Assessing soil health in Australia's rangelands 11:05-11.40

Centre for Ecosystem Science

Dr David Eldridge

Biological, Earth & Environmental Sciences, UNSW, Australia

Many measures of soil health

GRAZING LANDS

- are extensive
- low value, compared with cropping land
- have spatially variable soils

AND

- monitoring is expensive
- chemicals are expensive
- expertise and laboratories are limited

THEREFORE

- proxies and surrogates are important

SCORE CARD

Visual indicators for assessing soil quality under cropping

SOIL INDICATORS

Land use:
Site location/Paddock name:
Date:
Soil type:
Textural qualifier: ☐ Sandy ☐ Loamy ☐ Clayey
Moisture condition: ☐ Dry ☐ Slightly moist ☐ Moist ☐ Wet
Seasonal weather conditions: ☐ Dry ☐ Wet ☐ Cold ☐ Warm ☐ Average

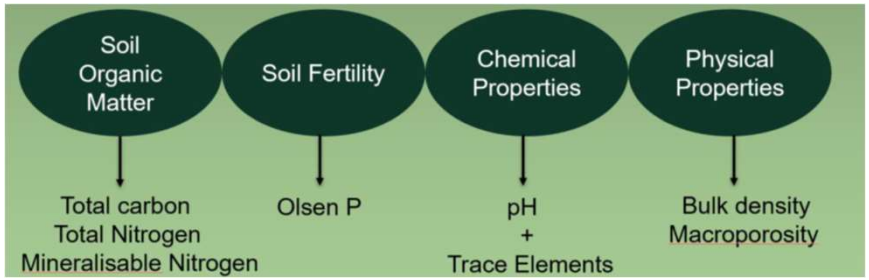
Visual Indicator of Soil Quality	Visual Score (VS) 0 = Poor condition 1 = Moderate condition 2 = Good condition	Weighting	VS Ranking
Soil structure & consistence (Fig. 1, p.17)		x 3	
Soil porosity (Fig. 2, p.19)		x 3	
Soil colour (Fig. 3, p.21)		x 2	
Number and colour of soil mottles (Fig. 4, p.23)		x 2	
Earthworm counts (Fig. 5, p. 25)		x 2	
Tillage pan (Fig. 6, p. 27)		x 2	
Degree of clod development (Fig. 7, p. 29)		x 1	
Degree of soil erosion (wind/water) (Fig. 8, p. 31)		x 2	
RANKING SCORE (Sum of VS rankings)			

Soil Quality Assessment	Ranking Score
Poor	< 10
Moderate	10 – 25
Good	> 25

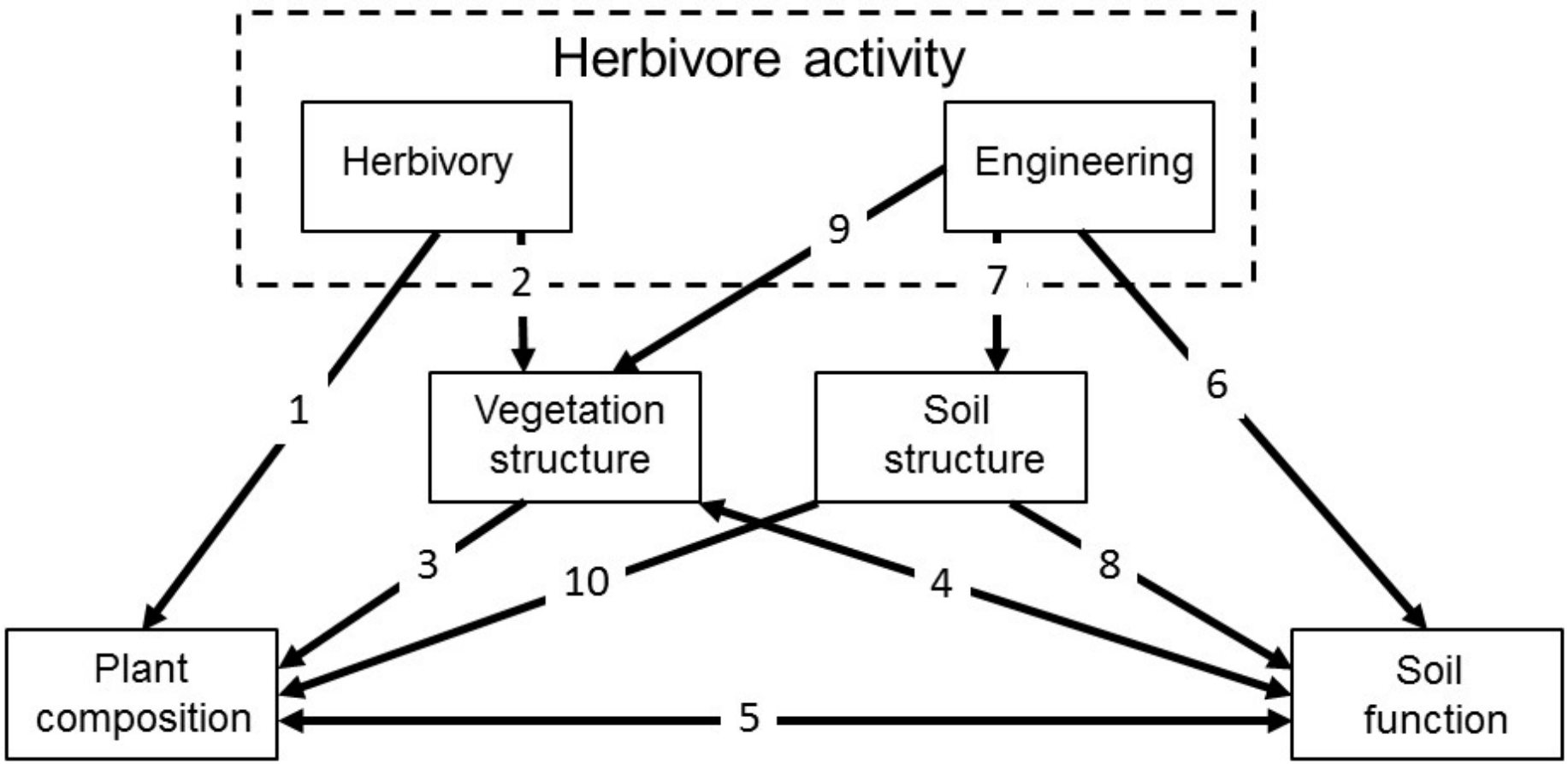
If your soil quality assessment is moderate or poor, guidelines for sustainable management are given in Volume 2, Part One.

Figure 3. Visual soil assessment guide, available online (for no cost) at: VSA field guide » Manaaki Whenua (landcareresearch.co.nz).

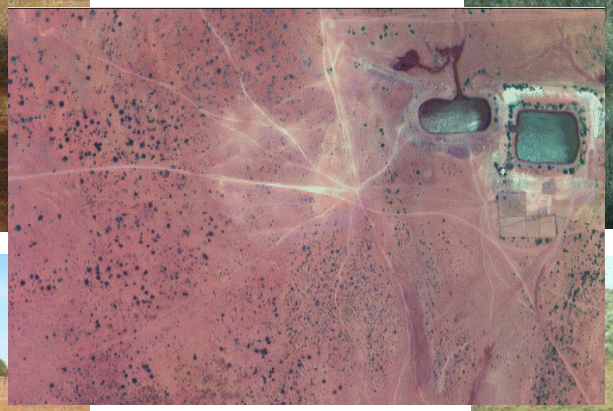
New Zealand State of the Environment soil quality indicators



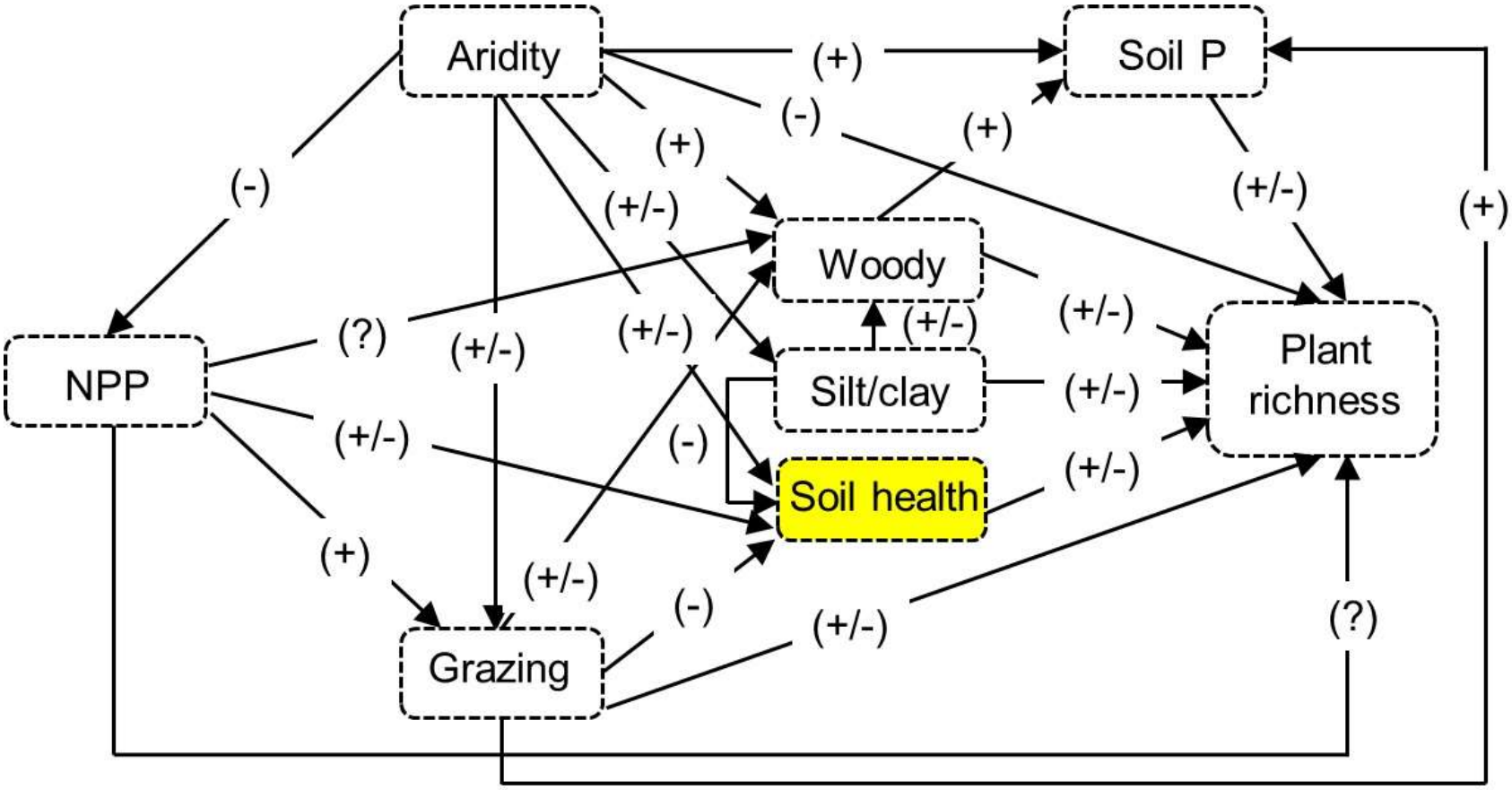
Generalized effects of herbivores



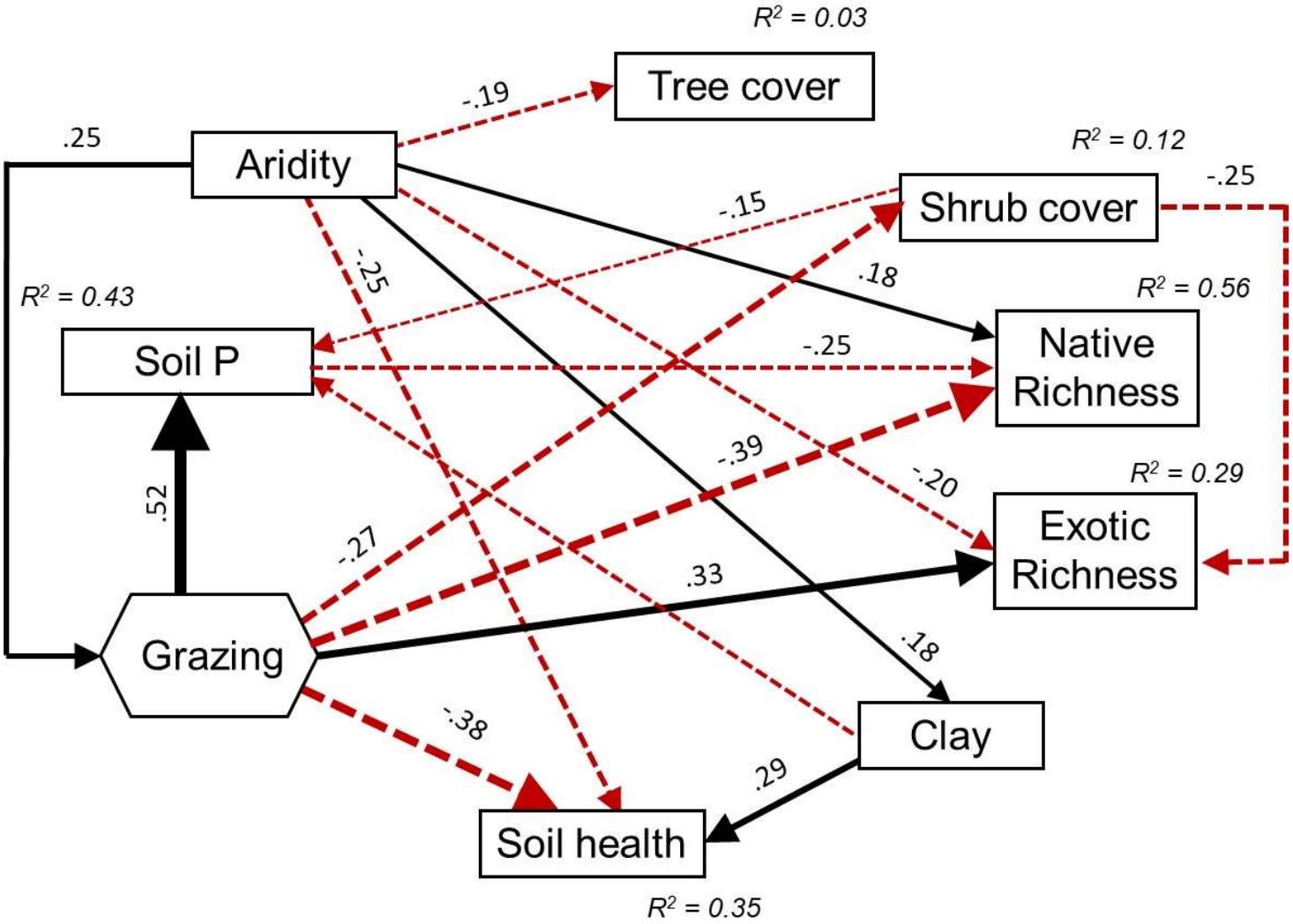
Many ways to study ecosystem effects of grazing



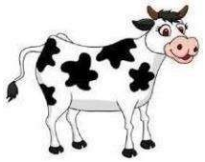
Modelling a grazing system using expert knowledge

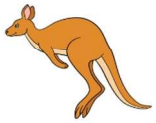
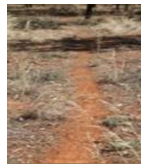


Grazing suppresses soil health



Grazing and soil health

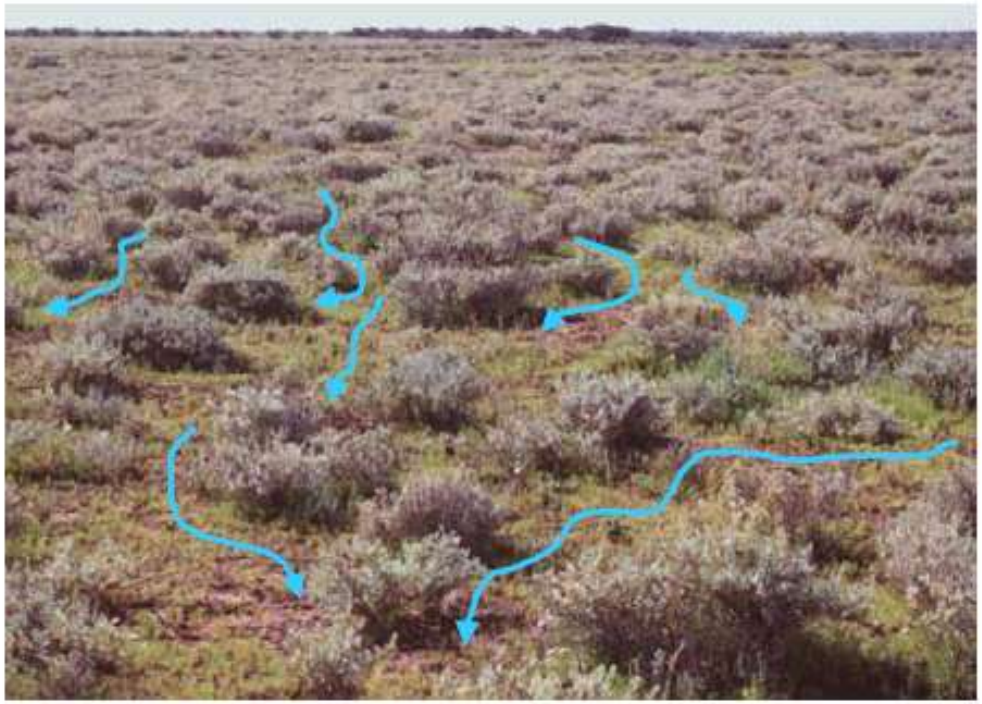


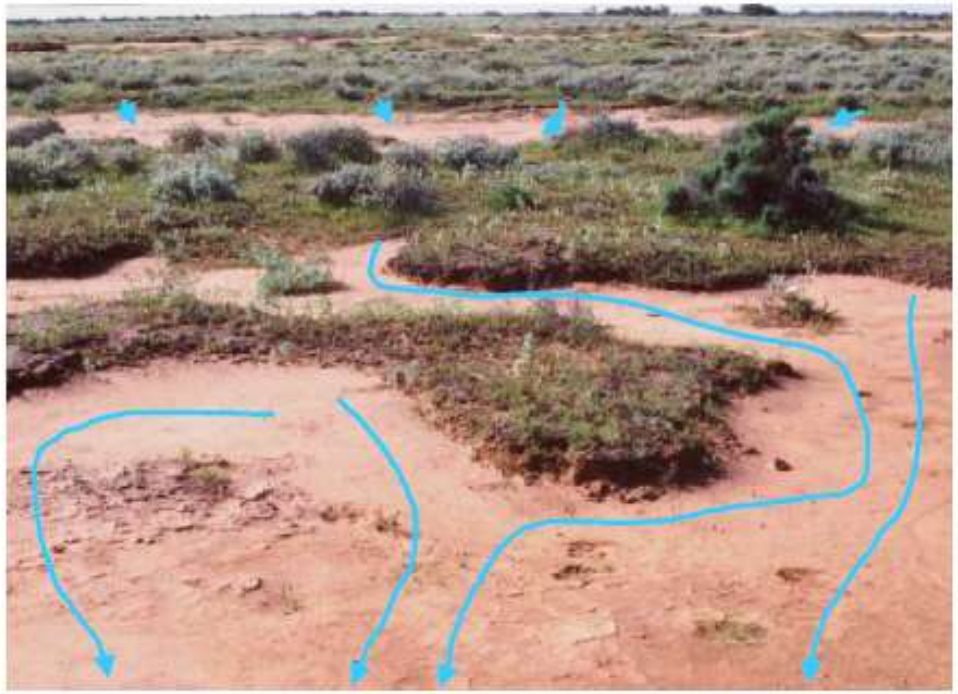
Attribute					
Health index	●		●		
Surface integrity	●	●	●		●
Soil roughness		●	●	●	●
Surface resistance	●	●			
Biocrust cover	●		●	●	●
Litter cover	●		●		●
Litter incorporation	●	●	●		
Litter depth	●	●			
Lag material			●		
Crust stability			●		
Surface cracking		●			
Soil N			●	●	
Soil C			●		
Soil P	●		●	●	
% ground litter	●		●		

Eldridge *et al.* (2016)
J. Appl. Ecol.

Using a landscape functional approach to soil health



Healthy (functional)

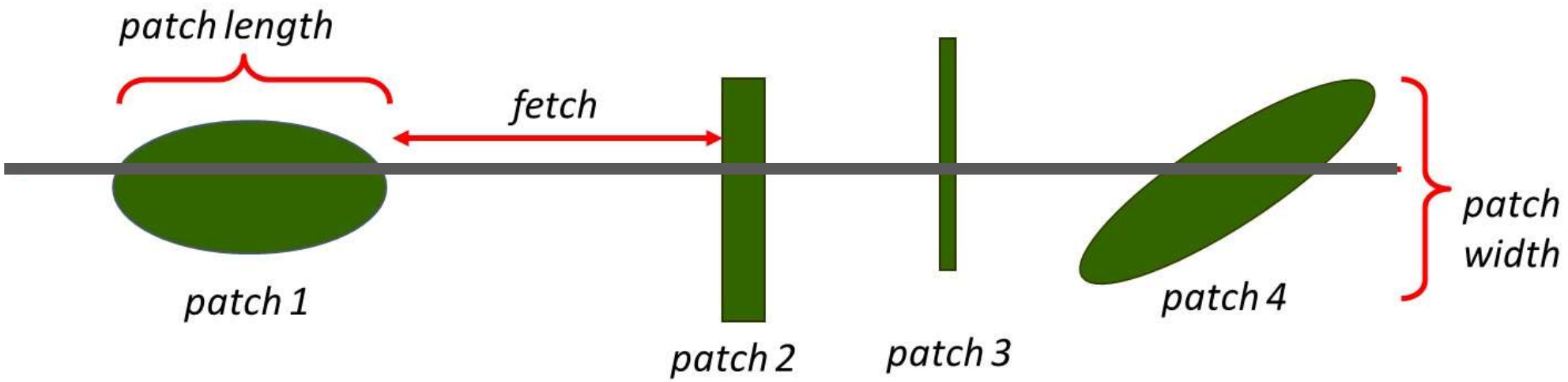


Unhealthy (dysfunctional)

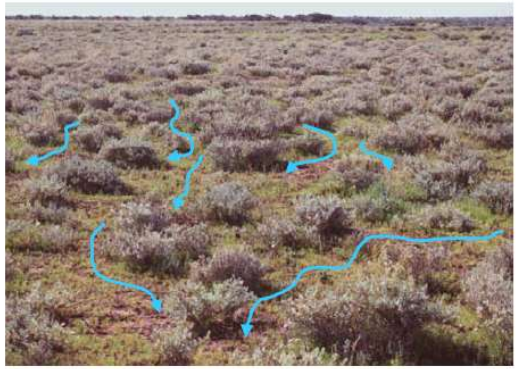
Source: Tongway (1991)

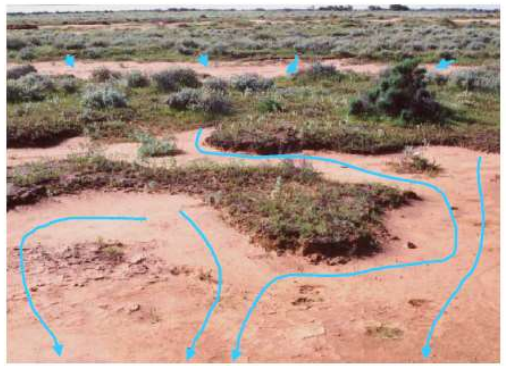
Measuring landscape function

- primary landscape pattern: (patch size, width and separation)
- related to the flow or resources (soil, seeds, water, organic matter)



Landscape function: functional cf. dysfunctional

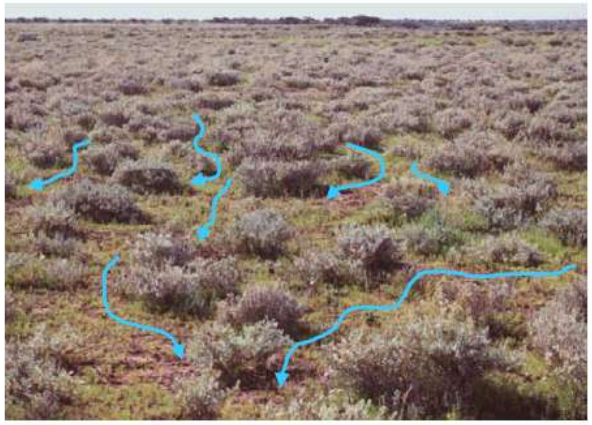




Attribute	Functional	Dysfunctional
No. of patches (/10m)	6.20	1.30
Total patch width (m/10m)	2.66	1.16
Average fetch length (m)	1.31	6.53

Source: Tongway (1991)

Using a landscape functional approach to soil health



Attribute	Functional	Dysfunctional
Available nitrogen (ppm)	75.4[a]	22.4[b]
Available phosphorus (ppm)	14.4[a]	9.5[a]
Organic carbon (%)	1.5[a]	0.8[b]
Infiltration rate (mm/hr)	49.2[a]	7.8[b]
Plant production (g/m^2)	231.2[a]	13.6[b]

Source: Tongway (1991)

Soil surface condition: 13 surface attributes

- soil roughness
- soil resistance
- crust cracking
- crust stability
- biocrust cover
- erosion cover
- depositional material
- plant foliage and basal cover
- litter cover, origin and incorporation
- soil texture

<u>Three soil health indices</u>

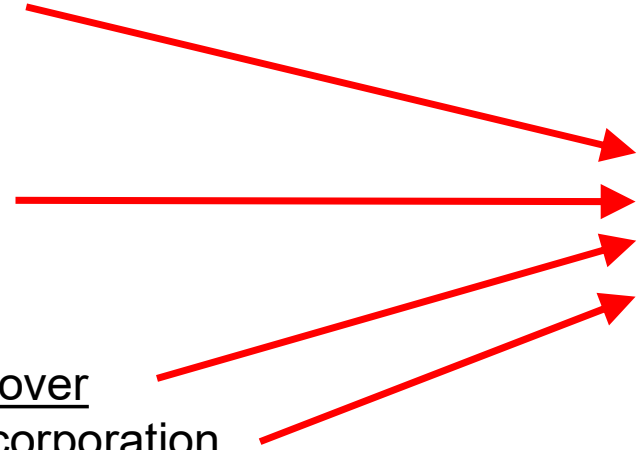
- Stability Index
- Nutrient index
- Infiltration index




Source: Tongway (1994)

Soil surface condition: 13 surface attributes

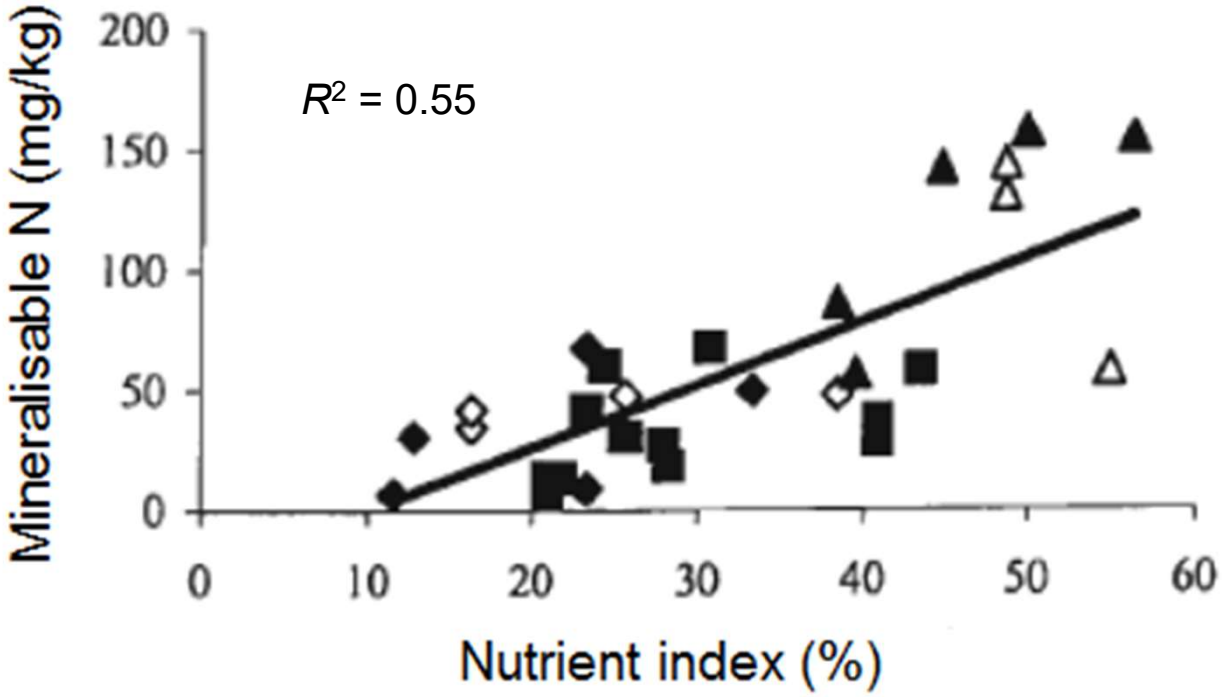
- soil roughness
- soil resistance
- crust cracking
- crust stability
- biocrust cover
- erosion cover
- depositional material
- plant foliage and basal cover
- litter cover, origin and incorporation
- soil texture



Source: Tongway (1994)

Nutrient index *vs* mineralisable nitrogen

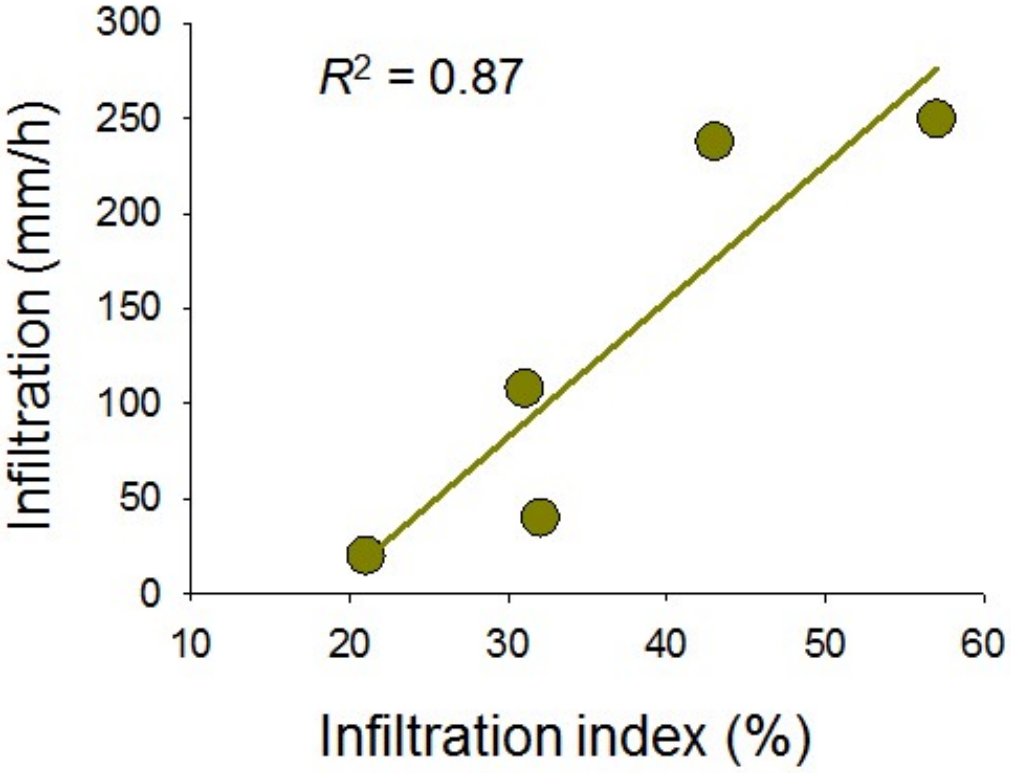
Source: http://www.uq.edu.au/cmlr/a_grigg.html



Gregory Mine – Emerald, Qld

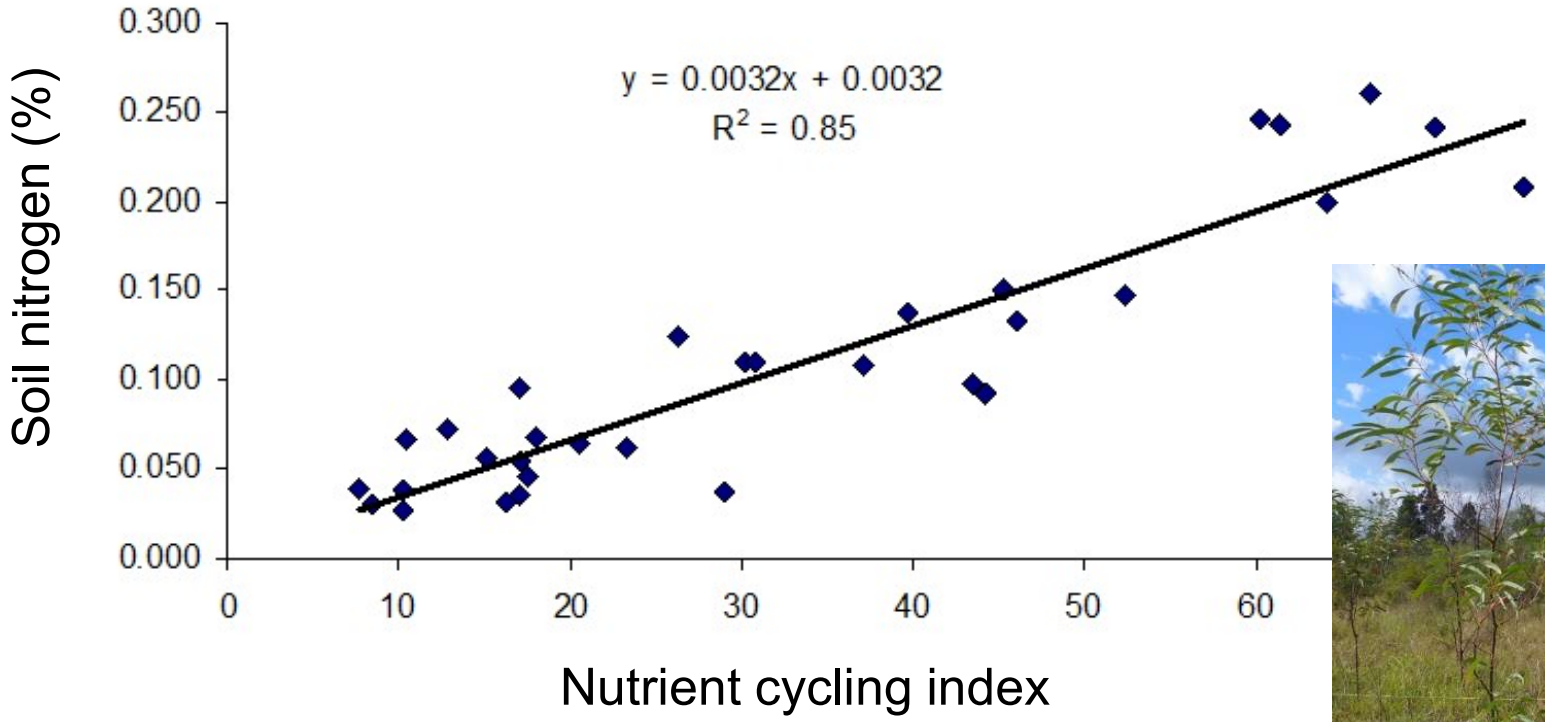
Source: Seaborn (2005)

Infiltration index *vs* steady-state infiltration



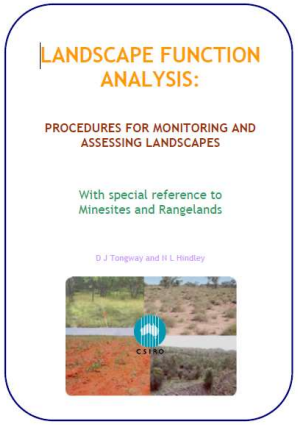
Kellerberrin woodland – Western Australia

Nutrient index *vs* total soil nitrogen



Bauxite mine, Gove - Northern Territory

Global studies using landscape function analysis



European Journal of Soil Science

Special Issue Article

Landscape function analysis to assess soil processes on farms following ecological restoration and changes in grazing management

Z. J. Read, H. P. King, D. J. Tongway, S. Ogilvy, R. S. B. Greene, G. Hand

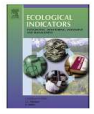
First published: 10 June 2016 | https://doi.org/10.1111/ejss.12352 | Citations: 8

ELSEVIER

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind



Original Articles

Grazing reduces the capacity of Landscape Function Analysis to predict regional-scale nutrient availability or decomposition, but not total nutrient pools

David J. Eldridge[a,*], Manuel Delgado-Baquerizo[b]

[a] NSW Office of Environment and Heritage, Centre for Ecosystem Science, School of Biological, Earth and Environmental Sciences, University of New South Wales, Sydney, New South Wales 2052, Australia
[b] Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO 80309, USA

ELSEVIER

Applied Soil Ecology

Volume 41, Issue 3, March 2009, Pages 342-350

Indices based on surface indicators predict soil functioning in Mediterranean semi-arid steppes

Fernando T. Maestre, María D. Puche

Stability and litter incorporation drive multifunction

SOIL STABILITY

LITTER INCORPORATION

Soil multifunctionality

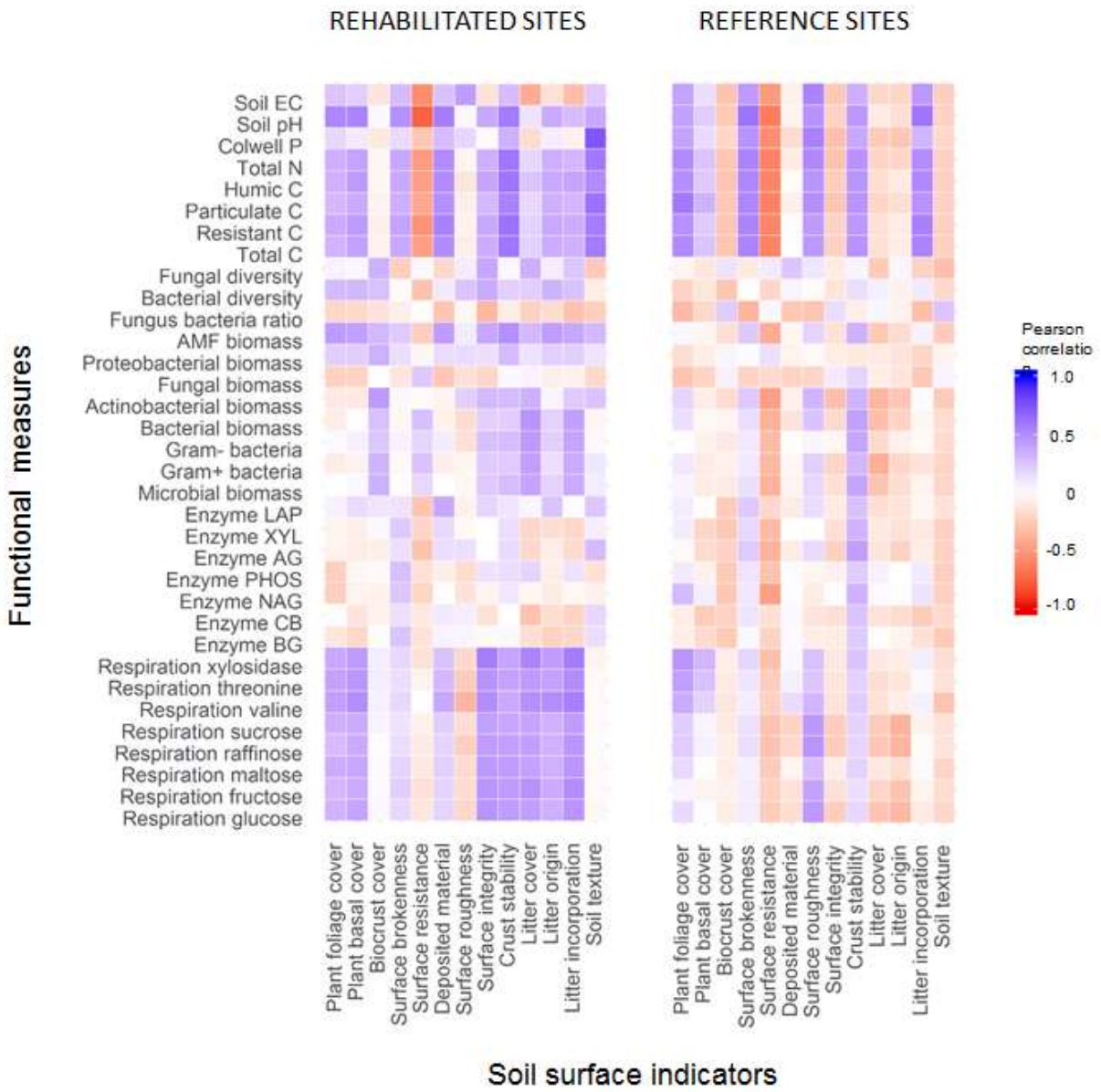
Journal of Applied Ecology
BRITISH ECOLOGICAL SOCIETY

RESEARCH ARTICLE

Surface indicators are correlated with soil multifunctionality in global drylands

David J. Eldridge, Manuel Delgado-Baquerizo, José L. Quero, Victoria Ochoa, Beatriz Gozalo, Pablo García-Palacios, Cristina Escolar, Miguel García-Gómez, Aníbal Prina ... See all authors

First published:15 November 2019 | https://doi.org/10.1111/1365-2664.13540



Predictive power depends on where you are

Some final thoughts

1. LFA transect method ★

   - informative in water-limited systems (drylands)
   - useful for assessing patch contribution

2. Soil surface condition assessment ★★★

   - effective proxy of soil function (but context dependent)
   - simple and intuitive
   - low cost
   - BUT, requires training

Source: Tongway (1994)