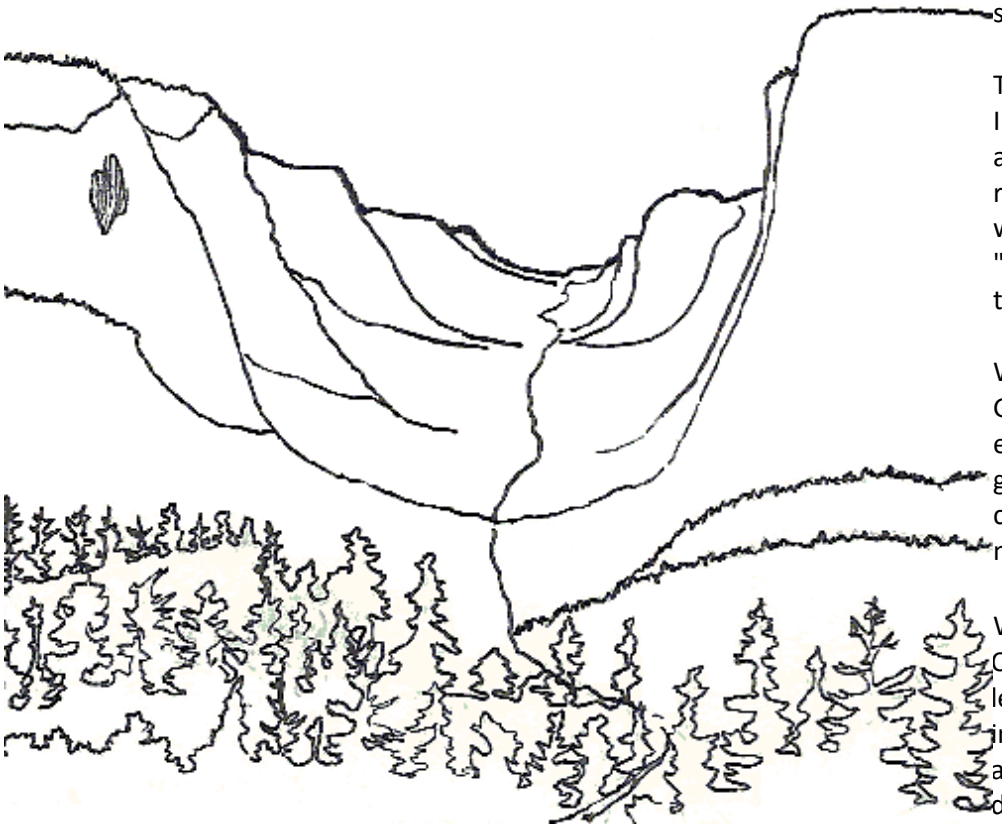
Climate Toolkit

I Climate Tipping points in the earth-system
II Carbon Farming



The Empty Glacial Valley, by the Author

Adding carbon dioxide to the atmosphere in large quantities is a stupid experiment that I do not think we should be doing -Elon Musk

I Tipping Points
What they don't tell you about Climate change

In most places we hear about the effects of climate change every day, but talk of solutions centers around sea level rise, more extreme storms or at worst desertification. But are these the only potential scenarios?
What happens in a large scale extinction event? What has happened in previous global warming events? Why don't we talk about these things, and what are some answers within the reach of the average person? Left to it's own devices, what will the earth do to reach climate equilibrium in the absence of humanity? I hope to summarize some answers here.

Tipping points
In addition to the effects on the climate of adding more greenhouse gasses to the atmosphere, the world is full of feedback loops, like time bombs, exponentially releasing more greenhouse gasses in response to small raises in temperature, which raises the temperature, which releases more gas, and so on. The term "runaway climate change" refers to these unstoppable cycles which feed into themselves. This booklet shows some of the main ones.

What is the greenhouse effect
Greenhouse gasses are necessary to keep our planet livable, but we learn more every day how fragile and chaotic our planet's climate is. Human-made greenhouse gasses are changing the climate: trapping more heat from the sun, creating extreme weather events, melting polar ice caps. Melted ice water can make winters more severe in some places for the time being.

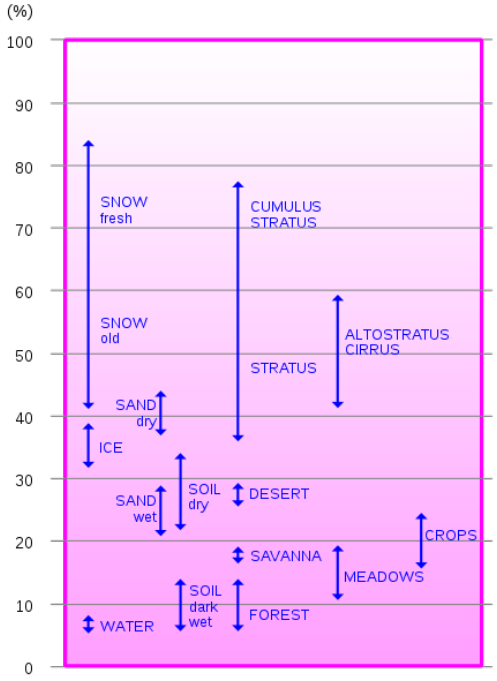
Why haven't we heard these facts before?
Climatology is one of the more complicated and changing fields, and we are still learning lots more about our ocean, climate and geologic systems and how they interact. Scientists make sure predictions are accurate before announcing them, and climatologists are liable to be defunded by changes in the political winds. A drastic prediction that is contested could threaten a tenuous position.

As well, research from sources with a conflict of interest such as oil and gas is common, and politicians do not want to cause panic or look bad. Public panic is not to be taken likely, and public officials are mindful of "crowd mentalities". But given the risk of any potential severe scenario I have decided to self publish some facts we do know .

1. Albedo effect: melted ocean water absorbs more heat than Ice caps

On a warm day put your hand on some asphalt and then some cement. Lighter surfaces reflect more sunlight and stay cooler than darker ones. Any reader fond of wearing black clothing will have noticed this is not the most practical summertime fashion decision. Ice and snow are some of nature's most reflective surfaces, and open ocean water some of the darkest

To a lesser extent, open prairies and grasslands are more reflective than northern pine forest, sometimes counteracting the greater carbon storage potential of the trees. Cities' paved surfaces create local urban heat bubbles. All these changes in reflectivity of the surface of the Earth add up, and we call this tipping point the Albedo effect. Some have suggested we all paint our roofs white.



2: Increased forest fires: Climate change makes life hard for large forests

The forests and rainforests of the earth represent a large amount of fixed carbon in the bodies of trees, their root mass and the soil they protect. In a straightforward way, trees experiencing stress from warmer climates and less rainfall are likely to die and be subject to forest fires, which release carbon and make it more difficult for these forests to be reestablished. In the East we have already seen damage from the longhorn beetle and spruce budworm. #

3: Ocean Methyl Clathrate release: The Clathrate Gun Hypothesis

Methyl clathrate oxidizes

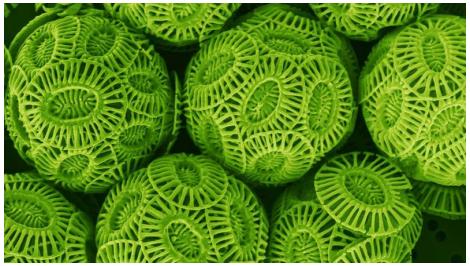
In colder parts of the world, living tissues don't decompose all the way back to CO2 again. Instead, a lack of warm-enough temperatures and free oxygen cause decomposing microbes to stop short at the point that these remains are made into methane. In cold and wet conditions, and under pressure this methane is made into an unstable methane ice. You guessed it: under warmer conditions this methyl clathrate has the capacity to be suddenly released as a greenhouse gas. It is thought that this sudden release, sometimes called the Clathrate Gun hypothesis, was instrumental in the lethal effects of the end Permian Extinction event, where more than 90% of all species were annihilated. #

It takes a long time for extra heat from a warmed climate to reach the bottom of the ocean. Perhaps it never will, perhaps sooner than we think, it is not yet known.

4: Permafrost methane release

As in the deep ocean, cold conditions mean that decomposition in arctic soils can only go so far. Permafrost methane is generated from the decomposed material of everything that lived and died in that spot. It is stable only so long as the soils remain frozen. Rising temperatures and thawing permafrost means that all that organic content is released at once as the potent greenhouse gas methane.

5: Ocean acidification: CO2 in the oceans kills life that would otherwise sequester carbon as limestone.



Roughly half of oxygen in the air is created by microscopic sea life. Plankton is a collective noun for many living things including larval fish and jellies, tiny preying crabs, and whole food webs. The ones that concern us are photosynthesizing cyanobacteria including radiolarians, coccolithiphores, foraminifera and diatoms. They gain energy from the sun and fix carbon as sugars and in their chalky shells. They are responsible of the bulk of all limestone formation. Over a half-million years this limestone is carried as bedrock to subduction zones, where the earth's volcanic heat releases the CO2 again. Over time, these lifeforms could reestablish a carbon absorption-emission balance on the Earth again. Whether this is soon enough to save our civiliziation remains to be seen.#

Carbonated soft drinks are made with CO2, which makes unstable carbolic acid, which only exists under pressure, then escapes in fizzy bubbles of CO2 again, giving pop a tart taste and eroding your teeth. CO2 in the atmosphere does the same to seawater, and a lot of CO2 has gone to do just that, lowering the pH of the ocean measurably (though the ocean still remains alkaline-of-neutral at this point).

However UCLA has found some initial signs that an important carbon-fixing plankton (Coccolithiphores) are resistant to some acidification. # This makes sense as they have survived previous extinction events such as the Great Dying and the one that killed off the dinosaurs.

6: Thermohaline convection shutdown: Stagnant seas

Ocean currents cycle heat energy in planet-scale systems, often likened to giant conveyor belts through our interlocking oceans. Some of these currents are driven by seawater reaching the poles. The water becomes cool and then sinks, pulling warm water behind it. Cold fresh water melting from the Greenlandic and Icelandic ice sheets can cause the slowdown of these currents.

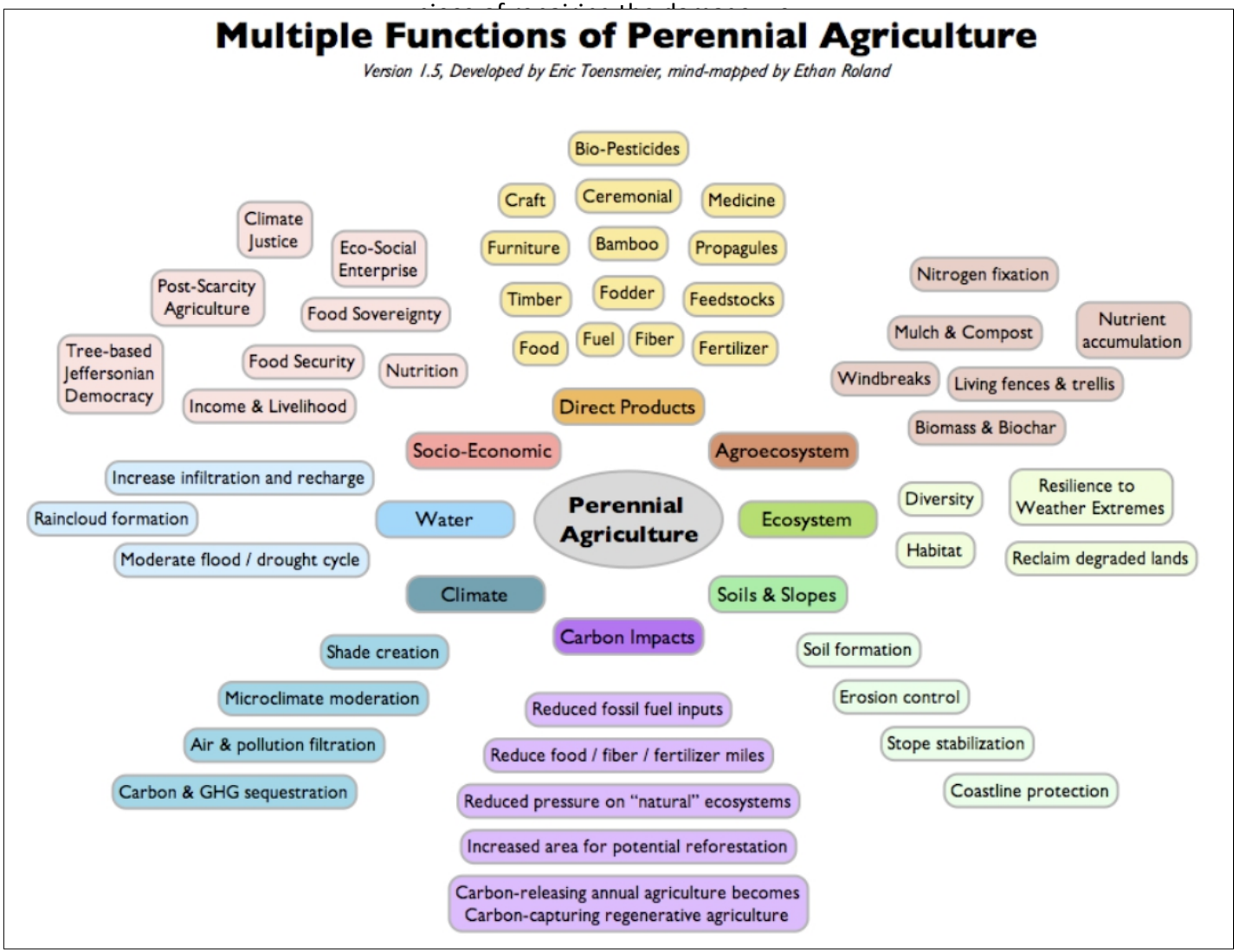
The gulf stream current has been measured to be slowing ( ) which might be causing unusual snow events in Europe and the Middle East. It is hypothesized ( ) that these currents provide oxygen and nutrients to the plankton community. Without these currents these may die, decay, and emit climate-forcing methane and toxic hydrogen sulfide in amounts that are toxic immediately, and causing runaway climate change later.

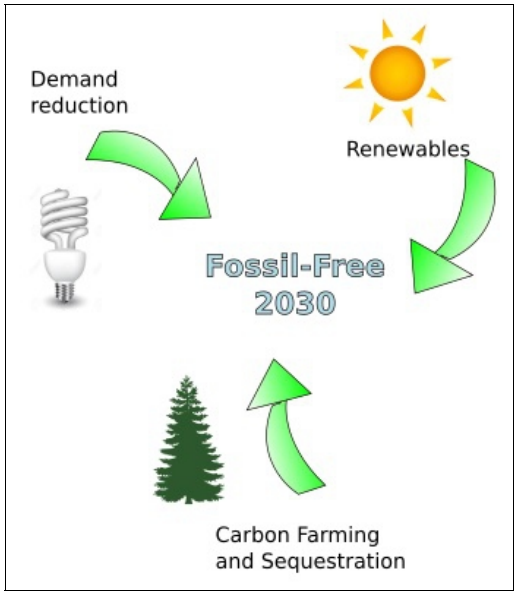
We are in an extinction event, the 6th experienced since life began that we know of. In future times it may define our age and be called the Holocene-Anthropocene event.

II Carbon farming

Carbon farming takes carbon fro the atmosphere, where it causes harm, and putting it in soil, where it builds soil fertility. Unlike other forms of geoengineering, this technology creates benefits to farmers and our food systems, and is accessible on a small scale to individuals and communities. We farm by causing plants to create large root structures, and then sometimes systematically cause plants to "root prune": creating cycles of root die-back and regrowth which places compost directly underground.

We need to work to reward farmers financially for these conservation practices, and create policy around maintaining land in no-till and soil building practices. While carbon farming is insufficient to allow our current emissions, it remains a critical





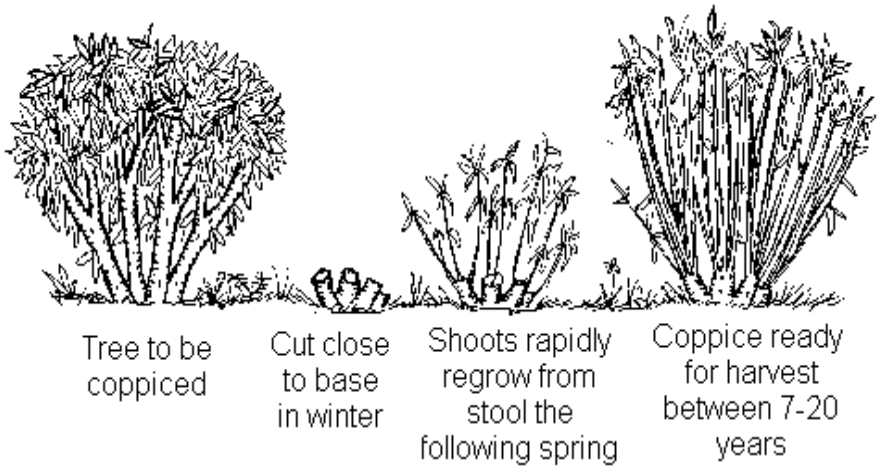
Author

David Holmgren

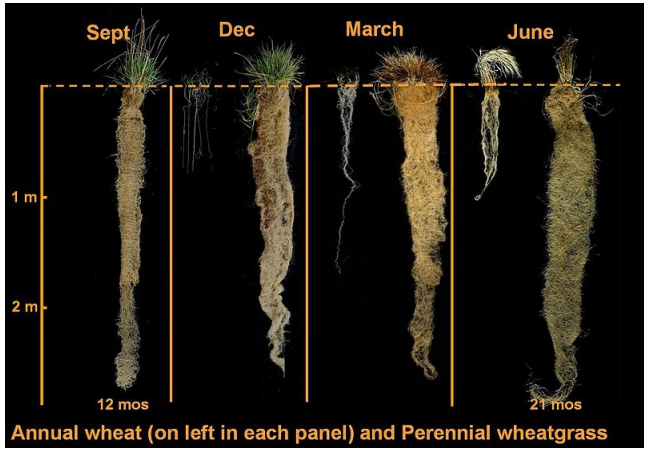
1: Coppice wood: immortal trees

We've all seen a tree growing where it is not wanted, by a foundation or under a fence, and yet when it's cut down will sprout many times more trunks and keep growing. We can create fields of such trees on purpose of shrubby new growth for many purposes: growing nuts, fruit or foliage for feeding animals, small diameter wood for firewood, mushroom logs, basket making, charcoal, paper fibre, thatching, round-wood construction, tool handles, bean poles, medicines, dyestock, and almost anything else.

Copses, as these fields are called, mimic thicket habitats and are refuges for birds and insects. The bottom part of the coppice, called a stool, is functionally immortal and fixes soil carbon each time it is pruned. The man on the back illustration is coppicing.



2: Perennial grains A Post-plough People



Ploughing has been a part of our civilization for so long it can be difficult to imagine farming without it. We plough in the spring, plant annual grains, harvest, and they die in winter. However perennial grains come with several advantages:

- Less work planting every year. Less tractoring means less emissions.
- Plants that live through winter can hold onto soil nutrients for much longer than annuals. Perennials are doing work whenever the weather is warm enough, long into the fall, thaws and spring when fields cleared of annual plants are losing minerals and nutrients to the nearest waterway.
- Harvesting grain stalks result in the same root-pruning that managed grazing does, meaning carbon is delivered to the soil. Over years roots of perennial grains go many feet deeper than annual grains and grasses, meaning more carbon makes it underground.
- When we turn the soil, we lose a lot of fertility when oxygen from the air meets carbon in the ground, creating carbon dioxide. Essentially, ploughing means we are burning our soil in a very real way. #

Javier Martin

We may be able to manage our fields like prairies, using the body of the grain for cattle who fertilize the plants in turn, or managing weeds through fire the way we manage our blueberry fields. Even a field on fire might sequester more carbon through its roots than is emitted by firing the leaves every few years. Other work is being done to create perennial beans, soy, corn, cotton, and oilseeds. You can buy perennial wheat seeds at some heirloom seed companies.

3**: tree crops: the nut-bread solution**

Nuts currently occupy a place in our diet as confections, but they could be a much greater part as breads, starch for noodles, cooking oil, protein and the food for meat animals. Nut orchards can last for thousands of years and orchards can use more conservation methods like silvopasture, see below. In a world of catastrophic climate implications and solutions, nut bread is on the deliciously benign solution.

4: Food forestry

In many parts of the world, it has always been normal to grow food crops together. When useful plants are grown in a forest-like arrangement, many of their needs can be met by one-another: fertilization, water conservation and mulching, pest reduction, hosting pest-eating insects and birds, re-seeding and planting, even weather manipulation can be performed by a food forest. They also make more efficient use of space, having tall plants, shorter ones, groundcovers, roots and vines very close together and expanding the zone of life up higher from the ground (Simpson). Soil depth and quality is improved, carbon is sequestered in the soil and in plant biomass.

We tend to grow in monocultures due to market forces pressing for specialization and centralization. It is also easier to harvest with large and specialized machines. Some energy is saved by only growing what is best in each area of the globe. But monocultures are highly susceptible to pest animals and diseases and rely heavily on pesticides. They also exhaust the soil of those nutrients needed to make crops that are carried away from the site. Modern farming is inching away to the food forest by beginning to reintroduce crop rotation and companion planting ( ).
In 200_ the World Health organization called small scale organic farming the primary means to feed the world in the next millennium.

4: Rotational grazing

Prairies are some of the best carbon-sequestering ecologies of them all. The vast soil reserves of the Canadian Prairie and American Great Plains that enable those regions to be grain exporters were created by migrating herds of megafauna like buffalo.

Like hardwood trees, grasses and perennial herbs also root-prune: when the top is taken off but the plant remains alive with time to recover. While overgrazing until the plants are dead can result in the formation of deserts, segmenting a pasture so that cattle, bison, sheep, goats alpacas, chickens or other grazers can eat from a different section only one day out of a month or longer can sequester carbon to the order of 0.1 -6 0.3 Tonnes/Hectare/Year (T/Ha/yr.

5 No till, cover crops and proper soil management

We can build deeper soil even with annual crops using proper soil management that many cultures have used traditionally. Fields on slopes must be terraced. We can plant winter-hardy crops and plough them under in the spring. Some systems leave weeds in place but weaken them with flooding or a roller-crimper. Finally some farmers let their crops fend for themselves. There is some evidence to suggest that weeds may not always be the deadly competition we assumed, but can in some ways contribute to the health of crops.

Conservation agriculture can include

0.1 - 6.0 T/Ha/yr

6: Pleistocene rewilding: Saving large animals

Once the world was full of large animals like Mammoths, Mastodons, and saber tooth cats. There were American horses and cheetahs, ground sloths and moas, woolly rhinoceros, cave lions, giant beavers and extra-large elk. Some of these megafauna remain like elephants, bison, buffalo, wildebeest, horses, cows, Siberian tigers, camels, wolves and caribou. Together they managed circumpolar high arctic prairies where today is covered by the boreal forests and tundra.

The boreal forest and tundra has less capacity to store soil carbon than this steppe prairie, and has a lower albedo. It is likely that many of these animals became extinct due to human hunting 13-10'000 years ago. This would have been the first time we changed the climate due to geoengineering.
One team of researchers in Russia is experimenting with recreating these landscapes and have imported European bison, sturdy horses, buffalo, wildebeest and more. They would like to clone mammoths and mastodons, but there are significant hurdles to thi.s and it is not necessary to see benefits. However, the Maasai are attributed with a saying: "Cattle make trees. It is elephants who make grass." http://www.cbc.ca/radio/quirks/quirks-quarks-for-may-23-2015-1.3083950/how-to-clone-a-mammoth-1.3084030

The Zimovs have found beneficial climate effects in three ways:

Pasture has a higher albedo than forest, and foraging animals are successful at maintaining grasses from tree encroachment.

- Animals compact snow while trampling and foraging for grass, lowering snow's insulative capacity, as well as exposing ground to arctic temperatures. Exposed ground from trampled snow can reach average temperatures of -30 C, rather than an average of 0C in boreal forest, preventing catastrophic methane release
- Grass roots sequester more carbon in arctic soils than forest. This also helps provide habitat for some animals that are critically endangered such as the snow leopard, Siberian tiger and European bison. #

Pleistocene Rewilding also turns marginal land into a potential resource against food insecurity. You can find out more and support at: https://www.kickstarter.com/projects/907484977/pleistocene-park-an-ice-age-ecosystem-to-save-the. This needs to be implemented in every polar country.

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