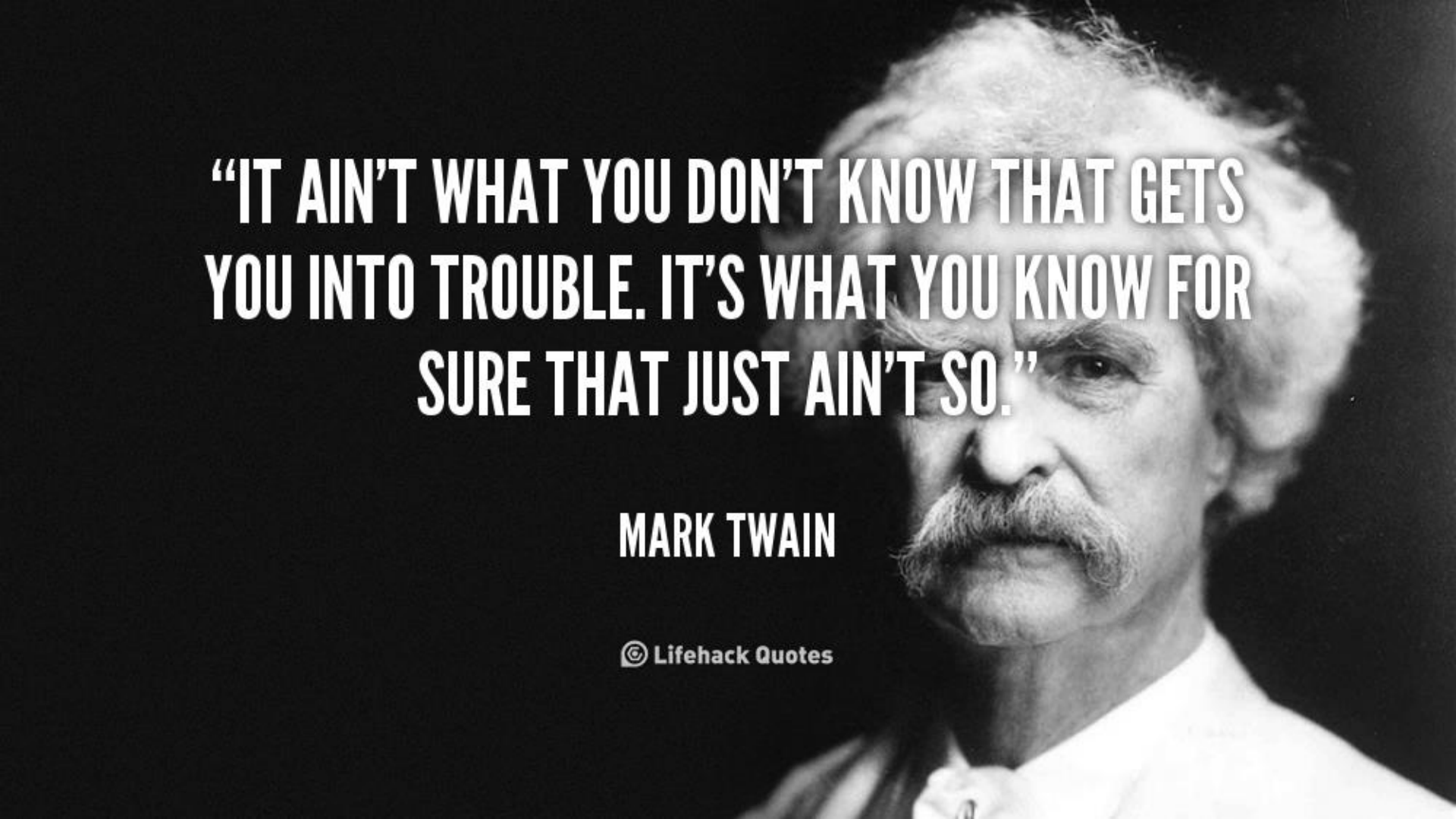
Reversing Climate Change

Restore the Soil to Save Humanity and the Planet


“IT AIN’T WHAT YOU DON’T KNOW THAT GETS YOU INTO TROUBLE. IT’S WHAT YOU KNOW FOR SURE THAT JUST AIN’T SO.”
MARK TWAIN
Lifehack Quotes

Climate Change

- 48% of Americans believe in human causes.
- 31% say natural causes.
- 20% say there is no evidence.

How to Fix It

- 51% say reduce power plant emissions.
- 49% say reduce International emissions.
- 46% say greater fuel efficiency for vehicles.
- 45% say corporate tax incentives.
- 41% say drive more hybrids.
- 38% say lower personal carbon footprint.

Stopping Emissions Won’t Work

If carbon dioxide emissions came to a sudden halt, the carbon dioxide already in the Earth's atmosphere could continue to warm our planet for hundreds of years, according to Princeton University-led research.

Frolicher, T. L., Winton, M., Sarmiento, J. L., (2014). Continued global warming after CO2 emissions stoppage. *Nature Climate Change*, 4, 40-44. Retrieved from https://www.nature.com/nclimate/journal/v4/n1/nclimate2060/metrics/news.

Carbon Emission Reduction

“If emissions of CO2 stopped altogether, it would take many thousands of years for atmospheric CO2 to return to ‘pre-industrial’ levels due to its very slow transfer to the deep ocean and ultimate burial in ocean sediments.”

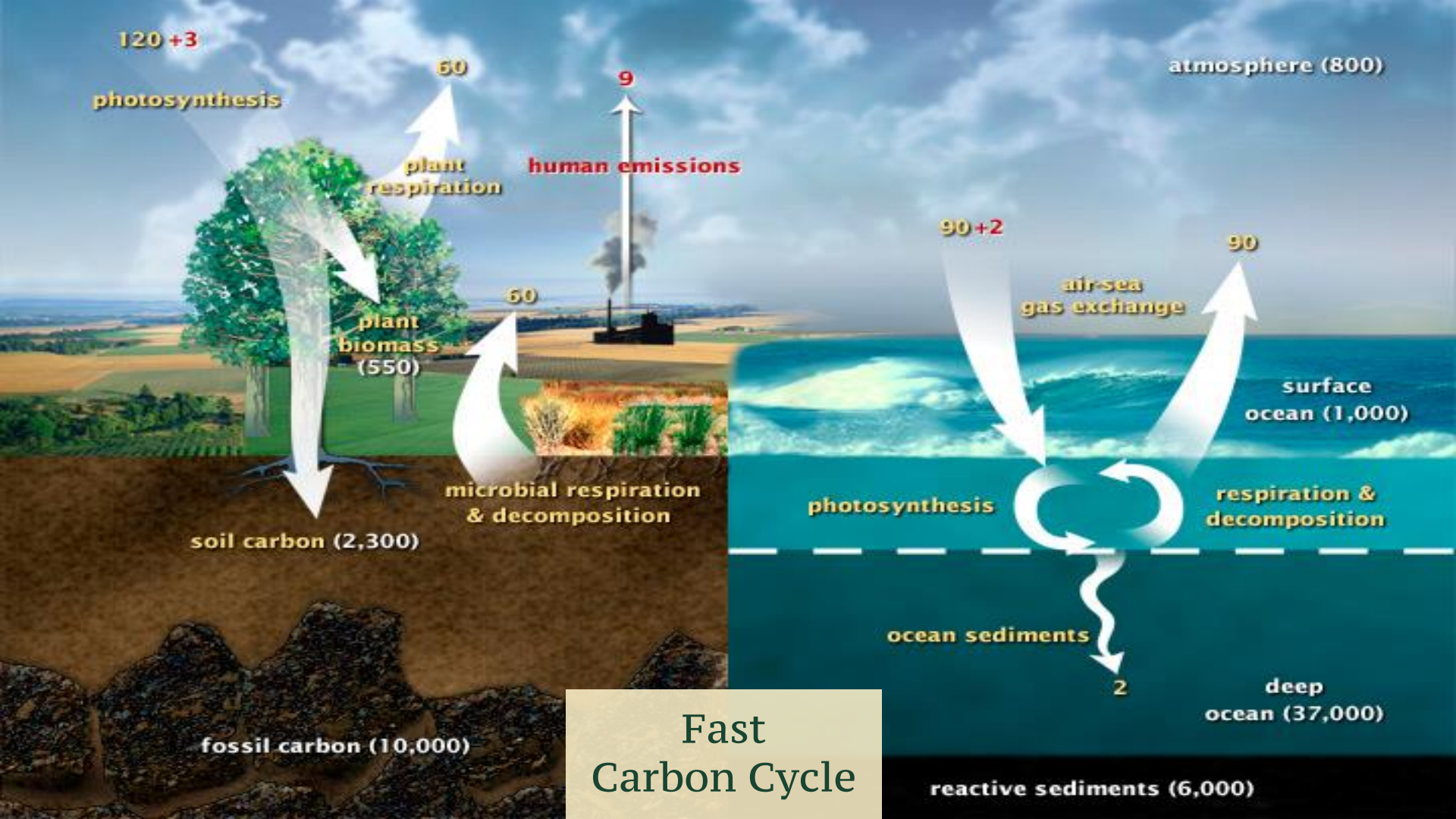
“Climate Change Evidence and Causes.” An overview from the Royal Society and the US National Academy of Sciences. Retrieved from https://royalsociety.org/~/media/Royal_Society_Content/policy/projects/climate-evidence-causes/climate-change-evidence-causes.pdf.

Fast Carbon Cycle

(explanation of graphic on next slide)

The graphic on next slide:

- Shows the movement of carbon between land, atmosphere, and oceans.
- Yellow text with yellow and white numbers = natural fluxes
- Red text & numbers = human contributions
- White text & numbers = stored carbon.



Fast Carbon Cycle

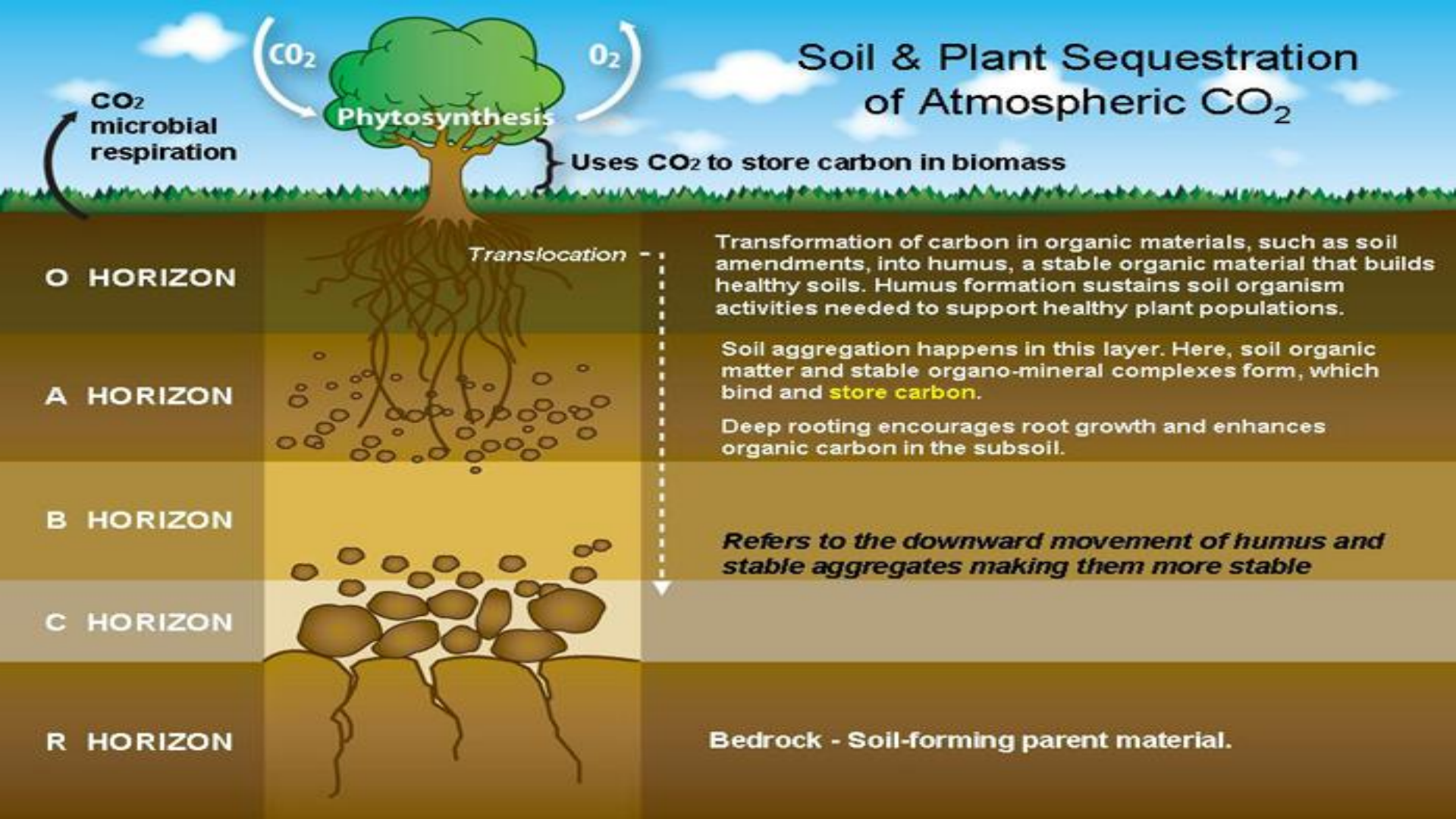
Carbon Storage

(more explanation of the Fast Carbon Cycle graphic in the previous slide)

To summarize, the Fast Carbon Cycle:

- Carbon in the atmosphere (800 Gt).
- Vegetation (550 Gt).
- Ocean (1,000 Gt).
- Soil (2,300 Gt).
- Soil stores 50 Gt less than that stored in air, plants and ocean combined.
- Minor change in soil carbon can cause major implications for the earth's atmosphere and climate.

Soil & Plant Sequestration of Atmospheric CO_2



A Formula To Reduce Climate Change

- 3t C/ ha/ yr x 5 bill ha = 15 Gt
- 15 Gtc x 20 yrs = 300 Gt C
- 1 ppm CO_2 = 2 Gt C
- 300Gt CO_2 = 150 ppm CO_2
- 402 ppm – 150 ppm = 252 ppm
- (pre-Industrial Age levels)

C= Carbon H= Hectare Gt= Gigatons PPM= Parts Per Million

Grasslands Restoration Carbon Formula

- 12t C/ ha/ yr x 5 bill ha = 60 Gt C
- 60 Gtc x 10 yrs = 600 Gt C
- 1 ppm CO_2 = 2 Gt C
- 600 Gt CO_2 = 300 ppm CO_2
- 400 ppm – 300 ppm = 100 ppm
- (or 150 ppm *below* pre-Industrial Age levels)

C= Carbon H= Hectare Gt= Gigatons PPM= Parts Per Million

Methane More Deadly Than Carbon

- Methane warms the planet on steroids.
- 10 to 20 years before decaying to CO2.
- Warms the planet 86 times as much as CO2.
- Methane controls how fast warming occurs.
- Sudden increases in atmospheric methane is climate change's more frightening tipping points.
- According to the Intergovernmental Panel on Climate Change.

Nitrous Oxide Most Dangerous

- 310 times more effective in trapping heat than carbon dioxide.
- Sixty percent produced naturally.
- Atmospheric lifetime of 110 years.
- An ozone destroyer.

Removing Atmospheric Nitrous Oxide

- Solar Chimney Power Plant (SCPP).
  - Tall chimney with a turbine in the base.
  - A large greenhouse (called a collector).
- Solar radiation heats up the air under the greenhouse.
- Hot air rises through the chimney.
- Turning the blades of the turbine, which generates electricity.
- Air containing N2O flows over a catalyst.
- Photocatalytic breakdown of N2O into nitrogen and oxygen.
- Photocatalytic material titanium dioxide is most efficient.

Further Insight on Greenhouse Gas

- Land-based living things sequester more carbon dioxide annually than they emit.
- The biosphere is a carbon sink.
- However, it is a net source of methane and nitrous oxide causing a warming comparable to 3.4 to 4.9 Gt of carbon dioxide emissions per year
- This is what the U.S. emits annually.

Microorganisms Sequester Methane

- Microbes consume vast quantities of methane.
- In 2010, Deepwater Horizon drilling rig blew out.
- 1% of annual global methane production in a single dose.
- They used microorganisms to consume the methane.

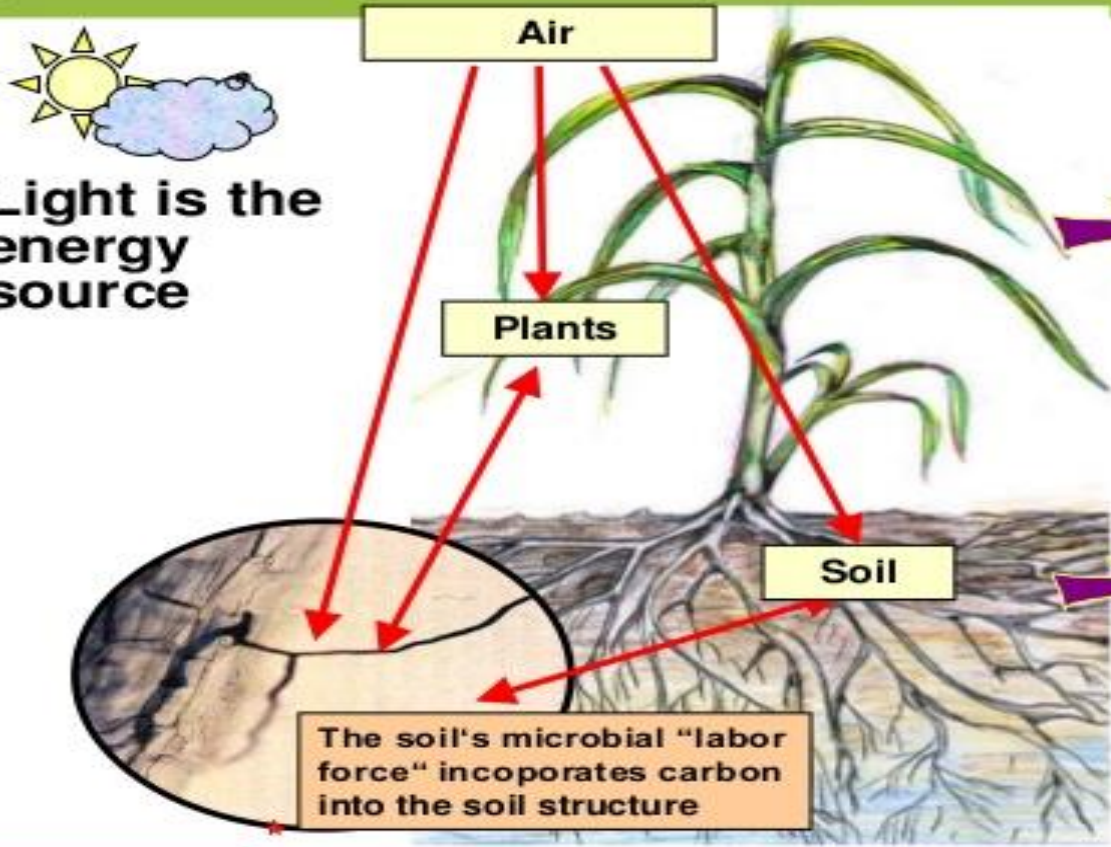
Kessler, J. D., Valentine, D. L., Redmond, M. C., Du, M., Chan, E. W, Mendes, S. D., . . . Weber, T. C. (2011). A Persistent Oxygen Anomaly Reveals the Fate of Spilled Methane in the Deep Gulf of Mexico. *Science*, 331(6015), 312-315. Retrieved from http://science.sciencemag.org/content/331/6015/312.

Healthy Soil And Grasslands Eat Methane

- Specialized microorganisms dominate the global methane cycle.
- Methane-eating microbes (methanotrophs) are virtually ubiquitous both on land and in the sea.
- Capable of removing methane from the atmosphere

  …. “Eating it out of the air.”

Proven Carbon Sequestration



Human nutrition and health starts in the soil, from which plants draw their nutrients

The soil microbial community provides the nutritional building blocks that plants need to grow and thrive

www.rodaleinstitute.org

Maximizing the Potential of Healthy Soil

- Cover crops.
- Deep root perennials.
- Rotational grazing of animals.

Soil Health Is Human Health

- Global health crisis, in addition to global climate crisis.
- We must restore the microbial, fungal and mineral constituents to soil.
- Create humus in the soil as plants grow.
- Food security.
- Carbon sequestration.
- Environmental sustainability.

Nutrient Density Promotes Health

- Hunter-gatherers.
  - Healthier than early farmers and people now.
  - Larger stronger bones, robust and taller.
  - No iron-deficiency.
  - No infection.
  - Virtually no dental cavities.
  - Less arthritis when compared to farmers.
- Diet of wild nuts, berries, fruits, wild game, fish, birds and fungi.
- High in minerals.

Loss of Nutrition

- British Institute of Food Research (IFR) tracks nutrient levels in foods.
- In 1997, researchers looked for changes between 1930 – 1980.
- Mineral content in the food had declined.
  - Vegetables lower in copper, sodium, magnesium, and calcium.
  - Fruits deficient in copper, iron, potassium, and magnesium.
  - Milk 60% iron loss.
  - Meat 60% less copper, 10% less magnesium.

Minerals Make Life Possible

- Macro and trace minerals are essential to life.
- Bacteria and mycorrhizal fungi need minerals to function.
  - Required for nutrient absorption.
  - Amino acid and vitamin production.
  - Magnesium performs 500 functions.
  - Not replaced by manure or compost.
  - Must be returned / added back to the soil.

Mychorrizal Fungi Stores Carbon

- Swedish scientists say carbon sequestration of the Boreal Forest is due to fungi.
- Newer carbon deposits found at deeper levels in the soil.
- *Ectomycorrhizal*, aka mycorrhizal fungi.
- Fungi eats the sugars and expels the residue into the soil.

Clemmensen, K. E., Finlay, R. D., Dahlberg, A., Stenlid, J., Wardle, D. A., Lindahl, B. D. (2015). Carbon sequestration is related to mycorrhizal fungal community shifts during long-term succession in boreal forests. *New Phytologist*, 205(4), 1525-36. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/25494880.

Mycorrhizal Fungi

- Increase crop yield.
- Expand surface absorption area of roots 100 to 1,000 times.
- Release powerful enzymes that dissolve hard-to-capture nutrients.
- Plants have higher rates of photosynthesis, produce higher leaf chlorophyll levels and grow 10-20% faster than non-colonized plants.
- Reduce water stress.
- Improve disease resistance by producing toxins that kill pathogenic fungi and bacteria.
- Generate higher profits and less crop loss for farmers.

Soil Ecosystem

- The largest carbon sink.
- We can increase carbon storage quickly.
- Maintains about 99% of the living biomass on the planet.
- Regulates atmospheric chemistry, global climate, sea level, and water supplies.

Carbon Can Work For Us

- Move CO2 from the atmosphere, where it is most dangerous, to the soil, where it is most stable.
- Provide the greatest ecosystem service benefits.
- Soil will stabilize the climate quickly.

Increase Profits for Farmers

- Reduce farmers' expenses with healthy soil.
  - Reduced need for chemical fertilizers, pesticides and herbicides.
  - Reduce damage from drought and flooding rains - Healthy soil holds more water.
- Increase farmers' crop yields with healthy soils.

Impacts on the Economy

- Increase farmers' profits → Multiplier Effect → spend more money locally.
- Reduce damage from runoff and flooding → farms, parks, lawns, fields & public land will hold more water.
- Reduce use of chemical fertilizers & pesticides on farms, public land, lawns→ Healthier Bay → Increase fishermen's profits.
- Healthier community → Reduced health care costs.

The Solution We Must Focus On

- Putting the carbon back into the soil.
- Using our soil organisms to reduce greenhouse gas emissions, i.e. carbon, methane and nitrous oxide.
- Maximizing our soils' ability to sequester, reduce and eliminate greenhouse gas emissions.

The Most Effective Strategy

- Replenish:
    - Mycorrhizal fungi.
    - Beneficial bacteria.
    - Minerals.
- Use deep root perennials and cover crops.
- Use rotational grazing of animals.

Leaders in the Field

- The Savory Institute http://savory.global/institute/
- Grass-fed Solutions http://www.grass-fed-solutions.com/carbon.html
- Regeneration International http://regenerationinternational.org/
- Rodale Institute https://rodaleinstitute.org/assets/WhitePaper.pdf
- Carbon Underground https://thecarbonunderground.org/

- Chesapeake Center for Regenerative Agriculture
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