The effect of ecosystem engineers on N cycling in an arid agroecosystem

Jessica G. Ernakovich[1], Theodore A. Evans[2], Ben Macdonald[3], Mark Farrell[1]

[1] CSIRO Agriculture & Food, Urrbrae, SA; [2] School of Animal Biology, University of Western Australia, Perth, WA; [3] CSIRO Agriculture & Food, Canberra, ACT

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Snapshot

- Ecosystem engineers—such as earthworms, termites and ants—are important to ecosystem functions, including aboveground productivity.
- Their contribution to soil nutrient cycling is not well understood, particularly in arid systems where termites and ants are the dominant ecosystem engineers.
- We explored the effect of termite and ant reduction on nitrogen (N) biogeochemistry in soils from the northeasternmost wheat growing region in W. Australia.
- Many soil N pools were up to 2.5 x larger with native populations, but the rate of transformations was lower relative to the reduced termite plots.
- Conservation of soil macrofauna, particularly those that translocate N through the soil profile, may be important in sustainable management of cropped lands.

Background

- Ecosystem engineers are beneficial to soil health and ecosystem productivity[1,2,3].
- Their presence can lead to substantially higher crop yields[4].
- Despite their importance, little is known about how they alter soil biogeochemistry.
- Soils with native termites and ants have higher mineral N, likely due, at least in part, to N-fixing bacteria in the termite hindgut[4].
- But, whether N transformations mediated by free-living soil microorganisms contributes to these differences is unknown.

Objectives and Hypothesis

- Objective: to assess the size of soil N pools and fluxes between pools, in order to determine the effect of termites and ants on soil processes.
- Hypothesis: ecosystem engineers alter the soil N cycle by increasing the amount of N-containing compounds (i.e. fixed mineral N) and by stimulating the activity of free-living microbes.

Approach

- Soils obtained from two-way factorial field experiment to assess the effect of soil macroinvertebrate reduction and shallow tillage on wheat yield[4].
- We measured soil N pools
  - combustible soil N,
  - total dissolved N (TDN), including dissolved organic N (DON) and mineral N [ammonium (NH_4^+) and nitrate (NO_3^-)], and
  - potentially mineralizable nitrogen (PMN).
- and soil N fluxes—proteolysis, N mineralization, and amino acid turnover.

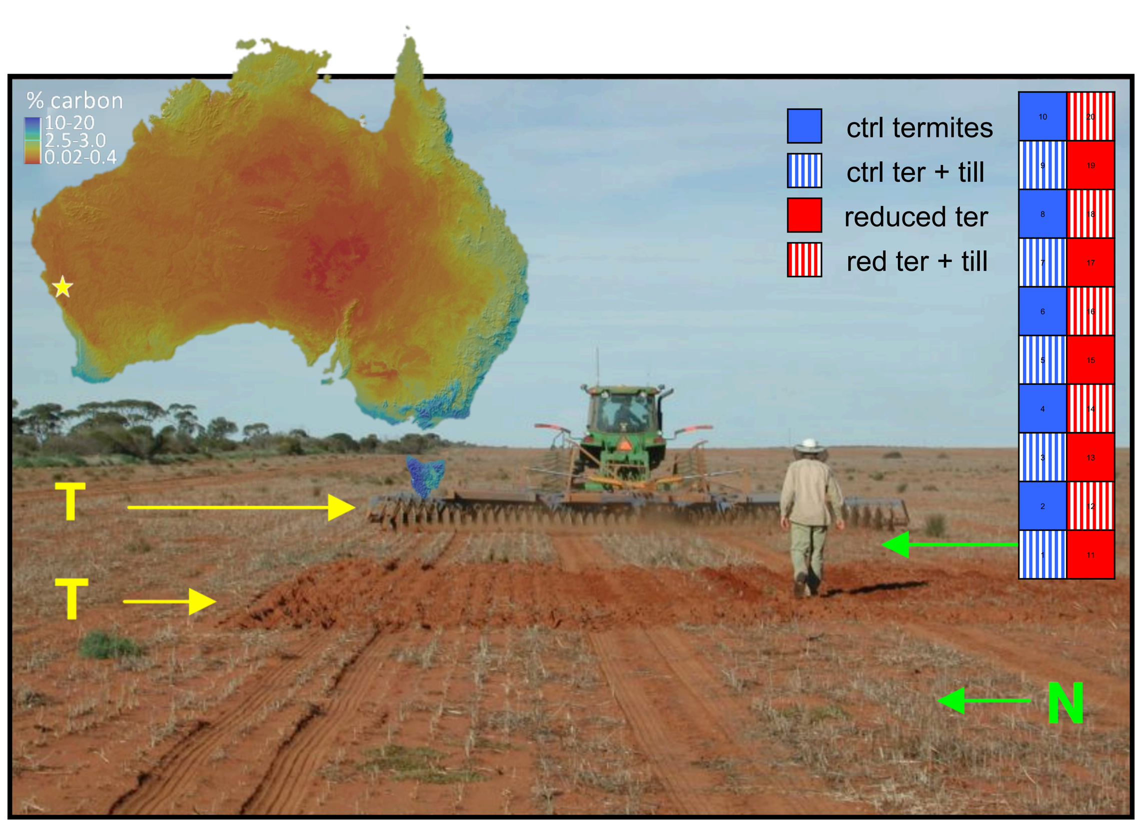

Figure 1: Field site image and diagram of the 2-way crossed design (right inset)[4]. (Left inset) Australia soil carbon map[5] with site location marked.

Results

Soil N pools

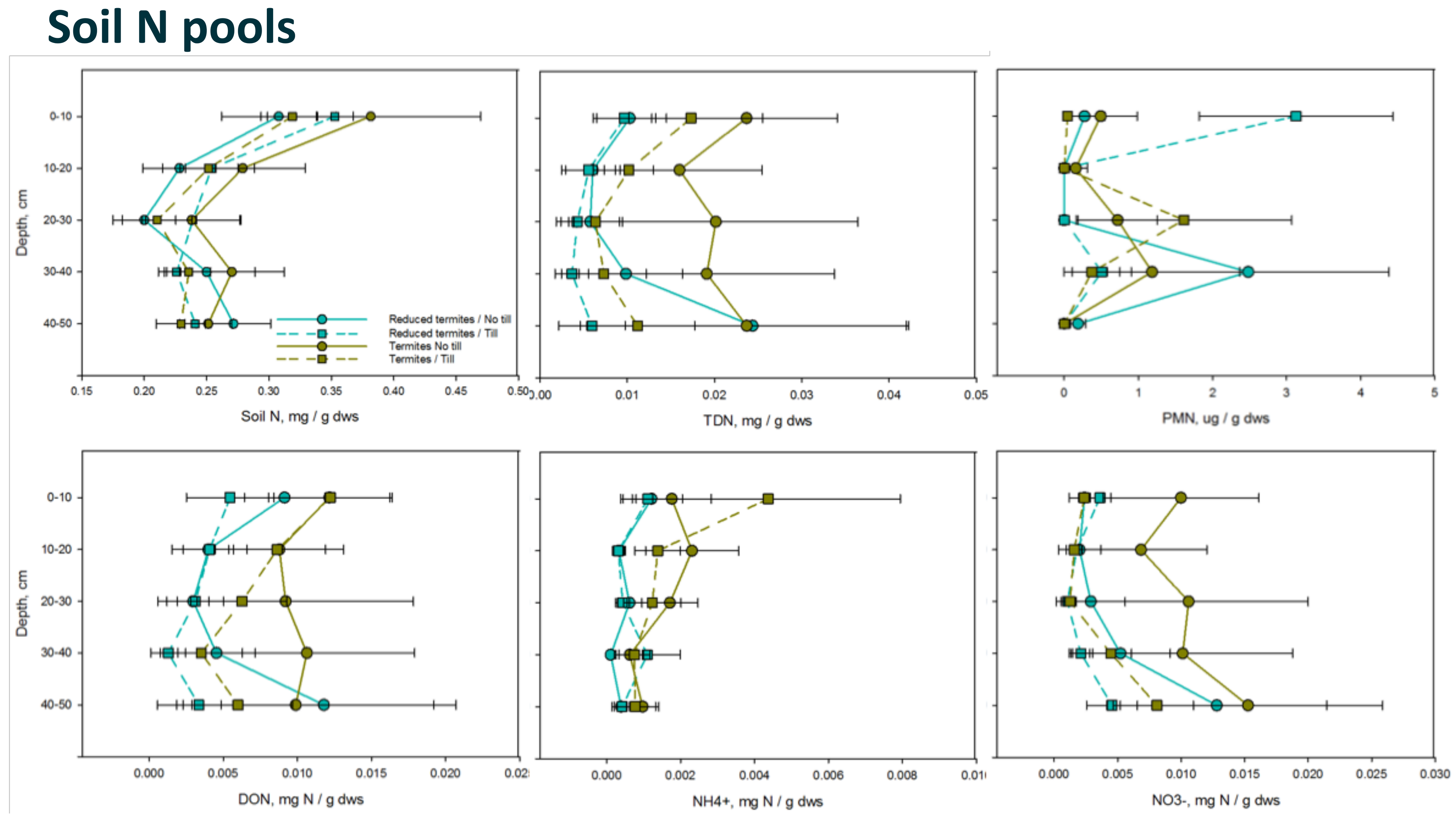

Figure 2: Soil N pools with depth.

- Pools were generally larger for soils with native rather than reduced termite populations. Soil N declined with depth, but TDN pools stayed constant.
- A termite x tillage interaction was apparent for many soil N pools.

Soil N fluxes

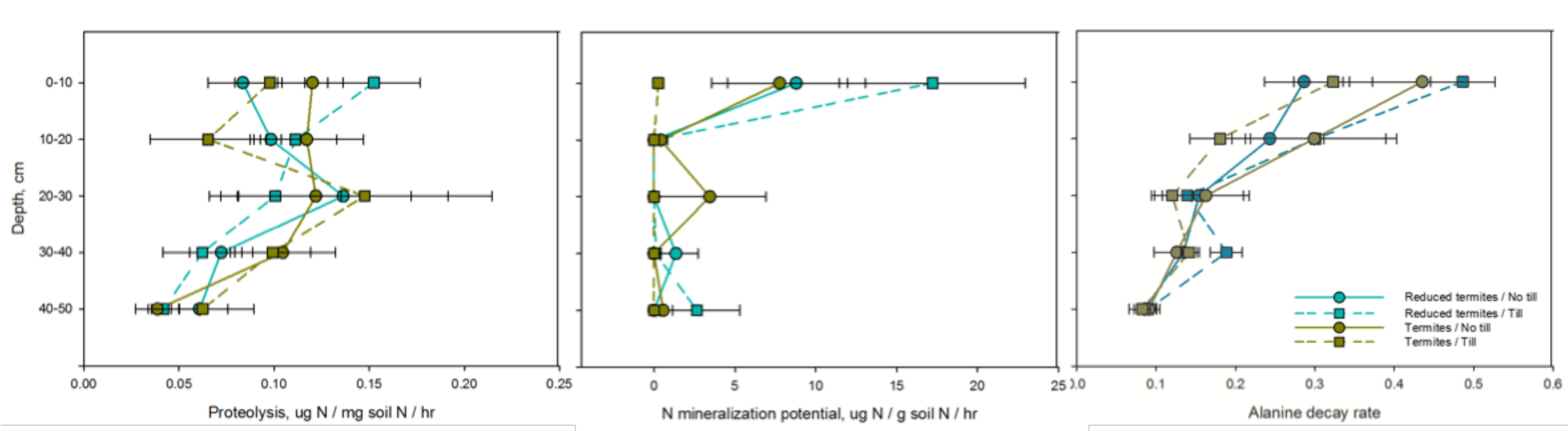

Figure 3: Soil N fluxes. These suggest the potential rates of N transformations between N pools by free-living soil microorganisms.

- Fluxes were often greatest in soils with reduced termite populations with tillage. Termite x tillage interaction was also observed.
- High rates in the top 10 cm, and sometimes also at 20-30 cm. This may be due to N movement by termites and/or higher microbial biomass at that depth.

Conclusions

- Ecosystem engineers enhanced soil N *pools*, but *fluxes* into the pools were largest when termites were reduced.
- The latter is potentially an artefact of field accessibility caused by differences in mixing (by termites or tillage).
  - Potential N transformation rates were enhanced by tillage when the termites were reduced, but were hindered by tillage when termites were abundant.
- Managing soils to promote biodiversity can have environmental and economic benefits by reducing external N fertilizer demand without yield trade-offs.

FOR FURTHER INFORMATION

Jessica Ernakovich
e jessica.ernakovich@csiro.au
w http://people.csiro.au/E/J/Jessica-Ernakovich

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