



# Environmental sustainability assessment tools for low carbon and climate resilient low income housing settlements



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## ABSTRACT

Reduction of greenhouse gases (GHG) emissions throughout the building lifecycle and climate vulnerability have recently become important environmental concerns in the development of low income housing. To address these concerns, several sustainability assessment tools have been developed to evaluate new development at urban scale. To evaluate the effectiveness of such tools in addressing greenhouse gas emission reduction and disaster resilience for low income housing schemes, five rating tools that are widely applied for assessing environmental sustainability of urban projects, namely, BREEAM-Community, LEED-ND, CASBEE-UD, SBTool2012, and GBI for Township, were reviewed. The analysis shows that both issues are addressed in the five rating tools for urban development, however aspects of disaster resilience are considered less and not comprehensive. Improvements to GHG emission reduction and disaster resilience, assessment methods, financial consideration, and assessment purposes have been suggested. These improvements can contribute to the development of low income settlements that emit low emissions and are resilient to natural disasters.

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## 1. Introduction

Housing the urban poor is a great challenge for low and middle income countries. During 1990–2000, 750 million people in developing countries were estimated to earn less than \$2 per day [1] and about 862 million people, a third of the world urban population, were reported to still live in slums in 2012, despite attempts to reduce the number of the urban poor under the Millennium Development Goal [2]. Several low cost housing programs have been implemented to provide accommodations for this socially disadvantaged group in cities. During the period 2000–2010, the slum upgrading programs claim to have assisted almost 220 million people in the slum communities [3], indicating the importance of housing programs, and this trend is expected to grow in the coming decades.

Since the mid-1990s, environmental sustainability in low cost housing has been emphasized [4] in correspondence with the promotion of sustainable human settlement development, as announced in the Istanbul Habitat Agenda II in 1995 [5]. Considering the significant numbers of housing in this segment, highly degraded environmental quality and inefficient resource exploitation can be expected if housing design is not environmentally sound. Therefore, green construction practices have been promoted and implemented, particularly in the developed countries, resulting in healthier living environment for low income families [6]. With growing concerns on the negative impacts of climate change and natural resource depletion, environmental issues including energy, water use efficiency and waste management have gained more recognition as important strategies for achieving sustainability in low cost housing as well [7]. The urban poor are viewed as the most vulnerable population to climate threats [8], and they are associated with sub-standard housings with low level of disaster resistance due to location of such housings often in the risky areas [9–11]. Therefore, improving housing conditions and infrastructure are key measures to help low income households to better cope with either everyday or catastrophic disasters [12]. The reduction of greenhouse gases emissions considering the building lifecycle and climate vulnerability thus has recently become major environmental concern in the development of low income housing with the aim to achieving sustainability [3]. With a vast number of housing that must be built or upgraded in the near future to meet MDG7, Target 11 on improving the lives of 100 million slum dwellers by 2020, this will be a great opportunity to increase the urban poor's wellbeing and avoid serious damages to their assets due to weather related disasters by building low carbon and climate resilient low income housing settlements.

To ensure that GHG emission reduction and disaster resilience are taken into account in the housing design for the urban poor, it is necessary that architects, planners, and developers have tools to evaluate the environmental performances of housing systems during design and planning process. Though several assessment tools have been developed to measure the sustainability of urban development projects [13–17], however, there is lack of critical

evaluation of the effectiveness of such tools in addressing the reduction of greenhouse gas emissions and climate vulnerability, and the evaluation of the applicability of such tools to low income housing, particularly in developing countries. The major objective of this article is, therefore, to review the sustainability assessment tools for urban development focusing on two aspects of GHG emission reduction and disaster resilience, and the application of such tools to assess low income housing. Specifically, this study aims, (a) to evaluate to what extent existing tools consider GHG emission reduction and disaster resilience; (b) to evaluate the application of the tools to assess GHG emission reduction and disaster resilience of low income housing by identifying their limitations in terms of comprehensiveness, assessment methods, and financial aspects and community participation; and (c) to identify and propose improvements required to enhance the effectiveness and the applicability of the assessment tools to low income housing. With improvements, a more comprehensive approach to evaluate existing settlements or new projects can be achieved, contributing to optimum solutions that integrate the principles of low carbon and climate resilient community to the development of low income housing. The paper consists of five sections: the first section provides an overview of the trend in low income housing growth in developing countries and the promotion of environmental sustainability in low income housing. Section 2 provides general background of low cost housing in developing countries, namely, definitions of various terms, types of housing and environmental issues related to energy use and climate risks. The next section reviews the sustainability assessment tools for urban neighborhood development, in terms of the coverage of GHG emission reduction and disaster resilience, assessment methods, and the consideration of financial aspect and community participation. Section 4 discusses strengths and weaknesses of the existing tools for the application to low income housing in developing countries. Then, the inclusion of key aspects needed to be incorporated in the assessment framework for low carbon and climate resilient low income housing is suggested before leading to concluding remarks.

## 2. Low income housing, energy issues and climate risk: a review

In developing countries, both formal and informal sector play the key role in housing provision [18]. This study focuses only on the formal mode of housing provision since formal housing providers have more potential in employing the assessment tools. Low income housing is known in various terms, including public housing, social housing, affordable housing, and community based housing. Each term refers to different actors involved in housing development and was coined in accordance with housing policies that evolved in the last 50–60 years. Housing policies have experienced major shifts in three periods – the first period in 1960s began with the public housing approach, the second period

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