



## Original Articles

# Modeling and measuring urban sustainability in multi-criteria based systems – A challenging issue



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## ABSTRACT

This paper addresses how urban sustainability is modeled and the ways criteria-based systems deal with its measurability for an effective and reliable assessment. Twelve sustainability models are reviewed and a subset is briefly presented. More importantly, this research work investigates five national rating systems of sustainable urban development compared with the newly developed CAMSUD system. The comparison focuses on the systems' structure, categorization, technical content and measurability. The main findings about the selected national rating systems thoroughly discussed in the paper are: (i) They all have a tree-like structure, (ii) their conceptualization and categorization follow three or four sustainability pillars models, sustainability topics or spatial scale; (iii) they use either planning-oriented or performance-oriented weighting approaches; (iv) the criteria are defined as sustainability goals, action measures or assignments to be fulfilled; (v) the sustainability items can hardly be juxtaposed since they are differently handled, (vi) overlapping criteria might occur, (vii) similar criteria can be categorized under different categories and this affects the emphasis put on these categories, (viii) all criteria are independently rated with no consideration of mutual interrelationships. In an attempt to solve some of these weaknesses, the newly developed CAMSUD system is introduced as alternative and relies on the following: (i) the system structure is considered as a network, (ii) the conceptualization and categorization is based on spatial scaling as well as on sustainability topics and pillars, (iii) many criteria are directly planning-relevant (23 of 40), (iv) the criteria are defined as sustainability goals rather than action measures and (v) the quantification of criteria is planned as to account for mutual interactions.

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## 1. Introduction

The concept of sustainability is differently perceived depending on the view perspective given by the background discipline of the observer. Disciplines with a focus on social issues (e.g. [Fücks, 2013](#); [Rückert-John, 2013](#); [Lorenz, 2014](#)), on technology (e.g. [Cerone et al., 2014](#)), on energy (e.g. [El Bassam et al., 2013](#); [Sayigh, 2014](#)) or on policy (e.g. [Brannstrom and Vadjunec, 2013](#)), just to name a few of them, address the theme by highlighting different contents.

Indeed, the sustainability goals at urban scale are newly addressed, in comparison to the building scale for which relatively mature rating systems developed over decades exist. First sustainability rating systems for urban areas are available but their endorsement is still underway. This study reports on an analysis of some of them and reveals that methodological aspects related to

the theoretical modeling as well as the practical measurability of urban sustainability are still unsolved. It points out the deficiencies, discusses the matter in detail and seeks to find ways in addressing the problem. The paper includes: (1) a report on the theoretical discourse prevailing in the literature on the comprehension of sustainability with an effort to highlight the most operational concepts, and (2) a transverse analysis and discussion of the measurability of urban sustainability criteria of selected rating systems as well as in a new assessment system developed by the authors (see [Ali-Toudert et al., 2016](#)).

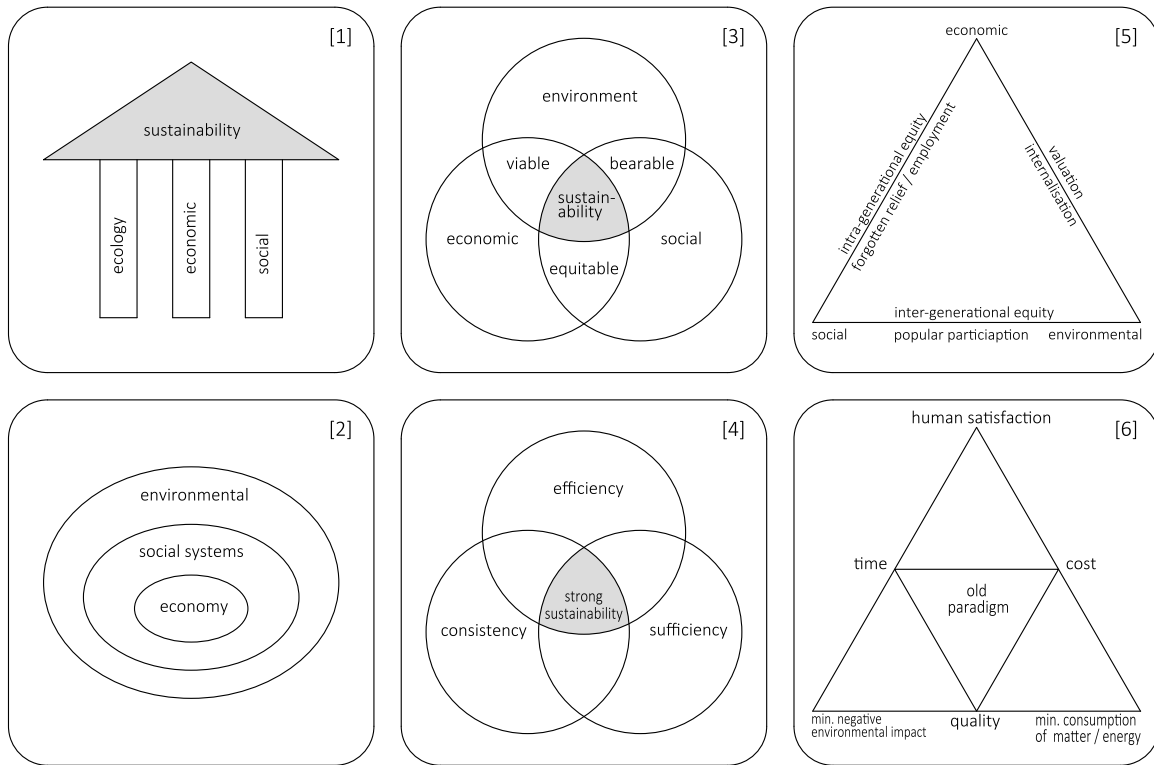
### 1.1. Models of sustainability

Many attempts, aimed at wholly comprehending the concept of sustainability, have yielded various theoretical models. [Fig. 1](#) gives a schematic summary of some recurrent models from the literature. It refers to: [1] [Spindler \(2011\)](#); [2] [Costanza and Wainger \(1991\)](#), [Neumayer \(1999\)](#); [3] [Kleine \(2009\)](#), [Spindler \(2011\)](#); [4] [Bott and Grassl \(2013\)](#); [5] [Munasinghe \(1993\)](#); [6] [Augenbroe and](#)

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three pillars model



four pillars model

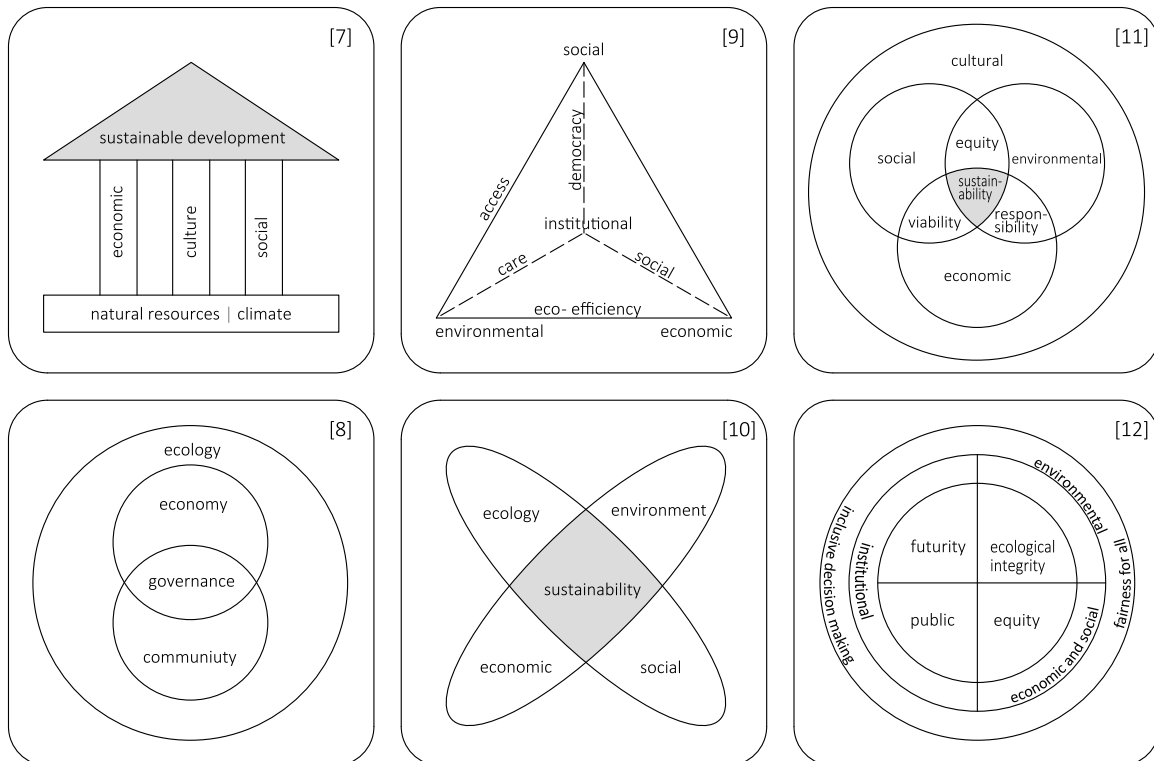


Fig. 1. Review of some existing sustainability models from the literature.

Pearce (2010); [7] Spindler, 2011; [8] Stoke (2008), Thwink, (2016); [9] Spangenberg (1997), Valentin and Spangenberg (2000), Lozano (2008); [10] NZMCH (2006); [11] Hawkes (2001), Duxbury and

Gillette (2007), Higgins (2015) and [12] Curwell et al., 2007. Fig. 1 shows at first glance some consensus but, when looked at in detail, also exhibits clear differences. Basically, sustainable devel-

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