Natural landforms, artificial substrates and habitat in the built environment

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outline

- Natural landforms & soils.
- Landforms, hierarchical landform analysis.
- Impacts of the built environment on landforms, soils & hydrology.
- Soil & substrate function.
- Landforms & soils as a basis of planning in the built environment.
- Conclusion.

Natural landforms & soils

- integral part of the built environment,
- foundation of both the living & built ecosystems,
- highest concentration of built environ, - cities.
- impose significant adverse impacts on natural systems.

Natural landforms & soils

To direct & plan sensitive development in the built environment knowledge of;

- the geomorphic context & setting,
- what landforms & soils are involved,
- their characteristics, properties & distribution is desirable.

Landforms & hierarchical landform analysis

- what are landforms?
- AGI (1980) – “Any physically recognisable form or feature of the Earths surface produced by natural causes, and having a characteristic shape”.
- includes major features; plains, plateaux, mountain ranges,
- minor features; hills, valleys, side slopes, terraces, dunes.

Landforms

- are distinctive features,
- characteristic morphology,
- recurring forms,
- represent a topographic response to specific processes, materials & geographic location.

NZ has a diverse & unique suite of landforms, due to its location on an active crustal plate boundary.

Hierarchical landform analysis

- stratifies the landscape on the basis of landforms.

involves:

analysis – simplification of the complex natural geographic environment.

classification – the organisation of data distinguishing one area from another and characterising each.

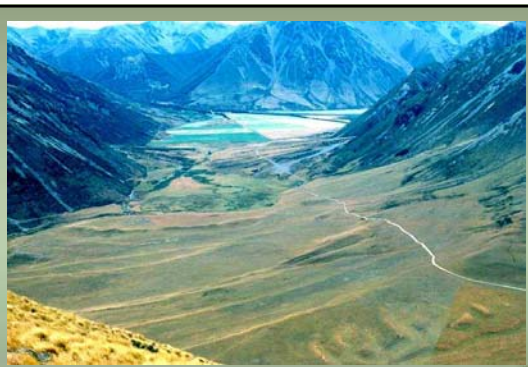
appraisal – interpretation and assessment of data for practical purposes.

Hierarchical landform analysis

- analysis separates the landscape into natural units based on origin, processes and form.
- landforms are distinguished by their physiographic form and the processes which shaped them.
- combinations of gross topography, surficial shape, micro relief, size, geological structure, active processes, degree of erosion etc, are used to distinguish each specific landform entity.

Hierarchical landform analysis

- data sources – aerial photos, topo/geol/soil maps.
- areas are divided into major landscapes, which are further subdivided.
- landform units are identified which are relatively homogenous wrt rock type, slope, soil and water regime.
- they usually have clear breaks & inflexions in slope, & often have a repetitive pattern.
- patterns on aerial photos are the result of complex interactions between geomorphic processes, climate, vegetation, hydrology and soils.



Hierarchical landform classification for part intermontane environment

Landforms			Parts of landforms	
Major physiographic unit	Major landform	Component landform	Landform element	Slope component
Montane basin	Moraine system	End moraine	Summit Side slope	Shoulder Backslope Footslope
	Alluvial Fan	Fan Head Middle Fan Fan toe fringe	Channel Overflow channel Channel Overflow channel Channel Overflow channel	
	Floodplain	Fine-grained meander channel floodplain	Levee Abandoned channel fill Lacustrine Swamp Crevasse splay Scour pool	

Landform nomenclature and genesis

- genetic landform terms are preferred, - alluvial fan, outwash terrace etc.
- indicate topographic form, mode of formation, kind of parent material & drainage.

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Landform nomenclature and genesis

- depositional systems are important.
- the distinctive form of each component e.g., meander floodplain, fan etc enables further subdivision, - reflecting patterns of sedimentation, texture, and drainage.
- the soil pattern is correlated with sedimentation through changes in textural composition and drainage conditions.

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Landform nomenclature and genesis

- in fluvial depositional environments the initial texture and distribution of soils are determined by depositional patterns which can be predicted using conceptual models.
- e.g. - floodplains are composed of sorted, stratified alluvium.

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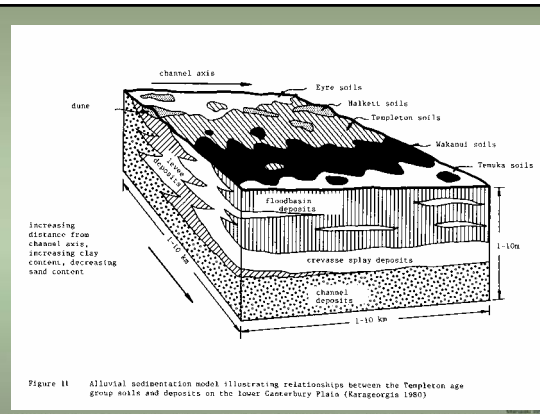

Figure 11 Alluvial sedimentation model illustrating relationships between the Templeton age group soils and deposits on the lower Canterbury Plain (Karageorgis 1980)

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Landforms analysis and genesis

- recap - hierarchical landform analysis delineates the landscape into named and defined physiographic components.
- these are capable of further subdivision, reflecting genesis, and related to the soil pattern.
- landscape stratigraphic relationships enables the pattern of older and younger land surfaces to be identified.

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Landforms in the built environment

- built environment is concentrated in cities.
- access, food & water supplies, trade routes and safe harbours determines location.
- on flat land, close to waterways.
- built on landforms & soils of floodplains, & river mouths, & on moderately sloping hills surrounding harbours

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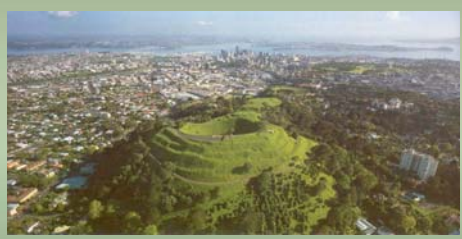

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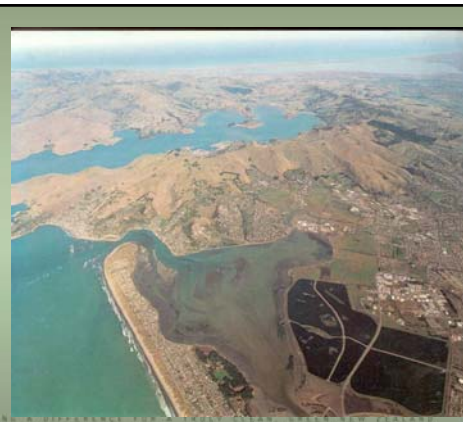

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Landforms			Parts of landforms	
Major physiographic unit	Major landform	Component landform	Landform element	Slope component
Piedmont slope-Alluvial plain	Floodplain	Terraces	Terrace tread Terrace riser	Shoulder Backslope Footslope
		Braided stream	Channel Abandoned channel fill	
		Fine-grained meander channel floodplain	Levee Abandoned channel fill Lacustrine Swamp Crevasse splay	
	Coastal plain	Young dunes Old dunes Peat plains / sand flats Estuarine plain	Dune Inter-dune swamp “ - Saline sandflat	Fore & back dune

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Impacts of the built environment on landforms & hydrology

- impose major changes to landforms & natural fluvial systems.
- landscape reshaped – slopes are lowered & smoothed.
- rills & gullies are dozed, sand dunes levelled, inter-dune swamps & sand flats buried.
- soils & substrates are bared, exposed to erosion, & compacted, and materials stockpiled.

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Impacts of the built environment on landforms & hydrology

The hydrological regime is altered by;

- draining swamps & wetlands that acted as detention basins;
- removing vegetation, altering components of the water balance.
- increasing imperviousness, - decreasing in infiltration, increasing runoff;
- modifying drainage patterns & density, and the timing and volume of runoff;

Result in increased 'flashiness', erosion rates & sediment yields

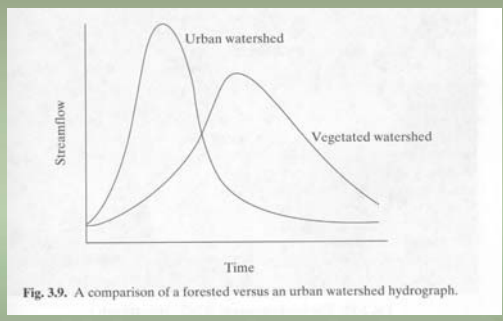


Fig. 3.9. A comparison of a forested versus an urban watershed hydrograph.

Impacts of urbanisation on soils

Urban soils are modified by:

- cutting and filling of slopes;
- compaction;
- increased erosion;
- improved (installation of drains) *or* impaired (by compaction) drainage;
- contamination by wood, concrete, asphalt etc.
- vegetation loss & replacement by impervious materials - impacting on soil temp & moisture regimes, organic matter cycling, organic matter content & biological activity

Impacts of urbanisation on soils

Urban soils:

- high variability,
- modified soil structure,
- high bulk density & low structural stability,
- surface crusting - often water repellent,
- restricted aeration and drainage,
- modified soil pH,
- low OM & plant nutrients,
- interrupted nutrient cycling,
- modified soil temperature and water regimes.

Impacts of urbanisation on soils

'healthy' soils have;

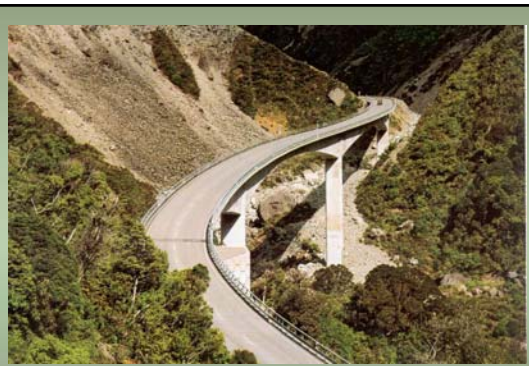
- easy root penetration to 90-120cm, f (degree of aggregation & macropores),
- high available water holding capacity,
- optimal gaseous diffusion,
- adequate nutrients in available and reserve forms,
- rich soil micro flora and fauna, - decompose OM, & release available nutrients, & enhance soil structure.

Impacts of urbanisation on soils

- the characteristics of many soils are less than optimal,
- natural communities have adapted to these inferior conditions,
- retaining or enhancing the characteristics of soils or artificial substrates as close to the optimum values is desirable.

Function of soil & substrates in built environment

- exactly the same as in the living ecosystem and include:
- provision of support for plants, buildings and other structures;



Functions of soil & substrates in built environment

- regulate water and nutrient storage and supply;
- resistance to erosion;
- habitat for organisms involved in:
  - nutrient cycling,
  - soil structural development and stability,
  - water holding capacity,
  - organic matter decomposition and turnover;
  - neutralisation of contaminates.

Artificial substrates in the built environment

have similar properties & habitat characteristics to natural soils.

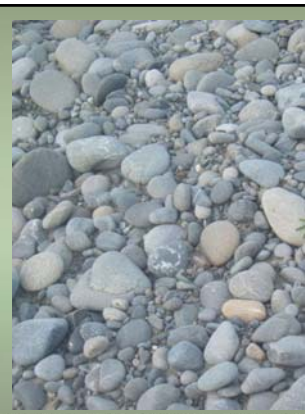
Concrete & masonry surfaces are similar to natural rock outcrops;

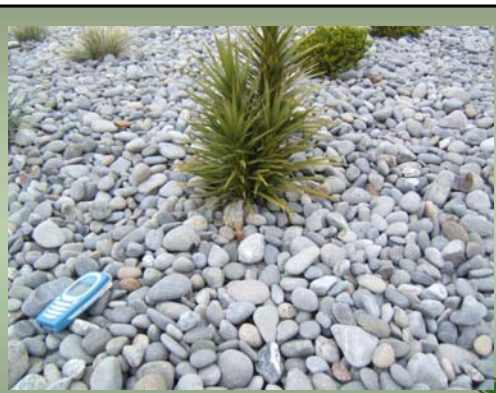
Artificial substrates in the built environment

Both have extremely limited;

- rooting depths,
- plant available water and nutrients,
- fluctuating temperature regimes.

Non-compacted ‘river run’ gravel fill retains similar properties to its riverbed source;





Artificial substrates in the built environment

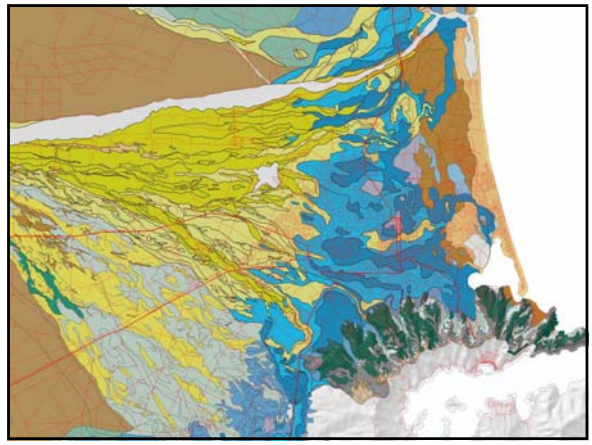
Both have;

- low or non existent clay contents,
- low organic matter levels,
- extremely low available water capacity,
- very low available & reserve nutrient pools,
- poor micro flora & fauna.

Landforms & soils as a basis for ecological restoration

Example: Lucas et. al. 1995-7, Christchurch City.

- 3 Major landforms (alluvial floodplains & terraces, coastal plains, & volcanic hills).
- subdivided at component landform, landform element & slope component level by age, parent material, texture, drainage, & soil type.
- form basis for interpreting plant habitat from soil characteristics, & provides guidance for revegetation



Major landform	Component landform / element	Soils	Soil mapping unit	Ecosystem
Alluvial floodplains,	Floodplains	Shallow droughty soils	Selwyn very stony s	Tussock
and terraces	Young terraces	Deep, moist soils. Shallow droughty soils Deep moist soils	Selwyn zl Waimakariri stony sl Waimakariri zl	Kowhai Ti Kouka Houhere
	Older terraces	Deep, moist soils. Deep poorly drained soils	Kaiapoi zl Taitapu zl, Te Kakahi zl	Totara Kaihikatea
Coastal Plains	Young dune complexes	Drought raw soils	Kairaki ls	Pingo
	Older mature dune complexes	Droughty weakly developed soils	Waikuku ls	Akeake
	Coastal peat plains	Organic soils	Waimairi peaty l, Aranui complex	Pukio
	Estuarine plain	Poorly drained saline soils	Motukarara sl	Oioi

Major landform	Component landform / element	Soils	Soil mapping unit	Ecosystem
Volcanic hills	Dry rocky ridges	Shallow soils form volcanic rock	Cashmere stony zl	Korokio
	Crests and shoulder slopes	Well drained moist soils from loess	Summit zl	Kotukutuku
	Mid-elevation gentle slopes	Deep soils from loess colluvium	Takahae zl	Silver Tussock
	Steep rocky bluffs	Shallow well drained soils from volcanic rock and colluvium	Evans	Porcupine shrub
	Steep lower slopes	Moist, deep soils from loess colluvium	Kiwi zl	Mikokoi
	Well drained slopes	Moist, deep soils from mixed loess-volcanic colluvium	Clifton zl	Horoeka
	Toe slopes and gully floors	Very moist deep soils from loess colluvium	Heathcote zl	Maitai
	Valley floors and seeps	Deep poorly drained soils	Horotane zl	Kaikomako

Conclusion

Ideally landforms, soil & substrate properties & their distribution should;

- guide development of the built environment,
- serve as a basis for ecological restoration at both the site and landscape scale.

Hierarchical landform analysis can assist the gathering & ordering of information;

- by delineating the landscape into named and defined physiographic components.
- further subdivisions, reflecting genesis, parent materials, texture & drainage, related to soil patterns.

Conclusion cont.

To minimise the impact of the built environ on landforms & soils sympathetic design and construction should;

- minimise cutting and filling;
- preserve natural runoff systems & maximise use of natural channels and detention areas;
- minimise imperviousness;
- avoid or remedy trafficking by heavy machinery;
- retain or enhance existing vegetation - especially near waterways;
- maintain soil organic matter and biological activity;
- avoid steep slopes, erodible soils, and watercourses.