# Sustainability

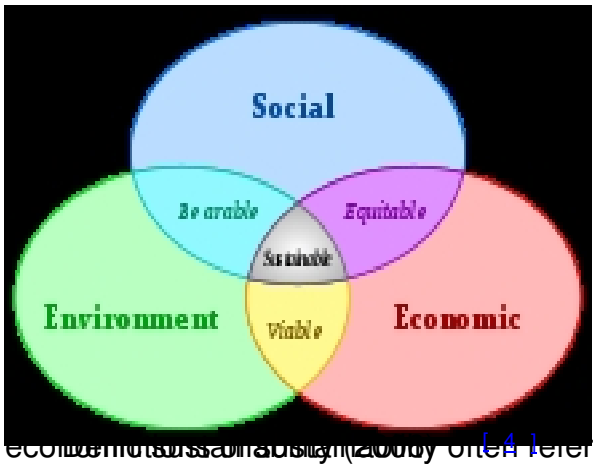
**Sustainability** is the capacity to endure. In **ecology** the word describes how biological systems remain diverse and productive over time. For humans it is the potential for long-term maintenance of well being, which in turn depends on the maintenance of the natural world and natural resources. [ 1 ]

Sustainability has become a wide-ranging term that can be applied to almost every facet of life on Earth, from local to a global scale and over various time periods. Long-lived and healthy wetlands and forests are examples of sustainable biological systems. Invisible chemical cycles redistribute water, oxygen, nitrogen and carbon through the world's living and non-living systems, and have sustained life since the beginning of time. As the earth's human population has increased, natural ecosystems have declined and changes in the balance of natural cycles has had a negative impact on both humans and other living systems. [ 2 ] Paul Hawken has written that "Sustainability is about stabilizing the currently disruptive relationship between earth's two most complex systems—human culture and the living world." [ 3 ]

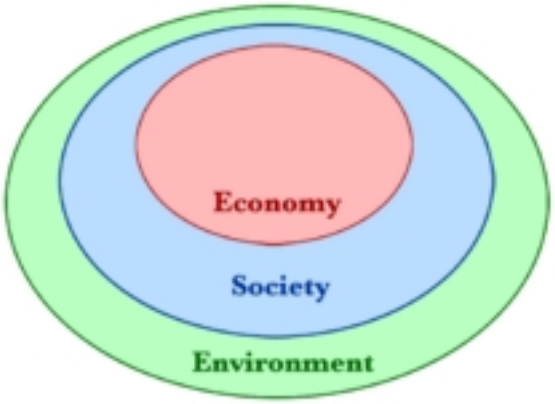
Ways of living more sustainably can take many forms from reorganising living conditions (e.g., ecovillages, eco-municipalities and sustainable cities), reappraising economic sectors (permaculture, green building, sustainable agriculture), or work practices (sustainable architecture), using science to develop new technologies (green technologies, renewable energy), to adjustments in individual lifestyles that conserve natural resources.

## Contents

## Definition




ecological sustainability (2000) often refer to the "three pillars" of social, environmental and




by Avi Brisman (2008)[ 5 ] showing how both economy and society are constrained

## History

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.[ 27 ][ 28 ]

In early human history, the use of fire and desire for specific foods may have altered the natural composition of plant and animal communities.[ 29 ] 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."[ 30 ]

The Western industrial revolution of the 17th 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.[ 31 ] 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. [ 32 ] [ 33 ] [ 34 ] [ 35 ] 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-induced enhanced greenhouse effect , produced largely by forest clearing and the burning of fossil fuels. [ 36 ] [ 37 ]

## Principles and concepts

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. 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.
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### Scale and context

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, 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. [ 39 ] 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."
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### Consumption — population, technology, resources

The overall driver of human impact on Earth systems is the destruction of biophysical resources, and especially, the Earth's ecosystems. The total 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. [ 41 ] [ 42 ]

One of the initial attempts to express human impact mathematically was developed in the '70s 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 [ 43 ]

## Measurement

Main article: Sustainability measurement

Sustainability measurement is a term that denotes the measurements used as the quantitative basis for the informed management of sustainability. [ 44 ] The metrics used for the measurement of sustainability (involving the sustainability of environmental, social and economic domains, both individually and in various combinations) are still evolving: they include indicators, benchmarks, audits, indexes and accounting, as well as assessment, appraisal [ 45 ] and other reporting systems. They are applied over a wide range of spatial and temporal scales. [ 46 ] [ 47 ]

Some of the best known and most widely used sustainability measures include corporate sustainability reporting, Triple Bottom Line accounting, and estimates of the quality of sustainability governance for

individual countries using the
Environmental Sustainability Index
and
Environmental Performance Index
.

## Population

Main article: Population control

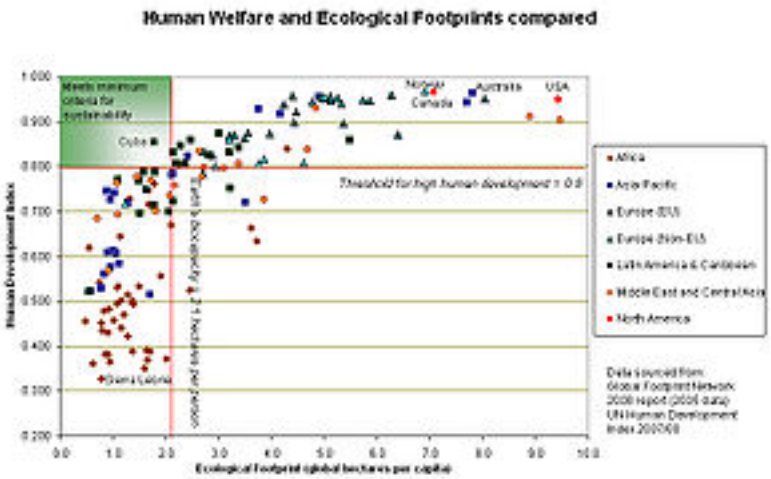
Graph showing human population growth from 10,000 BC – AD 2000, illustrating current exponential growth

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 will 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. [ 48 ] Long-term estimates 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. [ 49 ]

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. [ 50 ] 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. [ 51 ]

## Carrying capacity

Further information: Carrying capacity




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

More and more data are indicating that humans are not living within the carrying capacity of the planet. The Ecological footprint measures human consumption in terms of the biologically productive land 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).
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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) compares the sustainability of 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.
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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.
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## Global human impact on biodiversity

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. [ 55 ] 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.
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The *Millennium Ecosystem Assessment* is an international synthesis by over 1000 of the world's leading biological scientists that analyses 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.
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# Environmental dimension

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:

a) 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.

b) Management of human consumption of resources, 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. [ 58 ]

## Environmental management

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. [ 59 ] [ 60 ]

### Atmosphere

In March 2009 at a 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 targets "abrupt or irreversible" shifts in climate may occur that "will be very difficult for contemporary societies to cope with". [ 61 ] [ 62 ]

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, sulphur 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 sulphate 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. [ 63 ]

### Freshwater and Oceans

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 lakes, rivers, wetlands, the soil, aquifers and atmosphere. 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. [ 64 ] 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. [ 65 ]

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. [ 66 ] Ten per cent of the world's population – about 600 million people – live in low-lying areas vulnerable to sea level rise.

### Land use

A rice paddy. Rice, wheat, corn and potatoes make up more than half the world's food supply

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. [ 67 ] At the local human scale major sustainability benefits accrue from the pursuit of green cities and sustainable parks and gardens.
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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 [ 70 ] In temperate and boreal regions forest area is gradually increasing (with the exception of Siberia), but deforestation in the tropics is of major concern.
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Food is essential to life and feeding more than six 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 [
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and about 20% of its net primary productivity.
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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.
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## Management of human consumption

Helix of sustainability – the carbon cycle of manufacturing

The underlying driver of direct human impacts on the environment is human consumption. [ 75 ] 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.
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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 (the resources needed for each dollar spent on a good or service), and resource productivity (the amount of good or service produced for a given input of resource) are important tools for understanding the impacts of consumption with simple key resource categories indicating human needs being food, energy, materials and water.

### Energy

Main articles: Sustainable energy , Renewable energy , and Efficient energy use

Flow of $CO_2$ in an ecosystem

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 $CO_2$ 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 CO $_2$ levels at 450-650 ppm from current levels of about 380 ppm. Above this level and temperatures could rise by more than 2°C to produce "catastrophic"
climate change
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Reduction of current CO
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levels must be achieved against a background of global population increase and developing countries aspiring to energy-intensive high consumption Western lifestyles.
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Reducing greenhouse emissions, referred to as decarbonization, is being tackled at all scales, ranging from tracking the passage of carbon through the carbon cycle [ 80 ] 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.
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### Water

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. [ 82 ] 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 worsens, populations increase, aquifers become progressively depleted and supplies become polluted and unsanitary. [ 83 ]
From 1961 to 2001 water demand doubled - agricultural use increased by 75%, industrial use by more than 200%, and domestic use more than 400%.
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Humans currently use 40-50% of the globally available freshwater in the approximate proportion of 70% for agriculture, 22% for industry, and 8% for domestic purposes and the total volume is progressively increasing.
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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 water-self-sufficient by harvesting rainwater and reducing use of mains water. [ 65 ] [ 85 ]

### Food

Further information: Food and Food security

The American Public Health Association (APHA) defines a "sustainable food system" [ 86 ] [ 87 ]
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."
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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.
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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.
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The World Health Organization has published a
*Global Strategy on Diet, Physical Activity and Health*
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.
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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.
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**Materials, toxic substances, waste**

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. [ 97 ]

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. [ 98 ] 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.
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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. [ 100 ] 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.
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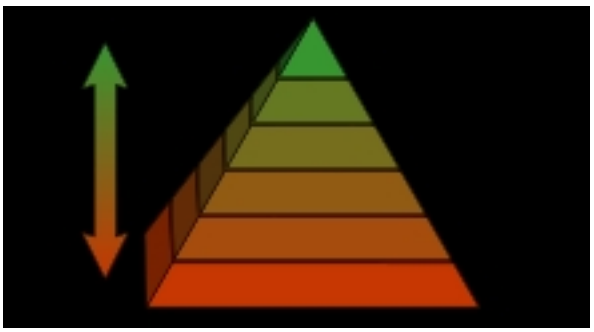

The waste hierarchy

Every economic activity produces material that can be classified as waste. The average human

uses 45-85 tonnes of materials each year. [ 97 ] 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 [ 103 ] and ecolabelling. In addition to the well-established “reduce, reuse and recycle” shoppers are using their purchasing power for ethical consumerism. [ 42 ]

## Economic dimension

Further information: Ecological economics and Environmental economics 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 those enjoyed by present persons." [ 1 ]

Sustainability interfaces with economics through the social and ecological consequences of economic activity. [ 17 ]

Sustainability economics represents: "... a broad interpretation of ecological economics where environmental and ecological variables and issues are basic but part of a multidimensional perspective. Social, cultural, health-related and monetary/financial aspects have to be integrated into the analysis." [ 104 ]

However the concept of sustainability is much broader than the concepts of sustained yield of welfare, resources, or profit margins [ 105 ]

At present the average per capita consumption of people in the developing world is sustainable but population numbers are increasing and individuals are aspiring to high consumption Western lifestyles. The developed world population is only increasing slightly but consumption levels are unsustainable. The challenge for sustainability is to curb and manage Western consumption while raising the standard of living of the developing world without increasing its

resource use and environmental impact. This must be done by using strategies and technology that break the link between, on the one hand, economic growth and on the other, environmental damage and resource depletion.
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In addressing this issue several key areas have been targeted for economic analysis and reform: the environmental effects of unconstrained economic growth; the consequences of nature being treated as an economic externality; and the possibility of an economics that takes greater account of the social and environmental consequences of market behaviour. [ 107 ]

## Decoupling environmental degradation and economic growth

Further information: Ecological economics

International Recycle Symbol

In the second half of the 20th century world population doubled, food production tripled, energy use quadrupled, and overall economic activity quintupled. [ 108 ] Historically there has been a close correlation between economic growth and environmental degradation: as communities grow, so the environment declines. This trend is clearly demonstrated on graphs of human population numbers, economic growth, and environmental indicators.
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Unsustainable economic growth has been starkly compared to the malignant growth of a cancer
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because it eats away at the Earth's ecosystem services which are its life-support system. There is concern that, unless resource use is checked, modern global civilization will follow the path of ancient civilizations that collapsed through overexploitation of their resource base.
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While conventional economics 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.
[ 113 ] [ 114 ]

The World Business Council for Sustainable Development states that "business cannot succeed in societies that fail".
[ 115 ]

Sustainability studies analyse ways to reduce (decouple) 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, new technology etc.
[ 116 ]

Ecological economics includes the study of societal metabolism, the throughput of resources that enter and exit the economic system in relation to environmental quality.
[ 117 ] [ 118 ]

## Nature as an economic externality

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. [ 119 ] 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. [ 120 ]

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.
[ 119 ]

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, water and nitrogen use etc., and the encouragement of payment for ecosystem services. Community currencies such as LETS, a gift economy and Time Banking have also been promoted as a way of supporting local economies and the environment. [ 121 ] [ 122 ] Green economics is another market-based attempt to address issues of equity and the environment.
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The global recession and a range of government policies that have been connected to that, are likely to bring the biggest annual fall in the world's carbon dioxide emissions in 40 years.
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## Economic opportunity

Treating the environment as an externality may generate short-term profit at the expense of sustainability. [ 125 ] Sustainable business practices, on the other hand, integrate ecological concerns with social and economic ones (i.e., the triple bottom line).
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Growth that depletes ecosystem services is sometimes termed "uneconomic growth" as it leads to a decline in quality of life.
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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.
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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.
[ 131 ]
The expansion of sustainable business opportunities can contribute to job creation through the introduction of green-collar workers.
[ 132 ]

## Social dimension

Further information: Social sustainability

Sustainability issues are generally expressed in scientific and environmental terms, 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. [ 133 ] "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." [ 134 ]

### Peace, security, 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. [ 134 ] 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.
[ 51 ]
Depletion of natural resources including fresh water
[ 135 ]
increases the likelihood of “resource wars”.
[ 136 ]
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 global systems including oceans and the atmosphere.
[ 137 ]

## Human relationship to nature

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.” [ 138 ] Still more basically, Bookchin argued that most of the activities that consume energy and destroy the environment are senseless because they contribute little to quality of life and well being. The function of work is to legitimize, even create, hierarchy. For this reason understanding the transformation of organic into hierarchical societies is crucial to finding a way forward.
[ 139 ]

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. [ 140 ]

Deep ecology establishes principles for the well-being of all life on Earth and the richness and diversity of life forms. This is only compatible with a substantial decrease of the human population and the end 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.
[ 141 ]

## Human settlements

### 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 [ 142 ]

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. [ 143 ] 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. [ 144 ]

Ultimately, the degree of human progress towards sustainability will depend on large scale social movements which influence both community choices and the built environment. Eco-municipalities may be one such movement. [ 145 ]

Eco-municipalities take a systems approach, based 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. [ 142 ]

There is a wealth of advice available to individuals wishing to reduce their personal impact on the environment through small, cheap and easily achievable steps. [ 146 ] [ 147 ] But the transition required to reduce global human consumption to within sustainable limits involves much larger changes, at all levels and contexts of society.
[
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]
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".
[
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]
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.
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## See also

- Conservation biology
- Cradle to Cradle
- Environmental issue
- Extinction
- Introduced species
- List of sustainability topics
- Micro-Sustainability
- Outline of sustainability
- Sociocultural evolution
- Sustainable development
- The Venus Project
- The Zeitgeist Movement
- World Cities Summit

## Notes

1. ^ *a* *b* Bromley, Daniel W. (2008). "sustainability," *The New Palgrave Dictionary of Economics*, 2nd Edition. Abstract.
2. ^ Earth Policy Institute Natural Systems. www.earth-policy.org, Data Center. Retrieved on: 2009-11-07
3. ^ Paul Hawken, *Blessed Unrest: How the Largest Movement in the World Came into Being and Why No One Saw It Coming* (New York: Viking, 2007), 172.
4. ^ Adams, W.M. (2006). "The Future of Sustainability: Re-thinking Environment and

Development in the Twenty-first Century." Report of the IUCN Renowned Thinkers Meeting, 29–31 January 2006. Retrieved on: 2009-02-16.

5. ^ Ott, K. (2003). "The Case for Strong Sustainability." In: Ott, K. & P. Thapa (eds.) (2003). *Greifswald's Environmental Ethics.* Greifswald: Steinbecker Verlag Ulrich Rose. ISBN 3931483320. Retrieved on: 2009-02-16.

6. ^ Dictionary.com
7. ^ Onions, Charles, T. (ed) (1964). *The Shorter Oxford English Dictionary*. Oxford: Clarendon Press. p. 2095.

8. ^ United Nations General Assembly (1987) *Report of the World Commission on Environment and Development: Our Common Future* . Transmitted to the General Assembly as an Annex to document A/42/427 - Development and International Co-operation: Environment. Retrieved on: 2009-02-15.

9. ^ United Nations General Assembly (March 20, 1987). " *Report of the World Commission on Environment and Development: Our Common Future* ; Transmitted to the General Assembly as an Annex to document A/42/427 - Development and International Co-operation: Environment; Our Common Future, Chapter 2: Towards Sustainable Development; Paragraph 1" . United Nations General Assembly . http://www.un-documents.net/ocf-02.htm . Retrieved 1 March 2010 .

10. ^ United Nations General Assembly (2005). 2005 World Summit Outcome , Resolution A/60/1, adopted by the General Assembly on 15 September 2005. Retrieved on: 2009-02-17.

11. ^ Forestry Commission of Great Britain. Sustainability . Retrieved on: 2009-03-09
12. ^ International Institute for Sustainable Development (2009). *What is Sustainable Development* ? . Retrieved on: 2009-02-18.]

13. ^ EurActiv (2004). "Sustainable Development: Introduction." Retrieved on: 2009-02-24

14. ^ Kates, R., Parris, T. & Leiserowitz, A. (2005). "What is Sustainable Development?" *Environment* **47(3)** : 8–21. Retrieved on: 2009-04-14.

15. ^ Holling, C. S. (2000). "Theories for Sustainable Futures" *Conservation Ecology* **4(2)**:

7. Retrieved on: 2009-02-24.

16. ^ Redclift, M. (2005). "Sustainable Development (1987–2005): an Oxymoron Comes of Age." *Sustainable Development* **13(4)**: 212–227.
17. ^ *a* *b* Daly & Cobb (1989).
18. ^ Porritt, J. (2006). *Capitalism as if the world mattered*. London: Earthscan. p. 46. ISBN 9781844071937.
19. ^ IUCN/UNEP/WWF (1991). "Caring for the Earth: A Strategy for Sustainable Living." Gland, Switzerland. Retrieved on: 2009-03-29.

20. ^ Markus J., Milne M.K., Kearins, K., & Walton, S. (2006). Creating Adventures in Wonderland: The Journey Metaphor and Environmental Sustainability. *Organization* **13(6)**: 801-839. Retrieved on 2009-09-23.

21. ^ The Earth Charter Initiative (2000). "The Earth Charter." Retrieved on: 2009-04-05.
22. ^ Costanza, R. & Patten, B.C. (1995). "Defining and predicting sustainability." *Ecological Economics* **15 (3)**: 193–196.

23. ^ Dunning, B. (2006). "Sustainable Sustainability." *Skeptoid.* Retrieved on: 2009-02-16.
24. ^ Marshall, J.D. & Toffel, M.W. (2005). "Framing the Elusive Concept of Sustainability: A Sustainability Hierarchy." *Environmental & Scientific Technology* **39(3)**: 673–682.
25. ^ Blewitt, J. (2008). *Understanding Sustainable Development*. London: Earthscan. pp. 21-24. ISBN 9781844074549.

26. ^ Ratner, B.D. (2004). "Sustainability as a Dialogue of Values: Challenges to the Sociology of Development." *Sociological Inquiry* **74(1)**: 50–69.
27. ^ Beddoea, R., Costanzaa, R., Farleya, J., Garza, E., Kent, J., Kubiszewski, I., Martinez, L., McCowen, T., Murphy, K., Myers, N., Ogden, Z., Stapleton, K., and Woodward, J. (February 24, 2009). "Overcoming systemic roadblocks to sustainability: The evolutionary redesign of worldviews, institutions, and technologies." *Proceedings of the National Academy of Sciences.* **106** 8 2483–2489. Retrieved on: 2009-08-20.

28. ^ Wright, R. (2004). *A Short History of Progress.* Toronto: Anansi. ISBN 0887847064.

29. ^ Scholars, R. (2003). Stories from the Stone Age . Beyond Productions in association with S4C and S4C International. Australian Broadcasting Corporation. Retrieved on: 2009-04-16.
30. ^ Clarke, W. C. (1977). "The Structure of Permanence: The Relevance of Self-Subsistence Communities for World Ecosystem Management," in *Subsistence*

*and Survival: Rural Ecology in the Pacific.*
Bayliss-Smith, T. and R. Feachem (eds). London: Academic Press, pp. 363–384.

31. ^ Hilgenkamp, K. (2005). Environmental Health: Ecological Perspectives . London: Jones & Bartlett. ISBN 9780763723774.

32. ^ Meadows, D.H., D.L. Meadows, J. Randers, and W. Behrens III. (1972). *The Limits to Growth.*
New York: Universe Books. ISBN 0876631650.

33. ^ a b World Wide Fund for Nature (2008). *Living Planet Report 2008* . Retrieved on: 2009-03-29.

34. ^ Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-being: Biodiversity Synthesis.* World Resources Institute, Washington, DC. pp. 1-85. Retrieved on: 2009-07-08-01.

35. ^ Turner, G.M. (2008). " A Comparison of The Limits to Growth with 30 Years of Reality." *Global Environmental Change* **18**: 397–411. Online version published by CSIRO Sustainable Ecosystems. Retrieved on: 2009-01-03

36. ^ U.S. Department of Commerce. Carbon Cycle Science . NOAA Earth System Research Laboratory. Retrieved on: 2009-03-14

37. ^ BBC News (August 2008). In depth: "Climate Change." BBC News, UK. Retrieved on: 2009-03-14

38. ^ William C. Clark, Nancy M. Dickson, "Sustainability science: The emerging research program", *PNAS* , Vol. 100, No. 14, June 6, 2003.

39. ^ Conceptual Framework Working Group of the Millennium Ecosystem Assessment. (2003). "Ecosystems and Human Well-being." London: Island Press. Chapter 5. "Dealing with Scale". pp. 107–124. ISBN 155634030.

40. ^ Botkin (1990).

41. ^ Clark (2006).

42. ^ a b Brower & Leon (1999).

43. ^ a b Ehrlich, P.R. & Holden, J.P. (1974). "Human Population and the global environment." *American Scientist* **62**(3): 282–292.

44. ^ "Sustainability Accounting in UK Local Government" . The Association of Chartered Certified Accountants . http://www.accaglobal.com/publicinterest/activities/research/reports/sustainable_and_transparent/rr-078 . Retrieved 2008-06-18
.

45. ^ Dalal-Clayton, Barry and Sadler, Barry 2009. *Sustainability Appraisal. A Sourcebook and Reference Guide to International Experience.*
London: Earthscan. ISBN 978-1-84407-357-3.

46. ^ Hak, T. et al. 2007. *Sustainability Indicators*, SCOPE 67. Island Press, London.
47. ^ Bell, Simon and Morse, Stephen 2008. *Sustainability Indicators. Measuring the Immeasurable?* 2nd edn. London: Earthscan. ISBN 978-1-84407-299-6.
48. ^ United Nations Department of Economic and Social Affairs, Population Division (2009). "World Population Prospects: The 2008 Revision." Highlights. Retrieved on: 2009-04-06.
49. ^ Lutz et al. (2004).
50. ^ " Booming nations 'threaten Earth' ". BBC News. January 12, 2006.
51. ^ *a* *b* Cohen, J.E. (2006). "Human Population: The Next Half Century." In Kennedy D. (Ed.) "Science Magazine's State of the Planet 2006-7". London: Island Press, pp. 13–21. ISSN 15591158.
52. ^ Adams & Jeanrenaud (2008) p. 45.
53. ^ UNEP Grid Arendal. [1] A selection of global-scale reports. Retrieved on: 2009-3-12
54. ^ Global Footprint Network. (2008). "Living Planet Report." Retrieved on: 2008-10-01.
55. ^ Krebs (2001) p. 513.
56. ^ Smil (2000)
57. ^ Millennium Ecosystem Assessment, pp. 6–19.
58. ^ Daly H.E. (1990). "Toward some operational principles of sustainable development." *Ecological Economics* **2** : 1–6.
59. ^ "The Economics and Social Benefits of NOAA Ecosystems Data and Products Table of Contents Data Users" . NOAA. http://www.economics.noaa.gov/?goal=ecosystems&file=users/ . Retrieved 2009-10-13.
60. ^ Buchenrieder, G., und A.R. Göltenboth: Sustainable freshwater resource management in the Tropics: The myth of effective indicators, 25th International Conference of Agricultural Economists (IAAE) on “Reshaping Agriculture’s Contributions to Society” in Durban, South Africa, 2003.
61. ^ University of Copenhagen (March 2009) "Key Messages from the Congress" News item on Copenhagen Climate Congress in March 2009. Retrieved on: 2009-03-18.
62. ^ Adams, D. (March 2009) "Stern attacks politicians over climate 'devastation'". *The Guardian* . Retrieved on: 2009-03-18.
63. ^ Hegerl, G.C. et al. (2007). "Climate Change 2007: The Physical Science Basis." Chapter 9, "Understanding and Attributing Climate Change." Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. p. 676. Cambridge: Cambridge University Press. Full report at: [2] IPCC Report. Retrieved on: 2009-03-18.

64. ^ Clarke & King (2006) pp. 20–21.
65. ^ [a] [b] Hoekstra, A.Y. (2006). "The Global Dimension of Water Governance: Nine Reasons for Global Arrangements in Order to Cope with Local Problems." *Value of Water Research Report Series* No. 20 UNESCO-IHE Institute for Water Education. Retrieved on: 2009-03-18.

66. ^ Kerr, R.A. (2004). "A slowing cog in the North Atlantic ocean's climate machine." *Science* **304**: 371–372. [3] Retrieved on: 2009-04-19.

67. ^ Krebs (2001) pp. 560–582.
68. ^ Organic Gardening Techniques , *Missouri University Extension*. October 2004. Retrieved June 17, 2009.

69. ^ Sustainable Gardening & Food Production , *Daniel Boone Regional Library*. Retrieved June 17, 2009]

70. ^ World Resources Institute (1998). *World Resources 1998–1999.* Oxford: Oxford University Press. ISBN 0195214080.

71. ^ Groombridge & Jenkins (2002).
72. ^ Food and Agriculture Organization (June 2006). "Food and Agriculture Statistics Global Outlook." Rome: FAO Statistics Division. Retrieved on: 2009-03-18.

73. ^ Imhoff, M.L. et al. (2004). "Global Patterns in Human Consumption of Net Primary Production." *Nature* **429**: 870–873.
74. ^ World Business Council for Sustainable Development This web site has multiple articles on WBCSD contributions to sustainable development. Retrieved on: 2009-04-07.

75. ^ Michaelis, L. & Lorek, S. (2004). “Consumption and the Environment in Europe: Trends and Futures.” Danish Environmental Protection Agency. Environmental Project No. 904. [4]

76. ^ Jackson, T. & Michaelis, L. (2003). "Policies for Sustainable Consumption". The UK Sustainable Development Commission. [5]
77. ^ IPCC (2007). " *Climate Change 2007: the Physical Science Basis. Summary for Policymakers* ." Retrieved on: 2009-03-18.
78. ^ UNFCC (2009). " *United Nations Framework Convention on Climate Change* ." Retrieved on: 2009-03-18.

79. ^ Goodall (2007).
80. ^ U.S. Department of NOAA Research. "The Carbon Cycle." Retrieved on:

2009-03-18.

81. ^ Fujixerox "Carbon Calculator Demonstration". One of many carbon calculators readily accessible on the web. Retrieved on: 2009-04-07.

82. ^ *a* *b* Shiklamov, I. (1998). "World Water Resources. A New Appraisal and Assessment for the 21st century." A Summary of the Monograph World Water Resources prepared in the Framework of the International Hydrological Programme. [6] Retrieved on: 2009-03-18.

83. ^ Clarke & King (2006) pp. 22–23.

84. ^ Millennium Ecosystem Assessment, pp. 51–53.

85. ^ Hoekstra, A.Y. & Chapagain, A.K. (2007). "The Water Footprints of Nations: Water Use by People as a Function of their Consumption Pattern." *Water Resource Management* **21(1)**: 35–48.

86. ^ Feenstra, G. (2002). "Creating Space for Sustainable Food Systems: Lessons from the Field". *Agriculture and Human Values* 19 (**2**): 99–106. doi:10.1023/A:1016095421310.

87. ^ Harmon A.H., Gerald B.L. (June, 2007). "Position of the American Dietetic Association: Food and Nutrition Professionals Can Implement Practices to Conserve Natural Resources and Support Ecological Sustainabiility" (PDF). *Journal of the American Dietetic Association* 107 ( **6** ): 1033–43.. doi:10.1016/j.jada.2007.05.138. PMID 17571455 . http://www.eatright.org/ada/files/Conservenp.pdf . Retrieved on: 2009-03-18.

88. ^ "Toward a Healthy, Sustainable Food System (Policy Number: 200712)" . American Public Health Association. 2007-06-11 . http://www.apha.org/advocacy/policy/policysearch/default.htm?id=1361 . Retrieved : 2008-08-18 .

89. ^ Mason & Singer (2006).

90. ^ McMichael A.J., Powles J.W., Butler C.D., Uauy R. (September 2007). "Food, Livestock Production, Energy, Climate change, and Health." (PDF). *Lancet* **370** (9594): 1253. doi:10.1016/S0140-6736(07)61256-2. PMID 17868818

.
http://www.eurekalert.org/images/release_graphics/pdf/EH5.pdf
.
Retrieved on: 2009-03-18.

91. ^ Baroni L., Cenci L., Tettamanti M., Berati M. (February 2007). "Evaluating the Environmental Impact of Various Dietary Patterns Combined with Different Food Production Systems." (PDF). *Eur. J. Clin. Nutr.* 61 ( **2** ): 279–86. doi:10.1038/sj.ejcn.1602522. PMID 17035955
.
http://www-personal.umich.edu/~choucc/environmental_impact_of_various_dietary_patterns.pdf
.
Retrieved on: 2009-03-18.

92. ^ Steinfeld H., Gerber P., Wassenaar T., Castel V., Rosales M., de Haan, C. (2006). " Livestock's Long Shadow - Environmental Issues and Options" 390 pp. Retrieved on: 2009-03-18.

93. ^ Heitschmidt R.K., Vermeire L.T., Grings E.E. (2004). "Is Rangeland Agriculture Sustainable?". *Journal of Animal Science.* **82** (E-Suppl): E138–146. PMID 15471792. Retrieved on: 2009-03-18.

94. ^ World Health Organisation (2004). "Global Strategy on Diet, Physical Activity and Health." Copy of the strategy endorsed by the World Health Assembly. Retrieved on: 2009-6-19.

95. ^ "Earth Stats." Gardensofbabylon.com. Retrieved on: 2009-07-07.
96. ^ Holmgren, D. (March 2005). "Retrofitting the suburbs for sustainability." CSIRO Sustainability Network. Retrieved on: 2009-07-07.

97. ^ *a* *b* Bournay, E. et al. (2006). *Vital waste graphics 2.* The Basel Convention, UNEP, GRID-Arendal. ISBN 8277010427.

98. ^ Anderberg, S. (1998). "Industrial metabolism and linkages between economics, ethics, and the environment". *Ecological Economics* **24**: 311–320.
99. ^ Product Stewardship Council (US) . Retrieved on: 2009-04-05.
100. ^ Emden & Peakall (1996).
101. ^ Hassall (1990).
102. ^ Database on Pesticides Consumption . Statistics for pesticide use around the world. Retrieved on: 2009-3-10.
103. ^ Fuad-Luke (2006).

104. ^ Soederbaum (2008).
105. ^ Hasna, A.M., Sustainability and Economic Theory : an Organism in Premise. The International Journal of Knowledge, Culture and Change Management,9(11): p. 1-12.

106. ^ Ruffing, K. (2007). "Indicators to Measure Decoupling of Environmental Pressure from Economic Growth." In: Hak et al. (2007) pp. 211–222.
107. ^ Hawken et al. (1999).
108. ^ National Research Council. (1999). *Our Common Journey.* Washington: National Academic Press. ISBN 1856497399.

109. ^ Adams & Jeanrenaud (2008) p. 15.
110. ^ Abbey, E. (1968). *Desert Solitaire*. New York: Ballantine Books, Random House. ISBN 0345326490. Actual quote from novel is: *growth for the sake of growth is the ideology of the cancer cell*

111. ^ Diamond, J. (2005). *Collapse: How Societies Choose to Fail or Succeed*. New York: Viking Books. ISBN 1586638637.

112. ^ Diamond (1997).
113. ^ Daly & Farley (2004) p.xxvi.
114. ^ Costanza et al. (2007). Ch. 1, pp. 1–4, Ch.3, p. 3.
115. ^ WBCSD's 10 messages by which to operate *World Business Council for Sustainable Development*. Retrieved 2009-04-06.

116. ^ Daly, H. (1996). *Beyond Growth: The Economics of Sustainable Development*. Boston: Beacon Press. ISBN 0807047090.

117. ^ Cleveland, C.J. "Biophysical economics", *Encyclopedia of Earth*, Last updated: 14 September 2006. Retrieved on: 2009-03-17.

118. ^ Costanza et al. (2007).
119. ^ *a* *b* Hardin, G. (December 1968). "The Tragedy of the Commons." *Science* **162(3859)**, 1243–1248. Retrieved on: 2009-03-17.

120. ^ Nemetz, P.N. (2003). "Basic Concepts of Sustainable Development for Business Students." *Journal of International Business Education* **1(1)**.
121. ^ Robert Costanza et al., "Complementary Currencies as a Method to Improve Local Sustainable Economic Welfare", University of Vermont, Burlington, VT, December 12th, 2003.

122. ^ David Boyle, "Sustainability and social assets: the potential of time banks and co-production", *Grassroots Initiatives for Sustainable Development*, June 10, 2005.
123. ^ Scott Cato, M. (2009). *Green Economics*. London: Earthscan, pp. 142–150. ISBN 9781844075713.

124. ^ Black, Richard (21 September 2009). "Recession and policies cut carbon" . BBC. http://news.bbc.co.uk/1/hi/sci/tech/8267475.stm . Retrieved 2009-10-13 .

125. ^ Kinsley, M. (1977). "Sustainable development: Prosperity without growth." Rocky Mountain Institute, Snowmass, Colorado, USA. Retrieved on: 2009-06-17

126. ^ Kinsley, M. and Lovins, L.H. (September 1997). "Paying for Growth, Prospering from Development." Retrieved on: 2009-06-15.

127. ^ Daly, H. (2007). Ecological economics: the concept of scale and its relation to allocation, distribution, and uneconomic growth. pp. 82–103. In H. Daly. *Ecological Economics and Sustainable Development: Selected Essays of Herman Daly* . Cheltenham, UK: Edward Elgar.

128. ^ Daly, H. (1999). Uneconomic growth and the built environment: in theory and in fact. In C.J. Kibert (ed.). *Reshaping the Built Environment: Ecology, Ethics, and Economics* . Washington DC: Island Press.

129. ^ Jackson, T. (February 2008). Tim Jackson, Roland Clift, "Where's the Profit in Industrial Ecology?" *Journal of Industrial Ecology* **2:(1)** : 3–5.

130. ^ Hargroves, K. & Smith, M. (eds.) (2005). *The Natural Advantage of Nations: Business Opportunities, Innovation and Governance in the 21st Century.* London: Earthscan/James&James. ISBN 1844071219 . (See the book's online companion )

131. ^ See, for example: Zhexembayeva, N. (May 2007). "Becoming Sustainable: Tools and Resources for Successful Organizational Transformation." Case Western University, Center for Business as an Agent of World Benefit 3(2) and websites of The Sustainable Business Institute , and the WBCSD." Retrieved on: 2009-04-01.

132. ^ Leo Hickman, "The future of work is green" *The Guardian*, February, 2009.

133. ^ Agenda 21 "Declaration of the 1992 Rio Conference on Environment and Development." Retrieved on: 2009-03-16.

134. ^ *a* *b* Blewitt (2008) p. 96.

135. ^ "Water and Political Conflicts" from United Nations Environment Programme 2008 "Vital Water Graphics"
Retrieved on: 2009-03-16.

136. ^ Billon, P. (ed.) (2005) The Geopolitics of Resource Wars Retrieved on: 2009-04-05.
137. ^ Kobtzeff, O. (2000). “Environmental Security and Civil Society”. In Gardner, H. (ed.) *Central and South-central Europe in Transition*
. Westport, Connecticut: Praeger, pp. 219–296.

138. ^ Bookchin (2004) pp. 24–25.
139. ^ Bookchin (2005)
140. ^ Bookchin (2007) p. 19.
141. ^ Devall & Sessions (1985) p. 70.
142. ^ *a* *b* James, S. (2003). "Eco-municipalities: Sweden and the United States: A Systems Approach to Creating Communities" . Retrieved on: 2009-03-16.
143. ^ Sale, Kirkpatrick (24 February 2006). "Economics of Scale vs. the Scale of Economics - Towards Basic Principles of a Bioregional Economy"
. Vermont Commons
.
http://www.vtcommons.org/journal/2006/02/kirkpatrick-sale-economics-scale-vs-scale-economics-towards-basic-principles-bioregi
. Retrieved 2009-10-13
.

144. ^ Ewing, R "Growing Cooler - the Evidence on Urban Development and Climate Change" . Retrieved on: 2009-03-16.
145. ^ LaColla, T. "It’s Easy to be Green! Eco-Municipalities: Here to Stay" .
theplanningcommission.org. Retrieved on: 2009-03-16.

146. ^ Sustainable Environment for Quality of Life. "100 Ways to Save the Environment." Retrieved on: 2009-06-13.
147. ^ Suzuki, D. (2009). "Small Steps." David Suzuki Foundation. Retrieved on: 2009-06-13.
148. ^ Stockholm Environment Institute "Great Transitions". Retrieved on: 2009-04-12.
149. ^ United Nations Environment Programme (2009). "United Nations Decade of Education for Sustainable Development."
Retrieved on: 2009-04-09.

150. ^ WWF. (April, 2008). "Weathercocks and Signposts: The Environment Movement at a Crossroads" . Summary also available here [7] . Retrieved on: 2009-03-13.

## References


- Adams, W. M. and Jeanrenaud, S. J. (2008). *Transition to Sustainability: Towards a Humane and Diverse World.* Gland, Switzerland: IUCN. 108 pp. ISBN 9782831710723.

- Blewitt, J. (2008). *Understanding Sustainable Development*. London: Earthscan. ISBN 9781844074549.
- Botkin, D.B. (1990). *Discordant Harmonies, a New Ecology for the 21st century.* New York: Oxford University Press. ISBN 9780195074697.

- Bookchin, M. (2004). *Post Scarcity Anarchism.* Oakland: AK Press, pp. 24–25. ISBN 9781904859062.
- Bookchin, M. (2005). *The Ecology of Freedom: the emergence and dissolution of hierarchy."* Oakland: AK Press. ISBN 1904859267.
- Bookchin, M. (2007). *Social Ecology and Communalism.* Oakland: AK Press, p. 19. ISBN 9781904859499.
- Brower, M. & Leon, W. (1999). *The Consumer's Guide to Effective Environmental Choices: Practical Advice from the Union of Concerned Scientists.* New York: Three Rivers Press. ISBN 060980281X.

- Clark, D. (2006). *A Rough Guide to Ethical Living*. London: Penguin. ISBN 9781843537922
- Clarke, R. & King, J. (2006). *The Atlas of Water.* London: Earthscan. ISBN 9781844071333.
- Costanza, R. et al. (2007). *An introduction to ecological economics* . This is an online editable text available on the Encyclopaedia of the Earth at. First published in 1997 by St. Lucie Press and the International Society for Ecological Economics. ISBN 1884015727.

- Daly, H. & J. Cobb (1989). *For the Common Good: Redirecting the Economy Toward Community, the Environment and a Sustainable Future.* Boston: Beacon Press. ISBN 0807047031.

- Daly, H.E. & Farley, J. (2004). *Ecological economics: principles and applications.* Washington: Island Press. ISBN 1559633123.

- Devall, W. and G. Sessions (1985). *Deep Ecology: Living As If Nature Mattered.* Layton, Utah: Gibbs Smith, p. 70. ISBN 9780879052478.

- Diamond, J. (1997). *Guns, Germs and Steel: the Fates of Human Societies*. New York: W.W. Norton & Co. ISBN 0393061310.

- Emden, H.F. van & Peakall, D.B. (1996). *Beyond Silent Spring.* Berkeley: Springer. ISBN 9780412728105.
- Fuad-Luke, A. (2006). *The Eco-design Handbook*. London: Thames & Hudson. ISBN

9780500285213.
- Goodall, C. (2007). *How to Live a Low-carbon Life*. London: Earthscan. ISBN 9781844074266.
- Groombridge, B. & Jenkins, M.D. (2002). *World Atlas of Biodiversity*. Berkeley: University of California Press. ISBN 9780520236684.

- Hak, T. et al. (2007). *Sustainability Indicators*, SCOPE 67. London: Island Press. ISBN 1597261319.
- Hassall, K.A. (1990). *The Biochemistry and Uses of Pesticides.* London: Macmillan. ISBN 0333497899.
- Hawken, P, Lovins, A.B. & L.H. (1999). *Natural Capitalism: Creating the next Industrial Revolution.* Snowmass, USA: Rocky Mountain Institute. ISBN 0316353000.
- Krebs, C.J. (2001). *Ecology: the Experimental Analysis of Distribution and Abundance*. Sydney: Benjamin Cummings. ISBN 0321042891.

- Leakey, R. & Lewin, R. (1995). *The Sixth Extinction: Patterns of Life and the Future of Humankind* . New York: Bantam Dell Publishing Group. ISBN 0385468091
- Lutz W., Sanderson W.C., & Scherbov S. (2004). *The End of World Population Growth in the 21st Century* London: Earthscan. ISBN 1844070891.
- Macy, J. & Young Brown, M. (1998). *Coming Back to Life: Practices to Reconnect Our Lives, Our World* . Gabriola Island: New Society Publishers, pp. 25–37. ISBN 086571391X.

- Mason, J. & Singer, P. (2006). *The Way We Eat: Why Our Food Choices Matter*. London: Random House. ISBN 157954889X

- Smil, V. (2000). *Cycles of Life*. New York: Scientific American Library. ISBN 9780716750796.
- Soederbaum, P. (2008). *Understanding Sustainability Economics*. London: Earthscan. ISBN 9781844076277.
- Wright, R. (2004). *A Short History of Progress.* Toronto: Anansi. ISBN 0887847064.
- Wilson, E.O. (2002). *The Future of Life*. New York: Knopf. ISBN 0679450785.

## Further reading

- Atkinson, G., Dietz, S. & Neumayer, E. (2007). *Handbook of Sustainable Development*. Cheltenham: Edward Elgar. ISBN 9781843765776.

- Bartlett, A. (1998). Reflections on Sustainability, Population Growth, and the Environment—Revisited revised version (January 1998) paper first published in *Population & Environment* **16(1)**: 5–35. Retrieved on: 2009-03-12.

- Benyus, J. (1997). *Biomimicry: Innovations Inspired by Nature*. New York: William Morrow. ISBN 0060533226.

- Blackburn, W.R. (2007). *The Sustainability Handbook*. London: Earthscan. ISBN 9781844074952.
- Costanza, R., Graumlich, L.J. & Steffen, W. (eds), (2007). *Sustainability or Collapse? An Integrated History and Future of People on Earth*
. Cambridge, MA.: MIT Press. ISBN 9780262033664.

- Norton, B. (2005). *Sustainability, A Philosophy of Adaptive Ecosystem Management*. Chicago: The University of Chicago Press. ISBN 9780226595214.

## External links

- Sustainability at the Open Directory Project
- *Compilation of Fact Sheets Published by the University of Michigan's Center for Sustainable Systems*
- Elements of sustainability at Microdocs
- Roadmap for a Sustainable Earth on-line book by Hiroshi Komiyama and Steven Kraines
- Making Your Ecommerce Store Eco-Friendly