the map and expressed in a code of five figures. A distinction was made between plane-, line- and point-shaped elements. Of course this distinction is entirely determined by the scale of the map. The presence figures are given according to the standards in Fig. 5. An example of the use of this code is given in Fig. 6.

Discussion

The vegetation map resulting from this study gives information about both the actual vegetation and the potential natural vegetation and it constitutes the first vegetation map covering the total surface of The Netherlands. The map is very global and when applying this method of mapping on a larger scale, one is faced with a number of problems.

One of the main problems is the great discrepancy between the number of legend units of the soil map (134) and those of the vegetation map (38). The soil classification used here is particularly useful for agricultural purposes, but less not relevant for correlation with vegetation data. A more detailed map of the potential natural vegetation requires further research on the relationship between soil and vegetation on the basis of an adapted soil classification.

As a result of the poverty in more or less natural woodland of the Dutch landscape, the potential natural vegetation of some areas cannot be classified below the level of alliance. The present woodland has been planted nearly always by man in recent times and is therefore not natural.

Fig. 4: Examples of ecotopes and ecotope complexes, characterized by their vegetation (as far as possible).

A. Forest vegetation	B. Scrub vegetation	C. Semi-natural land vegetation	D. Hardly natural or non-natural land vegetation	E. Water and marsh vegetation
dune forest springwood fenwood acidophilous deciduous forest basiphilous deciduous forest coniferous forest willow-coppice duck-decoy forest	wooded bank hedge dune-scrub complex plantations along roads and yards recent plantation of deciduous trees	dry heath wet heath shifting dunes river-dune old river-, sea- and polder-dike peat-ridge limestone grassland old unmanured hayfield river foreland grassland coastal ridge dune-slack dune grassland complex of dune-heath, -grassland and -valley	field orchard recent dike cultivated grassland peat-cutting area horticultural area factory area dry sand-excavation ruderal vegetation	spring heath-pool dike-burst pool duck-decoy pool former river-bed brook canal creek pond lake dune-lake fen complex marsh reed-swamp

Only in a few cases the older planted forests have been developed into a more natural vegetation. In large parts of The Netherlands (especially in the polders, except in the peat-polders) there has never been any woodland owing to the constant use as culture land. Nevertheless the spontaneous growth of trees and scrubs indicates the direction of development into a natural vegetation. For application on a larger scale, more research on this subject is necessary.

In this connection there is another problem concerning the relatively young age of a part of the soils in The Netherlands. A further development of the soil will change the soil characteristics and, as a result, the prediction on the potential natural vegetation. We confine ourselves to a period of 50–150 years and therefore exclude this problem, which is expected to be a longer term development.

The influence of ground water fluctuations on vegetation is still not known in detail. A global classification of ground water regimes has been applied for the legend of the soil maps, but its relevance for vegetation is still uncertain. Recent ground water lowering will influence the site and hence the vegetation so much, that vegetation types from another series can develop, and another type of potential natural vegetation will arise. The developing communities from that vegetation series can likely be recognized within a period of 50 years.

As mentioned earlier, there are regional differences within the vegetation types that manifest themselves on a level lower than that of associations. Well-known examples are the plant communities of fields, moist oligotrophic grasslands and acidiphilous deciduous forests. They are worth being mapped on a larger scale.

The ecotopes are listed as a survey of the main types of landscape ecological units and can be used as a general basis for an evaluation of the natural environment, as is done in our project by estimating the national significance of each ecotope. Still further research is necessary and will be carried out by the authors in characterizing ecotopes in a more inductive way. It should be noted that a lot of our ecotopes are typical for the Dutch landscape and hence difficult to compare with situations elsewhere, even in Northwestern Europe. For use on local maps, these ecotopes can be described more specifically. Especially the ecotopes of the various aquatic systems, so typical for The Netherlands, are to be characterized in a more ecological way.

The various ecotopes as distinguished in this study can be considered as basic landscape ecological units. A more complete ecological interpretation of such units may be obtained on the basis of phytosociological relevés, and subsequent analyses of the respective animal communities. These data have to be integrated into units which represent ecosystems or their complexes. However, much basic

Fig. 5.: Code for the occurrence of the ecotope groups per map area.

plane-shaped elements	>75% of the total surface	5
	50-75%	4
	25-50%	3
	<25%	2
	< 5%: see point-shaped elements	
line-shaped elements	very many	3
	rather many	2
	few	1
point-shaped elements	many	2
	few	1

The categories very many, many, rather many and few are specified as followes:

for hedges and brushwood	>1500 m per km^2	3
	800-1500 m per km^2	2
	< 800 m per km^2	1
for ditches and little waters	>8 km per km^2	3
	<8 km per km^2 + minimal 3 smaller pools	3
	2-8 km per km^2	2
	<2 km per km^2	1
for groves, heaths and small pools	>5 per km^2	2
	<5 per km^2	1

When a group is not represented, the figure 0 is given.

research will be necessary on the relationship between vegetation and fauna before interpretations on the level of cenoses are possible.

As a derivation from our vegetation map, an ecological evaluation is made, first of all meant as a general basis for the judgement of the various impacts on the natural environment, resulting from developments in physical planning (cf. Van der Maarel & Vellema 1975, Van der Maarel 1978). Details of this evaluation are also presented in our final report (Kalkhoven, Stumpel & Stumpel-Rienks 1976).

A further application of the vegetation map is an outline of the perspectives for the development of vegetation complexes within certain ecotopes and ecotope complexes, in order to increase their ecological quality. These data may become important in certain areas where nature management techniques are applied, in order to start a development aiming at the promotion of natural elements above agricultural and civil interests.

Summary

The method of mapping the vegetation on scale 1 : 200,000 and the starting points in relation to the potential natural vegetation and ecotopes, are discussed.

In view of the planological background of this study, some restrictions have been added to the concept of potential natural vegetation, concerning the period of development and the human influence.

The relationship between soil, ground water and vegetation was studied, which resulted in the map of the potential natural vegetation.

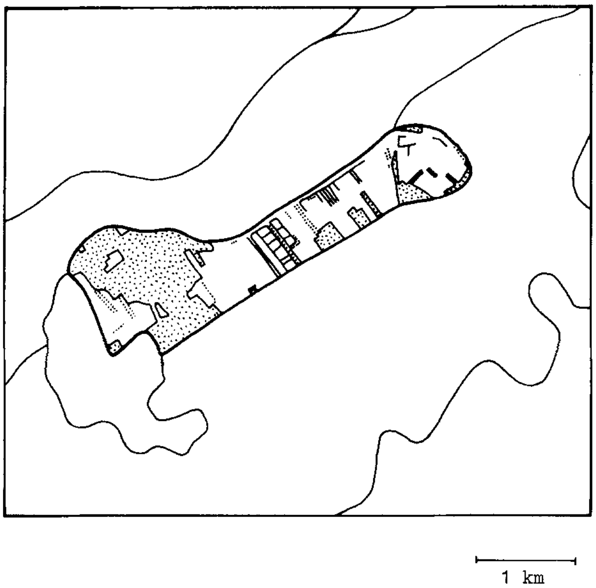

Fig. 6.: Example of the use of the ecotope occurrence code in one area on the vegetation map, in which the ecotopes are drawn in.

Legend for example area:

forest

wooded bank and single trees

ditches

fields and cultivated grassland

code: 31042
soil: hydromorphic podzol soil
potential natural vegetation: Complex of *Querco roboris-Betuletum* and *Fago-Quercetum*

In this case the code means:

3....	25–50 % oak and coniferous forest
.1...	few banks of oak coppice
..0..	no heath
...4.	50–75 % cultivated land
....2	a number of ditches

N.B. Another area may have the same code, but a different potential natural vegetation. In that case the structural groups are represented by other vegetation types!

Each type of potential natural vegetation stands for a series of vegetation types on the same site. Seven main series, with a number of sub-series are distinguished. Within each vegetation series the plant communities have been spread over five groups, according to their structure and naturalness.

Ecotopes and ecotope complexes are considered as landscape ecological units. A list of ecotopes was obtained by interpreting topographical maps and by inventory data.

The actual vegetation was mapped by estimating the size of the ecotopes within the separate areas. It was expressed in a five figure code for the five groups from the vegetation series. The information on potential natural vegetation and ecotopes is combined into the vegetation map of The Netherlands.

Interpretation problems, some of them specific for The Netherlands, are discussed and some remarks are made on the necessity of further research.

References

Anonymus, 1977. Samenvatting Globaal Ecologisch Model. Summary General Ecological Model. Part 3 of the Series General Physical Planning Outline, Ministry of Housing and Physical Planning, The Hague, 42 pp.

Bakker, H. de & Schelling, J. 1966. Systeem van bodemclassificatie voor Nederland. Soil Survey Institute, Wageningen, 217 pp + bijl.

Gaussen, H. 1955. Rapport général sur la cartographie écologique. Ann. Biol. 31: 221–231.

Hofmann, G. 1965. Über Vegetationskomplexe unter besonderer Berücksichtigung der Trockenwaldkomplexe. Feddes Repert. Beih. 142: 216–222.

Kalkhoven, J.T.R. 1974, Eine vorläufige Übersicht der potentiell-natürlichen Pflanzengesellschaften der Niederlande und der wichtigsten von denen abgeleiteten Vegetationskomplexe und Vegetationsreihen. Paper International Symposium 'Landschaftsgliederung mit Hilfe der Vegetation', Rinteln. (in press).

Kalkhoven, J.T.R., Stumpel, J.T.R., & Stumpel-Rienks, S.E. 1976. Landelijke Milieukartering. Environmental Survey of The Netherlands, a landscape ecological survey of the natural environment in The Netherlands for physical planning on national level. Staatsuitgeverij, The Hague, 141 pp + bijl.

Kloosterhuis, J.L. & Pape, J.C. 1976. Toelichting bij de bodemkaart van Nederland, schaal 1: 200 000, ten behoeve van de Landelijke Milieukartering. Report Nr. 1285 Soil Survey Institute, Wageningen, 85 pp.

Küchler, A.W. 1973. Problems in classifying and mapping vegetation for ecological regionalization. Ecology 54 (3): 512–523.

Lambert, A.M. 1971. The Making of the Dutch Landscape. Seminar Press Ltd, London, XII + 412 pp.

Leser, H. 1976. Landschaftsökologie. Ulmer, Stuttgart, 432 pp.

Maarel, E. van der 1975. Man-made natural ecosystems in environmental management and planning. In: W.H. van Dobben & R.H.Lowe-McConnell (eds): Unifying concepts in ecology, p. 263–274. Junk, The Hague/Pudoc, Wageningen.

Maarel, E. van der 1978. Ecological principles for physical planning. In: M.W.Holdgate & M.J. Woodman (eds): The breakdown and restoration of ecosystems. Plenum, New-York, p. 413–450.

Maarel, E. van der & Stumpel, A.H.P. 1975. Landschaftsökologische Kartierung und Bewertung in den Niederlanden. Verh. Ges. Ökologie, Erlangen 1974 p. 231–240. Junk, The Hague.
Maarel, E. van der & Vellema, K. 1975. Towards an ecological model for physical planning in the Netherlands. In: Ecological aspects of economic development planning. Report Seminar U.N. Economic Commission for Europe, Rotterdam, p. 128–143. E.C.E., Geneva.
Neef, E. 1970. Zu einigen Begriffen der Ökologie. Arch. Naturschutz und Landschaftsforschung 10: 233–240.
Noirfalise, A. & Sougnez, N. 1956. Les Chênaies de l'Ardenne verviétoise. Pedologie 6: 119–143.
Oberdorfer, E. 1964. Der insubrische Vegetationskomplex, seine Struktur und Abgrenzung gegen die submediterrane Vegetation in Oberitalien und in der Südschweiz. Beitr. Naturk. Forsch. SW. Deutschl. 23: 141–187.
Rey, P. & Izard, M. 1972. Notions générales d'utilisation des cartes de la végétation. 2nd edition. Centre national de la recherchescientifique, Paris 26 pp.
Schmithüsen, J. 1948. 'Fliesengefüge der Landschaft' und 'Ökotop'. Berichte Deutsch. Landesk. 5: 74–83.
Schmithüsen, J. 1968. Allgemeine Vegetationsgeographie. 3. Auflage. Walter de Gruyter, Berlin, XXIII + 463 pp.
Schwickerath, M. 1954. & Die Landschaft und ihre Wandlung auf geobotanischer und geographischer Grundlage entwickelt und erläutert im Bereich des Messtischblattes Stolberg. R. Georgi, Aachen, 118 pp.
Seibert, P. 1968. Gesellschaftsring und Gesellschaftskomplex in der Landschaftsgliederung. In: R. Tüxen (ed): Pflanzensoziologie und Landschaftsökologie, Stolzenau 1963, p. 48–60. Junk, The Hague.
Seibert, P. 1974. Die Rolle des Massstabes bei der Abgrenzung von Vegetations-einheiten. In: R. Tüxen (ed): Tatsachen und Probleme der Grenzen in der Vegetation, Rinteln, p. 103–118. J. Cramer Verlag, Lehre.
Sissingh, G. 1976. Betekenis en gevolgen van menselijke ingrepen voor de samenstelling en instandhouding van bossen, speciaal onder Nederlandse omstandigheden. Ned. Bosbouw Tijdschr. 48 (3): 86–96.
Sissingh, G. 1977. Optimal woodland development on sandy soils in the Netherlands. Vegetatio 35: 187–191.
Stumpel, A.H.P. 1974. Kartierung landschaftsökologischer Einheiten mit Hilfe von Vegetationskomplexen, Vegetationsreihen und Ergebnisse von Bodenkartierungen. Paper International Symposium 'Landschaftsgliederung mit Hilfe der Vegetation', Rinteln. (in press).
Stumpel-Rienks, S.E. 1974. De botanische waardering van ecotopen als bijdrage tot een globale waardering van het natuurlijk milieu. Gorteria 7: 91–98.
Sukopp, H. 1972. Wandel von Flora und Vegetation in Mitteleuropa unter dem Einfluss des Menschen. Ber. Landwirtschaft 50: 112–139.
Tansley, A.G. 1965. The British Islands and their Vegetation. 4. Imp. University Press, Cambridge, 930 pp.
Tjallingii, S.P. 1976. Enkele opmerkingen over het begrip ecotoop. Gorteria 8: 31–35.
Trautmann, W. (1972): Erläuterungen zur Karte 'Vegetation' (potentielle natürliche Vegetation). Deutscher Planungsatlas Band I: Nordrhein-Westfalen. Lieferung 3. Gebrüder Jänecke Verlag, Hannover.
Troll, C. 1970. Landschaftsökologie (Geoecology) und Biocoenologie. Eine terminologische Studie. Rev. Roum. Géol., Géophys. et Géogr., Sér. Géogr. 14 (1): 9–18.
Tüxen, R. 1956. Die heutige potentielle natürliche Vegetation als Gegenstand der Vegetationskartierung. Angewandte Pflanzensoziologie 13: 5–42.
Tüxen, R. 1973. Vorschlag zur Aufnahme von Gesellschaftskomplexen in potentiell natürlichen Vegetationsgebieten. Acta Bot. Acad. Scient. Hungar. 19: 379–384.
Werkgroep G.R.I.M. 1974. Landschapsecologische basisstudie voor het streekplangebied Midden-Gelderland. Provinciale Planologische Dienst, Arnhem, 156 pp.
Westhoff, V. 1955. Samenhang tussen vegetatie en milieu, in het bijzonder de bodem. TNO-nieuws 106: 9–16.
Westhoff, V. 1968. Die 'ausgeräumte' Landschaft, Biologische Verarmung und Bereicherung der Kulturlandschaften. In: K. Buchwald & W. Engelhardt (eds): Handbuch für Landschaftspflege und Naturschutz, Band 2, p. 1–10. Bayerischer Landwirtschaftsverlag München.
Westhoff, V. 1971. The dynamic structure of plant communities in relation to the objectives of conservation. In: E. Duffey & A.S. Watt (eds): The scientific management of animal and plant communities for conservation, p. 3–14. Blackwell, Oxford.
Westhoff, V. 1973. Vegetatie-ontwikkeling. In: A.D. Voûte & J. F. de Vries Broekman (eds): Natuurbeheer in Nederland, p. 46–54, 180–189. Samsom, Alphen aan de Rijn.
Westhoff, V. & Held, A.J. den 1969. Plantengemeenschappen in Nederland. Thieme, Zutphen, 324 pp.
Westhoff, V. & Maarel, E. van der (1973): The Braun-Blanquet Approach. In: R.H. Whittaker (ed): Handbook of Vegetation Science, Vol. 5, p. 617–726. Junk, The Hague.
Whittaker, R.H., Levin, S.A. & Root, R.B. (1973): Niche, habitat and ecotope. The American Naturalist 107: 321–338.

Accepted 3 January 1978