Soil Description Handbook

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2024-01-23

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Soil Description Handbook - New Zealand

v 2.0

This edition supersedes Milne 1995

publishing info goes here eventually

1 Introduction

TBD

- rationale, stuff from ToR
- recording standards
-

Part I

Setting and site

2 Setting and Site

discussion of how the immediate and larger surrounds affect soil development

rough scorpan/clorpt based layout

scales of observation - sticking to 2

3 Location

3.1 Absolute location

- appropriate coordinate systems - horizontal plus vertical
- vertical - absolute elevation, elevation above local low point/drainage
- measuring equipment
- required precision for various applications
- storing spatial data (i.e. use points) (too in the weeds???)
- NZ-specific concerns e.g. earthquake shifts, uplift (feed in epoch concept too)
- temporal - YYYY-MM-DD
- notes
  - use of alternative coord systems e.g. w3w (i.e. don't)
  - use of DGGS (stick to post-processing for now)

3.2 Relative location

3.2.1 triangulating off local features

- what counts as sufficiently permanent
- when to bother (e.g. poor location signal)

3.2.2 longform descriptions

- site approach instructions
- importance for relocating monitoring points

3.2.3 region data

- talk about when to tag sites to human administrative boundaries
- options: regional, district council; property boundaries
- code list for RCs?

3.2.4 temporal

- season
- time since significant weather events (see FAO)

3.3 Explaining location

- i.e. why and how the spot was singled out; when this matters
- codes for why

- codes for how

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4 Landscape

- setup - going big to small
- purpose - interpretive context
- note: discuss when a DEM/terrain derivatives can and can't be used post-field

4.1 Regional landscape

- scale: 100s-1000s of meters (ref Ontario guide for this idea)
- don't have a nationally accepted ecozone system yet
- do have LUC (brief discussion)
- do have SMap landform trees (brief discussion)

4.1.1 Relief

4.1.2 Modal slope

4.1.3 RMS

- adapt from aus

4.1.4 Mesoscale topographic index

- ref to RECCE, connect to Geomorphons concept

4.1.5 Landscape description

- shortcut terms, noting that they don't form a conceptual tesselation
- longform descriptions

4.2 Local landform

- scale: 1-10s of meters around site
- starting with simple measurements and moving to more interpretive ones

4.2.1 Slope

- gradient - range, units, precision

4.2.2 Aspect

- direction - range, units, precision, *direction*

4.2.3 Slope morphology

- pick up aus system and tweak

4.2.4 Slope length

- mention RUSLE connection

4.2.5 Active geomorphic agents

- eroded vs aggraded then types

4.2.6 Landform description

- shortcut terms, noting that they don't form a conceptual tesselation
- longform descriptions

5 Parent material

5.1 Geology

- map codes - when useful, when not
- don't just intersect a published map - scale limitations

5.2 Lithology

- LUC Rock Class system
- NZSC level 4 parent material system
- note strengths and weaknesses
- note: brief discussion of e.g. classification by silica index cf NSW

5.3 Parent material origin

- cross reference to active geomorphic agent from landscape section
- code list from NZSC level 4

6 Climate

- note: not weather! most of this is better off not measured in-field
- note: limitations of available climate data, use local records where possible
- talk about getting data from LENZ vs more local sources
- calculation from terrain for insolation

6.1 Global-Regional

- Koppen
- most work programs will take place within one zone
- Season (WRB list)

6.2 Local

6.2.1 Rainfall regime

- total annual
- rainfall seasonality (mean/sd off monthly totals)
- summer/winter ratio (Dec+Jan+Feb)/(June+Jul+Aug)

6.2.2 Temperature regime

- mean annual, etc
- frostiness

6.2.3 Insolation regime

- day length average and variability

6.2.4 Prevailing winds

- direction, strength by season
- rationale: aspect effects

7 Biota

- acknowledge veg focus

7.1 Vegetation

- cross reference to RECCE manual for detailed descriptions - not repeating here

7.1.1 Natural

- wrb veg types

7.1.2 Human-altered

- existing milne types that don't stray into land use

7.2 Macrofauna

- dominant species that significantly and directly affect the soil - diggers, stompers, prolific poopers
- current vs past (e.g. farm system vs earthworms under former forest cover)

- scale range elephants to ants
- not a must have but worth keeping front of mind when classifying/interpreting features

8 Land use and management

- link to Landscape and Landform scales - information on whether site is typical of the broader area

8.1 Landscape scale

- simple list - natural, pastoral, forested, intensive ag, lifestyle, urban

8.2 Landform scale

8.2.1 LCDB cover class

- go through system and common classes briefly

8.2.2 Cultivation type

- wrb cultivation types? or similar

8.2.3 Management practices

- maybe only relevant to paddock-scale research and management

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8.3 Current and past use(s)

- where known and relevant - e.g. previous forestry means a lot of surface disturbance
- time since clearing
- time since major soil-altering disturbance e.g. eruption, flooding with >0.5m deposition

Part II

Soil profile

9 Profile

- what are we doing here

9.1 Depth of observation

- requirements to classify against the NZSC
- requirements for mapping
- requirements for research

9.2 Equipment options

- for NZ conditions

9.3 Profile exposure options

- how to dig a pit safely
- how to measure depth on significant slopes

9.3.1 Method of profile exposure

- code list

9.3.2 Regolith stuff

TBD

10 Reference data

10.1 Naming/numbering sites and site collections

- tips for robust systems for projects of varying scale
- tips for working across multiple teams
- distinguishing site IDs from database IDs (e.g. you might want a UUID but you don't want to be writing one out by hand)
- tagging by eg. transect membership

10.2 Date/Time

- YYYY-MM-DD
- time optional but can be useful for connecting site data to photos etc

10.3 Authors

- pick one responsible officer for the description, note the others

- note: privacy law - don't put this data in public-facing downloads without anonymising

11 Land surface

- scale is landform - immediate surrounds

11.1 Surface cover

- record components as percent composition:
- bare ground (sediment or soil, <2mm)
- bare gravels (includes shells, bones etc)
- bare outcrop
- open water/ice/snow
- peat
- dry leaf litter (includes seed pods)
- grass/moss/herbs
- stems/trunks/roots
- record only to nearest 5-10%, no need to get carried away
- this should be able to be connected back to landform characteristics - don't repeat yourself here by e.g. recording gravel lithology again

11.2 Surface condition

- aus list should be ok - but that requires dry conditions, something of an issue in NZ
- include crusts here

11.3 Surface cracking

- modal width
- modal distance
- spatial arrangement (note connection to freeze-thaw, slip)
- note: WRB includes crack persistence but this might be a problem - speculative
- note: requires season and recent weather data for context

11.4 Surface water

- (where known)
- flood frequency basically (use wrb list)

11.5 Microrelief

- get something a bit simpler out of the aus and wrb systems
- nz - creep and slump features, terracettes, etc

11.6 Anthropogenic alterations

- start with WRB list but needs some development/local tuning

Part III

Soil horizons

12 Horizons

- concept, little history maybe

12.1 Depth and Thickness

12.2 Boundary shape

12.3 Boundary distinctness

note: when to make a new horizon note: names at the end - need supporting data to define

12.4 In situ moisture content

- at time of obs
- table 4 not table 3 - reconcile with WRB Table 8.28
- discussion of field vs lab measurement

13 Horizon colour

13.1 Matrix colour

- define the concept first - dominant by area, or by process?

13.1.1 Colour coding

- munsell and short code options
- how to record accurately (good light, sunnies off)
- note: obtaining colour data from photos (infobox)

13.2 Colour patterns

13.2.1 Pattern type

- redox, mixing, weathering

13.2.2 Pattern size

- overall - 'fabric' - fine/medium/coarse, nest in overall size classes

13.2.3 Pattern shape

- blotches, stripes

13.2.4 Pattern distinctness

- faint distinct prominent
- note: can automate this in DB if all colours are Munsell

note: other manuals often effectively 'double up' colour patterns with e.g. segregations, trying to avoid this and cut redundancy

14 Soil texture

- size domain
- clearly explain how fine earth fractions are compositional, but so is fine earth + coarse fraction
- example of how to adjust to get a full composition

14.1 Fine earth

14.1.1 Perceived texture

- discussion of difference between percieved texture and PSD by lab analysis
- influence of non-mineral components - OM, water
- influence of particle mineralogy, particularly clay
- influence of particle shape

14.1.2 Particle size estimate

- how to (refer to literature)
- recording on a triangle
- mean/sd of sand/silt/clay

note: influence of size fraction divisions

14.2 Coarse minerals

- record presence, abundance to nearest 5-10%
- record modal, min and max size - measure on longest dimension
- optional roundedness
- optional lithology
- still need to think more about how to structure this
- note: shape not much use without in situ orientation

14.3 other coarse components

14.3.1 natural

- shell, bone, charcoal, timber

14.3.2 artefacts

- per WRB list (maybe compress a little)

15 Structure

15.1 ped presence

- single grain
- massive
- weak moderate strong

15.2 ped shape

- standard set but add angular blocky back in
- be clear about vertical orientation for some shapes
- note: nut and crumb vs the world

15.3 ped size

- modal vertical dimension, and horizontal for tabular ped shapes (prism, lens, etc)
- record in mm

15.4 nesting peds

- ‘parting to’ etc
- db note: 1:1 cascading relationship not 1:n at horizon level

15.5 non-ped aggregates

- clods and fragments from cultivation

unresolved: - distinguishing earthworm casts - peds or nah? - reconciling peds, cutans and other ped coatings, and ‘fabric’

16 Secondary features

- define
- abundance charts (re-use wrb fig 8.1.2)

16.1 Redoximorphic features

- record abundance relative to whole soil mass in percentage increments of 5-10%

16.1.1 Feature development

- influenced by water regime and time
- ordered category
  - D, M, C, N, P

16.1.2 Feature colour

- inference to groups of minerals, can't narrow it down too much
- o, d, y, n

16.1.3 Translations

- existing systems have a larger set of codes to describe the same phenomenon (mottles, segs, pans)
- examples
  - soft jarosite mottles and ferrihydrite/goethite breakdown products in a ripened AASS
    - 20Mn, 10My with low chroma matrix
  - jarosite mottles in an AASS that otherwise remains reduced
    - 10My with low chroma matrix
  - iron oxidation products in imperfectly drained loess
    - 40Mo with low-medium chroma matrix
  - WRB ferric horizon
    - 20Co
  - WRB petroplinthic horizon
    - 70Po
  - WRB pisoplinthic horizon
    - 50Nn
  - moderately well drained horizon with some slight mottling
    - 05Mo, 01Md
  - well drained horizon with some slight mottling
    - 01Mo

more than x percent implies y degree of cementation. 85%+ = pan?

Note: these features define a soil horizon and thus thickness is already described. As such, a WRB ferric horizon would have to be at least 15cm thick in addition to having the character described above.

16.2 Precipitation features

- crystals and masses - halite, gypsum, carbonate, silica
- from upward vs downward solute+water movement (?)
- progression of concs/nodes to pans

16.3 Illuviation features

- lamellae
- clay coats
- cutans and other infill types
- fragipans (???)

16.4 Stress features

- pressure faces, slickensides, things of that nature

16.5 Cryogenic features

- for alpine areas and antarctic soils

Unresolved - wrb gets quite focused on distinguishing coarse frags and pans from broken up remnants of more complete indurated layers comprised of secondary material. Relevance unclear particularly in NZ

17 Consistence

- context and use
- note that some of these assessments can only be reliably conducted on undisturbed samples of soil, which usually rules out cored or augered samples
  - need alternatives for those?
- how to sample for these tests
- may need to complete assessments post-field
- expected accuracy vs lab tests (low)

17.1 Cohesive vs non Cohesive

- test instructions, cross link to remoulding, dilatency and plasticity tests (these are moved up front as well)
- Note: that flow chart in fig 13 can literally just be a table
- talk about dry coherence test here rather than 10 pages later

17.2 Remoulding

- currently missing clear instructions

17.3 Plasticity

- test instructions
- interpretation

17.4 Stickiness

- (moving up because easy to do right after plasticity test)
- instructions
- interpretation

17.5 Dilatency

- test instructions
- interpretation

17.6 Thixotropy

- instructions
- interpretation

17.7 Penetration resistance

- reconcile with unconfined strength
- moving up to before other tests as an undisturbed face is required

- what do we keep? Small penetrometer accuracy questionable (add refs), not commonly used at present - but Table 16 requires no gear

17.8 Particle Packing

- non-cohesive soils
- do we keep all of this or just T19?

17.9 Unconfined strength

- more clear distinction that two types of strength may be apparent (soil mass, individual peds)
- test instructions
- use of a pinch gauge for hand strength calibration (Drohan et al, 2020)
- interpretation
  - SMap specific information
- T13 (reconcile with WRB field guide - looks almost identical)

17.9.1 Remoulded strength

- instructions

17.9.2 Strength at plastic limit

- do we keep this?

17.9.3 Sensitivity

- ratio of natural to remoulded
- instructions
- when not to bother
- interpretation

17.10 Mode of failure

- link more clearly to NZSC
  - cutanoxidic horizon - behaviour varies significantly with water content
  - fragipan - requires brittle failure when moist
  - organic material - deformable in field condition
  - Oxidic - consistently friable across moisture states

17.11 Fluidity

- clearer statement that this test is for field-saturated soils only
- and that it effectively tests whether subaqueous deposition was the mode of emplacement
- instructions
- interpretation

17.12 Induration

- instructions

- interpretation
- NB not a field test

18 Field tests

- and not-quite-field tests

18.1 Chemical

18.1.1 pH

18.1.2 EC

18.1.3 Soluble salts

- don't lick them!

18.1.4 Carbonate

18.1.5 Manganese

18.1.6 Iron Sulfide

18.1.7 Allophane

- talk about reactive hydroxy-aluminium sites because its not *specifically* an allophane test

18.1.8 Redox

18.1.9 Water repellence

- brief discussion of seasonal behaviour

18.2 Physical

19 Roots and plant materials

19.1 Roots

- live and dead
- abundance
- size (modal, range)
- position in relation to peds

19.2 Timber and fibre

- peat-specific usually
- preserved organics can be encountered in non-peat situations where volcanic events have buried surface

20 Voids

- NB surface cracks already covered

20.1 Pores

- abundance
- macro v micro sizes
- inferred origin
- direct and indirect observation for connectivity

20.2 Other voids

- non-infilled space between coarse gravels (assessed via packing)
- spaces between dry peds (where shrink-swell is significant)

Part IV

Soil interpretations

21 Interpretations

- numerical properties can be classified
- other properties can be ranked for specific requirements
- set of properties define horizon names, whole of profile properties and soil classifications
- etc

22 Horizon properties

- some numerical properties are specific to a single soil feature and have a classification associated in text
- more general physical properties have multiple potential classifications, and none are globally accepted. Multiple options are presented below. These should not be used in the field.

22.1 Numerical classifications

22.1.1 Size classes

- use the particle size divisions
- talk about international differences

22.1.2 Abundance classes

- commonly boil down to 'barely appreciable', 'rare', 'common', 'abundant'
- think moar

22.2 Conventional horizon names

- support for NZSC level one-three (four??)
- profile position, major processes, significantly developed features

22.2.1 Primary Divisions

22.2.2 Secondary Divisions

22.2.3 Suffixes

- can theoretically automate if supporting parameters are described in db

22.2.4 Prefixes

22.3 Functional horizon names

- link to NZSC level 5
- physical/water movement focus missing from conventional system
- so, complementary
- more directly derived - so can theoretically automate if inputs are present

22.3.1 Names

22.3.2 Components

22.3.3 Permeability ratings

23 Profile properties

23.1 Drainage

23.2 Permeability

24 Site and setting properties

24.1 Slope classification

- talk through LUC and other systems

24.2 Aspect classification

- talk through cardinal compass direction and more tailored options

24.3 Climate classification

- ???

24.3.1 Critical limits

- e.g. rainfall and brown v pallic

25 The New Zealand Soil Classification

- not repeating it here, but highlighting which parameters are required to confidently classify to a given level
- include lab test requirements, where relevant

26 The World Reference Base for Soil Resources

- not repeating here, just providing some cross-correlations where mismatches occur
- also talk through pain points

27 NZ Land Use Classification

- talking about how soils data can be incorporated into the system

28 Crop Suitability Assessments

- talking about how soils data can be incorporated into an assessment
- align to soil judging requirements as well as major systems

Part V

Appendices

29 Appendices

Landing page

(Milne et al. 1995)

30 Equipment

30.1 Profile exposure tools

30.1.1 hand

30.1.2 mechanical

30.2 Profile description tools

30.3 Field test equipment

30.4 'Field lab' equipment

31 Recording data in the field

- value of structured notes and forms
- managing photos etc
- pros and cons of building an app

32 Database design

- security and user mgmt out of scope
- tooling suggestions for different scales of work e.g. PhD project vs running a business
- relational vs non relational
- high level example erd

33 Sampling programs

- maybe some scope creep here, revisit later

References

Milne, J. D. G., B. Clayden, P. L. Singleton, and A. D. Wilson. 1995. *Soil Description Handbook*. Revised. Lincoln, N.Z.: Manaaki Whenua Press.