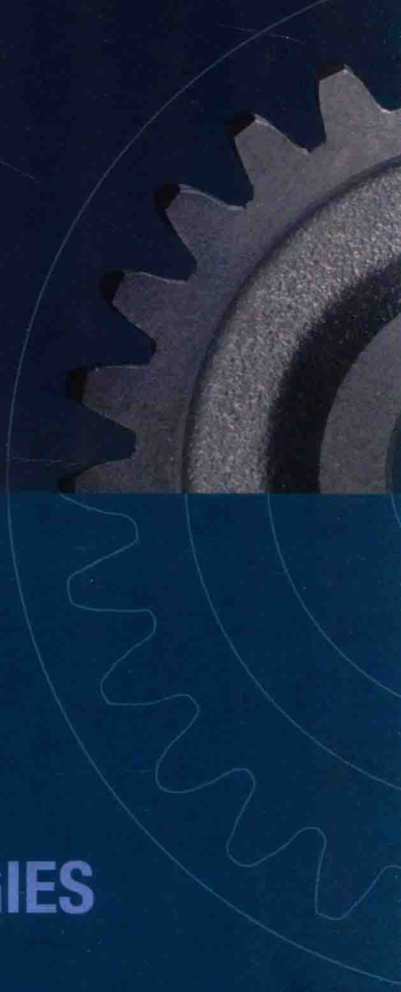

# PRACTICAL SUSTAINABILITY

## FROM GROUNDED THEORY TO EMERGING STRATEGIES

NASRIN R. KHALILI

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# Practical Sustainability

*To my sons, Parham and Parsa,*
*for their love, support, and encouragement.*

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CHAPTER 1

# *Theory and Concept of Sustainability and Sustainable Development*

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This chapter provides an overview of the theories and concepts of sustainability and sustainable development and their anticipated links to global environmental, economic, and social crises. The theory of climate change and its likely impact on natural resources and their capacity for supporting sustainable economic development are discussed, and a comprehensive analysis of the concepts of sustainability (definition and types) and the sustainable development paradigm is provided. Due to its relevance to the topic of environmental sustainability, an overview of the Natural Capital, Natural Steps, and Factor X rules and definitions are also provided. Scenario-based analysis that has been used successfully in the development of strategic planning exercises and sustainability-related policies, rules, and regulations is discussed. The core thrust of economic, social, and environmental sustainability, emerging strategies, and developing praxis presented in this chapter and throughout the book support the concept of *practical sustainability* defined here as an integrated approach to long-term environmental sustainability.

## Introduction

The *Random House Webster's College Dictionary* defines "environment" as the aggregate of surrounding things, conditions, or influences. The surroundings include the air, water, minerals, organisms, and all other external factors surrounding and affecting a given organism, as well as social and cultural forces. The term "ecology" is characterized as the branch of biology dealing with the relationships and interactions between organisms and their natural environment. Both environment and ecology have the potential to change according to external and internal, and natural and man-made forces, such as severe air and water pollution, drought, floods, deforestation, and land degradation due to natural disasters, wars, or political and social transformations. For example, heavy metal pollution, especially lead pollution, is considered to be one of the major factors that contributed to the fall of Rome.[1]

The industrial revolution and economic growth have also been linked to the observed environmental and ecological changes and transformations. The rate and the characteristics of the changes, however, vary according to the biophysical, geographical, social, cultural, and economic conditions and the intensity with which materials and energy are used and industrial pollutants are discharged to the environment.[2]

Economic growth, as expected, results in increases in both production and consumption of goods and services, and also generation of different types of pollution, waste, and by-products over a wide range of scales. Two important dimensions of the interaction between natural environmental resources and pollution are the "pollution patterns" and the "nature of variation" in the characteristics, health, and environment's absorptive capacity for emissions. The dynamics of such interactions change according to the natural resource endowment and the environmental space. As a result, if the mechanisms of economic growth are not controlled or altered, they could severely impact the environment via overexploitation of natural resources and degradation and loss of environmental utility (physical, chemical, and biological conditions), space, and adsorptive capacity.[3,4]

The most discussed, publicized, and politicized impact of economic growth and industrialization on the natural environment is, however, the theory of the "climate change" phenomenon. Climate can be defined by patterns of temperature, precipitation, humidity, wind, and seasons, or the average weather over a longer period of time. Climate change, therefore, is explained by the change in the statistical distribution of weather over given periods of time that could range from decades to millions of years. As a normal and expected phenomenon, climate has been changing throughout geological history, and as such, current climate changes can also be attributed to the natural variability. However, recent strong observational evidence and modeling studies suggest that human activities and industrial growth, especially during the last five decades, have significantly impacted the characteristics and dynamics of such a change, particularly with regard to the climate temperature profile and sea levels. Climate change is no longer perceived as the normal fluctuations of the weather; rather, it is identified as the factor that is altering the nature and rate of those changes.[5]

The *International Panel on Climate Change (IPCC)* refers to climate change as a change in the state of the climate that can be identified by changes in the mean or the variability of its properties over decades or longer. The *United Nations Framework Convention on Climate Change (UNFCCC)* has also identified climate change as a change of climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and is, in addition to natural climate variability, observed over comparable time periods.[6,7]

### *What Causes Climate Change and Global Warming?*

The main effect of the industrial process is attributed to the air emissions that result in changes in the concentration of certain trace gases such as carbon dioxide, chlorofluorocarbons, methane, nitrous oxide, ozone, and water vapor, known collectively as greenhouse gases (GHGs), in the atmosphere. Global GHG emissions due to industrial activities and human behavior have grown consistently since preindustrial times, resulting in a 70% increase between 1970 and 2004. The annual emission of carbon dioxide ($CO_2$), the most important anthropogenic GHG, alone has grown during this period by about 80%, from 21 to 38 gigatons (Gt), accounting for 77% of the total anthropogenic GHG emissions in 2004.

These results and other theoretical estimations suggest that carbon dioxide emissions alone account for about half of the human-induced GHG contribution to global warming since the late 1800s, with increases in the other GHGs accounting for the rest.[8]

Having strong potential for trapping heat, GHGs are accumulating in the troposphere, the earth's lower atmosphere. Acting as a blanket, these gases reduce the outgoing infrared radiation emitted by the earth and its atmosphere, resulting in an increase in the surface and atmospheric temperature and changes in the global temperature profile.

GHGs, however, differ in their warming influence, or radiative forcing, on the global climate system due to their different radiative properties and lifetimes in the atmosphere. The warming influence of GHGs may be expressed through a common metric based on the radiative forcing of $CO_2$, defined as "$CO_2$ equivalent" emission. Equivalent $CO_2$ emission is a standard and useful metric for comparing emissions of different GHGs. The equivalent $CO_2$ emission is obtained by multiplying the emission of a GHG by its Global Warming Potential (GWP) for a given time horizon. For a mix of GHGs, warming influence is then obtained by summing the equivalent $CO_2$ emissions of each gas. The $CO_2$-equivalent "concentration" is defined as the "concentration" of $CO_2$ that would cause the same amount of radiative forcing as a given mixture of $CO_2$ and other forcing components.[9]

The severity of the impacts of climate change, however, is subject to the circumstances of the exposure, geographical conditions, lifestyle, culture, social and technical resources, and the economic and concurrent health status of the exposed populations.[10]

## *The Potential Impacts of Climate Change*

With *a high level of confidence*, IPCC studies suggest that recent regional changes in temperature have had discernible impacts on the earth's physical and biological systems. Examples of such impacts include the enlargement and increased numbers of glacial lakes, increased ground instability in permafrost regions, rock avalanches in mountain regions, changes in some Arctic and Antarctic ecosystems including those in sea-ice biomes, increased runoff and earlier spring peak discharge in many glacier and snow-fed rivers, and warming of lakes and rivers in many regions that affected thermal structure and water quality.

Other effects of temperature increases that have been documented with *a medium confidence level* are in agricultural and forestry management in the higher latitudes of the Northern Hemisphere. Examples of such changes are earlier spring planting of crops and alterations in disturbances of forests due to fires and pests. Some aspects of human health, such as excess-heat-related mortality, changes in infectious disease vectors in parts of Europe, and earlier onset of and increase in seasonal production of allergenic pollen in Northern Hemisphere high and mid-latitudes are also attributed to the unexpected rate of global warming.[11]

Although debatable, it is logical to assume that the economies of all regions or nations would be damaged by an increase in global temperature, and as such we would face a global economy that is affected by this phenomenon.[12] The 2009 report "Shaping Climate-Resilient

Development," by the Economics of Climate Adaptation Working Group, estimated that climate risks could cost nations up to 19% of their GDP by 2030, with the highest impact being observed in developing countries. For example, in Florida, under a high climate change scenario, the report estimates an annual expected loss of $33 billion from hurricanes, more than 10% of GDP.

Even though the impacts of future ecological and climate changes can be spatially and socially differentiated and resource-dependent communities are expected to be impacted the most according to their natural and social systems, upon analysis of eight separate cases in China, the United States, Guyana, Mali, the United Kingdom, Samoa, India, and Tanzania, the report concluded that cost-effective adaptation measures to climate change already exist and, if used properly, could prevent between 40% and 68% of the expected global economic loss.[13,14]

### *Managing Climate Change Risk*

The IPCC has used socioeconomic information and emissions data to predict climatic change by characterizing anthropogenic drivers, impacts, responses to climate change, and their linkages. With an increased understanding of these linkages, it is now possible to evaluate potential development pathways and global emissions constraints that would reduce the risk of future impacts that society may wish to avoid. The 2009 report suggests a methodology for determining risks that climate change imposes on the economy and a set of decision-making tools for a tailored approach to estimating impacts based on local climate conditions.

Despite much uncertainty, "economic growth" has been identified as the main driver of biodiversity losses related to climate change. The main challenge today is how to configure economic growth in an ethical manner and address the rules of ethics/social behavior, atmospheric space for safe levels of GHG emissions, ecological space for socially beneficial economic growth, ecological and economic carrying capacities, development options, and economic growth space of the planet.[15] The core thrust of future economic developments should be satisfaction of the basic economic, social, and security needs now and in the future without undermining the natural resource base and environmental quality on which life depends. Under proper financial, social, and environmental policies and programs, climate change could move from *speculation* to a *strategic opportunity* for economic, environmental, and societal development.