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Research Article

Morphological Transformation of Cities; Integrating Sustainable Urban Form with Ecological Urbanism

Salman Ali[1]* and Baofeng Li[2]

[1]School of Architecture and Urban Planning, Huazhong University of Science and Technology, China

[2]Green Architecture Research Center, School of Architecture and Urban Planning, Huazhong University of Science and Technology, China

ISSN: 2639-0574

***Corresponding author:** Salman Ali, Hua Zhong university of science and technology, China

Submission: May 17, 2022

Published: June 09, 2022

Volume 5 - Issue 1

How to cite this article: Salman Ali, Baofeng Li. Morphological Transformation of Cities; Integrating Sustainable Urban Form with Ecological Urbanism. Adv Civil Eng Tech. 5(1). ACET.000605. 2022. DOI: 10.31031/ACET.2022.05.000605

Abstract

This paper identifies transformation of urban morphology, form and urbanization impacts on both city's form and ecological functions. It explores, in particular, the transformation of urban spatial configuration and their relationship with the ecosystem. Also, it addresses the question of whether urban form contributes to the sustainable ecological urbanism. The methodology aims to integrate existing urban form and ecological urbanism approaches to improve the ecosystem of future cities. The research demonstrates how one can transform a city into a sustainable ecological urban environment, using the integrated approaches. The synthesis between urban form and ecological urbanism are able to produce ecologically sustainable urban environment.

Keywords: Urban morphology; Transformation; Urban ecology; Sustainable forms; Ecological urbanism

Introduction

The mass shifting of people into cities resulted into a form of urbanisation in the world that is not very hospitable to our everyday needs and not compatible with the existing environment [1]. Urbanisation impacts on the functioning of the earth's ecosystems both locally and globally and the services they provide to the human and other organisms [2]. Since the human being depends upon ecosystems, changes in ecological conditions as a result of urbanisation ultimately affect their health and well-being [3]. As urbanisation is taking place around the world; their impacts on urban environment and climate is a distinct phenomenon. The urbanisation impact on the ecosystem mostly related to, e.g., Human population, density, and percentage impervious surfaces in urban areas. However, we do not know how different forms of cities affect environmental conditions differently. In order to promote the sustainability and resilience of cities, environmental knowledge must be better integrated into urban planning and design projects. Due to the gap between the two ideological cultures in ecology and design disciplines, this integration has proven its value challenging [4]. Now there is a need for practical methods to integrate ecological knowledge into urban planning practices, which had no substantial theoretical basis before [5].

The study of urban fabric (buildings, streets, gardens, parks, and monuments) is among the primary element of morphological analysis. The ideas behind the components of urban fabric take shape on the ground and make our cities. However, these components are continuously transformed through time and create dynamic interrelationship in the urban area's formations [6]. Several studies have presented the relationship between urbanisation and ecosystems; However, various urban forms which influence ecological systems is not yet known and discovered [7]. Some scholars raised the question directly that how can alternative urban shapes and patterns control the circulation of energy, materials, and organic entities in urban ecosystems [8]?

Since the development of cities and regions from natural ecosystems process goes back to 1960s, by the works of Ian McHarg and Philips Lewis [1]. Urban physical changes alter ecological conditions; alternative urban forms are expected to produce different environmental effects [9]. New conceptual design approaches, e.g., new urbanism, landscape urbanism and ecological urbanism are common manifestations for achieving sustainable cities [10]. The relationship of form, functions and urban natural environment needs efforts to understand this shift [11]. Also, we need to understand the trade-offs associated with the sustainable urban form and ecological urbanism [3].

The research paper aim is to explore the relationship between urban form and ecosystem by analysing the available literature. The main objectives of the research are to analyses transformation urban form through lenses of urban ecology. To investigate the impacts of urbanisation on urban form and ecosystem and provide thorough discussion about different approaches that provides a sustainable solution for cities and urban environment. The structure of research is consisting of a literature review; by integrating theoretical investigation, which is a suitable methodology when evaluating a large of interdisciplinary knowledge. The article presents the difference between urban morphology and urban form to analyses the urban configuration. This study examines the relationships between urban morphology, urban form and their spatial transformations due to urbanisation. It focuses on different urban design approaches i.e., ecological urbanism which can improve urban form and urban ecosystem.

Cities morphology and form

Habitat fragmentation refers to the process in which once continuous habitats are broken down into different fragments, which are mainly caused by human activities such as agriculture, rural development, and urbanization. Many animal and plant species became extinct in, posing the greatest threat to biodiversity on the planet [12]. Urban morphology is the study of the city as a human habitat: a combination of both nature and artifact [13]. Urban morphology research examines the forms of physical elements of human settlements. The physical evaluation of the forms of buildings or open spaces together, in a settlement and the transformations in the urban structure [14]. The term urban morphology is more or less used for urban fabric mainly focusing on the specific urban built environment with the configuration of building pattern [11] (Figure 1).

Figure 1: The morphology and city form. Source: Justin Cozart.

Urban form is referred to the arrangement of the large-scale functional units of a city; it is characterised as spatial patterns of industrial, commercial and residential land uses [15,16]. Additionally, the Urban form is a mixture of land use pattern, transportation system, and urban design [17]. Since forms are results from repetitive elements and groups of them are called patterns (street pattern, block size, and, lot or plot configuration, the layout of parks) therefore urban form present all element concepts (urban patterns) together [18]. According to Kevin Lynch urban form is " the spatial pattern of the large, inert, permanent physical objects of a city" [19].

In spite of the utilization of the term 'urban morphology' or 'urban form' would frequently interchangeably in the literature, they are for the most part dealt with in separate spatial scales. Urban design has lengthy debate history on the comparison of dispersed and compact cities forms or suburban spread versus urban densification [20]. Additionally, the link between urban design and sustainable form is well established. However, the discussion about sustainable cities and sustainable urbanism is a complex topic encompasses and related to the entire process of city ecosystem [21]. The current urban forms, its transformation over time and its impacts on ecosystem functioning with rapid urbanisation are most topical discussion within a sustainable framework.

Transforming urban morphology

The physical form of the cities has been changing over time [22]. Physical transformation created new kind of urban structures: cities which were dense, compact and continuous turn into diffuse, loose and discontinuous. This shift of form from close structure to open and fragmented has changed the scale by imposing mega-structures and relationships between buildings that are now functional. Urban zoning changed the classical form of cities and created new kinds of urban elements, in which the roads play a central role in the making of cities: ring roads, urban motorways, bypasses replace streets, crossroads and corners, while elevated walkways, platforms, and shopping centers become the new public squares. In these new forms of the urban environment, supermarkets and malls replace small department stores, streets and covered markets, open lawn and playing fields replace parks and gardens, and new private housing estate replaces the garden city [23]. In modern planning pattern, new freeways were built to connect car-dependent which result in devastating effects on neighborhoods.

The actual effectiveness of these replacement remains the subject of debate [24-26]. The New Urbanist practitioners discover their perfect urban form in the traditional city street grid form, which mainly concentrates the complexity and changeability of urban life in built fabric. They focus on the desired morphology of street layouts, zoning codes whereas allowing the design of individual buildings, spaces, and details to others. As their specific rules and regulations, and approaches are categorized in environmental determinism, it is often successful [27]. New urbanism offers an urban form which is mixed-use, diverse and functioned by public transit, have greater density, provide opportunities for walk able communities, and do not harm the urban environment, The physical form of the urban areas affects people's lives and can be a significant tool for the greater good. Urban design must not focus on the particular outcome but rather embrace the unforeseen functioning through the process as an alternative to urban form and allow the city to develop [28].

Rapid urbanisation is causing real ecological problems, including environmental pollution and loss of biodiversity [29,30]. Besides transformation, in urban form, the changes in the microclimate by modifying the nature of the surface area also generated a significant amount of heat. The urban heat island is probably the most well-known example of inadvertent climate alteration [31]. Urban form and greenery have a direct relationship; cities are typically warmer than surrounding areas especially at night and in summer. The reason is the heat island effect which results in lower quality of an environment [32]. Therefore, the ecology of cities is degraded severely by this process. Therefore, Retaining and protecting the urban vegetation is very important because it is the primary source of floral biodiversity, faunal habitat, and social amenity [33]. Urban ecology which is science-based research whose strategies are mostly developed in rural and non-urban areas. Its policies and design concepts are not yet implemented in urban areas [34].

Many planners and scholars believe that compactness in urban form is crucial to achieving sustainability, for example, Dum Reicher [35] argues that an environmentally friendly city needs to be compact, dense, and highly diverse [35]. According to the Jabareen' thematic typology of literature from the sustainable urban form, the Ideal Sustainable form has higher density, diversity, compact, mixed land uses, greening and have the passive solar energy [36]. The question is that how this ideal urban form would work in spatial and ecological terms, it is not yet solved. In the real world, According to Jabareen's table urban form especially which suits sustainable urban form: compact urban form is not matching with urban ecological form because it is impinging green spaces and other environmental aspects of a city. There also exists a contradiction between compact urban form and passive solar design; solar access will reduce because of higher densities as compactness increases shading. Therefore, the only ideal sustainable urban form of spatial planning can support ecological terms. The other conflict is design concepts whether it will evaluate existing urban form rather than focuses on future urban forms [11] (Figure 2).

Figure 2: The new urbanist project. Source: UG Ardener.

Sustainable urban form and ecosystem

Sustainable urban form debate support 'compact city' form of research policies, however, the field's researchers less agree with the idea [37]. The concept of sustainable and ecological cities remains for achieving. The sustainable city has multiple visions; achieving it indeed has various ways: making our cities more sustainable will be dependent on a wide range of selected actions [38]. Sustainable urban forms and spaces need urban thinkers who can look beyond as aesthetics and other functional systems [39]. The sustainable urban form is based on green urbanism or greening of the city because green space can contribute positively to urban areas [40]. There is a need for more synthesized urban design principle, not only a framework or a roadmap, but a comprehensive approach to tackle the major burning problems of urban forms and built environment.

The phenomenon of decline in the urban environment is not new, Commercialism and urban growth of cities are continually being destroyed the geography of built form and the natural process "the green land" [41]. Urban activities not only alter available nutrients and water, but also affect population, communities, and ecosystem dynamics [3]. Urban environment and key factors that influencing climate and urban morphology are land cover: (the percentage of built-up areas), paved and vegetated surfaces, bare soil and water. Additionally, urban morphology; the shapes of buildings and spaces between them: street widths and street spacing have a direct relation with the urban environment [42]. At landscape scale two factors: first, land-cover type, e.g., vegetation, bare soil or paved area, and second land-use type, e.g., residential, commercial or industrial have enormous influence on the urban environment [43].

There are multiple visions of sustainable urbanism and indeed multiple pathways to achieve it; however, the designing part starts from micro level to macro level; urban morphological analysis of cities. It may help us to take into account the pathways to make urbanisation healthier as we have seen recently that, some of the most well-designed urban projects; new eco-settlements, and public transport infrastructure projects have not responded climatically well and disturbed the ecology of areas (Figure 3).

Figure 3: The ecological urbanism project. Source: Derek Severson.

Ecological urbanism and ecosystem

Author, Mohsen Mostafavi [44] recently presented the concept of "ecological urbanism"; which can integrate ecology and urbanism. Urbanisation poses significant and environmental issues and new approaches to designing and planning urban areas are necessary [44]. Ecological urbanism and sustainability have become increasingly topical issues because individual cities vary in size; also, they are often ignored in the holistically sustainable discussion. The city has too often neglected regarding urban ecology and environment. When addressing these issues, modern solutions towards urbanism and planning consider cities as entities- in such setting ecological urbanism takes form [45]. In Green urbanism, the author elaborated the significant roles of cities and active urbanism in the creation of a more sustainable urban environment. He argues that old urban design approaches and strategies are not complete and need integration of ecologically and environmentally responsible forms of living and settlements. Timothy Beatley's [46] present some points about green urbanism; The city must strive to live within its ecological limits; The city design should be analogous to the function of nature. Additionally, it should have Circular metabolism instead of linear, regional and locally self-sufficient, more sustainable lifestyles facilities and finally the high quality of neighborhood and community [46].

Ecological urban design concept provides not only details about specific places like clusters of buildings, streets and other

public areas but also molded the structure of neighborhoods, districts and whole cities. Its thinking is relevant to all individuals; designers, government officials, and politicians who have a part in shaping or influencing the shape of cities and their surroundings. Ecological urban design principles produce less harmful solutions what Jaime Lerner, the greatest urban innovator of Brazil, call "urban acupuncture" rather than major surgery of cities [1]. The objective of ecological urbanism is to manage the city form and try to understand much better the complex urban structures that bind together many systems [45]. Ecological urbanism focuses on multiple instruments and operating simultaneously at various scales, urban form and ecosystem can harmonize through the act of design; a synthetic key to connect urbanism and ecology that is not countering its environment. This symbiotic relationship between ecologies and built environments must create in ways in which urban systems are not fading away [44]. We should pay attention to substances of urbanisation and its natural setting, as well as also must understand the process and logic of biological tissues; how they are working and integrated them with built structures, to fix and solve problems [44]. The integration of urban ecology and sustainable urban form can lead to sustainable ecological urbanism.

Discussion

The Complexity of the urban environment

Cities are complex, and there are many approaches to make it greener and more sustainable. The debate over the current paradigms and toolkits to work holistically on the goal of urban ecology and sustainable urbanism is rare [47]. Therefore, many scholars, planners and designers are motivated to seek forms of cities that will function in a far more positive way than at present and will also meet the sustainability criteria [36]. The approaches (form and ecological functions) debated the issue of sustainable cities at different levels and scopes. There cannot and should not be a final concept in urban morphology because the factors contributing to urban form and fabric will change over time because great cities and urban environment of the past have grown to be obsolete and dysfunctional with alterations in urban lifestyles. Research from different disciplines is playing a significant role in understanding the human settlement [34]. The new urban forms as a design concept have given a significant motivation to the issue that certain urban form might be more beneficial to the natural environment.

Ecology and landscape-based approaches

Many approaches have been addressed on different spatial levels, e.g., regional level, city level, community level, and building level. Among them two approaches are closer on the issue of sustainability, one is New Urbanism, and the other is landscape urbanism. New urbanism concept of environmental-friendly urban practices includes walkability, bicycling, compact building, public transport, and protection of green spaces. Their project has rarely achieved the high density and still far way of sustainable urbanism [28]. While landscape urbanism concept failed to address the issue of urban sprawl although some landscape Urbanists are now thinking in broader perspective of the environment and bring forward the idea of ecological urbanism [44]. The integrated use of these two concepts can give an important contribution to the development of the sustainable urban environment.

Ecological urbanism as a way of transformation

Ecological urbanism goes beyond metropolitan areas to protect agriculture and landscape and identify areas for sustainable city expansion. At every scale, it protects areas both urban and rural for better environmental and social performance. According to the current literature, the contemporary urban form and sustainable urban forms design factors are not compatible with urban ecology. Ecological urbanism points out two approaches.

A. Urban ecological approach embraces the complexity of city form, life and the endless things the people want to build.

B. It also embraces the beautiful complexity of the natural environment and the way the human being can be a part of that ecosystem without degrading it or dominating it.

Therefore, rather than working on future cities design, we should consider emphasizing environment and resilience of cities [39]. The integration of resilience can improve the quality of environmental, social and economic sustainability in cities [48].

Conclusion

This research concluded that a comprehensive approach is required for the urban structures and spatial functions within the natural environment, urban form alone is insufficient. This article explained the intermingling between morphology and urban form, as well as the urbanisation effects on sustainable urban forms and natural environments. It is apparent from the recent literature that the interaction between urban fabric and ecological processes is complex. Many common urban issues have found in the cities' urban forms and structure in terms sustainability and natural environment. Current research provides evidence about urbanisation effects on urban ecology. In this article, analysis has shown that urban morphology and urban form have relation with the sustainable urbanism.

The concepts of ecological urbanism framework provided a new framework for solving the current issues of the environment. We will need to investigate deeper understanding of these problems through multi-scale approaches to assess the impacts of urbanisation on urban form and urban ecology. Urban form: sustainable urban form with urban ecology through literature have been linked. Contemporary sustainable urban cities are not performing well enough according to ecological urbanism framework. Moreover, it fails to realize the complicated interactions between urban fabric and environmental process and systems. To understand how ecological urbanism can solve these problems.

Investigations have been done to integrate cities into nature. Moreover, we established what role greenery and ecology can play in urbanized areas. To what extent urban environment can be protected through ecological urbanism approaches. The article will

assist further the complex issues of urban fabric and to understand their effects on the ecology of cities. We have highlighted most exciting and critical challenges in urban morphology concerning sustainable urban form and ecological urbanism. A discussion has been offered based on sustainable approaches to deeper the interplay between urban structures and the natural environment for sustainable ecological urbanism.

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