Ranjith B. Mapa Editor

The Soils of Sri Lanka



Contents

| 1 | Soil Research and Soil Mapping History | 1 |
|-----|---|-----|
| 2 | Climate | 13 |
| 3 | Geology and Geomorphology | 23 |
| 4 | Soil Mineralogy S. P. Indraratne | 35 |
| 5 | Major Soils of the Dry Zone and Their Classification A. R. Dassanayake, G. G. R. De Silva, and Ranjith B. Mapa | 49 |
| 6 | Major Soils of the Intermediate Soils and Their Classification | 69 |
| 7 | Major Soils of the Wet Zone and Their Classification | 83 |
| 8 | Land Use | 95 |
| 9 | Soil Degradation | 103 |
| 10 | Environmental Soil Issues | 119 |
| Ind | av. | 125 |

List of Figures

| Fig. 1.1 | Provinces, districts and divisional secretary boundaries of Sri Lanka (Anonymous 2007) | 2 |
|----------------------|--|----|
| Fig. 1.2 | Topography of Sri Lanka (Kadupitiya et al. 2019) | - |
| Fig. 1.3 | The first provisional soil map of Sri Lanka published by Joachim | • |
| - 18, 110 | (1955: For the key refer to Table 1.2) | ť |
| Fig. 1.4 | Soil map of Sri Lanka published by de Alwis and Panabokk (1972) | ` |
| | (Scale of 1:5,000,000) | ç |
| Fig. 2.1 | Climatic zones of Sri Lanka (NRMC, Department of Agriculture, | |
| E . 22 | Peradeniya) | 15 |
| Fig. 2.2 | Relief map of Sri Lanka (NRMC, Department of Agriculture, | 1. |
| Ein 22 | Peradeniya). | 16 |
| Fig. 2.3 | Agro-climatic zones of Sri Lanka (NRMC, Department of Agriculture, | 10 |
| E:- 0.4 | Peradeniya). | 18 |
| Fig. 2.4 | Agro-ecological regions of Sri Lanka (NRMC, Department | 10 |
| Dia 2.1 | of Agriculture, Peradeniya) | 19 |
| Fig. 3.1 | Relief map of Sri Lanka | 24 |
| Fig. 3.2 | Diagrammatic cross section of Sri Lanka showing three peneplains | ~ |
| E. 22 | (modified after Wadia 1945) I-Lowest; II-Middle and III-Highest | 25 |
| Fig. 3.3 | Cross section showing different erosional levels (in Haputale one inch | |
| | to one mile topographic sheet; vertical scale is 2.5 times the horizontal | 25 |
| E:- 2.4 | scale) (modified after Cooray 1984) | 25 |
| Fig. 3.4 Fig. 3.5 | Evolution of three peneplains in Sri Lanka, a modified after Adams | 25 |
| | (1929), b modified after Wadia (1945), c modified after | |
| | | 26 |
| Fig. 3.6 | Characteristic flat topography with isolated hills in the lowlands | |
| | | 26 |
| Fig. 3.7 | · · · · · · · · · · · · · · · · · · · | 27 |
| Fig. 3.8 | Physiographic regions of the central highland of Sri Lanka | |
| | · | 28 |
| Fig. 3.9 | Drainage network and climatic zones of Sri Lanka (only major river | |
| | | 30 |
| Fig. 3.10 | | 31 |
| Fig. 3.11 | Miocene limestone beds that are overlain by Quaternary red and brown | |
| | | 32 |
| Fig. 3.12 | · · · · · · · · · · · · · · · · · · · | 33 |
| Fig. 4.1 | X-ray diffractrograms of soils a Red Yellow Podzolic soils from wet | |
| | zone, b Immature brown loam from intermediate zone, c Red Latosol | |
| | from dry zone, and d Non-Calcic Brown soils from dry zone of Sri | |
| | Lanka ($k = k$ -saturated: Mg = Mg-saturated: $G = Glycerol$ solvated: | |

| | V = vermiculite; Gi = Gibbsite; I = Illite; Ka = kaolinite; | |
|---------------------|---|----|
| | M = montmorillonite. Source Indraratne, unpublished) | 38 |
| Fig. 4.2 | X-ray diffractograms of the clay fraction of Red-Yellow Podzolic soils | |
| | collected from Sita Eliya soil (a 0–15 cm depth and b 15–30 cm depth) | |
| | (Ka = Kaolinite, V = Vermiculite, Gb = Gibbsite, K = K-saturated, | |
| | Mg = Mg-saturated, G = glycerol-solvated. Source Indraratne 2006) | 41 |
| Fig. 4.3 | X-ray diffractograms of the clay fraction of Alfisols collected from | |
| | Mahailluppallama soil at a 0-15 cm depth and b 15-30 cm depth | |
| | (Ka = Kaolinite, S = Smectite, I = Illite, K = K-saturated, | |
| | Mg = Mg-saturated, G = glycerol-solvated. Source Indraratne 2006) | 44 |
| Fig. 4.4 | X-ray diffractograms of the clay fraction (<2 μm) of Anuradhapura | |
| | (left) and Hambantota (right) Earth Dams. (Ka = Kaolinite, | |
| | S = Smectite, $I = Illite$, $K = K$ -saturated, $Mg = Mg$ -saturated, | |
| | G = glycerol-solvated) (Source Dias et al. 2003) | 45 |
| Fig. 4.5 | Potentiometric titration curves for tropical Alfisols soil at different | |
| | electrolyte concentrations (Source Sanjeevani et al. 2012) | 46 |
| Fig. 5.1 | The three climatic zones, wet, intermediate, and Dry zones | |
| Ü | of Sri Lanka (Dassanayake et al. 2007) | 50 |
| Fig. 5.2 | Schematic diagram showing the flat landscape of the Dry zone | |
| 2 | (Mapa et al. 2007) | 52 |
| Fig. 5.3 | Schematic diagram showing the undulating landscape of the Dry zone | |
| | (Mapa et al. 2007) | 52 |
| Fig. 5.4 | Schematic diagram showing the relationship between topography and | |
| * 1 5 , 5, , | drainage of the soils in the Dry zone a flat landscape in Northern | |
| | Province and b undulating landscape in North Central province (Mapa | |
| | et al. 2007). | 53 |
| Fig. 5.5 | One sheet of the soil map of the Dry zone of Sri Lanka showing the | |
| 1 16. 5.5 | distribution of major soil series (Mapa et al. 2007; Modified | |
| | by V. Pushpakumara, NRMC) | 56 |
| Fig. 5.6 | Landscape and soil profile of Madawachchiya soil series (Soil | |
| 118.010 | Taxonomy: Typic Rhodustalfs; FAO/WRB Legend: Cutanic Luvisols, | |
| | Rhodic, Skeletic, Clayic, Hypereutric) (Mapa et al. 2007) | 57 |
| Fig. 5.7 | Landscape and soil profile of Cheddikulum soil series (Soil Taxonomy: | |
| 116. 5.7 | Oxyaquic Haplustalfs: FAO/WRB Legend: Cutanic Luvisols, | |
| | Endosodic, Skeletic, Chromic) (Mapa et al. 2007) | 57 |
| Fig. 5.8 | Landscape and soil profile of Hurathgama soil series (Soil Taxonomy: | 0, |
| 1 16. 5.0 | Typic Endoaqualfs; FAO/WRB legend: Luvic Gleysols, Dystric) | |
| | (Mapa et al. 2007) | 58 |
| Fig. 5.9 | Landscape and soil profile of Negombo soil series (Soil Taxonomy: | 50 |
| 116.0.5 | Ustic Quartzipsamments; FAO/WRB Legend: Haplic Arenosols) | |
| | (Mapa et al. 2007) | 60 |
| 5.10 | | 00 |
| 7.10 | Typic Quartzipsaments; FAO/WRB Legend: Haplic Arenosols, | |
| | Eutric, Greyic) | 61 |
| | Landscape and soil profile of Puttalam Series (Soil Taxonomy: | O1 |
| | Sodic Endoaquents; FAO/WRB Legend: Haplic Solonchaks, Sodic) | |
| | (Mapa et al. 2007) | 61 |
| . 5.12 | | O1 |
| . 5.12 | Typic Ustipsamments; FAO/WRB Legend: Haplic Arenosols, Eutric) | |
| | (Mapa et al. 2007) | 62 |
| | (mapa et al. 2001) | 04 |

ist of Figures xvii

| Fig. 5.13 | Landscape and soil profile of Mawillu Series (Soil Taxonomy: Oxiaquic Udorthents; FAO/WRB Legend: Haplic Arenosols, Eutric) | |
|-----------|---|----------|
| Fig. 5.14 | (Mapa et al. 2007) | 63 |
| | (Mapa et al. 2007) | 64 |
| Fig. 5.15 | Landscape and soil profile of Manampitiya soil series (Soil Taxonomy: Oxyaquic Udifluents; FAO/WRB Legend: Haplic Fluvisols, Eutric, | |
| Fig. 5.16 | Oxyaquic) (Mapa et al. 2007) | 65 |
| Fig. 6.1 | Eutric) One sheet of the soil map of the Intermediate zone of Sri Lanka showing the distribution of major soil series (Mapa et al. 2005 Modified | 66 |
| Fig. 6.2 | by V. Pushpakumara, NRMC) | 70 73 |
| Fig. 6.3 | Landscape and soil profile of Kuliyapitiya series (Soil Taxonomy: Typic Hapludults; FAO/WRB legend: Cutanic Alisol) | |
| Fig. 6.4 | (Mapa et al. 2005) | 73 |
| Fig. 6.5 | Gleyic, Clayic) (Mapa et al. 2005) | 74 |
| Fig. 6.6 | Dystric) Landscape and soil profile of Welipellessa soil series (Soil Taxonomy: Aquic Quartzipsaments; FAO/WRB Legend: Gleyic Fluvisols, Dystric, | 75 |
| Fig. 6.7 | Arenic) (Mapa et al. 2005) | 76 76 |
| Fig. 6.8 | Schematic diagram showing hill and valley landform with low to moderate relief of the Intermediate zone (Mapa et al. 2005) | 70 77 |
| Fig. 6.9 | Landscape and soil profile of Waligapola soil series (Soil Taxonomy: Typic Dystrochrepts; FAO/WRB Legend: Haplic Cambisols, Eutric, | • |
| Fig. 6.10 | Haplohumults; FAO/WRB Legend: Cutanic Alisols, Skeletic, Humic, | 77 |
| Fig. 6.11 | Epidystric) (Mapa et al. 2005) | 78 |
| Fig. 6.12 | Typic Hapludults; FAO/WRB Legend: Cutanic Acrisols, Hyperdystric, | 79 |
| Fig. 6.13 | Cleyic, Humic) (Mapa et al. 2005) Landscape and Soil Profile of Ragala Soil Series (Soil Taxonomy: Typic Hapludults; FAO/WRB Legend: Leptic Regosols, (Dystric) | 80 |
| Fig. 6.14 | (Mapa et al. 2005) | 81 |
| | Typic Rhodudults; FAO/WRB Legend: Cutanic Alisols, Chromic, Hyperdystric) | 82 |

| Fig. 7.1 | One sheet of the soil map showing the distribution of major soil series of the Wet zone of Sri Lanka (Mapa et al. 1999; Modified | |
|-----------|---|-----|
| | by V. Pushpakumara) | 84 |
| Fig. 7.2 | Landscape and soil profile of the Rathupasa series (Soil Taxonomy: Psammentic Plaeudalfs; EAO/WRB legend: Haplic Arenosols, | |
| | Hypoferralic, Dystric) (Mapa et al. 1999) | 86 |
| Fig. 7.3 | Landscape and soil profile of Pugoda Series (Soil Taxonomy: Typic Ustifluents; FAO/WRB Legend: Haplic Fluvisols, Clayic, Dystric) | |
| | (Mapa et al. 1999) | 86 |
| Fig. 7.4 | Landscape and soil profile of the Boralu series (Soil Taxonomy: Typic | |
| | Plaeudults; FAO/WRB Legend: Pisolithic Plinthosols, Clayic, Dystric) | |
| | (Mapa et al. 1999) | 87 |
| Fig. 7.5 | Landscape and soil profile of Kiribthkumbura series (Soil Taxonomy: | |
| | Aeric Fulvaquents; FAO/WRB Legend: Haplic Gleysols, Colluvic, | |
| | Eutric, Gleyic) (Mapa et al. 1999) | 89 |
| Fig. 7.6 | Landscape and soil profileof Ukuwela soil series (Soil Taxonomy: | |
| | Typic Rhodudults; FAO/WRB Legend: Pisolithic Plinthosols, Clayic, | |
| F: 5.5 | Dystric) | 90 |
| Fig. 7.7 | Landscape and soil profile of Waddagala Series (Soil Taxonomy: Typic Haplohumults; FAO/WRB Legend; Cutanic Acrisols, Humic) | |
| | (Mapa et al. 1999) | 90 |
| Fig. 7.8 | Landscape and soil profile of Mattakele series (Soil Taxonomy: Typic | |
| | Hapludults; FAO/WRB Legend: Cutanic Acrisols, Clayic) | |
| | (Mapa et al. 1999) | 92 |
| Fig. 7.9 | Landscape and soil profile of Maskeliya Series (Soil Taxonomy: Typic | |
| | Distropepts; FAO/WRB Legend: Haplic Regosols, Dystric, Skeletic) | |
| | (Mapa et al. 1999) | 92 |
| Fig. 7.10 | Landscape and soil profile of Nuwara Eliya series (Soil Taxonomy: | |
| | Typic Plaeudults; FAO/WRB Legend: Cutanic Acrisols, Humic) | 93 |
| Fig. 8.1 | Land use systems of Sri Lanka (Adopted from LADA Sri Lanka project, | |
| TI 0.2 | NRMC) | 97 |
| Fig. 8.2 | Area under different land use systems as percentage of total area | 0.0 |
| F' 0.1 | of Sri Lanka. Adopted from LADA Sri Lanka project, NRMC | 98 |
| Fig. 9.1 | Soil degradation due to deforestation | 106 |
| Fig. 9.2 | Soil erosion in road embankment | 107 |
| Fig. 9.3 | Vegetable cultivation in steep sloping lands in Nuwara Eliya District | 111 |
| Fig. 9.4 | Landslides occurring during an event of a heavy rainstorm | 112 |
| Fig. 9.5 | Coastal erosion in Sri Lanka | 112 |
| Fig. 10.1 | Seasonal NO ₃ variations in shallow sand aquifers in Sri Lanka in areas | 100 |
| | under intensive fertilized irrigation (FAO 1990) | 123 |

List of Tables

| Table 1.1 | Increasing pressure for land with time on total and arable lands in Sri Lanka | 4 |
|-----------|---|----|
| Table 1.2 | Legend to the first provisional soil map published by Joachim in 1945 | - |
| | as shown in Fig. 1.3 | 7 |
| Table 1.3 | Great Soil Groups of Sri Lanka as classified by Mooman | · |
| | and Panabokke (1961) | 7 |
| Table 1.4 | Great soil groups of Sri Lanka according to the classification of De | |
| | Alwis and Panabokke (1972) and the 7th Approximation equivalents | 10 |
| Table 2.1 | Agro-ecological regions of Low Country Wet Zone | 20 |
| Table 2.2 | Agro-ecological regions of Mid-Country Wet Zone | 20 |
| Table 2.3 | Agro-ecological regions of Up Country Wet Zone | 20 |
| Table 2.4 | Agro-ecological regions of Low Country Intermediate Zone | 20 |
| Table 2.5 | Agro-ecological regions of Mid-Country Intermediate Zone | 20 |
| Table 2.6 | Agro-ecological regions of Up Country Intermediate Zone | 21 |
| Table 2.7 | Agro-ecological regions of Low Country Dry Zone | 21 |
| Table 4.1 | Great soil group (GSG), parent material and taxonomic equivalent | |
| | according to the 7th approximation for the soils of the wet zone and | |
| | semi-wet intermediate zone (Sources de Alwis and Panabokke 1972; | |
| | Mapa et al. 1999) | 37 |
| Table 4.2 | Great soil group (GSG), parent material and taxonomic equivalent | |
| | according to the 7th approximation for the soils of the dry zone and | |
| | semi-dry intermediate zone (Sources de Alwis and Panabokke 1972; | |
| | Mapa et al. 2010) | 39 |
| Table 4.3 | Mineralogical information of soils collected from selected locations | |
| | of Wet zone (Mineralogical information was collected from different | |
| | sources and suborders were assigned by considering the location and | |
| | mineralogy, Sources Indraratne 2006; Kyuma and Kawaguchi 1967; | |
| | Panabokke 1958; Yapa 1988) | 41 |
| Table 4.4 | Mineralogical information of soils collected from selected locations | |
| | of Intermediate zone (Mineralogical information was collected from | |
| | different sources and suborders were assigned by considering the | |
| | location and mineralogy. Sources Kyuma and Kawaguchi 1967; | |
| | Mapa 1992; Yapa 1988) | 42 |
| Table 4.5 | Mineralogical information of soils collected from selected locations | |
| | of dry zone (mineralogical information was collected from different | |
| | sources and suborders were assigned by considering the location and | |
| | mineralogy. <i>Sources</i> Indraratne 2006; Kyuma and Kawaguchi 1967; | 12 |
| T.LL 5 1 | Yapa 1988) | 43 |
| Table 5.1 | The well to moderately well-drained soil series of the residual/ | |
| | erosional surfaces in the Dry zone, Great Soil Groups and their | |

| | equivalent Soil Taxonomic and WRB legends (De Silva and | |
|---------------|---|-----|
| Table 5.2 | Dassanayake 2010) | 54 |
| | equivalent Soil Taxonomic, and WRB legends (De Silva and | |
| Table 5.3 | Dassanayake 2010) | 54 |
| | and WRB legends (Dassanayake and De Silva 2010a) | 59 |
| Table 5.4 | The soil series formed in two physiographic regions of the flood plains, Great Soil Groups, and their equivalents of Soil Taxonomic | |
| | and WRB legends (Dassanayake and De Silva 2010b) | 65 |
| Table 6.1 | The soil series occurring in the erosional/residual planation surfaces | 0.5 |
| Table 0.1 | in the low country intermediate zone, Great Soil Groups and their | |
| | equivalent Soil Taxonomic and WRB legends | |
| | (Dasanayake et al. 2005) | 71 |
| Table 6.2 | The soil series occurring in coastal plains and flood plains of the | |
| | depositional surfaces in the low country intermediate zone, great soil | |
| | groups and their equivalent Soil Taxonomic and WRB legends | |
| | (Dassanayake et al. 2005) | 71 |
| Table 6.3 | The soil series occurring in the Erosional/residual planation surface in | |
| | mid-country Intermediate zone, great soil groups and their equivalent | |
| | Soil Taxonomic and WRB legends (De Silva et al. 2005) | 72 |
| Table 6.4 | The soil series occurring in the up country intermediate zone, great | |
| | soil groups and their equivalent Soil Taxonomic and WRB legends | |
| | (Dassanayake and De Silva 2005) | 72 |
| Table 7.1 | Soils series occurring in the coastal and flood plains in the | |
| | depositional surfaces in the low country wet zone, their local names, | 0.5 |
| Table 7.2 | Soil Taxonomic and WRB equivalents | 85 |
| Table 7.2 | The soil series occurring in erosional/residual plantation surfaces in the low country wet zone, Great Soil Group names and their | |
| | equivalent Soil Taxonomic and WRB legends (Senarath and | |
| | Dassanayake 1999) | 85 |
| Table 7.3 | The soil series occurring in the mid-country Wet zone, their Great Soil | 05 |
| 14010 713 | Group names and their equivalent Soil Taxonomic and WRB legends | |
| | (Senarath and Dassanayake 1999) | 88 |
| Table 7.4 | The soil series occurring in the up country wet zone, their Great Soil | |
| | Group names and their equivalent Soil Taxonomic and WRB legends | |
| | (Dassanayake and Hettiarachchi 1999) | 91 |
| Table 8.1 | Major land use types of Sri Lanka—2014 | 96 |
| Table 8.2 | Change of the extents under major crops in Sri Lanka from 1962 to | |
| | 1982 and 1982 to 2000 (in thousands of hectare, Source Survey | |
| | Department (2007). National Atlas of Sri Lanka) | 98 |
|).1 | Human activities and root causes of soil degradation in Sri Lanka | 106 |
| .2 | Soil loss in different land-use systems in Sri Lanka | 100 |
| 0.2 | (Krishnarajah 1984) | 108 |
| 9.3 .e 9.4 | Tolerable soil erosion rates (Krishnaraja 1984) | 109 |
| .U 7.H | of Sri Lanka | 109 |
| Table 9.5 | Soil Erodibility values (K factor) of some Great Soil Groups | 107 |
| | in Sri Lanka | 110 |

st of Tables xxi

| T 11 0 6 | | |
|------------|---|-----|
| Table 9.6 | Sediment yield from some catchments in mid- and up country | |
| | of Sri Lanka (Wallingford 1995) | 110 |
| Table 9.7 | Sedimentation rates of reservoirs in Sri Lanka | 110 |
| Table 9.8 | Fertility status of soils in the country—Number of and percentage | |
| | of soil series falling under different levels of available P, | |
| | Exchangeable K, and Organic carbon contents | 113 |
| Table 9.9 | Some properties of intensively cultivated soils affected | |
| | by eutrophication | 114 |
| Table 9.10 | Soil salinity reported in rice lands in Sri Lanka | 115 |
| Table 10.1 | Concentrations of Arsenic in rice soils (µg/g) | 120 |
| Table 10.2 | Trace elements in fertilizers collected from different regions | |
| | in Sri Lanka (mg/kg) (Chandrajith et al. 2010) | 121 |
| Table 10.3 | Trace elements in fertilizer samples and manures collected | |
| | from Sri Lanka (mg/kg) | 122 |
| Table 10.4 | Trace element levels from organic fertilizers from Sri Lanka | 122 |