Classification, Netherlands

Alfred E. Hartemink
ISRIC—World Soil Information, Wageningen, The Netherlands

Henk de Bakker
Formerly with the Netherlands Soil Survey Institute, Wageningen, The Netherlands

INTRODUCTION

Although people have always classified soils, it is only since the mid 19th century that soil classification emerged as an important topic within soil science. It forced soil scientists to think systematically about soils and its genesis and developed to facilitate communication between soil scientists. It has also been the cause for much debate and confusion but two internationally accepted systems have emerged: Soil Taxonomy and the World Reference Base for Soil Resources (WRB). In addition, many national soil classification systems exist whose methods and approaches are based on one of the international soil classification systems or which have influenced these systems. Here we describe the Dutch soil classification system, which was essentially developed after the fourth International Congress of Soil Science in Amsterdam in 1950.

The Netherlands is a low-lying country with the lowest point at nearly 7 m below mean sea level just north of Rotterdam. The highest point is 321 m above mean sea level and located in the Southern part of the country. About half of the country is below sea level and would be inundated without dikes and dunes. It is also a wet country, and more than 90% of the soils have groundwater within 140 cm of the soil surface during winter. As a result, most Dutch soils are hydromorphic and require artificial drainage when taken in use. There is no consolidated rock and the parent material is alluvial (marine or fluviatile), or aeolian, glacial, or organic. About one-third of the country consists of embanked forelands from either the North Sea or the rivers Scheldt, Rhine, and Meuse; these polders have Holocene loamy and mostly clayey soils. About 40% of the Dutch soils have Pleistocene sands as parent material and 2% loess. Peat areas comprise about 25% of the Netherlands.

BRIEF HISTORY OF THE SOIL MAPPING AND SOIL CLASSIFICATION

W.C.H. Staring (1808–1877) made the first geological map of the Netherlands at a scale 1:200,000 in the 1850s. At the request of a teacher's society the map was simplified and used in educatio n on basic schools for over a century. Until the 1940s, there was little activity in soil surveying, although much work was done in the Dutch East Indies by E.C.J. Mohr (1873–1970), and there was intensive and detailed soil fertility research by D.J. Hissink (1874–1956) in Groningen.

The focus of Staring and his followers was on the topsoil, and relatively little was known about the whole solum, soil genesis, and geography. This changed in the 1930s when W.A.J. Oosting (1898–1942) started soil mapping around Wageningen. Inspired by the work of Oosting, C.H. Edelman (1903–1964) started soil surveying with his students in the riverine clay area during World War II. The Dutch Soil Survey Institute (StiBoKa) was founded by Edelman in 1945. Soil maps were very much in demand in areas with severe war damage such as, for example, polders that were inundated with sea water, minefields, and for restoring airfields to agricultural use. His book *Soils of The Netherlands* was published on the occasion of the 1950 congress of the International Society of Soil Science (ISSS) in Amsterdam.[1] The accompanying map (scale 1:400,000) reflects the main Staring classes (sea clay, river clay, sand, loess, and peat), but for the subdivision physiographic criteria are used. The Edelman approach was strongly based on geology and the landscape, which resulted in the Dutch school of physiographic soil mapping. The fieldwork for the map at a scale 1:200,000 took place between 1952 and 1954, and it was published in 1960. In 1952, the Soil Survey Institute started to map the whole country at 1:50,000 (110 sheets), which was published between 1964 and 1995.[2]

The physiographic approach for soil mapping was less suitable for soil classification, and the legends of the map provided more insight in geogenesis than in pedogenesis. In the 1950s and 1960s soil classification was widely discussed because of an increasing number of soil scientists working in soil mapping, increased international interaction following the ISSS congress in 1950, and the development of soil classification in the United States. Under guidance of the main author of *Soil Taxonomy*, G.D. Smith, Dutch soil scientists discussed the series of approximations and a committee started to frame a system

DOI: 10.1081/E-ESS-120022907

Table 1 The five orders, their diagnostic properties and equivalents in Soil Taxonomy and the World Reference Base

Orders	Main diagnostic property	Approximate equivalent in Soil Taxonomy	Approximate equivalent in the World Reference Base
Peat soils	>40-cm peat within 80-cm depth	Histosols	Histosols
Podzol soils	Soils with podzol B	Spodosols (Aquods and Orthods)	Podzols
Brick soils	Soils with a ''brick'' layer	Alfisols (Hapludalfs)	Luvisols, Planosols
Earth soils	Soils with a mineral earthy layer	Mollisols, Inceptisols (Aquic soils with a mollic or anthropic epipedon)	Anthrosols
Vague soils	Without foregoing diagnostic horizons	Entisols, Inceptisols	Fluvisols, Gleysols, Anthrosols, Regosols, Cambisols, Arenosols

of soil classification using inherent soil properties as differentiating criteria rather than physiographic and geological criteria. It formed the base for the current Dutch system of soil classification.[3]

THE DUTCH SYSTEM OF SOIL CLASSIFICATION

At the highest level, soils are differentiated by soil-forming processes and as such, the system has a profound pedogenic base. Units in the classification system are defined by morphometric properties and characteristics of the soil profile. There are five orders and a brief description including the equivalents in *Soil Taxonomy* is listed in Table 1. A podzol or textural B horizon and the formation of an A horizon are diagnostic criteria at the order level. In addition, the absence of soil formation or the presence of peat as parent material is used at the order level. No soil chemical criteria are used at the order level because of the heavy use of manure and inorganic fertilizer applications in the Netherlands.

Table 2 The soil classification of the Netherlands at the higher levels

Order	Suborder	Group	Subgroup
Peat soils	Earthy peat soils	Clayey earthy peat soils	''Aar'' peat soils
			''Koop'' peat soils
		Clay-poor earthy peat soils	''Bo'' peat soils
			''Made'' peat soils
	Raw peat soils	Initial raw peat soils	''Vliet'' peat soils
		Ordinary raw peat soils	''Weide'' peat soils
			''Waard'' peat soils
			''Meer'' peat soils
			''Vlier'' peat soils
Podzol soils	Moder podzol soils	Moder podzol soils	''Holt'' podzol soils with a sand cover
			''Loo'' podzol soils
			''Hoek'' podzol soils
			''Horst'' podzol soils
			''Holt'' podzol soils
	Hydropodzol soils	Peaty podzol soils	''Moer'' podzol soils with a clay cover
			''Moer'' podzol soils with a sand cover
			''Dam'' podzol soils
			''Moer'' podzol soils
		Ordinary hydropodzol soils	''Veld'' podzol soils with a clay cover
			''Veld'' podzol soils with a sand cover
			''Laar'' podzol soils
			''Veld'' podzol soils
	Xeropodzol soils	Xeropodzol soils	''Haar'' podzol soils with a sand cover
			''Kamp'' podzol soils
			''Heuvel'' podzol soils
			''Haar'' podzol soils

(*Continued*)

Table 2 The soil classification of the Netherlands at the higher levels (*Continued*)

Order	Suborder	Group	Subgroup
Brick soils	Hydrobrick soils	Hydrobrick soils	''Beemd'' brick soils
			''Kuil'' brick soils
	Xerobrick soils	Xerobrick soils	''Berg'' brick soils
			''Del'' brick soils
			''Rooi'' brick soils
			''Daal'' brick soils
			''Rade'' brick soils
Earth soils	Thick earth soils	''Enk'' earth soils	Brown ''enk'' earth soils
			Black ''enk'' earth soils
		''Tuin'' earth soils	''Tuin'' earth soils
	Hydroearth soils	Peaty earth soils	''Plas'' earth soils
			''Broek'' earth soils
		Sandy hydroearth soils	Brown ''beek'' earth soils
			''Goor'' earth soils
			Black ''beek'' earth soils
		Clayey hydroearth soils	''Lied'' earth soils
			''Tocht'' earth soils
			''Woud'' earth soils
			''Leek'' earth soils
	Xeroearth soils	Sandy xeroearth soils	''Akker'' earth soils
			''Kant'' earth soils
		Clayey xeroearth soils	''Hof'' earth soils
Vague soils	Initial vague soils	Initial vague soils	''Gors'' vague soils
			''Slik'' vague soils
	Hydrovague soils	Sandy hydrovague soils	''Vlak'' vague soils
		Clayey hydrovague soils	''Drecht'' vague soils
			''Nes'' vague soils
			''Polder'' vague soils
	Xerovague soils	''Krijt'' vague soils	''Krijt'' vague soils
		''Sandy'' xerovague soils	''Duin'' vague soils
			''Vorst'' vague soils
		Clayey xerovague soils	''Ooi'' vague soils

Source: From Ref. [3].

The five orders are subdivided into 13 suborders, 23 groups, and 58 subgroups (Table 2). Criteria to distinguish the lower levels of classification include texture, organic matter content, hydromorphic characteristics, peaty topsoil, plaggen epipedon, ripening class. Processes such as gley formation, ripening, and the influence of cultivation are considered at the suborder level, and hydromorphic properties are profoundly present at the suborder level as in many other systems of soil classification. At the group level, differences in parent material are considered as are the presence of peat layers and the stage of ripening. At the lowest level (subgroup) topsoil properties are important. Although the subgroup level is the lowest level in the Dutch Soil Classification System, lower classification levels are used in the 1:50,000 soil map of the Netherlands. It is interesting to note that the 1:50,000 soil map still reflects Staring's main classes of the mid 1800s.[4]

SOIL NOMENCLATURE

The highest categories (order, suborder, and group) have names adopted from the existing terminology, but in some cases artificial terms are chosen. At the subgroup level, names have been chosen that are a combination of Dutch toponyms and the name of the order. For example, ''Aar'' peat soils are found around the villages of Langeraar and Ter Aar in the province of South Holland, whereas most of the ''koop'' peat soils are named after villages ending in koop (e.g., Boskoop, Teckop). Some of the names stem from medieval reclamation (e.g., ''rooi'' from uprooting shrubs or trees). Other names are from rivers and lakes or low-lying areas (e.g., ''tocht,'' ''daal'') or from the dominant type of land use (''weide''=pasture; ''akker''=arable land).[3] An overview on toponyms and soil nomenclature is given by Siderius and de Bakker.[5]

CONCLUSION

The Dutch Soil Classification System was developed in the 1960s following decades of physiographic soil mapping. The system has a strong pedogenic base at the highest level, and parent material and hydromorphic properties are important. There are 5 orders, 13 suborders, 23 groups, and 58 subgroups. This system was used as the background of the legend for the 1:50,000 soil map published in 110 sheets between 1964 and 1995. Although the system stems from the 1980s and no attempts have been made to update or revise the system, it continues to provide useful information on the genesis and geography of soils in the Netherlands.

REFERENCES

1. Edelman, C.H. *Soilsx of the Netherlands*; North-Holland Publishing Company: Amsterdam, 1950.
2. Steur, G.G.L. The soil map of the Netherlands, scale 1:50 000. Some aspects of the grouping of the legend and the nomenclature of the mapping units. Boor Spade **1966**, *XV*, 43–58, (in Dutch, with summary in English).
3. de Bakker, H.; Schelling, J. *Systeem van Bodemclassificatie voor Nederland, de Hogere Niveaus*; PUDOC: Wageningen, 1989, (in Dutch, with 30 pages summary in English).
4. de Bakker, H. Purposes of soil classification. Geoderma **1970**, *4*, 195–208.
5. Siderius, W.; de Bakker, H. Toponymy and soil nomenclature in the Netherlands. Geoderma **2003**, *111*, 521–536.

Marcel Dekker, Inc.
270 Madison Avenue, New York, New York 10016