Soils of the Cubberla and Witton Creek Catchments

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Abstract
The soils of the Cubberla and Witton Creek catchments are the product of their parent materials and the historical development that has influenced their formation. Parent materials are described in another paper in this collection and include phyllites, weakly metamorphosed sedimentary rocks, a small area of granite, local alluvium and river alluvium. There are five broad soil groups in the catchment ranging from shallow stony soils (Tenosols) at the top of the Catchments at Mt Coot-tha to poorly drained soils (Hydrosols) on local creeks and deep alluvial soils (Dermosols) adjacent to the Brisbane River at Fig Tree Pocket. In between is a range of soils (Chromosols) that are shallow and poorly drained on hill-slopes and deeper and better-drained on lower slope positions.

Soil properties influence their suitability for uses such as suburban housing, recreation, construction and conservation. Soils on hill-slope and crest positions are stable, but shallow and infertile. They are generally suitable for construction, but restrict plant growth through limits on fertility and drainage. Soils on lower slopes are also stable, but are more fertile and better drained, making them more suitable for plant growth. They are also stable as construction platforms. Soils of the local alluvium are generally poorly drained and subject to short-term flooding. In these positions, soils are suitable for plant growth and recreation but are poor building soils. Soils on the Brisbane River alluvium are deep, well drained, stable and fertile, but are subject to infrequent but major flooding.

In the parts of the Catchments developed for urban uses there has been significant disturbance of soils due to construction, earthworks, importation of landscaping materials (rocks, soils, fertilizer and mulch) and the application of additional irrigation. Creek floodplains have been drained, filled and levelled for playing fields and car parks.

Introduction

The soils of the catchments of Cubberla and Witton Creeks are a product of their environment, having formed from the underlying rocks or from transported materials under the influence of climate over time and the effects of biological activity. The companion paper on the geology of the catchment provides a picture of the sources of rocks in the catchment and the forces that have acted to produce the present day landforms. This paper provides more detail on the soils that have resulted from these earth-forming processes and their distribution in the catchment. Information is also provided on the properties of the soils in relation to plant growth and their stability for construction activities.

How are soils formed?

Soils form at the rate of approximately 1mm of soil depth per year, but this rate varies with the effects of a wide range of influences.

Parent rocks

The source material for soil formation is the most important influence on soil formation. Some rock minerals such as the feldspars weather rapidly to smaller soil particles and others such as silica, being more resistant, result in larger soil particles.

Climate

Moisture and temperature are also very important influences. Hot, moist environments lead to higher rates of weathering and soil formation, while cold and dry environments have the opposite effect.

Organisms

Living organisms, especially micro-organisms and soil-living invertebrates such as earthworms, play a critical role in breaking down soil particles and transforming minerals into plant nutrients that in turn promote growth and the formation of soil organic matter – an essential component of soil.

Relief

The shape and slope of the land surface also plays an important role in influencing the rate at which soil material is transported downslope and away from the source. In turn, the deposition of transported material at the base of slopes can accelerate the rate of soil formation. Associated with this element is aspect, with warm, north-facing slopes likely to experience faster soil formation than cold, south-facing slopes.

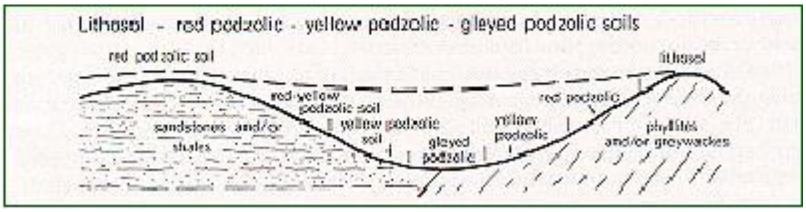
Time

In general, the longer soil formation processes have operated, the greater the depth of soil. However, this also depends on the rate of soil removal through soil erosion. In many Australian situations, very old soils are also very shallow due to the dominance of soil removal over soil formation.
As a result of the nature of the underlying rocks in these particular catchments, and the great age of the rocks, the soils can generally be characterized as old, infertile, with poor surface structure, low in organic matter, and with subsoils with high clay content and low pH (acidic).
The exceptions to this description are the alluvial soils formed on more recently transported material. These soils have higher clay content and tend to be more fertile due to the preferential deposition of fine soil materials carrying attached nutrients.

Soil Landscapes

Soils have been formed in the landscape in the following sequence from the top to the bottom of the catchment as shown in the following cross-section:

Fig. 1: Dissection of sandstones and shales or phyllites and/or greywackes to give sequences of *lithosols, red podzolic, red-yellow podzolic* and *gleyed podzolic soils.* *(Source:* Beckmann & Thompson, *Soil Landscapes of Brisbane and Environs)*



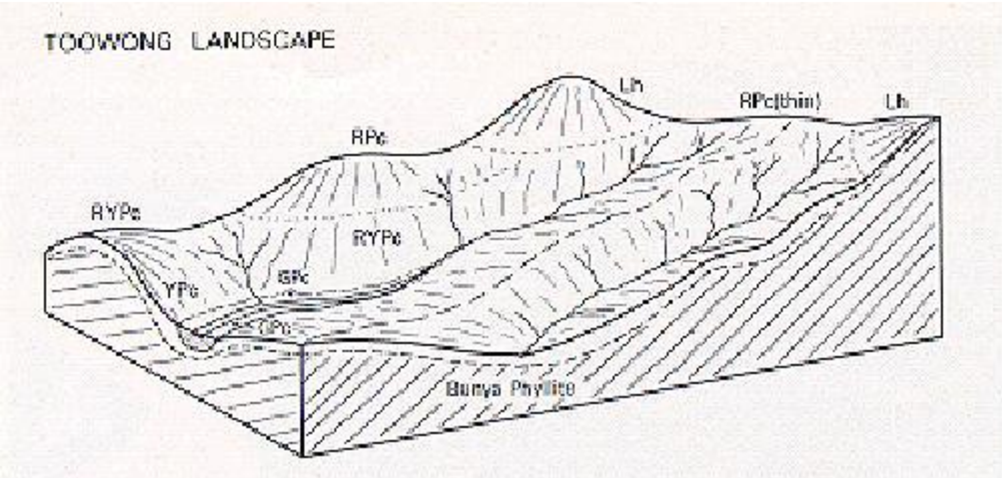
There are few, if any, remnants of the original land surface, even on the tops of hills. The major landform features in the catchment are broad rounded crests surmounting concavo-convex slopes leading to the drainage lines.

The sedimentary and metamorphosed sedimentary rocks show the effects of earlier deep weathering in the coarse mottling prevalent in many areas. Tenosols (*lithosols)* occur on the higher crests. Red Kurosols (*podzolic soils)* are the most common soils on broad rises that have appeared as dissection proceeded and on the upper slopes. Yellow Kurosols (*podzolic soils)* are common on the middle to lower slopes where the local drainage situation has controlled the state of hydration of the iron oxides in the system and leaching has created the subsoil colours.

On the lower slopes, the accumulation of finer material in the A horizon has resulted from surface transport and deposition. The finer textured B horizon acts as a barrier to vertical water movement through the profile and tends to deflect water downslope contributing to bleached A2 horizons and the development of gley features in the Hydrosols (*gleyed podzolic soils)* on colluvium on footslopes and on the valley floors.

These landforms provide five separate landscapes in the catchment with distinctive soil patterns seen in the following block diagram of the Toowong landscape that is similar to the Cubberla-Witton catchment.

Fig. 2: Block diagram of the Toowong landscape, showing the relationships of *lithosols* (Lh), and *red* (RPc), *red-yellow* (RYPc), *yellow* (YPc) and *gleyed* (GPc) *podzolic soils* over Bunya phyllite. (*Source:* Beckmann and Thompson, *Soil Landscapes of Brisbane and Environs)*



The Mt Coot-tha Landscape

The Mt Coot-tha landscape is dominated by gravely Tenosols (lithosols) with shallow gravely Kurosols (podzolic soils) formed on steep high hills of phyllite and hornfels.

Tenolsols have only weak pedologic organization apart from the A horizon. They are stony and gravely soils of sandy, loamy or clayey texture usually overlying fragmented and weathering rock at shallow depth. They occur mainly on ridge crests or steep to moderate upper slopes, where continual removal of fine earth by erosion limits profile development. Nutrient status varies with the composition of the parent rock, but available water capacity is commonly low and the soils have high stone and gravel content.

Soils of the Mt Coot-tha Landscape

Substrate	Phyllite, some Granite
Landform	Steep hills and crests

Soils	Shallow, gravely loam
Depth	<30cm
Use	Forest
Properties	Shallow, stable, infertile, low water availability

Chapel Hill and Kenmore Landscapes

Low hilly lands cut in the Bunya Phyllites (Chapel Hill) and Neranleigh-Fernvale Formation of weakly metamorphosed sedimentary rocks (Kenmore). Rock outcrops are common on steeper upper slopes and narrow crests. Elevation ranges from 8-75 m and slopes from moderate to gentle.

Thin gravelly Tenosols (*lithosols)* with a pale pinkish subsurface horizon are intermingled with shallow *red* Kurosols *(podzolic soils)* (see Attachment) in the higher parts of the landscape. Kurosols are dominant and are shallow to moderately deep with structured or moderately dense, red, heavy clay B horizons. The moister footslope sites are occupied by deep, mottled red-yellow Kurosols with a coarsely mottled yellow-brown and light grey stiff plastic to friable clay horizon in the deep subsoil. Where alluvium has accumulated on the drainage floors, there are minor areas of Hydrosols (*gleyed podzolic soils* and *humic gleys)*.

Kurosol**s** are the most common soils of the Brisbane area. They have pronounced texture contrast and a clear to gradual boundary between weakly structured sandy to loamy A horizons (pale in the A2) and red or yellow-brown clay B horizons of moderate blocky structure and firm to friable consistence. The pale or bleached A2 horizon is massive but porous and is very gravely when formed from phyllite. These soils are moderately to strongly acid, particularly in the subsoils that consist mainly of mica, kaolin, and clay minerals. Soil depth ranges from less than 0.5m to more than 1.0m. Both nutrient status and available water capacity per unit of depth are low. Most of these soils have very low phosphorus levels and deficiencies are common.

Soils of the Chapel Hill and Kenmore Landscapes

Substrate	Shale, siltstones
Landform	Hills and dissected slopes
Soils	Shallow, gravelly, sandy loam over clay
Depth	<30cm
Use	Forest, urban
Properties	Moderately shallow, stable, infertile, moderate water availability, erosion prone

Cubberla/Witton Creek Landscape

The narrow alluvial plains of the creeks draining to the Brisbane River are characterised by poor drainage and occasional flooding. Dominant soils are Hydrosols (*gleyed podzolic soils)* with sandy to loamy surface horizons and mottled grey and yellow-brown sandy clay or heavier subsoils. Small occurrences of *alluvial soils* and weakly developed Dermosols (*prairie soils)* and small areas of humic Hydrosols (*humic gleys*) also occur.

Hydrosols (see Attachment) are seasonally or permanently wet soils that may or may not experience episodic oxidising or reducing conditions. They are not necessarily soils of low permeability as site drainage is often the most important factor. They have pronounced texture contrast and clear to gradual boundaries between A and B horizons, a pale or bleached A2 horizon and acid reaction throughout, or acid and becoming neutral in the deep subsoil. There are usually some rusty spots and channel linings in the sandy to loamy A horizons. Typically the clay B horizons are coarse blocky to prismatic, grey on the faces and in the outer portion of the peds and mottled with ochreous colours within. Where the deeper subsoil is permanently saturated it is grey, with ochreous markings only along old root channels in the upper part. The clay subsoils are firm when moist to wet.

In the natural state, Hydrosols have marked deficiencies in major plant nutrients but their water regimes ensure available water for plant growth for longer periods than occur in adjacent freely draining podzolic soils. These soils respond well to surface drainage and correction of nutrient deficiencies

Soils of the Cubberla/Witton Creek Landscape

Substrate	Creek alluvium
Landform	Local floodplain
Soils	Silt loam over clay
Depth	>200cm
Use	Recreation
Properties	Stable, poor drainage, good water availability, local flooding, moderate fertility

Brisbane River Landscape

Soils of the **Brisbane River Landscape** are dominated by Dermosols (*prairie soils)* with some sandy *alluvial soils*. These soils show weak profile differentiation formed on the low undulating flood plain and terrace remnants.

Dermosols often have clay skins in ped faces. They lack a clear or abrupt textural B horizon, do not have a free iron oxide content greater than 5% Fe, are not calcareous throughout and have moderately to strongly structured B2 horizons.

These soils have dark friable loamy surface soil of moderate thickness and organic content with a gradual or clear change to brownish-yellowish clay subsoils, usually of blocky structure. Characteristically these soils are acid to mildly alkaline, moderately deep and have moderate to high available water capacity.

Soils of the Brisbane River Landscape

Substrate	Clay, silt, sand
Landform	River terraces, floodplain
Soils	Deep clay soils
Depth	>200cm
Use	Urban, recreation
Properties	Deep, well drained, fertile, flood-prone, stable

Important Soil Characteristics

The soils in the middle and lower parts of the local catchments are now extensively developed for urban housing and infrastructure. The upper catchments remains under native forest and the lower parts are used for recreation particularly on the creek and river alluvium. Soil properties have important influence on the use of the soils for plant growth and construction.

Plant growth

Soil properties important for plant growth are surface structure, available water storage capacity and soil fertility.

Surface Structure

Surface structure is important for water entry into the soil, aeration and root growth. Soils on slopes in the catchments have poor structure and tend to compact and set hard on drying. Under heavy rain, aeration is reduced and soil water relations are impaired, increasing run-off and erosion.

Available Water Storage Capacity

Available water storage capacity is necessary to store rainfall and provide moisture to plant roots between rainfall events. The freely draining, shallow, sloping soils have low available water within the root zone, lose water by rapid run-off and drain excessively. Vegetation on these soils exhausts the stored available water within two rainless weeks. Lower slope soils subject to seepage will provide much higher levels of water to plants.

Fertility

Fertility of the soils is low with gross deficiencies of Phosphorous, Nitrogen and Calcium. High levels of fertilizers and lime to raise the pH levels are necessary for good garden and lawn performance.

Construction

Soil attributes important for construction activities include drainage, stability and exposure to flooding.

Drainage

Drainage is important to provide good aeration in the root zone. Only the lower slope and creek flat soils are subject to prolonged saturation after rain due to seepage from higher locations.

Stability

Stability of the soils for construction is influenced by clay type, slip zones and saturation. Soils of the catchment are very stable except for the poorly drained creek flats, which are saturated after rain. Drainage works are generally successful in overcoming problems.

Flooding

Flooding is an obvious limitation to construction and development. Annual short duration flooding occurs on the creek flats with less frequent major flooding from the Brisbane River. There have been 14 river floods since 1841, of which seven have been serious.

Current Soil Processes

With the catchments now extensively developed for urban residential and commercial purposes the attributes of the soils have been dramatically altered from their natural state. The major influences have been disturbance during construction of houses and roads, landscaping for urban gardens and management to promote plant growth.

Disturbance for house and road construction has resulted in extensive earth movement by cutting and filling to convert sloping sites to level sites for concrete house slabs. This has resulted in the inversion of many soil profiles as excavated subsoil material has been placed or spread on top of previous topsoil material. Further changes have occurred as imported soil material has been extensively used to build up the depth of soils for planting and landscaping.

Landscaping for gardens has also been achieved by the placement of large amounts of imported rock for retaining walls. The main form of rock used has been granite brought from The Gap to the north of Mt Coot-tha.

Management practices on the 'new' soils have also brought about significant change through the addition of nutrients through fertilizers, irrigation of soils to promote increased and constant plant growth, and drainage works in the lower slope positions to accelerate the removal of subsoil moisture during wet periods.

During construction periods, large areas of disturbed soil are exposed to rainfall and run-off, resulting in serious erosion, unless careful management using mulches, silt traps and fences is practised. However once established, urban gardens are stable and generally well covered by vegetation and extensive mulching so that erosion is well controlled. Problems resulting from the 'new' soils include the leaching of lawn and garden fertilizers into streams and the 'escape' of garden plants to become weeds of local public land and watercourses.

Conclusion

The soils of the catchments have had a long and dramatic history of formation and development. Recent development pressures and modification have changed some of the soils beyond recognition, while in many areas of the upper catchments and in alluvial areas the soils are relatively unchanged.

There is a duty on all residents of the catchments to recoginse the fragility of the soil cover and to ensure that the soils and other natural resources are managed to stabilise the catchments and protect the quality of water flowing over and through the soils on its way to the creeks, river and bay.

Bibliography

Beckmann, G. and C.H. Thompson, 1992. *Soil Landscapes of the Brisbane Region and Environs*. CSIRO, Australia.

Grant, K., Finlayson, A.A., Richards, B.G., and Pappin, J.W. 1982. *Terrain Analysis, Classification, Assessment and Evaluation for Regional Development Purposes of the Moreton Region, Queensland*. Division of Applied Geomechanics Technical Paper No. 23 CSIRO, Australia.

For Attachment showing Kurosol (Red Podzolic Soil)/ Mid – lower slope on Phyllites, shales and showing Hydrosol (Gleyed Podzolic Soil)/ Lower slopes, alluvium on creek flats **please click here**

Source: Robin Trotter (ed.), *Cubberla and Witton Creeks, Their physical characteristics and land use over time, Proceedings of Symposia held in 2000 and 2001 on the Cubberla and Witton Creek Catchments,* 2001 Brisbane, Cubberla-Witton Catchments Network.