Sustainability

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INTRODUCTION

Sustainability and sustainable development (SD) are concepts discussed nowadays by social and natural scientists, philosophers, politicians and ordinary citizens. This is so, because the economic activity with the aid of science and technology has altered the physical and biological environments to such a degree that many are wondering about the long term effects of these alterations on our civilization. Some even worry about its survival. Such worries concern the long term survival or sustainability of biological and societal systems.

In this article several approaches of achieving and assessing SD will be discussed. Both the human and the ecological systems will be part of SD definitions and assessment. Components of the human system are such entities as the economy, public health, education etc. whereas for the ecological system one could use the components of biodiversity, air, land, and water.

No universally accepted definition of sustainability exists as it depends a lot on values and political and economic interests among others. Thus, several approaches can be found in the literature sharing a few common points. The most important approaches are outlined in the sequel.

BACKGROUND

Modern society is faced with a host of large scale problems that often appear to be intractable: extreme weather phenomena attributed to global warming, economic crises, toxic spills, deforestation, desertification, hunger, to name but a few. Projections of future human population, concentration of greenhouse gases in the atmosphere, number of species to become extinct, and so on, raise a fundamental question: is our society sustainable? Before answering one has to define sustainability one way or another.

In this article, various models and definitions of sustainability will be presented and lists of countries will be compiled according to sustainability performance.

The biological and physical environments provide the economy with:

1. Resources, e.g., food, fibers, water, oxygen, fuels, materials, minerals, and drugs
2. Services such as coastal protection, photosynthesis, soil formation and the cycles of H_2O, C, CO_2, N, O_2
3. Waste absorption.

The global ecosystem does not grow and, therefore, the present tendency of all economies to grow indefinitely cannot continue since the services on which they rely do not grow indefinitely either. Some economists contend that substituting one form of capital for another solves the problem of finiteness of the ecosystem. However, substitution has its limits too. For example, there are no substitutes for a stable climate or for extinct species and their services.

Economic activity is connected with witnessed dramatic environmental changes that have been exacerbated in the last decades. As a result, more and more people are interested in the concepts of sustainability.

Sustainable development does not necessarily mean growth, but improvement of the environment or society.

The Brundtland Report (UNEP, 1987) defines sustainable development (SD) as

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

The International Union for the Conservation of Nature (IUCN) (Guijt & Moiseev, 2001) defines itas

Development that improves the quality of human life within the carrying capacity of supporting ecosystems.

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Sustainability ought to cover environmental and societal aspects if it is to view human activity globally. Time and space have to be carefully considered.

The time scale depends on the specific attributes of SD. Agricultural pests have time scales of a few years while climate change of hundreds of years. One ought to take into account the limited human ability to predict complex societal phenomena beyond a few years or, at most, decades.

Space for the assessment of SD could be a region, a country, or the whole globe. If the scale is too small, SD becomes blurred. A small region interacts with other larger regions and cannot be examined as an independent entity. It is common to consider countries or regions with population above 100,000 or areas above 5,000 km^2.

Often sustainability is viewed as comprising two different levels, *weak* and *strong*.

Weak sustainability concerns mainly the economy and assumes that natural capital can be substituted with manufactured capital primarily thanks to technology. Steel succeeded wood in ship building when wood became scarce. However, there are no substitutes for many natural resources such as extinct species, oxygen, water, a stable climate and so on. Strong sustainability, which concerns primarily the environment, correctly argues that substitution is often impossible and, therefore, natural capital must be preserved and protected if our goal is SD.

In this article several approaches of achieving and assessing SD will be discussed. Both the human and the ecological systems will be part of SD definitions and assessment. Components of the human system are such entities as the economy, public health, education etc. whereas for the ecological system one could use the components of biodiversity, air, land, and water.

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Pressure-State-Response Indicators of OECD

The pressure-state-response (PSR) hierarchy of sustainability indicators has been introduced by the Organization for Economic Cooperation and Development (OECD). This approach assumes that humans exert pressures on the environment, which define its state and lead to certain responses by the society (OECD, 2003).

Environmental *pressures* could be indirect in the sense that human activities affect the environment or direct such as using resources and releasing pollutants. Pressure indicators are often expressed as emissions of pollutants. For example, in the case of climate change, CO_2, CH_4, N_2O, and CFCs emissions constitute pressures.

State of the environment deals with the quality of the environment and natural resources. State indicators express concentrations of pollutants, the status of biodiversity, etc. Concentration of greenhouse gases in parts per million in the atmosphere and global mean temperature express the state of climate change.

Finally *response* refers to reactions of societies vis-à-vis environmental problems. Such reactions concern preservation of biodiversity, prevention or mitigation of pollution, etc.

Ecological Footprint

The ecological footprint appeared first in (Rees, 1992) and (Wackernagel & Rees, 1996). It expresses resources consumed and wastes generated by a given population. These quantities are converted into land needed for the production of the resources as well as the assimilation of the concomitant waste. In a narrow sense the ecological footprint is the land that a population uses. This is the symmetrical problem to the one of carrying capacity where the population is computed that a given area can support for its living. The ecological footprint emphasizes environmental aspects and ignores the economy, education, public health etc.

The ecological footprint accounts for land beyond proximity with a given population since international trade allows for goods produced elsewhere to be consumed locally.

Aspects taken into account in its computation (Wackernagel & Yount, 1998) include:

1. Cropland needed to produce food for humans and feed for animals consumed by humans
2. Pastureland for livestock
3. Natural forests or tree plantations that provide timber for human use

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