Article

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Impact of Low-Impact Development Technologies from an Ecological Perspective in Different Residential Zones of the City of Atlanta, Georgia

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ABSTRACT
Low-impact development (LID) technologies have a great potential to reduce water usage and stormwater runoff and are therefore seen as sustainable improvements that can be made to traditional water infrastructure. These technologies include bioretention areas, rainwater capturing, and xeriscaping, all of which can be used in residential zones. Within the City of Atlanta, residential water usage accounts for 53% of the total water consumption; therefore, residential zones offer significant impact potential for the implementation of LID. This study analyzes the use of LID strategies within the different residential zones of the City of Atlanta from an ecological perspective by drawing analogies to natural ecosystems. The analysis shows that these technologies, especially with the addition of a greywater system, work to improve the conventional residential water network based upon these ecological metrics. The higher metric values suggest greater parity with healthy, natural ecosystems.

1. Introduction

Exponential population growth and urbanization has given rise to the construction of cities of immense complexity; however, the rapid growth has outpaced intelligent system design, resulting in a lack of well-performing, robust infrastructure and subsequent degradation of water and air quality. At present, over half of Earth's population lives in cities, with projections of urban migration increasing urban population distribution to over 65% by 2050 [1]. With this increasing urbanization comes an increased need for sustainable infrastructure that will meet current and future demand. The relationship of energy and material use to infrastructure can be examined using the concept of *urban metabolism*, which is defined by industrial ecologists as "the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste," [2]. While studying the interactions of natural and human-centered systems within and around cities, the establishment of an urban metabolism model can aid in the description and analysis of the material and energy distribution structures within these systems. In order to increase sustainability, cities must account for these flows by making structural adaptations that increase efficient, productive, and resilient exchanges of these material and energy streams.

Despite its focus on overall energy and material use, the concept of urban metabolism has been critiqued for using an inaccurate model because many characteristics of urban centers do not map clearly onto organisms, from which the concept of metabolism is derived [3]. However, urban systems are functionally equivalent to ecosystems in that the material and energy transferred between autonomous actors gives rise to system properties [3–5]. Thus, ecological techniques and approaches can lend insight regarding material and energy flows in urban systems.

Water comprises up to 90% of all material entering an urban system [6]. As a result, proper management of water infrastructure has the potential to dramatically change the overall impact of urban infrastructure. Low-impact development