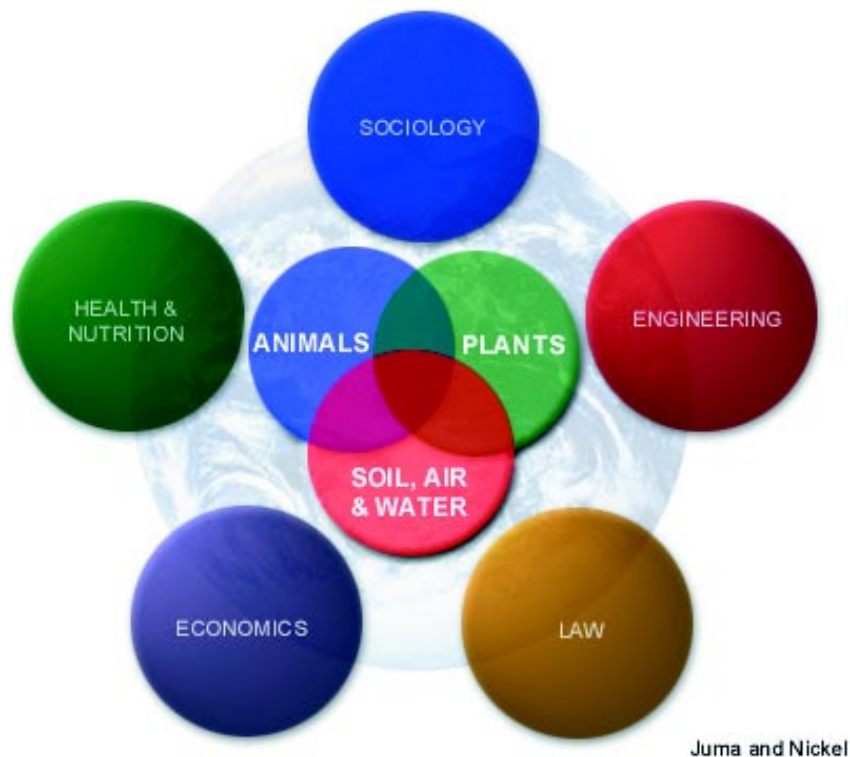


## 2.1 Introduction

Ecology is the scientific study of the interrelationships among and between organisms and their environment. The word ‘ecology’ is derived from the Greek word meaning ‘house’. People around the world have expanded the concept of ‘house’ to include the environments around the globe. Therefore, in its broadest sense, ecology refers to the study of living (microbes, plants, animals and humans) and nonliving components (the physical environment) as a whole. The word ‘system’ has been defined as regularly interacting and interdependent components forming a unified whole. Therefore, an anthropocentric (human-centered) definition of an ecosystem is: man as a part of, not apart from, a life-support system composed of the air, water, minerals, soil, plants, animals, and microorganisms, all of which function together and maintain the whole (Odum, 1993).

Humans have a remarkable impact on natural and managed ecosystems. One way to represent the cumulative interaction of humans on ecosystems is shown in Fig 2.1:



**Fig. 2.1.** Interaction of spheres of human activity on ecosystems and their components.

The biological component of ecosystems, consisting of autotrophic and heterotrophic organisms, is central to ecosystem structure and function. Plants are autotrophic organisms which produce above-ground biomass using natural resources such as soil, air and water. The energy and nutrients stored in plants are used to support heterotrophic organisms. The interactions occurring in this biophysical system for harnessing and transforming solar energy are complex and vary across ecosystems. Solar radiation is the ultimate source of energy which drives the cycling of water, nutrients and elements. It is also responsible for the development and maintenance of ecosystems.

The human impact on ecosystems can be divided into five spheres of activity. Engineering is a vast field which results in the development of technology to modify ecosystems. Some examples of engineering applications are: the development of machinery for cultivating soil, seeding crops and harvesting grain; genetic-engineering of microorganisms, plants and animals; and computer applications in food and fiber processing. The impact of technology is remarkable and Naveh (1980) has coined the word 'technosphere' to represent the sum total of large urban-industrial complexes created by human beings.

Environmental laws control the degree of manipulation as well as the conservation of ecosystems. These laws apply at local, regional, national and international levels. Currently, there are a number of high-level organizations which are coordinating research, synthesizing data to identify trends, and developing policies for sustaining the life support systems.

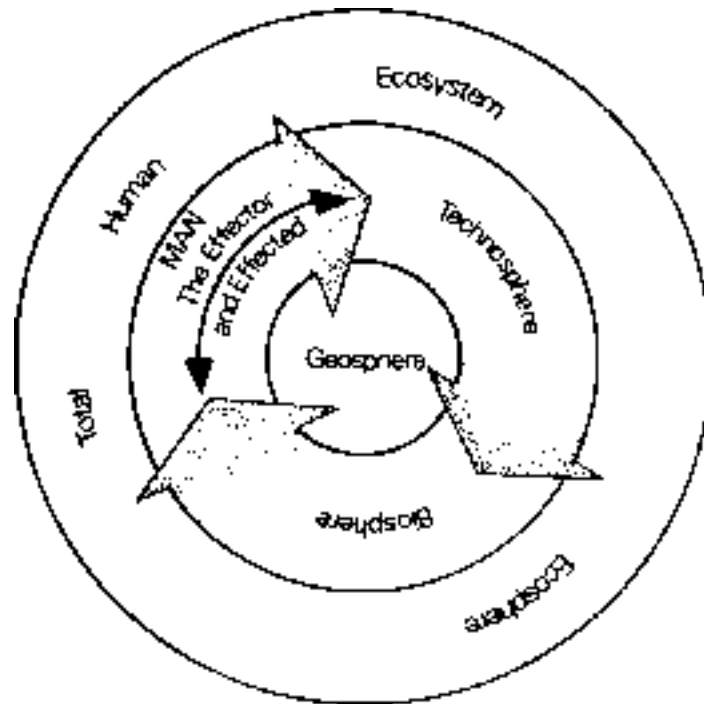
Traditionally, theories of macro- and micro-economics were used to assess the utilization of natural resources. Currently, a holistic approach is being developed to assess ecosystem services. It may be impossible to objectively assess the value of ecosystem services, however, this approach is forcing economists to redefine the boundaries of the systems being studied. In practical terms, the viability of operations at local, regional, national and international levels is governed by economic performance, which considers the costs of the environmental impacts of different human activities.

Human societies are organized into groups ranging from several people per unit area in rural communities to several thousand people per unit area in large cities. At present, approximately half of the human population (approximately 3 billion people) reside in large cities. The production of food, feed and fiber is left to a small segment of society. In spite of differences in group sizes and their physical locations, there are numerous and complex interactions between and within groups. The globalization of national economies has enabled societies in one country to use resources from other countries. For example, Canada is a net exporter of coarse grains, which are used to feed livestock in a number of countries in the Pacific rim. The demand for these resources and for finished products, such as beef and pork, is forcing a change in the land use patterns in Canada.

The well-being of human populations is directly related to their health and nutrition. Increasing human populations have forced the conversion of natural ecosystems into managed ecosystems. In addition to this, productive land is being claimed and reallocated for urban uses and for transportation corridors. Globally, the proportion of arable land per person has declined from 0.23 ha (23 m x 100 m) to 0.12 ha (12 m x 100 m) over a period of 46 years from 1950 to 1996. The amount of land in production has remained relatively constant, but the human population has doubled in the past 30 years.

Odum's definition of an ecosystem (man as a part of, not apart from, a life-support system composed of the air, water, minerals, soil, plants, animals, and microorganisms, all of which function together and maintain the whole) has been expanded by Naveh (1980) to include natural as well as built landscapes. Naveh (1980) has conceptualized that landscapes include visible and man-made components. Therefore, the total human ecosystem, in its broadest sense, addresses the issues of spatial and visual integration of the geosphere with the biosphere and the technosphere.

Modern man occupies a dual position by serving as a receiver of vital inputs from the biosphere and geosphere but, through the output of the technosphere, concurrently modifying the biosphere and the geosphere. He is thus affecting and being affected by these modifications (Fig. 2.2).



**Fig. 2.2.** Conceptual model of the total human ecosystem encompassing the dual role of man (Naveh, 1980). Reproduced with permission from Plenum Press, New York.

The human impact of modern man on terrestrial ecosystems has been summarized by Walker and Stephan (1997) as follows:

*The accelerating changes to the Earth's environment are being driven by the growth in human population, by the increasing level of resource consumption by human societies and by changes in technology and socio-political organizations. Four aspects of large-scale environmental perturbations are considered under the term 'global change': (I) changes in land use and land cover; (II) the world-wide decline in biodiversity; (III) changes in atmospheric composition, especially the increase in CO<sub>2</sub>; and (IV) changes in climate.*

The above mentioned issues also amplify some of the fourteen educational themes for Earth System Science education as described in Section 1.1. In this section, we will study the ecological and environmental importance of the pedosphere.