CARBON CAPTURE AND STORAGE: THE BIOLOGICAL POTENTIAL

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Thank you for the opportunity to contribute to the symposium on Victoria's energy future. Given that it focuses on our future, we must consider not just our energy options but their consequences. Specifically, we need to consider the consequences from their carbon emissions and related impact on the climate in the future. We must also consider our potential to biologically capture and store this carbon and how we can realise this.

If we look to nature as our mentor, this potential is of course vast, given that biology, via marine microbes, has been drawing down carbon from the atmosphere for 3.5 billion years to:

- sequester millions of billions of tonnes of carbon in the earth's chalk, limestone and coral deposits, and
- reduce original CO_2 levels from some 950,000 ppm to 7000 ppm by 500 million years ago.

These calcium carbonate deposits locked up much of the earth's calcium leading to the colonisation of life on land 420 million years ago by symbioses of fungi and algae to help them access this and other nutrients. In turn the organic detritus from these symbionts led to pedogenesis, the formation of soils and their ability to retain rainfall and nutrients enabling the evolution of plant life over the 13.9 b ha of the land surface.

This organic detritus has since then sequestered:

- up to 2000 tonnes carbon per ha
- at rates of 100 tonnes carbon /hectare/annum
- or some 9000 btC in land-based biosystems
- of which 3000 btC remain in current biosystems
- as well as 5000 btC in fossil fuels
- 1500 btC in peats
- much of the 10,000 btC in sediments and methane hydrates.

This biological draw-down of carbon reduced CO_2 levels from 7000 to 100 ppm, and stabilised them at 180–280 ppm in glacial and interglacials respectively.

WHY DOES THIS MATTER?

These biological carbon draw-down processes have governed and still govern not just terrestrial ecology but also the hydrology and thus climate of the blue planet. They are unique as the only process able to store solar energy as stable soil carbon compounds, which prevents them from being oxidised back to CO_2 and entropy. They are also now critical for our future as they are the key ecological and climate processes that humans can influence, for good or bad, via our land management. So what have we done to these processes and sinks?

For the past 10,000 years humans have:

- cleared and burnt some 75% of the earth's primary forests
- cultivated and oxidised most of these soils
- drained up to 90% of our swamps and wetlands,
- fallowed, eroded and salinised our croplands
- created 5 billion hectares of 'man made desert'.

In doing so we have reduced soil carbon levels, often from 10% to less than 1% and oxidised up to 20,000 btC. Globally we are still oxidising landscapes by 2 btC/an.

This has consequences not just to CO_2 levels. Archaeology confirms the civilisations that collapsed from Tibet, Babylon and the Mayans to Easter Island failed to apply President Roosevelt's warning that 'Nations that destroy their soils, destroy themselves'.

Humanity now faces this same existential decision. Will we continue to degrade the soils and biosystems we depend on or will we heed this warning in time?

The good news is that, if we do heed the warning, we can reverse this degradation by biosequestering up to 10 tC/ha/an back into our soils to regenerate the health, hydrology, productivity and resilience of our landscapes.

We can control the natural processes that govern this. This is because every molecule of CO_2 that has ever been fixed by photosynthesis has either:

- been oxidised back to CO2, by microbial activities or by fires, or
- been polymerised microbially into long-chain carbon compounds to form stable soil humates.

Which of these processes dominate is governed by the microbial ecology of the soils and this is influenced by our soil practices. As confirmed by CSIRO, our conventional oxidative agriculture still 'burns off' some 5–10 tC/ha/an and may at best sequester 0.3 tC/ha/an. By contrast, innovative farmers can biosequester up to 10TC/ha/an via a range of perennial grazing, pasture cropping, shelterwood and amendment strategies.

Our imperative, but also our opportunity, is to urgently extend the tailored adoption of such leading carbon biosequestration strategies by farmers Australia-wide. Australia has 770 m ha of land. Some 500 mha is under rural and 100 mha under Aboriginal use. All of it is at risk of aridification, wildfires and further degradation over the next decades as climate extremes intensify. We must urgently regenerate the resilience of these lands if we are to buffer and adapt to these extremes. To do this we have to restore the natural high carbon levels and structure of our soils and landscape. By regenerating even 20% of our rural landscape we could readily biosequester up to 1 billion tC/an or 600% of Australia's current direct carbon emissions.

It is not only doable but also essential. In fact in a recent discussion paper, Michael Jeffery, our former Governor General and now National Advocate for Soils, has called for the regeneration of 300 m ha of inland and northern Australia to limit its aridification and oxidation of up to 150 mtC/an via more wildfires.

The regeneration of these landscapes could contribute to drawing down the 20 btC/an we need globally to:

- offset current and past net emissions deficits
- restore the health of our soils and biosystems
- meet our water, food and bioservices needs.

The restoration of such landscapes and hydrological dynamics are now also our only option to cool regions. Such changes will not occur under 'business as usual'. For farmers to be able to invest in the needed changes they require policy certainty and viable opportunities. To create these we must stop protecting the status quo and provide incentives via valid prices to drive change.

We have to face the reality that CO_2 levels have increased abnormally over the past 250 years as the symptom of:

- our degradation and oxidation of our biosystems over the past 10,000 years
- our use of fossil fuel, most intensively over the past 50 years.

These changes have fundamentally impaired the hydrology of our residual biosystems, their ability to biosequester carbon and buffer the hydrological extremes that will impact Australia over the next years. These impacts cannot now be prevented by just reducing future CO_2 emissions by any level. In addition we must urgently regenerate the resilience of biosystems to help them buffer these extremes. Our only option for doing both of these simultaneously and naturally is to draw-down the carbon oxidised from these biosystems back into our soils. Fortunately we can do this practically and profitably provided we give farmers the certainty and incentive they need to enable them to invest in these changes. Our current policies will not do this. We must ensure they do for this is now critical if we are to secure our safe climate, wellbeing and future.