SUMMARY

Soil formation factors. The Quaternary deposits are the main **parent material** for soil formation, and glacial tills (moraines) prevail among them. Others are glaciolimnic, glaciofluvic, aeolian, marine, lacustrine (limnic), and organic deposits. Two-membered deposits, which consist of tills underneath and different Holocene formations above, are quite common. The seasonal stagnation of perched water in clayey till and/or at the contiguity of different texture layers is one of the widespread pedogenetic features.

The **climate** of Latvia is mainly conditioned by the Atlantic and is characterized by fluctuations in temperature and rainfall, and alterations of wet and dry periods. Mean annual air temperature varies between +4.4 and +6.6°C, but rainfall – between 560 and 795 mm, from which only 50 – 70 % is evaporated. Mild and wet climatic conditions are favorable for intensive chemical and biological weathering of minerals and rocks, for nutrient cycling, and for formation of mobile soil humus.

Topography. Geographically, Latvia is located on the northwestern edge of the East European Plain. The relief of the country is characterized by slight variations in elevation. The average elevation is 87 m asl., and maximum local relief is about 90 m. The highest point, Gaizinkalns, is 311.6 m asl. The topography was formed mainly as a result of Pleistocene glaciation, particularly in the last Baltic (Weichselian) event. More than 60 % of the territory are lowlands, 0 − 135 m asl. Most uplands are island-shaped, with bedrock cores, and rise up to 312 m.

Due to the favorable chemical composition of Quaternary deposits, various species and rather high biomass productivity represent virgin **vegetation**. Spruce and mixed forests dominate on till landscapes, whereas pine stands prevail on sands. At present, forests and woodland cover 46 %, but agricultural land – 38 % of the territory of the country.

Soils are young, and the absolute **age** generally makes less than 10 000 years, which is related to the deglaciation of the territory. The youngest soils can be found along the rivers and on the Baltic Sea terraces and dunes.

Human influence. Development of Latvia soils is greatly influenced by human activities. Firstly, changes in the vegetation occurred. At present, forests occupy only 45.5 % (2 838 thou. ha) from the territory of the country (6 450 thou. ha) and most of them are man-replanted. The share of agricultural land is 37.9 % from the territory or 2 445 thou. ha, from which arable land makes 73.5, orchards – 1.1, meadows – 8.8, and pastures – 16.6 %. Secondly, management of the surface and ground water regime has influenced natural hydrological conditions. Currently, about 64 % of agricultural land and 48 % of forests have been drained. Also other water management activities like construction of water reservoirs for power plants, dams, road dikes and polders, as well as dredging and modification of water courses, etc., have substantially influenced the anthropogenic and natural ecosystems, including soils. Thirdly, other human activities related to farming and agricultural production, such as amelioration (expansion of field contours and changes in field configuration, removal of stones and trees, modification of land surface, subsoiling, etc.), lime application, use of fertilizers, and soil tillage, have influenced the land and soil quality. These activities were very intensive within the period from 1960 up to 1990 and considerably influenced soil properties, especially for arable land. Agricultural activities have experienced some decline since 1990, which also, to some extent, has influenced the soil processes. Deterioration of water management systems and improper attention to their maintenance, overgrowing of farmland with bushes and deep-rooted weeds (especially on marginal lands), dramatic decrease in fertilizer and manure use and lime application, long-lasting repeated cropping of cash-crops, etc., are the main features of the present farming situation in general. They have periodically changed the soil moisture, oxidation-reduction, humus formation, nutrient turnover and other regimes, biodiversity, as well as have mechanically mixed not only the topsoil layers but also deeper soil horizons. Therefore the natural soil development equilibrium has been disturbed periodically. This has resulted in the formation of specific soil profile features, has caused high spatial variability of soil properties, as well as has increased the diversity of soil cover.

The main soils of Latvia. Albeluvisols[30] occur on noncalcareous sandy loam till and are characterized by an albic horizon with tonguing and eluvio-illuvial profile differentiation of clay and sesquioxides. These soils are base-unsaturated and poor in humus, but rich in fulvic acids. **Arenosols** occur on coarse sands in close complex with sandy Podzols and some sandy Regosols. **Cambisols** are formed on calcareous yellowish-grey and/or reddish-brown till, and quite rarely also on glaciofluvial deposits of different texture. These soils are characterized by cambic and/or cambic and argic horizons formed *in situ*. They contain 2 – 5 % of humic-fulvic humus, and the available moisture capacity is

[30] Soil names and soil terminology according to the WRB 2006.

high. **Fluvisols** cover a small and narrow area on some river valley plains, and Salic Fluvisols – on low coastal territories of the Baltic Sea. **Gleysols** are the prevailing soils in Latvia and include different hydromorphic formations of ground and/or combined surface-ground aquic regime both on glacial till and different aqueous deposits of the Baltic Sea transgressions, such as varved clays, clays, silty loams, fine sands, etc. Gleysols are mostly base-saturated, rich in organic matter, and often bi- or multisequal in texture and chemistry. **Histosols** occupy more than 10 % of the territory and are mostly Eutric. Large areas of Histosols are naturally stable and represent natural reserves. **Leptosols** are formed on ordinary and dolomitized limestone, but sometimes also on calcareous skeletal till and coarse glaciofluvial materials. They are rich in humus and its insoluble fractions, but are arid and with slow turnover of calcic compounds. **Luvisols** are the main automorphic soils. They are formed either on calcareous till in complex with Cambisols or on bisequal deposits which consist of silty-sandy materials on loamy till (Stagnic Luvisols) and are influenced by the seasonal perched water there. They have an argic horizon and only slightly expressed albic features. They are neutral, with a 2 – 4 % humic-fulvic humus, and high available moisture capacity. **Planosols** and **Stagnosols** are formed on clayey till as well as on some clay sediments of Holocene. For Planosols, a strict albic/argic discontinuity (abrupt textural change) is characteristic. Against the background of the albic horizon, neoferrans and mottles are present. **Podzols** are formed on sands of different genetic origin under pine stands without the herb layer. They are strongly acid, base-unsaturated, and extremely poor in clay and sesquioxides in topsoil. Carbic, Ortsteinic and Gleyic Podzols often occur in lowlands and microhollows. **Regosols** are formed on skeletal calcareous till and glaciofluvial material in close complex with Rendzic Leptosols, Calcaric Cambisols, or Luvisols; they are found also on eroded surfaces. Usually they are poor in humus and are arid, with low available moisture capacity[31].

Rationale for soil classification. Traditionally, the genetic approach is used for soil classification in Latvia. To separate soil taxonomic units, mainly understanding about the processes, which develop certain soil features, is used, but quantitative morphological (analytical) criteria are less important. Therefore subjective propositions about the possible soil development processes and the environmental factors influencing them have great importance. On a national scale, such soil classification system has been used for different purposes already since 1927. Soil types and subtypes alone or in the form of different associations and complexes are used basically as mapping units for large-scale (1:10 000) soil maps.

[31] Material derived from Loit Reintam annotation about the soils of the Baltic States.

The advantages of such approach, which is employed also in the current system, are: inheritance of data amount accumulated during the last 70 years, including materials of large-scale soil survey performed for all agricultural land of Latvia where this classification has been used for soil mapping unit definitions; comprehensibility and practicability of the system for users, simplicity and sustainability of traditional experience, and understandability of terminology which in most cases rather well expresses the main features important for soil use; and good integration with the local natural conditions (geology, landscape, climate, and vegetation). This approach, which often is based on empirical competence and experience, fits quite well for the local information need, and up to now has been mainly agriculture and forestry oriented.

We recognize that such approach cannot fully meet the requirements for international communication and also has some limitations for domestic use when new parameters should be integrated into the national system and advanced interpretations need to be applied, for example, modeling of natural processes for environmental applications, remote sensing, and indirect measurement methods of certain soil properties. Therefore many criteria should be well and strictly ("hard") defined and categorized, and the result must not vary among the experts involved in decision making, which might be considered as a weakness of this approach. For that reason, the international systems, e.g., WRB which strictly follows certain defined and measurable criteria and morphological features, have priorities.

In Latvia, in order to compromise these two lines, to satisfy the needs of local users (giving priority for information end-users, e.g., farmers and advisors), and to realize the requirements of more advanced applications and international communication, it is proposed to use the internationally recognized system for soil diagnosis and soil profile description, as well as methods of testing physical and chemical parameters necessary for soil classification. In this case, the information standard allows soil classification to be performed using both systems, national and international, depending on the situation (see figure 8.1.).

The scheme of Latvia soil classification includes three dependent (hierarchical) levels: classes, types, and subtypes. On the highest categorical level (class), the main criterion is hydromorphism. On the second level, the criteria are different features, such as depth of carbonates, evidence of certain processes of soil genesis (lessivage, podzolization, and reductomorphic and oximorphic processes), and profile development, but for hydromorphic soils – type and decomposition rate of organic soil materials.

Automorphic soils – developed on the relatively highest part of landscape with a deep groundwater table. Soil profile is water-saturated only for a short period within a year. This soil class comprises 6 soil types with 22 subtypes.

- Sod calcareous soils – well developed A horizon, and carbonates in soil profile within 0 – 60 cm from the surface.
- Brown soils – clay accumulation in B horizon *in situ* or by illuviation, and carbonates deeper than 60 cm.
- Podzolic soils – soils with some features of podzolization (bleached E horizon).
- Podzols – soils with distinct features of podzolization (well expressed E and Bs/Bhs horizons).
- Weakly developed soils – young and noticeably eroded soils with weekly developed or truncated genetic horizons.
- Anthrosols – development of soils is considerably influenced by a man. Includes the soils strongly altered by cultivation, as well as recultivated, technogenic and also buried soils.

Semihydromorphic soils – developed in planes or depressions on fine-textured parent material. Soil profile is water-saturated for a long period within a year including the growing season. Gleyic and/or stagnic properties are clearly distinguished. This soil class comprises 3 soil types with 24 subtypes.

- Gley soils – sod calcareous or brown soils with distinct gleyic and/or stagnic properties.
- Podzolic-gley soils – podzolic soils or podzols with gleyic and/or stagnic properties.
- Alluvial soils – developed on alluvial sediments.

Hydromorphic soils – organic soils: mires, peatlands, naturally water-saturated soils. This soil class comprises 3 soil types with 10 subtypes.

- Fen peat soils – organic soils from highly decomposed grass vegetation.
- Transitional mire soils – intermediate stage between fen and raised bog development.
- Raised bog soils – organic soils with considerable amounts of recognizable plant tissue.

On the third level, soil types are divided into subtypes according to additional properties: organic matter content in surface horizons and their thickness, as well as development of genetic horizons. For example, the soil unit name **Mucky-podzolic gley soil** is denotation for the Podzolic-gley soil with more than 50 % of organic matter in topsoil and a continuous layer of gleyed horizon.

Soil names. It should be pointed out that soil nomenclature reflects the main processes which have taken part in soil formation. For example, the soil unit name **Eroded sod-calcareous soil** denotes two dominating features – the process of sod formation (extensive grass root mat development in upper top-soil), and the presence of carbonates within 60 cm from the soil surface – and, additionally, some truncation of A horizon, which has happened due to erosion.

More detailed subdivision. Guidelines for the lower subdivision are also given, but generally they are not very strictly defined (compared with the above-mentioned). The lower subdivisions can be applied basing on parent material, soil texture (topsoil and subsoil), technological properties (topography, water regime, coarse fragments, degree of cultivation, erosion risk, slope), and other relevant features important for land use.

The English translation of soil names of Latvia soil classification is given in Appendix 2.

Comparison of taxonomic units. A scheme is proposed to correlate the Latvia soil units with WRB. A direct comparison is impossible due to the disparity of definitions and logics behind. For example, Podzolic soils, a soil type common in Latvia, can be keyed out at least in 6 WRB Reference soil groups depending on the additional characteristics they have. Whereas WRB Histosols can be allocated in a number of Latvia classification units representing all three classes: Automorphic, Semihydromorphic, and Hydromorphic soils. This distribution is too broad and makes direct comparison useless. Additional information and logical combinations can help reach the approximation applicable to information transfer. Such comparison with the use of reasonable algorithms is also supposed to be applied in exclusive situations, e.g., in conversion of old (historical) data. In all other situations and new data acquisition, a direct use of international soil classification systems and relevant keys is recommended in parallel with the national classification, e.g., the one presented in this edition.

History and the present classification. The book contains a detailed description of the previous schemes of Latvia soil classification since 1927, which is aimed at better understanding of the rationale of the current classification and possibility of using the previous soil maps, surveys, and publications. Correlation tables are included to compare taxonomic units of the old classification schemes with the new one in order to make use of the proposed system effective (see Appendix 1).

The contents of the book

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