And whilst we're all focused on carbon….
What about nitrogen?

Why nitrogen in a talk about carbon?

1. In order to sequester C as SOM, you also need N (and P, and S...)

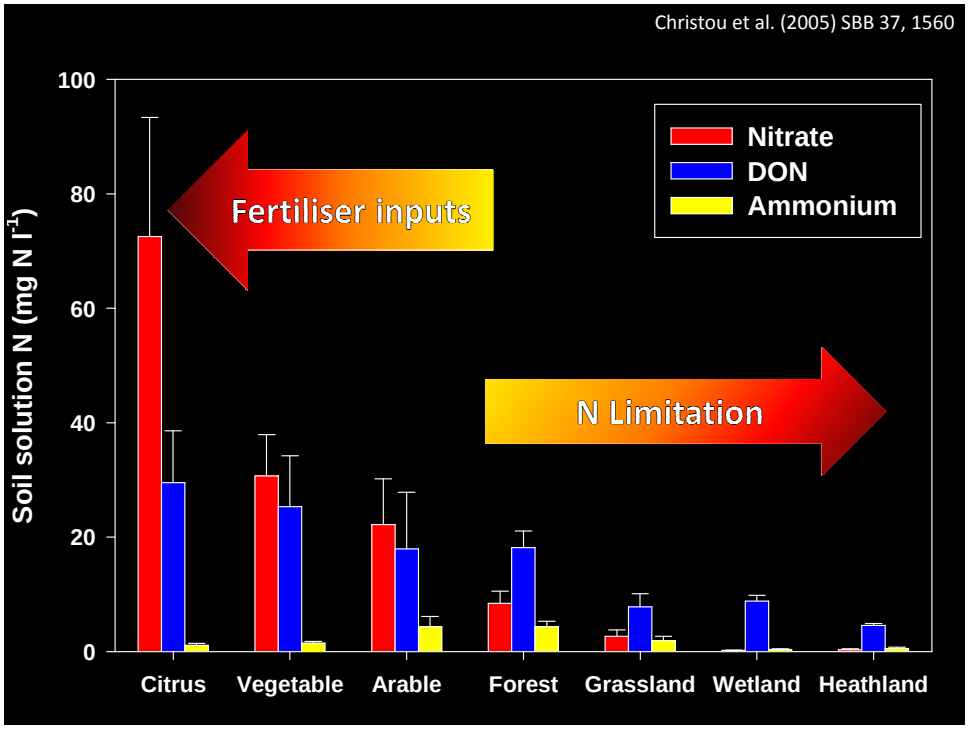
2. N_2O is obviously a major greenhouse gas

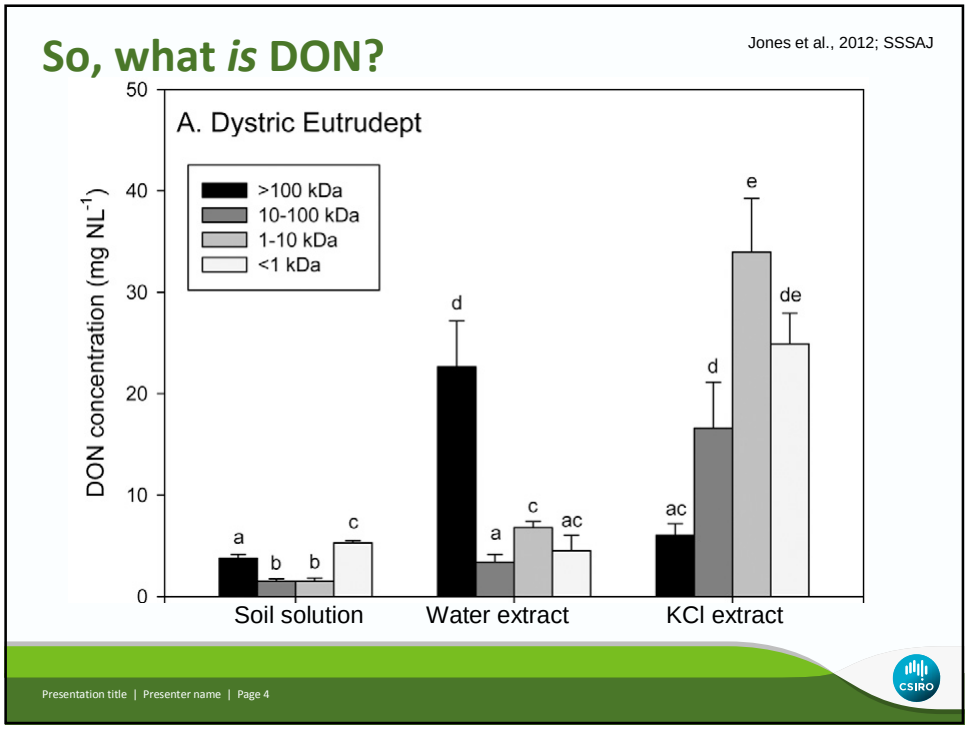
   Can additions of N in order to sequester C lead to increased N_2O?

3. Accurate applications of N, both to maximise crop yield and NUE, but to also provide enough N for C sequestration require a good understanding of the N status of a soil

   Traditionally, this means KCl-extractable NO_3^- and NH_4^+

   However...


Christou et al. (2005) SBB 37, 1560
Soil solution N (mg N l-1)
100
80
60
40
20
0
Nitrate
DON
Ammonium
Fertiliser inputs
N Limitation
Citrus
Vegetable
Arable
Forest
Grassland
Wetland
Heathland


So, what is DON?
Jones et al., 2012; SSSAJ
A. Dystric Eutrudept
DON concentration (mg NL-1)
50
40
30
20
10
0
>100 kDa
10-100 kDa
1-10 kDa
<1 kDa
a
b
b
c
d
a
c
ac
ac
d
e
de
Soil solution
Water extract
KCl extract
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So, what *is* DON?

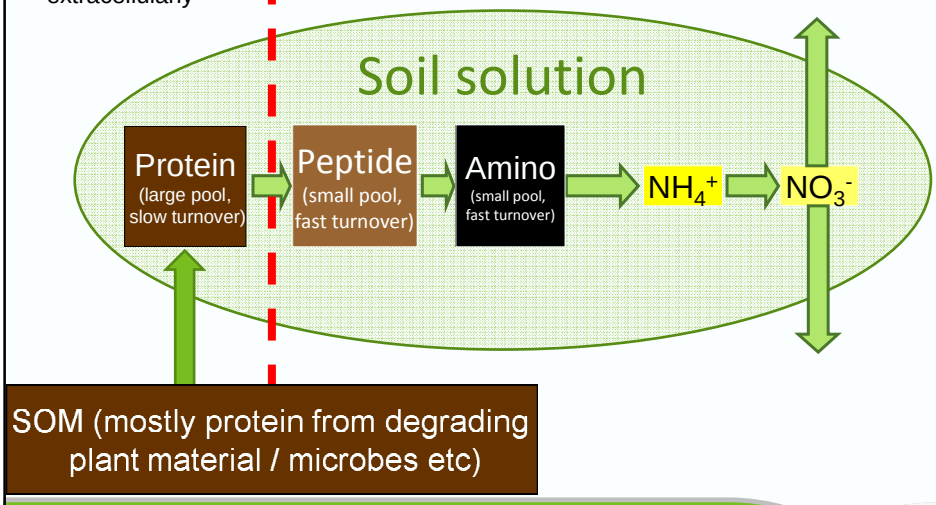
- A mixture of compounds containing N and C

- Mostly proteinaceous compounds

- A mix of high-, medium-, and low- molecular weight compounds, which behave differently and have discrete functionality in the soil
- Some are labile and move freely, some are not and sorb strongly
- Some are plant and microbe available, some are not
- Regardless of DIN concentration, some DON still represents readily available N

Plants / microbes must break this down extracellularly

These N species small enough to be taken up intact. Thus, competition between plants and microbes for N is happening across all these pools. Transformation between these pools is rapid (minutes → hours).



How do we measure it?

Issues, issues, issues....

Problem 1: Accurate extraction

- Must reflect conditions in the soil, and accurately include only plant- and microbe- available N
- But yet three common methods (KCl, water, and direct soil solution measurements) yield very different size-classes of molecules
- We know that only small compounds are directly utilisable, how do we differentiate
- Whilst intuitively, soil solution appears the most accurate, we also know for other analytes that sorb, such as phosphate, that it's a poor predictor of availability
- Finally, given the lability of some compounds in DON, rapid and appropriate preservation of samples is required

How do we measure it?

Issues, issues, issues....

Problem 2: Appropriate analysis

- Total DON numbers are usually TDN minus DIN – already you have error based upon these other two numbers
- We know that plants and microorganisms can only directly take up small molecules – currently this requires some form of molecular weight sieving which is costly, time consuming, (and possibly questionable...)
- One solution might be to measure only monomers

- GREAT! There's an easy method for amino acids. But....
  - What about peptides, and 'others...'

(lack of) Conclusions

•Nitrogen availability appears a lot more complex than perhaps we had conveniently hoped

•This has implications for budgeting managing leaching, emissions, yield, C sequestration, etc etc etc...

•It seems we don't really know what we're measuring

- How comparable are extraction methods
- What's available DON (and should be counted in with DIN)
- What's only soluble, but not labile (important from a leaching perspective, but perhaps less so for nutrition / emissions)

And finally....

What's in the 'black box'?