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A Cross Scale Analysis of the Relationship Between Energy Efficiency and Urban Morphology in the Greek City Context

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Abstract

Urban form is a decisive factor for the energy efficiency of the city. The compact city has been suggested as the most sustainable urban form, but it has been questioned as well by many researchers. Urban morphology is not a simple aggregation of geometry factors, but also the interaction among a set of parameters, that include constructional, functional and building regulation constraints concerning a range of different scales as well. This paper examines in which way the interaction of such parameters affects the energy efficiency of the urban tissue focusing in the Greek city context. A set of building block typologies are analyzed with regard to their geometry factors such as S/V ratios, plot ratio and building ratio. Thermal loads are calculated in order to draw conclusions about the relation between geometry factors and energy efficiency. The results of the research indicate that there is a strong relationship between urban morphology factors and energy efficiency. The theory of compactness of the urban form is generally confirmed by the results of the study which are valuable, since they indicate the energy profile of each typology and can be used for predicting the performance of potential energy demand of urban blocks with similar geometry.

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Keywords: urban morphology; energy efficiency; sustainable cities; urban block typology

1. Introduction

Compact city theory has been introduced since the 80's. Compactness has been considered by many researchers as a key factor towards sustainable urban development. However, it has been questioned by many researchers as it has been blamed for the low quality of life that follows the increased density of urban development [1, 2, 3, 4, 5, 6, 7, 8, 9, 10].

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On the other hand there are a large number of researches examining typologies according to their energy performance in order to define the most energy efficient urban form [11, 12, 13]. This paper examines the relationship between urban form and energy efficiency through the analysis of ten typical urban blocks with different parameters of geometry. The typologies selected to be examined are part of a larger database created for the typology approach of the urban block of Thessaloniki [14]. The study examines their energy performance concerning the demand for heating and cooling loads. An approach based on energy simulations is applied to typical urban blocks.

2. Typical urban block description

The typical urban blocks selected to be analyzed in this study have different geometry parameters (height, covered surface, building surface, and surface to volume ratio) but similar size (approximately 3.000 m^2). They also have different form and can be divided into two main categories (continuous and discontinuous form) according to the relative positioning of buildings in the urban block plot. Each urban block is considered to be a representative typology of the urban blocks of the urban tissue of the city of Thessaloniki and it is formed by a number of typical buildings which are considered to represent the most common building types met in the Greek city (Fig. 1).

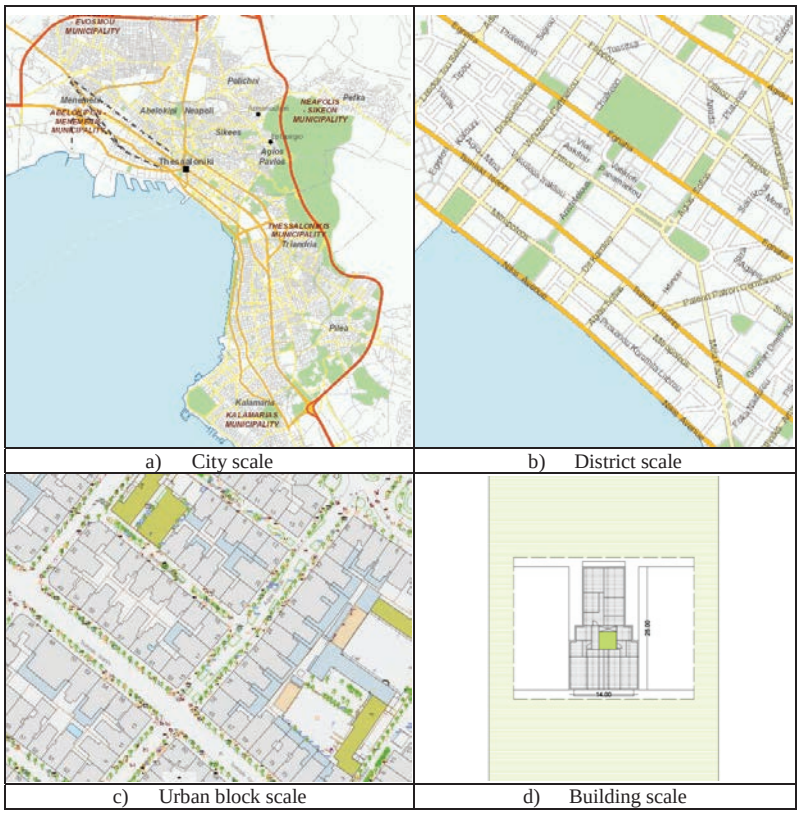

Fig. 1. Scales of analysis for the urban tissue of the city of Thessaloniki.

Elements of the façade such as openings and balconies have common typical dimensions. Typical road width is considered to be 15 m for all building blocks examined, and the surrounding buildings have common morphology and geometry to each examined case. The typical façade configuration for the front and the rear view of the buildings and a 3D model of a typical urban block are presented in Figures 2 (a), (b) and (c) accordingly. The geometry and form parameters of the ten typical urban blocks examined are presented in Table 1. The ten typical urban blocks are grouped according to their geometry factors into five different groups. Group 1 and goup 2 are