NOW THAT YOU KNOW

DAVID HOULE, TIM RUMAGE, BOB LEONARD
THIS SPACESHIP EARTH, INC.

PHOTO: NASA

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We are sure we will meet many more people who work for or with Origina subsequent to the publishing of this eBook, and we look forward to it. As of now we want to thank Hari Candadai and Jennifer Bellemare, who have facilitated this new relationship.

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Introduction

This eBook aims to provide a quick read to let you know what is going on with our climate crisis, why it is occurring and what can be done to address it effectively. The title of the book is also the title of the last chapter. Having spent the one to two hours to read this eBook, you will be prepared to change your thinking and actions, now that you know.

This eBook's genesis is a relationship set up in the first part of 2023. Origina, the global leader in IBM software maintenance, agreed to become the lead corporate supporter of This Spaceship Earth, Inc. (TSE) a global environmental non-profit. TSE looked at the actions and commitments Origina had made and realized that the company was sincere and not just interested in greenwashing or superficial ESG. Origina looked at TSE and saw an entity with the simple message of Crew Consciousness that could align with all of Origina's constituencies.

TSE and Origina agreed that the TSE crew would write an eBook that Origina will help disseminate globally to all their employees, clients and industry thought leaders.

This is the third book the three of us have written about our climate crisis. In 2015 Tim and David co-authored "This Spaceship Earth" The book's success led us to co-found a global non-profit, https://thisspaceshipearth.org/. In 2019 Bob and David co-authored "Moving to a Finite Earth Economy – Crew Manual".

Chapter 1 explains the concept of This Spaceship Earth. Chapter 2 is the Quartermaster's Report on the status of Spaceship Earth's ecosystem. You will read about the state of the planet and the state of the crew, in this case, all of humanity. You will see all the unfortunate and threatening trend lines. We hope this chapter will make you realize the magnitude of our climate crisis.

Chapter 3 explains why all these trend lines are happening and what we can do to course correct these trends. Chapter 4 provides a high-level look at Crew Consciousness and why you might want to become a crew member, not just a passenger on Spaceship Earth.

Chapter 5 sets forth what businesses and other organizations can and should do about our climate crisis (and how to discover opportunities within the climate risks). Chapter 6 explains what individuals can do. Finally, in Chapter 7 we ask you to decide what you are going to do, what your company might decide to do, NOW THAT YOU KNOW.

This book will give you the knowledge you need to understand better our climate crisis today and how you can help to end it. Climate touches everything… so you can take meaningful action no matter what your skills, education, experience, talents, likes/dislikes.

David Houle

Tim Rumage

Bob Leonard

This Spaceship Earth, Inc. https://thisspaceshipearth.org/

May 2023

Chapter 1 – This Spaceship Earth

Spaceship Earth is where all humans live. No other known planet is inhabited or inhabitable by humans… this is our only place. When viewed from space, this planetary home of ours seems a tiny beautiful blue orb in the blackness of space. It is the vessel in which we live, and upon which we can thrive.

R. Buckminster Fuller coined the term Spaceship Earth with his book, "Operating Manual for Spaceship Earth," published in 1969. That book, along with the famous "Earthrise" photo taken on December 24, 1968 by Apollo 8 mission lunar module pilot, astronaut Major William A. Anders, gave us all a true sense of how unique Earth is in the known universe. It should be a reminder of how precious Earth's health is.

If we all think of our planet as a spaceship, we would have a shift in consciousness.

We know of spaceships from the space programs and science fiction. They are a craft of finite space and limited resources in which humans live. The crew has to be efficient as energy, water and food are in limited supply. The craft is self-sufficient only to the extent that the crew and their technology are capable of creating the next generation of resources from the remnants of past generations' used materials. The individuals living on these mobile space islands need to co-exist. Any problem with or on the spacecraft is a liability for all those on board. It is collective and collaborative survival in the extreme.

Now, think of Earth as Spaceship Earth with the same language. It is inhabited by humans (billions more than when Fuller wrote his book). It has a finite amount of resources, so sustainability and efficiency are increasingly important. Water and food are precious. Due to the current human population of 8+ billion and our growing impact on the quantity and quality of resources, humanity is beginning to experience our spaceship's limitations. The air that most breathe is polluted. Much of our fresh water supply is threatened. There are many issues about the food we eat, including over 900 million of us who are undernourished.

Humans now live in ever-closer quarters and need to get along with each other. Everyone on Earth today is downwind and downstream from someone else, so a problem anywhere on the planet, in some way, is a problem for all on the planet.

There is one major difference. While space stations can be refueled and resupplied from the home planet; that is not an option for Spaceship Earth. There is no other planet that can rescue, resupply or serve as refuge for the inhabitants of Planet Earth. The critical difference between the spacecraft of the space programs and science fiction and Spaceship Earth is simply that: we live on a spaceship that must resupply itself from itself. This is why we need to recognize that we are crew not passengers.

Status of Spaceship Earth

In the 21st century, Spaceship Earth faces wicked problems… problems that transcend political boundaries. To solve them, all of humanity must cooperate and collaborate. That is where we are.

As the Quartermaster's Report in Chapter 2 indicates, human beings have exploded in number in the last few decades. There are 300% more humans alive today than in 1950. Our sheer numbers and our consumer societies are stressing all other forms of life on the planet. We are crowding out and making extinct other species at an unprecedented rate. We are experiencing profound changes in weather and sea level. The temperatures are rising. The status of the spaceship has moved into the critical zone.

We continue to live and behave as we have for decades. Yet, there are too many of us to continue on this path. The Industrial Age began when there were only one billion people on Spaceship Earth. At that population size, the Industrial Revolution might have been sustainable at a planetary level. It is not with 8+ billion people.

At this time, we are beyond equilibrium on This Spaceship Earth. A spaceship can only sustain itself if it stays within its resource footprint. As of this writing, humanity is operating at a resource depletion footprint of 1.6 of planets. We are using 60% more planetary resources every year than Nature can replenish. We

crossed the sustainable threshold of 1.0 about 40 years ago. What belief system would lead us to think that a continuation of this trend can result in anything other than disaster? Our historical belief that we are disconnected from each other and Nature… and that we must compete with each other have created our situation.

Yet, we fight with each other. We fight economic battles and military wars. We fight over land, water, energy, religion, race, political philosophies and border boundaries. This is the story of human history. The problem is that we have populated the planet to the point where it is resulting in catastrophe. We risk losing it all.

We can think we are different from each other – we are.

We can have different points of view – we have.

We can hold different religious beliefs – we do.

This sense of separateness has defined us for all of our short (in planetary terms) history. It's OK to have a sense of self-hood and independence. Yet, the reality is that we are all together on Spaceship Earth and we need each other.

We have entered the Shift Age: a time of transition from separation to interconnection.

"With the global economic changes underway and the resultant social changes taking root, we are developing the identity of global citizens. Whether one has come to this new identity through one's line of work or through political or cultural issues, we all, to varying degrees, see ourselves as global citizens. Globalization is no longer simply an economic term. We have entered the global stage of human evolution." – David Houle, from "Entering the Shift Age" (2013)

Now is the time we must radically shift how we view our relationships with each other and Spaceship Earth. Future historians will characterize this era as the time when humanity transitioned from nation state identities to a planetary human consciousness. The only other option is some catastrophic reversal of history.

You may think you are a citizen of a nation. But first and foremost, you reside on Spaceship Earth. We see no nation state boundaries in that photograph of Earth

from space. We all live, work and worship on Spaceship Earth. Unless we evolve to a higher collective consciousness, our long-term existence will be challenged. We have been unconscious passengers on Spaceship Earth. We must move as quickly as possible to thinking of ourselves as conscious crew of Spaceship Earth.

We are now in the fourth age of Modern Humanity.

- *Tools defined the Agricultural Age*
- *Machines defined the Industrial Age*
- *Technology defined the Information Age*
- *Consciousness will define the Shift Age*

  David Houle, "The Shift Age" (2007)

Thinking of ourselves as crew members will lead to a collective change in our behaviors. We all must become active crew members on Spaceship Earth. We need to transition to this dramatically altered sense of self as soon as possible.

What our future will be and how it will unfold is dependent upon our changes in thoughts, actions, behaviors and awareness, coupled with the speed of our transition, without relapse, to crew consciousness.

We have already created a future that is far different from what we have experienced in the last millennium. We have already taken decades of actions, the consequences of which will bring unprecedented change to the planet in the years and decades ahead. Trillions of dollars of losses, billions of lives disrupted, displaced or lost entirely, tens of thousands of species extinguished. Some of this will happen no matter what we do. We've gone too far down the wrong path. But all is not lost. It is not too late to regenerate. Crew consciousness can help.

The mission and vision of this book is to accelerate and globalize our transition to crew consciousness.

As we change from being unmindful passengers to conscious crew members, we need to inventory the status of our spacecraft and assess the implications of our needs and desires related to the quantity and quality of our resource base. We need

this information to ensure that we, the crew, can interact with Spaceship Earth in a way that benefits our home planet and safeguards the longevity of the crew.

Now let’s explore the current status of Spaceship Earth with the Quartermaster’s Report.

Chapter 2 – The Quartermaster's Report

The book, *This Spaceship Earth* was published in December 2015 and co-authored by David Houle and Tim Rumage. We included a Quartermaster's Report to provide a common data set regarding the issues of concern so that the reader could understand why we felt the need for the book and so that the reader could place themselves in a planetary context. Earth is our home planet, and the only known habitable planet for our species. Every place else, you need a space suit if you want to go outside. Here, on earth, you only have to open the door.

In general, the Quartermaster supervises, stores and distributes supplies/provisions as well as being the one responsible for making sure equipment, materials, and systems are available and functioning. This is not about what is preferred or desired, but what is. Therefore, in the world of the Quartermaster, if a 16 ounce glass has 8 ounces of liquid, the glass is neither half full nor half empty – it simply has 8 ounces of liquid.

The purpose of the Quartermaster's Report is to put forth the data that describes the status of the ship – in this case *This Spaceship Earth* (TSE). The reason for taking a planetary perspective is to realign our individual viewpoints and assumptions about resource quantity, quality and demand with that of TSE's current operational capability, capacity and actual status. Inputs, throughputs and outputs need to be in dynamic equilibrium with each other to maintain the life support systems (LSS) of TSE relative to the health of the crew.

Quartermaster's Trend-line Summary, June 2023

- Human Population increasing estimated to be 9.7 billion in 2050 and 10.4 billion in 2100
- Life Support system TSE in decline, not passively reversible
- Air Quality in decline, not passively reversible
- Availability of Safe, Potable Water in decline, not passively reversible
- Habitat quantity, quality and diversity in decline, not passively reversible
- Commercial Fish Stocks in decline, not passively reversible
- Population of non-human vertebrate species in decline, not passively reversible
- Population of assessed plant species in decline, not passively reversible
- Rate of Species Loss increasing, not passively reversible
- Greenhouse Gas Emission increasing, not passively reversible

- Average Global Temperature increasing, not passively reversible
- Sea Level Rise and rate of Sea Level Rise increasing, not passively reversible
- Extreme Weather Events increasing, not passively reversible
- Waste Generation increasing, not passively reversible

Note: “not passively reversible” means that the trend can only be reversed through active engagement and continuous commitment to improve and repair the system.

None of the trend lines have changed direction since the 2015 report

Quartermaster’s Report – June 2023

Crew Onboard

Human population reached 8 billion people on 15 November 2022

Human population: 8,036,357,257 (at 13:05 ET, 1 June 2023)

> In 2015 the net population growth rate was 2.5 people per second.
> In 2023 the net population growth has slowed to 2 people per second.
> In 2015 the world population was 7,426,597,537.
> So, the net population change has been 609,759,720 individuals.

To help put that number in perspective, the population increase since 2015 has been more than the current population of the Tokyo, Delhi, Shanghai, Dhaka, Sao Paulo, Mexico City, Cairo, Beijing, Mumbai, Osaka, Chongqing, Karachi, Kinshasa, Lagos, Istanbul, Buenos Aires, Kolkata, Manila, Guangzhou, Tianjin, Lahore, Rio de Janeiro, Bangalore, Shenzhen, Moscow, Chennai, Bogota, Jakarta, Paris, Lima, Bangkok, Hyderabad, Seoul, Nanjing, Chengdu, London, and Nagoya combined; which are the 37 most populous cities in the world.

Currently 56% of the world’s population lives in cities. To put that into perspective, more people live in cities today than were alive on the planet in 1980.

If the world’s population grows to 10 billion around 2050 as projected, the world will need to produce 70% more food. Without major changes to the food system, that would result in a catastrophic increase in greenhouse gas pollution due to increases in agriculture and deforestation.

Status	Population

Illiteracy	393 million in 2023 up from 122 million youth crew members in 2015
Lacking minimum literacy skills	781 million in 2023 up from 775 million adult crew members 2015. Nearly 2/3rds are female
Go hungry/Chronically undernourished	828 million in 2023 up from 805 million in 2015 crew members
Overweight	1.9 billion in 2023 up from 1.3 billion in 2015 crew members
Obese	650 million in 2023 up from 600 million in 2015 crew members 18 and older
Overweight or obese	39 million in 2023 down from 42 million in 2015 crew members aged 5 or younger
No access to clean water	2 billion in 2023 up from 783 million in 2015 crew members
Not enough access to clean water for adequate sanitation	3.6 billion in 2023 up from 2.5 billion in 2015 crew members
No access to safe and affordable surgery	Over 5 billion in 2023 up from 4.8 billion in 2015 crew members
Asthma	334 million crew members in 2023 – the number is unchanged from 2015
No access to electricity	770 million in 2023 down from 1.3 billion crew members in 2015
Rely on the use of biomass for cooking	3 billion in 2023 up from 2.7 billion 2015 crew members

Status of the Life Support System of TSE

Air Quality

- 99% of the global population breathes air that exceeds World Health Organization (WHO) air quality limits.
- In 2015, 1 in 8 global deaths is attributable to air pollution exposure.
- In 2023, 1 in 5 deaths worldwide was attributable to air pollution.
- In 2015, air pollution was considered the largest single environmental health risk and it remains so in 2023.
- More people die from air pollution exposure than die from breast, lung and colorectal cancers combined.
- Air pollution was also linked to low birth weight in babies, miscarriages, pediatric cancer, asthma attacks, and reduced fertility in both males and females.
- Air pollution is associated with increases in stress, psychological distress, risk of dementia, Alzheimer's, depression, schizophrenia, bipolar disorder and personality disorder.

Water Availability

- All the water that will ever be on Earth already exists. Earth does not "make new water," it recirculates water.
- The total volume of water of Earth/TSE is estimated at 1.386 billion km^3 (333 million cubic miles), with 97.5% being salt water and only 2.5% being fresh water.
- Of the fresh water, only 0.3% is in liquid form on the surface.
- Of all the Earth's water 1.7% is ground water which represents 30.1% of the freshwater supply.
- With every 1°C (1.8°F) increase in temperature, the atmosphere can hold 7% more water.
- Water is increasingly in short supply due to growing demands from agriculture, an expanding population, energy production, industry, Global Warming and Climate Change.
- 2 billion people on TSE lack access to safe drinking water (up from 1 billion in 2015).
- 3.6 billion people lack adequate sanitation services.
- 700 million people suffer today from water scarcity.
- 2.7 billion find water scarce for at least one month of the year.
- Agriculture uses 70% of the world's accessible freshwater.

Water Quality

- Annually 3,535,000 people die from water related diseases – 2.2 million of them are children.
- As of 15:17 hrs. on 1 June 2023, there were 5,198,708,354 people who did not have access to sewage systems.
- Unsafe water generates 4 billion cases of diarrhea per year resulting in 2,200,000 deaths per year – mostly in children under the age of 5.
- Every day, 2 million tons of sewage and other effluents drain into the world's waters.

We add 800,000,000,000,000 plastic microbeads to the wastewater treatment system every day in the USA. An estimated 8 trillion of those microbeads are discharged into aquatic environments daily. The remainder of the microbeads are trapped in the solids or sludge of the settling tanks and may re-enter the environment depending upon how the solids and sludge are processed.

Every year, more people die from unsafe water than from all forms of violence, including war.

Water Use

Average per capita daily water use:

USA	310.4 liters	(82 gallons)
Ireland	148 liters	(39.1 gallons
France	150 liters	(39.6 gallons)
China	180 liters	(47.6 gallons)
Australia	159 liters	(15.6gallons)
Kenya	37.9 liters	(10 gallons) for a Kenyan resident
Kenya	189 liters	(50 gallons) for a European resident

Average per capita daily water footprint:

USA	7800 liters	2060.5 gallons
Ireland	3600 liters	951 gallons
France	4900 liters	1294.4 gallons
China	2900 liters	766.1 gallons
Australia	6300 liters	1664.3 gallons
Kenya	3000 liters	792.5 gallons

A water footprint is the volume of water needed to produce the goods and services we used, (i.e. the water used to make your electricity, the food you eat, the clothes you wear. The measurement includes the water consumed and the water polluted in the various processes.

Virtual Water

How much water does it take to make:

1 pound of beef requires 1,799 gallons of water, which includes irrigation of the grain and grasses in feed, plus water for drinking and processing.

1 slice of bread requires 11 gallons of water.

1 gallon of beer requires 68 gallons of water,

1 gallon of wine requires 1,008 gallons of water (mostly for growing the grapes).

1 cup of apple juice requires 59.4 gallons of water to produce

1 cup of orange juice requires 53.1 gallons of water

1 pound of chicken requires 468 gallons of water.

A 2-liter bottle (67.6 ounces or 0.53 gallons) of soda/soft drink requires 132 gallons of water.

1 pound of soybeans requires 216 gallons of water.

1 egg requires 53 gallons of water.

1 cup of milk requires 54.9 gallons of water

1 pound of chocolate requires 3,170 gallons of water.

1 cup of tea requires 7.9 gallons of water

Virtual water (also known as embodied water) refers to the water needed to produce food and other goods.

1 microchip requires 32 liters (8.5 gallons) of virtual water.

A smartphone requires 910 liters (240.4 gallons) of virtual water.

A computer requires 20,000 liters (5883.4 gallons) or more of virtual water.

To make 3785.4 liters (1,000 gallons) of ultra-pure water used in making semi-conductors requires 5299.6 to 6056.7 liters (1,400 to 1,600 gallons) of municipal water.

It takes17,000 to 29,000 liters (4491 to 7661 gallons) of water to produce 1 kilogram (2.2 pounds) of raw cotton.

One cotton t-shirt requires 2,700 liters (713.3 gallons) of water.

One pair of cotton blue jeans takes 37,786 liters (9,982 gallons) of water.

Quartermaster's Note

Water is probably the most viewed, used and touched resource that is mentally invisible. We don't think of it collectively, cumulatively or continuously – yet we use it and need it all the time. We use it to make electricity, we use it for health and hygiene. We need it to make clothes, grow our food, and quench our thirst. Some go to the water to relax and recover while others go there to work and provide for their families. Water is a habitat, a connector, a means of transport and a mystery. Water is a means to cleanse. It also has been a way to reduce harm as in – "the solution to pollution is dilution".

Perhaps one of our greater misdeeds was taking water for granted. Now we have water contaminated with industrial chemicals, agricultural runoff, organic waste, pharmaceuticals, synthetic hormones, pesticides, PFAS (per- and polyfluoroalkyl substances), antidepressants and

plastics. Water, in too many places, is 'safe-by-definition.' Meaning that standards have been established for very specific chemicals, and if concentration of the tested chemicals do not exceed the standard, then the water is safe to drink. But there are so many chemicals that we are not required to test for and/or have no established safety standard.

We also need to be sensitive to the reality that climate change is altering the water cycle and altering the seasonality, frequency and volume of precipitation

This planet does not create water. It collects it, filters it, bioremediates it, redistributes it and recirculates it. Perhaps that is a model we should more fully embrace.

Land Use

- Humans have altered 97% of the Earth's land surface.
- Only 3% of the world's ecosystems are biologically intact
- 71% of the land on the planet is habitable. Of that 50 % is used for agriculture.
- 77% of the agricultural land is used for livestock and 23% is used for crops.
- In 2020, 35% of the corn crop in the US went to animal feed, 31% to biofuels, 32% to industrial uses and 2% was for human consumption.
- 33% of the croplands on TSE are used for livestock feed production.
- In 2015 loss of arable land is 46,332 sq. miles/year (12,000,000 hectares/year) due to drought and desertification. This rate is 30 to 35 times the historical rate.
- 1n 2023 the loss is greater at 19,131,840 hectares/year.
- Half of the topsoil on TSE has been lost in the last 150 years.
- Rate of deforestation: 46,000 to 58,000 square miles per year (11 to 15 million hectares/year).

Livestock Population

- In 2023 there are 34.4 billion chickens in the world, up from 19 billion chickens in 2015.
- In 2022 the pig population was 784 million, goat and sheep populations were each over 1 billion animals, and the cattle/cow population was approximately 940 million.

Habitat Change

- Forest Loss Between 1990 and 2010 was 15.5 million hectares per year.
- Forest Loss between 2010 and 2015 was 12 million hectares per year a 22.58% decline compared to 1990 to 2010.
- Forest Loss Between 2015 and 2020 was 10 million hectares per year. A 48% decline for 2015 to 2020 compared to 1990 to 2010 and a16.67% decline compared to 2010 to 2015.

But in 2020 Forest loss was 25.8 million hectares, double the amount of forested land lost in 2001.

The global rate of Soil Erosion is currently 19,296 hectares per day (47,681 acres per day).

The global rate of Desertification is currently 33,120 hectares per day (8,1841 acres per day).

(Desertification is the process by which fertile land becomes desert, generally because of drought, deforestation or inappropriate agriculture.)

The Amazon Rainforest

More than 20% of the Amazon Rainforest has been deforested which has changed its role in the Carbon Cycle. The Amazon Rainforest used to be a 'carbon sink' which sequestered carbon, but now it is a 'carbon source' releasing more CO_2 into the atmosphere than it sequesters. Deforestation has also reduced the volume of rain that falls in that environment. The rising temperature in the deforested portion of the Amazon from the loss of shade combined with the loss of precipitation means the revegetation of the deforested area will create a savannah habitat (a grassy plain with few trees) not the recovery of the rainforest.

The global rate of Toxic Chemical release into the environment is 18.7 tons per minute.
The global rate of Carbon Dioxide (CO_2) emissions into the atmosphere is 69,837 tons per minute.

Species

- The population of non-human vertebrate species has declined by 68% since 1970.
- Currently, 25% of all mammal species, 12.5% of all bird species, 50% of all amphibian species, and 70% of all assessed plant species are considered threatened or endangered.
- 40% of global insect populations are in decline and 1/3rd are endangered.
- Population of North American birds has dropped by 2.9 billion individuals since 1970.
- Many species of mammals have lost 80% of their former range land in the last century.

Crops and their Wild Relatives at Risk from Global Warming and Climate Change

coffee
chocolate
honey
avocados
wine (production of wine is estimated to be reduced by 80% by 2100)
strawberries
bananas
wild cotton
wild beans

Quartermaster's Note

The losses of habitat and species should be viewed at both the individual level, as well as for their collective and cumulative impact. 87% of all plants need animal pollinators – many of which are insects. It is estimated that 1 in 3 bites of the food we eat is provided by pollinators.

With crops, not only are yields at risk from rising temperatures, changing precipitation patterns, extreme weather events, changes in soil/habitat ecology, and changes in pathogens generated by Global Warming and Climate Change but so are the wild stocks which we have historically sourced.

We may have preferences and prejudices regarding certain plants, animals, mushrooms, insects, seafood, and other lifeforms. What we tend to overlook is that healthy environments are not about what we like… but about what we need to maintain healthy environments.

Biomass

Biomass is the product of population size by average body weight. It serves as an indicator of how much caloric energy a population needs as well as helping define the key species in an ecosystem.

Looking at the Biomass of mammals only:

36% of the mammal biomass is Humans,

60% of the mammal biomass is our Domesticated mammals (livestock, work animals and pets), and

4% of the mammal biomass is Wild mammals (Lions and Tigers and Bears, oh my, along with squirrels, moles, voles, etc.)

If we apply the concept of Biomass to the built environment, and estimate the population and weight of all buildings, homes, road, arenas, transportation hubs, and infrastructure we have built, the Biomass of our built environment is approximately, and currently, equal to the total Biomass of all living things on earth.

But what is more significant is that the biomass of the built environment doubles every 20 years and has done so since 1903.

Quartermaster's Note

The 2012 estimate for global anthropogenic CO_2 emissions was 34,500,000,000 tonnes,
which is the equivalent of launching **273 elephants per second** into the air for an entire year (assuming an average elephant body weight of 4 tonnes).

In 2022, the global energy related CO_2 emissions were 36.8 billion tonnes, or the equivalent of launching **292 elephants/ sec** into the air.

If you saw somebody launching 292 elephants into the air every second for a year, and then increased the number of elephants they were launching every second for each-and-every subsequent year, that you might have some questions about the wisdom and rationale of such activity. Especially when you looked skyward and saw more and more elephants floating over your head for decades, generations, centuries, and millennia.

Unfortunately, CO_2 is odorless, colorless, tasteless and invisible. That is a major part of the problem. CO_2 is undetectable by our sensory system. We can sense climate change as it becomes a driver of environmental change, but we are blind to it in the early causal stages. As such it becomes difficult for many people to make the Greenhouse Gas Connection to the events at hand.

Tons vs. Tonnes

(There are three measures of ton or tonnes. There is the US ton or short which weighs 2000 pounds. There is the English ton or long ton that weighs 2200 pounds and then there is the metric tonne

which weighs 2204.62 pounds. In this report you will see references to tons meaning the US short ton of 2000 pounds (907.185 kilograms) or metric tonnes of 2204.62 pounds (1000 kilograms). So 1 metric tonne = 1.102 US tons, and 1 US ton = 0.907 metric tonnes. Which ton/tonne comes first is determined by the unit that the data was originally reported in.)

Greenhouse Gases (GHGs)

And their Global Warming Potential (GWP) and Atmospheric Lifetime (ALT)

There are 3 individual gases and 1 family of gases that are of major concern relative to GHGs.

They are:

Carbon Dioxide (CO_2) with a GWP of 1 (SAR) or 1 (TAR) and an ATL of 300 to 1000 years

Methane (CH_4) with a GWP of 21 (SAR) or 23 (TAR) and an ATL of 12 years

Nitrous Oxide (N_2O) with a GWP of 310 (SAR) or 296 (TAR) and an ATL of 121 years

Fluorinated Gases (HFCs, PFCs, SF_6, and NF_3) with a range of GWP and ATL from the lowest HFE-8200 (a synthetic cleaning agent) with a GWP of 55 (TAR) and an ATL of 0.8 years to the highest Sulphur Hexafluoride (SF_6) with a GWP of 23,900 (SAR) or 22,000 (TAR) and an ATL of 3,200 years.

Quartermaster's Note

Greenhouse Gases include a wide range of chemicals, both natural and synthetic, which have different hangtimes in the atmosphere and different abilities to capture heat. To make comparisons between the different chemicals, the International Panel on Climate Change (IPCC) based the heat trapping of the different chemical on a 100-year timeline. The GWPs were first publish in **SAR, the IPCC Second Assessment Report published in 1995.** The GWPs were then refined, expanded and updated in **TAR, the IPCC Third Assessment Report published in 2001.** While most countries report their data using the TAR numbers, some like the US, still use the SAR numbers so both have been included.

CO_2 and CO_2 Equivalents

Because Carbon Dioxide (CO_2) has been the focal molecule of Global Warming conversations, it is the chemical most publicly tracked and reported. But to better understand the risk of Global Warming, it is important to understand the collective impact of all the gases released into the

atmosphere that have GWPs. That is where CO_2 equivalents (CO_{2eq}) come into play. Using the TAR data, Methane has a GWP of 23 and Nitrous Oxide has a GWP of 296. The translation is straightforward. Releasing 1 molecule of methane has a GWP equivalent to releasing 23 molecules of CO_2, while releasing 1 molecule of Nitrous Oxide has the GWP of releasing 296 molecules of Carbon Dioxide. How much of a difference can this make? Plenty.

Looking only at CO_2 data, the amount of CO_2 released into the atmosphere this year as of 17:15ET on 4 June 2023, was 15,478,219,482 tons according to Worldometer.
However, if one looks at the data for greenhouse gas emissions (CO_2 and all the other GHGs) at that same time, the CO_{2eq} was 24,856,515,000 tons according to the World Emissions Clock. That is a difference of more than 9 billion tons or about the same amount of CO_2 that the world released into the atmosphere in 1960.

Greenhouse Gas Emissions and Atmospheric Accumulation

	CO2 fossil fuels	CO2 land use change	CO2 total	CO2 Equivalent	CO2 average annual atmospheric level PPM	CO2 equivalent average annual atmospheric level PPM
2015	35.5	4.8	40.3		401.1	
2016	35.5	3.7	39.2		404.41	
2017	35.9	3.7	39.5		406.76	
2018	36.6	3.9	40.5		409.72	
2019	36.7	3.8	40.5		411.66	
2020	34.8	3.2	38.0	56.0	414.45	465 PPM
2021	37.9	3.2	41.1	57.5	416.45	
2022	36.8	3.9	40.7	57.8	418.56	

Data is reported in Gigatonnes (billions of tons)

CH_4 is at 260% of pre-industrial levels and rising.

N_2O is at 123% of pre-industrial levels and rising.

Carbon Neutrality

The concept of Carbon Neutrality, or net zero emissions, is that humanity will limit the amount of carbon dioxide released into the atmosphere to the same volume of carbon dioxide that can be sequestered in the same year. It is a noble goal and one that is consistent with our concept of

how the planet naturally recycles carbon to maintain dynamic equilibrium and, for us, livable environments and climates.

Quartermaster's Note

With the news reporting on wildfires, floods, droughts and extreme weather events, why is so much focus being put on Carbon Dioxide and other Greenhouse Gases? Simple. Carbon Dioxide and the other Greenhouse Gases are the heart of the matter. We cannot, and will not, resolve any of the climate issues without significantly changing our relationship and dependency on fossil carbon and other Global Warming chemicals.

Humans have been on Earth for 350,000 years. For most of that time Resident Carbon Dioxide (the amount of CO_2 in the atmosphere) ranged between 180 ppm and 280 ppm. Today, 4 June 2023, the CO_2 level in the atmosphere is 422.73 ppm. That is 142.73 ppm above the peak level during the time in which we created literature, art, cities, culture and agriculture. And our current lifestyles and lifeways are causing an ever-increasing concentration of Greenhouse Gases in the atmosphere.

Humans, for the most part, no longer live on contemporary local resources. We import much of the food we eat, water we drink, clothes we wear, energy we use, medicine we take and products we buy. It is a global economy. And to make that economy work, we heavily rely on fossil carbon. We burn it as part of the process to generate electricity. We burn it to generate our transportation fuels. We do multiple things to it to generate and distribute the foods we eat. It is our extensive use of this ancient necrosphere by which once living organisms became coal, oil and natural gas that is the source that culminates in the accumulation of heat trapping gases in our atmosphere.

We generate the material needed to cause global warming. And global warming triggers climate change. Heat is the transfer of energy from one entity to another while temperature is a measure of the energy in an entity.

The result is that by emitting GHGs that trap heat we generate Global Warming. Global Warming can trigger rising temperature, extreme weather events, marine heat waves, glacier melt, change in air currents, etc., which can cause sea level rise, changes in the water cycle, crop loss, droughts, etc. which then leads to habitat loss, biodiversity loss, changes in Human Health issues, etc. which can trigger a climate catastrophe which can destabilize populations, governments, economic systems, etc. and exacerbate a wide range of social and environmental problems. The quality of our lives, our social frameworks and our economic and political viability are based on the vitality of the environment and our ability to work within its constructs.

Climate

Since the industrial revolution:

- Atmospheric CO_2 has risen from 277 ppm to 424.65 ppm (31 May 2023). The increase in CO_2 has not been linear.
- From 1850 to 1950, CO_2 levels rose from 288 ppm to 315 ppm, an increase of 27 ppm over 100 years.
- From 1950 to 2015, CO_2 levels have risen from 315 ppm to 401 ppm, an increase of 86 ppm in 65 years.
- In 1950, CO_2 emissions were just over 6 billion tonnes per year.
- In 2015, CO_2 emissions were 34.5 billion tonnes per year.
- In 2022, CO_2 releases to the atmosphere were 50 billion tonnes.

Quartermaster's Note

Countries are required to report only anthropogenic emissions of CO_2 from fossil fuel combustion and industrial processes (CO2-FFI), net CO_2 emissions from land use, land-use change and forestry (CO2-LULUCF) and the anthropogenic emissions of Methane, Nitrous Oxide and Fluorinated Gases.

There is no requirement to report non-anthropogenic emissions such as outgassing from the ocean, decomposing vegetation/biomass, emissions from naturally occurring wildfires, net emissions changes from soil communities, etc.

Some data is difficult to gather or gather consistently across regions and national boundaries such as CO_2 from land use changes and forestry as well as Fluorinated-Gases. There can be leakage of GHGs facilities that can lead to significant undercounts – IEA reports that Methane emissions are 70% higher than official figures. And releases of CO4 and CH4 from permafrost could range from 14-175 gigatonnes per 1^{o}C (1.8^{o}F) according to a recent IPCC Assessment Report.

As such, it may be prudent to consider the reported data as a best underestimate, and that the rate of Global Warming and Climate Change can proceed faster than current projections.

New Record for CO_2

In May 2023, the level of atmospheric CO_2 reached a new record of 424 ppm. The last time Earth had a CO_2 level that high was 3 million years ago. At that time, average air temperature

ranged from 2.5-4ºC (4.5-7.2ºF) above today's average air temperature and sea level was 16.2 meters (53feet) higher.

Carbon Budget and the Paris Agreement

At COP 21 in Paris in 2015, a legally binding international treaty on climate change was adopted by 196 parties 12 December 2015. The Agreement went into legal force on 4 November 2016. The goal of the agreement was to limit the average rise in temperature to well below 2ºC (3.6ºF) and to strive to limit average temperature rise to 1.5ºC or (2.7ºF) above pre-industrial levels.

To accomplish the goal of limiting average temperature rise to 1.5ºC, global greenhouse gas emissions would have to peak by 2025 – at the latest – and then CO_2 emissions would have to be limited to a total of decline by 43% by 2030 and continue to decline to reach zero emission by 2050.

So how many gigatonnes of CO_2 can we add to the atmosphere and still have a 50:50 chance of holding the average temperature rise to 1.5ºC of pre-industrial levels? In 2020 the IPCC Working Group estimated the carbon budget (the amount of CO_2 that could be released and still meet the goal) was 500 gigatonnes of CO_2. By the start of 2023, the remaining carbon budget was 380 gigatonnes of CO_2. Unfortunately, the cumulative emissions of CO_2 from existing and planned fossil fuel infrastructure to 2030 was 780 gigatonnes for the same timeline.

We are currently on track for average global temperature to rise by 1.5ºC in the early 2030s, pass the 2ºC mark by 2050 and be 2.7ºC (4.86ºF) hotter in 2100. All these estimates would be higher and faster if the calculations were based on CO_2 equivalents of Greenhouse Gas Emissions.

Heat Index

Temperatures are considered dangerous when they exceed 40°C (103°F) and extremely dangerous when they exceed 51°C. These are the thresholds used to predict habitability in the future.

Between 1979 to 1998, the dangerous Heat Index threshold was exceeded in the tropics and subtropics on 15 % of the days each year.

By 2050, in tropical regions, the dangerous Heat Index could be exceeded on 50% percent of the days each year.

By 2100, the dangerous Heat Index could be exceeded on most days and about 25% of those days could exceed extremely dangerous thresholds.

Climate Change Is Exacerbating the Spread of Disease

According to the CDC's National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), the warming climate causes ticks, mosquitos and other animals (and the infectious diseases they carry) to expand their geographical range and infect new populations.

The change in climate may also permit Harmful Algae Blooms (HABs) to occur in more areas and/or last longer making more people sick.

Even fungal diseases are spreading into new locations as climate changes now allow them to thrive in areas that previously would not permit their survival.

A report in European Respiratory Review indicates that the warming climate can directly and indirectly promote or aggravate respiratory diseases by increasing the amount of pollen, plant allergens and mold, and by worsening air quality.

The Marine Environment

The marine environment is probably the best place to show how interconnected and interactive global warming, climate change and human activity truly are. 92% of the excess heat generated by global warming resides in the ocean. The top 700 meters (2,300 feet) has warmed by 1.5^{o}F since 1901. That may seem like a small temperature change but think about how much heat it would take to raise a volume of water of roughly 319 billion cubic miles by 1.5^{o}F.

As air temperature and water temperature rise, glaciers melt faster, which sets the stage for sea level rise (SLR). The two causes of SLR are the addition of land-based melt water and the thermal expansion of water from its maximum density. For fresh water, maximum density is 3.98^{o}C. As water temperature increases or decreases from that point, water expands and takes up more space. Functionally this is a double hit. Higher temperatures mean more ice turns to water faster and the resulting water takes up more volume. Density of seawater is more complex as its density is a function of temperature, salinity and pressure.

As the surface of a glacier melts it can be colonized by algae. As the algae is pigmented, it absorbs more heat than the surrounding glacier and can add to an increased melt rate. The same results occur when dust or other dark material falls on the glacier. As the width of the glacier narrows and as the water warms, the darker areas that used to be ice covered increases the heat

level around the glacier causing enhanced glacier melt, as does the darker ocean water. The surface water on the glacier can also lead to the formation of moulins which bore through the glacier and can act as a lubricant allowing the glacier to slide faster towards the sea.

Melt water has another important impact to consider. And that is the addition of fresh water from the glaciers changes the salinity and thus reduces the density of the ocean water. By reducing the density, the rate at which surface water sinks slows down. This impacts the strength of the ocean currents it generates which impacts the nutrient load it can carry and distribute.

The nutrient load impacts the biomass of algae and phytoplankton which impacts the biomass of marine herbivores and the subsequent levels of carnivores and apex predators, as well as the amount of fish available for human consumption. Fewer available nutrients mean less food for everything and everybody else.

The changes in density and the warming of the ocean have also increased the stratification of the ocean which has limited the vertical flow of nutrients.

There are 2 other marine concerns of note – marine heat waves and dead zones. Species have a thermal neutral zone – an ambient temperature at which they are most physiologically efficient. As temperatures depart from that preferred zone, the organisms need to acquire more food to have the energy to maintain themselves. If the rate or scale of temperature change is too great or lasts for too long a period of time, the species will need to relocate, or higher numbers of individuals will die. One heat wave in British Columbia in July of 2021 killed one billion intertidal organisms. Another marine heat wave in 2015/16 killed an estimated 1 million seabirds in the Pacific Northwest. The working hypothesis at present is that the birds were out eaten by fish resulting in the birds starving. As the sea surface temperature rose, the fish needed to eat more prey to have the energy to regulate their physiology. Cod fish only need to eat the equivalent of 1% of their body weight per day while birds need to consume 50% of their body mass per day.

Compounding the issue for the birds is that the heat wave can cause a redistribution of their prey resulting in the foraging individuals having to spend more time and energy seeking food. This can mean the chicks are more vulnerable to predators and the weather at the nesting colony, reducing chick viability and successful recruitment.

An ongoing effect of warming is species moving towards the poles or deeper in the ocean to find their thermal neutral zones. This could also impact the phenology (sequence of events) of marine communities as predators and prey may disperse or breed at different times as each species responds to different environmental cues.

Dead zones are marine areas where the oxygen level is too low to support the marine community that once lived there. Dead zones can be the result of sediment runoff or nutrient loading as well as changes in temperature and salinity. The term dead zone may not be the best mental construct for thinking about these sites, for they are not dead as much as they are different. There are bacteria and algal mats that can successfully live in these zones. A more appropriate concept may be to think of these areas as new ecosystems and acknowledge that we have helped create an ecological system that supports hypoxic species (organisms that need and can dominate low oxygen environments). After all, hypoxic is a relative measurement based on the oxygen levels we prefer.

These same environmental factors of temperature change, salinity change, light and spectral penetration, rate of sea level rise, nutrient load and water chemistry apply to other habitats and communities like coral reefs.

I suspect this is what John Muir meant we he said, "*Tug on anything and you find it connected to the rest of the universe.*"

There are two other major reasons we should care about the ocean. First, 70% of the oxygen we breathe comes from the phytoplankton in the ocean. Second the ocean absorbs 25% of our CO_2 emissions. A reason to be worried about the oceans – phytoplankton levels may have dropped 40% since 1950 due to ocean warming.

Carbon Balance

For the bulk of human existence, the amount of CO_2 that was released to the atmosphere was balanced by the amount of CO_2 that was sequestered by plants and soil microbial communities on shore and algae and photosynthesis organisms in the ocean. Before the industrial revolution, atmospheric CO_2 was 277 ppm. With the industrial revolution and our increasing use of coal, we can see a slow and gradual rise in atmospheric CO_2. It is not until the 1950s that we begin the dramatic rise in atmospheric CO_2. Up until that time the environment appears to have had the capacity to take up and utilize our increasing emissions.

We know that plants can uptake CO_2. It seemed logical, therefore, that trees would/should be able to sequester much of the CO_2 we were going to release. Some studies suggested that exposing trees to more CO_2 caused them to grow faster. And they did, to a point. Growing requires a mixture of multiple inputs that must be balanced with each other in quantity over a period of time. As atmospheric CO_2 became more plentiful trees could grow faster until some other element in the water and nutrient mix of the tree became the limiting factor in growth.

Additionally, there were two other impactful events occurring. One was deforestation and the other was the rapid development of the built environment. Deforestation would have a visible and environmental impact on habitat quantity and quality, as well as reducing the ability of the impacted region to sequester CO_2. The less obvious impact (to many) was the loss of the soil microbial community. That is where much of the CO_2 was being sequestered. As we continued to turn soil into dirt during our building projects and forest removal, we were changing the dynamics of the entire carbon cycle. Yet on the economic side of our field of view, we were making progress as we converted fossil carbon into chemicals, products, and CO_2. And since we use the growth of the economy as our central, if not only, measure of prosperity… we kept going.

But the constant take, by us, of the environment's ability to sequester carbon is a key factor in generating the predicament we find ourselves in today. And this brings us, in part, to Ocean Acidification.

Ocean Acidification

We have changed the temperature structure of the ocean which in turn has changed the make-up of marine life. There appears to be a successional change in the ocean in which once primary or plentiful species, from humanity's perspective, are in decline and are being replaced by other species. But the crucial factor for this section of the report is that some of the CO_2 being absorbed by the ocean is not being biologically sequestered but is reacting chemically with the ocean environment. So rather than having the carbon of CO_2 being used to promote physiological growth of organisms, and the oxygen being released into the ocean, the CO_2 is directly interacting with the water (H_2O). This has always been a part of ocean chemistry, but with increasing amounts of CO_2 being released into the atmosphere this type of interaction is becoming more prevalent.

(Yes, we are going to do a little chemistry right now,
but you will successfully get through it.)

The key players in this discussion are Carbon Dioxide (CO_2), Water (H_2O), Carbonic Acid (H_2CO_3), Carbonate Ion (CO_3), Bicarbonate (HCO_3), Hydrogen (H^+) and Calcium (Ca^+).

First, we put the CO_2 and the H_2O together and we create Carbonic Acid (H_2CO_3). We have the same number of Hs, Os, and Cs on both sides of the equation. However, H_2CO_3, which is a weak acid, and is not a structurally stable compound. As a result, one of the Hydrogens (H^+) disassociates (breaks off/away) from the H_2CO_3 and we end up with Bicarbonate (HCO_3^-) and a free hydrogen (H^+).

But what happened to the Calcium (Ca)? And therein lies the problem. To make their shells, marine organisms need Calcium Carbonate ($CaCO_3$).

The more Carbon Dioxide (CO_2) the ocean absorbs, the more Carbonate Ions ($CO_3^{-)}$ are converted to Bicarbonate (HCO_3) and a free Hydrogens (H^+). As a result of the increase in free Hydrogen, the ocean becomes more acidic. The fewer Carbonate Ions there are, the more difficult it is for marine organisms to make their shells. The more acidic the water becomes, the greater the potential for the shells to be dissolved by the acid especially if their shells are not thick enough to protect them. That results in those species having an increased mortality rate and lower recruitment rates, which lead to a more fragile food web.

Quartermaster's Note

The pH scale runs from 0 to 14 and is used to measure Hydrogen ion (H^+) activity. The more acidic a chemical is, the lower its pH reading (closer to 0). The more alkaline a chemical is, the higher its PH reading (closer to 14). On this exponential scale, 6 is ten times more acidic than 7, and 5 is 100 more acidic than 7.

Aquatic and Marine Environments

- The ocean had a pH reading of 8.2 and now it is 8.1. But given the logarithmic nature of the scale, that slight numerical difference means that the ocean has become 30% more acidic in the last 200 years – faster than any change in ocean chemistry in the last 50,000,000 years.
- The pH level of the ocean is projected to be 7.8 by 2100.
- Marine vertebrate populations have declined by 49% between 1970 and 2012.
- Tropical Reefs have lost more than half their reef-building corals over the last 30 years.
- Globally, there are 405 dead zones (places with too little oxygen to support marine life) in coastal waters. Collectively, they comprise an area of 95,000 square miles and the number of dead zones increased by 33% between 1995 and 2007.
- Rate of ocean warming has quadrupled since late 20th century.

Fish Stocks

- Overexploited/depleted stocks are at 29% (up from 10% in 1974).

- Fully exploited fish stocks are at 61% (up from 51% in 1974).
- Non-fully exploited fish stocks are at 10% (down from 40% in 1974).
- Populations of the fish family that include tuna, mackerel, and bonito, have fallen by almost 75% since 1970.

Ocean currents near Antarctica could slow by 40% in the next 30 years unless significant cuts in GHG emissions are made. Those currents support about 75% of the global phytoplankton production, the base of the food chain.

Global ocean oxygen losses from 1960 to 2010 were approximately 2%.

"As the warming ocean loses oxygen, the delicate balance of marine life is thrown into disarray." – Dr. Grethel Aguilar, IUCN acting director general

Surface Ocean Salinity is dynamic and is influenced by the volume of rainfall. Regions with less rain become saltier and places with more rain become less salty.

Sea Level Rise (SLR)

Antarctica loses 25,000,000 tons of ice an hour – that is a faster flow rate than Niagara Falls.

Greenland is melting 100X faster than previous estimates. The Greenland Ice Sheet is estimated to contribute 50cm/20 inches of sea level rise due to melting by 2100.

Sea Level Rise in the next three decades is anticipated to be:

10 - 14 inches (0.25 - 0.35 meters) for the East coast.

14 - 18 inches (0.35 - 0.45 meters) for the Gulf coast.

4 - 8 inches (0.1 - 0.2 meters) for the West coast.

8 - 10 inches (0.2 - 0.25 meters) for the Caribbean.

6 - 8 inches (0.15 - 0.2 meters) for the Hawaiian Islands.

8 - 10 inches (0.2 - 0.25 meters) for northern Alaska.

SLR of about 2 feet (0.6 meters) along the U.S. coastline is likely between 2020 and 2100 because of GHG emissions to date. Failing to curb future emissions could cause an additional 1.5

to 5 feet (0.5 - 1.5 meters) of rise for a total of 3.5 to 7 feet (1.1 - 2.1 meters) by the end of this century.

Assuming a low level of carbon emissions over the next 80 years, 190 million people currently live in areas that will be underwater by 2100. If emissions are high, that number grows to 630 million people.

Sea Level

- Prior to 1900, sea level in the modern era had been relatively constant.
- From 1900 to 1990, tide gauge data indicates that sea level was rising at approximately 0.047 inches per year (1.2 mm per year).
- From 1990 to 2010, sea level rose at a rate of 0.12 inches per year (3mm per year) or 2.5 times faster than it had in the previous 90 years.
- In 2015, Global Mean Sea Level had risen 4 to 8 inches since 1900.
- Current projections indicate that Global Mean Sea Level will rise by another 12 to 18 inches by 2045.

Average Global Temperature

- The average global temperature in 2014 was 58.42 F (14.68C), which was 1.22 F (0.68 C) above the 1951 to 1980 average.
- 2014 marked the 38th straight year in which the global average temperatures were above the 20th century average.
- May, June, August, September, October, and December of 2014 were all the warmest months on record, globally… until June of 2023, which is the now the warmest month since record keeping began.
- The amount of warming is not uniform across the planet, with the greatest warming occurring between 40N and 70N Latitude.
- The average global temperature in 2022 was 58.55^{o}F (14.76^{o}C) which was 1.55^{o}F (0.86^{o}C) warmer than the 20th century average of 57^{o}F (13.9^{o}C) and 1.9^{o}F (1.06^{o}C) warmer than the pre-industrial period.

Waste

- 1,300,000,000 tons of the food produced for human consumption is lost and/or wasted every year. That is approximately 1/3 of the food produced.
- Approximately 1/3 of the worldwide fisheries catch of 93 million tons is wasted — thrown back into the sea dead or dying. This by-catch is not included in the above data.
- Globally, we generate 1,300,000,000 tonnes of municipal solid waste per year.
- The average American throws out 5 pounds of trash per day.
- 500 pounds of non-biodegradable plastic enters the marine ecosystem every second.
- Over 58% of the total amount of energy produced in the United States from all sources is lost before reaching the destination where it is used.

The increase in pollution coupled with the degradation of resources is an indication that TSE is currently being operated outside its margins of safety.

At present, humanity is operating TSE at a level that would require 1.75 TSEs to balance both the consumption of resources and the generation of pollutants with TSE's bio-capacity to generate useful biological material and absorb waste. Humanity has pushed TSE 75% over the red line, and the overshoot is increasing.

In 1997, Charles Moore discovered a region of the Pacific Ocean with a large amount of plastic debris. This area is now referred to as the Great Pacific Garbage Patch (GPGP). While the gyre resulting from ocean currents defines the location of the garbage patch, it is land-based plastics and marine debris that constitute the make-up of the GPGP. Plastics do not biodegrade but physically break down into smaller (micro-plastic) and smaller (nano-plastic) pieces over an extended period of time. The slow rate of mechanical breakdown combined with the high volume of improperly disposed of plastics results in the growing dimension of the GPGP. Subsequent to the discovery of the GPGP, 4 other garbage patches have been found – one in each ocean. In 2013, United Nations Educational, Scientific, and Cultural Organization (UNESCO) symbolically recognized the Garbage Patch Nation comprised of the 5 areas of concentrated discarded material – one in each major gyre of the North Pacific, the South Pacific, the North Atlantic, the South Atlantic and the Indian Ocean. At the time of recognition, the population of the Garbage Patch Nation consisted of an estimated 36,939 tons of garbage and covered an area of 15, 915,933 square miles. It is estimated that 80% of the population is from land-based sources.

In 2023, the estimate of plastic in the ocean was 170,000,000,000,000 pieces of plastic weighing approximately 2,400,000 metric tonnes. The weight doubles every 6 years. Our individual share of ocean plastic is 26,000 pieces per person.

Lost Fishing gear is also a major waste problem in the marine environment. A 2023 research study estimated the annual losses of fish gear to include:

- 78,000 sq km (30,000 sq miles) of purse seine nets and gillnets
- 215 sq km of bottom trawl nets
- 740,000 km (46,000 miles) of main long lines
- 15.5 million km (9.6m miles) of branch lines
- 13 billion longline hooks
- 25 million traps and pots

In 2018, the global economy was 9.1% circular.

In 2020 the percentage of the economy had dropped to 8.6%.

In 2023, the percentage has shrunk again to 7.2%

This means that more than 90% of the economy relies on the extraction or harvesting of new (virgin) materials. It also means that more than 90% of the resources used to produce the new products will be lost or unavailable to be used as resources to make the next generation of products because the new generation of products are not designed to be reused or recycled.

Quartermaster's Note

In a linear economy, natural resources are taken from the environment, turned into objects of economic exchange, used for a period of time, and then discarded as trash/waste as those products can no longer fulfill their original economic role and do not (cannot?) have a next use as either product or resource.

In the human lexicon "trash" and "waste" tend to be used interchangeably as both indicate that material in question was not designed to be reused and should simply be disposed of.

In the natural world there is no trash, and waste is material that is discharged by one species that becomes a resource material for other species.

Humans are the only known species that makes trash and believes in the mental construct that natural resources can be, and should be, turned into non-functional objects of disposal.

Additional Examples of Trash

E-Trash

Humanity generated 44 million tonnes of E-Trash in 2017.

Humanity generated 50 million tonnes of E-Trash in 2019.

Humanity generated 57.4 million tonnes of E-Trash in 2021 (more than the weight of the Great Wall of China).

And the projection for 2050 is that humanity will generate 120 million tonnes of E-Trash.

As to the value of E-Trash, currently 7% of the world's gold is in E-Trash.

There is 100X more gold in a ton of E-Trash than there is in a ton of gold ore.

Humanity also generates:

2.01 billion tons of Municipal Solid Trash per year, up from 1.3 billion tons in 2015.

7.6 billion tons of Industrial Trash per year, and

92 million tons of Textile Trash per year.

In the U.S. the average American throws out almost 5 pounds of trash per day. That number is the same for 2015 and 2023. But the U.S. population has gone up by 13.5 million people, so we are dealing with an extra 67.5 million pounds of trash per day.

Space Trash

In 2009 there were 19,000 pieces of Space Trash 10cm or larger being tracked.

In 2021 there were 23,000 pieces of Space Trash 10cm or larger, 500,000 pieces between 1cm and 10cm.

In 2023 there are 36,500 pieces of Space Trash 10cm or larger, 1,000,000 pieces between 1cm and 10cm and 130 million pieces between 1mm and 1cm.

According to Lawrence Livermore Laboratory, in 2015 approximately 58% of the total amount of energy produced in the United States from all sources is "Rejected Energy."

In 2023, 67% of the energy produced in the US becomes "Rejected Energy."

Rejected Energy is the amount of energy lost to heat, and in the thermodynamics of energy changing form. If your vehicle has an internal combustion engine, part of the energy in the

gasoline when you burn it creates the mechanical energy you need to move the car. Neither the burning of the gas nor the transfer to mechanical energy is 100% efficient.

Food Loss and Waste

Approximately 1/3rd of all food produced, or about 2.5 billion tons, is lost or wasted each – up from 1.3 billion tons in 2015.

Food waste is defined as food intended for human consumption, but is discarded or expires prior to consumption. Food loss is defined as the loss of uneaten agricultural, forestry, or fishery products that occurs during the production and distribution stage causing a reduction in either the quantity, or quality (nutritionally or calorically) of food.

Quartermaster's Note

When considering the cumulative and collective impact of food loss and food waste, you should also consider the amount of water, natural and synthetic chemicals, energy and fuel used to plant the crops, grow them, harvest them, transport, wash, sort, package, distribute and maintain them either in storage or on the store shelves.

Annually, approximately 38 million tons of by-catch (marine life, such as sea-stars, turtles, whales, dolphins, birds, juvenile fish and non-market fish species) are also caught by fishing gear and discarded. A high proportion of the by-catch does not survive. In 2015, the by-catch was approximately 31 million tons.

In 2015, 500 pounds of non-biodegradable plastic entered the marine ecosystem every second. In 2023 it is 888 pounds.

World consumption of Natural Resources has passed 100.6 billion tons per year. That would put the average consumption rate at 14 metric tonnes per person. The use of resources is not equal as individuals in developed/industrial countries use more. The per capita consumption rate for the U.S. is 18.4 metric tons.

Earth Overshoot Day

The Global Footprint Network hosts and calculates Earth Overshoot Day (EOD). Earth's Biocapacity divided by Humanity's Ecological Footprint times 365 = Earth Overshoot Day.

Essentially EOD is the day when humanity's demand for ecological resources and environmental services exceeds what the Earth can provide in a year.

In 2015, Earth Overshoot Day was August 13.

In 2022, Earth Overshoot was July 28.

In 2023, Earth Overshoot Day will be August 2.

The moving of EOD back by 5 days in 2022 is a positive step. How much of the move is driven by a slowing economy, or a growing commitment to decarbonize, or an increase in carbon sequestration through regenerative restoration projects… or a combination of the three is difficult to differentiate at present. The good news is that the date moved back. To meet the IPCC goals of reducing CO_2 emissions by 43% by 2030 from 2010 levels will require moving the date back by 9 days each year for the next 7 years. But this year looks to be a good start.

Humanity's Ecological Footprint

The number of Planet Earths we need to meet our demand for renewable resources and absorption of our waste is measured by ecological footprint.

Year	Humanity's Global Footprint
1961	0.75 Earths
1965	0.82 Earths
1970	1.00 Earths
1975	1.10 Earths
1980	1.15 Earths
1985	1.14 Earths
1900	1.22 Earths
1995	1.25 Earths
2000	1.30 Earths
2005	1.46 Earths
2010	1.50 Earths
2015	1.56 Earths
2020	1.75 Earths

Humanity's ecological footprint was first calculated in 1961. At that time, humanity operated in a manner that maintained a surplus of resources. By 1970, humanity was in a break-even model of demand for resources relative to the regeneration of resources. Unfortunately, in the early 1970s, we crossed the line and ever since have been operating with a growing deficit. It now takes the capacity of more than one Planet Earth to meet our demands and neutralize our waste.

Since 1961, Humanity's ecological footprint has more than doubled, increasing from 0.7 planets/TSEs to 1.6 planets/TSEs. The largest change has been in the carbon footprint, which has increased from 36% of the footprint to 53%.

Year	Overshoot Date
1987	December 19
1990	December 7
1995	November 21
2000	November 1
2005	October 20
2010	August 21
2014	August 19
2015	August 13
2020	August 22
2022	July 28
2023	August 2

In 2020, Earth Overshoot Day moved back in time – not because we had consciously and collectively decided to be better crew members of This Spaceship Earth or better stewards of the planet – but because the Pandemic limited our ability to consume.

Quartermaster's Commentary

We are not being a crew that maintains a surplus of supplies. We are not even being a crew that breaks even. We are currently a gaggle of crew, passengers and castaways on a 365-day voyage who runs out of supplies 157 days before we circle back to our starting point.

Overshooting one's resources is not just unwise, it's risky. And, to do it every year for the better part of 50 years is stupid.

We live on Earth. It is a one planet game, yet we act as if we have a spare. It currently takes 1.75 years to supply our 1-year resource hunger. At some point, the cumulative, collective and

continuous harm we are causing will create a reckoning of unfathomable proportion. We are the source of and the solution to all the problems facing us. So, the question is simple – do we want to play the long game, or a painfully short one?

In reviewing the Quartermaster's Report, several questions come to the forefront.

- Did the crew know this was the status of TSE?
- Is this what the crew wanted the status of TSE to be?
- How did this become the status of TSE?
- And finally, how can the crew operate TSE to ensure the vitality and viability of the LSS (life support system) for our intended journey into the future?

The Quartermaster's Report is a current snapshot of humanity's interaction with This Spaceship Earth. The report is numerically factual. Readers and users of the report can interpret the information for themselves, with the proviso that their review includes the full data set not just selective parts.

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Tim Rumage
Chief Science Officer
This Spaceship Earth

Chapter 3 – How Did We Get Here?

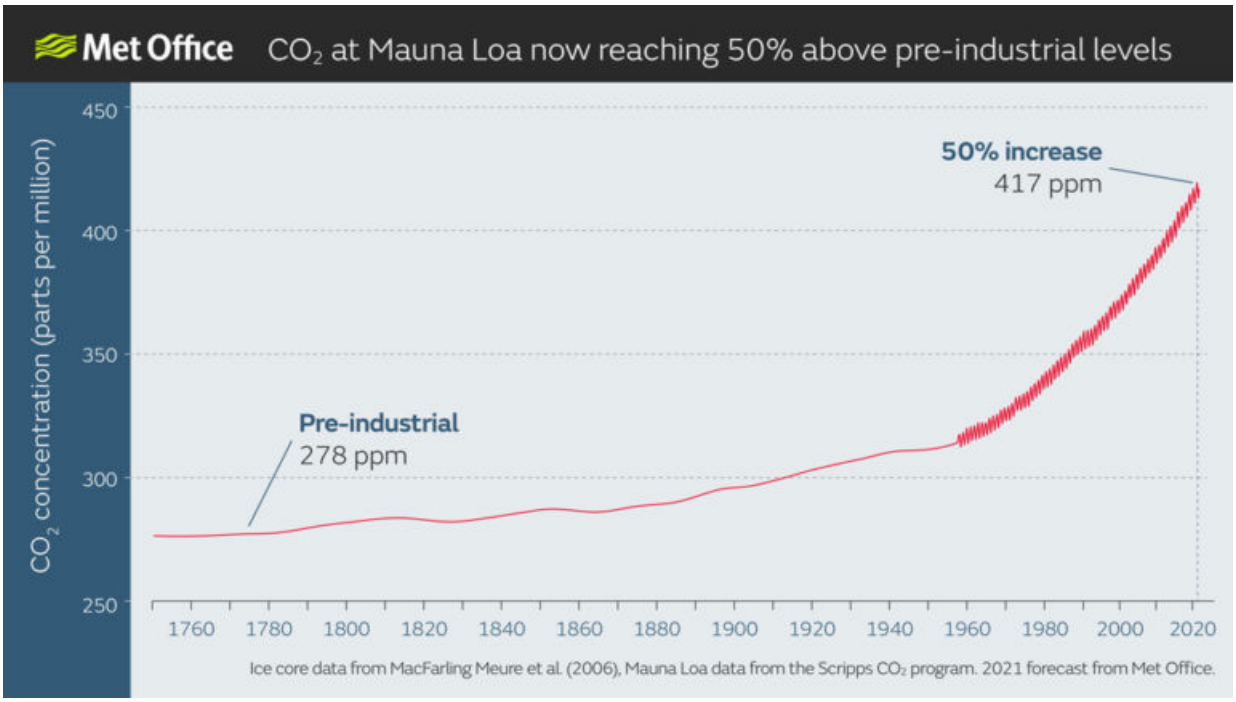
"The major problems in the world are the result of the difference between how nature works and the way people think." – Gregory Bateson, anthropologist

"*It is difficult to get a man to understand something when his salary depends upon his not understanding it."* – Upton Sinclair, novelist

The climate crisis that is happening now, has never happened before since homo sapiens have lived on the planet. Climate scientists have, since 1970, moved from linear projections of impending disaster to geometric and then exponential projections simply because there was no historic model upon which to extrapolate. Scientists have been accurate about what is happening, but have been too conservative concerning the speed of changes.

The Industrial Age began around 1800. This marks the beginning of GHG emissions. First discovery and use of coal as fuel for steam engines, and then petroleum in internal combustion and then jet engines, completely altered the relationship of humanity to Earth. Since 1900 there has been an explosion of inventions and new technologies all utilizing, directly or indirectly, fossil fuels. Trains, planes, cars, and factories all need energy, and that energy has come from the petroleum combustion complex economy.

As these energy-intensive inventions spread around the world in the 20th century, ever more GHG emissions were released into the atmosphere. This raised the PPM of CO_2 in the atmosphere from



The other key dynamic was that the human population quadrupled in the 20th century. Ever more people desired and acquired (if they could) labor saving devices (like washing machines), vehicles, air travel, ocean cruises, home heating and cooling, and more. It took 300,000 years for humanity to reach a global population of one billion in 1800, one and a half billion by 1900, and six billion by 2000. There are now a bit more than eight billion of us on Spaceship Earth.

Those who benefit from the existing industries and markets are loath to let go and give them up. Vested interests have gone to great lengths to maintain their power and control. It has been well documented that the fossil fuel industry both knew of the potential problems of GHG emissions and spent large sums of money to underwrite “research” that disputed the developing reality.

While many environmentalists rail against these well-funded deniers, the real problem is that most humans want more stuff. We have all been raised in consumer economies that train us to buy and consume. Goods to be consumed must be produced and production means the use of fossil fuels. So as this famous Pogo cartoon states, we are the enemy.

Chapter 2, The Quartermaster's Report, laid out all the issues and dangers of our journey. We are largely responsible. How humanity lives on the planet is triggering the sixth extinction event in the history of the planet, the first one caused by a single species… us.

So we are the problem. We can be the solution. We don't need to save the planet, we need to save ourselves from ourselves. By the end of this book you will know what is going on, why it is going on, what you and we can do about it, and it is up to us… now that you know.

What Can Be Done?

There are six big and necessary actions that our species can take to change our trajectory from civilizational collapse to long-term viability. Here are the six, which we will then briefly explain.

1. Lower GHG Emissions ASAP
2. Draw down CO_2 from the atmosphere.
3. Crew Consciousness
4. Conscious Non-Consumption
5. Regeneration for Present and Future
6. Reduction of the human population to 3-4 billion by 2100.

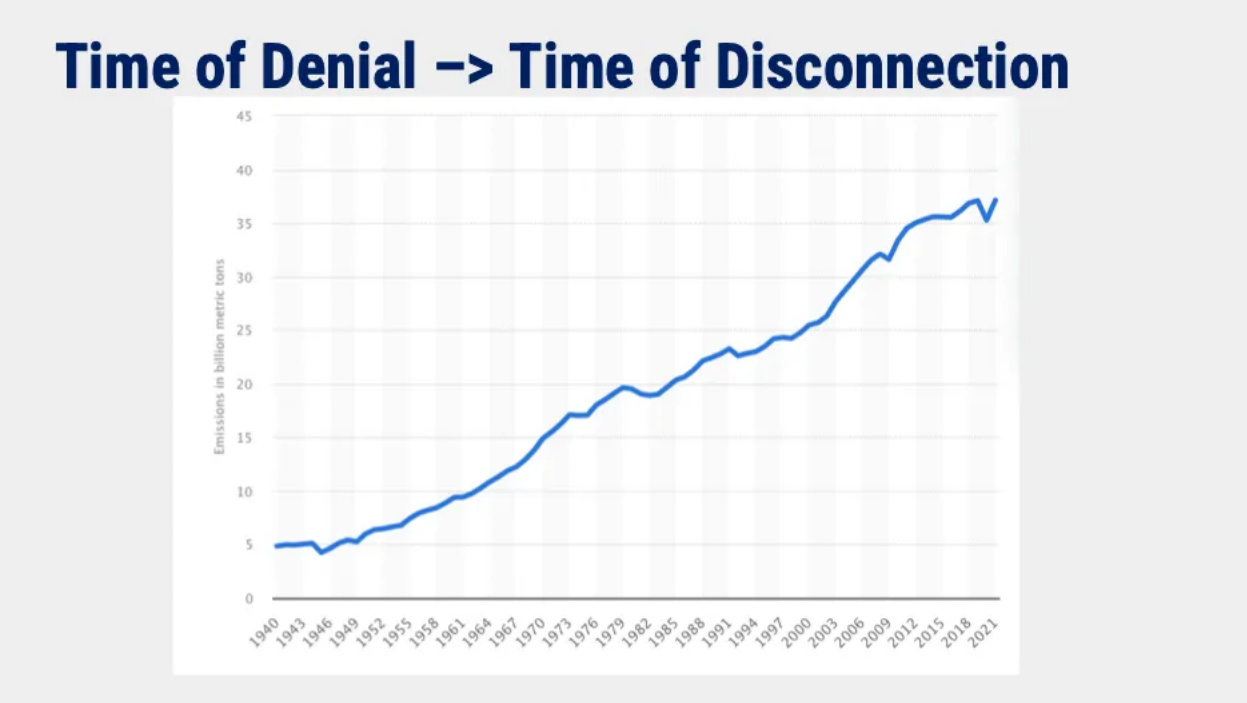
Lower GHG Emissions ASAP

This is the one that everyone knows. This is the easy one to understand: do less bad stuff. Cut emissions from the use of fossil fuels and do it as soon as possible. GHG emissions go up into the atmosphere, where they can stay for decades and even centuries. This accumulation is what has triggered the warming of the planet, as it has created the greenhouse effect we have been discussing for decades.

The key word is “discussing”.

Many of you reading this have made clear and firm efforts to reduce the GHG emissions from your life. You drive an EV, you monitor your thermostats, you install solar panels, you upgrade your home insulation, and many other things to lower fossil fuel use.

We talk with other climate-conscious people and think progress has been made, but the bigger picture is that our species has not. We think we have defeated the deniers but in fact, we now live in a time of disconnection.



This chart shows that since WWII humanity has emitted ever more annual GHG emissions. Even in this century, when the growth of wind and solar have each increased in energy output by more than 1,000% and the awareness of our climate crisis has grown significantly… yet emissions keep increasing.

Except for one year – 2020.

What happened in 2020?

It was the first time in human history that several billion people did the same thing simultaneously. A majority of us, particularly in the high energy consumption developed countries of the world, went into several months of lockdown due to pandemic quarantines.

We stopped doing what we usually do.

We drove less. We did not go out for dining, entertainment or social reasons. We worked from home. We only shopped for essentials in physical retail. We Zoomed rather than attend conferences. We stopped activities that emitted GHGs.

HUMANITY STOPPED DOING WHAT IT HAD BEEN DOING, AND DID SOMETHING ELSE.

One of Einstein's most famous quotes speaks to this situation:

"Without changing our patterns of thought, we will not be able to solve the problems we created with our current pattern of thought."

Humanity needs to change how we live. At least the majority of us. Certainly those that live in developed, high-emitting countries. The countries that have the highest per capita CO_2 emissions need to make the biggest changes in how they operate.

This chart shows countries with the highest per capita CO_2 emissions. Remember, the global average, including these countries, is 4 tons per capita.

To motivate large swaths of humanity to radically change how they live, it's going to take significant financial, political, and social incentives.

The missing ingredient is urgency. We are in an urgent situation. We do not have much longer to alter our trajectory. To stay with the tonnage metric, we need to scale up emissions reduction globally so that we are below 30 gigatons of annual emissions by 2030 at the latest, plus with an accelerating decrease beyond that.

So, lowering GHG emissions is the first step of six. We have to stop what we are doing and start doing something else. Stop emitting GHG. Even if we do that, the warming of the planet will not stop, it will only slow the speed of warming.

Draw Down CO_2 from the Atmosphere

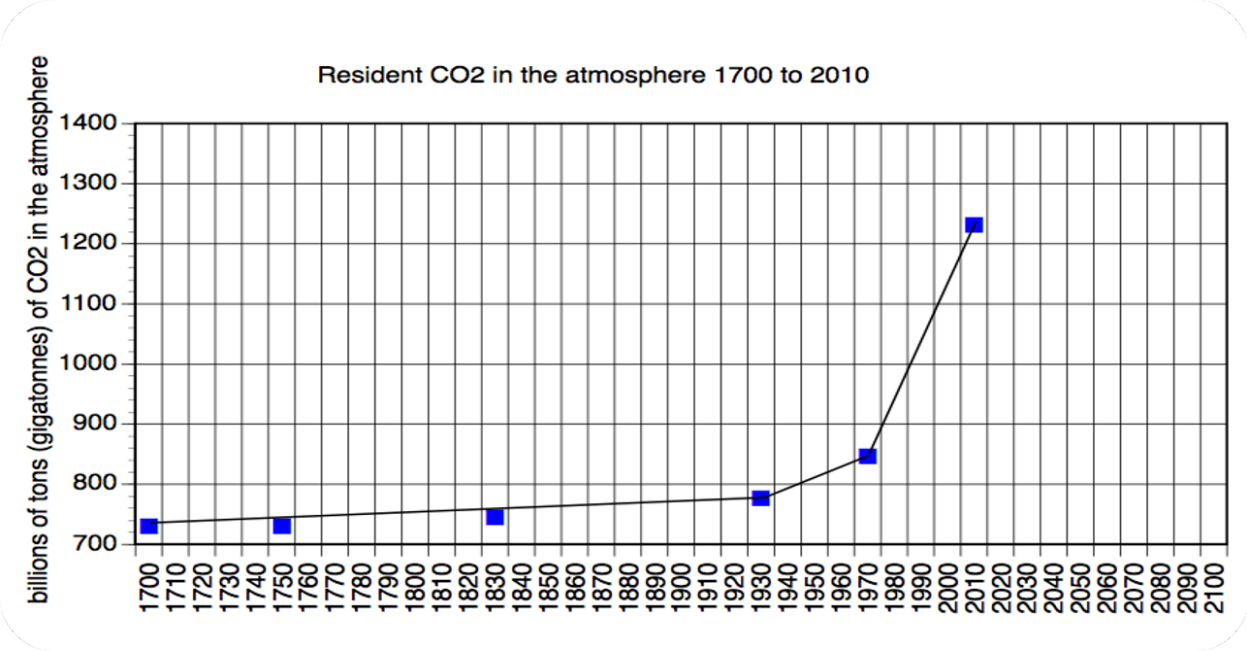
For decades, we have been doing the bad stuff, emitting evermore CO_2 into the atmosphere. The result? The planet has been warming. That warming has triggered an accelerating climate catastrophe being experienced everywhere on Spaceship Earth.

So, the emissions we have been putting up since 1800, particularly in the last 50 years, have triggered this warming. The aggregate CO_2 emissions through time created the greenhouse effect and the resultant warming. Not the emissions we put up today, tomorrow, or next year, as their effect will be felt in the future.

Here is the simple way to state it: if all GHG emissions stopped tonight, the planet would continue warming for many decades. Even if we stopped all fossil fuel use today, the earth will continue. Stopping emissions will not stop the warming.

Drawing down the CO_2 already in the atmosphere will. CO_2 emissions remain in the atmosphere for decades and even centuries. It is the aggregate of 150 years of CO_2 that is causing the warming. The amount of CO_2 in the atmosphere at the beginning of the Industrial Revolution was approximately 730 gigatons [a gigaton is a billion tons]. Today it is more than 1300 gigatons.

In our 2015 book, This Spaceship Earth, planetary ethicist and climate scientist Tim Rumage and futurist David Houle named this accumulating CO_2 **resident CO_2**. The amount of CO_2 that resides in the atmosphere.



So, what to do about drawing down resident CO_2? First, there has been good news from various scientific studies that the atmosphere has much more capability for self-cleansing than we thought. We have been stressing the Earth's atmosphere so severely that it could not even remotely keep up.

Carbon capture technologies remove CO_2 from the atmosphere, usually at the origin of emissions. So a big factory might have carbon capture technology in its smokestacks or exhaust. And there is Direct Air Capture or DAC technologies. It's too early to tell whether that can scale sufficiently to make a difference.

Then there is the planting of trees. Many companies and organizations are promising to take a share of revenue or profit to plant trees. Usually the vision for the number of trees is in the millions, and a few have made a reach goal of a billion.

There are two issues with this effort. First, it is very important how the trees are planted, where certain trees should be planted, and what kind of tree is planted. There is a developing science about global reforestation. Second, it has been estimated that there are now about three trillion trees on Earth. A consensus estimate is that before humanity, there were five trillion. Our goal for reforestation is to plant one trillion trees to reach four trillion.

All of these are part of the drawdown mix. The problem is that none are happening at the speed or scale needed. There are one or two dozen DAC plants in the world. There needs to be one opening every day of every year until 2030. The current DAC plants are designed capture megatons. Humanity puts up gigatons. As for trees, the scale and timing should be a billion a day for the next three years. It is hard to imagine this happening without massive coordinated effort from nation-state governments and multinational corporations. An ideal vision for the future is to have a Department of CO_2 Reduction as part of any national government.

We can do this big and necessary thing. We now need to infuse urgency and scale into our doing.

Crew Consciousness

Actively crewing can be done across most aspects of life. Crew members are constantly looking to lower their carbon footprints. Decisions are made as to what car to drive, what temperature to set the thermostat at, whether to eat meat, whether to buy new or "vintage' clothing. We make dozens of decisions every day that can be informed by crew consciousness.

There are a bit more than eight billion humans alive today. It is not reasonable to expect all to become crew members of Spaceship Earth. If one billion humans choose to become crew and take crew actions it should be enough of a critical mass to alter beliefs and social norms. Of course ,the more influence crew members have, the better. Media celebrities, politicians, business leaders, journalists, religious leaders, and investment professionals are all people who need to self-identify as crew members.

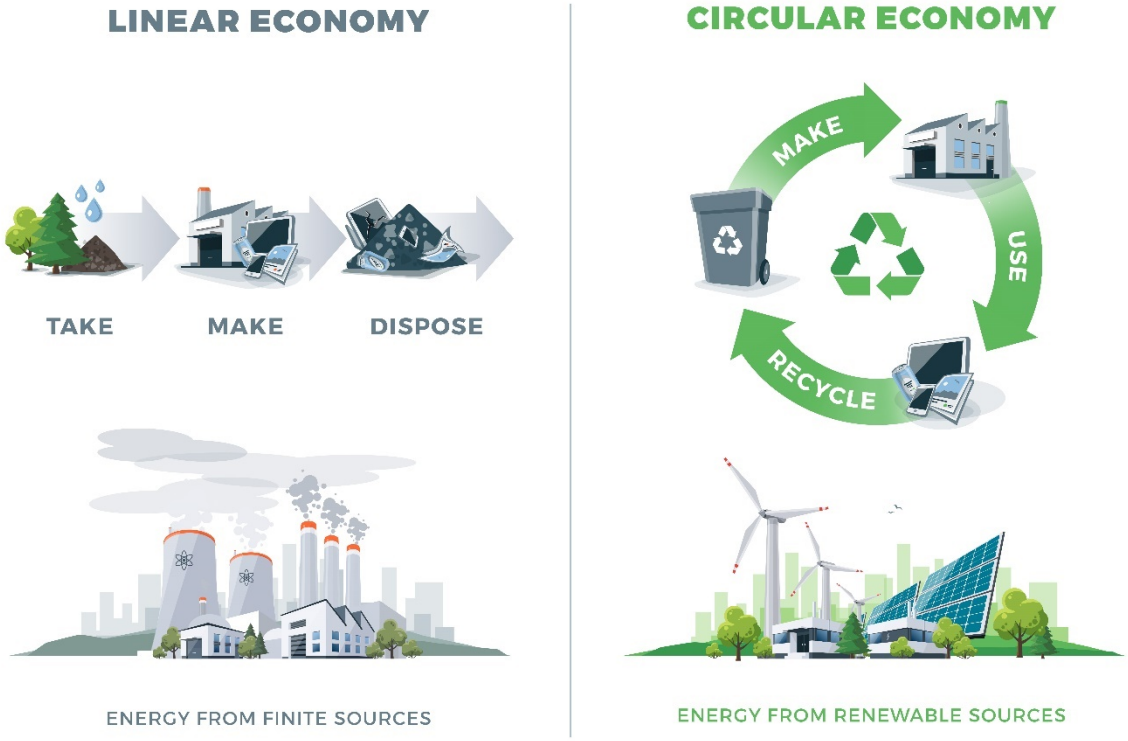
Spaceship Earth is the only place that humans live. We are currently on a trajectory that will lead to civilizational collapse and species extinction.

In the last 60 years, millions of people have expressed a desire to become an astronaut. Spaceship Earth needs you to become one now.

Conscious Non-Consumption

This is difficult, particularly for Americans, Europeans and all who live in developed economies. It falls under the umbrella of acting as crew, but it deserves to be examined more closely.

Anyone reading this has grown up in a consumer culture. We are raised to consume. We think shopping is a pastime or something to do when depressed or upset. We buy brands for our sense of personal identity. We need the rush of a new purchase. This is a linear economy. A linear economy starts with extracting natural resources, manufacturing them into products, the sales/purchase of the product, the use of the product, and the disposal of the product. A better model is the circular economy.

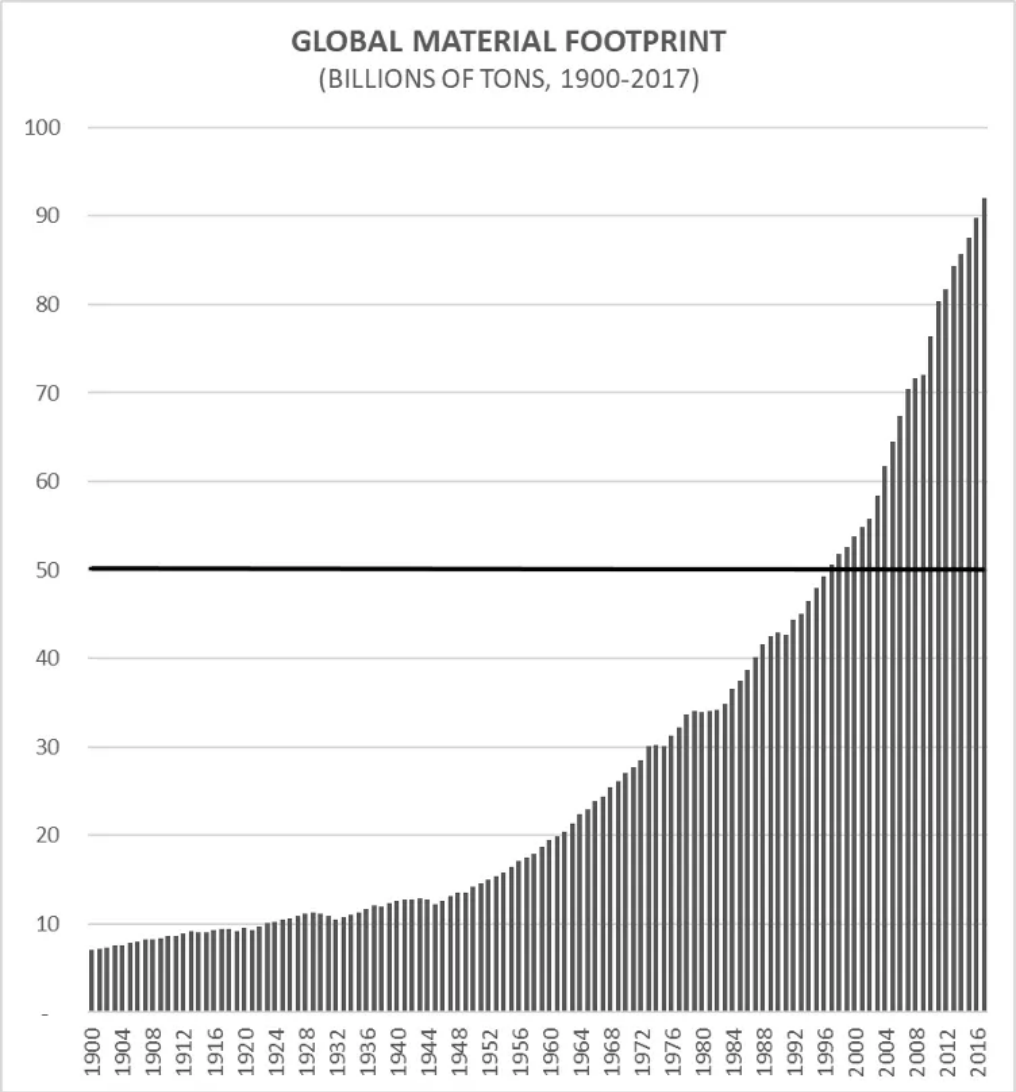


Humanity needs to be operating fully within a circular economy. The problem is that in the last 50 years since this concept became widely known, we have failed miserably in moving to a circular economy. As David wrote here, only 9% of global GDP could be called circular. This is way too little over a 50 year time period. Yes, the circular economy is a really nice concept that most environmentalists embrace, but it has failed. More needs to be done.

In 2019, knowing this, Bob Leonard and David Houle set out to write a book with an even more climate-focused economic model, the Finite Earth Economy. We took the pleasant Kumbaya concept of circular economy and turbo-charged it. The Finite Earth Economy involves the changing of taxes, social policy and the basic principles of recycling. We wrote about upcycling; it wasn't enough to recycle, so we had to upcycle products. Use waste to create new products that are up the product hierarchy, not down. Time to move on from recycled materials for shoes and playgrounds.

"Waste is a design flaw." James Fathers, coauthor of "The 2020s: The Golden Age of Design and Redesign"

In our consumer, linear economies, waste is considered acceptable. That is the problem. Nature has no waste. None. Nature is the most complex system humanity has ever experienced. That is why there is such a movement toward biomimicry (using nature as a model with zero waste). And why humanity is drowning in its own waste.



Nature is the perfect system known or experienced by humanity. A completely integrated complex system with no waste. In the near future, humanity must develop a systems approach that incorporates as much biomimicry as possible.

Another way to think about this is that currently, humanity is consuming 1.6 earths per year in terms of resources to keep all of our consumer economies going.

So, doing what we do in a consumer economy causes emissions and overconsumption, both big negatives in successfully addressing our climate crisis.

The solution is clear, stop buying stuff. The problem is that we are all conditioned to buy. What are advertisements for? To prompt us to buy something. Usually something that we don't really need, but just want. This opens up a bigger issue of

needing to find self-worth through externalities rather than internal dynamics. Part of the success of consumer economies is the taught belief of consumers that if they buy something it will make their life better. Quick, go look in your closet at all the clothes you bought to make you temporarily happy and that you haven't worn in months.

We will continue to need to buy items, but can be much more crew conscious in how we do that and what we buy.

Regeneration for Present and Future

It is time to change our language. It is time to step up our commitment.

The word "sustainable" is no longer relevant. Is it desirable to sustain our already degraded ecosystem? No. We need to improve it.

A product is called "sustainable" A community puts "sustainable" policies and processes in place. But no matter how many "sustainable " policies, procedures, products are put in place, every year we emit more, consume more, pollute more, birth more, mine more. So using and doing what we think is "sustainable" does not seem to make humanity live sustainably.

We keep doing the bad stuff but somehow think that using the right language makes us smugly "green". Is humanity living sustainably as a species? No! So don't think that a "sustainable" this or a "sustainable" that makes a difference.

Nature is completely regenerative. We need to step up to nature's level if we want to be "green."

Regenerative is a higher bar than "sustainable." We need to create a regenerative civilization. We have no choice if we want to keep civilization from collapsing by 2100 or our species (along with many others) from going extinct.

See what comes up for you when you say these two phrases:

Are these policies regenerative? Are these policies sustainable?

Or these two:

Is this a regenerative product? Is this a sustainable product?

Yes, sustainable feels okay to say, but regenerative does not. Why? Because we haven't used the word much let alone done regenerative things. Most of us don't even understand what the word means.

Regenerate:

To effect a complete moral reform in.

To re-create, reconstitute or make over, especially in a better form or condition.

To revive or produce anew; bring into existence again.

[biology] To renew or restore.

[physics] To restore to a favorable state or physical condition.

Here is a simple and high level way to think about humans, the climate crisis and what we need to do to change course.

Since 1800 we have spent 200 years degrading the planet, polluting the air and water, accelerating species extinction, and treating all of nature as something for us to consume at little or no cost. Consider this a debt. A debt to the planet that needs to be repaid. Repaid in less than 100 years. We have until 2100 to repay the loan, or we go into default. The default here means civilization collapse.

Our karma of degradation now needs to move to a karma of regeneration.

Regeneration is what nature does. Humanity is a part of nature, yet we are the only species that is not regenerative. We must become aligned with nature, with Spaceship Earth.

If we cannot create a largely regenerative society we are doomed. It didn't have to be this way, but 200 years of degradation puts us in this position. We need to adopt and deploy:

Regenerative farming that brings back healthy soil.

Regenerative planting of trees and other CO_2-consuming plants.

Regenerative design with zero waste.

Upcycling (not just recycling).

Regenerative production with additive properties, not just extractive.

Regenerative economics, where regeneration of nature is factored into all costs.

This is a massive effort that humanity has no experience in doing at scale. But we can learn. We can learn from Nature and from Indigenous people who have been acting as crew for millennia.

We have a 200 year old debt that we will need to pay off in the next 100. years

We need to save ourselves from ourselves.

Time for new language, which will lead to new thinking, which hopefully will lead to new actions being taken.

Reduction of the Human Population to Four Billion by 2100

"Those who fail to see that population growth and climate change are two sides of the same coin are either ignorant or hiding from the truth. These two huge environmental problems are inseparable and to discuss one while ignoring the other is irrational." – James Lovelock, scientist and environmentalist

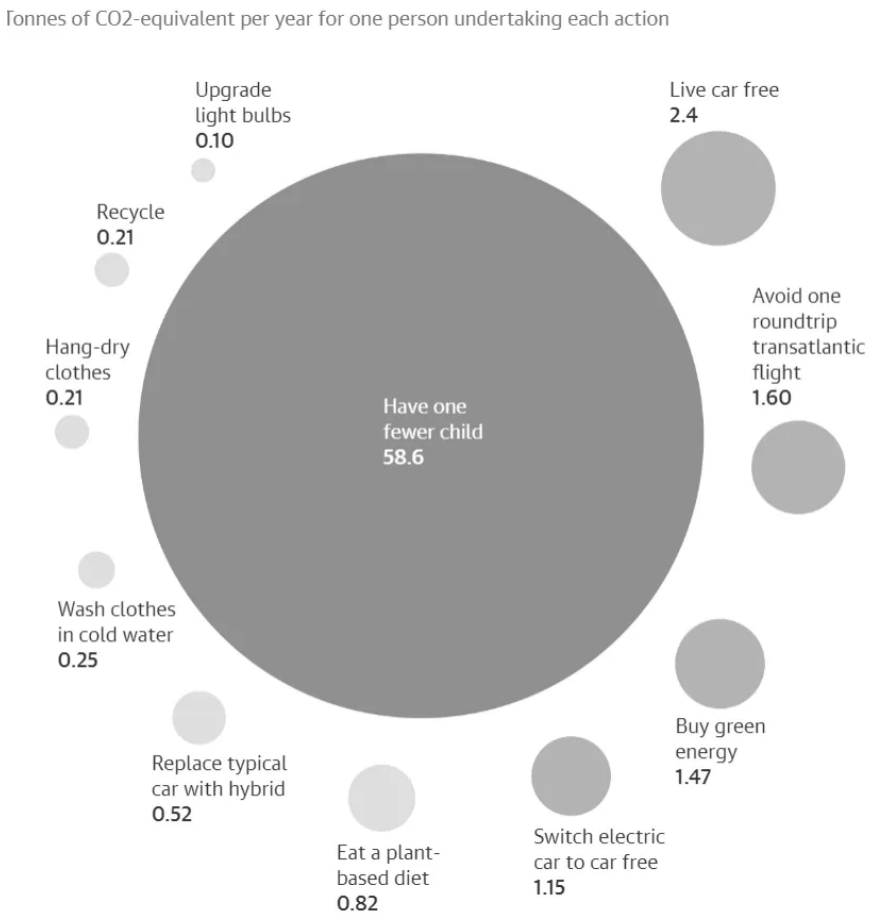
Except for a few limited and failed efforts by individual countries, there has not been any historical practice to manage and plan population growth.

Planned population decline and moving to a no-growth economy both relate to global GDP, as GDP is the standard measurement of economic growth (which has a deep correlation to population growth).

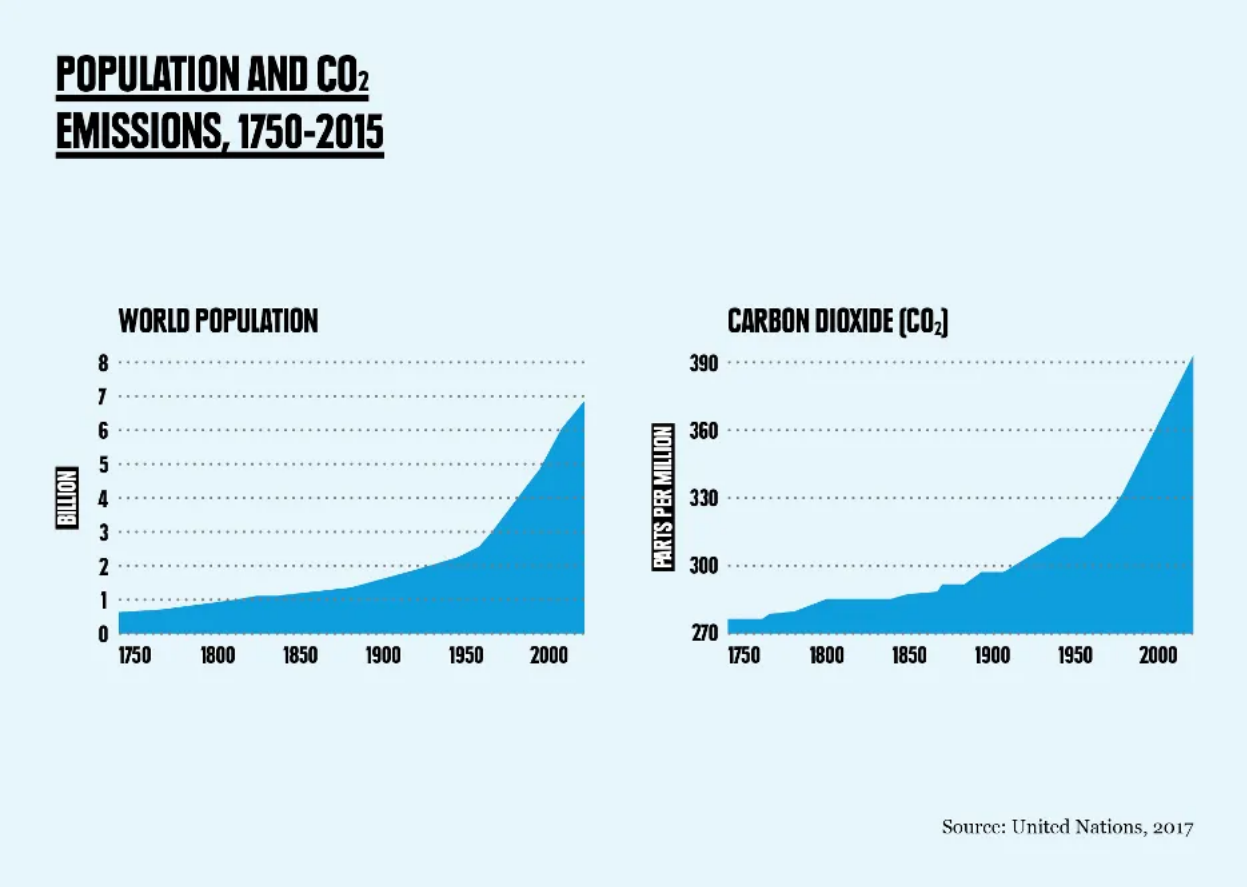
Why do we need to consider the planned reduction of the global human population, and why to a four billion level?

Some charts to explain:

This first one shows what actions trigger lowering CO_2 emissions and how, in summing up all of them, they don't come close to the emissions triggered through time by having a child.

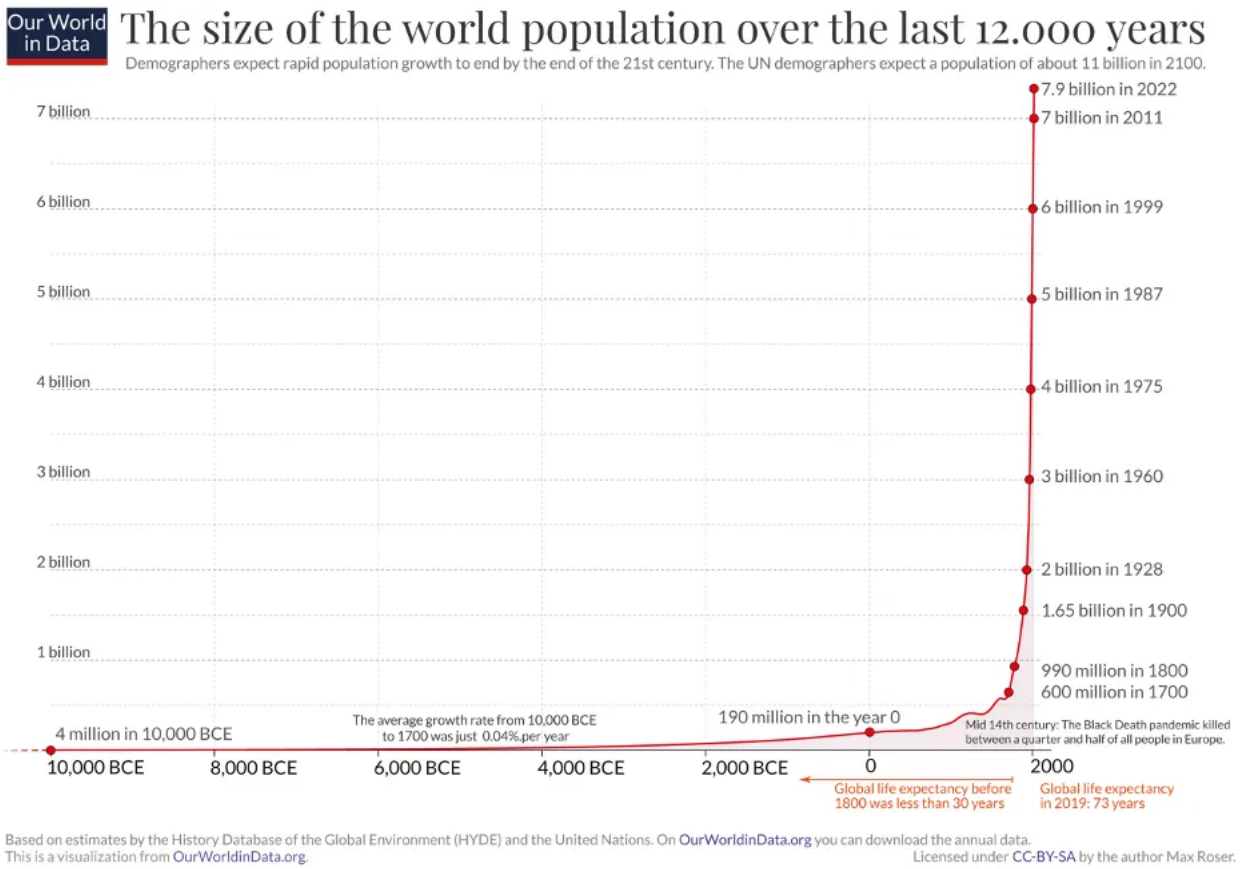


The figure was calculated by totaling the emissions per child and their descendants, then dividing this total by the parent's lifespan. Each parent was ascribed 50% of the child's emissions, 25% of their grandchild's emissions and 12.5% for their great-grandchildren.



Simple. Through time the population has a direct relationship on CO_2 emissions.

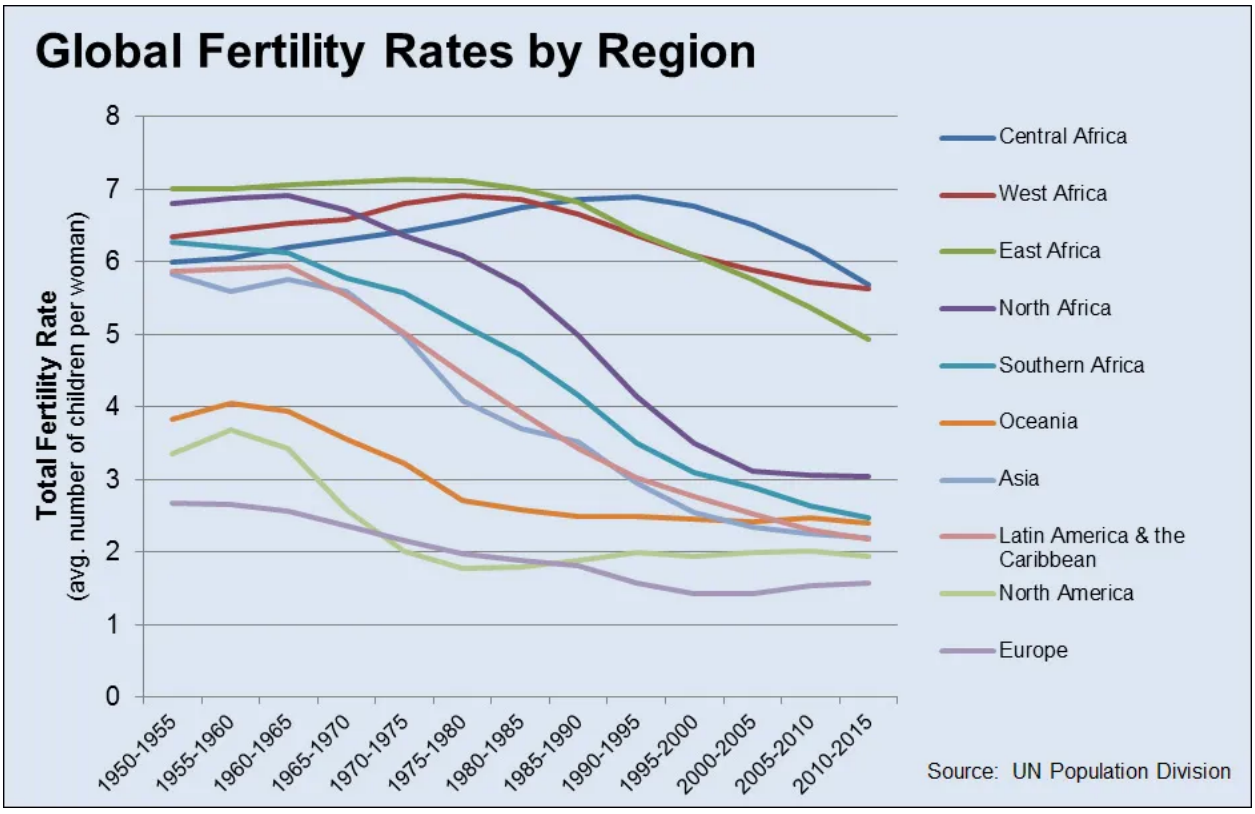
This chart shows the population growth in billions. It is clear that the vast amount of growth has occurred in the last fifty years.



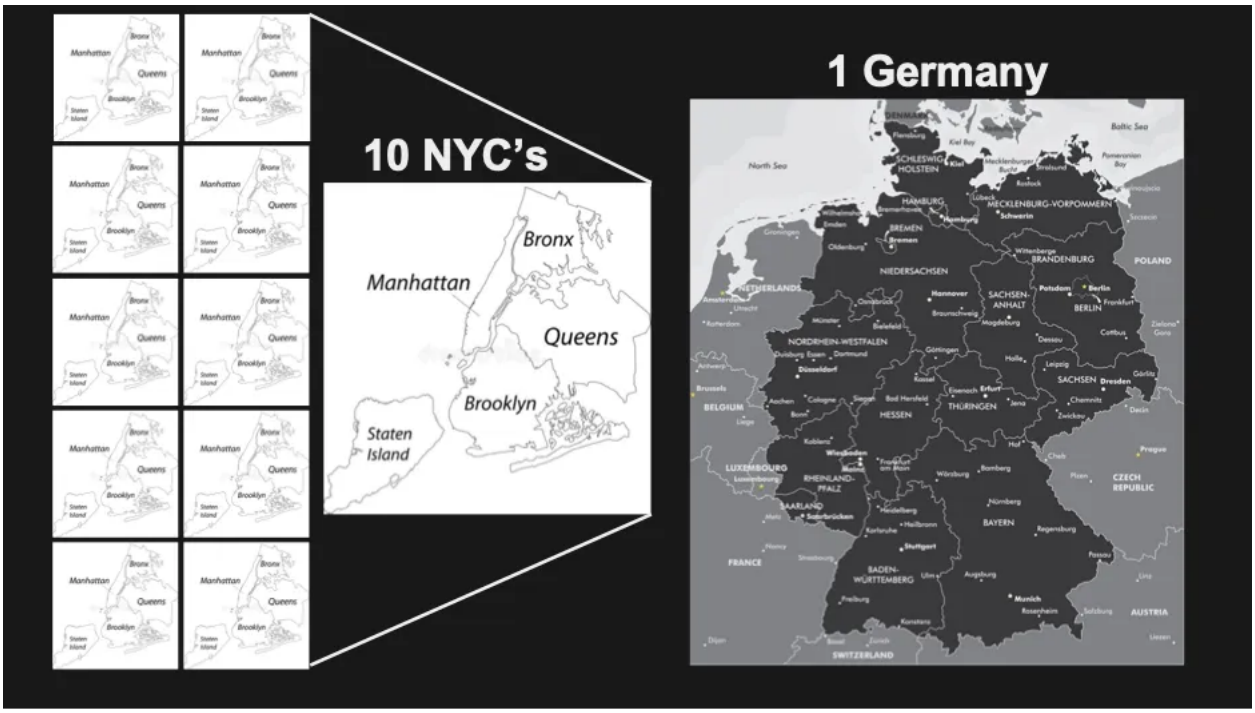
To keep a population at a constant number, the replacement rate requires an average birth rate of 2.1 children per childbearing woman. Above this number the total population increases. Below 2.1 it decreases. As the next chart shows, global birthrates are declining. North America and Europe are now below 2.1, Latin America, Southern Africa and North Africa are at or below 3.0 and Asia is moving toward 2.1. Only the central part of Africa is still above 5.

So, overall the global population is already down trending in terms of birth rates, with only Africa needing massive and immediate help in population planning. This means that humanity needs to accelerate the decline in birth rates by massive intervention where the rates are over 4 and managed intervention in all the areas where the number is 3 or lower.

There is a growing movement to reach 1.5 globally by 2030 so that a four billion population by 2100 is doable.



At a time when there are millions of refugees and millions who go hungry every night, does it not seem like lunacy to add the equivalent of 10 New York Cities or one Germany to global population every year?



Why do we need to plan for population reduction?

Well, we know that if we stay on the trajectory we are on, there will be fighting over food, water, land and medical supplies. The current 8+ billion human inhabitants will increase to 10+ billion by the end of the century. By population planning, we can avoid the horrors that will come with a civilizational collapse.

There is a school of thought that we will not have to do this, that uncontrolled population growth to 10 to 11 billion humans by 2100 is to be accepted and even embraced. The belief that there will be some technologies that will provide global cooling, quickly so that we don't have to do all the "hard stuff" and have a technology fix is a risky one.

For its entire history, humanity has always used technology to conquer nature. Much of this technology has obviously caused massive damage to the biosphere. Progress has been partially defined as overcoming nature. Whenever we build stuff we generally don't take into account any species but us. When all the Interstate highways were paved, did we reflect on the migratory patterns of land mammals? Nope.

So, what can you do? How can people take collective actions to face this life-threatening crisis? Become a crew member of This Spaceship Earth.

Chapter 4 – Crew Consciousness

"*There are no passengers on Spaceship Earth. We are all crew."*

Marshall McLuhan

"*Tools defined the Agricultural Age. Machines defined the Industrial Age. Technology defined the Information Age. Consciousness will define the Shift Age."*

David Houle

Crew consciousness is becoming a crew member and not simply remaining a passive passenger. Most people, at least in developed, consumer economies, act as uninformed passengers on "cruise ship earth" as planetary ethicist Tim Rumage is fond of saying. Mindless passengers on a cruise ship have no idea where the food they eat comes from, how it got to the ship or how it is prepared. They don't know where the trash goes, what the CO_2 footprint of the cruise is, and are basically fully and completely disconnected with the consequences of actions taken.

Think about your monthly electric bill. When you see the bill, if the amount to be paid is close to what it has been in prior months, you pay it. If it is higher or lower than what you expected, you think back and realize that say it was very hot or cold, hence the greater use of HVAC.

Let's say your average monthly electric bill is $125 – about the national US average. If it's $150 you stop to recall why it is higher, then you pay it. The next question is "How much energy are you paying for?" Most people have no idea.

So, people come to the monthly ritual of paying the electric bill purely as price-conditioned consumers. If the bill is at or near $125 it is paid without thinking. If the bill is much higher, then one reflects back to see what made the bill so high. It might have been a heat or cold wave-"oh yeah, it was up in the 90s for a week last month". Then the customer pays the bill.

What the answer "$125" tells me is that the person has used somewhere in the area of 1,000 kwh in the month. We at This Spaceship Earth have an idea we call "the

2% solution.” Next month, try to reduce your energy use by 2%. In the case of 1,000 kwh that means reducing energy consumption by 20 kwh. After six months of “crewing”, your energy use will be down to 880 kwh. That means that the customer is using 12% less electricity than six months prior and that the monthly bill will also be 12% less.

So mindless passengers come to the monthly electric bill payment as price conditioned consumers and only look at the bill's first page. Crew members look at the second page of the bill to see how much electricity was used, and then take action to lower usage.

One can take that sense of active crewing across most aspects of life. Crew members are constantly looking to lower their carbon footprints. Decisions are made as to what car to buy and drive, how to travel long distances, what to set the thermostat at, and what products to purchase.

Here is a partial list of how to act as crew. Much of this is known to you, but again, until you/we/me actually do these things, we are passengers.

If you want to become crew, start out slowly. Pick just one thing and do it. Be it picking up plastic from a local park, making compost for the home garden, or setting the thermostat to conserve energy. Just do it. You will feel good about what you are doing and then will want to do more.

Think of Earth as the only place you have on which to live. Now think of Earth as This Spaceship Earth. Then think of any spaceship that is on a mission, either real or fiction. What does the crew have to do? Manage all onboard resources to ensure that there will be enough to complete the mission. If not, then the mission gets aborted.

We at This Spaceship Earth are on a mission to have 1 billion humans decide they want to be active crew members. That is about12% of all humans. If there are 1 billion people who are actively crewing TSE we think that will be a critical mass to trigger the necessary changes.

Are you ready to become crew?

Chapter 5 – What Businesses Can Do

"*Businesses need to transform… be skeptical of business as usual. There needs to be a movement. There has to be a better way. Crew consciousness is the shift we need."* – Tomás O'Leary, CEO, Origina

- Looking 10 years ahead, how do you think your market will change? What changes do you foresee in the cost and availability of materials and commodities that you need? What might your energy and water costs be? Or your IT cost?
- How will stronger legislation concerning air and water quality impact your operations?
- How will international treaties about climate change or restrictions on chemical use/disposal impact your operations?
- How will your organization's dynamics with currently identifiable competitors change in the next 10 years?
- What is the unseen disruptive innovation that could happen in your industry?
- How do you keep your business adaptable and resilient?

In the next 10 to 15 years many key resources will come not from mining the ground but from mining landfills. Businesses will find it cost effective and probably necessary to call back all their "end-of-life" products to be the resources for the next generation of products. It may be that profit is maximized through the "object-of-service" model rather than the current "product-for-sale" methodology.

"*Be the stewards of the future you want."* – Yvette Montero Salvatico, futurist

The financial and reputational risks associated with our climate crisis are on the rise. Companies that fail to account for and manage climate-related risks are not

only a threat to the environment, they are a threat to themselves. Everything needs to be redesigned for a zero carbon circular economy.

Crew consciousness provides a tool for organizations to transform themselves by placing climate activism, climate risk management, mitigation, adaptation, resilience and climate opportunity discovery at the core of their operations.

Starting with the Right to Repair, businesses can build a roadmap to a cleaner, healthier more robust and just future operating within a global circular economy. It will take time and resources, but by promoting climate activism as a purpose beyond profit, and crew consciousness as company culture, suddenly all stakeholders know where they are trying to get to and why, and are willing to work together to achieve a common goal.

Crew Consciousness

You learned all about crew consciousness in the last chapter. Humanity must evolve past being passive passengers to being active crew members on Spaceship Earth. That shift in consciousness encourages behaviors that successfully address our climate crisis. I'm going to show you here how crew consciousness can be embedded into the operating system of your organization to drive climate resilience, climate risk management and climate opportunity discovery.

Crew consciousness refers to the concept of perceiving Earth as a shared spaceship and recognizing the interconnectedness of all life on the planet. While crew consciousness itself may not directly address climate resilience, it can contribute to fostering the necessary mindset and values that promote climate resilience in several ways:

1. Collective Responsibility: Crew consciousness emphasizes the notion that all individuals on Earth are part of the same crew. This perspective encourages a sense of collective responsibility for the well-being of the planet and its inhabitants. Climate resilience requires collaborative efforts at local, national and global levels, involving governments, businesses, communities and individuals working together to address the impacts of climate change.

2. Systems Thinking: Crew consciousness encourages systems thinking, recognizing the Earth and its climate as a complex interconnected system. Climate resilience requires understanding the intricate relationships between various social, economic and environmental factors. By adopting a systems thinking approach, decision-makers can develop comprehensive strategies that consider the interdependencies and feedback loops within the Earth's ecosystem, and devise solutions that don't result in unintended consequences.
3. Regenerative Practices: The principles of crew consciousness align with regenerative practices that promote environmental stewardship. These practices include reducing greenhouse gas emissions, conserving resources, adopting renewable energy sources, and implementing regenerative agriculture and land management techniques. By embracing such practices, societies can lower their carbon footprints and contribute to building a low-carbon, climate-resilient future.
4. Adaptation and Innovation: Crew consciousness can foster an open and adaptive mindset, acknowledging the need for continuous learning and innovation in the face of climate change. A climate-resilient society should be equipped to adapt to changing conditions and develop innovative solutions to mitigate the impacts of our climate crisis. Embracing crew consciousness can encourage creativity and cooperation, leading to the development of new technologies, practices and policies that enhance climate resilience.
5. Education and Awareness: Crew consciousness emphasizes the importance of raising awareness and educating people about the fragility and interconnectedness of our planetary ecosystem. By promoting education on climate change, its causes, and its impacts, crew consciousness can contribute to building a knowledgeable and informed society… a climate literate society. This, in turn, can lead to informed decision-making, active participation in climate action, and the development of resilient communities.

Crew Consciousness can help you and your organizations to navigate our climate crisis successfully (and help midwife a better world for generations to come). A catalyst for the transformation we must make. People are looking for meaning in their lives. They are looking for purpose. They are looking for community. Banding together to overcome our climate crisis via crew consciousness can accomplish all that. Readers adopt crew consciousness and a path to a circular (and eventually regenerative) economy as an organizational principle (North Star).

It's going to take all of us to solve the wicked problem that is our climate crisis. Communities need businesses to keep running, and businesses need the communities in which they are embedded to survive and thrive… that means making them climate resilient.

Companies need to climate proof their facilities, and they need their employees to show up to work and their suppliers to deliver. They can't do that if the roads are underwater, or if their homes have been damaged by wildfires, or if there's no food on the shelves in the local supermarket.

Crew consciousness means we ALL do our parts – government, business, every institution, community, family and individual… all think and act like crew members on Spaceship Earth.

The Workplace

Because our world is more fluid, unpredictable, less stable and more at risk than at any time since World War II, resilient business strategies should be ingrained throughout your organization. Investors will want to know whether a company can prove it is resilient. No business strategy can succeed if it doesn't account for the impacts of our climate crisis, supply chains subject to rapid disruption, and shifting political environments.

Supply Chains

In recent decades businesses have focused on maximizing efficiency. To save costs and streamline operations, manufacturers have limited themselves to a handful of suppliers in a few countries. These global supply chains created savings and

boosted profits when all was running smoothly. But the pandemic disrupted all that… and our climate crisis guarantees ongoing disruptions.

Markets will benefit from an adjustment to supply chains by selecting suppliers that are closer to home. Resilience will outperform efficiency through the cultivation of multiple suppliers.

By digitizing other processes, companies can harness the opportunities that come from economies of knowledge, compensating for those lost in scale.[1]

What can the private sector do to help build resilience?

There are three big opportunities. The private sector can:

1. Innovate and scale those resilience strategies that also make business sense.
2. Lobby for the public policy and programs we need, and
3. Communicate the importance of resilience efforts and our shared interests. Show that resilience doesn't need to be one more topic that divides and polarizes our communities. Help people see that we really are all in this together.

Lobby for Public Policy

Climate resilience requires thoughtful and ambitious public programs to mitigate the harshest outcomes. The public sector should be determining (and figuring out how to pay for) climate adaptations like sea walls, relocating people from coastal areas, planning to shelter people in urban areas from catastrophic heat waves, rezoning to introduce bike paths and green spaces (which reduce temperatures and absorb rainfall runoff), and preparing for surges in climate refugees.

The challenge is not so much identifying what needs to be done (that has already happened); rather, it’s getting government leaders to take action. Now is the time to make the substantial investments in infrastructure and policy we need.

The business community has a strong voice, proven government lobbying capabilities, and recognized expertise in making long-term investments to manage risks. Business leaders are therefore well positioned to step up and be champions for the governmental programs we need. We don't see nearly enough discussion about these urgent public policy matters. Business leaders can change that.

Contribute to Constructive Discourse

On the one hand, none of this is going to be easy; but on the other hand, all of it is in everyone's interest. Investments in resilience are investments in the public good, period. But we know today's divisive political environment has not been conducive to large-scale government-led problem solving.

Upskilling Your Stakeholders with Climate Literacy

Our climate crisis ensures that we will be operating in a Volatile, Uncertain, Complex and Ambiguous (VUCA) environment for decades. It is crucial for organizations to determine what new skills will be required to develop and deliver the products and services needed to meet this global challenge.

Some of the skills are obvious – those needed to reduce carbon footprints of supply chains, manufacturing processes and the products sold. There is plenty of information available around that. Let's focus instead on the skills that will enable organizations to deliver innovative products for a new world – the carbon free world that we must transition to.

Most organizations offer a mix of mandated training (e.g. workplace safety, compliance and ethics) and optional enrichment (e.g., mindfulness, unconscious bias, time management) for their employees. But where are the educational tools on living sustainably, where the learnings are personally relevant and emphasize taking action?

Not only is sustainable living embedded in the UN Sustainable Development Goals (4 Education and 12.8 Responsible Consumption), but educating your employees on sustainable action-taking is a critical measure of employee engagement and job satisfaction.

Over 70% percent of Gen Zers and 40% of Millennials cite the climate crisis as their #1 personal concern and believe it should be a priority of business as well. These generations are your current and future employees and customers.

New Product Development

Our climate crisis is a global, extremely complex systemic problem. It cannot be solved by using siloed legacy thinking. Designing a low-carbon future requires unprecedented levels of collaboration, creativity and imagination.

Much of what we need to do to successfully alleviate our climate crisis is related to design. So many of the design decisions made every day have a climate implication: each one can help promote a low-carbon future that doesn't rely on fossil fuels. Those who create the products and built environments of everyday life have an important role to play.

Here we are in the 21st Century with much of the world built out, paved over and with ever more overcrowded megacities. We have to redesign much of the built environment. We must make design/redesign decisions on transportation, housing, and highest use real estate retrofitting.

Successful organizations will:

- openly and aggressively move to reduce their carbon emissions.
- market that fact relative to their competitors.

- create goodwill and market share by establishing leadership positions.
- redesign all forms of industry, transportation and daily life from being powered by fossil fuels to being powered by clean, non-polluting energy sources.

Fugro Case Study – Case Study of a Successful Climate Transition Plan

Fugro is a large geo-engineering firm headquartered in the Netherlands. Historically, it has worked with oil and gas companies. Leadership realized early that they would have to change their business model… that fossil fuels is a sunset industry, and in order to survive, Fugro needed to make transformative changes.

Fugro's core competencies, tools and technologies have been repurposed to deliver climate-related solutions. Here's a quote from their website:

"For Fugro, sustainable business means that we continuously rethink what we do and how we do it. We unlock insights from Geo-data, a critical element for the sustainable development and operation of our clients' infrastructure, plants, buildings and natural resources. With our products, services and innovative solutions, we directly contribute to modern infrastructure, climate change mitigating projects such as flood and coastal protection, and safe and efficient power grids. Fugro plays an important role in the ongoing energy transition with the development of renewable energy assets such as offshore windfarms, while assisting in safe and efficient development, construction, operation and decommissioning of fossil fuels while this is still an important part of the global energy mix. Fugro, together with its clients and other stakeholders, plays a fundamental role in creating a safe and livable world."

That isn't PR or greenwashing… it is a commercially focused strategy designed to make the organization thrive in the "new abnormal". They took transformation seriously and are positioning to be a major player in a zero carbon economy. They have made our climate crisis the centerpiece of their transformation… and it is paying off.

It is likely that your business does not have the extent of climate impacts Fugro was vulnerable to. Yet no matter what your business, you will be impacted. It's

best to assess those potential impacts so you can manage your risks and leverage your opportunities.

We should not be counting on the private sector to take on initiatives that don't make business sense. That's not a realistic goal. We should ask the private sector to do everything it can to address the challenge. We should encourage companies to take longer term views. An ounce of prevention is worth a pound of cure. Short-termism with an exclusive focus on efficiency and profit is no longer appropriate or healthy. Climate resilience requires proactive strategies that anticipate climate risks and opportunities and plan for them over longer time periods.

Biomimicry and Cradle to Cradle Design

Nature produces abundance all day every day with no waste or toxicity. She accomplished this via 3.8 billion years of trial and error R&D.

Could we model our own product designs on Nature's? A tree produces thousands of blossoms in order to bear fruit, yet that abundance isn't wasteful. It's safe, beautiful and highly effective. The blossoms fall away to biodegrade and enrich the soil. If not picked, the fruit is eaten by birds and seeds are distributed to produce more trees. Products might be designed so that, after their useful life, they provide nourishment for something new – either as biological nutrients that safely re-enter the environment, or as industrial nutrients that circulate within closed-loop production cycles, feeding the manufacture of other goods.

That would minimize the extraction of ever more resources from the earth.

Nature has her own waste disposal solutions. In nature nothing is wasted. All things that were once alive eventually become part of the earth again, returning usable resources. So why not study how nature produces abundantly without waste?

Bill McDonough, the architect and designer, has formulated a design principle which he lays out in his book ***Cradle to Cradle***. He demonstrates that our current production systems are based on a 'cradle to grave' design model that dates to the Industrial Revolution. This process casts off as much as 90 percent of the materials it uses as waste, much of it toxic. McDonough challenges the notion that human industry must inevitably damage the natural world.

There's an established science that analyzes nature's ideas and adapts them for human use. It's called biomimicry. So far, most biomimicry breakthroughs have been designed and deployed to build better products – lighter, stronger, faster, etc. What if biomimicry scientists (biomimicists?) tackled Bill McDonough's closed loop, zero waste, cradle to cradle design challenges?

We want to continue (and expand) our current quality of life, so we should borrow design and production techniques from Mother Nature. But we don't have a lot of time. Today, design teams are leveraging technology to rapidly iterate among thousands of potential design solutions before arriving at the optimal one. The same thinking can be applied to the design of climate solutions – continually iterating and optimizing designs until we have the best solution to grow to the scale we need.

At the core of all design and redesign projects will be several tenets:

- approach each design problem from a holistic perspective using systemic design principles,
- lower greenhouse gas emissions as quickly and completely as possible in every facet of the supply chain and production processes,
- restore as much of the natural world as possible through clean-up, restoration and regeneration,
- create direct linkages between what people do and the consequences they unwittingly create,
- replace quantity with quality… retire "planned obsolescence",
- look to Nature for elegant design solutions,
- design all products to have a long life of utility, and to be easily disassembled and reintroduced into the production life cycle when their useful life is over.

By relentlessly applying the principles outlined above (engaging more people in the design process, understanding the impact of our decisions, and rapidly iterating until we arrive at optimal designs) we can create elegant solutions to our climate crisis.

New York Times columnist Thomas Friedman framed our climate crisis as an issue of economic competitiveness and innovation. The businesses that are more successful at producing new energy technologies and zero carbon products will thrive.

Leadership in the corporate sector has a massive role to play. Far swifter and more meaningful change can come from within a business than when it's mandated by government regulations. Business models need to be forward-thinking, not relying on traditional methods of production, and must change company cultures in the process.

Complex problems have complex solutions. Design thinking, systems thinking, cradle to cradle and biomimicry design methodologies, communication, collaboration, creativity, data analysis, social science and emotional intelligence are the skills needed to successfully navigate and mitigate the VUCA world our climate crisis is delivering.

Culture Eats Strategy for Breakfast

Effective leaders build a strong organizational culture by binding stakeholders together via a common purpose. What better purpose than addressing the most serious threat humankind has ever faced? Our climate crisis imperils every species, government, business, institution, community, family and individual on Spaceship Earth.

The unfamiliar and uncertain often taps into the fear element of our fight-or-flight warning system. We need to overcome our initial fear and move forward, using the challenge to innovate and adapt. If we allow ourselves to become trapped in the uncertainty, our modus operandi becomes firefighting. Firefighting is not a strategy.

Move from the day-to-day operational considerations of management to the longer-term transformative dimensions of leadership.

The ability of an entire organization to consistently adapt over and over again requires the whole crew of stakeholders, not just the C-suite. And to orient the whole crew takes a North Star. A common purpose known and accepted by all provides context and direction for every decision, every action, by every person,

every day. That's how a challenging, even uncertain, landscape becomes an opportunity.

Uncertainty is an opportunity. Leaders willing to say they don't have all the answers demonstrate an open mind, show that vulnerability is OK, and that experimentation should be rewarded.

Uncertainty should be met with a willingness to engage in the discovery process and embrace others' ideas. The difficulty involved in grappling with uncertainty means the lessons learned, knowledge gained, and experience garnered will be long lasting. What comes easy is soon forgotten.

Businesses seeking long-term viability in the era of climate change can learn from highly reliable organizations (HROs). HROs include entities like aircraft carriers and nuclear power plants that must focus on significant high impact risks. Resilience in environments that are uncertain and high risk require a culture that provides "a license to think and act". Command and control, and rigid bureaucracies should give way to more fluid management and decision structures. That has implications for many C-suite teams.

Dragon flies have holoptic eyes. That is they have 360 degree vision. They see everything in front of them, behind them, to their right and left, above and below them. When crew consciousness is internalized by all stakeholders, it provides an all hands on deck 360 degree picture. By upskilling all stakeholders in an organization with climate literacy, we can effectively create a highly reliable organization. Each individual stakeholder will be equipped to understand the climate implications, risks and opportunities unique to their role in the organization and their singular perspective of the organization. Equip them with the training and tools they need, and give them the authority to get creative around adapting to climate risks and discovering climate solution opportunities.

People largely distrust our institutions… including governments and corporations. They (especially the younger ones – your current and future customers and employees) are vigilant for any signs of opacity or BS. The only way forward is to do the right thing, to walk the talk, and to be honest and forthcoming about what you're planning, how you're going to make it happen… and to give regular updates (even when you fail to meet your milestones).

Every leader must have a clear and realistic understanding of their company culture. Culture affects your ability to deliver on your climate promises.

Culture reveals what is truly *valued*.

Climate as Company Culture

CO_2 remains resident in the atmosphere for decades. Emitting any amount of CO_2 adds to the accumulation. The more CO_2, the more warming. Every organization should be doing all it can to reduce emissions to avoid the worst disruptions from our climate crisis. You should be looking at your supply chains, your manufacturing processes, your products, your packaging and your distribution channels. Where can you lower emissions? Designing and delivering low or no emission products is a massive opportunity. As average consumers become aware of the severity of the situation, they are increasingly searching out companies who are making a concerted effort to reduce their emissions.

Drawing down resident CO_2 can be an opportunity. It's an opportunity to get creative either via R&D to develop and deploy relevant technologies, or by launching a corporate-wide effort to draw down CO_2 using natural methods. One idea would be to grow green plants on the exterior walls of company buildings, and plant vegetable gardens on the roofs.

Imagine if employees were encouraged to tend vegetables on the roof of their place of work, and to take them home, or distribute them to local food pantries. That would spread the news that Company XYZ is a good place to work, a terrific corporate citizen, and is taking meaningful action to address our climate crisis.

As creatures of habit, humans tend to change their behavior slowly, especially when a threat is perceived to be at a distance (geographically or in a timeline). But even small changes in behavior are greatly amplified by behavioral contagion – the social scientist's term for how ideas and behaviors spread from person to person like infectious diseases.

Adaptation is making the necessary changes to minimize the risks your company faces from our climate crisis. Each organization is unique and will face its own unique risks. Does it have facilities close to an ocean shore where they will be vulnerable to sea level rise and storm surge? Does it use significant amounts of

water in its manufacturing plant in a location that is experiencing longer, deeper and more frequent droughts? Does it have operations in an area susceptible to business disruption due to forest fires?

All the above strategies and tactics help to make the situation real in the eyes of the public. When they see a sea wall being built, or a vegetable garden being planted on the roof of an office building, or a request for climate-related insurance coverage, or low emission products announced, they understand that action is being taken to meet the challenges of our climate crisis. And, in turn, they are more likely to take relevant actions in their personal lives, and to demand action from governments.

Companies can draw on a variety of risk management tools to enhance their physical, operational, and financial resilience. Enhanced business continuity planning (supply chain analyses and operational recovery strategies) can maximize operational resilience. Companies can map infrastructure vulnerabilities to natural hazards, and identify climate risks with respect to location, facility and asset.

How can these risks be managed? They might involve something as simple as building a seawall, or as disruptive as moving operations to another geography. After Hurricane Sandy, Bloomberg moved its data center from the southern tip of Manhattan to high ground in New Jersey.

Traditional companies often become brittle and lose the flexibility they need to survive in a Volatile, Uncertain, Complex and Ambiguous world. There are significant opportunities for companies to co-create adaptation solutions with their suppliers, their customers, academia or even NGOs. Co-creation helps in developing systemic solutions that avoid unintended consequences. The diverse viewpoints, priorities and experiences of a variety of stakeholders aids in the creation of elegant solutions. Through pooling expertise from within your ecosystem, and tackling the issue from different perspectives, this “collision” can result in real innovation. Innovation that can be transferred into the development of new products, services and markets, and to strengthen your competitive advantage.

Climate as Purpose

Our climate crisis is the greatest challenge humankind has ever faced, and it threatens every living thing on Spaceship Earth. Successfully addressing it is a worthwhile purpose for all organizations. From a commercial perspective, there are also significant opportunities available from doing so.

Addressing our climate crisis requires mitigation and adaptation. Mitigation works to prevent the worst effects of our climate crisis. Adaptation works to manage the climate risks that an organization is facing, or likely to face in the near future.

Addressing our climate crisis is a purpose that all organizations can and should adopt. Cutting emissions in supply chains, manufacturing processes, packaging, product delivery, and in the use of a product are all efforts that will happen… either proactively or via government mandate. The earlier done, the less disruptive these efforts will be, and the more rewarded the organization will be. There's no market differentiation in complying to mandates.

Purpose as Motivation

People are looking for meaning at work. Organizations who frame that meaning around the impact they have on customers stand out. They engage customers and employees alike; they transcend their market. They become coveted brands and destination employers. Climate mitigation is the ultimate positive impact on customers.

Once it has been simply and clearly articulated, corporate purpose must drive what the organization does – its strategy and capital allocation decisions. Strategy is about choices that are made and choices that are consciously rejected after serious consideration. For a purpose to be authentic, it has to be the reference point for strategic decisions. Internally, leaders should ensure that purpose translates into what everyone in the organization does. Unless purpose statements translate into actions they are meaningless. Externally, leaders should ensure that the organization's purpose connects with partner organizations throughout its supply chain and customer markets.

Ownership of purpose starts with executive leadership. It has to put in place appropriate structures, control systems and processes for enacting purpose. The purpose must be embraced by everyone in the organization. The purpose should also be endorsed by the organization's external stakeholders.

A key role of leadership is to bring organizational purpose to life through communication and narrative strategies. Well-crafted stories build a sense of shared identity around a common purpose. That inspires those working in the organization to believe they are contributing as a team to something that is meaningful and fulfilling.

The narratives should be vivid and uplifting, and also authentic in conveying honestly and openly the challenges and failures as well as the successes. They should reveal a willingness of leadership to accept their share of the costs of failure as well as the rewards of success. A story about how a misstep was addressed and corrected resonates with people. It comforts them that mistakes happen, and they can be handled and learned from. It demonstrates transparency on the part of leadership… and that generates trust.

Managing Climate Risk

Surviving impacts from our climate crisis requires that businesses actively manage their climate-related risks… including business disruptions due to extreme weather events, tightening environmental regulations, and evolving consumer demands. Companies should be working on and deploying climate-related risk strategies and crisis plans – and that requires increased climate competence throughout the organization (including in the C-suite).

Creativity and imagination are capabilities we are all born with and use easily as children. Unfortunately our educational system and culture do not nurture them. If you activate your imagination constantly, you also activate your innate capacity to think, and imagine, in systems.

It is impossible to create a resilient business without understanding the range of possible futures a company might have to deal with. Organizations should be investigating the possible, plausible and preferred futures they will be operating in. If you anticipate several potential scenarios your organization might encounter as

you develop your plans, you'll be far better prepared to act quickly and decisively when you're faced with a disruption.

The main challenge in developing long-term risk management strategies is the high level of uncertainty and complexity inherent in our climate crisis. Scenario planning should examine how the various components of risk will evolve in response to climate issues. It is important to understand that scenarios should not focus *solely* on the risks inherent in our climate crisis. Scenario planning must simultaneously take into account changing consumer trends, technological developments, changes in regulations and more.

Comprehensive research leveraging diverse perspectives can not only proactively manage risks, but often reveal business opportunities. Adaptation to climate risks requires a high level of investment and the right tools. From a physical risk perspective, simply relying on historical data (e.g. frequency of severe weather events, building design codes) is highly unreliable for climate planning purposes. Our climate crisis is an unprecedented phenomenon and there are no historical references.

“New Abnormal” Low/No Carbon Business Models

Part of the transition will be producing less, and including circular design and production. Not quantitative growth, but qualitative growth.

While the movement towards a multi-stakeholder approach to business has increased in recent years, our climate crisis creates an opportunity for a conscious mindset change. That is, an opportunity to upskill for climate literacy, and upgrade company cultures to include climate resilience and crew consciousness. Responsible business leaders will recognize this moment as an opportunity to use a societal lens that contributes to stability and makes everyone better off in the long term.

How does one forecast and strategize when living in a time when anything can happen? The first step is to change how we perceive uncertainty. What if we embrace it?

“Anything can happen.” What an opportunity! There are an infinite number of potential futures… and we can cultivate the one we will experience by the actions we take today.

That requires knowing what you want. So what do you (business leaders) want? It’s safe to assume you want your business to survive and thrive. You want it to provide for yourself and your employees. I’d add that it should also benefit all stakeholders (customers, suppliers, investors and the communities in which you operate).

Future Fit Transformation

What if you are the type of leader who views survival as not enough? What if you want your business and yourself (and all your stakeholders) to thrive?

What if you decide to do everything you can to redesign your business to meet the challenges of our climate crisis?

What if you identified the specific climate risks your operations are vulnerable to and took action to mitigate them?

What if you inventoried your internal resources, your tools and technologies, your intellectual property and partnerships to uncover latent capabilities that can be repurposed as climate opportunities… innovative products and services that your existing customers (and new ones) will want in five or ten years?

That’s a tall order, but it’s doable. It requires long term planning (something you know you should be doing). And it requires money. Will investors balk? Perhaps. But if you can paint a compelling picture of your preferred future, many will choose to stick with you.

If you have a well-researched climate transition plan… including a timeline with milestones and a budget outlining how you will get from here to there; plus a compelling future scenario narrative; plus an acknowledgement that stuff happens and a plan to handle that; you’ll find the money that you need.

It’s so much better to have a plan to avoid disasters than to be forced to deploy a disaster recovery plan.

Be Prepared

Your business may not be as well positioned for a complete makeover as Fugro, yet it is vulnerable to climate risks, and you likely have unrecognized climate opportunities. Please consider creating a climate transition plan.

Each organization will experience different climate impacts specific to their locations, supply chains, products and services, and many other variables. It is not a matter of "if" but "when". Taking the time, doing the work, and making the investments to prepare for impacts (both risks and opportunities) will make all the difference as we progress through an ever more VUCA environment.

Leading organizations in these volatile and complex times require new approaches and mindsets. Trends in society, technology, employment and the economy are all converging in unexpected ways, forever changing the way people view the world.

Leadership Traits

What it takes to be successful; highlighting three leadership styles – adaptive, resilient and transformative – that will enable you to meet the demands of a changing world.

Adaptive

Our climate crisis demands urgent attention from leaders – not just for our planet, but for new generations entering the workforce. Younger workers are increasingly challenging their workplaces to step up and evolve linear business models into circular economies. If leaders don't respond holistically and productively, they risk losing a whole generation of engaged minds who will happily consider taking their skills elsewhere.

In uncertain times, finding and pursuing a higher purpose becomes more crucial. For organizations, a shared purpose – supported by a series of shared values – can help increase focus, cohesion and resilience. Team members are more likely to solve complex problems together when they're aligned, working towards the same goal, and confident in the organization's North Star. A clear shared purpose and

values can reassure individuals of an organization's overall mission, imbue a sense of ownership among its teams, and ultimately drive stronger performance.

There's no "one size fits all" in the future of leadership. With the rate of change showing no signs of slowing down, organizations must prepare to adapt, flex, learn and listen. Leaders need to understand the needs of their people, customers, markets, and the planet in order to lead in ways that meet, exceed and harmonize with demands that are changing faster every day.[2]

Resilience

Repeatedly rebounding from disruption is tough, but some companies have a recipe for success: a systems mindset emphasizing agility, psychological safety, adaptable leadership and cohesive culture.

Resilient organizations don't just bounce back from misfortune or change; they bounce forward. They absorb the shocks and turn them into opportunities. When challenges emerge, leaders and teams in resilient organizations quickly assess the situation, reorient themselves, double down on what's working, and walk away from what's not.

Cultivating such organizational resilience is difficult, however – especially today, when business leaders, frontline workers and business units are being buffeted by multiple simultaneous disruptions. (Think of the war in Ukraine, the sudden rise of Artificial Intelligence, the global pandemic and resulting Great Resignation, polarized societies, plus the increasing impacts of our climate crisis.)

There is no shelf life on change and no expiration date on organizational resilience. There will *always* be more uncertainty, more change, and a constant push for teams to realize outcomes more quickly. The companies that cultivate organizational resilience, driven not only by disruptions but also by opportunity, can gain an important, lasting advantage over competitors.

- They can build *self-sufficient teams* that, when held accountable and given ownership of outcomes, feel empowered to carry out strategic plans and stay close to customers, and which, through premortems, postmortems, and other feedback loops and mechanisms, have the information they need to continually change course or innovate.

- They can find and promote *adaptable leaders* who don't just react when faced with a natural disaster, a competitor's moves, or a change in team dynamics. They take the time to coach team members through the change. They catalyze new behaviors, and they develop capabilities that can help set the conditions for both a short-term response and long-term resiliency.
- And they can *invest in talent and culture*… now and for the future. The companies that focus on building resilient operations, teams and leaders may gain a two-way talent advantage: such adaptable environments are more likely to attract top talent who will have a greater chance of success and, in turn, be more likely to perpetuate a cycle of resilience.[5]

Corporate-Led Resilience Strategies that Make Business Sense

We should do everything we can to encourage businesses to seize all opportunities related to climate change that will also provide appropriate returns.

The good news is that there are many opportunities to both address climate resilience and also achieve positive business outcomes. Resilience initiatives can present new market opportunities that drive top line growth, investments that reduce risk, and engagements that rally stakeholders and community members.

For example:

1. Reinsurance companies have expert risk management and scenario planning capabilities concerning the impacts of our climate crisis. They can share (sell) their analyses of where risks will be most severe. By sharing this information fully with the public, they can discourage risky behavior (such as immediately rebuilding in coastal areas after hurricanes).
2. Companies in the agricultural sector can prioritize tools and strategies to produce food in the face of heat waves, water crises (including both droughts, and intense rain events), and infestations by pests.
3. Natural resource companies can deploy emerging technologies to improve forest management in order to reduce fire risks.

4. Engineering companies can prioritize heat-resistant metals. (Portland OR had to close mass transit because the rails warped during an extreme heat event.)
5. Construction companies can develop infrastructure – including nature-based tools – to manage dangerous excess water and excess heat in urban settings.[3]

Climate touches everything. No matter what your business or industry, there are climate-related risks and opportunities. Find them.

Transparency

Increased scrutiny demands transparency and honest accounting of environmental impacts. This should include proactive disclosure of current environmental effects; measures taken to reduce these effects; and policies to increase regeneration. A company that is upfront about its environmental impacts, as well as disclosing the countermeasures it has put in place, can demonstrate its commitment to progressing a circular economy and improve its relationships with all stakeholders… and minimize the risk of adverse press attention.

Even a partially opaque organization (which most are) increases VUCA levels. If stakeholders don't understand a company's mission and objectives, if problems are hidden from view, if they feel ignored, they lose trust. They lose enthusiasm. And they lose loyalty. Eventually, they disengage and move on.

When transparency is intrinsic to a corporate culture, employees are more engaged and committed to the vision. They understand the mission and feel comfortable sharing ideas, displaying creativity, and innovating to achieve desired objectives.

Transparency builds trust. An environment lacking in robust trust fosters ambiguity. Ambiguity produces polarized views and disinformation. Maintaining trust is absolutely vital because, once it is lost, it's an arduous, time-consuming process to win it back.

How does a company deliver the full value of transparency to the workplace? Direct, clear and honest communication… without bullshit. And it's important that

communication is omni-directional (up, down, sideways – every which way). Employees are most engaged and committed to the process when they feel heard.

A VUCA world requires excellent communication – to get things done, to adapt quickly, move with agility and protect reputation. How do we improve communications? Via an open environment that encourages the sharing of ideas without judgement. While this is not easy, there are training programs designed to improve workplace communications and teach people from all backgrounds to relate to one another without judgement. An open flow of communications prevents bottlenecks and other issues. Senior management must engage employees and relate to them as people.

Be proactive… not reactive. In a world that experiences almost exponential rates of change, proactive communication of a company's vision and mission is vital. Proactive communication of a company's values clearly conveys the behaviors expected from staff towards each other and to stakeholders.

It is important to let your employees in on company problems. If they're aware, they will help you find a solution. Staff, and potentially other stakeholders, must feel empowered. They will often have more expertise and experience in the issues they deal with than the organization's leaders do. If they are given the right conditions, respect and training, they will rise to the occasion.

Transparency doesn't cost much in dollars. Successful implementation will take time and effort. Start by being honest about what you are doing, and why. Invite stakeholders to help you accomplish transparency. True team efforts always produce superior results.

Some Questions to Get You Started

1. What happens to your company's trash? How much is being fully recycled? Can you do better than the current situation?
2. Ask stakeholders/crew members to volunteer to be the crew captain of various components like electricity use, carbon footprint of the company's transportation systems, and waste reduction in manufacturing processes.

3. What is the amount of water used by the company in a month? Can it be reduced by 2% per month?
4. What is the amount of e-waste that your business is responsible for annually? Try to reduce that by 25% year over year.

Call to Action

Our world is changing faster than most of us realize. Our climate crisis guarantees that this will continue for decades at least. Crew Consciousness represents our collective potential to come together to achieve a transformation that not only addresses climate, but gives us better work lives, a cleaner more abundant environment, healthier air, food and water, slows the loss of plant and animal biodiversity, evolves humanity, promotes cooperation and collaboration.

Crew Consciousness is a deeply humanistic and spiritual practice. It is how we choose to reframe our world beyond the Fourth Industrial Revolution. Embrace the challenges and risks. Explore your potential organizational futures and use crew consciousness to pull your preferred future into the present.

We invite you to join us on our mission!

[1] https://www.imd.org/research-knowledge/sustainability/articles/five-ways-businesses-contribute-to-balanced-post-coronavirus-future

[2] https://www.icf.com/insights/engagement/adaptive-leadership-changing-world

[3] https://www.csrwire.com/press_releases/44926-resilient-business-strategies-the-road-to-recovery-based-on-sustainability-principles

[4] https://www.mckinsey.com/capabilities/people-and-organizational-performance/our-insights/raising-the-resilience-of-your-organization

Chapter 6 – What Individuals Can Do

We need to make significant changes in how we live. That requires top down changes (technology, regulations, tax policies, investments, infrastructure) and bottom up changes (personal habits, evolved status markers, local zoning laws, increased civic participation).

Bottom up is just as important as top down… not only for the effects of widespread adoption of reduce, reuse, recycle; but for the byproducts. In this instance, actions precede belief system changes. Once the process is begun, people understand what it means to be a crew member on Spaceship Earth. They see opportunities everywhere to improve processes and reduce their carbon footprints. And they become active in their communities… activists who learn to use the tools available to them to influence those in a top down position.

With any luck, a virtuous cycle ensues. Top down to bottom up and back again. Each feeding the other. Every sequence decreasing emissions and reducing waste, until crew consciousness, a stewardship mindset, pervades every strata of society.[1]

The two most important concepts to keep in mind are crew consciousness and a game plan to quickly reduce your carbon footprint and GHG emissions. Sooner or later, you are going to be taxed on emissions. Combine the two concepts: crew members en masse quickly changing how they live and reducing their carbon footprints. That synergy will be significant in its effectiveness in reaching our goals.

Let's start with some items where we have data.

Individual Action

One person can make a difference by thinking and acting as an active crew member. Start small and simple. As these tasks become habit, they no longer feel strange. They happen automatically. Then you can add more to your daily activities.

"We need to evolve from being passive passengers on Cruise Ship Earth to being active crew members on Spaceship Earth." – Tim Rumage, Planetary Ethicist

"If you think that you are too small to make a difference, try spending the night with a mosquito in the room." – Dalai Lama

Becoming a Crew Member on Spaceship Earth

The fundamental cause of climate change is siloed thinking. This means that humans who live in Growth Economies do not have a cause and effect connection with nature and Earth. We are disconnected from the most complex, elegant and interconnected systems that comprise the environment in which we live.

When you put out your garbage cans and recycling bins, the garbage trucks come and haul your waste away. But in reality it isn't gone, it has just been moved to a place that is out of your sight… where the majority of it will either be incinerated or buried in a landfill. But it is still on Spaceship Earth. Out of sight, out of mind.

Think about sailing on the cruise ship referenced in the quote above. We sit down at all you can eat buffets without knowing where the food came from. We have no idea what happens to the waste from those meals. It's a great metaphor for how we live. Where did the food come from that you ate today? What will happen to what is not eaten and any other waste from the meal? You likely don't know.

Most of us are unconscious consumers… a part of the process that is causing global warming, our climate crisis and the sixth extinction of species. Why? We are not active participants in the process. We purchase, consume and discard without curiosity or knowledge about where the raw materials came from, what processes were deployed to make the product, which GHGs and other pollutants were emitted during use, and where the used product goes when it is discarded. That is a consumer process, not how Spaceship Earth was designed to work.

In a growth economy, our role is to consume. Because you are thought of and treated as a consumer, you are targeted by hundreds of advertisements every day. We are persuaded to buy. We are taught that buying makes us feel better about

ourselves. That buying ever more somehow makes us cooler, smarter, more desirable. We are even sold the idea that “shopping” is a productive activity.

The truth is that consumption for consumption’s sake is not cool. Crew consciousness replaces this disconnected, self-centered, consumer mindset, with one that honors and protects the earth, and preserves it for our progeny.

Becoming crew has two major outcomes:

1. You become aware of the consequences of your actions. You no longer can say you didn’t realize. You take responsibility.
2. As the number of crew members increases, the benefits that accrue to the biosphere also increases accordingly. Scale kicks in. This aspect of being crew makes it clear that individual acts, when scaled, do make an important difference.

Here are a couple of examples that can directly be connected to CO_2 emissions.

Think about how much beef you consume. Every quarter pound hamburger generates six pounds of CO_2. This is largely due to today’s industrialized farming and ranching. Say you eat two quarter pound cheeseburgers a week. In a year, you consume roughly 40 pounds of beef. Multiply that by 24 pounds of CO_2 per pound of beef, and that emits 960 pounds of CO_2 into the atmosphere. Almost a half a ton of CO_2! What if you reduce your consumption to two quarter pounders a month? That translates into nine pounds of beef or 216 pounds of CO_2… a reduction of 744 pounds of CO_2 emitted into the atmosphere What if you buy and consume only plant-based beef? There are still emissions from the growing of those plants, and their transportation and manufacture, but far less than 216 pounds of CO_2. That is acting as a crew member.

Crew consciousness makes one feel responsible for Spaceship Earth, the only home we have. Acting as a crew member, and recruiting others to become crew, creates a group sense of aligned action.

Plastic

In the U.S., and in many other parts of the world, 90% of plastic is NOT recycled. Every household has more than enough plastic in the home already. Instead of buying anything packaged in plastic, pack your lunch in a reusable plastic container. Bring one to the restaurant for your leftovers. Carry several to a store that sells in bulk. Eliminating one pound of new plastic removes three pounds of CO_2 emissions.

The average US household throws away 185 pounds of plastic per year which emits 555 pounds of CO_2 via the manufacturing and transport processes. Reuse as much plastic as possible and get others to do so as well. If just 10 million households cut plastic consumption by 25%, there will be a net saving of 230,000 tons of CO_2 emissions.

Cutting beef consumption, decreasing electricity used, and repurposing plastic are just three examples of how crew members can make a real difference. Another way of looking at this is that it saves money to lower CO_2 emissions. All the above actions save money as well as CO_2.

Consumer Consciousness

"Human beings are good at many things, but thinking about our species as a whole is not one of our strong points." – Sir David Attenborough

The choices we make as consumers can make a huge difference. We need to have a paradigm shift regarding how we spend our money. Think of every dollar you spend as a vote. A product purchased is you fulfilling a need for yourself or your family… and in another space, it's a data point on a product sales report. This data is used to decide what a company will make more or less of, and what will be on the shelves in the stores. Next time you are at the store consider this concept. We, as consumers, need to act as crew, making informed decisions, voting with every dollar, making our demands for earth conscious products known.

Visit your local farmer's market once a week. Bring your own reusable cloth bags. Pick up fresh fruits and veggies without putting anything in a plastic bag or clamshell. Less waste coming in means less waste going out.

Ditch plastic baggies. Replace them with reused jelly jars, saved yogurt tubs and other plastic containers.

Stop using paper towels and napkins. Buy some cloth napkins for the dinner table, and cut up old bed sheets and towels to use around the kitchen.

If you live close enough, bike to work. If you don't, start a carpool or take mass transit. Investigate whether your employer will allow you to work from home a few days per week. Buy an electric vehicle.

If you eat eggs, raise chickens. Keep bees. They will provide you with honey. The chickens will eat any ticks and fleas in your yard, and the bees will pollinate your flower and vegetable gardens.

Many power utilities are now offering the opportunity for customers to enroll in a "Green Power" program where you pay a little extra (about $60 a year) for your power, and the utility has to prove to you and the government at the end of the year that it used power from alternative energy sources (wind, solar, hydro, etc.). If they can't document their alternative energy use, they are fined. Therefore you are holding them accountable to invest in alternatives.

You decide who you buy from. Every decision you make from the car you drive, to the toys you give your children, to the clothes you wear has a ripple effect on Spaceship Earth.

Every dollar we spend is a vote:

- We are voting for where our food is produced – if it must be transported long distances, or is locally and organically grown.
- We are voting for the ingredients that comprise each product we buy – are they toxic chemicals or non-biodegradable plastics?
- We are voting for how much waste is generated in the manufacture of each product.
- We are voting for the entire impact the product will have throughout its useful life and after it's disposed of.

We need to educate ourselves about the foods and products we consume… about all the "stuff" that we surround ourselves with. Go into your bathroom, open every cabinet and drawer, and pull out all the items. Place them on the floor and categorize them: lotions, shampoo and conditioner, makeup, razors, shaving cream, hair bands, contact solution, clippers, travel bottles, meds, nail polish, etc. Step back and look at all of the small plastic containers. Think back to how many of those came packaged in a box or sealed in plastic.

Decide which products you can do without. Promise yourself not to buy any more of them. Then decide which items are necessary and research options to buy that product in bulk. Bulk buys use less packaging and require fewer purchases (and fewer trips to the store) per year.

Once you are done with this highly achievable project, make a plan and set aside time to do this to other rooms in your home. How about your kitchen, closet or garage? You can simplify your life by paring down to your lifestyle's necessities.

Think before you buy. Do you really need a new sweater? How many are sitting in your dresser drawer? Is your urge for a new sweater prompted by a need to stay warm, or is it because your sweater is no longer in style? "Fast fashion" is a major contributor to global warming. The fashion industry was responsible for 1.7 billion tons of carbon dioxide in 2015. Buy quality over quantity. Have two sweaters in that dresser drawer instead of six.[3]

As we move to a circular economy, wearing the latest fashion will lose its cachet. Respect will be earned by those who purchase smart… those who look beyond themselves and consider the consequences of their purchases on Spaceship Earth and all of its inhabitants.

Neighborhood

"Do what you can, with what you have, from where you are." – Theodore Roosevelt

Make a concerted effort to be part of your neighborhood community. Get to know your neighbors, if you don't already. Start a neighborhood environmental team. Begin by socializing… picnics and barbecues (you can grill vegetables). Then grow by presenting educational seminars. There are many environmental groups

with chapters in every city. The Citizens Climate Lobby (CCL), the Climate Reality Project, and the Pachamama Alliance are among many who will happily present to your neighborhood group.

Host native plant giveaways. Get creative. In the process, you will plant seeds of awareness, and make new friends and allies. Then you're ready to tackle some slightly more ambitious projects like these:

Alternative Transportation Challenge

Use friendly competition to get neighbors biking, walking and taking public transit more often… good for the environment and your health.

Bike and Transit Buddy Programs

Match experienced cyclists (Mentors) with people who would like to bike more, but could use some guidance (New Riders). Match experienced public transit riders with interested, but less experienced riders. Matching programs decrease car usage and CO_2 emissions by increasing bike riding and public transportation use.

Bulk Energy Purchasing

Save money and reduce your carbon emissions by participating in a community purchasing program. These programs give homeowners volume discounts when their neighborhoods decide to go solar.

Bulk Food Buying Clubs

Bulk food purchasing provides healthy options at a price cheaper than many grocery stores. In addition, it builds community as people work together to select and distribute food. Reducing trips to the grocery store decreases the use of fossil fuels and emissions from personal vehicles.

Clean Up and Recycling Events

Provide the neighborhood an opportunity to dispose of items that are not collected curbside. Cleanup events minimize waste by matching hard-to-recycle items with willing recyclers. Neighborhood clean-up events:

- Reduce the amount of waste hauled by trucks or freight to landfills.
- Reduce the amount of toxic waste (think cigarette butts) that can flow into the natural environment and cause harm to other species.
- Save energy by recycling hard to extract materials.

Community Composting

Install a large composting bin in a central place where neighbors can drop off their food scraps. Over time the food scraps decompose into nutrient-rich soil that can be used in the community garden. This reduces the amount of food waste which generates methane in our landfills.

Composting makes soil not dirt. Most homeowners are growing on dirt – which has no life in it and no capacity to sequester CO_2. Spread the compost around your yards and flower gardens. It will gradually evolve your dirt into soil loaded with microbes and other organisms which sequester CO_2. As the soil is built up you can reduce, and eventually eliminate, the need for fertilizer and other synthetic chemicals and help heal the local environment.

NOTE: Composting has many advantages. It keeps food scraps out of landfills where they rot and emit methane. The aerobic process of composting does not produce methane because methane-producing microbes are not active in the presence of oxygen. The nutrient rich soil produced by composting sequesters CO_2, and it precludes the need to apply nitrogen fertilizers which tend to run off the soil and befoul our waterways.[4]

Community Vegetable Gardens

Some people have more garden space than they can manage, and do not have an interest in gardening. Other people may want to garden, but don't have the space. Matching up these two groups increases local vegetable production and reduces transportation emissions.

Neighborhood Green Business Agreements

Create a green buying club. Approach local merchants and promise to give them all your business if they promise to take actions to reduce their carbon footprints and/or stock sustainable products in bulk. Think about how many half gallon plastic containers of laundry detergent you buy every year. Now cut that number down to one because you can take it in for a refill at the supermarket.

Neighborhood Tool & Resource Sharing Programs

Why does every household need a full array of tools when they are used infrequently? Establish lending libraries of various tools and resources for neighbors to borrow. These programs connect neighbors with the tools they need without the cost of buying them. Tool and Resource Sharing reduces consumption which cuts down on multiple emissions processes such as manufacturing of products and transporting them.

Neighborhood Tree Planting

Trees provide an invaluable resource since they naturally sequester carbon. Shade provided by trees reduces the need for cooling and thereby decreases energy use in the summer. Create work projects for kids to learn early that planting a tree is always a good thing, and cutting one down is not.

Be mindful of the species of trees you choose. Research if the particular species is appropriate for the planting location. Focus on native species and those that bear fruit.

In addition, consider planting native wildflowers to feed local pollinators. And avoid using pesticides. They don’t only kill pests.

Weatherization Teams

Form a group of neighbors to work together to weatherize each other’s homes. This may include sealing air leaks or installing vinyl storm windows. Identify

homes that need weatherizing. Check in with your senior neighbors or others who may need extra help around the home.

Local Institutions

Churches, schools, city hall… reach out to them to establish programs. Get to know the people who run these institutions. Find out which city administrators are open to making changes that reduce GHG gases and waste. Here are a few suggested programs you can initiate:

- Replace plastic cutlery in schools, church cafeterias, etc. with reusable flat ware.
- Establish community gardens for congregations, at senior citizen centers, at schools, in neighborhood parks, etc.
- Lobby the mayor's office for zoning changes that allow gray water to be used to irrigate gardens, solar panels to be installed just about anywhere, mini-wind turbines on buildings, more bike lanes, etc.
- Put on educational events at churches and schools. Partner with environmental groups. Teach kids and adults what you've learned to do.

Get involved in your community. Educate yourself on the positions of local politicians, and vote! Make it clear that addressing our climate crisis is the most important criteria on who you vote for.

Again, carbon emissions as a base for taxation will have a profound effect on all these institutions and groups. They will want to lower their own emissions by working more closely with those that have the expertise. A perfect opportunity to spread crew consciousness.

Policy

"It isn't enough to do our best, sometimes we have to do what is required." – Winston Churchill

Write your congress person, lobby for changes in the laws, learn about the voting records of elected officials and VOTE!

Democracy is based on an educated electorate, therefore, to have a true democracy we need to ensure climate change literacy.

Voting is the cornerstone of democracy. However, these days in America, only about 60% of the eligible population votes during presidential election years, and about 40% vote during midterm elections. For this reason, we have elected officials who are expanding the climate crisis instead of solving it… and we are partially to blame. Our collective voices are what will drive change for our communities. For some, this will mean running for a government position within their county, city or state. For most, it means taking a few personal steps like those outlined above. Either way is a win for humanity.

Takeaways

1. Addressing climate change by moving to a circular economy must occur on all levels: global down to personal.
2. There are a variety of things to do as an individual, as a member of a family, as a resident of a neighborhood, and as a citizen of a town.
3. Carbon emissions are the culprit. Cut them as much as possible, as soon as possible.
4. Think of yourself as a crew member on Spaceship Earth. There is no resupply ship coming, so we must make do with what we have on board.
5. As a crew member, consider the cause and effect of all that you do: what you buy, what you eat, how you transport yourself and your family.
6. Stand tall in the knowledge that your crew actions make a difference.
7. Recruit other crew members. Collectively you will boost each other and become ever more crew conscious.
8. Crew actions will quickly become habits requiring little thought or extra effort.
9. As you interact with other crew members, new ways of thinking will arise to replace your old consumer mindset

This Spaceship Earth is your responsibility. Crew with vigor at all levels of life, from personal habits to national and global politics.

[1] https://www.greenbiz.com/article/cool-through-community-climate-action-moonshot

[2] https://www.visualcapitalist.com/what-uses-the-most-energy.com

[3] https://www.commonobjective.co/article/can-fashion-stop-climate-change

[4] https://www.agric.wa.au/climate-change/composting-avoid-methane-production

Chapter 7 – Now That You Know

The path we are currently on (fossil fuel based and primarily, if not solely, focused on the accumulation of financial wealth, a linear economy for maximizing profits and constant growth of GDP) does not have a happy ending. Our *modus operandi* generates global warming which triggers climate change which is rapidly reducing the vibrancy and viability of the life support system upon which we depend. We are, presently, creating the sixth confirmable mass extinction event in the history of Spaceship Earth. A mass extinction event in which we have set the stage for our own disappearance.

All of the undesirable and largely unintended consequences that can happen as a result of our climate crisis WILL happen, but only if we allow them to. The path we have made and are traveling on is the problem. It is the one without a happy ending.

That is what the organization *This Spaceship Earth* and the eBook, *"Now That You Know"* are all about. How do we create and move to a path that generates a thriving continuance?

"Do the best you can until you know better and when you know better do better." – Maya Angelou

You read this short eBook.

You understand how and why to regard our planet as Spaceship Earth.

You read the Quartermaster's Report and identified that all is not well with our only home.

You understand that Crew Consciousness is a crucial factor in successfully facing our climate crisis.

You gained the knowledge concerning the many pathways and actions that corporations can take to address the climate impacts they are vulnerable to… and

how they can transition from being part of the problem to being part of the solution.

You learned what it means to crew Spaceship Earth.

So, now that you know all of this, what are you going to do?

Are you going to continue to be a mindless passenger… or are you going to become an active, useful crew member on Spaceship Earth?

It is up to you.

What are you going to do now that you know?

Biographies

David Houle

David is a futurist, thinker and keynote speaker. He has keynoted numerous conferences across the US and internationally. In the last fourteen years he has delivered 1200+ presentations and keynotes on 6 continents and in 16 countries.

David spent more than 20 years in media and entertainment. He worked at NBC, CBS and was part of the senior executive team that launched MTV, Nickelodeon, VH1 and CNN Headline News.

He won two Emmys as co-executive Producer for a nationally syndicated children's program, "Energy Express". He won the prestigious George Foster Peabody award and the Heartland award for "Hank Aaron: Chasing the Dream" and was nominated for an Academy Award.

David was the Futurist in Residence at the Ringling College of Art + Design from 2011 to 2020.

He writes a popular and respected newsletter, https://evolutionshift.substack.com/ and a bi-weekly column for the Sarasota Herald-Tribune.

Tim Rumage

Tim Rumage is a planetary ethicist and naturalist. Taking an interdisciplinary and systems thinking approach to education, he has been teaching at the intersection of Science, Ecology, Art, Design and Architecture for more than 30 years.

Tim is the Coordinator/Developer of Environmental Studies at Ringling College of Art and Design where he teaches environmental science, sustainability, creating ecological cities, applied environmental design, food, water, biodiversity and environmental ethics.

He is also a Coordinator for Sustainability in Design Education for CUMULUS and a frequent lecturer at other colleges and for community organizations. As a trained field biologist, Tim has been engaged in a variety of interdisciplinary projects in the US and Africa involving habitat restoration and protection, green infrastructure, local food production and sustainability.

Bob Leonard

After a career in B2B Technology product management, Bob decided to follow his passion and turned his attention to the existential threat that is our climate crisis. He is the Chief Content Officer at This Spaceship Earth and the Managing Consultant at Climate Foresight Advisory.

Climate Foresight Advisory helps businesses determine the climate impacts (risks, threats and opportunities) they can expect, and advises on how to handle them.

Bob is the co-author of “Moving to a Finite Earth Economy: Crew Manual”.