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Developments in Engineering and Architecture

Editors

Boyko RANGUELOV
Zharas G. BERDENOV
Recep EFE

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DEVELOPMENTS IN ENGINEERING AND ARCHITECTURE

Editors

Boyko RANGUELOV
Zharas G. BERDENOV
Recep EFE

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Yunus ESER

Preface

The book includes 20 scientific articles, which are presented in English in a volume of 324 pages. The chapters examine a wide range of current issues of architecture and engineering. The book includes the following topics:

Rain water harvest and application methods in cities, the relation between permaculture and urban landscape resilience, the assessment methods of river habitats, participation in urban management, urban identity through art and aestheticism, ecological site classification and mapping studies in forest ecosystems, campus open spaces and "triangulations, the intended use of plants in campus open green spaces, the elements of landscape in Islamic garden design, smart urban agriculture, environmental residential design project process in online education, antique revivalism: the empire style in Ottoman architecture, floating structural system design in response to effects of climate change on coastal areas, evolution of the courtyard house in the pre-Islamic period in Mesopotamia, the place of urban furniture in the formation of historical environmental identity, conflict analysis in natural resources, buildings and their surroundings in the context of an interior-exterior spatial relationship, in search of blind and active faults to the north Bulgarian Black Sea costal area and electrophoretic analysis of total protein profiles of some pluteus species.

This book contains current and important studies in education sciences. Each chapter is written by academicians who are experts in the subject. Therefore, we hope that it will be useful to health sciences professionals, students and other experts.

We would like to thank the authors who made important contributions to the publication process of the book and made a good cooperation with us.

Especially we owe a debt of gratitude to the St. Kliment Ohridski University Publishing House for this opportunity they gave us and the preparation of the book for publication.

May, 2021 -----The Editors

SECTION 1

LANDSCAPE ARCHITECTURE

Chapter 2

The Relation between Permaculture and Urban Landscape Resilience

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INTRODUCTION

Food safety symbolizes a situation that occurs when all people, at all times, are able to access physically, socially and economically safe, sufficient nutritious food that is enough to meet their dietary needs and food preferences for an active and healthy life (Barrett, 2010). Availability (national), accessibility (household), utilization (individual) and stability have been identified as four dimensions of food security. Stability may be considered as a time dimension that affects all the levels. All these dimensions must be intact for complete food security. Apart from these, today's conditions emphasize the importance of accepting sustainability as another dimension of food security (Peng and Berry, 2019).

The COVID-19 pandemic has dramatically impacted the food system, with direct and indirect consequences on people, plants, and animals' lives and livelihoods. Given the system's complexity at risk, possibly some of these consequences are still to emerge over time. Restrictions on agricultural workers, planting, current and future harvests; shifts in agricultural livelihoods and food availability; food safety; plant and animal health and animal welfare; human nutrition and health are the pandemic's direct and indirect effects along with changes in public policies (Mardones et al., 2020).

The pandemic has reminded us how vital our basic needs, especially food safety, are. During the pandemic, food demand increased due to panic-buying and stockpiling of food products while putting tens of millions out of work, including those working in the food production sector abroad (Nicola et al., 2020; Colmey 2020). Many sectors, especially the food sector, have been adversely affected as COVID-19 brought a big part of the world to a standstill. Global Gross Domestic Product (GDP) is expected to contract by 5.2 per cent in 2020, the most significant contraction in economic activity since the Great Depression (Anonymous, 2020). This situation raises the question: are food and financial crises on the way? If so, these will not be the only problems people face. Long-term urban sustainability is challenged by several worldwide trends such as ongoing urbanization, land and water degradation, biodiversity, habitat loss and fragmentation, natural disasters,

and climate change. These trends will continue to exist with the new economic and food crisis. Unstable macro-economic and political situations or natural disasters aggravate these disturbances (Dubbeling et al., 2009; Miller et al., 2010). Cities are socio-ecological systems that can slip into a state of chaos due to rapid social, economic or environmental changes, disasters or conflicts (Dubbeling et al.2009). Urban spaces and communities can be destroyed by natural disasters (Jabereen, 2012).

The uncontrolled and unplanned growth of cities and their populations increase at the same rate, causing them to be affected equally by possible disasters, risks, stresses and shocks. Because urban services are not developed in a sufficiently inclusive manner in the whole city, cities are vulnerable to disasters other risks. Therefore, rapid urbanization has had high economic, social and environmental costs. The main ones are; a rise in the number of urban poor and illegal housing; problems with access to essential urban services and safe shelter, the incredibly high unemployment rate among the young population, unsustainable use of natural resources; high levels of water and air pollution and increased greenhouse gas emissions as a result of urban activities. As cities grow, they need more energy. Cities currently consume the world's energy and are responsible for more than 70% of global CO^2 emissions (Kaptan, 2013; Tuğaç, 2019; UN-Habitat, 2011).

In 2013, the world saw a climate milestone. The daily average concentration of CO^2 in the atmosphere is over 400 ppm for the first time in 55 years of measurement, also presumably more than 3 million years of Earth history (Kunzig, 2013). In 2016, the first mammal was declared extinct due to climate change (Waller et al., 2017). Nevertheless, it is not only animals that suffer from all these negativities; people continue to face health problems, water scarcity, and floods caused by climate change. It is observed that mortality rates have increased in urban populations due to the urban heat island effect (Norton et al., 2015). However, none of these can prevent people from living in cities, and experts expect 68% of the world's population to live in cities by 2050 (Anonymous, 2018).

The cities are responsible for natural and human-made disasters, and other dangers that occur due to environmental destruction caused by the activities carried out in them. Besides, they are the biggest victims of these disasters, shocks and stresses. The capacity of cities to be prepared for, respond to and adapt to the problems, dangers, disasters and risks they face determines their urban resilience. The resilience of a city depends on the excellent management of urbanization. Under these circumstances, the permaculture approach as a design methodology for sustainable human habitats needs to be developed as a new strategy. Because permaculture takes inspiration from how natural systems self-organize for resilience and productivity (Henfrey, 2018). Permaculture, which sees the problem as a solution, is thought to be the right strategy in urban landscape resilience studies.

URBAN RESILIENCE

According to Holling (1973), resilience determines the endurance of connections within a system. It measures these systems' ability to absorb the state variables' changes, driving variables, parameters, and persistence. In this definition, resilience is the system's property, persistence, or probability of extinction (Holling, 1973). Holling's studies were primarily on the ecological systems' capacity to resist change.

Resilience is a well-established concept in environmental systems research. It has robust literature related to resource management, governance, and strategic planning related to different research areas such as sustainability, climate change, ecology and risk management (Lister, 2016; Tuğaç 2019).

Galderisi (2014) mentioned that urban resilience is essentially a transformational rather than a stable concept and involves the change and development of the urban system in the face of changing conditions. Cities are complex systems characterized by environmental, social, physical and economic dimensions. They affected by heterogeneous threatening factors - from climate change to an individual or overlapped hazards, from environmental degradation to scarcity of resource - which require to be handled as a whole (Galderisi, 2014). Nowadays, the shocks, stresses, and pressures cities are forced to face have noticeably increased, such as floods, earthquakes, hurricanes, fires, volcanic eruptions, pandemics, chemical spills and explosions, terrorism, power outages, financial crises, cyber-attacks, and conflicts. Natural risk factors are well known with the increasing danger to climate change, the interdependence of phenomena, and globalization. Anthropogenic factors increase the threat and generate new risk factors—ethnic conflicts, wars, terrorist attacks, epidemics and pandemics, Etc. (Moraci et al., 2020). Dubbeling et al. (2009) stated that urban resilience refers to a continuous improvement in adaptation, absorption, transformation, and preparedness capacity. These capacities are essential to maintain cities' social, institutional, environmental and economic dimensions against shocks and stresses and develop responses to future risks (Tuğaç, 2019). Hazards, shocks, and disasters are often unpredictable events, while in long-term trends, stresses tend to be foreseeable and predictable. In sum, predictable or not, these events are dangerous and disruptive (Figueiredo et al., 2018). To achieve, maintain, and strengthen the resilience ability, any urban system should have the characteristics shown in Table 1 (Sharifi and Yamagata 2016a; Sharifi and Yamagata 2016b).

Table 1. *Urban system characteristics for the resilience ability (Sharifi and Yamagata 2016a; Sharifi and Yamagata 2016b).*

Urban system characteristics for the resilience ability	
Robustness	It refers to a system′s strength to withstand short-term, fast-moving internal and external shocks without any distress from significant degradation of the main functions. To enhance system security, the system itself needs to have the ability to neutralize and/or absorb the disturbance.
Stability	It is the ability of a system to reduce the long-term discontinuations while maintaining its required functions and rapidly returning to usual operations. Stability makes the system dependable and stable to operate continuously and satisfactorily to ensure supply continuity.
Flexibility	It indicates the ability to rearrange structure and functions when facing disruptions. A flexible system can sense threats, immediately detect failure, and make rapid changes at more minor scales of its subsystems. Thereby maintain overall performance during the disaster.
Resourcefulness	It relates to the proper identification, preparation, intervention and recovery of the resources under the responsibility of urban planners and decision-makers from possible disruptions.
Coordination Capacity	It refers to the management capacity to effectively coordinate preparedness and improvement actions across various sectors and organizations of different scales.
Redundancy	It refers to the availability of components with similar urban system functions to enhance its adaptive capacity and ability to absorb shocks. It gives a reserve capacity for problem-solving and ensures that unpredictable events causing the failure or displacement of one component will not disrupt the whole system.
Diversity	This principle aims to take action against supply disruptions and ensure that there are various options (resources, tools, etc.) to deal with disturbances and provide functionality in an urban system.
Foresight Capacity	It is directly related to the uncertainties innate in the urban system and preliminary work to eliminate possible disruptions. This principle is necessary for disaster preparedness as well as the absorption of the primary shocks.

Table 1 continued. *Urban system characteristics for the resilience ability (Sharifi and Yamagata 2016a; Sharifi and Yamagata 2016b).*

Independence	It gives the system a certain degree of self-reliance that may be needed to survive adversities. It also requires strong leadership that promotes the ability to set goals, visions and initiate actions.
Connectivity and Interdependence	It refers to having mechanisms that enable a system to have functional and physical relationships with other systems in the network and receive support, input, and feedback from them as part of an interconnected and integrated network.
Collaboration Capacity	It highlights the need for an inclusive and bottom-up approach towards urban management. It implies that the urban system should facilitate an environment for the active participation of a wide range of stakeholders in the decision-making process.
Agility	It represents the system′s capacity to mobilize the resources necessary for recovery and return to normal functioning within an acceptable time frame.
Adaptability	It refers to an urban system′s capacity to learn from the disaster to reduce its pre-disturbance vulnerabilities and enhance its ability to adapt to the changing conditions.
Self-Organization	It refers to the "emergence of macro-scale patterns", structures or relations from the mutually reinforcing interactions among "smaller-scale rules" and processes. It includes establishing and strengthening community-based and voluntary activities centred on social institutions and networks.
Creativity and Innovation	It represents the "urban system′s ability to use the disruption as an opportunity to attain a more advanced state". It is required to find innovative solutions for addressing emergent and unprecedented problems.
Efficiency	It entails considering the costs and benefits of actions and developing strategies for maximizing benefits given the limited resources available.
Equity	It plays a significant role in the achievement of resilience. It is vital to ensure the fair distribution of benefits and impacts across different groups in society.

Rockström et al. (2009) stated that global boundaries such as climate change, biodiversity loss, and changes to the global nitrogen cycle have already overstepped by humanity. Intense actions of increasing human populations like fossil fuels, deforestation, agricultural activities lead to interference with natural processes, habitat degradation and biodiversity loss. They are also accelerating climate change and its adverse effects. Climate change stressors are being added to the ongoing environmental problems and urging us to build healthy and diverse ecosystems. With that, the need to create healthy habitats that can adjust to significant changes and maintain themselves emerges. Habitats for people and the wildlife in all kinds of settlements, whether it is a city, a suburban community, or a rural area.

LANDSCAPE RESILIENCE

The emergence of resilience as a rhetorical idea is tied not only to the emerging reality of climate change but to an essential and growing synergy between research and policy responses in the fields of ecology, landscape architecture, and urbanism (Lister, 2016).

Resilience thinking in the landscape has several approaches because researchers took them from different perspectives relating to the study site or case (Bahrami and Hemmati, 2020). For instance, Standish et al. (2014) and Beller et al. (2015) 's studies are focused more on the ecological dimension of landscape, featuring social and economic factors. According to their publications, a resilient landscape will sustain its desired ecological functions and robust biodiversity even when facing physical and socio-economic challenges and uncertainties. Also, Cockburn et al. (2015) and UNDP (2018) have a more robust social and economic perspective while still having environmental concerns. They state that resilient landscapes will emphasize local communities' livelihoods and value chains. Cockburn et al. (2015) explain the resilient landscapes approach as a new form of working with stakeholders in multipurpose landscapes. It aims to build ecosystem resilience through learning, participation, localized action, and agricultural and forestry commodities' value chains. Agricultural landscapes and design systems working with nature gains importance in that conditions (Cengiz et al., 2019). Some scholars like Ahern (2013) and Sijmons (2015) point out the cities' significance in the landscape resilience context. Sijmons (2015) states that most global environmental problems have urban roots. Therefore, he suggests that we need to handle our urban problems first to solve environmental ones.

Understanding and accepting cities as dynamic and self-organizing systems and adopting landscape ecologists' significant contribution to urban planning and design with their interdisciplinary expertise, Ahern (2013) established five strategies to build resilience capacity. These are biodiversity; urban ecological networks and connectivity; multifunctionality; redundancy and modularization, adaptive design. These strategies individually and collectively suggest a transdisciplinary collaboration between scientists, professional experts, stakeholders, and decision-makers throughout the ongoing, iterative and adaptive

planning, design, and management process (Ahern, 2013). The "Cities of resilience" metaphor is a promising tool to investigate the connection between the community's perception of nature and the built environment. Communities form the resilient cities of the future and create socially and ecologically resilient environments that shape conscious communities (Akyol and Eşbah, 2013). Building landscape resilience inspires the cultivation of the landscape's capacity to recover from disruption and live with changes and uncertainties. No matter how integrating ecosystem and society within socio-ecological system resilience clashes with base concepts in social science. In summary, a landscape cannot provide the same values to everyone (Xu et al., 2021).

For designing and creating landscapes and communities that are more resilient and productive, permaculture practices will be a primary unifying concept. Resilient and productive landscapes will mitigate the estimated impacts of climate change and be more adaptive as climate change impacts temperature and precipitation patterns, alter growing seasons, increases plant moisture stress, and potentially triggers other extreme events (Brain et al., 2017)

PERMACULTURE

Permaculture has been drawing attention and becoming more and more popular amongst people from all kinds of professions, whether they are related to somehow working with nature or in a garden or not. For some people who are overwhelmed by city life, permaculture may seem to be a way out of this chaotic life and connected to nature and themselves more (Parlak, 2018). For most people who just heard the term, permaculture is seen as a "cool" form of organic gardening (Holmgren, 2018). However, permaculture's co-originator David Holmgren (2018) explains permaculture as "*a design system for resilient living and land use based on universal ethics and ecological design principles.*" He also mentions Permaculture as "*a global movement of individuals, groups and networks working to create the world we want, by providing our needs and organizing our lives in harmony with nature*."

The other originator of the concept (a.k.a. the father of Permaculture), Bill Mollison (1988), explains permaculture comprehensively. He says, "*Permaculture (permanent agriculture) is the conscious design and maintenance of agriculturally productive ecosystems which have the diversity, stability and resilience of natural ecosystems. The harmonious integration of landscape and people provides their food, energy, shelter, and other material and non-material needs sustainably. Without permanent agriculture, there is no possibility of a stable social order. Permaculture design is a system of assembling conceptual, material, and strategic components in a pattern which functions to benefit life in all its forms. The philosophy behind permaculture is one of working with, rather than against, nature; of protracted and thoughtful observation rather than protracted and thoughtless action; of looking at systems in all their functions, rather than asking only one yield of them; and of allowing systems to demonstrate their evolutions.*"

Even though it is tempting to think that permaculture is simply ecological gardening, as we can see in the originators' descriptions, it is much more holistic than that. It is a whole way of living sustainably, in harmony with nature and society. Holmgren (2002) stated that at the beginning, permaculture was defined as consciously designed landscapes that mimic nature to yield food and other needs. Still, now people, their buildings and the ways they organize themselves are central to permaculture. Therefore, the permaculture vision of permanent (sustainable) agriculture has evolved into a permanent (sustainable) culture. That means permaculture thinking can be used in every aspect of life, in a garden, city, or even in relationships.

In Permaculture One book, Mollison and Holmgren (1978) created the permaculture tree that outlined the theory and some initial permaculture design applications. Holmgren (2002), many years after the first book, with his deep writing experience, teaching and applying permaculture, conceived permaculture ethics and design principles to illustrate brief statements that can be remembered as a checklist.

The permaculture ethics and design principles guide designers to have a balanced relationship with the earth and let people sustainably have their needs. They are powerful thinking tools that can act as a checklist for design and decision making. A well-considered design should reflect all twelve principles (Figure 1) (Holmgren, 2018; URL-1). The art of good permaculture design is in deciding which techniques and strategies will solve a particular challenge in the most ecologically and socially sound manner (Hemenway, 2015).



Figure 1. *Permaculture's ethics and design principles, adapted from Holmgren's book (Holmgren, 2002; URL-1)*

Those ethics and design principles can be adapted to almost everything and everywhere. When they are adapted in urban areas, they can help grow plentiful food on the last bits of ground left in compacted cities, as they are assumed. Either, they can help us build sustainably and teach us how to use energy and water efficiently, etc. These are concrete features that we can touch or measure, but a human ecosystem that is the city is rich, and it includes much more than food or buildings. There are also invisible structures like social, psychological, economic elements and Permaculture's ethics and design principles will also be useful to have healthy invisible structures. We can use them to build not just houses but communities or to develop policies. As Hemenway (2015) expresses, we are not just gardening plants but people, neighbourhoods, and even cultures.

Even though the first concerns may change relating to the field and needs, Parlak (2018) tried to find efficient permaculture design indicators. With a comprehensive literature review, she came up with 18 indicators and let the experts (permaculture designers and academics working in various landscape architecture departments) grade the indicators between 0-5 according to their priorities (0 expresses the lowest and 5 expresses the highest priority). The indicators are given below, respectively, starting from the highest priority.

1. Permaculture design not to cause air, water and soil pollution.
2. Energy-efficiency of permaculture design.
3. Renewable resource utilization in permaculture design.
4. Waste recycling potential of permaculture design.
5. Permaculture design to be low in carbon footprint.
6. Permaculture design to have a low water footprint.
7. Usage of natural and sustainable materials in permaculture design.
8. Restricting or not using fossil fuels in permaculture design.
9. Permaculture design to generate less waste (annual amount of solid waste and wastewater).
10. Economic sustainability of permaculture design.
11. Permaculture design to support biodiversity (supporting both plant and animal especially insects diversity through the use of exotic species as well as local species).
12. The positive impact of permaculture design towards strengthening social ties (both in community and family units).
13. Permaculture design to have high resistance to natural disasters (earthquake, flood, storm, etc.).
14. Use of native plant species wholly or predominantly in permaculture design.
15. Construction of structures within the permaculture design (dwellings, passages or structures to control soil and water on the land) using the region's traditional methods.
16. The cost of permaculture design to be low.

17. Structures and practices within permaculture design are included in-laws and regulations (e.g., systems with soil bearing structures cannot be licensed since they do not have legally accepted static measurements).
18. The visual quality of permaculture design.

These criteria also show how permaculture can be related to and help to build resilience.

CONCLUSIONS

Human beings are often unprepared for sudden events that affect their lives before encountering a shock or stress that affects their ongoing lives. While the onset of shocks and stresses, the development process and its effects depend on the events (natural or human-made) that cause it, compensate its impact, and return to the casual life cycle mostly depends on the societies, the strategies followed and the management styles. The COVID-19 pandemic process, which has been going on since the end of 2019, is one of the latest examples of a social shock. The pandemic's spread was related to restrictions at national and international levels. The resulting panic environment became unreachable because of the high level of stockpiling of fresh and packaged foods. At this point, the importance of food safety has emerged in times of shock and stress. The aim of the food security responses should be to meet short-term needs, 'not harm', decrease the need for the affected population, adopt coping strategies that possibly will be damaging and contribute to restoring longer-term food security. Considering the food security assessment for pre-disaster (baseline) and during a disaster period may be the best option (OCHA, 2021). Resilience thinking has a high potential to contribute to food security and sustainable food systems (Tendall et al., 2015).

Resilience refers to a system's ability, from individual people, organization, society to whole economies, to hold together, recover effectively and sustain their ability to operate in the face of unexpected change and external shocks (Hopkins, 2008; Régibeau & Rockett, 2013).

Long-term environmental sustainability requires the capacity for resilience. In this regard, sustainability refers to the inherent and dynamic balance among social-cultural, economic, and ecological domains of human behaviour necessary for humankind's long-term surviving and thriving (Lister, 2016).

The fundamental difference between a cultivated (designed) ecosystem and a natural system is that most cultivated ecology species are intended to use humans or their livestock. Humans are only a tiny part of the natural species assembly, and only very little of its yields are directly available to us. However, almost every plant is selected to provide or support some direct yield for people in our settlements. Thus, urban areas' design relates principally to people's needs; it is, therefore, human-centred (anthropocentric) (Mollison, 1988). A design in urban settlements to be human-centred is not a bizarre concept, but we must consider nature and other organisms' needs in our design and respect their existence. So we

should design sustainably to live in harmony with others and resilient for ourselves to continue living on this planet decently.

If we aim for sustainability and resilience in our urban planning efforts, permaculture is the perfect toolbox to achieve that goal. However, we need to keep in mind that permaculture is not a series of techniques but rather a design approach that connects different disciplines and uses many strategies and methods (Hopkins, 2008; Hemenway 2015).

Ahern's (2012) strategies to build urban resilience and permaculture design principles coincide with each other. Permacultures tenth principle, "Use and value diversity", supports Ahern's first strategy; Biodiversity. Similarly, permaculture's eighth principle, "Integrate rather than segregate", is quite matching with Ahern's second strategy; Build urban ecological networks and manage connectivity. Multifunctionality is essential for permaculture, and it correlates with Ahern's third strategy, Plan and design for multifunctionality. The three ethics of permaculture, which are "care of the earth", "care of people", "fair share" and the design principles "obtain a yield", "apply self-regulation" and "accept feedback, use small and slow solutions", all in a parallel line with Ahern's fourth strategy: "build redundancy and practice modularization". The last principle and the last strategy state resilience in their ways: permaculture's twelfth principle, "creatively use and respond to change," and Ahern's fifth strategy; practice adaptive design implement "safe-to-fail" design experiments.

Supposing that resilience and sustainability are our goals, we shall use permaculture thinking and implementation to our projects and use different techniques according to the permaculture ethics and design principles. We can also analyze our design after implementing it according to Parlak (2018) indicators and improve towards these goals if needed.

As asserted in this study written by examining many leading studies, permaculture is profoundly influential in achieving urban resilience. Permaculture has even more, to offer like social and administrative contributions to simply put.

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