

CEZARY KABAŁA^{1*}, PRZEMYSŁAW CHARZYŃSKI², JACEK CHODOROWSKI³,
MAREK DREWNIK⁴, BARTŁOMIEJ GLINA⁵, ANDRZEJ GREINERT⁶, PIOTR HULISZ²,
MICHAŁ JANKOWSKI², JERZY JONCZAK⁷, BEATA ŁABAZ¹, ANDRZEJ ŁACHACZ⁸,
MARIAN MARZEC⁹, ŁUKASZ MENDYK⁵, PRZEMYSŁAW MUSIAŁ¹⁰, ŁUKASZ MUSIEŁOK⁴,
BOŻENA SMRECZAK¹¹, PAWEŁ SOWIŃSKI⁸, MARCIN ŚWITONIAK², ŁUKASZ UZAROWICZ⁷,
JAROSŁAW WAROSZEWSKI¹

¹ Wrocław University of Environmental and Life Sciences, Institute of Soil Science and Environmental Protection
ul. Grunwaldzka 53, 50-375 Wrocław, Poland

² Nicolai Copernicus University in Toruń, Faculty of Earth Sciences, Department of Soil Science and Landscape Management
ul. Lwowska 1, 87-100 Toruń, Poland

³ Maria Curie-Skłodowska University in Lublin, Department of Geology and Soil Science, ul. Kraśnicka 2cd,
20-718 Lublin, Poland

⁴ Jagiellonian University, Institute of Geography and Spatial Management, Department of Pedology and Soil Geography
ul. Gronostajowa 7, 30-387 Kraków, Poland

⁵ Poznań University of Life Sciences, Department of Soil Science and Land Protection
ul. Szydlowska 50, 60-656 Poznań, Poland

⁶ University of Zielona Góra, Institute of Environmental Engineering
ul. Szafrana 15, 65-516 Zielona Góra, Poland

⁷ Warsaw University of Life Sciences – SGGW, Department of Soil Environment Sciences,
ul. Nowoursynowska 159, 02-776 Warsaw, Poland

⁸ University of Warmia and Mazury in Olsztyn, Department of Soil Science and Land Reclamation
Plac Łódzki 3, 10-727 Olsztyn, Poland

⁹ Bureau for Forest Management and Geodesy
ul. Piastowska 9, 49-300 Brzeg, Poland

¹⁰ Bureau for Forest Management and Geodesy
ul. Leśników 21, Sękocin Stary, 05-090 Raszyn, Poland

¹¹ Institute of Soil Science and Plant Cultivation
ul. Czartoryskich 8, 24-100 Puławy, Poland

Polish Soil Classification, 6th edition – principles, classification scheme and correlations

Abstract: The sixth edition of the Polish Soil Classification (SGP6) aims to maintain soil classification in Poland as a modern scientific system that reflects current scientific knowledge, understanding of soil functions and the practical requirements of society. SGP6 continues the tradition of previous editions elaborated upon by the Soil Science Society of Poland in consistent application of quantitatively characterized diagnostic horizons, properties and materials; however, clearly referring to soil genesis. The present need to involve and name the soils created or naturally developed under increasing human impact has led to modernization of the soil definition. Thus, in SGP6, soil is defined as the surface part of the lithosphere or the accumulation of mineral and organic materials permanently connected to the lithosphere (through buildings or permanent constructions), coming from weathering or accumulation processes, originated naturally or anthropogenically, subject to transformation under the influence of soil-forming factors, and able to supply living organisms with water and nutrients. SGP6 distinguishes three hierarchical categories: soil order (nine in total), soil type (basic classification unit; 30 in total) and soil subtype (183 units derived from 62 unique definitions; listed hierarchically, separately in each soil type), supplemented by three non-hierarchical categories: soil variety (additional pedogenic or lithogenic features), soil genus (lithology/parent material) and soil species (soil texture). Non-hierarchical units have universal definitions that allow their application in various orders/types, if all defined requirements are met. The paper explains the principles, classification scheme and rules of SGP6, including the key to soil orders and types, explaining the relationships between diagnostic horizons, materials and properties distinguished in SGP6 and in the recent edition of WRB system as well as discussing the correlation of classification units between SGP6, WRB and Soil Taxonomy.

Keywords: soil classification, soil order, soil type, soil origin, World Reference Base, Soil Taxonomy

INTRODUCTION

Transformation of soils, progress in soil science and changing socio-economic conditions are major driving forces for the changes in soil classification, if the classification is to be understood as a modern reflection of current knowledge about soils and their functions in the natural environment and for human life (Arnold 2002). Therefore, every classification of soils, including the Polish Soil Classification, must be regularly verified and improved (Brevik et al. 2016). At the same time, it should not be forgotten that the classification system, and in particular the terminology used, reflects local scientific traditions, which should not be abandoned hastily (Krasilnikov et al. 2009). The sixth edition of the Polish Soil Classification (*Systematyka gleb Polski* 2019, later cited in an abbreviated form as SGP6), developed by the Commission for Soil Genesis, Classification and Cartography of the Soil Science Society of Poland, attempts to fulfill the abovementioned mission and expectations of different groups of professional users. SGP6 continues the tradition of previous editions of soil classification, in particular its fifth edition (*Systematyka gleb Polski* 2011), in the aspect of consistent application of precisely and quantitatively characterized diagnostic horizons, properties and materials. Quantitative clarification and digitization of classification criteria do not mean giving up the traditions of genetically oriented soil science. All classification units in SGP6 were determined in accordance with their genesis; some were even intentionally separated to emphasize the impact of various pathways of soil development (soil-forming processes) on their present morphology, properties and functions, even if it is not explicitly stated in the classification criteria.

The aim of this paper is to explain the principles and classification scheme of the Polish Soil Classification, 6th edition (*Systematyka gleb Polski* 2019). The correlations of diagnostic horizons, materials and properties as well as classification units at various levels with WRB (IUSS Working Group WRB 2015, later cited in an abbreviated form as WRB2015) and Soil Taxonomy (Soil Survey Staff 2014, cited in an abbreviated form as ST2014) is also given and briefly explained to indicate the close relationships between modern Polish soil classification and major international systems.

THE OBJECT OF CLASSIFICATION

The soil definition often depends on the requirements for which this definition and related classifica-

tion are made (Ibanez and Boixadera 2002). For many experts, the concept of soil was defined through the needs of agricultural and forest productivity (i.e. the usefulness for growing plants). Another perspective comes from an ecological approach, where soil can be a basis for every ecosystem, both naturally developed and human made, including those ecosystems considered unproductive or degraded (Jankowski and Bednarek 2000, Krupski et al. 2017, Musielok et al. 2018). Based on an ecological approach, it is very difficult, if at all possible, to determine the minimum soil contour area (or soil volume), if only cubic centimeters or decimeters of regolith accumulated in a rock crevice may create the basis for unique natural ecosystems (Miechówka and Drewnik 2018; Skiba and Komornicki 1983). In this context, questions are increasingly asked about the soils of ecosystems artificially created by humans or created by natural forces in an environment that has been substantially altered or created by man; for example, soils of road or railway embankments, earth covers on bunkers and other constructions, on green roofs, in niches on buildings and ruins filled with "anthropogenic regolith" etc. (Charzyński et al. 2013a, 2013b, 2015; Uzarowicz et al. 2017, 2018). In all these ecosystems, there are similar minerals that build natural soils, similar microorganisms enabling the circulation of matter and energy flow typical for soils, as well as enabling plant growth and soil fauna occurrence. Therefore, these are soils that build self-functioning ecosystems and which are relatively stable in time and space. However, not each accumulation of soil material lasts and functions as described above; for example, an earthy material accidentally accumulated on tractor wheels and on agricultural machinery or growing substrate on greenhouse benches (tables) or in pots on the windowsill. Therefore, in the Polish Soil Classification (SGP6), soil is defined as the surface part of the lithosphere or the accumulation of mineral and organic materials permanently connected to the lithosphere by buildings or permanent constructions, coming from weathering or accumulation processes, originated naturally or anthropogenically, subject to transformation under the influence of soil-forming factors, and able to supply the living organisms with water and nutrients.

DIAGNOSTIC HORIZONS, MATERIALS AND PROPERTIES

The Polish Soil Classification, since its fourth edition (1989), is based on soil features, being the combined results of soil-forming factors and processes, defined in terms of diagnostic horizons, diagnostic

materials and diagnostic properties, all of which to the highest possible extent should be observable and measurable in the field. General concepts and detailed criteria for many diagnostic horizons/materials/properties are taken from WRB2015. However, original Polish concepts, not reflected in an international soil classification, or local specific features of soil cover have led to adding a number of unique diagnostic horizons/materials and changing detailed criteria in the original definitions of many others. To avoid misunderstanding and incorrect classification (correlation), the names of all diagnostic horizons, materials and properties have changed spelling, mainly by replacing the standard ending "-ic" with "ik". All diagnostic horizons, materials and properties defined in Polish Soil Classification, along with brief explanation of their relationships with WRB2015, are listed in tables 1–3.

The criteria for diagnostic horizons/materials/properties generally are not fully disjunctive; however, horizons that have similar characteristics differ in at least one disjunctive, restrictive or exclusive criterion, which refers to the specific impacts of pedogenic factors or processes, creating a unique theoretical basis for a given diagnostic horizon. A separate key to diagnostic horizons has not been prepared, but the general key to soil orders and soil types (table 4) clearly indicates the order of analysis/elimination of diagnostic horizons, i.e. suggests which criteria should be taken into account first. In a case of humus-rich dark-coloured topsoil horizon this means for example, that first to be checked are the criteria for *histik/murszik/folik* horizons (the order of organic soils is placed first in the key), then for *hortik/antrik* (anthropogenic soils are placed on the second position in the key) and finally for *arenimurszik/mollik/umbrik*. Similarly, in

TABLE 1. The relationships between diagnostic horizons in Polish Soil Classification (SGP6) and WRB2015

SGP6	Relation to WRB 2015
<i>albik</i>	no equivalent; criteria like for <i>albic material</i> ; refers to Fe, Al and humus depletion (result of podzolization): $\geq 50\%$ of sand grains free of (Fe-)humus coatings; thickness ≥ 1 cm
<i>antrik</i>	no equivalent; criteria like for <i>anthric properties</i> ; phosphorus limits refer to citric acid and Mehlich 3 tests (Kabała et al. 2018); thickness ≥ 30 cm
<i>arenimurszik</i>	no equivalent; criteria like for <i>mollic/umbric</i> (thickness, organic carbon content, colour), but sandy texture and weak binding of mineral fraction and particles of organic matter ($\geq 10\%$ of sand particles has no humus coatings; organic matter easily separates from sand grains at soil grinding in dry state); often derived by drainage and mixing (ploughing) of <i>histik/murszik</i> horizons with underlying sandy subsoil (Łabaz and Kabała 2016)
<i>argik</i>	like <i>argic</i> , excluding criterion 2b (texture differentiation without visible clay coatings); required $\geq 20\%$ clay bridging/coatings
<i>eluwik</i>	no equivalent; criteria like for <i>albic material</i> ; refers to clay depletion (result of eluviation/lessivage): sand particles free of clay coatings and bridges, no coatings on structural aggregates, lower clay content compared to underlying horizon; thickness ≥ 1 cm
<i>folik</i>	like <i>follic</i>
<i>histik</i>	like <i>histic</i> , but <i>organic material</i> requires $\geq 12\%$ of organic carbon
<i>hortik</i>	like <i>hortic</i> , but required thickness ≥ 30 cm and required $pH_w \geq 5.5$ (instead of base saturation $\geq 50\%$); phosphorus limits refer to Olsen and Mehlich 3 tests (Kabała et al., 2018)
<i>kalcik</i>	like <i>calcic</i> , excluding criteria 2b (relative difference of $CaCO_3$ content in comparison to underlying layer) and 3 (petrocalcic)
<i>kambik</i>	like <i>cambic</i> , but sandy texture classes are excluded; larger presence of clay bridges/coatings is allowed ($< 20\%$, complementary to <i>argik</i>)
<i>mollik</i>	like <i>mollic</i> , but required thickness ≥ 30 cm and required $pH_w \geq 5.5$ (instead of base saturation $\geq 50\%$)
<i>murszik</i>	no equivalent; criteria like for <i>histic</i> horizon with additional requirements like for <i>murshic</i> qualifier; refers to peat degradation due to drainage and further pedogenic transformation (including humification and structure development)
<i>rubik</i>	no equivalent; refers to Fe (+Mn) subsurface precipitation at the contact of groundwaters of different origin; criteria similar to <i>rubic</i> qualifier, but hue redder than 7.5YR (and redder than parent material) and chroma ≥ 5 ; thickness ≥ 15 cm
<i>siderik</i>	no equivalent; considered an analogue to <i>cambic</i> horizon, but developed in sandy texture classes (criteria like for <i>brunic</i> qualifier); a Munsell colours 7.5YR or 10YR, value 4–6 and chroma ≥ 3 moist are required (if parent material has above mentioned colours, <i>siderik</i> has redder hue and/or higher chroma and/or lower colour value than parent material); thickness ≥ 15 cm
<i>spodik</i>	like <i>spodic</i>
<i>umbrik</i>	like <i>umbric</i> , but required thickness ≥ 30 cm and $pH_w < 5.5$ (instead of base saturation $< 50\%$) (Kabała and Łabaz 2018)
<i>wertik</i>	like <i>vertic</i>

TABLE 2. The relationships between diagnostic properties in SGP6 and WRB 2015

SGP6	English translation	Relation to WRB2015
<i>fragipan</i>	<i>fragipan</i>	like for <i>fragic</i> horizon, but no thickness requirements
<i>geomembrana</i>	<i>geomembrane</i>	no equivalent; synthetic membrane covering soil surface or dividing soil layers, impermeable or hardly permeable to water and gas
<i>głębokie wymieszanie</i>	<i>deep mixing</i>	no equivalent; deep (≥ 50 cm) mixing of soils (destruction of soil horization, fragments of horizons translocated within soil profile etc.), due to (1) very deep cultivation (ploughing), or (2) construction works; sharp lower boundary; soil surface typically not elevated
<i>lamelle</i>	<i>lamellae</i>	like for <i>lamellic</i> qualifier, but thickness criteria moved to subtype requirement
<i>lita skała</i>	<i>continuous rock</i>	like <i>continuous rock</i> , but cracks occupy $< 5\%$ of the cross section
<i>lita warstwa technogeniczna</i>	<i>technogenic hard layer</i>	like <i>technic hard material</i>
<i>nieciągłość litogeniczna</i>	<i>lithogenic discontinuity</i>	like <i>lithic discontinuity</i> , but textural differentiation resulting from alluvial and colluvial sedimentation is excluded
<i>orsztyn</i>	<i>ortstein</i>	like <i>ortsteinic</i> qualifier
<i>placik</i>	<i>placic</i>	like <i>placic</i> qualifie
<i>ruda darniowa</i>	<i>bog iron</i>	like for <i>ferric</i> horizon, but Fe-Mn-nodules form $> 20\%$ of a layer volume and criteria 1a (mottles) and 2 (relations to <i>plinthic</i>) are not considered
<i>właściwości gruntowo-glejowe</i>	<i>gleyic properties</i>	like <i>gleyic</i> properties
<i>właściwości opadowo-glejowe</i>	<i>stagnic properties</i>	like <i>stagnic</i> properties
<i>zasolenie</i>	<i>salinity</i>	no equivalent; like for <i>salic</i> horizon, but required $EC_e \geq 4$ dS m^{-1} , and $pH_e < 8.5$, and $SAR_e < 13$ or $ESP < 15\%$
<i>zasolenie z sodyfikacją</i>	<i>salinity with sodification</i>	no equivalent; like for <i>salic</i> horizon, but required $EC_e \geq 4$ dS m^{-1} , and $pH_e \geq 8.5$, and $SAR_e \geq 13$ or $ESP \geq 15\%$
<i>sodifikacja</i>	<i>sodification</i>	no equivalent; like for <i>salic</i> horizon, but required $EC_e < 4$ dS m^{-1} , and $pH_e < 8.5$, and $SAR_e \geq 13$ or $ESP \geq 15\%$
<i>zaciekowość eluwialna</i>	<i>eluvial tonguing</i>	like <i>retic</i> properties (including <i>albeluvic glossae</i>)
<i>zakwaszenie siarczanowe</i>	<i>sulfate acidification</i>	like for <i>thionic</i> horizon, but additionally colours of discontinuous accumulations are specified (hue 2.5Y or more yellow and chroma ≥ 6)

TABLE 3. The relationships between diagnostic materials in SGP6 and WRB 2015

SGP6	English translation	Relation to WRB 2015
<i>materiał organiczny</i>	<i>organic material</i>	like <i>organic material</i> , but in materials saturated with water for ≥ 30 consecutive days in most years, or drained, $\geq 12\%$ C_{org} is required, while in materials saturated with water for < 30 days $\geq 20\%$ C_{org} is required
<i>materiał mineralny</i>	<i>mineral material</i>	like <i>mineral material</i> , but in materials saturated with water for ≥ 30 consecutive days in most years $< 12\%$ C_{org} is required and in materials saturated with water for < 30 days in most years $< 20\%$ C_{org} is required
<i>torfy (peats)</i>		
<i>torf fibrowy</i>	<i>fibric peat</i>	criteria for recognizable plant tissue like for <i>fibric</i> qualifier, thickness/depth criteria specified in subtype definitions
<i>torf hemowy</i>	<i>hemic peat</i>	criteria for recognizable plant tissue like for <i>hemic</i> qualifier, thickness/depth criteria specified in subtype definition
<i>torf saprowy</i>	<i>sapric peat</i>	criteria for recognizable plant tissue like for <i>sapric</i> qualifier, thickness/depth criteria specified in subtype definitions
<i>materiały limniczne (limnic materials)</i>		
<i>gytia organiczna</i>	<i>organic gyttja</i>	no equivalent; meets the general criteria for <i>limnic materials</i> , contains $\geq 12\%$ of organic carbon and $< 20\%$ of $CaCO_3$; resilient in a moist state (able to spring back into shape after being compressed); cracking along horizontal planes after drainags

Table 3 continued

<i>gytia węglanowa</i>	<i>calcareous gyttja</i>	no equivalent; meets the general criteria for <i>limnic materials</i> , contains $\geq 12\%$ of organic carbon and $\geq 20\%$ of CaCO_3 ; weak resilience in a moist state; cracking along horizontal planes after drainage
<i>wapień łkowy</i>	<i>meadow limestone (marl)</i>	no equivalent; meets the general criteria for <i>limnic materials</i> , contains $< 12\%$ of organic carbon and $\geq 20\%$ of CaCO_3
<i>mul limnetyczny</i>	<i>lacustrine mud</i>	no equivalent; similar to limnic material (sedimentary peat) – sedimented in ponds, shallow lakes etc.; contains $\geq 12\%$ of organic carbon, meets the criteria of sapric qualifier but may contain lenses/layers of undecomposed plant residues, no evidences of resilience typical for <i>gyttja</i>
<i>mul telmatyczny</i>	<i>telmatic mud</i>	no equivalent; similar to limnic material (sedimentary peat) – sedimented in seasonally flooded wet valleys; contains 12–25% of organic carbon, meets the criteria of <i>sapric</i> qualifier excluding the roots and wood fragments, colour value ≥ 2 and chroma ≥ 2 moist, typically contains easily recognizable admixture (layers, lenses etc.) of mineral fractions, no evidences of resilience typical for <i>gyttja</i>
<i>materiały antropogeniczne (antrophogenic materials)</i>		
<i>artefakty</i>	<i>artefacts</i>	like <i>artefacts</i> ; additional distinction is made between <i>normal artefacts</i> and <i>reactive artefacts</i> (construction lime, ash and slag from metal smelting and coal burning, tailings, mining wastes containing sulfides and native sulfur, phosphogypsum, petrochemistry wastes, chemical industry wastes, bones etc.)
<i>głęboki materiał nasypany</i>	<i>thick heap material</i>	no equivalent, but similar to transportic qualifier; loose, earthen material (may contain skeletal fraction), having $< 20\%$ of <i>artefacts</i> (or $< 10\%$ of <i>reactive artefacts</i>), forming an intentionally constructed layer ≥ 50 cm thick (either an above-ground heap or below-ground infilling); the following expression of intentional heaping is required: sharp or distinct boundary to underlying native material, or underlying material contains artefacts (e.g. ash or construction rubble), or forms a mound (embankment, etc.) ≥ 150 cm high
<i>inne materiały mineralne (other mineral materials)</i>		
<i>materiał deluwialny</i>	<i>colluvial material</i>	like colluvic material, but limited to sediments accumulated in course of slope wash (sheet erosion), whereas landslides and other mass movements are excluded (as well as an eolian, fluvial and anthropogenic accumulation); (a) the following evidences of slope wash and accumulation are required: favourable location (foot slope, accumulation trap, ravine outlet etc.), or buried organic or humus layer, or <i>lithogenic discontinuity</i> in the contact with native soil; and (b) one or more of the following is required: irregular vertical changes in organic carbon content (at $\geq 0.2\%$ organic carbon in at least one of the layers), or homogeneous content of organic carbon ($\geq 0.2\%$) throughout the layer that overlies buried organic or humus horizon, or stratification or sedimentation structures are present
<i>materiał fluwialny</i>	<i>fluvic material</i>	like <i>fluvic material</i>
<i>materiał gruboszkieletowy</i>	<i>coarse-skeletal material</i>	no equivalent; contains $> 60\%$ (vol.) of skeletal fragments (> 2 mm in diameter) and has $> 35\%$ (vol.) of stones or coarser rock fragments
<i>materiał siarczkowy</i>	<i>sulfidic material</i>	like hypersulfidic material, but seasonal or permanent waterlogging is required, and the inorganic sulfidic sulfur content is replaced with a ratio of organic carbon to total sulfur ≥ 20

case of subsurface diagnostic B horizons, the order of analysis/elimination, related to the key to soil orders and types, is as follows: *spodik*, *rubik*, *siderik*, *kambik*.

One of crucial differences between SGP6 and WRB2015 is the required organic carbon content in the *organic materials*. In soils saturated with water for > 30 consecutive days in most years (or drained) $\geq 12\%$ of organic carbon was established at a sufficiently high to enable ecosystem services typical for organic soils (Piaścik and Łachacz 1990). In soils saturated for less than 30 consecutive days per year, the required organic carbon content is $\geq 20\%$, similar to that for WRB2015 (table 3). This difference influ-

ences the definition of the *histik* horizon (table 1) and soil allocation to order and type in the key, in particular the distinction between Histosols and Histic Gleysols (table 4). The other differences in diagnostic horizons are as follows:

- the *mollik* and *umbrik* (and also *antrik* and *arenimurszik*) horizons must be ≥ 30 cm thick (compared to ≥ 20 cm in WRB2015) that prevents an involvement of many normally ploughed soils into *chernozemic soils*,
- the *argik* horizon requires higher content of clay coatings/bridgings ($\geq 20\%$ instead of $\geq 5\%$ in WRB2015) that also influences the wider reco-

- gnition of *kambik* horizon and enables a transitional form of *kambik* with more prominent clay illuviation (Bwt horizon),
- the *albik* and *eluwik* horizons are distinguished instead of albic materials (WRB2015) to reflect pedogenic depletion of Fe/Al/humus and clay fraction in these horizons, respectively,
 - the *murszik* horizon is (traditionally in Poland) separately distinguished from *histik* to reflect pedogenic transformation after drainage, including the development of pedogenic structure in organic horizons (Marcinek and Spsychalski 1998; Piaścik and Gotkiewicz 2004; Piaścik and Łachacz 1990; Rzaśa 1963),
 - the *arenimurszik* horizon is a kind of mineral, sand-textured *mollik* or *umbrik* horizons, separately distinguished to reflect very weak binding of organic matter particles to mineral (sand) grains in topsoil layers developed mostly by advanced degradation of *murszik* horizons (Łabaz and Kabala 2016),
 - *rubik* horizon is a kind of subsurface horizon of Fe (and Mn) accumulation at the contact of various kinds of ground waters, featured by red colours (Jankowski 2013),
 - *siderik* is considered the sandy equivalent for the *kambik* horizon; it may be easily correlated with a Brunic qualifier in WRB2015 (Bednarek 1991).

Many diagnostic properties distinguished in SGP6 (table 2) have the same or very similar definitions to their equivalents in WRB2015, in particular *stagnic* and *gleyic properties*. A number of properties in SGP6 have in WRB2015 close equivalents in diagnostic materials (e.g. *lita skała/continuous rock*, *lita warstwa technogeniczna/technic hard material*), or in diagnostic horizons (e.g. *ruda darniowa/ferric* (Czerwiński and Kaczorek 1996), *fragipan/fragic* (Szymański et al. 2011), *zasolenie/salic*, *zakwaszenie siarczanowe/thionic* (Hulisz 2007, Hulisz et al. 2017)), or in qualifiers (*lamellic*, *ortsteinic*, *placic*). SGP6 provides unique definitions for *geomembrane* and *deep mixing* (in situ), both applied to classify the techno-genic soils (table 2). Also, numerous specific diagnostic materials, besides the materials similar to those present in WRB2015 (table 4), are distinguished in SGP6:

- the terms *fibrik*, *hemik* and *saprik* are applied to peats only as for primary organic materials,
- *gyttja* (Łachacz et al. 2009), *lacustrine* and *telmatic organic muds* (Kalisz and Łachacz 2008; Mendyk et al. 2015, Okruszko 1969, Roj-Rojewski and Walasek 2013), and *meadow limestone/marl* (Jarnuszewski and Meller 2018) are distinguished among *limnic materials*,

- *thick heap material* (*głęboki materiał nasypany*) is a soil layer ≥ 50 cm thick, poor in artefacts, intentionally displaced/transported to create the convex relief form (e.g. dam, road/railway embankment etc.), or to fulfil the concave form, or to level the ground surface (Charzyński et al. 2013b),
- *artefacts* have been distinguished into "normal" (for example concrete and stones) and "reactive" (e.g. ash, slag, tailings), to reflect their different reactivity and toxicity in soil environments (Charzyński et al. 2013a, Uzarowicz et al. 2017),
- *coarse skeletal material* reflects the specific composition of many mountain soils, influenced by weathering, denudation and slope processes (Drewnik 2008, Kacprzak et al. 2006, 2013; Skiba and Komornicki 1983),
- *colluvial material* (*materiał deluwialny*) has a definition related to the results of surface wash (sheet erosion) accelerated mainly by humans (due to removal of native vegetation and ploughing) and not to the landslides, creep and other slope mass movement/wasting (Świtoniak 2014, 2015).

CLASSIFICATION SCHEME

The SGP6 is a scientific system of soil units' allocation, hierarchical at the higher level of classification, and non-hierarchical (optional) at a lower level. There are three hierarchical categories in SGP6: soil order, soil type and soil subtype, supplemented by three non-hierarchical categories: soil variety, soil genus and soil species. Hierarchical units have a strict affiliation (allocation) to higher-order units and individual (unique) definitions, i.e. sets of requirements/criteria. Non-hierarchical units, on the other hand, are in the majority not assigned to particular higher-order units, but due to their universal definitions, they can be added to any order, type or subtype, if all the criteria listed in their definitions are met. Soil subtypes have an intermediate position, because on one hand they are listed in a hierarchical sequence, exclusive for each soil type, but many subtypes have universal definitions, identical through the classification (that make them similar to the principal qualifiers in WRB 2015, which also are hierarchically listed within each Reference Soil Group, but have universal definitions/criteria).

Soil type is the basic classification unit of SGP6. It is distinguished based on a specific sequence of genetic horizons, developed from a specific parent material and under specific environmental conditions. Thus, the soil type is featured not only by the presence of certain genetic or diagnostic horizons, but also the presence of associated properties or materials of

primary importance for the soil origin and the uniqueness of its physicochemical and biological properties. For distinguishing soil types, the traditions of Polish pedology have high importance.

The highest classification category is the soil order. It is distinguished based on the presence (or absence) of diagnostic horizons that reflect the action of particular soil-forming processes that transform the original parent material under specific environmental conditions, with a smaller or larger human contribution; taking into account the time perspective, i.e. the duration of pedogenic processes from the exposure, deposition or redeposition of the parent material. Soil orders are sets of soil types (basic classification units) and are distinguished mainly for systematic ordering of soil units and higher clarity of classification, as well as for a comprehensive review of the impact of main soil-forming factors and processes on the soil cover structure in Poland. Technically, the soil orders support rapid allocation of soils under classification to appropriate classification units. The limited number of nine orders makes it easy to remember the structure of classification and to understand the fundamental differences between the major classification units. First of all, however, the soil orders, as a collective and the highest classification categories, indicate the priorities of classification system, particularly useful where more than one diagnostic

horizon or various diagnostic properties and materials are simultaneously present in the soil profile. The Polish Soil Classification (SGP6) distinguishes 30 soil types grouped in nine orders (fig., tables 4–5). The sequence of soil orders is retained after earlier versions of Polish Soil Classifications, i.e. starts with weakly developed soils, followed by better developed mineral soils with diagnostic horizons, then hydromorphic soils, organic soils, and anthropogenic soils as the last order (table 6). This sequence reflects the advancement of (mineral) soil development and is regarded the formal construction of SGP6. However, the arrangement of soil orders in the key (table 4) is different, that was technically necessary to highlight the priorities of diagnostic features and to simplify the classification process.

The soil subtype is distinguished to emphasize the diversity of morphological or physicochemical features within the soil type, having high importance for the interpretation of the soil origin and its expected future evolution, as well as to stress the specific environmental soil functions. Among the subtypes, the following categories are distinguished:

1. **"typical" subtypes** – represent the most characteristic for the type expression of soil features, including the sequence of genetic horizons or combinations of diagnostic horizons and properties; in the list of subtypes they are logically always placed as last;

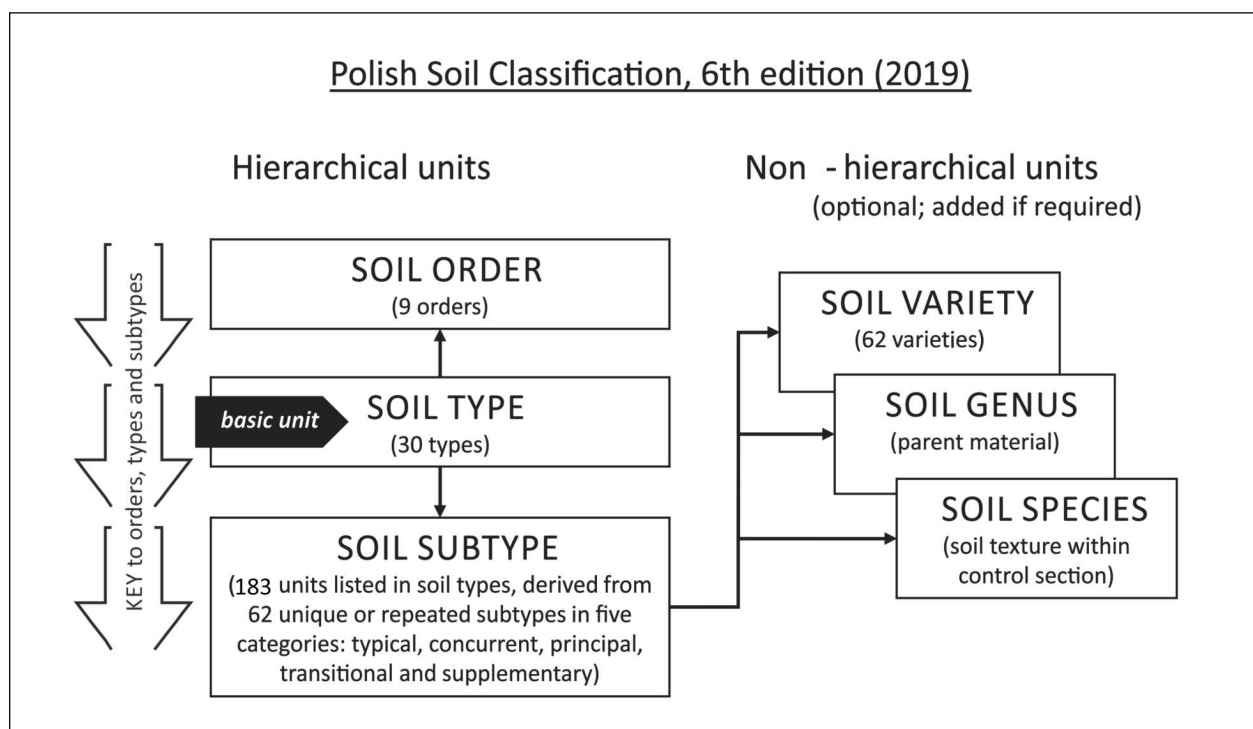


FIGURE. Architecture of the SGP6

TABLE 4. Key to soil orders and soil types

SOIL ORDERS	SOIL TYPES
Soils having <i>organic material</i> , either: 1. starting ≥ 30 cm from the soil surface and having within ≥ 60 cm from the soil surface combined thickness of ≥ 30 cm; or 2. starting at the soil surface and having a thickness of ≥ 10 cm, directly overlying <i>continuous rock</i> or coarse fragments the interstices of which are filled with organic material to the depth of ≥ 30 cm from the soil surface GLEBY ORGANICZNE	Organic soils having <i>murszik</i> horizon ≥ 30 cm thick Gleby murszowe Other organic soils which, <i>below murszik</i> horizon < 30 cm thick (if present), have <i>peat</i> that constitute $> 50\%$ of <i>organic material</i> within ≥ 100 cm or $> 50\%$ of all <i>organic material</i> if it does not reach the depth of 100 cm Gleby torfowe Other organic soils having <i>limnic material</i> Gleby limnowe Other organic soils Gleby ściółkowe
Other soils: 1. having an <i>antrik</i> or <i>hortik</i> horizon ≥ 50 cm thick; or 2. having <i>technogenic hard layer</i> or <i>geomembrane</i> of any thickness on the soil surface or starting within ≥ 100 cm of soil surface; or 3. <i>deeply mixed</i> or having <i>the thick heap material</i> , or having a combination of these two features reaching the depth ≥ 50 cm (if individually they do not fulfill the thickness for <i>deep mixing</i> or <i>thick heap material</i>); 4. having: (A) $\geq 20\%$ (vol., weigh. average) of <i>artefacts</i> in the upper 100 cm soil layer (or to <i>continuous rock/technogenic hard layer</i> if shallower), or (B) $\geq 10\%$ (vol., weigh. average) of <i>reactive artefacts</i> in the upper 100 cm soil layer (or to <i>continuous rock/technogenic hard layer</i> if shallower) GLEBY ANTROPOGENICZNE	Soils that meet both: (a) have an <i>antrik</i> or <i>hortik</i> horizon ≤ 50 cm thick, or fulfill the criteria for <i>deep mixing</i> caused by agricultural, horticultural or forest management and contain $< 20\%$ (vol., weigh. average) of <i>artefacts</i> to the depth of 100 cm from the soil surface, and (b) do not have <i>geomembrane</i> or <i>technogenic hard layer</i> starting ≥ 100 cm from the soil surface Gleby kulturozienne Other soils Gleby technogeniczne
Other soils having both (a) a <i>wertik</i> horizon starting ≥ 100 cm from the soil surface, and (b) $\geq 30\%$ clay in all soil layers from the soil surface to the <i>wertik</i> horizon GLEBY PECZNIEJĄCE	All soils that the criteria for the soil order Vertisole
Other soils having a <i>mollik</i> , <i>umbrik</i> or <i>arenimurszik</i> horizon (≥ 30 cm thick) GLEBY CZARNOZIEMNE	Soils having an <i>arenimurszik</i> horizon Gleby murszowate Other soils located on the Holocene alluvial terraces and having <i>fluvic material</i> starting ≥ 150 cm from the soil surface Mady czarnoziemne Other soils having <i>mollik</i> horizon, and: (a) have a continuous/weathered calcareous or gypsum rock starting ≥ 40 cm, or (b) directly below the humus horizon, have a layer ≥ 30 cm thick (or down to <i>continuous rock</i> , if shallower), which contains carbonates (or gypsum) in the fine earths and $\geq 10\%$ (weigh. average) of calcareous/gypsum rock fragments in the skeleton fraction (i.e. ≥ 2 mm in diameter), or (c) directly below the humus horizon have a layer ≥ 30 cm thick of <i>limnic material</i> containing $\geq 40\%$ CaCO_3 Rędziny czarnoziemne Other soils having the surface layer of <i>colluvial material</i> ≥ 50 cm thick, or ≥ 30 cm thick, if the colluvial material overlies the <i>organic material</i> Gleby deluwialne czarnoziemne Other soils having a <i>mollik</i> horizon and $\text{pH}_w \geq 5.5$ prevailing to a depth of 100 cm from the soil surface, and having one or both of the following: (a) <i>gleyic properties</i> , or (b) <i>stagnic properties</i> covering $> 80\%$ of the soil layer cross-section and having thickness of ≥ 25 cm, both starting 80 cm from the soil surface (or directly below the humus horizon, if > 80 cm thick) Czarne ziemie

Table 4 continued

SOIL ORDERS	SOIL TYPES
	Other soils having (a) <i>mollik</i> horizon, and (b) <i>kalcik</i> horizon or the layer containing secondary (pedogenic) carbonates both starting ≥ 150 cm from the soil surface Czarnoziemy
	Other soils having a <i>mollik</i> or <i>umbrik</i> horizon Gleby szare
Other soils having an <i>argik</i> horizon starting ≤ 100 cm from the soil surface GLEBY PŁOWOZIEMNE	All soils that meet the criteria for the soil order Gleby płowe
Other soils having a <i>spodik</i> horizon starting ≤ 100 cm from the soil surface, or starting ≤ 75 cm from the soil surface if <i>coarse-skeletal material</i> is present and starts from the soil surface GLEBY BIELICOZIEMNE	All soils that meet the criteria for the soil order Gleby bielicowe
Other soils having, either: 1. <i>gleyic properties</i> starting ≤ 30 cm from the soil surface; or 2. <i>stagnic properties</i> covering $\geq 50\%$ of the soil layer that starts ≤ 25 cm from the soil surface and is directly underlain by layer with <i>gleyic properties</i> , or 3. <i>stagnic properties</i> covering $\geq 50\%$ of the soil layer (in every subhorizon) starting from ≤ 25 cm and having thickness ≥ 50 cm or ≤ 25 cm, if directly underlain by <i>continuous rock</i> or impermeable (hardly permeable) soil layer GLEBY GLEJOZIEMNE	Soils with <i>gleyic properties</i> starting ≥ 30 cm from the soil surface Gleby gruntowo-glejowe
	Other soils Gleby opadowo-glejowe
Other soils having a <i>kambik</i> , <i>siderik</i> or <i>rubik</i> horizon, or soils having a B horizon that meets the criteria for <i>kambik</i> horizon, except of texture, which may be sandy in a part of the horizon GLEBY BRUNATNOZIEMNE	Soils having a <i>rubik</i> horizon Gleby ochrowe
	Other soils located on the Holocene alluvial terraces, polders, or plain sea/lake shores having <i>fluvic material</i> starting ≤ 150 cm from the soil surface Mady brunatne
	Other soils, which: (a) have a continuous/weathered calcareous or gypsum rock starting ≤ 40 cm from the soil surface, or (b) in the layer from 30 cm down to 60 cm (or down to <i>continuous rock</i> , if shallower) contains carbonates (or gypsum) in the fine earths and $\geq 10\%$ (weigh. average) of calcareous/gypsum rock fragments in the skeleton fraction (i.e. ≥ 2 mm in diameter) Rędziny brunatne
	Other soils having a <i>kambik</i> horizon Gleby brunatne
	Other soils Gleby rdzawe
Other soils GLEBY SŁABO UKSZTAŁTOWANE	Soils having: (a) combined thickness of all organic and mineral layers to the <i>continuous rock</i> ≤ 10 cm, or (b) combined thickness of O+A+E+B+BC horizons (if present) in a loose material, including <i>coarse-skeletal material</i> , ≤ 10 cm Gleby inicjalne
	Other soils located on the Holocene alluvial terraces, polders, or plain sea/lake shores having <i>fluvic material</i> starting ≤ 50 cm from the soil surface Mady właściwe

Table 4 continued

Other soil, which: (a) have a continuous/weathered calcareous or gypsum rock starting ≥ 30 cm from the soil surface, or (b) in the layer from 30 cm down to 60 cm (or down to <i>continuous rock</i> , if shallower) contains carbonates (or gypsum) in the fine earths and $\geq 10\%$ (weigh. average) of calcareous/gypsum rock fragments in the skeleton fraction (i.e. ≥ 2 mm in diameter), or (c) have a layer ≥ 30 cm thick, starting ≥ 30 cm from the soil surface, of drained <i>limnic material</i> containing $>40\%$ CaCO_3	Rędziny właściwe
Other soils having a <i>continuous rock</i> starting ≥ 50 cm from the soil surface	Rankery
Other soils having the surface layer of colluvial material ≥ 50 cm thick, or ≥ 30 cm thick if colluvial material overlies the organic material	Gleby deluwialne właściwe
Other soils having: (a) a sandy texture (sand or loamy sand classes) to a depth ≥ 100 cm from the soil surface and the layers of finer texture <10 cm thick (in total), and (b) $<40\%$ of skeletal fragments, excluding the buried periglacial/moraine pavement, to a depth of 100 cm from the soil surface, and (c) layer(s) containing $\geq 2\%$ CaCO_3 has a (total) thickness <10 cm to a depth of 50 cm or <30 cm to a depth of 100 cm from the soil surface	Arenosole
Other soils	Regosole

2. **"concurrent" subtypes** – substitute the "typical" subtype in soil types, if at least two subtypes have the features equally typical for the soil type (e.g. *fibric*, *hemic* and *sapric* subtypes in *peat soils*, or *ordinary*, *leached* and *acid* subtypes in *brown soils*); they are listed at the beginning of the list of subtypes;
3. **"principal" subtypes** – refer to additional features of primary importance for the interpretation of soil genesis, land use or environmental functions of the soil; their names are used instead of (replace) the name of soil type, also in combinations with other subtypes; however, the priority subtype does not combine with any other priority subtype; unique names of the priority subtypes aims to preserve the traditional soil nomenclature, i.e. soil names that have become established in Polish pedology, and to simplify (shorten) the soil names; the primary subtypes are marked with the symbol * (asterisk) in the hierarchical lists;
4. **"transitional" subtypes** – refer to the presence of the horizons and properties that are diagnostic for other soil types, but in a given soil type are considered less important (e.g. the *kambik* horizon in a *chernozemic soil*) or are weakly developed (e.g. have Fe-illuvial horizon that does not meet the criteria for *spodik*), or occur too deep (e.g. strong *gleyic properties* at a depth of 50–70 cm);
5. **"supplementary" subtypes** – indicate a special expression of pedogenic features or the presence of specific soil properties or materials.

A new, non-hierarchical classification category is the soil variety. Its concept is derived from the Classification of Forest Soils of Poland (Klasyfikacja gleb leśnych Polski 2000) and is close to the concept of supplementary qualifiers of WRB 2015. Soil variety is optionally added to indicate (a) lithogenic or pedogenic (secondary) features accompanying the main soil-forming process, (b) particularly strong, or adversely, relatively poor expression of features potentially important for soil classification, (c) restrictions for soil use, including anthropogenic transformation, salinity and soil pollution, (d) soil trophic potential for forest habitats (Brożek et al. 2000), etc. Soil varieties have the same (universal) definitions throughout the classification that allows an identification of a given soil feature regardless of the soil order or type. Moreover, the third and subsequent subtypes, if their diagnostic features were identified in the soil under classification, may be listed as soil variety (taking into account that only two subtypes may be applied in this rank). Also, the subtype not included in the hierarchical list of subtypes within the particular soil type of SGP6 may be indicated as an additional soil variety, if its diagnostic features were identified in a soil profile under consideration (table 6).

The non-hierarchical category of soil genus determines the kind of parent material from which the soil was developed, taking into account its variability (lithological discontinuity) within the profile. And the last, non-hierarchical category of soil species deter-

mines the soil texture (particle-size distribution) throughout the soil profile, also taking into account possible variability (that may be both of pedogenic or lithogenic origin). The names of texture classes in SGP6 are used after the Soil Texture Classification of Soil Science Society of Poland (2009).

BRIEF DESCRIPTION AND CORRELATION OF MAJOR SOIL UNITS

The correlation table (table 5) includes the closest English translations for the Polish names of soil orders, types and subtypes (SGP6), as well as their most common and typical equivalents in WRB2015 and ST2014 classifications. The correlation table was developed taking into account previous statements of Kabała et al. (2016) and Świtoniak et al. (2016).

The first order, *weakly developed soils (gleby słabo ukształtowane)*, brings together soils (a) at the early (initial) stage of development, where the thickness of soil profile (regolith) to the continuous rock is ≥ 10 cm or the combined thickness of all genetic horizons (O+A+E+B, if present) in an unconsolidated material is ≥ 10 cm, and (b) soils at early stage of development, thicker than initial (raw) soils, but without any diagnostic horizon except for *folik*. WRB2015 allocates such soils among different RSGs characterized by little or no profile differentiation. The first type of *raw mineral soils* (table 5) consists of six subtypes of *raw siliceous rocky* and *raw rendzina rocky soils* correlated with (Calcaric) Lithic Leptosols, *raw siliceous debris* and *raw rendzina debris soils* correlated with (Calcaric) Hyperskeletal Leptosols (Lasota et al. 2018), *raw alluvial soils* (Fluvisols) and *raw unconsolidated soils* (Protic Regosols). The other five soil types include weakly developed soils, but thicker than raw (initial) soils. *Rankers*, siliceous soils with continuous rock at ≥ 50 cm belong to Leptosols; however, they may have a sequence of clearly developed (but not diagnostic) horizons. *Ordinary rendzinas* are in the majority shallow and skeletal soils rich in primary (lithogenic) carbonates (Calcaric Leptosols), but may have a *folik* horizon (Miechówka and Drewnik 2018). *Ordinary rendzinas* do not have diagnostic horizons in terms of SGP6; whereas they may have mollic in line with WRB2015 requirements (if A is ≥ 20 cm thick). In this case, *the humic ordinary rendzinas* are correlated with Calcaric Leptic Phaeozems (Kabała 2018, Kowalska et al. 2019). The type of *ordinary alluvial soils* involves young soils on Holocene terraces, developed from fluvic material, lacking diagnostic horizons (Fluvisols). *Ordinary colluvial soils* are featured by evidence of successive accumulation of soil material

(thicker than 50 cm, or 30 cm if settled directly on peat) eroded from the above-located arable hill-slopes (Colluvic Regosols or Colluvic Arenosols). Arenosols in SGP6 are weakly developed sandy soils correlated with Arenosols in WRB2015, but the soil type in SGP6 is much "narrower" than its equivalent in WRB and does not include the initially developed and colluvial arenosols. Also, the Brunic Arenosols (WRB 2015), termed *rusty soils* in Poland, are moved from *arenosols* to *rusty soils* due to a thick subsurface Bv horizon, considered a diagnostic horizon (*siderik*) in SGP6. And the last soil type, *regosols*, may be easily correlated with Regosols in WRB2015.

The 2nd order, *brown earths (gleby brunatnoziemne)*, brings together soils that have *kambik*, *rubik* or *siderik* diagnostic horizons (comments regarding these horizons are summarized in table 1). Therefore, particular types of *brown earths* of SGP6 can be correlated with different RSGs of WRB2015. *Brown soils* (a type) typically refer to Eutric and Dystric Cambisols; *brown rendzinas* are correlated with Calcaric/Dolomitic Cambisols (Kowalska et al. 2017, Zagórski 2003) and *brown alluvial soils* are correlated with Fluvic Cambisols (Ligeża 2016). The main reason to separate the brown rendzinas and brown alluvial soils from "ordinary" brown soils is the different parent material, different landscape position and different ecosystem/habitat functions of these soils. The other two soil types, *ochrous* and *rusty soils* are primarily sandy soils (developed from glaciofluvial, eolian and older alluvial sands), thus belonging to Arenosols in WRB2015. However, they have well-developed *rubik* or *siderik* subsurface diagnostic horizons, not recognized in WRB 2015, but easily correlated with Rubic/Chromic or Brunic qualifiers, respectively (Jankowski 2013).

The 3rd order, *podzolic soils (gleby bielicoziemne)*, covers the soils with a *spodik* horizon, merged in one soil type – *gleby bielicowe*, closely related to Podzols of WRB2015. The soil type includes several subtypes related in the majority to redoximorphic features and various organic horizons developed at the soil surface (Chodorowski 2009, Kabała et al. 2012, Waroszewski et al. 2013). In Polish tradition, *podzolic soils* having and lacking topsoil A horizon are distinguished into separate units, a fact which also influences the number of subtypes and their combinations in SGP6. Moreover, only the podzols with clearly preserved eluvial horizon (*albik*) are considered the "typical", whereas *podzolic soils* lacking *albik* are classified as *latent podzolic soils* ("krypto-podzols"). The placement of *podzolic soils* after, not before, the *chernozemic soils* in the key to soil orders excludes the soils with *mollik/umbrik* horizons from *podzolic soils* in SGP6.

TABLE 5. English translations and the closest typical international equivalents for soil orders, types and subtypes distinguished in the Polish Soil Classification (2019)

Soil type	Soil subtype	Original Polish name	English translation	WRB 2015; equivalent	ST 2014 equivalent
Original name <i>English translation</i>					
Order 1 – Gleby słabo ukształtowane – Eng.: weakly developed soils – WRB 2015: Leptosols, Regosols, Arenosols, Fluvisols – ST 2014: Entisols					
Gleby inicjalne <i>Raw mineral soils</i>	litosole* ¹		<i>raw siliceous rocky soils (lithosols)</i>	Lithic/Nudolithic Leptosols	Lithic Udorthents ²
	rędziny inicjalne skaliste		<i>raw rocky rendzinas</i>	Calcaric Lithic Leptosols	Lithic Udorthents
	rędziny inicjalne rumoszone		<i>raw debris rendzinas</i>	Calcaric Hyperskeletal Leptosols	Typic Udorthents
	mady inicjalne		<i>raw alluvial soils</i>	Gleyic Fluvisols (Protic)	Typic/Aquic Udifluvents
	gleby inicjalne rumoszone		<i>raw siliceous debris soils</i>	Hyperskeletal Leptosols	Typic Udorthents
	gleby inicjalne luzne		<i>raw unconsolidated soils</i>	Protic Arenosols; Protic Regosols	Typic Udipsamments; Typic Udorthents
Rankery <i>Rankers</i>	typowe		<i>typical rankers</i>	Dystric/Eutric Skeletal Leptosols (Ochric)	Lithic Udorthents
	próchnicze		<i>humic rankers</i>	Dystric/Eutric Skeletal Leptosols (Humic)	Humic Lithic Dystrudepts
	zbrunatniałe		<i>brown rankers</i>	Dystric/Eutric Leptosols	Lithic Udorthents
	zielcowane		<i>podzolic rankers</i>	Dystric Leptosols (Albic/Protospodic)	Lithic Udorthents
	butwinowe		<i>raw-humus rankers</i>	Dystric Follic Leptosols	Humic Dystrudepts
Rędziny właścawe Ordinary rendzinas	typowe		<i>typical ordinary rendzinas</i>	Calcaric/Dolomitic Leptosols (Ochric)	Typic/Lithic Udorthents
	pararzędziny właściwe*		<i>ordinary pararendzinas</i>	Skeletal Calcisols; Calcaric Regosols	Typic Udorthents, Typic Eutruudepts
	rumoszone		<i>debris ordinary rendzinas</i>	Calcaric Hyperskeletal Leptosols	Typic Udorthents
	pojeziorne		<i>limnic ordinary rendzinas</i>	Calcaric Fluvisols	Typic/Mollic Fluvaquents
	próchnicze		<i>humic ordinary rendzinas</i>	Calcaric/Dolomitic Leptosols (Humic); Calcaric Leptic Phaeozems	Typic/Entic Haprendolls
	butwinowe		<i>raw-humus ordinary rendzinas</i>	Calcaric Follic Leptosols	Humic Lithic Eutruudepts
Mady właścawe Ordinary alluvial soils	typowe		<i>typical ordinary alluvial soils</i>	Dystric/Eutric Fluvisols (Ochric)	Typic Udifluvents
	próchnicze		<i>humic ordinary alluvial soils</i>	Dystric/Eutric Fluvisols (Humic); Fluvic Phaeozems	Mollic Udifluvents
	gruntowo-glejowe		<i>gleyic ordinary alluvial soils</i>	Gleyic Fluvisols	Aquic Udifluvents
	opadowo-glejowe		<i>stagnogleyic ordinary alluvial soils</i>	Stagnic Fluvisols	Oxyaquic Udifluvents

¹ Asterisk * indicates a principal soil subtype (its name replaces the soil type name, when used; principal subtype cannot be combined with any other principal subtype).

² Some raw mineral soils, rankers and rendzinas located in the highest parts of the Carpatian and Sudeten Mountains may have cryic soil temperature regime, thus may belong to the respective subgroups of Cryorthents, Dystricypts and Haplocrypts.

Table 5 continued

Gleby deluwialne właściwe Ordinary Colluvial soils	Colluvic Regosols Arenosols, (Colluvic); Orthents Quartz-psammments	typowe	typical ordinary colluvial soil	Colluvic Regosols (Ochric); Arenosols Distract/Eutric Arenosols (Colluvic, Ochric)	Typic Udorthents; Typic Quartzpsammments
		próchniczne	humic ordinary colluvial soils	Colluvic Regosols (Humic); Arenosols (Colluvic, Humic); Haplic Phaeozems (Colluvic)	Typic Udorthents; Typic Quartzpsammments;
		natorfowe	ordinary colluvial soils on peat	Novic Histosols (Colluvic); Colluvic Regosols (or Dystric/Eutric Arenosols (Colluvic) over Histosols	Terric Haplosaprists/Haplohemists
		gruntowo-glejowe	gleyic ordinary colluvial soils	Colluvic Gleyic Regosols; Gleyic Arenosols (Colluvic)	Aquic Udorthents; Aquic Quartzpsammments
		opadowo-glejowe	stagnogleyic ordinary colluvial soils	Colluvic Stagnic Regosols	Oxyaquic Udorthents
Arenosole Arenosols	Arenosols; Quartz-psammments	typowe	typical arenosols	Dystric/Eutric Arenosols (Ochric)	Typic Quartzpsammments
		murszowate	semimurshic arenosols	Dystric/Eutric Arenosols (Humic, Nechic)	Typic Quartzpsammments
		próchniczne	humic arenosols	Dystric/Eutric Arenosols (Humic)	Typic Quartzpsammments
		rdzawe	rusty arenosols	Dystric/Eutric Arenosols	Typic Quartzpsammments
		zbielcowane	podzolic arenosols	Albic Arenosols (Protospodic)	Spodic Quartzpsammments
		gruntowo-glejowe	gleyic arenosols	Gleyic Arenosols	Aquic Quartzpsammments
Regosole Regosols	Regosols; Orthents	typowe	typical regosols	Dystric/Eutric Regosols (Ochric)	Typic Udorthents
		rumoszone	debris regosols	Skeletal Regosols	Typic Udorthents
		próchniczne	humic regosols	Dystric/Eutric Regosols (Humic)	Typic Udorthents
		zbrunatniałe	brown regosols	Dystric/Eutric Regosols	Typic Udorthents
		zbielcowane	podzolic regosols	Dystric Regosols (Albic, Protospodic)	Typic Udorthents
Order 2 – Gleby brunatnoziemne – Eng.: brown earths – WRB 2015: Cambisols, Arenosols – ST 2014: Inceptisols					
Gleby brunatne Brown soils	Cambisols; Orthents	właściwe	ordinary brown soils	Eutric/Endocalcaric Cambisols	Typic Eutrudepts
		wylugowane	leached brown soils	Eutric/Epidystric Cambisols	Dystric Eutrudepts
		zbielcowane	podzolic brown soils	Dystric Cambisols (Protospodic)	Spodic Dystrudepts
		kwaśne	acid brown soils	Dystric Cambisols	Typic Dystrudepts
		próchniczne	humic brown soils	Eutric/Dystric Cambisols (Humic); Cambic Phaeozems	Humic Eutrudepts/Dystrudepts
		gruntowo-glejowe	gleyic brown soils	Gleyic Cambisols	Aquic Eutrudepts/Dystrudepts
		opadowo-glejowe	stagnogleyic brown soils	Stagnic Cambisols	Oxyaquic Eutrudepts/Dystrudepts
		rumoszone	debris brown soils	Skeletal Cambisols	Typic Eutrudepts/Dystrudepts

Table 5 continued

Rędziny brunatne <i>Brown rendzinas</i>	typowe pararędziny brunatne* rumoszone próchniczne	<i>typical brown rendzinas</i> <i>brown pararendzinas</i> <i>debris brown rendzinas</i> <i>humic brown rendzinas</i>	Dolomitic/Calcaric Leptic Cambisols (Ochric) Calcaric Cambisols Calcaric Skeletic Cambisols Calcaric Cambisols (Humic); Calcaric Cambic Phaeozems	Rendollic Eutrudepts Typic/Rendollic Eutrudepts Rendollic Eutrudepts Rendollic Eutrudepts
Mady brunatne <i>Brown alluvials</i>	typowe mady rdzawe* próchniczne	<i>typical brown alluvial soils</i> <i>rusty alluvial soils</i> <i>humus brown alluvial soils</i>	Fluvis Cambisols (Ochric) Fluvis Brunic Arenosols; Brunic Regosols (Fluvis) Fluvis Cambisols (Humic); Cambic Fluvis Phaeozems	Fluventic Eutrudepts Typic Udipsamments Fluventic Eutrudepts
Gleby ochrowe <i>Ochrous soils</i>	gruntowo-glejowe opadowo-glejowe typowe	<i>gleyic brown alluvial soils</i> <i>stagnogleyic brown alluvial soils</i> <i>typical ochrous soils</i>	Fluvis Gleyic Cambisols Fluvis Stagnic Cambisols Rubic/Chromic Arenosols (Ochric)	Fluvaquentic Eutrudepts Oxyaquic Eutrudepts Typic Udipsamments
Gleby rdzawe <i>Rusty soils</i>	próchniczne gruntowo-glejowe typowe gleby rdzawo-brunatne* zbielcowane	<i>humic ochrous soils</i> <i>gleyic ochrous soils</i> <i>typical rusty soils</i> <i>brown-rusty soils</i> <i>podzolic rusty soils</i>	Rubic/Chromic Arenosols (Humic) Rubic/Chromic Gleyic Arenosols Brunic Arenosols (Ochric) Dystric Brunic Arenosols; Brunic Regosols (Arenic) (Protosodic)	Typic Udipsamments Aquic Udipsamments Typic Udipsamments Typic Udipsamments Spodic Udipsamments
Gleby bielice <i>Podzolic soils</i>	próchniczne gruntowo-glejowe	<i>humic rusty soils</i> <i>gleyic rusty soils</i>	Brunic Arenosols (Humic) Brunic Gleyic Arenosols	Typic Udipsamments Aquic Udipsamments
Order 3 – Gleby bielicoziemne – Eng.: podzolic soils – WRB 2015; Podzols – ST 2014; Spodosols				
Gleby bielcowe <i>Podzolic soils</i>	typowe bielice* glejobielice* gleby glejobielcowe* stagnobielice* gleby stagnobielcowe* torfowe murszowe murszowate	<i>typical podzolic soils</i> <i>podzols</i> <i>gley-podzols</i> <i>gley-podzolic soils</i> <i>stagnopodzols</i> <i>stagnopodzolic soils</i> <i>peaty podzols</i> <i>murschic podzols</i> <i>semimurschic podzols</i>	Albic Podzols (Ochric) Albic Podzols Gleyic Albic Podzols Gleyic Albic Podzols (Ochric) Stagnic Albic Podzols Stagnic Albic Podzols (Ochric) Gleyic Histic Podzols Gleyic Histic Podzols (Murschic) Gleyic Podzols (Humic)	Typic Haplorhods Typic Haplorhods Aquic Haplorhods Aquic Haplorhods Oxyaquic Haplorhods Oxyaquic Haplorhods Histic Endoaquods/Epiaquods Histic Endoaquods/Epiaquods Umbric Endoaquods/Epiaquods

Table 5 continued

torfiaste	<i>mineral-peaty podzols</i>	Gleyic Podzols (Humic)	Typic Endoaquolls/Epiaquolls
orszynowe	<i>orstein podzolic soils</i>	Orsteinic Podzols	Typic Haplorthods
gleby skrytobielicowe*	<i>latent podzolic soils</i>	Entic Podzols	Typic Haplorthods
rumoszone	<i>debris podzolic soils</i>	Hyperskeletal/Skeletal Podzols	Typic/Lithic Haplorthods
Order 4 – Gleby pługowe – WRB 2015: Luvisols, Planosols, Retisols, Stagnosols – ST 2014: Alfisols			
Gleby pługowe <i>Clay-illuvial soils</i>	<i>typical clay-illuvial soils</i>	Albic Luvisols (Ochric)	Typic Hapludalfs
zerodowane	<i>eroded clay-illuvial soils</i>	Haplic Luvisols	Typic Hapludalfs
dwudzielne	<i>texturally contrasted clay-illuvial soils</i>	Luvic Planosols (Epiarenic; Endoloamic)	Arenic Hapludalfs
lamellowe	<i>lamellic clay-illuvial soils</i>	Lamellic Luvisols (Arenic)	Lamellic Hapludalfs
próchniczone	<i>humic clay-illuvial soils</i>	Haplic/Albic Luvisols (Humic); Luvic Phaeozems	Mollic Hapludalfs; Typic Argialbolls
zbrunatniałe	<i>brown clay-illuvial soils</i>	Albic Luvisols (Neocambic)	Typic Hapludalfs
rdzawe	<i>rusty clay-illuvial soils</i>	Albic Luvisols (Brunic)	Arenic Hapludalfs
zbielcowane	<i>podzolic clay-illuvial soils</i>	Albic Planosols (Protospodic); Albic Alisols (Protospodic)	Arenic Hapludalfs
wertikowe	<i>vertic clay-illuvial soils</i>	Vertic Luvisols; Luvic Vertic Stagnosols	Typic Endoaqualls
podmokłe	<i>waterlogged clay-illuvial soils</i>	Eutric Gleysols (Luvic)	Aquic Hapludalfs
gruntowo-glejowe	<i>gleyic clay-illuvial soils</i>	Gleyic Luvisols	Oxyaquic Hapludalfs
opadowo-glejowe	<i>stagnogleyic clay-illuvial soils</i>	Luvic Stagnosols; Stagnic Luvisols	Typic Glossudalfs
zaciekawe	<i>tonguing clay-illuvial soils</i>	Albic Retisols	Typic Glossudalfs
Order 5 – Gleby czarnoziemne – WRB 2015: Chernozems, Phaeozems, Umbrisols – ST 2011: Mollisols, Inceptisols			
Czarnoziemny <i>Chernozems</i>	<i>typical chernozems</i>	Haplic/Calcic Chernozems	Typic Calcudolls
wyługowane	<i>leached chernozems</i>	Haplic Phaeozems (Bathycalcic)	Typic Hapludolls
iluwiálne	<i>clay-illuvial chernozems</i>	Luvic Chernozems	Typic Argudolls
zbrunatniałe	<i>cambic chernozems</i>	Haplic/Calcic Chernozems (Cambic)	Typic Hapludolls/Calcudolls
opadowo-glejowe	<i>stagnogleyic chernozems</i>	Haplic/Calcic Chernozems (Stagnic)	Oxyaquic Hapludolls/Calcudolls
typowe	<i>typical black earths</i>	Gleyic/Stagnic Phaeozems; Gleyic Chernozems/Haplic chernozems (Stagnic)	Typic Endoaqualls/Epiaqualls Typic Calcicqualls
murszowate	<i>semimurshic black earths</i>	Gleyic Phaeozems (Nechic)	Typic Endoaqualls
wyługowane	<i>leached black earths</i>	Gleyic/Stagnic Phaeozems	Typic Endoaqualls
podmokłe	<i>waterlogged black earths</i>	Mollic Gleysols	Typic Endoaqualls
iluwiálne	<i>clay-illuvial black earths</i>	Luvic Gleyic/Stagnic Phaeozems	Typic Argicqualls
zbrunatniałe	<i>cambic black earths</i>	Cambic Gleyic/Stagnic Phaeozems	Typic Endoaqualls/Epiaqualls
wertikowe	<i>vertic black earths</i>	Vertic Chernozems (Stagnic)	Vertic Endoaqualls
kalkikowe	<i>calcic black earths</i>	Calcic Chernozems (Stagnic); Gleyic Calcic Chernozems	Typic Calcicqualls

Table 5 continued

Rędziny czarnoziemne <i>Chernozemic Rendzinas</i>	typowe pojeziorne	<i>typical chernozemic rendzinas</i> <i>limnic chernozemic rendzinas</i>	Rendzic Phaeozems Rendzic Phaeozems (Limnic)	Typic Haprendolls, Paicic Hapludolls Typic Haprendolls, Fluvaquentic Endoaquolls
Mady czarnoziemne <i>Chernozemic Rendzinas</i>	zbrunatniałe	<i>brown chernozemic rendzinas</i>	Cambic Rendzic Phaeozems	Inceptic Haprendolls
Mady czarnoziemne <i>Chernozemic Rendzinas</i>	typowe	<i>typical chernozemic alluvial soils</i>	Fluvic Phaeozems	Fluentic Hapludolls
Mady czarnoziemne <i>Chernozemic Rendzinas</i>	zbrunatniałe	<i>brown chernozemic alluvial soils</i>	Cambic Fluvic Phaeozems	Fluentic Hapludolls
Mady czarnoziemne <i>Chernozemic Rendzinas</i>	rdzawe	<i>rusty chernozemic alluvial soils</i>	Fluvic Phaeozems (Arenic, Brunic)	Fluentic Hapludolls
Mady czarnoziemne <i>Chernozemic Rendzinas</i>	gruntowo-glejowe	<i>gleyic chernozemic alluvial soils</i>	Fluvic Gleyic Phaeozems	Fluvaquentic Endoaquolls
Mady czarnoziemne <i>Chernozemic Rendzinas</i>	opadowo-glejowe	<i>stagnogleyic chernozemic alluvial soils</i>	Fluvic Stagnic Phaeozems	Fluvaquentic Epiaquolls
Głęby deluwialne czarnoziemne <i>Chernozemic colluvial soils</i>	typowe	<i>typical chernozemic colluvial soils</i>	Haplic Phaeozems (Colluvic)	Typic/Fluentic Hapludolls
Głęby deluwialne czarnoziemne <i>Chernozemic colluvial soils</i>	natorfowe	<i>chernozemic colluvial soils on peat</i>	Haplic Phaeozems (Colluvic) over Histosols	Terric Haplosaprists/ Haplohemists
Głęby deluwialne czarnoziemne <i>Chernozemic colluvial soils</i>	gruntowo-glejowe	<i>gleyic chernozemic colluvial soils</i>	Gleyic Phaeozems (Colluvic), Mollic Gleysols (Colluvic)	Typic/Fluvaquentic Endoaquolls, Fluvaquentic Hapludolls
Głęby deluwialne czarnoziemne <i>Chernozemic colluvial soils</i>	opadowo-glejowe	<i>stagnogleyic chernozemic colluvial soils</i>	Stagnic Phaeozems (Colluvic)	Typic/Fluvaquentic Epiaquolls, Fluvaquentic Hapludolls
Głęby murszowate <i>Semimurshic soils</i>	typowe	<i>typical semimurshic soils</i>	Mollic/Umbric Gleysols (Arenic, Humic)	Typic Humaquepts
Głęby murszowate <i>Semimurshic soils</i>	gleby murszaste*	<i>postmurshic soils</i>	Umbric Gleysols (Arenic, Nechic); Gleyic Umbrisols (Arenic, Nechic)	Typic Humaquepts
Głęby murszowate <i>Semimurshic soils</i>	rdzawe	<i>rusty semimurshic soils</i>	Brunic Gleyic Umbrisols (Arenic, Nechic)	Typic Humaquepts
Głęby murszowate <i>Semimurshic soils</i>	bielcowe	<i>podzolic semimurshic soils</i>	Umbric Podzol (Arenic, Nechic)	Typic Humaquepts
Głęby murszowate <i>Semimurshic soils</i>	rudawcowe	<i>iron-bog semimurshic soils</i>	Umbric Gleysols (Arenic, Ferric, Humic)	Aeric Humaquepts
Głęby szare <i>Grey soils</i>	podmokłe	<i>waterlogged semimurshic soils</i>	Umbric Gleysols (Humic, Nechic)	Typic Humaquepts
Głęby szare <i>Grey soils</i>	typowe	<i>typical grey soils</i>	Haplic Phaeozems	Eutric Humudepts
Głęby szare <i>Grey soils</i>	umbrisołe*	<i>umbrisols</i>	Haplic Umbrisols	Typic/Eutric Humudepts
Głęby szare <i>Grey soils</i>	zbrunatniałe	<i>cambic grey soils</i>	Cambic Phaeozems/Umbrisols	Typic/Eutric Humudepts
Głęby szare <i>Grey soils</i>	iluwialne	<i>clay-illuvial grey soils</i>	Luvic Phaeozems, Luvic/Alic Umbrisols	Mollic Hapludalfs
Głęby szare <i>Grey soils</i>	bielcowe	<i>podzolic grey soils</i>	Umbric Podzols	Eutric Humudepts
Głęby szare <i>Grey soils</i>	gruntowo-glejowe	<i>gleyic grey soils</i>	Gleyic Phaeozems/Umbrisols	Aquic Humudepts
Głęby szare <i>Grey soils</i>	opadowo-glejowe	<i>stagnogleyic grey soils</i>	Stagnic Phaeozems/Umbrisols	Oxyaquic Humudepts
Order 6 – Gleby pęczniące – Eng.: swelling soils – WRB 2015: Vertisols – ST 2014: Vertisols				
Wertisołe <i>Vertisols</i>	typowe	<i>typical vertisols</i>	Haplic Vertisols (Stagnic)	Oxyaquic Hapluderts
Wertisołe <i>Vertisols</i>	czarnoziemne	<i>black vertisols</i>	Pellic Vertisols (Mollic)	Typic Hapluderts
Wertisołe <i>Vertisols</i>	gruntowo-glejowe	<i>gleyic vertisols</i>	<i>Haplic Vertisols (Gleyic)</i>	Typic Endoaquerts

Table 5 continued

Order 7 – Gleby glejowienne – Eng.: gleyzemic soils – WRB 2015: Gleysols, Stagnosols – ST 2014: Entisols, Inceptisols			
Gleby gruntowo- glejowe Gleysols	Gleysols; Endoaquents, Humaquepts	typowe podwodne torfowe gytjowe mułowe murszowe murszowate torfaste próchniczne zbielcowane rudawcowe	typical gleysols subaquatic gleysols peaty gleysols gytja gleysols muddy gleysols murshic gleysols semimurshic gleysols mineral-peaty gleysols humic gleysols podzolic gleysols iron-bog gleysols
		Dystric/Eutric Gleysols Subaquatic Gleysols Histic Gleysols Dystric/Eutric Gleysols (Limnic) Fluvic Histic Gleysols (Limnic) Histic Gleysols (Murshic) Dystric/Eutric Gleysols (Humic, Nechic) Dystric/Eutric Gleysols (Humic) Dystric/Eutric Gleysols (Humic) Dystric Albic Gleysols (Protospodic) Dystric/Eutric Gleysols (Ferric)	Typic Endoaquents Typic Haplowassents Histic Humaquepts Typic Endoaquents Histic Humaquepts Histic Humaquepts Typic Humaquepts Typic Humaquepts Mollic Endoaquents, Typic Humaquepts Humaqueptic Endoaquents Aeric Endoaquents
Gleby opadowo- glejowe Stagnols	Stagnosols; Eptiaquents	typowe gleby epiglejowe* gleby amfglejowe* murszowe torfaste zbielcowane	typical stagnosols epistagnosols amphistagnosols murshic stagnosols mineral-peaty stagnosols podzolic stagnosols
		Dystric/Eutric Stagnosols Dystric/Eutric Stagnosols Gleyic Stagnosols Histic Stagnosols (Drainic) Dystric/Eutric Stagnosols (Humic) Dystric/Albic Stagnosols (Protospodic)	Typic Eptiaquents Typic Eptiaquents Typic Endoaquents Histic Humaquepts Humaqueptic/Mollic Endoaquents Typic Eptiaquents
Order 8 – Gleby organiczne – Eng.: organic soils – WRB 2015: Histosols, Histic Gleysols – ST 2014: Histosols			
Gleby torfowe Peat soils	Histosols; Sapristis, Hemists, Fibrists	gleby natorfowe* fibrowe hemowe saprowe murszowe gytjowe mułowe	earth-covered peat soils fibric peat soils hemic peat soils sapric peat soils murshic peat soils gytja peat soils muddy peat soils
		Fibric/Hemic/Sapric Histosols (Novic) Fibric Histosols Hemic Histosols Sapric Histosols Murshic Histosols Murshic Histosols (Limnic) Murshic Histosols (Fluvic/Limnic)	Terric Haplosapristis/ Haplohemists/Haplofibrists Sphagnofibrists, Haplofibrists Haplohemists Haplosapristis Haplosapristis Limnic Haplosapristis/Haplohemists Fluvaqueptic Haplosapristis/ Haplohemists
Gleby limnowe Limnic soils	Histosols (Limnic); Limnic Haplosapristis/ Haplohemists	gleby gytjowe* gleby mułowe* podwodne torfowe murszowe	gytja soils muddy soils subaquatic limnic soils peaty limnic soils murshic limnic soils
		Sapric Histosols (Limnic) Sapric Histosols (Fluvic/Limnic) Subaquatic Histosols (Limnic) Histosols (Limnic) Murshic Histosols (Limnic)	Limnic Haplosapristis/Haplohemists Limnic Haplosapristis/Haplohemists Sapric/Hemic Haplowassists Limnic Haplosapristis/Haplohemists Limnic Haplosapristis

Table 5 continued

Gleby murszowe <i>Murshic soils</i>	Murshic Histosols; <i>Sapristis Hemists, Fibristis</i>	gleby namurszowe* fibrowe hemowe saprowe gytiowe mulowe plytkie	<i>earth-covered murshic soils</i> <i>fibric murshic soils</i> <i>hemic murshic soils</i> <i>sapric murshic soils</i> <i>gytija murshic soils</i> <i>muddy murshic soils</i> <i>thin murshic soils</i>	Murshic Histosols (Novic) Murshic Fibric Histosols Murshic Hemic Histosols Murshic Sapric Histosols Murshic Histosols (Limnic) Murshic Histosols (Fluvic/Limnic) Murshic Histosols, Histic Gleysols	Terric Haplosapristis Hemic Haplofibristis Sapric Haplohemists Typic Haplosapristis Limnic Haplosapristis Limnic Haplosapristis Typic Haplosapristis
Gleby ściółkowe	Folic Histosols <i>Folists</i>	typowe skaliste rumoszone rędzinowe	<i>typical folisols</i> <i>rocky folisols</i> <i>debris folisols</i> <i>calcareous folisols</i>	Folic Histosols Folic Rockic Histosols Folic Mawic Histosols Folic Histosols (Calcare)	Typic Udifolists Lithic Udifolists Typic/Lithic Udifolists Typic/Lithic Udifolists
Order 9 – Gleby antropogeniczne – Eng.: anthropogenic soils – WRB 2015: Anthrosols, Technosols – ST 2014: no equivalents at order level					
Gleby kulturoziemne <i>Culturozems</i>	Anthrosols; <i>Mollisols</i>	hortisole* antrosole* rigosole* gruntowo-glejowe	<i>hortisols</i> <i>anthrosols</i> <i>rigosols</i> <i>gleyic culturozems</i>	Hortic Anthrosols Haplic Phaeozems (Anthric, Pachic) Dystric/Eutric Regosols (Relocatic) Gleyic Phaeozems (Anthric, Pachic); Gleyic Umbrisols (Anthric, Pachic); Gleyic Regosols (Relocatic)	Pachic Hapludolls, Haplic Vermudolls Pachic Hapludolls no equivalent (Entisols) –
Gleby technogeniczne <i>Technogenic soils</i>	Technosols; <i>Anthroportic/Anthrodensic Udorthents</i>	ekranosole* urbisole* industrisole* edifisole* konstruktosole* aggetosole* turbisole* próchniczne gruntowo-glejowe opadowo-glejowe	<i>ekranosols</i> <i>urbisols</i> <i>industrisols</i> <i>edifisols</i> <i>constructosols</i> <i>aggetosols</i> <i>turbisols</i> <i>humic technosols</i> <i>gleyic technosols</i> <i>stagnogleyic technosols</i>	Ekranic Technosols Urbic Technosols Spolic Technosols Isolatic Technosols (Protofolic); Technoskeletal Isolatic Technosols Isolatic Technosols; Linc Technosols Dystric/Eutric Regosols (Transportic) Dystric/Eutric Regosols (Relocatic) Technosols (Humic/Mollic/Umbric) Technosols (Gleyic) Technosols (Stagnic)	Anthrodensic Udorthents Anthroportic Udorthents Anthroportic Udorthents no equivalent Anthrodensic/Anthroportic Udorthents Anthroportic Udorthents no equivalent no equivalent (Hapludolls) – –

The 4th order of *clay-illuvial soils* (*gleby płowoziemne*) consists of one soil type (*gleby płowe*) that brings together various soils with an *argik* horizon. The placement of this order (in the key to soil orders, table 4) after the chernozemic soils excludes soils with *mollik/umbrik* horizons, whereas its placement before *podzolic soils* and *gleyzemic soils* gives a higher priority for the *argik* horizon compared to the *spodik* horizon and *stagnic/gleyic properties*. Only the soils with "complete" sequence of crucial genetic (E-Bt) and diagnostic (*eluwik-argik*) horizons are considered "typical", whereas soils featured by Ap-Bt morphology are distinguished as *eroded (truncated) clay-illuvial soils* (Kobierski 2013, Świtoniak 2014, Świtoniak et al. 2016). All these soils may be correlated with Luvisols in WRB2015 if the *stagnic properties* are weak to medium strong, or with Luvic Stagnosols if *stagnic properties* are strongly developed and start ≥ 25 cm from the soil surface (Waroszewski et al. 2018). Many of such soils, both silty- and loamy-textured, have eluvial tongues in an *argik* horizon, thus commonly were classified as Albeluvisols in accordance with previous WRB versions (Szymański et al. 2011). Former Albeluvisols were also correlated with *texturally contrasted soils* (*gleby płowe dwudzielne*), i.e. soils with sandy topsoil and an abrupt textural difference at ≥ 50 cm from the soil surface, if eluvial tongues were present in the Bt horizon. At present, the *texturally contrasted soils* with *stagnic properties* are correlated with Planosols (irrespective of the presence of *tonguing*) or with Retisols, if *stagnic properties* are weak (or absent) and *tonguing* is clearly developed (Komisarek and Szałata 2008; Kozłowski and Komisarek 2017; Muszyfaga and Kabala 2015; Waroszewski et al. 2019). This complicated system of equivalents is due to splitting the soils with an *argic* horizon into several separate RSGs in WRB 2015. In contrast, in SGP6, all these features are indicative of separate subtypes listed hierarchically (table 5), that may be used to name the soil individually or in combination, still within one type of *clay-illuvial soils* (*gleby płowe*). Extremely leached clay-illuvial soils, featured by very low base saturation and podzolization (*gleby płowe zbielicowane*) have to be correlated with Alisols, and particularly *wet (waterlogged) clay-illuvial soils* (*gleby płowe podmokłe*) with *gleyic properties* starting near the surface, have their equivalent in Gleysols (Luvic). Most of arable clay-illuvial soils in Poland have a plough layer thicker than 20 cm (due to the standard depth of ploughing) that may fulfil the requirements for a mollic horizon according to WRB2015 and result in soil „transfer” to Phaeozems. To avoid an inappropriate classi-

fication of many ordinary arable Luvisols as *chernozemic soils*, SGP6 requires significantly higher thickness for the *mollik* (and *umbrik*) horizon, i.e. 30 cm, instead of the 20 cm required in WRB2015. However, SGP6 allows simple correlation with WRB2015 by introducing the subtype of *humic clay-illuvial soils* (table 5), which have a mollic horizon in terms of WRB 2015.

The 5th order of *black soils* (*gleby czarnoziemne*) brings together soils with *mollik*, *umbrik* and *arenimurszik* horizons allocated into seven soil types. The definition of *chernozems (czarnoziemy)* in SGP6 is broader than of the respective RSG in WRB 2015 because the *mollik* (but not *chernic*) horizon is required (≥ 30 cm thick) and secondary carbonates must occur at ≥ 150 cm, irrespectively of the thickness of the *mollik* horizon (Łabaz et al., 2018). *Black earths (czarne ziemie)* have a *mollik* horizon and strong redoximorphic features, either as *gleyic* or *stagnic properties* (Konecka-Betley et al. 1996, Łabaz and Kabala 2014, Orzechowski et al. 2004). Some of these black earths have *kalcik* horizons below the *mollik* and therefore may be correlated with Gleyic/Stagnic Chernozems in WRB 2015; the other *black earths*, free of *secondary carbonates*, usually meet the requirements of Gleyic/Stagnic Phaeozems; whereas, the *waterlogged black earths* may fulfill the criteria of Mollic Gleysols. The next three types of soils with a *mollik* horizon correspond to Phaeozems. *Chernozemic rendzinas (rędziny czarnoziemne)* developed from carbonate (or gypsum) rocks correlate well with Rendzic Phaeozems. The type also includes the specific subtype of *limnic chernozemic rendzinas* developed of drained calcareous *gyttja* or highly calcareous *meadow/lacustrine marl* (Lemkowska and Sowiński 2018; Uggla 1976). *Chernozemic alluvial soils (mady czarnoziemne)* typically correlate with Fluvic Phaeozems, and *chernozemic colluvial soils (gleby deluwialne czarnoziemne)* may be classified as Phaeozems with a Colluvic qualifier (Świtoniak 2015). The unique type of *semimurszik soils (gleby murszowate)* requires an *arenimurszik* horizon featured by elevated content of organic matter and weak binding of organic particles to mineral grains. The concept and definition of an *arenimurszik* horizon has a long tradition in Polish pedology and it allows distinguishing between several steps of organic material degradation and transformation of organic layers into mineral-organic and mineral soil horizons after drainage (Łabaz and Kabala 2016, Mocek 1978, Rzaśa 1963). Typically, these sandy soils correlate with Gleyic Umbrisols or Umbric Gleysols. And finally, *the grey soils (gleby szare)* accommodate all other soils with *mollik*

or umbric horizons, which do not fulfil the criteria of any other above listed type of *chernozemic soils*. They are mostly correlated with Umbrisols, but some soils with *mollik* horizons, but lacking secondary carbonates and strong redoximorphic features, may be correlated with Haplic Phaeozems in WRB 2015.

The 6th order of *swelling soils* (*gleby pęczniące*) involves one type of soils with a *wertik* horizon and clayey texture throughout – *wertisols*, correlated simply with Vertisols of WRB2015. The most common and most important are *black vertisols* (*wertisole czarnoziemne*), correlated with the Pellic Vertisols (Mollic), and previously referred to as Smolnica soils (Mocek et al. 2009, Prusinkiewicz 2001).

The 7th order of *gleyzemic soils* (*gleby glejoziemne*) consists of two soil types: (a) soils featured with gleyic properties starting ≥ 30 cm from the soil surface, well correlated with Gleysols (WRB 2015), and (b) soils featured with strong *stagnic* properties at a shallow depth, generally correlated with Stagnosols (WRB 2015). However, the definitions of *gleysols* and *stagnosols* in SGP6 are narrower than the respective RSGs definitions in WRB2015 and do not include soils with diagnostic horizons such as *mollik*, *umbric*, *argik* and *spodik*, all of which are keyed out earlier (table 4).

The 8th order of *organic soils* (*gleby organiczne*) brings together soil developed of *organic material*, which have a *histik/murszik/folik* horizon ≥ 30 cm thick. Although the required thickness of organic horizon for Histosols (table 4) and the required content of organic carbon in an organic material (table 3) differ in SGP6 and WRB2015, these units are in general well correlated. Separate types of *peat soils*, *limnic soils*, *murszik soils* and *folisols*, subdivided into numerous respective subtypes, provide a broad possibility to reflect the different organic soil origin, composition, transformation or degradation paths, and functions in natural and human-impacted ecosystems (Glina et al. 2017; Kalisz and Łachacz 2008, Łachacz et al. 2009, Mendyk et al. 2015, Okruszko 1969, Roj-Rojewski and Walasek 2013; Skiba and Komornicki 1983; Wasak and Drewnik 2012). The unique type of *murszik soils* (*gleby murszowe*) includes soils developed of various primary organic materials (*peat*, *gyttja*, *mud* etc.); those surface layers have pedogenically transformed to a depth of at least 30 cm after soil drainage and under crop cultivation or forest management (Glina et al. 2016, Marcinek and Szychalski 1998, Mocek 1978, Piaścik and Łachacz 1990; Rząsa 1963). The resulting *murszik* horizon meets the criteria of histic horizon (WRB2015), but

consists in the majority of non-fibrous, humified organic material (sapric) and has higher bulk density and aggregate structure (Glina and Bogacz 2016; Piaścik and Gotkiewicz 2004), reflected in a Murshic qualifier (WRB2015).

The last, 9th order – *anthropogenic soils* (*gleby antropogeniczne*) – consists of two types of (a) soils deeply mixed and fertilized to create a thick "chernozemic-like" topsoil horizon aimed to improve their agricultural productivity – *culturozems*, correlated with Anthrosols (WRB2015), and (b) transformed or created in the course of intentional industrial or constructional activity, often consisting of artefacts (tab. 3) – *technogenic soils*, in the majority correlated with Technosols (WRB2015). The first soil type, *culturozems* (*gleby kulturoziemne*), is traditionally distinguished if a thick (>50 cm) *hortik* or *antrik* horizon is present, or the soil is deeply mixed (*rigosols*) (Krupski et al. 2017). A new soil type of *technogenic soils* brings together three previous types of urbanozemic, industriozeamic and saline soils (Systematyka gleb Polski 2011). The soil subtypes are distinguished based on the presence of specific kind of *artefacts* – *urbisols* and *industriosols* (Greinert 2015, Uzarowicz et al. 2017, 2018), the presence of the (near) surface soil coverage/sealing with impermeable layer of concrete, asphalt etc. – *ekransols* (Charzyński et al. 2013a), or the presence of a geomembrane or technogenic hard layer within the soil profile (*constructosols*), including the concrete bunkers/fortification (Charzyński et al. 2013b). Soils on the ruins, degraded walls or roofs of buildings are distinguished as *edifisols* (Charzyński et al. 2015). All these soils are simply correlated with Technosols accompanied with respective Principal qualifiers (table 5). Additionally, technogenic soils in SGP6 involve the *aggerosols* – soil developed from earth material poor in *artefacts* (*thick heap material*), transported more or less locally that forms an anthropogenic convex relief form (e.g. dam, road embankment) or fulfills concave forms. These soils may be correlated in WRB2015 with Regosols (Transportic) that seems inappropriate in case of soils existing in intentionally constructed relief forms. Also, the soils transformed/degraded due to *deep mixing* (in situ) of native soil at construction or other non-agricultural activity, termed *turbisols*, are distinguished as a subtype of *technogenic soils* in SGP6, but in WRB2015 must be correlated with Regosols (Relocatic). An indication of soil contamination (toxicity), alkalization, salinization, excessive fertilization etc. may be added as a variety (table 6).

RULES FOR SOIL CLASSIFICATION

The only appropriate way for soil classification (naming) in SGP6 is to follow the key to soil orders and types (table 4) because the key reflects the priorities of classification (i.e. the diagnostic features that have higher priority than others are listed earlier (higher) and have to be considered first). When classifying soils, the following rules must be applied:

1. Classification must always start from the beginning of the key.

2. Classification must stop in a first (the earliest) classification unit if all those requirements are met by the soil under assessment. In other words, classification may follow to the next unit in the key only if the soil does not meet all criteria listed in the unit placed earlier in the key.

3. The soil classification begins at the order level (i.e. the soil must be first allocated to an appropriate soil order).

4. The key to soil types in a selected order can be followed, when the soil certainly meets the criteria of this order and does not meet all the criteria of the previous order (placed earlier in the key).

TABLE 6. Soil varieties in Polish Soil Classification (SGP6): original names, English translations and their WRB closest equivalents

SGP6 (names in a plural form)	English translation	Qualifiers in WRB2015
(3 rd subtype used as a variety)	If 2 subtypes (allowed maximum) have already been used in a soil name, the 3 rd (and eventually next subtypes from the hierarchical list of subtypes) may be added as variety (varieties).	
(omitted subtype used as a variety)	If the soil under classification meets the criteria for a subtype defined in SGP6, but not indicated in a hierarchical list of subtypes for given soil type, may be added to soil name as a variety.	
Barriers for roots and water		
fragipanowe (fi)	fragipan	Fragic
placikowe (pc)	placic	Placic
rudawcowe (ru)	bog iron	Ferric
orszynowe (or)	ortstein	Ortsteinic
zagęszczone (zg)	densified	like Densic, but limited to the layer underlying the plough horizon
słabolamellowe (sl)	proto-lamellar	like Lamellic, but total thickness of lamellae not specified (may be <5 cm); Proto-lamellic
Litho- and pedogenic features		
limnowęglanowe (lw)	limni-calcareous	no equivalent; to the depth of 100 cm has Limnic material that contains ≥20% CaCO ₃ in a layer ≥20 cm thick
węglanowe (ca)	calcareous	no equivalent; has a layer ≥10 cm thick to the depth of 50 cm or ≥20 cm to the depth of 100 cm, which contains ≥2% CaCO ₃ in fine earths
głęboko węglanowe (gw)	deep calcareous	Bathycalcaric
gipsowe (gi)	gypseous	no equivalent, but often may be correlated with Gypsic; has a gypsic hard rock at the depth of ≤150 cm and >50% of gypsic rock fragments in the skeleton fraction
mieszane (mx)	mixed	no equivalent; applied to rendzina soils with a gypsic/calcareous rock at the depth of ≥150 cm, that have (1) siliceous rock fragments in the skeleton fraction, or (2) siliceous materials (e.g. quartz sand) dominating in the fine earths
przykryte (pz)	covered	Aeolic, Epicolluvic, Novic
czerwone (cz)	red	Chromic, Rhodic (colour hue, moist, redder than 7.5YR)
głęboko próchniczne (gh)	deep humic	Pachic
zasolone (zs)	saline	Protosalic
słono-sodowe (ss)	saline-sodic	Protosalic and Sodic
sodowo-alkaliczne (sd)	sodic-alkaline	Sodic, Alkalic
kwaśno-siarczanowe (ks)	sulfate acidic	Thionic
siarczkowe (sr)	sulfidic	Hypersulfidic
ornitogeniczne (or)	ornithogenic	like Ornithic; but includes also soils of bird nesting sites having microrelief changed due to nest constructions
pogrzebane (bxx)	buried	like Thapto-, but applied to native soil (instead of simple diagnostic horizon) buried under modern colluvial or anthropogenic soil

Table 6 continued

Deep/weak redoximorphic features		
średnio głęboko gruntowo-glejowe (sgg)	medium deep gleyic	like Endogleyic, but gleyic properties between 80 and 130 cm
średnio głęboko opadowo-glejowe (sog)	medium deep stagnic	like Endostagnic, but stagnic properties between 80 and 130 cm
głęboko gruntowo-glejowe (ggg)	deep gleyic	like Bathygleyic, but gleyic properties below 130 cm
głęboko opadowo-glejowe (gog)	deep stagnic	like Bathystagnic, but stagnic properties below 130 cm
słabo gruntowo-glejowe (sgg)	weakly gleyic	no equivalent, like Proto-gleyic
słabo opadowo-glejowe (sog)	weakly stagnic	no equivalent, like Proto-stagnic
Anthropogenic features		
odwodnione (ow)	drained	Drainic
zawodnione (zw)	artificially waterlogged	no equivalent; waterlogged due to recent human activity, but stagnic or gleyic properties not developed
zaburzone (zb)	disturbed	like Relocatic, but to the depth of <50 cm
nasypowe (ns)	heaped	like Transportic, but <50 cm thick
zrekultywowane (zr)	reclaimed	no equivalent; technogenic soils or soils with Relocatic or Transportic characteristics after technical or biological reclamation, have humus horizon ≥ 10 cm thick
skazone (toksyczne) (tx)	contaminated (toxic)	Toxic
kulturoziemne (kz)	culturozemnic	Hortic, Anthric
pomierlerzowe (ml)	charcoal-pile	no equivalent, but may meet criteria for Pretic; has a layer ≥ 20 cm thick that contains >5% (vol.) of charcoal; mostly in sites of former charcoal production
antropo-węglowe (aw)	anthropo-carbonic	Carbonic
antropo-siarczkowe (as)	anthropo-sulfidic	like Sulfidic, but limited to anthropogenic materials
antropo-siarczanowe (az)	anthropo-sulfatic	no equivalent; contain sulfates of anthropogenic origin that fulfil criteria for <i>artefacts</i>
Specific anthropogenic features in forest soils		
porolne (lp)	post-arable	no equivalent; forest soil cultivated before afforestation; have plough layer ≥ 20 cm thick or ≥ 10 cm thick and clearly detectable differences in vegetation
agrotroficzne (la)	agrotrophic	no equivalent; like post-arable variety, but significantly enriched with nutrients that still has clear impact on vegetation
sylwiuprawne (ls)	sylicultural	no equivalent; forest soil that have plough/mixed layer ≥ 20 cm thick due to forest cultivation
sylwitroficzne (ly)	sylytrophic	no equivalent; like sylicultural variety, but significantly enriched with nutrients that has clear impact on vegetation
zalkalizowane (lz)	artificially alkalized	no equivalent; forest soils that have topsoil layer alkalized due to imission of alkaline industrial dust
Trophic status of forest habitat (may be applied to non-forest soils planned for afforestation or for site comparison)³		
dystroficzne (dy)	dystrophic	no equivalent, but correlates with Dystric
oligotroficzne (ol)	oligotrophic	no equivalent, but correlates with Dystric
mesotroficzne (me)	mesotrophic	no equivalent, but correlates with Eutric
eutroficzne (eu)	eutrophic	no equivalent, but correlates with Eutric
Water supply type in organic and mineral-organic soils		
ombrogeniczne (om)	ombrogeneous	Ombric
soligeniczne (zr)	soligeneous	Rheic, but limited to spring water
fluwiogeniczne (fw)	fluviogeneous	Rheic, but limited to river (flood) water
basenowe (ba)	ground water supplied	Rheic, but limited to ground water
stokowe (so)	slope water supplied	like Rheic, but limited to surface and ground water on hill-slopes

³ according to trophic soil index (SIG) (Brożek et al. 2011).

Table 6 continued

Peatland types and thickness		
płytkie (pt)	shallow	Histic
wysokotorfowiskowe (tw)	raised bog	no equivalent; dystrophic raised bog with mosses in majority
przełściowo-torfowiskowe (tp)	transitional bog	no equivalent; mesotrophic transitional bog with various vegetation
niskotorfowiskowe mechowiskowe (tmm)	moss fen	no equivalent; eutrophic fen with mosses in majority
niskotorfowiskowe turzycowiskowe (tnt)	sedge fen	no equivalent; eutrophic fen with sedge species in majority
niskotorfowiskowe szuwarowe (tns)	reed bed fen	no equivalent; eutrophic fen with reed bed vegetation in majority
niskotorfowiskowe olesowe (tno)	woodland fen	no equivalent; eutrophic fen with dominant forest vegetation (mostly alder)

5. There is no exclusive key to soil subtypes, but the list of subtypes within a certain type is hierarchical (strictly ordered), i.e. the subtype placed earlier in the list has a higher priority than the subtypes mentioned below. Thus, the selection of subtypes should always start from the beginning of their list.
6. Soil subtypes can be combined if the soil has diagnostic features of more than one subtype. When combining subtypes, the following rules apply:
 - a) the "typical" subtype is excluded from the combinations (may be used as single only); it means that the "typical" subtype is used if none of the earlier listed subtypes can be applied;
 - b) two subtypes may be combined at maximum; the third and more subtypes, if necessary, can be added to soil name as the variety;
 - (c) combined subtypes cannot exclude each other in any of the listed criteria;
 - d) any concurrent subtype and primary subtype cannot be combined with other concurrent subtype or primary subtype;
 - e) the order of subtypes in the combination must follow their order in the hierarchical list of subtypes; thus, the concurrent/primary subtype will be always placed before the transitional or supplementary subtype;
 - (f) rules c-e apply differently in peat soils because the layers of different organic materials may occur in the soil profile in various combinations (the rules are separately specified).
7. Soil varieties are used optionally only, but for various reasons, it is recommended to record them in all fieldwork. The following rules apply at recording of soil varieties:
 - (a) the varieties are given in brackets after the type and subtype(s), but before the genus and species;
 - (b) the varieties are separated by a comma(s);
 - (c) the varieties in the soil name are listed in the same order as varieties are listed in the classification.

CLASSIFICATION OF BURIED SOILS

Although the Polish Soil Classification (SGP6), similarly to other contemporary international and national systems, refers mainly to soils that are currently forming and existing on the land surface, it may be also used for naming of the buried (fossil) soils – due to the absence of alternatives. However, it should be stressed that its use for classification of the buried (subsurface) soils cannot distort the sense of surface (modern) soil classification because the classification priorities are established taking into account current productivity and environmental functions of soils identified on the land surface. It is assumed that the buried soils will be distinguished rather exceptionally, mainly for scientific requirements.

SGP6 can separately classify the surface (modern) soil and the buried soil using the following rules:

1. Buried soil is a soil covered by younger sediments. The presence of the secondary soil-forming process that overlaps the original soil profile without physical coverage with the younger sediment is not a basis for distinguishing buried soil.
2. Buried soil and the overlying younger material are classified as one (surface/modern) soil, when as a whole they meet the criteria of:
 - (a) organic, gleyzemic or anthropogenic soil orders,
 - (b) the subtype of texturally contrasted clay-illuvial soils,
 - (c) alluvial or colluvial soil types (in the orders where they are distinguished).
3. Surface soil (developed from the younger covering material) may be classified separately from the buried soil if:
 - (a) the covering material is >50 cm thick, and
 - (b) the surface soil meets all diagnostic criteria for a given soil type, and

- (c) separate classification of surface soil does not interfere with the classification of soil as a whole.
4. If the thickness of the younger covering material is <50 cm, the buried soil is classified with priority (like surface soil) and the presence of thin covering material is indicated as a variety.
 5. In the case of anthropogenic and colluvial soils, it is possible to indicate the name of native soil (de facto buried) as the variety; however, this supplementary information does not change the classification of the modern soil recognized as an anthropogenic or colluvial one.

CLOSING WORDS

Classification, as a system comprehensively covering all pedological knowledge on soil genesis and relationships, should be periodically revised in accordance with the state-of-the-art. We hope the modernized sixth edition of Polish Soil Classification will allow for enhanced, both precise and syntetic description of soil resources in Poland, their diversity and environmental and utility functions, and will become a platform for new cartographic studies, preparation of modern soil databases and initiation of new interdisciplinary scientific studies at the highest international level. SGP6, benefiting from the achievements of global soil science, offers at the same time a number of essential modifications and innovative solutions for international classification systems.

ACKNOWLEDGEMENTS

We would like to thank all members of the Commission for Soil Genesis, Classification and Cartography of the Soil Science Society of Poland and all other people who actively supported preparation of SGP6 with kind suggestions, professional discussion and field testing, in particular: Prof. Renata Bednarek, Prof. Stanisław Białousz, Prof. Adam Bogacz, Prof. Józef Chojnicki, Prof. Danuta Czepińska-Kamińska, Dr Wojciech Kwasowski, Prof. Andrzej Mocek, Prof. Stefan Skiba, Prof. Piotr Skłodowski and Dr hab. Wojciech Szymański.

We would like also to express our gratitude to authors of the previous editions of the Polish Soil Classification and Classification of Forest Soils of Poland; such work has continually greatly supported development of new ideas in soil science and modern understanding of soil classification in Poland to a significant degree.

We are also grateful to the President of the Soil Science Society of Poland, Prof. Zbigniew Zagórski, for his strong support of this project.

REFERENCES

- Arnold R.W., 2002. Soil classification principles. [In:] Soil Classification 2001 (Micheli E., Nachtergaele F.O., Jones R.J.A., Montanarella L., Editors). ESBR Report No 7, EUR 20398 EN, Luxembourg: 3–8.
- Bednarek R., 1991. Wiek, geneza i stanowisko systematyczne gleb rdzawych w świetle badań paleopedologicznych w okolicach Osia (Bory Tucholskie). Wyd. UMK, Toruń: 422 ss.
- Brevik E.C., Calzolari C., Miller B.A., Pereira P., Kabala C., Baumgarten A., Jordán A., 2016. Soil mapping, classification, and pedologic modeling: History and future directions. *Geoderma* 264: 256–274.
- Brożek S., Lasota J., Zwydak M., Wanic T., Gruba P., Błońska E., 2011. Zastosowanie siedliskowego indeksu glebowego (SIG) w diagnozie typów siedlisk leśnych. *Roczniki Gleboznawcze – Soil Science Annual* 62(4): 133–149.
- Charzyński P., Bednarek R., Greinert A., Hulisz P., Uzarowicz Ł., 2013a. Classification of technogenic soils according to WRB system in the light of Polish experiences. *Soil Science Annual* 64(4): 145–150.
- Charzyński P., Hulisz P., Bednarek R., 2013b. Technogenic soils of Poland. *PTSH*, Toruń: 357 pp.
- Charzyński P., Hulisz P., Bednarek R., Piernik A., Winkler M., Chmurzyński M., 2015. Edifisols – a new soil unit of technogenic soils. *Journal of Soils and Sediments* 15(8): 1675–1686.
- Chodorowski J., 2009. Geneza, wiek oraz cechy diagnostyczne orsztynu w świetle badań gleb piaszczystych Kotliny Sandomierskiej. Wydawnictwo UMCS. Lublin: 132 pp.
- Czerwiński Z., Kaczorek D., 1996. Właściwości i typologia gleb wytworzonych z rudy darniowej. *Roczniki Gleboznawcze – Soil Science Annual* 47(1): 97–101.
- Drewnik M., 2008. Geomorfologiczne uwarunkowania rozwoju pokrywy glebowej w obszarach górskich na przykładzie Tatr. Wydawnictwo UJ, Kraków: 118 pp.
- Glina B., Bogacz A., 2016. Selected issues relating to classification of mountain organic soils in Poland according to the Polish Soil Classification 2011. *Soil Science Annual* 67(4): 185–189.
- Glina B., Bogacz A., Gulyás M., Zawieja B., Gajewski P., Kaczmarek Z., 2016. The effect of long-term forestry drainage on the current state of peatland soils: A case study from the Central Sudetes (SW Poland). *Mires and Peat* 18(21): 1–11.
- Glina B., Malkiewicz M., Mendyk Ł., Bogacz A., Woźniczka P., 2017. Human affected disturbances in vegetation cover and peatland development in the late Holocene recorded in shallow mountain peatlands (Central Sudetes, SW Poland). *Boreas* 46(2): 294–307.
- Greinert A., 2015. The heterogeneity of urban soils in the light of their properties. *Journal of Soils and Sediments* 15(8): 1725–1737.
- Hulisz P., 2007. Proposals of systematics of Polish salt-affected soils. *Roczniki Gleboznawcze – Soil Science Annual* 58(1/2): 1–10.
- Hulisz P., Kwasowski W., Praczyński J., Malinowski R., 2017. Coastal acid sulphate soils in Poland: a review. *Soil Science Annual* 68(1): 46–54.

- Ibanez J.J., Boixadera J., 2002. The search for a new paradigm in pedology. [In:] *Soil Classification 2001* (Micheli E., Nachtergaele F.O., Jones R.J.A., Montanarella L., Editors). ESR Report No 7, EUR 20398 EN, Luxembourg: 93–110.
- IUSS Working Group WRB, 2015. World Reference Base for soil resources 2014. International soil classification system for naming soils and creating legends for soil maps. Update 2015. World Soil Resources Report No. 106. FAO, Rome: 212 pp.
- Jankowski M., 2013. Gleby ochrowe. Pozycja w krajobrazie, właściwości, geneza i miejsce w systematyce. Wyd. Nauk. UMK: 129 ss.
- Jankowski M., Bednarek R., 2000. Quantitative and qualitative changes of properties as basis for distinguishing development stages of soils formed from dune sands. *Polish Journal Soil Science* 33(2): 61–69.
- Januszewski G., Meller E., 2018. Morphological and physical properties of dehydrated Holocene carbonate limnic deposits in post-bog areas of NW Poland. *Journal of Ecological Engineering* 19(1): 136–142.
- Kabała C., 2018. Rendzina (rędzina) – Soil of the Year 2018 in Poland. Introduction to origin, classification and land use of rendzinas. *Soil Science Annual* 69(2): 63–74.
- Kabała C., Gałka B., Łabaz B., Anjos L., de Souza Cavassani R., 2018. Towards more simple and coherent chemical criteria in a classification of anthropogenic soils: A comparison of phosphorus tests for diagnostic horizons and properties. *Geoderma* 320: 1–11.
- Kabała C., Łabaz B., 2018. Relationships between soil pH and base saturation – conclusions for Polish and international soil classifications. *Soil Science Annual* 69(4): 206–214.
- Kabała C., Świtoniak M., Charzyński P., 2016. Correlation between the Polish Soil Classification (2011) and international soil classification system World Reference Base for Soil Resources (2015). *Soil Science Annual* 67(2): 88–100.
- Kabała C., Waroszewski J., Bogacz A., Łabaz B., 2012. On the specifics of Podzols in mountain areas. *Soil Science Annual* 63(2): 55–64.
- Kacprzak A., Drewnik M., Uzarowicz Ł., 2006. Rozwój i kierunki przemian węglanowych gleb rumoszowych na terenie Pienińskiego parku Narodowego. *Pieniny – Przyroda i Człowiek* 9: 41–50.
- Kacprzak A., Migoń P., Musielok Ł., 2013. Using soils as indicators of past slope instability in forested terrain, Kamienne Mts., SW Poland. *Geomorphology* 194: 65–75.
- Kalisz B., Łachacz A., 2008. Morfologia i systematyka gleb mułowych na przykładzie transektów w dolinie Omulwi i Rozogi. *Roczniki Gleboznawcze – Soil Science Annual* 59(3/4): 89–96.
- Klasyfikacja gleb leśnych Polski, 2000. Centrum Informacyjne Lasów Państwowych, Warszawa: 127 pp.
- Klasyfikacja uziarnienia gleb i utworów mineralnych Polskiego Towarzystwa Gleboznawczego 2008, 2009. *Roczniki Gleboznawcze – Soil Science Annual*, 60(2): 6–15
- Kobierski M., 2013. Morfologia, właściwości oraz skład mineralny gleb pływających zerodowanych w wybranych obszarach morenowych województwa kujawsko-pomorskiego. Wyd. UTP, Bydgoszcz, 166: 121 pp.
- Komisarek J., Szałata S., 2008. Zróżnicowanie uziarnienia w profilach gleb pływających zaciekowych z obszaru Wielkopolski. *Nauka Przyroda Technologie* 2(2): 10.
- Konecka-Betley K., Czepińska-Kamińska D., Janowska E., 1996. Czarne ziemie w staroaluwialnym krajobrazie Puszczy Kampinoskiej. *Roczniki Gleboznawcze – Soil Science Annual*, 47(3–4): 145–158.
- Kowalska J., Kajdas B., Zaleski T., 2017. Variability of morphological, physical and chemical properties of soils derived from carbonate-rich parent material in the Pieniny Mountains (south Poland). *Soil Science Annual* 68(1): 27–38.
- Kowalska J. B., Zaleski T., Józefowska A., Mazurek R., 2019. Soil formation on calcium carbonate-rich parent material in the outer Carpathian Mountains-A case study. *Catena* 174: 436–451.
- Kozłowski M., Komisarek J., 2017. Textural diversity in selected Retisols in the catena of the Opalenica Plain (western Poland). *Soil Science Annual* 68(1): 11–18.
- Krasilnikov P., Martí J. J. I., Arnold R., Shoba S., 2009. A handbook of soil terminology, correlation and classification. Routledge, London, UK: 448 pp.
- Krupski M., Kabała C., Sady A., Gliński R., Wojcieszak J., 2017. Double- and triple-depth digging and Anthrosol formation in a medieval and modern-era city (Wrocław, SW Poland). *Geoarchaeological research on past horticultural practices. Catena* 153: 9–20.
- Lasota J., Błońska E., Pacanowski P., 2018. Forest sites and forest types on rendzinas in Poland. *Soil Science Annual* 69(2): 121–129.
- Lemkowska B., Sowiński P., 2018. Limnic Rendzinas in the Mazurian Lakeland (NE Poland). *Soil Science Annual* 69(2): 109–120.
- Ligeza S., 2016. Zmienność współczesnych mąd puławskiego odcinka Wisły. Wydawnictwo UP w Lublinie, Lublin: 131 pp.
- Łabaz B., Kabała C., 2014. Geneza, właściwości i klasyfikacja czarnych ziem w Polsce. *Soil Science Annual* 65(2): 80–90.
- Łabaz B., Kabała C., 2016. Human-induced development of mollic and umbric horizons in drained and farmed swampy alluvial soils. *Catena* 139: 117–126.
- Łabaz B., Muszyfaga E., Waroszewski J., Bogacz A., Jezierski P., Kabała C., 2018. Landscape-related transformation and differentiation of Chernozems – Catenary approach in the Silesian Lowland, SW Poland. *Catena* 161: 63–76.
- Łachacz A., Nitkiewicz M., Pisarek W., 2009. Soil conditions and vegetation on gytja lands in the Masurian Lakeland. [W:] *Wetlands – their functions and protection* (Łachacz A., Editor), Department of Land Reclamation and Environmental Management, University of Warmia and Mazury in Olsztyn: 61–94.
- Marcinek J., Spychalski M., 1998. Degradacja gleb organicznych doliny Obry po ich odwodnieniu i wieloletnim rolniczym użytkowaniu. *Zeszyty Problemowe Postępów Nauk Rolniczych* 460: 219–236.
- Mendyk Ł., Świtoniak M., Bednarek R., Falkowski A., 2015. Genesis and classification of the soils developed from the sediments of the former Oleszek mill pond basin (the Chełmińskie Lakeland, N Poland). *Soil Science Annual* 66(1): 29–35.

- Miechówka A., Drewnik M., 2018. Rendzina soils in the Tatra Mountains, central Europe: a review. *Soil Science Annual* 69(2): 88–100.
- Mocek A., 1978. Gleby o charakterze murszowym w otulinie Słowińskiego Parku Narodowego. *Roczniki Gleboznawcze – Soil Science Annual* 29(3): 175–202.
- Mocek A., Owczarzak W., Tabaczyński R., 2009. Uziarnienie oraz skład mineralogiczny frakcji ilastej czarnych ziem Gniewskich. *Roczniki Gleboznawcze – Soil Science Annual* 60(3): 123–132.
- Musieliok Ł., Drewnik M., Stolarczyk M., Gus M., Bartkowiak S., Kożyczkowski K., Lasota J., Motak A., Szczechowska K., Wałły M., 2018. Rates of anthropogenic transformation of soils in the Botanical Garden of Jagiellonian University in Kraków (Poland). *Catena* 170: 272–282.
- Muszyfaga E., Kabała C., 2015. Lithological discontinuity in Glosic Planosols (Albelvisols) of Lower Silesia (SW Poland). *Soil Science Annual* 66(4): 180–190.
- Okrusko H., 1969. Powstawanie mułów i gleb mułowych. *Roczniki Gleboznawcze – Soil Science Annual* 20(1): 25–49.
- Orzechowski M., Smólczyński S., Sowiński P., 2004. Przekształcenia antropogeniczne gleb obniżeń śródmorenowych Pojezierza Mazurskiego. *Roczniki Gleboznawcze – Soil Science Annual* 55(2): 311–320.
- Piaścik H., Gotkiewicz J., 2004. Przeobrażenia odwodnionych gleb torfowych jako przyczyna ich degradacji. *Roczniki Gleboznawcze – Soil Science Annual* 45(2): 331–338.
- Piaścik H., Łachacz A., 1990. Właściwości fizyczno-wodne i retencyjne gleb mineralno-murszowych, murszowatych i murszastych sandru mazursko-kurpiowskiego. *Acta Acad. Agricult. Tech. Olst. Geod. Ruris Regulat.* 20: 79–88.
- Prusinkiewicz Z., 2001. Smolnice gniewskie-właściwości, geneza, systematyka. *Roczniki Gleboznawcze – Soil Science Annual* 52(1–2): 5–21.
- Roj-Rojewski S., Wałasek M., 2013. Katena gleb mułowo-madowych w okolicy Suraża w Dolinie Górnej Narwi. *Soil Science Annual* 64(2): 34–40.
- Rząsa S., 1963. Geneza i ewolucja mineralnych gleb murszowych na terenie odwadnianym. *Roczniki WSR w Poznaniu* 18: 151–223.
- Skiba S., Komornicki T., 1983. Gleby organiczno-sufozyjne w Tatrach Polskich. *Roczniki Gleboznawcze – Soil Science Annual* 34(4): 113–122.
- Systematyka gleb Polski, 2011. *Roczniki Gleboznawcze – Soil Science Annual* 62(3): 1–193.
- Systematyka gleb Polski, 2019. *Polskie Towarzystwo Gleboznawcze, Komisja Genezy Klasyfikacji i Kartografii Gleb. Wydawnictwo Uniwersytetu Przyrodniczego we Wrocławiu, Polskie Towarzystwo Gleboznawcze, Wrocław -Warszawa: 250 pp.*
- Soil Survey Staff, 2014. *Keys to Soil Taxonomy, 12th ed. USDA-Natural Resources Conservation Service, Washington, DC: 633 pp.*
- Szymański W., Skiba M., Skiba S., 2011. Fragipan horizon degradation and bleached tongues formation in Albelvisols of the Carpathian Foothills, Poland. *Geoderma* 167: 340–350.
- Świtoniak M., 2014. Use of soil profile truncation to estimate influence of accelerated erosion on soil cover transformation in young morainic landscapes, North-Eastern Poland. *Catena* 116: 173–184.
- Świtoniak M., 2015. Issues relating to classification of colluvial soils in young morainic areas (Chełmno and Brodnica Lake District, northern Poland). *Soil Science Annual* 66(2): 57–66.
- Świtoniak M., Kabała C., Charzyński P., 2016. Propozycja angielskich nazw jednostek Systematyki gleb Polski. *Soil Science Annual* 67(3): 103–116.
- Świtoniak M., Mroczek P., Bednarek R., 2016. Luvisols or Cambisols? Micromorphological study of soil truncation in young morainic landscapes – Case study: Brodnica and Chełmno Lake Districts (North Poland). *Catena* 137: 583–595.
- Uggla H., 1976. „Rędziny” Pojezierza Mazurskiego. *Roczniki Gleboznawcze – Soil Science Annual* 27(2), 113–125.
- Uzarowicz Ł., Kwasowski W., Śpiewak O., Świtoniak M., 2018. Indicators of pedogenesis of Technosol developed in an ash settling pond at the Bełchatów thermal power station (central Poland). *Soil Science Annual* 69(1): 49–59.
- Uzarowicz Ł., Zagórski Z., Mendak E., Bartmiński P., Szara E., Kondras M., Oktaba L., Turek A., Rogoziński R., 2017. Technogenic soils (Technosols) developed from fly ash and bottom ash from thermal power stations combusting bituminous coal and lignite. Part I. Properties, classification, and indicators of early pedogenesis. *Catena* 157: 75–89.
- Waroszewski J., Kaliński K., Malkiewicz M., Mazurek R., Kozłowski G., Kabała C., 2013. Pleistocene-Holocene coverbeds on granite regolith as parent material for Podzols – An example from the Sudeten Mountains. *Catena* 104: 161–173.
- Waroszewski J., Sprafke T., Kabała C., Kobiernski M., Kierczak J., Muszyfaga E., Łabaz B., 2019. Tracking textural, mineralogical and geochemical signatures in soils developed from basalt-derived materials covered with loess sediments (SW Poland). *Geoderma* 337: 983–997.
- Waroszewski J., Sprafke T., Kabała C., Muszyfaga E., Łabaz B., Woźniczka P., 2018. Aeolian silt contribution to soils on mountain slopes (Mt. Ślęza, southwest Poland). *Quaternary Research* 89(3): 702–717.
- Wasak K., Drewnik M., 2012. Properties of humus horizons of soils developed in the lower montane belt in the Tatra Mountains. *Polish Journal Soil Science* 45(1): 57–68.
- Zagórski Z., 2003. Mineralogiczne i mikromorfologiczne wskaźniki genezy i właściwości rędzin wytworzonych ze skał węglanowych różnych formacji geologicznych. *Fundacja „Rozwój SGGW”*: 245 ss.

Received: May 27, 2019

Accepted: July 24, 2019

Associated editor: J. Chojnicki

Systematyka gleb Polski, wydanie szóste – podstawy teoretyczne, schemat klasyfikacji i korelacje

Streszczenie: Szóste wydanie Systematyki gleb Polski (SGP6) ma na celu ugruntowanie pozycji klasyfikacji gleb w Polsce jako nowoczesnego systemu naukowego, który odzwierciedla aktualny stan wiedzy naukowej, współczesne rozumienie funkcji gleb oraz potrzeby praktyczne, w tym związane z kartografią gleb. SGP6 kontynuuje tradycję ostatnich wydań systematyki przygotowanych pod auspicjami Polskiego Towarzystwa Gleboznawczego, w szczególności w zakresie konsekwentnego stosowania ilościowo zdefiniowanych poziomów, właściwości i materiałów diagnostycznych, ale zawsze odnoszących się do genezy i współczesnego przeobrażenia gleb. Definicja gleby – przedmiotu klasyfikacji – została zmodernizowana w odpowiedzi na współczesne potrzeby szerszego uwzględnienia (oraz właściwego nazwania) gleb stworzonych przez człowieka lub podlegających silnym przeobrażeniom pod wpływem człowieka. Zatem na potrzeby SGP6 gleba jest definiowana jako powierzchniowa część litosfery lub trwale powiązane z litosferą (za pośrednictwem budynków lub budowli) nagromadzenie części mineralnych i organicznych, pochodzących z wietrzenia lub akumulacji, naturalnej lub antropogenicznej, ulegające przeobrażeniu przy udziale czynników glebotwórczych oraz mające zdolność zaopatrywania organizmów żywych w wodę i składniki pokarmowe. SGP6 wyróżnia trzy hierarchiczne poziomy klasyfikacji: rząd (w łącznej liczbie 9), typ (podstawowa jednostka klasyfikacyjna; łącznie 30 typów) i podtyp (łącznie 183 jednostki wyróżniane na podstawie 62 zdefiniowanych podtypów; podtypy są wymienione hierarchicznie, osobno w każdym typie), którym towarzyszą trzy niehierarchiczne poziomy klasyfikacyjne: odmiana (definiująca dodatkowe cechy pedo-, lito- lub antropogeniczne), rodzaj (definiujący rodzaj skały macierzystej) i gatunek (definiujący uziarnienie w profilu). Jednostki niehierarchiczne mają uniwersalne definicje, co umożliwia ich użycie w różnych rzędach/typach, jeśli tylko spełnione są wszystkie wymagania wymienione w definicji. Poniższy artykuł objaśnia podstawy teoretyczne, schemat klasyfikacji oraz zasady klasyfikacji gleb w SGP6, obejmuje klucz do rzędów i typów, tabelę wyjaśniającą zależności między poziomami, właściwościami i materiałami diagnostycznymi wyróżnianymi w SGP6 oraz w ostatnim wydaniu klasyfikacji międzynarodowej FAO-WRB, a także tabelę korelacji między SGP6 a WRB i Soil Taxonomy.

Słowa kluczowe: systematyka gleb, rząd gleb, typ gleb, geneza gleb, World Reference Base, Soil Taxonomy