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Sustainability

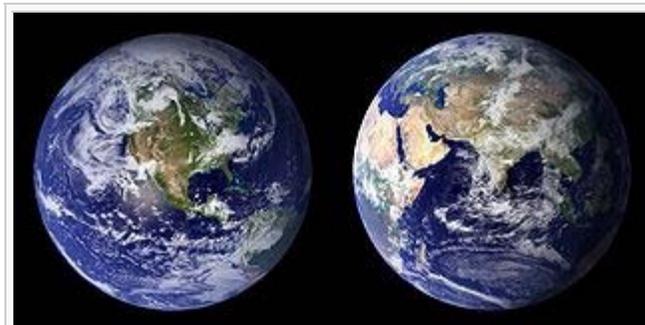


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Sustainability is the capacity to endure. For humans, sustainability is the long-term maintenance of responsibility, which has environmental, economic, and social dimensions, and encompasses the concept of [stewardship](#), the responsible management of [resource use](#). In [ecology](#), sustainability describes how biological systems remain [diverse](#) and productive over time, a necessary precondition for the well-being of humans and other [organisms](#). Long-lived and healthy [wetlands](#) and [forests](#) are examples of sustainable biological systems.

Healthy [ecosystems](#) and environments provide vital resources and processes (known as "[ecosystem services](#)"). There are two major ways of managing human impact on ecosystem services. One approach is [environmental management](#); this approach is based largely on information gained from educated professionals in [earth science](#), [environmental science](#), and [conservation biology](#). Another approach is management of [consumption](#) of resources, which is based largely on information gained from educated professionals in [economics](#).

Human sustainability interfaces with economics through the voluntary trade consequences of economic activity. Moving towards sustainability is also a social challenge that entails, among other factors, [international](#) and national [law](#), [urban planning](#) and [transport](#), local and individual [lifestyles](#) and [ethical consumerism](#). Ways of living more sustainably can take many forms from controlling living conditions (e.g., [ecovillages](#), [eco-municipalities](#) and [sustainable cities](#)), to reappraising work practices (e.g., using [permaculture](#), [green building](#), [sustainable agriculture](#)), or developing new [technologies](#) that reduce the consumption of [resources](#).



Achieving sustainability will enable the earth to continue supporting human life as we know it. "Blue Marble" NASA composite images: 2001 (left), 2002 (right).



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Simple English
Srpskohrvatski /
српскохрватски

Татарча/tatarça
Türkçe
Tiếng Việt
□□

- 6.1 Decoupling environmental degradation and economic growth
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Definition

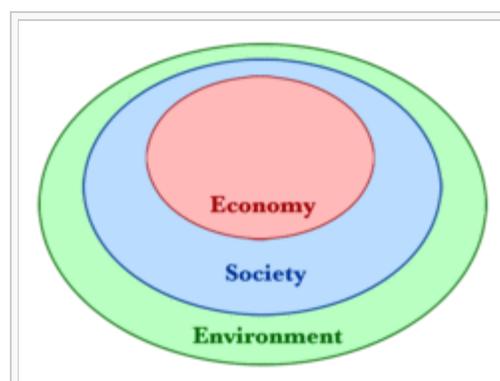
[[edit](#)]

The word sustainability is derived from the Latin *sustinere* (*tenere*, to hold; *sus*, up). Dictionaries provide more than ten meanings for *sustain*, the main ones being to "maintain", "support", or "endure".^{[3][4]}

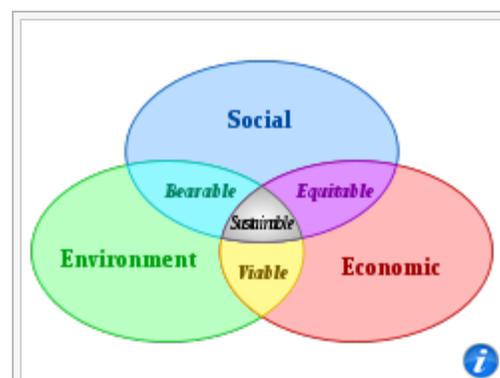
However, since the 1980s *sustainability* has been used more in the sense of human sustainability on planet Earth and this has resulted in the most widely quoted definition of sustainability as a part of the concept *sustainable development*, that of the [Brundtland Commission](#) of the [United Nations](#) on March 20, 1987: "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."^{[5][6]}

At the [2005 World Summit](#) it was noted that this requires the reconciliation of [environmental](#), [social](#) equity and [economic](#) demands - the "three pillars" of sustainability or (the 3 E's).^[7] This view has been expressed as an illustration using three overlapping ellipses indicating that the three pillars of sustainability are not mutually exclusive and can be mutually reinforcing.^[8] The three pillars - or the "[triple bottom line](#)" - have served as a common ground for numerous [sustainability standards and certification](#) systems in recent years, in particular in the food industry.^{[9][10]} Standards which today explicitly refer to the triple bottom line include [Rainforest Alliance](#), [Fairtrade](#), [UTZ Certified](#), and [The Common Code for the Coffee Community](#).^{[11][12]} The triple bottom line is also recognized by the [ISEAL Alliance](#) - the global association for social and environmental standards.

The triple bottom line as defined by the UN is not universally accepted and has undergone various interpretations.^{[13][14][15]} What sustainability is, what its goals should be, and how these goals are to be achieved are all open to interpretation.^[16] For many [environmentalists](#), the idea of sustainable development is an [oxymoron](#) as development seems to entail environmental degradation.^[17]



A [diagram](#) indicating the relationship between the three pillars of sustainability suggesting that both economy and society are constrained by environmental limits.^{[1][[verification needed](#)][[dubious](#) – [discuss](#)]}



Scheme of sustainable development: at the confluence of three constituent parts.^[2]

Ecological economist [Herman Daly](#) has asked, "what use is a sawmill without a forest?"^[18] From this perspective, the economy is a subsystem of human society, which is itself a subsystem of the biosphere, and a gain in one sector is a loss from another.^[19] This can be illustrated as three concentric circles.

A universally accepted definition of sustainability remains elusive because it is often linked with other concepts such as "sustainable development" or "sustainable agriculture" (often placed in an anthropocentric context). On the one hand it needs to be factual and scientific, a clear statement of a specific "destination". The simple definition "sustainability is improving the quality of human life while living within the carrying capacity of supporting eco-systems",^[20] though vague, conveys the idea of sustainability having quantifiable limits. But sustainability is also a call to action, a task in progress or "journey" and therefore a political process, so some definitions set out common goals and values.^[21] The [Earth Charter](#)^[22] speaks of "a sustainable global society founded on respect for nature, universal human rights, economic justice, and a culture of peace."

To add complication, the word *sustainability* is applied not only to human sustainability on Earth, but to many situations and contexts over many scales of space and time, from small local ones to the global balance of production and consumption. It can also refer to a future intention: "sustainable agriculture" is not necessarily a current situation but a goal for the future, a prediction.^[23] For all these reasons sustainability is perceived, at one extreme, as nothing more than a feel-good [buzzword](#) with little meaning or substance^{[24][25]} but, at the other, as an important but unfocused concept like "liberty" or "justice".^[26] It has also been described as a "dialogue of values that defies consensual definition".^[27]

Some researchers and institutions have pointed out that these three dimensions are not enough to reflect the complexity of contemporary society and suggest that culture could be included in this development model.^[28]

History

[\[edit\]](#)

Main article: [History of sustainability](#)

The history of sustainability traces human-dominated [ecological](#) systems from the earliest [civilizations](#) to the present. This history is characterized by the increased regional success of a particular [society](#), followed by crises that were either resolved, producing sustainability, or not, leading to decline.^{[29][30]}

In early human history, the use of fire and desire for specific foods may have altered the natural composition of plant and animal communities.^[31] Between 8,000 and 10,000 years ago, [Agrarian](#) communities emerged which depended largely on their [environment](#) and the creation of a "structure of permanence."^[32]

The Western [industrial revolution](#) of the 18th to 19th centuries tapped into the vast growth potential of the energy in [fossil fuels](#). [Coal](#) was used to power ever more efficient engines and later to generate electricity. Modern sanitation systems and advances in medicine protected large populations from disease.^[33] In the mid-20th century, a gathering [environmental movement](#) pointed out that there were environmental costs associated with the many material benefits that were now being enjoyed. In the late 20th century, environmental problems became global in scale.^{[34][35][36][37]} The 1973 and 1979 [energy crises](#) demonstrated the extent to which the global community had become dependent on non-renewable energy resources.

In the 21st century, there is increasing global awareness of the threat posed by the human [greenhouse effect](#), produced largely by forest clearing and the burning of fossil fuels.^{[38][39]}

Principles and concepts

[\[edit\]](#)

The philosophical and analytic framework of sustainability draws on and connects with many different

disciplines and fields; in recent years an area that has come to be called **sustainability science** has emerged.^[40] Sustainability science is not yet an autonomous field or discipline of its own, and has tended to be problem-driven and oriented towards guiding decision-making.^[41]

Scale and context

[\[edit\]](#)

Sustainability is studied and managed over many scales (levels or frames of reference) of time and space and in many contexts of environmental, social and economic organization. The focus ranges from the total **carrying capacity** (sustainability) of planet Earth to the sustainability of economic sectors, ecosystems, countries, municipalities, neighbourhoods, home gardens, individual lives, individual goods and services^[*clarification needed*], occupations, lifestyles, behaviour patterns and so on. In short, it can entail the full compass of biological and human activity or any part of it.^[42] As Daniel Botkin, author and environmentalist, has stated: "We see a landscape that is always in flux, changing over many scales of time and space."^[43]

Consumption — population, technology, resources

[\[edit\]](#)

A major driver of human impact on Earth systems is the destruction of **biophysical resources**, and especially, the Earth's ecosystems. The environmental impact of a community or of humankind as a whole depends both on population and impact per person, which in turn depends in complex ways on what resources are being used, whether or not those resources are renewable, and the scale of the human activity relative to the carrying capacity of the ecosystems involved. Careful resource management can be applied at many scales, from economic sectors like agriculture, manufacturing and industry, to work organizations, the consumption patterns of households and individuals and to the resource demands of individual goods and services.^{[44][45]}

One of the initial attempts to express human impact mathematically was developed in the 1970s and is called the **I PAT** formula. This formulation attempts to explain human consumption in terms of three components: **population** numbers, levels of consumption (which it terms "affluence", although the usage is different), and impact per unit of resource use (which is termed "technology", because this impact depends on the **technology** used). The equation is expressed:

$$I = P \times A \times T$$

Where: I = Environmental impact, P = Population, A = Affluence, T = Technology^[46]

Measurement

[\[edit\]](#)

Main article: [Sustainability measurement](#)

Sustainability measurement is a term that denotes the measurements used as the quantitative basis for the informed management of sustainability.^[47] The metrics used for the measurement of sustainability (involving the sustainability of environmental, social and economic domains, both individually and in various combinations) are evolving: they include **indicators**, benchmarks, audits, **sustainability standards and certification** systems like **Fairtrade** and **Organic**, indexes and accounting, as well as assessment, appraisal^[48] and other reporting systems. They are applied over a wide range of spatial and temporal scales.^{[49][50]}

Some of the best known and most widely used sustainability measures include corporate **sustainability reporting**, **Triple Bottom Line accounting**, World Sustainability Society and estimates of the quality of sustainability governance for individual countries using the **Environmental Sustainability Index** and **Environmental Performance Index**.

Population

[\[edit\]](#)

Main article: [Human population control](#)

According to the 2008 Revision of the official United Nations population estimates and projections, the [world population](#) is projected to reach 7 billion early in 2012, up from the current 6.9 billion (May 2009), to exceed 9 billion people by 2050. Most of the increase will be in [developing countries](#) whose population is projected to rise from 5.6 billion in 2009 to 7.9 billion in 2050. This increase will be distributed among the population aged 15–59 (1.2 billion) and 60 or over (1.1 billion) because the number of children under age 15 in developing countries is predicted to decrease. In contrast, the population of the more [developed regions](#) is expected to undergo only slight increase from 1.23 billion to 1.28 billion, and this would have declined to 1.15 billion but for a projected net migration from developing to developed countries, which is expected to average 2.4 million persons annually from 2009 to 2050.^[51] Long-term estimates in 2004 of global population suggest a peak at around 2070 of nine to ten billion people, and then a slow decrease to 8.4 billion by 2100.^[52]

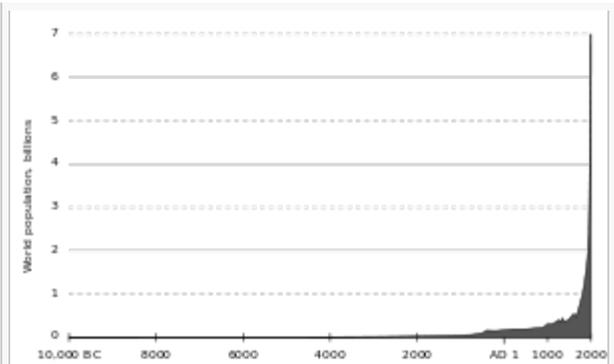
Emerging economies like those of China and India aspire to the living standards of the Western world as does the non-industrialized world in general.^[53] It is the combination of population increase in the developing world and unsustainable consumption levels in the developed world that poses a stark challenge to sustainability.^[54]

Carrying capacity

Further information: [Carrying capacity](#)

At the global scale scientific data now indicates that humans are living beyond the [carrying capacity](#) of planet Earth and that this cannot continue indefinitely. This scientific evidence comes from many sources but is presented in detail in the [Millennium Ecosystem Assessment](#) and the [planetary boundaries](#) framework.^[55] An early detailed examination of global limits was published in the 1972 book *Limits to Growth*, which has prompted follow-up commentary and analysis.^[56] A 2012 review in *Nature* by 22 international researchers expressed concerns that the Earth may be "approaching a state shift" in its biosphere.^[57]

The [Ecological footprint](#) measures human consumption in terms of the biologically productive land

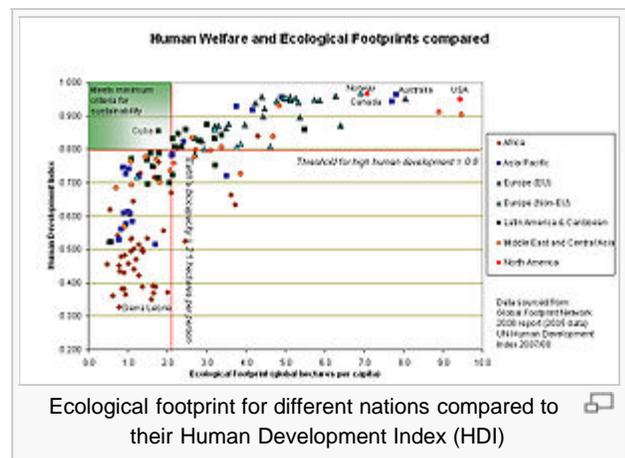


Graph showing human population growth from 10,000 BC – 2000 AD, illustrating current exponential growth



World population growth rate, 1950-2050, as estimated in 2011 by the U.S. Census Bureau, International Data Base

[[edit](#)]



Ecological footprint for different nations compared to their Human Development Index (HDI)

needed to provide the resources, and absorb the wastes of the average global citizen. In 2008 it required 2.7 [global hectares](#) per person, 30% more than the natural biological capacity of 2.1 global hectares (assuming no provision for other organisms).^[35] The resulting [ecological deficit](#) must be met from unsustainable *extra* sources and these are obtained in three ways: embedded in the goods and services of world trade; taken from the past (e.g. [fossil fuels](#)); or borrowed from the future as unsustainable resource usage (e.g. by [over exploiting forests](#) and [fisheries](#)).

The figure (right) examines sustainability at the scale of individual countries by contrasting their Ecological Footprint with their UN [Human Development Index](#) (a measure of standard of living). The graph shows what is necessary for countries to maintain an acceptable standard of living for their citizens while, at the same time, maintaining sustainable resource use. The general trend is for higher standards of living to become less sustainable. As always, [population growth](#) has a marked influence on levels of consumption and the efficiency of resource use.^{[46][58]} The sustainability goal is to raise the global standard of living without increasing the use of resources beyond globally sustainable levels; that is, to not exceed "one planet" consumption. Information generated by reports at the national, regional and city scales confirm the global trend towards societies that are becoming less sustainable over time.^{[59][60]}

Global human impact on biodiversity

[\[edit\]](#)

Further information: [Millennium Ecosystem Assessment](#)

At a fundamental level [energy flow](#) and [biogeochemical cycling](#) set an upper limit on the number and mass of organisms in any ecosystem.^[61] Human impacts on the Earth are demonstrated in a general way through detrimental changes in the global biogeochemical cycles of chemicals that are critical to life, most notably those of [water](#), [oxygen](#), [carbon](#), [nitrogen](#) and [phosphorus](#).^[62]

The *Millennium Ecosystem Assessment* is an international synthesis by over 1000 of the world's leading biological scientists that analyzes the state of the Earth's [ecosystems](#) and provides summaries and guidelines for decision-makers. It concludes that human activity is having a significant and escalating impact on the [biodiversity](#) of world [ecosystems](#), reducing both their [resilience](#) and [biocapacity](#). The report refers to natural systems as humanity's "life-support system", providing essential "[ecosystem services](#)". The assessment measures 24 ecosystem services concluding that only four have shown improvement over the last 50 years, 15 are in serious decline, and five are in a precarious condition.^[63]

Environmental dimension

[\[edit\]](#)

Healthy ecosystems provide vital goods and services to humans and other organisms. There are two major ways of reducing negative human impact and enhancing [ecosystem services](#) and the first of these is [environmental management](#). This direct approach is based largely on information gained from [earth science](#), [environmental science](#) and [conservation biology](#). However, this is management at the end of a long series of indirect causal factors that are initiated by human [consumption](#), so a second approach is through demand management of human resource use.

Management of human consumption of resources is an indirect approach based largely on information gained from [economics](#). Herman Daly has suggested three broad criteria for ecological sustainability: renewable resources should provide a [sustainable yield](#) (the rate of harvest should not exceed the rate of regeneration); for non-renewable resources there should be equivalent development of renewable substitutes; waste generation should not exceed the assimilative capacity of the environment.^[64]

Environmental management

[\[edit\]](#)

Main article: [Sustainability and environmental management](#)

At the global scale and in the broadest sense environmental management involves the [oceans](#), [freshwater](#) systems, land and [atmosphere](#), but following the sustainability principle of scale it can be equally applied to any ecosystem from a tropical rainforest to a home garden.^{[65][66]}

Atmosphere [edit]

At a March 2009 meeting of the [Copenhagen Climate Council](#), 2,500 climate experts from 80 countries issued a keynote statement that there is now "no excuse" for failing to act on global warming and that without strong carbon reduction "abrupt or irreversible" shifts in climate may occur that "will be very difficult for contemporary societies to cope with".^{[67][68]} Management of the global atmosphere now involves assessment of all aspects of the [carbon cycle](#) to identify opportunities to address human-induced [climate change](#) and this has become a major focus of scientific research because of the potential catastrophic effects on biodiversity and human communities (see [Energy](#) below).

Other human impacts on the atmosphere include the [air pollution](#) in cities, the [pollutants](#) including toxic chemicals like [nitrogen oxides](#), [sulfur oxides](#), [volatile organic compounds](#) and [particulate matter](#) that produce [photochemical smog](#) and [acid rain](#), and the [chlorofluorocarbons](#) that degrade the [ozone layer](#). [Anthropogenic particulates](#) such as sulfate [aerosols](#) in the atmosphere reduce the direct [irradiance](#) and reflectance ([albedo](#)) of the [Earth's](#) surface. Known as [global dimming](#), the decrease is estimated to have been about 4% between 1960 and 1990 although the trend has subsequently reversed. Global dimming may have disturbed the global [water cycle](#) by reducing evaporation and rainfall in some areas. It also creates a cooling effect and this may have partially masked the effect of [greenhouse gases](#) on [global warming](#).^[69]

Freshwater and oceans [edit]

Water covers 71% of the Earth's surface. Of this, 97.5% is the salty water of the [oceans](#) and only 2.5% freshwater, most of which is locked up in the [Antarctic ice sheet](#). The remaining freshwater is found in glaciers, lakes, rivers, wetlands, the soil, aquifers and atmosphere. Due to the water cycle, fresh water supply is continually replenished by precipitation, however there is still a limited amount necessitating management of this resource. Awareness of the global importance of preserving [water](#) for [ecosystem services](#) has only recently emerged as, during the 20th century, more than half the world's [wetlands](#) have been lost along with their valuable environmental services. Increasing [urbanization](#) pollutes clean water supplies and much of the world still does not have access to clean, safe [water](#).^[70] Greater emphasis is now being placed on the improved management of blue (harvestable) and green (soil water available for plant use) water, and this applies at all scales of water management.^[71]

[Ocean](#) circulation patterns have a strong influence on [climate](#) and [weather](#) and, in turn, the food supply of both humans and other organisms. Scientists have warned of the possibility, under the influence of climate change, of a sudden alteration in circulation patterns of [ocean currents](#) that could drastically alter the climate in some regions of the globe.^[72] Ten per cent of the world's population – about 600 million people – live in low-lying areas vulnerable to sea level rise.

Land use [edit]

Loss of biodiversity stems largely from the habitat loss and fragmentation produced by the human appropriation of land for development, forestry and agriculture as [natural capital](#) is progressively converted to man-made capital. Land use change is fundamental to the operations of the [biosphere](#) because alterations in the relative proportions of land dedicated to [urbanisation](#), [agriculture](#), [forest](#), [woodland](#), [grassland](#) and [pasture](#) have a marked effect on the global

water, carbon and nitrogen [biogeochemical cycles](#) and this can impact negatively on both natural and human systems.^[73] At the local human scale, major sustainability benefits accrue from [sustainable parks and gardens](#) and [green cities](#).^{[74][75]}

Since the Neolithic Revolution about 47% of the world's forests have been lost to human use. Present-day forests occupy about a quarter of the world's ice-free land with about half of these occurring in the tropics.^[76] In temperate and boreal regions forest area is gradually increasing (with the exception of Siberia), but [deforestation](#) in the tropics is of major concern.^[77]

Food is essential to life. Feeding more than seven billion human bodies takes a heavy toll on the Earth's resources. This begins with the appropriation of about 38% of the Earth's land surface^[78] and about 20% of its net primary productivity.^[79] Added to this are the resource-hungry activities of industrial agribusiness – everything from the crop need for irrigation water, synthetic [fertilizers](#) and [pesticides](#) to the resource costs of food packaging, [transport](#) (now a major part of global trade) and retail. Environmental problems associated with [industrial agriculture](#) and [agribusiness](#) are now being addressed through such movements as [sustainable agriculture](#), [organic farming](#) and more sustainable business practices.^[80]

Management of human consumption

[\[edit\]](#)

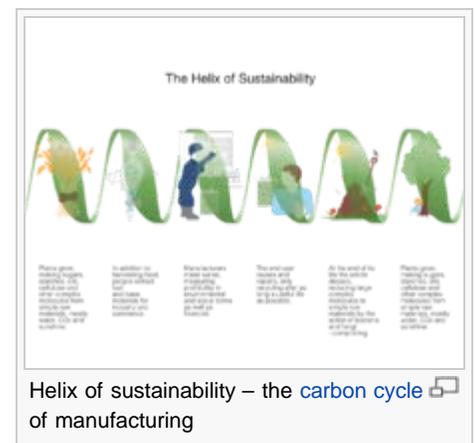
Further information: [Consumption \(economics\)](#)

The underlying driver of direct human impacts on the environment is human consumption.^[81] This impact is reduced by not only consuming less but by also making the full cycle of production, use and disposal more sustainable. Consumption of goods and services can be analysed and managed at all scales through the chain of consumption, starting with the effects of individual lifestyle choices and spending patterns, through to the resource demands of specific goods and services, the impacts of economic sectors, through national economies to the global economy.^[82] Analysis of consumption patterns relates resource use to the environmental, social and economic impacts at the scale or context under investigation. The ideas of embodied resource use (the total resources needed to produce a product or service), [resource intensity](#), and [resource productivity](#) are important tools for understanding the impacts of consumption. Key resource categories relating to human needs are [food](#), [energy](#), [materials](#) and [water](#).

In 2010, the [International Resource Panel](#), hosted by the [United Nations Environment Programme](#) (UNEP), published the first global scientific assessment on the impacts of consumption and production^[83] and identified priority actions for developed and developing countries. The study found



A rice paddy. Rice, wheat, corn and potatoes make up more than half the world's food supply. [\[copy\]](#)



Helix of sustainability – the [carbon cycle](#) of manufacturing [\[copy\]](#)

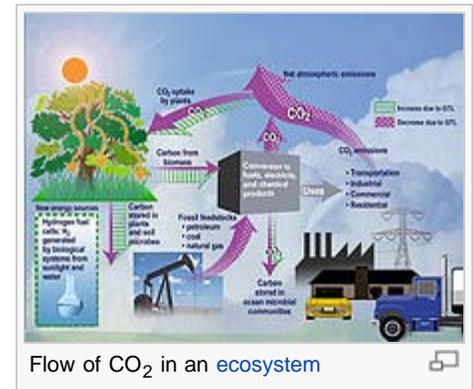
that the most critical impacts are related to [ecosystem](#) health, human health and [resource depletion](#). From a production perspective, it found that fossil-fuel combusting processes, [agriculture](#) and [fisheries](#) have the most important impacts. Meanwhile, from a final [consumption](#) perspective, it found that household consumption related to mobility, shelter, [food](#) and energy-using products cause the majority of [life-cycle](#) impacts of consumption.

Energy

[[edit](#)]

Main articles: [Sustainable energy](#), [Renewable energy](#), and [Efficient energy use](#)

The Sun's energy, stored by plants ([primary producers](#)) during [photosynthesis](#), passes through the food chain to other organisms to ultimately power all living processes. Since the [industrial revolution](#) the concentrated energy of the [Sun](#) stored in fossilized plants as [fossil fuels](#) has been a major driver of [technology](#) which, in turn, has been the source of both economic and political power. In 2007 climate scientists of the [IPCC](#) concluded that there was at least a 90% probability that atmospheric increase in CO₂ was human-induced, mostly as a result of fossil fuel emissions but, to a lesser extent from changes in land use. Stabilizing the world's climate will require high-income countries to reduce their emissions by 60–90% over 2006 levels by 2050 which should hold CO₂ levels at 450–650 ppm from current levels of about 380 ppm. Above this level, temperatures could rise by more than 2°C to produce "catastrophic" [climate change](#).^{[84][85]} Reduction of current CO₂ levels must be achieved against a background of global population increase and developing countries aspiring to energy-intensive high consumption Western lifestyles.^[86]



Reducing greenhouse emissions, is being tackled at all scales, ranging from tracking the passage of carbon through the [carbon cycle](#)^[87] to the [commercialization of renewable energy](#), developing less carbon-hungry technology and transport systems and attempts by individuals to lead [carbon neutral](#) lifestyles by monitoring the fossil fuel use embodied in all the goods and services they use.^[88]

Water

[[edit](#)]

Further information: [Water resources](#)

[Water security](#) and [food security](#) are inextricably linked. In the decade 1951–60 human water withdrawals were four times greater than the previous decade. This rapid increase resulted from scientific and technological developments impacting through the [economy](#) – especially the increase in irrigated land, growth in industrial and power sectors, and intensive [dam](#) construction on all continents. This altered the [water cycle](#) of [rivers](#) and [lakes](#), affected their [water quality](#) and had a significant impact on the [global water cycle](#).^[89] Currently towards 35% of human water use is unsustainable, drawing on diminishing aquifers and reducing the flows of major rivers: this percentage is likely to increase if [climate change](#) impacts become more severe, [populations](#) increase, aquifers become progressively depleted and supplies become polluted and unsanitary.^[90] From 1961 to 2001 water demand doubled - agricultural use increased by 75%, industrial use by more than 200%, and domestic use more than 400%.^[91] In the 1990s it was estimated that humans were using 40–50% of the globally available freshwater in the approximate proportion of 70% for [agriculture](#), 22% for [industry](#), and 8% for domestic purposes with total use progressively increasing.^[89]

Water efficiency is being improved on a global scale by increased [demand management](#), improved infrastructure, improved water [productivity](#) of agriculture, minimising the water intensity (embodied water) of goods and services, addressing shortages in the non-industrialised world, concentrating food production in areas of high productivity, and planning for [climate change](#). At the local level,

people are becoming more self-sufficient by harvesting rainwater and reducing use of mains water.^{[71][92]}

Food

[edit]

Further information: [Food](#) and [Food security](#)

The [American Public Health Association](#) (APHA) defines a "sustainable food system"^{[93][94]} as "one that provides healthy food to meet current food needs while maintaining healthy ecosystems that can also provide food for generations to come with minimal negative impact to the environment. A sustainable food system also encourages local production and distribution infrastructures and makes nutritious food available, accessible, and affordable to all. Further, it is humane and just, protecting farmers and other workers, consumers, and communities."^[95] Concerns about the environmental impacts of [agribusiness](#) and the stark contrast between the [obesity](#) problems of the Western world and the poverty and food insecurity of the developing world have generated a strong movement towards healthy, sustainable eating as a major component of overall [ethical consumerism](#).^[96] The environmental effects of different dietary patterns depend on many factors, including the proportion of animal and plant foods consumed and the method of food production.^{[97][98][99][100]} The [World Health Organization](#) has published a *Global Strategy on Diet, Physical Activity and Health* report which was endorsed by the May 2004 [World Health Assembly](#). It recommends the Mediterranean diet which is associated with health and [longevity](#) and is low in [meat](#), rich in [fruits](#) and [vegetables](#), low in added sugar and limited salt, and low in [saturated fatty acids](#); the traditional source of [fat](#) in the Mediterranean is [olive oil](#), rich in [monounsaturated fat](#). The healthy rice-based Japanese diet is also high in [carbohydrates](#) and low in fat. Both diets are low in [meat](#) and [saturated fats](#) and high in [legumes](#) and other vegetables; they are associated with a low incidence of ailments and low environmental impact.^[101]



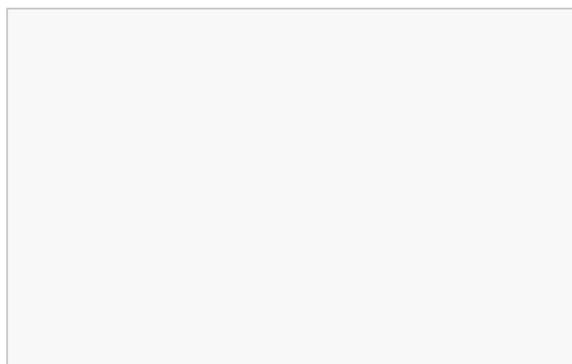
Feijoada - A typical black bean food dish from [Brazil](#)

At the global level the environmental impact of agribusiness is being addressed through [sustainable agriculture](#) and [organic farming](#). At the local level there are various movements working towards local food production, more productive use of urban wastelands and domestic gardens including [permaculture](#), [urban horticulture](#), [local food](#), [slow food](#), [sustainable gardening](#), and [organic gardening](#).^{[102][103]}

[Sustainable seafood](#) is seafood from either fished or farmed sources that can maintain or increase production in the future without jeopardizing the ecosystems from which it was acquired. The sustainable seafood movement has gained momentum as more people become aware about both [overfishing](#) and environmentally destructive fishing methods.

Materials, toxic substances, waste

[edit]



As global population and affluence has increased, so has the use of various [materials](#) increased in volume, diversity and distance transported. Included here are raw materials, minerals, synthetic chemicals (including [hazardous substances](#)), manufactured products, food, living organisms and waste.^[104] By 2050, humanity could consume an estimated 140 billion tons of minerals, ores, fossil fuels and biomass per year (three times its current amount) unless



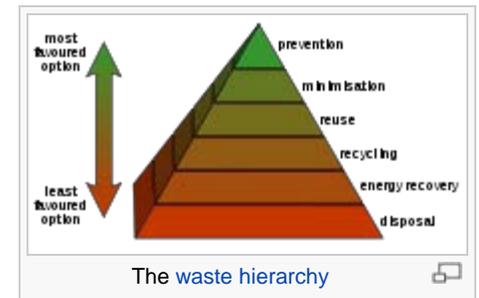
An electric wire reel reused as a center table in a [Rio de Janeiro decoration fair](#). The reuse of materials is a sustainable practice that is rapidly growing among [designers](#) in [Brazil](#).

the economic growth rate is decoupled from the rate of natural resource consumption. Developed countries' citizens consume an average of 16 tons of those four key resources per capita (ranging up to 40 or more tons per person in

some developed countries with resource consumption levels far beyond what is likely sustainable.^[105]

Sustainable use of materials has targeted the idea of [dematerialization](#), converting the linear path of materials (extraction, use, disposal in landfill) to a [circular material flow](#) that reuses materials as much as possible, much like the cycling and reuse of waste in nature.^[106] This approach is supported by [product stewardship](#) and the increasing use of [material flow analysis](#) at all levels, especially individual countries and the global economy.^[107] The use of sustainable biomaterials that come from renewable sources and that can be recycled is preferred to the use on non-renewables from a life cycle standpoint.

[Synthetic chemical](#) production has escalated following the stimulus it received during the second World War. Chemical production includes everything from herbicides, pesticides and fertilizers to domestic chemicals and hazardous substances.^[108] Apart from the build-up of greenhouse gas emissions in the atmosphere, chemicals of particular concern include: [heavy metals](#), [nuclear waste](#), [chlorofluorocarbons](#), [persistent organic pollutants](#) and all harmful chemicals capable of [bioaccumulation](#). Although most synthetic chemicals are harmless there needs to be rigorous testing of new chemicals, in all countries, for adverse environmental and health effects. International legislation has been established to deal with the global distribution and management of [dangerous goods](#).^{[109][110]}



Every economic activity produces material that can be classified as waste. To reduce waste industry, business and government are now mimicking nature by turning the waste produced by [industrial metabolism](#) into resource. Dematerialization is being encouraged through the ideas of [industrial ecology](#), [ecodesign](#)^[111] and [ecolabelling](#). In addition to the well-established “reduce, reuse and recycle,” shoppers are using their purchasing power for [ethical consumerism](#).^[45]

Economic dimension

[[edit](#)]

Further information: [Ecological economics](#), [Environmental economics](#), and [Green economy](#)

On one account, sustainability "concerns the specification of a set of actions to be taken by present persons that will not diminish the prospects of future persons to enjoy levels of consumption, wealth, utility, or welfare comparable to

is concerned largely with economic growth and the efficient allocation of resources, ecological economics has the explicit goal of sustainable scale (rather than continual growth), [fair distribution](#) and efficient allocation, in that order.^{[122][123]} The [World Business Council for Sustainable Development](#) states that "business cannot succeed in societies that fail".^[124]

In [economic](#) and [environmental](#) fields, the term [decoupling](#) is becoming increasingly used in the context of economic production and environmental quality. When used in this way, it refers to the ability of an economy to grow without incurring corresponding increases in environmental pressure. Ecological economics includes the study of societal metabolism, the throughput of resources that enter and exit the economic system in relation to [environmental quality](#).^{[125][126]} An economy that is able to sustain GDP growth without having a negative impact on the environment is said to be decoupled. Exactly how, if, or to what extent this can be achieved is a subject of much debate. In 2011 the [International Resource Panel](#), hosted by the [United Nations Environment Programme](#) (UNEP), warned that by 2050 the human race could be devouring 140 billion tons of minerals, ores, fossil fuels and biomass per year – three times its current rate of consumption – unless nations can make serious attempts at decoupling.^[127] The report noted that citizens of developed countries consume an average of 16 tons of those four key resources per capita per annum (ranging up to 40 or more tons per person in some developed countries). By comparison, the average person in India today consumes four tons per year. Sustainability studies analyse ways to reduce [resource intensity](#) (the amount of resource (e.g. water, energy, or materials) needed for the production, consumption and disposal of a unit of good or service) whether this be achieved from improved economic management, product design, or new technology.^[128]

Nature as an economic externality

[\[edit\]](#)

Further information: [Ecosystem services](#)

The economic importance of nature is indicated by the use of the expression [ecosystem services](#) to highlight the market relevance of an increasingly scarce natural world that can no longer be regarded as both unlimited and free.^[129] In general, as a [commodity](#) or service becomes more scarce the [price](#) increases and this acts as a restraint that encourages frugality, technical innovation and alternative products. However, this only applies when the product or service falls within the market system.^[130] As ecosystem services are generally treated as economic [externalities](#) they are unpriced and therefore overused and degraded, a situation sometimes referred to as the [Tragedy of the Commons](#).^[129]

One approach to this dilemma has been the attempt to "internalise" these "externalities" by using market strategies like [ecotaxes](#) and incentives, tradeable permits for carbon, and the encouragement of payment for ecosystem services. [Community currencies](#) associated with [Local Exchange Trading Systems](#) (LETS), a [gift economy](#) and [Time Banking](#) have also been promoted as a way of supporting local economies and the environment.^{[131][132]} [Green economics](#) is another market-based attempt to address issues of equity and the environment.^[133] The global recession and a range of associated government policies are likely to bring the biggest annual fall in the world's carbon dioxide emissions in 40 years.^[134]

Economic opportunity

[\[edit\]](#)



Deforestation of native [rain forest](#) in Rio de Janeiro City for extraction of [clay](#) for [civil engineering](#) (2009 picture)

Treating the environment as an externality may generate short-term profit at the expense of sustainability.^[135] **Sustainable business** practices, on the other hand, integrate ecological concerns with social and economic ones (i.e., the **triple bottom line**).^{[136][137]} Growth that depletes ecosystem services is sometimes termed "**uneconomic growth**" as it leads to a decline in **quality of life**.^{[138][139]} Minimising such growth can provide opportunities for local businesses. For example, industrial waste can be treated as an "economic resource in the wrong place". The benefits of **waste reduction** include savings from disposal costs, fewer environmental penalties, and reduced liability insurance. This may lead to increased market share due to an improved public image.^{[140][141]} Energy efficiency can also increase profits by reducing costs.

The idea of sustainability as a business opportunity has led to the formation of organizations such as the Sustainability Consortium of the **Society for Organizational Learning**, the Sustainable Business Institute, and the World Council for Sustainable Development.^[142] Research focusing on progressive corporate leaders who have embedded sustainability into commercial strategy has yielded a leadership competency model for sustainability.^{[143][144]} The expansion of sustainable business opportunities can contribute to **job creation** through the introduction of **green-collar** workers.^[145]

Social dimension

[edit]

Further information: [Social sustainability](#)

Sustainability issues are generally expressed in **scientific** and environmental terms, as well as in ethical terms of **stewardship**, but implementing change is a social challenge that entails, among other things, **international** and national **law**, **urban planning** and **transport**, local and individual **lifestyles** and **ethical consumerism**.^[146] "The relationship between human rights and human development, corporate power and environmental justice, global poverty and citizen action, suggest that responsible global citizenship is an inescapable element of what may at first glance seem to be simply matters of personal consumer and moral choice."^[147]

Peace, security, social justice

[edit]

Further information: [Peace](#) and [Social justice](#)

Social disruptions like **war**, **crime** and **corruption** divert resources from areas of greatest human need, damage the capacity of societies to plan for the future, and generally threaten human well-being and the environment.^[147] Broad-based strategies for more sustainable social systems include: improved education and the political empowerment of women, especially in developing countries; **greater regard for social justice, notably equity between rich and poor both within and between countries; and intergenerational equity**.^[54] Depletion of natural resources including fresh water^[148] increases the likelihood of "resource wars".^[149] This aspect of sustainability has been referred to as **environmental security** and creates a clear need for **global environmental agreements** to manage resources such as aquifers and rivers which span political boundaries, and to protect shared global systems including **oceans** and the **atmosphere**.^[150]

Poverty

[edit]

Further information: [Poverty](#)

A major hurdle to achieve sustainability is the alleviation of poverty. It has been widely acknowledged that poverty is one source of environmental degradation. Such acknowledgment has been made by the **Brundtland Commission report Our Common Future**^[151] and the Millennium Development Goals.^[152] According to the Brundtland report, "poverty is a major cause and effect of global environmental problems. It is therefore futile to attempt to deal with environmental problems without a broader perspective that encompasses the factors underlying world poverty and international inequality."^[153] Individuals living in poverty tend to rely heavily on their local ecosystem as a source

for basic needs (such as nutrition and medicine) and general well-being.^[154] As population growth continues to increase, increasing pressure is being placed on the local ecosystem to provide these basic essentials. According to the UN Population Fund, high fertility and poverty have been strongly correlated, and the world's poorest countries also have the highest fertility and population growth rates.^[155] The word sustainability is also used widely by western country development agencies and international charities to focus their poverty alleviation efforts in ways that can be sustained by the local populous and its environment. For example, teaching [water treatment](#) to the poor by boiling their water with [charcoal](#), would not generally be considered a sustainable strategy, whereas using [PET solar water disinfection](#) would be. Also, sustainable [best practices](#) can involve the [recycling](#) of materials, such as the use of recycled plastics for lumber where deforestation has devastated a country's timber base. Another example of sustainable practices in poverty alleviation is the use of exported recycled materials from developed to developing countries, such as [Bridges to Prosperity's](#) use of wire rope from shipping container [gantry cranes](#) to act as the structural wire rope for [footbridges](#) that cross rivers in poor rural areas in Asia and Africa.^[156]

Human relationship to nature

[\[edit\]](#)

According to [Murray Bookchin](#), the idea that humans must dominate nature is common in [hierarchical](#) societies. Bookchin contends that [capitalism](#) and [market](#) relationships, if unchecked, have the capacity to reduce the planet to a mere resource to be exploited. Nature is thus treated as a [commodity](#): "The plundering of the human spirit by the market place is paralleled by the plundering of the earth by capital."^[157] [Social ecology](#), founded by Bookchin, is based on the conviction that nearly all of humanity's present ecological problems originate in, indeed are mere symptoms of, dysfunctional social arrangements. Whereas most authors proceed as if our ecological problems can be fixed by implementing recommendations which stem from physical, biological, economic etc., studies, Bookchin's claim is that these problems can only be resolved by understanding the underlying social processes and intervening in those processes by applying the concepts and methods of the social sciences.^[158]

[Deep ecology](#) establishes principles for the well-being of all life on Earth and the richness and diversity of life forms. **This requires a substantial decrease in human population and consumption along with the reduction of human interference with the nonhuman world.** To achieve this, deep ecologists advocate policies for basic economic, technological, and ideological structures that will improve the *quality of life* rather than the *standard of living*. Those who subscribe to these principles are obliged to make the necessary change happen.^[159]

Human settlements

[\[edit\]](#)

One approach to [sustainable living](#), exemplified by small-scale urban [transition towns](#) and rural [ecovillages](#), seeks to create self-reliant communities based on principles of [simple living](#), which maximise [self-sufficiency](#) particularly in food production. These principles, on a broader scale, underpin the concept of a [bioregional](#) economy.^[161] **Other approaches, loosely based around new urbanism, are successfully reducing environmental impacts by altering the built environment to create and preserve sustainable cities which support sustainable transport. Residents in compact urban neighbourhoods drive fewer miles, and have significantly lower environmental impacts across a range of measures, compared with those living in sprawling suburbs.**^[162]

Large scale [social movements](#) can influence both community choices and the built environment. [Eco-municipalities](#) may be one such movement.^[163] Eco-municipalities take a [systems](#) approach, based

Sustainability principles

1. Reduce dependence upon fossil fuels, underground metals, and minerals
2. Reduce dependence upon synthetic chemicals and other unnatural substances
3. Reduce encroachment upon nature
4. Meet human needs fairly & efficiently^[160]

on sustainability principles. The eco-municipality movement is participatory, involving community members in a bottom-up approach. In Sweden, more than 70 cities and towns—25 per cent of all municipalities in the country—have adopted a common set of "[Sustainability Principles](#)" and implemented these systematically throughout their municipal operations. There are now twelve eco-municipalities in the United States and the [American Planning Association](#) has adopted sustainability objectives based on the same principles.^[160]

There is a wealth of advice available to individuals wishing to reduce their personal impact on the environment through small, inexpensive and easily achievable steps.^{[164][165]} But the transition required to reduce global human consumption to within sustainable limits involves much larger changes, at all levels and contexts of society.^[166] The [United Nations](#) has recognised the central role of education, and have declared a [decade of education for sustainable development](#), 2005–2014, which aims to "challenge us all to adopt new behaviours and practices to secure our future".^[167] The [Worldwide Fund for Nature](#) proposes a strategy for sustainability that goes beyond education to tackle underlying individualistic and materialistic [societal values](#) head-on and strengthen people's connections with the natural world.^[168]

See also

[edit]

- [Appropriate technology](#)
- [Chemical Leasing](#)
- [Conservation biology](#)
- [Cradle-to-cradle design](#)
- [Ecopsychology](#)
- [Environmental issue](#)
- [Extinction](#)
- [Introduced species](#)
- [List of sustainability topics](#)
- [Micro-sustainability](#)
- [Outline of sustainability](#)
- [Permaculture](#)
- [Sociocultural evolution](#)
- [Stewardship](#)
- [Sustainability and systemic change resistance](#)
- [Sustainable development](#)
- [Sustainability standards and certification](#)
- [World Cities Summit](#)



Notes

[edit]

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