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THE PROBLEM OF DETERMINATION OF STANDARD DEPTHS OF THE SOIL SOLUM OF THE SELECTED SOIL TYPES AND SUBTYPES IN SLOVAKIA

Mladen Kolény

Comenius University in Bratislava, Faculty of Natural Sciences, Department of Physical Geography and Geoecology, Bratislava, Slovakia

Abstract: In this contribution the problem of determination of standard depths of the soil solum of selected soil types and subtypes in Slovakia is analyzed. In the following, some proceedings include the dynamics of soil-creating factors and conditions, the soil processes and human influences on the attributes of depth, especially eutric luvi-sols and cambisols in the parts of Trnava loess highland and the mountain of Malé Karpaty. In the less frequently focused region we name the bearing problems that brake research of depths of soil solum and soils.

Key words: soil, soil solum, haplic luvisol, eutric cambisol

1. PREFACE

The boundaries of natural complexes do not seem dominant in landscape, in the research of new position of boundaries in the unifying Europe and subsequently also in the research of development of regions or their components. They are more stable in consequence of relatively weaker dynamics of natural components (rocks, relief, soils, flora) in opposite to the human components and elements of landscape. They often determine secondary human activities and objects. Mostly, they do not have sharp, clear, distinct horizontal or vertical boundaries of areas of appearance. The research of these types of boundaries is a permanent research problem. A lot of following human activities, which are not negligible for development or regress of a region is related with soil and its productive and unproductive functions.

The aim of this contribution is the analysis of problematic dynamics of soil creating and soil-interfering processes and their reflection in the depth of soil solum, soil respectively and also the human influence on acceleration of these processes. We would rather refer to the seriousness of the problematic, which is not focused enough. It is not possible to arrive so far as to unequivocal taxative measures of depth of soil solum, soil

respectively, for all soil units. We will try to do it for some selected combinations of soil types and their surrounding natural factors and conditions. A part of Central-European chernozems, greysols, haplic luvisols, ortic luvisols, pseudogleys, cambisols with the accent on haplic luvisols and cambisols will be concerned.

2. THEORETICAL-METHODOLOGICAL INTRODUCTION

Soil is a special natural component, which is created from a specific concrete combination of natural factors and conditions, bound to vertical relations (interrelation) on given type of area by the soil-creating processes. We understand them as a complex of physical, chemical and biological actions, which change relatively irreversibly loose rocks on qualitatively new naturals, soils. These have, in comparison with non-solidified sediments, individual structure (with diagnostic and transitional horizons) and special unique qualities (fertility, for example). The creation of soils is temporarily a long process including natural erosive-accumulative processes, which lasts by terrestrial climax soil types hundreds or even thousands of years. We abstract from the human intervention. The destruction of the natural soil cover is possible by direct human interference in a few hours or days and his indirect coverage in a few years or decades. Many dynamic exogenous powers influence also naturally against soil development processes (from initial, through successive into climax phase). But they have a different intensity in different types of area. Their conclusion is the reduced depth of soil solum on the places of erosion, possibly the whole depth of soil, on the contrary in accumulation places excessive thickness. Also the natural erosion processes create the sizable depth difference and variability of soil solum.

Thickness and composition of particular horizons change according to soil ontogenesis in specific location. By development (ontogenesis) we understand a gradual change of firm or loose rock into soil in relatively constant climatic proportions through elementary process (in initial phase of soil-creating) subsequently also the accumulation of organic substance (in primary successive phases) into the change of primary rock minerals into secondary (clay), whereby the previous processes preserve themselves and it displays in soil qualities and also in soil structure (in horizons) their cumulative effect (they create for example higher concentration of humus or thicker horizons contingently the type of clay minerals changes). The top (climax) phase for certain position can be one of two lately mentioned but usually the soil material succumbs the inner-soil translocation vertically oriented process. The development (evolution) on the contrary to development (growth) of soils happens in climatically changing conditions gradual or also suddenly. In neither case soil reacts synchronically to these changes. A part of the qualities change only gradually, some constantly stay and create residua through which it can be indicated the original soil attributes in time of its rise in the previous climatic periods. This phenomenon is called the memory of soil. The laterit soil processes are especially intense, which display after the change of sub-tropic or tropic climate into genial for example by strong red coloration (rubification).

It needs to be understood that by the soil solum over-surface, surface and under-surface diagnostic soil horizons up to soil-creating substrate is usually non-solidified loose rock. The depth of soil solum is the sum of thickness of all the

horizons mentioned. The depth of soil is defined as the depth of soil solum together with soil-creating substrate down to tough parental rock. In the first case, the depth of soil solum is restricted from several centimeters (usually a soil with a thickness over 10 cm is accepted as a soil) up to several meters (in Central-European area, the depths are maximally down to 5 m, in tropics down to 20 m, exceptionally more). The question of the fossil soil strata (paleosols) is not solved yet and also the selectively deeper appearance of roots. Most of our pedologists in sense of Morpho-genetic Soil Classification System of Slovakia (2000) do not classify paleosols and they have an opinion that roots of plants can be anchored beyond the soil in cracks of solid rocks or in loose ones. We perceive the reduction of depth in first row in temporal aspect opposite the maximum, potentially reachable. The territorial point of view is also important. The depth of soil solum seems to be here the result of influence of soil-creating factors and soil processes opposite the soil interfering from which the natural influence is dominating above the human. The most important whole-surface influence is the elimination of forest and arrival of agricultural activity, especially the creation of fields and their cultivation (Klimaszewski, 1981; Lach, 1984). Agricultural use of land is one of the most important dynamics among the geomorphologic processes. The human's construction activity and the terrain modification connected are not negligible too.

3. METHODICAL PROCEEDINGS AND CONCLUSIONS

The methods, useful in observation of standard depths, are based on the analysis of empirically acquired data by complex soil research of agricultural (from 1960 to 1971) and forest soil fund (from 1975 to 1985), after 1990 also urban soils or proper information acquired in terrain also in laboratory according to works (Čurlík, Šurina, 1996; Fiala et al., 2000). The database is uninterruptedly completed. The standard depths of soil solum or soil are not complexly processed until now for particular soil types and subtypes. In contrary to human-geographical components (residences, traffic, industry, services), soil is a component less dynamic but dynamic enough and often a problematic one. Methods are oriented on specific observation of problems of soil erosive-accumulative phenomena in selected areas. Relations of greatest relevancy among components, elements and attributes of landscape are in scope of research. We focus on the move of soil material in the link on inclination form and length of slope by water erosion, also on the quantity, run and intensity of rain in balance of temperatures and evaporation in character of plant cover in the manner of land use and in proportion in selected soil attributes (for example, the granulation of fine soil with fraction less than 2 mm, structure of soil, water capacity and alike). By wind erosion, the link depends on direction and intensity of the wind, character of the plant cover and soil granulation. We deal with specification of conditions, which are restricted on mountainous positions by ice-block erosion. Our solution in water river erosion is from regularities of flowing water in its bed and the influences on changes of the balance of lengthwise profile of water flow. Independent methodological base offers usage of materials from Remote Sensing, aerial photography especially. The cardinal problem is determination of standard depths of soil solum of non-eroding surfaces in comparison with surfaces with different type of erosion.

We will devote ourselves from many types of erosion to accelerative type of erosion and also to linear water erosion in selected parts of agricultural soil fund and only partially to the wind and forest soil fund. Specifically, we express the problem of determination of standard depths of chosen haplic luvisol areas of Trnava loess highland in territories of Šenkvice – Vištuk and Kočín – Šterusy in following on relevant soil attributes. Both areas in the model are under influence of agricultural activity. Because of this we introduce a comparison of forested area also in the mountain of Malé Karpaty with relatively flat relief on Miocene-Pliocene plateau and catena of cambisols and on slopes of horsts.

We did not go through the division of depths of soils according to agricultural classification: shallow soils less than 30 cm, mid-deep from 30 cm to 60 cm and deep more than 60 cm. Our opinion is that every soil type needs a special classification, which should be derived from their natural development. The substrate plays its role here, horizontal relations of the soil with another soils and relief proportions, especially inclination, also.

4. RESULTS OF THE WORK

At first we adopt global point of view to standard depths of soils, which was already advised. Briefly the results of our research in the chosen areas will be presented. The first area of several years repeated terrain soil research is located in southern part of Trnava loess highland between villages of Šemkvice and Vištuk. Departing from the foot line of Malé Karpaty, the area lays in a distance of about 3 kilometers. Dominating rock in this part of mountain is amphibolite. The haplic luvisols are dominating, they arise from loess and cover flat ridges (mostly with inclination less than 1 degree, less 3 degrees) and slants (mostly with the inclination from 3 to 7 degrees, less from 7 to 12 degrees in a break slant over Vištuk, occasionally in expressive dells above 12 degrees). We derived the standard depth from more than 200 sounds onto 75 cm up to 80 cm, shallower on a slant with 1 degree with mildly eroding (the combination of water and wind one with the human influence) and deeper than 90 cm are surely accumulated. There is not an absolute correlation between surface inclination and the depth of soil solum.

The second area of Trnava loess highland consists of haplic luvisols area in the territory Lančár – Kočín – Šterusy in the contact zone (less than 500 meters) of mountain with appearance of dolomites. The thickness of soil solum of haplic luvisols on ridges does not go over 60 cm up to 70 cm, so there is standard of the depth of soil solum shallower from 10 to 15 cm. The sondage contains more than 50 sounds, which are geodetically exactly localized and compared also with aerial photography maps.

Third area under research in the Malé Karpaty mountain localized above Zochova chata has prevalence of cambisols arisen from granites and quartzites. More than 60 sounds are from the plateau and tectonic slants, filled with periglacial material. The depth of soil solum with exceptions in quartzites is very convertible and the standard positions vary from 60 cm to 150 cm, inside crypto-karst holes on short steep slopes (more than 12 degrees) even more. Here, the idea of inner-soil slaking in-situ gets serious breaches. A point of view can be adopted orientatively since of standard depths of soil solum of their model subtypes (in detail from reasons explained). Haplic chernozems have 60 cm,

greysols 100 cm, haplic luvisols 75 down to 80 cm, luvisols 140 cm, planosols more than 150 down to 180 cm (paleosols are deeper). Cambisols agriculturally used would not over-attain 100 cm.

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Problém určenia štandartnej hĺbky pôdneho sóla vo vybraných pôdnych typoch a subtypoch na Slovensku

Resume

Hranice prírodných komplexov, či ich komponentov, v krajine nie sú dominantné. V dôsledku relatívne slabšej dynamiky časti prírodnín (hornina, reliéf, pôda, rastlinstvo) oproti humánnym komponentom a elementom krajiny sú v nej však stabilnejšie. Spravidla sa neprejavujú ostro, jasne, zreteľne, ale sú skôr postupné, málo zreteľné až difúzne, a to v horizontálnom či vertikálnom smere. Skúmanie hraníc je stálym výs- kumným problémom.

Cieľom príspevku je analýza problémovej dynamiky pôdotvorných a pôdorušivých procesov a ich odraz v hĺbke pôdneho sóla, resp. pôdy, ako aj vplyvu človeka na urýchlenie týchto procesov. Poukazujeme na závažnosť nie dostatočne riešenej problematiky, ale zatiaľ možno stanoviť iba predbežné miery hĺbky pôdneho sóla, resp. pôdy pre vybrané kombinácie určitých pôdnych typov a ich okolitých prírodných

faktorov, a to pre černozeme, sivozeme, hnedozeme, luvizeme, pseudogleje a kambizeme, s akcentom na hnedozeme a kambizeme.

Tvorba pôd je vrátane prirodzených erózno-akumulačných procesov časovo dlhodobý proces, ktorý sa ráta na stovky ba až tisíce rokov bez zásahov človeka. Zničenie prirodzenej pôdnej pokrývky je možné priamym zásahom človeka za niekoľko hodín až dní a jeho nepriamym pôsobením za niekoľko rokov až desaťročí. Mnohé dynamické exogénne sily pôsobia však aj prirodzene proti pôdnym procesom vývinovým, majú ale rozličnú intenzitu v určitých typoch územia. Ich výsledkom je na miestach erózie redukovaná hĺbka pôdneho sóla, prípadne aj celková hĺbka pôdy, v miestach akumulácie naopak nadmerná hrúbka. Aj prirodzené erózne procesy teda vytvárajú značnú hĺbkovú diferencovanosť a variabilitu pôdneho sóla.

Hrúbka i skladba jednotlivých horizontov pôd sa na konkrétnom stanovišti mení. Hĺbka pôdneho sóla je suma hrúbky všetkých nadložných, povrchových a podpovrchových diagnostických pôdnych horizontov až po pôdotvorný substrát, ktorým je spravidla nespevnená sypká hornina. Hĺbka pôdy je definovaná ako hĺbka pôdneho sóla aj spolu s pôdotvorným substrátom až po pevnú materskú horninu.

Metódy výskumu hĺbok pôdneho sóla sú orientované na špecifické sledovanie problémov pôdnych erózno-akumulačných javov vo vybraných územiach. Ide o výskum relevantných vzťahov medzi komponentmi, elementmi a atribútmi krajiny. Pri vodnej erózii skúmame presun pôdnej hmoty vo väzbe najmä na sklon, na charakter rastlinnej pokrývky, na spôsob land use a v pomere ku vybraným pôdnym atribútom (napr. ku zrnitosti jemnozeme). Najmenšie sklony plošín so sklonom do 1° by mali mať najštandardnejšie hĺbky pôdneho sóla.

Samostatnú metodickú bázu poskytuje využitie materiálov diaľkového prieskumu Zeme (DPZ) najmä ortofotomáp. Kardinálnym problémom je stanovenie štandardných hĺbok pôdneho sóla neerodovaných plôch voči plochám s rozličnými typmi erózie.

V príspevku sme riešili hĺbku pôdneho sóla vybraných pôdnych typov a subtypov Slovenska konceptuálnym prístupom na báze empirických poznatkov štátnych prieskumov pôd, ako aj využitím detailnejších terénnych údajov vo vybraných hnedozemných a kambizemných oblastiach Podunajskej nížiny a Malých Karpát. Jadro príspevku tvorí podrobná analýza príčin problémového taxatívneho stanovenia štandardných hĺbok pôdneho sóla na relatívne neerodovaných horizontálnych plochách už uvedených pôd (ich modálnych subtypov). Pre poľnohospodársky využívané pôdy možno predbežne stanoviť tieto štandardné hodnoty hĺbky pôdneho sóla: u černozemí je to 60 cm, sivozemí 100 cm, hnedozemí 75 až 85 cm, luvizemí 140 cm, pseudoglejov viac ako 150 cm až do 180 cm (hlbšie sú už len paleopôdy), kambizemí do 100 cm. Textúrny koeficient luvických horizontov je 2,5 a viackrát vyšší ako v ornici. Také množstvo kutanu sa dá predpokladať len z podstatne hrubšej pôdy. Z A-horizontu ubudlo 170 cm poľnohospodárskou činnosťou, vetrom i prívalovými dažďami i plošinovej polohe.

Využitie informácií o štandardnej hĺbke pôdneho sóla je umožňuje pre stanovenie urýchlenej erózie pôdy.