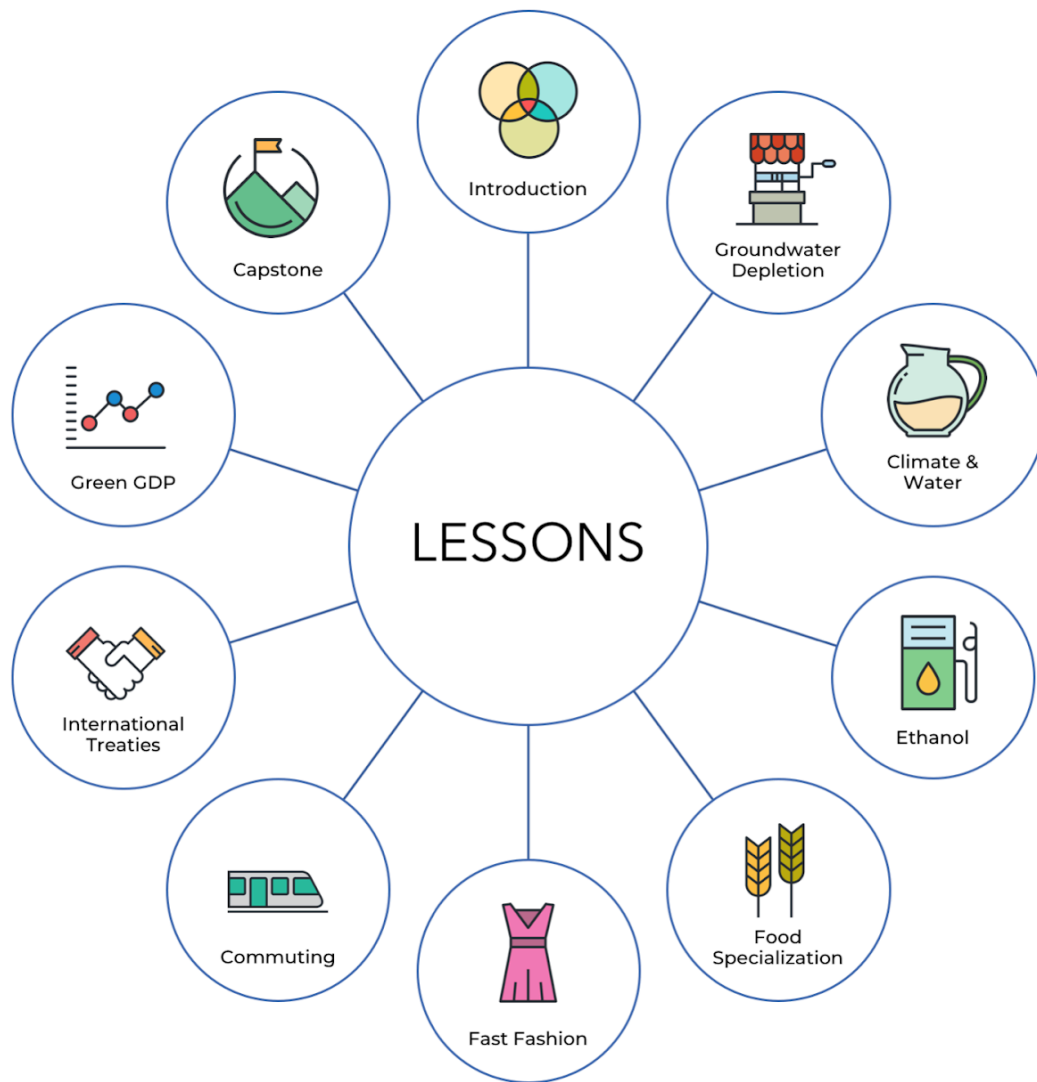


Overview of the Lessons



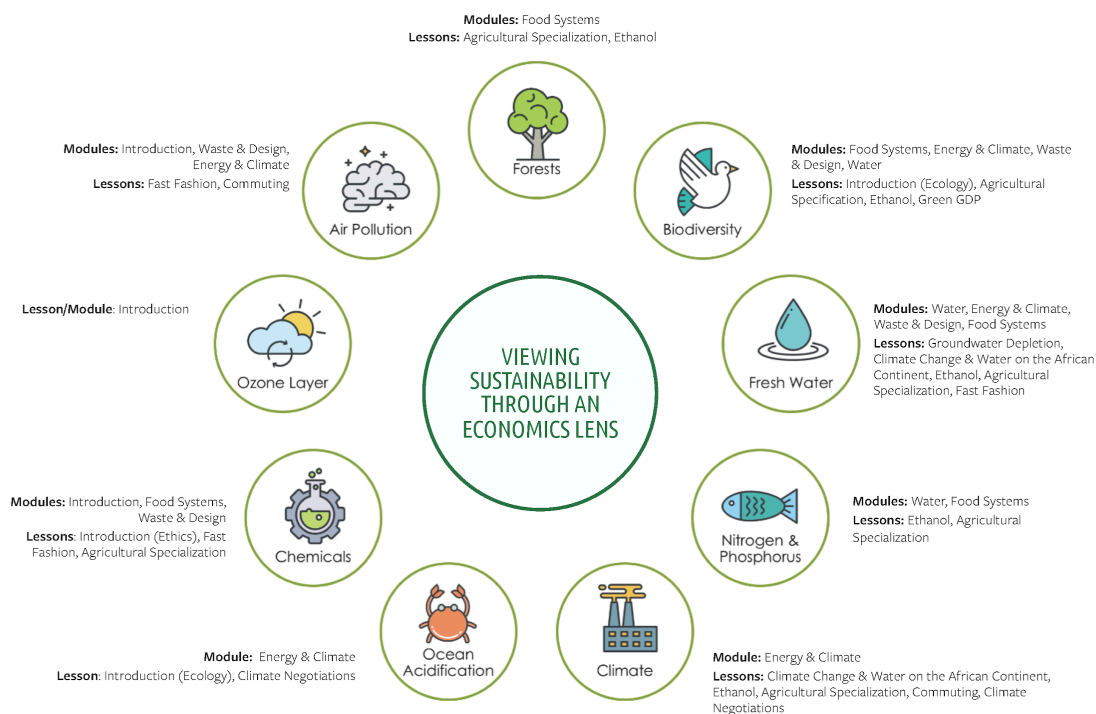
Guide to Sustainability Themes (see all on one page [here](#))

	Planetary Boundary	Expanded Thinking	Core Sustainability	Sustainable Development
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			Questions	Goals
Groundwater	Freshwater Use	Nation, Future, Ecology	Who gets to decide?	6- Clean Water & Sanitation; 9- Industry, Innovation & Infrastructure; 12 – Responsible Production; 16 – Peace, Justice & Strong Institutions
Water Access	Climate Change, Freshwater Use	Humanity, Future Generations	Who bears the burden?	6- Clean Water & Sanitation; 1- Poverty; 3- Good Health & Well-being; 5-Gender Equality; 11- Sustainable Cities; 13- Climate Action
Ethanol Subsidies	Nitrogen & Phosphorus, Freshwater Use	Nation, Humanity, Ecology	What are we trying to sustain?	7-Affordable & Clean Energy; 2- Zero Hunger; #12 – Responsible Production; 13- Climate Action; 14- Life Below Water
Food Specialization	Biodiversity Loss, Nitrogen & Phosphorus	Humanity, Ecology	Who benefits?	2- Zero Hunger; #12 – Responsible Production; 14- Life Below Water; 15- Life on Land
Fast Fashion	Chemical Pollution, Freshwater Use, Air Particles	Humanity, Future Generations	Sustainability when? Sustainability where?	12- Responsible Consumption & Production; 8 – Decent Work; 14- Life Below Water; 15- Life on Land
Commuting	Climate Change, Air Particles	Nation, Ecology	Whose needs are prioritized?	9- Industry, Innovation & Infrastructure; 11- Sustainable Cities & Communities; 13- Climate Action
International Cooperation	Climate Change, Ocean Acidification, Biodiversity Loss	Nation, Humanity, Future Generations	Who has power?	7- Affordable & Clean Energy; 10- Reduced Inequalities; 13- Climate Action; 16- Peace, Justice & Strong Institutions; 17- Partnerships
Green GDP & Growth	All	Self, Humanity, Future Generations, Ecology	What is valued?	3- Good Health & Well-Being; 8- Decent Work & Economic

				Growth; 12- Responsible Production & Consumption; 13-Climate Action; 16- Peace, Justice & Strong Institutions; 17- Partnerships
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PLANETARY BOUNDARIES: MODULES & LESSON LINKS



I. The 3 E's of Sustainability: An Introduction

This lesson has three parts: Economics, Ethics & Ecology. Each part introduces the vocabulary and key foundational concepts that will be reinforced in later lessons. Teachers may wish to use some pieces but not others. For instance, teachers in economics classes may find the economics vocabulary too simplistic but will want to provide some background in ethics and ecology. Likewise, teachers in science classes may find they have already covered many of the ecological concepts but that they need to introduce some basic economics.

Lesson author: Mike

II. Groundwater Depletion and Market Failure: A Simulation

Economic theory predicts that competition will lead to an overuse of shared resources. Groundwater depletion is a perfect example of this phenomenon, a classic market failure that economists call the tragedy of the commons. In this lesson students will participate in a simulation to experience how farmers seeking to maximize profits deplete shared aquifers.

Lesson author: Mike

Economics Benchmarks

9.2.4.8.2: Identify and analyze market failure caused by poorly-defined property rights or poorly enforced property rights, externalities, and public goods; evaluate the rationale and effectiveness of government attempts to remedy these problems.

Sustainability Themes

Planetary boundary: Freshwater Use

Expanded thinking: Nation, Future Generations, Ecology

Distributive justice: Who Gets to Decide?

Sustainable development goals: 6- Clean Water & Sanitation; 9- Industry, Innovation & Infrastructure; 12 – Responsible Production; 16 – Peace, Justice & Strong Institutions

III. Water & Climate: A Diversity of Challenges on the African Continent

Economics is all about scarcity and trade-offs. This lesson uses the economic concepts of constraints and opportunity costs to explore the decisions that women in four African communities confront in their efforts to secure drinking water for their families. Students learn economic modeling and use reading comprehension tools to consider the wide ranging impacts of climate change.

Lesson author: Emily

Economics Benchmarks

9.2.3.3.1 - Identify the incentives and trade-offs related to a choice made by an individual, household, organization or government; describe the opportunity cost of a choice; and analyze the consequences of a choice (both intended and unintended).

9.2.3.4.1 - Explain how the availability of productive resources and technology limits the production of goods and services.

Sustainability Themes

Planetary boundary: Climate change, freshwater

Expanded thinking: Humanity & future generations

Distributive justice: Who bears the burden?

Sustainable development goals: 6- Clean Water & Sanitation; 1- Poverty; 3- Good Health & Well-being; 5-Gender Equality; 11- Sustainable Cities; 13- Climate Action

IV. Ethanol Subsidies and Unintended Environmental Consequences

Economics is sometimes called the dismal science due to the discipline's tendency to highlight unintended consequences that may result from policy implementation. In this lesson students examine the impact of ethanol subsidies on related markets such as corn and fertilizer. The

subsidies, while intended to promote an environmentally friendly alternative to fossil fuels, had a range of unintended consequences including increases in food prices, chemical runoff and land use changes that are contrary to the goals of sustainability.

Lesson author: Emily

Economics Benchmarks

9.2.4.5.5 - Use demand and supply curves to explain how the equilibrium price and quantity in a market is determined as buyers and sellers adjust their offers in response to shortages or surpluses.

9.2.4.5.6 - Explain how changes (shifts) in the demand and supply of an item result in changes in its market price and quantity; explain how these shifts can lead to changes in prices and quantities in other markets.

Sustainability Themes

Planetary boundary: Nitrogen & Phosphorus, Freshwater

Expanded thinking: Nation, humanity & ecological processes

Distributive justice: What are we trying to sustain?

Sustainable development goals: 7-Affordable & Clean Energy; 2- Zero Hunger; #12 – Responsible Production; 13- Climate Action; 14- Life Below Water

V. Food Production and Specialization: Some Pros and Cons

Economics is based on mutually beneficial exchanges. When economic agents specialize according to comparative advantage and trade, productivity increases create a “win-win” scenario where everyone can be better off. In this lesson students learn the intuition behind the economic gains from specialization in food markets and explore the ecosystem impacts of industrial farming. Using a structured controversy format, students compare the pros and cons of large scale farming. The pairs then come together in four-person teams to present and discuss contrasting positions regarding the question: *Should farms specialize food production?*

Lesson author: Jaime

Economics Benchmarks

9.2.5.12.1: Apply the principles of absolute and comparative advantage to explain the increase in world production due to specialization and trade; identify the groups that benefit and lose with free-trade treaties, trading blocs and trade barriers.

Sustainability Themes

Planetary boundary: Biodiversity loss, Nitrogen & Phosphorus

Expanded thinking: Humanity & Ecological processes

Distributive justice: Who benefits?

Sustainable development goals: 2- Zero Hunger; 12 – Responsible Production; 14- Life Below Water; 15- Life on Land

VI. Fast Fashion and Externalities: What's Your Waste Size?

Economic theories are built on the idea that people respond to incentives. Inexpensive fashion creates an incentive to buy new clothes on a regular basis and discard unwanted items creating a cycle of consumption and waste. Consumers have no incentive to consider the social or

environmental costs of their behavior. This lesson uses the economic concept of negative externalities to argue that fast fashion represents a classic market failure. In this lesson students work in groups to read clues about fast fashion to determine who is ultimately responsible for the negative externalities this industry creates. Groups then brainstorm ways in which those parties could be held accountable to pay for the cost of clean up.

Lesson author: Jaime

Economics Benchmarks

9.2.4.8.2: Identify and analyze market failure caused by poorly-defined property rights or poorly enforced property rights, externalities, and public goods; evaluate the rationale and effectiveness of government attempts to remedy these problems.

Sustainability Themes

Planetary boundary: Chemical Pollution, Freshwater Use, Air Particles

Expanded thinking: Humanity & future generations

Distributive justice: Sustainability When? Sustainability Where?

Sustainable development goals: 12- Responsible Consumption & Production; 8 – Decent Work; 14- Life Below Water; 15- Life on Land

VII. Commuting and Incentives

Economic reasoning leads to more informed public policy. In this lesson students apply reasoned decision-making based on cost-benefit analysis to debate transportation infrastructure alternatives for a large metro area with the goal of reducing carbon emissions from vehicles. Students engage in a role play where they represent various stakeholders who voice their support or opposition to a range of potential policies.

Lesson author Ethan

Economics Benchmarks

9.2.1.1.1: Apply reasoned decision-making techniques in making choices; explain why different individuals, households, organizations and/or governments faced with the same alternatives might make different choices.

Sustainability Themes

Planetary boundary: Climate Change, Air particles

Expanded thinking: Nation & Ecological processes

Distributive justice: Whose needs are prioritized?

Sustainable development goals: 9- Industry, Innovation & Infrastructure; 11- Sustainable Cities & Communities; 13- Climate Action

VIII. International Environmental Treaties and Game Theory

Economics can help us understand why international treaties to address climate change by reducing carbon emissions are difficult to achieve. Using basic game theory, this lesson describes these sort of negotiations as an instance of the classic Prisoner's Dilemma in which the parties all have an incentive to cheat on any agreement. Institutions such as the World Trade Organization must wrestle with this problem in order to promote international cooperation.

Lesson author: James

Economics Benchmarks

9.2.5.12.1: International trade, exchange rates and international institutions affect individuals, organizations and governments throughout the world.

Sustainability Themes

Planetary boundary: Climate Change, Ocean Acidification, Biodiversity Loss

Expanded thinking: Nation, Humanity, Future Generations

Distributive justice: Who has power?

Sustainable development goals: 7- Affordable & Clean Energy; 10- Reduced Inequalities; 13- Climate Action; 16- Peace, Justice & Strong Institutions; 17- Partnerships

IX. Green GDP and Other Alternative Growth Indicators

Economic growth is measured by gross domestic product (GDP) but economists have long recognized the limitations to GDP. It undervalues women's contributions and can mistakenly tally economic destruction as growth. This lesson introduces the concept of GDP and asks students to imagine alternative measures that incorporate the concepts of sustainability.

Lesson author: James

Economics Benchmarks

9.2.5.9.1: Measure economic growth in terms of percentage changes in real Gross Domestic Product over time; analyze past and recent data to identify factors that promote or impair long-run economic growth and its sustainability.

Sustainability Themes

Planetary boundary: All

Expanded thinking: Self, humanity, future generations & ecological processes

Distributive justice: What is valued?

Sustainable development goal: 3- Good Health & Well-Being; 8- Decent Work & Economic Growth; 12- Responsible Production & Consumption; 13-Climate Action; 16- Peace, Justice & Strong Institutions; 17- Partnerships

X. Capstone: Making a Difference - Social Entrepreneurship in Action

The capstone lesson is a project that asks students to confront the challenges of sustainability and begin to work towards solutions. Students choose one of the four sustainability areas (agriculture, waste, energy, water) and put together a proposal for a project designed to help communities solve a related problem. They present their project ideas "shark tank" style in front of a panel, which chooses a winning proposal. This panel can be comprised of their peers, teachers and administrators and/or community members.

Lesson author: Ethan

I. Introduction

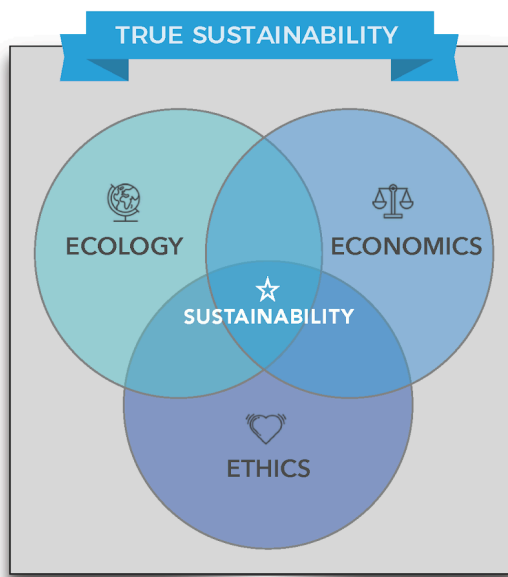
SUSTAINABILITY: AN ESSENTIAL GUIDE

*What are sustainability's key elements? Where we are now with our progress?
Where do we want to be? What needs to change to get there? How will we make it all happen?*



Sustainability represents the intersection of three essential elements: ecology, economics, and ethics. Looking at any of the elements in isolation risks unintended consequences.

THE THREE ELEMENTS OF SUSTAINABILITY



ECOLOGY

- Understand limits
- Think in systems
- Nurture resilience



ECONOMICS

- Internalize externalities
- Recognize limits
- Consider true quality of life



ETHICS

- Use expanded thinking
- Consider distribution of burdens & benefits
- Incorporate inclusive decision-making

KEY MESSAGES

- Sustainability integrates 3 essential elements: ecology, economics, and ethics
- The three elements can sometimes compete, so we need to understand trade-offs
- Sustainability urges us to broaden our perspective and consider the needs of future generations & other communities that may be marginalized
- True sustainability "multi-solves" to address several problems at once
- True solutions are "regenerative" - they don't just limit harm, they improve social & natural systems
- Looking at systems as a whole enables us to consider root causes

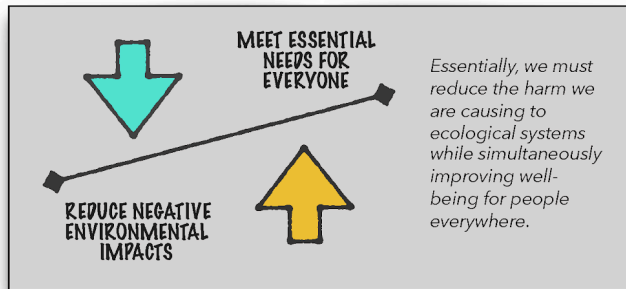


viewing sustainability
through an economics lens



What are the root issues at the crux of sustainability? How will we reach of our goals of ecological stability, meeting fundamental human needs for everyone (like food, water, and access to electricity), all while ensuring a vibrant economy that offers decent work and income to all?

WHAT NEEDS TO CHANGE TO MEET OUR GOALS?



What tools do we have available that will help us act sustainably, improve our decision-making, and integrate the core elements of ecology, economics, and ethics?

HOW ARE WE GOING TO MAKE IT HAPPEN?

REGENERATIVE DESIGN

True solutions are "regenerative." They don't just limit harm, they improve social & natural systems

SYSTEMS THINKING

Looking at systems as a whole enables us to consider root causes, not just the symptoms of a problem

EXPANDED THINKING

Sustainability asks us to see the bigger picture. How will our actions affect people in other countries? What about future generations? Expanding our frame of reference can help avoid unintended consequences

GREEN GROWTH

Inclusive green growth policies improve well-being for all, stimulate innovation, increase available capital, and promote efficiency

INVOLVEMENT

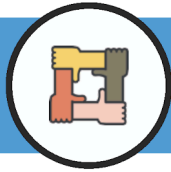
We need all hands on deck! Your involvement, in whatever capacity you choose, is essential

INCLUSIVE GOVERNANCE

Inclusive governance ensures that all affected parties, including those traditionally marginalized, are at the table to define problems & develop solutions



SUSTAINABILITY: AN ESSENTIAL GUIDE ETHICS



An important component of sustainability involves social integrity and concern for the well-being of all people. Sometimes the principle of social well-being can get lost in concerns about the environment, but it is integral to our understanding of what sustainability really is.

At its core, sustainability is about ethics because it is about choosing what we want for our future. We can ask ourselves what we really value, and work toward achieving that. In this way, sustainability helps direct our technical, political, and entrepreneurial skills toward intentional and inclusive goals.

WELL-BEING

What matters when we think about human well-being? Certainly, there are some basic essentials for human survival—things like food, water, and shelter. But there are also things like political voice, gender equality, social equity, and education that help people to thrive and live with dignity. We will endorse a broad understanding of what contributes to human flourishing in our approach.

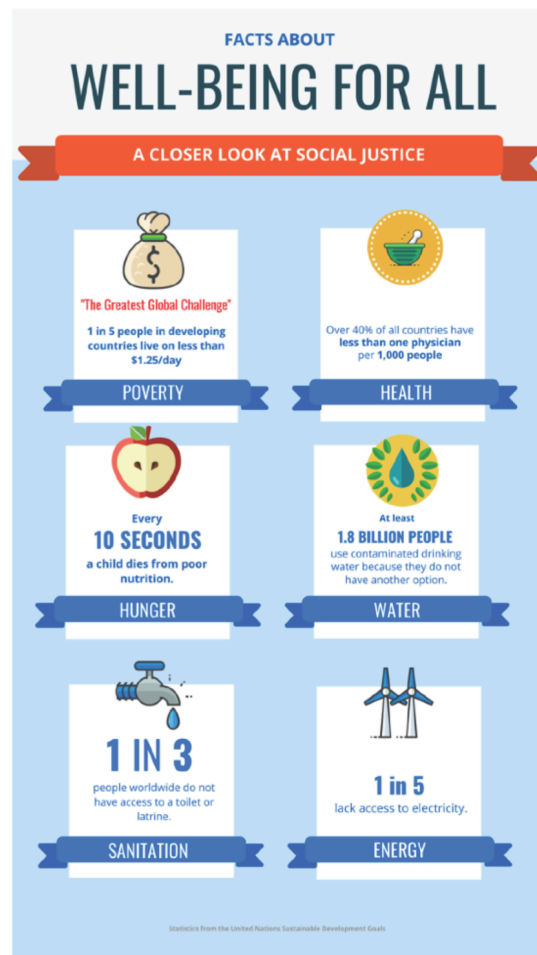


**MANY NEEDS ARE
STILL UNMET**

In the history of the last 200 years, we have made incredible progress in increasing the health and wealth of the human population (Roser, 2017). However, we still have intense needs worldwide.



viewing sustainability
through an economics lens



WELL-BEING FOR ALL

Progress: 2023

17 Sustainable Development Goals:

1. No Poverty
2. Zero Hunger
3. Good Health and Well-being
4. Quality Education
5. Gender Equality
6. Clean Water and Sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation and Infrastructure
10. Reduced Inequalities
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace, Justice and Strong Institutions
17. Partnerships for the Goals

Timeline: 2015 - 2030

Source: United Nations Development Programme (UNDP)

1

The world community has recognized the importance of addressing these issues in 2015, the centenary of the United Nations original quest for Sustainable Development Goals. These include a series of 17 specific goals designed to end poverty, protect the planet, and ensure prosperity for all. These targets have been set to be achieved by the year 2030, and will require energy, and responsible consumption and production. These are specific targets aimed at addressing issues identified over the last 50 years as key to sustainable development. We need to build economic resilience, and have successfully achieved a series of social needs and transforming the planet.

2

1 Goal 1: Be Healthy
Endow people with the good health and well-being they need to live full and productive lives and to contribute to the development of their communities

2 Goal 2: Save Money
Endow people with the financial resources and skills to improve their lives and to contribute to the development of their communities

3 Goal 3: Health and Wellness
Ensure healthy lives and promote well-being for all at all ages

4 Goal 4: Quality Education
Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

5 Goal 5: Family Income
Achieve good quality employment and decent work for all

6 Goal 6: Clean Water and Sanitation
Ensure availability and sustainable management of water and sanitation for all

7 Goal 7: Affordable and Clean Energy
Ensure sustainable energy for all

8 Goal 8: Good Health and Well-being
Ensure healthy and sustainable economic growth and sustainable employment and decent work for all

9 Goal 9: Industry, Innovation and Infrastructure
Build resilient infrastructure, promote inclusive and sustainable industrialization, foster innovation

10 Goal 10: Reduced Inequalities
Reduce income inequalities and promote social, economic and environmental inclusion

11 Goal 11: Sustainable Cities and Communities
Make cities and human settlements inclusive, safe, resilient and sustainable

12 Goal 12: Responsible Consumption and Production
Ensure sustainable consumption and production patterns

13 Goal 13: Climate Action
Take urgent action to combat climate change and its impacts

14 Goal 14: Life Below Water
Conserve and sustainably use the oceans, seas and marine resources for sustainable development

15 Goal 15: Life on Land
Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, conserve and enhance biodiversity

16 Goal 16: Peace, Justice and Strong Institutions
Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, build effective, accountable and inclusive institutions at all levels

2

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SUSTAINABILITY: AN ESSENTIAL GUIDE



ECOLOGY

EXPANDING OUR IDEA OF THE ENVIRONMENT

For many, the environment is what comes to mind when first thinking about the word “sustainability.” In this section, we will expand our understanding of “the environment” to embrace ecology and ecological systems. As a discipline, ecology is concerned with processes, interactions, and relationships within ecosystems. An ecosystem is a biological community of living beings working together and interacting with nonliving things in the environment (like rocks and minerals). So we might have plants, algae, and bacteria living in water. Small fish might eat these plants, then big fish eat the small fish, and decomposing bacteria break down waste material and dead organisms. It's all a big cycle.

The ecological approach to sustainability emphasizes the interrelationships between people, the living world, and natural systems. It uses “systems thinking” to consider causes and consequences, and strives to see how things are connected. This enables us to think deeply about solving our problems because it considers root causes.

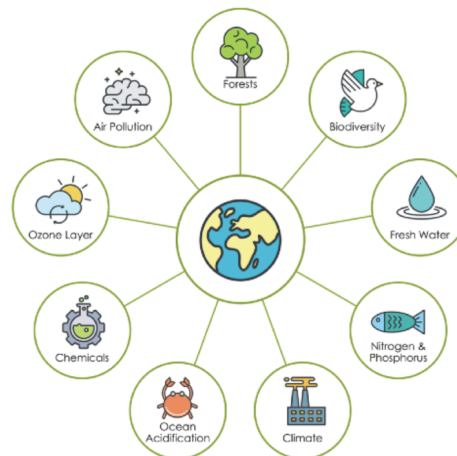
ECOLOGICAL LIMITS

An important paper on the concept of environmental limits combined research from 28 internationally renowned scientists and identified nine “**planetary boundaries**” needed to keep our planet in a stable state ([Rockstrom et al 2009](#), [Steffen et al 2015](#)). Each boundary is a type of limit or threshold that is essential to the integrity of our earth system. To understand these thresholds, think of your body temperature: it needs to remain above 95 degrees Fahrenheit and below 106 degrees Fahrenheit for you to stay alive. In a similar way, the earth needs to stay within certain ranges to keep our ecosystems functioning the way they have been since the Holocene Epoch began 10,000 years ago. If we cross these planetary boundaries, we run the risk of generating abrupt or irreversible environmental changes, and the planet's ecosystems may function differently, in ways we can't predict.

 [Infographic](#) [4 minute video](#)

THE NINE PLANETARY BOUNDARIES

LIMITS TO KEEP US SAFE

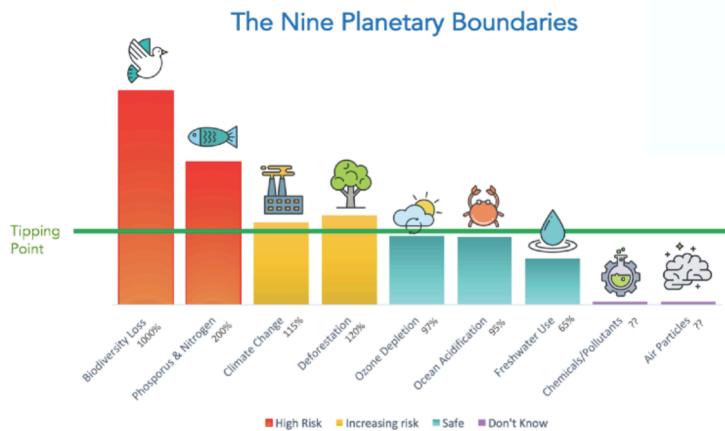
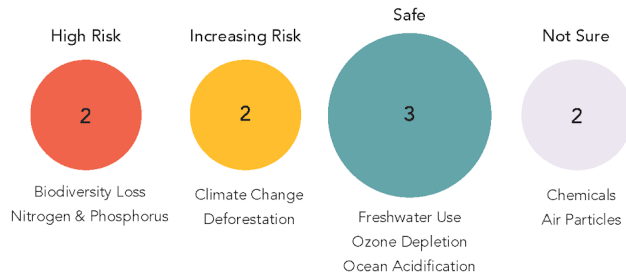


PLANETARY BOUNDARIES

Each of the nine planetary boundaries is a type of a limit or threshold. Passing these limits could trigger “tipping points” that could bring significant change to the way the earth functions.

OUR CURRENT CONDITION

To date, we have changed the planet enough to introduce a high risk situation for biodiversity and phosphorus / nitrogen cycles, and increasing risk for climate change and the loss of forests. We are still in a safe zone for ozone depletion, ocean acidification, and freshwater use. Limits have not yet been defined for chemical pollutants and air particles.



TIPPING TOWARD THE UNKNOWN

The green line (left) represents the upper safe limit of each of the earth's nine essential systems. If the earth system has crossed above that line (as depicted in red or yellow), we have already transgressed the boundary.

Crossing a boundary may trigger a “tipping point” that may potentially bring significant change to the way the earth operates.

CONNECTIONS BETWEEN PLANETARY BOUNDARIES

The nine planetary boundaries do not exist in isolation from each other. Instead, they interact in important ways using feedback loops. This means that when one boundary is impacted, the changes reverberate and affect other planetary systems.

Tracing Connections: Coral Reefs

We can see this clearly with the health of coral reef systems. Coral reefs act like nurseries for marine life and account for about one quarter of the ocean's productivity. The reef nurseries are home for millions of species, and they help produce fish, the primary source of animal protein for 1 billion people worldwide. Reefs also provide

storm protection for coastlines and income from tourism, so they are important to many people.

When people burn fossil fuels, they emit carbon dioxide into the atmosphere. Some of the carbon dioxide stays in the atmosphere, and some is absorbed by land (like when trees absorb carbon dioxide and produce oxygen as part of photosynthesis).

However, our oceans absorb about *one quarter* of the carbon dioxide that we emit in our atmosphere. When the carbon dioxide gas mixes with ocean water, it forms carbonic acid, and it makes the ocean more acidic.

These acidic conditions, combined with warming ocean temperatures, can really stress coral reefs. If the reefs are repeatedly stressed, they can become bleached and possibly die, resulting in a significant loss of biodiversity. So ocean acidification, climate change, and biodiversity are tightly linked together.

Tracing Connections: Forests

As another example, when forests, wetlands, or grasslands are cleared or burned to create cropland, the carbon naturally stored in the trees or plants is released into the atmosphere, contributing to climate change (and more ocean acidification).

II. Groundwater Depletion and Market Failure

III. Water & Climate: A Diversity of Challenges on the African Continent

IV. Ethanol and Unintended Environmental Consequences

V. Food Production and Specialization: Some Pros and Cons

Sustainability Themes

Planetary boundary: Biodiversity loss

Expanded thinking: Nation, humanity & ecological processes

Distributive justice: Who benefits?

Sustainable development goal: Zero hunger

VI. Fast Fashion and Externalities: What's Your Waste Size?

VII. Commuting and Incentives

VIII. International Environmental Treaties and Game Theory

IX. Green GDP and Economic Growth

X. Capstone: Making a difference - Social entrepreneurship in action