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SOIL GENETICS IN HYDROPEDOLOGICAL SURVEY IN MOUNTAIN AREAS

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The drainage problems of an area are closely related to its geomorphological and pedogenetical conditions. The presence or absence of layers with good water-transmitting properties, of barriers to groundwater flow, of springs, as well as the relation between groundwater and surface water will directly or indirectly affect the conditions in or near the rootzone.

Morphological description of soils has always been used in hydropedological survey but we have lately tried to use morphological-genetical characteristics on different levels. This effort is connected with shifting of most drainage actions from plain and flat areas to the highlands and mountains, that is with shifting from land and soils waterlogged by a high level of an allochtonic groundwater table to the soils that are waterlogged mostly periodically by shallow subsurface water running laterally from slopes and from higher parts of land. This water has its origin in higher precipitation and in sources in relatively cold and humid climate. This excess "slope" water is accumulated in depressions where runoff is limited and both shallow subsurface water and deeper groundwater cause the waterlogging in combined way.

In water saturated conditions it is possible to use many methods for hydraulic conductivity measurement and many methods for determining of drainage systems parameters. Morphologic-genetical characteristics of soils have remained in the background in this case. It is impossible to use these methods in the conditions of unsaturated lateral water flow through the soil on slopes. Field and laboratory measurements are complicated and tedious. The results are not satisfactory in practice. In these areas we are faced with such questions as: how to characterize a complicated mozaic of soil cover; how to characterize a soil profile consisting of a number of different layers changing in position and magnitude from one place to another; how to characterize quick changes of soil and land drainage, how to characterize water stagnation or directions and intensity of water lateral flow. Although hydromorphic catenas are usually created they are very irregular and under slope springs even "inverse".

In these mountain and highland areas the exact knowledge of the extent of soil reclamation interference is also very important. By our investigations it is not exceptional (in routine actions) that 20—30% of all reclaimed surface has been worked on unnecessarily because anhydromorphic soils have been taken into account.

Different forms and periodicity of waterlogging cause different processes of oxidation end reduction. Vertical and lateral percolation and water flow cause leaching out of iron and manganese and excess of water causes accumulation of organic matter. Morphological features are regularly arranged according to the genesis of the profile; many authors have dealt with this problem, for example Scheeling [10], Blümel [3], Bloomfield [1], Brewer, Sleeman [4], Blume [2], Němeček [6, 8], Němeček, Novák [7]. From depth and quantity of morphological features indicate quantitatively and qualitatively all genetic processes — in our case mainly processes of hydromorphic development. Graduating of morphologic features in the profile is an indicator of profile relative percolation, of processes of waterlogging and even of agronomical consequences of waterlogging.

METHODS AND RESULTS

The set of formed morphological features in the mineral part of the soil and similarly the characteristics of accumulated organic matter on the surface of the soil have been taken into account. Morphological evaluation of hydromorphism comprises the following steps:

1. Evaluation of morphological degrees of hydromorphism of individual profile horizons.

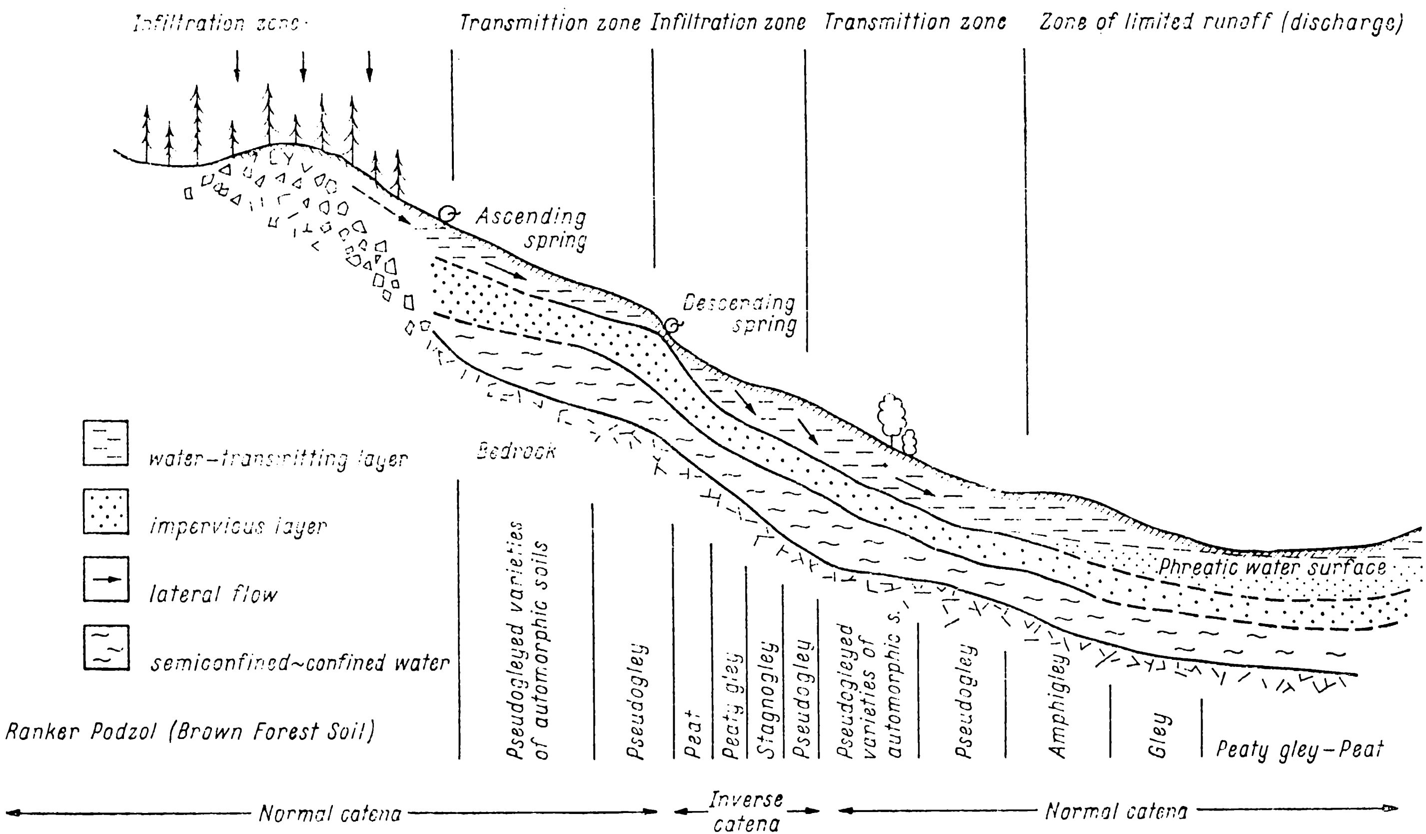
2. Evaluation of the depth distribution and relative amplification or reduction of the hydromorphic features according to the depth (both 1 and 2 according to Němeček 1974).

3. Evaluation of so called agronomical consequences of waterlogging (as an addition to morphological evaluation).

4. Evaluation of presence and depth of water-transmitting layers and water-impervious layers, that is evaluation of profile permeability.

5. Evaluation of macroporosity (visible pores, cracks) mainly in eluvial water transmitting horizons and evaluation of intensity of lateral flow (lateral eluviation).

6. Evaluation of terrain, possibly peaty lenses (depth, structure, surface — if they exist), origin of foreign water (subsurface water, deep groundwater, water from springs, overflow of brooks, in some cases



Soil cover on the waterlogged slopes

even water from the remnants of old settlement), intensity and directions of water flow.

7. Classification of soil profiles, specification of soil cover units (mostly as associations due to mosaic), specification of soil melioration units. Typical situations and soil cover on waterlogged slopes are demonstrated at figure.

Morphological features of profile hydromorphism are evaluated separately in 3 groups of horizons:

1. Horizons of surface accumulation of organic matter: the colour, base saturation, form and content of organic matter and thickness of horizon are evaluated.

2. Leached out (eluvial) horizons (it is necessary to decide if the horizon is leached out by vertical or lateral flow): in permeable materials the iron (+Mn, Al) are vertically and/or laterally leached out and are accumulated in depressions of terrain and/or in base of profile.

Leached out horizons on slopes are usually equal to water transmitting layers. The thickness, degree of bleaching, presence of Fe—Mn features, visible voids and cracks characteristics and (if possible) the intensity of water flow are evaluated.

3. Deeper mineral horizons: we evaluate the localization and rations among:

— rusty Fe—Mn neoformations and their shape (pedotubules, rounded concretions, sharp boundary or diffused mottling a.s.o);

— grey, blue- or greengrey spots and parts with reduced Fe^{2+} or leached out parts;

— brown patches that are the residues of weathering processes and are not affected by redox hydromorphic processes.

In all horizons we must consider the character of colour, ratio among differently coloured spots, contrast, sharpness or diffusity of boundaries.

The formation and development of genetical-morphological features are of course significantly influenced by soil texture, chemical and mineralogical composition of parent material. On light or medium textured parennt materials (loesslike sediments, weathering products of eruptive and metamorphic rocks) the features are very distinct. On coarse light sands the morphologic features can by very indistinct, especially in a laterally leached out horizon. The evaluation of features in heavy and minerally rich parent materials (basic eruptive rocks) is also difficult because the colour of substratum and its weathering products does not make specification easy. The possible presence of fossil and relict features must also be considered.

Gravity moisture can move well in vertical and/or horizontal directions through water transmitting layers. Permeability in the impervious layer is usually at least 10 times less than in the water transmitting layers.

Table 1

Morphological degrees of hydromorphism of organic matter horizons

Degree of hydromorphism	Colour	Thickness	Humus content	Neoformations	Other marks	Horizons symbols[x]
0 - 3	dark	> 30 cm	2-3%	rarely concretions	base saturated	mollic, dark - Ap, AH
0 - 3	lighter	< 30 cm	2-3%	rarely concretions	saturated or unsaturated	humic - Ah
4 a	dark	> 30 cm	3-4% max 6%	concretions	usually saturated	dark mollic hydrogenic - Ahmg
4 b	lighter	< 25 cm	3-4% max 6%	concretions	saturated or unsaturated	hydrogenic humic - Ahg
4 c	lighter	< 25 cm	10-20%	mottling, pedotubules	mostly unsaturated	anmoor, peaty - At
4 d	lighter	> 25 cm	20-30% nondecomposed	0.	mostly unsaturated	peaty - T

[x] Classification and symbols of all horizons according to last modified Němeček soil classification of ČSSR /1976/

Depths of the water transmitting and impervious horizons belong to the most important morphological data. These data decide about the depth of catch ditches or catch drains just so as about the drainage system as a whole. There is no sense in laying them under the layers with limited permeability. The depth of the impervious layer may vary in the area. In places where water-impervious layers approach the surface of the soil there appear springs of the descending type (somewhere even in line), periodical or permanent.

Table 2

Morphological degrees of hydromorphism of leached out horizons

Degree of hydromorphism	Brown matrix	Grey matrix	Rusty accumulations Fe-Mn	Concretions Fe-Mn	Horizons, symbols
0	slight /dominate/	slight /medium/	0	sporadic	fair - eluvial - E
1	very slight	medium /dominate/	slight	medium	fair - eluvial - E
2	0	dominate	medium	dostinct	concretional, leached out - Ecn
3	0	dominate + slight green	distinct	very distinct	concretional distinctly leache out - Ecn
4	0	blue-green grey	0 /slight/	0	hydrogenic laterally leached out - Ge

Table 3

Morphological degrees of hydromorphism of mineral base horizons

Degree of hydromorphism	Brown matrix	Grey matrix	Rusty /non-concretional/ accumulations Fe-Mn	Concretions Fe-Mn	Horizons, symbols
0	dominate /→ 100%/ rich chroma	0	0	0	different anhydromorphic - Bm, Bv, Bt
1	80-100% less chroma	slightly distinct	slight	slightly distinct	pseudogleyed/slightly/ varietes of anhydrom. soil - Bmg, Bvg, Btg, Gm
2	20-80%	distinct very contrast	distinct	distinct	pseudogleyed weathering horizons - Bmg, Bvg, Btg
3	20%	very distinct	distinct, pedotubules	present	pseudogleyed of gleyed mottling horizons - Gm, Go /Bmg, Bvg/
4	0	distinct blue-green	0	0	gleyed - Gr /Gor/

Basic information about the lateral flow through the soil is provided by evaluation of bleaching and by the character of visible pores and cracks. In some wet periods of the year it is possible to estimate and even to measure the intensity of the water flow. It is recommended to draw a map of the depths of waterlogged (impervious) horizons and of the directions of lateral flow. Such a map can replace the conventional map of groundwater table that is used in flat land.

For taking all these data and characteristics it is necessary to dig profile pits up to 160—180 cm deep and if possible deeper.

Table 4

Standard degrees of hydromorphism in basic semi- and hydromorphic soil types

Soils	1	2	3	4	5	6	7	8	9
Depth cm			Degrees of hydromorphism						
0-30	0	0-1	0-2	2-4b	4b-c	3-4 a-b	4b	4b-c	4c-d
30-60	0	0-1	1-2	2-4	4	3-4	4	4	4
60-100	0-1	1	2	3	4	3-4	4	4	4
100-150	0-1 /2/	0-3	2	2-3	3	4	4 /3/	4	4

Soils:
1 .... anhydromorphic soils
2 .... slightly pseudogleyed varietes of anhydromorphic soils
3 .... pseudogleyed intertypes
4 .... pseudogleys + laterally leached out pseudogleys
5 .... stagnogleys + laterally leached out peaty stagnogleys
6 .... amphigleys
7 .... gleys
8 .... hydrogleys
9 .... peaty gleys, peat soils

Table 5

Agronomic consequences of waterlogging /lack of airness/:

0 - optimum
1 - spring cultivation belated for 1 week
2 - spring cultivation belated for 2 weeks
3 - spring cultivation belated for 3 weeks
4 - spring cultivation belated for 4 weeks
5 - long-termed waterlogging

Upper side of the impervious layer

Depth - cm	Waterlogging	Moisture degree /excess of surface water/
10 - 40	shallow - long-termed	strongly influenced - 3
40 - 80	medium - in the depth of 40-60 cm	medium influenced - 2
80 - 140	deep - in the depth of 60-100 cm	slightly influenced - 1
under 140	very deep - under 100-120 cm	practically noninfluenced - 0

Although the of methods described above are a really good contribution for hydropedological survey in hilly and mountain areas, it still takes good judgement, and local experience for successful building of drainage systems.

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ГЕНЕТИЧЕСКИЕ ПРИЗНАКИ ПОЧВ КАК ОСНОВАНИЕ ДЕЯТЕЛЬНОСТИ ПОЧВОВЕДЧЕСКО-МЕЛИОРАТИВНЫХ СЛУЖБ В ГОРНЫХ РАЙИОНАХ

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Резюме

На горных и предгорных территориях при преобладающих горизонтальных движениях воды в ненасыщенном состоянии не могут использовываться стандартные методы измерения параметров необходимых для планирования дренажных систем на периодически переувлажненных почвах. Почвоведческо-мелиоративные службы работающие на указанных территориях встречаются с трудностями связанными с такими вопросами, как следует характеризовать сложные мозаики почвенного покрова в горных районах, как характеризовать положение, глубину и пределы водонепроницаемых и водоносных слоев, главные направления стока подповерхностных вод и соотношение между этими водами и более глубокими уровнями грунтовых вод, а также как характеризовать быстрые изменения дренажа почвы и площади.

Ответы на эти вопросы можно получить путем анализа гидроморфно-генетических признаков. Признаки гидроморфизации оценивали отдельно для гумусно-аккумуляционных горизонтов, для элювиальных горизонтов (выбеления) и для более глубоких минеральных горизонтов. Комбинация указанных признаков может составлять основу для точного определения степени интенсивности гидроморфизации и пересыщения почв водой. Состав указанных признаков позволяет также идентифицировать водонепроницаемые и водоносные слои, определять интенсивность и направления подповерхностного стока вод, равно как и оценивать влияние этих вод на земледельческие последствия переувлажнения. Рассматриваются типичные схемы почвенного покрова на переувлажненных склонах.

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GENETYCZNE CECHY GLEB JAKO PODSTAWA DZIAŁALNOŚCI SŁUŻB GLEBOZNAWCZO-MELIORACYJNYCH W TERENACH GÓRSKICH

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Streszczenie

W terenach górskich i pogórkowatych przy dominujących poziomych ruchach wody w stanie nienasyconym nie można korzystać ze standardowych metod pomiaru parametrów niezbędnych do planowania systemów drenarskich dla gleb okresowo nadmiernie uwilgotnionych. Służby gleboznawczo-melioracyjne działające na tych terenach napotykają na następujące trudności: jak scharakteryzować skomplikowane mozaiki pokrywy glebowej w terenach górskich; jak scharakteryzować położenie, głębokość i rozległość warstw nieprzepuszczalnych i wodonośnych oraz główne kierunki spływu wód podpowierzchniowych, a także relacje między tymi wodami a głębszymi poziomami wód gruntowych; jak charakteryzować szybkie zmiany drenażu gleby i terenu.

Odpowiedzi na te pytania można uzyskać analizując cechy hydromorficzno-genetyczne. Cechy hydromorfizmu oceniono oddzielnie dla poziomów próchniczno-akumulacyjnych, dla poziomów wymywania (wybielania) i dla głębszych poziomów

mineralnych. Zestaw stanowiący kombinację tych cech może być podstawą do ścisłego odstopniowania nasilenia hydromorfizmu oraz przesycenia gleb wodą. Zestaw tych cech umożliwia także zidentyfikowanie warstw nieprzepuszczalnych i wodonośnych oraz określenie intensywności i kierunków podpowierzchniowych spływów wody, a także ocenę wpływu tych wód na rolnicze konsekwencje nadmiernego uwilgotnienia. Przedstawiono typowe układy pokrywy glebowej na nadmiernie uwilgotnionych zboczach.

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