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ON THE THEORETICAL CONCEPT OF THE POTENTIAL NATURAL VEGETATION AND PROPOSALS FOR AN UP-TO-DATE MODIFICATION

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Abstract: In the extent to which it is used, the concept of the potential natural vegetation (PNV) is one of the most successful novelties in vegetation science over the last decades. However, previous applications of the concept have shown that the theoretical principles were used inconsistently or interpreted in an incorrect sense. The present problems in application (which become evident when visualizing historical aspects of the concept) mainly result from (a) inconsistent treatment of the construction criteria; (b) failure to distinguish between the "potential natural vegetation", the "reconstructed natural vegetation" and the vegetation developing during succession, (c) the lack of a precise definition for reference terms to construct potential natural vegetation (e.g. treating reversible vs. irreversible changes of vegetation). For a sensible application of the concept it is suggested (a) to construct the potential natural vegetation on the basis of natural site conditions as well as permanently effective site changes as a consequence of human impact, (b) to consider the PNV to be in balance with all site conditions taken as basis for its construction. In practice, however, the construction basis may also derive from a particular question underlying the making of a PNV-map. A suggestion for a re-definition of the term "potential natural vegetation" as well as a key for PNV-mapping (valid for landscapes of Northern Germany) are given.

INTRODUCTION

Nowhere in Central Europe has the natural character of the primeval landscape been preserved, due to human activity. The forests which formerly covered a large part of Central Europe were replaced by meadows or arable land with increasing human settlement. According to the manifold ways in which the land was used by man, a mosaic of very different plant communities developed.

The existing ("real") vegetation can be compared with a "potential natural vegetation" (TÜXEN 1956; abbr. as PNV) construed as what the vegetation might be if human impact on it is prevented. The purpose of this paper is to describe the biotic potential of a site by means of vegetation units (DIERSCHKE 1974: 305, DIERSSEN 1990: 15, FISCHER 1992: 39-40). The terms of reference are the existing site conditions, partly natural, partly created by man.

Although the concept has generally been accepted, its application and interpretation have shown that theoretical principles were used inconsistently or interpreted in a contradictory sense. The present study tries to explain and to assess the problems involved. Proposals are

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made suggesting an up-to-date modification and a re-definition of the term "potential natural vegetation". In addition, problems and limits in construction and interpretation of PNV-maps are demonstrated.

HISTORICAL ASPECTS

Current problems in the application of the PNV-concept become more evident when the historical aspects are visualized. Therefore a brief survey to this topic is given in this chapter. For a more detailed description see MORAVEC (1969: 138-145, 1979: 163-165).

Already at the turn of the century biologists and vegetation geographers considered what kind of biotic potential (e.g. possible growth of plants) could be assigned to a particular site. At the root of this question was the observation that the vegetation of a site, observed over a longer period, did not stay unaltered, but was subject to certain changes (cf. KERNER VON MARILAUN 1863, HULT 1881, WARMING 1896, MOSS 1910). It was realized that vegetation development led towards a definable plant community which, compared to the previous "starting and transitional associations" (WARMING 1896: 361), appeared to be relatively stable. Even over longer periods it showed only slight alterations in species composition. Later on these "end-communities" were characterized by the terms "chief association" (MOSS 1910: 26-28), "climatic formation" (COWLES 1910, cited from MOSS 1910: 36), "climax formation" (WARMING & GRAEBNER 1918: 335, 357) or "climax community" (SCHMITHÜSEN 1968: 239, ELLENBERG 1978: 73, cf. also examples in WHITTAKER 1962: 71). Thus a development of the climax theory was possible alongside succession theory.

With the "monoclimax" hypothesis, mainly worked out by COWLES, COOPER, and CLEMENTS (cf. e.g. CLEMENTS 1916 and 1936), the term "climax" found a new interpretation which was vigorously discussed. The supporters of this new interpretation felt that "in an area with a uniform climate ... the natural vegetation development in combination with a soil development that is likewise dependent upon the climate and determined by the vegetation [leads] towards an equalization of the original site differences and thus finally to the same plant community as the climatically conditioned final link of the vegetation development (climax) within the total territory of the climatic area" (SCHMITHÜSEN 1968: 280).

Most phytosociologists working in Europe were sceptical about CLEMENTS' idea. His monoclimax theory was generally rejected (cf. GAMS 1918, DU RIETZ 1919, 1921: 97, ROMELL 1920, TANSLEY 1920, DOMIN 1923, SCHMITHÜSEN 1950, 1968: 280, WHITTAKER 1953, MORAVEC 1969: 141-145). Critics objected that "particular site conditions" should always be considered "with regard to site specific interrelations and thus to its changeability which depends on the total of the remaining factors" (SCHMITHÜSEN 1950: 176). Consequently the importance of a single factor was estimated as secondary - contrary to the evaluation of the climate in the monoclimax theory. Consequently, TÜXEN & DIEMONT (1937) suggested that in dependency on soil or exposure several climax communities may be assigned to one area. Accordingly they established the terms "climax group" and "climax swarm". SCHMITHÜSEN (1950: 176) considered this approach as a necessary pendant to the CLEMENTS' theory: if the climax theory was to be applied sensibly in the future, the monoclimax-concept, which in his opinion was not to the point, had to make room for a "polyclimax theory" or "polyclimax-approach" (cf. also BRAUN-BLANQUET 1964: 641, WHITTAKER 1962: 52).

Differing definitions and interpretations of the climax term complicated the future application of the climax theory. WHITTAKER (1962: 71-72) emphasizes that the term "climax" has been used with differing connotations (cf. "ambiguity of the concept of climax" in MORAVEC 1969: 142). According to BRAUN-BLANQUET (1964: 641) there exist no less than 35 terms with the designation "climax". So it is understandable that "no problem has been discussed that much and that vigorously amongst ... geobotanists as has the climax term" (BRAUN-BLANQUET 1964: 639).

The precise definition of the dimension of time in which a particular climax vegetation can develop at a site remained a major problem of the climax concept, when climax is defined as a final stage of vegetation development. In this case it is impossible to give a qualitative and quantitative estimation of changes taking place successively at a site (cf. GIGON 1975) as a presupposition for the hypothetical construction of a climax communitiy without taking into account a time component.

According to SCHMITHÜSEN (1968: 281) a site's biotic potential appears relevant only if formulated with reference to the present time. Therefore it is of major interest to know which biotic potential an area of reference possesses under its present site conditions (TÜXEN 1956: 9). These considerations moved TÜXEN to introduce a new concept in vegetation science: the potential natural vegetation ought to express the biotic potential of a reference area - with regard to all site factors relevant for vegetation development and by means of vegetation units (application of the floristic phytosociological principle in the classification of vegetation and definition of mapping units; cf. MORAVEC 1979: 165). Thus the PNV concept follows a purpose comparable to that of the climax theory. Its actual approach, however, is new and characteristic: as a basis of reference for construction of the potential natural vegetation only actually existing (or imaginarily postulated) site conditions are taken into account. The "time" problem of the climax theory is thus evaded, its application with regard to the question formulated above is irrelevant (cf. DIERSCHKE 1974: 305, 1994: 444, DIERSSEN 1990: 115).

The historical development of the PNV concept as explained above, throws light on problems which have arisen from the - not always accurate and theoretically logical - application of this concept during the last decades. They will illustrated in the following section.

CRITICAL REFLECTIONS ON THE THEORETICAL CONCEPT OF POTENTIAL NATURAL VEGETATION

According to TÜXEN (1956: 5) the term "potential natural vegetation" is defined as an "imagined natural state of vegetation ... that could be outlined for the present time or for a certain earlier period, if human influence on vegetation was removed - the remaining conditions of life presently existing or having existed during those periods still being valid - and the natural vegetation was imagined as switched into the new balance within a split second ... to exclude the possible effects of climatic changes and the consequences thereof".

The theoretical concept of PNV based on this definition and employed in its actual form, however, requires a critical analysis in various respects because of the following considerations (cf. KOWARIK 1987: 54-55, HÄRDTLE 1989: 7-8):

(a) Constructing the PNV, many authors diverge from TÜXEN's definition without explicitly mentioning or giving reasons for this anywhere in the text. Thus the term "potential natural vegetation" has been interpreted in different ways and distorted. Moreover, many publications do not consistently take into account the fundamentals of construction as determined by TÜXEN's definition.

(b) Although TÜXEN's PNV-concept follows an actualistic approach, thus avoiding the climax theory problem of "time" (cf. prev. chap.), its definition admits a certain scope of interpretation with regard to determination of the terms of reference for constructing PNV (e.g. an unequivocal and comprehensible determination of the site conditions which are to be taken as a basis for the PNV-construction, cannot be derived from the definition).

(c) Compared to the 1950s (introduction of the PNV-concept by TÜXEN), environmental situations today have changed (e.g. effects of immission or the depression of soil water levels). Nevertheless, the existing demand for PNV-maps that can be universally employed at present (e.g. as a source of information for planning in nature conservation and landscape protection) allows us to discuss a modification of the original concept in accordance with present ecological conditions.

Item (a) illustrates the need to consider fundamental principles (prevention of methodical mistakes). Items (b) and (c) argue for a comprehensive (and if necessary new) definition of the construction bases for PNV-maps. This poses the questions:

- whether a time dimension should be considered in the construction of the PNV and
- to what extent and which man-made site conditions and continuously influenced environmental conditions are to be considered in the construction.

Inconsistent treatment of the construction criteria

A frequent methodical mistake is the inconsistent treatment of construction criteria expounded clearly in the theoretical concept, e.g. the lack of consideration of irreversible anthropogenous site changes in the construction of the PNV. This mistake may be illustrated by an example: The PNV-map of TRAUTMANN (1966) reveals forest communities as PNV-units on sealed areas within the town centre of Minden. These communities, however, do not comply with PNV-units in the sense of TÜXEN's definition, as their construction does not take anthropogenous site changes into consideration (in the given example e.g. the sealing of soils). As a consequence, no statements on the ecology of these sites can be derived from the given PNV-units; these cannot be considered as communities of the PNV, but represent a "reconstructed natural vegetation" of these sites (for the concept of "reconstructed natural vegetation" cf. NEUHÄUSL 1963, 1968, 1984, MIKYŠKA et al. 1968, MORAVEC et al. 1991). To avoid such inconsistencies it would be more appropriate to accept "blank spots" on PNV-maps (cf. KOWARIK 1987: 53) or to mark these as areas with great anthropogenic alterations (particularly as PNV-mapping on these sites is of secondary interest regarding the objective of PNV-maps).

Effect of time

As to what extent a time dimension is to be taken into account in PNV-construction, TÜXEN (1956: 5) says: the potential natural vegetation is to be "imagined as switched into the new balance within a split second". TRAUTMANN (1966: 14) agrees with this in an article on the bases of PNV-mapping: "The potential natural vegetation does not develop slowly, say in the course of a succession lasting for centuries, out of the real vegetation. It rather has to be imagined as coming into existence at once. Consequently, every site has its own particular potential natural vegetation which changes as soon as there is a change to the site - due to nature or due to human impact" (cf. also TÜXEN 1963: 140, NEUHÄUSL 1975: 118, 1984: 206, HOHENESTER 1978: 3, WELSS 1985: 2, HÄRDTLE 1989: 9). Therefore site changes that might take place successively must be excluded from the basis of reference for PNV-construction; a time factor, then, is not to be considered in the construction of PNV. That means: PNV is not the anticipated "end-stadium" of a succession actually developing in space and time (an erroneous supposition which can be explained from the historical development of the PNV-concept; cf. e.g. SCHMITHÜSEN 1968: 239, STUMPEL & KALKHOVEN 1978: 164), but exclusively an abstract and hypothetical state of vegetation. "End communities" as final links of a succession can only be compared to units of the potential natural vegetation with regard to one characteristic: both represent a stable state of vegetation showing a certain stage of development at a particular site.

It is far more difficult to define precisely to what extent former and actual anthropogenous influence upon a site is to be considered in the construction of PNV. On this point the definition given by TÜXEN (1956) admits of a wide interpretation. Clearly excluded from PNV-construction, however, is the direct (immediately effective) influence upon a reference area (i.e. modes of use such as mowing, grazing or fertilization). Its effects are to be excluded from the construction for the present and for the future. The consideration of obviously irreversible site changes due to man (such as peat digging in bogs, anthropogenous forming of podsols by heath culture, sealing of the ground, deposition of soil material) has been unequivocally established by TÜXEN's definition (cf. also TÜXEN 1956: 6-7, TRAUTMANN 1966: 37-39, NEUHÄUSL 1975: 120-122, 1984: 206-208, BOHN 1981: 7).

To estimate site changes relevant for the construction of PNV, irreversible changes may be compared to reversible ones. According to NEUHÄUSL (1975: 121, 1984: 206-207), the latter should not be taken into account in PNV-construction. Nevertheless, a theoretically clear distinction between irreversible and reversible changes (i.e. according to NEUHÄUSL between changes to be and not to be considered) is difficult. On the one hand, the recording of site changes on the accuracy with which a site has been observed. On the other hand, the borderline reversible-irreversible is shifted and made difficult to determine by the degree of change and how far a site is capable of regeneration. To explain this by an example: some anthropogenous impact upon a site may lose its influence after some days or weeks whereas another may still have an effect upon vegetation development at this site decades or centuries later.

However, TRAUTMANN's demand (1966: 17) to "express a site's actual biotic potential" by means of the potential natural vegetation implies taking into account even such site changes in the construction which are reversible only over a long period (e.g. changes in quality of soils, cf. BLUME & SUKOPP 1976). This demand is reasonable, because to neglect changes that are distinctive of site qualities in a cultivated landscape the actual concern of the PNV would be lost and future site characteristics would be taken as basis of construction.

So the main problem is to find a reasonable dividing line between site changes that are to be considered and site changes that can be neglected for the construction of PNV. In order to be able to disregard short-term effective anthropogenous site changes for PNV-construction by definition, the term "balance" (existing between a PNV-unit and its site; cf. definitions in TÜXEN 1956: 5, TRAUTMANN 1966: 14, NEUHÄUSL 1984: 206) must be defined more precisely.

In viewing this balance as a homeostatic state (cf. REMMERT 1990: 112) based on a functional integration of PNV and its site, a well-poised material balance within this (imaginarily constructed) ecosystem must be given, i.e. a constancy of site parameters typical for this system (cf. JENNY 1961). For example, the washing out of nutrients beyond the limits typical for the (constructed) ecosystem is to be excluded [and as a consequence "adaptive changes" (MORAVEC 1969: 161) of the plant community], because with regard to nutrient balance an equilibrium would not be achieved (the extent of nutrient depletion exceeds the natural process of nutrient depletion with regard to soil development). To put it another way: a PNV-unit is wrongly constructed for a particular site, if the nutrient depletion at this site goes beyond the limits typical for the constructed system. On this basis short-term effective anthropogenous site changes must be disregarded in PNV-construction (e.g. anthropogenously supplied nutrients which are washed out of sandy soil relatively soon).

Man made changes to environment

How to estimate reversible but lasting environmental changes affecting a reference area from the outside (e.g. immission stress, extensive depression of the ground water level, climatic changes near cities) in the construction of PNV cannot be answered by the PNV-definition given by TÜXEN. In this respect the definition needs amplification as to its content. A possible solution is offered in the approach suggested by NEUHÄUSL (1980, 1984), which was integrated into the PNV-concept by KOWARIK (1987): NEUHÄUSL compares the existing concept of PNV to the concept of an "environmental natural vegetation" (= the natural vegetation in accord with the anthropogenous environment sensu NEUHÄUSL 1980). Similar to PNV, the "environmental natural vegetation" is in balance with all site conditions as well as irreversible site changes caused by man. In addition, however, its construction takes into account long-lasting reversible as well as regionally effective anthropogenous environmental changes to a reference area such as soil contamination, regionally effective air pollution or depression of ground water level (NEUHÄUSL 1984: 206).

With these considerations, NEUHÄUSL tries to solve the problem of PNV-mapping in areas which have undergone lasting changes in site conditions or which have suffered regional effective pollution. For example, the construction of a PNV-map for such areas while neglecting the anthropogenous impact would create a purely theoretical idea of vegetation no longer employable as a planning basis and reflecting the PNV for a post-cultural landscape completely deserted by man. Concerning the application of PNV-maps (representation of the actual biotic potential of sites, interpretation with regard to landscape characterization, use as a basis for planning nature protection and management), it is useful to integrate NEUHÄUSL's approach in a further developed PNV-concept, which can be interpreted to serve present demands.

In view of the problems discussed in the preceding section and the propositions made for an up-to-date modification, the term "potential natural vegetation" may be defined as follows:

The potential natural vegetation is an abstract and hypothetical state of vegetation, which is to be imagined as coming into existence within a split second. The potential natural vegetation is in balance with the site conditions taken as the basis for its construction. This means that the (constructed) ecosystem shows a homeostatic state. In addition to natural site conditions, permanently effective site changes are to be considered as construction bases for the PNV. Furthermore, lasting environmental factors affecting a reference area from outside (e.g. immission, groundwater depression) are to be taken into account for PNV-construction. Present and future human influence within the reference area and the effects of site changes that would be compensated for by the existence of the PNV are to be excluded from the construction.

PROBLEMS AND LIMITS IN CONSTRUCTION AND INTERPRETATION OF MAPS OF THE POTENTIAL NATURAL VEGETATION

As mentioned in the preceding chapter, a clear theoretical distinction between irreversible and reversible site changes is not the only problem. It is equally difficult to give a general and comprehensible definition for those reversible changes to be considered and those that are to be disregarded. On this point, the definition suggested above allows for margins of interpretation as well. In practice, however, the site qualities which should be taken as the basis for determining PNV often cannot be derived from a generally formulated definition. They rather result from the formulation of questions underlying the making of PNV-maps. For example, the PNV-units for a particular site will differ according to whether a considerably depressed ground water level is assumed as characteristic or whether one is interested in the PNV after a rise of the ground water level caused by altered drainage. From a comparison and estimation of the possible PNV for each particular case, development concepts for nature preservation could then be derived. To render a PNV-map intelligible, therefore, it is necessary to explain the construction bases derived from a particular question in a comprehensible manner.

In addition, the degree of accuracy to which site parameters can be considered (and expressed by PNV-units) is determined by the synsystematic rank in which units of the PNV are to be differentiated. It may be possible to rate out interference, if units of PNV are regarded in the rank of a class or an order. On the other hand, site changes will become more evident, if PNV-units are determined in the rank of associations or subassociations.

With consideration of environmental conditions affecting an area of reference from the outside and continuously, becomes important to determine to what extent forest communities within immission-stressed areas can still be regarded as units of the PNV. The usefulness of a PNV-map with regard to the establishment of near-nature forests (cf. TRAUTMANN 1966: 81-85, AUHAGEN 1985: 132-135) is thus reduced or even annihilated.

To what extent a PNV-map is expressive and can be interpreted largely depends upon the scale chosen for the map. On the one hand, maps with a small scale (1:25 000) are inappropriate for the dissolution of a site's subtle mosaic, so that they can only give limited evidence (cf. MATUSZKIEWICZ 1979: 673, 677; 1982: 155). On the other hand, maps with a large scale (e.g. 1:5 000) cannot be used for the description of landscape. Here again, the question determines which scale is finally chosen, which site conditions can be considered and expressed by units of PNV.

According to NEUHÄUSL (1975: 123) PNV-units, which may be constructed on anthropogenously radically changed sites, can be arranged in two categories:

(1) Site conditions taken into consideration allow the construction of a potential plant community, which at present exists in a similar or nearly the same composition of vegetation and physiognomy.

Tab. 1a. An example of the coincidence between PNV-units and replacement communities, both in indicator species and site conditions. The table presents a key for PNV-mapping valid for landscapes of Northern Germany formed by the ultimate and penultimate glacial period (Lower Saxony and Schleswig-Holstein). In the table a "×" indicates a good coincidence between PNV-indicator (replacement community, indicator species or site conditions) and the PNV-unit considered; a "(×)" is given in cases of a weak diagnostical value. Nomenclature of species after EHRENDORFER (1973), nomenclature of plant communities after POTT (1992) and HÄRDTLE (1995). S = Saale moraines; W = Weichsel moraines. 1 - *Betuletum pubescentis* (secondary); 2 - *Betulo-Quercetum typicum*; 3 - *Betulo-Quercetum molinietosum*; 4 - *Fago-Quercetum typicum* (dry type); 5 - *Fago-Quercetum typicum* (*Molinia caerulea* - type); 6 - *Fago-Quercetum milietosum* (dry type); 7 - *Fago-Quercetum milietosum* (*Molinia caerulea* - type); 8 - *Carici elongatae-Alnetum*; 9 - *Alnus glutinosa* - community (*Filipendula* - type); 10 - *Alnus glutinosa* - community (*Molinia caerulea* - type); 11 - *Alno-Fraxinetum*; 12 - *Crepis-Fraxinus* - community; 13 - *Hordelymo-Fagetum* (*Geum urbanum* - type); 14 - *Hordelymo-Fagetum typicum*; 15 - *Galio-Fagetum typicum*; 16 - *Galio-Fagetum polytrichetosum*; 17 - *Luzula pilosa-Fagus sylvatica* - community.

PNV - unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Occurrence	SW	S	S	S	S	S	S	SW	SW	SW	SW	SW	SW	SW	SW	SW	W
Important indicators species																	
a) wayside, bush																	
Eriophorum vaginatum	×																
Eriophorum angustifolium	×																
Aulacomnium palustre	×																
Erica tetralix	×	(×)	×														
Molinia caerulea	×		×		×		×	(×)		×							
Carex nigra	×		×		×		(×)			×							
Sphagnum palustre	×		×		×												
Lysimachia vulgaris					×		×				×	×					
Deschampsia cespitosa					×		×										
Juncus effusus					×		×				×	×					
Salix aurita			×		×		×										
Populus tremula				×	×	×	×										×
Agrostis tenuis				×	×	×	×									×	×
Sieglingia decumbens				×	×	×	×										×
Lathyrus montanus				×	×	×	×										
Dactylis glomerata agg.				×	×	×	×										
Galium album				×	×	×	×										
b) hedge, hedgerow																	
Salix cinerea					×		×	×	×	×	×	×					
Salix ×multinervis					×		×	×	×	×	×	×					
Fraxinus excelsior (dominant)											×	×					
Alnus glutinosa (dominant)											×	×					
Corylus avellana											×	×	×	×	×	×	×
Prunus spinosa											×	×	×	×	×	×	×
Sambucus nigra											×	×	×	×	×		×
Viburnum opulus											×	×	×	×	×	×	×
Euonymus europaea											×	×	×	×	(×)		×
Stachys sylvatica											×	×	(×)				
c) grassland																	
Alopecurus geniculatus					×		×	×	×	×	×	×					
Ranunculus repens					×		×	×	×	×	×	×					
Lychnis flos-cuculi					×		×	×	×	×	×	×					
Cardamine pratensis					×		×	×	×	×	×	×					
Glyceria fluitans					×		(×)	×	×	×	×						
Angelica sylvestris								×	×	×	×	×					
Cirsium palustre								×	×	×	×	×					
Cirsium oleraceum									×	(×)	×	×					

PNV - unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Phalaris arundinacea								×	×	(×)	×	×					
Caltha palustris								×	×	(×)	×	×					
Filipendula ulmaria								×	×	(×)	×	×					
Urtica dioica									×		×	×					
d) agricultural land																	
Glyceria declinata					×		×				×	×					
Stachys palustris					×		×				×	×					
Bidens tripartitus					×		×				×	×					
Potentilla anserina					×		×										
e) pine forest (including species under a))																	
Polytrichum commune	×															×	×
Carex pilulifera				×	×	×	×									×	×
(diagnostical value considered only for units 1-7)																	
Stellaria holostea				×	×	×	×										
Hedera helix				×	×	×	×										
Oxalis acetosella				×	×	×	×										
Lonicera periclymenum				×	×	×	×										
Milium effusum						×	×										
Polygonatum multiflorum						×	×										
Anemone nemorosa						×	×										
Replacement communities																	
Ericetum tetralicis sphagnetosum	×																
Ericetum tetralicis typicum	(×)	(×)	×														
Genisto - Callunetum																	
cladonietosum (*Molinia* - variant)			×		×												
cladonietosum (typical variant)		×		×													
sieglingietosum (*Molinia* - variant)					×		×										
sieglingietosum (typical variant)				×		×											
Corynephoretum canescentis		×		×													
Digitario-Setarion - communities				×	×	×	×								(×)	(×)	(×)
Arnoseridion - communitites				×	×	×	×										
Aperion communitites						(×)	(×)				×	×	×	×	×	×	×
Caricion lasiocarpae - communities	×																
Caricetum nigrae			×		×		(×)										
Ranunculo - Alopecuretum																	
Glyceria fluitans - variant					×		(×)		×	×	×						
typical variant					(×)		×		×	×	×	×					
Lolio - Cynosuretum																	
lotetosum (*Ranunculus flam.* - variant)					×		×										
lotetosum (typical variant)					×		×					(×)	×				
typicum				×	×	×	×					(×)	×	×	×	×	×
luzuletosum				(×)		×									(×)	(×)	×
Magnocaricion - communitites								×	(×)	(×)							
Filipendulion - communitites									×	×	×	×					
Angelicc - Cirsietum																	
caricetosum nigrae									(×)	×	(×)	(×)					
typicum									×		×	×					
Scirpetum sylvatici								(×)	×	×	×	×					
Senecioni - Brometum																	
caricetosum nigrae									(×)	×							
typicum									×		×	×					

Tab 1b. For the explanation see Tab. 1a.

PNV - unit	Soilpoints (after German soil assessment): mean values	extreme values	no of spot checks	Soil types and diagnostic important horizons (the number in brackets give the thickness of individual horizons; nomenclature after FAO - system)	Ground water level (forest communities) [middle value of the highest (winter time) and the lowest (summer time) ground water levels from two years; the number *in the brackets give the deviation for the* dryest and dampest examined stand]	No of stands considered	Ground water level (replacement communitites) [values taken from the soil map of the geological regional office in Schleswig - - Holstein from 1978 and own measurements; the values give the highest (winter time) and lowest (summer time) ground water level]
1	24	20-28	11	Histosol, Gleysol-Podzol, Planosol,			soil surface, -80 cm
	21	16-25	16	H_h(> 50 cm), rarely H_n			
2	11	8-14		Regosol / Arenosol, Podzol; in case of Podzol:			
			9	B_h, B_s or B_{hs} (up to 100 cm)			as in the unit 4)
3	11	8-14		Regosol/Arenosol, (with gound water influence),			
				Gleysol-Podzol; B_h, B_s or B_{hs} with G_o, G_r			
				(in case of Gleysol-Podzol)			as in the unit 5)
4	15	9-18	26	Podzol, rarely Luvisol- Podzol,			
				B_h, B_s or B_{hs} (40-70 cm), in case of			
				Luvisol-Podzol B_tC	<-120 cm (all over the year)	5	<-120 cm (all over the year)
5	17	8-26	60	Gleysol-Podzol, rarely Planosol-Podzol,			
				B_h, B_s or B_{hs} (up to 100 cm), with G_o			
				(or S, respectively)	-20 cm (14; -27), -111 cm (-91; -133)	5	-20 cm , -100 cm
6	22	17-28	25	Podzolic Cambisol, Podzol, rarely Podzol-Luvisol,			
				A_{he}, B_h, B_s (B_{hs}) (5-70 cm), in case of Podzol-Luvisol			
				with B_tC	<-120 cm (all over the year)	5	<-120 cm (all over the year)
7	23	17-29	33	Gleysol-Podzol, Podzol-Gleysol, Podzolic Gleysol,			
				Gleyic Luvisol-Podzol, B_h, B_s or B_{hs} (20-80 cm), with G_o			
				(or (S) B_tC, respectively)	-29 cm, -140 cm	1	-20 cm, -100 cm
8	not determined			Histosol, H_h (>100 cm)			+20 cm, -50 cm
9	37	32-47	44	Histosol, H_h (>100 cm), earthy			soil surface, -80 cm (to -100 cm)
10	28	26-30	8	Histosol, H_h (>100 cm), earthy			soil surface, -80 cm (to -100 cm)
11	44	34-51		Gleysol, A_a (or A_h) (20-40 cm),			
			44	G_o (up to 150 cm in case of Oxigleysol), G_r	-8 cm (+1; -18), -66 cm (46; -77)	6	(soil surface to) -10 cm, -100 cm
12	44	34-51		Gleysol, A_h (20-40 cm),			
				G_o (up to 150 cm in case of Oxygleysol), G_r	-9 cm (-2; -13), -94 cm (-68; -145)	5	(soil surface to) -20 cm, -100 cm
13	48	44-51	10	Gleysol (with impeded water, S_w (15-40 cm), S_d (up to 70 cm)	-37 cm (-3; -45), -177 cm (-104; -224)	5	-30 cm, <-120 cm
14	49	45-55	10	Gleysol-Luvisol (with impeded water), B_tS, A_h and A_l >40 cm	-54 cm (-54), -233 cm (-223; -244)	2	(-40 cm to) -60 cm, <-120 cm
15	40	38-49	8	Gleyic Luvisol (with impeded water),			
				A_h >10 cm, A_l (25-45 cm), B_t (30-50 cm)	-61 cm (-41; -102), -284 cm (-220; -460)	6	(-50 cm to) -100 cm, <-120 cm
16	30	25-33	12	Luvisol (on loamy soils with features of impeded water),			
				Cambisol, A_h <10 cm, with weak podzolic features	as in the unit 15)	5	as in the unit 15)
17	not determined			Podzolic Luvisol, Podzolic Cambisol, rarely Podzol,			
				B_sA_l or B_{sv}, respectively	as in the unit 15)	3	as in the unit 15)

(2) As a consequence of human impact site conditions have been formed which call for the construction of a vegetation type that cannot be compared to any known, i.e. actually existing plant community.

Whereas in the first case an idea (though not precise) of a PNV-unit's floristic composition and structure can be formed by means of vegetation relevés within according stands, there are no such possibilities of comparison in the second case. PNV-units can here be classified as communities without synsystematical rank or be appointed to a syntaxon of the rank of an order or a class (cf. STUMPEL & KALKHOVEN 1978: 169). Since basically all units of the PNV must be considered to be abstract and hypothetical, all vegetation types derived from vegetation relevés (in real stands) can only give a more or less precise idea of PNV-units. As the PNV is a purely mental conception of a vegetation state, the accuracy of its construction can never be proved empirically. Even if falsification by demonstration of an incorrect construction does not succeed, a statement "equivalence of real and potential natural vegetation" strictly speaking can only be admitted as a reasonable supposition.

METHODS OF MAPPING POTENTIAL NATURAL VEGETATION

Methods of PNV-mapping, particularly determination and construction of PNV under given site conditions have already been explained by several authors (cf. TÜXEN 1956, TRAUTMANN 1966, DIERSCHKE 1974, NEUHÄUSL 1975, 1984, KALKHOVEN & WERF 1988, HÄRDTLE 1989). This chapter therefore gives only a brief summary of the assumptions and methods on which the whole process of PNV-construction is based.

In principle the methods of PNV-construction (as well as mapping of the "reconstructed natural vegetation") are mainly based on the classification of remains of natural or near-natural plant communities in vegetation units (phytosociological approach), typization of their environmental conditions into habitat types, and detection of correlations between vegetation units and habitat types; mapping is performed by extrapolation of the original distribution of individual vegetation units (mapping units) on sites of similar habitat types (MORAVEC et al. 1991).

An important basis for PNV-mapping is knowledge of the natural or near-natural vegetation of an area. In Central Europe phytosociological studies of forest communities may mainly serve as a frame for PNV-mapping, as units of PNV are mostly formed by forest communities. Equally helpful for PNV-construction are plant communities replacing natural vegetation (cf. MEISEL-JAHN 1955: 36-38, DIERSCHKE 1974, HÄRDTLE 1989: 25-27). However, their diagnostic value may vary in individual cases and requires calibration to site conditions in the area of investigation. Moreover PNV-mapping must consider that the diagnostic value of these communities decreases with increasing human impact. In some cases indicator species serve as a diagnostic criterion for the determination and delimitation of PNV-units (cf. DIERSCHKE 1974: 314-316, 1982, WITTIG 1977, WEBER 1983). These species mainly appear on extensive agrarian or unused sites, e.g. on waysides or fallow land. The more a landscape has changed under human influence, the more site conditions (e.g. soil types, soil humidity) gain importance in supplementing and confirming an elaborated mapping result. Soil colour and structure, in particular, provide clues for the detection of boundaries between different habitat types or mapping units.

However, relationships between PNV-units and habitat types (e.g. soil types) are not of general validity, but have to be proved for each landscape characterized by an individual geomorphological situation. Tab. 1 gives an example for the coincidence between PNV-units and replacement communities, indicator species as well as site conditions. This table presents a key for PNV-mapping valid for landscapes of Northern Germany formed by the ultimate and penultimate glacial period (Lower Saxony and Schleswig-Holstein).

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