REGENERATE OUR SOIL CARBON SPONGE

WALTER JEHNE

Walter Jehne is an internationally known Australian soil microbiologist and climate scientist and the founder of Healthy Soils Australia.

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There are 8 billion people currently on this finite planet.

While 10 billion were projected by 2050, poorly recognized security threats challenge this.

Despite warnings these threats arise from dangerous hydrological climate extremes, including from:

- Intensified storms, hurricanes, floods, droughts, aridification and wildfires.
- Humid heat hazes whose health risks take large regions beyond human survival.
- Acute shortages of safe accessible fresh water to sustain urban and farm essentials.
- Food affordability crises given that 9 missed meals separate social stability from chaos.
- The impaired nutritional integrity of our food and its preventative health impacts.

We need solutions to avoid these threats and consequences, urgently, globally.

Fortunately nature has provided Earth and us with its solution: Water, which already:

- Covers 71% of Earth as oceans plus much of the land as snow, ice, lakes and rivers.
- Governs some 95% of the heat dynamics and thus climate of this blue planet.
- Governs some 80% of the natural and human enhanced greenhouse gas effect.
- Absorbs and for now retains 93% of the extra heat we trapped via this effect.
- Is fundamental to the creation and survival of all life and bio-systems on this planet.

Given that water already governs much of the Earth's climate, ecology and balance, we need to understand the processes through which it does this, how we may have unbalanced them, and what we can and must do to restore these balances and address these threats.

To understand the why, what and how of each of these threats to our security, and what agency we may have through this understanding, to restore or rebalance these processes and thereby minimize their hydrological consequences both locally and globally and in time.

To do this we need to understand how nature created and regulates these hydrological processes, and thereby much of the Earth's bio-geochemical cycles, soils, hydrology, life, bio-systems and the largely stable former climate we evolved in and depend on fundamentally.

How nature, via paedogenesis, formed soil sponges, by microbes solubilising rock and leaving behind organic detritus which enabled more water to be retained in the soil to accelerate their evolution and extension of their hydrology, plant and animal successions to help create the Earth's hydrologically cooled and buffered climate.

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The regeneration of the Earth's soil carbon sponge

Despite 50 years of discussion, denial and delay focused on the abnormal rise in CO2 levels few recognize it as largely a symptom of our oxidation of our current and fossil soil sponges. Even fewer have considered how this oxidation affected key climate drivers such as water.

This lack of attention was based largely on the assumption that because water was such a dominant driver of the Earth's climate, we could not possibly have changed it. Also as CO2 is a minor greenhouse gas, its abnormal rise was the prime threat, not a symptom of a potentially much larger one.

This meant that we failed to recognize how the oxidation of these sponges and their hydrological consequences may be altering the Earth's heat dynamics, warming, and climate. Similarly how regeneration of these sponges may be able to re-balance this hydrology and climate.

Recognising this is critical – as slowing down the rise in the CO2 symptom or reducing it can't now prevent the hydrological climate extreme that threatens our bio-systems and survival. That instead we need urgently to use this extra CO2 as a resource to regenerate the sponge and the hydrological and climate processes we have unbalanced, in order to restore our safe climate.

So how can we bypass these assumptions and the inertia of business-as-usual to regenerate the Earth's soil carbon sponge, hydrology and safe climate, at scale, and in time?

Nature sustainably bio-sequesters from 0-300 tonnes of Carbon per hectare per annum via its various bio-systems. Leading farmers globally can sequester up to 10tC/ha/an. Extended over 1 billion hectares, or 20% of farmed lands, this could take us a long way to achieving a zero net emissions target globally and to help regenerate and rehydrate those landscapes.

Industrial agriculture by contrast often loses 5-10tC/ha/an from its soil via its expensive oxidative practices and inputs while also degrading its long term draw down capacity.

Proposals by Regenerate Earth show that we can practically reduce Earth's current emissions of some 130 billion tC/an, and enhance the drawdown of 120btC/an, by the use of green bio-systems. Doing this could sustainably and profitably retain and return up to 20btC/an back into our soils, to achieve negative net Carbon emissions of up to 10btC/an by 2030, and rapidly rehydrate, buffer and cool the climate.

However rather than carbon accounting, the critical do or die issue if we are to avoid these dangerous hydrological climate threats, is that every gram of this retained or returned carbon is used to regenerate the Earth's soil carbon sponge, hydrology and cooling.

Similarly, that every gram helps to regenerate the bio-fertility, productivity, resilience, food output and the nutritional integrity of that food and the health of the resultant bio-systems.

As in nature, powerful positive feedback effects can help such regeneration:

- Each gram of carbon sequestered in the soil sponge can increase the water retention in the sponge by some 8 grams and up to 20 grams via improving soil structures.
- Each gram of carbon sequestered, by increasing the structure and exposure of mineral surfaces in that soil, can increase the availability of essential plant nutrients and thus the bio-fertility of that soil without the need for nutrient additions.
- This increase in soil structure will also aid the proliferation of roots and microbial symbionts in that soil to depth, thereby increasing the

plant's access to further soil volumes and nutrient resources while also increasing the resilience of the plants.

- This increase in root substrates and exudates will also aid the activity of beneficial microbes in these soils and their fixation, solubilisation, access, uptake and cycling of essential nutrients to aid growth and help control stress and disease agents.
- This regeneration of soil health can greatly enhance plant productivity and resilience even in degraded soils with minimal inputs by enhancing the longevity of green plant growth and thereby its protective hydrological buffering and cooling processes.

Extended globally, these soil health innovations can more than secure the essential food needs of the 10 billion via more autonomous, efficient, sustainable and equitable rural and urban farming systems that require lower external inputs. The food produced should have far higher nutritional integrity and preventative health values and benefits socially.

These soil health and hydrological innovations will enable large areas of former productive but now degraded wasteland to be regenerated back into productive rangeland, grain cropping and agro-forestry systems and address the identified food-related security threats.

Addressing the identified climate threats

In addition to addressing the security threats to global food and health values, regeneration of the Earth's soil carbon sponge, and its resultant soil health and hydrological outcomes, are now our only means and last chance to also address our existential climate threats.

As in nature this stems from the exceptional capacity of the Earth's regenerated soil carbon sponge to; infiltrate, retain and make available water to extend the longevity of green plant growth, its transpiration and its natural physical cooling or 'air conditioning' of the climate.

For water to transpire it must be converted from liquid into a gas, water vapour. This phase change requires some 590 calories of heat energy per gram of water transpired. As this heat comes from and leaves that surface it cools it. When the water vapour condenses this heat is released, with much of it radiating out to space thereby further cooling the planet.

On average 24% of the heat received by the Earth's surface, as incident solar radiation, is transferred from its surface into the air and back out to space via these processes. Locally this transfer of heat can cool transpiring areas significantly on hot summer days.

Theoretically we could offset the Earth's abnormal warming of 1.2C to date by increasing such heat fluxes by some 4-5% globally. This cooling could be induced safely within weeks, not the centuries estimated for reductions in CO_2 emissions to have any meaningful effect.

Regeneration of the Earth's soil carbon sponge and hydrology can also increase the soil area able to be protected by perennial plants as well as their longevity of cooling plant growth. These shaded moist soils with transpiring plants mostly absorb far less incident solar radiation compared to bare exposed dry soils and may stay far cooler; mostly at below 20C, compared with the 60C that the surface of exposed bare soils may reach nearby.

Consistent with the physics of 'black body radiators', this difference in the temperature of the surface vastly alters the amount of heat that is re-radiated from these soils, with the hotter bare exposed soil re-radiating vastly more heat than the shaded moist cooler soil.

As the greenhouse effect is driven largely by how much heat is being re-radiated from an area, and less so by the concentration of greenhouse gases in the air able to absorb that re-radiated heat, this directly and profoundly influences that local climate.

It means that we can turn down the local greenhouse warming effects from very high to low

simply by reducing the absorption and re-radiation of heat from our soils by keeping them protected and cool. We can do this rapidly within days, largely independent of the level of greenhouse gases in the air; as such gases can't absorb heat that has not been emitted.

As in nature, we can practically use either or both of these processes to safely and rapidly cool regions. However both need water. That is why regeneration of the Earth's soil carbon sponge and its capacity to infiltrate, retain and make available rainfalls is so critical.

Addressing water security threats

The quantity of heat being re-radiated from land surfaces not only influences the relative local strength of the greenhouse effect but it can also govern whether either high pressure heat domes or lower pressure zones form over landscapes. Whereas bare hot dry land with high re-radiation levels normally form high pressure heat domes, protected cool moist areas with far lower re-radiation generally form cooler low pressure zones.

These pressure differences greatly influence local air flows with air flowing from high to low pressure areas. They also influence where cool moist low pressure air can flow; given that such low pressure air cannot flow into or displace the hot air in high pressure regions.

As a consequence, hot dry areas with high pressure heat domes over them often block the inflow of cool low pressure air with high moisture levels. This can prevent rain reaching such high pressure regions intensifying their aridification. Conversely, protected green moist cooler regions with low pressure zones above them, often funnel in moist low pressure air flows to enhance local rainfalls.

It is also consistent with observations that rain often follows rain and that once dry, areas often miss out on intermittent regional rainfalls and further aridify.

These landscape-induced differences in pressure zones can also influence the reliability and spatial movement of monsoonal air flows and rainfalls. Former moist rangelands, if aridified due to overgrazing, soil degradation or wildfires, often have less reliable monsoonal rain and further aridify. Conversely nearby regenerated or reforested areas often receive more rain. This raises the question, can we restore the Australian and other former monsoons?

Catalysing action to address these security threats

Just as our degradation of our soils and their hydrology has contributed to these security threats; is our regeneration of the Earth's soil carbon sponge now our only option to avoid these threats in the limited time available?

As demonstrated in nature and by leading innovators, we have adequate knowledge of the ecological processes and balances that govern these threats and their avoidance, as well as the practical capability and imperative to address them urgently at scale and in time. While there will always be more to learn to tailor optimum solutions to specific needs, we will only learn this by doing it. Delaying further to learn more will often make us too late.

Given that nature and innovative leaders confirm there are safe solutions to address these imperatives we need to face our reality and just do it by:

- Empowering grass roots agency and action by farmers and youth everywhere to;
- Regenerate the Earth's soil carbon sponge, soil health and thus its hydrology to;
- Naturally rehydrate, reforest and cool and buffer the bio-systems they depend on.

However to effect these changes in time and at scale we must stop humanity deluding itself that business-as-usual can address these crises. We must demonstrate viable alternatives.

To do this we must demonstrate that business-as-usual, and its protection via many policies, subsidies and externalised consequences, are impediments that must be removed via the evidence of alternatives based on new metrics and values to catalyse the needed changes.

We must demonstrate that the wise ecological re-balancing of the Earth's fundamental soil and hydrological processes that govern our wellbeing and that we have impaired need to and can be restored. That we have and are standing on that solution: regenerating healthy soil.

Whether we can catalyse the needed changes in time or not, we can be confident that nature will again use these same soil, hydrological and plant processes to regenerate Earth.

Our only issue is will we help her in this and thus avoid our collapse within decades or let her do it without and after we have joined the many other 'civilizations' that also failed to respect the health of their soils, and are found in the dust of archaeology.