

1.3 Sustainability

1.3.1 Sustainability measures the extent to which practices allow the long-term viability of a system

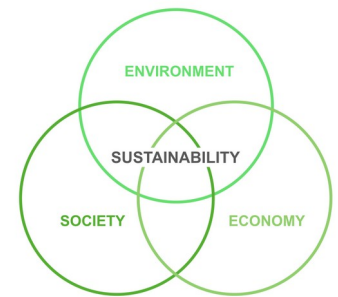
→ **Sustainability** is the responsible maintenance of socio-ecological systems such that there is no diminishment of resources and conditions for future generations.

Importance of Sustainability ([video](#))

- **Resource Preservation:** Conserves natural resources (water, soil, air) for future needs.
- **Stable Societies:** Builds resilient societies by reducing conflicts over resources.
- **Economic Resilience:** Fosters sustainable industries for long-term economic stability.

1.3.2 Sustainability consists of environmental, social and economic pillars.

The three pillars form the foundation for sustainable development. Each pillar supports different aspects of maintaining a balanced and resilient system.



Key Sustainability Pillars:

1. **Environmental Sustainability:** Focuses on conserving natural resources and protecting ecosystems to protect biodiversity and associated ecosystem services (clean air, water, soil).

Key Practices include natural **resource conservation**, **nature protection**, and **pollution mitigation**.

Examples: Renewable energy, reforestation, sustainable agriculture, habitat preservation.

2. **Social Sustainability:** Aims to improve social equity, life quality and well-being of all community members. Promotes shared sustainable development benefits (environmental justice).

Key Practices include upholding **human rights**, promoting **equity/inclusion** and **community resilience**.

Examples: Fair trade, inclusive education, healthcare access, community-centered planning.

3. **Economic Sustainability:** Focuses on creating an economy that can maintain itself over time without depleting natural resources.

Key Practices include **efficient resource use**, **green innovation** and **circular economy principles**.

Examples: Minimising carbon footprints, recycling, upcycling, efficient or renewable energy.

1.3.3 Environmental sustainability is the use and management of natural resources that allows their replacement, as well as recovery and regeneration of ecosystems.

Ensures resource use at a rate that allows natural regeneration.

Conservation of biodiversity is central to environmental sustainability. Conserving habitats, protecting endangered species, and promoting ecosystem resilience are critical for maintaining the intricate web of life on Earth and preserving ecosystem services. **Examples:** Establishing national parks, protected areas, wildlife reserves, setting quotas.

Active restoration of ecosystems is increasingly recognized as a vital component of environmental sustainability. **Examples:** Reforestation initiatives in deforested areas help restore forest ecosystems. They also sequester carbon dioxide from the atmosphere, mitigating climate change. Wetland and riparian zone restoration can improve water quality, reduce flooding and enhance biodiversity. Reintroducing endangered species into their native habitats (e.g. beavers).

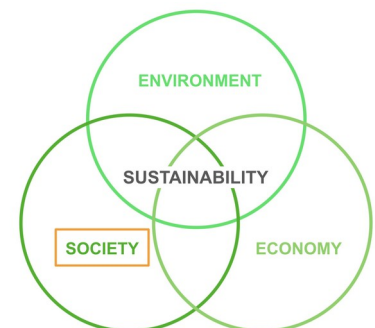
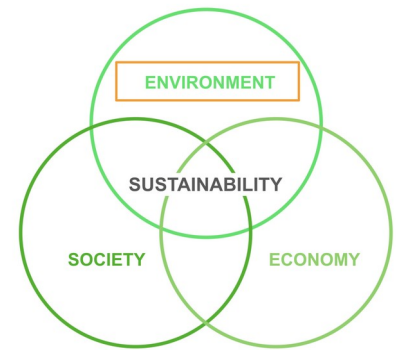
Pollution control minimizes waste and emissions to reduce environmental damage, a crucial aspect of environmental sustainability. Pollutants come in various forms (organic or inorganic, light, sound or heat energy, air pollution), the control of which is vital due to its widespread costs. These encompass fatalities, health conditions, compromised natural resources (soil, water) as well as air quality.

Examples: Installing scrubbers in power plants reduces sulfur dioxide emissions (major air pollutant). Wetland restoration projects can filter and purify contaminated water before it enters rivers. Clean technologies, renewable energy and improving wastewater treatment mitigate air and water pollution.

1.3.4 Social sustainability focuses on creating structures and systems that support human well-being (health, education, equity, community).

Healthcare Access: Ensuring universal access to healthcare services is essential and involves providing affordable, quality healthcare to all society members, regardless of socio-economic status or background.

Education Equity: Education is a fundamental human right and tool for social empowerment. Promoting it involves eliminating barriers to access and ensuring that all individuals have the opportunity to reach their full potential through quality education.

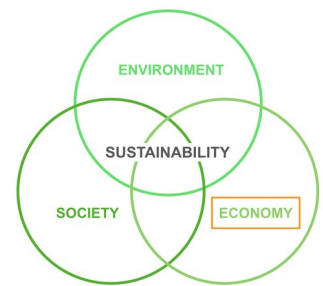


Inclusion: Social sustainability requires addressing systemic inequalities and promoting fair access to resources, opportunities and services for all society. This includes combating discrimination based on race, gender, ethnicity, religion, disability, or sexual orientation, and creating opportunities for marginalized groups to participate fully in social, economic, and political life.

Community Well-being: This involves fostering social cohesion, promoting community engagement, and investing in infrastructure that enhances the quality of life for all residents. Local engagement and support networks strengthen communities to cope with challenges, such as climate change impacts.

Cultural Preservation: Social sustainability also encompasses the preservation of cultural diversity and heritage. This includes recognizing and respecting cultural rights of indigenous peoples and minority groups, as well as safeguarding traditional knowledge, languages and spiritual practices.

1.3.5 Economic sustainability focuses on creating the economic structures and systems to support production and consumption of goods and services that will support human needs into the future.



Resource Management: Sustainable use of resources ensures human needs are met without harming ecosystems. This includes conservation, waste reduction and renewable energy.

Innovation and Technology: Investing in technology and innovation boosts productivity, economic diversity, and sustainable growth opportunities.

Circular Economy: Moves from a linear model to a closed-loop system, emphasizing resource efficiency, product longevity, and waste reduction for sustainable production and consumption.

Equitable Development: Inclusive growth benefits all societal segments, addressing income disparities, poverty reduction, and resilience for vulnerable populations.

1.3.6 Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs.

The concept of sustainable development gained prominence with the release of the **Brundtland Report (1987)**, also known as "**Our Common Future**". Commissioned by the United Nations, the report introduced the social and economic dimensions to the discourse on sustainable development, emphasizing the need for collective action to address global challenges.

1.3.9 Environmental justice

- Environmental justice ensures the fair distribution of environmental **benefits** and **burdens**, advocating for everyone's right to live in a clean and healthy environment, regardless of race, gender, socio-economic status, or nationality.

Key Principles:

- **Equal Rights:** Everyone deserves access to unpolluted environments and natural resources.
- **Fair Policy Development:** Environmental laws and policies must prevent communities from disproportionately facing pollution or environmental hazards due to economics or politics.
- **Equity:** Sustainable development must include social equity; any model lacking fairness is inherently unsustainable.

1.3.10 Inequalities in income, race, gender and cultural identity within and between different societies lead to disparities in access to water, food and energy.

→ **Inequality** takes many forms which contribute to social stratification and limit access to essential resources, enhancing systemic injustices. Inequality in income, race or gender affects access to clean water, nutritious food, and energy, worsening poverty and health disparities.

Income Inequality and Utility Access: Low-income households often struggle to afford utilities like electricity, heating, and sanitation, limiting quality of life and economic opportunities.

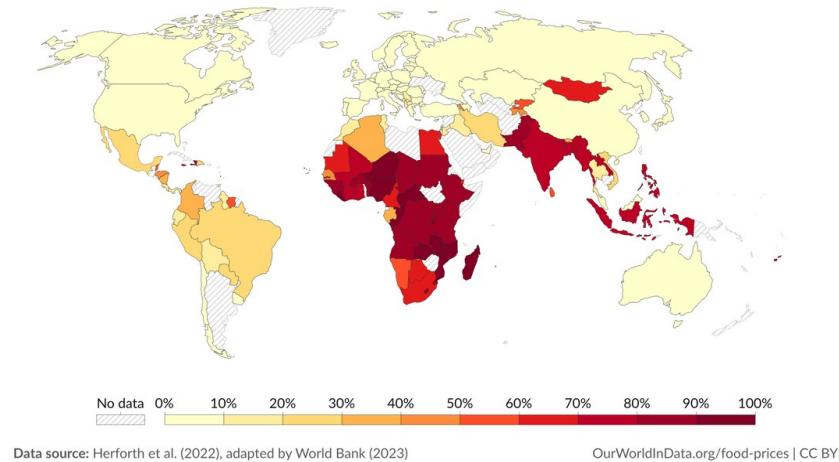
Compounded Barriers: Overlapping inequalities, such as race and socio-economic status, multiply barriers to resource access for marginalized groups.

Environmental Injustice: Marginalized communities often bear a disproportionate burden of pollution and environmental hazards.

Privatization: In low-income areas, privatization can restrict access to clean, affordable resources (e.g. [water](#)) due to increased costs, prioritizing profit over public welfare.

Share of population that cannot afford a healthy diet, 2021

A diet is deemed unaffordable if it costs more than 52% of a household's income. The cost of a healthy diet is the lowest-cost set of foods available that would meet requirements in dietary guidelines from governments and public health agencies.



1.3.11 Sustainability and environmental justice is applied from individual to global operating scales.

Individual → Business → Community → City (Urban) → Country (National) → Global

Individual Scale:

At the individual level, sustainability involves personal choices in daily life (conserve water, reduce waste). Environmental justice might involve advocacy or participation in local initiatives.

- **Sustainability:** Person chooses reusable bags/containers instead of single-use plastics.
- **Environmental Justice:** Participating in or organizing local park and river clean ups. Advocating for fair distribution of clean air and water resources in their community.

Business Scale:

Businesses affect sustainability through operational practices, product design and supply chain decisions, while influencing environmental justice with corporate social responsibility initiatives.

- **Sustainability:** A company switching to renewable energy sources or designing products with a lower environmental impact (e.g. biodegradable materials).
- **Environmental Justice:** A corporation establishing a fair trade partnership that ensures equitable wages and safe working conditions for farmers in developing countries.

Community Scale:

A community (religious, cultural, political, indigenous) can influence sustainability and environmental justice through collective action, cultural practice and local governance.

- **Sustainability:** A cultural group promoting traditional agricultural practices that are both sustainable and help preserve biodiversity (TEK/LEK).
- **Environmental Justice:** A religious community advocating for the rights of local populations affected by environmental degradation from nearby industrial activities.

City (Urban) Scale:

Cities can implement policies that promote sustainability. Urban planning can address environmental justice by ensuring equitable access to resources.

- **Sustainability:** A city implementing a public transportation system to reduce car emissions, or creating green roofs on buildings (improves air quality, reduces heat).
- **Environmental Justice:** Ensure all neighborhoods, have clean park access, good public transportation, and are not disproportionately affected by industrial pollution.

Country (National) Scale:

At the national level, governments can create laws, policies, socio-economic systems that foster sustainability (e.g. emissions regulations, national parks). Environmental justice at this level involves addressing disparities in environmental impacts among different populations.

- **Sustainability:** National policies that incentivize renewable energy use, such as solar or wind power, or laws that require recycling and waste reduction in industries.
- **Environmental Justice:** Policies ensuring communities have equal protection under environmental laws and access to environmental benefits (clean air, water) regardless of race or economic status.

Global Scale:

Internationally, organizations like the United Nations (UN) address sustainability through global initiatives (e.g. SDGs). Global environmental justice involves tackling issues that disproportionately affect the poorest nations, like climate change.

- **Sustainability:** International agreements like the Paris Climate Agreement, where countries commit to reducing carbon emissions to combat climate change.
- **Environmental Justice:** Global efforts to ensure that developing countries receive support to adapt to climate change impacts (funding for flood defenses, drought-resistant crops) ensuring the burdens and benefits of climate actions are shared equitably.

How do we measure the dimensions of sustainability?

1.3.7 Unsustainable use of natural resources can lead to ecosystem collapse.

Case Study: The Collapse of the Atlantic Cod Fisheries

Background: The Atlantic cod (*Gadus morhua*) is a species of fish found in the North Atlantic Ocean. It has been one of the most economically important species for centuries, in places like Canada. In the late 20th century, the rate of fishing exceeded the natural reproduction rate of cod (overfishing), leading to dramatic decline and population collapse.

Causes:

- **Overfishing:** The commercial fishing industry, equipped with advanced technology and large-scale vessels, intensified fishing efforts, leading to overexploitation of cod stocks.
- **Lack of Regulation:** Inadequate management and regulations allowed unsustainable fishing practices, such as high quotas and destructive gear use.
- **Ecological Factors:** Environmental changes, including fluctuations in ocean temperatures, habitat degradation and shifts in prey availability, also contributed.

Consequences:

- **Economic Impact:** The collapse had significant repercussions for coastal communities and livelihoods. Many fishermen lost jobs, and economies suffered severe downturns.
- **Ecological Imbalance:** The decline of the Atlantic cod had cascading effects on marine ecosystems, disrupting food webs and altering ecosystem dynamics. Predatory species dependent on cod faced declines, while prey species experienced population booms.
- **Social Disruption:** Not only fishermen were affected, there were broader implications for coastal communities, like loss of cultural heritage, social cohesion, traditional ways of life.

1.3.8 Common indicators of economic development, such as gross domestic product (GDP), neglect the value of natural systems and may lead to unsustainable development.

Gross Domestic Product (GDP): Measures the total value of all final goods and services used within an economy over a year. **Watch the [video](#)!**

Types of GDP:

- **Real GDP:** Adjusted for inflation, representing the true economic growth of a country.

- **Real GDP per Capita:** Real GDP divided by the population, offering a per-person output.

→ However, GDP lacks a complete view of economic development impacts on natural ecosystems and social equity.

Limitations of GDP:

- **Focus on Short-Term Gains:** GDP-centered policies often prioritize immediate economic growth, overlooking sustainable resource management, leading to resource depletion, pollution and environmental degradation.
- **Ignoring Natural Capital:** GDP does not account for the depletion of natural resources or ecological impacts, risking the health of ecosystems.
- **Social Inequity:** A singular focus on GDP growth may neglect equitable development, failing to ensure that economic benefits are fairly distributed across society.

1.3.12 Sustainability indicators include quantitative measures of biodiversity, pollution, human population, climate change, material and carbon footprints, and others.

These indicators can be applied on a range of **scales**, from individual all the way to global.

Key Types of Indicators:

- **Environmental Footprints:** Metrics like ecological, carbon, and water footprints assess resource consumption and emissions linked to production and consumption.
- **Indicator Species:** Sensitive species serve as indirect environmental health measures (e.g. Trent Biotic Index).
- **Diversity Indices:** Quantify and track changes in species diversity within ecosystems (e.g. Simpson's reciprocal index).
- **Socio-economic Indicators:** Linked to demographic factors, these track human population trends and impacts on sustainability.
- **Climate Change Indicators:** E.g. greenhouse gas emissions and temperature changes.

Scale of Indicators:

- **Individual Level:** Indicators can measure a single person's carbon footprint or waste.

- **Local Level:** Indicators measure community or industry-specific factors, such as neighborhood energy use or manufacturing waste.
- **Global Level:** Indicators monitor large-scale trends, such as deforestation in the Amazon or oceanic plastic pollution, supporting international cooperation.

1.3.13 The concept of ecological footprints can be used to measure sustainability.

An [ecological footprint](#) measures the land and resources that sustain a population or activity.

Purpose: Quantifies resource consumption and waste generation in terms of land area needed for activities such as food production, energy use, and waste absorption. It acts as an inverse measure of carrying capacity, indicating the area required to sustainably support a population.

Indicators of Unsustainability: When ecological footprints exceed the Earth's regenerative capacity (biocapacity), it leads to resource depletion, environmental degradation, long-term threats to quality of life.

Factors That Increase Ecological Footprints:

- High fossil fuel reliance
- Increased technology and energy use (though technology can also reduce footprints)
- High levels of imported resources (adding transport costs)
- Large per capita carbon waste and energy use
- High per capita food consumption and meat-rich diets

Strategies to Reduce Ecological Footprints:

- Reduce, reuse and recycle resources, also import resources to relieve local pressure
- Improve resource efficiency and pollution control
- Employ technology to boost carrying capacity and land efficiency
- Manage population growth to align with resource use

1.3.14 Carbon footprint measurements ([explore!](#))

Carbon Footprint: amount of greenhouse gases (GHGs), measured in carbon dioxide equivalents (tonnes).

Water footprint: measures water use, measured in cubic metres per year.

1.3.15 Biocapacity is the capacity of a given biologically productive area to generate an ongoing supply of renewable resources and to absorb its resulting wastes.

Biocapacity refers to the capacity of biologically productive areas (e.g. forests, fishing grounds, croplands) to regenerate resources and absorb waste, particularly carbon dioxide. It's measured in **global hectares (gha)**, representing the productivity.

If : Ecological Footprint > Biocapacity → Unsustainability

Relationship with Ecological Footprint

- Ecological Footprints measure the demand placed on ecosystems by humans, including area needed to produce resources (for consumption) and absorb waste.
- Unsustainability occurs when the ecological footprint of a population exceeds the biocapacity of a region. Resources are used faster than they can be regenerated.

Consequences of Exceeding Biocapacity:

1. **Resource Depletion:** Exhaustion of soils, forests, and water bodies.
2. **Waste Accumulation:** Pollution and greenhouse gas buildup due to unabsorbed waste.
3. **Loss of Biodiversity:** Habitat destruction disrupts ecosystems and decreases species diversity.

Examples:

- **Deforestation:** Land clearing for agriculture reduces regional biocapacity.
- **Overfishing:** Excessive fishing depletes fish stocks, impacting marine biodiversity and food security.

1.3.16 Citizen science plays a role in monitoring Earth systems and whether resources are being used sustainably.

Citizen science involves public participation and collaboration in scientific research with the aim to increase scientific knowledge. It allows for extensive data collection and observation at scales or resolutions that professional scientists alone are not able to achieve, especially in environmental monitoring. Information for

citizen science projects can be gathered through **crowdsourcing**. This involves obtaining information from a large group of people who submit data via the internet or social media.

1.3.17 There are a range of frameworks and models that support our understanding of sustainability, each with uses and limitations.

Sustainability models simplify complex interactions between human activities and the environment to help predict outcomes, assess impacts, and support sustainable decision-making. Of course, they also have limitations due to their simplified nature.

Key Frameworks and Models:

1. **Triple Bottom Line (TBL):** Expands traditional business frameworks to include **environmental** and **social** performance alongside economic results, emphasizing that true sustainability requires success across all three areas.
2. **Circular Economy Model:** Focuses on resource reuse and waste minimization in a **closed-loop system**. It's gaining traction in business but difficult to implement in existing economic structures.
3. **Planetary Boundaries Framework:** Identifies 9 global environmental limits within which humanity can safely operate. Valuable for understanding ecological thresholds but lacks social dimensions.

1.3.18 The UN Sustainable Development Goals (SDGs) are a set of social and environmental goals and targets to guide action on sustainability and environmental justice



The [SDGs](#) are 17 interconnected global goals aimed at achieving a sustainable future by 2030. Adopted by UN Member States in 2015, they serve as a model or "blueprint" to address critical social, economic and

environmental challenges. These goals aim to reduce poverty, protect the environment, and ensure that all people enjoy peace and prosperity by 2030.

Purpose and Scope:

- **Broad Objectives:** Address key areas including poverty, health, education, inequality, economic growth, climate change, and conservation of oceans and forests.
- **Specific Targets:** Each goal has measurable targets, often quantifiable and time-bound (*SMART*).

Uses of the SDGs:

- **Policy Guidance:** Provide a framework for governments and organizations to create socially and environmentally sustainable policies.
- **Resource Mobilization:** Directs government and private resources to essential areas like clean water, sanitation, and renewable energy.
- **Awareness:** Raises awareness, fostering collaborative action across sectors to tackle global issues.

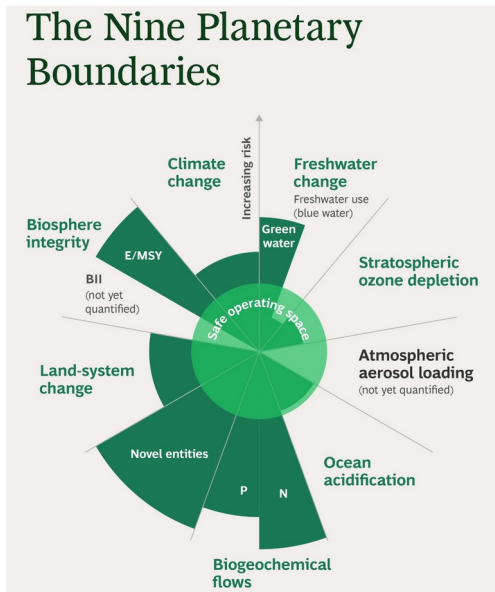
Successes

- **Private Sector Engagement:** Growing alignment of business strategies with SDGs, spurring sustainable practices and innovations.

Limitations

- **Top-down bureaucratic approach:** Action often designed and implemented through international and national institutions, which makes decision-making slow and reduces local participation.
- **Limited consideration of local contexts:** The global nature of the SDGs may overlook the unique social, economic, cultural, and environmental conditions of individual communities and countries.
- **Insufficient supporting data:** Many countries lack reliable, up-to-date data to effectively monitor progress, measure outcomes, and guide evidence-based policy decisions.

1.3.19 The planetary boundaries model describes the nine processes and systems that have regulated the stability and resilience of the Earth system in the Holocene epoch. It also identifies limits and proposes that crossing those increases the risk of abrupt and irreversible change.



The Nine Planetary Boundaries

1. Climate Change
2. Freshwater Use
3. Stratospheric Ozone Depletion
4. Atmospheric Aerosol Loading
5. Ocean Acidification
6. Nitrogen and Phosphorus Cycles
7. Land System Change
8. Biodiversity Loss
9. Novel Entities (e.g. chemical pollution)

Proposed in 2009 by [Johan Rockström](#) and Will Steffen, the **Planetary Boundaries model** defines nine critical thresholds essential for maintaining Earth's stability and resilience, ensuring conditions that have allowed human civilizations to thrive since the beginning of the Holocene epoch (~11,700 y.a.).