Urban Soil Ecosystem Services

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Soil Biodiversity

Has a function... in providing ecosystem services
SOIL

Physical and chemical properties

Biodiversity
plant roots
microorganisms
soil fauna

Ecological processes

pollutants
carbon
water
nutrients

sink

source

SOIL ECOSYSTEM SERVICES

carbon storage
climate amelioration
water storage and filtration
pollution mediation
flood mitigation
food and timber supply
soil retention
education
health and wellbeing
The example of soil carbon and climate amelioration

Most of the world's organic carbon is stored in soils

Stored carbon in soil exceeds the amount in vegetation and atmosphere combined

3.4 tonnes of soil per person worldwide are lost to erosion

Every year a city as large as Berlin is transformed into urban areas (half of urban soils are sealed)

Soil is a living medium: it contains about 25-30% of all biodiversity.

[UN-FAO summary]
### Carbon storage (the amount of organic matter) in soil

<table>
<thead>
<tr>
<th></th>
<th>Arable</th>
<th>Permanent grassland</th>
<th>Semi-natural vegetation</th>
<th>Mature forest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon storage (tonnes Carbon ha(^{-1}))</td>
<td>72</td>
<td>100</td>
<td>122</td>
<td>221 - 450</td>
</tr>
</tbody>
</table>

[tonnes Carbon ha\(^{-1}\)]
How much carbon in urban soils?

Carbon

\[ \begin{align*}
51.7 \text{ t ha}^{-1} \\
21.8 \text{ t ha}^{-1} \\
9.8 \text{ t ha}^{-1}
\end{align*} \]
Functionality of soil fauna

Soil fauna modify the structure, drainage and chemical characteristics of soil, through burrowing and processing of soil and organic matter.

This has a profound effect on soil carbon, fertility and pollutants.
Earthworms are frequently described as soil engineers.
Charles Darwin... after visiting New Zealand during the Voyage of the Beagle (1835)

“It is not a pleasant place...

The greater part of the English are the very refuse of society ...

... Neither is the country itself attractive”
“It may be doubted whether there are many other animals which have played so important a part in the history of the world, as have these lowly organized creatures.”

Charles Darwin (1881) *The formation of Vegetable Mould through the Action of Worms, with Observations on their Habits.*

[This was his last book, published a year before he died].
New Zealand’s Native Earthworms

We know of about 200 species of NZ native earthworms [mostly from studies in the 1950s]

This is probably a huge underestimate
New Zealand Earthworms

- 178 species of native earthworms (mostly in families Megascolecidae and Acanthodrilidae).
- 23 species of the family Lumbricidae introduced by Europeans: these are now the only or the main species on agricultural land.
- There are at least 25 native species in Canterbury.
New Zealand Earthworms

- In 1996, a study of 105 field located at 24 commercial farms on the Canterbury plain found no native earthworms.
- Native earthworms are found most commonly near native vegetation or undisturbed land.
- [Riccarton Bush has *Octochaetus* spp and *Maoridrilus* spp that are bioluminescent].

In a recent study 3 earthworm species unknown to science were found in a Lincoln township reserve, and 8 unknown species in a dry grassland reserve at Bankside.

**Megascolecidae Sp.1 (YN7_White)**

16S, GenBank accession number KP771677 (submitted 12 Feb 2015)
ACCGTGCAAAGGTAGCATAATAACTTGCTATTAGTGGCATAATGAAACGGATAACGAAATAAGAAGACTGG
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COI, GenBank accession number KP771672 (submitted 12 Feb 2015)
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ATTTGTATGAGCTTGTAATCATAGCTTAGACTACTACTATTATCTCTACCAGTTCTGAGCTGGCTTATACTATAC
ACTAACAGATCGAACCTAAACACCTCTATTTCGGTCTGCT
How to distinguish native (Megascolecid) from exotic (Lumbricid) earthworms

Count the segments from the mouth to the clitellum in mature specimens.
Conclusions

- Soil biodiversity and soil ecosystem services in urban areas has local and global significance.

- We should add organic matter (carbon) to urban soils to support above- and below-ground biodiversity.

- Composts, mulches, understory planting, no cultivation areas are most important.

- NZ citizen science: please tell when you find native species.

- Better management of urban soil biodiversity would provide improved human health and well-being.
Healthy Soils

Healthy Cities, Healthy People