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From Eco-urbanism to Eco-Fusion: An Augmented Multi-Scalar Framework in Sustainable Urbanism

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Abstract: This paper introduces the new concept of "eco-fusion" through an exploratory case study project. It suggests the importance of multi-scalar practice in the broader field of eco-urbanism. This study introduces eco-fusion as a multiplexed paradigm, which is then discussed in two different development models. This paper first highlights the position of "eco" in urbanism by providing a brief account of key terms and how they relate to one another. It then points out the associations between eco-fusion and sustainable urban development. Through an exploratory case study example in China, the practical factors of eco-development are assessed. The study aims to provide a set of intermediate development stages while maintaining each spatial level's interface in their own defined and distinguished contexts. The key objective is to consider integrating the natural and built environments, which is considered the best practice of eco-development in urbanism. This study's findings highlight integrated methods in eco-urbanism and suggest new directions for eco-planning/eco-design strategies.

Keywords: eco-fusion; eco-urbanism; multi-scalar approach; sustainable urbanism; sustainable cities

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1. Introduction

It is crucial to frame the status of "eco-ism" in the field of research and practice in urbanism. In doing so, this paper aims to elaborate on the concept of "eco-fusion" that was first introduced by Cheshmehzangi in a technical report for the City of Ningbo, China, in 2016 [1] and then officially published in 2018 [2]. In sum, eco-fusion that is nested in the eco-urbanism field enhances a multi-scalar approach to boost eco-development. In order to demonstrate this argument, the paper comprises four main parts. First, the concept of eco-urbanism and sustainable urbanism is introduced. This is discussed at three main scales of eco-development: the city, the community, and the building levels. Second, a detailed literature review shows how eco-urbanism is nested into eco-innovation and how it differs from urban ecology. It also highlights how the interplay between different scales has not been adopted in the various eco-development phases. The third part explains the eco-fusion approach and how it sits in the eco-urbanism field. This is done through exploration rather than scientific case study research. Fourth, we summarize the findings and discuss the practical values of an integrated multi-scalar approach in eco-urbanism.

In order to verify the multi-scalar approach, the application of eco-fusion is tested through an exploratory case study example in the City of Ningbo, China. The reasons behind the choice of this case study are two-fold. First, the authors are very familiar

with this specific city and have conducted several investigations about the practice of eco-development in the Chinese context. Second, China is one of the leading countries in implementing and achieving sustainable development agenda, especially in terms of investments and the number of interventions [3]. We note that other leading countries, such as Australia, Germany, Japan, Singapore, the UK, and the US, are mainly leading from other perspectives of technological innovations, experimentation, and technical knowledge of eco-urbanism [4,5]. Even if our case study exploration remains a limitation, related mainly to the difficulty of developing a fully consistent multi-scalar approach, we believe that it will help clarify limitations and potential future directions of investigation and practice in the field of eco-urbanism.

The concept of "eco", which finds its roots in the ecology field, encompasses experimental cases for sustainable urbanism in the urban design field. This experimentation is among many other sustainable cities' concepts such as green, smart, resilient, low-carbon, and knowledge cities. de Jong et al. [6] refer to these terms as "a multitude of concepts promoting sustainable urbanization" (p. 25). Debates on sustainable urbanism are fast-moving and complex. Part of the challenge is unraveling the meanings behind terms that can often appear to be similar or interchangeable but are usually used differently. Moreover, their application in practice may produce further divergences. To clarify the matters, we have sketched key terms and debates between various terminologies in Figure 1. At a larger scale, eco-development is part of the grand idea of sustainable development [2]. Amongst other examples, the eco-city is one of the mainstreams in sustainable urban development strategies. In order to achieve eco-development in practice, we often utilize strategies and/or methods of development known as eco-innovation strategies.

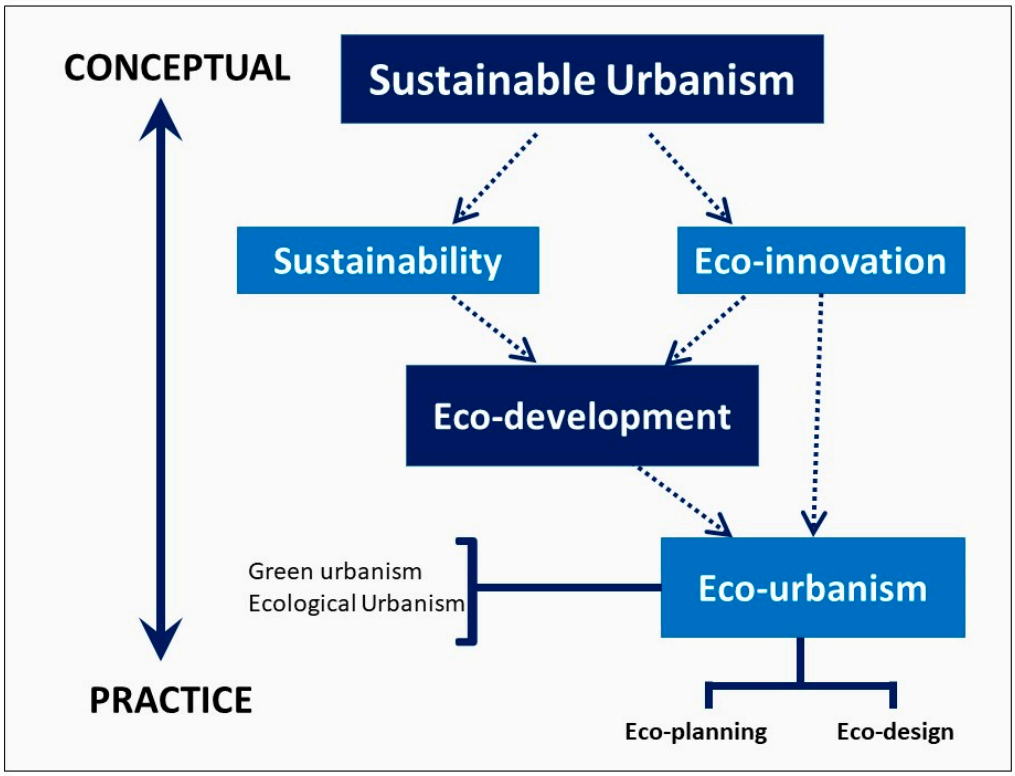

Figure 1. Mapping the conceptual and practice terrains of sustainable urbanism. (Source: the authors' own). Note: The figure simplifies the relationships between key themes in sustainable urbanism. In practice, the boundaries between terms are blurred, and debate takes place across all aspects.

As explained in the literature review, eco-innovation links two streams, on of "sustainability" and the one of "innovation" [7], and it is an overarching area of research that has informed eco-development thinking. Eco-innovation encompasses multiple eco-strategies,

one of which is "eco-urbanism", which is studied here. Eco-urbanism is a field that includes eco-planning and eco-design strategies, involving studies and investigations of cities and sustainability. The term is linked with the earlier notion of "green urbanism", which is a synonym for ecological urbanism [8]. Eco-urbanism differs from green urbanism because it mainly focuses on social inclusiveness and environmental sensitiveness in urbanism. It also provides eco practices, which are less ideologically driven and more practically oriented. As a relatively new research area, eco-urbanism is an important part of sustainable development movements [9].

Eco-urbanism mainly comprises three scales of development: (1) the city scale and district scale at the macro level; (2) the community scale or neighborhood scale at the meso level; (3) the building-scale at the micro level. In eco terms, they are, respectively, defined as eco-city, eco-community, and eco-building, and they are the backbone of eco-development practices [2]. Nevertheless, these different scales of eco-development, if considered separately, do not maximize their synergies. For instance, we may have an eco-building, often regarded as a green building, without having a surrounding eco-city, or vice versa. Based on these assumptions, the introduction of the concept of eco-fusion, which is nested within eco-urbanism at an analytical level, seeks to understand better the dynamic relationships between the three different scales of eco-development and how their interplay can contribute to the efforts of promoting more effective sustainable urbanism.

Aims and Objectives

In practice, eco-fusion enables planners and designers to think holistically and provide a set of sustainability guidelines for further implementation and practical directions. Therefore, this paper aims to introduce eco-fusion as a concept that provides a set of intermediate stages in development while maintaining each spatial level's interface in its own defined and distinguished context. To better address the ideals of sustainable (urban) development, the concept of eco/green remains one of the experimental methods of achieving a harmonious development. Through this, the mere inclusion of the natural environment is not adequate for integrated planning and design. Therefore, this new concept is studied through the exploration of a case study example. In doing so, we aim to suggest the practical importance of eco-fusion in the practice of eco-urbanism. The key objective is to consider integrating the natural and the built environments, which is considered the best practice of eco-development in urbanism. This includes the ideals of (1) integrated urban planning, including major factors of green infrastructure, a network of ecologies of the city environments, etc.; (2) integrated urban design, including significant factors of ecological innovation and green development key performance indicators KPIs; and (3) integrated building design, including major factors of green strategies at the microscale and the integration of buildings in a larger context. In this paper, these ideals are studied at the macro, meso, and micro scales. In doing so, the study first provides a comprehensive literature review on the topic, clarifying the wide range of available terminologies and practices. We then introduce the new conception of eco-fusion before exploring the topic through a case study research. This case study research is done through an exploratory study rather than scientific research in eco-urbanism. After the case study introduction, we explore the case at three spatial levels of macro, meso, and micro. The analysis is then expanded by conducting a multi-scalar analysis, which is the basis of eco-fusion as a new concept. The findings stress the importance of the integrated multi-scalar approach, which is studied throughout this paper. We finally provide some concluding remarks and highlight limitations and future research.

2. Literature Review: From Eco-Innovation and Eco-Urbanism to Eco-Fusion

In general, eco-urbanism research and practice are focused on environmental sustainability. Still, they should be studied and understood from the essence of innovations that consider all sustainability dimensions, including the social and economic aspects [10,11]. The first part of the literature review presents an in-depth understanding of eco-innovation

and eco-urbanism before delving into arguments on the multi-level perspectives about this topic and its linkage with the concept of eco-fusion. The second part of the review serves as a more detailed discussion about the idea of eco-fusion. It provides a better understanding of how it sits in eco-urbanism as part of the overarching sustainability studies in the built environment.

Even if the concept of eco/green in the built environment goes further back than the 1980s, it only came to widespread use in the late 1980s when Richard Register coined the concept of eco-city. The concept is strongly based on the values of urban ecology and building cities for a healthier future. It was then when the concept of eco, and particularly eco-city, was idealized as a new approach to urban planning focused on governance and living within the means of the natural environments [12,13]. In most contexts, the terminologies of eco and green development are very similar to each other or are commonly interchangeable [14]. In essence, both terminologies address the ecological dimension of any development, particularly in the field of urbanism. Nevertheless, what we mean by "eco" is very much dependent on the sector and the context in which we discuss the term. In this regard, it is also essential to highlight the linkage between innovation and sustainability that emerged as the notion of eco-innovation [15]. Since then, the term is recognized as a breakthrough in sustainability and innovation [16–19]. The later definitions of the concept highlight sustainability factors, such as reducing environmental impact [20] and tools of change towards sustainable development [7]. In theory, eco-innovation can easily be understood as part of eco-development thinking, as it clearly defines the goals of environmental sustainability, technological advancements, eco-planning, eco-design, eco-efficiency, environmental technology, environmental design, and sustainable innovation [6].

In practice, eco-innovation is realized as the development of products and processes to achieve eco-development, one of which is eco-urbanism in the planning and design practices. Hence, eco-urbanism's integrative nature holds an opportunity for multi-scalar research and consideration of multiple dimensions of urbanism [2,21,22]. Eco-urbanism addresses the ecological attributes of city environments, or urban ecologies, which are increasingly important in the field of urbanism. Moreover, eco-urbanism indicates a very different understanding of ecology, particularly related to urbanism's ecological sciences [23,24]. It addresses the ecological and environmental sensitivity of urban environments [25,26]. It is also commonly confused with the term "urban ecology", which refers to the understanding of integrating eco into the field of urban planning and design [27–29], i.e., the integration of ecological understanding of the city environments as part of the overall eco-urbanism approach, which includes both eco-planning and eco-design features. Urban ecology is a scientific field of research in urbanism [30] and differs from the understanding of eco-urbanism.

Furthermore, urban ecology is utilized to better understand the workability of urban systems [31,32]. It should be seen as the state-of-the-science through heterogeneous human-environment systems and spatial considerations [33]. On the other hand, eco-urbanism's discourse highlights a more holistic understanding of ecologies in the urban environments and as part of planning and design practices. Hence, eco-urbanism is mainly defined as an approach that addresses urban environments' environmental and ecological features [8,9,34]. In contrast, urban ecology is "the study of the ways that human and ecological systems evolve together in urbanizing regions" [35] (p. 14). It "integrates both basic (i.e., fundamental) and applied (i.e., problem-oriented) and social science research to explore and elucidate the multiple dimensions of urban ecosystems" [36] (p. 9). In this sense, eco-urbanism is more practical, guiding, and is applied in the planning and design process. For instance, a layer-approach to planning needs scale analysis of eco-development [2,22].

The applicability of eco-urbanism in the practice of eco-development is a field composed of planning and design directions, methods, and paradigms. However, the central dimension remains as the promotion of ecologically sustainable urban development [9,37]. Eco-urbanism embodies the idea of urban living in harmony with natural environments [38]. As is highlighted in the well-known Brundtland Report, "...the 'environment' is where

we live; and 'development' is what we all do in attempting to improve our lot within that abode. The two are inseparable" [39] (p. 7). In this regard, eco-development and eco-urbanism can help merge the two worlds of built and natural environments; hence, it is regarded as 'harmonious living', or 'ecological civilization', both of which are commonly used as key terminologies for eco-development approaches. The latter has been commonly used in China since its introduction in 2007. It is also part of the sustainable urban development movement [40], which progressed soon after pilot projects were implemented across the country from 2009 onwards. In more recent years, eco-urbanism is often regarded as ecological urbanism [41] or associated with analytical studies of urban eco-efficiency [42,43]. Nevertheless, as a field of research, it is mainly fabricated from the previous movements of sustainable urbanism.

It is therefore essential to reflect on the values of eco-urbanism on planning processes and how they utilize sustainability as a guiding framework, i.e., "a paradigm shift from physical determinism to sustainability-based pluralism" [9] (p. 13). By recognizing how eco-urbanism can contribute to sustainable development ideals, we can enhance how conventional planning is processed and implemented. More importantly, although it has been practiced at multiple spatial scales/levels of the built environment [1,9,22], eco-urbanism is yet to be explored through the interplay of various scales [2] or in a more integrated approach at the planning and design levels. In conclusion, the proposed concept of eco-fusion that sits in the practice of eco-urbanism explores the potential of multiple spatial levels' interplay, spanning from the city to the single building dimension, and aims at achieving a holistic and multi-dimensional eco-development approach.

3. The Notion of Eco-Fusion and Its Implications

From the notions of eco-innovations, urban ecology, and eco-urbanism, illustrated through the literature review, we note the concept of eco-fusion sits in the practice of eco-urbanism. The integrated model of eco-fusion is an advanced practice-based urban sustainability conception that enhances the interplay among multiple scales of the built environment [1]. This concept draws upon eco-urbanism ideals and supports eco-design and eco-planning solutions with the intention to achieve sustainable development at multiple scales, as well as recognizing scalar tradeoffs. We offer two ways to better understand the meaning and the implications of eco-fusion, as exemplified in Figure 2. In Model A, eco-fusion sits among the three spatial levels of eco-city, eco-community, and eco-building, i.e., through eco-urbanism practices. Although the boundaries are fixed, we can recognize that these levels will be in a constant state of flux. Moreover, the diagram shows the central overlapping point among these three spatial dimensions. On the other hand, Model B explains how eco-fusion vertically runs through all three scales as a synergetic linking mechanism. This model is space-based, and it is related to the interplay among the three different practices of eco-urbanism. In other words, eco-fusion can be likened to a telescope that is continuously zooming in and out to bring into sharper focus the scalar developments. While we might hope that the lens is never static, temporary halts, for both analytical and practice reasons, are needed to explore how relationships are changing, and ideas of sustainability are progressing within and between scales.

In the existing research, many of the eco-urbanism studies focus on one spatial level. Only a handful of studies respond to a multiple scalar understanding of eco-urbanism [1,2,39,44]. Among these, the "eco-city study" is the most common, which is not necessarily the best of all spatial levels due to its complexities in transitions and institutional arrangements [45]. By analyzing the Chinese context, we can verify that nearly all eco-city projects to date are either located on reclaimed lands [46] or are enclaved experimental projects in or around cities [47]. In both cases, very little attention is given to understanding the development's capacity for innovation, and much of the focus remains on the overall development of the KPI systems instead. While this happens in most cases at the larger scale of development, planners and developers of those projects often find it challenging to implement their strategies holistically and at a smaller scale. For this reason, the first round

of eco-city projects is known as experimental cases, setting a mark for future policies and practical paradigms [5]. Similarly, at the neighborhood/community level, there are many experimental cases of planning, where we see innovative design strategies that are tested at a relatively smaller scale. However, there is often no correlation between these meso-scale projects and the macro-level strategies or planning systems, which creates deficiencies in the practice of eco-urbanism [2]. This also means that there is a high possibility of having smaller eco projects that do not scale up or are not integrated into or exported to the larger scale of district or city level. At the building level, there is substantial progress on green technologies and eco-design solutions, but little has been done to combine the building scale eco-design strategies with the subsequent larger scales of planning.

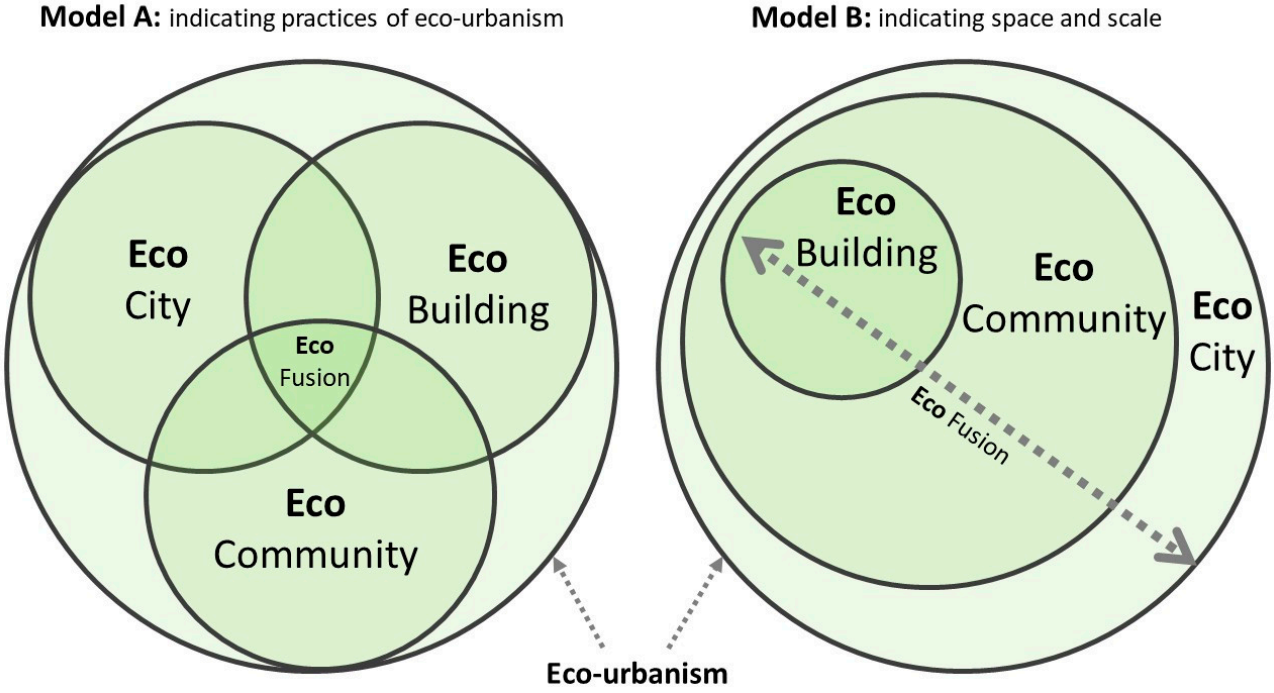

Figure 2. Two models of eco-fusion and how it sits in eco-urbanism and its three spatial levels of eco-city, eco-community, and eco-building (Source: the authors' own).

Eco-fusion is then a representation of integrated eco-urbanism, integrating eco-development strategies across multiple spatial levels of the built environment. Nevertheless, integration and multi-level analysis do not end in themselves as they need to have a purpose for the practice of eco-urbanism. In eco-fusion, the multiplicity of spatial levels is based on the three factors of (1) integrated urban planning and design opportunities, (2) interplay across and in between multiple levels, and (3) holistic approach to urbanism that utilizes innovative strategies and practices. Hence, eco-fusion is mainly utilized to achieve eco-urbanism in the built environment by mainly considering the interplay between multiple spatial levels. This approach considers the integration of eco/green strategies from the practice of a singular spatial level and how they can come together at multiple levels and form a holistic practice of eco-urbanism. The proposed Model B of Figure 2 is modestly demonstrated as city/district → community/neighborhood → site/building. In this procedural approach, similar to the one adopted by [21], each scale is identified individually and integrated into the other two scales. This means that while each dimension's practices are well defined on their own, they also link to the other scales of the built environment. By doing so, we allow for holistic thinking in eco-urbanism that goes beyond just the practice of integration.

This multi-scalar approach can offer a blend of eco-development strategies and possibilities that may eventually (and potentially) enhance the current practice of eco-urbanism

(both planning and design), comprising the three levels of eco-city, eco-community, and eco-building. This enables us to consider eco-development through its horizontal indicators and dimensions and its verticality of scale, implementation, and governance. In other words, eco-strategies can vertically run through our spatial levels, creating a more comprehensive process of city management and integration in planning and design [2]. Furthermore, this enables creating a more transparent and practical framework for stakeholder constellations at different levels, such as the city/municipal management level, the district level, and communities and site management. By doing so, projects of such a kind provide a more coherent approach to realizing eco-strategies that involve multiple stakeholders (e.g., decision-makers, practitioners, planners, designers, and developers) operating at different scales. In this process, it is possible to anticipate better information sharing for project data, a more comprehensive management network, and a much-enhanced dialogue among the engaged parties. The concept of eco-fusion is then developed as an approach to consolidate eco-strategies in both horizontal and vertical directions and to enable better management for governance and adaptability for innovation [1].

Through further analysis of eco-city development projects in China [5], we can identify efficient and innovative trends at their individual scales. Therefore, to thoroughly test the idea of eco-fusion in practice, a particular pilot project was initiated and examined. In this exploratory case study, planning and design processes were conducted at three levels and considering the interplay between these spatial scales. After the methodology section, we introduce this case study. We then conduct a detailed analysis of individual spatial levels before highlighting the results.

4. Methodology

This study benefits from using an exploratory case study to assess the applicability of the eco-fusion concept. In doing so, this research study includes four methodological packages, representing four steps of the study's methodological framework. The first step is case study selection. In this step, we identify Ningbo as an exploratory case for two reasons: (a) the selected case study area is a new urban project site, and (b) the city plans to promote green development through this new development. For these two reasons, the site is representative of a newly built case and has a specific KPI system for green/eco-development. A detailed case study introduction supports the first step. The case of Ningbo is a representative case of a city, which aims to promote green development in its new development areas. The case is not ubiquitous but is used as an exploratory study rather a scientific case study.

Second, we conduct a general case study analysis, including zoning analysis, planning features analysis, and contextual analysis. In doing so, we highlight the primary green/eco strategies of the area and the project phases and design strategies of the site. Third, we analyze the case through individual spatial levels of macro, meso, and micro. In doing so, we explore the project KPIs, planning and design strategies, and contextual characteristics of the area. This step is supported by our exploratory work that includes urban structure analysis of the area at the macro level, KPI breakdown and masterplanning strategies at the meso level, and KPI definition and design consideration at the micro level. In the last step, we focus on results and discussions by considering three key areas of interaction between the three studied spatial levels, integration between them for a multi-scalar approach, and defining the eco-fusion model through the exploratory example. All four steps are summarized in Figure 3 below.

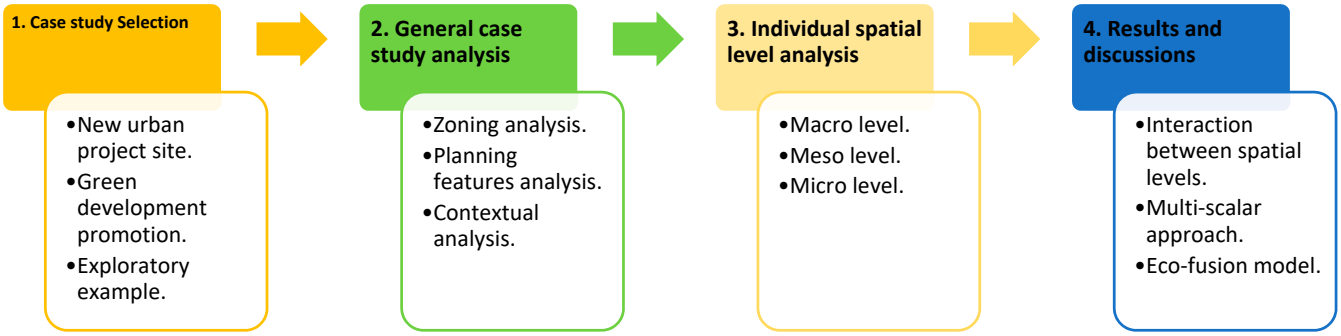

Figure 3. Summary of the methodological framework of the study (source: the authors' own).

5. Case Study: A Project Example for Defining Eco-Fusion in Practice

The municipality of Ningbo is an urban area on the Eastern edge of the Zhejiang Province, East China, and it has the world's fourth-largest port in terms of annual throughput in 2019 [48]. As one of the main provincial cities (second to Hangzhou, the province capital), Ningbo plays a strategic role in the region's industrial development and marine economy [49]. The greater Ningbo area is home to around 10 million people and comprises 11 districts, with five of them located outside the urban region (Figure 4). Apart from its current six main districts, the city has recently proposed developing various new districts in the near future, including the site for this study, the New East Town (NET).

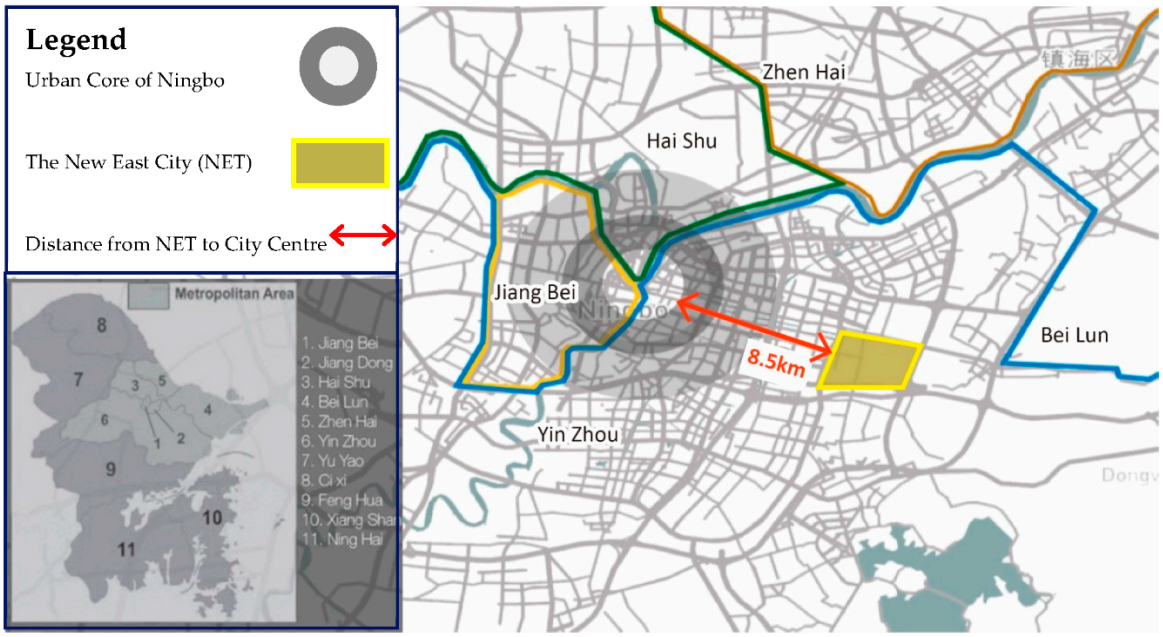

Figure 4. Location and proximity of New East City in the City of Ningbo; note: the rectangular red site in the east is the New East Town (NET) (Source: Project Booklet of Eco-Fusion programme, generated in autumn 2016).

As shown in Figure 4, in the overall planning of Ningbo City, the NET appears as a comprehensive zone located on the Eastern side of the city. Apart from its functionality as a new business district, the NET is home to several administrative offices, focusing on developing financial service trade, business, conference and exhibition, administrative management, public culture, and city functions. It also aims to improve the current standards of business services and living, leisure, and entertainment facilities while becoming one of the most important logistics and transportation nodes of the city [49,50]. Much of this is owed to its strategic location between the main ports of Ningbo and the central areas

of the city. According to the government's plan, the new development is proposed to create a significant transitory zone and a destination of its own.

The NET development is divided into two main phases, of which the first is currently near completion. As shown in Figure 5, the whole area is divided into two parts: (1) one central region located on the western side, which is almost completed, and (2) a periphery region located on the eastern side that includes a large body of brownfields and farm housing areas, together with an existing old town, which is mostly completed at the current date [51–54]. A prolonged eco-corridor, mostly completed and operational and functioning as a green buffer, separates the two development phases. It serves as a central linear ecological park for the NET, and it is the largest of its kind in the City of Ningbo. Secondary green corridors define the district's perimeter, and they are particularly visible on the two eastern and western edges. An east-to-west central corridor is also introduced to create a tangible functional connection, landscaping network, and circulation between the project's two phases [51,55]. Moreover, the zoning planning of the NET indicates a cluster of central active areas, a mixed-use business area on the western side, and a primarily residential development on the eastern one, as shown in Figure 6.

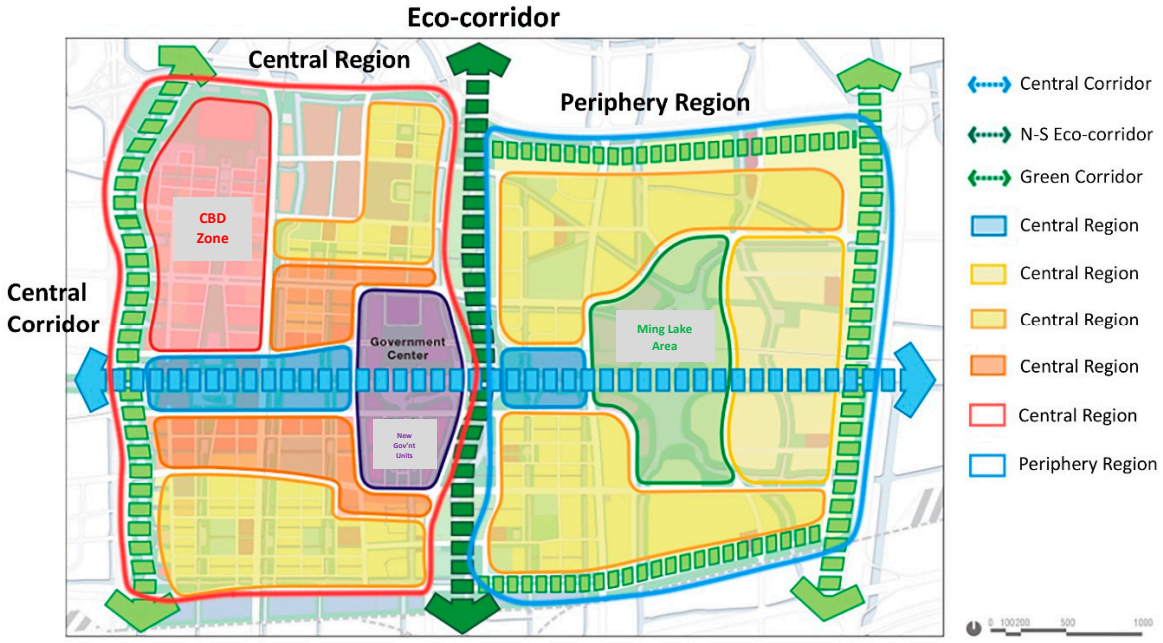

Figure 5. Demonstration of different zones of the New East Town (NET) in the City of Ningbo with its eco-corridor in between phase 1 (right side—Central Region) and phase 2 (left side—Periphery Region) of the whole development zone (Source: Project Booklet of Eco-Fusion programme, adapted from [54,55]).

In addition to these green infrastructures, an underground transportation hub, a bus station, and related projects offer new transportation routes and linkages. There is also an underground pedestrian transfer, a transformative project for this major urban hub [49–51]. During the first phase, the project included a significant area of the business district, high-rise buildings of offices and finance zones, hotels, governmental buildings, exhibitions, and new retail and housing areas [50]. In this phase, very little consideration of eco-strategies was incorporated into the overall planning. The eastern part of the zone comprises new development areas for housing, retails, services, and the old town area's refurbishment. The project managers have decided to bring in a new direction of eco-urbanism and green development into the sites' planning and development. In this phase, a new artificial lake named Ming Lake (still under construction) has been proposed as part of the new area's water resilient strategies, namely for demonstration of the Sponge City Programme (SCP) in the NET zone. Hence, as part of the green development strate-

gies, the officials have taken the lead to develop a new set of eco/green and sponge development strategies.

Figure 6. Zoning drawing of New East Ningbo area (Source: Project Booklet of Eco-Fusion programme, adapted from [53,54]).

To better explore the concept of eco-fusion, this project is developed in a procedural approach at three spatial levels. Several masterplan options are developed as part of the step-by-step development in the planning phase in collaboration with the local government officials. At a later stage, several architectural design interventions are proposed at the micro level. This enables us to define eco-fusion and then describe how it is applied in a multi-scalar practice [2,22]. The overarching perspective of eco-urbanism and eco-fusion integration is a strategic approach to mid-stage masterplan development and later design interventions. Hence, the eco-fusion process starts with an overall analysis of the city and the zones (at the sub-district level) before zooming in to the allocated eco/green development area of the project. The meso scale then includes an "eco-planning" exercise before it breaks into proposed urban blocks at the site level. It is then further developed at the final stage of eco-building design intervention, with consecutive design strategy refinement based on the project's earlier stages.

5.1. Eco-Fusion at the Macro Level

Generally, the starting point of planning and design practices is at the macro-level, which provides an analytical understanding of the project in its larger context of city, district, and area. However, macro-level studies of eco-urbanism projects often include very few design implications at a detailed scale. At such a level, the focus is on planning issues of the larger context of the city or district level. For instance, Figure 7 demonstrates the conducted assessment of the green structure of the NET, which reflects on the sub-

district conditions. Through further analysis in the immediate context and surrounding areas, this approach enables us to have a better grasp of the urban structure. This is an example of the green space framework of NET from the spatial planning perspective of the macro scale.

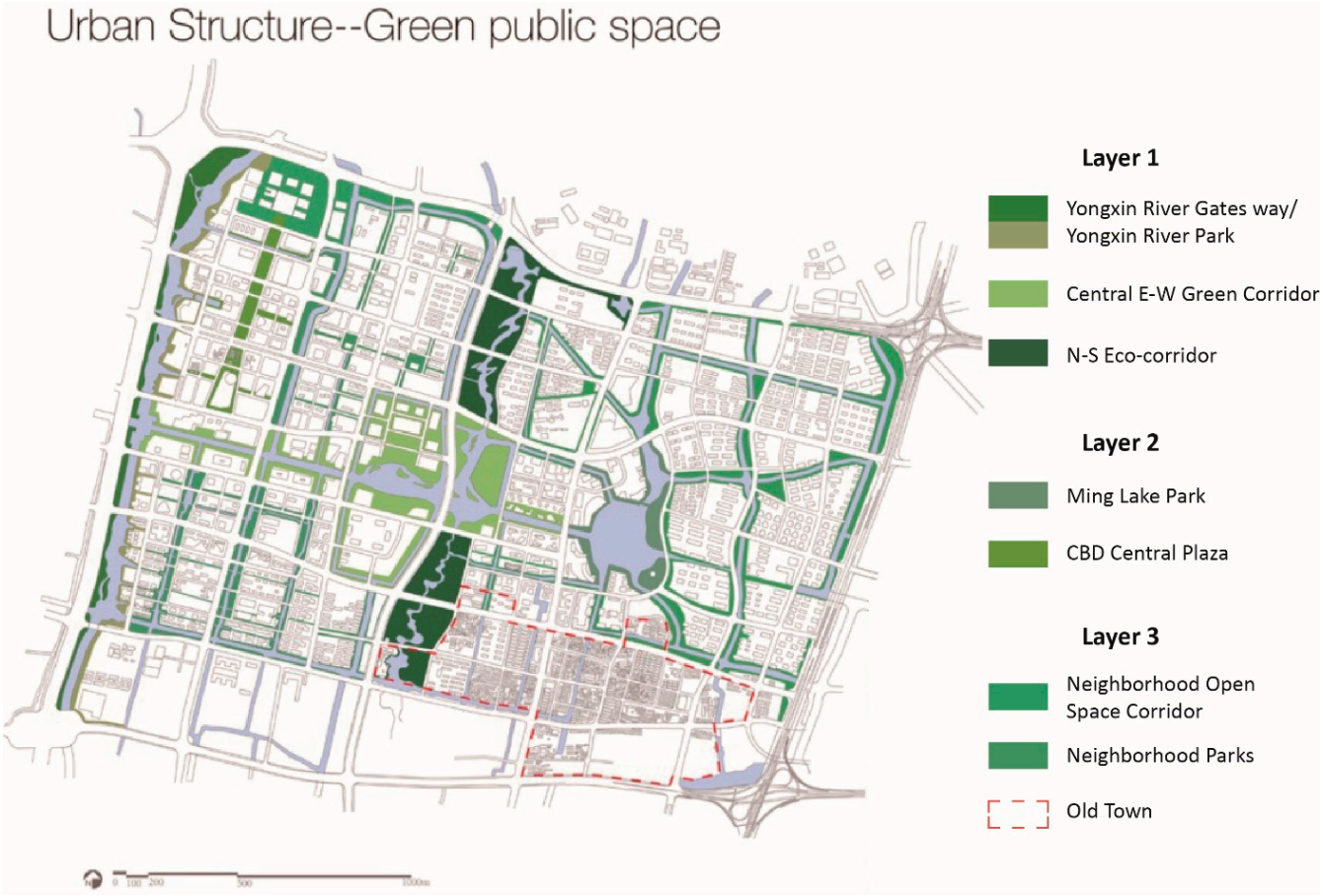

Figure 7. Urban Green Structure of the NET, Ningbo (Source: Project Booklet of Eco-Fusion programme, adapted from governmental planning documents [56].

In terms of the NET's urban fabric, the planning and design practices at the macro level assume Ming Lake as the core to build a park. Once completed, it will be surrounded by commercial leisure, star-rated hotels, businesses, commercial offices, and cultural entertainment around the lake and surrounding areas. Meanwhile, along the main river, a finger-like waterfront green space is formed to define the green belt system of Ming Lake. The green belt landscape of the NET is constructed together with the N–S eco-corridor. The plan for the western part of Ming Lake is mainly to build the canal culture diffuse space, while the plan for the eastern part of Ming Lake is primarily to build a decent liveable ecological environment. Through the greenway system and the pedestrian-friendly street network, the park is connected in series to form an open space pattern system covering the whole area of 500 m, which is conducive to the connection of public space and supporting facilities, providing the public space for residents to relax and exercise.

From the eco-urbanism perspective, such studies provide a better overview of the natural environments within the development area, both existing and proposed. For instance, the hierarchy of green infrastructure and their variety are highlighted based on their functionality and as part of the overall spatial planning strategy. More importantly, the macro-level planning assessments provide a multi-layered dimension of natural environments and their networks, status, and integration in a larger context [53]. Usually, eco-urbanism projects start from a larger scale before zooming in to a particular site or

building plot. Similarly, what we have here is a full demonstration of how a particular site sits in a larger context of mixed green spaces, urban corridors (such as eco-corridor), water-net bodies, and other natural habitats. If to be planned, the macro-level planning stage suggests the overall ideas of green development, including proposals for KPIs, spatial planning strategies, and integrated design solutions.

In sum, eco-urbanism at the macro level is an amalgamation of multiple aspects, mainly narrated as the overall contextual analysis. This is already a multi-layered approach with requirements of defining the local conditions comprised of socio-spatial configurations, environmental/ecological and geographical attributes, morphological understanding of the overall urban context on a larger scale, and associated patterns like demography, natural environments, and networks/connectivity of the built environment. This enables further development of the groundwork for developing the KPI system at the meso level.

5.2. Eco-Fusion at the Meso Level

At the meso scale, the level of design and planning changes. This community level of the built environment is crucial in many new development zones like the NET. So far, the eco-planning directions at this level are scarce. This is the scale where the KPIs are then developed to guide implementation and to be tested in monitoring and assessment, leading to the gradual development of masterplans and spatial configurations. In a design process, mesoscale master planning requires careful site analysis; an example of which is a detailed vegetation study, as shown in Figure 8.

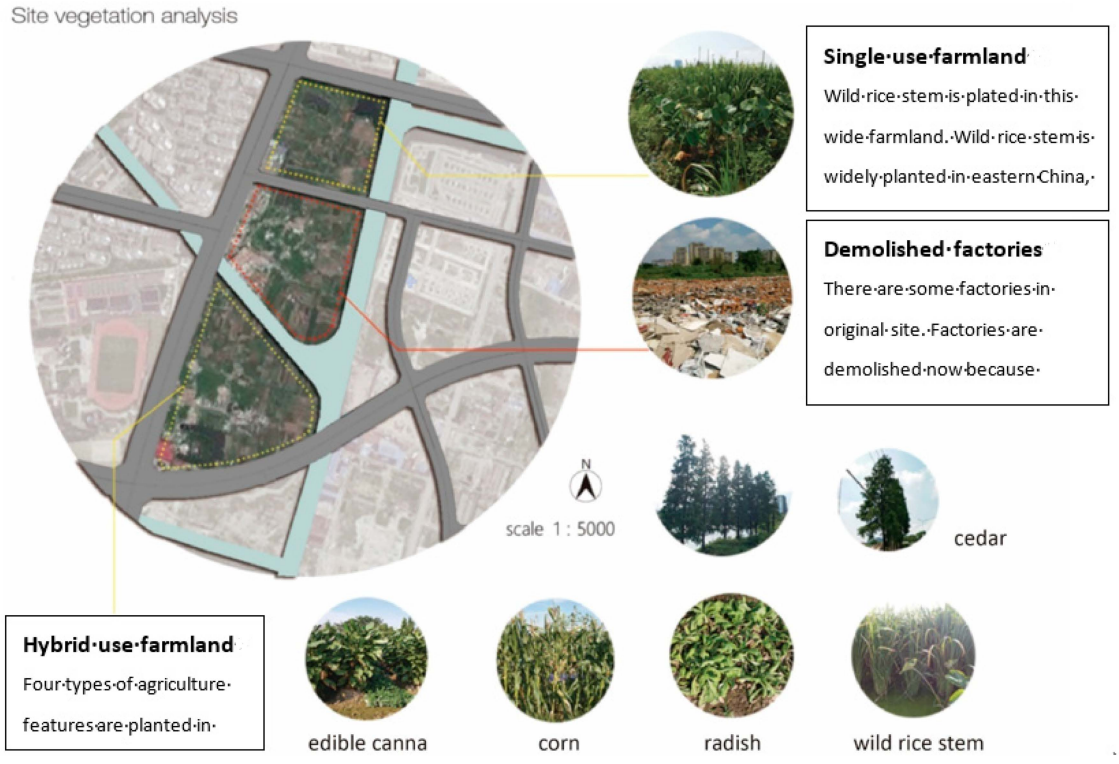

Figure 8. Site vegetation analysis at meso scale (Source: Project Booklet of Eco-Fusion programme, digitally archived in the department's projects, generated in Autumn 2016).

At the meso scale, the philosophy of eco-urbanism is expected to be fully implemented in practice in preparation for the construction phase. It is the scale where we devise a more design-oriented approach that requires the understanding of KPIs, the goals of eco-urbanism, and the project's deliverables. At this scale, we delve into the integration of eco-planning strategies with eco-design approaches that should emerge in the interplay between meso and micro scales. In contemporary China, most of the new urban development

projects start at this level, where relatively large-scale planning and a set of urban design control strategies are implemented [57]. To ensure representing an eco-urban neighborhood, one must address the integration of multiple planning and design principles that lead to the facilitation of eco-urbanism ideals in practice [58]. Therefore, the planning and design measures play a significant role in the initial development, later modifications, and final implementation and construction phases of the development.

The eco-urbanism strategies are then translated and transferred to a more detailed design level where eco-strategies and developed KPIs are utilized systematically in the design development process. For this project study, each of the five masterplan interventions included and applied a set of KPIs related to their specific eco-urbanism concept, such as water, green infrastructure, density modeling, and urban layout. For instance, for the KPI on flooding resilient measures, we utilize a context-specific spatial strategy planning of 30–40% green space allocation in the masterplan. In another example, for recycled rainwater indicators, we provide non-traditional water utilization of over 30% through green roof design and technological purification facilities. Apart from the environmental indicators, other KPIs include social, economic, transport/mobility (including accessibility, walkability, and parking strategies) that respond to the masterplans' overall eco-strategies. The below master plan is selected as one of the five eco master plan projects under the eco-fusion master planning schemes. The project highlights green infrastructure as the primary eco feature of this particular proposal.

In this scheme (Figure 9), a larger part of the area is devoted to urban farming units and integrated urban parks, which are identified as part of the green infrastructure (GI) planning. Most of these spaces and functionalities are designed through an integrated spatial planning approach of the GIs, focused on accessible and functional green spaces and resilient measures that are in place for the eco-urbanism strategy of the master plan. In this case, much of the GI use in the northern edge of the site is for on-site food production units, following the concept of urban farming, which was implemented in the green promotion of the area at the macro level. In the central areas, green spaces are designated for children's playing areas, leisure, and education spaces, where the site is also maintained for flooding measures. This point responds to both the multiple environmental and socio-economic benefits of GI use and the implementation of the sponge initiative in the masterplan. The importance of accessibility to green spaces and functionality of green spaces was then considered as a central strategy in the later design development at the micro scale (i.e., building intervention).

This masterplan generates an idea of eco-urbanism from the perspective of green space and a self-sufficient living environment. Production and consumption are maintained within the boundaries of the community/neighborhood level. It also creates a hierarchy of GIs that are responsive to flooding issues that threaten the site's resilience against heavy rainfall and overflow of the nearby (proposed) artificial lake located towards the southern edge of the site—i.e., the Ming Lake. The masterplan was then directed towards the integration of ecological values into the site. These values are driven from the macro-level strategies and into the spatial planning strategies at the meso scale and the later master plan proposal. One of the most important aspects of eco planning and/or design at the meso scale is implementing design directions and the actual execution of KPIs at a smaller scale [2]. As an example of eco-urbanism at the master planning phase, the scheme responds to both the sustainability KPIs and the pattern of development that is expected from the eco-planning and eco-design directions.

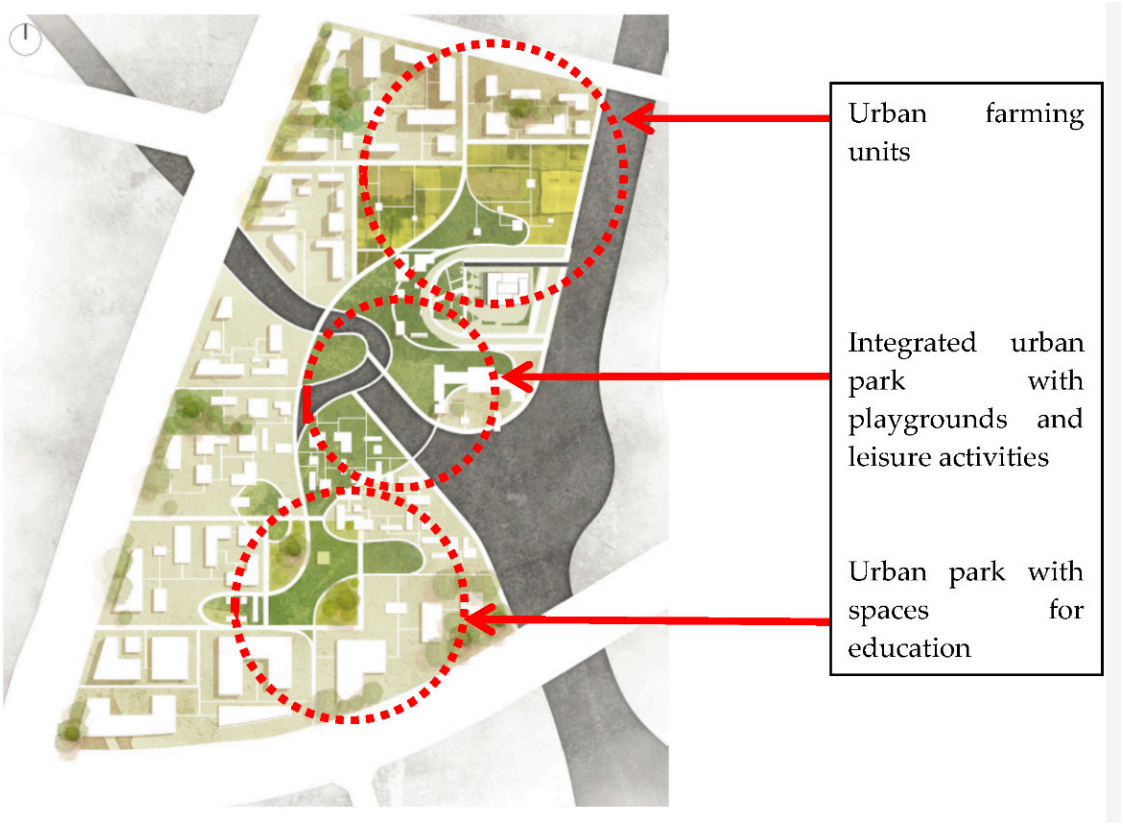

Figure 9. One of the masterplan examples of the site, with the theme of eco-fusion as the backbone of project development at three consecutive levels (Source: Project Booklet of Eco-Fusion programme, digitally archived in the department's projects, generated in autumn 2016).

5.3. Eco-Fusion at the Micro Level

Generally, the micro level is known as the detailed design level and is often inclusive of design interventions that provide a proposal of either a single building or a cluster of buildings. (The argument of the macro, meso and micro planning and design level is different from the three levels of planning in China, namely Master Plan (zhengti guihua), Detailed Regulatory Plan (kongzhixing xiangxi guihua), and Detailed Construction Plan (xiujianxing xiangxi guihua.) Alternatively, design at the micro level could suggest strategic directions for later scheme development through a horizontal progression, which is in addition to this verticality of design development at multiple scales. As part of the same masterplan proposal shown in Figure 9, an attempt was made to develop a vertical farming unit (see Figure 10). At this scale, green technologies and installations are recognized as key areas of progression [1]. The earlier assessments at the macro level, KPI development at the meso level, and the masterplan proposal towards the later stage of the meso level are now narrowed down to detailed urban design and into the formation of an architectural intervention, i.e., eco/green building design. At this scale, the type of building intervention is associated with the overall masterplan project. This method should ideally respond to the overall aims and objectives of the proposed eco-urbanism, which addresses both horizontality and verticality of development.

By doing so, a building project will not be alienated from the overall masterplan phase and will be subject to directions of the KPIs and concept of eco-urbanism at the larger scales. At this phase, the concept of eco-fusion is interpreted in the interplay of the design development process and reflects on the common practice of enclaved eco/green architectural design. Nevertheless, not all projects include the opportunity to have multiple scales in planning and design development; therefore, this design thinking method is mainly applicable for projects that include both urban design and architectural

interventions in the same direction, as it happens from eco-planning to eco-design. In the cases of having only the eco-design of a building project, the intervention would simply be a standalone eco/green design project.

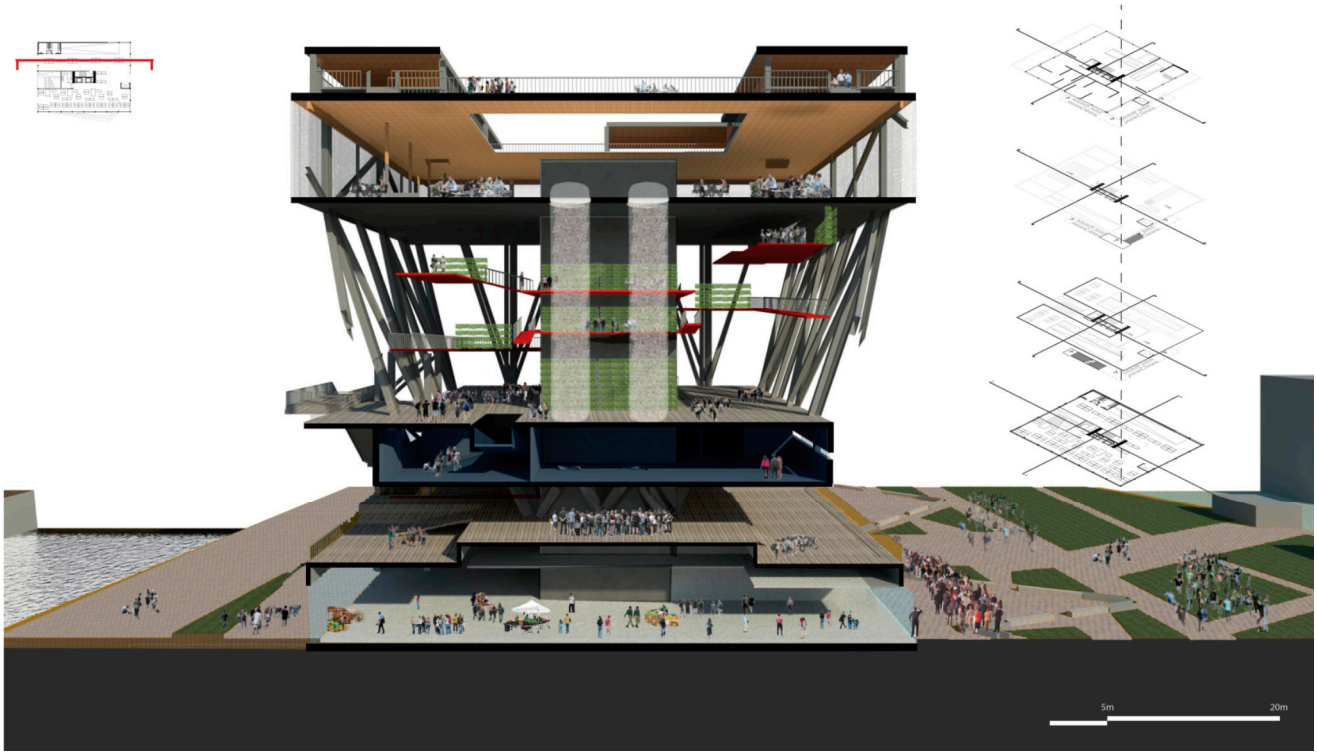

Figure 10. One example of a green building design at the micro scale. Typology: vertical urban farming with mixed uses (Source: Project Booklet of Eco-Fusion programme, digitally archived in the Department's projects, generated in spring 2017).

Furthermore, we confirm that the performance of eco-fusion at the micro-level influences the other scales. We can argue that it is at this scale where we can refer back to the KPIs of the meso scale and ecological values of the macro scale; i.e., the essence of eco-urbanism at the design development stage comes into its final form. The final product of building design depends on how the masterplan strategies are developed and devolved in a process rather than as standalone projects. By doing so, we can respond to issues that often exist in the conventional planning or eco-urbanism approach at a singular scale. By reaching this micro-level stage, we can identify the materiality of eco–urbanism at a more perceptible scale of building design, which is significantly different in comparison to larger scales of meso and macro. These differences are based on each level's components and changes in their attention—i.e., at the macro-level, they are generally policy-oriented; at the meso-level, they are socially oriented; and at the micro-level, they are technologically oriented [2].

5.4. Results

In this paper, a case study is used as an exploratory study to suggest the importance of multi-scalar practice in the broader field of eco-urbanism. This is defined as the new conception of eco-fusion. The results are summarized in four areas. First, the study highlights the importance of the multi-scalar approach, as shown specifically in two models of Figure 2. In model A, we see the example of replicating the sustainable development model in the central point of three classical sustainability dimensions of social, environmental, and economic. Instead of dimensions, we have three spatial levels of macro, meso, and micro, and the eco-fusion model is achieved by implementing the eco/green indicators at three spatial levels. However, in model B, we propose integrated urban planning and

design opportunities, which are defined as the interplay across and between multiple levels of the built environment (i.e., macro, meso, and micro). This research paper's exploratory case study examines this interplay and its practical effectiveness in achieving a multi-scalar eco-urbanism model.

Second, our exploration here helps consider the use of KPIs and eco planning/design strategies to inform design. In doing so, both the design process and final design are considered. The recommendations are twofold, (a) to consider eco-fusion in a procedural approach and (b) to interpret eco-fusion as a tool for design decision-making. Third, the study's findings suggest the implementation and interpretation of KPIs and their breakdown in the process of design decision-making. The utilization of KPIs or KPI systems is suggested to reflect more broadly on contextual factors, eco/green promotion processes, and planning and design interventions. In particular, our exploratory case study's findings highlight methods of breaking down KPIs into smaller spatial levels, particularly at the design-level. This is often a difficulty in the practice of eco-urbanism [2], which could be addressed in a holistic process of interpreting larger-scale KPIs at the community and site levels. Fourth, this exploratory study results suggest a better understanding of urban sustainability practices from the consideration of integrating the three spatial levels of the built environment. We have achieved this by exploring each scale, identified individually and integrated into the other two scales. Therefore, the study examines this model through the promising interplay between three spatial levels. In doing so, we could achieve: (a) integrated urban planning at the macro level, (b) integrated urban design at the meso level, and (c) integrated building design at the micro level and the integration of buildings in a larger context. In sum, the results of the study verify the practical values of the new conception of eco-fusion. The conception, however, should be further examined in future urban construction projects. In doing so, we could move towards an integrated multi-scalar approach in eco-urbanism.

6. Discussion: Towards an Integrated Multi-Scalar Approach

In eco-fusion, the final product is not as important as the development process that occurs at and in between various scales. Figure 2 in the earlier section of the paper represents two methods of achieving eco-fusion in practice, and Figure 11 below provides an overview of the eco-fusion model in practice. As the concept is developed through multiple spatial levels of the built environment, a singular spatial level is no longer verified on its own. Therefore, each spatial level is developed in conjunction with other scales of the built environment, which occurs in a procedural approach [21]. As demonstrated in this paper, the project examples highlight this process in three interlinked stages, benefiting one another in an integrated process. The integration of eco-design thinking as a multi-scalar approach suggests a unified method of eco-urbanism, but from the consideration of eco-district (or eco-city in a larger context), eco-community/neighborhood, and eco-building (or often known as the green building). The eco-urbanism development phases are taken into a process and distinguished as the following: eco-planning → eco-masterplan/urban design → eco/green building design (Figure 11). This process is also more in line with the proposed "Type B" represented in Figure 2.

Like any other planning procedures, there is often a mismatch between the rhetorical situations and the realities in eco-urbanism [9]. The process in which eco-development is developed, maintained and monitored needs to become more confined in one package than at separate scales. As an approach to address challenges posed by climate change and resource constraints [59], eco-urbanism should be understood more holistically. This means it is not feasible to address these challenges at one scale alone. Hence, we should consider the variety of size, spatiality, socio-political status/context, and types of development across different scales [60]. An integrated method in eco-urbanism is only then possible once the obstacles between spatial levels are abolished or minimized for better operations. Hence, the multiple scalar approach [2,22] provides an opportunity for a procedural approach to planning and design development [21]. Incorporating green technologies and systems

in eco-urbanism should then be structured both horizontally and vertically in the overall framework of a specific masterplan or development.

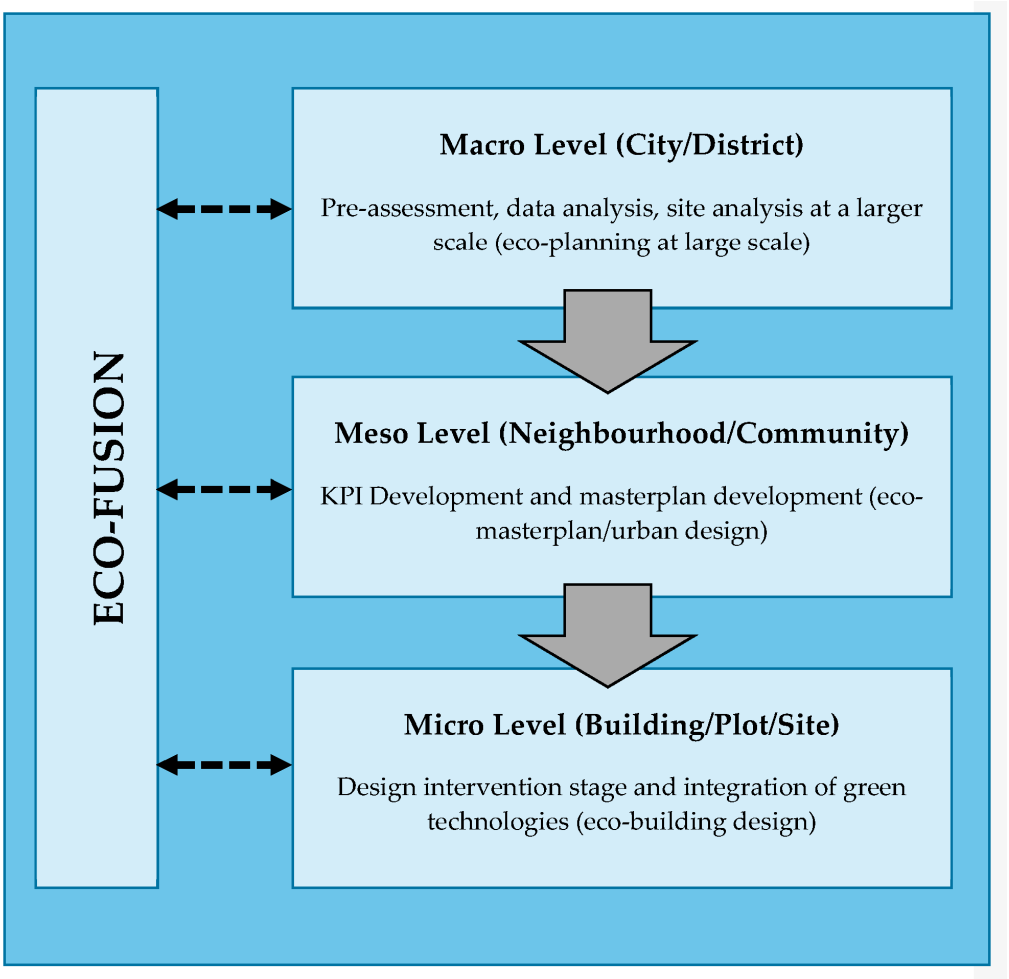

Figure 11. Summary of the Eco-Fusion Model and the interplay between three spatial levels including the necessary practical directions. Note: this figure responds to both the scalar approach and the integration of thinking in eco-fusion, developed mainly from Figures 1 and 2. This figure simplifies the conception based on the requirements of each scale and what is expected as part of the overall planning and design thinking of eco-fusion for the practice of eco-urbanism.

In summary, this paper directly responds to the challenges we face in implementing eco-urbanism ideals in practice, particularly in meeting the ever-growing climate change impacts on cities and seeking suitable sustainable urban development pathways. Through the project example, we can verify that eco-fusion, as a multiplexed paradigm, benefits from the variety of innovation platforms that we currently practice, not only the commonly-taken environmental dimension but also social, institutional, and economic dimensions [60–62]. This includes examples of multi-dimensional innovation that creates pathways to extended areas of the circular economy [63,64], green development, and smart development [5,65,66]. This includes applying three innovation dimensions comprising technological, institutional, and business models [67] that respond to the overall goals of sustainable development [68–70]. As an approach of its own, eco-fusion provides holistic thinking in planning and design that enhances the interplay between various spatial levels, develops synergies between them, and suggests integrated eco-urbanism solutions. It is arguable that the concept existed as the integrated model of eco-urbanism for years but was barely discussed in academia. Hence, its recognition as a holistic approach or model of eco-urbanism is essential in the field, and this paper contributed to this through a practical

pilot case. As highlighted earlier, this study introduced the concept of eco-fusion at first and then demonstrated how this concept is interpreted in a design development process. For future research directions, we believe that there is still scope for innovation to suggest new methods of governance, implementation, and the development of new paradigms for eco-urbanism.

Our thinking needs to be more critical and integrated if we intend to move beyond the rhetorical and give substance to eco-urbanism as "a set of emerging responses . . . primarily concerned with attempts to construct integrated responses to infrastructure that cut across multiple infrastructure networks—energy, food, water, waste, etc.—and that are (re)bundled together at particular scales in the design of new buildings, neighbourhoods, towns, blocks, and cities" [47] (p. 302). Furthermore, due to its multiplicity, eco-fusion explicitly links up the multi-scale innovations and strategies of eco-planning and design with integrated thinking to recognize that there can be tradeoffs between scales. The tradeoffs could also be between sustainability dimensions (i.e., social, economic, and environmental imperatives) as we move towards more sustainable pathways [70]. Lastly, the new conception of eco-fusion, coined by Cheshmehzangi [1], draws attention to how commentators and practitioners seek to understand and promote urban development/urbanism at multiple scales.

7. Conclusions, Limitations and Future Research Directions

The study introduces the concept of eco-fusion through two stages. First, it frames the status of eco-ism and introduces various eco terms in the associated fields of research (e.g., sustainable development, urbanism, urban development, urban studies). This approach helps epitomize the term concerning those larger-scale concepts such as eco-development, eco-innovation, and eco-urbanism. This is developed through the adaptation of concepts and practice in eco-ism and innovation concerning this term for multi-scalar eco-urbanism practices. Second, the study illustrates the concept through a case and how it comes together in various scales. Many scholars have demonstrated the importance of the multi-scalar approach [2,21,22], as it provides a strong understanding of the horizontal and vertical development of eco-projects. Hence, as a concept, eco-fusion is vital in exploring the interplay between multiple spatial levels of the built environment. It also provides a benefit for project progression through a multitude of eco-strategies driven from eco-innovations and towards the development of eco-standards and benchmarks developed through systematic methods of KPIs and detailed design directions. In this regard, the case study example has demonstrated this approach through a development process, not just a design project or a research case study. We highlight the importance of the multiplicity and the multi-spatiality of eco-urbanism in the built environment. The concept of eco-fusion refers to this integration of multiple levels and the approach in which an eco-development process can be generated, nourished, and delivered. This new conception implies an augmented eco-innovation strategy for the field of eco-urbanism. Reflecting on the study's aims, the integration factor of eco-urbanism in practice has proven to be a multi-scalar approach. More importantly, this is vital to the development of the eco-fusion concept. The connectivity of eco-strategies through this step-by-step formation, as shown in the case study example, is crucial in the overall development process and can lead to a more comprehensive eco-urbanism approach. As a result, the interplay between different spatial levels is suggested for future research and practice directions.

The research's novelty suggests a new conception of eco-fusion that should be utilized at multiple levels of the built environment. Eco-fusion provides a set of intermediate stages in development while maintaining each spatial level interface in their own defined and distinguished contexts. Involving this would allow us to evaluate eco-urbanism both horizontally and vertically. Therefore, the interplay between different spatial levels is taken into account and integrates the natural and the built environment. As the concept indicates, this can be established by identifying and optimizing strategies through urban planning (macro level), neighborhood/community design (meso level), and building

design (micro level). To conclude, this study provides a new platform for future research on eco-development or eco-urbanism and particularly from a multi-scalar perspective or approach. It is not important in itself whether the NET represents an isolated or particular case as the research and practice of eco-fusion in a multi-scalar framework are very few in China. What matters is that even generalizability is limited to a certain extent. Therefore, a holistic approach or model from eco-urbanism to eco-fusion is suggested for future urban construction projects.

Lastly, there are two research limitations. First, the conception of eco-fusion is demonstrated through an exploratory design example in Ningbo. Though this is sufficient for presenting a new design conception, we believe it can be further improved through more case studies and practical urban projects. Second, there is scope to improve the methods used for decomposing KPIs from macro to micro levels. This can be achieved by conducting a mathematical analysis. Future research directions should involve a larger pool of cases and examine whether they can adopt this model. This study mainly offers exploratory research to establish eco-fusion as a concept in eco-urbanism. Based on this framework, the eco-fusion model can be further clarified and developed in the overarching area of sustainable urbanism. Moreover, there is still scope for innovation to suggest new methods of governance, implementation, and the development of new paradigms for eco-urbanism.

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