Do you feel hopeless about climate change and the damage we're doing to our planet? I did, but I then was shown a new way to look at the problem!	*In recent decades, anthropogenically induced changes in climate have caused impacts on natural and human systems on all continents and the oceans. The extent of these impacts indicates the sensitivity of natural and human systems to a changing climate.* ***Science*** http://ar5-syr.ipcc.ch/topic_summary.php
Climate change is all about too much carbon in our atmosphere But carbon is not our enemy, its the building block of life, everything alive is made of it, it's us! The problem and the solution are simply a matter of balance. Lets step back and look at the five pools where carbon is stored on planet earth.	*Life on Earth depends on energy from the sun. About half the sun's light reaching Earth's atmosphere passes through the air and clouds to the surface, where it is absorbed and then radiated upward in the form of infrared heat. About 90 percent of this heat is then absorbed by the greenhouse gases in our atmosphere and radiated back toward the surface. Similar to the way a greenhouse works. Carbon dioxide is the most prevalent greenhouse gas in our atmosphere. What happens when more carbon and other greenhouse gases are added to the atmosphere is more heat gets trapped. This increased heat is rapidly changing our global climate, destabilizing weather patterns, and disrupting the ecosystems everywhere.* ***Science:*** http://climate.nasa.gov/causes/ *We are carbon based lifeforms. Carbon is the key component of all life! It would be impossible for life on earth to exist the way it does without carbon. It is the main component of sugars, proteins, fats, DNA, muscle tissue, most everything in your body and the bodies of all living things on the planet. Unlike aerosols, or other toxic chemicals, carbon is not a pollutant. However, too much of it in the wrong place can be highly destabilizing.* *Most of Earth's carbon is stored in rocks, soils and ocean sediments. The rest is in the ocean, atmosphere, biosphere, and in the fossil pool. Carbon flows between these "pools" in an exchange called the carbon cycle. Any change in the cycle that shifts carbon out of one pool puts more carbon in another one of the pools.* ***Science:***

Starting about 500 million years ago, when plants came onto land, carbon began to cycle in an amazing balance between these pools, a balance that allowed for life as we know it to evolve.	*http://earthobservatory.nasa.gov/Features/CarbonCycle/* *The earth's climate was not always how it is today. Before plants came onto land the earth was much hotter because of so much more carbon in the atmosphere. The evolutionary development of photosynthetic capacity in plants is complex and occurred over a long period of time. Plants evolved from a group of green algae as early as 500-700 million years ago. Photosynthesis as a process evolved in the oceans much earlier, around 3.4 billion years ago. Land based plants played a critical role in creating the type of atmosphere we have on our planet today. They create oxygen, and remove carbon from the atmosphere transforming it into carbohydrates (sugars) and using them to build the biosphere and soil. Over the long term, the cycling of carbon between the primary 5 pools maintains a balance that prevents all of Earth's carbon from entering the atmosphere (as is the case on Venus) or from being stored entirely in rocks. This balance helps keep Earth's temperature relatively stable and livable.* ***For More:*** *On Plants Evolution.* *https://web.archive.org/web/19991009125017/http://www.clas.ufl.edu/users/pciesiel/gly3150/plant.html* *On Evolution of Life on Earth* *http://www.nas.edu/evolution/* *On the carbon cycle* *http://earthobservatory.nasa.gov/Features/CarbonCycle/* ***Science:*** *For a more in depth discussion of photosynthesis and it's effects on our atmosphere see "The Evolution of Photosynthesis and its Environmental Impact" Lars Olof Björn1 and Govindjee2 1 Lund University* *http://www.life.illinois.edu/govindjee/recent_papers_files/Ch.12a03B&G_07.pdf* *You can see the photosynthetic portion of the carbon cycle today and role the biosphere plays in sequestering carbon in this satillite video from NASA* *https://www.youtube.com/watch?v=x1SgmFa0r04*

Then one lifeform, us, figured out how to extract carbon from the fossil pool. We've been burning it for energy, putting it into play, disrupting that balance.	*Whenever there are changes in the amount of carbon in one pool, it will affect the amount in the other pools. In the Industrial Revolution, starting in 1760, humans learned how to extract fossil fuels from where they were stored underground and use them for power. From the coal that powered the classic steam engine to today's oil and gasoline based automobiles, we use fossil fuels to power our world. Much of our modern economy including electricity, transportation, plastics, textiles and cosmetics are based in fossil fuels. All of which have contributed to changing the carbon pool balance.* ***For More:*** *On the Industrial Revolution* *https://en.wikipedia.org/wiki/Industrial_Revolution* ***Science:*** *National Research Council* *Video, Climate Change, Evidence, Impacts and Choices* *http://nas-sites.org/americasclimatechoices/videos-multimedia/climate-change-lines-of-evidence-videos/* *Climate Change, Evidence, Impacts and Choices* *http://nas-sites.org/americasclimatechoices/files/2012/06/19014_cvtx_R1.pdf*
The way we manage land and do agriculture is moving even MORE carbon from the soil and biosphere into the atmosphere.	*In soil, carbon makes up 50% of soil organic matter, or humus. Soil Organic matter is vital to healthy soils, yet most modern agricultural operations are focused on the management of nitrogen, phosphorus and potassium (NPK) and not on carbon (C).* *The soil is the largest storehouse of carbon on land. Several major mainstream management practices in agriculture degrade soil carbon and release greenhouse gas emissions. It is estimated that the world's cultivated soils have lost between 50 and 70 percent of their original carbon stock, much of which has oxidized upon exposure to air to become CO_2.* *Tillage: Exposes carbon aggregates and life forms to oxygen releasing the soil carbon into the atmosphere as CO_2. Tillage also*

	increases vulnerability to wind and water erosion. *Bare Soil: Nature covers itself to build and protect the carbon organisms and create carbon glues that build healthy soil. Bare soil means less sequestration and more emissions.* *Fertilizer and pesticide application: can cause the release of excess greenhouse gas emissions by killing important organisms that build soil and maintain healthy soil.* *Other agricultural practices like clearing forests, overgrazing, and concentrated production of livestock and their manure can also cause significant greenhouse gas emissions.* *Organic matter is vital to healthy soils, yet most modern agricultural operations are not managed in ways to retain high levels. Only half the original organic matter remains in most modern cultivated soils. In general, organic matter levels have fallen from 5-6 percent of the soil to less than 3 percent on most cropland soils.* ***For More On*** *Soil Organic Matter* *http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/mgnt/?cid=nrcs142p2_053859* *Soils and Carbon* *http://e360.yale.edu/feature/soil_as_carbon_storehouse_new_weapon_in_climate_fight/2744/* ***Science*** *Dr Rattan Lal Ohio State Univeristy* *http://senr.osu.edu/our-people/rattan-lal* *US Environmental Protection Agency* *http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2015-Chapter-5-Agriculture.pdf*

Specifically we've moved 880 gigatons of carbon dioxide into the atmosphere which is heating up the planet and destabilizing our climate.	*The Intergovernmental Panel on Climate Change estimates that between 1750 and 2011, cumulative anthropogenic CO_2 emissions were 2040 ± 310 $GtCO_2$. About 40% of these emissions have remained in the atmosphere (880 ± 35 $GtCO_2$); the rest was removed from the atmosphere and stored on land (in plants and soils) and in the ocean.* *Changes in many extreme weather and climate events have been observed since about 1950. These include a decrease in cold temperature extremes, an increase in warm temperature extremes, an increase in extreme high sea levels and an increase in the number of heavy precipitation events in a number of regions.* ***Science:*** *IPCC 5th Assesment* *http://www.ipcc.ch/report/ar5/syr/* *"Ice Melt, Sea Level Rise, and Super Storms; evidence from paleoclimate data, climate modeling, and modern observations that 2 °C global warming is highly dangerous"* *http://www.atmos-chem-phys-discuss.net/15/20059/2015/acpd-15-20059-2015.html* ***Action Partner:*** *Oxfam Food & Climate Justice* *https://www.oxfam.org/en/campaigns/food-and-climate-justice*
Now, the oceans have absorbed a lot of this excess carbon, which is resulting in ocean acidification and accelerating a mass extinction of sea life.	*The ocean has absorbed about 30% of the emitted anthropogenic CO_2, causing ocean acidification. In salt water carbon forms carbonic acid and starting just after the Industrial Revolution, ocean water has become 30 percent more acidic. This change in pH is faster than any known change in ocean chemistry in the last 50 million years. Such a quick change in ocean chemistry doesn't give marine life time to adapt. Many of the smaller calcium shelled organisms cannot survive and the disruption to the food chain is already causing many problems for larger sea mammals.* ***For More:*** *On ocean acidification*

	http://ocean.si.edu/ocean-acidification http://www.nrdc.org/oceans/acidification/aboutthefilm.asp ***Science:*** *National Oceanic and Atmospheric Administration* *http://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F* ***Action Partners:*** *Mission Blue http://mission-blue.org/about/*
So in order to save life as we know it, of course we have to stop releasing fossil carbon.	*There is no single silver bullet when it comes to solving climate change. The good news is that there are a wide variety of actions that will all help reduce emissions. Using energy more efficiently, switching away from fossil fuels towards clean renewable power for our homes, business and vehicles, and managing our waste wisely by recycling and composting will reduce carbon emissions significantly. Many of these strategies have positive co-benefits like being better for our health and being more economical.* ***For More:*** *See article by Scientific American http://www.scientificamerican.com/article/7-solutions-to-climate-change-happening-now/* ***Economics:*** *Global* *http://mudancasclimaticas.cptec.inpe.br/~rmclima/pdfs/destaques/sternreview_report_complete.pdf* *Business http://www.rmi.org/* ***Action Partners:*** *Harvard Climate, Energy & Health* *http://www.chgeharvard.org/category/climate-energy-and-health* *World Resources Institute* *http://www.wri.org/our-work/topics/climate*
The big question is “where do we put this excess carbon to get this cycle back in balance?”	*The latest science from the IPCC indicates that in order to stabilize our climate we will not only need to reduce the volume of emissions we release but also drawdown the excess amount already in the atmosphere. There are many biological (natural) ways that carbon can be moved from the atmosphere back into other pools. These range from proven methods to new areas that are just being explored. There are also a wide range of*

	proposed technological solutions, known as geoengineering, which are deliberate large-scale interventions in the Earth's natural systems to counteract climate change. We will need to continue to support and explore ways to draw down atmospheric carbon. ***For More*** *On GeoEngineering* *https://en.wikipedia.org/wiki/Climate_engineering* ***Science:*** *IPCC 5th Assesment, Summary for Policy Makers; pg 28 {Box 6.1, 12.4, 12.5}* *https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf* ***Action Partners*** *350.org* *http://350.org/* *Project Drawdown* *http://www.drawdown.org/solutions/* *Post Carbon Institute* *http://www.postcarbon.org/program/res/*
Well remember when I said that the solution was right under our feet? It literally is. It's the soil!	*Soil is one of the most important natural resources on the planet! Together with sunlight, air and water it provides the basis for life today. Soil is complex mix of minerals, air, water, and countless microorganisms that comes in many types. It is what allows us to grow our food, filter water, and is host to the greatest concentration of biomass anywhere on the planet. It forms at the surface of land, like a skin for the ground.* ***Science:*** *Soil Science Society of American* *https://www.soils.org/discover-soils/soil-basics* ***Action Partners:*** *American Farmland Trust* *https://www.farmland.org/our-work/areas-of-focus/soil*
Plants, with sunlight and water, perform photosynthesis. They pull carbon in from	*All the carbon in carbohydrates come from the air and nowhere else. Through*

the air and turn it into carbohydrates, sugars! Then they pump some of these sugars down through their roots to feed micro organisms who use that carbon to build soil. Voila! Carbon moved! The plants pump it in, and the soil stores it. Nature's living technology is amazing!	*photosynthesis, plants convert the sun's energy into simple sugars or carbohydrates. The plants use water (H_2O) from the soil and carbon dioxide (CO_2) from the air and recombine them to form carbohydrates (COH) and oxygen (O_2).* *These carbohydrates then form the basis of the food chain for humans, animals and the soil ecosystem. Living plant roots actively exude sugars, amino acids and other compounds into the soil to feed soil organisms that in return provide nutrients to the plants and build the soil. Microbes in the soil create enzymes to break down existing organic matter or mineral soil, making nutrients more available to the plant. And, they use these carbohydrates (sugars) to build carbon glues that aggregate the soil particles so air and water can move through the soil system.* *Mycorrhizae are a specific and especially beneficial fungi that form symbiotic associations with plant roots in the soil. Enlarging the surface-absorbing area of the roots by 100 to 1,000 times or more, mycorrhizae create long threads that create a net which acts like an extension of the root system. This makes the roots of the plant much more effective in the uptake of water and nutrients.* ***For More:*** *On mycorrhizal fungi* *http://www.ted.com/talks/paul_stamets_on_6_ways_mushrooms_can_save_the_world?language=en* ***Science:*** *National Resource Conservation Service, "How Does Soil Function?"* *http://www.nrcs.usda.gov/wps/portal/nrcs/main/wv/soils/health/* ***Action Partners:*** *1% for the Planet* *http://onepercentfortheplanet.org/about/mission/*

Scientists have recently discovered that applying a thin layer of COMPOST, one time, sets up an ongoing positive feedback loop that brings more and more carbon into the soil each year.

In concert with other REGENERATIVE practices like
NOT TILLING THE SOIL,

PLANTING TREES and COVER CROPS,

and PLANNED GRAZING,

we can build and retain gigatons of soil carbon.

This is carbon farming!
This is regenerative agriculture!

And there is nothing more powerful than an idea whose time has come.

A suite of studies conducted by University of California at Berkeley based Silver Labs for the Marin Carbon Project have demonstrated that photosynthetic soil carbon sequestration in grazed rangelands can be promoted by a one time application of compost and that this carbon is transferred to and stored in the more recalcitrant fractions of the soil. Compost itself is also good at increasing soil organic matter (SOM) because it breaks down more slowly and improves soil structure more quickly than other organic materials. Increases in SOM increase plant and soil health which in turn enhances photosynthetic transfer of carbon dioxide to soil carbon.

There are dozens of other common conservation and agricultural practices that can also build and retain soil carbon. The USDA refers to these as "carbon farming" practices. There is also a movement in today's agricultural community looking at practices that are "regenerative" in nature; those that build soil, increase tolerance to drought, enhance biodiversity and sequester carbon.

Science:
Marin Carbon Project
http://www.marincarbonproject.org/marin-carbon-project-science

Action Partners:
Carbon Farming
Carbon Cycle Institute
http://www.carboncycle.org/carbon-farming/
Natural Resource Conservation Service
http://www.comet-planner.com/
Marin Agricultural Land Trust
http://www.malt.org/

Regenerative Agriculture
Carbon Underground
https://www.thecarbonunderground.org/regen

	erative-farming/ *Rodale Institute* *http://newfarm.rodaleinstitute.org/features/0802/regenerative.shtml*
Unlike carbon in the atmosphere, more carbon in the ground is good for us! It makes **healthy soil**, which is nutrient rich and full of life and holds way more water. This means more nutritious food, and crops that are more resilient in the face of drought. That's good news for farmers, families and everyone that eats!	*Soil Organic Matter (50% carbon) is one of the most important aspects of what makes a soil healthy. Soil health, is defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans. By regulating water, buffering pollution, providing habitat for microorganisms, cycling nutrients and providing stable structure for plants, healthy soil increases drought tolerance and increases productivity.* ***Science*** *UN Food & Agriculture Organization* *http://www.fao.org/docrep/009/a0100e/a0100e05.htm* *NRCS* *http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/health/?cid=stelprdb1193043* ***Action Partners:*** *NRCS Soil Assistance Program* *http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/health/?cid=stelprdb1250888* *NRCS and Drought Resistance* *http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/sd/home/?cid=stelprdb1048530* *The nutrients in our diets come from plants growing in soil or from animals that eat plants. As plants roots absorb water, they also take in nutrients dissolved in the water (nitrogen, calcium, iron, and others). The healthier the soil the more nutrients are present and available for the plants. The humates that make up Humus/Soil Organic Matter are made up of carbon chains that have positive and negative location sites where elements attach. Less carbon in the soil = Less available minerals.*

	Science: *Barber, S. A. Soil Nutrient Bioavailability: A Mechanistic Approach. New York: Wiley, 1984.* *http://www.eolss.net/sample-chapters/c10/e5-24-04-03.pdf* ***Action partners:*** *Center for Food Safety* *http://www.centerforfoodsafety.org/issues/3183/soil#*
Remember this: the way we grow our food, fiber and fuel either puts carbon up into our atmosphere or pulls it down into the ground. The regeneration of soil is the task of our generation. Our health the health of our soils and the health of our planet are one and the same.	*Food, fiber and fuel are all products of our agricultural system. If managed properly agriculture can become a climate solution.* ***Action Partners:*** *Fibershed http://www.fibershed.com/* *Carbon Cycle Institute* *http://www.carboncycle.org/* *Home Grown* *http://www.hgofarms.com/growers/* *Cornucopia Institute* *http://www.cornucopia.org/*
Thank you for hearing the call!	For further questions please contact Info@kisstheground.co