Overview of the Lessons

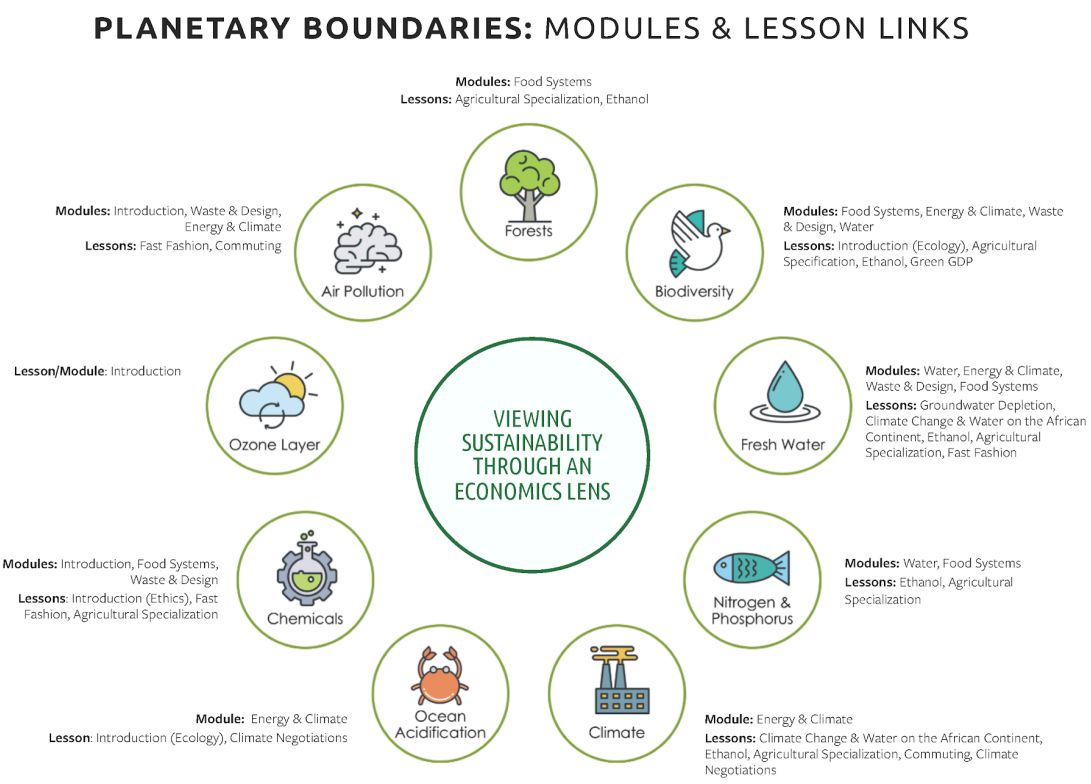


Guide to Sustainability Themes (see all on one page here)

	Planetary Boundary	Expanded Thinking	Core Sustainability	Sustainable Development

			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



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 famers 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

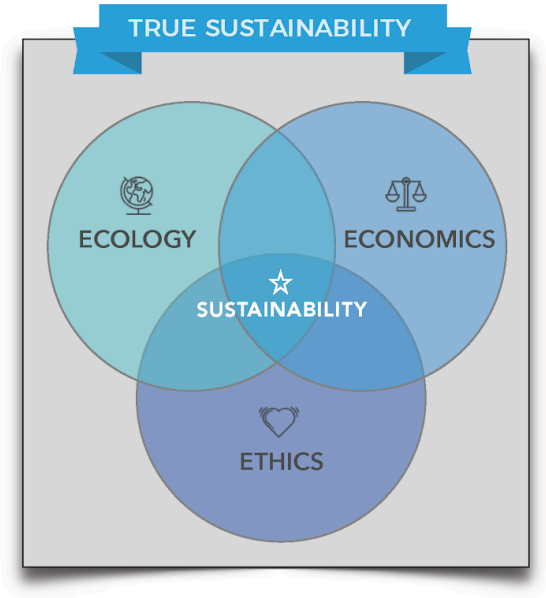
I. Introduction

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

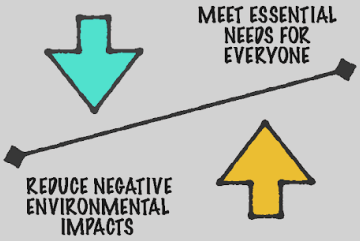
KEY MESSAGES

- 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?



Essentially, we must reduce the harm we are causing to ecological systems while simultaneously improving well-being for people everywhere.



TAKE ACTION NOW!

The actions we take in the next 3 to 20 years will have a profound impact on our climate system, ocean health, cities, and biodiversity loss.

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

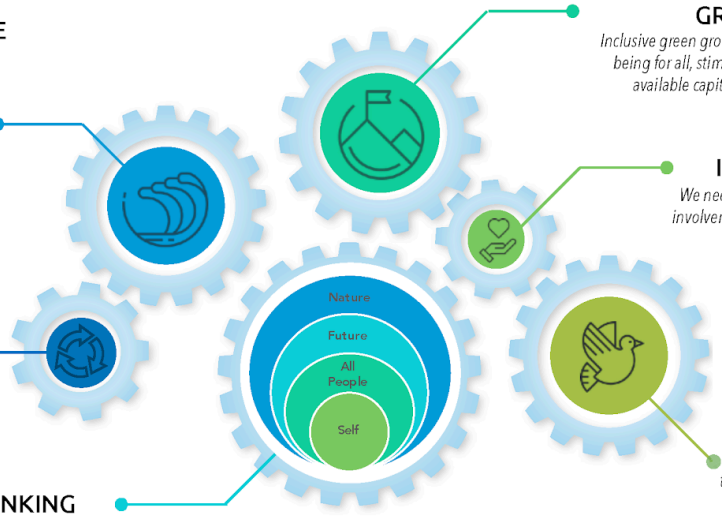
True solutions are "regenerative." They don't just limit harm, they improve social & natural systems

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

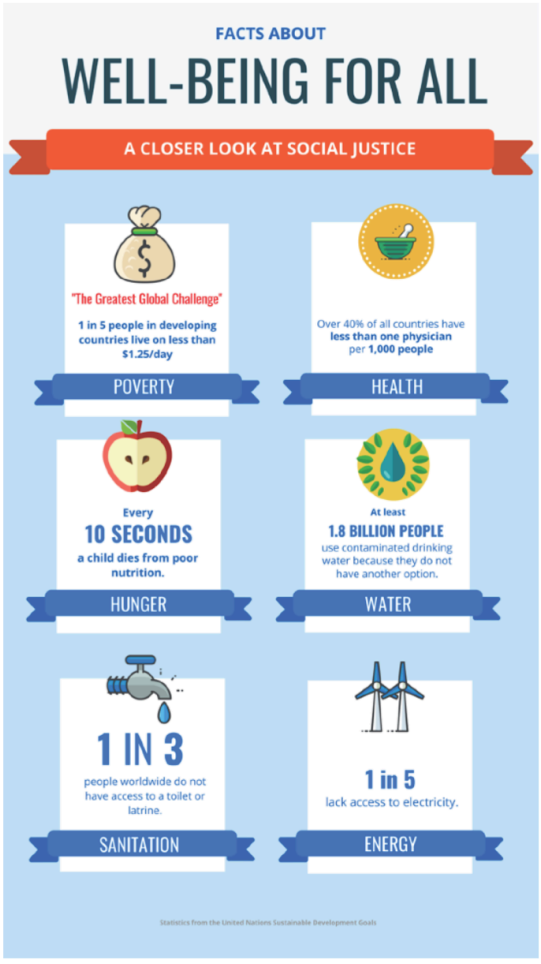
SUSTAINABILITY: AN ESSENTIAL GUIDE
ETHICS

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



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.

As 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

FACTS ABOUT

WELL-BEING FOR ALL

A CLOSER LOOK AT SOCIAL JUSTICE

POVERTY

HEALTH

10 SECONDS

1 IN 3

HUNGER

WATER

EDUCATION

ENERGY

1



THE SUSTAINABLE DEVELOPMENT GOALS

The world community has recognized the significant challenges facing us. In 2015, the countries of the United Nations adopted new Sustainable Development Goals. These involve a series of 17 specific goals designed to end poverty, protect the planet, and ensure prosperity for all. They include things like zero hunger, clean water and sanitation, affordable and clean energy, and responsible consumption and production. There are specific targets aimed at achieving these standards over the next 15 years. They are ambitious, and they recognize that we need to build economic growth while simultaneously addressing a range of social needs and protecting the planet.

THE GLOBAL GOALS

For Sustainable Development

*How does **sustainable development** connect to our idea of sustainability? Some have said that sustainability is the **goal**, and sustainable development is the **path** to get there.*

2



A closer look

SUSTAINABLE DEVELOPMENT GOALS

Goal 1: No Poverty
End poverty and all its forms, everywhere

Goal 2: Zero Hunger
End hunger, achieve food security, improve nutrition, promote sustainable agriculture

Goal 3: Good Health and Well-being
Ensure healthy lives and promote the well-being for people of all ages

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

Goal 5: Gender Equality
Achieve gender equality and empower all women and girls

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

Goal 7: Affordable and Clean Energy
Ensure access to affordable, reliable, sustainable, and modern energy for all

Goal 8: Decent Work and Economic Growth
Promote sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all

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

Goal 10: Reduced Inequalities
Reduce income inequality within and among countries

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

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

Goal 13: Climate Action
Take urgent action to combat climate change, regulate emissions and promote developments in renewable energy

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

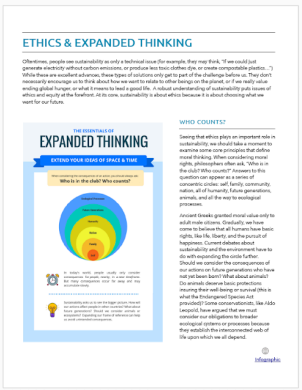
Goal 15: Life on Land
Protect, restore, and promote sustainable use of terrestrial ecosystems; sustainably manage forests; combat desertification; halt and reverse land degradation; halt biodiversity loss

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

Goal 17: Partnerships for the Goals
Strengthen the means of implementation and revitalize the global partnership for sustainable development

Fact sheet

3



ETHICS & EXPANDED THINKING

Oftentimes, people see sustainability as only a technical issue (for example, they may think, "if we could just generate electricity without carbon emissions, or produce less toxic clothes dye, or create compostable plastics…"). While these are excellent advances, these types of solutions only get to part of the challenge before us. They don't necessarily encourage us to think about how we want to relate to other beings on the planet, or if we really value ending global hunger, or what it means to lead a good life. A robust understanding of sustainability puts issues of ethics and equity at the forefront. At its core, sustainability is about ethics because it is about choosing what we want for our future.

THE ESSENTIALS OF

EXPANDED THINKING

EXTEND YOUR IDEAS OF SPACE & TIME

Who is in the club? Who counts?

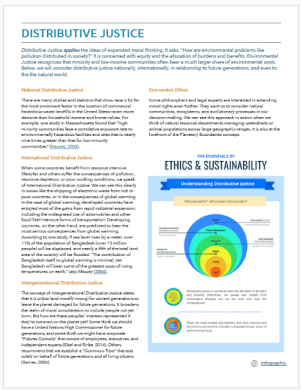
Infographic

WHO COUNTS?

Seeing that ethics plays an important role in sustainability, we should take a moment to examine some core principles that define moral thinking. When considering moral rights, philosophers often ask, "Who is in the club? Who counts?" Answers to this question can appear as a series of concentric circles: self, family, community, nation, all of humanity, future generations, animals, and all the way to ecological processes.

Ancient Greeks granted moral value only to adult male citizens. Gradually, we have come to believe that all humans have basic rights, like life, liberty, and the pursuit of happiness. Current debates about sustainability and the environment have to do with expanding the circle further. Should we consider the consequences of our actions on future generations who have not yet been born? What about animals? Do animals deserve basic protections ensuring their well-being or survival (this is what the Endangered Species Act provides)? Some conservationists, like Aldo Leopold, have argued that we must consider our obligations to broader ecological systems or processes because they establish the interconnected web of life upon which we all depend.

4



DISTRIBUTIVE JUSTICE

Distributive Justice applies the ideas of expanded moral thinking. It asks, "How are environmental problems like pollution distributed in society?" It is concerned with equity and the allocation of burdens and benefits. Environmental justice recognizes that poverty and socio-economic inequalities often mean a much larger share of environmental costs. Below, we will consider distributive justice nationally, internationally, in relationship to future generations, and even to the the natural world.

National Distributive Justice

There are many studies and statistics that show race is (a) for the most significant factor in where toxic waste facilities and hazardous waste landfills in the United States even more decisive than household income and home values. For example, one study in Massachusetts found that "high-minority communities face a cumulative exposure rate to environmentally hazardous facilities and sites that is nearly nine times greater than that for low-minority communities" (Mohai, 2006).

International Distributive Justice

When some societies benefit from resource intensive lifestyles and others suffer the consequences of pollution, resource-depletion, or poor working conditions, we speak of International Distributive Justice. We can see this clearly in issues like the shipping of electronic waste from rich to poor countries, or in the consequences of global warming that will be felt most by those who have contributed the least enjoyed most of the gains from rapid industrial expansion, including the widespread use of automobiles and other fossil fuel-intensive forms of transportation. Developing countries, on the other hand, are predicted to bear the brunt of consequences from climate change. According to one study, if sea level rises by a meter, over 11% of the population of Bangladesh (over 13 million people) will be displaced, and nearly a fifth of the total land area of the country will be flooded. "The overtopulation of Bangladesh itself by global warming is minimal, yet Bangladesh will bear some of the greatest costs of rising temperatures on earth," says Mayer (2006).

Intergenerational Distributive Justice

The concept of Intergenerational Distributive Justice states that it is unjust (and morally wrong) for current generations to leave the planet damaged for future generations. It broadens the realm of moral consideration to include people not yet born. Do we have obligations to the people who will live after us? Do we have obligations to the planet itself? Some think we should have a United Nations High Commissioner for future generations, and some think we might have corporate "Futures Counsels" that consist of employees, economists, and independent experts (Elliot and Rose, 2014). Others recommend that we establish a "Commons Trust" that acts (legally on behalf of future generations and all living citizens (Sterner, 2006).

THE ESSENTIALS OF

ETHICS & SUSTAINABILITY

Understanding Distributive Justice

Who benefits? Who bears the burden?

Infographic

5

SUSTAINABILITY: AN ESSENTIAL GUIDE

ECOLOGY

EXPANDING OUR IDEA OF THE ENVIRONMENT

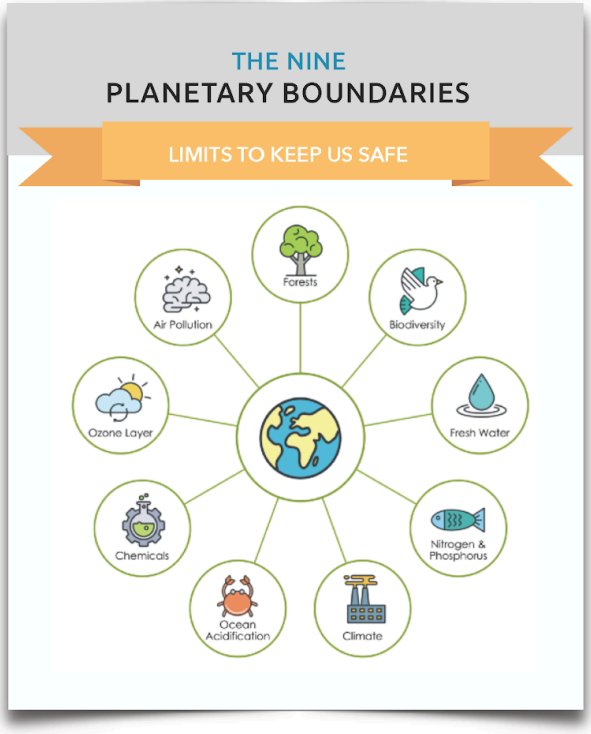
For many, the environment is what comes to mind when first thinking about the word "sustainability." In this section, we will expand our understanding of "the environment" to embrace ecology and ecological systems. As a discipline, ecology is concerned with processes, interactions, and relationships 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

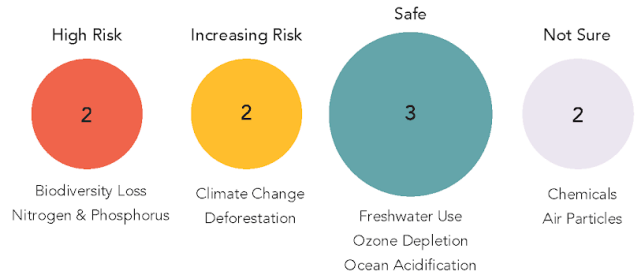


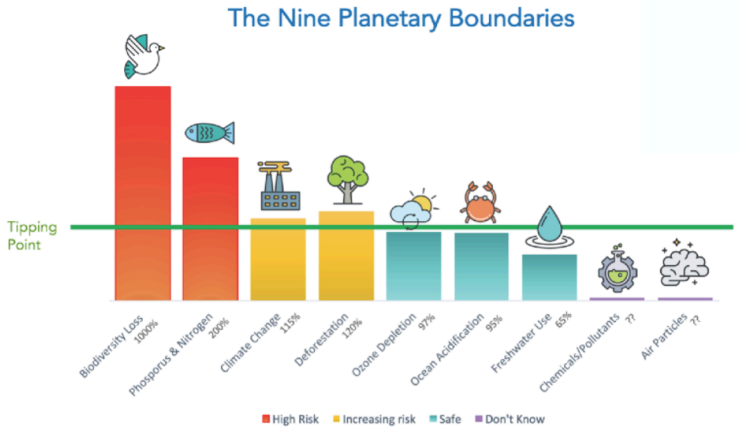
PLANETARY BOUNDARIES

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