Regenerate Earth

The practical drawdown of 20 billion tonnes of carbon back into soils annually, to rehydrate bio-systems and safely cool climates

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Introduction

There are now 7.4 billion of us on this finite planet. There may be 10 billion by mid-century. The size and well-being of our future world population will be governed by their access to adequate water and food, which can only be provided by healthy bio-systems—the same bio-systems that provide the stable hydrology, weather, economies and societies we depend on.

How the future plays out will depend on how well we understand, respect and regenerate the natural processes governing these bio-systems, which also govern our climate, health, social equity and stability.

Pedogenesis: its underpinning of terrestrial life and our future—and now our only means to regenerate bio-systems and safely cool the planet.

420 million years ago there were no terrestrial bio-systems or life on land: there were only inert rocks from which nutrients leached into the oceans, where aquatic life-forms competed for them.

Pioneer organisms (particularly fungi) that were able to colonize and solubilise nutrients from these rocks had major competitive advantages. More so where they formed symbioses with algae that could fix solar energy via photosynthesis to enable the resultant lichens to autonomously colonize rocks and survive as the first life-forms on land.

In doing so, these lichens left behind dead organic detritus and initiated **pedogenesis:** the formation of soils, loose mixtures of mineral and organic detritus with bulk densities as low as one gram per cubic centimetre (g/cc) instead of the 2.6-3.5 g/cc of their parent rocks.

This mixture of mineral and organic detritus and air (with vast exposed surface areas) formed the Earth's **soil carbon sponge** with its greatly enhanced capacity to infiltrate and retain rain, enhance access to essential nutrients, and support a diverse range of microbial processes.

The growth of the soil carbon sponge enabled the rapid evolution and extension of microbial and plant life and thus ever more organic detritus and soil sponges across the land, allowing the Earth's productive and resilient terrestrial bio-systems and diverse microbial, plant and animal life to form.

These bio-systems drew down vast quantities of carbon from the air through photosynthesis, and much of that carbon was then bio-sequestered by fungi into stable soil carbon and eventually fossil fuels. As a result CO_2 levels in the air declined, limiting plant growth, while oxygen levels increased, triggering massive fires that oxidized much of the carbon fixed by plants and bio-systems back to CO_2.

The surviving bio-systems evolved balances of their carbon drawdown and oxidation rates. This often involved microbial ecologies in the soil or guts of herbivores that bio-converted fire fuels and risks into bio-fertilizers and soil organic matter. These aided the productivity, resilience, hydrology, and further carbon drawdown capacity of these soils and bio-systems.

As the Earth's soil carbon sponge and vegetation extended over 29% of the Earth's surface it could retain more rainwater. This further extended the longevity and area of green growth and its transpiration as water vapour, creating massive latent heat fluxes that cooled the climate.

The formation of this extensive soil carbon sponge fundamentally altered the Earth's hydrology, which still governs 95% of the heat dynamics and hydrological cooling of the blue planet and thus its climate. Hence what we do to this soil carbon sponge has consequences.

How we manage the carbon oxidation versus drawdown rates in our soil also has consequences.

Nature created our soils, bio-systems, their hydrology and climate via carbon drawdown rates that exceeded oxidation rates, yet for 10,000 years we have reversed this, greatly increasing carbon oxidation relative to draw down rates via our clearing and burning of forests and soils for agriculture.

Our industrial forms of agriculture have accelerated this greatly over the past 70 years via our excessive use of fire, cultivation, fertilizers, bio-cides, irrigation and fallowing all of which oxidize soil carbon. In fact, if we include fires, we now oxidize far more carbon from global bio-systems than what is accounted for in our 'acknowledged' emissions. Indeed our high input agriculture often loses 5-10 tonnes of carbon per hectare per year (tC/ha/an) from soils, as well as the embodied emissions from inputs.

Carbon levels in most agricultural soils have declined over the past 100 years, from some 5 percent to less than 1 percent in many places. These oxidative losses have degraded the structure, productivity and resilience of these soils and their capacity to infiltrate, retain and sustain water to cool climates.

As nature demonstrated via pedogenesis 420 million years ago, we only have one process by which we can restore these soils and bio-systems and thus their hydrology and ability to safely cool the climate the 3 watts/m2 needed to offset dangerous hydrological extremes. The process is to reverse the ratio of carbon oxidation to bio-sequestration, in order to regenerate the resilience and hydrology of the soil carbon sponge. We can do this via our management of our soils and landscapes

The following outlines a practical blueprint for how we can do this globally, using photosynthesis to draw down 20 billion tC/an (twice our current net 'acknowledged' annual deficit) back into our soils via profitable grassroots actions. Not only will this restore former CO_2 levels, but it will also regenerate the hydrology of the Earth's soil carbon sponge, and its capacity to safely, naturally cool our climate.

We have perhaps a decade within which to do this. We *can* do it but only through urgent grassroots efforts to draw down carbon and regenerate the Earth's soil carbon sponge.

Our inescapable global reality and imperative, 2020-2030

Why does this matter? As outlined above (whether we wish to recognize it or not) we will all be impacted by new global realities over the next decades as the following scenarios continue to unfold:

1. **Climate extremes intensify unpredictably** with the aridification of many formerly productive regions as well as extreme storms and their dangerous impacts.

2. **Water insecurities** challenge the wellbeing, food security and health of four billion people as streams, snowpack, and groundwater resources decline and become less reliable.

3. **Intensification of wildfires and diseases due to climate extremes** impact residual bio-systems, their habitats, bio-resources, and ability to draw down carbon via photosynthesis.

4. **The degradation of soils** due to oxidation, erosion, and acidification accelerates under industrial practices—further threatening water, food, and bio-system essentials.

5. **Social and strategic instability increases** as communities and nations are impacted by the above ecological and thus economic, health, and existential extremes.

Our capacity to address these realities, and buffer and adapt to their extremes, over the next decades will largely govern our ability to secure our existential needs in the future.

After over 50 years of warnings and 30 years of global policy denial and delay, it is now too late for reductions in future CO_2 emissions to adequately slow down its rise or its greenhouse effects. It is now too late even for the drawdown of carbon to zero or negative net emissions, by itself, to prevent accelerating the dangerous hydrological feedbacks and climate extremes.

Instead, we must face the reality that we have seriously disturbed the Earth's climatic balances which will continue to accelerate dangerous climate extremes and impacts unless we immediately take the following steps:

1. **Safely and naturally cool regional and the global climate** by three watts per square meter to offset and buffer the greenhouse warming we have induced to date.

2. **Secure the essential water (and thus food) needs** of the more than 5 billion people (over half the projected population) expected live in urban concentrations by mid century, so as to sustain their stability.

3. **Regenerate and extend the resilience of the Earth's residual bio-systems** so they can buffer these climate extremes and secure our water, food, and life essentials.

We must deliver these outcomes equitably, via practical global action, within this decade.

While there will always be more to know, after 60 years and US $60 billion already spent on IPCC research, we know enough of what we need to do. What we need to know now, may be learnt best by doing it.

Even so, all elements in the following blueprint are fully substantiated by verified scientific and practical evidence. Leading innovators have confirmed the practical veracity of each of the response strategies proposed. Further detail can be provided.

We have the science and means to make the changes. What we need urgently is the commitment to use them.

Our hopeful, yet last chance, global solution

Although the situation is urgent, we *can* still safely and naturally cool climates and secure our essential needs. To do this we must restore the natural processes that created the bio-systems we depend on fundamentally for our essential needs, hydrology, safe climate and future. Clearly we can, and must, also reduce our fossil fuel use and emissions. However we can't secure these outcomes solely via more policy talks or dangerous geo-engineering delusions.

Just as nature did via pedogenesis 420 million years ago, we must use our understanding of the microbial and plant processes that created our terrestrial bio-sphere to regenerate them, quickly. We must rely on photosynthesis to draw down carbon from the air back into soils to:

- Regenerate the Earth's soil carbon sponge and its ability to retain and make available water and nutrients.
- Regenerate and extend the former bio-diverse productive plant bio-systems so that plants can fix and bio-sequester ever more carbon in those 'sponges'.

We can use these processes to rapidly regenerate the more than eight billion hectares of degraded soils and bio-systems to restore the Earth's key bio-hydrological cycles that still govern 95% of the heating and cooling dynamics of the blue planet.

This is only possible if we empower urgent grassroots community action globally to draw down the massive quantities of carbon we have oxidized from the air back into our soils to regenerate them, their hydrology and the Earth's natural cooling processes.

Instead of 420 million years, we can and must do this over the next decades if we:

1. **Draw down up to 20 billion tonnes of carbon annually** back into our soils to offset the 10 btC/an in our current net emissions plus some 10 btC/an of legacy emissions.
2. **Regenerate and rehydrate the Earth's soil carbon sponge** and in-soil reservoirs that we degraded over the past 8,000—but especially the past 60—years of oxidative agriculture.
3. **Regenerate the capacity of the Earth's rehydrated residual bio-systems** to extend and fix and draw down 30% additional carbon to achieve our 20 btC/an target.
4. Enable these regenerated bio-systems to **secure the essential water and food needs** of the projected 10 billion people by mid-century so as to sustain social stabilities.
5. **Restore natural hydrological processes to cool climates by** the 3 watts/m2 needed to offset the abnormal greenhouse warming we have induced by degrading those natural processes.

As nature did, we only have one means to do this. That is to maximize plant growth so as to:

A. Draw down carbon from the air to fix it via plant photosynthesis

and then…

B. Minimize how much of that fixed carbon is oxidized back to CO_2

and instead allow it to be…

C. Converted via soil fungi into stable soil carbon to restore the Earth's carbon 'sponge'.

This A, B and C process is simple and natural, but what matters is that we *do* it, now.

Implementing these carbon draw down and regeneration outcomes

Every year the Earth's residual bio-systems draw down some 120 billion tonnes of carbon from the air via photosynthesis. Half is fixed by phytoplankton in the oceans and half by plants on land.

We have degraded half of the Earth's soil and plant productivity and turned 5 billion hectares (40% of the land surface) into desert and wasteland. Therefore (and because we live mostly on land), in order to practically draw down the 20 btC/an we may need to give priority to maximizing:

- The *area* of land under perennial or even opportunistic green plant growth.
- The *time or longevity* of that green plant growth and its draw down of carbon.
- The *degree* to which the carbon fixed is bio-converted into stable soil carbon rather than oxidized back into CO_2 by burning or oxidative soil management.

As nature does with pedogenesis, we can maximize the bio-conversion of biomass into stable soil carbon by limiting its oxidation; enhancing the rehydration, productivity, and longevity of green growth; and allowing the formation of soils and the re-vegetation of current wastelands.

Table 1 outlines a range of practical soil and bio-system regeneration actions that can readily draw down the target 20 btC/an. In so doing, we can readily regenerate and extend the productivity, resilience, and health of the Earth's residual soils and bio-systems and their capacity to sustain our essential water, food, habitat, economic and social needs.

While some natural bio-systems and leading regenerative farming systems can fix well over 200 tC/ha/an through photosynthesis, and bio-sequester over half of this as stable soil carbon, not all systems will fix or draw down carbon at these rates. However, innovative regenerative farmers using these processes may fix up to 40 tC/ha/an and turn up to 10 tC/ha/an into stable soil carbon.

By contrast while some soils under high input industrial practices may fix similar levels of plant biomass above ground, most of this may rapidly oxidize to CO_2, due to the excessive clearing, burning, cultivation, over fertilization, use of bio-cides, irrigation and fallowing of such soils. Such soils may often *lose* 5-10 tC/ha/an as CO_2 emissions, accelerating their structural degradation, loss of productivity, and the farmer's financial dependence on ever more inputs.

These high input industrial agricultural practices have seriously degraded soils in over half of the Earth's 1.5 billion hectares of crop lands and many grazing systems. Each year up to 16 million hectares are added to 'civilizations" legacy of 5 billion hectares of man-made desert and wasteland.

Archaeology is littered with the ruins of failed civilizations that collapsed as they degraded their soils, and with them the water, food and bio-systems those civilizations relied on for their survival. President Franklin D. Roosevelt made it very clear when he said "The nation that destroys its soils, destroys itself."

Conversely, as nature and regenerative agriculture demonstrate, pedogenesis and the drawdown of carbon back into the Earth's soil carbon sponge can uniquely regenerate soils, and restore the vitality of the human and natural communities that rely on them.

Our action imperative and blueprint to draw down the 20 btC/an globally

While this may seem audacious, our current reality gives us no option but to act audaciously. Further denial of our ecological mismanagement, or intensifying dangerous consequences, is no longer tenable. Instead we need urgent global action to rectify this situation.

To do this we need a blueprint for practical action: a plan to quickly and efficiently draw down 20 btC/an globally. The following is an outline for such an action blueprint:

The 10 key regeneration actions that could readily draw down the 20 btC/an include:

1. Reduction of emissions by reducing the 350 million hectares of forests burnt annually.
2. Reduction of emissions by reducing the over 2 billion hectares of rangelands burnt annually.
3. Increased carbon drawdown by our forests via enhanced management.
4. Increased carbon drawdown by rangelands via ecological grazing strategies.
5. The carbon drawdown potential from the natural regeneration of shelterwoods.
6. The carbon drawdown potential from regenerating degraded wetland areas.
7. The regeneration of the carbon levels and drawdown capacity of cropping soils.
8. The partial regeneration of the soils of our man-made deserts and wastelands.
9. Reduced use of, and emissions from, fossil fuels through efficiency measures.
10. Reduced emissions from the reuse of wastes and lower embodied energies.

Table 1, below, details the global effect and potential of these management actions in regard to:

a. The global area of each major land management type (UNEP billion ha)
b. The area and % that is impacted by our degradation each year (billion ha)
c. The carbon drawdown potential per hectare via each management action

d. The total global carbon emissions that could potentially be saved by this action

e. A realistic practical estimate of our capacity to prevent these carbon emissions

f. The realistic potential savings and drawdown of carbon due to these actions.

g. Notes and references to further detail these land management options.

Full details on the science and potential of these actions to draw down carbon are available.

Table 1:

Action	**Global area in hectares**	**Area of impact in hectares, %/year**	**Draw-down rate in tC/ha/ an**	**Draw-down totals in billions of tC/ an**	**Realistic savings %**	**Potential saved emissions**	**Ref**
1. Reduce forest wildfires	3.5 b	0.35 b 10%/an	10-40 Mean 20	7 btC/ an	50%	3.5 btC/ an	UNEP
2. Reduce rangeland wildfires	6 b	2 b 33%	2-6 Mean 4	8	50%	4.0 btC/ an	UNEP
3. Enhance forest management.	3.5 b	2 b 60%	+5	10	33%	3.3 btC/ an	IUFRO
4.Enhance grazing management	6 b	3b 50%	+3	9	50%	4.5 btC/ an	HM RCS
5.Restore shelterwoods in rangelands	6 b	2 b 33%	+5	10	50%	5.0 btC/ an	IUFRO
6.Restore wetlands	0.1 b	+0.4 b 400%	+8	3.2	50%	1.8 btC/an	HSA
7.Regenerate cropping soils	1.5 b	1 b 66%	+6	6	66%	4.0 btC/an	FAO HSA
8. Regenerate wasteland & desert soils	5.0 b	1.0 b 20%	+2	2	75%	1.5 btC/an	UNCC D
9. Reduce fossil fuel emissions				8.0	25%	2.0 btC/an	IPCC

10. Reduce waste and embodied emmissions				1.0	50%	0.5 btC/an	
Totals				64.2 btC/an		30.1 btC/ an	

Based on this confirmed data and conservative estimates in the table, it is clear that we could readily and practically realize our 20 btC/an drawdown target and imperative.

Further major drawdown potentials exist from regenerating marine bio-systems such as sea-grass beds and our marine mammal populations whose excrements were key to fertilizing massive phytoplankton blooms that fixed much carbon. However, given the current degradation of our soils it would be far more practical, and will have far more co-benefits, if we can realize our 20 btC/an target by regenerating our soil.

While past climate analyses have disregarded the first six of these actions by assuming that they are natural processes beyond our responsibility, our potential to manage these processes, and reduce their emissions risks and climate impacts is very real, highly beneficial, and should not be ignored.

While policies recognize our responsibility for actions seven and eight, we have not addressed them. Policies over the past 30 years have largely focused on action number nine—yet talk to marginally reduce future fossil fuel emissions (if and when economic conditions allow and if global agreements can be confirmed) has clearly failed and is now grossly inadequate to address our current crisis.

Our imperative, responsibility and "response-ability" is clear: We know what we must and can do and we know how to do it, practically and beneficially. The only issue left is to *do it*, now, before climate extremes limit our last chance to do so.

Practical actions and synergies to aid in our drawdown of the 20 btC/an

A wide range of innovative farmers and grassroots communities globally are already driving local action that is moving towards the realization of our 20 btC/an drawdown target. These practical actions and outcomes are fully consistent with the confirmed science of the ecological processes outlined in A, B and C above to draw down carbon to regenerate bio-systems.

These natural ecological processes include accelerating the in-situ microbial bio-degradation of forest and rangeland litter so as to reduce fuel loads and the risk and impact of dangerous wildfires that are intensifying as many climates aridify and become more extreme.

This reduction in fire impacts and risks can deliver dual climate benefits, by greatly reducing CO_2 emissions from the fires themselves, as well as allowing the survival of bio-systems that can then continue to draw down carbon from the air. While many landscapes regenerate after fire, the emissions, soil oxidation, and long lag effects after intense wildfires are far from carbon neutral as currently assumed.

The accelerated microbial recycling of litter will also greatly aid nutrient cycling and thus the productivity, resilience, health and capacity of bio-systems to draw down more carbon. The bio-conversion of plant litter into stable soil carbon should also aid the structure and function of soils, increasing their capacity for infiltration and retention of rain to extend the longevity of growth and carbon fixation through photosynthesis.

As in nature such ecological regeneration processes can deliver many synergistic multiplier benefits that reduce emissions, aid bio-productivity and draw down even more carbon. This can aid the hydrology of bio-systems to help meet our needs and naturally cool climates.

Ecological grazing strategies can similarly bio-convert dry grass fuels into protein, bio-fertilizers and soil carbon and reduce wildfire risks in our 6 billion hectares of seasonally dry rangelands. This grazing can aid the nutritional and hydrological dynamics—and thus the productivity, longevity of green growth and carbon drawdown capacity and hydrology—of such rangelands

Short, high-impact grazing with long rest periods can also aid the natural regeneration of shelterwoods in these rangelands. These can enhance nutrient cycling and rain retention, and thus the productivity, resilience and carbon drawdown of these grass-and-tree bio-systems. This may be critical in our regeneration of deserts and wastelands, as aridities intensify.

Multiple synergistic benefits can also be realized from regenerating our cropping soils and wetlands, and in better recycling of nutrients from urban wastes safely back into our soil.

While these strategies need to be tailored for different sites, collectively they can realize our 20 btC/an drawdown target. In so doing they will help restore the Earth's soil carbon sponge and its hydrology on which our water, food, bio-systems and social stability depends.

Most importantly this regeneration of the Earth's soil carbon sponge is now our only means to safely and naturally cool the climate so as to offset the 3 watts/m2 global warming induced to date and help buffer the intensifying dangerous climate extremes, (as outlined in the paper "Restoring Water Cycles to Naturally Cool Climates and Reverse Global Warming.")

Policy incentives to catalyse these regeneration outcomes in time

This blueprint and action agenda make it clear that we have all the resources we need to practically and safely regenerate our soils, their hydrology, our bio-systems and thus our safe climate; provided we implement these essential regenerative actions in time.

Despite the evidence from leading grassroots innovators, the urgent mass action needed to do this has been, and is still being, impeded by policies that subsidize and protect the status quo and externalize their costs and consequences to the public, the environment and future generations.

After 60 years of scientific warnings and 30 years of deny and delay tactics, nations now recognize these realities and their need to expedite zero net carbon emission targets, followed by negative net carbon emission targets, as agreed at COP 21 in Paris in 2015.

As outlined at global soils week in Berlin in 2015, highly effective practical options exist for nations to use the strategies in Table 1 to draw down carbon and regenerate their soils, hydrology and landscapes.

For example, strategies such as Regenerate Australia have outlined how such ecological practices could profitably regenerate and rehydrate 300 million hectares of inland and northern Australia by drawing down over 2 btC/an back into the soil carbon sponge. Such strategies and outcomes could be readily tailored and extended globally to profitably realize a 20 btC/an drawdown target to help secure our safe climate and future. However, to help catalyse these changes we need not just demonstrations but also clear commercial incentives via price signals and costs to drive national and vested self-interests.

Firms and nations must fully account for all their carbon dynamics. This must and can be readily verified globally via satellites. We must value such carbon accounting so that verified negative emissions have a value as drawdown credits that can be traded as offsets against positive net emissions obligations in a global carbon trading system. This system could readily set a commercial price on verified carbon emissions and offsets.

Only when verified carbon credits have a value in such a global carbon market will farmers, industry, and nations have the commercial incentive and policy certainty they currently lack to invest in the urgent drawdown of carbon to achieve the 20 btC/an drawdown target. Only by putting a valid cost on carbon externalities will they be internalized responsibly. By putting a valid price on verified carbon credits, carbon will be recognized not as a pollutant but as a valuable resource when sequestered in soils rather than a costly liability when emitted.

These policies will help carbon finally be recognized, as in nature, as the only basis and building block for all life and all bio-systems, their hydrology, and our safe climate and future.

Summary

There is only one process via which we can secure our safe climate and future. This is pedogenesis: the microbial bio-conversion of plant exudates and detritus into stable soil carbon.

Our future is governed by how well we manage to regenerate the Earth's soil carbon sponge.

While plant photosynthesis is critical to fix solar energy into plant bio-mass, it is what happens next to that biomass that matters. Does it rapidly oxidize back to CO_2 by burning or does it get partly bio-converted by fungi into stable soil carbon? There are no other options.

Pedogenesis, the evolution of soils and bio-systems, their hydrology, our stable climate, resiliency in the face of flooding and drought, and regional and global cooling all depend on this simple balance between how much of the carbon that is fixed by plants is burnt or bio-sequestered. We live in the balance between fire and fungi.

As humans we can, and have, only influenced the Earth's geo-chemical processes and climate via our capacity to alter the balance between these two processes that govern the carbon dynamics of the planet. Are we oxidizing or bio-sequestering its carbon, are we managing our food production, environment, and climate via fire or fungi?

While human civilizations can prosper, briefly, by oxidizing the carbon and natural capital of their bio-systems via the clearing and burning of vegetation, the cultivation and degradation of soils, and excessive use of synthetic fertilizers, biocides, irrigation and bare fallowing to meet their food and bio-resource needs, such civilizations are deigned to—and will—collapse.

Alternatively, if we respect pedogenesis and how natural bio-systems regenerate, we can turn the dead mineral detritus and deserts from such collapses back into productive soils and bio-systems on every continent, as nature did 420 million years ago and repeatedly still does. In doing so we can enhance the hydrological and nutrient cycles so they can sustain the water, food and ecological services we all depend on for life..

Our management of these processes of 'fire or fungi' now largely governs to what extent land management practices oxidize the carbon and thus destroy the living structure and productivity of our soils or alternatively restores them by allowing plants to draw down carbon from the air and bio-sequester it back into soils via fungi. We can choose to what extent our land is turned into either desert or healthy productive bio-systems, by fire or fungi.

The abnormal rise in atmospheric CO_2 levels over the past 250 years should be seen as a clear symptom that we have grossly impaired the Earth's natural carbon dynamics via its excessive oxidation by our extended land clearing, burning, and tillage over millennia. The accelerated rise in CO_2 levels over the past 60 years is linked to our recent accelerated emissions from the burning of fossil fuels and our industrial agriculture.

Slowing down or even reversing these symptoms will not rectify their underlying cause: our gross impairment of the Earth's natural carbon oxidation-to-drawdown balance. We can only rectify this by regenerating the carbon drawdown capacity of the Earth's residual bio-systems as outlined in this proposal.

However, after 50 years of denial and delay, our task may not be that easy or simple. The evidence is that our degradation of our bio-systems and their hydrological dynamics has already dangerously exceeded planetary climate buffers and thresholds. This is accelerating a range of positive climatic feedback processes, resulting in intensifying dangerous hydrological extremes not able to be moderated by the oceans' former vast natural buffering and lag effects. These hydrological extremes now pose major risks to most of the Earth's natural bio-systems, stable climate and our future. All the evidence points to the fact they are intensifying, and will continue to do so.

As such we now have left ourselves no option but to use nature's own strategies to safely and naturally cool climates to try to buffer and limit these dangerous hydrological extremes.

Fortunately, we should be able to still do this but only a nature does: by drawing down carbon from the air back into our soils, not just to reduce the CO_2 symptoms, but to regenerate the Earth's soil carbon sponge, its in-soil water reservoirs and synergistic processes to restore its former bio-systems, natural former drawdown capacity and thus the natural hydrological cooling processes.These hydrological processes still govern 95% of the heat dynamics of the blue planet. Restoring the processes we have impaired is now our only means to safely cool the climate.

This outcome can now only be achieved via global grassroots community action to draw down carbon to regenerate the Earth's soil carbon sponge, its hydrology and bio-systems. Global and national policies must provide these grassroots communities with the certainty and incentives they need to be able to invest in such mass regenerative action.

The COP21 zero-net emission and then negative net emission targets, the introduction of a commercial globally verified carbon accounting and trading system, and a valid carbon price are all important positive components and steps in this critical global last chance response.

While we can and must regenerate Earth via these processes, we are running out of time.

By embracing and empowering practical grassroots action to implement blueprints such as this to draw down the 20 btC/an we can now secure our safe climate and future.

More than ever our wellbeing, climate, and future lies in our soils, and in your hands.

Thank you.