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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

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

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

SGP6	English translation	Relation to WRB2015
fragipan	*fragipan*	like for *fragic* horizon, but no thickness requirements
geomembrana	*geomembrane*	no equivalent; synthetic membrane covering soil surface or dividing soil layers, impermeable or hardly permeable to water and gas
głębokie wymieszanie	*deep mixing*	no equivalent; deep (≥50 cm) mixing of soils (destruction of soil horizonation, 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
lamelle	*lamellae*	like for *lamellic* qualifier, but thickness criteria moved to subtype requirement
lita skała	*continuous rock*	like *continuous rock*, but cracks occupy <5% of the cross section
lita warstwa technogeniczna	*technogenic hard layer*	like *technic hard material*
nieciągłość litogeniczna	*lithogenic discontinuity*	like *lithic discontinuity*, but textural differentiation resulting from alluvial and colluvial sedimentation is excluded
orsztyn	*ortstein*	like *ortsteinic* qualifier
placik	*placic*	like *placic* qualifie
ruda darniowa	*bog iron*	like for *ferric* horizon, but Fe-Mn-nodules form >20% of a layer volume and criteria 1a (mottles) and 2 (relations to *plinthic*) are not considered
właściwości gruntowo-glejowe	*gleyic properties*	like *gleyi*c properties
właściwości opadowo-glejowe	*stagnic properties*	like *stagnic* properties
zasolenie	*salinity*	no equivalent; like for *salic* horizon, but required EC_e ≥4 dS m^{-1}, and pH_e <8.5, and SAR_e <13 or ESP <15%
zasolenie z sodyfikacją	*salinity with sodification*	no equivalent; like for *salic* horizon, but required EC_e ≥4 dS m^{-1}, and pH_e ≥8.5, and SAR_e ≥13 or ESP ≥15%
sodyfikacja	*sodification*	no equivalent; like for *salic* horizon, but required EC_e<4 dS m^{-1}, and pH_e <8.5, and SAR_e ≥13 or ESP ≥15%
zaciekowość eluwialna	*eluvial tonguing*	like *retic* properties (including *albeluvic glossae*)
zakwaszenie siarczanowe	*sulfate acidification*	like for *thionic* 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
materiał organiczny	*organic material*	like *organic material*, but in materials saturated with water for ≥30 consecutive days in most years, or drained, ≥12% C_{org} is required, while in materials saturated with water for <30 days ≥20% C_{org} is required
materiał mineralny	*mineral material*	like *mineral material*, 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% Corg is required
torfy (peats)		
torf fibrowy	*fibric peat*	criteria for recognizable plant tissue like for *fibric* qualifier, thickness/depth criteria specified in subtype definitions
torf hemowy	*hemic peat*	criteria for recognizable plant tissue like for *hemic* qualifier, thickness/depth criteria specified in subtype definition
torf saprowy	*sapric peat*	criteria for recognizable plant tissue like for *sapric* qualifier, thickness/depth criteria specified in subtype definitions
materiały limniczne (limnic materials)		
gytia organiczna	*organic gyttja*	no equivalent; meets the general criteria for *limnic materials*, contains ≥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

gytia węglanowa	*calcareous gyttja*	no equivalent; meets the general criteria for *limnic materials*, contains ≥12% of organic carbon and ≥20% of $CaCO_3$; weak resilience in a moist state; cracking along horizontal planes after drainage
wapień łąkowy	*meadow limestone (marl)*	no equivalent; meets the general criteria for *limnic materials*, contains <12% of organic carbon and ≥20% of $CaCO_3$
muł limnetyczny	*lacustrine mud*	no equivalent; similar to limnic material (sedimentary peat) – sedimented in ponds, shallow lakes etc.; contains ≥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 *gyttja*
muł telmatyczny	*telmatic mud*	no equivalent; similar to limnic material (sedimentary peat) – sedimented in seasonally flooded wet valleys; contains 12–25% of organic carbon, meets the criteria of *sapric* 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 *gyttja*
materiały antropogeniczne (antrophogenic materials)		
artefakty	*artefacts*	like *artefacts*; additional distinction is made between *normal artefacts* and *reactive artefacts* (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.)
głęboki materiał nasypany	*thick heap material*	no equivalent, but similar to transportic qualifier; loose, earthen material (may contain skeletal fraction), having <20% of *artefacts* (or <10% of *reactive artefacts*), 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
inne materiały mineralne (other mineral materials)		
materiał deluwialny	*colluvial material*	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 *lithogenic discontinuity* in the contact with native soil; and (b) one or more of the following is required: irregular vertical changes in organic carbon content (at ≥0.2% organic carbon in at least one of the layers), or homogeneous content of organic carbon (≥0.2%) throughout the layer that overlies buried organic or humus horizon, or stratification or sedimentation structures are present
materiał fluwialny	*fluvic material*	like *fluvic* material
materiał gruboszkieletowy	*coarse-skeletic material*	no equivalent; contains >60% (vol.) of skeletal fragments (>2 mm in diameter) and has >35% (vol.) of stones or coarser rock fragments
materiał siarczkowy	*sulfidic material*	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) ≥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 ≥20%, similar to that for WRB2015 (table 3). This difference influences 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 (≥20% instead of ≥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 Spychalski 1998; Piaścik and Gotkiewicz 2004; Piaścik and Łachacz 1990; Rząsa 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 matterials*,
- *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 skeletic 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 Classfications, i.e. starts with weakly developed soils, followed by better developed mineral soils with diagnostic horizons, then hydromorphic soils, organic soils, and antrhropogenic 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 priotrities 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;

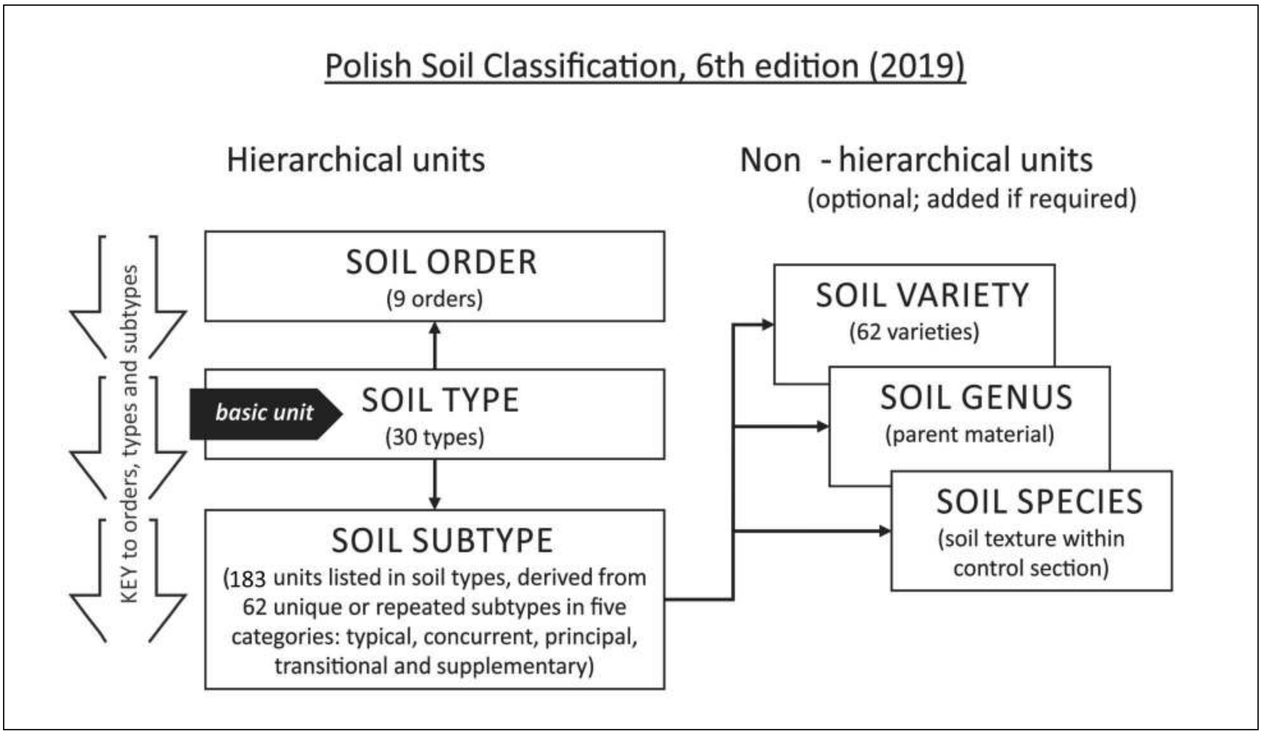

FIGURE. Architecture of the SGP6

TABLE 4. Key to soil orders and soil types

SOIL ORDERS	SOIL TYPES
Soils having *organic material*, 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 *continous rock* or coarse fragments the interstices of wich are filled with organic material to the depth of ≥30 cm from the soil surface **GLEBY ORGANICZNE**	Organic soils having *murszik* horizon ≥30 cm thick **Gleby murszowe**
	Other organic soils which, *below murszik* horizon <30 cm thick (if present), have *peat* that constitute >50% of *organic material* within ≥100 cm or >50% of all *organic materia*l if it does not reach the depth of 100 cm **Gleby torfowe**
	Other organic soils having *limnic material* **Gleby limnowe**
	Other organic soils **Gleby ściółkowe**
Other soils: 1. having an *antrik* or *hortik* horizon ≥50 cm thick; or 2. having *technogenic hard layer* or *geomembrane* of any thickness on the soil surface or starting within ≥100 cm of soil surface; or 3. *deeply mixed* or having *the thick heap material*, or having a combination of these two features reaching the depth ≥50 cm (if individually they do not futfill the tickness for *deep mixing* or *thick heap material*; 4. having: (A) ≥20% (vol., weigh. average) of *artefacts* in the upper 100 cm soil layer (or to *continuous rock/technogenic hard layer* if shallower), or (B) ≥10% (vol., weigh. average) of *reactive artefacts* in the upper 100 cm soil layer (or to *continuous rock/technogenic hard layer* if shallower) **GLEBY ANTROPOGENICZNE**	Soils that meet both: (a) have an *antrik* or *hortik* horizon ≤50 cm thick, or fulfill the criteria for *deep mixing* caused by agricultural, horticultural or forest management and contain <20% vol., weigh. average) of *artefacts* to the depth of 100 cm from the soil surface, and (b) do not have *geomembrane* or *technogenic hard layer* starting ≥100 cm from the soil surface **Gleby kulturoziemne**
	Other soils **Gleby technogeniczne**
Other soils having both (a) a *wertik* horizon starting ≥100 cm from the soil surface, and (b) ≥30% clay in all soil layers from the soil surface to the *wertik* horizon **GLEBY PECZNIEJĄCE**	All soils that the criteria for the soil order **Wertisole**
Other soils having a *mollik, umbrik* or *arenimurszik* horizon (≥30 cm thick) **GLEBY CZARNOZIEMNE**	Soils having an *arenimurszik* horizon **Gleby murszowate**
	Other soils located on the Holocene alluvial terraces and having *fluvic material* starting ≥150 cm from the soil surface **Mady czarnoziemne**
	Other soils having *mollik* 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 *continuous rock, if shallower*), which contains carbonates (or gypsum) in the fine earths and ≥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 *limnic material* containing ≥40% $CaCO_3$ **Rędziny czarnoziemne**
	Other soils having the surface layer of *colluvial material* ≥50 cm thick, or ≥30 cm thick, if the colluvial material overlies the *organic material* **Gleby deluwialne czarnoziemne**
	Other soils having a mollik horizon and pH_w ≥5.5 prevailing to a depth of 100 cm from the soil surface, and having one or both of the following: (a) *gleyic properties*, or (b) *stagnic properties* 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) *mollik* horizon, and (b) kalcik horizon or the layer containing secondary (pedogenic) carbonates both starting ≥150 cm from the soil surface **Czarnoziemy**
	Other soils having a *mollik* or *umbrik* horizon **Gleby szare**
Other soils having an *argik* horizon starting ≤100 from the soil surface **GLEBY PŁOWOZIEMNE**	All soils that meet the criteria for the soil order **Gleby płowe**
Other soils having a *spodik* horizon starting ≤100 cm from the soil surface, or starting ≤75 cm from the soil surface if *coarse-skeletic material* 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. *gleyic properties* starting ≤30 cm from the soil surface; or 2. stagnic properties covering ≥50% of the soil layer that starts ≤25 cm from the soil surface and is directly underlain by layer with *gleyic properties*, or 3. *stagnic properties* covering ≥50% of the soil layer (in every subhorizon) starting from ≤25 cm and having thickness ≥50 cm or ≤25 cm, if directly underlain by *continuous rock* or impermeable (hardly permeable) soil layer **GLEBY GLEJOZIEMNE**	Soils with *gleyic properties* starting ≥30 cm from the soil surface **Gleby gruntowo-glejowe**
	Other soils **Gleby opadowo-glejowe**
Other soils having a *kambik, siderik* or *rubik horizon*, or soils having a B horizon that meets the criteria for kambik horizon, except of texture, which may be sandy in a part of the horizon **GLEBY BRUNATNOZIEMNE**	Soils having a *rubik* horizon **Gleby ochrowe**
	Other soils located on the Holocene alluvial terraces, polders, or plain sea/lake shores having *fluvic material* 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 *continuous rock*, if shallower) contains carbonates (or gypsum) in the fine earths and ≥10% (weigh. average) of calcareous/gypsum rock fragments in the skeleton fraction (i.e. ≥2 mm in diameter) **Rędziny brunatne**
	Other soils having a *kambik* 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 *continuous rock* ≤10 cm, or (b) combined thickness of O+A+E+B+BC horizons (if present) in a loose material, including *coarse-skeletic material*, ≤10 cm **Gleby inicjalne**
	Other soils located on the Holocene alluvial terraces, polders, or plain sea/lake shores having *fluvic material* 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 *continuous rock*, if shallower) contains carbonates (or gypsum) in the fine earths and ≥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 *limnic material* containing >40% $CaCO_3$	**Rędziny właściwe**
	Other soils having a *continuous rock* 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 ≥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 determines 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) Hyperskeletic 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 (Ligęza 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* laking *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 name *English translation*	Equivalents in WRB 2015; *ST2014*	Original Polish name	English translation	WRB 2015; equivalent	ST 2014 equivalent
Order 1 – Gleby słabo ukształtowane – ***Eng.: weakly developed soils*** **– WRB 2015: Leptosols, Regosols, Arenosols, Fluvisols – ST 2014: Entisols**					
Gleby inicjalne *Raw mineral soils*	Leptosols, Regosols, Arenosols; *Orthents, Fluvents*	litosole*[1]	*raw siliceous rocky soils (lithosols)*	Lithic/Nudilithic Leptosols	Lithic Udorthents[2]
		rędziny inicjalne skaliste	*raw rocky rendzinas*	Calcaric Lithic Leptosols	Lithic Udorthents
		rędziny inicjalne rumoszowe	*raw debris rendzinas*	Calcaric Hyperskeletic Leptosols	Typic Udorthents
		mady inicjalne	*raw alluvial soils*	Gleyic Fluvisols (Protic)	Typic/Aquic Udifluvents
		gleby inicjalne rumoszowe	*raw siliceous debris soils*	Hyperskeletic Leptosols	Typic Udorthents
		gleby inicjalne luź ne	*raw unconsolidated soils*	Protic Arenosols; Protic Regosols	Typic Udipsamments; Typic Udorthents
Rankery *Rankers*	Leptosols; *Orthents, Udepts*	typowe	*typical rankers*	Dystric/Eutric Skeletic Leptosols (Ochric)	Lithic Udorthents
		próchniczne	*humic rankers*	Dystric/Eutric Skeletic Leptosols (Humic)	Humic Lithic Dystrudepts
		zbrunatniałe	*brown rankers*	Dystric/Eutric Leptosols	Lithic Udorthents
		zbielicowane	*podzolic rankers*	Dystric Leptosols (Albic/Protospodic)	Lithic Udorthents
		butwinowe	*raw-humus rankers*	Dystric Folic Leptosols	Humic Dystrudepts
Rędziny właś ciwe *Ordinary rendzinas*	Calcaric Leptosols; *Orthents, Eutrudepts*	typowe	*typical ordinary rendzinas*	Calcaric/Dolomitic Leptosols (Ochric)	Typic/Lithic Udorthents
		pararędziny właś ciwe*	*ordinary pararendzinas*	Skeletic Calcisols; Calcaric Regosols	Typic Udorthents, Typic Eutrudepts
		rumoszowe	*debris ordinary rendzinas*	Calcaric Hyperskeletic Leptosols	Typic Udorthents
		pojeziorne	*limnic ordinary rendzinas*	Calcaric Fluvisols	Typic/Mollic Fluvaquents
		próchniczne	*humic ordinary rendzinas*	Calcaric/Dolomitic Leptosols (Humic); Calcaric Leptic Phaeozems	Typic/Entic Haplrendolls
		butwinowe	*raw-humus ordinary rendzinas*	Calcaric Folic Leptosols	Humic Lithic Eutrudepts
Mady właś ciwe *Ordinary alluvial soils*	Fluvisols; *Fluvents*	typowe	*typical ordinary alluvial soils*	Dystric/Eutric Fluvisols (Ochric)	Typic Udifluvents
		próchniczne	*humic ordinary alluvial soils*	Dystric/Eutric Fluvisols (Humic); Fluvic Phaeozems	Mollic Udifluvents
		gruntowo-glejowe	*gleyic oridnary alluvial soils*	Gleyic Fluvisols	Aquic Udifluvents
		opadowo-glejowe	*stagnogleyic ordinary alluvial soils*	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 repective subgroups of Cryorthents, Dystrocryepts and Haplocryepts.

Table 5 continued

Gleby deluwialne właściwe *Ordinary Colluvial soils*	Colluvic Regosols Arenosols, (Colluvic); *Orthents* *Quartzi-psammemts*	typowe	*typical ordinary colluvial soil*	Colluvic Regosols (Ochric); Arenosols Distract/Eutric Arenosols (Colluvic, Ochric)	Typic Udorthents; Typic Quartzipsamments
		próchniczne	*humic ordinary colluvial soils*	Colluvic Regosols (Humic); Arenosols (Colluvic, Humic); Haplic Phaeozems (Colluvic)	Typic Udorthents; Typic Quartzipsamments;
		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 Quartzipsamments
		opadowo-glejowe	*stagnogleyic ordinary colluvial soils*	Colluvic Stagnic Regosols	Oxyaquic Udorthents
Arenosole Arenosols	Arenosols; Quartzi-psamments	typowe	*typical arenosols*	Dystric/Eutric Arenosols (Ochric)	Typic Quartzipsamments
		murszowate	*semimurshic arenosols*	Dystric/Eutric Arenosols (Humic, Nechic)	Typic Quartzipsamments
		próchniczne	*humic arenosols*	Dystric/Eutric Arenosols (Humic)	Typic Quartzipsamments
		rdzawe	*rusty arenosols*	Dystric/Eutric Arenosols	Typic Quartzipsamments
		zbielicowane	*podzolic arenosols*	Albic Arenosols (Protospodic)	Spodic Quartzipsamments
		gruntowo-glejowe	*gleyic arenosols*	Gleyic Arenosols	Aquic Quartzipsamments
Regosole Regosols	Regosols; *Orthents*	typowe	*typical regosols*	Dystric/Eutric Regosols (Ochric)	Typic Udorthents
		rumoszowe	*debris regosols*	Skeletic Regosols	Typic Udorthents
		próchniczne	*humic regosols*	Dystric/Eutric Regosols (Humic)	Typic Udorthents
		zbrunatniałe	*brown regosols*	Dystric/Eutric Regosols	Typic Udorthents
		zbielicowane	*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
		wyługowane	*leached brown soils*	Eutric/Epidystric Cambisols	Dystric Eutrudepts
		zbielicowane	*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
		rumoszowe	*debris brown soils*	Skeletic Cambisols	Typic Eutrudepts/Dystrudepts

Table 5 continued

Rędziny brunatne *Brown rendzinas*	Calcaric Cambisols *Rendollic Eutrudepts;*	typowe	*typical brown rendzinas*	Dolomitic/Calcaric Leptic Cambisols (Ochric)	Rendollic Eutrudepts
		parארędziny brunatne*	*brown pararendzinas*	Calcaric Cambisols	Typic/Rendollic Eutrudepts
		rumoszowe	*debris brown rendzinas*	Calcaric Skeletic Cambisols	Rendollic Eutrudepts
		próchniczne	*humic brown rendzinas*	Calcaric Cambisols (Humic); Calcaric Cambic Phaeozems	Rendollic Eutrudepts
Mady brunatne *Brown alluvials*	Fluvic Cambisols; *Fluventic Eutrudepts*	typowe	*typical brown alluvial soils*	Fluvic Cambisols (Ochric)	Fluventic Eutrudepts
		mady rdzawe*	*rusty alluvial soils*	Fluvic Brunic Arenosols; Brunic Regosols (Fluvic)	Typic Udipsamments
		próchniczne	*humus brown alluvial soils*	Fluvic Cambisols (Humic); Cambic Fluvic Phaeozems	Fluventic Eutrudepts
		gruntowo-glejowe	*gleyic brown alluvial soils*	Fluvic Gleyic Cambisols	Fluvaqentic Eutrudepts
		opadowo-glejowe	*stagnogleyic brown alluvial soils*	Fluvic Stagnic Cambisols	Oxyaquic Eutrudepts
Gleby ochrowe *Ochrous soils*	Rubic/Chromic *Arenosols; Psamments*	typowe	*typical ochrous soils*	Rubic/Chromic Arenosols (Ochric)	Typic Udipsamments
		próchniczne	*humic ochrous soils*	Rubic/Chromic Arenosols (Humic)	Typic Udipsamments
		gruntowo-glejowe	*gleyic ochrous soils*	Rubic/Chromic Gleyic Arenosols	Aquic Udipsamments
Gleby rdzawe *Rusty soils*	Brunic *Arenosols; Psamments*	typowe	*typical rusty soils*	Brunic Arenosols (Ochric)	Typic Udipsamments
		gleby rdzawo-brunatne*	*brown-rusty soils*	Dystric Brunic Arenosols; Brunic Regosols (Arenic)	Typic Udipsamments
		zbielicowane	*podzolic rusty soils*	Dystric Albic Brunic Arenosols (Protospodic)	Spodic Udipsamments
		próchniczne	*humic rusty soils*	Brunic Arenosols (Humic)	Typic Udipsamments
		gruntowo-glejowe	*gleyic rusty soils*	Brunic Gleyic Arenosols	Aquic Udipsamments
Order 3 – Gleby bielicoziemne – ***Eng.: podzolic soils*** **– WRB 2015: Podzols – ST 2014: Spodosols**					
Gleby bielicowe *Podzolic soils*	Podzols; *Orthods, Aquods*	typowe	*typical podzolic soils*	Albic Podzols (Ochric)	Typic Haplorthods
		bielice*	*podzols*	Albic Podzols	Typic Haplorthods
		glejobielice*	*gley-podzols*	Gleyic Albic Podzols	Aquic Haplorthods
		gleby glejobielicowe*	*gley-podzolic soils*	Gleyic Albic Podzols (Ochric)	Aquic Haplorthods
		stagnobielice*	*stagnopodzols*	Stagnic Albic Podzols	Oxyaquic Haplorthods
		gleby stagnobielicowe*	*stagnopodzolic soils*	Stagnic Albic Podzols (Ochric)	Oxyaquic Haplorthods
		torfowe	*peaty podzols*	Gleyic Histic Podzols	Histic Endoaquods/Epiaquods
		murszowe	*murshic podzols*	Gleyic Histic Podzols (Murshic)	Histic Endoaquods/Epiaquods
		murszowate	*semimurshic podzols*	Gleyic Podzols (Humic)	Umbric Endoaquods/Epiaquods

Table 5 continued

		torfiaste	*mineral-peaty podzols*	Gleyic Podzols (Humic)	Typic Endoaquods/Epiaquods
		orsztynowe	*orstein podzolic soils*	Ortsteinic Podzols	Typic Haplorthods
		gleby skrytobielicowe*	*latent podzolic soils*	Entic Podzols	Typic Haplorthods
		rumoszowe	*debris podzolic soils*	Hyperskeletic/Skeletic Podozols	Typic/Lithic Haplorthods
Order 4 – Gleby płowoziemne – *Eng.: clay-illuvial soils* – WRB 2015: Luvisols, Planosols, Retisols, Stagnosols – ST 2014: Alfisols					
Gleby płowe *Clay-illuvial soils*	Luvisols, Planosols, Retisols, Stagnosols; *Alfisols*	typowe	*typical clay-illuvial soils*	Albic Luvisols (Ochric)	Typic Hapludalfs
		zerodowane	*eroded clay-illuvial soils*	Haplic Luvisols	Typic Hapludalfs
		dwudzielne	*texturally contrasted clay-illuvial soils*	Luvic Planosols (Epiarenic, Endoloamic)	Arenic Haplualfs
		lamellowe	*lamellic clay-illuvial soils*	Lamellic Luvisols (Arenic)	Lamellic Hapluafs
		próchniczne	*humic clay-illuvial soils*	Haplic/Albic Luvisols (Humic); Luvic Phaeozems	Mollic Hapluafs; Typic Argialbolls
		zbrunatniałe	*brown clay-illuvial soils*	Albic Luvisols (Neocambic)	Typic Hapludalfs
		rdzawe	*rusty clay-illuvial soils*	Albic Luvisols (Brunic)	Arenic Hapludalfs
		zbielicowane	*podzolic clay-illuvial soils*	Albic Planosols (Protospodic); Albic Alisols (Protospodic)	Arenic Hapluafs
		wertikowe	*vertic clay-illuvial soils*	Vertic Luvisols; Luvic Vertic Stagnosols	
		podmokłe	*waterlogged clay-illuvial soils*	Eutric Gleysols (Luvic)	Typic Endoaqualfs
		gruntowo-glejowe	*gleyic clay-illuvial soils*	Gleyic Luvisols	Aquic Hapludalfs
		opadowo-glejowe	*stagnogleyic clay-illuvial soils*	Luvic Stagnosols; Stagnic Luvisols	Oxyaquic Hapludalfs
		zaciekowe	*tonguing clay-illuvial soils*	Albic Retisols	Typic Glossudalfs
Order 5 – Gleby czarnoziemne – *Eng.: black soils* – WRB 2015: Chernozems, Phaeozems, Umbrisols – ST 2011: Mollisols, Inceptisols					
Czarnoziemy *Chernozems*	Chernozems; *Udolls*	typowe	*typical chernozems*	Haplic/Calcic Chernozems	Typic Calciudolls
		wyługowane	*leached chernozems*	Haplic Phaeozems (Bathycalcic)	Typic Hapludolls
		iluwialne	*clay-illuvial chernozems*	Luvic Chernozems	Typic Argiudolls
		zbrunatniałe	*cambic chernozems*	Haplic/Calcic Chernozems (Cambic)	Typic Hapludolls/Calciudolls
		opadowo-glejowe	*stagnogleyic chernozems*	Haplic/Calcic Chernozems (Stagnic)	Oxyaquic Hapludolls/Calciudolls
Czarne ziemie *Black earths*	Gleyic/Stagnic Phaeozems, Gleyic/Stagnic Chernozems; *Aquolls*	typowe	*typical black earths*	Gleyic/StagnicPhaeozems; GleyicChernozemsHaplic chernozems (Stagnic)	Typic Endoaquolls/Epiaquolls Typic Calciaquolls
		murszowate	*semimurshic black earths*	Gleyic Phaeozems (Nechic)	Typic Endoaquolls
		wyługowane	*leached black earths*	Gleyic/Stagnic Phaeozems	Typic Endoaquolls
		podmokłe	*waterlogged black earths*	Mollic Gleysols	Typic Endoaquolls
		iluwialne	*clay-illuvial black earths*	Luvic Gleyic/Stagnic Phaeozems	Typic Argiaquolls
		zbrunatniałe	*cambic black earths*	Cambic Gleyic/Stagnic Phaeozems	Typic Endoaquolls/Epiaquolls
		wertikowe	*vertic black earths*	Vertic Chernozems (Stagnic)	Vertic Endoaquolls
		kalcikowe	*calcic black earths*	Calcic Chernozems (Stagnic); Gleyic Calcic Chernozems	Typic Calciaquolls

Table 5 continued

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

Table 5 continued

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

Table 5 continued

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

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 (irrespectively 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; Musztyfaga 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 hierarchi-cally (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 classification 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 Kabała 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 Kabała 2016, Mocek 1978, Rząsa 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 umbrik 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 correlated with Haplic Phaeozems in WRB 2015.

The 6th order of *swelling soils (gleby pęczniejące)* 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, umbrik, 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 Spychalski 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, industriozemic 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. – *ekranosols* (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). Additiolenally, 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 antropogenic 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), alkalinization, 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
(3rd subtype used as a variety)	If 2 subtypes (allowed maximum) have already been used in a soil name, the 3rd (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 (fr)	fragipan	Fragic
placikowe (pc)	placic	Placic
rudawcowe (ru)	bog iron	Ferric
orsztynowe (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 Gypsiric; has a gypsiric hard rock at the depth of ≤150 cm and >50% of gypsiric rock fragments in the skeleton fraction
mieszane (mx)	mixed	no equivalent; applied to rendzina soils with a gypsiric/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 ot Transportic characteristics after technical or biological reclamation, have humus horizon ≥10 cm thick
skażone (toksyczne) (tx)	contaminated (toxic)	Toxic
kulturoziemne (kz)	culturozemic	Hortic, Anthric
pomielerzowe (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 *artefacts*
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)	sylvicultural	no equivalent; forest soil that have plough/mixed layer ≥20 cm thick due to forest cultivation
sylwitroficzne (ly)	sylvitrophic	no equivalent; like sylvicultural 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
przejś ciowo-torfowiskowe (tp)	transitional bog	no equivalent; mesotrophic transitional bog with various vegetation
niskotorfowiskowe mechowiskowe (tnm)	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.

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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