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CO_2: you have to measure it to manage it

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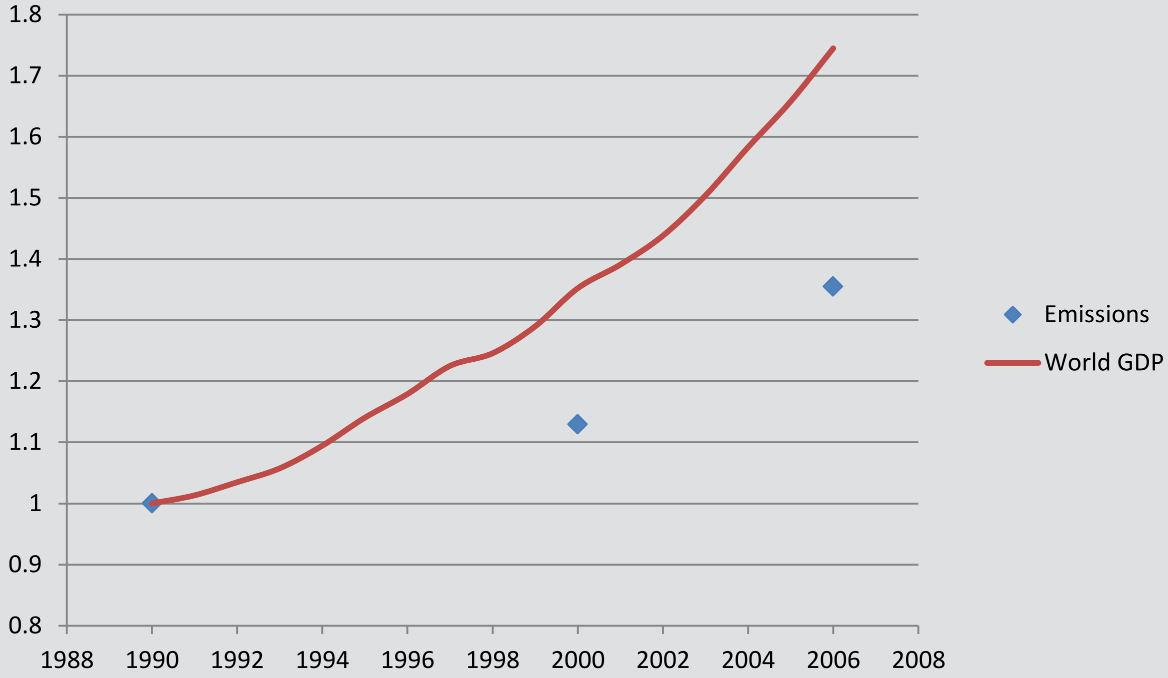
Global emissions and world GDP since 1990

Rebased: 1990 value = 1




Measuring progress in GHG emissions

Net global anthropogenic GHG emissions must ultimately fall to zero if the climate is to be stabilised.

To achieve this, the rate of change of emissions must :

1. First, go to zero
2. Then become negative

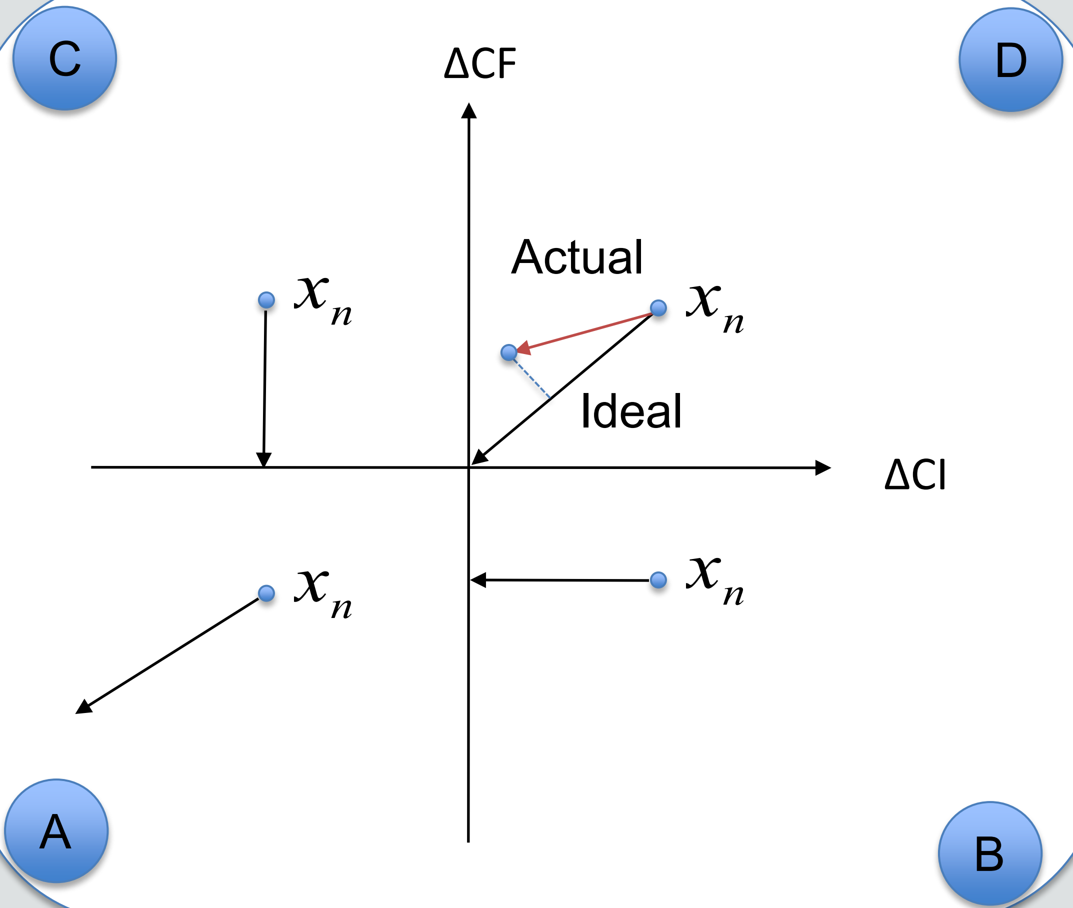
Although there are good conventions over calculating emissions and emissions intensity, they are not leading to global decarbonisation.

An absolute, objective yardstick for emission reduction does exist:

1. Emissions must be reduced to within carrying capacity (gross emissions = flux to sinks)

2. Economic prosperity must be maintained

The ‘Carbon Vectors’ Performance Indicator



$$Performance = P_{n+1} = \frac{\mathbf{A}_{n+1}^{\mathbf{T}}\mathbf{I}_{n+1}}{\left|\mathbf{I}_{n+1}\right|^2}$$

Division	Actor	Performance
A1	Luxembourg Unilever Anglo American Germany	-0.28 -0.30 -0.35 -0.64
A2	Ireland	-1.30
A4	UK	-1.16
C1	BHP Billiton	1.62
C4	Xstrata	0.94
D1	Norway SAB Miller	2.22 1.64
D4	BT Group	-11.6

Ennis, C. J. (2010) A league table for economically sustainable decarbonisation”, Proceedings of the Greening of Industry Network Conference , Seoul, South Korea.

ERDF Project: Resource Efficiency Pathways for Sustainable Growth

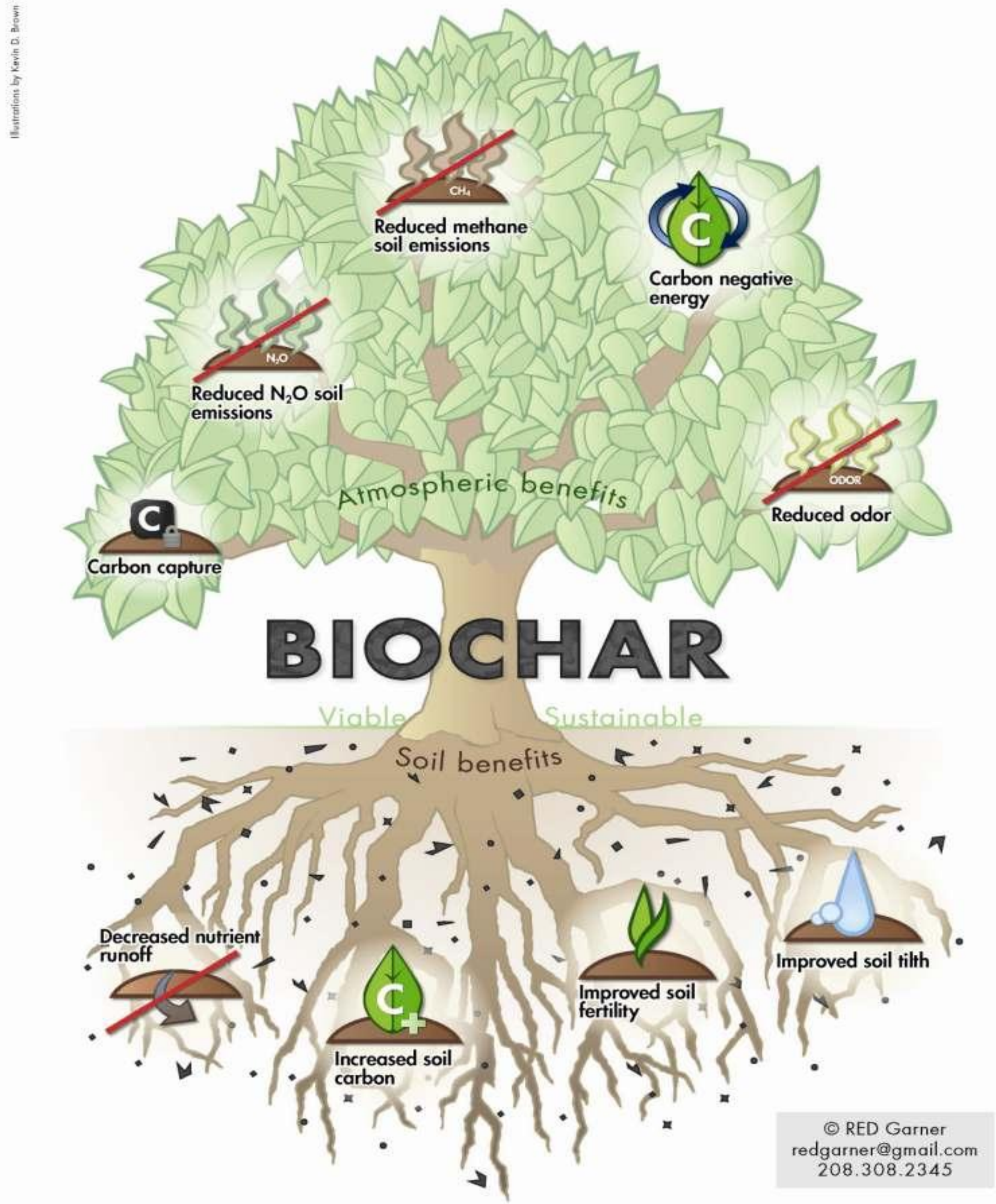

Managing emissions: Biochar

Benefits of Biochar

- Atmosphefic benefits
  - Reduced direct emissions of potent GHGs
  - Reduced GHG emissions associated with reduced agricultural inputs (e.g fertilizers, activities)
  - Carbon negative energy and safe, solid phase carbon sequestration

- Soil benefits
  - Improved agricultural yields
  - Better water retention
  - Nutrient retention

- Viable, sustainable technology
  - Ancient chemical technology
  - Sustainable technical mitigation potential estimated to be 12% current annual fossil carbon emissions



Biochar: commercial realisation

- UK Markets:
  - Contaminated land restoration
- Developing markets
  - Soil fertility improvements
  - Water management

Ennis, C. J., Evans, A. G., Islam, M., Ralebitso-Senior, T. K., Senior, E. "Biochar: carbon sequestration, land remediation and impacts on soil microbiology." *Critical Reviews in Environmental Science and Technology*, 2011, in press.

Biochar: UK commercialisation

1. Microbial ecology of biochar in contaminated land remediation
2. Biochar and brownfield land restoration: Charbon project (UKERC/NESTA)

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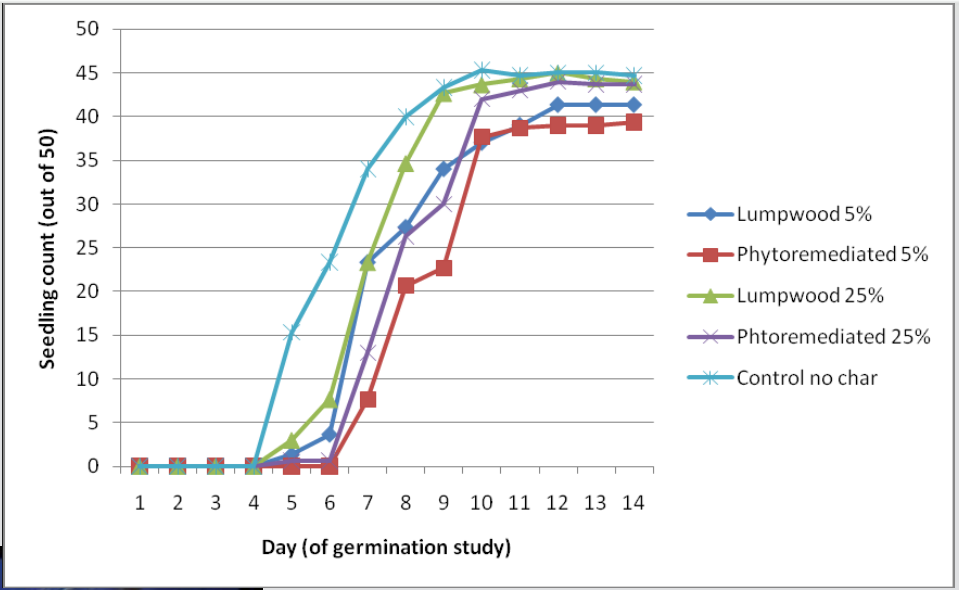
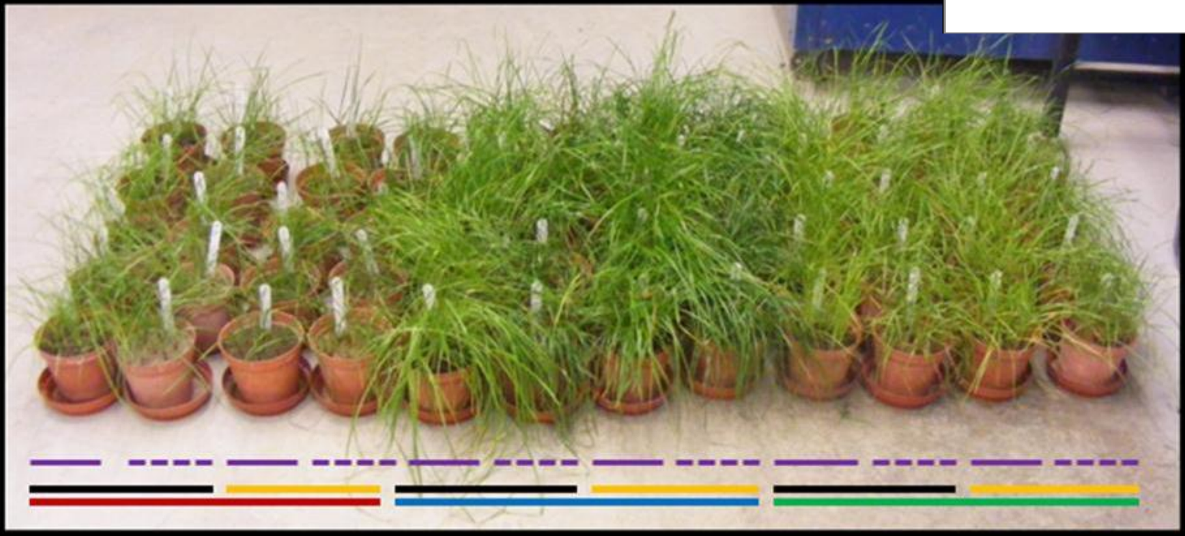
Pot trial results:

- Biochar showed no negative effect on plant growth
- In poor soil, biochar may:
  - Reduce water-deficit stress
  - Increase plant biomass
- Phytoremediation-derived biochar did not reduce germination





Soil Type

Clay

Compost

Sandy

Treatment

Biochar

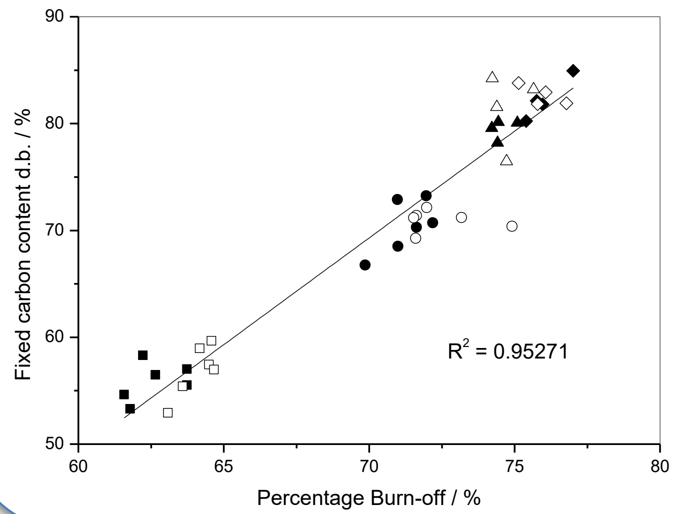
No-biochar

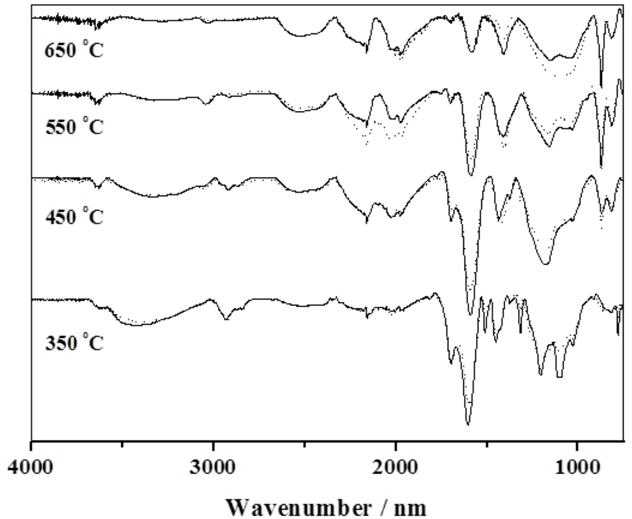
Normal watering

Drought

Phytoremediation willow biochar quality

HTT / °C	Percentage burn-off range / %	pH range	Surface area range / $m^2\ g^{-1}$	Acidic groups† / mmol g^{-1}	Basic groups† / mmol g^{-1}	Pore volume range / $10^{-3}\ cm^3\ g^{-1}$	Average pore diameter range / nm
350	61.5 – 64.6	5.58 – 7.61	0.403 – 0.808	0.106	0.296	0.309 – 0.468	30.58 – 34.62
450	69.9 – 74.9	7.73 – 9.70	0.796 – 2.594	-	0.356	0.807 – 3.746	12.22 – 19.82
550	74.2 – 75.6	9.23 – 10.47	175.4 – 213.4	-	1.059	69.5 – 87.3	3.56 – 3.94
650	75.1 – 77.0	10.89 – 11.61	176.0 – 247.4	-	3.254	81.0 – 109	4.44 – 6.12





Biochar: commercialisation in developing markets

North-East England – Tamil Nadu (NEEDIL) research network

Royal Society / India’s DST funded workshop

Biochar in Southern India:

- developing an integrated bioprocess utilising regionally significant feedstock
- improving regional soil carbon stocks and fertility
- sustainably sequestering carbon

CO_2 : you have to...

- Measure it:
  - Carbon Vectors performance indicator
- To manage it:
  - Moving towards commercial biochar systems in the UK and India

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