

# Chapter 9

## Approaches for Measuring Sustainability

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### ABSTRACT

*The environment provides the economy with resources (e.g., water, air, fuels, food, metals, minerals, and drugs), services (e.g., the cycles of  $H_2O$ , C,  $CO_2$ , N,  $O_2$ ; photosynthesis, and soil formation), and mechanisms to absorb waste. Economic growth is based on these three services, and since the global ecosystem does not grow, economic growth cannot continue indefinitely. The concepts of sustainability and sustainable development have received much attention among policy-makers and scientists as a result of the existence of limits to growth and the dramatic environmental changes of the last decades. Sustainability integrates environmental, economic, and societal aspects. It also covers different geographical scales: ecosystems, regions, countries, and the globe. In this chapter, the authors review various models of sustainability assessment. Since there is no universally accepted definition and measuring technique of sustainability, these different models lead to different assessments. They also present a discussion of the sustainability indicators, aggregation tools, and data imputation techniques used in each approach.*

### INTRODUCTION

In 1987, the United Nations Environment Programme (UNEP) released the Brundtland Report (UNEP, 1987), which defines sustainable development as “development which meets the needs of

the present without compromising the ability of future generations to meet their own needs.” The report recognizes sustainable development as distinct from environmental protection, and suggests that economic development should be ecologically viable and that environmental protection does not preclude economic development. The United Nations 2005 World Summit Outcome Docu-

DOI: 10.4018/978-1-4666-4852-4.ch009

ment refers to the “interdependent and mutually reinforcing pillars” of sustainable development as economic development, social development, and environmental protection (WHO, 2005). Others suggest that “sustainability occurs when we maintain or improve the material and social conditions for human health and the environment over time without exceeding the ecological capabilities that support them.”

As noted by Voinov and Smith (1994) and Adams (2006), sustainable development encompasses environmental, social and economic dimensions (Figure 1). Other researchers and international organizations suggest that cultural sustainability should be added as a fourth dimension (see for example UNESCO, 2002).

Often two general types of sustainability are distinguished: strong and weak sustainability. Strong sustainability focuses primarily on the environment whereas weak sustainability on the economy. Weak sustainability assumes that we can substitute natural capital with manufactured capital thanks to human ingenuity. This approach, however, has several shortcomings since it is dif-

ficult or often impossible to assign prices or weights to natural resources and also certain natural resources such as oxygen, water, a stable climate cannot be substituted. Adams (2006) believes that the main reason why the environment continues to be degraded and development does not achieve desirable equity goals is the prevalence of the concept of weak sustainability among policy-makers since development decisions by governments and businesses usually have short-term goals and are biased towards economic development, thus ignoring the other dimensions of sustainability.

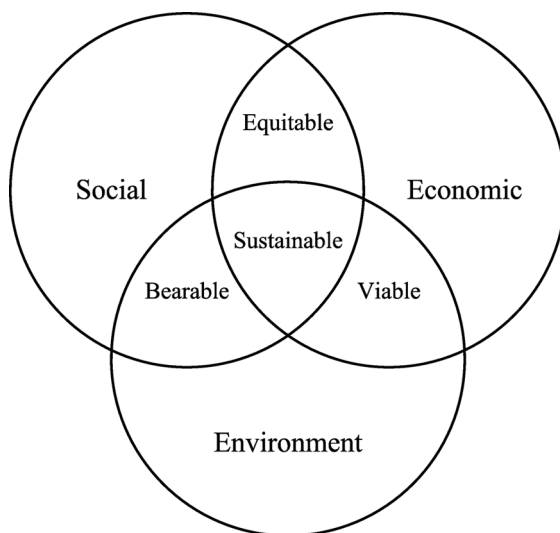
Despite the lack of a clear definition, it is evident that sustainability should be treated holistically comprising ecological, social, and economic components. The systems approach proposed in Voinov and Smith (1994) assumes that it is impossible to sustain one part of the total system without the others being involved. In systems analysis, there are usually three dimensions along which a system can be considered: time, space, and structure. Therefore, to devise efficient policies of sustainable development, the temporal, spatial, and structural dimensions of sustainability must all be taken into account.

In this chapter, we review various models of sustainability assessment. Since there is no universally accepted definition and measuring technique of sustainability, these different models lead to different assessments. We also present a discussion of the sustainability indicators, aggregation tools, and data imputation techniques used in each approach and a brief comparison of their results.

## IMPORTANCE OF SUSTAINABILITY

Sustainability looks to the future and in some way guarantees an acceptable social and ecological system for future generations. The concepts of sustainability and sustainable development have received much attention among policy-makers and scientists, as a result of the existence of limits to

*Figure 1. The three structural dimensions of sustainable development*



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